DEENDAYAL PORT AUTHORITY
(Erstwhile Deendayal Port Trust)

Administrative Office Building
Post Box NO. 50
GANDHIDHAM (Kutch).
Gujarat: 370 201.
Fax: (02836) 220050
Ph.: (02836) 220038.

EG/WK/4751/Part (CCA Renewal) /1142

Dated :11/04/2022

Smt. Urvashi Upadhyay
Environmental Engineer,
Unit Head, Kachchh,
Gujarat Pollution Control Board,
Paryavaran Bhavan,
Sector 10A, Gandhinagar- 382 010.

Sub: Consolidated Consent & Authorization (Renewal) order no AWH-110594 date of issue 22/01/2021 (GPCB ID 28494) - **Submission of compliance report of stipulated conditions mentioned in the CCA Order issued by the GPCB req.**

Ref.:
1. **CCA issued by the GPCB vide Letter No.: PC/CCA-Kutch-811/GPCB10 28494/93560, Dated: 05/10/2011.**
2. Compliance report submitted by DPA vide Letter No.: MR/GN/1527 (Part 1)/073, Dated:08/12/2011.
3. Compliance report submitted by DPA vide letter No: MR/GN/1527 (Part 1)/270, Dated: 21/09/2012.
4. Compliance report submitted by DPA vide Letter No.: MR/GN/1527 (Part-1)/172, Dated: 23/05/2013.
5. GPCB Letter No.: PC/CCA-Kutch-812/GPCB10 28494/207116, Dated: 13/03/2014
6. Compliance report submitted by DPA vide Letter No.: MR/GN/1527 (Part 1)/264 Dated: 15/05/2014.
7. **CCA (renewal) issued by the GPCB Letter No.: GPCB/CCA-Kutch-812/(2)GPCB ID 28494/327172, dated :11/09/2015.**
8. Compliance report submitted by DPA vide Letter No.: MR/GN/1527 (Part 1)/, Dated: 29/04/2015.
9. Compliance report submitted by DPA vide Letter No.: EG/WK/EMC/CCA(Part-II)/219 Dated: 27/06/16.
10. Compliance report submitted by DPA vide Letter No.: EG/WK/EMC/CCA(Part-II)/232 dtd.: 23/06/2017.
11. Compliance report submitted by DPA vide letter no. EG/WK/EMC/CCA (part II)/312 dated 21/6/2018.
12. Compliance report submitted by DPA vide letter no. EG/WK/EMC/CCA (Part III) dated 28/5/2019.
13. **Amendment in CCA order dated 11/9/15 issued by the GPCB vide no. AWH 101662 dated 6/8/2019.**
14. Compliance report submitted by DPA vide letter no. EG/WK/4751(CCA Renewal) dated 10/06/2020.

Sir,

It is requested to kindly refer above cited references for the said subject.

In this regard, it is relevant to mention here that, the Deendayal Port Authority (Erstwhile Deendayal Port Trust) had filed online application dated 20/5/2020 for renewal of CCA order issued by the GPCB vide order no. AWH-72820 dated of issue-31/08/2015 (Valid up to 21/7/2020) & subsequent amendment order issued by the GPCB (for inclusion of 14th & 16th CB) vide no. AWH 101662 dated 6/8/2019.

In response, the GPCB had issued **Consent Order No. AWH -110594 dated 8/12/2020, Validity up to 21/7/2025 (renewal of CCA)** & subsequently issued detailed order vide outward no. 581914 dated 22/1/2021 & correction in CCA order vide dated 9/4/2021 **(Copies attached – Annexure I)**.

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It is also relevant to submit here that, the DPA from time to time had regularly submitted compliance report of the stipulated conditions mentioned in the CCA Order.

Now, please find enclosed herewith compliance report of conditions stipulated in CCA Order (period up to June -2022) along with necessary enclosures as **Annexure II (soft copy in CD as well as through email),** for kind information & record please.

This has the approval of the Chief Engineer, Deendayal Port Authority.

Yours faithfully,

Encl.: As above

Manager (Environment)
Deendayal Port Authority

Copy to: 1) The Deputy Director General of Forest (Central),
Ministry of Environment, Forests & Climate Change,
Integrated Regional Office,
Gandhinagar, A wing-407 & 409
Aranya Bhavan Near CH-3 Circle
Sector 10A, Gandhinagar - 382010
Email : rows.bpl-mef@nic.in, eccomplaince-guj@gov.in

2) Regional Officer,
Gujarat Pollution Control Board,
Regional office,
East Kutch, Gandhidham-370201.
Email Id. ro-gpcb-kute@gujarat.gov.in

Annexure –I

Consent Order No. AWH-110594 dated 8/12/2020 validity up to 21/7/2025 and correction in CCA order vide dated 9/4/2021

GPCB

GUJARAT POLLUTION CONTROL BOARD

PARYAVARAN BHAVAN
Sector-10-A, **Gandhinagar**-382 010
Phone : (079) 23226295
Fax : (079) 23232156
Website : www.gpcb.gov.in

By R.P.A.D

In exercise of the power conferred under section-25 of the Water (Prevention and Control of Pollution) Act-1974, under section-21 of the Air (Prevention and Control of Pollution)-1981 and Authorization under rule 6(2) of the Hazardous and Other Waste (Management and Trans boundary) Rules, 2016 framed under the Environmental (Protection) Act-1986.

And whereas Board has received consolidated consent application **inward No.176457** dated 22/09/2020 for the **Renewal of Consolidated Consent and Authorization (CC&A)** of this Board under the provisions / rules of the aforesaid Acts. Consents & Authorization are hereby granted as under:

CONSENTS AND AUTHORISATION:
(Under the provisions /rules of the aforesaid environmental acts)

To,
M/s. Deendayal Port Trust, (New name) (ID-28494)
M/s. Kandla Port Trust, (Old name),
Kandla, A.O Building Gandhidham,
Tal: Gandhidham, Dist: Kutch - 370201

1. **Consent Order No. AWH-110594 Date of issue: 08/12/2020.**
2. The consents shall be **valid upto 21/07/2025** for the use of outlet for the discharge of trade **effluent** and emission due to operation of industrial plant for manufacturing of the following items/ products:

Sr. No	Product/Services	Quantity
1	Dry Cargo Handling	26,54,00,000 MT/Month
2.	Liquid Cargo Handling	54,64,00,000 MT/Month
3.	Loading and unloading operation at 13th Berth	2 MMTPA
4.	Loading and unloading operation at 15th Berth	2 MMTPA

Subject to specific condition:

1. Unit shall strictly adhere to compliance ministry in its Clearance letter file no. 11-82/2011-IA-III, dated 19/12/2016.
2. Unit shall also strictly adhere to all conditions of Environment and CRZ Clearance issued by MoEF vide letter no F. no. 11-70/2006-IA-III dated 01/10/2008.
3. Applicant shall comply with Manufacture, Storage and Import of Hazardous Chemicals Rules-1989 (MSIHC) as amended time to time.
4. Applicant shall ensure that all storage terminal located within DPT area shall strictly comply with MSIHC Rules including site notification & submit details periodically to board with relevant details.
5. Applicant shall renew Public Liability Insurance time to time & submit a copy to this Board.

6. Unit shall notify site under MSIHC Rule-1989 from competent authority as mentioned in schedule-5 of MSIHC Notifications
7. Industry shall not withdraw groundwater without prior NOC from CGWA as per Hon National Green Tribunal order.
8. Industry shall manage Solid Wastes generated from industrial activities as per Solid Waste Management Rules-2016 (solid waste as defined in Rule-3(46)).
9. Industry shall comply with Plastic Waste Management Rules– 2016 and amendments made therein.
10. Industry shall strictly comply with coal handling guideline of this board
11. Industry shall provide dedicated storage facility for dry cargos & ensure to take adequate measures to prevent dusting.
12. Applicant shall ensure that there shall be no damage to the existing mangrove patches near site and also ensure the free flow of water to avoid damage to the mangroves
13. Applicant shall ensure as per EC condition that no creeks or rivers are blocked due to any activities at the site and free flow of water is maintained.
14. Applicant shall provide proper system for collection, storage & treatment & disposal of waste water generated by vessel as per MARPOL & maintain records
15. Applicant shall install storm drainage catch basin to avoid directly discharge into surface water
16. Waste effluent accumulated with port activities including storm water & sewage from port operation including sewage ballast water, bilge water & clean waste water from ships shall be as per MARPOL norms
17. Applicant shall make separate records regarding generation, collection, transportation & disposal of waste generation from ship & maintain its records
18. Applicant shall made necessary arrangement for the plastic Waste, Solid Waste or other waste generation due to port activities & for facilitation of reception facilities under MARPOL & Environment (Protection) Act-1986 rules etc.
19. Ports shall obtain approval of their oil spill contingency plan (OSCP) as required under national oil spill disaster contingency plan (NOS-DCP) of coast guard, ministry of defence, govt. of India.
20. Best environmental practices by ports maybe uploaded on "Indian ports Association" as well as the same maybe linked to websites of CPCB and respective SPCBs.
21. Manually handling of cargo should be converted into mechanized system, in time bound manner.

3. **Conditions under the Water act-1974:**
   - 3.1 Source of Water: - GWIL.
   - 3.2 There shall be no industrial water consumption and waste water generation from manufacturing process and other ancillary operations
   - 3.3 The quantity of the fresh water consumption for domestic purpose shall not exceed 1300 KLD
   - 3.4 The quantity of domestic waste water shall not exceed 800 KLD

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3.5 Domestic effluent shall be treated in existing STP & treated effluent conforming to following norms shall be discharged on land within premises strickly for gardening and plantation purpose & no sewage shall be disposed outside premises in any manner

PARAMETERS	PRESCRIBED LIMITS
pH	6.5 to 8.5
BOD (3 days at 27° C)	30 mg/L
Suspended Solid	100 mg/L
Fecal Coli form	< 1000 MPN/ 100 ml

3.6 Treated domestic effluent confirming to above norms shall be discharge on land only for gardening & plantation within premises.

3.7 Unit shall provide flow meter at inlet & outlet of STP & maintain its record.

3.8 Disposal system for storm water shall be provided separately. In no case storm water & sewage from port facility shall not be discharge into surface water.

4. Conditions under the Air Act-1981:

4.1 The following shall be used as a fuel in D G. Sets:

Sr. No.	Utility	Fuel	Quantity
1	D G Sets	HSD	500 Ltr/Hr

4.2 The applicant shall install & operate air pollution control system efficiently in order to achieve prescribed norms.

4.3. The flue gas emission through stack attached to D.G Sets shall conform to the following standards

Sr. No.	Stack attached to	Stack height in Meter	APCM	Parameter	Permissible Limit
1 & 2	DG sets (2 nos.) (1010 KVA)	15 each	--	PM SO_2 NO_x	150 mg/NM³ 100 ppm 50 ppm

4.4 There shall be no process gas emission from manufacturing process and other ancillary operations.

4.5 The concentration of the following parameters in the ambient air within the premises of the industry and a distance of 10meters from the source) other than the stack/vent) shall not exceed the following levels.

Sr. No.	Pollutant	Time Weighted Average	Concentration in Ambient air in µg/M³
1	Sulphur Dioxide (SO_2)	Annual 24 Hours	50 80
2	Nitrogen Dioxide (NO_2)	Annual 24 Hours	40 80
3.	Particulate Matter (Size less than 10 µm) or PM_{10}	Annual 24 Hours	60 100
4.	Particulate Matter (Size less than 2.5 µm) or $PM_{2.5}$	Annual 24 Hours	40 60

4.6. The applicant shall provide portholes, ladder, platform etc at chimney(s) for monitoring the air emissions and the same shall be open for inspection to/and for use of Board's staff. The chimney(s) vents attached to various sources of emission shall be designed by numbers such as S-1, S-2, etc. and these shall be painted/displayed to facilitate identification.

4.7. The industry shall take adequate measures for control of noise levels from its own sources within the premises so as to maintain ambient air quality standards in respect of noise to less than 75dB(A) during day time and70 dB (A) during night time. Daytime is reckoned in between 6a.m. and10 p.m. and nighttime is reckoned between 10 p.m. and 6 a.m.

5. AUTHORIZATION as per HAZARDOUS AND OTHER WASTE (MANAGEMENT AND TRANSBOUNDARY) RULES, 2016 Form-2 [See rule 6 (2)]

Form for grant of authorization for occupier or operator handling Hazardous waste

5.1 Authorization order no:-**AWH-110594**Date of issue: 08/12/2020.

5.2 **M/s. Kandla Port Trust** is hereby granted an authorization to operate facility for following hazardous wastes on the premises situated at Kandla, A.O Building Gandhidham, Tal. Gandhidham, Dist : Kutch

Sr. No.	Waste	Quantity/ Year	Schedule &Category	Facility
1	Used Spent Oil	1125 MT	I-5.1	Collection, Storage, Transportation and disposal by selling to authorized recycler.
2	Waste Residue Containing Oil	3344.43 MT	I-5.2	Collection, Storage, Transportation and disposal by selling to authorized recycler.

5.3 The authorization shall be valid up to **21/07/2025.**

5.4 The authorization is subject to the conditions stated below and such other conditions as may be specified in the rules from time to time under the Environment (Protection) Act-1986

5.5 The authorization is granted to operate a facility for collection, storage within factory premises transportation and ultimate disposal of Hazardous wastes as per condition no 5.2 to the industry having valid CCA of this Board.

5.6 TERMS AND CONDITIONS OF AUTHORISATION

1. The applicant shall comply with the provisions of the Environment (Protection) Act-1986 and the rules made there under
2. The authorization or its renewal shall be produced for inspection at the request of an officer authorized by the Gujarat Pollution Control Board
3. The persons authorized shall not rent, lend, sell, and transfer or otherwise transport the hazardous wastes without obtaining prior permission of the Gujarat Pollution Control Board

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4. Any unauthorized change in personnel, equipment or working conditions as mentioned in the authorization order by the persons authorized shall constitute a beach of this authorization
5 The person authorized shall implement Emergency Response Procedure (ERP) for which this authorization is being granted considering all site specific possible scenarios such as spillages, leakages, fire etc and their possible impacts and also carry out mock drill in this regard at regular interval of time.
6 The person authorized shall comply with the provisions outlined in the Central Pollution Control Board guidelines on "Implementing Liabilities for Environmental Damages due to Handling and Disposal of Hazardous Wastes and Penalty"
7. It is the duty of the authorized person to take prior permission of the Gujarat Pollution Control Board to close down the facility.
8 An application for the renewal of an authorization shall be made as laid down in rules 6(2) under Hazardous and Other Waste Rules. 2016.
9 The imported hazardous and other wastes shall be fully insured for transit as well as for any accidental occurrence and its clean-up operation
10. The record of consumption and fate of the imported hazardous and other wastes shall be maintained
11. The hazardous and other wastes which gets generated during recycling or reuse or recovery or pre-processing or utilization of imported hazardous or other wastes shall be treated and disposed of as per specific conditions of authorization.
12. The importer or exporter shall bear the cost of import or export and mitigation of damages if any.
13. Any other conditions for compliance as per the Guidelines issued by the Ministry of Environment, Forest and Climate Change or Central Pollution Control Board from time to time.
14. The waste generator shall be totally responsible for (i.e. collection, storage, transportation and ultimate disposal) the wastes generated.
15. Records of waste generation. its management and annual return shall be submitted to Gujarat Pollution Control Board in Form-4 by 30th day of June of every year for the preceding period April to March
16. In case of any accident, details of the same shall be submitted on Form-11 to Gujarat Pollution Control Board
17. As per "Public Liability Insurance Act-91" company shall get Insurance Policy, if applicable.
18. Empty drums and containers of toxic and hazard material shall be treated as per guideline published for "Management & Handling of discarded containers". Records of the same shall be maintained and forwarded to Gujarat Pollution Control Board regularly.
19 In case of transport of hazardous wastes to a facility for (i.e. treatment, storage and disposal) existing in a State other than the State where hazardous wastes are generated, the occupier shall obtain 'No Objection Certificate' from the State Pollution Control Board or Committee of the concerned State or Union Territory Administration where the facility exists.
20 Unit shall take all concrete measures to show tangible results in waste generation. reduction, avoidance, reuse and recycle Actions taken in this regard shall be submitted within three months and also along with Form-4

21. Industry shall have to display the relevant information with regards to hazardous waste as indicated in the Hon. Supreme Court's Order in W.P. No.657 of 1995 dated 14th October 2003.

22. Industry shall have to display on-line data outside the main factory gate with regard to quantity and nature of hazardous chemicals being handled in the plant, including wastewater and air emissions and solid hazardous wastes generated within the factory premises.

6. **SPECIFIC CONDITIONS:-**

6.1 The authorized actual user of hazardous and other wastes shall maintain records of hazardous and other wastes purchased in a passbook issued by the State Pollution Control Board along with the authorization.

6.2 Handling over of the hazardous and other wastes to the authorized actual user shall be only after making the entry in the passbook of the actual user.

6.3 In case of renewal of authorization, a self-certified compliance report in respect of effluent, emission standards and the conditions specified in the authorization for hazardous and other wastes shall be submitted to SPCB.

6.4 The occupier of the facility shall comply Standard operating procedure/guidelines published by MOEF&CC or CPCB or GPCB from time to time.

6.5 Unit shall comply provisions of E-Waste Management Rules-2016.

6.6 The disposal of Hazardous Waste shall be carried out as per the waste Management hierarchy.

6.7 The occupiers of facilities shall not store the hazardous and other wastes for a period not exceeding **ninety days**. Prior permission of the Board shall be obtained for extension of the storage period.

6.8 The occupier shall maintain the records of generation, sale, storage, transport, recycling, co processing and disposal of hazardous waste and make available during the inspection.

6.9 The transportation of the hazardous waste shall be carried out in GPS mounted dedicated vehicles.

7. **GENERAL CONDITIONS: -**

7.1 Any change in personnel, equipment or working conditions as mentioned in the consents form/order should immediately be intimated to this Board.

7.2 Applicant shall also comply with the general conditions given in annexure I.

7.3 Whenever due to accident or other unforeseen act or ever, such emissions occur or is apprehended to occur in excess of standards laid down such information shall be forthwith reported to Board, concerned Police Station Office of Directorate of Health Service, Department of Explosives, Inspectorate of Factories and local body.

7.4 In case of failure of pollution control equipments, the production process connected to it shall be stopped. Remedial actions/measures shall be implemented immediately to bring entire situation normal.

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7.5 The Environmental Management Unit/Cell shall be setup to ensure implementation on and monitoring of environmental safeguards and other conditions stipulated by statutory authorities. The Environmental Management Cell/Unit shall directly report to the Chief Executive of the organization and shall work as a focal point for internalizing environmental issues. These cells/units also coordinate the exerciseof environmental audit and preparation of environmental statements.

7.6 The Environmental audit shall be carried out yearly and the environmental statements pertaining to the previous year shall be submitting to this State Board latest by 30th September every year.

7.7 The Board reserves the right to review and/or revoke the consent and/or make variations in the conditions, which the Board deems, fit in accordance with Section 27 of the Act.

7.8 In case of change of ownership/management the name and address of the new owners/ partners/directors/proprietor should immediately be intimated to the Board

7.9 Industry shall have to display the relevant information with regard to hazardous waste as indicated in the Hon. Supreme order in w.p. no. 657 of 1995 dated 14th October 2003.

For and on behalf of
GUJARAT POLLUTION CONTROL BOARD

(Smt. U.K. Upadhyay)
Environment Engineer

NO: GPCB/CCA-Kutch-812(5)/ID-28494/ **Date:-**
Issued to:
M/s. Deendayal Port Trust, (New name),
M/s. Kandla Port Trust, (Old name),
Kandla, A.O Building Gandhidham,
Tal: Gandhidham, Dist: Kutch - 370 201

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GUJARAT POLLUTION CONTROL BOARD

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Website : www.gpcb.gov.in

By R.P.A.D.

NO: PC/ CCA- KUTCH-812(5)/ GPCB ID: 28494/ **Date: -**

Correction in Consolidated Consent & Authorization order no AWH-110594 date of issue 22/01/2021 (Under the provisions/rules of Environmental acts)

To,

M/s. Deendayal Port Trust, (New name)
M/s. Kandla Port Trust, (old name),
Kandla, A.O Building Gandhidham,
Tal:-Gandhidham,
Dist: Kutch – 370 201.

Subject : Correction of Consolidated Consent and Authorization (CC& A) of this Board

Reference : 1) CCA issued vide order no. PC/ CCA- KUTCH-812(5)/ GPCB ID: 28494/ 581914 dated 22/01/2021.
2) Your letter dated 25/01/2021.

In exercise of the power conferred under section-27 of the Water (Prevention and Control of Pollution) Act-1974, under section-21 of the Air (Prevention and Control of Pollution)-1981 and Authorization under rule 6(2) of the Hazardous & Other Waste (Management &Transboundary Movement) Rules-2016 & as amended framed under the Environmental (Protection) Act-1986 and without reducing your responsibility under the said Acts/Rules in anyway. The Board had granted CCA vide order no. AWH-110594 dated 22/01/2021

ANDWHEREAS the Board is empowered to amend CCA conditions. Accordingly, considering your request for corrected & after care full consideration, the CCA order no AWH-110594 is hereby corrected/ amended as below;

1 The condition no 2 of the said CCA order shall be corrected as below;

2 The consent shall be **valid upto 21/07/2025** for the use of outlet for the discharge of trade effluent and emission due to operation of industrial plant for manufacturing of the following items/ products:

Sr No.	Product	Quantity
1.	Dry Cargo Handling	26,54,00,000 MT/Month
2.	Liquid Cargo Handling	54,64,00,000 MT/Month
3.	Loading and unloading operation of 13th and 15th berth	2 MMTPA(Each)
4.	Loading and unloading operation of 14th and 16th berth	4.5 MMTPA (Each)

2. All other terms and condition mentioned in AWH – 110594 issued vide CCA letter PC/ CCA- KUTCH-812(5)/ GPCB ID: 28494/581914 dated 22/01/2021 shall remain unchanged.

For and on behalf of
Gujarat Pollution Control Board

(Smt. U. K. Upadhyay)
Environment Engineer

Annexure –II

Compliance Report of conditions stipulated in CCA order (up to June 2022) with enclosures

Compliance Report Up to June, 2022

Subject: Point wise compliance report of stipulated conditions mentioned in the Consolidated Consent& Authorization order no AWH-110594 dated 22/01/2021 to Deendayal Port Authority, (New Name) PCB ID -28494

Reference: CCA issued vide consent order no. GPCB/CCA-Kutch-812(5)/GPCB ID-28494 dated 22/01/2021

Sr. No	Conditions	Compliance Status
1	**Specific Conditions**	
1	Unit shall strictly adhere to compliance ministry in its letter file no. 11-82/2011-IA-III, dated 2016	DPA has been regularly submitting the six-monthly compliance reports of stipulated conditions of EC & CRZ clearance granted by the MoEF&CC, GoI, to the concerned authority. Last compliance report sent on 07/10/2021 is attached herewith as **Annexure-A.**
2	Unit shall strictly adhere to all conditions of Environment and CRZ clearance issued by MoEF vide letter no. F.No. 11-70/2006-IA-III	It is hereby assured that DPA is complying with all the conditions of EC and CRZ clearance issued by MoEF vide letter no. F. No. 11-70/2006-IA-III and regularly submitting the compliance report to the ministry. Last compliance report sent on 07/10/2021 is attached herewith as **Annexure-B.**
3	Applicant shall comply with Manufacture, storage and import of Hazardous Chemicals Rules-1989 (MSIHC) as amended time to time.	As per the Lease deed all the statutory clearance and its compliance needs to be done by the plot allotee/BOT operator. All plot allotees/BOT operators are complying with the said rules.
4	Applicant shall ensure that all storage terminal located within DPA area shall strictly comply with MSIHC rules including site notification & submit details periodically to board with relevant details.	As per the Lease deed all the statutory clearance and its compliance needs to be done by the plot allotee/BOT operator. All plot allotees/BOT operators are complying with the said rules.
5	Applicant shall renew Public Liability Insurance time to time &submit a copy to this Board.	Public Liability Insurance is renewed time to time as required. The Public Liability Insurance was last renewed on 22/07/2021 and is valid till 22/07/2022. The same is attached herewith as **Annexure-C.**
6	Unit shall notify site under MSIHC Rule – 1989 from component authority as mentioned in Schedule – 5 of MSIHC notification.	As per the Lease deed all the statutory clearance and its compliance needs to be done by the plot allotee/BOT operator. All plot allotees/BOT operators are complying with the said rules.
7.	Industry shall not withdraw groundwater without prior NOC from CGWA as per Hon. National Green tribunal order.	Point noted. All plot allottees and BOT Operators have confirmed that Water requirement is being met through GWSSB (Narmada Pipeline) & through private tankers.
8.	Industry shall manage Solid waste	Garbage facility is provided as per MARPOL Act

	generated from Industrial activities as per Solid Waste Management Rules-2016 (Solid waste as defined in Rule -3 (46))	73/78 to the vessel berthed at Deendayal Port Authority. A copy of "Grant of Permission / License for removal of Dry Solid Waste(Non-Hazardous) from Vessels calling at Deendayal Port" is attached herewith as **Annexure-D.** Companies authorized by Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB) have been awarded the work of collection, transporting and disposal of solid waste by the Deendayal Port Authority. In additional to the above, DPA has invited a tender for Appointment of Advisor for "Preparation of Plan for Management of Plastic Wastes, Solid waste including C&D wastes, E-wastes, Hazardous wastes including Biomedical". The tender is in scrutiny stage.
9.	Industry shall comply with Plastic Waste Management Rules – 2016 and amendments made therein	DPA is managing its plastic waste as per Plastic Waste Management Rules – 2016 and amendments made therein. In order to strictly implement the said rules, DPA had issued a circular regarding plastic waste minimization, source segregation, recycling etc. vide its Circular no. EG/WK/4751/Part 243(A) dated 03/09/2021. A copy of "Grant of Permission / License for removal of Dry Solid Waste(Non-Hazardous) from Vessels calling at Deendayal Port" is attached herewith as **Annexure-D.** It is relevant to mention here, that DPA has invited tender for Appointment of Advisor for "Preparation of Plan for Management of Plastic Wastes, Solid waste including C&D wastes, E-wastes, Hazardous wastes including Biomedical". The tender is under evaluation.
10.	Industry shall strictly comply with coal handling guidelines of this board.	DPA vide its circular no. TF/SH/Circulars/2019/1256 dated 10/10/2019 has issued a circular for "controlling of Dust pollution arising out of Coal Handling". The same is attached herewith as **Annexure-E**. It is relevant to mention here that DPA has installed Mist Canon at the Port area to minimize the coal dust. The work related to construction **of protection wall with wind screen to prevent coal dust** deposition in

		building has already been completed during the year 2011-2012. DPA appointed M/s Detox Corporation, Surat (NABL Accredited laboratory) for regular Monitoring of environmental parameters since the year 2016. The work is in progress &DPA submitted monitoring data regularly to all the concerned authorities along with compliance reports submitted. The Environmental Monitoring Reports as submitted by M/s Detox Corporation is enclosed herewith as **Annexure F.**
11.	Industry shall provide dedicated storage facility for dry cargo and ensure to take adequate measure to prevent dusting.	DPA has provided dedicated storage facilities for all type of Cargo including 33 warehouse and 67 open storage space. DPA vide its circular no. TF/SH/Circulars/2019/1256 dated 10/10/2019 has issued a circular for "controlling of Dust pollution arising out of Coal Handling". The same is attached herewith as **Annexure-E**. It is relevant to mention here that DPA has installed Mist Canon at the Port area to minimize the coal dust. In addition to the above, DPA appointed M/s Detox Corporation, Surat (NABL Accredited laboratory) for regular Monitoring of environmental parameters since the year 2016. The work is in progress &DPA submitted monitoring data regularly to all the concerned authorities along with compliance reports submitted. The Environmental Monitoring Reports as submitted by M/s Detox Corporation is enclosed herewith as **Annexure F.** Further to prevent the dusting DPA invited the tender for "Appointment of consultant for the study & preparation of techno economic feasibility report for mechanized handling of cargo at DPA". The tender is in scrutiny stage.
12.	The applicant shall ensure that there shall be no damage to the existing mangrove patches near site and also ensure the free flow of water to avoid damage to the mangroves.	As per the directions of the GCZMA and MoEF&CC,GoI, till date, DPA had already undertaken Mangrove Plantation in an area of 1500 Ha. till date since the year 2005. A statement showing details of mangrove plantation at various locations with cost incurred is placed at **Annexure G.**

		It is also relevant to submit here that, as per the direction of the Gujarat Coastal Zone Management Authority, DPA had already prepared &submitted a report on mangrove conservation and management plan formulated by Gujarat Institute of Desert Ecology during the study period of Jan-April, 2015 (Report attached as **Annexure H**). In addition to the above, DPA appointed M/s GUIDE, Bhuj vide work order dated 1/9/2017 for "Regular Monitoring of Mangrove Plantation carried out by DPA" (period 15/9/2017 to 14/9/2018). Final report submitted by M/s GUIDE, Bhuj is hereby attached as **Annexure I**. Further, DPA vide work order dated 3/5/2021 has assigned work to M/s GUIDE, Bhuj for Monitoring of mangrove plantation carried out by DPA (Period from 24/5/2021 to 23/5/2022). M/s GUIDE, Bhuj submitted its inception report for the said project on 21/09/2021 (Copy placed at **Annexure J**).
13.	Applicant shall ensure as per EC condition that no creeks or rivers are blocked due to any activities at the site and free flow of water is maintained.	The plot allottees/BOT operators have assured that, no creeks or rivers are being blocked, due to any activities at the project site and free flow of water is being maintained.
14.	Applicant shall provide proper system for collection, storage and treatment and disposal of waste water generated by vessel as per MARPOL & maintain records.	DPA has a dedicated Sewage Treatment Plant (STP)at Deendayal Port, Kandla and Gopalpuri Township, Gandhidham for treatment of waste water. The water is being stored at underground tanks at various locations at Kandla. DPA is planning to invite a tender for Construction, Operation and Maintenance of a WTP for 2.5 MLD Capacity at Kandla. The same is in inception stage.
15.	Applicant shall install storm drainage catch basin to avoid directly discharge into surface water.	Point Noted. Necessary surface drainage system including storm water network has been provided for proper drainage.
16.	Waste effluent accumulated with port activities including storm water & sewage from port operation including sewage ballast water, bilge water & clean waste from ships shall be as per MARPOL norms.	Complied with the condition. A copy of Grant of License/Permission to carry out the work of collection and disposal of "Hazardous Waste/Sludge/ Waste Oil" from Vessels calling at Deendayal Port" is attached herewith as **Annexure-K.**
17.	Applicant shall make separate records regarding generation, collection, transportation and disposal of waste generation from ship & maintain its records.	Point noted for the compliance.

18.	Applicant shall made necessary arrangement for plastic waste, solid waste or other waste generation due to port activities & for facilitation of reception facilities under MARPOL & Environment (Protection) Act – 1986 rules etc.	Complied with the condition.. A copy of "Grant of Permission / License for removal of Dry Solid Waste (Non Hazardous) from Vessels calling at Deendayal Port" is attached herewith as **Annexure-D.** It is relevant to mention here, that DPA has invited tender for Appointment of Advisor for "Preparation of Plan for Management of Plastic Wastes, Solid waste including C&D wastes, E-wastes, Hazardous wastes including Biomedical". The tender is under evaluation.
19.	Ports shall obtain approval of their oil spill contingency plan (OSCP) as required under national oil spill disaster contingency plan (NOS-DCP) of coast guard. Ministry of defense, govt. of India.	DPA is already having Oil Spill Contingency Plan (Copy placed at **Annexure-L**).
20.	Best environmental practices by ports maybe uploaded on "Indian ports Association" as well as the same may be linked to websites of CPCB and respective SPCBs.	DPA is ISO 14001:2015 certified port for "Providing port facility and related maritime services for vessel and Cargo handling including storage" (Certificate copy placed at **Annexure-M**). As per the directions of the GCZMA and MoEF&CC,GoI, till date, DPA had already undertaken Mangrove Plantation in an area of 1500 Ha. till date since the year 2005. A statement showing details of mangrove plantation at various locations with cost incurred is placed at **Annexure G.** DPA has appointed M/s GEMI, Gandhinagar for the work "Making Deendayal Port a Green Port– Intended Sustainable Development under the Green Port Initiatives". M/s GEMI, Gandhinagar had submitted the Final Report on 10/03/2021(Report attached as **Annexure-N**). In addition to the above, DPA has been submitting regularly the compliance of the conditions stipulated in Environmental & CRZ Clearance, CRZ recommendation and CTE to MoEF&CC along with all statutory bodies. The same is being uploaded in MoEF&CC parivesh portal on regular basis. DPA also has been regularly submitting Annual Return of Hazardous waste in Form IV and Environmental Statement in Form V for the entire port area and uploading the same in GPCB site on regular basis. Form IV and V for the year 2021-22 is attached herewith as **Annexure-O & P respectively**.
21.	Manually handling of cargo should be	DPA is in process for mechanization of Solid

<table>
<tr><td></td><td>converted into mechanized system, in time bound manner.</td><td>Cargo handling and it will be implemented Q2-2022.
In view of the same, DPA has invited tenders for “Development of Mechanized Fertilizer & Other Clean Cargo Handling Facilities on DBOT basis under PPP mode”. The same is under evaluation stage.
DPA has also invited tender for “Appointment of consultant for the study & preparation of techno economical feasibility report for mechanized handling of cargo at DPA”. The same is also under evaluation stage.</td></tr>
<tr><td>3.</td><td colspan="2">Conditions Under Water Act - 1974</td></tr>
<tr><td>3.1</td><td>Source of Water – GWIL</td><td>Point noted</td></tr>
<tr><td>3.2</td><td>There shall be no industrial water consumption and waste water generation from manufacturing process and other ancillary operations.</td><td>Not applicable. No manufacturing process or any other ancillary operations involved.</td></tr>
<tr><td>3.3</td><td>The quantity of the fresh water consumption for domestic purpose shall not exceed 1300 KLD</td><td>Point noted for compliance.

DPA has been regularly submitting Environmental Statement in Form V for the entire port area and uploading the same in GPCB site on regular basis. Form V for the year 2021-22 which includes total water consumption is attached herewith as Annexure P.</td></tr>
<tr><td>3.4</td><td>The quantity of domestic waste water shall not exceed 800 KLD</td><td>Point noted for compliance.

DPA has been regularly submitting Environmental Statement in Form V for the entire port area and uploading the same in GPCB site on regular basis. Form V for the year 2021-22 which includes total water consumption is attached herewith as Annexure P.</td></tr>
<tr><td>2.5</td><td>Domestic effluent shall be treated effluent conforming to following norms shall be discharged on land within premises strictly for gardening and plantation & no sewage shall be disposed outside premises in any manner.
<table>
<tr><td>Parameters</td><td>Permissible Limit</td></tr>
<tr><td>pH</td><td>6.5 to 8.5</td></tr>
<tr><td>BOD(5 days at 20 ^{0}C)</td><td>30 mg/lit</td></tr>
<tr><td>Suspended Solid</td><td>100 mg/lit</td></tr>
<tr><td>Fecal coli form</td><td>< 1000 MPN/100 ml</td></tr>
</table></td><td>DPA appointed M/s Detox Corporation, Surat (NABL Accredited laboratory) for regular Monitoring of environmental parameters since the year 2016. The work is in progress & DPA submitted monitoring data regularly to all the concerned authorities along with compliance reports submitted.

The Environmental Monitoring Reports as submitted by M/s Detox Corporation is enclosed herewith as Annexure F.</td></tr>
<tr><td>3.6</td><td>Treated domestic effluent confirming to above norms shall be discharged on land only for gardening & plantation within</td><td>Sewage is treated in the STP of Kandla and Gopalpuri Residential Colony. The treated effluent from STP is utilized for gardening</td></tr>
</table>

<table>
<tr><td></td><td>premises.</td><td>purpose.</td></tr>
<tr><td>3.7</td><td>Unit shall provide flow meter at inlet & outlet of STP & maintain its record.</td><td>DPA has appointed M/s Patel construction for Operation and maintenance of the STP at Kandla.

Both the Sewage Treatment Plants at Kandla and Gopalpuri Residential colonies are equipped with flow meters at inlet and outlet and record is being maintained.</td></tr>
<tr><td>3.8</td><td>Disposal system for storm water shall be provided separately, in no case storm water and sewage from port facilities shall not be discharged into surface water.</td><td>Point Noted. Necessary surface drainage system including storm water network has been provided for proper drainage.</td></tr>
<tr><td>4.</td><td colspan="2">Conditions under air act 1981:</td></tr>
<tr><td>4.1</td><td>The following shall be used as a fuel in D.G sets<table><tr><td>Sr.No.</td><td>Utility</td><td>Fuel</td><td>Quantity</td></tr><tr><td>1.</td><td>D.G Set</td><td>HSD</td><td>500 Ltr/Hr</td></tr></table></td><td>Noted for compliance.

Total consumption of HSD is as below: -

D.G -1 – 1050 L for the year 2021
D.G -2 – 105 L for the year 2021</td></tr>
<tr><td>4.2</td><td>The applicant shall install & operate air pollution control system efficiently in order to achieve prescribed norms.</td><td>DPA is taking measures for mitigation of air pollution: -

- Regular sprinkling of water is being done to suppress the fugitive dust. In addition, DPA has installed Mist canon at various strategic locations to suppress dust from Port Operations.
- DPA is in process for mechanization of dry cargo handling. In this regard, Tender has been invited for “Appointment of consultant for the study & preparation of techno economic feasibility report for mechanized handling of cargo at DPA”. The same is under evaluation.
- Deendayal Port Authority had taken up massive greenbelt development activities in and around Kandla, Residential colony, Administrative building etc.
- DPA had entrusted the work to Forest Department, Gujarat for developing green belt in and around Port area at a cost of Rs. 352 lakhs in an area of about 32 hectares and the work is completed.</td></tr>
<tr><td>4.3</td><td>The flue gas emission through stack attached to D.G sets shall confirm to the following standards<table><tr><td>Sr. No.</td><td>Stack attached to</td><td>Stack height in meter</td><td>APC M</td><td>Paramet er</td><td>Perr le limi</td></tr><tr><td>1.</td><td>D.G sets</td><td>15 each</td><td>--</td><td>PM</td><td>150</td></tr></table></td><td>DPA appointed M/s Detox Corporation, Surat (NABL Accredited laboratory) for regular Monitoring of environmental parameters since the year 2016. The work is in progress & DPA submitted monitoring data regularly to all the concerned authorities along with compliance reports submitted.

The Environmental Monitoring Reports as</td></tr>
</table>

<table>
<tr><td></td><td><table><tr><td></td><td>(2 No.s)
(1010
KVA)</td><td></td><td></td><td>SO_2
NO_x</td><td>mg/NM3
100 ppm
50 ppm</td></tr></table></td><td>submitted by M/s Detox Corporation is enclosed herewith as Annexure F</td></tr>
<tr><td>4.4</td><td>There shall be no process gas emission from manufacturing in the ambient air within the premises of the industry and a distance of 10 meters form the source other than the stack/vent shall not exceed the following levels.</td><td>Not applicable.

No manufacturing process is involved.</td></tr>
<tr><td>4.5</td><td>The concentration of the following parameters in the ambient air within the premises of the industry and a distance of 10 meters from the source other than the stack/vent shall not exceed the following levels.

<table>
<tr><th>Sr. no.</th><th>Pollutant</th><th>Time weighted Average</th><th>Concentrati in ambient in μg/m^3</th></tr>
<tr><td>1.</td><td>Sulphur Dioxide (SO_2)</td><td>Annual
24 Hour</td><td>50
80</td></tr>
<tr><td>2.</td><td>Nitrogen Dioxide (NO_2)</td><td>Annual
24 Hour</td><td>40
80</td></tr>
<tr><td>3.</td><td>Particulate matter (size less than 10 μm) or PM_{10}</td><td>Annual
24 Hour</td><td>60
100</td></tr>
<tr><td>4.</td><td>Particulate matter (size less than 2.5 μm) or $PM_{2.5}$</td><td>Annual
24 Hour</td><td>40
60</td></tr>
</table></td><td>Point noted for compliance.

DPA appointed M/s Detox Corporation, Surat (NABL Accredited laboratory) for regular Monitoring of environmental parameters since the year 2016. The work is in progress & DPA submitted monitoring data regularly to all the concerned authorities along with compliance reports submitted.

The Environmental Monitoring Reports as submitted by M/s Detox Corporation is enclosed herewith as Annexure F.

Further, DPA already invited tender for ‘Online Continuous Ambient Air Quality Monitoring (CAAQM) For the Period of Three Years at Deendayal Port Authority’. The same is under evaluation stage.

Deendayal Port Authority had taken up massive greenbelt development activities in and around Kandla, Residential colony, Administrative building etc.

DPA had entrusted the work to Forest Department, Gujarat for developing green belt in and around Port area at a cost of Rs. 352 lakhs in an area of about 32 hectares and the work is completed.</td></tr>
<tr><td>4.6</td><td>The applicant shall provide portholes, ladder, platform etc at chimney (s) for monitoring the air emissions and the same shall be open for inspection to/and for use of Board’s staff. The chimney(s) vents attached to various sources of emission shall be designated by number such as S-1, S-2, etc and these shall be painted/ displayed to facilitate identification.</td><td>Point noted for compliance.</td></tr>
<tr><td>4.7</td><td>The industry shall take adequate measures for control of noise levels from its own sources within the premises so as to maintain ambient air quality standards in respect of noise to less than 75 dB(A)</td><td>Point noted for compliance.

DPA appointed M/s Detox Corporation, Surat (NABL Accredited laboratory) for regular Monitoring of environmental parameters since the year 2016. The work is in progress & DPA</td></tr>
</table>

<table>
<tr><td></td><td>during day time and 70 dB(A) during night time. Daytime is reckoned in between 6:00 am and 10:00 pm and night time is reckoned between 10:00 pm and 6:00 am</td><td>submitted monitoring data regularly to all the concerned authorities along with compliance reports submitted.

The Environmental Monitoring Reports as submitted by M/s Detox Corporation is enclosed herewith as Annexure F.

It is relevant to mention here, that, Deendayal Port Authority had taken up massive greenbelt development activities in and around Kandla, Residential colony, Administrative building etc.
DPA had entrusted the work to Forest Department, Gujarat for developing green belt in and around Port area at a cost of Rs. 352 lakhs in an area of about 32 hectares and the work is completed.</td></tr>
<tr><td>5.</td><td colspan="2">Authorization as per Hazardous And Other Waste (Management and Transboundary) Rules, 2016 form -2 [see rule 6 (2)]</td></tr>
<tr><td>5.1</td><td>Authorization order no. AWH-110594 date of issue: 08/12/2020</td><td>--</td></tr>
<tr><td>5.2</td><td>M/s. Kandla Port Authority is hereby granted an authorization to operate facilities for following hazardous waste on the premises situated at Kandla, A.O building Gandhidham Tal.: Gandhidham, Dist: Kutch
<table>
<tr><td>Sr. No</td><td>Waste</td><td>Quantity / Year</td><td>Schedule & Category</td><td>Facility</td></tr>
<tr><td>1.</td><td>Used spent oil</td><td>1125 MT</td><td>1-5.1</td><td>Collection, Storage, transportati And dispos selling to Authorized Recycler</td></tr>
<tr><td>2.</td><td>Waste Residu e Contain ing oil</td><td>3344.43 MT</td><td>1-5.2</td><td>Collection, Storage, transportati And dispos selling to Authorized Recycler</td></tr>
</table></td><td>DPA has been regularly submitting Annual Return of Hazardous waste in Form IV for the entire port area and uploading the same in GPCB site on regular basis. Form IV for the year 2021-22 was submitted vide letter no. EG/WK/EMC/Part(III)131 dated 06/07/2022 and is attached herewith as Annexure-O.</td></tr>
<tr><td>5.3</td><td>The authorization shall be valid up to 21/07/2025</td><td>Point noted.</td></tr>
<tr><td>5.4</td><td>The authorization is subject to the conditions stated below and such other conditions as may be specified in the rules from time to time under the Environment (Protection) Act – 1986.</td><td>Point noted.</td></tr>
<tr><td>5.5</td><td>The authorization is granted to operate a facility for collection, storage within factory premises transportation and ultimate disposal of hazardous wastes as per conditions no. 5.2 to the industry</td><td>Point noted.</td></tr>
</table>

	having valid CCA of this board.	
5.6	**Terms and Condition of Authorization**	
1.	The applicant shall comply with the provision of the Environment (Protection) Act-1986 and the rules made there under	Agreed with the condition.
2.	The authorization or its renewal shall be produced for inspection at the request of an officer authorized by the Gujarat pollution Control Board.	Agreed with the condition.
3.	The person authorized shall not rent, lend, sell, and transfer or otherwise transport the hazardous wastes without obtaining prior permission of the Gujarat Pollution Control Board.	Agreed with the condition.
4.	Any unauthorized change in personnel, equipment or working conditions as mentioned in the authorized order by the persons authorized shall constitute a beach of this authorization	Agreed with the condition.
5.	The person authorized shall implement Emergency Response Procedure (ERP) for which this authorization is being granted considering all site-specific possible scenarios such as spillages, leakages, fire etc, and their possible impact and also carry out mock drill in this regard at regular interval of time.	DPA is already having Disaster management plan (Attached as **Annexure-Q**) considering all site-specific possible scenarios such as spillages, leakages, fire etc, and their possible impact. In addition to the above mock drills are also carried out regularly for effective implementation of the same.
6.	The person authorized shall comply with the provisions outlined in the Central Pollution Control Board guidelines on "Implementing Liabilities for Environmental damages due to handling and disposal of Hazardous waste and penalty."	Agreed with the condition.
7.	It is the duty of the authorized person to take prior permission of the Gujarat Pollution Control Board to close down the facility.	Agreed with the condition.
8.	An application for the renewal of an authorization shall be made as laid down in rules 6 (2) under Hazardous and other wastes rules, 2016	Agreed with the condition.
9.	The imported hazardous and other wastes shall be fully insured for transit as well as for any accidental occurrence and its clean-up operation.	Not applicable. DPA is not involved in import of any kind of hazardous waste.
10.	The record of consumption and fate of the imported hazardous and other wastes shall be maintained.	Not applicable. DPA is not involved in import of any kind of hazardous waste.
11.	The hazardous and other wastes which	Not applicable.

	gets generated during recycling or reuse or recovery or pre-processing or utilization of imported hazardous or other wastes shall be treated and disposed of as per specific conditions of authorization.	
12.	The importer or exporter shall bear the cost of import or export and mitigation of damage if any.	Point noted.
13.	Any other conditions for compliance as per the guidelines issued by the ministry of Environment, Forest and climate change or Central Pollution Control Board from time to time.	Point noted.
14.	The waste generator shall be totally responsible for (i.e collection, storage, transportation and ultimate disposal) the wastes generated.	Agreed with the condition.
15.	Record of waste generation, its management and annual return shall be submitted to Gujarat Pollution Control board in form -4 by 30th day of June of every year for the preceding period April to March.	DPA has been regularly submitting Annual Return of Hazardous waste in Form IV for the entire port area and uploading the same in GPCB site on regular basis. Form IV for the year 2021-22 was submitted vide letter no. EG/WK/EMC/Part(III)131 dated 06/07/2022 and is attached herewith as **Annexure-O**.
16.	In case of any accidents, details of the same shall be submitted on Form-11 to Gujarat Pollution Control Board.	Agreed with the condition.
17.	As per "Public Liability Insurance Act – 91" company shall get Insurance policy, if applicable.	Public Liability Insurance is renewed time to time as required. The Public Liability Insurance was last renewed on 22/07/2021 and is valid till 22/07/2022 The same is attached herewith as **Annexure-C.**
18.	Empty drums and containers of toxic and hazardous material shall be treated as per guidelines published for "Management and Handling of discharged containers" records of the same shall be maintained and forwarded to Gujarat Pollution Control Board regularly.	Point Noted.
19.	In case of transport of hazardous waste to a facility for (i.e treatment, storage and disposal) existing in a state other than the state where hazardous wastes generated, the occupier shall obtain "No Objection Certificate" from the State Pollution Control Board or Committee of the concerned state of Union Territory Administration where facility exists.	Not Applicable. DPA has appointed CPCB approved vendors for collection and disposal of "Hazardous Waste/Sludge/ Waste Oil". A copy of Grant of License/Permission to carry out the work of collection and disposal of "Hazardous Waste/Sludge/ Waste Oil" from Vessels calling at Deendayal Port" is attached herewith as **Annexure-K.**
20.	Unit shall all concrete measures to show tangible results in waste generation, reduction, avoidance, reuse and recycle.	Point noted.

	Actions taken in this regard shall be submitted within three months and also along with form -4	
21.	Industry shall have to display the relevant information with regards to hazardous waste as indicated in the Hon. Supreme Court's Order in WP No. 657 of 1995 dated 14th October 2003.	Agreed with the condition.
22.	Industry shall have to display on-line data outside the main factory gate with regard to quantity and nature of hazardous chemicals being handled in the plant, including wastewater and air emissions and solid hazardous wastes generated within the factory premises.	Agreed with the condition.
6.	**Specific Conditions: -**	
6.1	The authorized actual user of hazardous and other waste shall maintain records of hazardous and other wastes purchased in a passbook issued by the State Pollution Control Board along with the authorization.	Not Applicable. To be complied by the Authorized recycler.
6.2	Handling over of the hazardous and other wastes to the authorized actual user shall be only after making the entry in the passbook of the actual user.	DPA is keeping the details of hazardous waste handed over to the authorized recycler. DPA has been regularly submitting Annual Return of Hazardous waste in Form IV for the entire port area and uploading the same in GPCB site on regular basis. Form IV for the year 2021-22 was submitted vide letter no. EG/WK/EMC/Part(III)131 dated 06/07/2022 and is attached herewith as **Annexure-O**.
6.3	In case of renewal of authorization, a self-certified compliance report in respect of effluent, emission standards and the conditions specified in the authorization for hazardous and other wastes shall be submitted SPCB.	Point noted for compliance.
6.4	The occupier of the facility shall comply standard operating procedure/guidelines published by MoEF&CC or CPCB or GPCB from time to time.	Agreed with the condition.
6.5	Unit shall comply provisions of E-waste management Rules - 2016	Point noted for compliance. It is relevant to mention here, that DPA has invited tender for Appointment of Advisor for "Preparation of Plan for Management of Plastic Wastes, Solid waste including C&D wastes, E-wastes, Hazardous wastes including Biomedical". The tender is under evaluation.
6.6	The disposal of hazardous waste shall be carried out as per the waste management hierarchy.	Waste Management Heirarchy i.e. Prevent, Reduse, Reuse, Recycle, Recover and Disposal is being strictly followed in order by the CPCB

		approved vendors appointed for the collection of hazardous waste.
6.7	The occupier of facilities shall not store the hazardous and other wastes for a period not exceeding ninety days. Prior permission of the board shall be obtained for extension of the storage period.	DPA appointed CPCB approved vendors for collection of hazardous waste and they are collecting it regularly.
6.8	The occupier shall maintain the records of generation, sale, storage, transport, recycling, co-processing and disposal of hazardous waste and make available during the inspection.	DPA maintains the record of all type of waste. DPA also has been regularly submitting Environmental Statement in Form V for the entire port area and uploading the same in GPCB site on regular basis. Form V for the year 2021-22 is attached herewith as **Annexure-P.**
6.9	The transportation of the hazardous waste shall be carried out in GPS mounted dedicated vehicles.	DPA has appointed CPCB authorized vendors for collection and transportation of Hazardous waste.
7.	**General Conditions: -**	
7.1	Any change in personnel, equipment or working conditions as mentioned in the consents from order should immediately be intimated to this Board.	Point noted for compliance.
7.2	Applicant shall also comply with the general conditions given in Annexure 1	Agreed with the condition.
7.3	Wherever due to accident or other unforeseen act or ever, such emissions occur or apprehend to occur in excess of standards laid down such information shall the forthwith reported to board, concerned police station office of Directorate of Health Service, Department of explosive, Inspectorate of Factories and local body.	Agreed with the condition.
7.4	In case failure of pollution control equipments, the production process connected to it shall be stopped. Remedial actions/measures shall be implemented immediately to bring entire situation normal.	Not applicable. No production activity is involved.
7.5	The Environment management Unit/cell shall be setup to ensure implementation on and monitoring of Environmental safeguards and other conditions stipulated by statutory authorities. The Environment management Cell/Unit shall directly report to the Chief executive of the organization and shall work as a focal point for internalizing environmental issues. These cells/units also coordinate the exercise of environmental audit and preparation of environmental statements.	DPA is already having Environment Management cell. Further, DPA has also appointed expert agency for providing Environmental Experts from time to time. DPA appointed M/s Precitech Laboratories, Vapi for providing Environmental Experts vide work order dated 5/2/2021. A copy of Work order is attached herewith as **Annexure-R.** Further DPA has appointed Manager Environment on contractual basis for the period of 3+2 years. A copy of office order is attached herewith as

		Annexure-S
7.6	The environmental audit shall be carried out yearly and the environmental statements pertaining to the previous year shall be submitted to this State Board latest by 30th September every year.	As per Environment Audit Scheme, DPA is not a Schedule 1 or Schedule 2 industry. Hence, no Environmental Audit is required.
7.7	The Board reserves the right to review and/or revoke the consent and/or make variation in the conditions, which the Board deems, fit in accordance with section 27 of the Act.	Point noted.
7.8	In case of change of ownership/management the name and address of the new owners/partners/directors/proprietor should immediately be intimated to the Board.	Point Noted
7.9	Industry shall have to display relevant information with regard to hazardous waste as indicated in the Hon. Supreme order in w.p no. 657 of 1995 dated 14th October 8	Point Noted

Annexure –A

EC & CRZ Compliance Report (File no. 11-82/2011-IA-III, dated 2016) sent on 07/10/2021

DEENDAYAL PORT TRUST
(Erstwhile: KANDLA PORT TRUST)

Administrative Office Building
Post Box No. 50
GANDHIDHAM (Kutch).
Gujarat: 370 201.
Fax: (02836) 220050
Ph.: (02836) 220038

www.deendayalport.gov.in

Dated: 09/10/2021

EG/WK/4751/Part (Comp. 1) 95

To,
The Deputy Chief conservator of Forest (Central),
Ministry of Environment, Forests & Climate Change,
Regional Office, Western Region
Kendriya Paryavaran Bhavan
Link Road No.3, Ravi Shankar Nagar,
Bhopal- 462 016(M.P.).
Email : rowz.bpl-mef@nic.in, eccompliance-guj@gov.in

Kind Attn.: Dr. H.V.C. Chary Guntupalli, Scientist D, MoEF&CC, GoI, Bhopal.

Sub: Development of 7 Integrated facilities (Stage I) within the existing Deendayal Port Trust (Erstwhile: Kandla Port Trust) limit at District Kutch (Gujarat) – Environmental & CRZ Clearance – **Submission of Compliance Report reg.**

Ref.: 1) Ministry's letter vide F. No. 6-1/2017 (ENV) dated 1/5/2017.
2) KPT letter no. EG/WK/4751/Part (Compliance)/77 dated 3/6/2017.
3) DPT letter no. EG/WK/4751/part (Compliance)/610 dated 13/12/2017 – Submission of Six Monthly Compliance Report (June, 2017 to Nov., 2017).
4) DPT letter no. EG/WK/4751/part (Compliance)/315 dated 14 (21)/6/2018 – Submission of Six Monthly Compliance Report (Dec, 2017 to May, 2018).
5) DPT letter no. EG/WK/4751/part (Compliance)/115 dated 30(2)/3(4)/2019 – Submission of Six Monthly Compliance Report (up to March, 2019).
6) DPT letter no. EG/WK/4751/part (Compliance 1)/155 dated 14/11/2019 – Submission of Compliance Report (up to October, 2019).
7) DPT letter no. EG/WK/4751/part (Compliance 1) dated 29/12/2020 – Submission of Compliance Report (up to November, 2020).

Sir,

It is requested to kindly refer above cited references for the said subject.

In this regard, it is to state that, DPT vide above referred letter dated 3/6/2017 had submitted details/information (including point-wise compliance of stipulated conditions & duly filled in data sheet) asked by the Regional Office, MoEF&CC, GoI, Bhopal in connection with the EC & CRZ Clearance granted by the MoEF&CC, GoI dated 19/12/2016 for the subject mentioned above. Further, DPT vide above referred letter dated 13/12/2017, 14 (21)/6/2018,30(2)/03(4)/2019,14/11/2019 & 29/12/2020 had submitted compliance report of stipulated conditions for the period June,2017 to November, 2017, for the period Dec.2017 to May,2018 , for the period up to March, 2019 , period up to October, 2019 & period up to November, 2020, respectively.

..............cont.........

Now, as directed in above referred letter dated 1/5/2017 of the Regional Office, MoEF&CC, GoI, Bhopal, please find enclosed herewith compliance report of stipulated conditions mentioned in the EC & CRZ Clearance granted by the MoEF&CC, GoI dated 19/12/2016 **(Annexure 1)** & Monitoring Report in Data Sheet **(Annexure 2) (Period : up to May, 2021)** for kind information and record please.

Further, as per the MoEF&CC, Notification S.O.5845 (E) dated 26.11.2018, stated that "**In the said notification, in paragraph 10, in sub-paragraph (ii), for the words "hard and soft copies" the words "soft copy" shall be substituted**". Accordingly, we are submitting herewith soft copy of the same in CD as well as through e-mail in ID rowz.bpl-mef@nic.in & eccompliance-guj@gov.in.

This has the approval of Chief Engineer, Deendayal Port Trust.

Thanking You.

Yours faithfully,

6/10/21

Encl.: As above

Superintending Engineer (PL) & EMC (I/c)
Deendayal Port Trust

Copy along with point wise compliance of stipulated conditions, to:

1) Shri Amardeep Raju,
Scientist E, Ministry of Environment, Forest and Climate Change,
& Member Secretary (EAC-Infra.1),
Indira Paryavaran Bhawan,
3rd Floor, Vayu Wing, Jor Bagh Road, Aliganj,
New Delhi- 110 003;
E-mail: ad.raju@nic.in

2) Shri Prasoon Gargava,
Scientist E & Regional Director,
Central Pollution Control Board,
Parivesh Bhawan,
Opp. VMC Ward Office No.10, Subhanpura,
Vadodara – 390 023.
Email Id. Prasoon.cpcb@nic.in

3) Smt. Urvashi Upadhyay,
Environment Engineer,
Unit Head, Kachchh ,
Gujarat Pollution Control Board,
Paryavaran Bhavan,
Sector 10A, **Gandhinagar- 382 010.**
Email-kut-uh-gpcb@gujarat.gov.in

4) The Regional Officer,
Gujarat Pollution Control Board,
Regional Office (East Kutch)
Administrative Office Building,
Deendayal Port Trust, Gandhidham.
Email Id. ro-gpcb-kute@gujarat.gov.in

Annexure -I

Annexure 1

Subject: Development of 7 integrated facilities (Stage I) within existing Deendayal Port at Kandla - Environmental & CRZ Clearance.

CURRENT STATUS OF WORK (As on 31/5/2021)

Name of Project	Status
1. Development of oil jetty to handle liquid cargo and ship bunkering terminal at old Kandla on BOT Basis (jetty: 300m x 15m, approach 450 m X 10 m, back up area 5.5 HA, capacity – 3.39 MMTPA, capital dredging 1,73,660 m3 maintenance dredging 1,56,294 m3 Estimated cost: 276.53 Core.	**The award of concession issued on 11/12/2020. The concessionaire M/s Kandla Oil Terminal Pvt.Ltd. has carried out off-shore & on-shore geotechnical investigation. However, construction activities yet to commence on project site.**
2. Multipurpose cargo Terminal at Tekra off Tuna on BOT basis (T shape jetty 600m X 80 m Capacity 18MMTPA, back up area 101 Ha capital dredging 1,26,57,175 m3 maintenance dredging 18,98,576. 25 m3 m3 Estimated cost: 1686.66 Core	The Feasibility Report has been approved by the Board of DPT in its meeting held on 19.02.2021. PPPAC memo along with Bidding documents sent to the Ministry of Ports, Shipping & Waterways, Government of India on 26.02.2021. Tariff Authority of Major Ports has approved the Tariff for the Project on 15.09.2021 The project under appraisal/approval stage by the MoPSW,GoI. **No construction activity started yet.**
3. Up gradation of Barge handling capacity at Bundar basis at Kandla capacity 3.33 MMTA back-up area 5 Ha, Estimated cost: 109.59 Core	**The up-gradation work completed.**
4. Construction of Rail over Bridge at NH 8 A near Nakti Bridge (crossing of NH 8 A Estimated cost: 32.17 Core	**No Project activity started yet.**
5. Mechanization of Dry Cargo handling capacity at Kandla Port (Berth 7 and 8 capacity 7.35 MMTPA estimated cost 80.61 Core	**Mechanization of Berths completed.**
6. Strengthening of Oil jetty 1 (Estimated cost: 7.5 Core	**The strengthening work completed.**
7. Modification and strengthening of Cargo berth No. 6 at Kandla Port Estimated cost: 11.5 Core	**The modification & strengthening work completed.**

"PART – B"

Point wise compliance status to various stipulations laid down by the Ministry in its Clearance letter File No. 11-82/2011-IA – III, Dated: 19th December, 2016 are as follows:

SR. NO.	EC Conditions	Compliance status
A. Specific conditions		
I.	Construction activity shall be carried out strictly according to the provisions of CRZ Notification, 2011. No construction work other than those permitted in Costal Regulation Notification shall be carried out in coastal regulation zone area.	Out of total 7 project activities, construction activities of 4 projects (project at Sr. No. 3, 5, 6 & 7 mentioned in the EC & CRZ Clearance), have already been completed. During this period of compliance report, no construction activity with regard to remaining 3projects (Project at Sr. No. 1, 2 & 4) has been carried out. However, it is assured that, anyConstruction activity carried out, shall be strictly as per the provisions of the CRZ notification, 2011. Further, it is also assured that, no activity other than those permissible in Coastal Regulation Notification shall be carried out in CRZ area.
II.	The Project Proponent shall ensure that there shall be no damage to the existing mangrove patches near site and also ensure the free flow of water to avoid damage to the mangroves.	During this period of compliance report, no construction activity with regard to remaining 3projects (Project at Sr. No. 1, 2 & 4) has been carried out. However, it is assured that, due care shall be taken for protecting existing mangrove patches near site and also for free flow of water to avoid damage to the mangroves.
III.	The Project Proponent shall ensure that no creeks or rivers are blocked due to any activities at the project site and free flow of water is maintained.	During this period of compliance report, no construction activity with regard to remaining 3projects (Project at Sr. No. 1, 2 & 4) has been carried out. However, it is assured that, No creeks or rivers shall be blocked, due to any activities at the project site and free flow of water shall be maintained.

IV.	Shoreline should not be disturbed due to dumping. Periodical study on shore line changes shall be conducted and mitigation carried out, if necessary. The detail shall be submitted along with the six monthly monitoring report.	During this period of compliance report, no construction activity with regard to remaining 3projects (Project at Sr. No. 1, 2 & 4) has been carried out. A copy of CWPRS letter 12.08.2016 for dumping of dredged material had already been submitted along with compliance report submitted vide letter dated 3/6/2017. Periodical study on shore line changes will be conducted and if needed mitigation will be carried out. The details will be submitted in due course along with six monthly monitoring reports.
V.	The foreshore facilities shall be set up in the stable / low or medium eroding site as demarcated in the shoreline change map by NCSCM. Further, NCSCM shall be authorized to monitor the project during construction and operation phases so as to ensure that the foreshore facilities cause minimum or no impact to the geomorphological systems.	Necessary CRZ recommendation from the Gujarat Coastal Zone Management Authority had already been obtained for establishment of 7 project facilities dated 1/7/2015 **(Copy submitted along with compliance report submitted dated 3/6/2017)** and accordingly, the MoEF&CC, GoI had accorded EC & CRZ Clearance dated 19/12/2016 for the proposed 7 project facilities. Further, DPT has already given assurance in the compliance report submitted vide letter dated 3/6/2017 regarding authorizing NCSCM.
VI.	The PP should take measures to ensure that construction materials / debris (Mortar, cementing materials etc.) do not fall into the water. Construction materials including labour camps should be located at adequate distance from CRZ areas.	During this period of compliance report, no construction activity with regard to remaining 3projects (Project at Sr. No. 1, 2 & 4) has been carried out. However, it is assured that, the construction activities shall be carried out, with due care so that construction material /debris do not fall into the water. Further, it is also assured that, construction materials including labour camps will be located outside CRZ areas.
VII.	Dredged materials should be analyzed for presence of contaminants and also to decide the disposal options. Monitoring of dredging activities should be conducted and the findings should be shared with the Gujarat SPCB and regional office of the ministry.	As already informed, DPT appointed Gujarat Institute of Desert Ecology, Bhuj for analysis of dredged material, as under : 1) Work order dated 1/9/2017 amounting to Rs. 39,65,190 + 18% GST (for one year) - Work completed - The copy of Final Report submitted by M/s GUIDE,Bhuj had already been submitted along with compliance report submitted

		vide letter dated 2/4/2019. 2) Work order dated 16/10/2018 amounting to Rs. 1,18,95,570.00 + applicable GST (for three years i.e. 2018-21 - – Work completed for the period (2018-19 & 2019-20). For the period 2020-21, the monitoring completed and final report will be submitted by M/s GUIDE,Bhuj soon. The final report submitted by M/s GUIDE, Bhuj during June, 2020 (Study Period November, 2018 to October, 2019) had already been submitted along with compliance report submitted vide letter dated 29/12/2020. For the study period 2019- 20 (November,2019 to October, 2020), a copy of final report submitted by M/s GUIDE, Bhuj is attached herewith as **Annexure A.**
VIII.	PP in consultation with GCZMA should prepare a regional strategic Impact Assessment Report with a special focus on region where the PP started construction without permission. The cost towards the study should be borne by the PP.	DPT has already informed in the compliance report submitted dated 13/12/2017regarding appointment of M/s Gujarat Institute of Desert Ecology, Bhuj (work order dated 1/9/2017) for preparation of Regional Strategic Impact assessment Report and M/s GUIDE, Bhuj has already started work w.e.f. 15/09/2017 including monitoring of environmental parameters. • Initially DPT has requested GCZMA on dated 03/01/2017. • The technical committee of Gujarat Coastal Zone Management Authority has discussed the matter in its meeting held on 12/4/2018& 12/06/2018 at Gandhinagar. • The GCZMA meeting, it was decided to carryout site visit by the subcommittee of GCZMA (Minutes of the meeting is hoisted in the website of GCZMA)on dated 12.06.2018. • The visit of the subcommittee of the Gujarat Coastal Zone Management Authority to Deendayal Port Trust, Gandhidham on 12/7/2018. • The subcommittee meeting it was decided that, DPT has to submit

		revised Draft TOR. • Accordingly, as per the suggestions of the subcommittee of the GCZMA, DPT submitted desired details on 25/07/2018. • Request letter submitted to the GCZMA on dated 21/02/2019, 20/4/2019, 13/12/20019, 24/2/2020, 27/5/2020, 17/11/2020, 24/2/2021. • **10/3/2021 – The proposal considered by the GCZMA in its meeting held but due to some technical issues in network connectivity, the proposal was not discussed.** • **24/8/2021– Request letter again sent to the GCZMA to include the proposal in ensuing meeting of the GCZMA and finalize the Revised ToRat an earliest. (Copy - Annexure B.)** • **Approval of revised TOR is still awaited from GCZMA.**
IX.	A comprehensive and integrated conservation plan including detailed Bathymetry Study and protection of Creeks / Mangrove area including buffer zone, mapping of coordinates, running length, HTL, CRZ boundary should be put in place. The plan should take note of all the conditions of approvals granted to all the project Proponents in this area, and the reported cases of disappearance of Mangroves near project site. The preservation of entire area to maintain the fragile ecological conditions should be a part of the plan in relation to the creek and Mangrove conservation	The final report submitted by M/s GUIDE, Bhuj (vide letter dated 21/5/2018) has already been communicated to the MoEF&CC, GoI, Bhopal along with six monthly compliance report submitted vide letter dated 21/06/2018.
X.	The commitments made during the Public Hearing and recorded in the minutes shall be complied with letter and spirit. A hard copy of the action taken shall be submitted to the ministry.	The commitments made during the Public Hearing are being complied with letter & spirit. In this regard, the details of CSR Activities carried out till date & planned for future is enclosed herewith as **Annexure C.**

XI.	All the conditions stipulated in the earlier clearance including the recommendations of Environment Management Plan, Disaster Management Plan shall be strictly complied with.	DPT had already taken necessary steps for compliance of all the conditions stipulatedin the earlier clearance including the recommendations of Environment Management Plan, Disaster Management Plan. DPT is already having updated Disaster management Plan. Further, DPT had appointed M/s Detox Corporation, Surat for routine Environmental Monitoring & management Plan**(Monitoring reports– Annexure D).**
XII.	Disposal sites for excavated materials should be so designed that the revised land use after dumping and changes in the land use pattern do not interfere with the natural drainage.	During this period of compliance report, no construction activity with regard to remaining 3projects (Project at Sr. No. 1, 2 & 4) has been carried out. It is assured that, due care shall be taken for identification of disposal sites for dumping of excavated materials as per the condition stipulated.
XIII.	PP shall install continuous automatic ambient air quality monitoring system (24 x 7) for all relevant parameters at two locations to monitor ambient air quality status of the project area. Data should be transferred online to CPCB and SPCB website.	Out of 7 projects 3 new projects are yet not started. DPT hasalready initiated the action for inviting the tenders for carrying out online ambient air quality monitoring system (24 X 7). However, as already informed, DPT appointed M/s Detox Corporation, Surat for Monitoring of environmental parameters since the year 2016. The work is in progress & DPT submitted monitoring data regularly to all the concerned authorities along with compliance reports.
XIV.	The ground water shall not be tapped within the CRZ areas by the PP to meet with the water requirement in any case.	During this period of compliance report, no construction activity with regard to remaining 3projects (Project at Sr. No. 1, 2 & 4) has been carried out. No ground water shall be tapped for water requirement.
XV.	Necessary arrangements for the treatment of the effluents and solid wastes must be made and it must be ensured that they confirm to the standards laid down by competent authorities including the state or	As informed earlier in the compliance report submitted vide letter dated 13/12/2017, DPT had awarded the work for installation of Sewage Treatment Plant to M/s Detox Corporation, Surat. The new STP had already been commissioned with the

	Central Pollution Control Board and under the Environmental (Protection) Act, 1986.	capacity of 1.5 MLD. The solid waste generated will be handed over to the authorized vendor for further treatment.
XVI.	All the operational areas will be connected with the network of liquid waste collection corridor comprising of storm water, oily waste and sewage collection pipelines.	During this period of compliance report, no construction activity with regard to remaining 3projects (Project at Sr. No. 1, 2 & 4) has been carried out. The 4 projects completed are of modification/strengthening/up-gradation of existing facilities having already developed network of storm water drainage & other facilities. Further, oil wastes etc. are being disposed of by selling to the authorized vendor of GPCB/CPCB, as per norms. However, for remaining projects, DPT/BOT operator will provide the necessary facilities in dovetail with condition stipulated.
XVII.	Automatic/Online monitoring system (24 x 7 monitoring devices) for water pollution in respect of flow measurement and relevant pollutants in the treatment system to be installed. The data to be made available to the respective SPCB and in the company's website.	DPT awarded the work to M/s Detox Corporation, Surat for regular monitoring of Environmental parameterssince the year 2016. The work is in progress & DPT submitted monitoring data regularly to all the concerned authorities along with compliance reports.
XVIII.	Marine ecology shall be monitored regularly also in terms of sea weeds, sea grasses, mudflats, sand dunes, fisheries, echinoderms, shrimps, turtles, corals, coastal vegetation, mangroves and other marine bio diversity components as part of the management plan. Marine ecology shall be monitored regularly also in terms of all micro, macro and mega floral and faunal components of marine biodiversity.	The final report submitted by M/s GUIDE, Bhuj (vide letter dated 21/5/2018) has already been communicated to the MoEF&CC, GoI, Bhopal along with six monthly compliance report submitted vide letter dated 21/06/2018. Further, as already informed, DPT had also entrusted the work to M/s GUIDE, Bhuj for continuous monitoring for the period from 2018-2021. The Final Report submitted by M/s GUIDE,Bhuj for 2019-20had already been submitted along with compliance report submitted vide letter dated 29/12/2020. **A copy of Final Report submitted by M/s GUIDE, Bhuj for the period 2020-**

		21 is attached herewith as Annexure E. **Further, as per the requirement of the condition for regular monitoring, DPT entrusted the work to M/s GUIDE, Bhuj vide work order dated 3/5/2021 (For the period 2021-2024). The work is in progress.**
XIX.	Measure should be taken to contain, control and recover the accidental spills of fuel and cargo handle.	Point Noted. An adequate control measure has already been taken to control and recover the accidental spills of fuel and cargo handle. DPT is already having Oil Spill Contingency Plan.
XX.	All the mitigation measures submitted in the EIA report shall be prepared in a matrix format and the compliance for each mitigation plan shall be submitted to RO, MoEF&CC along with half yearly compliance report.	All the mitigation measures submitted in the EIA report has already been prepared in a matrix format along with status of compliance of each mitigation plan and communicated to the Ministry.
XXI.	Ship/barges shall not be allowed to release any oily bilge waste or ballast water in the sea. Any effluent from the jetty which have leachable characteristics shall be segregated and recycled/disposed as per SPCB guideline.	Point Noted. DPT assured that Ship/barges shall not be allowed to release any oily bilge waste or ballast water in the sea. It is also confirmed that Any effluent from the jetty which has leachable characteristics shall be segregated, treated andrecycled/disposed as per SPCB guidelines.
XXII.	Location of DG sets and other emission generating equipment shall be decided keeping in view the predominant wind direction so that emission do not effect nearby resident areas. Installation and operation of DG Sets shall comply with the guideline of CPCB	Point noted. DG sets will be installed keeping in view the predominant wind direction, as per prescribed guidelines DG sets shall be used in case of power failure only.
XIII.	All the mechanized handling systems and other associated equipments such as hoppers, belt conveyors, stacker cum reclaimers shall have integrated dust suppression system. Dust suppression system shall be provided at all transfer point.	Point noted. DPT/BOT operator will take necessary step for providing all the mechanized handling systems and other associated equipments such as hoppers, belt conveyors, stacker cum reclaimers with integrated dust suppression system.DPT/BOT operator will provide Dust suppression system at all transfer point. DPT has already installed water sprinkling

		system in Port area for coal handling areas.
XIV.	No products other than permitted under the CRZ Notification, 2011 shall be stored in the CRZ area.	Point Noted. It is hereby assured that only products permitted under the CRZ Notification, 2011 shall be stored in the CRZ area.
XXV.	It shall be ensured by the Project Proponent that the activities does not cause disturbance to the fishing activity, movement of fishing boats and destruction to mangroves during the construction and operation phase.	Point noted. DPT area is restricted for fishing activities. However, due care shall be taken during the construction & operational phase so that the activities does not cause disturbance to the fishing activity, movement of fishing boats and destruction to mangroves.
XVI.	As proposed, green belt over an area of 36.8 ha shall be developed with at least 10 meter wide green belt on all sides along the periphery of the project area, in downward direction and along road side etc. Selection of plant species shall be as per the CPCB guidelines in consultation with the DFO.	As already informed, DPT entrusted work of green belt development in and around Port area to the Forest Department, Gujarat at a cost of Rs. 352 lakhs (Area 32 hectares). The work is completed.
XVII.	Mangrove plantation in an area of 100ha shall be carried out by KPT within 2 years in a time bound manner. Action taken report shall be submitted to the Regional Office of MoEF&CC.	As informed earlier, DPT has already appointed M/s Gujarat Ecology Commission (Government of Gujarat firm) for mangrove plantation in an area of 100 ha. Amounting to Rs. 45 lakhs. A copy of MoU executed with M/s GEC has already been communicated along with compliance report submitted vide letter dated 13/12/2017. **<u>The mangrove plantation in an area of 100 Ha. has already been completed by M/s GEC, Gandhinagar.</u>**
VIII.	Municipal Solid Waste and Hazardous wastes shall be managed as per Municipal Solid Waste Rule, 2016 and Hazardous Waste Management Rules 2016	Municipal solid waste and Hazardous wastes collected, segregated and handover to GPCB authorized vendor as per Municipal solid waste Rule, 2016 and Hazardous waste management Rules, 2016 for further treatment.
XIX.	The project Proponent shall take up and earmark adequate fund for socio-economic development and welfare measure as proposed under the CSR programmed. This shall be taken up on priority.	The details of fund earmarked under CSR activities and CSR activities under taken till date & proposed activities, is placed at **<u>Annexure C.</u>**

XXX.	The Project Proponent shall set up separate Environmental Management Cell for effective implementation of the stipulated environmental safeguards under the supervision of a senior executive	DPT is already having Environment Management cell. Further, DPT has also appointed expert agency for providingEnvironmental Experts from time to time. Recently, DPT appointed M/s Precitech Laboratories Pvt. Ltd., Vapi for three years vide work order dated 5/2/2021.
XXI.	The funds earmarked for environmental management plan shall be included in the budget and this shall not be diverted for any other purpose.	The allocation made under the scheme of "Environmental Services & Clearance thereof other related Expenditure" during BE 2020-21 is Rs. 271 Lakhs & BE 2021- 22 is Rs. 266 Lakhs. In the EIA Report of this proposal, an amount of Rs. 8,28,750/- has been earmarked for environmental management plan.
XXII.	The proponent shall abide by all the commitments and recommendations made in the EIA/EMP reports so also during their presentation to the EAC.	Point noted. DPT will abide by the all the commitments and recommendations made in the EIA/EMP reports.
XIII.	Company shall prepare operating manual in respect of all activities. It shall cover all safety & environment related issues and system. Measure to be taken for protection. One set of environmental manual shall be made available at the project site. Awareness shall be created at each level of the management. All the schedules and results of environmental monitoring shall be available at the project site office.	Operating manual plan in respect of all activities has already been communicated along with compliance report submitted vide letter dated 2/4/2019.
XIV.	Corporate Social Responsibility a. The company shall have a well laid down Environmental Policy approved by the Board of Directors b. The Environmental policy shall prescribe for standard operating process/procedure to bring into focus any infringements / deviation/violation of the environmental or forest norms c. The system or Administrative order of the hierarchical company to deal	The DPT has Environmental Policy approved by the Board of Directors. The Environmental policy has already prescribe for standard operating process/procedure to bring into focus any infringements / deviation/violation of the environmental or forest norms. DPT is already having well established environmental Cell for ensuring proper checks on non compliances/violations of Environmental norms.

	with environmental issues and for ensuring compliance with the environmental clearance conditions shall be furnished. d. To have proper checks and balances, the company shall have a well laid down system of reporting of non compliances / violations of environmental norms to the board of directors of the company and/or share holders or stake holders at large.	
B. <u>General Condition</u>		
i.	The Project Authorities must strictly adhere to the stipulations made by the State Pollution Control Board (SPCB), State Govt. and any other statutory authority.	Point Noted. DPT/BOT operator will strictly adhere to the stipulations made by the State Pollution Control Board (SPCB), State Govt. and any other statutory authority.
ii.	Full support shall be extended to the officers of this ministry/regional office at Bhopal by the project Proponent during inspection of the project for monitoring purposes by furnishing full details and action plan including action taken reports. In respect of mitigation measures and other environmental protection activities.	Point noted. DPTwill provide Full Support to the officers of this Ministry / Regional Office at Bhopal during inspection of the project for monitoring purposes byfurnishing full details and action planincluding action taken reports in respect of mitigation measures andother environmental protectionActivities.
iii.	A six monthly monitoring report shall need to be submitted by the project proponents to the regional office of this ministry at Bhopal regarding the implementation of the stipulated conditions.	Point noted. Monitoring reports are being submitted regularly to the regional office of the ministry at Bhopal regarding the implementation of the stipulated conditions, as per norms.
iv	Ministry of Environment Forest and Climate Change or any other competent authority may stipulate any other additional conditions or modify the existing one, if necessary in the interest of environment and the same shall be complied with.	Point Noted. Agreed to the condition.

v	The ministry reserves the right to revoke this clearance if any of the condition stipulated are not complied with the satisfaction of the ministry	Point noted. Agreed to the condition.
vi	In the event of a change in project profile or change in the implementation agency, a fresh reference shall be made to the ministry of Environment, Forest and Climate Change.	Point Noted.
vii	The Project Proponents shall inform the regional office as well as the ministry, the date of the financial closure and final approval of the project by the concerned authorities and the date of start of Land Development work	DPT vide letter dated 14/12/2020 w.r.t. project No.1 i.e***. "Development of Oil Jetty to Handle Liquid Cargo and Ship Bunkering Terminal at Old Kandla under PPP Mode"***, has already informed to the Regional Office, MoEF&CC, GoI, Bhopal & copy to MoEF&CC, GoI, New Delhi about the award of concession granted to the Concessionaire M/s Kandla Oil Terminal Limited dated 11/12/2020 and accordingly they may start the project implementation work .
viii	A copy of the clearance letter shall be marked to concerned panchayat / local NGO, if any, from whom any suggestion/representation has been made received while processing the proposal	DPT vide letter dated 29/12/2016 had already informed to Conservation Action Trust &Paryavaran Mitra (from whom KPT received the representation during the Public Hearing).
ix	A copy of the environmental clearance letter shall also be displayed on the website of the concerned State Pollution Control Board. The EC letter shall also be displayed at the Regional Office, District Industries Centre and Collector's Office / Tehsildar's office for30 days.	---------
11	The stipulations would be enforced among others under the provisions of water (Prevention and Control of Pollution) Act 1974, the Air (Prevention and control of Pollution) Act 1981, the environment (Protection) Act, 1986, the Public Liability (Insurance) Act, 1991 and EIA Notification 1994, including the amendments and rules	Point Noted. DPT/BOT operator will submit regular monitoring data of Environmental parameters regularly. DPT appointed M/s Detox Corporation for regular monitoring of Environmental parameters**(Monitoring Data – Annexure D).**

	made thereafter.	
12	All other statutory clearance such as the approvals for storage of diesel from Chief Controller of Explosives, Fire Department, Civil Aviation Department, Forest Conservation Act, 1980 and Wildlife (Protection) Act, 1972 etc. shall be obtained, as applicable by project proponents from the respective competent authorities.	DPT/BOT Operator will obtain all other statutory clearance applicable as per condition stipulated.
13	The project proponent shall advertise in at least two local Newspapers widely circulated in the region, one of which shall be in the vernacular language informing that the project has been accorded Environmental and CRZ Clearance and copies of clearance letters are available with the state Pollution Control Board and may also be seen on the website of the Ministry of Environment and Forests at http://www.envfor.nic.in. the advertisement should be made within 10 days from the date if receipt of the clearance letter and a copy of the same should be forwarded to the Regional Office of this Ministry at Bhopal.	Deendayal Port had already given advertisement in two news papers i.e. in KUTCHMITRA (Gujarati) & in The Indian Express (Ahmedabad Edition) (English) dated 20/12/2016. Further, DPT vide letter dated 22/12/2016 had already forwarded the copies to the Regional Office, MoEF&CC, GoI, Bhopal.
14	This Clearance is subject to final order of the Hon'ble Supreme Court of India in the matter of Goa Foundation Vs. Union of India in Writ Petition (Civil) No. 460 of 2004 as may be applicable to this project.	Point Noted. Agreed with the condition.
15	Status of compliance to the various stipulated Environmental conditions and environmental safeguards will be uploaded by the project proponent in its website.	Point Noted. Status of compliance to the various stipulated Environmental conditions are being uploaded in the website of DPT. Present compliance report has already been uploaded in the website www.deendayalport.gov.in.
16	Any appeal against this clearance shall be lie with the National Green Tribunal, if preferred, within a period of 30 days as prescribed under Section 16 of the National Green Tribunal Act, 2010.	Point Noted.
17	A copy of the clearance letter shall be sent by the proponent to concerned Panchayat, Zilla Parisad / Municipal Corporation, Urban Local Body and the	KPT vide letter dated 29/12/2016 had already informed to Conservation Action Trust & Paryavaran Mitra (from whom KPT received the representation during the

	Local NGO, if any, from whom suggestions / representations, if any, were received while processing the proposal. The clearance letter shall also be put on the website of the company by the proponent.	Public Hearing).
18	The Proponent shall upload the status of compliance of the stipulated Clearance conditions, including results of monitored data on their website and shall update the same periodically. It shall simultaneously be sent to the Regional Office of MoEF, the respective Zonal Office of CPCB and the SPCB.	Point Noted. Status of compliance to the various stipulated Environmental conditions are being uploaded in website of DPT. Present compliance report has already been uploaded in the website www.deenbdayalport.gov.in. Copy of the compliance report has also been marked to the Regional Office of MoEF&CC, GoI, the respective Zonal Office of CPCB and the SPCB.
19	The environmental statement for each financial year ending 31st March in Form – V as is mandated to be submitted by the project proponent to the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently, shall also be put on the website of the company along with the status of compliance of clearance conditions and shall also be sent to the respective Regional Office of MoEF by e – Mail.	Point Noted. As informed earlier, out of 7 projects, the projects mentioned at Sr. No. 3,5,6 & 7 in the EC Letter dated 19/12/2016, are not a new projects (strengthening/ up gradation work). These projects are already covered under consent to operate granted by the GPCB for whole DPT area (GPCB ID 28494 – Renewed Consent Order no-AWH-110594 dated of issue-8/12/2020- Valid Upto21/7/2025) and for which DPT regularly submitted the Environmental statement in Form V to the GPCB. A copy of last Environmental Statement submitted to the GPCB (year 2020-21) for entire DPT area is enclosed herewith as **Annexure G**. Further, DPT also uploaded the said Environmental statement in Form V in the websitewww.deendayalport.gov.in. For projects at Sr.No. 1, 2 & 4, no construction activity started. After commissioning of these projects, DPT/BOT operator will submit Form V to GPCB.

ANNEXURE A

Final Report

Studies on Dredged Materials for the presence of Contaminants and suggesting suitable disposal options

(As per EC & CRZ Clearance accorded by the MoEF & CC, GoI dated 19/12/2016- specific condition no. vii)

DPT Work order No. EG/WK/4751/Part (EC&CRZ-1) / 865. Dt. 18.10.2018

Submitted by

Gujarat Institute Of Desert Ecology

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**Project Co-ordinator : ** Dr. V. Vijay Kumar, Director

S. No	Name & Designation	Role	Background
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2.	Dr. G. Jayanthi Scientist	Co- Investigator (Physico-chemical)	PhD in Botany; Research experience with Post Doctoral experience
3.	Dr. K. Prabhu Project Scientist	Co- Investigator (Zooplankton)	Ph.D in Marine Biology with Post Doctoral experience in Planktonology
4.	Dr. Durga Prasad Behera Project Scientist	Co- Investigator (Phytoplankton)	Ph.D in Marine Biology with experience in Planktonology
5.	Dr. S. Sivaraj Project Scientist	Co- Investigator (Macrobenthos)	Ph.D in Marine Biotechnology with Post Doctoral Experience in Benthic fauna
Technical Staff			
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10.	Ms. Dipti Parmar Jr. Scientific Assistant	Team member	M.Sc. in Environmental Sciences; Experience in soil and water analysis.

Gujarat Institute
of Desert Ecology

Certificate

This is to state that this Consolidated Report of the work entitled, **"Studies on dredged material for the presence of contaminants"** has been prepared in line with the Work order issued by DPT vide No. EG/WK/4751/Part (EC & CRZ-1) / 865. Dt. 18.10.2018 as per the EC & CRZ Clearance accorded by the MoEF & CC, GoI dated 19/12/2016, Specific Condition No. vii. The work order is for the study for the period of 3 years from 2018 –2021.

This report covers the study conducted during November 2019 – October 2020.

Authorized Signatory **Institute Seal**

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Abbreviations

µg	microgram
AAS	Atomic Absorption Spectrophotometer
Avg	Average
BDL	Below Detectable Limit
C	Celcius
Cd	Cadmium
cm	Centimetre
Cr	Chromium
CWPRS	Central Water and Power Research Station
DPT	Deendayal Port Trust
g/L	Grams per litre
GIS	Geographical Information System
GoK	Gulf of Kachchh
GPS	Global Positioning System
GUIDE	Gujarat Institute of Desert Ecology
HCl	Hydrochloric acid
Hg	Mercury
HNO_3	Nitric Acid
$K_2Cr_2O_7$	Potassium Dichromate
kg	kilogram
km	Kilometres
KOH	Potassium Hydroxide
m	metres
max	maximum
min	Minimum
ml	millilitre
MoEF & CC	Ministry of Environment, Forests & Climate Change
Pb	Lead
pH	Potential of Hydrogen
PHc	Petroleum Hydrocarbon
Ppm	Parts per million
ppt	Parts per thousands
TOC	Total Organic Carbon
TP	Total Phosphorus

1.0. Snapshot of the project "Studies on Dredged Materials for the presence of Contaminants"

DPT intends to develop seven integrated facilities to meet the increasing cargo handling demands of their port. Ministry of Environment, Forests and Climate Change (MoEF & CC), New Delhi, while according environmental clearance to these developmental initiatives, among other conditions, stipulated to carry out "Studies on dredged materials for the presence of contaminants" as per the EC & CRZ Clearance accorded by the MoEF & CC, GoI dated 19/12/2016, Specific Condition No. vii and the task of carrying out the study was given to Gujarat Institute of Desert Ecology (GUIDE), Bhuj during September 2017 and the study encompasses a detailed study of various physical, chemical and biological characteristics of the sediment. This report covers the study conducted for the period from November 2019 – October 2020.

The data of the present study is detailed out as snapshot below:

S. No	Components of the Study	Remarks
1	MoEF & CC sanction letter and details	MoEF & CC's clearance to seven integrated project and specific conditions thereof. Ref.No. F. No. 11-82/2011-IA III; letter dated 19th December 2016. Specific condition No. vii.
2	Deendayal Port letter sanctioning the project	NO.EG/WK/4751/Part (EC & CRZ-1) / 865. Dated 18.10.2018.
3	Duration of the project	Three years (01.11.2018 – 30.10.2021)
4	Period of survey carried out for various components	1st season study (Winter) 2nd season study (Pre-monsoon) 3rd season study (Monsoon)

5	Survey area within the port limit	Dumping locations of dredged materials as suggested by the CWPRS
6	No of locations sampled within the port limits	Two sampling locations, i.e., one sub-tidal and one creek for Season 1 and 2 and Three sampling locations, i.e., two sub-tidal and one creek for Season 3
7	**Components of the report**	
7.1	Sediment Quality – Physico-chemical	The petroleum hydrocarbon concentration in the sediment matrix was well within the permissible limits. Heavy metals such as Cobalt, Cadmium were found in below detection limits and the other heavy metals were in significant concentrations.
7.2	Sediment Quality – Biological	The macrobenthic faunal community stduies infer that there was no significant variation with respect to the faunal density at all the sampling sites between the periods of observation (350-1725 Nos/m^2; 575-2050 Nos/m^2; 425-1475 Nos/m^{2}in 2018-2019 and 375-1025 Nos/m^2; 500-1375 Nos/m^2 in 2019-2020) showed only the marginal variation.
7.3	Water Quality – Physico-chemical	A total of 21 physico-chemical parameters were analyzed in the marine water samples of this year. Heavy metal such as Lead, Cobalt and copper revealed below detection limits in almost all the seasons in most of the samples. But nickel metal was found to be the predominant metal in all the three seasons.
7.4	Water Quality – Biological	A community dominated by fewer species such as

		Noctiluca, Trichodesmium and Blue-green algae. In case of Zooplankton,Calanoid copepod, decapod and harpacticoid copepods were predominantly represented in the dredging and disposal sites of Kandla coastal environment.
7.5	Management plan for dredged material	• Use of suction dredger can be followed. • Dewatering of the fines through sediment traps may be a good option. • Activities during bad weather conditions can be avoided. • Dredging activity areas should be screened for the presence of presence of RET Species which are indigenous to the Gulf of Kachchh region. • Dredging activity at appropriate timing in line with tides and tidal current direction may be considered. • Similar to the current practice, disposal of dredged materials continued to be done only in pre-designated sites. • Usage of turbidity curtains and using artificial reef structures to enhance marine biodiversity have been suggested.

2.0.Background of the project

Deendayal Port Trust (DPT) one among the 12 major ports of the country and is located at the tail end of Gulf of Kachchh, is a largest creek based Ports in the county which is located in the north-western coast of India in the state of Gujarat. DPT caters the maritime trade requirement of many hinterland states and is well connected by the network of rail and road and serves as a gate way port for export and import of northern and western Indian states of Jammu & Kashmir, Delhi, Punjab, Himachal Pradesh, Haryana, Rajasthan, Gujarat and parts of Madhya Pradesh, Uttaranchal and Uttar Pradesh. About 35% of the country's total export takes place through the ports of Gujarat in which the contribution by Deendayal port is considerable.

An assortment of liquid and dry cargo is being handled at Deendayal Port. The dry cargo includes fertilizers, iron and steel, food grains, metal products, ores, cement, coal, machinery, sugar, wooden logs, etc. The liquid cargo includes edible oil, crude oil and other petroleum products. The port handled a total cargo of 105 MMTPA during 2016-17, 110 MMTPA during 2017-18, 115 MMTPA during 2018-19 and 122.5 MMTPA during 2019-2020 with ranking being No. 1 among all the major ports in India for 12th Consecutive year. Further, a regular expansion of infrastructure and port facilities is under way to cater future logistic requirements. The port has high commercial importance in the Indian maritime trade as it handled 36.1 million tons (17%) of cargo out of total cargo of 213.1 million tons of the maritime cargo of India during 2015. This port caters the maritime trade requirement of many hinterland states and is well connected by the network of rail and road and serves as a gate way port for export and import of northern and western Indian states of Jammu & Kashmir, Delhi, Punjab, Himachal Pradesh, Haryana, Rajasthan, Gujarat and parts of Madhya Pradesh, Uttaranchal and Uttar Pradesh.

In recent times, Kandla Port has taken up Development of 7 Integrated facilities, and the Ministry of Environment, Forest and Climate Change (MoEF & CC), has put up some conditions while according Environmental and CRZ clearance. One of the conditions is to carry out the *"Study on Dredged Material for presence of contaminants"* as accorded by the MoEF&CC,GoI dated 19/12/2016 - Specific condition no. vii)" which states that ***"Dredged materials should be***

analyzed for presence of contaminants and also to decide the disposal options. Monitoring of dredging activities should be conducted and the findings should be shared with the Gujarat SPCB and Regional Office of the Ministry".

2.1. Need of the study

Based on the above condition, DPT has assigned the task of carrying out the study to Gujarat Institute of Desert Ecology (GUIDE), Bhuj. This study will be attempted three times in a year at two specified locations. Further, the study will envisage the evaluation of physico-chemical constituents in the dredged materials in the dumped locations in the study area. GUIDE has received the Work order for this Dredging project with project time period being Three years (01.11.2018 – 31.10.2021). In this connection, the study was taken up for evaluation of dredged materials for the presence of contamination was conducted with the methodical investigation of evaluating physical, chemical and biological characteristics of the dredged materials with special reference to pollutants including heavy metal, Petroleum hydrocarbon etc.

2.2. Scope of Study

1. To monitor the locations where dredged materials are dumped will be conducted.
2. Dredged materials in the area will be analyzed for the presence of contaminants in two different locations.
3. Detailed assessment of the dredged materials for physical, chemical and biological characteristics will be studied.
4. Suggesting suitable disposal options for the dredged material will be made.

2.3. Selection of sampling locations for 2017-18

DPT has assigned the study on the presence of contaminants in the dredged materials for the year 2017-18 based on the location earmarked by DPT by Hydraulic & Dredging Division based on the e-mail dated 24 October 2018 and the GPS locations are mentioned in below Table 1.

Table 1: GPS Co-ordinates of sampling locations (2017-18)

Station	Latitude (N)	Longitude (E)
Location 1 (Sub-titdal / Offshore)	22° 51' 00" N	70° 10’ 00" E
Location 2 (Phang creek)	23° 04' 28" N	70°13’ 28" E

2.4. Selection of sampling locations for 2019-20

In line with the studies conducted during 2017-18 and 2018-19, the study for the presence of contaminants in the dredged materials for the year 2019-20 was planned considering the location details as provided to DPT by Hydraulic & Dredging Division earmarking the locations on dumping ground. Further, as per the discussion and as per DPT request, during the third season of the study during September 2020, an additional site (Cargo Jetty location) was also studied and the GPS locations are mentioned in below Table 2.

Table 2: GPS Co-ordinates of sampling locations (2019-20)

Station	Latitude (N)	Longitude (E)
Location 1 (Offshore)	22° 51' 00" N	70° 10’ 00" E
Location 2 (Phang creek)	23° 04' 28" N	70°13’ 28" E
Location 3 (Cargo jetty)	22°56' 31" N	70 13' 00" E

2.5. Port and its Environment

Rapid coastal industrialization in recent years has underlined the importance of complete understanding and continuous monitoring of marine environments, especially, coastal stretches where human activity is intense. Ports are economic instruments for trade and a vital component in the nation’s economy. Nevertheless, port activities such as land reclamation, dredging and large-scale construction and its continuous expansion negatively affect the marine ecosystems in its vicinity. In a port environment, activities like dredging, continuous movement of vessels and human create major impacts at the marine/coastal environment in its vicinity.

2.6. Port Activities

The traffic handled by the Port has shown consistent increase and is growing at a fast pace every year. The total traffic including liquid and dry cargo handled by the port was 105 MMTPA during 2016-17 and 110 MMTPA during 2017-18 and to the tune of 115 MMTPA during 2018-2019. Cargo traffic handled at Deendayal port is mainly comprised of Iron scrap, steel, food grains, ore, timber logs, salt extractions, POL products, edible oils and chemicals of 66 varieties. Containerized cargo traffic through this port has also shown a significant growth during the last few years. The dry cargo traffic at the port has been increasing steadily every year at a much faster pace with an average annual rate of growth of around 11.94%. The Port has presently fourteen (14) jetties and six oil terminals and many other allied facilities to handle both dry and liquid cargo. Regular expansion/developmental activities such as addition of jetties, Special Economic Zones, industrial parks, go downs, ship repairing and bunkering facilities and railway lines are underway in order to cope with the increasing cargo handling demands.

As part of its ongoing expansion, Deendayal Port authorities intend to develop seven (7) integrated facilities which include development of oil jetty and ship bunkering terminal at old Kandla, a multi-purpose oil terminal near Tuna, upgradation of barge handling facility at Kandla, construction of one rail over bridge and strengthening of existing oil jetties. Deendayal Port has also proposed to develop a multipurpose cargo terminal and a container terminal at the creek mouth. This entails regular vessel movement, and capital and maintenance dredging of different proportions. Development of multipurpose cargo terminal at Tekra off Tuna and construction of railway over-bridge at the inner end of Nakthi creek is sanctioned by the ministry. The cargo terminal will come up very close to the mouth of the Nakthi creek and it envisages capital and maintenance dredging to the tune of 12657175 and 1898576 m^3, respectively.

2.7.EC conditions

Deendayal Port has taken up activities including Special Economic Zone (SEZ) establishment. Recently, Deendayal Port has taken up Development of 7 Integrated facilities, and the Ministry of Environment, Forest and Climate Change (MoEF & CC), has put up some conditions while according Environmental and CRZ clearance. One of the conditions is to carry out the "Study on Dredged Material for presence of contaminants" as accorded by the MoEF & CC, GoI dated 19/12/2016 - Specific condition no. vii)".

In this regard, DPT has assigned the task of carrying out this particular study to Gujarat Institute of Desert Ecology (GUIDE), Bhuj. This study on Evaluation of dredging contamination was conducted Three times in a year at two different dumping locations with the methodical investigation of evaluating physical and chemical characteristics of the dredged materials with special reference to pollutants such as heavy metals and petroleum hydrocarbon. Further, the study also envisaged the management options to reduce the possible contamination due to dredged materials.

2.8.Study Area

Deendayal port is located at Gandhidham taluka, Kachchh district. The coastal belt in and around DPT port jurisdiction is characterized by a network of creek systems and mudflats which are covered by sparse halophytic vegetation like scrubby to moderately dense mangroves, creek water and salt-encrusted landmass which forms the major land component. The surrounding environment in a radius of 10 km from the port includes built-up areas, salt pans, human habitations and port related structures on the west and north creek system, mangrove formations and mudflats in the east and south. The nearest major habitation is Gandhidham town about 12 km west of DPT port with a population of 2, 48,705 (as per 2011 census). Deendayal Port and its surroundings have mangroves, mudflats and creek systems as major ecological entities.

2.9.Scope of the study

GUIDE has received the Work order for this Dredging project in the Last week of October 2018 with effective Project period being 01.11.2018 – 30.10.2021 (Three years). The present project is designed considering the scope of work given in the EC conditions with the specific objectives as detailed below:

1. To characterize the physical, chemical and biological characteristics of the bottom sediment from two dumping locations.

2. To study the physical, chemical and biological characteristics of the marine water from two dumping locations.

3. To compare the characteristics of the dredged materials during three season monitoring in the year and to suggest management options for such dredged materials.

2.10. Approach Strategy

GUIDE has been given the work for conducting the study by DPT to study the presence of contaminants in two dumping locations of Gulf of Kachchh. The study was undertaken to understand the pattern of pollutants present in the dredged materials present in the dumping locations considering the general environmental setting of the entire Gulf. Coastal waters often reveal significant temporal, spatial and seasonal changes with reference to sediment and water environmental and other ecological aspects and such variations should be clearly understood for assessing the prevailing status of a coastal water body.

2.11. Macro-level assessment and sampling site delineation

In order to understand the project site and to identify the sampling location, a reconnaissance survey was carried out. Referring appropriate GIS imageries, extent and availability of habitats were estimated, pre-fixed sampling locations as prescribed by CWPRS was selected and types of sampling techniques to be employed was decided. In the offshore realm, the dumping location was visited in order to estimate approach and other details. In this survey, sampling locations for the locations to be studied were identified and fixed with GPS reference.

2.12. Period of Dredging study

This report covers the monitoring results for the period from November 2019 - October 2020.

2.13. Sampling frequency

Water and sediment quality in terms of physical, chemical and biological characteristics were spot sampled at both the locations thrice during the study period. This detailed report represents the outcome of all the Three seasons study in which the first season sampling was conducted for a period of 2 days during 30^{th} & 31^{st} December 20201, the second season study was conducted for a period of 2 days during 22^{nd} & 23^{rd} June 2020 and the final season study was conducted during 13^{th}, 14^{th} and 15^{th} August 2020 for a period of three days as per the locations details mentioned in the map as Figure 1.

Figure 1: Map showing locations sampling during 2019-20

3.0.Background

Marine sediments plays very important role in coastal environment due to its organic matter input that provides nutrients and energy to the abiotic ecosystem and is also acts as sensitive indicator of contamination especially in aquatic environments (Pekey et al. 2004 and Atgn et al. 2000) which can indicate the changes caused due to both, natural and manmade events (Kucuksezgin et al. 2006). The sediment texture is the composition of sand, silt, clay groups are commonly referred to as the soil separates. Sediment texture is defined as the relative proportions of each class. Sediments, in general, have strong tendency to accumulate contaminants, especially heavy metals. Further, they harbor high physical–chemical stability and studying their characteristics usually indicates the optimum health of the marine system (Leoni and Sartori 1996). Thus, in the present study, the physico-chemical characteristics of the marine sediment collected from the study area was used to ascertain the nature of the marine environment of the coast.

This chapter narrates the sediment sample collection from the study area, the methodology adopted for the analysis and the data. The marine sediment samples were collected in prefixed stations using a Van-Veen type of grab sampler and the samples after collection were air dried and used for further analysis for the parameters. The sediment samples were preserved with Rose Bengal and formalin to avoid decomposition of samples and processed for analysis (Table 3)

Table 3: Physico-chemical and biological characteristics of sediment samples

S. No	Physico-chemical and Biological parameters
1	pH (1: 10 suspension)
2	Salinity
3	Petroleum Hydrocarbon
4	Magnesium
5	Sand (%)
	Silt (%)
	Clay (%)
6	Total organic carbon
7	Phosphorus
8	Sulphur
9	Nickel
10	Lead
11	Cadmium
12	Chromium
13	Zinc
14	Copper
15	Manganese
16	Cobalt
17	Macrobenthos Biomass (g/m^2,wet wt) Population (no/m^2) Total Group (no.) Major Groups

3.1. pH / Salinity (1: 10 suspension)

pH of the soil is the measure of H^+ ion activity of the soil water system. It indicates whether the soil is acidic, neutral or alkaline in nature. Since ions are the carrier of electricity, the electrical conductivity (EC) of the soil water system rises according to the content of soluble salts. The measurement of EC can be directly related to soluble salts concentration of the soil at any particular temperature. Ten gram of the finely sieved soil will be dissolved in 100ml of water to prepare a leachate. This will be subjected to vigorous shaking using a rotator shaker for 1 hour to facilitate proper homogenization of the suspension. The suspension will be allowed to settle for two 2 hours and the supernatant after filtration will be used for the analysis of pH and salinity using the pH and EC meter (Make: Systronics 361) and Refractometer (Make: Atago). Each sample will be analyzed in triplicates and the mean values will be taken into consideration.

3.2. Petroleum Hydrocarbons

Sediment after refluxing with KOH-methanol mixture will be extracted with hexane. After removal of excess hexane, the residue will be subjected to clean-up procedure by silica gel column chromatography. The hydrocarbon content will be then estimated by measuring the fluorescence as per standard method.

3.3. Textural analysis (Sand/Silt/Clay)

Sediments will be collected using Van Veen grab whereas intertidal sediments will be collected using a handheld shovel. After collection, the scooped samples will be transferred to polythene bags, labeled and stored under refrigerated conditions. The sediment samples will be thawed, oven dried at 40C and ground to a fine powder before analyses.

For texture analysis, specified unit of sediment samples will be sieved using sieves of different mesh size as per Unified Soil Classification System (USCS). Cumulative weight retained in each sieve will be calculated starting from the largest sieve size and adding subsequent sediment weights from the smaller size sieves. The percent retained will be calculated from the weight retained and the total weight of the sample. The cumulative percent will be calculated by sequentially subtracting percent retained from 100%.

3.4. Total organic carbon

Total organic carbon is the carbon stored in soil organic matter which enters the soil through the decomposition of plant and animal residues, root exudates, living and dead microorganisms, soil biota etc. Total Organic carbon in the soil is oxidized with potassium dichromate in the presence of concentrated sulphuric acid. Potassium dichromate produces nascent oxygen, which combines with the carbon of organic matter to produce CO_2. The excess volume of $K_2Cr_2O_7$ is titrated against the standard solution of ferrous ammonium Sulphate in presence of H_3PO_4 using Ferroin indicator to detect the first appearance of unoxidised ferrous iron and thus volume of $K_2Cr_2O_7$ can be found out which is actually required to oxidize organic carbon.

Procedure

Percentage of Total organic carbon in the soil/sediment will be determined by oxidizing organic matter in the soil samples by chromic acid and estimating excess chromic acid by titrating it against ferrous ammonium sulphate with ferroin as an indicator. The detailed step-by-step procedure is as follows:

One gm of 0.5 mm sieved soil will be weighed and put into 500 ml conical flask and to which 10 ml of K2Cr2O7 will be added with pipette and swirled. Immediately using a burette, 20 ml Conc. H_2SO_4 will be added and mixed gently until soil and reagents are mixed. The reaction will be allowed to proceed for 30 min in a marble stone to avoid the damage caused due to release of intense heat due to reaction of sulphuric acid. Further, 200 ml of distilled water will be added slowly and 10 ml of concentrated Orthophosphric acid and about 0.2 gm NaF will be added and allowed the sample and reagent mixture to stand for 1.5 hrs because the titration end point is better visible in a cooled solution. One ml of ferroin indicator will be added into the conical flask just before the titration and then titrated the excess K_2Cr_2O with 0.5 N Ferrous Ammonium Sulphate till the color flashes from yellowish green to greenish and finally brownish red at the end point. Simultaneously a blank test will be also run without soil sample.

3.5. Total Phosphorus

Phosphorus in soil is commonly performed by Bray's method and in this method, specific colored compounds are formed with the addition of appropriate reagents in the solution, the intensity of which is proportionate to the concentration of the element being estimated. The color intensity is measured spectrophotometrically. In spectrophotometrically analysis, light of definite wavelength (not exceeding say 0.1 to 1.0 nm in band width) extending to the ultraviolet region of the spectrum constitutes the light source. The photoelectric cells in spectrophotometer measure the light transmitted by the solution.

Fifty ml of the Bray's extractant will be added to 100 ml conical flask containing 5 gm of soil sample and shaken for 5 minutes and filtered. Exactly 5 ml of the filtered soil extract will be taken with a bulb pipette in a 25 ml measuring flask and 5 ml of the molybdate reagent with an automatic pipette will be added and diluted to 20 ml with distilled water and shaken well. Further, to this, 1 ml of the dilute Stannous Chloride solution will be added and volume made upto 25 ml mark and shaken thoroughly. The mixture will be kept for color development and after 10 minutes the readings will be taken in the spectrophotometer at 660 nm wave length after setting the instrument to zero with the blank prepared similarly but without the soil.

3.6. Total Sulphur

Sulphur in the sediment extract **was** estimated turbidimetrically using a spectrophotometer. The standards of sulphur was prepared in series such as 2, 4, 6, 8 and 10 ppm working solution from stock solution. In this, 25ml of solution was added in the volumetric flask separately to each flask and 2.5 ml of conditioning reagent solution was also added followed by 5 ml of extraction solution was added. To this mixture, 0.2-0.3 gm of barium chloride was also added and shaken well and madeup to 25 ml with distilled water and the readings were taken at 340nm spectrophotometer.

The sample was analyzed by taking 5g of marine sediment into a 100ml conical flask, to which, 25 ml of 0.15 % $CaCl_2$ solution was added and shaken for 30 minutes. Then this was filtered through Whatman no. 42 filter paper and then 5 ml of sample aliquot was taken in a 25 volumetric flask, to which 2.5 ml of conditioning reagent and 0.2 to 0.3 g of barium chloride powder was added and made up to 25 ml distilled water and shaken well for 2 minutes and the absorbance was read in the same manner as standard solutions.

3.7. Heavy metals

Heavy metals are of concern especially as it relates to the environment are Cadmium (Cd), Lead (Pb), Mercury (Hg), Chromium (Cr), Nickel (Ni), Cobalt (Co), Arsenic (As), Copper (Cu), Zinc (Zn), Manganese (Mn) etc. For the release of mineral elements from soil and sediments, wet oxidation of samples are generally performed. Wet oxidation employs oxidizing acids (Tri / Di-acid mixtures).

Soil sample will be weighed to 0.5 gm and taken in 100ml beaker covered with a watch glass and 12 ml of Aqua regia in (1: 3 HNO_3 : HCl) will be added and the beaker will be kept in digestion for 3 hours at 100^0c on a hot plate using sand bath and the samples will be evaporated to near dryness and the samples will be kept cool for 5 mins and then 20 ml of 2% nitric acid will be added and kept for 15 minutes in hot plate for digestion and remove from hot plate and cooled and filtered using Whatmann No. 42 mm filter paper and then the final make up to 50 ml with 2 % nitric acid will be made. The extracted sample will be then aspirated to an AAS.

3.8. Results

Sediment analysis is increasingly important in evaluating qualities of the total ecosystem of a body of water in addition to the water sample analysis. In comparison to water quality analysis, sediment analysis reflects the long term quality situation independent of current inputs. Thus, in the present study, the physico-chemical characteristics of the marine sediment collected from the study area was used to ascertain the nature of the marine environment of the coast.

3.8.1. Physico-chemical characteristics of the sediment during Season 1

The brief on the sediment characteristics of Season 1 is described as follows and the data is shown in Table 4. The salinity profile of the water is also reflected in the sediment profile of the environment and in the present study the salinity profile of the sampling locations ranged between 12.14 – 25.61 ppt with the average salinity recorded was 17.46 in site 1 and 18.90 in site 2 during first season. The PHC concentrations in the sediment samples were recorded with a minimum concentration of 0.4 – 1.26 µg/Kg/. The magnesium content in the sediment samples revealed the magnesium concentrations in the range of 390.37 - 1041.01 mg/Kg with the mean magnesium concentration value of 662.68 at site 1 and 532.55 mg/Kg at site 2. The total organic carbon on the sediment was registered to be 0.06 – 0.91% with the mean TOC concentration recorded as 0.29% and 0.60% at site 1 and site 2 respectively.

The textural analysis of the sediment reveals that the dominant portion of the sediment was silty (Avg. 47.454%) followed by clay (Avg. 36.33%) and sand (Avg. 16.22%). The lowest and highest concentration of phosphorus concentration of the bottom sediments were recorded between 1.41 – 3.41 mg/Kg with the mean phosphorus concentration of 9.49 mg/Kg and 4.00 mg/Kg at site 1 and site 2 respectively, When the sulphur concentrations are concerned, a mean sulphur concentration of 14.67 mg/Kg at site 1 and 30.54 mg/Kg at site 2 was observed.

Among the heavy metals analyzed, lead concentration ranged between 14.0 - 24.15 mg/Kg with an average concentration being 18.48 mg/Kg at site 1 and at site 2 it ranged between 7.35 -22.65 mg/Kg with a average lead concentration of 18.33 mg/Kg. The heavy metal Nickel has recorded a concentration ranging from 6.25 - 67.75 mg/Kg with a mean concentration of 24.81 mg/Kg at location 1 and 23.6 - 52.1 mg/Kg with Average of 41.65 mg/Kg at site 2.. The mean cadmium concentration of 0.34 – 0.72 mg/Kg at site 1 and site 2 respectively. The lowest chromium concentration of 5.15 mg/Kg was recorded at site 2 and the highest concentration of 56.55 mg/Kg was recorded at site 1. The values of zinc at site 1 was ranging between 23.1 – 60.85 mg/Kg and at site 2 it was 3.35 – 93.95 mg/Kg. Elements like copper recorded a mean concentration at site 1 and site in the order 16.02 and 24.01 mg/Kg respectively. The manganese concentration was in the range between 239.95 - 327.45 with an average value being 272.71 mg/Kg at site 1, whereas in site it was in the range between 48.35 - 281.05with an average value of 232.30 mg/Kg. The study in both the locations revealed lower concentrations of cobalt and the average concentration was 4.10 mg/Kg and 0.75 mg/Kg at site 1 and site 2 respectively.

Table 4: Physico-chemical characteristics of sediment samples from the study area during January 2019

		Offshore						Phang Creek					
S. No	Parameters	1A	1B	1C	1D	1E	Control 1	2A	2B	2C	2D	2E	Control 2
1	pH (1: 10 suspension)	7.6	7.8	7.3	7.9	7.4	7.6	7.8	8	8	7.9	7.6	8
2	Salinity (ppt)	14.7	17.76	25.61	14.62	15.69	16.35	12.14	21.47	17.26	18.91	23.38	20.24
3	Petroleum Hydrocarbon (µg/Kg)	1.26	0.71	0.86	0.76	0.4	0.78	0.67	0.68	0.52	0.5	0.53	0.55
4	Magnesium (mg/Kg)	563.88	390.37	1041.01	607.25	694	679.54	607.25	534.96	419.29	477.13	636.17	520.5
5	Sand (%)	1.5	53.3	1.1	0.9	1.2	39.3	6.2	39.6	41.9	42.9	36.2	3.3
	Silt (%)	9.1	20.9	69.6	74.3	76.8	34	92.2	19.3	36.7	39.7	24.2	17.8
	Clay (%)	89.4	25.8	29.3	24.8	22	26.7	1.6	41.1	21.4	17.4	39.6	78.9
6	Total organic carbon (%)	0.19	0.58	0.28	0.22	0.24	0.25	0.06	0.6	0.49	0.66	0.91	0.87
7	Phosphorus (mg/Kg)	3.52	3.41	5.88	4.7	4	4.7	1.41	6.58	4.23	4.47	3.05	4.23
8	Sulphur (mg/Kg)	9.42	21.1	12.47	9.19	10.01	25.81	7.83	20.81	21.97	50.37	58.78	23.48
9	Nickel (mg/Kg)	10.55	67.75	7.85	6.25	11.25	45.2	BDL	52.1	45.3	41.65	45.6	23.6
10	Lead (mg/Kg)	14	24.15	15.9	16.65	19.45	20.7	7.35	21.45	20.95	21.3	22.65	16.3
11	Cadmium (mg/Kg)	BDL	0.35	BDL	0.05	0.1	0.85	BDL	BDL	0.45	0.65	1.05	BDL
12	Chromium (mg/Kg)	23.7	56.55	15.7	18.4	20.1	42.45	5.15	51.5	40.9	40.45	41.65	25.05
13	Zinc (mg/Kg)	32.1	23.1	28.7	32.9	27.6	60.85	3.35	63.35	93.95	54.2	89.65	49.65
14	Copper (mg/Kg)	8.1	33.45	7.35	9.3	8.85	29.05	BDL	31	26.5	26.25	27.85	8.45
15	Manganese (mg/Kg)	239.95	327.45	250.6	253.75	281.7	282.8	48.35	271.25	261	265.55	281.05	266.6
16	Cobalt (mg/Kg)	BDL	7.05	BDL	BDL	BDL	1.15	BDL	1.8	0.45	0.15	0.6	BDL

Note: BDL denotes Below Detection Limit

3.8.2. Physico-chemical characteristics of the sediment characteristics during Season 2

The pH of the sediment sample of the three locations was recorded between 7.3 – 8.1. The PHC concentrations in the sediment samples were recorded with a minimum concentration of 0.593 – 1.817 µg/Kg and the mean PHc concentration of the sediment was registered as 1.23 when both the sites are concerned. The salinity profile of the water is also reflected in the sediment profile of the environment and in the present study the salinity profile of the sampling locations ranged between 4.29 – 22.47 ppt with the average salinity recorded was 11.38. The magnesium content in the sediment samples revealed the magnesium concentrations in the range of 130.3 – 521.23 mg/Kg with the mean magnesium concentration value of 293.18 mg/Kg when both the sites are concerned. The total organic carbon on the sediment was registered to be 0.08 – 0.58% with the mean TOC concentration recorded as 0.27% when site 1 and site 2 is considered. The sulphur concentrations ranged between 1.56 – 2.72 mg/Kg with a mean sulphur concentration of 8.79 mg/Kg. Among the two locations studied the lowest and highest concentration of phosphorus concentration of the bottom sediments were recorded between 4.79 – 17.27 mg/Kg with the mean phosphorus concentration of 8.79.

Other than chemical constituents, heavy metals such as Nickel, Lead, Cadmium, Chromium, Zinc, Copper, Manganese and Cobalt were also analysed and the data is shown in table 5. Among the metals analyzed, Lead, cadmium, chromium and Cobalt were found to be in the below detection concentrations at mg/Kg unit. Few of the samples revealed a below detection limit of zinc at mg/Kg units. Among the values recorded, the zinc concentration was ranging between 3.55 – 34.5 mg/Kg and the mean zinc concentration of 21.96 mg/Kg was recorded among both the stations during Season 2. When other metals are concerned, nickel has recorded a concentration ranging from 2.05 - 41.95 mg/Kg with a mean concentration of 16.34 mg/Kg among both the locations. The copper concentration ranged between 4.65 – 13.25mg/Kg respectively with the average copper concentration in the sediment samples as 8.25 mg/Kg. The manganese concentration was in the range between 7.8 - 239.45 mg/Kg with an average value being 106.61 mg/Kg when both the sites were studied (Table 5).

Table 5: Physico-chemical characteristics of sediment samples from the study area during May 2019

		Offshore						Phang Creek					
S. No	Parameters	1A	1B	1C	1D	1E	Control 1	2A	2B	2C	2D	2E	Control 2
1	pH (1: 10 suspension)	8.1	7.9	7.6	7.5	7.5	7.5	7.4	7.3	7.6	7.7	7.3	7.5
2	Salinity (ppt)	6.77	4.29	5.94	7.76	6.11	9.66	12.63	22.47	11.4	17.01	19.99	12.47
3	Petroleum Hydrocarbon (μg/Kg)	0.731	0.593	1.548	1.32	1.343	0.756	1.817	1.62	1.5	0.907	1.217	1.382
4	Magnesium (mg/Kg)	225	130.3	189.54	248.75	248.75	355.38	248.83	379	189.54	414.63	521.23	367.22
5	Sand (%)	0.9	6.5	1	1.2	3.7	1.8	31	24.1	27.6	8.8	7.9	6.5
	Silt (%)	3.4	5.2	3.9	4.4	1.4	3.2	11.8	9.7	8.8	6.8	6.1	7.1
	Clay (%)	95.7	88.3	95.1	94.4	94.9	95	57.2	66.2	63.6	84.4	86	86.4
6	Total organic carbon (%)	0.08	0.08	0.11	0.13	0.23	0.18	0.22	0.28	0.28	0.52	0.58	0.53
7	Phosphorus (mg/Kg)	6.95	6.71	6.47	5.75	9.11	6.71	14.15	17.27	13.43	4.79	5.27	8.87
8	Sulphur (mg/Kg)	2.114	1.764	1.62	1.596	1.767	1.569	1.662	2.123	1.785	2.601	2.721	2.709
9	Nickel (mg/Kg)	5.55	5.25	14.6	22.9	13.6	19.8	24.3	2.05	7.35	22.65	41.95	16.05
10	Lead (mg/Kg)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
11	Cadmium (mg/Kg)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
12	Chromium (mg/Kg)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
13	Zinc (mg/Kg)	BDL	BDL	22.55	23.4	3.55	3.55	34.5	33.15	33.05	BDL	BDL	BDL
14	Copper (mg/Kg)	BDL	BDL	BDL	BDL	4.75	4.65	13.25	13.05	13.15	5.55	5.75	5.85
15	Manganese (mg/Kg)	30	30.85	29.8	9.55	8.9	7.8	233.55	230.9	239.45	151.95	152.1	154.5
16	Cobalt (mg/Kg)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Note: BDL denotes Below Detection Limit.

3.8.3. Physico-chemical characteristics of the sediment characteristics during Season 3

One of the critical parameter petroleum hydrocarbons in the sediment samples were recorded with the maximum concentration of 12.14 mg/Kg which was well within the permissible limits prescribed for that parameter. The salinity profile of the sediment sample ranged between 6.60 ppt - 21.89 ppt with the average salinity concentration between 16.86 ppt. The textural analysis of the sediment reveals that the dominant portion of the sediment was silty (Avg. 18.22%) followed by clay (Avg. 70.99%) and sand (Avg. 10.79%) and the textural characteristics was very much similar to the recorded values in the previous season with clay being the predominant type followed by silt and sand.

The mean value pH of the sediment samples was 7.57 with the minimum and maximum values recorded were between 7.23 -8.10. The total organic carbon on the sediment was registered to be 0.12 – 0.61% with the mean TOC concentration recorded as 0.26% among all the three sites are concerned. Even TOC profile of the sediments similar to previous season with no major significant changes were noticed. The magnesium content in the sediment samples revealed the magnesium concentrations in the range of 161.60 – 600.00 mg/Kg with the mean magnesium concentration value of 400.09 mg/Kg when both the sites are concerned. The sulphur concentrations ranged between 0.04 – 0.63 mg/Kg with a mean sulphur concentration of 0.33 mg/Kg. During this season, it was observed that sulphur concentrations were found to be low when compared to previous seasons and the reason for the same could be attributed due to monsoon characteristics. Among the three locations studied the lowest and highest concentration of phosphorus concentration of the bottom sediments were recorded between 4.10 – 16.79 mg/Kg with the mean phosphorus concentration of 10.76 mg/kg.

Heavy metals such as Nickel, Lead, Cadmium, Chromium, Zinc, Copper, Manganese and Cobalt were also analysed and the data is shown in table 6. The manganese concentration was in the range between 210.75 – 352.90 mg/Kg with an average value being 319.77 mg/Kg when all the three sites are concerned as shown in table 6.

When other trace metals are concerned, the zinc concentration was ranging between 12.75 – 167.40 mg/Kg and the mean zinc concentration of 86.73 mg/Kg was recorded among the three stations studied during Season 3. This concentration was higher than the Season 2 study. Similarly nickel has recorded a concentration ranging from 3.60 – 73.75 mg/Kg with a mean concentration of 46.94 mg/Kg among the locations studied and the nickel concentrations were very much higher than the previous seasons. Few of the samples revealed a below detection limit (mg/Kg) of the trace element Cobalt. Trace metals like copper have 2.45 – 45.70 mg/Kg respectively with the average copper concentration in the sediment samples as 26.76 mg/Kg. Among all the metals studied, Lead has been recorded in below detection concentrations (mg/Kg) in all the three locations studied.

Table 6: Physico-chemical characteristics of sediment samples from Offshore location (Site 1) and Phang creek (Site 2) and Cargo Jetty during (Site 3) September 2019

S. No	Parameters	1A	1B	1C	1D	1E	Control 1	2A	2B	2C	2D	2E	Control 2	3A	3B	3C	3D	3E	Control 3
1	pH (1: 10 suspension)	7.83	7.3	7.3	8.1	7.61	7.84	7.34	7.45	7.52	7.23	7.63	8.1	7.59	7.4	7.43	7.5	7.57	7.48
2	Salinity (ppt)	11.15	10.73	16.1	19.82	6.6	19.82	15.69	16.93	21.89	20.65	19	18.17	17.34	13.63	14.45	19	21.89	20.65
3	Petroleum Hydrocarbon (µg/Kg)	6.911	7.627	6.628	5.287	6.694	7.174	6.742	10.531	8.343	8.273	12.137	7.551	6.743	6.961	8.169	6.573	5.296	5.858
4	Magnesium (mg/Kg)	300	392.4	507.9	253.9	161.6	392.4	392.4	530.9	507.9	600	392.4	461.7	369	277	346.3	415.5	461.7	438.6
5	Sand (%)	1.4	1.1	2.9	14.1	12.4	25.9	23	0.7	5.8	12.2	23.3	19.9	18.8	1.9	0.5	10.2	0.8	19.4
	Silt (%)	6.1	9.2	10.6	28.8	5.3	33.4	9.3	20	28.8	22.8	17.7	10.7	34.9	38.2	1.5	28.9	1.2	20.5
	Clay (%)	92.5	89.7	86.5	57.1	82.3	40.7	67.7	79.3	65.4	65	59	69.4	46.3	59.9	98	60.9	98	60.1
6	Total organic carbon (%)	0.34	0.3	0.27	0.61	0.22	0.56	0.12	0.18	0.2	0.15	0.22	0.32	0.18	0.16	0.14	0.12	0.2	0.35
7	Phosphorus (mg/Kg)	4.1	6.71	8	16.41	6.34	11.75	8	7	14.55	13	16.79	12.12	12.87	11.56	10	9.88	13	11.56
8	Sulphur (mg/Kg)	0.038	0.205	0.238	0.353	0.627	0.429	0.262	0.362	0.458	0.41	0.343	0.21	0.362	0.252	0.295	0.362	0.391	0.4
9	Nickel (mg/Kg)	21.75	28.8	29.4	58.8	3.6	73.75	37.75	47.3	62.5	50.85	55.25	42.7	62	63.8	46.2	41.35	55.95	63.2
10	Lead (mg/Kg)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
11	Cadmium (mg/Kg)	BDL	0.7	0.6	1.5	1.85	1.55	1.1	1.55	1.3	1	1.1	1.1	BDL	0.95	1.15	0.85	0.65	1.65
12	Chromium (mg/Kg)	21.85	27.85	27.9	56.1	16.85	70.1	38.85	46.6	61.1	56.65	56.45	48.5	63.75	66.05	49.55	56.85	67.95	76.15
13	Zinc (mg/Kg)	38.75	44.95	49.4	67.75	12.75	167.05	84.6	84.9	107.85	98.7	129.4	56.2	138.6	167.4	63.05	55.8	71.6	122.35
14	Copper (mg/Kg)	10.35	13.85	13.35	39.65	2.45	45.7	19.85	24.25	36.3	30.05	33.25	22.6	33.85	36.85	25.25	25.05	30.9	38.1
15	Manganese (mg/Kg)	280.15	299.15	304.5	318.5	210.75	343.2	307.05	333.25	339.7	333.45	338.8	322.4	339.55	352.9	325.05	319.45	338.35	349.6
16	Cobalt (mg/Kg)	BDL	BDL	BDL	3.15	BDL	8.9	BDL	1.1	5.1	0.15	4.4	BDL	3.6	9.1	BDL	BDL	2.5	6.15

Note: BDL denotes Below Detection Limit.

Table 7: Comparison of the mean physico-chemical characteristics of the present study (2019-20) sediment data with the data of 2017-18 and 2018-19

Parameters	Period of study (in year)								
	2017-2018			2018-2019			2019-2020 (Present study)		
	S1	S2	S3	S1	S2	S3	S1	S2	S3
pH (1: 10 suspension)	8.02	7.91	7.89	8.18	7.96	7.26	7.74	7.58	7.57
Petroleum Hydrocarbons (µg/L)	2.08	5.84	4.12	5.15	16.19	4.84	0.69	1.24	7.42
Sand (%)	18.58	14.42	16.28	30.01	21.21	33.96	22.28	10.08	10.79
Silt (%)	22.79	20.98	23.73	60.29	13.73	9.91	42.88	5.98	18.22
Clay (%)	58.63	64.61	59.99	9.7	65.07	56.14	34.83	83.93	70.99
Total organic carbon (%)	1.11	1.23	1.31	0.521	0.58	0.38	0.45	0.27	0.26
Phosphorus (mg/Kg)	1.65	1.85	1.77	11.96	8.80	11.94	6.74	8.79	10.76
Nickel (mg/Kg)	0.32	0.53	0.31	8.73	7.10	0.48	32.46	16.34	46.94
Lead (mg/Kg)	2.35	6.54	2.76	33.545	47.12	BDL	18.40	BDL	BDL
Cadmium (mg/Kg)	BDL	0.08	0.12	BDL	BDL	BDL	0.50	BDL	1.16
Chromium (mg/Kg)	0.12	0.28	0.16	75.54	116.13	11.58	31.80	BDL	50.51
Zinc (mg/Kg)	0.09	0.23	0.2	37.29	54.47	0.42	46.62	21.96	86.73
Copper (mg/Kg)	0.63	1.06	0.78	12.575	18.54	1.79	19.65	8.25	26.76
Cobalt (mg/Kg)	0.21	0.66	0.93	BDL	BDL	BDL	1.87	BDL	4.42

Note: BDL denotes Below Detection Limit.

The consolidated mean data of 2017-2018, 2018-19 and 2019-20 is shown in Table 7. The pH value of the sediment samples during the present year does not have any significant variation when compared to the past two years, i.e., 2017-18 and 2018-19. The petroleum hydrocarbon concentrations observed in the present study was also similar to the past studies conducted by GUIDE. The Total organic carbon content of the sediment samples during the present and the previous year were comparatively lower when compared to the study conducted in 2017-18.. The past 3 years study revealed that the clay portion of the sediment sample is found to be dominant followed by silt and sand.

The concentration of the nickel had been increased during the present study when compared to the past two years, whereas the lead concentration has been significantly reduced from last year. Cadmium concentrations since past 3 years is observed to follow a similar trend with trace concentrations observed in the sediment samples. Chromium concentration has found to be at a lesser concentration when compared with the previous year of study (2018-19). Similar to the metal nickel, zinc and copper concentrations are found to be in an increasing trend which is evident from the data, whereas cobalt metal concentration is found to be at a lesser concentration which is in line with the previous years study. The consolidated mean data of 2017-18, 2018-19 and 2019-20 of the sediment characteristics is shown in table 7.

3.0.Introduction

The macrobenthic population can be analyzed to measure the degree and severity of the impacts of pollutants in the aquatic ecosystem. Macroinvertebrates include those organisms large enough to be caught with a net or retained on a sieve. These species may be benthic, floating freely in the water column, inhabiting substrates such as sediments, rubble, or trees, or pelagic, and they play a key role in the network of marine ecosystems and food. The biological conditions occurring at the sediment-water interface where various effects of organic oxidation and toxins occur are strongly associated with benthic macrofauna (Le Bris and Glemarec 1996). Benthic macrofauna is therefore one of the greatest biological instruments for environmental change reflection (Dakki and ligny 1998). Ecological indicators are a subset of environmental indicators that are widely used to provide synoptic knowledge on the status of environments (Marques et al., 2009). As far as the port environment, dredging is one of the most common anthropogenic disturbances in the harbor carried out for making the channels navigable or during the construction of new structures. Hence benthic communities living in subtidal habitats are the logical subject of study in any environmental monitoring program. In the point of view, the present study carried out during December 2019 – September 2020 for three seasons (Winter, Summer, and Monsoon) to assess the benthic communities in two locations (Offshore; S1A-SE & Control) and (Phane Creek; S2A –S2E & Control) whereas in monsoon season one more offshore location has been added in the Deendayal port.

4.1. Methodology

To studying the benthic organisms, triplicate samples were collected at each station using Van veen grab which covered an area of 0.1m^2. The wet sediment was sieved with varying mesh sizes (0.5 mm-macrofauna) for segregating the organisms. The organisms retained in the sieve were fixed in 5-7% formalin and stained further with Rose Bengal solution for easy spotting at the time of sorting. The number of organisms in each grab sample was expressed as number/ meter square (No/m^2). All the species were sorted, enumerated, and identified to the advanced taxonomic level possible with the consultation of available literature. The works of Fauvel (1953), Day (1967) were referred for polychaetes; Barnes (1980) and Lyla *et al*. (1999) for crustaceans; SubbaRao *et al.* (1991) and Ramakrishna (2003) for molluscs.

Further, the data were treated with univariate statistical methods in PRIMER (Ver. 6.) statistical software (Clarke and Warwick, 1994).

a) Shannon – Wiener index

In the present study, the data were analyzed for diversity index (H’) by following Shannon – Wiener’s formula (1949):

$H' = -\sum^{S} Pi \log 2\ Pi$……. i = 1

which can be rewritten as

$$H' = \frac{3.3219\ (N \log N - \sum ni - \log ni}{N}$$

where, H’= species diversity in bits of information per individual

ni = proportion of the samples belonging to the ith species

(number of individuals of the ith species)

N = total number of individuals in the collection and

∑ = sum

b) Species richness(S) was calculated using the following formula given by Margalef (1958)

c) Margalef index (d)

d = (S-1) / log N

d) Pielou’s evenness index

The equitability (J’) was computed using the following formula of Pielou (1966):

$$J' = \frac{H'}{\log_2 S} \text{ or } \frac{H'}{\text{InS}}$$

Where, J' = evenness; H' = species diversity in bits of information per individual and S = total number of species.

4.2. Results and Discussion

4.2.1 Species Composition of Subtidal Macrofauna

In the winter season 2019, three groups of benthic organisms namely molluscs, polychaetes, and "Others" were recorded. Totally 23 species of macrofauna were recorded. Of these, molluscs topped the list with 13 followed by polychaetes and "Others" with 5 species each of the total benthic organisms recorded. Concerningthe summer season 2020, altogether 27 species of macrofauna were recorded. Of these, molluscs topped the list with 15 followed by polychaetes (7) and "Others" with 5 species of the total benthic organisms recorded. As in the summer season 2020, in monsoon season 2020 also molluscs retained the first position with 12 species of the total 24 species followed by polychaetes (7) and "Others (5) in the benthic organism collected (Table 10, 11 and 12). The overall benthic data were viewed, forms like *Pholas* sp., *Natica* sp., *Capitella capitata*, *Goniada* sp., *Nephtys* sp., *Nereis* sp., placed the maximum contribution during in all the season.

4.2.2. Subtidal Population density

In winter season 2019, the population density of macrofauna were viewed, it varied from 375 to 1050 Nos/m^{-2} with maximum at S1B and minimum at S2B (Fig.2) and the overall average density of subtidal fauna was 729 No/m^2. During the summer season 2020, it varied from 500 to 1375 Nos/m^{-2} with maximum at S2C and minimum at S2B (Fig.3), and the average density was 993 No/m^2. As in monsoon season 2020, it ranged between 500 and 1200 Nos/m^{-2} with maximum at S1-CONTROL and minimum at S3C (Fig.4) and the average was 818 No/m^2.By comparing the three seasons, the maximum population density was recorded in summer-2020 (500 to 1375 Nos/m^{-2}) and minimum in the winter season (375 to 1050 Nos/m^{-2}).

Figure 2. Overall population densities of subtidal macrobenthos recorded in various sampling stations of Deendayal port during winter 2019

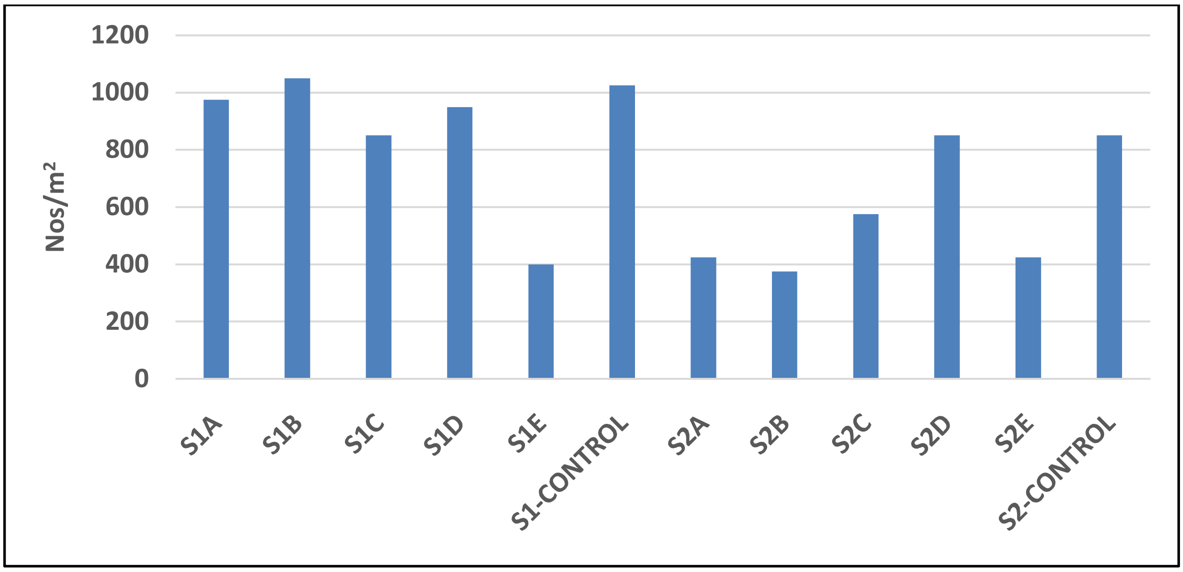


Figure 3. Overall population densities of Subtidal macrobenthos recorded in various sampling stations of Deendayal port during summer 2020

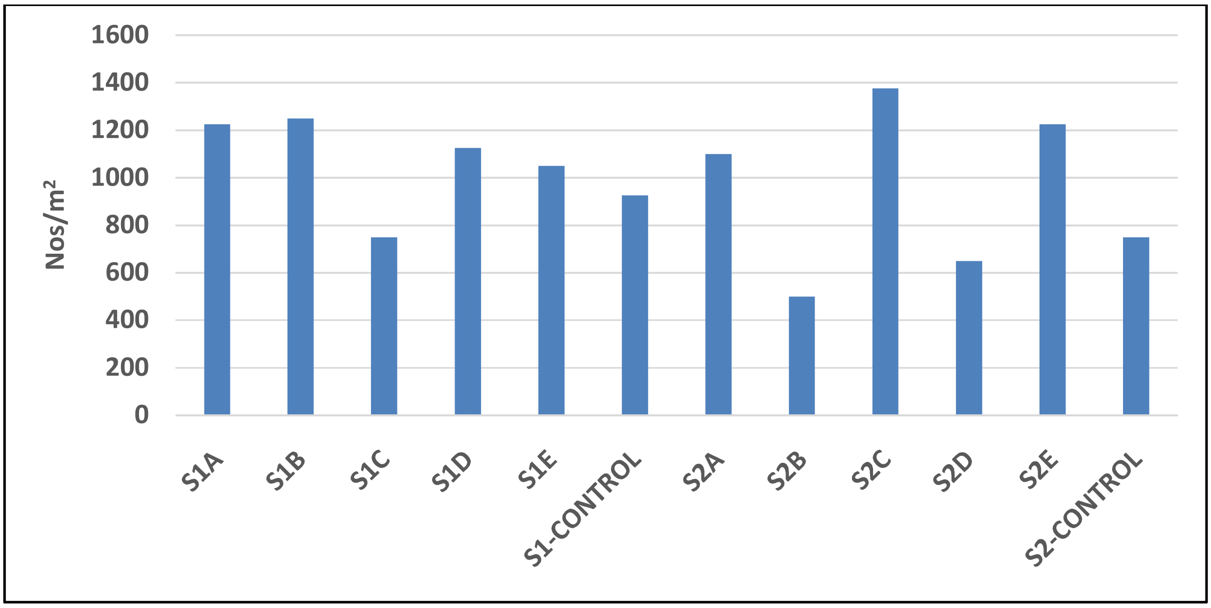
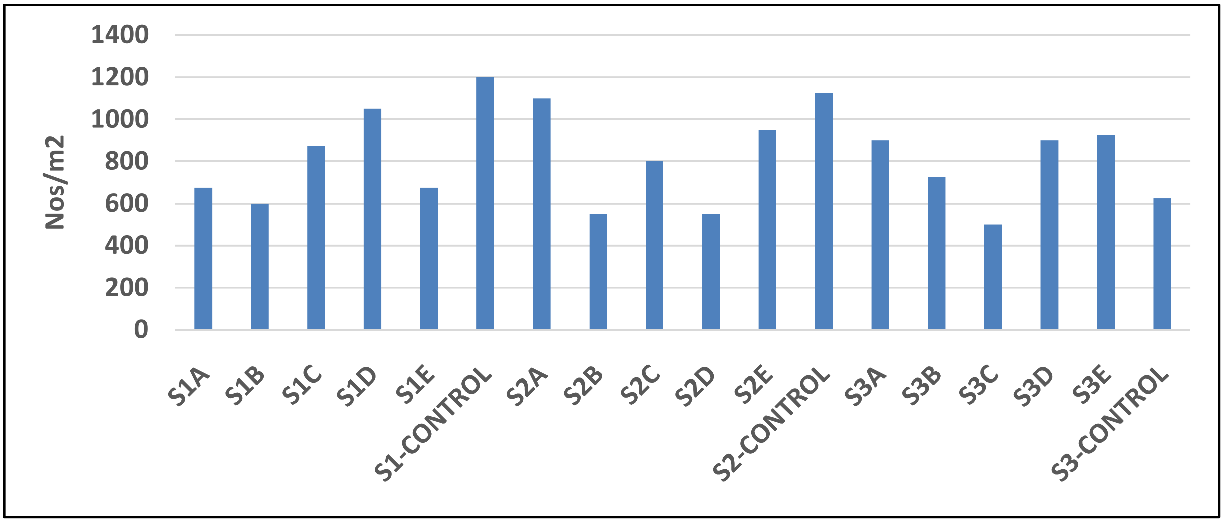


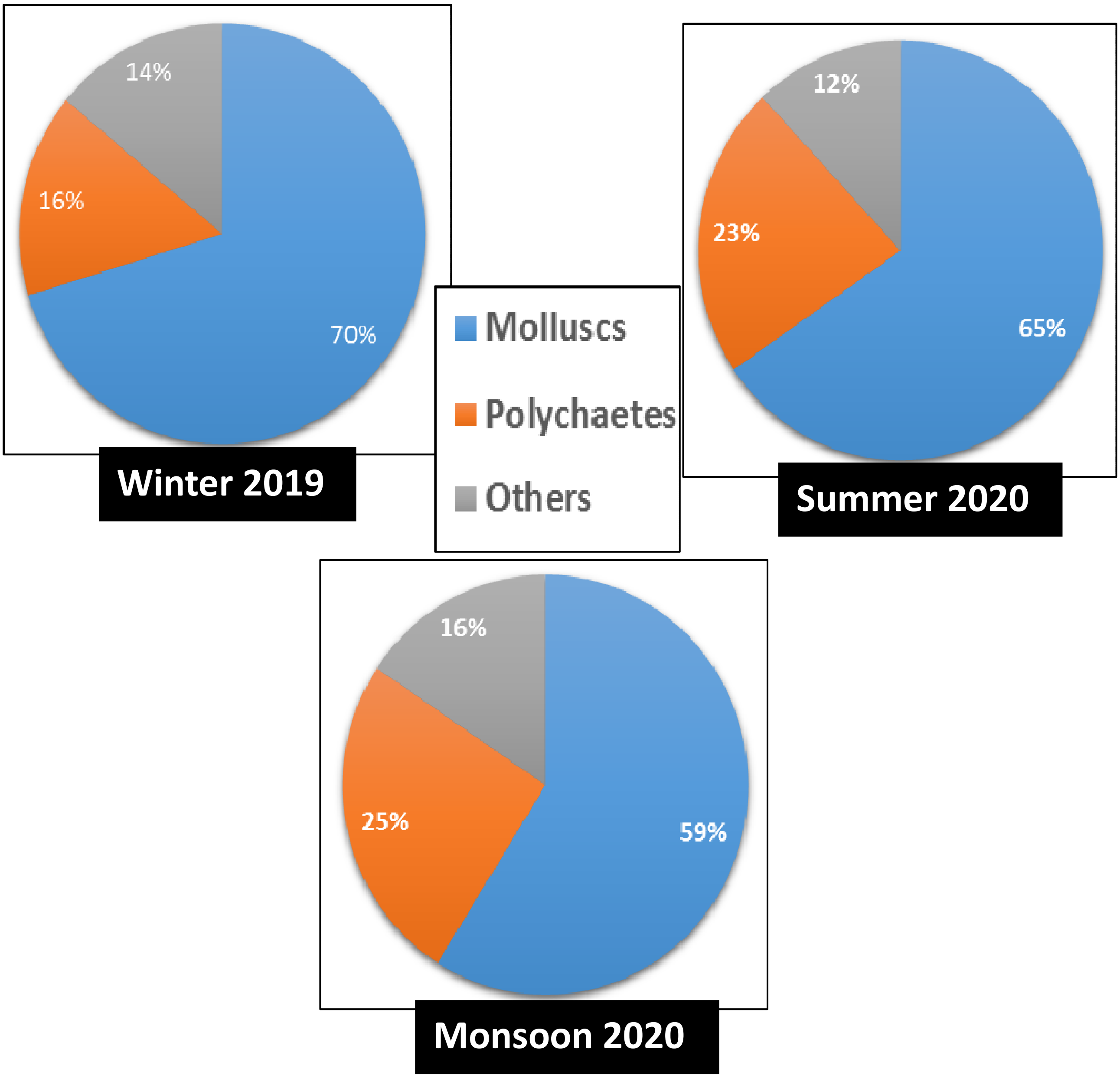
Figure 4. Overall population densities of subtidal macrobenthos recorded in various sampling stations of Deendayal port during monsoon 2020



4.2.3. Overall Percentage composition

The overall percentage composition of macrobenthic fauna showed in winter season 2019, the molluscs constituted the maximum with 70% followed by polychaetes (16%) and “Others” (14%) respectively to the benthic samples collected. The same trend were also observed in summer 2020 (molluscs 65%, polychaetes 23% and Others 12%) and monsoon 2020 (molluscs 59%, polychaetes 25%, and Others 16%) (Fig.5).

Figure 5. Overall percentage composition of macrobenthos recorded in the sampling stations of Deendayal port during 2019-2020



4.2.4. Diversity Indices

The diversity indices were viewed during winter season 2019, the shannon diversity values varied from 1.12 to 2.48 with maximum at station S1A and minimum at S2A. Margalef index, which is a measure of richness of forms that take into account both the number of taxa and the number of individuals in taxa ranged from 0.63 to 1.88 with maximum at S1-Control and minimum at S2C. The evenness values varied from 0.50 to 0.96 with maximum in S1E and minimum in S1D (Table 8). For the summer season 2020, the shannon diversity values varied from 1.47 to 2.59 with maximum at station S2A and minimum at S2B. Margalef index, which is a measure of richness of forms that take into account both the number of taxa and number of individuals in taxa ranged from 0.97 to 2.35 with maximum at S2C and minimum at S2B. The evenness values varied from 0.61 to 0.95 with maximum in S1C and minimum in S1A (Table 8). In monsoon 2020, the diversity value ranged between 2.02 and 2.45 with maximum in S1-Control and minimum in S3C. The Margalef richness varied from 1.13 to 1.99 with maximum in S2-Control and minimum in S3C. The evenness values varied from 0.64 to 0.94 with maximum in S2B and minimum in S3C (Table 8).

Table 8: Diversity indices in various stations of Deendayal port

	Off-shore						Phang Creek					
	S1A	S1B	S1C	S1D	S1E	CONTROL	S2A	S2B	S2C	S2D	S2E	CONTROL
	Winter-2019											
Individuals	975	1050	850	950	400	1025	425	375	575	850	425	850
Shannon Diversity	2.48	1.87	1.25	1.51	1.75	2.31	1.12	2.03	1.49	1.55	1.73	2.29
Evenness	0.92	0.65	0.58	0.50	0.96	0.72	0.61	0.95	0.89	0.67	0.81	0.90
Margalef	1.74	1.29	0.74	1.17	0.83	1.88	0.66	1.18	0.63	0.89	0.99	1.48
	Summer-2020											
Individuals	1225	1250	750	1125	1050	925	1100	500	1375	650	1225	750
Shannon Diversity	2.07	2.41	2.34	2.19	2.52	1.89	2.59	1.47	2.58	2.42	2.34	2.53
Evennes	0.61	0.74	0.95	0.64	0.89	0.83	0.89	0.62	0.73	0.94	0.80	0.89
Margalef	1.69	1.96	1.51	1.85	1.87	1.03	2.00	0.97	2.35	1.70	1.69	1.96

	Monsoon-2020																	
	Off shore												Phang Creek					
	S1A	S1B	S1C	S1D	S1E	S1- CONTROL	S2A	S2B	S2C	S2D	S2E	S2- CONTROL	S3A	S3B	S3C	S3D	S3E	S3- CONTROL
Individuals	675	600	875	1050	675	1200	1100	550	800	550	950	1125	900	725	500	900	925	625
Shannon Diversity	2.11	2.22	2.11	2.12	2.24	2.45	2.40	2.24	2.07	2.14	2.23	2.39	2.34	2.32	2.02	2.33	2.18	1.89
Evennes	0.82	0.92	0.75	0.64	0.85	0.83	0.79	0.94	0.72	0.94	0.78	0.72	0.80	0.92	0.94	0.86	0.74	0.73
Margalef	1.38	1.41	1.48	1.73	1.54	1.83	1.86	1.43	1.50	1.27	1.60	1.99	1.76	1.52	1.13	1.62	1.61	1.24

4.2.5. Comparing with earlier studies conducted by GUIDE

The species contribution of subtidal macrobenthic fauna are not significantly varied in terms of species composition and population density during the study period. The population density of the present study was slightly lower (500 to 1200 Nos/m^2) compare with earlier studies conducted by GUIDE in the same study sites for the year (2018- 2019) and (2019-2020). It is inferred that there was no significant variation with respect to the faunal density at all the sampling sites between the periods of observation (350-1725 Nos/m^2; 575-2050 Nos/m^2; 425-1475 Nos/m^2in 2018-2019 and 375-1025 Nos/m^2; 500-1375 Nos/m^2 in 2019-2020) showed only the marginal variation as mentioned in table 9.

Table 9: Data showing the trend of last two years

	Year (2018-2019)			Year (2019-2020)		
	Winter	**Summer**	**Monsoon**	**Winter**	**Summer**	**Present study**
Molluscs	15	17	13	13	15	12
Polychaetes	5	6	5	5	7	7
Others	5	6	5	5	5	5
Total no of species	20	29	23	23	27	24
Population density Nos/m^2	350-1725	575-2050	425-1475	375-1025	500-1375	500-1200

4.2.6. Comparing with studies conducted elsewhere

The results obtained for the two years report (2018 – 2019) and (2018 – 2020) for the three different seasons demonstrates that the subtidal bottom substratum did not vary considerably to affect the production of the benthos significantly and the environment is suitable for the existence of diverse groups of fauna. The predominance of molluscs and polychaetes in the nearshore areas has been from the Dharmadam coast (Anu and Bijoy Nandan, 2014), Kathiyavar coast (Poonam et al., 2014),and Odisha and Andhra coasts (Jagmine et al.,2015). The total faunal density in the present study showed similar trends observed from Bhitarkanika mangroves (Mahapatro et al. 2011) and Andaman and Nicobar Islands (Ramakrishna et al., 2011) where the population density was maximum 1015/m^2.

The diversity indices are the measure of the degree to which species or organisms in a sample are taxonomically or phylogenetically related to each other (Clarke and Warwick, 1994). The quantification of biodiversity is fundamental to the identification of changes that may be taking place and their possible consequences. Biodiversity can be measured at many levels and in numerous ways (Hambler and Speight, 1995) but it simply relates to the number of species in an area. In our study, the diversity indices were viewed, the result showed that the maximum diversity was recorded in summer 2020 (1.47 to 2.59) with maximum at station S2A and minimum at S2B and minimum in monsoon 2020 (2.02 and 2.45) with maximum in S1-CONTROL and minimum in S3C.Shillabeer and Tapp (1989) stated that the marine environment is far more dynamic therefore, there may be a wide range of variations in the diversity of benthos of the environment. Thus, variations in the species diversity observed in the present study could be deduced to the dynamic nature of the marine environment. In general, the diversity indices indicate a healthy environment when the Shannon diversity ranged between 3.0 and above in the coastal environment (Magurran 1991). True to the above statement, in the present investigation, the occurrence of number of species and diversity indices was rather low owing to high turbidity, organic level, tidal flow and high rate of siltation. In our investigation, the occurrence of number of species and diversity indices is rather low owing to high turbidity, organic level, tidal flow, and high rate of siltation. These features coupled with harbor activities and continuous movement of cargo and container ships which impact the subtidal faunal community lead to less biodiversity.

Table 10: Macrobenthic faunal distribution in Deendayal Port (December 2019)

Molluscs	**S1A**	**S1B**	**S1C**	**S1D**	**S1E**	**S1-CONTROL**	**S2A**	**S2B**	**S2C**	**S2D**	**S2E**	**S2-CONTROL**	**% of Occurrence**
Anadara sp.	0	0	0	50	100	25	0	0	0	100	0	0	33.33
Cerithidea cingulate	0	75	0	100	0	50	50	0	175	25	0	0	50
Crassostrea sp.	0	175	0	25	50	0	0	0	150	0	0	75	41.67
Gafrarium sp.	50	75	0	0	0	0	0	50	0	50	25	50	50
Gastropods veliger	50	0	25	0	0	100	0	0	0	0	0	0	25
Meretrix sp.	75	75	0	0	50	0	0	0	50	0	0	0	33.33
Natica sp.	0	50	0	0	0	25	0	75	0	0	0	0	25
Pharella sp.	0	25	0	0	0	0	0	0	0	0	75	25	25
Pholas sp.	100	425	525	550	75	300	275	0	150	425	0	175	83.33
Placenta sp.	0	25	0	25	0	0	0	0	0	0	0	0	16.67
Thais bufo	50	0	50	75	75	25	0	50	0	0	0	100	58.33
Telescopium sp.	0	25	0	0	0	125	0	0	0	75	0	0	25
Turritella sp.	50	0	0	0	0	0	0	50	0	0	75	50	33.33
Polychaetes	0	0	0	0	0	0	0	0	0	0	0	0	0
Capitella capitata	100	0	0	0	0	75	0	0	0	0	0	100	25
Glycera sp.	100	0	0	50	0	25	50	50	0	0	0	0	41.67
Goniada sp.	0	0	75	0	0	0	0	0	0	0	25	75	25
Nephtys sp.	150	100	0	0	0	75	0	0	0	0	0	0	25
Nereis sp.	0	0	100	25	0	25	0	25	0	0	150	0	41.67
Others	0	0	0	0	0	0	0	0	0	0	0	0	0
Ampithoe sp.	75	0	0	0	50	0	25	0	0	75	0	0	33.33
Isopods	25	0	0	0	0	50	0	0	50	100	0	0	33.33
Fish larvae	0	0	0	50	0	50	25	0	0	0	0	75	33.33
Gammarus sp.	75	0	0	0	0	0	0	25	0	0	25	50	33.33
Penaeus sp.	75	0	75	0	0	75	0	50	0	0	50	75	50
Population density Nos/m^2	**975**	**1050**	**850**	**950**	**400**	**1025**	**425**	**375**	**575**	**850**	**425**	**850**	
Biomass wet weight (g/m^2)	**3.7**	**3.9**	**3.3**	**3.3**	**2.2**	**3.7**	**2.4**	**1.9**	**2.4**	**3.2**	**2.1**	**3.4**	

Table 11: Macrobenthic faunal distribution in Deendayal Port (June 2020)

Molluscs	**1A**	**1B**	**1C**	**1D**	**1E**	**Control 1**	**2A**	**2B**	**2C**	**2D**	**2E**	**Control 2**	**% Occurrence**
Anadara sp.	50	0	100	0	0	0	0	0	25	0	100	0	33.33
Cerithidea cingulate	75	75	0	0	0	175	0	50	50	0	25	50	58.33
Crassostrea sp.	25	225	50	0	75	150	0	0	0	0	0	0	33.33
Gafrarium sp.	0	100	0	0	50	0	50	0	0	50	50	25	50.00
Littorina sp	0	0	0	25	0	0	50	0	100	0	0	0	25.00
Meretrix sp.	0	75	50	0	0	50	75	0	0	0	0	0	33.33
Natica sp.	50	0	75	0	0	50	0	25	25	75	0	50	58.33
Pharella sp.	0	25	0	50	25	0	75	0	0	0	75	75	50.00
Pholas sp.	525	300	100	425	175	275	200	275	325	0	350	75	91.67
Placenta sp.	75	50	0	100	0	0	0	0	0	100	0	0	33.33
Mitra sp.	0	50	75	50	100	0	50	0	25	50	0	50	66.67
Telescopium sp.	75	25	0	0	0	0	0	0	125	0	75	0	33.33
Turritella sp.	0	0	0	0	50	0	50	0	0	50	0	75	33.33
Thais bufo	75	0	75	50	100	0	50	0	25	50	0	0	58.33
Indothais sp.	25	25	0	25	0	0	0	50	125	0	75	0	50.00
Polychaetes													
Capitella capitata	0	50	0	25	100	0	100	0	75	75	0	50	58.33
Glycera sp.	75	0	75	0	0	100	0	50	25	50	50	50	66.67
Goniada sp.	0	0	0	75	75	0	0	0	0	0	0	25	25.00
Nephtys sp.	50	75	0	50	0	0	100	0	75	0	75	0	50.00
Nereis sp.	75	0	0	100	0	75	0	0	50	25	100	125	58.33
Prionospio sp.	0	0	75	50	100	0	50	0	25	50	0	0	50.00
Pereneries sp.	0	50	0	0	0	0	0	0	125	0	75	0	25.00
Others													
Ampithoe sp.	0	0	50	0	50	0	75	25	0	0	75	25	50.00
Isopods	0	50	0	0	0	50	25	0	50	0	100	0	41.67
Copepods	50	0	25	0	25	0	0	25	50	0	0	0	41.67
Gammarus sp.	0	75	0	25	50	0	75	0	0	25	0	25	50.00
Penaeus sp.	0	0	0	75	75	0	75	0	75	50	0	50	50.00
Population Density Nos/m^2	**1225**	**1250**	**750**	**1125**	**1050**	**925**	**1100**	**500**	**1375**	**650**	**1225**	**750**	
Biomass wet wt gm/m^2	**4.1**	**4.2**	**3.3**	**3.9**	**3.8**	**3.4**	**3.8**	**2.9**	**4.2**	**3.1**	**3.9**	**3.1**	

Table 12: Macrobenthic faunal distribution in Deendayal Port during monsoon 2020

Molluscs	S1A	S1B	S1C	S1D	S1E	S1-CONTROL	S1A	S2B	S2C	S2D	S2E	S2-CONTROL	S3A	S3B	S3C	S3D	S3E	S3-CONTROL	% 0f Occurrence
Anadara sp.	0	0	0	25	0	0	0	0	25	0	100	25	0	100	0	0	25	0	33.33
Cerithidea sp.	50	50	0	0	0	175	0	50	50	0	25	0	75	0	0	0	50	0	44.44
Crassostrea sp.	0	0	25	0	25	150	0	0	0	0	0	25	225	50	0	75	0	50	44.44
Barbatia sp.	0	25	0	0	50	75	0	25	0	0	25	50	25	0	50	0	0	0	44.44
Meretrix sp.	0	75	50	0	0	50	75	0	0	0	0	0	25	50	0	0	50	0	38.89
Natica sp.	50	0	75	0	0	50	0	50	25	75	0	50	125	0	75	75	25	0	61.11
Pharella sp.	75	25	0	50	25	0	75	0	0	0	75	0	0	25	0	0	0	0	38.89
Pholas sp.	200	0	300	325	175	250	200	0	275	0	275	350	50	125	0	200	300	250	77.78
Placenta sp.	75	75	0	0	0	0	0	75	0	100	0	75	50	0	100	0	0	0	38.89
Mitra sp.	0	0	0	100	0	75	25	0	25	50	0	50	50	75	50	100	0	50	61.11
Telescopium sp.	75	0	75	0	0	50	25	25	125	0	75	100	25	0	0	0	0	0	50.00
Crassostrea sp.	0	100	0	50	0	50	50	0	0	50	0	50	0	0	0	50	0	50	44.44
Polychaetes																			
Capitella sp.	0	75	0	75	75	50	75	0	0	0	50	0	0	50	0	25	100	0	50.00
Glycera sp.	50	0	50	25	50	0	225	75	0	75	0	75	75	0	75	0	0	0	55.56
Goniada sp.	0	0	0	0	0	0	25	0	50	0	0	0	0	0	0	75	75	50	27.78
Nephtys sp.	0	75	50	75	0	50	0	50	0	0	50	0	50	75	0	50	0	0	50.00
Nereis sp.	0	0	0	225	50	75	75	0	50	75	25	75	75	0	0	100	0	75	61.11
Prionospio sp.	0	50	0	25	0	50	0	0	0	0	0	0	0	0	75	50	100	0	33.33
Pereneries sp.	0	0	0	25	50	0	0	75	0	50	75	0	0	50	0	0	0	25	38.89
Others																			
Ampithoe sp.	25	0	75	25	0	0	75	50	0	0	75	50	0	0	50	0	50	50	55.56
Isopods	0	50	25	0	50	50	25	0	50	0	100	0	0	50	0	0	0	0	44.44
Copepods	0	0	0	25	50	0	0	75	50	0	0	25	50	0	25	0	25	25	50.00
Gammarus sp.	25	0	75	0	0	0	75	0	0	25	0	50	0	75	0	25	50	0	44.44
Penaeus sp.	50	0	75	0	75	0	75	0	75	50	0	75	0	0	0	75	75	0	50.00
Population density Nos/m^2	**675**	**600**	**875**	**1050**	**675**	**1200**	**1100**	**550**	**800**	**550**	**950**	**1125**	**900**	**725**	**500**	**900**	**925**	**625**	
Biomass wet weight (g/m^2)	**2.6**	**2.3**	**3.4**	**3.7**	**2.4**	**4.2**	**4.1**	**1.9**	**3.3**	**1.8**	**3.4**	**3.5**	**3.3**	**2.8**	**1.8**	**3.6**	**3.7**	**2.1**	

4.2.7. Conclusion

The most important task in the port/harbour is dredging to keep the navigation channels open. By doing these activities the sediment removal from the site and also deposit to the adjacent area. It can make direct effect of macrobenthos living in the site and adjacent areas and indirect changes in the physico-chemical characteristics such as depth, turbidity and sediment texture. Owing to these activities, the overall diversity and distribution of macrobenthic faunal organism is quite low. To overcome this problem, to use silt curtains during the dredging and dumping operation to minimize the impact.

5. Introduction

Physicochemical parameters are used to describe the quality of the marine ecosystem. The changes in the aquatic community in the ecosystem are influenced by these parameters. The quality of aquatic systems gets affected by anthropogenic activities such as restricted mining, extensive industrialization, large scale urbanization, modern agricultural methods and faulty waste disposal practices. These activities affect the water quality and physicochemical features in aquatic systems. Further, the change in productivity pattern of the marine environment is highly influenced by the flow of nutrients which generally originates from natural and anthropogenic sources. This change in quality of marine water impacts the composition and availability of aquatic organisms directly and will also affect the natural process in the marine ecosystem including coral reef habitats and seagrass habitats etc. Similar to marine water, marine sediments are the eventual receptor of pollutants / contaminants from various activities including both Off shore and on shore, especially harbors and coastal areas worldwide have sediments which are contaminated with various pollutants such as heavy metals, petroleum hydrocarbons, polyaromatic hydrocarbons, polychlorinated biphenyls etc. Hence assessing the water for various characteristics will indicate the intensity of pollutants present in such environments.

5.1. Materials and Methods

In the present study, the marine water and marine sediment samples were collected using standard protocol and analysis of the same was done following standard methods for marine water and sediment analysis as prescribed by APHA (2012), NIO manual (1982) and ICMAM Manual (2012). Surface water samples for general analysis were collected using a clean polyethylene bucket while an adequately weighted Niskin sampler was used to collect water samples from the bottom. A glass bottle sampler (1 L) was used for collecting water samples at 1 m below the surface. Parameters such as pH, Temperature, Salinity were recorded on spot using hand held meters and the same was also verified iin the Laboratory. The water samples collected were stored in refrigerated conditions until further analysis of other parameters. As per the standard protocol, the fixatives and preservatives were added to the samples in case of parameters such as Dissolved Oxygen, Chemical Oxygen Demand and preservation using nitric acid for heavy metals. In case of biological characteristics, the marine water samples for planktonic analysis were added with formalin.

In general, all the collected water and sediment samples were stored in a sterile, polythene bottles and ziplock bags in an icebox to maintain suitable conditions till it is brought to the Laboratory. The list of parameters and the method adopted for the analysis of samples are detailed below (Table 13).

Table 13: Physico-chemical and biological characteristics of marine water samples

S. No	Physico-chemical and Biological parameters
1	pH
2	Salinity
3	Total Dissolved Solids
4	Total Suspended Solids
5	Turbidity
6	Dissolved Oxygen
7	Bio-Chemical Oxygen Demand
8	Chemical Oxygen Demand
9	Phenolic Compounds
10	Petroleum Hydrocarbons
11	Oil and grease
12	Cadmium
13	Lead
14	Mercury
15	Chromium
16	Arsenic
17	Copper
18	Cobalt
19	Nickel
20	Zinc
21	Magnesium
22	Chlorophyll
23	Phaeophytin
24	Phytoplankton Phytoplankton cell counts (no/L) Total Genera (no.) Major Genera
25	Zooplankton Biomass (ml/100m^3) Population (no/100m^3) Total Group (no.), Major Groups

5.1.1. pH and Temperature

A Thermo fisher pH / EC / Temperature meter was used for pH and Temperature measurements. The instrument was calibrated with standard buffers just before use.

5.1.2. Salinity

A suitable volume of the sample was titrated against silver nitrate (20 g/l) with potassium chromate as an indicator. The chlorinity is estimated and from that salinity values were derived using formula.

5.1.3. Total Dissolved Solids (TDS)

The samples were subjected for gravimetric procedure for confirmation of the readings obtained from the hand held meter. About 100 ml of the water sample was taken in a beaker and filtered which was then dried totally in a Hot Air Oven (105°C). TDS values were calculated using the difference in the initial and final weight.

Total Suspended Solids (TSS)

Hundred ml of the sample was filtered through each pre-weighed filter and placed in the Hot air oven at specified temperature as per the protocol for 1 hour. The filter paper was allowed to cool in a desiccator and obtain a constant weight by repeating the drying and desiccation steps.

5.1.4. Turbidity

The sample tube (Nephlometric cuvette) was filled with distilled water and placed in the sample holder. The lid of the sample compartment was closed. By adjusting the '*SET ZERO*' knob, the meter reading was adjusted to read zero. The sample tube with distilled water was removed and the 40 NTU standard solution was filled in the tube and the meter reading was set to read 100. Other standards were also run. The turbidity of the marine water sample was then found out by filling the sample tube with the sample, and the reading was noted.

5.1.5. Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD)

DO was determined by Winkler's method. For the determination of BOD, direct unseeded method was employed. The sample was filled in a BOD bottle in the field and incubated in the laboratory for 3 days after which DO was again determined and the difference was calculated.

5.1.6. Chemical Oxygen Demand (COD)

Chemical Oxygen Demand (COD) of the water samples were estimated by acidifying a known quantity of sample with sulphuric acid to reduce the pH. The organic matter in the sample was oxidized completely by potassium dichromate (K2Cr207) in the presence of H_2SO_4 to produce CO_2 and H_2O. The excess K2Cr207 remaining after the reaction was titrated with sodium thiosulphate, using starch as indicator. The volume of dichromate consumed gives the oxygen required for oxidation of the organic matter.

5.1.7. Phenolic compounds

Phenols in water (500 ml) were converted to an orange coloured antipyrine complex by adding 4-aminoantipyrine. The complex was extracted in chloroform (25 ml) and the absorbance was measured at 460 nm using phenol as a standard.

5.1.8. Petroleum Hydrocarbons (PHc)

Water sample (1 l) was extracted with hexane and the organic layer was separated, dried over anhydrous sulphate and reduced to 10 ml at 30^{o}C under low pressure. Fluorescence of the extract was measured at 360 nm (excitation at 310 nm) with Saudi Arabian crude residue as a standard. The residue was obtained by evaporating lighter fractions of the crude oil at 120^{o}C.

5.1.9. Oil and Grease

About 500 ml of sample was transferred to the separating funnel and sample bottle was carefully rinsed with 30ml of trichlorotrifluoroethane and add the solvent washings was added to the separating funnel. To this, 5ml of 1:1 HCL was added and shaken vigorously for about 2 minutes If soluble emulsion was formed, then the sample container was shaken for 5 to 10 minutes. Then the layers were allowed to separate and the lower layer (organic layer) was discarded from separating funnel. Then the solvent layer was drained through a funnel containing solvent moistened filter paper into a clean pre weight distillation flask. Then solvent was distilled from distillation flask over a water bath at 70 ^{0}C. Then the residue was transferred using minimum quantity of solvent into a clean pre weighed dried beaker and the beaker was placed on water bath for 15 minutes at 70 ^{0}C and evaporate off all the solvent and it was cooled in desiccators for 30 minutes and weight was taken.

5.1.10. Heavy metals

Heavy metals are of concern especially as it relates to the environment are Cadmium (Cd), Lead (Pb), Mercury (Hg), Chromium (Cr), Arsenic (As), Copper (Cu), Cobalt (Co), Nickel (Ni), Zinc (Zn), Magnesium (Mg) etc. For the release of mineral elements from soil and sediments, wet oxidation of samples are generally performed. Wet oxidation employs oxidizing acids (Tri / Di-acid mixtures).

Soil sample will be weighed to 0.5 gm and taken in 100ml beaker covered with a watch glass and 12 ml of Aqua regia in (1: 3 HNO3 : HCl) will be added and the beaker will be kept in digestion for 3 hours at 100^{0}c on a hot plate using sand bath and the samples will be evaporated to near dryness and the samples will be kept cool for 5 mins and then 20 ml of 2% nitric acid will be added and kept for 15 minutes in hot plate for digestion and remove from hot plate and cooled and filtered using Whatmann No. 42 mm filter paper and then the final make up to 50 ml with 2 % nitric acid will be made. The extracted sample will be then aspirated to an AAS.

5.2.Results and Discussion

5.2.1. Physico-chemical characteristics of the marine water samples of Season 1

The marine water samples were collected from two dumping locations during Season 1, Season 2 and Season 3 and an additional location was studied during Season 3 and all the collected marine water samples from the three pre-designated locations were analyzed for various Physico-chemical and biological characteristics (Table 14 and 15) as per standard analysis protocols (NIO, 1982).

The salinity profile of the marine water samples ranged from 33.34 – 36.7 ppt when all the locations are concerned, whereas the average salinity of 35.43 ppt (Offshore), 34.22 ppt (Phang creek) in location 1 and location 2 respectively. When the pH of the water samples are concerned, minimum pH of the marine water sample was recorded in 7.9 and the maximum value of 8.1 was observed. The minimum and maximum concentration of petroleum hydrocarbon in the marine water samples are recorded as 2.68 - 3.21µg/L at site 1 and 2.94 - 3.35 at site 2 during the study. The total suspended solids in the location 1 and 2 were ranging between 74 – 246 mg/L and 125 – 314 mg/L respectively. The mean turbidity concentrations of turbidity at site 1 and site 2 was recorded as 153.25 and 289.25 NTU respectively. The Dissolved oxygen values recorded at site was in the range between 6.8 - 7.1 mg/L (Av. 6.925 mg/L) at site 1 and 6.8 - 7.2 mg/L (Av.7.03 mg/L) at site 2. The average Oil and grease concentration at site 1 was 4.533 mg/L and 4.47 at site 2 and both were within the prescribed limits of GPCB which is 10 mg/L.

When the heavy metal concentrations in the marine water samples are analyzed in two sites, it revealed that the Nickel concentraions in the sample recorded a lowest of 0.035 mg/L and highest of 3.225 mg/L and the mean value of 1.216 mg/L at site 1, whereas site 2 recorded a lowest nickel concentraion of 2.37 mg/L and highest of 3.37 mg/L with a mean nickel concentraion of 3.11 mg/L at site 2. When the trace metal Lead is concerned, among both the stations studied, the lowest concentraion of 0.48 mg/L and the highest concentraion of 2.95 mg/L were recorded. The mean Manganese concentraions were 0.111 mg/L and 0.25 at site 1 and site 2 respectively. The cobalt metal concentration recorded a lowest value of 0.22 mg/L and the highest concentraion of 1.46 mg/L, both at site 1 when compared to site 2. The Chromium element recorded a below detection limit at site 1 at ppm level, whereas the minimum concentraion of 0.065 mg/L and the highest concentraion of 0.48 mg/L (Av. 0.26 mg/L). The zinc concentration was observed to be 0.065 - 0.69 mg/L with a mean concentration of 0.215 mg/L at site 1 and the zinc concentraion ranged between 0.59 - 0.915 mg/L with average zinc concentraion of 0.78 mg/L at site 2. In contrary to other trace metals recorded, the copper concentration was recorded in below detection limits (mg/L) in both the sites.

Table 14: Physico-chemical characteristics of the marine water from sampling location 1 (Offshore)

S. No	Parameters	1A		1B		1C		1D		1E		Control 1	
		SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
1	Temperature (^{0}C)	20	19.5	22	21	19.6	19.7	19.8	19.7	20	19.8	20	19.8
2	pH	8	8.1	8	8.1	8.1	8	8.1	8	8.1	8	8.1	8
3	Salinity (ppt)	34.39	34.18	34.81	33.34	35.65	35.86	35.32	35.65	36.28	36.49	36.49	36.7
4	Total Dissolved Solids (mg/L)	51114	38055	37123	39918	36437	37632	36033	35376	37236	35970	37100	35922
5	Total Suspended Solids (mg/L)	139	109	132	135	189	112	74	203	243	246	209	210
6	Turbidity (NTU)	102	117	65	92	197	211	172	225	175	210	123	150
7	Dissolved Oxygen (mg/L)	7	7	7.1	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.8
8	Bio-Chemical Oxygen Demand (mg/L)	4.2	5	2.8	1.8	2.9	2.5	2.4	0.5	1.7	1	1.4	0.9
9	Chemical Oxygen Demand (mg/L)	62.4	54.2	52.8	48.4	58.6	50.2	60.8	48.4	48.6	44.4	44.0	38.6
10	Phenolic Compounds (µg/L)	0.12	BDL	BDL	0.25	0.37	0.5	BDL	BDL	0.25	0.12	0.37	0.25
11	Petroleum Hydrocarbons (µg/L)	3.18	2.94	3.13	3.07	2.78	2.68	3.07	2.92	3.08	3.02	3.21	3.1
12	Oil and grease (mg/L)	4	6.4	7.2	10	4	5.6	4.4	4	3.2	2	1.6	2
13	Magnesium (mg/L)	1487.16	1487.16	1611.09	1549.12	1858.95	1735.02	1115.37	1301.26	1425.19	1301.26	1549.12	1611.09
14	Nickel (mg/L)	1.255	0.43	1.095	1.165	1.39	2.945	0.035	0.19	1.225	0.42	3.225	BDL
15	Lead (mg/L)	0.705	0.48	0.81	1.015	1.115	1.86	0.72	0.845	1.37	1.025	2.25	0.655
16	Cadmium (mg/L)	0.2	0.11	0.12	0.145	0.205	0.505	BDL	0.06	0.18	0.05	0.545	BDL
17	Chromium (mg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
18	Zinc (mg/L)	0.135	0.08	0.105	0.145	0.065	0.32	BDL	BDL	0.065	0.33	0.69	BDL
19	Copper (mg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
20	Manganese (mg/L)	0.145	0.135	0.105	0.15	0.01	0.145	BDL	BDL	0.04	BDL	0.155	BDL
21	Cobalt (mg/L)	0.66	0.22	0.465	0.57	0.515	1.395	BDL	BDL	0.49	BDL	1.46	BDL

Note: BDL denotes Below Detection Limit.

Table 15: Physico-chemical characteristics of the marine water from sampling location 2 (Phang Creek)

S. No	Parameters	2A		2B		2C		2D		2E		Control 2	
		SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
1	Temperature (^{0}C)	17.6	17.5	17.7	17.6	17.8	17.7	18.9	19	19.5	19.4	19.7	19.8
2	pH	7.9	7.9	8	8	8	8	7.9	8	8	8	8.1	8.1
3	Salinity (ppt)	34.07	34.07	33.64	33.43	35.56	33.43	34.49	34.92	34.07	34.07	33.43	35.43
4	Total Dissolved Solids (mg/L)	34800	35041	36405	51456	35388	24466	35817	35996	35729	40634	36129	36030
5	Total Suspended Solids (mg/L)	291	300	303	314	292	297	282	278	203	277	127	125
6	Turbidity (NTU)	283	252	281	295	274	296	245	243	254	318	355	375
7	Dissolved Oxygen (mg/L)	7.1	7.1	6.9	7	7.1	7.2	6.8	6.9	7.1	7.1	7	7.1
8	Bio-Chemical Oxygen Demand (mg/L)	2.4	2.6	1.5	1.2	1.8	1.3	1.2	1	0.8	0.5	1.2	1.2
9	Chemical Oxygen Demand (mg/L)	56.2	50.8	62.4	60.8	57.8	55.4	60.2	48.6	60.4	60.2	58.4	54.6
10	Phenolic Compounds (µg/L)	BDL	BDL	BDL	BDL	0.13	1.78	0.41	BDL	BDL	0.13	0.41	0.13
11	Petroleum Hydrocarbons (µg/L)	2.94	2.94	3.02	3.01	3.19	3.19	3.27	3.26	3.35	3.28	3.16	3.12
12	Oil and grease (mg/L)	5.6	8	5.6	6	4.8	4.8	2.8	1.2	2.4	5.2	4.4	2.8
13	Magnesium (mg/L)	1673.05	1673.05	1611.09	1239.3	1549.12	1487.16	1425.19	1425.19	1549.12	1487.16	1549.12	1735.02
14	Nickel (mg/L)	3.37	3.195	3.2	3.355	3.175	3.185	3.255	3.2	3.24	2.825	2.925	2.37
15	Lead (mg/L)	2.555	2.55	2.65	2.85	2.815	2.805	2.92	2.92	2.95	2.905	2.925	2.72
16	Cadmium (mg/L)	0.44	0.565	0.545	0.6	0.53	0.54	0.565	0.58	0.48	0.415	0.54	0.405
17	Chromium (mg/L)	BDL	BDL	0.065	0.18	0.21	0.195	0.235	0.305	0.415	0.24	0.48	0.255
18	Zinc (mg/L)	0.88	0.88	0.78	0.915	0.79	0.77	0.81	0.79	0.81	0.73	0.59	0.62
19	Copper (mg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
20	Manganese (mg/L)	0.3	0.27	0.23	0.27	0.28	0.275	0.26	0.225	0.235	0.23	0.255	0.195
21	Cobalt (mg/L)	1.400	1.325	1.240	1.355	1.345	1.275	1.225	1.120	1.095	0.975	1.000	0.630

Note: BDL denotes Below Detection Limit.

5.2.2. Physico-chemical characteristics of the marine water samples during Season 2

The Season 2 of the study covers the data gathered during June 2020 of the project of 2019-20. Two marine water samples were collected from two pre-designated locations was analyzed for various Physico-chemical and biological characteristics (Table 16 and 17) as per standard analysis protocols. When the pH parameter is concerned, the minimum pH of the marine water sample was recorded in 7.6 and the maximum value of 7.9 was recorded. The salinity profile of the marine water samples ranged from 38.29 – 42.45 ppt when all the locations are concerned, whereas the average salinity of 39.78 ppt (Offshore), 41.69 ppt (Phang creek) in location 1 and location 2 respectively. The total suspended solids in the location 1 and 2 was ranging between 263-696 mg/L and 385 – 1092 mg/L respectively.

When PHc Concentration is concerned, the minimum and maximum concentration of petroleum hydrocarbon in the marine water samples are recorded as 0.059 – 0.84 µg/L at site 1 and 0.26 – 0.87 at site 2 during the study. The mean turbidity concentrations of turbidity at site 1 and site 2 was recorded as 357.08 NTU and 524.33 NTU respectively. The Dissolved oxygen values recorded at site was in the range between 4.8 – 5.3 mg/L (Av. 5.00 mg/L) at site 1 and 3.7 – 4.5 mg/L (Av.4.02 mg/L) at site 2. The mean concentration of Oil and grease at site 1 was 3.958 mg/L and 4.67 at site 2 and both were within the prescribed limits of GPCB which is 10 mg/L.

The marine water samples subjected for heavy metal analysis for examination of pollutants from the two water samples, all the marine water samples exhibited chromium and copper metals were found to be as below detection limit at mg/L concentration. Nickel concentration in the marine water samples recorded a lowest of 0.025 mg/L and highest of 1.86 mg/L with a mean concentration of 0.7 mg/L at site 1, whereas site 2 recorded a lowest nickel concentration of 0.11 mg/L and highest of 2.69 mg/L was observed with an average nickel concentration as 1.36 mg/L. The mean Cadmium concentration at site 1 was 0.141 mg/L and at site 2 was 0.16 mg/L. The zinc concentration was observed to be 0.14 – 0.37 mg/L with a mean concentration of 0.258 mg/L at site 1 and the zinc concentration ranged between 0.03 – 0.625 mg/L with average zinc concentration of 0.28 mg/L at site 2. The mean Manganese concentrations were 1.037 mg/L and 0.85 at site 1 and site 2 respectively.

Table 16: Physico-chemical characteristics of the marine water from sampling location 1 (Offshore)

S. No	Parameters	1A		1B		1C		1D		1E		Control 1	
		SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
1	Temperature (^{0}C)	31.8	31.5	31.7	31.4	31.6	31.6	31.7	32	31.7	31.8	31.7	31.5
2	pH (onsite)	7.8	7.8	7.8	7.8	7.9	7.8	7.8	7.7	7.7	7.7	7.7	7.8
3	Salinity (ppt)	39.33	41	38.29	39.75	40.17	39.12	39.96	39.12	39.33	40.17	39.12	42.04
4	Total Dissolved Solids (mg/L)	44018	43977	43372	42925	44191	50328	44934	44386	44558	44674	44966	45142
5	Total Suspended Solids (mg/L)	402	483	496	681	457	263	430	498	266	614	543	304
6	Turbidity (NTU)	383	390	472	459	382	164	380	390	149	461	435	220
7	Dissolved Oxygen(mg/L)	5.3	5.3	4.9	4.9	4.9	5	4.8	5.2	5	4.8	5.1	4.8
8	Bio-Chemical Oxygen Demand (mg/L)	0.9	0.7	0.6	0.2	0.3	0.3	0.2	0.7	0.6	0.1	0.7	0.1
9.	Chemical Oxygen Demand (mg/L)	42	38	44	40	36	32	50	38	44	34	42	40
10	Phenolic Compounds (µg/L)	1.186	1.355	BDL	BDL	0.508	0.847	3.44	1.016	0.508	1.186	3.44	1.355
11	Petroleum Hydrocarbons (µg/L)	0.78	0.56	0.48	0.23	0.059	0.32	0.25	0.141	0.51	0.33	0.84	0.41
12	Oil and grease (mg/L)	3.5	5	4.5	3.5	2.5	4	7.5	4	4	5.5	1.5	2
13	Magnesium (mg/L)	1518.7	1579.5	1518.7	1397.2	1518.7	1397.2	1640.2	1640.2	1701	1518.7	1761.7	1701
14	Nickel (mg/L)	0.65	0.92	0.36	0.425	0.04	0.025	BDL	0.065	1.86	1.79	0.785	0.775
15	Lead (mg/L)	0.32	0.52	0.19	0.87	1.98	1.67	1.43	1.32	0.65	0.53	1.1	0.92
16	Cadmium (mg/L)	0.175	0.145	0.065	BDL	BDL	BDL	BDL	BDL	0.24	0.03	0.16	0.175
17	Chromium (mg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
18	Zinc (mg/L)	0.235	0.28	0.31	0.345	0.175	0.14	0.145	0.24	0.34	0.37	0.23	0.28
19	Copper (mg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
20	Manganese (mg/L)	0.465	0.655	0.62	0.63	0.485	1.3	1.39	1.28	1.34	1.345	1.44	1.495
21	Cobalt (mg/L)	0.4	0.835	0.56	0.575	0.92	0.58	0.64	0.58	1.065	1.03	0.595	0.76

Note: BDL denotes Below Detection Limit.

Table 17: Physico-chemical characteristics of the marine water from sampling location 2 (Phang Creek)

S. No	Parameters	2A		2B		2C		2D		2E		Control 2	
		SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
1	Temperature (^{0}C)	32.3	32.3	32.4	32.3	32.3	32.3	32.2	32.3	32.1	32	32	32.1
2	pH (onsite)	7.8	7.8	7.8	7.8	7.8	7.9	7.9	7.7	7.6	7.8	7.7	7.8
3	Salinity (ppt)	42.04	41.21	41.21	40.79	41.21	42.04	40.7	42.45	42.04	42.04	42.04	42.45
4	Total Dissolved Solids (mg/L)	47672	47021	48691	52186	49552	49495	47718	48051	48729	51593	47918	48373
5	Total Suspended Solids (mg/L)	488	488	455	385	845	822	866	905	1034	1092	932	956
6	Turbidity (NTU)	356	365	361	283	606	537	588	583	679	681	623	630
7	Dissolved Oxygen(mg/L)	4.3	3.9	4.2	4	4.5	4.2	4	3.9	3.7	3.8	3.9	3.8
8	Bio-Chemical Oxygen Demand (mg/L)	0.1	0.1	0.4	0.1	0.6	0.3	0.2	0.2	0.1	0.2	0.1	0.1
9	Chemical Oxygen Demand (mg/L)	52	50	46	50	44	42	42	44	38	32	36	30
10	Phenolic Compounds (µg/L)	0.428	0.285	2.285	0.714	2.285	3.714	0.857	0.571	1.142	0.857	0.714	0.428
11	Petroleum Hydrocarbons (µg/L)	0.29	0.26	0.69	0.87	0.6	0.69	0.65	0.42	0.79	0.37	0.52	0.35
12	Oil and grease (mg/L)	5	4	3.5	4	4	4	4.5	4	6	5.5	6	5.5
13	Magnesium (mg/L)	1640.2	1579.5	1640.2	1579.5	1579.5	1640.2	1640.2	1579.5	1640.2	1640.2	1579.5	1518.7
14	Nickel (mg/L)	0.22	BDL	0.62	0.11	BDL	0.4	1.69	1.86	1.825	1.955	2.695	2.195
15	Lead (mg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
16	Cadmium (mg/L)	BDL	0.005	0.22	0.24	0.035	BDL	0.195	0.275	0.125	0.06	0.265	0.22
17	Chromium (mg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
18	Zinc (mg/L)	0.275	0.29	0.61	0.625	0.065	0.08	0.48	0.455	0.03	0.185	0.11	0.115
19	Copper (mg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
20	Manganese (mg/L)	1.205	1.205	0.685	0.725	0.75	0.67	0.865	0.865	0.77	0.69	0.91	0.855
21	Cobalt (mg/L)	0.505	0.435	0.815	0.690	0.230	0.045	0.700	0.765	0.515	0.465	0.855	0.990

Note: BDL denotes Below Detection Limit.

5.2.3. Physico-chemical characteristics of the water samples during Season 3

As a last season of the study, the marine water sampling was collected during August 2020. The marine water samples collected were analyzed for various Physico-chemical and biological characteristics (Table 18-20) as per standard analysis protocols (NIO, 1982).

In the offshore marine water samples, the pH was ranging from 7.8 – 8.0 with no major variation among the samples. The phenolic compounds of the water samples were in the range of 0.18 -2.46 µg/L with a mean concentration of 1.35 µg/L. The petroleum hydrocarbon concentration in the water samples was a minimum of 2.14 µg/L and a maximum of 5.24 µg/L with the Mean±SD of 4.02±1.00 µg/L. The maximum Oil and grease concentration was 8.60 mg/L which was well within the prescribed limits of 10 mg/L and the average oil and grease content in all the twelve samples collected was 5.82 mg/L. Among the heavy metals, lead and chromium metal was in below detection limits in the marine water samples. The maximum concentration of Nickel, Cadmium, Zinc, Copper, Manganese, Cobalt were in the concentration of 5.16 mg/L, 1.06 mg/L, 0.72 mg/L, 0.01 mg/L, 0.27 and 3.07 mg/L. In the creek samples, the heavy metal concentrations were in the order Nickel > Zinc > Cadmium > Cobalt > Manganese > Copper (Table 18, 19 and 20)

In the third sampling site, cargo jetty the marine water samples showed almost a similar trend of heavy metal concentration in the water samples which is as follows, Nickel>Cobalt>Cadmium>Zinc>Managense>Copper. The predominance of heavy metals observed in the water samples collected from all the 3 sites exhibited almost a similar trend of occurrence with Nickel being the most dominant metal species found in the water sample.

Table 18: Physico-chemical characteristics of the marine water from sampling location 1 (Offshore)

S. No	Parameters	1A		1B		1C		1D		1E		Control 1	
		SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
1	Temperature (^{0}C)	19.5	19	20	19.5	19.5	20	19.5	19	20	19.5	20	19
2	pH (onsite)	7.9	7.9	8	7.9	7.9	8	7.9	7.9	8	7.9	7.9	7.8
3	Salinity (ppt)	33.53	33.96	31.79	32.66	33.09	32.66	32.66	32.22	30.91	30.91	32.66	32.66
4	Total Dissolved Solids (mg/L)	41145	50355	39029	40246	40792	41198	39757	40212	40555	39492	40574	42615
5	Total Suspended Solids (mg/L)	326	281	243	256	568	553	466	608	584	618	427	479
6	Turbidity (NTU)	208	189	150	181	575	572	488	590	496	532	430	421
7	Dissolved Oxygen(mg/L)	5.5	5.3	5.6	5.6	5.4	5.6	5.4	5.5	5.4	5.4	5.5	5.5
8	Bio-Chemical Oxygen Demand (mg/L)	1.2	0.57	1.3	0.38	0.86	0.86	0.86	0.48	0.48	0.57	0.77	0.57
9	Chemical Oxygen Demand (mg/L)	48	40	48	42	38	42	48	42	60	48	40	32
10	Phenolic Compounds (µg/L)	2.281	1.404	1.579	2.456	BDL	0.351	1.754	1.228	0.175	0.877	BDL	BDL
11	Petroleum Hydrocarbons (µg/L)	4.848	2.822	3.664	4.216	4.744	3.362	2.142	3	4.56	4.604	5.044	5.244
12	Oil and grease (mg/L)	4.8	7.6	4.6	2.6	7.6	8.6	8	5.4	6.4	3.6	4.4	6.2
13	Magnesium (mg/L)	1336.5	1458	1397.2	1336.5	1458	1397.2	1458	1458	1336.5	1336.5	1275.5	1275.5
14	Nickel (mg/L)	BDL	BDL	1.66	5.155	0.385	BDL	BDL	3.235	BDL	2.675	BDL	1.69
15	Lead (mg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
16	Cadmium (mg/L)	BDL	BDL	0.265	1.06	BDL	BDL	0.03	0.545	BDL	0.45	BDL	0.33
17	Chromium (mg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
18	Zinc (mg/L)	BDL	BDL	0.34	0.715	0.07	BDL	BDL	0.415	BDL	0.325	BDL	0.145
19	Copper (mg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.01	BDL	BDL	BDL
20	Manganese (mg/L)	BDL	BDL	BDL	0.27	BDL	BDL	BDL	0.04	BDL	BDL	BDL	BDL
21	Cobalt (mg/L)	BDL	BDL	0.86	3.065	0.01	BDL	BDL	1.775	BDL	1.3	BDL	0.54

Note: BDL denotes Below Detection Limit.

Table 19: Physico-chemical characteristics of the marine water from sampling location 2 (Phang Creek)

S. No	Parameters	2A		2B		2C		2D		2E		Control 2	
		SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
1	Temperature (^{0}C)	19	19.5	19.5	19	19	19.5	19.5	19.5	19	18.5	18.5	19
2	pH (onsite)	8	7.9	8.1	8	8	8.1	7.9	8	8	7.9	7.9	8
3	Salinity (ppt)	32.66	33.09	31.35	31.79	32.22	32.66	33.09	33.09	32.66	33.09	31.35	31.79
4	Total Dissolved Solids (mg/L)	41378	41103	40895	40925	40941	40953	41381	41108	41173	41610	40570	40167
5	Total Suspended Solids (mg/L)	355	398	359	390	472	526	437	436	533	475	550	463
6	Turbidity (NTU)	298	275	300	307	296	379	299	335	317	312	342	337
7	Dissolved Oxygen(mg/L)	3.3	5.3	5.3	5.4	5.3	5.4	5.3	5.2	5.1	4.9	4.8	5
8	Bio-Chemical Oxygen Demand (mg/L)	0.48	0.28	0.19	0.28	0.96	0.28	0.28	0.19	0.48	0.096	0.38	0.28
9	Chemical Oxygen Demand (mg/L)	48	42	48	44	64	60	48	40	48	44	40	32
10	Phenolic Compounds (µg/L)	0.217	0.217	0.652	0.87	0.435	1.304	1.087	0.87	1.087	1.304	1.087	1.522
11	Petroleum Hydrocarbons (µg/L)	4.104	3.284	5.504	5.58	5.028	4.344	4.444	4.856	4.972	5.508	0.408	2.855
12	Oil and grease (mg/L)	8.2	8.2	8.8	2.4	5.4	9.2	5.2	7.2	4.6	9.2	5.6	8.4
13	Magnesium (mg/L)	1336.5	1336.5	1397.2	1397.2	1397.2	1397.2	1458	1458	1518.7	1458	1336.5	1336.5
14	Nickel (mg/L)	0.965	0.77	0.52	0.875	BDL	0.61	BDL	0.42	1.08	0.585	0.725	1.39
15	Lead (mg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
16	Cadmium (mg/L)	0.135	0.17	0.14	0.135	BDL	0.155	BDL	0.02	0.155	0.165	0.165	0.295
17	Chromium (mg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
18	Zinc (mg/L)	0.29	0.32	0.42	0.295	BDL	0.045	BDL	0.08	0.09	0.09	0.03	0.115
19	Copper (mg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.01	BDL	BDL	BDL
20	Manganese (mg/L)	0.065	BDL	BDL	0.08	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
21	Cobalt (mg/L)	0.18	0.025	BDL	0.085	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.03

Note: BDL denotes Below Detection Limit.

Table 20: Physico-chemical characteristics of the marine water from sampling location 3 (Cargo Jetty)

S. No	Parameters	3A		3B		3C		3D		3E		3. Control	
		SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
1	Temperature (^{0}C)	20	19.5	21	20	19.5	19	19.5	19	19.5	19	19	19
2	pH (onsite)	8	7.9	7.9	8	7.9	7.8	7.9	7.8	7.9	7.8	7.8	7.8
3	Salinity (ppt)	30.91	31.35	32.66	32.66	31.79	31.79	31.79	32.22	32.66	32.22	31.79	32.22
4	Total Dissolved Solids (mg/L)	41276	58894	40839	40574	40038	40434	39827	41029	41177	40432	40157	40588
5	Total Suspended Solids (mg/L)	647	644	618	653	495	555	627	595	512	584	670	739
6	Turbidity (NTU)	439	434	421	436	331	391	346	369	419	462	379	353
7	Dissolved Oxygen(mg/L)	5.5	5.5	5.8	5.4	5.9	5.4	5.6	5.3	5.6	5.8	5.7	5.6
8	Bio-Chemical Oxygen Demand (mg/L)	0.48	1.06	0.48	0.28	0.77	0.38	0.48	0.28	0.38	0.67	0.77	0.67
9	Chemical Oxygen Demand (mg/L)	64	60	52	52	60	52	48	44	42	44	38	32
10	Phenolic Compounds (µg/L)	BDL	0.217	BDL	BDL	0.652	0.435	2.609	2.826	0.217	BDL	0.652	0.87
11	Petroleum Hydrocarbons (µg/L)	2.525	4.5	3.821	3.989	4.664	4.292	5.408	5.564	5.22	4.4	5.064	5.928
12	Oil and grease (mg/L)	5.2	6.4	5.2	8.6	2.4	2	12	7.2	9.6	7	5.6	5.2
13	Magnesium (mg/L)	1336.5	1336.5	1458	1397.2	1336.5	1336.5	1275.7	1336.5	1458	1458	1336.5	1336.5
14	Nickel (mg/L)	3.205	0.615	BDL	BDL	3.63	1.465	BDL	4.165	3.88	BDL	0.99	2.65
15	Lead (mg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
16	Cadmium (mg/L)	0.62	0.09	BDL	BDL	0.135	0.29	BDL	0.81	0.89	BDL	0.665	0.15
17	Chromium (mg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
18	Zinc (mg/L)	0.25	BDL	BDL	BDL	BDL	BDL	BDL	0.54	0.44	BDL	0.26	BDL
19	Copper (mg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.01	BDL	BDL	BDL
20	Manganese (mg/L)	0.04	BDL	BDL	BDL	BDL	BDL	BDL	0.145	0.14	BDL	0.01	BDL
21	Cobalt (mg/L)	1.35	BDL	BDL	BDL	BDL	0.14	BDL	1.845	1.685	BDL	BDL	BDL

Note: BDL denotes Below Detection Limit.

6.0. Introduction

Phytoplankton constitutes a basic link in the food chain of all aquatic organisms (Jaiswar 2002). The population phytoplankton represents the indices of health and productivity of an aquatic ecosystem (Prabhahar et al. 2011) and community determines the spatial and temporal changes in the environment (Levandowsky 1972, Figueredo & Giani 2001). The abundance, species composition, and succession of phytoplankton are largely dependent on Physico- chemical and available nutrients in the water (Chattopadhyay et al. 2003) and it has long been interested in ecology. In estuaries and creek water, the phytoplankton population is greatly influenced by the freshwater influx, tidal amplitude grazing by zooplankton, and turbidity of water. The nutrients supply in estuaries is influence by monsoon (Maya et al. 2011), entry of domestic and industrial waste, urban drainage, and agricultural effluents (Gao & Song 2005). The dynamics of phytoplankton are one of the environmental cues to determine the health of the ecosystem's function and how they work. The species composition and population density of phytoplankton are sensitive to environmental changes. Their documentation concerning the dynamic environment is a valuable characteristic of water quality. Coastal and near-shore waters are more productive regions in the marine environment due to nutrient add employing regeneration, upwelling, and land run-off. Phytoplankton blooms in these waters follow a seasonal pattern that shapes the coastal marine ecosystem. Environmental forcing, nutrient availability, predator communities, and land-driven inputs are the major factors that control coastal and near shore phytoplankton community and blooms (Bhaskar et al 2011). Several anthropogenic factors in these environments can result in alteration of coastal water quality (eutrophication), the introduction of non-native species (ballast action), alteration of predator community (overfishing), etc. As a result, non-periodic and exceptional blooms of both non-toxic or toxic phytoplankton species lasting for few weeks to months are frequently reported, influencing the seasonal patterns of dominant phytoplankton community structure, thereby affecting coastal and estuarine biogeochemical processes (Cloern,1996). In harbor and port area water quality is changing rapidly changing due to multiple human activity. The phytoplankton due to its significant contribution in food web required recurrently study in changing environment of harbor.

Regular cargo handling, fishing trawler movements, and shipping intensification, anthropogenic pollutant influx are the key sources of water so the holistic approach to the hydrobiological events of the aquatic environment, analysis of phytoplankton is essential. In general, phytoplankton community structure and density are some of the reliable indicators of water quality in the present study to know the environmental quality of DPT coastal waters in the dredging and dumping sites. The present study focus on the entire study during period of 2020 for the season consisting of pre-monsoon (January),monoon (June) and post-monsoon (September).

6.1. Chlorophyll and Phaeophytin

Phytoplankton (Chlorophyll a) pigment which is responsible for synthesizing the energy for metabolic activities of phytoplankton through the process of photosynthesis in CO_2 is used and O_2 is released is an essential part to understand the consequence of pollutants due to release in the system. To estimate this, known volume of water (500 ml) was filtered through a 0.45 µm Millipore Glass filter paper and the pigments retained on the filter paper were extracted in 90% acetone. For the estimation of chlorophyll *a* and phaeophytin the fluorescence of the acetone extract was measured using Fluorometer (Turner Design) before and after treatment with dilute acid (0.1N HCL).

6.2. Phytoplankton sampling and analysis

Phytoplankton samples were collected in the ten prefixed sampling sites using standard plankton net with a mesh size of 51 µm. Plankton nets are with a square mouth covering an area of 0.900 cm^2 (30cm square mouth) fitted with a flow meter (Hydrobios). Nets were towed from a moving boat for 10 minutes and the plankton adhering to the net was concentrated in the net bucket. Plankton soup from the net bucket was transferred to a pre-cleaned and rinsed container and preserved with 5% neutralized formaldehyde. The containers were appropriately labeled. The initial and final flow meter reading was noted down for calculating the amount of water filtered to estimate plankton density. As per flow meter reading, a total amount of of165 m^3 of water was filtered by the net. One liter of water was separately collected for density estimation to counter check density estimation obtained by the flow meter reading. Quantitative analysis of phytoplankton (cell count) was carried out using a sedge wick-Rafter counting chamber. One ml of soup added to a Sedgwick counting chamber was observed under an inverted compound microscope. The number of cells present in individual cells of the counting chambers (1/1000) was noted and identified up to a generic level. Several observations were fixed to represent the entire quantity of the soup (generally more than30 times) and the recorded data were used to calculate the density(No/l) using the formula,N = n×v/V (where N is the total no/l; n is an average number of cells in 1 ml; v is the

volume of concentrate; V is the total volume of water filtered). The phytoplankton diversity richness and evenness were past software.

6.3 Primary Productivity

Phytoplankton (Chlorophyll a) pigment which is responsible for synthesizing the energy for metabolic activities of phytoplankton through the process of photosynthesis in CO_2 is used and O_2 is released is an essential part to understand the consequence of pollutants due to release in the system.

As per the studies conducted by GUIDE during Season 1, the levels of chlorophyll and phaeophytin concentrations observed indicates relatively low primary production as shown in the below table 21 and 22. During Season 1, the Chlorophyll concentration in the marine water ranged between 0.32-0.46 mg/m^3 with mean chlorophyll concentration of 0.383 mg/m^3, whereas the phaeophytin ranged between 0.22 – 0.42 mg/m^3 (Avg. 0.311 mg/m^3)in the offshore waters. In case of creek waters, the Chlorophyll concentration in the marine water ranged between 0.47 – 0.56 mg/m^3 mean concentration of 0.50 mg/m^3, whereas the phaeophytin ranged between 0.32 - 0.52 mg/m^3 (Avg. 0.37 mg/m^3)in the offshore waters (Table 21 & 22).

Table 21: Chlorophyll and Phaeophytin concentration observed in the offshore site

Parameters	1A		1B		1C		1D		1E		1 Control	
	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
Chlorophyll a	0.40	0.37	0.32	0.32	0.41	0.46	0.40	0.41	0.37	0.41	0.36	0.36
Phaeophytin	0.36	0.36	0.28	0.29	0.42	0.27	0.22	0.28	0.28	0.31	0.27	0.39

Table 22: Chlorophyll and Phaeophytin concentration observed in the Phang creek site

Parameters	2A		2B		2C		2D		2E		2 Control	
	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
Chlorophyll a	0.47	0.51	0.47	0.47	0.47	0.52	0.47	0.48	0.52	0.47	0.56	0.56
Phaeophytin	0.32	0.39	0.32	0.32	0.39	0.32	0.36	0.32	0.32	0.36	0.45	0.52

In case of Season 2 sampling and analysis, the Chlorophyll concentration in the Offshore water ranged between 0.26 – 0.99 mg/m^3 with mean chlorophyll concentration of 0.692 mg/m^3, whereas the phaeophytin ranged between 0.21 – 0.49 mg/m^3 (Avg. 0.345 mg/m^3)in the offshore waters. In case of creek waters, the Chlorophyll concentration in the marine water ranged between 0.35 -.1.2 mg/m^3 mean concentration of 0.82 mg/m^3, whereas the phaeophytin ranged between 0.1 -0.98 mg/m^3 (Avg. 0.36 mg/m^3)in the offshore waters (Table 23 & 24). Due to the high turbidity in water that restricts sunlight penetration essential for nutrient uptake by phytoplankton and thus inhibiting primary production. The ratio of chlorophyll to phaeophytin is generally above 1.5 as expected for natural estuarine and coastal waters.

Table 23: Chlorophyll and Phaeophytin concentration observed in the offshore site

Parameters	1A		1B		1C		1D		1E		1 Control	
	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
Chlorophyll a	0.51	0.40	0.73	0.93	0.92	0.67	0.92	0.74	0.85	0.26	0.39	0.99
Phaeophytin	0.42	0.32	0.21	0.49	0.36	0.38	0.36	0.23	0.43	0.4	0.32	0.21

Table 24: Chlorophyll and Phaeophytin concentration observed in the Phang creek site

Parameters	2A		2B		2C		2D		2E		2 Control	
	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
Chlorophyll a	0.87	0.95	1.20	0.35	0.74	0.99	0.85	0.92	0.98	0.50	0.67	0.84
Phaeophytin	0.21	0.75	0.98	0.10	0.38	0.35	0.52	0.36	0.10	0.11	0.11	0.41

During the final season of the project, the marine water samples were subjected for the estimation of Chlorophyll and phaeophytin in which the chlorophyll concentration at site 1 (offshore) registered as 0.23 - 0.47 mg/m^3 with a mean concentration as 0.368 mg/m^3 and the phaeophytin concentration are recorded as 0.1 - 0.32 mg/m^3 with the average phaeophytin concentration as 0.178 mg/m^3. At location 2 (Phang creek), the mean concentration of chlorophyll and phaeophytin has been recorded as 0.34 mg/m^3 and 0.12 mg/m^3 respectively. In case of cargo jetty water samples, the minimum, maximum and mean concentrations of chlorophyll and phaeophytin has been recoded as 0.038 mg/m^3, 0.383 mg/m^3 and 0.281 mg/m^3 and 0.08 mg/m^3, 0.22 mg/m^3 and 0.119 mg/m^3 respectively. The data on chlorophyll and phaeophytin concentrations have been listed in table 25,26 & 27.

Table 25: Chlorophyll and Phaeophytin concentration observed in the offshore site

Parameters	1A		1B		1C		1D		1E		Control 1	
	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
Chlorophyll a	0.41	0.30	0.42	0.33	0.38	0.47	0.42	0.32	0.40	0.23	0.47	0.27
Phaeophytin	0.12	0.15	0.18	0.21	0.12	0.28	0.22	0.12	0.20	0.11	0.32	0.10

Table 26: Chlorophyll and Phaeophytin concentration observed in the Phang creek site

Parameters	2A		2B		2C		2D		2E		Control 2	
	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
Chlorophyll a	0.3	0.28	0.32	0.42	0.3	0.21	0.3	0.47	0.54	0.38	0.3	0.32
Phaeophytin	0.09	0.11	0.18	0.13	0.08	0.07	0.11	0.21	0.26	0.09	0.07	0.08

Table 27: Chlorophyll and Phaeophytin concentration observed in the Cargo Jetty site

Parameters	3A		3B		3C		3D		3E		Control 3	
	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
Chlorophyll a	0.23	0.38	0.38	0.38	0.21	0.23	0.38	0.33	0.27	0.25	0.30	0.04
Phaeophytin	0.10	0.10	0.10	0.09	0.08	0.09	0.12	BDL	0.22	0.11	0.21	BDL

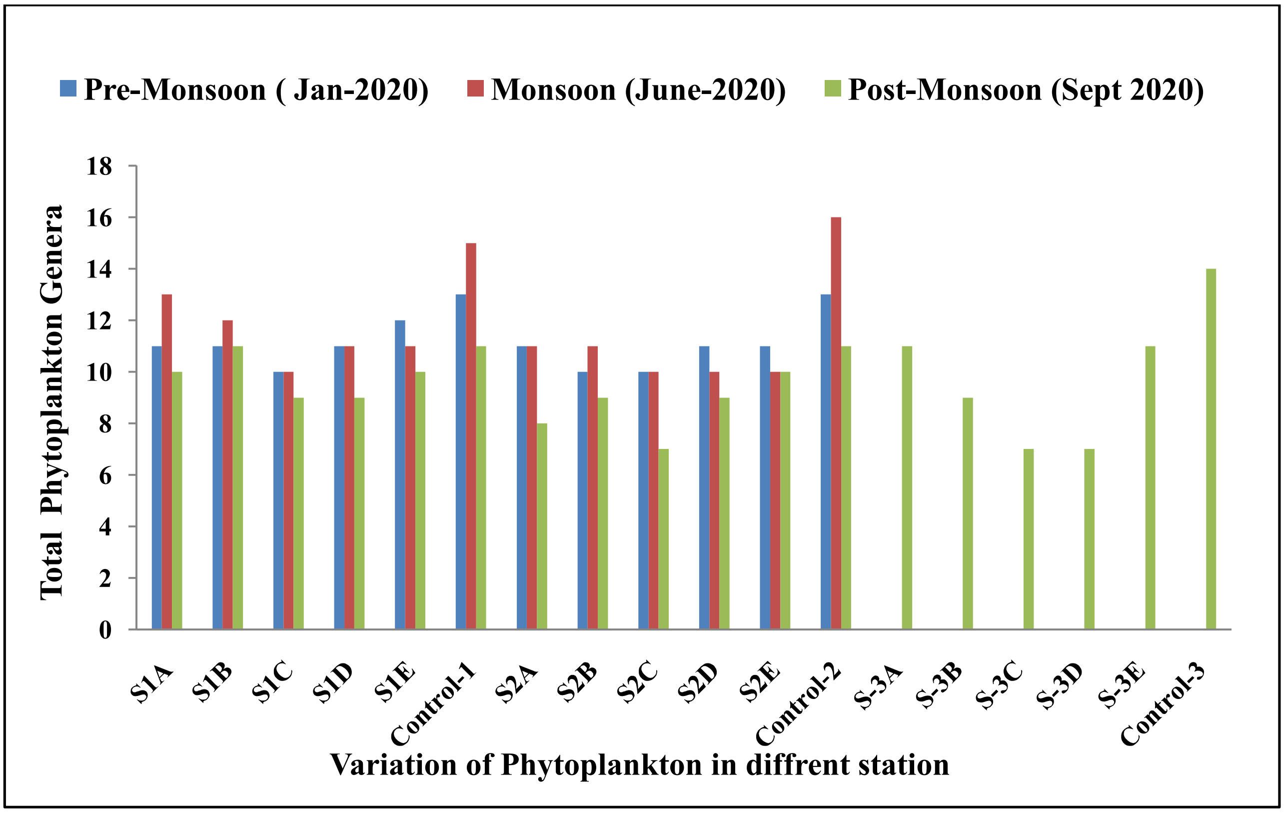
6.4. Phytoplankton Composition and Distribution

Phytoplankton community during pre-monsoon season (January 2020) in the sampling sites of DPT is constituted by five major groups namely Pennales, Centrales, Perinidiales, Cyanobacteria, and Blue Green Algae Similar pattern of group trend was observed during monsoon season (June 2020) and post-monsoon (September 2020) expect the occurrences of dinoflagellates groups. During the entire study period the centric diatoms dominated over the pennants diatoms. In pre-monsoon centric diatoms dominated the phytoplankton composition with 12 genera out of the recorded 13 genera. Similar trend observed during Monsoon (14 genera out of the recorded 16 genera) and post-monsoon (9 genera out of the recorded 20 genera). A single species of *Trichodesmium* and *Noctiluca* was encountered in whole 3 season.

6.5. Generic variation on sampling and control location

During the pre-monsoon the generic numbers varied from 10 to 12. In stations, higher genera were observed along the station S1A to S1E i.e 10 to 12 in number followed by S2A to S2E i.e. 10 to 11 in number where as in monsoon generic numbers was higher than per-monsoon which varied from 10 to 16. In stations, higher genera were observed along the station S1A to S1E *i.e* 10 to 13 in number followed by S2A to S2E i.e. 10 to 11 in number. But during post-monsoon the generic variation is in medium range which varied from 7 to 14 from the study station S-1A to S- 3E. In stations, higher genera were observed along the station S-1A to S-1E i.e 9 to 11 in number followed by S-3A to S-3E *i.e.* 7 to 11 in number (Figure 6). All the station in comparison with the control location of all the season 13 numbers of genera was encountered in both control location i.e control-1 and control-2 during the pre-monsoon season, where as in monsoon 15 to 16 numbers of genera were recorded both control location but during post-monsoon in all 3 controls locations *i.e.,* Control-1, Control-2, Control-3,11 to 14 numbers of genera were recorded where the highest genera were recorded at station Control-3 followed by control-1 and control-2.During pre-monsoon the centric diatoms such as *Coscinodiscus*, *Ditylum* and *Melosira* had wide occurrence where as in monsoon similar observation in addition *Odentella* had wide occurrence and in post monsoon similar observation also encounter except *Bacillaria*. In control location occurrence of blue green algae control station 2 during pre-monsoon where as in monsoon occurrences of *Phaeocystis* contro station-1 and in post-monsoon *Noctiluca* and Blue-green algae only encountered at control-3 station.

Figure 6. Generic variation of phytoplankton genera along different study stations

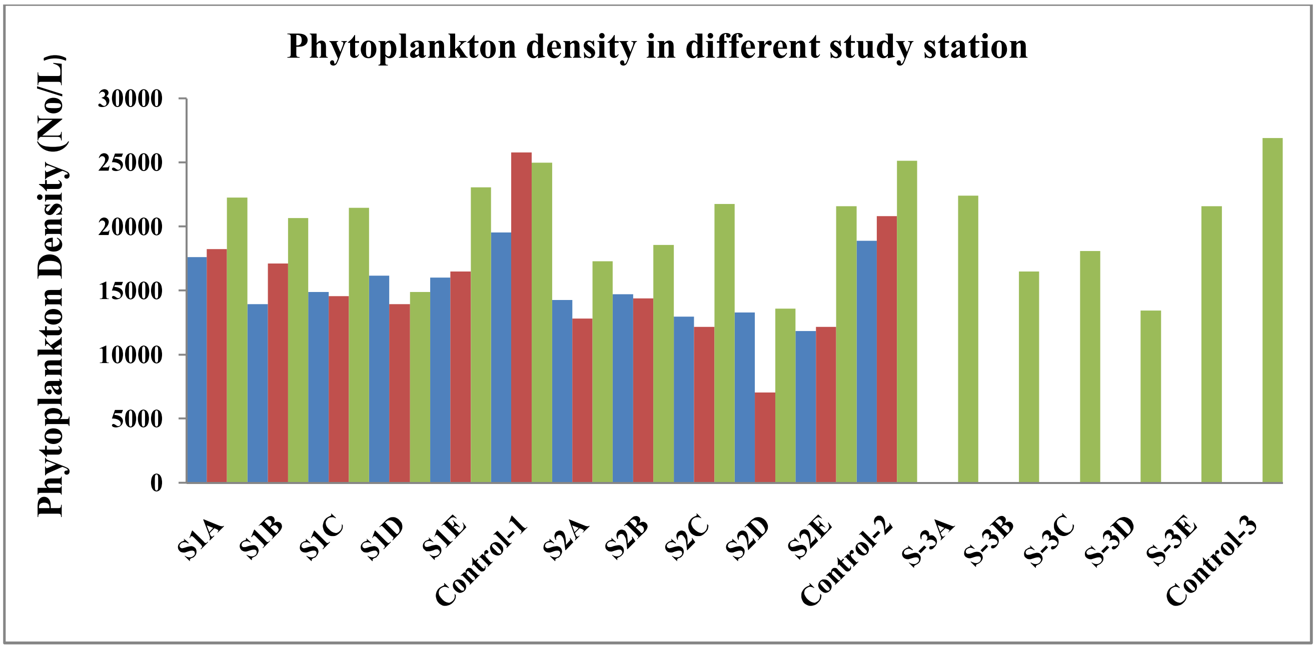


6.6. Phytoplankton Density in sampling and control locations

During the pre-monsoon the Phytoplankton density values across sampling sites ranged between 11840 No./l to 17600 No./l with an overall average density of 13408-15712 No./l (Table 28). The highest density was recorded at station S1A (17600 No./l) and lowest density was recorded at station S2E (11840 No./l) Phytoplankton density values across control sites ranged between 18880 to 19520 No./l with an overall average density of 19200 No./l. The highest phytoplankton density was observed at the control site S1 (19520 No./l) and the lowest density was observed at station S2. Likewise during monsoon season Phytoplankton density values across sampling sites ranged between 7040 No./l to 18240 No./l with an overall average density of 11712-16046No./l (Table 29). The highest density was recorded at station S1A (18240 No./l) and lowest density was recorded at station S2D (7040 No./l) but in control sites the phytoplankton density ranged between 20800 to 25760 No./l with an overall average density of 23280 No./l. The highest phytoplankton density was observed at the control site S1 (25760 No./l) and the lowest density was observed at station S2. Similarly during post-monsoon Phytoplankton density values across sampling sites ranged between 13,440 No./l to 23,040 No./l with an overall average density of 18,400-20.448 No./l from the station S-1 A to S-3 E (Table 30). The highest density was recorded at station S1E (23,040 No./l) and the lowest density was recorded at station S3D (13,440 No./l). Phytoplankton density values across control sites ranged between 24,960 to 26,880 No./l with an overall average density of 25,653 No./l. The highest phytoplankton density was observed at the control site Control-3 (26,880 No./l) and the lowest density was observed at station Control-1 (24,960).The density of phytoplankton along the different station is presented in Figure 7 .

Overall the density and diversity of phytoplankton are quit low in pre-monsoon and monsoon in all the dredging site as compared to control site which might due partial effect of dredging action. But during post monsoon phytoplankton density is quit higher as compared to previous season in all the dredging site as well as control site. species composition was comparatively higher in post-monsoon as compared pre-monsoon and monsoon. Phytoplankton abundance was low during monsoon season and this could be due to heavy rainfall, decreased salinity, temperature, pH and high turbidity(Babu et al., 2013; Rajasekar et al., 2010).

Figure 7. Phytoplankton density in different study stations



6.7. Phytoplankton Diversity Index

Information on species diversity, richness, and evenness of biological components of the ecosystem is essential to understand detrimental changes in environs or deterioration of water quality. Species diversity is a basic measure of community structure and organization and the most important parameter to understand the health status of the ecosystem. The index gives a measure of how the individuals in a community are distributed (Table 31).

During pre-monsoon the Shannon diversity indices (H') for phytoplankton in the 10 sampling sites plus 2 control sites of total 12 sites ranged marginally from 2.21to 2.50 with the lowest value recorded at S2B and highest value at Control 1(2.50). Whereas during monsoon ranged marginally from 2.09to 2.67 with the lowest value recorded at S1C and highest value at Control 2(2.67).But during post-monsoon the shannon diversity indices (H') values for phytoplankton in the 15 sampling site plus 2 control site of total 18 site ranged marginally from 1.73 to 2.43 with the lowest value recorded at S-2C and highest value at Control 3 (2.48).The species evenness index measure of the degree of concentration of individuals in different types (species/taxa or groups) and indicates whether the community is dominated by few species or many species. During pre-monsoon it was varied from 0.86 to 0.98. The highest species evenness index recorded at S1E (0.98) and the lowest was recorded at station S1B (0.86). In Monsoon, it varied from 0.804 to 0.962. The highest species evenness index recorded at S1B (0.962) and the lowest was recorded at station Contriol-1 (0.804). Similarly during post-monsoon varied from 0.756 to 0.940, where highest species evenness index was recorded at Control-2 (0.940) and the lowest was recorded at station S1C (0.756). The Simpson's diversity represents uniformity of generic composition in a community which varied during pre-monsoon was 0.88 to 0.91 and in monsoon it was varied from 0.853 to 0.923 where as in post-monsoon it was varied from 0.793 to 0.905 respectively.

Margalef"s Species richness Index represents the measure of the richness of species/taxa that are normalized for sample size. Two factors, namely the number of taxa/species and individuals in each taxon is taken into consideration to calculate species richness. The Mergalef' index during pre-monsoon in all the 12 sites ranged from 0.94 to 1.22. In monsoon it was ranged from 0.93 to 1.50 and in post-monsoon in all the 18 sites ranged from 0.60 to 1.27. The highest value was recorded in all the control location The highest values were found during monsoon and the lowest values were observed during pre-monsoon season. The observed highest value in monsoon was due to high species composition observed during the study and due to upwelling along the Arabian coast during monsoon it might help in production of phytoplankton species. In spite dredging also play crucial role in disturbance of phytoplankton genera. In pre monsoon and post-monsoon season dredging will be effect more in phytoplankton species as compared to monsoon season and it was clearly compared with all the control location where the all the index value was high. In general condition. Dupuis and Hann (2009) also reported desirable environmental condition promotes the growth of diatoms during post-monsoon season. Low species richness and diversity indices on monsoon might have associated with lower salinity and temperature as reported by Rajasegar et al. (2000) and Mani (1992). But in Kndla creek system it is exceptional which might be due to upwelling phenomena all along the Arabian coast.

Table 28: Phytoplankton genera and Density (Units/l) in the Sampling Sites January 2020 (Pre-monsoon) Annexure 1

Group		S1A	S1B	S1C	S1D	S1E	CONTROL1	S2A	S2B	S2C	S2D	S2E	CONTROL2
Centrales	*Bacillaria* sp	0	640	1120	800	1280	1280	0	800	800	1120	800	800
	Chaetoceros sp	0	0	0	0	0	1600	0	0	0	0	0	1920
	Coscinodiscus sp	3200	2880	1920	2880	1600	1280	2240	2400	2240	2400	1600	2880
	Ditylum sp	2080	480	1280	800	1280	1920	2080	960	960	1120	1120	800
	Melosira sp	1600	1600	1120	1920	1440	1280	1120	960	1280	1440	1120	2400
	Odontella sp	1600	1280	0	800	1600	1120	1120	1120	1280	800	800	1280
	Planktoniella sp	800	0	1600	0	0	0	1280	0	1120	0	0	0
	Pleurosigma sp	1440	480	2080	800	800	1920	1120	1280	1120	1120	1600	800
	Rhizosolenia sp	1280	1920	0	1280	960	1120	1120	1120	0	960	960	1600
	Skeletonema	0	0	0	0	0	800	0	0	0	0	0	0
	Thalassiosira sp	0	640	0	0	0	0	0	0	0	0	0	0
Pennate	*Asterionella* sp	1280	800	1920	1280	1600	3200	960	1280	1120	1120	1120	1280
	Navicula sp	0	0	0	0	1440	0	0	0	0	0		0
	Nitzschia sp	1920	0	1280	0	0	0	1280	0	0	0	0	0
	Synedra sp	0	1600	1280	800	1440	1120	0	1920	1600	1120	640	2400
	Thalassionema sp	1920	1600	1280	2880	1280	1280	1120	2880	1440	1280	1280	960
Peridiniales	*Ceratium* sp	0	0	0	1920	1280	0	0	0	0	800	800	0
Cynobacteria	*Trichodesmium* sp	480	0	0	0	0	1600	800	0	0	0	0	800
	Blue green algae	0	0	0	0	0	0	0	0	0	0	0	960
Density No/Litre		17600	13920	14880	16160	16000	19520	14240	14720	12960	13280	11840	18880
Total genera		11	11	10	11	12	13	11	10	10	11	11	13

Table 29: Phytoplankton genera and Density (Units/l) in the Sampling Sites June 2020 (Monsoon) Anxure-2

	Genera	1A	1B	1C	1D	1E	Control 1	2A	2B	2C	2D	2E	Control 2
Group	*Bacillaria* sp.	1440	1280	2880	1600	1920	4480	1280	2240	1600	0	1440	1440
Centrales	*Bellerochea* sp.	1920	0	0	0	0	0	0	0	640	0	0	0
	Chaetoceros sp.	0	0	0	0	2400	1600	0	0	0	0	0	1280
	Coscinodiscus sp.	3200	2400	3680	1920	3200	4800	2880	1600	1920	1280	1920	3200
	Ditylum sp.	800	1440	800	1440	1120	1280	800	640	960	480	1280	800
	Melosira sp.	1440	1120	960	1600	1760	800	960	2080	1920	960	480	1440
	Odentella sp.	1440	1280	960	800	960	480	800	800	1440	480	480	1920
	Phaeocystis sp.	0	0	0	0	0	1920	0	0	0	0	0	0
	Planktoniela sp.	640	1600	1280	0	0	0	0	960	480	320	0	0
	Pleurosigma sp.	1120	1120	800	960	1440	640	1440	1120	1440	160	960	640
	Rhizosolenia sp.	960	1440	0	640	640	1920	480	1280	640	320	1120	1120
	Skeletonema sp.	0	0	0	0	0	1280	0	0	0	0	0	640
	Thalassiosira sp.	0	800	0	0	0	0	0	0	0	480	0	0
	Triceratium sp.	0	0	0	0	0	0	0	0	0	0	0	960
Pennate	*Asterionella* sp.	1920	1600	0	1440	0	1600	1920	1440	0	960	1920	0
	Navicula sp.	0	0	0	0	800	0	0	0	0	0	0	1440
	Nitzschia sp.	1280	0	0	0	0	1440	0	0	1120	0	0	1280
	Synedra sp.	0	1920	1920	1440	0	1760	640	2240	0	1600	1600	1920
	Thalassionema sp.	1280	1120	800	800	800	1280	800	0	0	0	0	800
Peridiniales	*Ceratium* sp.	0	0	0	1280	1440	0	800	0	0	0	960	0
	Photoperidinium sp.	0	0	480	0	0	0	0	0	0	0	0	0
Dinoflagellates	*Dinophysis* sp.	0	0	0	0	0	0	0	0	0	0	0	1120
Cyanobacteria	*Trichdesmium* sp.	800	0	0	0	0	480	0	0	0	0	0	800
	Total genera	**13**	**12**	**10**	**11**	**11**	**15**	**11**	**11**	**10**	**10**	**10**	**16**
	Denssity No/Litre	**18240**	**17120**	**14560**	**13920**	**16480**	**25760**	**12800**	**14400**	**12160**	**7040**	**12160**	**20800**

Table 30: Phytoplankton genera and Density (Units/l) in the Sampling Sites June 2020 (Monsoon)

Group	Genus	S-1A	S-1B	S-1C	S-1D	S-1E	Control-1	S-2A	S-2B	S-2C	S-2D	S-2E	Control-2	S-3A	S-3B	S-3C	S-3D	S-3E	Control-3
	Amphora	1920	0	0	0	0	0	0	0	0	0	0	0	2400	0	0	0	0	0
	Asterionella	1120	1120	1600	800	1280	2880	1920	0	1920	800	1280	0	1600	0	1920	800	1280	800
	Navicula	0	0	0	800	0	1600	0	0	0	480	0	3040	0	0	0	0	0	1920
Pennales	*Nitzschia*	0	0	0	960	0	0	0	0	0	640	0	1280	1920	0	0	0	0	1280
	Synedra	5120	4800	7200	3200	4800	2720	3520	4000	7200	3200	4800	3200	3520	2880	3520	3840	4320	3200
	Thalassionema	0	0	1920	1120	1120	0	0	0	1920	960	1120	0	0	0	1920	1280	1120	0
	Biddulphia	0	0	0	0	0	0	0	0	0	0	0	0	1280	0	0	0	0	0
	Bacillaria	3200	1600	2400	1600	1760	1600	2400	1760	2880	1280	1760	1920	1760	0	2880	1280	1760	1920
	Chaetoceros	0	0	0	1600	1280	0	0	0	0	1760	1280	0	0	0	0	1760	640	0
	Coscinodiscus	4800	2400	4000	4000	4000	4800	4000	3200	5120	3520	2880	3680	3520	3200	5120	3520	3200	4800
	Ditylum	800	1280	1920	0	0	2400	640	0	1920	0	0	2400	960	0	1920	0	0	2400
Centrales	*Melosira*	480	3520	0	0	2880	1920	0	3200	0	0	2560	2880	0	3200	0	0	2560	2880
	Odontella	1600	800	0	0	1600	0	1600	1280	0	0	1600	0	1120	1280	0	0	1600	0
	Pleurosigma	0	1280	960	0	1920	1440	1920	1600	0	0	1920	1440	1920	1600	0	0	1920	1440
	Rhizosolenia	0	800	640	0	0	2080	0	640	0	0	0	2400	0	640	0	0	0	2400
	Thalassiosira	0	1920	800	0	2400	1600	0	1600	800	0	2400	1600	0	1600	800	0	2400	640
Dinoflagellates	*Ceratium*	800	1120	0	800	0	1920	1280	1280	0	960	0	1280	2400	1280	0	960	0	1280
Cynobacteria	*Noctiluca*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	640
	Blue green alhae	0	0	0	0	0	0	0	0	0	0	0	0	0	800	0	0	800	1280
	Phaeocyst	2400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total genera		**10**	**11**	**9**	**9**	**10**	**11**	**8**	**9**	**7**	**9**	**10**	**11**	**11**	**9**	**7**	**7**	**11**	**14**
Phytoplankton cell counts (no/l)		**22240**	**20640**	**21440**	**14880**	**23040**	**24960**	**17280**	**18560**	**21760**	**13600**	**21600**	**25120**	**22400**	**16480**	**18080**	**13440**	**21600**	**26880**

Table 31. Diversity indices of DPT Sampling Site and control site during 2020 in different season

Station	Taxa_S	Individuals	Dominance_D	Shannon_H	Simpson_1-D	Evenness_e^H/S	Menhinick	Margalef
1A	13	18240	0.09	2.47	0.907	0.911	0.096	1.22
1B	12	17120	0.09	2.45	0.91	0.962	0.092	1.13
1C	10	14560	0.15	2.10	0.853	0.815	0.083	0.94
1D	11	13920	0.10	2.35	0.901	0.952	0.093	1.05
1E	11	16480	0.11	2.28	0.887	0.891	0.086	1.03
Control 1	15	25760	0.10	2.49	0.899	0.804	0.093	1.38
2A	11	12800	0.12	2.26	0.879	0.868	0.097	1.06
2B	10	14400	0.12	2.23	0.885	0.926	0.083	0.94
2C	10	12160	0.12	2.21	0.883	0.914	0.091	0.96
2E	10	12160	0.12	2.22	0.884	0.916	0.091	0.96
Control 2	16	20800	0.08	2.67	0.923	0.905	0.111	1.51
Monsoon (June 2020)								
Station	**Taxa_S**	**Individuals**	**Dominance_D**	**Shannon_H**	**Simpson_1-D**	**Evenness_e^H/S**	**Menhinick**	**Margalef**
1A	13	18240	0.09	2.47	0.91	0.91	0.10	1.22
1B	12	17120	0.09	2.45	0.91	0.96	0.09	1.13
1C	10	14560	0.15	2.10	0.85	0.82	0.08	0.94
1D	11	13920	0.10	2.35	0.90	0.95	0.09	1.05
1E	11	16480	0.11	2.28	0.89	0.89	0.09	1.03
Control 1	15	25760	0.10	2.49	0.90	0.80	0.09	1.38
2A	11	12800	0.12	2.26	0.88	0.87	0.10	1.06
2B	10	14400	0.12	2.23	0.89	0.93	0.08	0.94
2C	10	12160	0.12	2.21	0.88	0.91	0.09	0.96
2E	10	12160	0.12	2.22	0.88	0.92	0.09	0.96
Control 2	16	20800	0.08	2.67	0.92	0.91	0.11	1.51
Post monsoon (September 2020)								
Station	**Taxa_S**	**Individuals**	**Dominance_D**	**Shannon_H**	**Simpson_1-D**	**Evenness_e^H/S**	**Menhinick**	**Margalef**
S-1A	10	22240	0.15	2.06	0.85	0.79	0.07	0.90
S-1B	11	20640	0.13	2.22	0.87	0.84	0.08	1.01
S-1C_	9	21440	0.19	1.92	0.81	0.76	0.06	0.80
S-1D_	9	14880	0.16	2.01	0.84	0.83	0.07	0.83
S-1E	10	23040	0.13	2.18	0.87	0.89	0.07	0.90
Control-1	11	24960	0.11	2.33	0.89	0.93	0.07	0.99
S-2A	8	17280	0.15	1.96	0.85	0.89	0.06	0.72
S-2B	9	18560	0.14	2.07	0.86	0.88	0.07	0.81
S-2C	7	21760	0.21	1.74	0.79	0.81	0.05	0.60
S-2D	9	13600	0.16	1.98	0.84	0.81	0.08	0.84
S-2E	10	21600	0.12	2.20	0.88	0.90	0.07	0.90
Control-2	11	25120	0.1	2.34	0.90	0.94	0.07	0.99
S3A_	11	22400	0.11	2.32	0.89	0.92	0.07	1.00
S3B	9	16480	0.14	2.06	0.86	0.88	0.07	0.82
S3C_	7	18080	0.18	1.82	0.82	0.88	0.05	0.61
S3D_	7	13440	0.19	1.78	0.81	0.85	0.06	0.63
S3E	11	21600	0.12	2.26	0.88	0.87	0.08	1.00
Control-3	14	26880	0.1	2.48	0.91	0.86	0.09	1.28

6.8. Conclusion

The observed average phytoplankton density value during pre monsoon was lower which could be due to seasonal as well as the partial effect of dredging but in monsoon and post monsoon the phytoplankton density was quite higher as compared to pre-monsoon In Shannon Wiener legislation, the aquatic environment (soil/water) is classified as very good when H´is>4, good quality 4-3, moderate quality 3-2, poor quality 2-1 and very poor quality <1. A community becomes extra dissimilar as the stress increases and accordingly species diversity decreases with poor water quality. At present, the quality of DPT water and its periphery environment is under moderate quality during all the 3 season. A community dominated by fewer species such as *Noctiluca, Trichodesmium* and Blue-green algae indicate environmental stress (Plafkin*etal.*, 1989). However, the present density as compared with the previous study at Kandla creek (NIO,1998; Nair *et al.*2002) indicating that there is no outburst of phytoplankton growth and or eutrophication. Generally, nutrient enrichment in coastal waters would result in a decrease in diversity and an increase in biomass promoting some algal species to dominate and suppress other species diversity. However, due to dredging along with the sampling site the density, diversity and the different phytoplankton indices is quite low as compared to the control site, it may recover by fresh ingress of seawater by high tide.

7.0 Introduction

The zooplankton fauna of Indian waters is very diverse,which could be due to a series of environmental factors,most significantly ocean currents, upwelling, high primaryproductivityandsalinity (Smith and Madhupratap2005; Jagadeesan *et al*., 2013). The species compositionsof both holoplankton and meroplankton showmarked spatial, seasonal, and diurnal fluctuations in boththeBay of Bengal and Arabian Sea. The preponderance of copepods hasbeen reported as a common feature in coastal and oceanicenvironments. Zooplankters are strongly responsive to environmental variables including light, temperature, salinity, pH, dissolved oxygen, turbulence, and food availability. In recognition of this multifaceted ecological and economic significance of zooplankton in marine environments, there has been a long emphasis on studying their systematics, ecology, and other biological aspects at different spatiotemporal scales.Zooplankton plays a major role in the functioning and productivity of aquatic ecosystems through its impact on the nutrient dynamics and its unique position in the food web. In reverse, they can also act as a vital disease reservoir. Many species of zooplankton can be used as biological indicators for water pollution, water quality, and eutrophication.Zooplankton communities are highly influenced by Spatio-temporal variations in hydrochemical parameters and physical forces.As the study area of DPT is concern this area is under the influence of various port activities like dredging activity,so regular monitoring is highly essential toknow the environment pressure on dredging location of Kandla port environment.

7.1. Methodology

The present investigation was carried out in the three sampling sites such as offshore dredging, near cargo jetty and Phang creek disposal site during 2019- 2020. Five replicate samples and one control samples were collected in each dredging and disposal sites. Zooplankton samples were collected using a standard zooplankton net with a mouth area of 0.25 m^2 fitted with a flow meter. The net was towed from a boat for 5 min with a constant boat speed of 2 nautical miles per hour. The initial and final reading in the flow meter was noted down and the soup collected in the plankton bucket was transferred to appropriately labeled container and preserved with 5% neutralized formaldehyde. To counter-check the zooplankton density values obtained, water samples of 100 Lwere collected and preserved, which was later analysed for zooplankton density. One ml of the zooplankton soup was added to a Sedgwick counting chamber and was observed under a compound microscope. The group/taxa were identified using standard identification keys and their number was counted. Random cells in the counting chamber were taken for consideration and the number of zooplankton was noted down along with their binomial name. This was repeated for five 1 ml samples and the average value was considered for the final calculation. For greater accuracy, the final density values were counter-checked and compared with the data collected by the settlement method. Univariate measures [Shannon-Wiener diversity index (H'), Margalef's species richness (d), and Pielou's evenness (J'), Simpson dominance (D)] were determined using past software.

7.2. Results and Discussion

7.2.1. Distribution of Zooplankton

The zooplankton status of DPT offshore dredging sites, near Cargo jetty and Phang creek dumping sites were studied during 2019-2020.During first seasonal study (January 2020), a total of 23 genera were recorded at offshore and Phang creek sites (Table 32). In both the sites, Calanoida contributed the major group with 9genera followed by Harpacticoida (4 genera) (Table 32). Among Calanoida, Centropages are dominated in throughout the sampling sites. Whereas Decapoda, Brachyuran larvae widely occurred in all sampling sites and contributed major taxa in a decapod group. In Harpacticoida group, *Euterpina* sp. was dominated in the sampling locations followed by *Microsetella* sp. "Others' such as Mysida, Copelata, Cyclopoida, Polychaete larvae, Rotaliida and Choreotrichida were contributed to the single genera (Table 32). In the present survey, mesoplanktonic forms of fish larvae were represented in the all sampling stations.

The second seasonal study (June 2020) a total of 31 genera belongs to 13 groups were recorded at offshore dredging site and 27 genera belongs to 13 groups were recorded in the Phang creek (Table 34 and 35). Among groups, Calanoida represented the dominant group in both the sampling sites which constitute of 14 genera at Offshore while 13genera at Phang creek site respectively. Harpacticoida and Decapoda were second dominant group at both sampling sites. Others are contributed a single genera in this group.

During third season (September 2020), a total of 35 genera belongs to 12 groups were recorded at Phang creek (Table 37) whereas 30 genera belongs to 12 groups were recorded at Offshore dredging site (Table 38).Likewise, a total of 40 genera belongs to 15 groups were reported at near cargo jetty site (Table 39).Among groups, Calanoida represented the dominant group in both the sampling sites which constitute of 19 genera at Phang creek site, 17 genera offshore at site and 18 genera were recorded at Cargo jetty sites respectively. Harpacticoida and Decapoda were second dominant group at all three sampling sites. Others are contributed a single genera in this group.

7.2.2. Zooplankton Density

An overall average density of zooplankton in the dredging sites during January 2020 is 13283No/L. The highest density of 18000 No/Lwas recorded at S1 (D) followed by S1 (A) 15400 No/L which is located the offshore navigational channel (Table 32). Generally, genus Centropages, Brachyuran larvae, Euterpina and fish larva werepredominantly to the zooplankton density whereas other copepods such as *Acrocalanus* sp., *Aetideus* sp., *Pseudocalanus* sp., *Lucifer* sp. and *Paracalanidae* sp. were comparatively less density in all sampling locations. In the Phan creek site, the highest density of 15200 No/L was recorded in S2 (E) followed by S2 (E) (14000 No/L). The *Centropages* sp., *Pseudocalanus* sp., Brachyuran larvae, *Microsettela* sp., *Euterpina* sp. and fish larva were contributed predominantly in phan creek whereas others such as *Temora* sp., Gastropod larvae, *Oikopleura* sp. and *Nannocalanus*sp. were poor distribution in dumping locations.

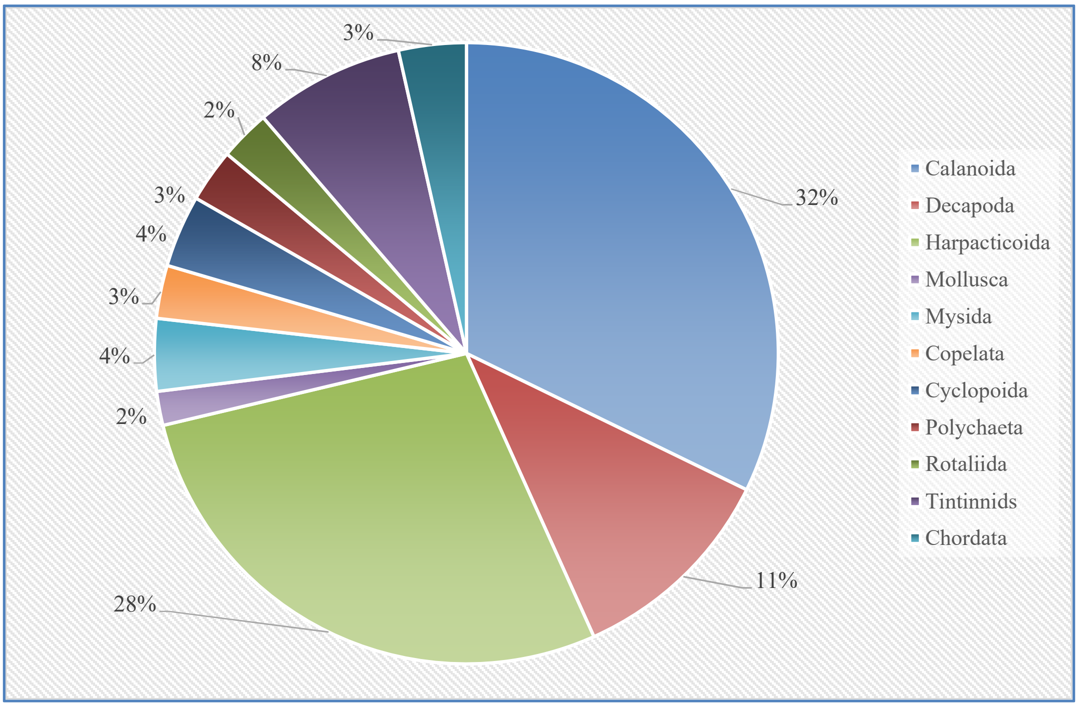
During second season (June 2020), the highest species density was recorded at control site (19400 no/L) followed by S1 (A) (16400 no/L) at offshore dredging sites. Similarly, highest species density was recorded S2 (B) (30600 no/L) followed by control site (22200 no/L) at Phang creek. The highest species richness was reported at offshore dredging site which compared to phang creek sites.

During the third season (August 2020) the highest species density was recorded at station S1(A)(32800 no/L) followed by S1(C) (32200 no/L) of Phang creek sites. Similarly, the highest species density was recorded at station S2 (E)(31400 no/L) followed by S2 (C) (23600 no/L) at offshore dredging sites. However, near the cargo jetty the highest species density was reported at control site (18800 no/L) followed by S3 (B) (18200 no/L). Among all three station offshore dredging site and phang creek disposal sites was showed highest species density during the monsoon season.

7.3.3. Percentage composition of Zooplankton

Overall percentage composition of zooplankton during the first seasonal study (January 2020) was shown in Figure 8. Calanoida group constituted the highest percentage (49.7% & 57.1%) followed by Harpacticoida (16.1% & 22.4%) and Decapoda (11.82% & 10.2%) in both offshore and phang creek sampling sites.

Figure 8. Percentage composition of Zooplankton during January 2020



During second seasonal study (June 2020), the percentage composition of Calanoida group constituted the highest percentage (49.7% & 57.1%) followed by Harpacticoida (16.1% & 22.4%) and Decapoda (11.82% & 10.2%) in both offshore and phang creek sampling sites (Figure 9). During the third seasonal study (August 2020), the percentage composition of zooplankton at dredging site, Calanoida group constituted the highest percentage of all three sampling location such as Phang creek, offshore site and near cargo jetty, 40%, 63.5% and 50.8% of respectively. Likewise, Harpacticoida contributed highest percentage at offshore dredging sites (8.5%) followed by near cargo jetty (5.8%) and Phang creek sites (3.9%). Whereas, Mysida (15.4%), Polychaete (12.7%) and Foraminifera were dominated at cargo jetty sites which compared to Phang creek and offshore dredging sites. Other groups were contributed lower percentage of occurrence in all three sampling sites (Figure 10).

Figure 9. Percentage composition of Zooplankton (A-Phang Creek; B-Offshore) during June 2020

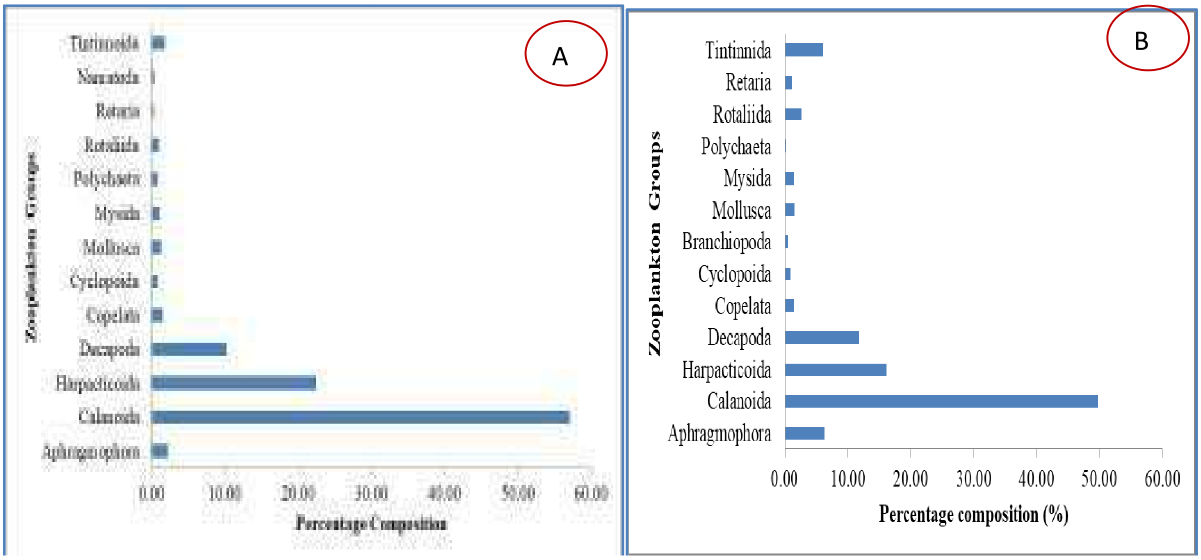
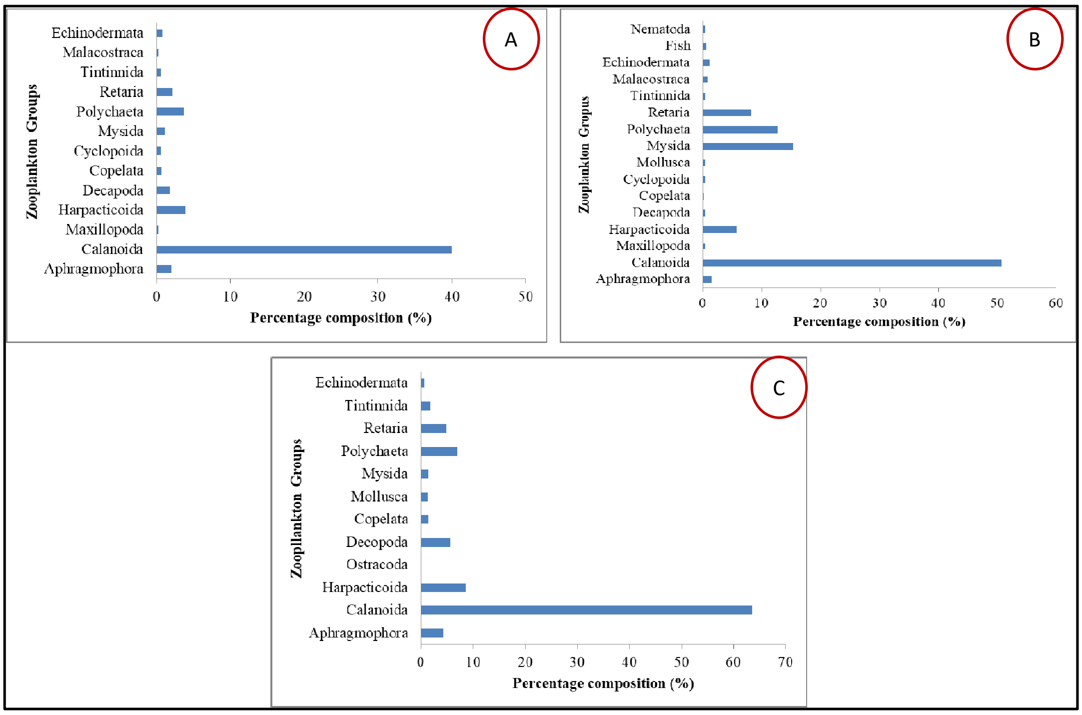


Figure 10. Percentage composition of Zooplankton (A-Phang creek; B- offshore; C-Cargo jetty) during August 2020



7.3.4. Diversity indices of Zooplankton

Information on species diversity, richness, and evenness of biological components of the ecosystem is essential to understand detrimental changes in environs or deterioration of water quality. Species diversity is a basic measure of community structure and organization and the most important parameter to understand the health status of the ecosystem. Seasonal variation of Shannon diversity indices (H') values for Zooplankton in the dredging sampling sites and control sites were analysed. During the January 2020, highest species diversity was reported at offshore dredging site control (2.540) followed by 1A (2.51). Similarly, highest species evenness was reported at 1B (0.858) followed by 1C (0.811). Likewise, species diversity in dumping sites showed highest in control site (2.620) followed by 2E (2.460). The species richness of the zooplankton in dumping sites showed highest in Control site (1.589) followed 2A (1.586). The species richness, diversity of the zooplankton was moderate during January 2020 (Table 33).

During the second season June 2020, highest species diversity was reported at offshore dredging site 1-D and 1-E (2.71) followed by 1-C (2.5). Similarly, highest species evenness was reported at 1-D (0.79) followed by 1-C (0.71). Likewise, species diversity in dumping sites showed highest in 2-B (2.493) followed by control site (2.374). The species richness of the zooplankton in dumping sites showed highest in 2-B (1.355) followed 2-A (1.39) (Table 36). During the third season August 2020, highest species diversity was reported at offshore dredging site, Cargo jetty and Phang creek site shown in Table 39. The highest diversity indices was reported at 2 –A (2.688) followed by 1-D (2.589) and 3 E (2.588). The species richness of the zooplankton in the dredging and dumping sites showed highest in 1-B (1.988) followed by 3-5 (1.888) and 2-A (1.937) respectively (Table 40). The distribution of species diversity, evenness and richness of the zooplankton in Kandla marine and creek ecosystems are moderate.

7.4 Conclusion

Analysis of zooplankton density and composition in these two seasonal study indicated zooplankton faunal distribution and diversity was moderate during 2019-20. This moderate zooplankton distribution and species composition is attributable to the prevailing environmental conditions of Kandla coastal and creek ecosystems. The creek ecosystem of Deendayal Port is characterized by hypersaline environment due to high aridity in the vicinity coupled with a low average annual rainfall. As a result, the salinity in the creek as well as offshore waters of Kandla within the port round the year exceeds 35ppt with a short spell of lower salinity levels in the range of 25-3ppt during monsoon season (GUIDE, 2011). This short annual rainfall event are not strong enough to alter the coastal physio-chemical parameters significantly, especially salinity which is a major influencing factor. In the present study, Calanoid copepod, decapod and harpacticoid copepods were predominantly represented in the dredging and disposal sites of Kandla coastal environment. Furthermore, the copepods, decapod forms like Brachyurans, Zoea larva and Mysid larvae, were dominant apparently due to increased microhabitat available at the nearby mangrove ecosystem. According to Nair et al. (1968) suggested that normally northern region of Arabian Sea experiences high biological productivity in during winter, which results from convective, overturning and associated winter cooling. Low density values observed during monsoon and post-monsoon season might be influenced by sudden shift in salinity and other environmental parameters, which in turn decreases the zooplankton population density.

Table 32. Occurrence, diversity and percentage composition of Zooplankton from Dredging site of DPT during January 2020

S. No	Genus/Taxa	S 1 (A)	S 1 (B)	S 1 (C)	S 1 (D)	S 1 (E)	Control 1	S 2 (A)	S 2 (B)	S 2 (C)	S 2 (D)	S 2 (E)	Control 2	% of occurrence
	Calanoida													
1	Acartia sp.	1000	2000				400	400	200			800	400	
2	Acrocalanus sp.			1000			600	200	600		400			
3	Aetideus sp.	1800		200	600	1800			600	200	400		600	
4	Calanus sp.	1000	1600	400	2000			2000			200		200	
5	Calanoida sp.	800	600								200		600	
6	Centropages sp.	400	800		400		2800	3000	1000	600	1400	1800	200	
7	Paracalanus sp.	1000			600				600	1000	1200		1000	
8	Pseudocalanus sp.	200		600		200	400	200	200	800		400	200	
9	Temora sp.	200	800			1400	1400	400	2200	200				
	Decapoda													32.2
10	Lucifer sp.		200		1000				800			800	400	
11	Brachyuran larvae	3000		1800	2400	1000		1000		800	2400	1000	1000	
	Harpacticoida													11.0
12	Macrosetella sp.		1200		2200	600	200		600	1200	200	1800	1600	
13	Microsetella sp.		1200		1400		600	1000		1000				
14	Euterpina sp.	1600	1400	800	4200	2000	1800	800	3200	1600	2000	3000	1000	
15	Shrimp larva	400		200			800	600	800		1200	1200	1200	
	Mollusca													28.0
16	Gastropod larvae	200		1000		400		200				1000		
	Mysida													1.8
17	Mysis sp.	1000		1400		600	1000			800			1200	
	Copelata													3.8
18	Oikopleura		200		800		200	1000			1200	1000		
	Cyclopoida													2.8
19	Oithona	600	800		1000	200	600	600		800	1400			
	Polychaeta													3.8
20	Polychaete larvae	200		600		200	1000		600			600	1200	
	Rotaliida													2.8
21	Globigerina sp.			1000	1000	200	400	800	200	400		200		
	Tintinnids													2.6

22	Tintinnopsis sp.	1800		1800		1000	1000	400	1800	1800	1000	1000	800	
	Chordata													7.8
23	Fish larvae	200	800	200	400	200	800	200	400		800	600	1000	
	Density (No/L)	**15400**	**11600**	**11000**	**18000**	**9800**	**14000**	**12800**	**13800**	**11200**	**14000**	**15200**	**12600**	
	Density of Taxa	**17**	**12**	**13**	**13**	**14**	**16**	**16**	**15**	**13**	**14**	**14**	**16**	

Table 33.Diversity indices of zooplankton during January 2020

	Offshore site						**Phang Creek**					
Diversity indices	**1(A)**	**1(B)**	**1(C)**	**1(D)**	**1(E)**	**Control**	**2 (A)**	**2 (B)**	**2 (C)**	**2(D)**	**2(E)**	**Control**
Taxa_S	17	12	13	13	13	16	16	15	13	14	14	16
Shannon_H	2.518	2.332	2.356	2.324	2.249	2.540	2.446	2.386	2.416	2.410	2.460	2.620
Evenness_e^H/S	0.729	0.858	0.811	0.786	0.729	0.792	0.721	0.725	0.862	0.795	0.836	0.858
Menhinick	0.137	0.111	0.124	0.097	0.131	0.135	0.141	0.128	0.123	0.118	0.114	0.143
Margalef	1.659	1.175	1.290	1.225	1.306	1.571	1.586	1.469	1.287	1.362	1.350	1.589

Table 34: Density and distribution of Zooplankton at offshore dredging sites during June 2020

S. No.	Species	1A	1B	1C	1D	1E	Control	% of Occurrence
	Aphragmophora							
1	Sagitta sp.		600	3200	600	200	1000	**6.36**
	Calanoida							
2	*Acrocalanus*sp.	600	800	1200	800	400	600	5.00
3	*Calanoida*sp.	400	4000					5.00
4	*Calanopia*sp.			1000	200	200		1.59
5	*Calanus*sp.						400	0.45
6	*Centropages*sp.	2200		1000	400	200	1400	5.91
7	*Copepods*sp.	800			600	600	4400	7.27
8	*Eucalanus*sp.		1600			400		2.27
9	*Eucheata*sp.	400	200					0.68
10	*Pseudocalanus*sp.		800		200			1.14
11	*Pseudodiaptomus*sp.		200	400		200	600	1.59
12	*Paracalanus*sp.	4800	2600	1000	800	2000	1400	14.32
13	*Labidocera*sp.			1000		200		1.36
14	*Temora* sp.	400			1200	600	600	3.18
	Total	**9600**	**10200**	**5600**	**4200**	**4800**	**9400**	**49.77**
	Harpacticoida							
15	*Euterpina*sp.	1400	2000	1400	800	200	2000	8.86
16	*Microsetella*sp.	1000	800	800	400	400	1400	5.45
17	*Macrosetella*sp.	400	600	400	200			1.82
	Total	**2800**	**3400**	**2600**	**1400**	**600**	**3400**	**16.14**
	Decapoda							
18	*Nauplius*sp.	1400			400	200		2.27
19	*Cardian* larva	400	200					0.68
20	*Brachyuran* Larva	800						0.91
21	Zoea larva		1400	1200	1000	200	3200	7.95
	Total	**2600**	**1600**	**1200**	**1400**	**400**	**3200**	**11.82**
	Copelata							
22	*Oikiopleura*sp.	400				400	400	1.36
	Cyclopoida							
23	*Oithona*sp.			400	200	200		0.91
	Branchiopoda							
24	*Cladocera*sp.	400						0.45
	Mollusca							
25	Gastropod veliger			200	200	400		0.91

26	Bivalve veliger			200	400			0.68
	Total			**400**	**600**	**400**		**1.59**
	Mysida							
27	*Mysid* larva				400	200	600	1.36
	Polychaeta							
28	Polychaete larva	200						0.23
	Rotaliida							
29	*Globigerina*sp.	400	200		800	1000		2.73
	Retaria							
30	Foraminiferanssp.			400		600		1.14
	Tintinnida							
31	*Tintinnopsis*sp.			400	2200	1600	1200	6.14
Density (No/L)		**16400**	**16000**	**14200**	**11800**	**10400**	**19200**	**100.00**
Total taxa richness		**17**	**14**	**16**	**22**	**21**	**14**	

Table 35: Density and distribution of Zooplankton at Phang creek site during June 2020

S. No	Species	2A	2B	2C	2D	2E	Control	% occurrence
	Aphragmophora							
1	*Sagitta* sp.		1800				600	**2.1**
	Calanoida							
2	*Acrocalanus* sp.	600	1800	1400	1200	1400	1000	6.5
3	*Calanoida* sp.	4800	5800					9.3
4	*Calanus* sp.	1200	2000	2000				4.6
5	*Centropages* sp.	2600	1400				3600	6.7
6	*Copepods* sp.	1000	2600	1800		4400	4000	12.1
7	*Eucalanus* sp.				2600			2.3
8	*Eucheata* sp.		600					0.5
9	*Pseudocalanus* sp.		600					0.5
10	*Pseudodiaptomus* sp.	400						0.4
11	*Paracalanus* sp.	3200	3200		1000	1000	800	8.1
12	*Labidocera* sp.						400	0.4
13	*Temora* sp.		2800		2600		1400	6.0
	Total	**13800**	**20800**	**5200**	**7400**	**6800**	**11200**	**57.1**
	Harpacticoida							57.1
14	*Euterpina* sp.	1000	2000	3400	800	1000	2200	9.1
15	*Microsetella* sp.	400	2400	2000	2000	1600	3400	10.3
16	*Macrosetella* sp.	200	600	400	800	200	1200	3.0
	Total	**1600**	**5000**	**5800**	**3600**	**2800**	**6800**	**22.4**
	Decapoda							
17	*Lucifer* sp.					1400		1.2
18	Zoea larva	1200	2800	2600	400	1600	1600	8.9
	Total	**1200**	**2800**	**2600**	**400**	**3000**	**1600**	**10.2**
	Copelata							
19	*Oikiopleura* sp.					1600		1.4
	Cyclopoida							
20	*Oithona* sp.				400		400	0.7
	Mollusca							
21	Bivalve veliger			1400				1.2
	Mysida							
22	*Mysid* larva	400		800				1.1
	Polychaeta							
23	*Polychaete* larva				400		400	0.7
	Rotaliida							
24	*Globigerina* sp.	200		800				0.9
	Retaria							
25	Foraminiferans					200		0.2

	Namatoda							
26	*Nematode* sp.					400		0.4
	Tintinnoida							
27	*Tintinnopsis* sp.	200	200			400	1200	1.8
	Total Density (No/L)	**17400**	**30600**	**16600**	**12200**	**15200**	**22200**	
	Total Taxa richness	**14**	**15**	**10**	**10**	**12**	**14**	Total: **27**

Table 36. Diversity Indices of Zooplankton during June 2020

	Offshore site						Phang Creek					
Diversity indices	1(A)	1(B)	1(C)	1(D)	1(E)	Control	2(A)	2(B)	2(C)	2(D)	2(E)	Control
Taxa_S	17	14	16	19	21	14	14	15	10	10	12	14
Shannon_H	2.41	2.26	2.51	2.71	2.71	2.37	2.178	2.493	2.165	2.082	2.173	2.374
Evenness_e^H/S	0.66	0.68	0.77	0.79	0.72	0.76	0.631	0.807	0.872	0.802	0.732	0.767
Menhinick	0.13	0.11	0.13	0.17	0.21	0.10	0.106	0.086	0.078	0.091	0.097	0.094
Margalef	1.65	1.34	1.57	1.92	2.16	1.32	1.331	1.355	0.926	0.957	1.142	1.299

Table 37. Density and distribution of Zooplankton at Phang Creek during August 2020

S. No.	Species	1 (A)	1 (B)	1 (C)	1 (D)	1 (E)	Control	% of Occurrence
	Aphragmophora							
1	Sagitta sp.	1000	400	400		600	600	2.0
	Calanoida							
2	*Acrocalanus* sp.	1200	1000	1000	400	1000	1000	3.7
3	Candacia sp.			200				0.1
4	*Calanus* sp.	2000	1400	4800	600	1800	1800	8.1
5	*Centropages* sp.	1000	800	2000	2400	1600	1600	6.1
6	Corycaeus coleus			400				0.3
7	Corycaeus sp.	200		600		400	400	1.0
8	*Copepods* sp.	1000	4600	3000	3800	1600	1600	10.2
9	*Eucalanus* sp.	2000		800	200	600	600	2.7
10	*Eucheata* sp.		400					0.3
11	*Pesudocalanus* sp.			600				0.4
12	*Pseudodiaptomus* sp.	200	400					0.4
13	*Paracalanus* sp.	2200	1000		1000	600	600	3.5
14	*Labidocera* sp.			600				0.4
15	*Temora* sp.	400	600		400			0.9
	Total	**11200**	**10600**	**14400**	**8800**	**8200**	**8200**	40.0
	Maxillopoda							
16	Sapphirina	400						0.3
	Harpacticoida							
17	*Euterpina* sp.	2000		400	600	600	600	2.7
18	*Microsetella* sp.	400						0.3
19	*Macrosetella* sp.			200	400	400	400	0.9
	Total	**2400**	**0**	**600**	**1000**	**1000**	**1000**	3.9
	Decapoda							
20	Decopods				400	400	400	0.8

21	*Cardian* larva	400						0.3
22	*Brachyuran* Larva				200			0.1
23	Zoea larva	200	200	600				0.7
	Total							
	Copelata							
24	Cyclopods					400	400	0.5
25	*Oikiopleura* sp.		200					0.1
	Cyclopoida							
26	*Oithona* sp.		400		600			0.7
	Mysida							
27	*Mysid* larva	200	200	200	400	400	400	1.2
	Polychaeta							
28	Polychaete larva	2200	1000	200	1400	400	400	3.7
	Retaria							
29	Foraminiferans sp.	800	800	200	400	600	600	2.2
	Tintinnida							
29	*Tintinnopsis*sp.	600		400				0.7
	Malacostraca							
29	Isopods	400						0.3
	Echinodermata							
30	Ophiopluteus larva	400		600	200			0.8
	Density (No/L)	**32800**	**24000**	**32200**	**23200**	**20600**	**20600**	100.0

Table 38. Density and distribution of Zooplankton at Offshore site during August 2020

S. No.	Species	2 (A)	2 (B)	2 (C)	2(D)	2 (E)	Control	% of Occurrence
	Aphragmophora							
1	Sagitta sp.			2400	1400	1000	600	4.2
	Calanoida							
2	*Acrartia* sp.		600					0.5
3	*Acrocalanus* sp.	2200	1000	4000	3000	2200	400	9.9
4	*Acrocalanus gracilis*	200		600				0.6
5	*Calanoida* sp.	1400						1.1
6	*Candacia* sp.	0		200				0.2
7	*Calanus* sp.	0	3800	3000	3000	4400	3200	13.4
8	*Centropages* sp.	2400	3000	2600	3000	3600	200	11.4
9	*Corycaeus*sp.				800			0.6
10	*Copepods* sp.	3000	600	3000	2600	4600	2400	12.5
11	*Eucalanus* sp.	1600	1000	600	1000	400		3.5
12	*Eucheata* sp.	400			200			0.5
13	*Microcalanu*s sp.	200						0.2
14	*Onceae* sp.			400		400		0.6
15	*Pseudodiaptomus* sp.	200						0.2
16	*Paracalanus* sp.	600	800	600	2400		1400	4.5
17	*Labidocera* sp.			1000		600		1.2
18	*Subcalanus* sp.			600				0.5
19	*Temora* sp.		200			1200	600	1.5
20	*Temora discaulata*			1000				0.8
	Total	12200	11000	17600	16000	17400	8200	63.5
	Harpacticoida							
21	*Euterpina* sp.		800		1000	1000	1600	3.4
22	*Microsetella* sp.	400	400	200	1000	1000	400	2.6
23	*Macrosetella* sp.	1200	600	400	400	400		2.3

24	*Clytemnestra* sp.		200					0.2
	Total	1600	2000	600	2400	2400	2000	8.5
	Ostracoda							
25	Ostrocod sp.		200					0.2
	Decopoda							
26	Zoea larva	400	600	600	1400	3000	1200	5.5
	Copelata							
27	Cyclopods	400						0.3
28	Cyclopoida				600			0.5
29	*Oithona* sp.		400		400			0.6
	Total	**400**	**400**		**1000**			1.4
	Mollusca							
30	Gastropod veliger	200					600	0.6
30	Bivalve veliger		400				400	0.6
	Total	200	400				1000	1.2
	Mysida							
31	*Mysid* larva	200	200				1400	1.4
	Polychaeta							
32	Polychaete larva	800	400	400	1000	3200	3200	6.9
	Retaria							
33	Foraminiferans sp.		200	1000		3000	2200	4.9
	Tintinnida							
34	*Tintinnopsis*sp.			400		1400	400	1.7
	Echinodermata							
35	*Ophiopluteus* larva	200	200		400			0.6
	Density (No/L)	**16000**	**15600**	**23000**	**23600**	**31400**	**20200**	**100.0**

Table 39. Density and distribution of Zooplankton at Cargo jetty site during August 2020

S. No.	Species	3 (A)	3 (B)	3 (C)	3 (D)	3 (E)	Control	% of occurrence
	Aphragmophora							
1	Sagitta sp.						1400	1.6
	Calanoida							
2	*Acrocalanus* sp.	600	1000	200	2000	600	3600	8.9
3	Canthocalanus sp.					200		0.2
4	*Calanoida* sp.	800						0.9
7	*Calanus* sp.		1800	400	1000	3000	3200	10.5
8	*Centropages* sp.	600	1200	1200	600	1200	400	5.8
9	Corycaeus sp.					400	200	0.7
10	*Copepods* sp.	2000	1800	1800	1600	600	1800	10.7
11	*Eucheata* sp.					400		0.4
12	Isias sp.		200					0.2
14	Microcalanus sp.		0		200			0.2
15	Nannocalans sp.		0		200			0.2
16	*Pseudodiaptomus* sp.		400			200	600	1.3
17	*Paracalanus* sp.		2400	800	2200	600	1400	8.2
18	Rhincalanusnastitus		800					0.9
19	Rhincalanus sp.			400				0.4
20	*Labidocera* sp.					400		0.4
21	*Temora* sp.	400						0.4
22	Undinula sp.				200			0.2
	Total	**4400**	**9600**	**4800**	**8000**	**7600**	**11200**	50.8
	Maxillopoda							
23	Cirripeda larva	400						0.4
	Harpacticoida							
24	*Euterpina* sp.		200	400	1000	800	1200	4.0
25	*Microsetella* sp.	200			200	600	200	1.3

26	*Macrosetella* sp.				200	200		0.4
	Total	**200**	**200**	**400**	**1400**	**1600**	**1400**	5.8
	Decapoda							
27	Decopods				200			0.2
28	Zoea larva		200					0.2
	Total		**200**		**200**			0.4
	Copelata							
29	*Oikiopleura* sp.	200						0.2
	Cyclopoida							
30	*Oithona* sp.		400					0.4
	Mollusca							
31	Gastropod veliger					200		0.2
32	Bivalve veliger		200					0.2
	Total		**200**			**200**		0.4
	Mysida							
33	*Mysid* larva	5200	2400	3200		200	2800	15.4
	Polychaeta							
34	Polychaete larva	800	4400	1400	800	2600	1400	12.7
	Retaria							
35	Foraminiferans sp.	4000	800	800	200	1000	600	8.2
	Tintinnida							
36	*Tintinnopsis* sp.	400						0.4
	Malacostraca							
37	Isopods	800						0.9
	Echinodermata							
38	Ophiopluteus larva	200		600		200		1.1
	Fish							
39	Fish egg	600						0.7
	Nematoda							
40	Nematode larva					400		0.4

	Density (No/L)	**17200**	**18200**	**11200**	**10600**	**13800**	**18800**	100.0
	Species richness	**18**	**17**	**11**	**14**	**20**	**13**	

Table 40. Diversity indices of Zooplankton during September 2020

	Offshore site						**Phang Creek**						**Cargo Jetty**					
Diversity indices	**1(A)**	**1(B)**	**1(C)**	**1(D)**	**1(E)**	**Control**	**2(A)**	**2(B)**	**2(C)**	**2(D)**	**2(E)**	**Control**	**3A**	**3B**	**3C**	**3D**	**3E**	**Control**
Taxa_S	18	20	19	17	16	16	20	14	17	16	14	14	15	15	11	14	19	13
Shannon_H	2.479	2.530	2.567	2.589	2.508	2.200	2.688	2.199	2.321	2.330	2.459	2.459	2.148	2.315	2.114	2.254	2.538	2.281
Evenness_e^H/S	0.663	0.628	0.686	0.783	0.767	2.487	0.736	0.644	0.599	0.642	0.836	0.836	0.571	0.675	0.753	0.680	0.666	0.752
Menhinick	0.142	0.160	0.125	0.111	0.090	0.751	0.148	0.123	0.132	0.138	0.135	0.135	0.114	0.111	0.104	0.136	0.162	0.095
Margalef	1.756	1.968	1.792	1.589	1.449	0.113	1.937	1.372	1.647	1.578	1.400	1.400	1.436	1.427	1.073	1.403	1.888	1.219

8.0. Port activities including Dredging

Dredging is the major activity that increases water turbidity and suspended load thereby impacting plankton and productivity. Very high prevailing sedimentation in the Deendayal region necessitates huge quantity of maintenance dredging. A typical by product of dredging activities is the resuspension of sediments into the water column, which have effects on marine organisms.Further Dredging related suspended sediment plumes may differ in scope, timing, duration and intensity from those natural conditions, thus potentially causing conditions not normally experienced by the organisms (Snigdha, 2005). Effects of suspended sediments are highly species-specific and can vary greatly (Clarke and Wilber, 2000). Increase in suspended materials in the water column will diminish the light penetration with potential adverse effects on the photosynthetic capability of phytoplankton and other aquatic plants (Iannuzzi et al., 1996). Apart from this, various activities during the construction phase of the project such as dredging, sand compaction and other construction work in water make it turbid and also lead to increased levels of suspended solids. Keeping the above scenario in mind and in order to understand the environmental impacts of such dredged/dumped materials in two different locations, a detailed comprehensive study comprising three different season was conducted. In the present study, various significant parameters were studied during different seasons.

8.1. Likely impacts of dredging and disposal activities on the marine environment

In any activity in the ports of coastal environment, dredging activity is going to be a common and an unavoidable one and the impact of dredging are visualized in mangrove environment. Dredge spoils and the resultant turbidity may reach the near mangrove environment through tidal currents and likely to cause impacts. Hence, it is to be ensured that dredge spoils, fine suspended matter and highly turbid waters are contained to the maximum extent to prevent its reach to mangroves. The dispersal and settlement of re-suspended sediments arising from dredging activity may adversely affect the seaweed ecosystem. Sedimentation, directly and indirectly, affects the seaweed biodiversity; indirect effects include seaweeds mortality due to sediment accumulation, poor light penetration and turbidity. Direct deposition of sediments on seaweeds can block the physiological processes such as photosynthesis, and gas and nutrient exchange. Seaweeds require adequate sunlight for growth and development. However, continuous ship movements and sediment deposition during transportation can reduce the sunlight penetration.

As Deendayal Port Trust is engaged in various major projects and have also completed various projects for which the maintenance dredging in Kandla creek is happening and in near future DPT will also be involved in various activities including Multipurpose Terminal Tuna Tekra & Oil jetty Bunkering projects which involves major quantities of Dredging (Capital as well as Maintenance). Hence, continuous maintenenace dredging and disposal of the dredged materials by the port in nearby open waters is going to be a continuous process. Dredging the bottom will churn up the bottom sediment and disperse fine particulate matter in the water column resulting suspended load increase in the water column and formation of turbidity plumes in and around the dredging site. Harmful substances, including heavy metals, oil, TBT, PCBs and pesticides locked in the seabed sediments will be released due to bottom churning and their impact depends on to what extent the sediment is contaminated. However, their impact will be totally absent in the sediments beyond 200 meters of the dredging site. During dredging operation, dumped material mostly is spread upstream and downstream and no hump is allowed to be formed. It is estimated that the maximum rise in bed level will be only few cm at the dumping site which will be very less since the sediment plume is spread widely. The resultant sediment plume is limited to a small area and the background ambient suspended load is reached quickly beyond the disposal site. Major impact on sediment quality at the disposal site will be due to cascading effect of the falling sediments from the dredge bucket. Re-suspended heavy metal contaminants are likely to be added to the already existing contaminants at the bottom sediment of the disposal site increasing its concentration.

8.2 Impacts on Benthic Communities Biomass in the Disposal Site

When dredged materials are concerned, the benthic faunal habitats are the sediments and hence understanding the likely impacts on the benthic community need to be considered in a activity where dredging activities are going on. Since dumping is a continuous process, burial of biomass will continue for the entire dumping period. However, the visible impacts will be restricted in the dumping area with the less impact expected in the zone beyond disposal site and studies suggest that in general, the biomass will resume back to its background level beyond 200 meters from the boundary of the dumping location and within the dumping site again major effect will be smothering and blanketing due to descending sediment load on the bottom. The revival and rehabilitation chance of benthic community will resume once the dumping is stopped but considering the vastness of Gulf system, the benthic biomass to be affected may be less. It is unlikely that disposal activities will cause major impact in the intertidal fauna or quality of the sediment in terms of physical and chemical characteristics and metal pollutants as impacts arising out of petroleum hydrocarbons (PHC) and heavy metals which are locked in the sediment and released due to disposal is expected to be low as the levels of PHCs and heavy metals in the sediment were mostly normal and no abnormal levels of these elements which could pose serious threats to the ecosystem have been noticed during the present study. Further, capital and maintenance dredging carried out earlier for the existing navigational channels and the earlier reports done by GUIDE has not shown any major signs of degradation on the benthic community of this region.

8.3 Management of Dredging impacts

In general a comprehensive dredging management plan should be considered for any port environment so as to ensure that the project activities should be carried out with No or a very minimal effects to the environment. Dredging activities, either, capital or maintenance dredging affects the quality of marine water thereby affecting the life forms present in it. Among various physical characteristics, total suspended solids and turbidity play a major role in affecting the water column which in turn affects the marine organisms. During dredging activities, there is a high chance of dispersal of suspended sediment load gets mixed up in the water column, thereby increasing the load of TSS.

Other than capital dredging, maintenance dredging is also carried out on a regular basis in a port environment which is done to ensure the depth and width of the channel. Among these two types of dredging activity, the maintenance dredging poses major disposal problems due to the removal of deeper sediments during construction dredging and such sediments, in general, contains natural and manmade pollutants. Further, disposal of dredged materials should be in line with statutory regulations. In order to confirm this, a long term monitoring of the dredging activity and the study of dredged materials is required. Though various mitigation measures are being undertaken and followed widely to cutdown the entry of sediments in to the water column, some of the points are listed below:

- Implementation of the use of suction dredger instead of bucket dredger can be a better option.
- Further, dewatering of the fines suspended matter through sediment traps can be followed.
- Dredging activities during bad weather conditions can be avoided.
- Dredging should be undertaken in such a way that it does not harm the marine organisms breeding especially the ones which are economically important.
- Further, the dredging activity areas should be screened for the presence of presence of RET Species which are indigenous to the Gulf of Kachchh region.
- In order to ameliorate the likely impacts due to sediment load through changes in operational procedure such as appropriately timing the operation in tune with tides and tidal current direction) may be considered.
- Similar to the current practice being followed, disposal of dredged materials continued to be done only in pre-designated sites.
- Turbidity curtains, nowadays, are increasingly used during dredging operations as suggested by Researchers (Sawaragi, 1995; Elander and Hammar, 1998; Otoyo, 2003; Dreyer, 2006; Guo *et al*., 2009; Ishizaki and Rikitake, 2010; Ueno, 2010, Trang and Keat, 2010) which could also be attempted based on its operational convenience. Moreover various other factors such as current speed, water depth and wave heights to be considered as these also play role in the efficiency of Turbidity curtains. Turbidity curtains allow suspended sediments to settle out of the water column in the dredging spot thus minimizing sediment transport towards the shore. Constructed with thermoplastic material, they serve as a primary method to control turbidity in dredging sites. There are various types of curtains like floating, hanging, solid diversion baffles and permeable and impermeable screens. However, they have proved to be an effective method to contain sediment load in ecologically sensitive areas such as mangroves and corals during dredging operations.

- The initial screening for evaluating disposal options is based on physical and chemical analysis for geotechnical character and the presence of contaminants in the sediments. Depending on the physical and chemical character of the dredged material, disposal may be confined, unconfined or treated prior to release in open water, along the shoreline, or on land.
- To mitigate potential contaminant passing from the port area, it should be addressed through proper design of storm water handling and treatment facilities; placement of sewage and wastewater outfalls; compatibility of local land use (e.g. proximity of agriculture fields or mining operations), procedures for handling hazardous materials and types of industries permitted to operate in the port area.
- Many management measures such as enhancing the biodiversity of the intertidal / subtidal areas by means of artificial reef structures and controlling water column turbidity by deploying mechanisms to trap silts arising out of dredging activity may be better options which can be implemented by the port authorities.

8.4 Conclusion and Recommendations

Similar to the previous years, the project in 2019-20 also subjected the sediment quality for various characteristics such as physical, chemical and biological parameters (pH, Sediment texture, Total organic Carbon, Total Nitrogen, Total Phosphorus, and heavy metals such as Cadmium, Lead, Chromium, Copper, Nickel, Zinc, Mercury and Cobalt and Petroleum hydrocarbon and Phenolic compounds) from the disposal locations. This monitoring was conducted during three seasons. Based on the data gathered, this Final report was prepared. During this period, marine water from the locations was also studied to understand the impact of the dredged material on the water column. The study was conducted in a systematic manner involving standard protocols and the gathered data on the physical, chemical constituents and biological characteristics were used for interpretation.

The present study envisaged the characterization of marine water and sediment samples to understand the occurrence of various pollutants including heavy metals and Petroleum hydrocarbons are observed well within the permissible limits prescribed for Coastal water quality standards. There were few metals especially nickel which was found to be predominant in water during all the three seasons than the previous years. Various factors might play a role in the occurrence of such elements including manmade and natural pollutants sources due to run off, environmental factors and sampling locations. As Surface runoff carries a broad spectrum of pollutants and it is well known that such runoff can be significant pathways for the transfer of heavy metals into the environment. Yet another unexpected climatic factor was the rainfall occurred during monsoon 2020 wherein Kachchh district received fairly good amount of rain.

Kandla port located in the tail end of Gulf of Kachchh and the innate characteristics of the region is the suspended load and turbidity in the water column which reduces the light penetration in general which in turn impacts the primary productivity of the ecosystem. Hence, comparatively low biological community structure of the water and sediment was observed during this study similar to previous year. Hence regular monitoring of the sediment matrix and water column of a coastal environment is essential not just to understand the environmental health but will be helpful to find out the pattern and to contrivance appropriate management measures arising due to dredging impacts.

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ANNEXURE B

DEENDAYAL PORT TRUST
(Erstwhile KANDLA PORT TRUST)

Administrative Office Building
Post Box NO. 50
GANDHIDHAM (Kutch).
Gujarat: 370 201.
Fax: (02836) 220050
Ph.: (02836) 220038

www.deendayalport.gov.in

EG/WK/4751/Part (EC & CRZ- II)

Dated: 24/8/2021

To,
The Director (Environment) & Additional Secretary
And Member Secretary, GCZMA,
Government of Gujarat, Forest & Environment Department,
Block No. 14, 8th Floor, Sachivalay,
Gandhinagar 382 010.

Sub: Development of 7 Integrated Facilities (Stage I) within the existing Kandla Port Trust limit at District Kutch (Gujarat) by M/s Kandla Port Trust – Environmental & CRZ Clearance – Suggestions of the Gujarat Coastal Zone Management Authority for Preparation of Regional Strategic Impact Assessment Report – **Finalization of Revised TOR reg.**

Ref.: 1) Environmental & CRZ Clearance accorded by the Ministry of Environment, Forests & Climate Change, GoI vide F. no. 11-81/2011- IA III dated 19/12/2016.
2) KPT request letter no. EG/WK/4751 (EC & CRZ) dated 3/1/2017 & 3/4/2017.
3) KPT letter no. EG/WK/4751/CRZ II dated 11/8/2017 along with Draft TOR for preparation of RSIA Report.
4) Presentation before the technical committee of the GCZMA on 12/4/2018.
5) Presentation before the sub-committee of the GCZMA on 12/7/2018.
6) Submission of Revised TOR (as suggested by the subcommittee) vide letter No. EG/WK/4751/Part (EC & CRZ – II)/758 dated 25(27)/7/2018.
7) DPT request letter vide no. EG/WK/4751/Part (EC&CRZ-II) Dated 17/10/2018, 16/1/2019, 21/2/2019, 20/4/2019, 13/12/2019 , 24/2/2020 , 27/5/2020 ,17/11/2020 & 24/2/2021.
8) Email dated 8/3/2021 from the Director (Environment) & M.S, GCZMA reg. proposal included in the Agenda of the GCZMA scheduled to be held on 10/3/2021 for presentation.

Sir,

Kindly refer to the above references on the said subject.

In this regard, kindly to state that, the subject proposal was included in the Agenda of the Gujarat Coastal Zone Management Authority Meeting held on 10/3/2021. However, due to some technical issue in the network connectivity, the proposal was not discussed & it was informed by the GCZMA officials to include the proposal in the next GCZMA meeting.

..............Cont................

It is also once again relevant to mention here that, DPT had awarded the work to M/s GUIDE,Bhuj during September, 2017 i.e. on 1/9/2017, with a time period of 14 months i.e. up to 14/11/2018 and subsequently, on request of DPT , M/s GUIDE, Bhuj awaited for finalization of TOR from the GCZMA to finalize the report. Now, they have repeatedly requested DPT to finalize the RSIA Study report, due to their occupancy in other works already taken on hand. However, without finalization of TOR from GCZMA, it would not be possible to finalize the RSIA Report, as the specific condition of EC & CRZ Clearance mandates preparation of RSIA in consultation with GCZMA.

Therefore, it is very much essential to furnish TOR finalized by the GCZMA to M/s GUIDE,Bhuj, on priority. After that only, M/s GUIDE,Bhuj may be able to finalize the RSIA Study report & DPT may be able to submit the same to the MoEF&CC,GoI, in compliance of the stipulated condition mentioned in the EC & CRZ Clearance dated 19/12/2016 (Specific Condition no. viii).

In view of the above submission, it is once again requested to kindly include our subject proposal in the ensuing GCZMA Meeting and finalize the Terms of Reference at an earliest, please.

Yours faithfully,

Superintending Engineer (PL) & EMC (i/c)
Deendayal Port Trust

ANNEXURE C

Annexure C

CSR Activities at Deendayal Port Trust

Details of CSR

Sr. No	Year	Board Resolution For Budget Provision	Board Approved Budget Provision	Board Resolution for approval of the CSR activities	Board Approved Amount For CSR Activities	Actual Exp. Upto Nov'20 (Rs. In Lakhs)	Net balance (Rs. In Lakhs)	Remarks
1	2	3	4	5	6	7	6-7	
1	2011-2012	369 of 28.03.2012	3.00 Cr					
2	2012-2013	17 of 31.05.2012	4.00 Cr					
				61 of 30.08.2012	564.00 Lakh	564.00	Nil	Works completed
3	2013 -2014	99 of 30.09.2013	6.43 Cr					
4	2014-2015	322 of 21.11.2014	1.07 Cr	20 of 16.04.2015	236.22 Lakh	188.18	8.04	Works in progress
5	2015-2016	151 of 12.02.2016	1.50 Cr	48 of 12.08.2016	28.00 Lakh	5.00	23.00	Works in progress
6	2016-2017	138 of 06.01.2017	2.60 Cr	52 of 2.8.2017	140.30 Lakh	146.00	-5.70	Works completed
7	2017-2018	41 of 2.08.2017	7.02 Cr	15 of 04.05.2018	155.10 Lakh	115.37	39.73	Works in progress
8	2018-19	51 of 07.08.2019	6.70 Cr	111 of 4.12.2018	154.90 Lakh	50.50	104.40	Works in progress
					1278.52 Lakh	**1069.05**	**209.47**	
9	2019-20	58 of 10.10.2019	5.49 Cr	92 of 06.12.2019	1838.57 Lakh	Nil		MoS approval is awaited
		Total	**37.81 Cr**		**3117.09 Lakh**			
						Spent in PM Fund for COVID-19–800 Lakhs		

Year-wise details of CSR works undertaken by DPT during 2012 – 13 to 2019 – 20 are given in **Tables 7.3a, 7.3b, 7.3c, 7.3d, 7.3e, 7.3f** and **7.3g**.

Table 7.3a: CSR Works Undertaken by DPT during 2011-12 and 2012 – 13

Sl. No.	Name of Work	Cost (Rs. In lakhs)
1	Repair of road from Dr. Baba Saheb Ambedkar Circle to NH 8A (via Ganesh Nagar)	518
2	Repair of road from S.T. Bus Stand to Sunderpuri Cross Road via Collector Road	
3	Repair of road from NH 8A Railway Crossing to Maninagar (along railway track)	
4	Repair of road from Khanna Market Road (Collector Road) to Green Palace Hotel	
5	Construction of internal roads at “Shri Ram” Harijan Co-operative Housing Society (near Kidana)	
6	Construction of cremation ground and graveyard with other facilities at Vadinar	19.44
7	Providing cement concrete internal roads in Village Vadinar Stage - I	16.16
8	Approach road provided for developing tourism at Village Veera near Harsidhi Mata Temple	4.65
9	Water tank along with R.O. provided near developing tourism area	0.30
10	Creating facilities of flooring and steps surrounding lake to stop soil erosion and attract tourists at Village Veera.	4.80
	TOTAL	563.35

Table 7.3b: CSR Works Undertaken by DPT during 2014-15

Sl. No.	Name of Work	Cost (Rs. In lakhs)
1	Construction of community hall – cum – school at Maheshwari Nagar, Gandhidham	51.90
2	Renovation of “Muktidham” (cremation ground) at Kandla	10.65
3	Sunderpuri – 1 Valmiki Community Hall	5.00
4	Sunderpuri – 2 Valmiki Community Hall	5.00
5	Ganeshnagar Community Hall	10.00
6	Jagjivan Maheshwari Community Hall	10.00
7	Various works of road at Sapnanagar	99.19
8	Construction of compound wall in the dam of Jogninar Village	14.48
	TOTAL	206.22

Table 7.3c: CSR Works Undertaken by DPT during 2015-16

Sl. No.	Name of Work	Cost (Rs. In lakhs)
1	Construction of Bus Stand at Vadinar Village	10.00
2	Providing drainage system at Vadinar Village	6.00
3	Providing and laying of water supply lines in Vadinar Village	6.00
4	Road from Gandhidham Post Office to Merchantile Marine Department Office along with toilet facilities	60.00
5	Construction of toilets for girls / women at Khari Rohar, Village	3.00
6	Construction of toilets for girls at Mathak Primary School, Mathak, Village	3.00
	TOTAL	**88.00**

Table 7.3d: CSR Works Approved by DPT Board for 2016-17

Sl. No.	Name of Work	Cost (Rs. In lakhs)
1	RCC community hall at Harsidhi Mata Temple, Village Veera, Anjar Taluka	19.00
2	Fabricated Community Hall at Sanghad Village, Anjar Taluka	21.00
3	CSR Works for Shri Maheshwari Meghvad Samaj, Gandhidham at graveyard behind Redison Hotel	8.00
4	CSR Works for Shri Dhanraj Matiyadev Mukti Dham, Sector 14, Rotary Nagar, Gandhidham	30.50
5	CSR Works for Nirvasit Harijan Co-operative Housing Society, Gandhidham Health Cum Education Centre	41.00
6	CSR Works for Shri Rotary Nagar Primary School, Gandhidham	2.80
7	CSR Works at NU-4, NU-10(B) Sapnanagar & Saktinagar, Golden Jubilee Park at Gandhidham	18.00
	TOTAL	**140.30**

Table 7.3e: CSR Works Approved for 2017-18

Sl. No.	Name of Work	Proposal Received from / / Name of Organization / N.G.O	Cost (Rs. In lakhs)
1	CSR Works at Shri Ganesh Nagar High School, Gandhidham	Principal, Shri Ganesh Nagar Govt High School, Gandhidham	38.30 Lakhs
2	CSR Works for MOLANA AZAD Primary School, Kandla	Shri M L Bellani, Trustee, DPT, Shri Kandla Port Education Society, New Kandla	7.00 Lakhs
3	Grant financial contribution for facility of Army Cantonment for 50 nos. air coolers at Kutch Border Area	Shri Vinod L Chavda, MP	15 Lakhs
4	40% of the estimated cost of providing drainage lines at Tuna and Vandi villages under Swachh Bharat Abhiyan.	Shri Sarpanch, Tuna Village & Vandi village & Shri M L Bellani, Trustee, DPT	**Rs. 39.80 Lakhs** *Approx. estimated Cost Rs.99.50 Lakhs, of which 40% to be contributed by DPT.*
5	CSR works for S.H.N. Academy English School (managed by Indian Inst. Of Sindhology – Bharati Sindhu Vidyapeeth), Adipur	Director, S.H.N Academy English School	**40 Lakhs**
6	Construction of internal roads at Bhaktinagar Society, Kidana	Smt Maltiben Maheshwari, MLA	**15 Lakh**
		TOTAL	**155.10**

Table 7.3f: CSR Works Approved for 2018-19

Sl. No.	Name of Work	Proposal Received from / / Name of Organization / N.G.O	Cost (Rs. In lakhs)
1	CSR work to Donate 100 Nos of Computers to Daughters of Martyred Soldiers in the country under the "BETI BACHAO BETI PADHAO" program by Atharva Foundation, Mumbai	Chairman, Atharva Foundation, Mumbai	**24.00**
2	CSR work to Donate ONE (40 Seater) School Bus for Deaf Children Students for the Institute of Mata Lachmi Rotary Society, Adipur	Mata Lachmi Rotary Society, Adipur	**18.00**
3	CSR work to Providing One R.O Plant with Cooler at PanchyatPrathmikSala, Gadpadar Village for the ANARDE Foundation, Kandla&Gandhidham Center.	Dist. Rural Development Officer, Annarde Foundation-Kandla & Gandhidham	**1.50**
4	CSR work for Providing Drainage Line at MeghparBorichi village, AnjarTaluka	Shri Vasanbhai Ahir, MLA, Gujarat Govt	**25.00**
5	CSR work for Construction of Health Centre at Kidana Village	Shri Vinod L Chavda, MP	**13.00**
6	CSR work to provide 4 Nos. of Big Dust Bin for MithiRoharJuth Gram Panchayat.	Shri Sarapanch, Mithi RoharJuth Gram Panchayat	**3.40**

Sl. No.	Name of Work	Proposal Received from / / Name of Organization / N.G.O	Cost (Rs. In lakhs)
7	CSR work for Renovation & construction of shed at CharanSamaj, Gandhidham –Adipur.	Shri Vinod L Chavda, MP	**10.00**
8	CSR Work for Renovation/Repairing of Ceiling of School Building at A. P Vidhyalay, Kandla.	Smt Maltiben K. Maheshwary, MP, Gandhidham.	**10.00**
9	CSR work for Construction of Over Head Tank & Providing 10 Nos of Computers (for students) of NavjivanViklangSevashray, Bhachau, Kutch	Shri Jitendra Joshi, Founder Secretary, Shri Navjivan Viklang Sevashray, Bhachau, Kutch	**9.50**
10	CSR work to Provide Books & Tuition fees for Educational facilities to weaker section children of ValmikiSamaj, Kutch.	Shri Manohar Jala, Chairman of "National Commission of Safai Karamcharis"	**2.00**
11	CSR work to provide Water Purifier & Cooler for the ST. Joseph's Hospital, Gandhidham	Smt. Maltiben K Mahewari, MLA ,Gandhidham	**1.50**
12	CSR work for Construction of Second Floor (Phase – I) for Training Centre of "GarbhSanskran Kendra" "Samarth Bharat Abhiyan" of Kutch Kalyan Sangh, Gandhidham	Shri Vinod L Chavda, MP, Kutch	**37.00**
		TOTAL	**154.90**

Table 7.3g: CSR works approved for the year 2019-20 (approval from Ministry of Shipping still awaited)

Sl. No.	Name of Work	Proposal Received from / / Name of Organization / N.G.O	Cost (Rs. In lakhs)
1	CSR activities for Providing Drainage line at Nani Nagalpar village.	Sarpanch of Village:-Nani Nagalpar, Taluk: Anjar.	**3.00**
2	CSR activities for Development of ANGANWADI Building at School no- 12 at Ward no 3 & 6 at Anjar.	Shri Vasanbhai Ahir, MLA	**7.00**
3	CSR activities for Improving the facilities of Garden at Sapna Nagar(NU-4)& (NU-10 B),Gandhidham.	Shri K P Maheshwari, Resident Sapnanagar, Gandhidham	**18.00**
4	CSR activities for Providing of Plastic Shredding Machine to Mirror Charitable Trust, Gandhidham.	Mirror Charitable Trust ,Gandhidham	**4.75**
5	CSR activities for development of School premises of Shri Guru Nanak Edu. Society, Gim.	Shri Guru Nanak Education Society, Gandhidham.	**30.00**
6	CSR activities for the improvement of the facilities at St. Joseph Hospital & Shantisadan at Gandhidham	St. Joseph Hospital Trust, Gandhidham	**20.00**
7	CSR activities for the improvement of the facilities at SVP (SardarValabhbhai Patel) Multipurpose Hall at Gandhidham	Request from MarwadiYuva Munch & UNION Gandhidham	**500.00**
8	Consideration of Expenditure for running of St Ann's High School at Vadinar of last 5 years 2014 to 2019 under CSR.	Proposal from COM, OOT Vadinar, DPT	**825.00**
9	CSR activities for development of school premises of Shri Adipur Group Kanya Sala no-1 at Adipur	Principal, Shri Adipur Group KanyaSala, Adipur	**6.50**
10	CSR activities for development of school premises of Shri Jagjivan Nagar Panchyat Prathmiksala, Gandhidham.	Principal, Shri Jagjivan Nagar Panchyat Prathmiksala, Gandhidham.	**16.50**
11	CSR activities for development of school premises of Ganeshnagar Government high school, Gandhidham.	Shri Vinod L Chavda, MP, Kutch	**9.00**
12	CSR activities for improving greenery, increase carbon sequestration and beat Pollution at Kandla, DPT reg.	Work awarded to Forest Department , Bhuj	**352.32**
13	CSR activities for providing infrastructures facilities at "Bhiratna Sarmas Kanya Chhatralaya" under the Trust of Samaj Nav- Nirman at Mirjapur highway, Ta Bhuj.	SamajNav- Nirman at Mirjapur highway, Ta Bhuj.	**46.50**
		TOTAL	**1838.57**

ANNEXURE D

ENVIRONMENT MONITORING REPORT
OF
DEENDAYAL PORT TRUST

(Annual Report)
(March 2020 to February 2021)

(Report No - DCPL/DPT(19-22)/AMR/20-21/01)

Submitted to

Deendayal Port Trust

Prepared by

Detox Corporation Pvt. Ltd.
Detox House, Udhna Darwaja, Ring Road
Surat - 395002

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1. Introduction

The environmental Monitoring plan is the key document in the environmental management system and sets out the detailed targets, objectives and procedures that will be adopted in order to achieve the goals set out in the environmental policy. EMP document is a collation of background information relevant to the Kandla Port Environmental Management and Monitoring Plan (EMMP).

1.1. The Environment (Protection) Act, 1986

The EPA 1986 came into force in all of India in November of 1986, under an official notification. The Act contains 26 sections divided into 4 chapters. The Act has its genesis in Indian Constitution’s Article 48(A) and Article 51(A)g. The Act is a part of Article 253 of the Indian Constitution.

The rules of Environment protection came into force on 19th November 1986 and these rules provide for the following:

- The standards of quality of air, soil and water for various areas and purposes of environment.
- The standard set up to know about the limits of the environmental pollutants.
- Rules include the procedure and safeguards needed to handle the hazardous substance.
- Restrictions and some prohibitions on handling the hazardous substances in different areas and premise
- The procedures and safeguards required for the prevention of accidents which may cause environmental pollution and also the remedies for it.
- The prohibition and restrictions possessed on the location of industries in different areas.

1.2. EIA and CRZ Notification

The Ministry of Environment, Forests & Climate Change (MoEF & CC), Government of India, exercising the powers conferred upon it under the provisions of the Environment (Protection) Act, 1986, issued the Environment Impact Assessment Notification, 2006 and its subsequent amendments.

1.2.1. EIA Notification

The basic objective of the Environment Impact Assessment is to identify, predict, mitigate and communicate the possible impacts due the proposed project to the Government authority and people likely to be affected and incorporate the conditions for construction, operation, maintenance and waste disposal phases of the project to mitigate the negative (adverse) impacts and enhance the positive impacts for the sustainable development of the region.

Environmental Impact Notification S.O.1533 (E), dtd.14th September 2006 as amended 2009, issued under Environment (Protection) Act 1986, has made it mandatory to obtain prior environmental clearance (EC) for scheduled development projects. The notification has classified projects under two categories A & B. Category A projects (including expansion and modernization of existing projects) require clearance from The Ministry of Environment, Forests & Climate Change (MoEF & CC), Govt. of India (GoI) and for category B from State Environmental Impact Assessment Authority (SEIAA), constituted by Govt. of India.

Some important features of the said Notification are:

I. Prior Environmental Clearance (EC) is required by all new projects or activities listed in the Schedule of the EIA Notification 2006 and subsequent amendments thereafter. EC is required before

commencement of any construction work or preparation of land by the project management.

II. Prior EC is also required by the existing projects or activities if its capacity is likely to exceed the threshold limit mentioned in the said Schedule.

III. All category B projects where general condition does not apply, the project proponents are required to apply to the SEAC who will hear the case according to the procedure laid down in the EIA notification and based on whose recommendation, EC may be granted or rejected by the SEIAA.

IV. For all category A projects and also category B projects where general condition applies, the project proponents are required to apply directly to The Ministry of Environment, Forests & Climate Change (MoEFCC), Government of India, who would consider the project for grant or rejection of the EC based on the recommendation of the Expert Appraisal Committee at the central level.

V. If projects attract CRZ clearance, then clearance under CRZ rules is also required.

1.2.2. Coastal Regulation Zone (CRZ)

The Union Cabinet approved the Coastal Regulation Zone (CRZ) Notification, 2018 which were last reviewed and issued in 2011. The notification was released after a series of representations received by the Ministry of Environment, Forest & Climate Change (MoEF&CC) from various Coastal States/UTs for a comprehensive review of the provisions of the CRZ Notification, 2011.

1.2.2.1. Classification of CRZ

For the purpose of conserving and protecting the coastal areas and marine waters, the CRZ area shall be classified as follows, namely: -

CRZ-I A

CRZ-I A shall constitute the ecologically sensitive areas (ESAs) and the geomorphological features which play a role in maintaining the integrity of the coast viz.: Mangroves, corals, biologically active mudflats, Marine national parks, turtle nesting grounds etc.

CRZ-I B

The intertidal zone i.e. the area between Low Tide Line and High Tide Line shall constitute the CRZ-I B.

CRZ-II

CRZ-II shall constitute the developed land areas up to or close to the shoreline, within the existing municipal limits or in other existing legally designated urban areas, which are substantially built-up with a ratio of built-up plots to that of total plots being more than 50 per cent and have been provided with drainage and approach roads and other infrastructural facilities, such as water supply, sewerage mains, etc.

CRZ-III

Land areas that are relatively undisturbed (viz. rural areas, etc.) and those which do not fall under CRZ-II, shall constitute CRZ-III, and CRZ-III shall be further classified into following categories: -

CRZ-III A

Such densely populated CRZ-III areas, where the population density is more than 2161 per square kilometer as per 2011 census base, shall be designated as CRZ-III A and in CRZ-III A, area up to 50 meters from the HTL on the landward side shall be earmarked as the 'No Development Zone (NDZ)', provided the CZMP as per this notification, framed with due consultative process, have been approved, failing which, a NDZ of 200 meters shall continue to apply.

CRZ-III B

All other CRZ-III areas with population density of less than 2161 per square kilometer, as per 2011 census base, shall be designated as CRZ-III B and in CRZ-III B, the area up to 200 meters from the HTL on the landward side shall be earmarked as the 'No Development Zone (NDZ)'.

Land area up to 50 meters from the HTL, or width of the creek whichever is less, along the tidal influenced water bodies in the CRZ III, shall also be earmarked as the NDZ in CRZ III.

CRZ- IV

The CRZ- IV shall constitute the water area and shall be further classified as under:

- **CRZ- IVA**

The water area and the sea bed area between the Low Tide Line up to twelve nautical miles on the seaward side shall constitute CRZ-IV A.

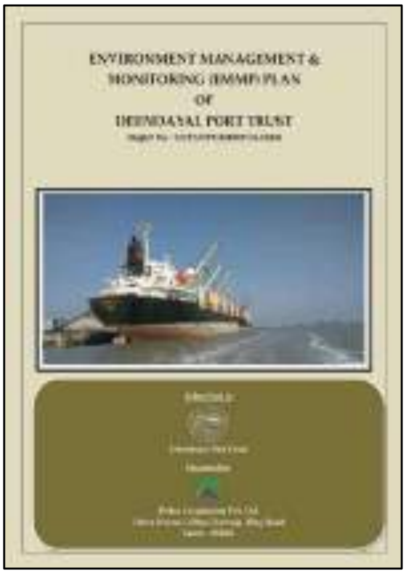
- **CRZ- IVB**

CRZ-IV B areas shall include the water area and the bed area between LTL at the bank of the tidal influenced water body to the LTL on the opposite side of the bank, extending from the mouth of the water body at the sea up to the influence of tide, i.e., salinity of five parts per thousand (ppt) during the driest season of the year.

1.2.3. EMMP Plan

As per the guidelines of Ministry of Environment Forests and Climate Change and also as per the environment management plans submitted by various agencies during their EIA studies, DPT has appointed M/s. Detox Corporation Pvt. Ltd. for the work of "Preparing and Monitoring of Environmental Management Plan for Deendayal Port Trust at Kandla vide Work Order No. EG/WK/EMC/11023/2011/IV/213 Dated-07/12/2019.

As part of this assignment, M/s. Detox Corporation Pvt. Ltd. prepared an Environmental Management and Monitoring Plan (EMMP) and submitted this EMMP prior to commencement of the Environment Monitoring of Deendayal Port in February 2020. The EMMP summarized the background information as a resource to develop Environment Monitoring Plan, based on the results of the EIA studies carried out at Deendayal Port by several agencies.



This environmental Management and Monitoring Plan (EMMP) plan submitted in February 2020 was the key document in the environmental management system and set out the detailed targets, objectives and procedures that are adopted in order to achieve the goals to efficiently manage the environmental policy of Deendayal Port Trust.

2. DEENDAYAL PORT TRUST

Deendayal Port is one of the most important ports of India. This port is situated at Latitude 23º 01′ N and Longitude 70º 13′ E on the shores of the Kandla Creek. The Deendayal Port came into existence in the year 1931 with a single Pier construction. Later on with the loss of Karachi port to Pakistan during partition, after independence the Government of India chose Kandla as an ideal sea outlet. Thus the Deendayal Port was developed and since then Deendayal Port has played a pivotal role in enhancing country`s maritime trade.

The Port of Kandla was declared a major port in 1955. The Deendayal Port Trust was created by law in 1963 to manage the new port. In 1978, The Deendayal Port had commissioned the off-shore Oil Terminal facilities at Vadinar jointly with Indian Oil Corporation, by providing Single Buoy Mooring (SBM) system, having a capacity of 54 MMTPA, which was first of its kind in India. Further, significant quantum of infrastructure up-gradation has been effected, excellent maritime infrastructure has been created having capacity of 32 MMTPA by M/s Essar Oil Refinery in Jamnagar district.

The port governed by Deendayal Port Trust (DPT) is a gateway port to the hinterland in western and northern states of Jammu & Kashmir, Delhi, Punjab, Himachal Pradesh, Haryana, Rajasthan, Gujarat and parts of Madhya Pradesh, Uttaranchal and Uttar Pradesh. It is in the district of Kutch and is located on the west bank of Kandla creek which runs into the Gulf of Kutch at a distance of 90 nautical miles from the Arabian Sea. The Port is well connected by the network of rail and road and is a gateway port for export and import of goods for northern states (Map 1). The width

of the channel varies from 200 meters to 1,000 meters. The contour depth along the shipping channel is around 10 meters. The total length of the Deendayal Port approach Channel is around 23 kms. Presently, the Port has sixteen cargo berths for handling dry cargo traffic, six oil jetties for handling Petroleum Oil products and other liquid cargo traffic at Kandla Creek and 3 Single Buoy Mooring (SBM) at Vadinar for handling crude oil and two product jetties for handling petroleum products.

2.1. The Physical Environment

Deendayal Port (23^0 02′ 29.92″ N, 70^0 13′ 08.99″ E) is located at the tail end of Gulf of Kachchh (GoK), an east west oriented Gulf system in the western part of Gujarat. It is about 90 nautical miles from the open waters of Arabian Sea. Kandla creek harboring the Deendayal Port is one of the major creeks of the inner Gulf of Kachchh. Gulf of Kachchh (GoK) is 75 km wide at its mouth and after running about 170 km away from the Arabian sea towards east, narrows down into a constriction at 70^0 20′ E at *Sat Saida* Bet and then bifurcates into many creek systems (Map 1). The Little Rann at the tail end of GoK has a network of many small and large creeks, intermingling with marshy tidal flats rich in fine clays. Kandla creek is one of the major tributaries of this creek system, which empties into the inner GoK. All these creeks bring water from the Little Rann into Kandla creek, which has a fairly good depth and stable banks.

Coastal and inland environmental setting of Kandla, similar to other parts of Kachchh, has marked climatological peculiarities like aridity, geomorphology and coastal and terrestrial ecosystems. Annual rainfall in Kachchh district was 458 mm during 2001- 10 whereas it was 443 mm at Gandhidham taluka during the same period which is often irregular. Rain during monsoon is confined to only 15-20 days and occurs as an instant downpour. The mean rainfall in year 2019 was 194 mm.

On the terrestrial side there are no major rivers or rivulets or freshwater streams. Winter and summer temperatures range from 7^{o}- 47^{o}C with a yearly average humidity of 60% which increases to 80% during southwest monsoon and decreases to 50% during November-December. Average wind speed is 4.65 m/s with a maximum of 10.61 m/s during June. Drought is a common phenomenon in Kachchh with 2 drought year in a cycle of 5 years. Annual temperature fluctuation in the district is extreme, ranging from 4^{o}C to 47.5^{o}C.

2.2. Biophysical Environment

a. Creek system

The creek system consists of 3 main creeks the Nakti, the Kandla and the Hansthal, and the Little Gulf of Kutch interconnecting through many other big and small creeks, all along the coast. Very few rivers drain into the Gulf and they carry only a small quantity of freshwater, except during the brief monsoon. They are broad-valleyed and their river bed is mostly composed of coarse sand and gravel. The Gulf is uniquely characterized by numerous hydrographic features like pinnacles, as much as 10 m high. The southern shore has numerous islands and inlets covered with mangroves and surrounded by coral reefs. The northern shore is predominantly sandy or muddy confronted by numerous shoals.

The Marine water of Gulf of Kutch and its creeks like Kandla creek, Nakti creek and Khori creek are providing the suitable habitat for marine vegetation. The Gulf abounds in marine wealth and is considered as one of the biologically rich marine habitat along the west coast of India. The marine vegetation is highly varied, which includes sand dune vegetation, mangroves, sea grasses, macrophytes and phytoplankton. The dominant species of sand dune flora are *Euphorbia caudicifolia, E. nerifolia, Aloevera sp, Ephedra foliata, Urochodra setulosa, Sporobolus maderaspatenus,*

Eragrostis unioloides, Calotropis procera, Fimbristylis sp, *Indigofera* sp and *Ipomoea pescaprae*. The common sea grasses found growing on the mud flats are *Halophila ovata* and *H.beccarii*.

b. Mangroves

Deendayal Port Trust (DPT) is one of the largest ports of India in terms of volume of cargo handled. Among Indian ports, this port also has the largest coastal habitats such as mangroves (193.1 km2) and mudflats (312.9 km2). DPT has implemented mangrove plantation in 1300 ha during 2005 - 2017 through various implementing agencies at Sat Saida Bet, Nakti creek and Kantiyajal. The Deendayal Port Trust has entrusted the task of evaluating 1300 ha of mangrove plantation in these three locations to Gujarat Institute of Desert Ecology (GUIDE), Bhuj.

Coastal belt in and around Kandla region is characterized by a network of creek systems and mudflats which are covered by sparse halophytic vegetation like scrubby to dense mangroves, creek water and salt encrusted land mass which forms the major land component. The surrounding environment in a radius of 10 km from the Port is mostly built up areas consisting salt works, human habitations and Port related structures on west and north, creek system, mangrove formations and mudflats in the east and south. Deendayal Port and its surroundings have mangroves, mudflats and creek systems as major ecological entities.

Mangrove plantation activity by DPT was initiated in 2005 as mandated by the Ministry of Environment, Forests & Climate Change (MoEF&CC). Subsequently, 1300 ha of mangrove plantation has been completed till the end of 2017 in different years in order to meet the legal mandate of Ministry of Environment, Forests and Climate Change (MoEF & CC). The mangrove plantation activities were carried out at Sat Saida Bet, Nakti creek and Kantiyajal of Bharuch district in South Gujarat. At Sat Saida Bet,

plantation activities were carried out in phased out manner i.e. 20 ha during 2005-2006, 200 ha during 2011-2012, 300 ha during 2012-2013, and 330 ha during 2013-2014 (Plate1). At Nakti creek plantation was carried out during 2008-2009 and 2010-2011 in 50 ha and 100 ha, respectively (GUIDE, 2018).

A. marina was the preferred species for plantation activities in all the three locations due to prevailing high salinity and high success rate of this species. At Nakti creek *Rhizophora mucronata* and *Ceriops tagal* were also planted in small numbers along with *A. marina*. Likewise, at Kantiyajal attempts were made for planting *R. mucronata* along with *A. marina*.

c. Marine Fauna

In the marine environment of Deendayal Port, there are eleven species of mollusca, seven species of shrimps (Prawn) and seven species of annelids. Besides these, there are twelve groups of phytoplankton, 7 groups of zooplanktons. The density of meio-fauna ranged from 382 to 670 nos/10 cm^2. The density of benthic macro fauna ranged from 952 to 1092 no/m^2. The dominant macro-faunal group was porifera (Mantec, 2014).

d. Terrestrial Biodiversity

Sensitive ecological habitats like forest, grassland, agricultural land, wetlands are absent within and in the proximity of the Deendayal Port due to its highly built-up nature. The species richness and abundance of aquatic birds and terrestrial fauna (reptiles, mammals) in the port environ and its surrounding was low with least conservation significance.

There are 11 species of herpetofauna (reptiles and amphibians), 53 species of terrestrial birds, 49 species of aquatic birds in the Port Environs. Due to absence of forest habitat in the immediate vicinity of Deendayal Port, only nine species of mammals were recorded with very low abundance.

Map 1: Deendayal Port and its Physical Environs

3. Environment Management Plan

Port activities can often affect the quality of air, noise and marine water in the surrounding areas due to the wide range of port operation activities. For the determination of environment quality, need for identification of sources, control and disposal of waste from various point and non-point sources and for prediction of various parameters of sound environmental quality, regular monitoring and assessment are required.

The Environment management plan is the key document in the environmental management system and sets out the detailed targets, objectives and procedures that will be adopted in order to achieve the goals set out in the environmental policy.

It is extremely essential that port and harbour projects should have an environmental management plan (EMP), which also incorporates monitoring of air, noise, soil and marine water quality along with the collection of meteorological data.

Deendayal Port Trust targets the achievement of high environmental standards and strives to ensure that activities within the Port are environmentally and ecologically sustainable and have minimal impact on the natural environment.

Several developmental projects have been initiated and EIAs have been carried out for the said projects. These EIA studies have also submitted the suggestions on the environmental management of the project area and Deendayal Port in general. These suggestions and mitigation measures have also been considered in framing the current environment management plan.

The present Environment Management Plan summarizes the suggestions of the ECs received from the Ministry of Environment, Forests & Climate Change (MoEF & CC), and consents granted by Gujarat Pollution Control Board (GPCB).

The projects for which ECs were granted and which formed the framework of the present EMP are as below;

- EC and CRZ Clearance for Construction of 13th to 16th Cargo berth at Kandla in year 2008
- EC & CRZ clearance for development of plots for construction of liquid storage tank farms at Kandla , district Kutch in year 2009
- Environmental and CRZ Clearance to DPT for development of plots for construction of warehouses/Godowns (stage II) in year 2012.
- Environmental and CRZ clearance for Single Point Mooring (SPM) and Allied facilities off Veera in the Gulf of Kachchh for handling Crude Oil on BOT basis in year 2013.
- Developing seven integrated facilities within the Existing Kandla port at Kandla, Gujarat –December 2016
- Proposed Smart Industrial Port City (SIPC) at green Field Site 1 (Adipur side –Northeast of Antarjaal, South of Tagore Road, 580 Acres), Gandhidham, Kutch -Gujarat" - October 2017
- Proposed Smart Industrial Port City (SIPC) at Green Field Site 2 (DPT Complex, 849.96 Acres), Gandhidham, Kutch –Gujarat. – October 2017.

Based on the suggestions of the above referred EIAs, following environmental parameters have been suggested to be monitored.

3.1. Air Quality

Air quality in a port area can be affected by dust and particulates from traffic (re-suspension of road dust), site clearing, loading and un-loading of cargo, construction activity and emissions from vehicles bringing materials to the site and from ships and construction equipments. The

photochemical reactions (complex chain reactions between sunlight and gaseous pollutants), emissions from burning waste materials and escaping dust (due to handling of fine-particulate materials such as fertilizers and minerals) are also major sources of air pollution in port areas. Air quality can also be affected by secondary developments such as modernization and increased vehicular traffic.

Besides day to day port activities, ship emissions are the main source of SO in harbour areas. Emissions from port activities account for about 4.5% of total shipping emissions.

In Deendayal Port, major source of air pollution are large volumes of dry cargo especially coal handled at berths and their loading and unloading during transportation.

i. During Construction Phase

- Generation of dust due to handling and transport in uncovered trucks on dusty roads. Fugitive dust, emissions and dust generation due to concrete mixing, cement handling, welding operation of construction machinery.
- Combustion emissions from ships propulsion and auxiliary engines and boilers, followed by combustion source emissions from vehicles and land-based engines and boilers. Storage and handling of dry bulk cargo and vehicle traffic on unpaved roads, may also contribute to particulate matter emissions.

Measures to be taken

i. During Construction Phase

- Water sprinklers shall be used; Improperly functioning vehicles & equipment shall be removed; Vehicle engines shall not be left running when not in use; Prudent and good construction practices shall be used to minimize the spread of sediments;
- Vehicle trips to be minimized to the extent possible
- Any dry, dusty materials should be stored in sealed containers or

prevented from blowing

- Stack emissions from DG sets to be monitored
- Ambient air quality within the premises of the proposed project to be monitored.
- Exhaust from vehicles to be minimized by use of fuel-efficient vehicles and well maintained vehicles having PUC certificate.
- Compaction of soil during various construction activities
- Ambient air quality within the premises of the proposed project to be monitored.
- The ambient air quality will conform to the standards for PM_{10}, $PM_{2.5}$, SO_2 and NOx.

ii. During Operation Phase

- Emissions of NOx and Sox shall be maintain within the limits established by international regulations (MARPOL)
- Low-sulfur fuels shall be used in port
- Encouraging storage planning to avoid or minimize re storage and reshuffling of cargo
- Transfer equipment (e.g. cranes, forklifts, and trucks) shall be kept in good working condition
- Dust suppression mechanisms (e.g. water spray or covered storage areas) shall be used

3.1.1. Air Quality Management

The air quality at most of the locations in port areas and in residential areas should be within the norms as specified by the National Ambient Air Quality Standards barring particulate matter. However, day to day operations in the dry cargo berth areas produce more particulate matter.

The following measures are being undertaken to control fugitive dust:

- To control dust from operations at the existing dry cargo berths, especially where dusty cargo is handled, water should be sprinkled on the berths to suppress fugitive dust. Treated sewage should be utilized for dust suppression operations.
- Protection wall with wind screen should be set up to prevent spread

of fugitive dust from coal wagon loading yard.

- To reduce fugitive dust generation from transport roads, the roads from the berths to the national road network should be always kept in good repair. This would also reduce emissions from trucks' engines due to lower fuel consumption.
- Swiping of dust on routine basis should be carried out on these roads.
- Wherever possible dry bulk cargo should be transported by trucks covered with tarpaulin sheets.
- Coal dispatched in wagons should also be properly covered with tarpaulin sheets.
- Gaseous pollutants in the exhaust fumes generated by diesel powered machinery should be minimized by ensuring vigorous maintenance adhering to stringent overhaul schedules.
- Green belt should be developed along the side of the roads, railway lines and stack-yards to screen fugitive dust generated from the roads.

3.2. Noise Quality

Ports contain several noise sources in various sectors with different characteristics. Sources include, ships, trade operations, loading and unloading of the cargo, transportation and movement of heavy vehicles. Such activities strongly impact the environment of the surrounding area and, as a consequence, port workers.

i. During Construction Phase

- Vehicular noise, use of excavation equipment; Use of construction equipment and power tools; Use of pile drivers, boring equipment, power tools, drill bits, etc.

ii. During Operation Phase

- Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships.

- Generation of vehicular noise

Measures to be taken

i. During Construction Phase

- During night time transportation activities shall not be allowed
- Adequate silencers must be attached with all vehicles to reduce the noise
- Machineries/equipment causing high noise level shall not be operated during the night time
- Construction machinery shall be in good working condition and engines turned off when not in use.
- Suitable mufflers on engine exhausts and compressor components shall be installed
- Acoustic enclosures for equipment casing radiating noise shall be installed
- Vibration isolation for mechanical equipment shall be installed
- Personal Protective Equipments shall be provided for eardrum protection of the workers as well as visitors
- Periodical maintenance of all equipments and transport vehicles shall be done.
- Implement good working practices (equipment selection and siting) to minimize noise and reduce its impacts on human health (ear muffs, safe distances, and enclosures).
- Noise to be monitored in ambient air within the project premises.
- All equipment operated within specified design parameters.
- Vehicle trips to be minimized to the extent possible

ii. During Operation Phase

- Suitable mufflers on engine exhausts and compressor components shall be installed
- Acoustic enclosures for equipment casing radiating noise shall be installed
- Vibration isolation for mechanical equipment shall be installed
- noise sources shall be relocated to less sensitive areas to take advantage of distance and shielding
- Periodical maintenance of all equipments and transport vehicles shall be done.

3.2.1. Noise Quality Management

At the port, noise is generated due to operation of high capacity liquid cargo pumps, diesel powered trucks, cranes and other material handling equipment, diesel powered railway locomotives, railway wagons, and ships' horns (occasionally). The following measures shall be implemented to control noise:

- High capacity liquid cargo pumps, diesel powered mobile cargo handling equipment, should be properly maintained as per maintenance schedule to reduce noise. Attention should be paid towards rigorous maintenance of the silencers of diesel engines.
- Operators should be issued earmuffs. Wearing personal protective equipment should be compulsory and the Safety Officer / Supervisor should carry out regular inspections to this effect. Duty hours of operators of noisy machinery may be regulated to keep their noise exposure levels within limits.
- The dust barriers comprising of high-walls also act as a noise barrier.
- Dispatch of materials by trucks should be regulated such that, the traffic is evenly distributed. This will avoid congestion and consequent excessive noise and vehicular emissions.

3.3. Water Quality

Deendayal Port is one of the largest port of the country and thus, is engaged in wide variety of activities such as movement of large vessels, oil tankers and its allied small and medium vessels and handling of dry cargo several such activities whose waste if spills in water, can cause harmful effects to marine water quality. Regardless of their size, the environmental impact of seaports largely depends on these commercial activities. In port areas or in their vicinity, several activities, such as fisheries, industrial installations, storage of hazardous materials, may cause further environmental impacts.

i. During Construction Phase

- Turbidity level may increase in the water body due to dredging and other construction activity which may lead to the considerable impacts on marine resources. Increase turbidity may affect the rate of the photosynthetic activity of the aquatic life.

ii. During Operation Phase

- Water effluents associated with port activities may include storm water and sewage from port operations, as well as sewage, ballast water, bilge water, and vessel cleaning wastewater from ships.

Measures to be taken

i. During Construction Phase

- Excavation and dredging methods will be selected to minimize suspension of sediments
- Care should be taken that no construction material shall fall in the water
- Plastics sheet or tarpaulin shall be provide in order to avoid any chance of dumping of construction materials into the water
- Storage area of the construction material shall be at adequate distance from the coastal area.
- No untreated discharge to be made to surface water, groundwater or soil.
- The discharge point should be selected properly and sampling and analysis should be undertaken prior to discharge
- Take care in disposal of wastewater generated such that soil and groundwater resources are protected.
- Ensure drainage system and specific design measures are working effectively.

ii. During Operation Phase

- No untreated discharge to be made to surface water, groundwater or soil.
- Take care in disposal of wastewater generated such that soil and groundwater resources are protected
- Installation of storm drainage catch basins to avoid discharge directly into surface waters

- Oil /water separators and trapping catch basins shall be provided
- The capacity of oily waste collection shall be established based on applicable MARPOL provisions
- Wastewater with noxious chemicals from bulk tank cleaning shall be collected through appropriate on-site or off-site treatment prior to discharge.
- Drinking water parameter will be monitored as per requirement of GPCB/MoEF & CC

3.4. Impact on Marine Fauna (Planktons & Benthos)

i. During Construction Phase

- Pilling & dredging may lead to increased turbidity, less penetration of light and hence less photosynthesis and resulting less primary productivity. Due to this fishes and other fauna may migrate.

ii. **During Operation Phase**

- Spillage of Oil & wastes from Ships may impact on the creek biota, especially mangroves and fishes.

Measures to be taken

i. During Construction Phase

- Pilling and dredging shall be done by such methods so as to reduce the impact.
- Silt curtain shall be used to reduce the impact of turbidity and thus reducing the loss of primary productivity and subsequent impact on food chain

ii. During Operation Phase

- No discharge from ships shall be allowed, MARPOL norms shall be complied.
- Due care shall be taken from spillage of the oil and other chemicals during loading or unloading.

3.5. Hazardous Waste / Oil Spills

- Spills may occur due to accidents (e.g. collisions, groundings, fires), equipment failure (e.g. Pipelines, hoses, flanges), or improper

operating procedures during cargo transfer or fueling.

Measures to be taken

- Oil and chemical-handling facilities shall be located with consideration of natural drainage systems and environmentally-sensitive areas
- Hazardous materials storage and handling facilities shall be constructed away from active traffic
- DPT shall follow the spill prevention, control, and countermeasure plan consistent with the IMO Manual on Oil Pollution Section II-Contingency Planning.
- Implement waste management plan that identifies and characterizes every waste arising associated with proposed activities and which identifies the procedures for collection, handling and disposal of each waste arising.

3.6. Hazardous Waste Management

Hazardous waste means any waste which by reason of characteristics such as physical, chemical, biological, reactive, toxic, flammable or corrosive, causes danger to health or environment. It comprises the waste generated during the manufacturing processes of the commercial products such as industries involved in petroleum refining, production of pharmaceuticals, petroleum, paint, aluminum, electronic products, etc. Management of hazardous waste mainly includes two components viz. i) Collection, Waste handling and Segregation 7 ii)Treatment, Storage and Disposal.

Disposal of solid waste generated by ships calling at DPT has been outsourced and the collection & disposal are undertaken by the Licensed Agencies. The removal of hazardous and non-hazardous wastes such as garbage, food waste, plastic, metal, batteries, etc., are done in accordance with the provisions of the Hazardous Waste (Management & Handling

Rules) and in compliance of the guidelines of Pollution Control Boards, MARPOL 73/78 and other Statutory Authorities.

The Companies authorized by the Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB) have been awarded the work of collection, transportation and disposal of hazardous Wastes by the Deendayal Port Trust. The same is handed over to authorize parties for further Treatment & disposal.

3.6.1. Policy and Management

Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs) together form the regulatory and administrative core of the waste management sector in India. At the state level, the management of solid waste is the responsibility of Urban Local bodies. Industries generating hazardous wastes must seek permission from the respective SPCB. A key issue is that municipal authorities do not possess the budgets to adequately cover the costs associated with developing effective waste management systems. The lack of strategic plans, as well as systems for governance (particularly waste collection/segregation) and regulation are major barriers to achieving effective Solid Waste Management (SWM) in India.

3.6.2. Deendayal Port Trusts' Policy on Waste Management

Deendayal Port Trust should appoint recognized consultancy firm in the field of Environmental Planning & advisory services (NABET–accredited agency in sector Ports, harbours, jetties, terminals, break water and dredging), for–preparation of waste management plan of–entire DPT–area considering various rules/regulations in force with following objectives;

- Identification & categorization of various Wastes, into hazardous & non-hazardous Biodegradable wastes , Solid wastes including C & D Wastes, Biomedical Waste ,plastic waste, E- waste etc. with assessment of quantity & disposal.

- Separate identification of Ship waste into hazardous, non-hazardous & Biodegradable waste as per the MARPOL 73/78 (as amended) and other conventions of IMO as applicable for Port and Harbour.
- Preparation of Training Module for Port officers & Employees.
- The consultant shall have to coordinate with all concerned departments of DPT for collection of required details/information/data.
- The selected consultant shall have to provide comprehensive reception and safe disposal facilities plan with subsequent monitoring plan including provision for engagement external agencies/private operators.
- The selected consultant is required to list out requirement & procedure for obtaining necessary clearance/license from statutory authorities under respective category of waste management rules.
- Review Procedure with respect to Audits/Inspection reports of licensed contractors.
- Consultant shall have to assist DPT in implementation of waste management plan during the contract period.
- Considering above all, the consultant shall have to prepare & submit detailed waste management plan covering all wastes and also shall have to prepare & submit waste management plan of each waste, separately, as under:
  - ✓ Solid waste management plan including C & D wastes as per Municipal solid wastes (management & handling) rules, 2000 & C & D wastes management rules 2016 (GSR 317 E dated 29/3/2016).
  - ✓ Plastic waste Management Plan as per plastic waste management Rules 2016 (GSR 320 (E) dated 18/3/2016).
  - ✓ E wastes management plan as per e waste management rules 2016 (GSR 337 E dated 23/3/2016).
  - ✓ Biomedical waste management plan as per Bio medical wastes management rules 2016 & its subsequent amendment in 2019.
  - ✓ Hazardous & other wastes (Management & trans-boundary

movement) Rules, 2016 & subsequent amendment in 2019.

3.6.2.1. Measures taken by Deendayal Port Trust

- DPT obtained authorization from the GPCB vide Consent (Consolidated Consent & Authorization) Order no. AWH -72820 date of Issue: 31/08/2015, valid up to 21/7/2020.
- Deendayal Port Trust is maintaining the records for collection and disposal of Wastes generated from Port area etc.
- Deendayal Port Trust is regularly submitting the Hazardous Waste Statement in From – IV every financial year to the Gujarat Pollution Control Board, Gandhinagar.
- A report on collection and disposal of the wastes from ships is submitted by the licensees to Deendayal Port and GPCB.
- The DPT officials inspect each vessel calling at the Port with reference to the Garbage Record Book in accordance with the MARPOL 1973/78.

3.6.3. Bio-medical Waste Management

To protect the environment and human health from infectious bio-medical waste, Ministry of Environment, Forest and Climate Change, vide Notification G.S.R. 234(E) dated March 16, 2018 made amendments to Bio-Medical Waste Management Rules (1998), to improve compliance and strengthen the implementation of environmentally sound management of biomedical waste in India.

Salient features of Bio-Medical Waste Management (Amendment) Rules, 2018 are as follows:

1) Bio-medical waste generators including hospitals, nursing homes, clinics, dispensaries, veterinary institutions, animal houses, pathological laboratories, blood banks, health care facilities, and clinical establishments will have to phase out chlorinated plastic bags (excluding blood bags) and gloves by March 27, 2019.

2) All healthcare facilities shall make available the annual report on its website within a period of two years from the date of publication of the Bio-Medical Waste Management (Amendment) Rules, 2018.
3) Operators of common bio-medical waste treatment and disposal facilities shall establish bar coding and global positioning system for handling of bio-medical waste in accordance with guidelines issued by the Central Pollution Control Board by March 27, 2019.
4) The State Pollution Control Boards/ Pollution Control Committees have to compile, review and analyze the information received and send tis information to the Central Pollution Control Board in a new Form (Form IV A), which seeks detailed information regarding district-wise bio-medical waste generation, information on Health Care Facilities having captive treatment facilities, information on common bio-medical waste treatment and disposal facilities.
5) Every occupier, i.e. a person having administrative control over the institution and the premises generating biomedical waste shall pre-treat the laboratory waste, microbiological waste, blood samples, and blood bags through disinfection or sterilization on-site in the manner as prescribed by the World Health Organization (WHO) or guidelines on safe management of wastes from health care activities and WHO Blue Book 2014 and then sent to the Common bio-medical waste treatment facility for final disposal.

3.6.4. Plastic Waste Management

The Government has notified the Plastic Waste Management Rules, 2016, in suppression of the earlier Plastic Waste (Management and Handling) Rules, 2011.The draft rules, namely the Plastic Waste Management Rules, 2015 were published by the Government of India vide G.S.R. 423(E), dated the 25th May, 2015 in the Gazette of India, inviting public objections and suggestions. The Plastic Waste Management Rules, 2016 aim to:

- Increase minimum thickness of plastic carry bags from 40 to 50 microns and stipulate minimum thickness of 50 micron for plastic sheets also to facilitate collection and recycle of plastic waste,

- Expand the jurisdiction of applicability from the municipal area to rural areas, because plastic has reached rural areas also;
- To bring in the responsibilities of producers and generators, both in plastic waste management system and to introduce collect back system of plastic waste by the producers/brand owners, as per extended producers responsibility;
- To introduce collection of plastic waste management fee through pre-registration of the producers, importers of plastic carry bags/multilayered packaging and vendors selling the same for establishing the waste management system;
- To promote use of plastic waste for road construction as per Indian Road Congress guidelines or energy recovery, or waste to oil etc. for gainful utilization of waste and also address the waste disposal issue; to entrust more responsibility on waste generators, namely payment of user charge as prescribed by local authority, collection and handing over of waste by the institutional generator, event organizers.

3.6.5. E-Waste Management

Ministry for Environment, Forest and Climate Change, has amended the E-waste (Management) Rules vide notification G.S.R. 261(E), dated March 22, 2018 in supersession of the e-waste (Management & Handling) Rules, 2011. The amendment was done to facilitate and effectively implement the environmentally sound management of e-waste in India with the objective of channelizing the E-waste generated in the country towards authorized dismantlers and recyclers in order to formalize the e-waste recycling sector.

Some of the salient features of the E-waste (Management) Amendment Rules, 2018 are as follows:

1) The e-waste collection targets under Extended Producer Responsibility (EPR) have been revised and will be applicable from 1 October 2017. The phase-wise collection targets for e-waste in weight shall be 10% of the quantity of waste generation as indicated in the EPR Plan during 2017-18, with a 10% increase every year until 2023. After 2023 onwards,

the target has been made 70% of the quantity of waste generation as indicated in the EPR Plan.

2) Separate e-waste collection targets have been drafted for new producers, i.e. those producers whose number of years of sales operation is less than the average lives of their products. The average lives of the products will be as per the guidelines issued by CPCB from time to time.

3) Producer Responsibility Organizations (PROs) shall apply to the Central Pollution Control board (CPCB) for registration to undertake activities prescribed in the Rules.

4) Under the Reduction of Hazardous Substances (RoHS) provisions, cost for sampling and testing shall be borne by the government for conducting the RoHS test. If the product does not comply with RoHS provisions, then the cost of the test will be borne by the Producers.

3.6.6. E-waste Management at Deendayal Port Trust

"E-Waste (Management & Handling) Rules, 2011 were notified in 2011 and had come into force since 1st May, 2012. In order to ensure effective implementation of E-Waste Rules and to clearly delineated the role of producers in EPR, MoEF&CC, Government of India in supersession of E-Waste (Management and Handling) Rules, 2011 has notified the E-Waste (Management) Rules, 2016 vide G.S.R. 338(E) dated 23.03.2016 which will be effective from 01-10-2016.

Over a period of 20 years several IT items and consumables got accumulated and during *Swachh Bharat Abhiyan* conducted by the Port during 2017, the E-waste (viz. CPU, Monitor, Keyboards, Printers, Mouse, UPS, Stabilizer, etc.) were accumulated and were disposed off and stored at one location in the Port for E-waste disposal as per regulations.

3.7. Dredging Management

The present guidelines for dredging management has been suggested by the Ministry of Shipping in the report titled "Guidelines on undertaking dredging at major Ports" released in November, 2015.

When the major ports plan to take up a capital dredging project irrespective of the size of the project, the following actions have to be taken up by the ports simultaneously so that proposal can be taken to approval stage at the earliest possible time.

I. Engaging Marine survey, Geo technical/Geo physical survey agencies to carry out bathymetric surveys, geo technical investigations etc., if the same is not available with the port
II. Preparation of Detailed Project Report/Feasibility Report/other port specific investigation required if any by consultants or by Port themselves.
III. Engaging Agencies wherever required as per the provision, for preparation of Environment Impact Assessment

3.7.1. Deendayal Port Trusts' Policy on Dredging Management

The Ministry of Environment, Forest and Climate Change (MoEF & CC), had asked DPT to carry out the *"Study on Dredged Material for presence of contaminants"* as accorded by the MoEF & CC, GoI dated 19/12/2016.

Based on the above condition, DPT should assign the task of carrying out the study "*Studies on Dredged materials for the presence of contaminants and suggesting suitable disposal options*" to Gujarat Institute of Desert Ecology (GUIDE), Bhuj for the period of Nov 2018 to October 2021, with following objectives;

- To monitor the locations where dredged materials are dumped will be conducted.
- Dredged materials in the area will be analyzed for the presence of contaminants in two different locations.
- Detailed assessment of the dredged materials for physical, chemical and biological characteristics will be studied.
- Suggesting suitable disposal options for the dredged material will be made.

Further, the study will envisage the evaluation of physico-chemical constituents in the dredged materials in the dumped locations in the study area.

3.7.2. Managing Dredging Impacts

(As suggested by GUIDE vide their report on "*Studies on Dredged materials for the presence of contaminants and suggesting suitable disposal options*")

Some measures to be taken to prevent the reach of dredged materials reach to nearby sensitive environment are listed below:

- In order to ameliorate the likely impacts due to sediment load through changes in operational procedure such as appropriately timing the operation in tune with tides and tidal current direction) may be considered.

- Efforts may be attempted in disposing the trapped sediments only in pre-designated sites.

- Turbidity curtains, nowadays, are increasingly used during dredging operations as suggested by Researchers (Sawaragi, 1995; Elander and Hammar, 1998; Otoyo, 2003; Dreyer, 2006; Guo *et a!.,* 2009; Ishizaki and Rikitake, 2010; Ueno, 2010, Trang and Keat, 2010) which could also be attempted based on its operational convenience. Moreover various other factors such as current speed, water depth and wave heights to be considered as these also play role in the efficiency of Turbidity curtains. Turbidity curtains allow suspended sediments to settle out of the water column in the dredging spot thus minimizing sediment transport towards the shore. Constructed with thermoplastic material, they serve as a primary method to control turbidity in dredging sites. There are various types of curtains like floating, hanging, solid diversion baffles and permeable and impermeable screens. However, they have proved to be an effective method to contain sediment load in ecologically sensitive areas such as mangroves and corals during dredging operations.

- Many management measures such as enhancing the biodiversity of the intertidal/sub tidal areas by means of artificial reef structures and controlling water column turbidity by deploying mechanisms to trap silts arising out of dredging activity may be better options which can be implemented by the port authorities.

3.8. Other Important International Treaties and Indian acts supporting EMP

Shipping is an international activity and hence national specifications and regulations relating to loading and safety at sea are largely based on international agreements and conventions. International regulations relevant to port and harbors are given herein. India is a signatory to these International agreements/conventions.

3.8.1. Shipping

i. International Maritime Dangerous Goods Code (IMDG-code)

The IMDG code relates to methods of safe transport of dangerous cargoes and related activities. It sets out procedures for documentation, storage, segregation, packing, marking and labelling of dangerous goods (http://hazmat.dot.gov.imdg.html).

ii. International Convention for the Prevention of Pollution from ships (MARPOL)

The main objectives of this convention are to prevent the pollution of the marine environment by the operational discharges of oil and other harmful substances and the minimization of the accidental discharges of such substances. Further details are available at www.imo.org/imo/ convent/pollute.html.

iii. United Nations Convention on the Law of the Sea (UNCLOS), 1982

The main objective is the obligation to prevent pollution damage by addressing particular sources of pollution, including those from land based activities, seabed activities, dumping, vessels and from or through the atmosphere. (www.tufts.edu/departments/fletcher/ multi/texts/BH825.txt).

3.8.2. Other International Conventions

i. Ramsar Convention on Wetlands

The Convention on Wetlands, called the Ramsar Convention, is an inter-governmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources (http://www.ramsar.org).

ii. Convention in International Trade in Endangered Species (CITES)

CITES is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival (http://www.cites.org).

3.8.3. Indian Acts

- The Indian Ports Act, 1908 and amendments thereon
- The Wildlife (Protection) Act, 1972 and amendments thereon
- The Water (Prevention & Control of Pollution) Act, 1974 and amendments thereon
- The Water (Prevention & Control of Pollution) Cess Act, 1977 and amendments thereon
- The Forest (Conservation) Act, 1980 and amendments thereon
- The Air (Prevention & Control of Pollution) Act, 1981 and amendments thereon
- The Environmental (Protection) Act, 1986 and amendments thereon
- The Public Liability Insurance Act, 1991 and amendments thereon
- The Biological Diversity Act, 2002 and amendments thereon (http://envfor.nic.in)
- The Indian Explosives Act, 1884 and amendments thereon (http://explosives.nic.in)

3.9. General Considerations for Environment Management of Deendayal Port

During the developments of key projects for Kandla Port, as the guidelines of the Ministry of Environment, Forests & Climate Change (MoEFCC), (Govt. of India), Central Pollution Control Board and Gujarat Pollution Control Board, DPT with reputed EIA consultants carried out comprehensive EIA and reports were submitted to respective departments. Based on these EIA studies, several key considerations for the management of Environment were suggested which are listed as below as per the category.

3.9.1. Construction and Operation Phase

- Heavy vehicles shall be covered with tarpaulin sheets to minimize fugitive dust from moorum during transportation
- There shall be regular emission checks on vehicles
- Wherever required, culverts, road crossings may be provided for uninterrupted flow of creek waters
- Storage areas shall be lined to prevent any leaching. The yards shall be covered to prevent any dust emission from the stored cargo
- Solid wastes generated shall be collected and disposed appropriately
- Movement of construction barges, ships, machinery etc should be restricted to the pre-decided operational area, to avoid disturbance to larger marine area
- There shall be bunding around the proposed construction site to prevent leaching of material from the site into the coastal waters
- It shall be ensured that construction debris is cleared by the contractor after completion of work

3.9.2. Control of Discharge

- All liquids containing oil shall pass into the sea only via oil separation systems (MARPOL Regulation 9 & 12).

- Sludge shall not be discharged. The sludge and the separated oil residues are either to be incinerated on board in special furnaces or discharged in port to the oil collection facilities.
- Adequate facilities for discharging oily residues shall be provided and effective supervision and monitoring of adherence to the regulations shall be done.
- The servicing yards shall be provided with appropriate facilities for receiving oily residues and other solid wastes such as batteries etc.
- Channels of minimum 1m widths and frequent intervals shall be provided around the plots to provide drainage in the event of tidal ingress in the creek.
- Proper drainage shall be designed and provided for flushing out tidal inflows

3.9.3. Control of Exhaust Emissions from Vessels

- Exhausts shall be frequently cleaned
- Correct adjustment and maintenance of engines and boilers shall be ensured.
- Mechanical precautions (like safety valves) shall be included to ensure the containment of the gases which escape during loading and discharge operations
- There shall be a reporting structure and responsibility for handling spills; Emergency numbers for contact during emergencies shall be readily available at the harbour.
- Fuel storage tanks shall be frequently monitored for leakages
- Fuel lines shall be adequately protected from being tampered

3.9.4. Compensatory Afforestation

- DPT shall be responsible for compensatory afforestation for mangroves lost due to proposed developmental activities. This shall be carried out in consultation with organizations like Gujarat

Department of Forest Department / various agencies and with mangrove experts.

4. Environment Management Policy of Deendayal Port Trust

In 2013, the DPT achieved certification of its Environmental Management System to ISO 14001. In 2019, DPT obtained ISO 14001:2015 certifications. One of the key requirements of the ISO 14001 series is that the systems, plans and controls are under the operational control of the entity committed to managing the activity. The DPT also manages environmental risk to land and marine areas under its control arising from third party industrial activities. While these parties and the associated risks are covered in the risk register, the controls are managed by standalone EMP's of the third party in accordance with the DPT development Approval Process and /or through direct state or central Government requirements as part of an:

- Environmental Clearance, CRZ Clearance, in the case of a new project; and
- Consent to Establish /NOC for an establishment, and Consent to Operate/NOC for operation of the projects.

4.1. The Key Objectives of Deendayal Port Trust

- To provide our Clientele, efficient and economical Port services. To render value for money and value added services to our Customers to their utmost satisfaction.
- To create facilities of international standards, and facilitate quicker turnaround of vessels. To maintain peaceful industrial relations by recognizing our work force as an asset and develop them to adopt to the changing Port scenario.
- To participate in social development by contributing our mite to the society at large.
- To be Environment friendly.

4.2. QHSE Policy of Deendayal Port

Quality, Occupational health, Safety and Environmental Policy (QHSE) of Deendayal Port Trust is the statement of its intentions, principles & commitment in relation to its overall QHSE performance, which provides a frame work for the action and for the setting of QHSE objectives & targets. QHSE policy has been developed through initial status review of quality, Occupational health, Safety and Environment Management comprising of following key areas namely;

- Legislative, regulatory and other requirements
- Identification of equipment and services supporting quality of final services.
- Identification of significant OH&S risks and Environmental aspects.
- Examination of all existing environmental & Occupational health and safety management practices and procedures.
- Evaluation and feedback from the investigation of previous incidents and accidents.

The QHSE policy of Deendayal Port Trust has been communicated at all levels through display in all the relevant places. The policy has also been communicated to external parties by way of displaying it at the main gate of Deendayal Port Trust in Hindi/ English / local (vernacular) language.

Management representative of Deendayal Port Trust has established, implemented and maintaining the QHSE management system and continually improves its effectiveness by regular monitoring in accordance with the requirements of this international standard. MR has identified the various processes needed for the QHSE management system and their application throughout the organization.

The sequence and interrelation of these processes are determined to control the effectiveness of these processes & operations. The criteria &

methods are determined necessary resources & information/details are made available at the point of use so that operations & processes can be monitored. (Ref: Department Operational Manual and their Process Flow Chart).

Measurement of these processes are timely analyzed and the relevant actions are implemented to achieve planned results & for continual improvement.

QHSE Policy

Kandla Port Trust

QHSE Policy

We At Kandla Port Trust are commited to providing maritime service timely, of best quality with cost effectiveness & matching the expectation of customers with professionalism with commitment to managing environmental matters as an integral part of our business. In particular, it is our policy to assure the environmental integrity of our processes and facilities at all times and at all places. We will do so by adhering to the following principles :

Compliance

Comply with applicable laws and regulations and will implement programs and procedures to assure compliance. Compliance with environmental standards will be a key ingredient in the training, Performance reviews and motivations of all employees.

Risk Reduction, Prevention and Resource Management

Seek opportunities, beyond compliance requirement, for reducing risk to the environment, establish and meet our own quality standards where appropriate. employ management systems and procedures specifically designed to prevent activities and/or conditions that pose a threat to the environment. Look for ways to minimize risk and protect our employees and the communities in which we operate by employing clean technology, including safe technologies and operating Procedures, as well as being prepared for emergencies.

Strive to minimize release to the air, land or water through use of cleaner technologies and the safer Handling, Minimize the amount and toxicity of waste scarce resource such as water, energy, land and forests in an environmentally sensitive manner.

Communications

Communicate our commitment to our employees, vendors and customers. Solicit their input in meeting our EMS goals.

Continuously Improvement

Continuously measure our progress. We will review our progress at least on an annual basis. Continuously seek opportunities to improve our adherence to these principles and will periodically report progress to our stakeholders. Comply the requirement of International Standard for continual improvement.

5. Environment Monitoring Plan

Environment Monitoring Plan is very important for monitoring the environmental status of the port for sustainable development. The EMP mainly consists of monitoring of the Air quality, Marine water quality, Ecological and Biological quality and Noise quality of the Deendayal Port area. The monitoring programme is also required to suggest suitable mitigation measures for the deviation found in the results of the monitoring, so as to keep the pollution level within control.

The list of main elements for which Environmental monitoring is carried out is mentioned below.

- Air Quality Monitoring
- Drinking Water Monitoring
- Noise Monitoring
- Marine Water Monitoring
- Soil Monitoring
- Sewage Treatment Plant Monitoring
- Meteorological Monitoring

M/s Detox Corporation Pvt. Ltd. appointed by Deendayal Port Trust will carry out monitoring of the various environmental aspects of the port with following objectives;

- To review the locations of ambient air and marine water quality monitoring stations within the impacted region in and around DPT establishment, in view of the developmental projects.
- To assess the ambient air quality and marine water quality at selected stations in terms of gases and particulate matter, physical, chemical and biological parameters for the assignment period.
- To assess the marine water quality in terms of aquatic flora and fauna and sediment quality in terms of benthic flora and fauna.
- To assess the trends of air and water quality by comparing the data

collected over a specified time period.

- To assess the trends of water quality in terms of marine ecology by comparing the data collected over a specified time period.

- To review the results and to check compliance with environmental quality standards.

- To suggest mitigation measures, if necessary, based on the findings of this study.

- To recommend future action plans on air and marine water quality monitoring programme based on the findings of this study.

- Drinking Water samples at twenty stations will also be monitored for various physical, chemical and biological parameters viz., color, odor, turbidity, conductivity, pH, total dissolved solids, chlorides, hardness, total iron, sulfate, NH4, +-N, PO4, and bacterial count on a monthly basis.

- Every week a sample (inlet and outlet) of the Sewage Treatment Plant (STP) shall be analyzed to see the water quality being discharged by DPT. However, the results will be submitted every month. If in a particular month any deviation is observed, the same shall be submitted immediately to the Employer.

- Noise monitoring will be carried out twice a day at the representative stations for a period of 24 hours. A report of the same will be submitted to DPT.

- Meteorological parameters are very important from air pollution point of view and precise and continuous data collection is of utmost importance. The data collected is analyzed as per the standards. Meteorological data on wind speed, wind direction, temperature, relative humidity, solar radiation and rainfall will be collected from one permanent station at DPT and one permanent station at Vadinar.

- All Locations & Monitoring parameters are tentative and subject to change as per GPCB/CPCB/MoEF&CC Guideline.

5.1. Selection of Sampling Locations

Sampling locations have been selected by Deendayal Port Trust considering various activities of Deendayal Port Trust and its environs and various Environment Impact Assessment Studies carried out in Deendayal Port. The sampling locations of various air, water and marine water surveys will be reviewed periodically and may be altered if required as per the suggestions/discussions with the Deendayal Port Authority and Environmental consultants engaged by the Deendayal Port Trust.

The major components of the monitoring are:

5.1.1. Air Quality Monitoring

Air Monitoring is done at eight fixed locations in port area. The description of stations is depicted in Table 1. The monitoring cycle at all eight monitoring stations is twice in a week.

Method of Monitoring

Sampling and analysis will be carried out as per CPCB guidelines for Ambient Air Quality monitoring. The monitoring is carried-out for air quality parameters mentioned in the National Ambient Air Quality Standards (NAAQS), CPCB Notification published in 2009. Sampling for Particulate Matter (PM_{10}) and Total Suspended Particulate Matter (TSPM) is done for a twenty four hour period.

Frequency of AAQ Monitoring

The monitoring cycle at all eight monitoring Stations is twice in a week. Sampling for Particulate matter (PM_{10}, $PM_{2.5}$) and total suspended particulate matter is done for a twenty four hour period. Sampling for gaseous samples like SO_x, NOx will be done for a twenty four hour period with sample collection at every eight hour. Table 1 gives description of Ambient Air Monitoring Stations.

Table 1: Ambient Air Monitoring Stations

Sr. No.	Location	Station Description	Location Codes
1	6 Stations at Kandla	Marine Bhavan	AL- 1
2		Oil Jetty	AL -2
3		Kandla Port Colony	AL-3
4		Gopalpuri Hospital	AL -4
5		Coal Storage Area	AL- 5
6		Tuna Port	AL-6
7	2 Stations at Vadinar	Signal Building	AL-7
8		Vadinar Colony	AL- 8

Map 2: Ambient Air Monitoring stations at Deendayal Port

5.1.2. Monitoring of Drinking Water Quality

Method of Monitoring

The sampling and analysis will be done as per standard methods and CPCB/GPCB Guidelines. The water samples will be analysed for various parameters viz; Color, Odor, Turbidity, Conductivity, pH, Chlorides, TDS, Total hardness, Iron, Sulphate, Salinity, Biological Oxygen Demand (BOD), Chlorides, Sodium(Na), Potassium(as K+), Calcium (as Ca), Magnesium (Mg), Fluorides (F), Nitrate (NO_3), Nitrite (NO_2), Manganese (Mn), Iron (Fe), Chromium (Cr_6+), Copper(as Cu), Cadmium (Cd) , Arsenic (As),Mercury (Hg), Lead (Pb), Zinc (Zn), CFU, & bacterial count. The method will be manual at all monitoring stations.

Frequency of Drinking Water Monitoring:

The monitoring at all twenty drinking water stations will be done once a month.

Drinking Water Monitoring Stations

A list of locations for collecting the drinking water samples is depicted in Table 2.

Table 2: Monitoring locations for Drinking Water

Sr. No	Monitoring Locations	Location Code
Location at Kandla		
1	Nirman Building 1	DW -1
2	P & C Building	DW -2
3	Main Gate (North)	DW -3
4	Canteen	DW -4
5	West gate I	DW -5
6	Wharf area	DW -6
7	Sewasadan-3	DW -7
8	Workshop	DW -8
9	Custom building	DW -9
10	Port Colony Kandla	DW -10

Sr. No	Monitoring Locations	Location Code
11	Hospital Kandla	DW -11
12	A.O. Building	DW -12
13	School Gopalpuri	DW -13
14	Guest House	DW -14
15	E- Type quarter	DW -15
16	F-type quarter	DW -16
17	Hospital Gopalpuri	DW -17
18	Tuna Port	DW -18
Locations at Vadinar		
19	Nr. Vadinar Jetty	DW -19
20	Port colony	DW -20

5.1.3. Monitoring of Marine Water Quality and Biological Parameters

Methodology for Physico-chemical Monitoring

Water samples will be collected for analyzing physico-chemical and biochemical parameters viz. pH, Temperature, Colour, Odour, Salinity, Turbidity, SS, TDS, TS, DO, COD, BOD, Silicate, PO_4, SO_4, NO_3, NO_2, Ca, Mg, Na, K, Iron (as Fe), Chromium (as Cr), Copper (As Cu), Arsenic (as As), Cadmium (as Cd), Mercury (Hg), Lead (as Pb), Zinc (as Zn), petroleum hydrocarbons, trace metals total coliform & fecal coliform.

Methodology for Biological Monitoring

Sampling will be conducted from sub surface layer in high tide period and low tide period of the tide from all sampling stations during consecutive spring tide and neap tide.

Net sampling for qualitative evaluation of mixed plankton will be conducted only once during between maximum high water and slack water and maximum low water and Slack water.
Sediment sampling for qualitative and quantitative evaluation of benthic organisms will be conducted only once during one tidal cycle during maximum low water and slack water.

The collected samples will be first collected in a clean bucket to reduce the heterogeneity. From the collected water sample 1 liter of water sample will be taken in an opaque plastic bottle for chlorophyll estimation. Quantitative plankton samples will be collected by filtering rest of the water sample using plankton net of 20µm mesh size.

Methodology adopted for Plankton sampling

Mixed plankton sample for qualitative evaluation will be obtained from the sub surface layer, at each sampling locations by towing the net horizontally with the weight during highest high tide and slack period and lowest low

tide and slack period .After the tow of about 15-20 minutes at speed of 1-1.5 m/s. For quantitative evaluation 50 L sample will be collected from the sub surface during high tide and low tide period will be filtered through 20µm mesh size net assembly.

Methodology adopted for benthic fauna sampling

Van veen sampler (0.1 m^2) will be used for sampling bottom sediments during lowest low tide. The fixation of benthic fauna will be normally done by bulk fixation of the sediment sample. The bulk fixation will be done by using 10% formalin (buffered with borate) with Rose Bengal as stain. The organisms will be preserved with seawater as diluting agent.

Frequency

Phytoplankton (Qualitative & Quantitative) Zooplankton (Qualitative & Quantitative) & Benthos (Qualitative & Quantitative) samples will be collected during high tide and low tide during each spring and neap tides of the month.

Sampling Stations

The monitoring of marine environment for the study of biological and ecological parameters will be carried out in harbour regions of DPT (Table 3) during Spring tide period of full moon phase of Lunar Cycle.

Table 3: Sampling Locations for Marine Monitoring

Sr. No	Monitoring locations	Location Code
Locations at Kandla		
1	Near passenger Jetty One	ML -1
2	Near Berth No. 8 & 9	ML -2
3	Kandla Creek Near KPT colony	ML -3
4	Near 13^{th} & 14^{th} Berth	ML -4
5	Nakti Creek Near Tuna Port	ML -5
6	Nakti Creek Near NH-8A Bridge	ML -6
Locations at Vadinar		
7	Nr. SBM 2	ML -7
8	Nr. Vadinar Jetty	ML -8

Map 1.3 Marine Sampling Locations at Deendayal Port

Map 1.4 Marine Sampling Locations at Vadinar Port

5.1.4. Noise Monitoring

Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading of cargo to/from ships. Noise Monitoring will be done at 13 stations at Kandla, and three locations in Vadinar.

Method and Frequency of monitoring

Sampling will be done at all stations for 24 hour period once in month. Data will be recorded using automated sound level meter. The intensity of sound will be measured in sound pressure level (SPL) and common unit of measurement is decibel (Db).

Sampling Stations

The sampling locations for noise monitoring as listed in table 4.

Table 4: Locations for Noise Monitoring

Sr. No	Name of locations	Location Code	Sr. No	Name of locations	Location Code
Locations at Kandla			8	Nirman Building 1	NL - 8
1	West Gate no 1	NL -1	NL -	Tuna Port	NL - 9
2	Main gate (North)	NL -2	NL -	Port & customs office	NL - 10
3	Wharf area/Jetty Area	NL -3	**Location at Vadinar**		
4	Main road/ Central Road	NL -4	11	Nr. Port Gate - Vadinar	NL - 11
5	Canteen Area	NL -5	12	Nr. Vadinar Jetty	NL - 12
6	ATM building	NL -6	13	Port colony Vadinar	NL - 13
7	Marine Bhavan	NL -7			

5.1.5. Soil Quality Monitoring

Soil quality monitoring is important for evaluating the effects of environment management practices of a region/area.

Method of Monitoring

The soil samples will be collected from four locations in Kandla and two locations in Vadinar Port. The soil samples will be filled in polythene bags,

labeled in the field with number and site name and taken to the laboratory for analysis (as per IS 2720). Physical and chemical properties of soil at selected locations will be studied.

Frequency of monitoring

Sampling will be done at all stations in Kandla and Vadinar once in a month.

Soil quality Monitoring Stations

List of the locations for collecting the soil samples are as per Table 5:

Table 5: List of sampling locations for Soil Quality Monitoring

Sr. No	Name of locations	Location Code
Locations at Kandla		
1	Tuna Port	SL -1
2	IFFCO Plant	SL -2
3	Khori Creek	SL -3
4	Nakti creek bridge at NH-8A	SL -4
Location at Vadinar		
5	Nr. Vadinar Port Office	SL -5
6	Nr. Vadinar Colony	SL -6

Map 1.5A Soil Sampling Locations in Deendayal Port

Map 1.5B Soil Sampling Locations in Vadinar Port

5.1.6. Monitoring of performance of the Sewage Treatment Plant (STP) at Gopalpuri Township, Deendayal Port & Vadinar

The principal objective of wastewater treatment is generally to allow human and industrial effluents to be disposed off without danger to human health or unacceptable damage to the natural environment.

Method of Monitoring

The parameters monitored will be pH, BOD, COD, residual chlorine, MLSS, MLVSS and TSS. The data collected will be analyzed as per the standards. The performance of the Sewage Treatment plant will be studied by collecting samples of the influent, aeration tank and effluent tank.

Frequency of monitoring

Sampling will be done at all stations from inlet, aeration tank and outlet of an STP once in week.

Monitoring Stations:

Lists of the location for collecting the STP samples are as per table 6.

Table 6: List of sampling locations for STP

Sr. No	Sampling location
1	STP at Kandla
2	STP at Gopalpuri
3	STP At Vadinar

6. Monitoring Results

Based on the EMMP submitted, M/s Detox Corporation Pvt. Ltd. carried out monitoring of the following environmental aspects of the port for the period of March 2020 to February 2021. However, due to nationwide lockdown imposed by Government of India from 23rd March to 14th April and subsequent lockdown imposed by state government *(Circular No. 13/NCV/102020/SFS-1/G)* till 17th May 2020, the sample collection was not possible.

1 Ambient Air

The monitoring was carried out twice a week. The results obtained from the sampling and analysis is submitted to Deendayal Port authority on monthly basis. The monthly averaged and annual results for the ambient air monitoring are given in the sections followed.

I. Total Suspended Particulate Matter (TSPM)

The frequency of sampling was twice a week for every sampling station.

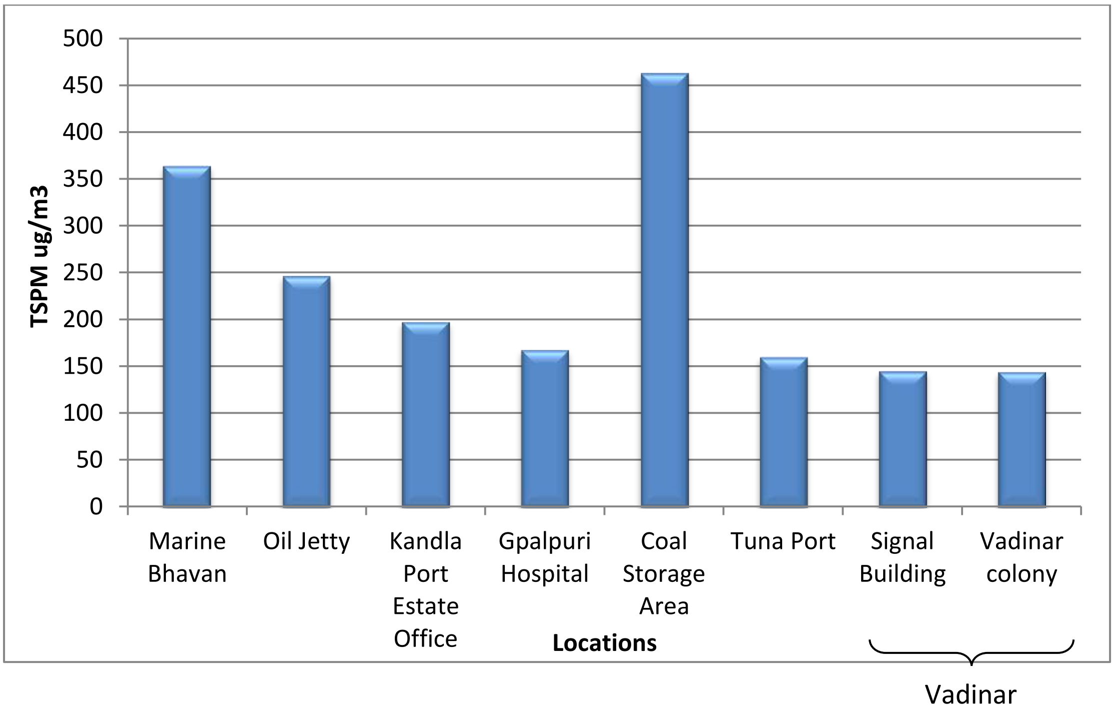
Table 6.1 TSPM (in µg/m^3) values at monitoring locations in Kandla and Vadinar Port

Months	Marine Bhavan	Oil Jetty	Kandla Estate Office	Gopalpuri Hospital	Coal Storage Area	Tuna Port	Signal Building	Vadinar colony
Mar-20	325.9	171.1	155.9	151.4	347.4	173.4	129.1	132.9
Apr-20	**COVID-19 Lockdown**							
May-20	**COVID-19 Lockdown**							
Jun-20	207.2	180	164	153	319	169	148	157
Jul-20	233	197	188	164	276	171	152	147
Aug-20	349	260	162	133	506	93	133	152
Sep-20	405	257	130	155	459	204	151.4	145
Oct-20	313	204	152	122	436	70	124.6	122.9
Nov-20	364	287	245	182	505	167	151	149.9
Dec-20	635	323	321	208	621	179.4	156.6	174
Jan-21	387	261	165	165	438	236	157	154
Feb-21	422	329	296	247	723	140	148	163
Annual Mean	**364.1**	**246.9**	**197.9**	**168.1**	**463.0**	**160.3**	**145.1**	**154.5**

The mean TSPM values were highest at Coal Storage location and Marine Bhavan, followed by Oil Jetty. TSPM values were least at both the locations of Vadinar Port. The major cause of TSPM values at Coal Storage and Marine Bhavan is large amount of coal is handled at Berth No. 6, 7, 8 and use of grabs for unloading of coal directly in the truck cause coal to spread in air as well as coal dust to fall on ground. This settled coal dust again mixes with the air during trucks movement through it.

Also, the coal laden trucks are not always covered with tarpaulin sheets and these results in spillage of coal from trucks/dumpers during its transit from vessel to yard or storage site.

Fig 6.1 Observed values (annual mean) of TSPM at all eight monitoring stations



Interpretation of Results

- Maximum TSPM of 723.0 µg/m^3 was recorded in the month of February' 21 at Coal storage site and the minimum value was recorded in the month of October '20 at Tuna Port 70.1 µg/m^3.

- At Vadinar, maximum TSPM of 157 µg/m^3 was recorded in the month of January at Vadinar signal building site and the minimum value was recorded in the month of October'20 at Vadinar Port colony (122 µg/m^3).

II. Particulate Matter (PM_{10})

PM_{10} is particulate matters which are 10 micrometers or less in diameter. The frequency of sampling was twice a week for every sampling station.

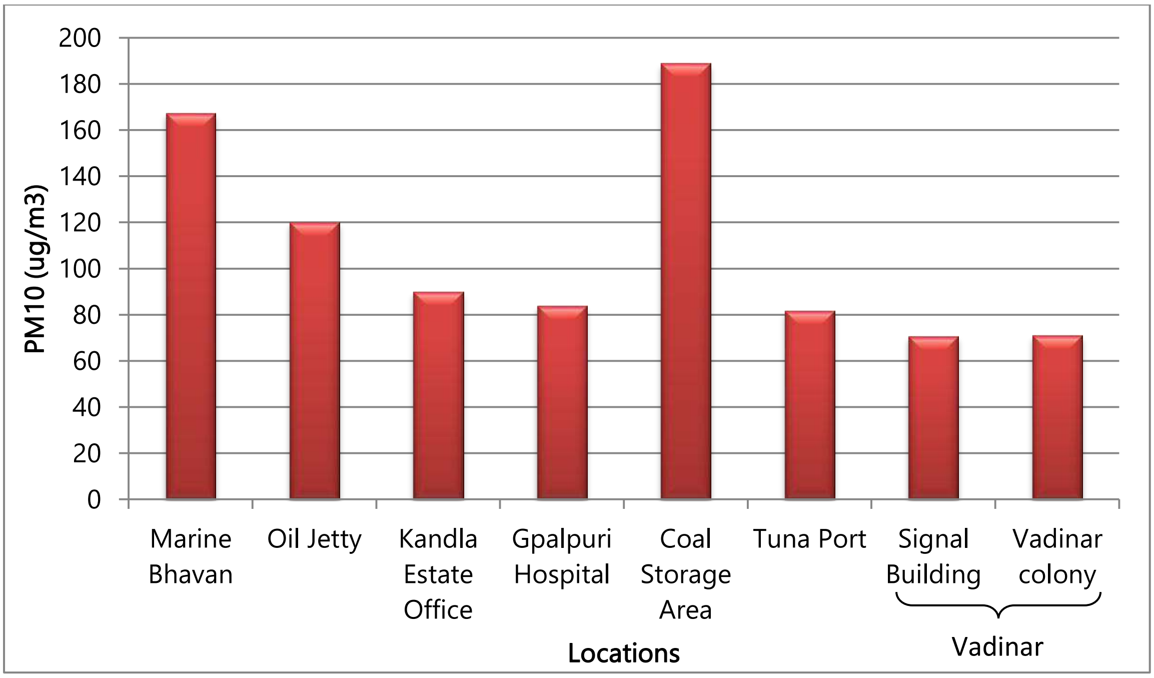
Table 6.2 PM_{10} (in µg/m^3) values at monitoring locations in Kandla and Vadinar Port

Months	Marine Bhavan	Oil Jetty	Kandla Estate Office	Gopalpuri Hospital	Coal Storage Area	Tuna Port	Signal Building	Vadinar colony
Mar-20	175.9	116.3	87	74.9	162.6	88	74.4	54.6
Apr-20	**COVID-19 Lockdown**							
May-20								
Jun-20	81.9	81.6	79.8	87	108.8	72	59.8	52.9
Jul-20	89.1	85.6	81.6	81.6	110.6	73	77.6	72.6
Aug-20	191.7	99.7	86.6	93	184.6	54	75	72.6
Sep-20	254	154	79	91	266	86	82.5	81
Oct-20	96.4	91.1	73	63.6	112.4	49	63.5	67.8
Nov-20	103	87.8	81.3	78.4	242.3	97.4	56.5	67.3
Dec-20	297	167	144	104	233	92.4	51.5	79
Jan-21	232	153	91	91	261	134	85	83
Feb-21	153	166	96	73	208	71	81	79
Annual Mean	**167.4**	**120.2**	**89.9**	**83.8**	**188.9**	**81.7**	**70.7**	**71.0**

The mean PM_{10} Values were highest at Coal Storage location and Marine Bhavan, followed by Oil Jetty. PM_{10} values were least at both the locations of Vadinar Port. Higher PM_{10} values at Coal Storage and Marine Bhavan is a result of large amount of coal handling and its inappropriate transportation methods.

Coal laden trucks are seldom covered with tarpaulin sheets and these results in spillage of coal from trucks/dumpers resulting into higher PM_{10} values.

Fig 6.2 Observed values (annual mean) of PM_{10} at all eight monitoring stations



Interpretation of Results

- Maximum value of PM_{10} of 297 µg/m^3 was recorded in the month of December'20 at Coal storage site and the minimum value was recorded in the month of October at Tuna Port 49.0 µg/m^3.
- In Vadinar, maximum value of PM_{10} of 85 µg/m3 was recorded in the month of March at Port admin building site and the minimum value was recorded in the month of December at Vadinar Port signal building (51.5 µg/m^3).

III. Particulate Matter ($PM_{2.5}$)

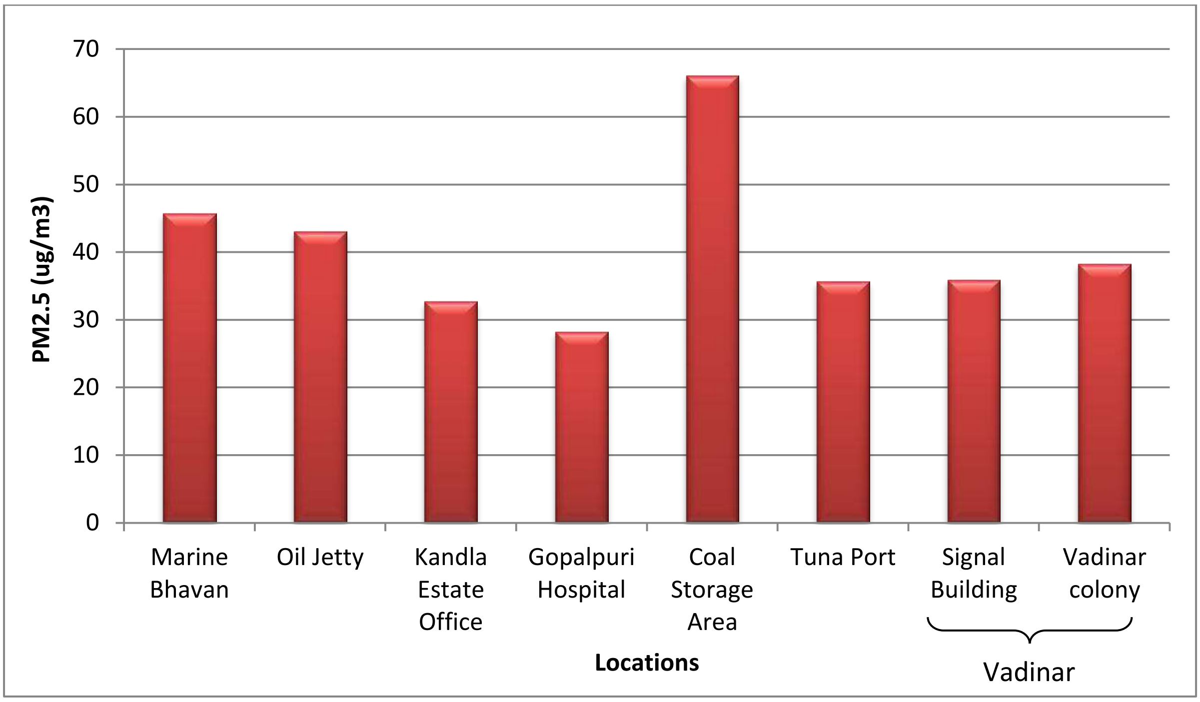
$PM_{2.5}$ particles are air pollutants with a diameter of 2.5 micrometers or less, small enough to invade even the smallest airways. $PM_{2.5}$ was also monitored twice a week for every sampling station.

Table 6.3 $PM_{2.5}$ (in µg/m^3) values at monitoring locations in Kandla and Vadinar Port

Months	Marine Bhavan	Oil Jetty	Kandla Estate Office	Gopalpuri Hospital	Coal Storage Area	Tuna Port	Signal Building	Vadinar colony
Mar-20	32.9	46.6	45.1	38.3	75.1	37.5	32.4	30.8
Apr-20	**COVID-19 Lockdown**							
May-20								
Jun-20	32.8	22	25	23	62.5	22	38.8	38.3
Jul-20	27	28.6	36.3	25	42	26	40	41
Aug-20	25	27	19	19	68.4	22	32	41
Sep-20	55	49	37	47	53	46	37.3	39
Oct-20	39	21	28	14	63.1	17	35.6	36.3
Nov-20	57.3	43.9	31.4	27	90.5	49.6	28.6	32.3
Dec-20	55	71	24	23	67	52.6	30.6	41
Jan-21	51	49	41	41	55	50	44	42
Feb-21	82	73	40	25	84	34	40	41
Annual Mean	**45.7**	**43.1**	**32.7**	**28.2**	**66.1**	**35.7**	**35.9**	**38.3**

Average $PM_{2.5}$ values were highest at Coal Storage location (mean = 66.1 µg/m^3) followed by Marine Bhavan (mean = 45.7 µg/m^3) and Oil Jetty (mean = 43.1 µg/m^3). $PM_{2.5}$ values At Vadinar Port the $PM_{2.5}$ values were significantly lower.

Fig 6.3 Observed values (annual mean) of $PM_{2.5}$ at all eight monitoring stations



Interpretation of Results

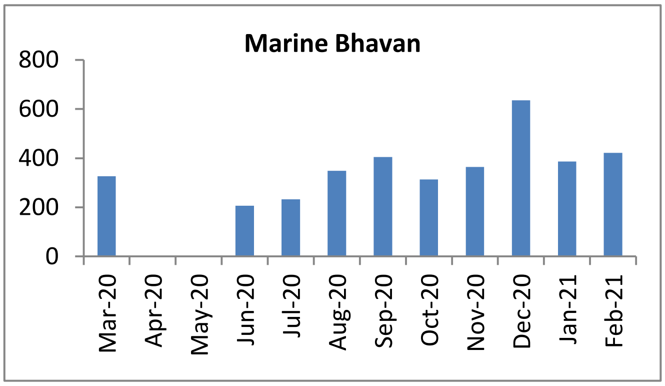
- Maximum value of $PM_{2.5}$ (90.5 µg/m^3) was recorded in the month of November at Coal storage site and the minimum value was recorded in the month of August at Gopalpuri Hospital (14.0 µg/m^3).

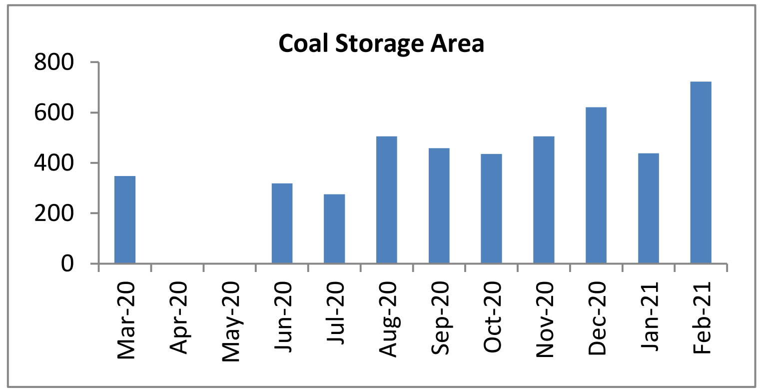
- Annual mean values of $PM_{2.5}$ was highest at Coal Storage Area (66.1 µg/m^3).

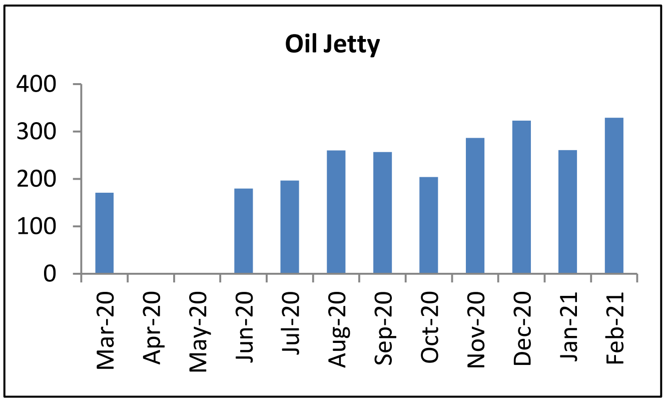
- In Vadinar, maximum value of $PM_{2.5}$ of 44.0 µg/m^3 was recorded in the month of January' 21 at Signal building site and the minimum value was recorded in the month of November at Vadinar Port colony (28.6 µg/m^3).

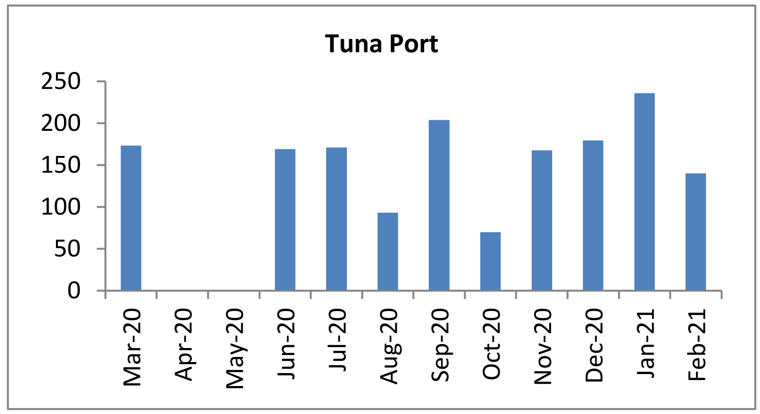
Location wise graphs depicting trends in TSPM, PM_{10} and $PM_{2.5}$ in all locations of Kandla and Vadinar Port are depicted in Fig 5.1 to 5.6.

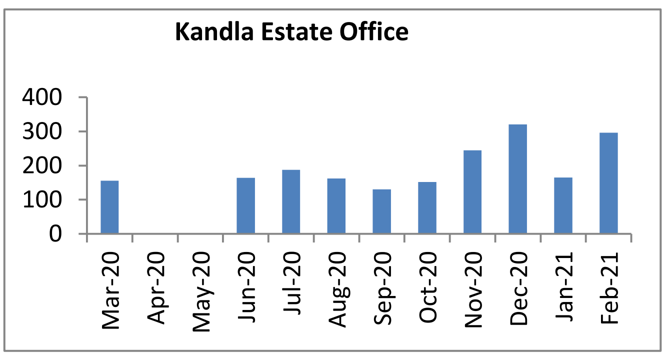
Trend in TSPM values of various AAQ Monitoring Locations

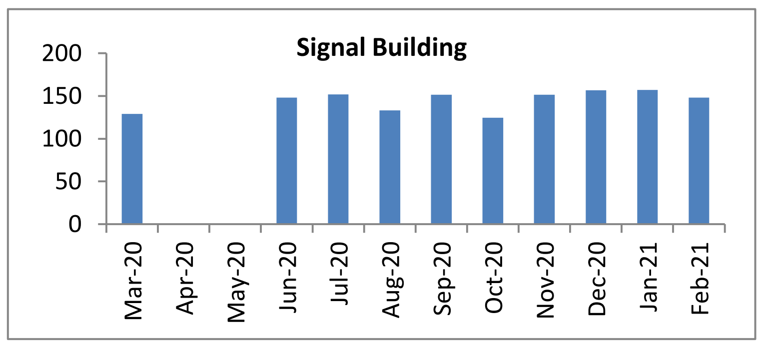


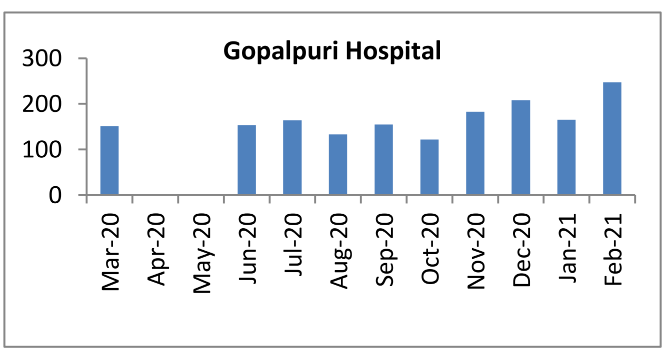


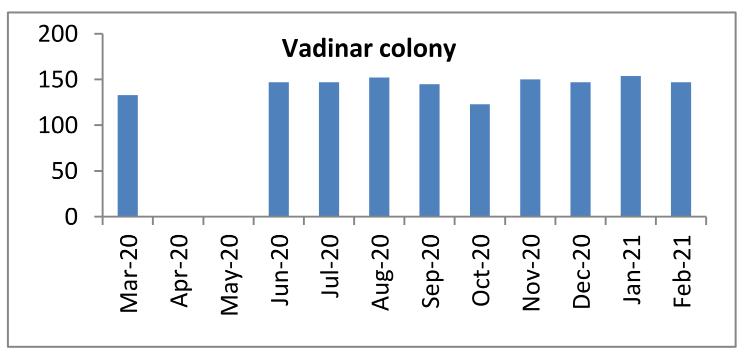




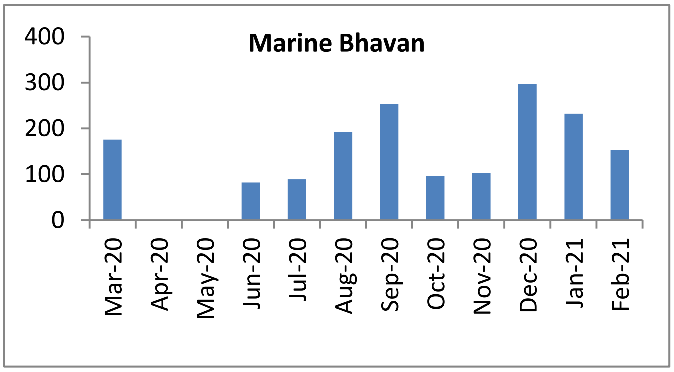


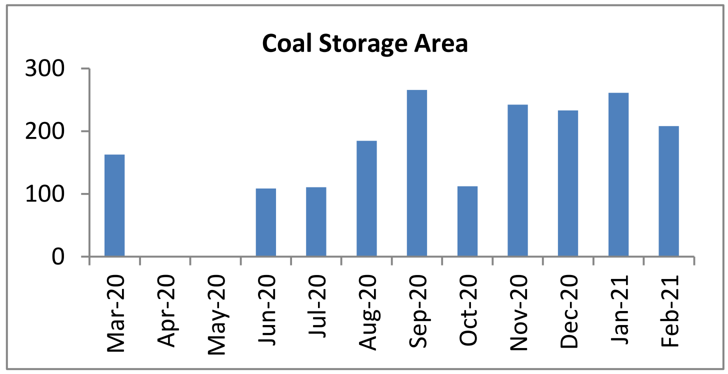


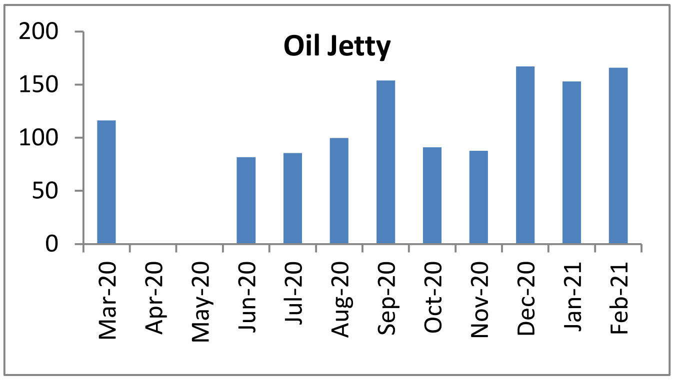


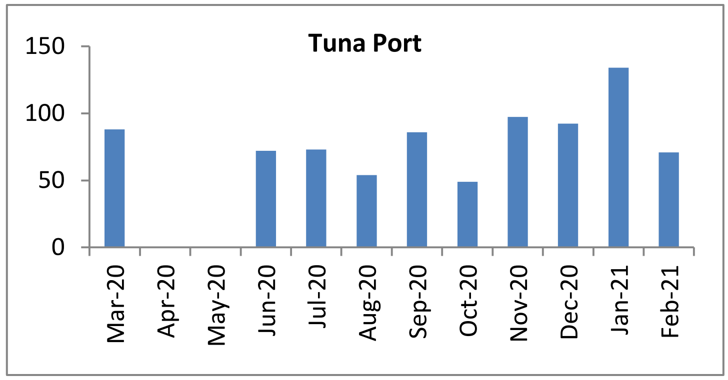


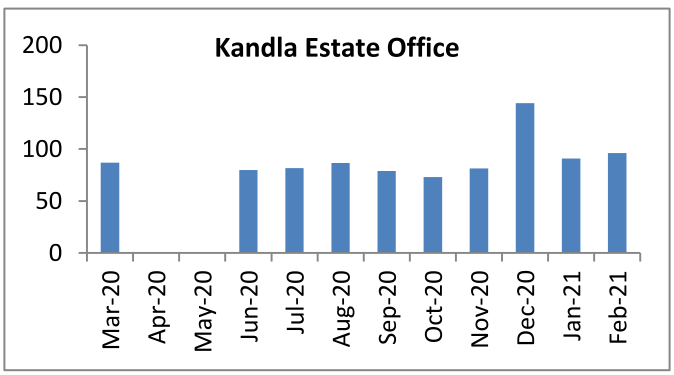
Trend in PM_{10} values of various AAQ Monitoring Locations

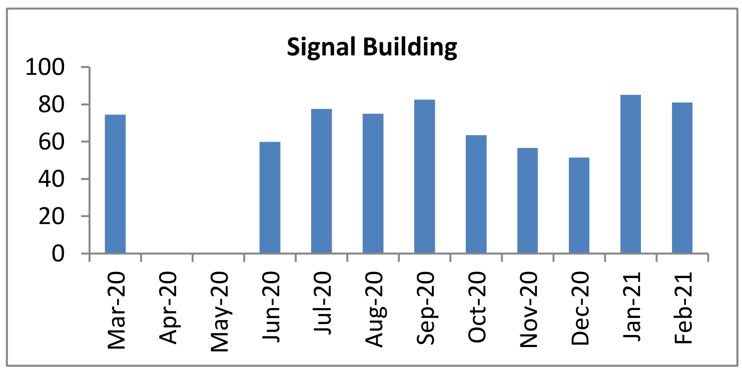


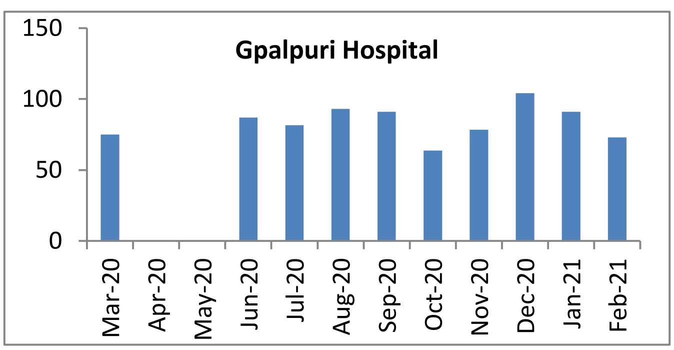


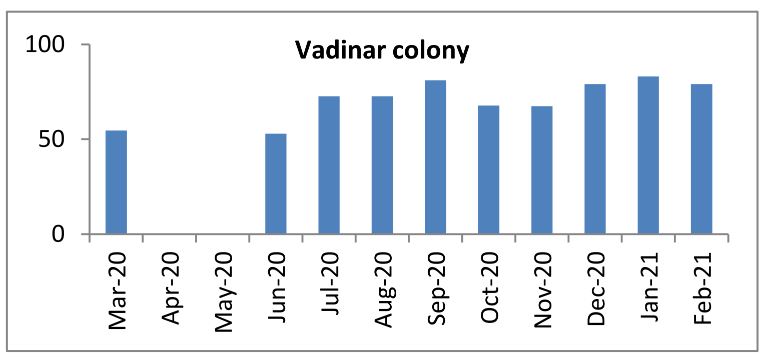




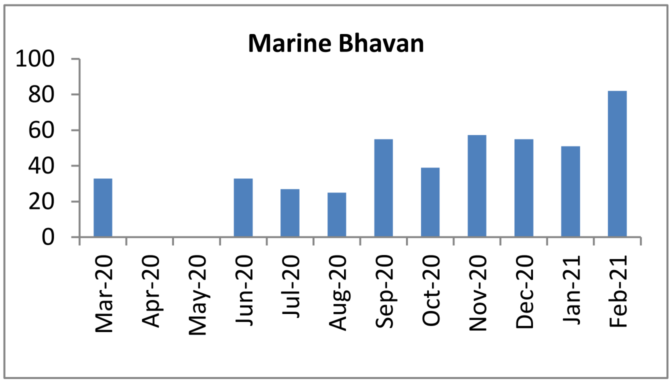


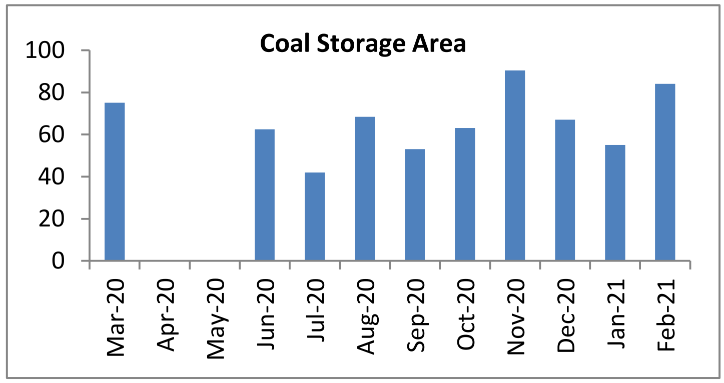


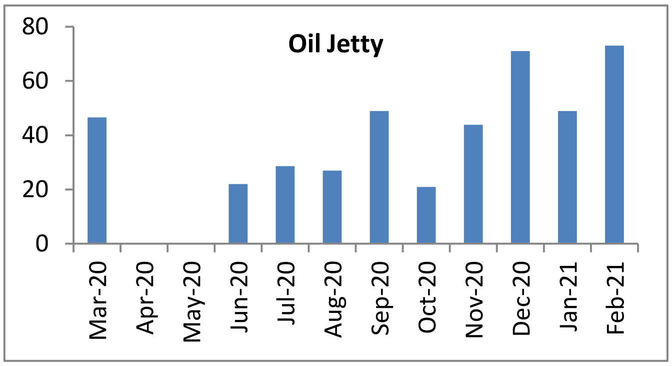


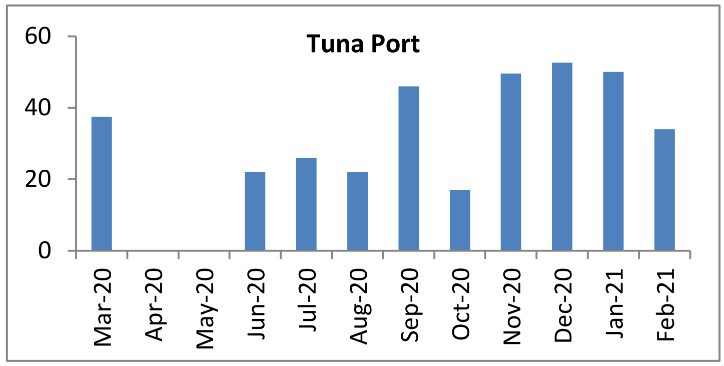


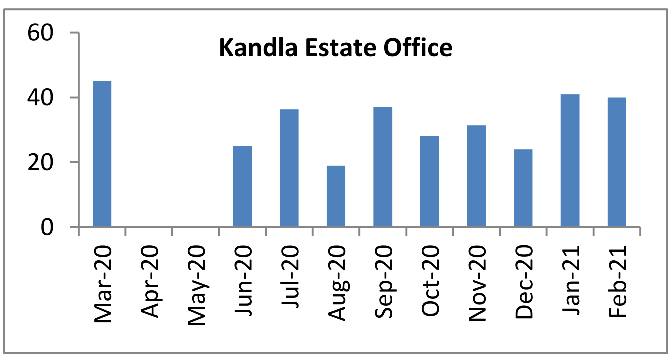
Trend in $PM_{2.5}$ values of various AAQ Monitoring Locations

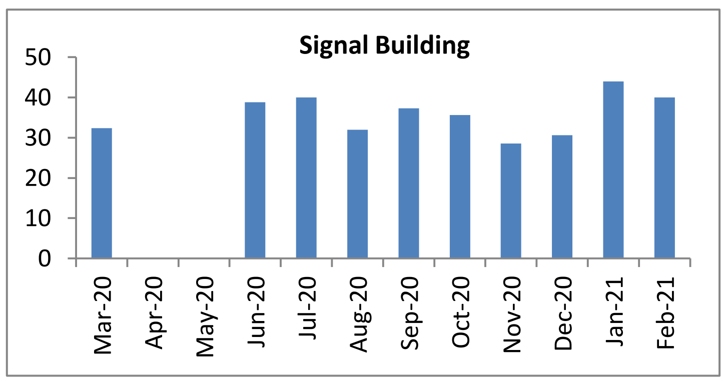


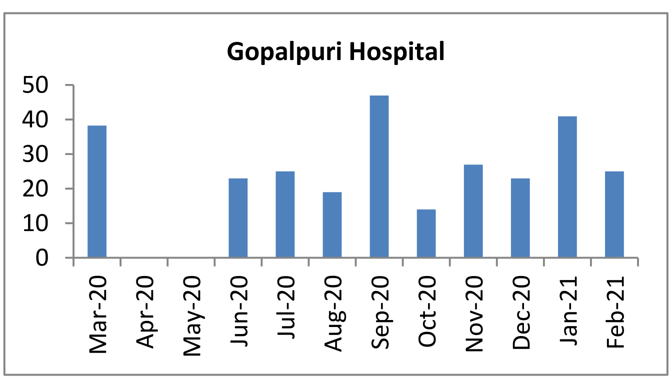


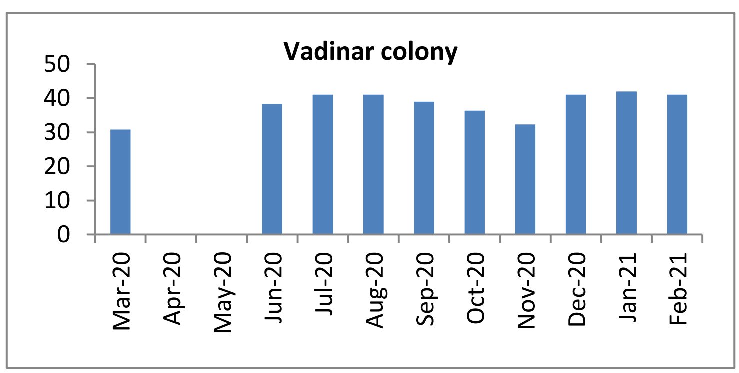












2. Drinking Water Quality Monitoring

Drinking Water Quality Monitoring was carried out at twenty stations at Kandla, Vadinar & Township Area of Deendayal Port.

Drinking water samples are collected from 20 locations (18 locations in Kandla and 2 locations in Vadinar). Samples for physico-chemical analysis are collected and analysed in laboratory for various parameters, viz. Color, Odor, Turbidity, Conductivity, pH, Chlorides, TDS, Total Hardness, Iron, Sulphate, Salinity, DO, BOD, Na, K, Ca, Mg, F, NO3, NO2, Mn, Cu, Cd, As, Hg, Pb, Zn, Bacterial Count (CFU).

Monitoring Results

Mean values of drinking water of Deendayal Port Locations are given in table 5.1. The values shown are the annual average of all the locations of Deendayal Port Colony, Port and Harbor area as well as Deendayal Port Trust office buildings.

Table 6.4: Annual average values of Drinking water at Deendayal Port Trust

Sr. No.	Parameter	Unit	1st quarter Mean	2nd quarter Mean	3rd quarter Mean	Value (Annual Avg.)	Acceptable Limits	Permissible Limits
1	pH	pH Unit	7.9	7.5	7.4	7.5	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/L	669.4	386.7	1117.0	794.6	500	2000
3	Turbidity	NTU	83.1	55.3	0.4	43.6	1	5
4	Odor	-	Odorless	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	Colorless	5	15
6	Conductivity	µs/cm	1248.0	809.9	2278.7	1630.5	NS*	NS*
7	Bio.Oxygen Demand	mg/L	<2	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/L	234.8	417.7	631.5	504.0	250	1000
9	Ca as Ca	mg/L	103.0	98.4	66.9	80.5	75	200
10	Mg as Mg	mg/L	23.2	50.0	54.5	51.0	30	100
11	Total Hardness	mg/L	248.6	308.2	391.0	354.4	200	600
12	Iron as Fe	mg/L	0.1	0.1	<0.01	0.1	0.3	1
13	Fluorides as F	mg/L	0.5	0.8	0.5	0.6	1	1.5

Sr. No.	Parameter	Unit	1st quarter Mean	2nd quarter Mean	3rd quarter Mean	Value (Annual Avg.)	Acceptable Limits	Permissible Limits
14	Sulphate as SO_4	mg/L	143.0	94.8	178.3	168.4	200	400
15	Nitrite as NO2	mg/L	209.4	209.4	<0.1	209.4	NS*	NS*
16	Nitrate as NO3	mg/L	11.8	7.2	10.4	8.8	45	100
17	Salinity	%	1.7	1.6	1.1	1.3	NS*	NS*
18	Sodium as Na	mg/L	90.8	230.8	265.3	234.0	NS*	NS*
19	Potassium as K	mg/L	52.9	37.3	3.1	18.7	NS*	NS*
20	Manganese	mg/L	<0.04	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/L	<0.03	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/L	<0.05	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/L	<0.002	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/L	<0.01	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/L	<0.001	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/L	<0.01	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/L	<0.1	<0.1	<0.1	<0.1	5	15
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent	Absent

NS = Not specified, ND= Not detected

Discussion

The colour of all drinking water samples was < 5 Hazen unit and odour of the samples was also agreeable. The values of turbidity, Iron as Fe and Ammonia as NH_3-N were observed to be below detection limits of measurement i.e. <0.1 NT, <0.03 mg/L and <0.1 mg/L respectively. Apparently these parameters were not at alarming levels. Some important parameters for drinking water are discussed below in detail;

pH

pH value in the studied area varied from 7.3 to 8.2 pH unit during the first year of monitoring. The limit of pH value for drinking water is specified as 6.5 to 8.5. All the sampling points showed pH values within the prescribed limit by Indian Standards.

Total Dissolved Solids (TDS)

TDS values in the studied area varied between 140-1647 mg/L. The mean TDS value was 776.7 mg/L. None of the sampling points showed higher TDS values than the prescribed limit by Indian standards which are 500-2000 mg/L.

Conductivity

Conductivity is used to measure the concentration of dissolved solids which have been ionized in a polar solution such as water. The conductivity in the samples collected during the month of June ranged from 796-2841 µs/cm. Electrical conductivity standards do not appear in BIS standards for drinking water.

Chlorides

Chloride values in drinking water for the present year varied between 215-895 mg/L. Excessive chloride concentration increase rates of corrosion of metals in the distribution system. This can lead to increased concentration of metals in the supply.

Calcium

Calcium value in drinking water for the present year the studied area varied between 25.7 – 124.1 mg/L. The mean Ca was observed to be 83.7 mg/L. If calcium is present beyond the maximum acceptable limit, it causes incrustation of pipes.

Magnesium

Magnesium value in the studied area for the present year varied from 10.6 mg/L to 69.7 mg/L. All the locations had Magnesium within the prescribed limits of 30-100 mg/L.

Total Hardness

Total Hardness value in the studied area for the present year varied between 188-510 mg/L. The prescribed limit by Indian Standards is 200-600 mg/L.

Fluoride

Fluoride value in the studied area varied between 0.3 – 1.4 mg/L. The permissible limit as per Indian Standards is 1.0-1.5 mg/L. Moderate amount of fluoride in water lead to dental effects, but long-term ingestion of large amounts can lead to potentially severe skeletal problems.

Sulphates

Sulphate value in the studied area varied between 32 –315 mg/L. All the sampling points showed 67ulphates values within the prescribed limits by Indian Standards (200-400 mg/L). Sulphate occurs naturally in water as a result of leaching from gypsum and other common minerals. Sulphate content in drinking water exceeding the 400 mg/L imparts bitter taste.

Nitrites (NO_2)

Nitrite values in all the water samples were observed to be <0.1 mg/L. There are no specified standard values for Nitrites in drinking water. Groundwater contains nitrate due to leaching of nitrate with the percolating water and by sewage and other wastes rich in nitrates.

Salinity

Salinity in drinking water in the present samples collected ranged from 0.4 to 1.1 %. There are no prescribed Indian standards for salinity in Drinking water.

Heavy Metals in Drinking Water

In the present study period drinking water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals were well below/ the permissible limits of the Indian Standards for drinking water.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that total Coliform values is observed to be 0.1 to cfu/100 ml. total Coliform and E-Coli values showed that all the drinking water samples were safe from any bacteriological contamination.

Conclusion

The results are compared with acceptable limits as prescribed in IS 10500:2012 – Drinking Water Specification. It was observed from the data analysis that during the first year (March '20 to February '21) the drinking water was safe for human consumption at all drinking water monitoring stations.

Fig 6.7 Annual average values of TDS at all the drinking water monitoring stations

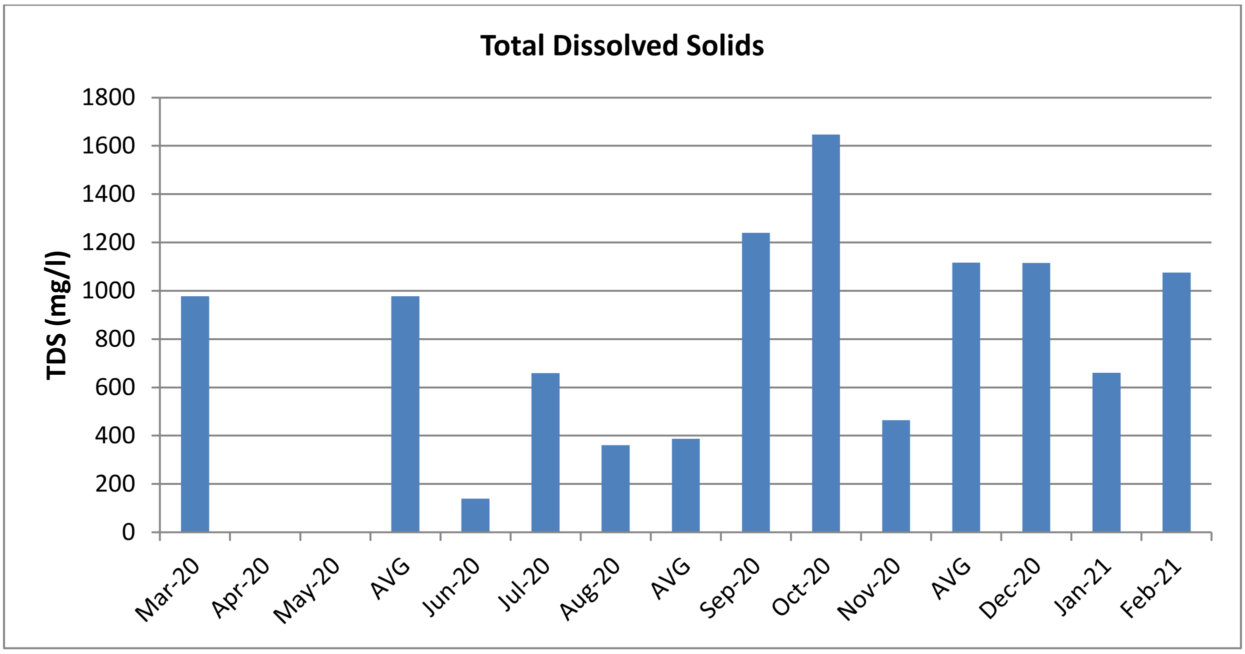


Fig 6.8 Yearly trends in mean annual average values of TDS at all the drinking water monitoring stations

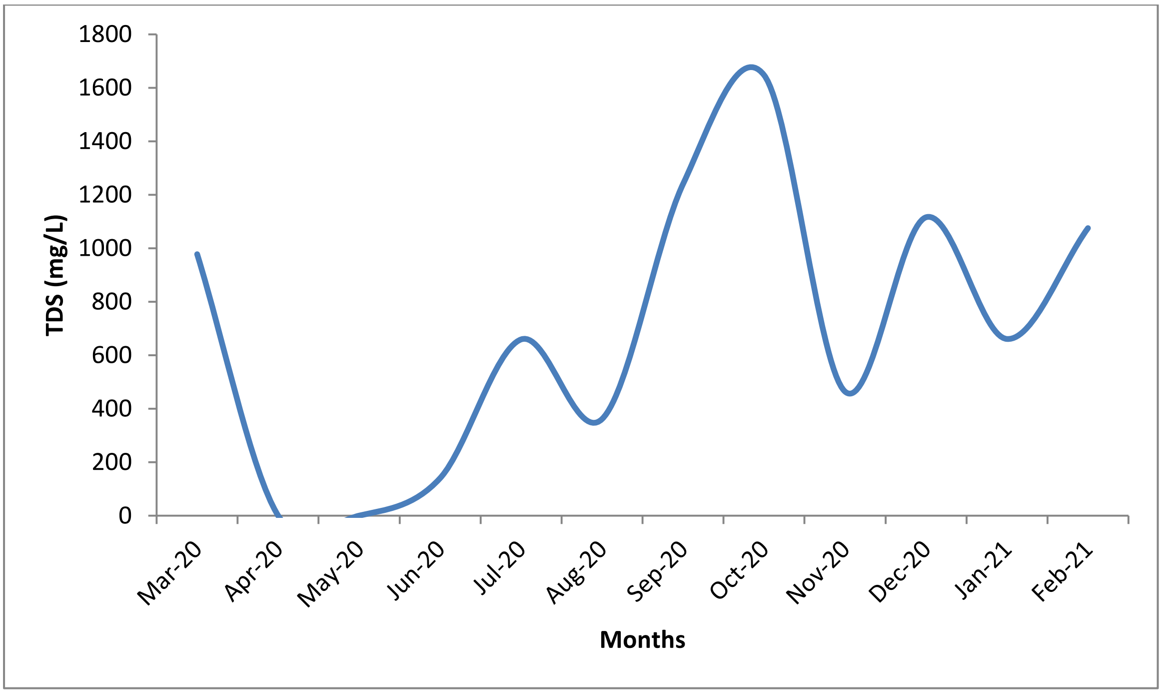


Fig 6.9 Annual average values of Total Hardness at all the drinking water monitoring stations

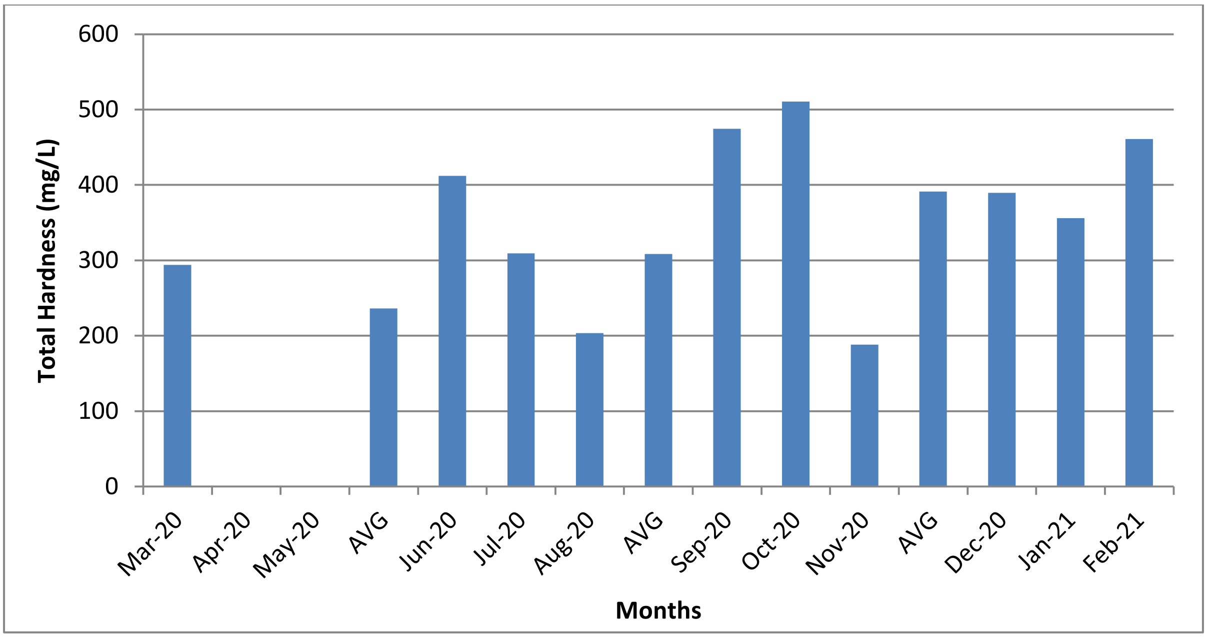
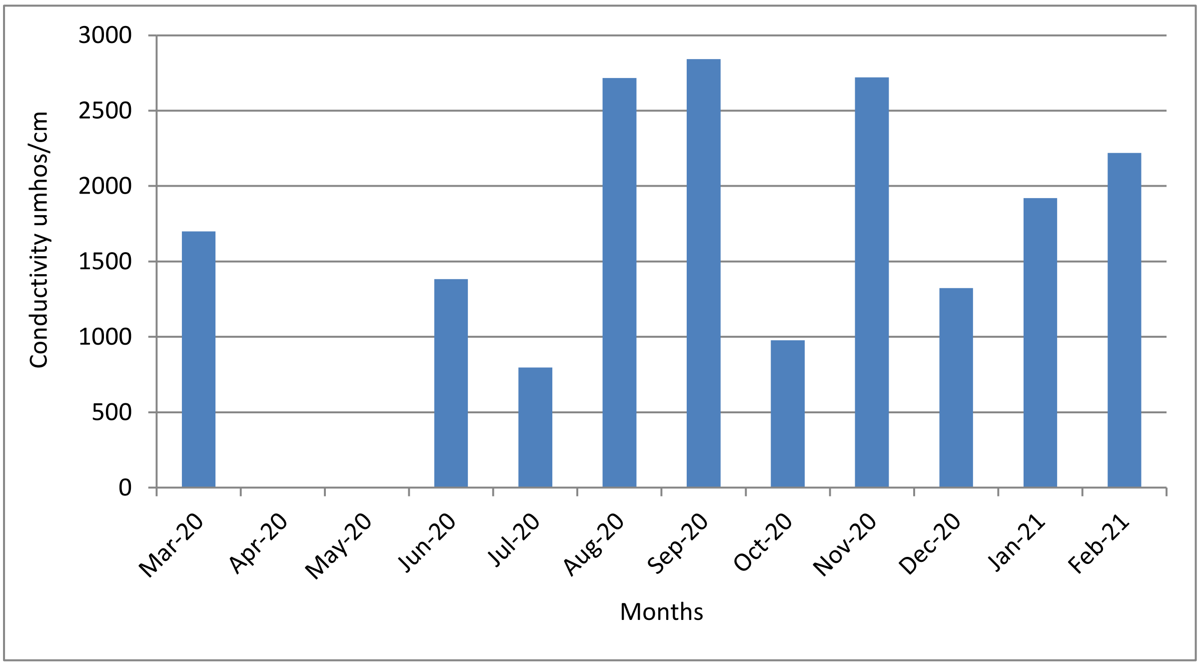


Fig 6.10 Annual average values of Conductivity at all the drinking water monitoring stations



3. Marine Water Monitoring

Marine Water Monitoring was carried out at six stations at Deendayal Port and two locations at Vadinar Port.

Water samples were analyzed for physico-chemical and Biochemical parameters. Besides these, Phytoplankton (Qualitative & Quantitative) Zooplankton (Qualitative & Quantitative) & Benthos (Qualitative & Quantitative) samples were collected during spring tide and neap tide from all the eight fixed monitoring stations.

Results

The annual average values of monitored parameters for marine waters of DPT are given as per table 6.3.

Table 6.3 Annual average values of various physico-chemical parameters at Deendayal Port during neap tide

Sr. No.	Parameters	Unit	1st quarter Mean	2nd quarter Mean	3rd quarter Mean	4th Quarter Mean
1	pH	pH unit	7.9	7.6	7.6	7.5
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	odorless	odorless	odorless	odorless
4	Salinity	ppt	33.3	33.1	33.1	33.4
5	Turbidity	NTU	66.6	70.2	60.6	68.2
6	Total Dissolved Solids	mg/L	36790.0	35760.1	34897.8	35509.6
7	Total Suspended Solids	mg/L	114.5	100.0	95.9	98.9
8	Total Solids	mg/L	36904.6	35860.1	34993.7	35608.5
9	DO	mg/L	5.7	5.6	5.9	5.4
10	COD	mg/L	99.1	91.3	89.6	85.6
11	BOD	mg/L	<2	<2	<2	<2
12	Silica	mg/L	1.4	1.4	1.5	1.2
13	Phosphate	mg/L	0.6	0.5	0.1	0.2
14	Sulphate	mg/L	3206.6	3469.2	2394.7	3459.0
15	Nitrate	mg/L	3.4	4.0	4.6	6.1
16	Nitrite	mg/L	<0.1	<0.1	<0.1	<0.1
17	Calcium	mg/L	661.1	642.4	445.5	505.0
18	Magnesium	mg/L	1709.6	1841.3	1225.7	1656.0

Sr. No.	Parameters	Unit	1st quarter Mean	2nd quarter Mean	3rd quarter Mean	4th Quarter Mean
19	Sodium	mg/L	10982.2	11125.1	9724.8	12467.6
20	Potassium	mg/L	391.0	442.2	327.0	400.9
21	Iron	mg/L	1.6	1.8	1.7	2.4
22	Chromium	mg/L	0.2	0.2	0.1	0.2
23	Copper	mg/L	0.1	0.1	0.1	0.1
24	Arsenic	mg/L	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/L	<0.001	<0.001	<0.001	<0.001
26	Mercury	mg/L	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/L	0.2	0.2	0.2	0.2
28	Zinc	mg/L	0.1	0.1	0.1	0.1

Discussion

Coastal ecosystems are characterized by daily fluctuations, driven by tidal amplitude, wind direction and also on the anthropogenic activities carried out on the coasts. Marine water parameters at Kandla Harbor and creek waters also showed an high array of fluctuations in several of its parameters such as TDS, TSS, salinity and salts.

Some of the important parameters are explained below;

pH

The pH of all marine water samples collected from Deendayal Port varied from 7.5 to 7.9 pH Unit. The mean pH of all samples was 7.64 pH unit.

Salinity

Salinity in the DPT marine water ranged from 32.9 ppt to 33.5 ppt. The mean salinity at was recorded to be 33.2 ppt.

Turbidity

Turbidity in the DPT marine water ranged from 60.2 – 73.1 NTU. The mean turbidity of all the locations of Deendayal Port was 66.4 NTU. Turbidity at Vadinar port was <1.0 NTU.

Total Dissolved Solids (TDS)

TDS values varied from 34411 to 37022 mg/L at all locations of Deendayal Port. Mean TDS values at Deendayal Port was 35739 mg/L.

Dissolved Oxygen (DO)

DO value in the studied area varied between 5.4 – 6.0 mg/L. The mean DO values of Kandla Marine waters were 5.7 mg/L.

Nitrates (NO3)

The mean Nitrate values in all the marine water samples were of Deendayal Port was 4.5 mg/L at DPT waters. Nitrite was rarely detected from marine waters of Vadinar.

Sodium (Na)

Sodium value in the Deendayal Port marine waters varied between 9675-12913 mg/L. The mean Na recorded at DPT waters was 11074.9 mg/L.

Trace Metals

In the present study period water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals reported below trace levels.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that total Coliform values is observed to be 0.1 to cfu/100 ml.

3.1 Productivity Study

Chlorophyll-A

Water Samples for the chlorophyll estimation collected from sub surface layer during high tide and low tide period of the tidal cycle for each sampling locations and analysed for Chlorophyll -a and after acidification for Pheophytin –a.

In the sub surface water chlorophyll-a was varying from 0.25 to 1.26 mg/m^3 in harbour region of DPT during sampling done in from March 2020 to February 2021. In the nearby creeks chlorophyll-a was varying from 0.31-1.93 mg/m^3.

In the sub surface water chlorophyll-a was varying from 0.807 – 4.718 mg/m3 at Vadinar jetty and 0.731 mg/m3 to 3.210 mg/m3near SPM during sampling done spring tide period and during Neap tide.

Algal Biomass

Chlorophyll- a value was used as algal biomass indicator (APHA 1998). Algal biomass was estimated by converting Chlorophyll value.

In the sub surface water algal biomass was varying from 16.5 to 84.6 mg/m^3 in harbour region of DPT during sampling done in from March 2020 to February 2021. In the nearby creeks Algal Biomass was varying from 20.5 to 102.7 mg/m^3.

Fig 6.11 Annual average values of Chlorophyll-a in harbor waters of DPT

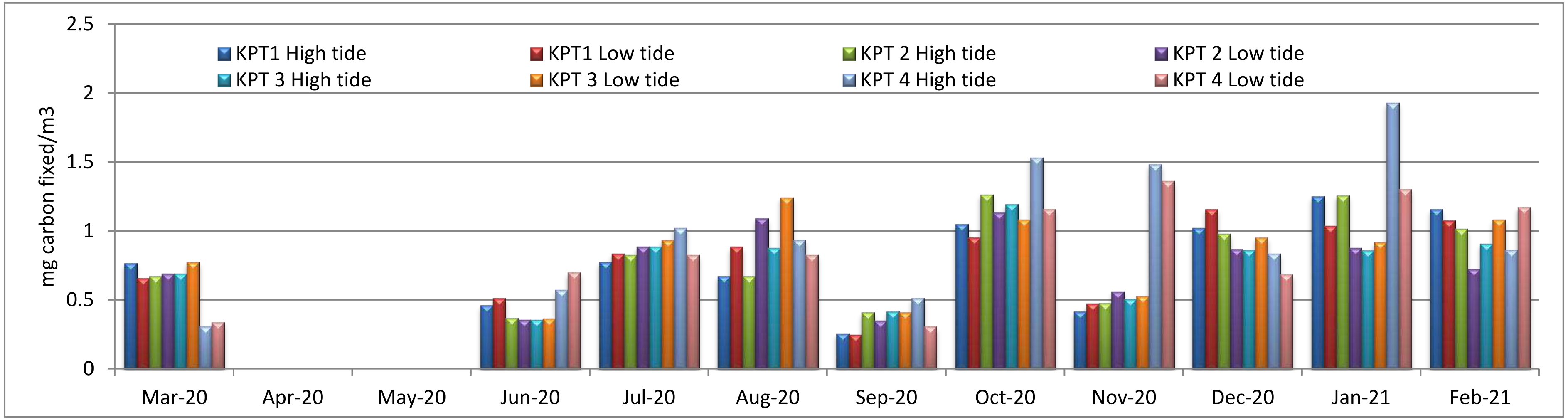
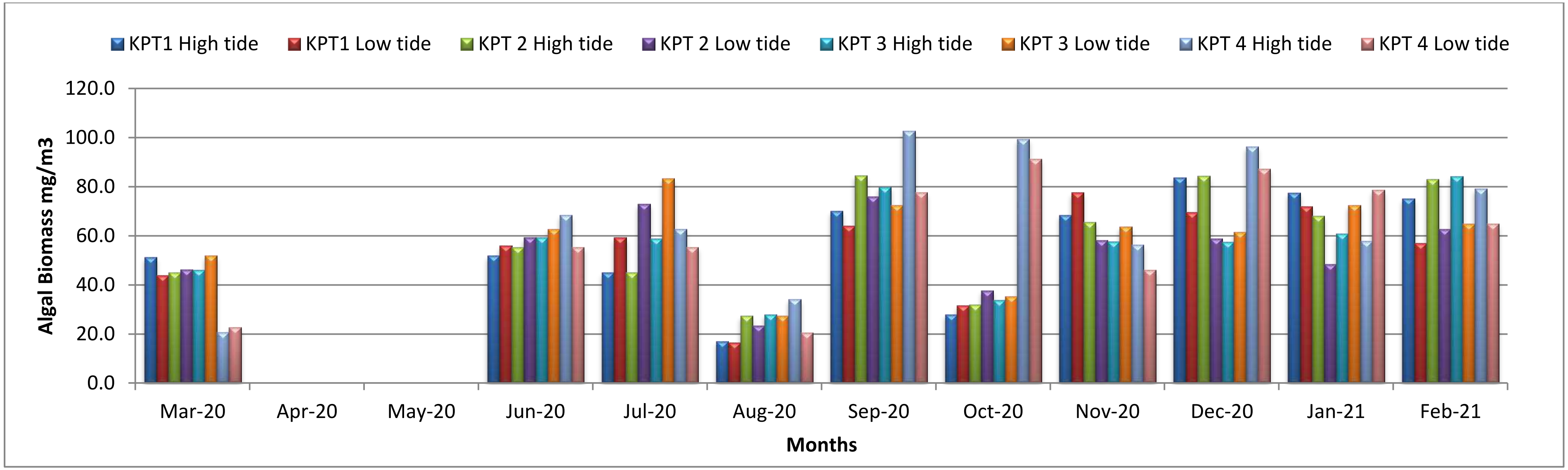


Fig 6.12 Annual average values of Algal Biomass in harbor waters of DPT



3.2 Phytoplankton and Zooplankton

The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by Blue green algae and diatoms during spring tide period and neap tide period. Diatoms were represented by 13 genera belonging to 3 classes, 9 orders and 12 families.

The Zooplankton community of the sub surface water in the harbour and nearby creeks is comparatively low and represented by mainly four groups Tintinids, Copepods, Foramiferans, and larval forms of Crustaceans.

However, Vadinar waters were observed to be rich in terms of diversity and abundance of phytoplankton and zooplanktons.

4. Noise Monitoring

Noise monitoring is carried out as per 'Noise Pollution (Regulation and Control) Rules, 2000. The results of noise monitoring results are annual mean of each location of Kandla and Vadinar Port (Table 5.3).

Table 5.3 Annual avg. of noise level at locations of Kandla (10 locations) and Vadinar (3 locations) Port

Sr. No.	Locations	Day Time Average Noise Level(SPL) in dB(A)	Night Time Average Noise Level(SPL) in dB(A)
	Time	6 am. And 10 pm.	10 pm. To 6 am
1	Marine Bhavan	67.8	59.8
2	Nirman Building 1	67.2	62.5
3	Tuna Port	53.0	48.7
4	Main Gate North	64.6	60.4
5	West Gate I	70.0	66.1
6	Canteen Area	68.8	58.7
7	Main Road	66.9	59.4
8	ATM Building	61.3	62.3
9	Wharf /Jetty Area	66.2	63.6
10	Port & Custom Office	58.9	52.2
	Vadinar Port		
11	Nr. Vadinar Port Gate	51.8	49.7
12	Port Colony Vadinar	51.5	50.6
13	Nr. Vadinar Jetty	54.1	47.5

Observations:

- The Day Time Average Noise Level in all ten locations at Deendayal Port ranged from 53.0 dB to 70.0 dB
- The noise levels were within the day time limits (75 dB (A)) of industrial area.
- The Night Time Average Noise Level in all ten locations of Deendayal Port ranged from 48.7 dB to 66.1 dB and it was within the permissible limits of 70 dBA for the industrial area for the night time.

- The mean day time noise levels at Vadinar were 52.5 dB and the mean noise levels at night hours was 49.3 dB.

5. Soil Monitoring

Sampling and analysis of soil samples was undertaken at six locations within the study area (Deendayal Port and Vadinar Port). The soil monitoring locations are coastal soils and exhibits saline soil characteristics, typical of a muddy shore.

The texture of soil of all locations was Sandy Loam. The soil at all the locations is saline in nature. The mean pH of the soil at all the locations of Kandla was 8.08 pH unit suggesting it to be slightly to medium alkaline.

Electrical conductivity of the soil was high with low moisture and organic carbon indicating less productivity of the soil and its unsuitability for any agriculture activities.

Other metals like copper, nickel and lead were detected in traces or within permissible limits. The overall surrounding soils were found to be less in essential nutrients, hence less suitable for plant growth.

6. Sewage Treatment Monitoring

This involve safe collection of waste water (spent/used water) from wash areas, bathroom, cargo operational units, etc., waste from toilets of various buildings and its conveyance to the treatment plant and final disposal in conformity with the requirement and guide lines of State Pollution Control Board and other statutory bodies.

The waste water is let into sewer network (network of pipes and manholes) and let by gravity and intermittent pumping stations to the main Sewage Treatment Plant (STP).

The Sewage Treatment Monitoring is carried out at Deendayal Port Colony

(Gopalpuri), Vadinar Port and Deendayal Port.

STP at Gopalpuri Port Colony

Gopalpuri STP is working properly and overall performance of the existing STP was found satisfactory. The removal efficiency of BOD, TSS was in order. The individual units were also performing well and their removal efficiencies are satisfactory. Thus with the sample tested in laboratory the plant is working satisfactory and the individual units are also working well.

STP at Kandla Port

STP with improved capacity of 1.5 MLD at Deendayal Port is operational. The newly installed sewage treatment plant has 1500 cum/day fluidized media reactor based STP to treat domestic waste water generated from the campus and treated water will be utilized for gardening and plantation purpose.

7. Conclusion

i. Ambient Air

Ambient Air Quality monitoring results for the first year shows TSPM, PM_{10} and $PM_{2.5}$ concentrations of the ambient air were within the permissible limits as per the National Ambient Air Quality Standards (NAAQS 2009). The concentration of PM_{10} was above the permissible limit at Coal Storage Area, Marine Bhavan and occasionally at Oil Jetty Area and Tuna Port area at some occasions.

Deendayal Port has handled 305.480 Lakh tonne of dry cargo and in 2017-18, DPT handled 310.038 Lakh tonne dry cargo. This huge volume of dry cargo handled at DPT along with high winds in coastal areas causes slight rise in the Ambient Air Quality near coal berth.

Very high volume of dry cargo is being handled (especially coal) at berth no. 7, 8 and 9. Besides handling of coal, thousands of vehicles laded with coal and other dry cargo criss-cross the port/harbour roads causing the rise in suspended particles in the air.

ii. Drinking Water Quality

The results of the current year monitoring suggest that, the drinking water parameters of all the locations (18 at Kandla and 2 at Vadinar Port) were found within the permissible limits as per the BIS 10500 (2012) drinking water specification.

iii. Noise Quality

The day and night time noise quality was found within the permissible limits of the Noise Pollution (regulation and control) rules, 2000. The Day Time and Night Time Average Noise Level (SPL) in all ten locations at Deendayal

Port were within the permissible limits of 75 dBA (for day time) and 70 dBA (for the night time) for an industrial area.

iv. Marine Water Quality

The marine water samples were collected from the harbour area and the creek area and were monitored for 28 different parameters. The mean DO levels of DPT waters ranged from 4.9 mg/L to 6.0 mg/L (mean = 5.6 mg/L), which is normal for marine waters of ports and harbors.

Evaluation of the Phytoplankton and Zooplankton population in DPT harbour area and within the immediate surroundings of the port suggests that the Kandla waters harbours low to moderate diversity and abundance of phytoplankton and zooplanktons.

v. Sewage Treatment Plant

Gopalpuri STP is working properly and overall performance of the existing STP was found satisfactory.

A new STP with improved capacity of 1.5 MLD at Deendayal Port is operational which is working as per the standards of CPCB/GPCB.

At Vadinar Port, sewage water released into septic tank for treatment and then released. Immediate actions should be taken to commission a full fledge STP plant at Vadinar.

7.1. Steps taken by Deendayal Port to improve Environment

- 'Safety Week' is being celebrated in Kandla Port by demonstrating mock drill, firefighting, emergency preparedness, health checkup program etc.
- Regular Safety training and mockdrill are being carried out and awareness is being created by lectures among the workers of the Port.
- Personal Protective Equipments (PPE) like ear plugs, helmets, safety suits, etc are being used during Port Operational work.
- Sewage generated at Port Area as well as in Port colonies is being properly treated through Sewage Treatment Plants at outside Port area at Kandla and Port colony at Gopalpuri. However, DPT is planning to construct a new STP with the latest technology as the existing one is very old.
- Deendayal Port Trust have planted about one lakhs trees in road side dividers, colony areas at Kandla and Gopalpuri, in green belt area of Gandhidham & Adipur Township, Sewage Treatment Plants at Gopalpuri & Kandla and some green belt development plans initiated at different locations in Town ship areas.
- Deendayal Port Trust also carries out Environmental Auditing every year through recognized environmental auditor (Schedule I) of Gujarat Pollution Control Board from the year 2010 .Three Audit Reports for the year 2010, 2011 and 2012 were already submitted to GPCB as per the norms.
- DPT planted Mangroves in an area of 1350 hectares from 2005 to 2019:

Mangrove Plantation Plan carried out in following phases;
1) Year 2005-06 – 20 hectares
2) Year 2008-09 - 50 hectares
3) Year 2010-11 – 100 hectares
4) Year 2011-12 – 200 hectares
5) Year 2012-13 – 300 hectares
6) Year 2013-14- 330 hectares
7) Year 2015-17 - 300 hectares
8) Year 2018-19 - 50 hectares

Total - 1350 hectares

- Water sprinkling on coal is regularly done to prevent coal dust pollution in the port area.
- To control the dust from bulk cargo like fertilizer, coal, sulphur, etc, the Port-users are encouraged to use hopper during discharge from vessels.
- Annual maintenance contracts have been awarded for garbage collection, cleaning of buildings and roads.
- Deendayal Port Trust is maintaining the records for collection and disposal of Solid Wastes generated from Port area, Residential area and Office Buildings.
- Deendayal Port Trust is regularly submitting the Hazardous Waste Statement in From – IV and Form V in environment sheet every financial year to the Gujarat Pollution Control Board, Gandhinagar.
- A report on collection and disposal of the wastes from ships is submitted by the licensees to Deendayal Port and GPCB. A monthly report is given to the DG (Shipping) also.
- All trucks before leaving the storage yards are covered with tarpaulin and not over loaded as well as there is no spillage during transportation.
- Sewage generated at Port area and Port colonies is being properly treated through Sewage Treatment Plants outside Port area at Kandla and Port Colony at Gopalpuri.
- Deendayal Port has engaged CPCB/GPCB authorized agencies for the disposal of Hazardous waste (spent / used oil from ships) as per the Hazardous Wastes (Management and Handling) Rules.
- Pollution under Control (PUC) Certificate is mandatory for vehicles and equipments operating in the Port.
- Deendayal Port has awarded several projects to M/s Gujarat Institute of Desert Ecology (GUIDE), Bhuj relating to monitoring of Marine environment viz;
    - Regular Monitoring of Marine Ecology of Kandla Port Area since 2017-18
    - Creek Bathymetry
    - Analysis of dredging contaminants

- Strategic Regional Impact Assessment Studies
- Assessment and Monitoring of Mangrove Plantation in 1300 Ha area.
- Biodiversity Action Plan for DPT and its surrounding areas

7.1.1. ISO 14001:2015 - Environmental Management System of Deendayal Port Trust

Deendayal port has appointed QMS India Ltd. as for Continual Improvement of ISO 14001:2015 - Environmental Management System with following scope;

- Review of environmental aspect-impacts,
- Review and monitoring of legal requirement
- Review and monitoring of emergency preparedness
- Management review by every six months
- Training of internal auditors and EMC members
- Active participation during external audit.

7.1.2. Green Ports Initiative

Deendayal Port is committed to sustainable development and adequate measures are being taken to maintain the Environmental well-being of the Port and its surrounding environs. Weighing in the environmental perspective for sustained growth, the Ministry of Shipping had started 'Project Green Ports' which will help in making the Major Ports across India cleaner and greener. 'Project Green Ports' will have two verticals - one is 'Green Ports Initiatives' related to environmental issues and second is 'Swachh Bharat Abhiyaan'.

The Green Port Initiatives include twelve initiatives such as preparation and monitoring plan, acquiring equipments required for monitoring environmental pollution, acquiring dust suppression system, setting up of sewage/waste water treatment plants/ garbage disposal plant, setting up Green Cover area, projects for energy generation from renewable energy

sources, completion of shortfalls of Oil Spill Response (OSR) facilities (Tier-I), prohibition of disposal of almost all kind of garbage at sea, improving the quality of harbour wastes etc.

Deendayal port has also appointed GEMI as an Advisor for "Making Deendayal Port a Green Port - Intended Sustainable Development under the Green Port Initiatives.

- Deendayal Port has also signed MoU with Gujarat Forest Department in August 2019 for Green Belt Development in an area of 31.942 Ha of land owned by Deendayal Port Trust. The plantation is being carried out by the Social Forestry division of Kachchh.

8. Suggestions

8.1. Ambient Air Quality

PM_{10} values at Coal storage area, Marine Bhavan, Oil Jetty and Tuna Port were occasionally found above the permissible standards and $PM_{2.5}$ was occasionally found above permissible limits at Coal storage area. (100 µg/m^3 for PM_{10} & 60 µg/m^3 for $PM_{2.5}$). The principle reason for higher PM_{10} values at Coal Storage and Marine Bhavan are bulk handling of coal, other dry cargo and heavy traffic of transport vehicles.

8.1.1. Sprinkling

- Heavy duty Water sprinklers should be used inside port where large scale dry cargo is handled.
- Mobile air Sprinklers should also be procured, which suppresses the fine dust from blowing during handling of dry cargo.

8.1.2. Enclosed conveyors

- Port users should be motivated to use enclosed conveyors which prevents secondary dust emissions due to wind in the port area.

8.1.3. Mechanized handling systems

- This involves using screw type unloaders which results in much less spillage and loss of material as compared to bucket unloaders. Mechanized systems can also use pre-packed containers for ease and pollution free loading unloading. Diligent use of various systems can keep the pollution due to ports at minimum level.

Besides these prevention measures, Gujarat Pollution Control Board (GPCB) has also issued guidelines for handling of Coal. Guidelines for Coal Transport, Storage and Handling given below should be strictly followed; (*https://gpcb.gujarat.gov.in/uploads/coal-handling-guidelines1.pdf)*

8.2. GPCB Guidelines for Coal handling units:

(A) Location criteria

- In case of coal handling activities at the ports and jetties or extension thereof, the distance and land use criteria may be relaxed and compensated by advanced/sophisticated pollution control measures and mechanization & thick plantation, however all such ports and jetties, where coal handling is carried out, shall provide closed conveyor belt and mechanization for handling of coal

(B) Storage and handling criteria

- Coal handling unit/Agency shall store coal in such a way that coal heap should not be higher than 5 meter and clear distance between two adjoining heaps at G.L. should be 5 meters, so that in case of fire, approach is available.

- There should be mechanized loading/unloading system from the loading /unloading area to the stacking yards and in to the vehicles.

- Coal handling unit/Agency shall take all corrective steps to resolve the issue of air pollution at permitted coal storage/handling area where coal is being stored.

(C) Transport criteria

- Coal handling unit/Agency shall ensure that all trucks before leaving the storage yard shall be showered with water with adequate system, Shall be covered with tarpaulin or any other effective measure/device completely and also that trucks are not over loaded as well as there is no spillage during transportation.

- The vehicle carrying the coal should not be overloaded by raising the height of carriage. Weigh scale shall be provided within the loading area only and port / coal park authority shall ensure that no overloading is done.

- The top of the vehicle should be covered with fixed cover to avoid spillage or dusting of coal.

(D) Pollution prevention criteria

- Coal handling unit/Agency shall provide paved approach with adequate traffic carrying capacity

- Coal handling unit/Agency shall construct compound wall all along periphery of the premises with minimum 9 meters height

- Continuous water sprinkling shall be carried out on the top of the heap at regular intervals to prevent dusting, fire & smoke. To prevent fugitive emission during loading/unloading, fixed pipe network with sufficient water storage and pump shall be installed. Water sprinkling shall be carried out at each and every stage of handling to avoid generation of coal dust or other dust within premises

- Coal handling unit/Agency shall ensure regular sweeping of coal dust from internal and main road and also ensure that there is adequate space for free movement of vehicles.

- The following adequate Air Pollution Control Measures shall be installed and to be operated efficiently.

- Dust containment cum suppression system for the coal stack, loading and unloading.

- Construction of effective wind breaking wall suitable to local condition to prevent the suspension of particles from the heaps.

- Construction of metal road & RCC Pucca flooring in the plot area/godown etc.

- System for regular cleaning and wetting of the floor area within the premises.

- Entire coal storage area/godown should be covered with permanent weather shed roofing and side walls i.e., in closed shed, in case of crushing/sieving/grading activity is carried out (i.e. G. I. Sheet) along with adequate additional APCM should be installed.

- Coal handling unit/Agency shall carryout three rows plantation with tall growing tress all along the periphery of the coal handling premises, inside & outside of the premises along with road.

- Proper drainage system shall be provided in all coal storage area so that water drained from sprinkling & runoff is collected at a common tank and can be reused after screening through the coal slit or any other effective treatment system.

- All the engineering control measures and state of art technology including covered conveyer belts, mechanized loading and unloading, provision of silo etc. shall be provided in addition to the measures recommended in the environmental guidelines for curbing the pollution.

(E) Safety requirement

- Coal handling unit/Agency shall provide adequate fire-fighting measure to avoid any fire or related hazards including adequate water storage facility, and the premises shall be exclusively used for storage of the coal.

- An onsite emergency plan shall be prepared and implemented by coal handling unit.

(F) Legal criteria

- Necessary permission from all the applicable regulatory authorities and adequate steps under the provisions of applicable environmental acts/ rules shall be taken.

- Coal handling unit/Agency shall prepare EMP (Environment Management Plan) and implement the same in true spirit and thus maintain overall environment of that area.

- Coal handling unit/Agency shall not carry out the operation of loading/unloading of coal/coal dust at any place, till adequate air pollution control equipment for dust control/suppression are installed and efficiently operated and the consent under the provisions of Air (Prevention & Control of Pollution) Act, 1981 is obtained by the coal

yard owners/ Coal handling unit/Agency / coal importers.

- Coal handling unit/Agency shall operate continuous Ambient Air Quality Monitoring Stations as per CPCB guideline.
- In case of port which provides the facility to individual developers an agreement/MoU shall be made between port authority and developer for curtailment of pollution. Port authority shall be responsible for supervising and controlling the pollution control related activities and implementation of the environmental guidelines.

8.3. Sewage Treatment Plant at Vadinar

- At Vadinar, the sewage waste water from the colony is drained into septic tank and later, is released for plantation/gardening. Till the new STP is commissioned; operation of the existing unit should be maintained.

ANNEXURE- I-A

Ambient Air Quality Standards (NAAQS)

Pollutants	Time weighted average	Concentration in Ambient air µg/m³		
		Industrial Areas	Resi. rural & other areas	Sensitive Areas
Suspended Particulate Matter (SPM)	Annual Average*	360	140	70
	24 hours**	500	200	100
Respirable Particulate Matter (size >10 mm) (RPM)	Annual Average*	120	60	50
	24 hours**	150	100	75
Carbon Monoxide (CO)	8 hours**	5.0	2.0 mg/ m^3	1.0 mg/
	1 hour	10.0 mg/ m^3	4.0 mg/ m^3	2.0 mg/ m^3

- Annual arithmetic mean of minimum of 104 measurements in a year taken twice a week. 24 hourly at uniform interval
- 24 hourly / 8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days

Note:

- National Ambient Air Quality Standard: The levels of air quality with an adequate margin of safety, to protect the public health, vegetation and property.
- Wherever and whenever two consecutive values exceeds the limit specified above for the respective category, it would be considered adequate reason to institute regular/continuous monitoring and further investigations.
- The State Government / State Board shall notify the sensitive and other

areas in the respective states within a period of six months from the date of Notification of National Ambient Air Quality Standards.

[{S.O. 384 (E), Air (Prevention & Cont. of Pollution) Act, 1981 dated April 11, 1994]

ANNEXURE- I-B

Drinking Water Standards (BIS)

Sr. No.	Parameter	Unit	Acceptable Limits	Permissible Limits
1	pH	pH Unit	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	500	2000
3	Turbidity	NTU	1.0	5.0
4	Odor	-	Agreeable	Agreeable
5	Color	Hazen Units	5.0	15.0
6	Conductivity	µs/cm	NS*	NS*
7	Dissolved Oxygen	mg/l	NS*	NS*
8	Biochemical Oxygen Demand	mg/l	NS*	NS*
9	Chloride as Cl	mg/l	250.0	1000.0
10	Ca as Ca	mg/l	75.0	200.0
11	Mg as Mg	mg/l	30.0	100.0
12	Total Hardness	mg/l	200.0	600.0
13	Iron as Fe	mg/l	0.3	1.0
14	Fluorides as F	mg/l	1.0	1.5
15	Sulphate as SO4	mg/l	200.0	400
16	Nitrite as NO2	mg/l	NS*	NS*
17	Nitrate as NO3	mg/l	45.0	100
18	Salinity	%o	NS*	NS*
19	Sodium as Na	mg/l	NS*	NS*
20	Potassium as K	mg/l	NS*	NS*
21	Manganese	mg/l	0.1	0.3
22	Hexavalent Chromium	mg/l	NS*	NS*
23	Copper	mg/l	0.05	1.5
24	Cadmium	mg/l	0.003	0.003
25	Arsenic	mg/l	0.01	0.05
26	Mercury	mg/l	0.001	0.001
27	Lead	mg/l	0.01	0.01
28	Zinc	mg/l	5.0	15.0
29	Bacterial Count	CFU/100ml	Absent	Absent

(BIS specifications (IS 10500-1991)

Bacteriological Standards (for Drinking water)

	Organisms	Requirements
All water intended for drinking		
	(a) E. coli or thermo-tolerant Coliform bacteria	Shall not be detectable in any 100 ml sample
Treated water entering the distribution system		
	a) E. coli or thermo-tolerant Coliform bacteria	Shall not be detectable in any 100 ml sample
	b) Total Coliform bacteria	Shall not be detectable in any 100 ml sample
Treated water in the distribution system		
	a) E. coli or thermo-tolerant Coliform bacteria	Shall not be detectable in any 100 ml sample
	b) Total Coliform bacteria	Shall not be detectable in any 100 ml sample

(BIS specifications (IS 10500-1991)

ANNEXURE- I-C

Noise Quality Standards

Area Code	Category of Area	Limits in dB(A) Leq	
		Day Time	Night Time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

- Day Time is recorded in between 6 a.m. and 9 p.m.
- Night time is recorded in between 9 p.m. to 6 a.m.
- Silence zone is defined as areas up to 100 meters around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by the Competent Authority.
- Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.
- Mixed categories of areas should be declared as one of the four above mentioned categories by the Competent Authority and the corresponding standards shall apply.

[Source: EPA Notification [G.S.R. 1063 (E) dt. 26.12.1989 published in the Gazette No. 643 dt. 26.12.1989.]

ENVIRONMENTAL MONITORING REPORT
FOR
DEENDAYAL PORT TRUST

REPORT NO.	:	DCPL/DPT/20-21/11
Month	:	March 2021
Issue No	:	01
Revision No	:	00
Prepared by	:	DETOX CORPORATION PVT. LTD., SURAT

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Introduction

Monitoring of various environmental aspects of the Deendayal Port is being carried out by Detox Corporation Pvt. Ltd. through collection of samples, analysis of the same, comparing results with respect to the national standards and any other relevant standards by GBCB/CPCB/MoEF&CC to identify non conformities in the Environment of the Deendayal Port. The results shall address the identified impacts and suggest measures to minimize the environmental impact due to various operations at Deendayal Port.

The environmental monitoring is carried out as per the Environment Management and Monitoring Plan submitted by Detox Corporation Pvt. Ltd.

1. Ambient Air Quality Monitoring

As per the Environmental Monitoring Plan of Deendayal Port Trust, Air monitoring was carried out at six identified locations at Deendayal Port and two locations at Vadinar Port.

1.1. Air Quality Monitoring Methodology

Air quality is measured in all the stations, for 24 hour for Total Suspended Particulate Matter (TSPM), PM_{10}, $PM_{2.5}$, SO_2, NO_X, NH_3, Benzene, CO & CO_2. The Air samplers are operated for a period of 24 hours and after a continuous operation of 8 hours of the sampler, the reagents were replaced to obtain 3 samples per day for each parameter namely; SO_2, NO_X and NH_3. The EPM 2000 filter paper and PTFE Membrane bound filter paper are used for a period of 24 hours to obtain one sample each of TSPM, PM_{10} & $PM_{2.5}$.

The AAQ samples are collected twice a week from all the eight locations as per the EMP.

1.2. Results

The Ambient Air Quality (AAQ) monitoring data for six stations, viz. Marine Bhavan, Oil Jetty, Deendayal Port Colony, Gopalpuri Hospital, Tuna Port and Nr. Coal Storage Area for the month of March 2021 are given in Tables 1A to 6B. The AAQ monitoring data for two stations at Vadinar (Vadinar Port Colony & Signal Building) are given in Tables 7A to 8B.

Location 1: Marine Bhavan (AL1)

Table 1A : Results of Air Pollutant Concentration at Marine Bhavan

	Date	TSPM [μg/m^3]	PM10 [μg/m^3]	PM2.5 [μg/m^3]	SO2 [μg/m^3]		NOx [μg/m^3]		NH3 [μg/m^3]	
Sampling Period		**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit		**500 μg/m^3**	**100 μg/m^3**	**60 μg/m^3**		**80 μg/m^3**		**80 μg/m^3**		**400 μg/m^3**
AL1 – 1	03.03.2021	284	188	95	5.71	4.10	6.35	8.89	8.93	8.85
					3.52		9.53		9.96	
					3.08		10.80		7.66	
AL1 – 2	05.03.2021	414	162	60	9.23	9.52	19.05	16.94	9.45	10.98
					10.99		22.23		9.96	
					8.35		9.53		13.53	
AL1 – 3	10.03.2021	667	84	28	12.75	9.38	22.23	20.33	8.93	9.96
					9.67		26.04		9.96	
					5.71		12.70		10.98	
AL1 – 4	12.03.2021	803	166	31	15.39	12.60	17.78	18.42	14.04	13.44
					12.31		17.78		14.55	
					10.11		19.69		11.74	
AL1 – 5	17.03.2021	694	107	13	8.35	9.08	9.53	11.64	9.45	10.98
					10.98		12.07		9.70	
					7.91		13.34		13.79	
AL1 - 6	19.03.2021	424	95	71	8.35	9.08	8.89	14.61	9.45	11.74
					10.98		15.88		9.70	
					7.91		19.05		16.08	
AL1 - 7	24.03.2021	430	125	81	7.91	7.03	19.69	23.50	4.85	4.42
					5.71		24.77		3.83	
					7.47		26.04		4.60	
AL1 – 8	26.03.2021	520	109	66	7.47	7.03	1.91	13.55	6.89	7.40
					5.28		25.41		7.91	
					8.35		13.34		7.40	
Monthly Average		**530**	**130**	**56**		**8.48**		**15.98**		**9.72**
Standard Deviation		**175**	**38**	**29**		**2.48**		**4.77**		**2.81**

* NMHC- Non- Methane Hydrocarbons BDL- Below Detection Limit (Detection Limit – NMHC: 1ppm)

Table 1B : Results of Air Pollutant Concentration at Marine Bhavan					
	Date	**C_6H_6 [µg/m^3]**	**HC**	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**		**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**		**4.0 mg/m^3**	**-**
AL1 – 1	03.03.2021	1.02	BDL	1.65	351
AL1 – 2	05.03.2021	1.18	BDL	1.76	346
AL1 – 3	10.03.2021	1.1	BDL	1.81	371
AL1 – 4	12.03.2021	1.06	BDL	1.64	354
AL1 – 5	17.03.2021	1.09	BDL	1.75	385
AL1 - 6	19.03.2021	1.25	BDL	1.8	380
AL1 - 7	24.03.2021	1.2	BDL	1.1	326
AL1 - 8	26.03.2021	1.1	BDL	1.3	298
Monthly Average		**1.13**	**NA**	**1.60**	**351**
Standard Deviation		**0.08**		**0.26**	**29**

Location 2: Oil Jetty (AL2)

Table 2A : Results of Air Pollutant Concentration at Oil Jetty										
	Date	TSPM [µg/m³]	PM_{10} [µg/m³]	$PM_{2.5}$ [µg/m³]	SO_2 [µg/m³]		NOx [µg/m³]		NH3 [µg/m³]	
Sampling No.		24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit		500 µg/m³	100 µg/m³	60 µg/m³		80 µg/m³		80 µg/m³		400 µg/m³
AL2 -1	03.03.2021	162	72	37	3.52	5.71	6.99	8.26	9.96	7.74
					4.84		15.88		4.34	
					8.79		1.91		8.93	
AL2 -2	05.03.2021	505	94	36	5.28	5.28	9.53	7.83	5.36	9.19
					6.59		6.99		10.72	
					3.96		6.99		11.49	
AL2 -3	10.03.2021	505	94	36	10.99	9.38	24.77	22.23	7.40	8.59
					13.19		17.15		9.45	
					3.96		24.77		8.93	
AL2 -4	12.03.2021	517	81	17	10.99	9.52	13.34	16.30	14.55	16.42
					8.79		18.42		16.08	
					8.79		17.15		18.64	
AL2 – 5	17.03.2021	492	108	84	4.83	5.42	10.80	10.16	9.45	13.44
					5.27		11.43		16.08	
					6.15		8.26		14.81	
AL2 – 6	19.03.2021	461	139	74	7.91	8.06	15.88	10.37	21.19	16.51
					8.35		6.99		15.57	
					7.91		8.26		12.76	
AL2 – 7	24.03.2021	593	93	46	8.83	7.04	18.42	19.48	9.45	7.74
					5.71		16.51		10.47	
					6.59		23.50		3.32	
AL2 -8	26.03.2021	337	144	73	8.35	8.64	5.72	5.93	10.72	6.81
					8.79		4.45		3.32	
					8.79		7.62		6.38	
Monthly Average		**447**	**103**	**50**		**7.38**		**12.57**		**10.81**
Standard Deviation		**135**	**26**	**24**		**1.77**		**5.99**		**4.02**

Table 2B : Results of Air Pollutant Concentration at Oil Jetty					
	Date	C_6H_6 [µg/m^3]	HC	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr		Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3		4.0 mg/m^3	-
AL2 -1	03.03.2021	1.04	BDL	1.8	364
AL2 -2	05.03.2021	1.1	BDL	1.74	375
AL2 -3	10.03.2021	1.29	BDL	1.7	362
AL2 -4	12.03.2021	1.19	BDL	1.69	359
AL2 – 5	17.03.2021	1.01	BDL	1.84	358
AL2 – 6	19.03.2021	1.16	BDL	1.87	376
AL2 -7	24.03.2021	1.2	BDL	1.5	301
AL2 – 8	26.03.2021	1.1	BDL	1.72	322
Monthly Average		**1.14**		**1.73**	**352**
Standard Deviation		**0.09**		**0.11**	**27**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 1ppm)

Location 3: Deendayal Colony – Estate Office (AL-3)

Table 3A : Results of Air Pollutant Concentration at Estate Office										
	Date	TSPM [µg/m³]	PM_{10} [µg/m³]	$PM_{2.5}$ [µg/m³]	SO_2 [µg/m³]		NOx [µg/m³]		NH3 [µg/m³]	
Sampling No.		24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit		500 µg/m³	100 µg/m³	60 µg/m³		80 µg/m³		80 µg/m³		400 µg/m³
AL3 – 1	03.03.2021	119	55	30	3.96	3.08	6.35	11.22	6.38	6.13
					1.32		9.53		6.89	
					3.96		17.78		5.11	
AL3 – 2	05.03.2021	291	96	48	4.84	4.84	24.14	14.40	11.49	11.49
					4.84		8.26		15.32	
					4.84		10.80		7.66	
AL3 – 3	10.03.2021	555	101	36	10.11	6.59	13.34	20.54	1.28	5.36
					5.28		19.69		9.45	
					4.40		28.58		5.36	
AL3 – 4	12.03.2021	467	64	27	9.23	9.67	6.99	8.68	20.68	12.17
					15.39		8.26		2.81	
					4.40		10.80		13.02	
AL3 – 5	17.03.2021	416	76	25	5.71	4.83	19.05	11.86	6.89	6.64
					4.83		6.99		7.15	
					3.96		9.53		5.87	
AL3 – 6	19.03.2021	378	57	28	6.15	6.74	9.53	8.89	6.38	8.76
					8.35		11.43		10.47	
					5.71		5.72		9.45	
AL3 – 7	24.03.2021	172	101	49	5.71	6.01	15.88	16.94	5.36	6.55
					3.96		17.15		6.38	
					8.35		17.78		7.91	
AL3 – 8	26.03.2021	225	173	29	6.15	6.74	18.42	20.75	9.45	7.66
					8.35		31.76		6.13	
					5.71		12.07		7.40	
Monthly Average		**328**	**90**	**34**		**6.06**		**14.16**		**8.09**
Standard Deviation		**152**	**38**	**10**		**1.93**		**4.83**		**2.52**

Table 3B : Results of Air Pollutant Concentration at Deendayal Port Colony					
	Date	C_6H_6 [µg/m^3]	HC	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		**8 hr**		**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**		**4.0 mg/m^3**	**-**
AL3 -1	03.03.2021	1.03	BDL	1.86	360
AL3 -2	05.03.2021	1.2	BDL	1.74	382
AL3 -3	10.03.2021	1.1	BDL	1.81	342
AL3 -4	12.03.2021	1.02	BDL	1.76	345
AL3 – 5	17.03.2021	1.12	BDL	1.66	377
AL3 – 6	19.03.2021	1.23	BDL	1.58	365
AL3 – 7	24.03.2021	1.2	BDL	1.74	352
AL3 – 8	26.03.2021	1.24	BDL	1.62	333
Monthly Average		**1.14**		**1.72**	**357**
Standard Deviation		**0.09**		**0.10**	**17**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 1ppm)

Location 4: Gopalpuri Hospital (AL-4)

Table 4A : Results of Air Pollutant Concentration at Gopalpuri Hospital

	Date	TSPM [µg/m³]	PM₁₀ [µg/m³]	PM₂.₅ [µg/m³]	SO₂ [µg/m³]		NOx [µg/m³]		NH3 [µg/m³]	
Sampling No.		**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit		**500 µg/m³**	**100 µg/m³**	**60 µg/m³**		**80 µg/m³**		**80 µg/m³**		**400 µg/m³**
AL4 -1	03.03.2021	193	44	16	0.88	4.69	6.99	7.20	0.77	2.30
					9.23		7.62		2.81	
					3.96		6.99		3.32	
AL4 -2	05.03.2021	399	94	38	1.32	1.47	13.34	6.78	7.66	5.79
					0.88		5.08		8.93	
					2.20		1.91		0.77	
AL4 -3	10.03.2021	479	98	26	4.84	3.52	6.99	5.08	5.36	3.23
					3.96		4.45		2.30	
					1.76		3.81		2.04	
AL4 -4	12.03.2021	277	130	39	2.20	3.37	6.99	6.56	4.34	3.83
					3.52		7.62		4.60	
					4.40		5.08		2.55	
AL4 – 5	17.03.2021	173	79	26	5.28	5.71	1.91	5.29	4.34	3.23
					5.71		5.72		3.32	
					6.15		8.26		2.04	
AL4 – 6	19.03.2021	159	105	26	4.84	3.96	15.88	14.19	7.91	7.06
					1.32		19.69		6.38	
					5.71		6.99		6.89	
AL4 – 7	24.03.2021	210	125	37	4.84	5.42	15.88	10.37	2.04	2.55
					5.71		9.53		2.55	
					5.71		5.72		3.06	
AL4 – 8	26.03.2021	234	110	26	9.67	8.64	5.72	7.62	4.34	4.42
					8.35		7.62		5.87	
					7.91		9.53		3.06	
Monthly Average		**266**	**98**	**29**		**4.60**		**7.89**		**4.05**
Standard Deviation		**115**	**27**	**8**		**2.11**		**3.02**		**1.64**

Table 4B : Results of Air Pollutant Concentration at Gopalpuri Hospital					
	Date	**C_6H_6 [µg/m^3]**	**HC**	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**		**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**		**4.0 mg/m^3**	**-**
AL4 -1	03.03.2021	1.22	BDL	1.84	386
AL4 -2	05.03.2021	1.06	BDL	1.66	377
AL4 -3	10.03.2021	1.32	BDL	1.72	366
AL4 -4	12.03.2021	1.18	BDL	1.67	367
AL4 – 5	17.03.2021	1.22	BDL	1.7	384
AL4 – 6	19.03.2021	1.02	BDL	1.58	359
AL4 – 7	24.03.2021	1.18	BDL	1.6	333
AL4 – 8	26.03.2021	1.2	BDL	1.55	301
Monthly Average		**1.18**	**NA**	**1.67**	**359**
Standard Deviation		**0.09**		**0.09**	**29**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 1ppm)

Location 5: Coal Storage Area (AL-5)

Table 5A : Results of Air Pollutant Concentration at Coal Storage Area

	Date	TSPM [µg/m³]	PM_{10} [µg/m³]	$PM_{2.5}$ [µg/m³]	SO_2 [µg/m³]		NOx [µg/m³]		NH3 [µg/m³]	
Sampling No.		**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit		**500 µg/m³**	**100 µg/m³**	**60 µg/m³**		**80 µg/m³**		**80 µg/m³**		**400 µg/m³**
AL6 – 1	03.03.2021	337	105	40	10.99	5.13	14.61	13.13	13.53	12.59
					0.88		6.99		11.49	
					3.52		17.78		12.76	
AL6 – 2	05.03.2021	377	197	98	3.96	7.33	19.69	19.27	17.10	13.61
					9.23		17.15		13.53	
					8.79		20.96		10.21	
AL6 – 3	10.03.2021	582	138	44	5.71	6.45	12.07	16.09	6.89	9.45
					6.15		15.88		11.49	
					7.47		20.33		9.96	
AL6 – 4	12.03.2021	162	98	51	12.31	9.82	28.58	27.95	9.45	8.93
					13.19		26.68		9.96	
					3.96		28.58		7.40	
AL6 – 5	17.03.2021	557	180	47	8.35	9.67	18.42	17.36	13.02	16.34
					12.75		22.87		14.30	
					7.91		10.80		21.70	
AL6 – 6	19.03.2021	256	121	87	5.28	5.71	16.51	14.19	13.53	14.38
					5.71		10.16		16.59	
					6.15		15.88		13.02	
AL6 – 7	24.03.2021	593	243	73	9.23	7.47	27.31	27.52	5.36	9.62
					5.71		31.76		9.45	
					7.47		23.50		14.04	
AL6 – 8	26.03.2021	617	225	94	7.03	6.74	5.72	11.22	7.40	10.21
					8.35		12.07		9.45	
					4.84		15.88		13.79	
Monthly Average		435	163	67		7.29		18.34		11.89
Standard Deviation		175	56	24		1.70		6.31		2.73

Table 5B : Results of Air Pollutant Concentration at Coal Storage Area					
	Date	C_6H_6 [µg/m^3]	HC	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr		Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3		4.0 mg/m^3	-
AL6 – 1	03.03.2021	1.02	BDL	1.61	377
AL6 – 2	05.03.2021	1.36	BDL	1.74	386
AL6 – 3	10.03.2021	1.22	BDL	1.82	371
AL6 – 4	12.03.2021	1.12	BDL	1.77	396
AL6 – 5	17.03.2021	1.06	BDL	1.86	366
AL6 – 6	19.03.2021	1.32	BDL	1.59	358
AL6 – 7	24.03.2021	1.22	BDL	1.62	346
AL6 – 8	26.03.2021	1.20	BDL	1.58	322
Monthly Average		**1.19**	**NA**	**1.70**	**365**
Standard Deviation		**0.12**		**0.11**	**23**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 1ppm)

Location 6: Tuna Port (AL-6)

Table 6A : Results of Air Pollutant Concentration at Tuna Port										
	Date	TSPM [µg/m³]	PM_{10} [µg/m³]	$PM_{2.5}$ [µg/m³]	SO_2 [µg/m³]		NOx [µg/m³]		NH3 [µg/m³]	
Sampling No.		24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit		500 µg/m³	100 µg/m³	60 µg/m³		80 µg/m³		80 µg/m³		400 µg/m³
AL5 -1	03.03.2021	84	30	15	11.87	5.13	12.07	13.13	4.86	12.59
					1.32		8.26		7.66	
					4.84		10.80		5.36	
AL5 – 2	05.03.2021	220	87	40	3.96	7.33	12.07	19.27	4.85	13.61
					1.32		8.26		7.40	
					2.20		17.15		7.91	
AL5 – 3	10.03.2021	272	74	45	1.32	6.45	6.99	16.09	5.62	9.45
					3.96		7.61		8.17	
					3.52		8.26		7.91	
AL5 – 4	12.03.2021	137	87	20	5.28	9.82	15.88	27.95	5.62	8.93
					4.40		17.78		5.87	
					3.96		13.34		6.13	
AL5 – 5	17.03.2021	134	104	17	3.08	9.67	8.26	17.36	5.62	16.34
					3.96		8.89		5.87	
					2.64		8.26		10.21	
AL5 – 6	19.03.2021	194	44	13	4.84	5.71	12.07	14.19	16.59	14.38
					3.96		11.42		10.72	
					3.52		10.80		16.59	
AL5 – 7	24.03.2021	162	52	28	2.20	7.47	7.62	27.52	4.85	9.62
					3.96		8.26		4.60	
					1.32		6.99		4.36	
AL5 – 8	26.03.2021	120	64	15	5.71	6.74	6.99	11.22	5.62	10.21
					3.08		12.07		11.49	
					3.96		9.53		7.15	
Monthly Average		165	68	24		7.29		18.34		11.89
Standard Deviation		61	25	12		1.70		6.31		2.73

Table 6B : Results of Air Pollutant Concentration at Tuna Port					
	Date	C_6H_6 [µg/m^3]	HC	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr		Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3		4.0 mg/m^3	-
AL5 -1	03.03.2021	1.34	BDL	1.45	331
AL5 – 2	05.03.2021	1.48	BDL	1.37	364
AL5 – 3	10.03.2021	1.54	BDL	1.63	333
AL5 – 4	12.03.2021	1.32	BDL	1.75	355
AL5 – 5	17.03.2021	1.47	BDL	1.31	371
AL5 – 6	19.03.2021	1.46	BDL	1.27	315
AL5 – 7	24.03.2021	1.52	BDL	1.36	375
AL5 – 8	26.03.2021	1.22	BDL	1.48	329
Monthly Average		**1.42**	**NA**	**1.45**	**347**
Standard Deviation		**0.11**		**0.16**	**22**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 1ppm)

Location 7: Vadinar Colony (Vadinar) (AL-7)

Table 7A : Results of Air Pollutant Concentration at Vadinar Colony											
	Date	TSPM [µg/m^3]	PM_{10} [µg/m^3]	$PM_{2.5}$ [µg/m^3]	SO_2 [µg/m^3]		NOx [µg/m^3]		NH3 [µg/m^3]	
Sampling No.		24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit		500 µg/m^3	100 µg/m^3	60 µg/m^3		80 µg/m^3		80 µg/m^3		400 µg/m^3
AL8 -1	03.03.2021	143	57	27	10.84	12.15	17.03	14.91	11.65	13.78
					14.34		15.12		9.61	
					11.27		12.58		20.08	
AL8 -2	05.03.2021	185	67	37	6.88	11.71	11.94	16.19	11.91	19.90
					14.34		15.76		24.16	
					13.91		20.87		23.63	
AL8 -3	10.03.2021	197	57	41	9.07	10.10	24.64	18.29	11.65	16.67
					9.95		13.85		20.08	
					11.27		16.39		18.29	
AL8 -4	12.03.2021	210	61	44	9.51	11.10	15.12	15.33	11.4	11.06
					13.85		16.39		9.87	
					9.95		14.48		11.91	
AL8 -5	17.03.2021	211	51	38	9.52	8.64	17.03	14.91	18.29	16.93
					9.52		15.12		20.08	
					6.88		12.58		12.42	
AL8 -6	19.03.2021	219	65	49	9.95	10.39	15.75	15.75	36.16	22.54
					12.15		15.12		13.18	
					9.07		16.39		18.29	
AL8 -7	24.03.2021	210	70	36	6.88	8.49	14.48	15.97	12.42	11.23
					9.07		18.30		11.65	
					9.51		15.12		9.61	
AL8 -8	26.03.2021	191	57	35	12.15	10.54	17.05	14.92	11.91	13.22
					9.51		17.03		14.16	
					9.95		10.67		13.6	
Monthly Average		**147**	**79**	**41**		**10.39**		**15.78**		**15.67**
Standard Deviation		**13**	**8**	**7**		**1.32**		**1.13**		**4.11**

Table 7B : Results of Air Pollutant Concentration at Vadinar Colony					
	Date	**C_6H_6 [µg/m^3]**	**HC**	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**		**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**		**4.0 mg/m^3**	**-**
AL1 -1	03.03.2021	1.36	BDL	1.77	364
AL1-2	05.03.2021	1.22	BDL	1.84	388
AL1 -3	10.03.2021	1.06	BDL	1.67	374
AL1-4	12.03.2021	1.14	BDL	1.58	366
AL1 -5	17.03.2021	1.28	BDL	1.48	358
AL1-6	19.03.2021	1.2	BDL	1.67	345
AL1-7	24.03.2021	1.33	BDL	1.77	355
AL1-8	26.03.2021	1.06	BDL	1.65	346
Monthly Average		**1.21**	**NA**	**1.68**	**362.00**
Standard Deviation		**0.11**	**0.00**	**0.12**	**14.39**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 1ppm)

Location 8: Signal Building (Vadinar) (AL-8)

Table 8A : Results of Air Pollutant Concentration at Signal Building										
	Date	TSPM [µg/m³]	PM_{10} [µg/m³]	$PM_{2.5}$ [µg/m³]	SO_2 [µg/m³]		NOx [µg/m³]		NH3 [µg/m³]	
Sampling No.		**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit		**500 µg/m³**	**100 µg/m³**	**60 µg/m³**		**80 µg/m³**		**80 µg/m³**		**400 µg/m³**
AL7 -1	03.03.2021	123	83	39	11.22	10.34	21.53	23.23	14.89	15.74
					8.58		27.89		19.99	
					11.21		20.27		12.33	
AL7 -2	05.03.2021	158	65	32	11.22	10.48	13.28	16.67	12.33	17.61
					9.89		11.37		19.48	
					10.33		25.35		21.02	
AL7 -3	10.03.2021	177	62	41	11.65	10.48	24.07	14.76	18.46	16.50
					8.58		8.83		18.46	
					11.22		11.37		12.59	
AL7 -4	12.03.2021	156	75	36	8.14	9.89	24.07	24.92	19.99	14.80
					11.21		20.90		12.59	
					10.33		29.79		11.82	
AL7 -5	17.03.2021	126	51	31	8.58	10.19	17.09	17.94	11.82	14.20
					11.65		25.35		12.33	
					10.33		11.37		18.46	
AL7 -6	19.03.2021	125	73	43	11.65	10.34	20.27	14.55	18.46	13.01
					8.14		9.47		8.76	
					11.22		13.91		11.82	
AL7 -7	24.03.2021	143	83	41	11.65	11.36	13.28	15.82	19.99	16.93
					11.21		13.28		12.33	
					11.21		20.90		18.46	
AL7 -8	26.03.2021	169	81	31	11.65	11.51	21.53	22.38	11.82	14.20
					14.29		25.35		12.33	
					8.58		20.27		18.46	
Monthly Average		**157**	**73**	**21**		**10.6**		**18.8**		**15.4**
Standard Deviation		**18**	**6**	**5**		**1.5**		**6.1**		**3.7**

Table 8B : Results of Air Pollutant Concentration at Signal Building					
	Date	C_6H_6 [µg/m^3]	HC	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr		Grab Sampling	Grab Sampling
NAAQMS limit	500 µg/m^3	5.0 µg/m^3		4.0 mg/m^3	-
AL1 -1	03.03.2021	1.18	BDL	1.78	333
AL1-2	05.03.2021	1.06	BDL	1.68	345
AL1 -3	10.03.2021	1.16	BDL	1.77	362
AL1-4	12.03.2021	1.28	BDL	1.87	377
AL1 -5	17.03.2021	1.36	BDL	1.85	359
AL1-6	19.03.2021	1.22	BDL	1.74	374
AL1-7	24.03.2021	1.07	BDL	1.62	366
AL1-8	26.03.2021	1.11	BDL	1.44	347
Monthly Average		**1.2**	**NA**	**1.7**	**357.9**
Standard Deviation		**0.1**	**0.0**	**0.1**	**15.2**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 1ppm)

1.4 Observations and Conclusion

During the monitoring period, the overall Ambient Air Quality of the port area was found to be well within the desired levels for various pollutants. However, Near Coal storage area, Marine Bhavan, Oil Jetty PM_{10} values and at Coal storage location, $PM_{2.5}$ were above the permissible standards of CPCB. All other pollutants were recorded well below the prescribed limits.

2. Drinking Water Quality Monitoring

Drinking Water Quality Monitoring was carried out at twenty stations at Kandla, Vadinar & Township Area of Deendayal Port.

Drinking Water Monitoring Methodology

Drinking water samples were collected from 20 locations as prescribed in the tender document. Samples for physico-chemical analysis were collected in 1 liter carboys and samples for Biological parameters were collected in BOD bottles. These samples were then analyzed in laboratory for various drinking water parameters at Kandla Lab/Surat.

The Sampling and Analysis was done as per standard methods and CPCB/GPCB Guidelines. The water samples were analyzed for various parameters, viz. Color , Odor, Turbidity , Conductivity , pH , Chlorides , TDS, Total Hardness, Iron , Sulphate , Salinity, BOD, Na, K, Ca, Mg, F, NO_3, NO_2, Mn, Cr-6, Cu, Cd, As, Hg, Pb, Zn, Bacterial Count (CFU) .

2.1. Results

The Drinking Water Quality monitoring data for 20 stations are given in below from table No. 9 to Table No. 15

Table 9: Drinking Water Quality Monitoring Parameters for Nirman Building 1, P & C building & Main Gate (North) at Kandla

Sr. No.	Parameter	Unit	Nirman Building 1	P & C building	Main Gate North	Acceptable Limits	Permissible Limits
1	pH	pH Unit	7.15	7.25	7.26	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1180	1090	1170	500	2000
3	Turbidity	NTU	0	0	0	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	1940	1945	1950	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/l	467.95	417.84	498.01	250.0	1000.0
9	Ca as Ca	mg/l	100.20	92.18	84.17	75.0	200.0
10	Mg as Mg	mg/l	68.04	63.18	82.62	30.0	100.0
11	Total Hardness	mg/l	530	490	550	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	1.0
13	Fluorides as F	mg/l	0.66	0.61	0.31	1.0	1.5
14	Sulphate as SO4	mg/l	212.4	316.8	301.2	200.0	400
15	Nitrite as NO2	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate as NO3	mg/l	1.97	3.59	1.76	45.0	100
17	Salinity	%o	0.14	1.22	1.17	NS*	NS*
18	Sodium as Na	mg/l	325	289	258	NS*	NS*
19	Potassium as K	mg/l	3.82	4.21	5.01	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 10: Drinking Water Quality Monitoring Parameters for Canteen, West Gate -I & Wharf Area at Kandla

Sr. No.	Parameter	Unit	Canteen	West Gate I	Wharf Area	Acceptable Limits	Permissible Limits
1	pH	pH Unit	7.65	7.17	7.29	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1050	1130	1010	500	2000
3	Turbidity	NTU	0	0	1	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	1940	1900	1904	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	501	<2	NS*	NS*
8	Chloride	mg/l	377.75	447.90	477.97	250.0	1000.0
9	Ca as Ca	mg/l	80.16	100.20	100.20	75.0	200.0
10	Mg as Mg	mg/l	72.90	68.04	58.32	30.0	100.0
11	Total Hardness	mg/l	500	530	490	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	1.0
13	Fluorides	mg/l	0.64	0.66	0.54	1.0	1.5
14	Sulphate	mg/l	318	274.8	382.8	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	4.15	2.60	2.04	45.0	100
17	Salinity	%	1.23	1.17	1.25	NS*	NS*
18	Sodium as Na	mg/l	413	395	354	NS*	NS*
19	Potassium as K	mg/l	3.01	4.11	5.85	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100 ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 11: Drinking Water Quality Monitoring Parameters for Sewa sadan – 3, Workshop I & Custom Building at Kandla

Sr. No.	Parameter	Unit	Sewa Sadan – 3	Workshop	Custom Building	Acceptable Limits	Permissible Limits
1	pH	pH Unit	7.55	7.17	7.19	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1040	1170	1190	500	2000
3	Turbidity	NTU	1	0	1	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorles s	5.0	15.0
6	Conductivity	µs/cm	1940	1904	2770	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	422.85	472.96	382.76	250.0	1000.0
9	Ca as Ca	mg/l	92.18	80.16	76.15	75.0	200.0
10	Mg as Mg	mg/l	58.32	60.75	70.47	30.0	100.0
11	Total Hardness	mg/l	470	450	480	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	1.0
13	Fluorides	mg/l	0.38	0.63	0.23	1.0	1.5
14	Sulphate	mg/l	354	282	390	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	1.97	1.48	2.39	45.0	100
17	Salinity	%0	1.31	1.22	1.13	NS*	NS*
18	Sodium as Na	mg/l	435	410	503	NS*	NS*
19	Potassium as K	mg/l	3.89	4.21	4.82	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100 ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 12: Drinking Water Quality Monitoring Parameters for Port Colony Kandla, Hospital Kandla & A.O. Building at Gandhidham

Sr. No.	Parameter	Unit	Port Colony Kandla	Hospital Kandla	A.O. Building	Acceptable Limits	Permissible Limits
1	pH	pH Unit	7.56	7.51	7.47	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1190	1110	1080	500	2000
3	Turbidity	NTU	0	0	1	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	2220	2160	1839	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	477.97	447.90	442.89	250.0	1000.0
9	Ca as Ca	mg/l	84.17	96.19	76.15	75.0	200.0
10	Mg as Mg	mg/l	70.47	58.32	65.61	30.0	100.0
11	Total Hardness	mg/l	500	480	460	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	1.0
13	Fluorides	mg/l	0.32	0.64	0.48	1.0	1.5
14	Sulphate	mg/l	397.2	393.6	309.6	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	2.89	3.31	3.31	45.0	100
17	Salinity	%0	1.13	1.25	1.26	NS*	NS*
18	Sodium as Na	mg/l	521	333	580	NS*	NS*
19	Potassium as K	mg/l	4.36	3.89	3.83	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100 ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 13: Drinking Water Quality Monitoring Parameters for School Gopalpuri, Guest House & E - Type Quarter at Gopalpuri, Gandhidham

Sr. No.	Parameter	Unit	School Gopalpuri	Guest House	E - Type Quarter	Acceptable Limits	Permissible Limits
1	pH	pH Unit	7.68	7.25	7.62	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	950	950	970	500	2000
3	Turbidity	NTU	2	2	1	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	1660	1840	1630	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	498.01	543.11	498.01	250.0	1000.0
9	Ca as Ca	mg/l	80.16	92.18	80.16	75.0	200.0
10	Mg as Mg	mg/l	63.18	63.18	68.04	30.0	100.0
11	Total Hardness	mg/l	460	490	480	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	1.0
13	Fluorides	mg/l	0.41	0.25	0.48	1.0	1.5
14	Sulphate	mg/l	397.2	393.6	385.2	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	3.87	4.51	3.66	45.0	100
17	Salinity	%0	1.22	1.13	1.16	NS*	NS*
18	Sodium as Na	mg/l	299	342	416	NS*	NS*
19	Potassium as K	mg/l	3.64	4.78	4.29	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 14: Drinking Water Quality Monitoring Parameters for F - Type Quarter, Hospital Gopalpuri & Tuna Port

Sr. No.	Parameter	Unit	F - Type Quarter	Hospital Gopalpuri	Tuna Port	Acceptable Limits	Permissible Limits
1	pH	pH Unit	7.21	7.63	7.38	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1050	1090	680.00	500	2000
3	Turbidity	NTU	0	0	0.00	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Unit	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	1640	1638	1211.00	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	482.98	508.04	365.81	250.0	1000.0
9	Ca as Ca	mg/l	88.18	80.16	76.15	75.0	200.0
10	Mg as Mg	mg/l	65.61	63.18	29.16	30.0	100.0
11	Total Hardness	mg/l	490	460	310.00	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	<0.01	0.3	1.0
13	Fluorides	mg/l	0.41	0.65	0.57	1.0	1.5
14	Sulphate	mg/l	297.6	385.2	58.80	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.1	NS*	NS*
16	Nitrate	mg/l	4.15	4.44	17.46	45.0	100
17	Salinity	%	1.13	1.18	0.66	NS*	NS*
18	Sodium as Na	mg/l	281	302	249.00	NS*	NS*
19	Potassium as K	mg/l	4.51	4.04	4.80	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 15: Drinking Water Quality Monitoring Parameters for Vadinar Jetty & Port Colony at Vadinar

Sr. No.	Parameter	Unit	Vadinar Jetty	Port Colony Vadinar	Acceptable Limits	Permissible Limits
1	pH	pH Unit	7.77	7.58	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	160	189	500	2000
3	Turbidity	NTU	ND	ND	1.0	5.0
4	Odor	-	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	321	377	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	NS*	NS*
8	Chloride	mg/l	120.00	128.00	250.0	1000.0
9	Ca as Ca	mg/l	40.08	48.10	75.0	200.0
10	Mg as Mg	mg/l	27.20	28.62	30.0	100.0
11	Total Hardness	mg/l	220.0	232.0	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	0.3	1.0
13	Fluorides	mg/l	0.20	0.32	1.0	1.5
14	Sulphate	mg/l	66.42	76.22	200.0	400
15	Nitrite	mg/l	<0.1	<0.1	NS*	NS*
16	Nitrate	mg/l	2.42	2.78	45.0	100
17	Salinity	%	0.22	0.23	NS*	NS*
18	Sodium as Na	mg/l	78.0	82.0	NS*	NS*
19	Potassium as K	mg/l	2.2	2.3	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent

*NS: Not Specified

2.2. Results & Discussion

The colour of all drinking water samples was < 5 Hazen unit and odour of the samples was also agreeable. The values of turbidity, Iron as Fe and Ammonia as NH_3-N were observed to be below detection limits of measurement i.e. <0.1 NT, <0.03 mg/L and <0.1 mg/L respectively. Apparently these parameters are not at alarming levels.

Heavy Metals in Drinking Water

In the present study period drinking water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals were well below the permissible limits prescribed by the Indian Standards.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that total Coliform values is observed to be 0.1 to cfu/100 ml. total Coliform and E-Coli values showed that all the drinking water samples were safe from any bacteriological contamination.

2.3. Conclusions

These results are compared with acceptable limits as prescribed in IS 10500:2012 – Drinking Water Specification. It is seen from the analysis data that during the study period the water was safe for human consumption at all drinking water monitoring stations in and around the port.

3. Noise Level Monitoring

Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships. Noise Monitoring was done at 13 stations at Kandla, Vadinar and Township area.

3.1. Method of Monitoring

Sampling was done at all stations for 24 hour period. Data was recorded using automated sound level meter. The intensity of sound was measured in sound pressure level (SPL) and common unit of measurement is decibel (Db).

3.2. Results

Table 16: Noise Monitoring data for ten locations of Deendayal Port and two locations of Vadinar Port

Sr. No.	Location	Day Time Average Noise Level (SPL) in dB(A)	Night Time Average Noise Level (SPL) in dB(A)
	Sampling Time	**6:00 am to 10:00 PM**	**10:00PM to 6:00 AM**
1	Marine Bhavan	63.54	57.07
2	Nirman Building 1	64.22	61.72
3	Tuna Port	54.79	49.93
4	Main Gate North	60.69	58.8
5	West Gate I	66.84	67.7
6	Canteen Area	66.98	61.96
7	Main Road	64.27	57.57
8	ATM Building	67.29	60.98
9	Wharf Area /Jetty Area	68.35	64.16
10	Port & Custom Office	60.71	50.81
	Vadinar Port		
11	Entrance Gate of Vadinar Port	50.56	52.72
12	Nr. Port Colony, Vadinar	53.69	53.84
13	Nr. Vadinar Jetty	53.82	54.02

3.3. Conclusions

Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships.

The Day Time Average Noise Level (SPL) in all ten locations at Deendayal Port ranged from 54.8 dB to 68.3 dB and it was within the permissible limits of 75 dBA for the industrial area for the daytime. The Night Time Average Noise Level (SPL) in all ten locations of Deendayal Port ranged from 49.9 dB to 67.7 dB and it was within the permissible limits of 70 dBA for the industrial area for the night time. The mean day time noise levels at Deendayal Port was 63.8 dB whereas the mean day time noise levels at Vadinar were 52.7 dB.

4. Soil Monitoring

Sampling and analysis of soil samples were undertaken at six locations within the study area (Deendayal Port and Vadinar Port) as a part of EMP. The soil sampling locations are initially decided based on the locations as provided in the tender document of the Deendayal Port.

4.1. Methodology

The soil samples were collected in the month of March 2021. The samples collected from the all locations are homogeneous representative of each location. At random locations were identified at each location and soil was dug from 30 cm below the surface. It was uniformly mixed before homogenizing the soil samples. The samples were filled in polythene bags, labeled in the field with number and site name and sent to laboratory for analysis.

4.2. Results

Table-17: Chemical Characteristics of soil in the study area

Parameter	Unit	Station Name					
		SL1	SL2	SL3	SL4	SL5	SL6
		Tuna Port	IFFCO Plant	Khori Creek	Nakti Creek	KPT Admin Site	KPT Colony
		Near main gate of Port	10 m away from main gate	Sand from creek at low tide		Vadinar	
Texture		Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
pH	-	8.71	7.98	8.75	8.39	8.46	8.82
Electrical Conductivity	µs/cm	10,600.0	28,900.0	8,500.0	13,340.0	585.0	875.0
Moisture	%	21.72	23.97	19.04	22.65	7.16	9.67
Total Organic Carbon	%	1.62	6.29	1.46	1.61	2.53	2.42
Alkalinity	mg/kg	40.04	40.04	60.06	40.04	60.06	60.06
Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloride	mg/kg	1,244.0	2,487.0	1,144.0	1,386.0	280.0	290.0
Sulphate	mg/kg	102.0	204.0	120.0	214.0	330.0	210.0
Phosphorus	mg/kg	31.44	21.25	17.74	35.87	2.83	3.36
Potassium	mg/kg	1,178.0	1,715.0	903.0	743.0	131.0	103.0
Calcium	mg/kg	4,843.0	4,710.0	4,235.0	3,453.0	56.0	94.0
Sodium	mg/kg	501.00	601.00	200.00	501.00	1,303.00	501.00
Copper as Cu	mg/kg	52.2	60.8	40.6	21.2	16.6	17.4
Lead as Pb	mg/kg	5	1	4.2	6.8	ND	ND
Nickel as Ni	mg/kg	33.30	27.52	31.62	22.02	26.42	22.10
Zinc as Zn	mg/kg	56.20	43.20	46	62.00	40.00	36.00
Cadmium as Cd	mg/kg	ND	ND	ND	ND	ND	ND

4.3. Discussion

The soil monitoring locations are coastal soils and exhibits saline soil characteristics, typical of a muddy shore. The soil monitoring of all the locations is of Deendayal and Vadinar Port are all saline in nature. The texture of soil of all locations was Sandy Loam. The mean pH of the soil at all the locations of Kandla was 8.46 pH unit suggesting it to be slightly to medium alkaline.

Heavy Metals in the Soil

Traces of Copper, Lead, Nickel, Zinc and Cadmium were observed in the soil samples collected from all the four locations of Deendayal Port and two locations of Vadinar Port. However, the concentration of these heavy metals was observed to be very less

4.4. Conclusion

The soils of Deendayal Port and Vadinar Port appears to be neutral to basic with varying levels of Chloride, Sulphate, NPK and Calcium. As the nature of soil at different locations are different with respect to its proximity to the sea, the samples showed high degree of variations in their chemical properties.

5. Sewage Treatment Plant Monitoring

This involves safe collection of waste water (spent/used water) from wash areas, bathroom, industrial units, etc., waste from toilets of various buildings and its conveyance to the treatment plant and final disposal in conformity with the requirement and guide lines of State Pollution Control Board and other statutory bodies.

5.1. Methodology for STP Monitoring

To monitor the working efficiency of Sewage Treatment Plant (STP), STP Inlet and Outlet Samples were collected once a week. Locations selected are namely Gopalpuri Township, Deendayal Port and Vadinar. Samples were collected in 1 liter carboys and were analyzed in laboratory for various parameters.

5.2. Results

5.2.1. Deendayal Port STP

Table 18: Sewage Water Monitoring at Kandla STP (1st Week)

	Date of Sampling		5.03.21	
Sr. No.	**Parameter**	**Unit**	**KPT Inlet**	**KPT Outlet**
1	pH	pH Unit	7.61	7.21
2	Total Suspended Solids	mg/l	199.1	23
3	Residual Chlorine	mg/l	<1.0	<0.5
4	Chemical Oxygen Demand	mg/l	272.7	50.5
5	Biochemical Oxygen Demand	mg/l	85.0	11.0
Aeration Tank				
6	MLSS	mg/l	15.0	
7	MLVSS	mg/l	84.0	

Table 19: Sewage Water Monitoring at Kandla STP (2nd Week)

	Date of Sampling		12.03.21	
Sr. No.	**Parameter**	**Unit**	**KPT Inlet**	**KPT Outlet**
1	pH	pH Unit	7.62	7.09
2	Total Suspended Solids	mg/l	123.3	25
3	Residual Chlorine	mg/l	<1.0	<0.5
4	Chemical Oxygen Demand	mg/l	303	91.5
5	Biochemical Oxygen Demand	mg/l	110.0	19.0
Aeration Tank				
6	MLSS	mg/l	26.0	
7	MLVSS	mg/l	60.0	

Table 20: Sewage Water Monitoring at Kandla STP (3rd Week)

	Date of Sampling		19.03.21	
Sr. No.	**Parameter**	**Unit**	**KPT Inlet**	**KPT Outlet**
1	pH	pH Unit	7.51	7.11
2	Total Suspended Solids	mg/l	170.1	27.3
3	Residual Chlorine	mg/l	<1.0	<0.5
4	Chemical Oxygen Demand	mg/l	404.0	45.0
5	Biochemical Oxygen Demand	mg/l	124.0	14.0
Aeration Tank				
6	MLSS	mg/l	22.0	
7	MLVSS	mg/l	86.0	

Table 21: Sewage Water Monitoring at Kandla STP (4th Week)

	Date of Sampling		26.03.21	
Sr. No.	**Parameter**	**Unit**	**KPT Inlet**	**KPT Outlet**
1	pH	pH Unit	7.39	7.09
2	Total Suspended Solids	mg/l	176	28.2
3	Residual Chlorine	mg/l	<1.0	<0.5
4	Chemical Oxygen Demand	mg/l	253	51
5	Biochemical Oxygen Demand	mg/l	86.0	17.0
Aeration Tank				
6	MLSS	mg/l	37.0	
7	MLVSS	mg/l	86.0	

5.2.2. Gopalpuri Colony STP

Table 22: Sewage Water Monitoring at Gopalpuri STP (1st Week)

Date of Sampling			05.03.21	
Sr. No.	**Parameter**	**Unit**	**Gopalpuri Township Inlet**	**Gopalpuri Township Outlet**
1	pH	pH Unit	7.56	7.1
2	Total Suspended Solids	mg/l	245.8	68.9
3	Residual Chlorine	mg/l	<1.0	<1.0
4	Chemical Oxygen Demand	mg/l	101	80.8
5	Biochemical Oxygen Demand	mg/l	28.0	17.0
Aeration Tank				
6	MLSS	mg/l	11.0	
7	MLVSS	mg/l	96.0	

Table 23: Sewage Water Monitoring at Gopalpuri STP (2nd Week)

Date of Sampling			12.03.21	
Sr. No.	Parameter	Unit	Gopalpuri Township Inlet	Gopalpuri Township Outlet
1	pH	pH Unit	7.26	7.1
2	Total Suspended Solids	mg/l	67.1	21.5
3	Residual Chlorine	mg/l	<1.0	<1.0
4	Chemical Oxygen Demand	mg/l	404	151.5
5	Biochemical Oxygen Demand	mg/l	120.0	32.0
Aeration Tank				
6	MLSS	mg/l	18.0	
7	MLVSS	mg/l	82.0	

Table 24: Sewage Water Monitoring at Gopalpuri STP (3rd Week)

Date of Sampling			19.03.21	
Sr. No.	Parameter	Unit	Gopalpuri Township Inlet	Gopalpuri Township Outlet
1	pH	pH Unit	7.62	7.15
2	Total Suspended Solids	mg/l	440	45.2
3	Residual Chlorine	mg/l	<1.0	<1.0
4	Chemical Oxygen Demand	mg/l	404.0	71
5	Biochemical Oxygen Demand	mg/l	126.0	18.0
Aeration Tank				
6	MLSS	mg/l	32.0	
7	MLVSS	mg/l	90.0	

Table 25: Sewage Water Monitoring at Gopalpuri STP (4th Week)

Date of Sampling			26.03.21	
Sr. No.	Parameter	Unit	Gopalpuri Township Inlet	Gopalpuri Township Outlet
1	pH	pH Unit	7.66	7.16
2	Total Suspended Solids	mg/l	126	48.9
3	Residual Chlorine	mg/l	<1.0	<1.0
4	Chemical Oxygen Demand	mg/l	455	111
5	Biochemical Oxygen Demand	mg/l	142.0	36.0
Aeration Tank				
6	MLSS	mg/l	22.0	
7	MLVSS	mg/l	90.0	

5.2.3. Vadinar STP

Table 26: Sewage Water Monitoring at Vadinar STP (1st Week)

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar STP O/L
1	pH	pH unit	7.22	Not Working
2	Total Suspended Solids	mg/l	100	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	70.0	
5	BOD @ 27 °C	mg/l	18.0	

Table 27: Sewage Water Monitoring at Vadinar STP (2ndWeek)

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar STP O/L
1	pH	pH unit	7.58	Not Working
2	Total Suspended Solids	mg/l	80.0	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	58.0	
5	BOD @ 27 °C	mg/l	14.0	

Table 28: Sewage Water Monitoring at Vadinar STP (3rdWeek)

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar STP O/L
1	pH	pH unit	7.16	Not Working
2	Total Suspended Solids	mg/l	96.0	
3	Residual Chlorine	mg/l	<0.1	
4	COD	mg/l	101	
5	BOD @ 27 °C	mg/l	30.0	

Table 29: Sewage Water Monitoring at Vadinar STP (4th Week)

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar STP O/L
1	pH	pH unit	7.32	Not Working
2	Total Suspended Solids	mg/l	62	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	68.0	
5	BOD @ 27 °C	mg/l	20.0	

5.3 Conclusion

The GPCB standards of BOD, TSS and Residual Chlorine are 20 mg/lit, 30 mg/lit & 0.5 mg/lit respectively. The STP at Gopalpuri is working within set standards of GPCB/CPCB. The STP at Vadinar is non-functional and thus, steps should be taken to commission the STP at Vadinar Port.

6. Marine Water Monitoring

The Forty Second Amendment to the Constitution in 1976 underscored the importance of ‘green thinking’. Article 48A enjoins the state to protect and improve the environment and safeguard the forests and wildlife in the country. Further, Article 51A(g) states that the “fundamental duty of every citizen is to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures”.

Policy Statement for Abatement of Pollution (1992) has suggested developing relevant legislation and regulation, fiscal incentives, voluntary agreements and educational programs and information campaigns. It emphasizes the need for integration by incorporating environmental considerations into decision making at all levels by adopting frameworks namely, pollution prevention at source, application of best practicable solution, ensure polluter pays for control of pollution, focus on heavily polluted areas and river stretches and involve public in decision-making. The National Conservation Strategy and Policy Statement on Environment and Development, (1992) aimed at “Integrating environmental concerns with developmental imperatives to meet the challenges by redirecting the thrust of our developmental process so that the basic needs of our people could be fulfilled by making judicious and sustainable use of natural resources.” The priorities mentioned in this policy document include the sustainable use of land and water resources, prevention and control of pollution and preservation of biodiversity.

The National Water Policy, (2002) contains provisions for developing, conserving, sustainable utilizing and managing this important water resources and need to be governed by national perspectives.

6.1. Marine Environment

On national and state levels, we have several policies and regulation like Water (Prevention and Control of Pollution) Act, 1974, to regulate pollution discharges and restore water quality of our aquatic resources including the prescription of monitoring activities. One of the important provisions of the Water Act, 1974, is to maintain and restore the ‘wholesomeness’ of our aquatic resources. Water quality monitoring is one of the first steps required in the rational development and management of water resources. In the field of water quality management, there has been a steady evolution in procedures for designing system to obtain information on the changes of water quality. The monitoring comprises all activities to obtain 'information' with respect to the water system.

6.2. Sampling Stations

The monitoring of marine environment for the study of biological and ecological Parameters was carried out on 12th March, 2021 in in harbour region of KPT, 13th March, 2021 in creeks near by the port and on 15th March 2021 at Vadinar region during Spring tide period of lunar cycle.

The monitoring of marine environment for the study of biological and ecological parameters was repeated again on 19th and 20th March 2021 in harbour regions of KPT and nearby creeks respectively and on 22th March 2021 near Vadinar jetty during Neap tide period corresponding to Last Quarter of lunar cycle.

Plankton samples from sub surface layer was collected both during high tide period and low tide period from four water quality monitoring stations of DPT harbour area and one stations in Nakti creek and one station in Khori creek. Sampling at second sampling station of Nakti creek was possible only during high tide period. The same sampling schedule was repeated during consecutive spring tide and neap tide in same month. Plankton samples from sub surface layer were collected during high tide period and low tide period from monitoring station near Vadinar jetty during spring tide period and neap tide. Collected water samples were processed for estimation of Chlorophyll- a, Pheophytin- a, qualitative &quantitative evaluation of phytoplankton, qualitative &quantitative evaluation zooplanktons (density and their population).

Table 28: Sampling Locations

Offshore monitoring requirement	Number of locations
Offshore Installations	4 in Kandla creek 1 in Nakti creek 1 in Khori creek 1 near Vadinar Jetty 1 near 1st SBM
Total Number of locations	**8**

6.3. Marine Water Quality

Marine water quality of marine waters of Deendayal Port Harbor waters, Khori and Nakti Creeks and two locations of Vadinar are monitored for various physico-chemical parameters during spring and neap tide of each month.

The results of marine water quality and Marine sediments are as below;

Table 29: Marine Water Quality Monitoring Parameters for location near KPT colony

Parameters	Unit	Kandla Creek Near KPT colony (1) 23°0'58"N 70°13'22."E			
		Spring Tide		Neap Tide	
Tide →		High Tide	Low Tide	High Tide	Low Tide
pH	pH unit	7.73	7.51	7.15	7.26
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	32.2	32.6	32.8	32.2
Turbidity	NTU	36.0	31.0	26.0	28.0
Total Dissolved Solids	mg/l	34635.0	39060.0	43469.0	45346.0
Total Suspended Solids	mg/l	523.0	495.0	602.0	479.0
Total Solids	mg/l	35158.0	39555.0	44071.0	45825.0
DO	mg/l	4.9	4.0	5.9	4.3
COD	mg/l	68.0	69.0	72.0	76.0
BOD	mg/l	<2	<2	<2	<2
Silica	mg/l	0.48	0.38	0.43	0.44
Phosphate	mg/l	0.15	0.16	0.27	0.24
Sulphate	mg/l	2352.0	2076.0	2352.0	2196.0
Nitrate	mg/l	8.66	2.60	9.29	3.66
Nitrite	mg/l	<0.1	<0.1	<0.1	<0.1
Calcium	mg/l	721	683	601	521
Magnesium	mg/l	1409	559	1531	1482
Sodium	mg/l	11120.0	11521.0	12820.0	13425.0
Potassium	mg/l	289.0	277.0	320.0	333.0
Iron	mg/l	1.85	1.95	1.77	1.79
Chromium	mg/l	0.11	0.11	0.13	0.12
Copper	mg/l	0.07	0.06	0.07	0.07
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.05	0.06	0.03	0.02
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.17	0.17	0.14	0.16
Zinc	mg/l	0.05	0.06	0.05	0.05

Table 30: Marine Water Quality Monitoring Parameters for location near passenger Jetty One at Kandla

Parameters	Unit	Near passenger Jetty One (2)			
		23° 0'18 "N 70°13'31"E			
		Spring Tide		Neap Tide	
Tide →		High Tide	Low Tide	High Tide	Low Tide
pH	pH unit	7.18	7.35	7.13	7.28
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	32.2	32.8	32.7	33.1
Turbidity	NTU	20.0	30.0	27.0	27.0
Total Dissolved Solids	mg/l	39310.0	42110.0	42189.0	18464.0
Total Suspended Solids	mg/l	608.0	600.0	676.0	685.0
Total Solids	mg/l	39918.0	42710.0	42865.0	19149.0
DO	mg/l	4.6	3.3	5.3	5.4
COD	mg/l	72.0	78.0	62.0	58.0
BOD	mg/l	<2	<2	<2	<2
Silica	mg/l	0.36	0.23	0.45	0.53
Phosphate	mg/l	0.23	0.24	0.24	0.17
Sulphate	mg/l	2652.0	2556.0	2460.0	3156.0
Nitrate	mg/l	4.71	8.52	8.10	4.43
Nitrite	mg/l	<0.1	<0.1	<0.1	<0.1
Calcium	mg/l	403	721	682	561
Magnesium	mg/l	1041	1312	1555	1409
Sodium	mg/l	12111.0	11892.0	12444.0	13058.0
Potassium	mg/l	278.0	268.0	348.0	358.0
Iron	mg/l	1.88	1.91	1.79	1.78
Chromium	mg/l	0.14	0.15	0.10	0.11
Copper	mg/l	0.08	0.09	0.08	0.06
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.05	0.04	0.03	0.03
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.15	0.16	0.15	0.17
Zinc	mg/l	0.06	0.05	0.07	0.05

Table 31: Marine Water Quality Monitoring Parameters for location Near Coal Berth

Parameters	Unit	Near Coal Berth 22°59'12"N 70°13'40"E			
		Spring Tide		Neap Tide	
Tide →		**High Tide**	**Low Tide**	**High Tide**	**Low Tide**
pH	pH unit	7.43	7.19	7.13	7.25
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	31.2	31.6	32.4	31.8
Turbidity	NTU	37.0	40.0	31.0	35.0
Total Dissolved Solids	mg/l	41570.0	37700.0	38554.0	31024.0
Total Suspended Solids	mg/l	605.0	554.0	347.0	315.0
Total Solids	mg/l	42175.0	38254.0	38901.0	31339.0
DO	mg/l	3.9	3.5	5.2	5.3
COD	mg/l	82.0	80.0	82.0	72.0
BOD	mg/l	<2	<2	<2	<2
Silica	mg/l	0.27	0.31	0.38	0.33
Phosphate	mg/l	0.16	0.17	0.16	0.27
Sulphate	mg/l	2616.0	2628.0	2532.0	2220.0
Nitrate	mg/l	10.21	6.68	2.88	4.50
Nitrite	mg/l	<0.1	<0.1	<0.1	<0.1
Calcium	mg/l	681	761	481	601
Magnesium	mg/l	1409	1215	1531	1628
Sodium	mg/l	10585.0	10824.0	11524.0	11442.0
Potassium	mg/l	196.0	188.0	352.0	286.0
Iron	mg/l	1.93	1.95	1.78	2.12
Chromium	mg/l	0.17	0.17	0.12	0.13
Copper	mg/l	0.08	0.08	0.09	0.07
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.05	0.04	0.05	0.05
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.15	0.14	0.15	0.17
Zinc	mg/l	0.08	0.10	0.09	0.07

Table 32: Marine Water Quality Monitoring Parameters for location Khori creek at Kandla

Parameters	Unit	KPT 4			
		Near 15/16 Berth			
		Spring Tide		Neap Tide	
Tide →		**High Tide**	**Low Tide**	**High Tide**	**Low Tide**
pH	pH unit	7.25	7.13	7.18	7.18
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	32.2	32.4	32.6	33.0
Turbidity	NTU	25.0	21.0	30.0	3.0
Total Dissolved Solids	mg/l	37910.0	42270.0	44781.0	4215.0
Total Suspended Solids	mg/l	446.0	443.0	681.0	600.0
Total Solids	mg/l	38356.0	42713.0	45462.0	4815.0
DO	mg/l	3.4	3.3	5.2	5.0
COD	mg/l	79.0	96.0	59.0	62.0
BOD	mg/l	<2	<2	<2	<2
Silica	mg/l	0.42	0.51	0.35	0.51
Phosphate	mg/l	0.20	0.24	0.38	0.28
Sulphate	mg/l	2556.0	2736.0	2844.0	3156.0
Nitrate	mg/l	10.42	11.12	2.46	9.08
Nitrite	mg/l	<0.1	<0.1	<0.1	<0.1
Calcium	mg/l	882	761	641	521
Magnesium	mg/l	1045	1191	1482	1458
Sodium	mg/l	10528.0	10052.0	10152.0	10782.0
Potassium	mg/l	196.0	199.0	248.0	253.0
Iron	mg/l	2.28	2.20	2.34	2.22
Chromium	mg/l	0.18	0.14	0.17	0.16
Copper	mg/l	0.07	0.07	0.08	0.10
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.07	0.05	0.06	0.06
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.17	0.18	0.19	0.19
Zinc	mg/l	0.12	0.07	0.07	0.07

Table 33: Marine Water Quality Monitoring Parameters for location Nakti Creek near Tuna Port

Parameters	Unit	Nakti Creek Near Tuna Port 22°57'49."N 70° 7'0.67"E			
		Spring Tide		Neap Tide	
Tide →		High Tide	Low Tide	High Tide	Low Tide
pH	pH unit	7.54	8.11	7.25	7.10
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	31.8	33.0	32.8	33.1
Turbidity	NTU	29.0	27.0	37.0	30.0
Total Dissolved Solids	mg/l	37820.0	41420.0	40683.0	40589.0
Total Suspended Solids	mg/l	571.0	618.0	685.0	566.0
Total Solids	mg/l	38391.0	42038.0	41368.0	41155.0
DO	mg/l	4.1	3.3	5.7	6.0
COD	mg/l	88.0	106.0	72.0	78.0
BOD	mg/l	<2	<2	<2	<2
Silica	mg/l	0.44	0.42	0.42	0.49
Phosphate	mg/l	0.23	0.24	0.23	0.15
Sulphate	mg/l	2088.0	2316.0	2556.0	2628.0
Nitrate	mg/l	10.84	10.06	4.07	8.16
Nitrite	mg/l	<0.1	<0.1	<0.1	<0.1
Calcium	mg/l	1082	922	481	561
Magnesium	mg/l	778	1482	1531	1555
Sodium	mg/l	11852.0	12125.0	14452.0	14625.0
Potassium	mg/l	296.0	325.0	382.0	368.0
Iron	mg/l	2.25	2.24	2.26	2.26
Chromium	mg/l	0.21	0.21	0.15	0.18
Copper	mg/l	0.09	0.10	0.11	0.11
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.06	0.06	0.05	0.06
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.17	0.21	0.21	0.18
Zinc	mg/l	0.07	0.08	0.09	0.07

Table 34: Marine Water Quality Monitoring Parameters for location Nakti Creek Near NH-8A at Kandla

Parameters	Unit	Nakti Creek Near NH-8A 23° 02'01"N 70° 09'31"E			
		Spring Tide		Neap Tide	
Tide →		High Tide	Low Tide	High Tide	Low Tide
pH	pH unit	7.57	Sampling not possible during Low Tide	7.11	Sampling not possible during Low Tide
Color	-	Colorless		Colorless	
Odor	-	Odorless		Odorless	
Salinity	ppt	33.5		32.8	
Turbidity	NTU	38.0		19.0	
Total Dissolved Solids	mg/l	42002.0		27530.0	
Total Suspended Solids	mg/l	1330.0		362.0	
Total Solids	mg/l	43332.0		27892.0	
DO	mg/l	4.0		5.8	
COD	mg/l	108.0		80.0	
BOD	mg/l	<2		<2	
Silica	mg/l	0.38		0.49	
Phosphate	mg/l	0.28		0.23	
Sulphate	mg/l	2208.0		2724.0	
Nitrate	mg/l	11.75		8.02	
Nitrite	mg/l	<0.1		<0.1	
Calcium	mg/l	681		601	
Magnesium	mg/l	1312		1361	
Sodium	mg/l	13252.0		14852.0	
Potassium	mg/l	352.0		377.0	
Iron	mg/l	2.26		2.27	
Chromium	mg/l	0.23		0.20	
Copper	mg/l	0.10		0.10	
Arsenic	mg/l	<0.01		<0.01	
Cadmium	mg/l	0.07		0.05	
Mercury	mg/l	<0.001		<0.001	
Lead	mg/l	0.22		0.22	
Zinc	mg/l	0.11		0.11	

Table 35: Marine Water Quality Monitoring Parameters for locations Nr. Vadinar Jetty

Parameters	Unit	Nr. Vadinar Jetty 22°26'25.26"N 69°40'20.41"E			
		Spring Tide		Neap Tide	
Tide →		High Tide	Low Tide	High Tide	Low Tide
pH	pH unit	7.58	7.38	7.26	7.21
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	32.8	30.6	33.2	33.0
Turbidity	NTU	36.0	22.0	23.0	27.0
Total Dissolved Solids	mg/l	39310.0	83696.0	41820.0	32961.0
Total Suspended Solids	mg/l	580.0	50.0	352.0	35.0
Total Solids	mg/l	39890.0	83746.0	42172.0	32996
DO	mg/l	5.4	6.2	5.6	6.1
COD	mg/l	78.0	42.0	62.0	43.0
BOD	mg/l	<2	<2	<2	<2
Silica	mg/l	0.42	1.86	0.58	0.75
Phosphate	mg/l	0.23	0.05	0.23	0.15
Sulphate	mg/l	2610.0	2304.0	3621.0	2436.0
Nitrate	mg/l	4.71	2.46	4.82	1.76
Nitrite	mg/l	<0.1	<0.1	<0.1	<0.1
Calcium	mg/l	683	401	561	441
Magnesium	mg/l	1386	1531	1409	1312
Sodium	mg/l	13111.0	14975.0	13452.0	15750.0
Potassium	mg/l	292.0	628.0	362.0	702.0
Iron	mg/l	2.25	1.76	2.22	1.44
Chromium	mg/l	0.18	0.11	0.15	0.14
Copper	mg/l	0.10	0.06	0.11	0.08
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.07	<0.001	0.06	<0.001
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.12	0.07	0.18	0.10
Zinc	mg/l	0.08	0.09	0.08	0.05

Trace Metals

In the present study period water samples contained traces of Cr (mean=0.14 mg/L), Cu (mean=0.14 mg/L), Pb (mean = 0.21 mg/L), Cd, As, Hg, and Zn (mean = 0.07 mg/L). All these heavy metals reported were below trace levels.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that total Coliform values is observed to be 0.1 to cfu/100 ml.

6.4. Marine Sediments

Sediment samples were collected with Van Veen Grab from the six locations in Deendayal Port Waters and two locations in Vadinar Port. Samples were collected and preserved in silver foil in ice box to prevent the contamination/decaying of the samples.

The Sediment Quality results are given in below from table no. 35A & table no. 35B

Table 35A: Results of analysis of sediment of Kandla & Vadinar Port (Neap Tide)

Sr. No.	Parameters	Unit	KPT -1 (HT)	KPT -1 (LT)	KPT - 2 (HT)	KPT 2 LT	KPT -3 (LT)	KPT4 (LT)	Natki - 1 (LT)	Jetty (HT)
1	Texture		Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	%	0.74	0.64	1.88	0.89	1.20	0.96	0.65	1.02
3	Organic Carbon	%	0.37	0.40	0.63	0.90	1.26	1.06	0.86	1.12
4	Inorganic Phosphate	mg/kg	126.0	120.0	111.0	126.0	128.0	189.0	166.0	126.0
5	Moisture	%	16.22	16.50	17.62	16.42	19.20	14.52	17.48	20.32
6	Aluminum	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	32.0	26.0	26.2	22.0	28.0	38.0	39.5	32.0
8	Phosphate	mg/kg	6.66	7.25	3.52	8.62	7.26	6.52	7.06	9.20
9	Sulphate	mg/kg	138.0	136.0	158.0	162.0	111.0	162.0	112.0	136.0
10	Nitrite	mg/kg	0.1	0.11	0.11	0.12	0.1	0.11	0.12	0.11
11	Nitrate	mg/kg	6.62	9.26	7.66	8.68	9.02	10.02	10.33	6.52
12	Calcium	mg/kg	356.0	348.0	296.0	301.0	312.0	396.0	389.0	401.0
13	Magnesium	mg/kg	166.0	156.0	122.0	142.0	178.0	122.0	215.0	252.0
14	Sodium	mg/kg	6365.0	6665.0	7156.0	7242.0	8925.0	8778.0	9678.0	9789.0
15	Potassium	mg/kg	1282.0	1268.0	488.0	495.0	589.0	788.0	898.0	760.0
16	Chromium	mg/kg	8.54	9.54	12.35	10.06	9.55	10.51	9.55	12.65
17	Nickel	mg/kg	10.04	11.56	12.55	11.63	10.51	12.4	15.64	16.24
18	Copper	mg/kg	11.26	10.67	12.6	14.27	15.39	16.26	14.56	15.36
19	Zinc	mg/kg	28.64	30.21	35.06	30.00	34.64	38.46	37.05	40.21
20	Cadmium	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND
21	Lead	mg/kg	19.27	20.35	19.33	25.23	24.28	26.78	27.28	28.67
22	Mercury	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND

Table 35B: Results of Analysis of Sediment of Kandla & Vadinar Port (Spring Tide)

Sr. No.	Parameters	Unit	KPT - 1 (HT)	KPT - 1 (LT)	KPT - 2 (HT)	KPT - 2 (LT)	KPT - 3 (HT)	KPT - 3 (LT)	KPT - 4 (HT)	KPT - 4 (LT)	Natki - 1 (HT)	Natki - 1 (LT)
1	Texture		Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	%	0.66	0.53	0.66	1.08	0.96	1.26	0.96	0.82	0.62	0.62
3	Organic Carbon	%	0.36	0.42	0.52	0.69	0.85	1.06	0.88	0.72	0.52	0.50
4	Inorganic Phosphate	mg/kg	152.0	142.0	126.0	130.0	136.0	133.0	196.0	188.0	126.0	162.0
5	Moisture	%	12.82	14.62	16.22	18.52	19.62	20.25	20.12	20.25	18.62	22.22
6	Aluminum	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	12.82	16.32	14.36	16.28	20.2	12.5	18.2	16.3	22.80	26.20
8	Phosphate	mg/kg	16.2	15.55	17.6	16.2	16.50	19.04	18.62	17.02	16.88	16.62
9	Sulphate	mg/kg	288.0	296.0	302.0	289.0	312.0	311.0	325.0	320.0	379.0	406.0
10	Nitrite	mg/kg	0.11	0.10	0.11	0.12	0.1	0.11	0.12	0.13	0.11	0.14
11	Nitrate	mg/kg	11.2	11.02	10.6	10.42	9.45	10.02	11.26	11.06	12.68	12.7
12	Calcium	mg/kg	306.0	312.0	289.0	299.0	262.0	272.0	320.0	310.0	345.0	340.0
13	Magnesium	mg/kg	113.0	120.0	101.0	100.0	126.0	120.0	115.0	106.0	132.0	128.0
14	Sodium	mg/kg	11282.0	11352.0	12452.0	12600.0	11025.0	11068.0	10282.0	10189.0	9282.0	9665.0
15	Potassium	mg/kg	400.0	428.0	389.0	388.0	325.0	289.0	378.0	486.0	485.0	385.0
16	Chromium	mg/kg	14.21	10.06	9.54	15.22	19.21	8.15	9.56	10.85	17.68	15.63
17	Nickel	mg/kg	11.36	12.34	9.58	10.89	11.35	12.39	14.67	15.69	16.64	15.66
18	Copper	mg/kg	15.24	16.25	13.36	10.89	16.25	18.24	10.02	11.35	19.31	18.74
19	Zinc	mg/kg	35.64	34.68	38.52	30.63	28.63	45.56	42.64	52.51	43.58	45.62
20	Cadmium	mg/kg	ND	ND	ND	ND	1.71	1.39	ND	ND	1.22	1.35
21	Lead	mg/kg	17.34	18.66	16.24	23.54	18.3	17.33	15.02	14	16.31	14.06
22	Mercury	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

6.5. Sampling Methodology (Biological Monitoring of Marine Waters)

A marine sampling is an estimation of the body of information in the population. The theory of the sampling design depends upon the underlying frequency distribution of the population of interest. Water sampling is carried out to collect a representative sample of suitable volume from the specified depth and retain it free from contamination during retrieval.

Sampling was conducted from sub surface layer in high tide period and low tide period of the tide from all sampling stations during consecutive spring tide and neap tide.

Net sampling for qualitative evaluation of mixed plankton was conducted only once during between Maximum High water and Slack water and Maximum low water and Slack water).

Sediment sampling for qualitative and quantitative evaluation of benthic organisms was conducted only once during one tidal cycle during Maximum low water and Slack water.

The collected samples were first collected in a clean bucket to reduce the heterogeneity. From the collected water sample 1 liter of water sample were taken in an opaque plastic bottle for chlorophyll estimation. Quantitative Plankton samples were collected by filtering rest of the water sample using plankton net of 20µm mesh size.

Methodology adopted for Plankton sampling

Mixed plankton sample for qualitative evaluation were obtained from the sub surface layer, at each sampling locations by towing the net horizontally with the weight during highest high tide and slack period. And lowest low tide and slack period .After the tow of about 15-20 minutes at speed of 1-1.5 m/s, plankton net was pulled up and washed down to the tail and collected the plankton adhered to plankton net in the collection bucket at the bottom by springing outer and inner surface of the net with sea water, while the net was hanging with the mouth upward. As already mentioned for quantitative evaluation 50 L sample each was collected from the sub surface during high tide and low tide period were filtered through 20µm mesh size net assembly.

Methodology adopted for Benthic fauna sampling

Van veen sampler (0.1 m^2) was used for sampling bottom sediments during lowest low tide. Two sets of sediments were sampled from each location, the macro fauna in the sediments were sieved on board to separate out the organisms. The fixation of benthic fauna is normally done by bulk fixation of the sediment sample. The bulk fixation is done by using 10% formalin (Buffered with borate) with Rose Bengal as stain. The organisms were preserved with seawater as diluting agent.

Samples Processing for Chlorophyll Estimation

Samples for the chlorophyll estimation were preserved in ice box on board in darkness to avoid degradation in opaque container covered with aluminum foil. Immediately after reaching the shore after sampling, 1 litter of collected water sample was filtered through GF/F filters (pore size 0.45 µm) by using vacuum filtration assembly. After vacuum filtration the glass micro fiber filter paper was grunted in tissue grinder, macerating of glass fiber filter paper along with the filtrate was done in 90% aqueous Acetone in the glass tissue grinder with glass grinding tube. Glass fiber filter paper will assist breaking the cell during grinding and chlorophyll content was extracted with 10 ml of 90% Acetone, under cold dark conditions along with saturated magnesium carbonate solution in glass screw cap tubes. After an extraction period of 24 hours, the samples were transferred to calibrated centrifuge tubes and adjusted the volume to original volume with 90% aqueous acetone solution to make up the evaporation loss. The extract was clarified by using centrifuge in closed tubes. The clarified extracts were then decanted in clean cuvette and optical density was observed at wavelength 630, 664, 665 nm. By using corrected optical density, Chlorophyll-a value was calculated as given in (APHA, 1998). The extract of pigments was then measured by spectrophotometer at wavelength of 750 nm and 664 nm before acidification and at 665 nm after acidification by 0.1ml of 0.1N HCl.

Samples Processing for Plankton

The entire area open water in the sea is the pelagic realm. Pelagic organisms live in the open sea. In contrast to the pelagic realm, the benthic realm comprises organisms and zone of the bottom of the sea. Vertically the pelagic realm can be dividing into two zones based on light penetration; upper photic or euphotic zone and lower dark water mass, aphotic zone below the photic zone.

The term plankton is general term for organisms have such limited powers of locomotion that they are at the mercy of the prevailing water movement. Plankton is subdivided to phytoplankton and zooplankton. Phytoplankton is free floating organisms that are capable of photosynthesis and zooplankton is the various free floating animals.

Phytoplankton

The phytoplankton includes a wide range of photosynthetic and phototrophic organisms. Marine phytoplankton is mostly microscopic and unicellular floating flora, which are the primary producers that support the pelagic food-chain. The two most prominent groups of phytoplankton are diatoms (Bacillariophyceae) and dinoflagellates (Dinophyceae).

Zooplankton

Zooplankton can be subdivided into holoplankton, i.e., permanent members of the plankton (e.g., Calanoid copepods), and meroplankton, i.e., temporary members in the plankton e.g., larvae of fish, shrimp, and crab). The meroplankton group consists of larval and young stages of animals that will adopt a different lifestyle once they mature. In contrast to phytoplankton which consist of a relatively smaller variety of organisms, Zooplankton are extremely divers, consist of a host of larval and adult forms representing many animal phylum.

Among the zooplankton two group always dominate than others; they are the members of sub class copepods (Phylum Athropoda), and Tintinids(Phylum Protozoa) among the net planktons. These small animals are of vital importance in marine ecosystem as one of the primary herbivores animals in the sea, and it is they provide vital link between primary producer (autotrophs) and numerous small and large marine consumers.

Preservation and storage

Both filtered plankton and those collected from the plankton net were preserved with 5% buffered formalin and stored in 1L plastic container for further processing in the laboratory.

Sample concentration

The collected plankton samples were concentrated by using centrifuge and made up to 50 ml with 5% formalin -Glycerin mixture.

Taxonomic evaluation

Before processing, the sample was mixed carefully and a subsample was taken with a calibrated Stempel-pipette. 1 ml of the concentrated plankton samples were transferred on a glass slide with automatic pipette. The plankton sample on the glass slides were stained by using Lugol's iodine and added glycerin to avoid drying while observation. The plankton samples were identified by using Labex triangular Research microscope with photographic attachment. Microphotographs of the plankton samples were taken for record as well as for confirming the identification. The bigger sized zooplankton was observed through dissecting stereomicroscope with magnification of 20-30 x. Plankton organisms in the whole slide were identified to the lowest taxon possible. A thorough literature search was conducted for the identification of the different groups of zooplankton that were encountered.

Cell counts by drop count method

The common glass slide mounted with a 1ml of concentrated phytoplankton/ zooplankton sample in glycerol and covered with cover slip 22x 60mm was placed under the compound microscope provided with a mechanical stage. The plankton was then counted from the microscopic field of the left top corner of the slide. Then slide is moved horizontally along the right side and plankton in each microscopic field was thus counted. When first microscopic field row was finished the next consecutive row was adjusted using the mechanical device of the stage. In this way all the plankton present in entire microscopic field are counted.

From this total number in 1ml of the concentrated plankton, total number of plankton in the original volume of sample filtered was calculated as units/L

Samples Processing for Benthic Organisms

Benthos is those organisms that are associated with the sea bed or benthic habitats. Epibenthic organisms live attached to a hard substratum or rooted to a shallow depth below the surface. In fauna organisms live below the sediment–water interface. Interstitial organisms live and move in pore water among sedimentary grains.

Because the benthic organisms are often collected and separated on sieves, a classification based on the overall size is used. Macro benthos include organisms whose shortest dimension is greater than or equal to 0.5 mm. Meio benthos are smaller than 0.5mm but larger than 42µ in size.

The terms such as macro fauna and Meio fauna generally have little relevance with taxonomic classification. The terms Meio fauna and macro fauna depend on the size. Meio fauna were considered as good bioassay of community health and rather sensitive indicators of environmental changes

Sample sieving

Sediments samples were sieved to extract the organisms. Sieving was performed carefully as possible to avoid any damage to the animals. The large portion of the sediment was split in to smaller portions and mixed with sea water in a bucket. The cohesive lumps were broken down by continuous stirring. The disaggregated sediments were then passed through the sieves.

Sample staining

Sorting of the Meio fauna from the sieve is difficult task especially in the preserved material, because organisms are not easily detectable. To facilitate the animal detection the entire sample retained on the sieve after sieving operation were stained by immersing the sieve in a flat bottom tub with 1% Rose Bangal stain; a protein stain. A staining period of 10-30 minutes is sufficient for sample detection.

6.6. Results

Chlorophyll-A & Pheophytin-A

Water Samples for the chlorophyll estimation were collected from sub surface layer during high tide and low tide period of the tidal cycle for each sampling locations and analysed for Chlorophyll -a and after acidification for Pheophytin –a. Chlorophyll- a value was used as algal biomass indicator (APHA 1998) Algal biomass was estimated by converting Chlorophyll value.

In the sub surface water chlorophyll-a was varying from 0.512-834 mg/m3.in harbour region of KPT during sampling done in Neap tide period of March,2021. In the nearby creeks chlorophyll-a was varying from 0.850 1.071 mg/m3.While chlorophyll-a was varying 0.426-0.938 mg/m3.in harbour region of KPT during sampling done in spring period of March, 2021 and in the sampling stations creeks chlorophyll-a was varying from 0.613-1.189 mg/m3.Pheophytin –a level was below detectable limit in the all the sampling stations during spring tide and neap tide.

In the sub surface water chlorophyll-a was varying from 0.732-0.629 mg/m3 between high tide and low tide at Vadinar jetty during sampling done during Neap tide period. While chlorophyll was detected at the jetty region during spring tide period was 0.967 -0.835 mg/m3 during low tide and high tide respectively 0.629 mg/m3 chlorophyll-a was detected in the sampling dine during the high tide period at SBM during Neap tide period 0.732 mg/m^3 chlorophyll-a was detected in the sampling dine during the high tide period at SBM during Spring tide period

Table 36: variations in productivity from sampling stations in KPT harbour area near by creeks and Vadinar area during Neap tide

Sr. No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin-a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
KPTHARBOUR AREA					
1	KPT1	High tide	0.629	BDL	42.14
		Low tide	0.526	BDL	35.24
2	KPT 2	High tide	0.512	BDL	34.30
		Low tide	0.527	BDL	35.31
3	KPT 3	High tide	0.834	BDL	55.88
		Low tide	0.732	BDL	49.04

	KPT-4	High tide	1.071	BDL	71.75
		Low tide	0.937	BDL	62.78
CREEKS					
5	KPT-5 Nakti-I	High tide	0.850	BDL	56.95
		Low tide	0.834	BDL	55.88
6	KPT-6 Naktii -II	High tide	ND	ND	ND
VADINAR					
7	VADINAR-I jetty	High tide	0.732	BDL	49.04
		Low tide	0.629	BDL	42.14

Table 37 Variations In Productivity from Sampling Stations In Kpt Harbour Area Near By Creeks And Vadinar Area During Spring Tide In In March , 2021

Sr. No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
KPT HARBOUR AREA					
1	KPT1	High tide	0.716	0.716	BDL
		Low tide	0.495	0.495	BDL
2	KPT 2	High tide	0.938	0.938	BDL
		Low tide	0.527	0.527	BDL
3	KPT 3	High tide	0.817	0.817	BDL
		Low tide	0.426	0.426	BDL
4	KPT-4	High tide	0.850	BDL	56.95
		Low tide	0.613	BDL	41.07
CREEKS					
5	KPT-5 Nakti-I	High tide	1.189	BDL	79.66
		Low tide	0.833	BDL	55.81
6	KPT-6 Nakti-II	High tide	ND	ND	ND
7	VADINAR-I jetty	High tide	0.835	BDL	55.94
		Low tide	0.967	BDL	64.79

Productivity Estimation (Oxygen Method)

Productivity is defined as the rate at which inorganic carbon is converted to an organic form. Chlorophyll-bearing organisms (phytoplankton, periphytons,) serve as primary producers in the aquatic food chains. Photosynthesis ultimately results in the formation in a wide range in organic compounds, release in oxygen and reduction in Carbon dioxide (CO2) in the surrounding waters. Primary Productivity can be determined by measuring the changes in the Oxygen and CO_2 concentration. There are two methods in measuring the rate in carbon uptake and net photosynthesis in situ, Oxygen method and the Carbon 14 method. In both methods, clear(light) and darkened(Dark) bottles are filled with water samples and suspended at particular depth for an incubation period in several hours or samples are incubated under controlled conditions in chambers in the laboratory.

The chief advantages in the Oxygen method are that it provides estimates in gross and net productivity and respiration and those analyses can be performed with inexpensive laboratory equipment and common reagents. The dissolved oxygen (DO) concentration is determined at the beginning and end in the incubation period. Productivity is calculated on the assumption that one atom in carbon is assimilated for each molecule in oxygen released.

Table 38 Variations in Productivity from Sampling Stations in DPT Harbour Area Near by Creeks and Vadinar Area during neap Tide

Sr. No.	**Station**	**Tide**	**Net Productivity mg carbon fixed/m^3**
KPT HARBOUR AREA			
1	KPT1	High tide	112.5
		Low tide	75
2	KPT 2	High tide	112.5
		Low tide	150
3	KPT 3	High tide	150
		Low tide	150
4	KPT-4	High tide	150
		Low tide	150
CREEKS			
5	KPT-5 (Nakti–I)	High tide	112.5
		Low tide	150
6	KPT-6 (Nakti–II)	High tide	150
VADINAR			
7	VADINAR-I jetty	High tide	75
		Low tide	150

Table 39: Variations in productivity from sampling stations in DPT harbour area near by creeks and Vadinar area during spring tide

Sr. No	Station	Tide	Net Productivity mg carbon fixed/m^3
KPT HARBOUR AREA			
1	KPT1	High tide	75
		Low tide	112.5
2	KPT 2	High tide	112.5
		Low tide	75
3	KPT 3	High tide	112.5
		Low tide	150
4	KPT-4	High tide	150
		Low tide	112.5
CREEK			
5	KPT-5 (Nakti-I)	High tide	150
		Low tide	150
6	KPT-6 (Nakti–II)	High tide	75
VADINAR1			
7	VADINAR-I jetty	High tide	75
		Low tide	150

Table 40: Variations in productivity from sampling stations in KPT harbour area near by creeks and Vadinar area during Neap tide

Sr. No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin-a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
KPTHARBOUR AREA					
1	KPT1	High tide	0.748	BDL	42.08
		Low tide	0.613	BDL	34.30
2	KPT 2	High tide	0.716	BDL	43.21
		Low tide	0.527	BDL	34.17
3	KPT 3	High tide	0.936	BDL	42.01
		Low tide	0.834	BDL	35.24
4	KPT-4	High tide	0.850	BDL	55.95
		Low tide	0.937	BDL	48.98
		CREEKS			
5	KPT-5 Nakti-I	High tide	0.732	BDL	62.64
		Low tide	0.817	BDL	49.04
6	KPT-6 Naktii -II	High tide	ND	ND	-
VADINAR					
7	VADINAR-I jetty	High tide	0.645	BDL	35.31
		Low tide	0.527	BDL	36.38

Table 41 Variations in Productivity from Sampling Stations in KPT Harbour Area near by Creeks and Vadinar area during Spring Tide

Sr. No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
KPT HARBOUR AREA					
1	KPT1	High tide	0.747	BDL	50.05
		Low tide	0.645	BDL	43.21
2	KPT 2	High tide	0.763	BDL	51.12
		Low tide	0.537	BDL	35.98
3	KPT 3	High tide	0.630	BDL	42.21
		Low tide	0.527	BDL	35.31
4	KPT-4	High tide	0.510	BDL	34.17
		Low tide	0.613	BDL	41.07
	CREEKS				
5	KPT-5 Nakti-I	High tide	0.730	BDL	48.91
		Low tide	0.834	BDL	55.88
6	KPT-6 Nakti-II	High tide	ND	ND	-
7	VADINAR-I jetty	High tide	0.953	BDL	63.85
		Low tide	1.038	BDL	69.55

Productivity Estimation, Oxygen Method

Productivity is defined as the rate at which inorganic carbon is converted to an organic form. Chlorophyll bearing organisms (phytoplankton, periphytons,) serves as primary producers in the aquatic food chains. Photosynthesis ultimately results in the formation of a wide range of organic compounds, release of oxygen and reduction of Carbon dioxide (CO_2) in the surrounding waters. Primary Productivity can be determined by measuring the changes in the Oxygen and CO_2 concentration. There are two methods of measuring the rate of carbon uptake and net photosynthesis in situ, Oxygen method and the Carbon 14 method. In methods, clear (light) and darkened (Dark) bottles are filled with water samples and suspended at particular depth for an incubation period of several hours or samples are incubated under controlled conditions in chambers in the laboratory.

The chief advantages of the Oxygen method are that it provides estimates of gross and net productivity and respiration and those analyses can be performed with inexpensive laboratory equipment and common reagents. The dissolved oxygen (DO) concentration is determined at the beginning and end of the incubation period. Productivity is calculated on the assumption that one atom of carbon is assimilated for each molecule of oxygen released.

Table 42 Variations in Productivity from sampling stations in KPT Harbour Area nearby creeks and Vadinar area during neap Tide

Sr. No.	Station	Tide	Net Productivity mg carbon fixed/m^3
KPT HARBOUR AREA			
1	KPT1	High tide	112.5
		Low tide	75
2	KPT 2	High tide	112.5
		Low tide	75
3	KPT 3	High tide	75
		Low tide	112.5
4	KPT-4 (Khori–I)	High tide	75
		Low tide	112.5
	CREEKS		
5	KPT-5 (Nakti–I)	High tide	225
		Low tide	112.5
6	KPT-6 (Nakti–II)	High tide	75
VADINAR			
7	VADINAR-I jetty	High tide	112.5
		Low tide	75

Table 43 Variations in productivity from sampling stations in KPT harbour area near by creeks and Vadinar area during spring tide

Sr. No	Station	Tide	Net Productivity mg carbon fixed/m^3
KPT HARBOUR AREA			
1	KPT1	High tide	75
		Low tide	112.5
2	KPT 2	High tide	75
		Low tide	150
3	KPT 3	High tide	112.5
		Low tide	112.5
4	KPT-4 (Khori–I)	High tide	75
		Low tide	112.5
	CREEK		
5	KPT-5 (Nakti-I)	High tide	112.5
		Low tide	187.5
6	KPT-6 (Nakti–II)	High tide	112.5
VADINAR1			
7	VADINAR-I jetty	High tide	150
		Low tide	112.5

Phytoplankton Population

For the evaluation of the Phytoplankton population in KPT harbour area and within the immediate surroundings of the port, sampling was conducted from 6 sampling locations (3 in harbour area and two in Nakti creek and one in Khori creek) during high tide period and low tide period of consecutive spring tide and neap tide. The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by Blue green algae, Diatoms during spring tide and Neap tide period. Diatoms were represented by 14 genera. Dinoflagellates were totally absent during the sampling conducted in March 2021 during this sampling run, while Blue green algae were represented by very few strands of *Stigonema* sp. that also near Nakti creek during spring tide sampling. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 8-62 units/ L during high tide period and 49-56 units/ L during low tide of Neap tide. While Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 22-94 units/ L during high tide and 97-114 units/L during low tide of Spring tide period.

For the evaluation of the Phytoplankton population in Vadinar Jetty area and within the immediate surroundings, sampling was conducted only from one sampling location near Jetty area. Sampling was conducted during high tide period and low tide of spring tide and Neap tide at jetty location. The phytoplankton community of the sub surface water in the jetty area was represented by three groups, Diatoms, Blue green algae and Dinoflagellates. Diatoms were represented by 20 genera. Blue green algae were represented by. *Oscillatoria sp. Stigonema sp*. Dinoflagellates were represented by very few population of *Protoperidinium SP., Ceratium furca*. Phytoplankton of the sampling stations at sub surface layer in the Jetty area 86 units/L and 89 units/L, respectively during low tide and high tide period of Neap tide and 249 units/L and 240 units/L respectively during low tide and high tide period of Spring tide.

Zooplankton Population

For the evaluation of the Zooplankton population in KPT harbour area and within the immediate surroundings of the port sampling was conducted from 6 sampling locations (4 in harbour area and one in Nakti creek and one in Khori creek) during high tide period and low tide period of consecutive Neap tide and spring tide. The Zooplankton community of the sub surface water in the harbour and nearby creeks during March, 2021 was represented by mainly three groups, Tintinids, Copepods, and larval forms of Crustacea. Zooplankton of the sampling stations at sub surface layer in the KPT harbour area, varying from 14 -58 N/L during high tide and 59-77 N/L during low tide of Neap Tide period. While Zooplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 21-86 N/ L during high tide and 84-96 N/ L during low tide of Spring tide period.

For the evaluation of the Zooplankton population in Vadinar Jetty area and within the immediate surroundings, sampling was conducted from one sampling location in Jetty area Sampling was conducted during high tide period and low tide period of neap tide and spring tide at jetty location. The Zooplankton community of the sub surface water in the jetty was represented by six groups, Tintinids, Copepods, Decapods and larval forms Crustaceans, and Polychaetes. Zooplankton of the sampling stations at sub surface layer in the Jetty area was 64 N/ L, 67 N/ L during low tide and high tide respectively of Neap tide period and 1115-121 N/L during low tide and high tide respectively of Spring tide period.

Table 40: Systematic account of Phytoplankton in the sampling locations in of KPT harbour area and nearby creeks during spring tide and Spring tide period

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#
BLUE GREEN ALGAE	**Cynophyta**	**Cyanophyceae**	Stigonematales	Stigonemataceae	*Stigonema* sp	*B1*
DIATOMS	**Bacillariophyta**	**Coscinodiscophyceae**	Thalassiosirales	Thalassiosiraceae	*Planktoniella SP.*	*D1*
				Skeletonemataceae	Skeletonema sp	*D2*
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	*D3*
			Triceratiales	Triceratiaceae	Triceratium sp	*D4*
					Odontella sp.	*D5*
			Biddulphiales	Biddulphiaceae	*Biddulphia sp.*	*D6*
			Hemiaulales	Bellerocheaceae	Bellerochea sp	*D7*
			Lithodesmiales	Lithodesmiaceae	Ditylum sp	*D8*
			Rhizosoleniales	Rhizosoleniales	Rhizosolenia sp	*D9*
			Chaetocerotales	Chaetocerotaceae	Chaetoceros sp	*D10*
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma sp.*	*D11*
		Fragilariophyceae	Fragilariales	Fragilariaceae	Synedra sp	*D12*
			Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	*D13*
					Thalassionema sp	*D14*

Table 41: Systematic account of Phytoplankton in the sampling locations in of Vadinar during Spring tide & Neap tide period

GROUP	PHYLUM Division	CLASS	ORDER	FAMILY	GENUS/SPECIES	#
BLUE GREEN ALGAE	**Cynophyta**	**Cyanophyceae**	Pleurocapsales	Oscillatriaceae	*Oscillatoria* sp.	*B1*
			Stigonematales	Stigonemataceae	*Stigonema* sp	*B2*
Diatoms	**Bacillariophyta**	**Coscinodiscophyceae**	Thalassiosirales	Thalassiosiraceae	*Planktoniella sp.*	*D1*
					Thalassiosira sp	*D2*
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp*	*D3*
			Melosirales	Melosiraceae	Melosira sp	*D4*
			Biddulphiales	Biddulphiaceae	*Biddulphia sp*	*D5*
			Hemiaulales	Hemiaulaceae	Eucampia sp	*D6*
				Bellerocheaceae	Bellerochea sp	*D7*
			Rhizosoleniales	Rhizosoleniaceae	Rhizosolenia sp	*D8*
					Guinardia sp	*D9*
			Triceratiales	Triceratiaceae	*.Odontella SP.*	*D10*
					Triceratium sp	*D11*
			Lithodesmiales	Lithodesmiaceae	*Ditylum sp.*	*D12*
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros SP.*	*D13*
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma sp.*	*D14*
			Bacillariales	Bacillariaceae	*Bacillariasp*	*D15*
					Nitzschia sp.	*D16*
		Fragilariophyceae	Fragilariales	Fragilariaceae	*Synedra sp*	*D17*
			Licmophorales	Licmophoraceae	Licmosphenia sp	*D18*
			Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	*D19*
					Thalassionema sp	*D20*
DINOFLAGELLATES	**Dinophyta**	**Desmophyceae**	Peridiniales	Protoperidiniaceae:	*Protoperidinium SP.*	*F1*
			Gonyaulacales	Ceratiaceae	*Ceratium furca*	*F2*

Table 42: Quantitative Evaluation of Marine Phytoplankton in sub-surface samples from sampling locations of KPT harbour area creeks during spring tide

GENUS/ SPECIES		ABUNDANCE IN UNITS/CELLS / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING HIGH TIDE PERIOD						ABUNDANCE IN UNITS/CELLS / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING LOW TIDE PERIOD				
		KPT HARBOUR			CREEKS			KPT HARBOUR			CREEKS	
		KPT -1	KPT-2	KPT-3	KPT-4	KPT-5	KPT-6	KPT-1	KPT-2	KPT-3	KPT-4	KPT-5
DIATOMS												
D1	*Planktoniella SP.*	4	2	2	6	4	0	7	4	4	5	2
D2	Skeletonema sp	0	0	0	0	0	0	0	0	0	0	0
D3	*Coscinodiscus sp.*	17	12	14	10	14	0	10	18	12	10	17
D4	Triceratium sp	0	0	0	0	0	0	0	0	0	0	0
D5	*Odontella sp.*	0	0	0	0	0	0	0	0	0	0	0
D6	*Biddulphia sp.*	9	10	7	10	9	2	9	6	10	9	14
D7	Bellerochea sp	0	0	0	4	6	0	0	2	0	4	6
D8	Ditylum sp	0	0	0	0	0	0	0	0	0	0	0
D9	Rhizosolenia sp	6	4	7	5	2	0	6	5	8	4	4
D10	Chaetoceros sp	0	4	2	2	5	0	4	2	5	4	0
D11	*Pleurosigma sp.*	2	0	2	0	2	0	0	0	2	4	6
D12	Synedra sp	4	2	6	4	4	2	8	6	4	2	3
D13	*Thalassiothrix sp.*	2	4	8	6	10	4	9	8	12	7	4
D14	Thalassionema sp	0	2	4	8	6	0	0	0	0	0	0
DIATOMS Total units/L												
BLUE GREEN ALGAE												
B1	*Stigonema* sp	0	0	0	0	0	0	0	0	0	0	0
Blue green algae Total units/L		0	0	0	0	0	0	0	0	0	0	0
TOTAL PHYTOPLANKTON UNITS/L		44	40	52	55	62	8	53	51	57	49	56

Table 43: Quantitative Evaluation of Marine Phytoplankton in sub-surface samples from sampling locations of KPT harbour area Creeks during neap tide

GENUS/ SPECIES		ABUNDANCE IN UNITS/CELLS / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING HIGH TIDE PERIOD						ABUNDANCE IN UNITS/CELLS / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING LOW TIDE PERIOD				
		KPT HARBOUR			CREEKS			KPT HARBOUR			CREEKS	
		KPT -1	KPT-2	KPT-3	KPT-4	KPT-5	KPT-6	KPT-1	KPT -2	KPT-3	KPT-4	KPT-5
DIATOMS												
D1	*Planktoniella SP.*	6	8	4	9	10	0	9	12	14	10	12
D2	Skeletonema sp	8	4	6	4	4	0	10	12	9	6	10
D3	*Coscinodiscus sp.*	18	12	16	14	10	6	20	18	12	16	19
D4	Triceratium sp	0	0	2	6	4	0	0	0	4	6	8
D5	*Odontella sp.*	5	6	6	7	4	2	8	10	6	4	7
D6	*Biddulphia sp.*	8	9	10	7	9	4	7	4	8	9	6
D7	Bellerochea sp	4	6	2	7	6	0	6	4	8	6	4
D8	Ditylum sp	4	2	6	6	9	0	4	7	3	5	4
D9	Rhizosolenia sp	4	2	0	4	2	0	5	4	2	3	4
D10	Chaetoceros sp	0	0	0	0	0	0	0	0	0	0	0
D11	*Pleurosigma sp.*	4	0	2	0	2	0	0	0	0	4	6
D12	Synedra sp	4	2	6	4	4	2	8	6	4	2	3
D13	*Thalassiothrix sp.*	12	15	16	10	9	6	14	18	20	15	16
D14	Thalassionema sp	9	4	6	8	7	2	8	9	10	7	6
DIATOMS Total units/L		86	70	82	86	80	22	99	104	100	93	105
BLUE GREEN ALGAE												
B1	*Stigonema* sp	0	0	0	8	12	0	0	0	0	4	9
Blue green algae Total units/L		0	0	0	8	12	0	0	0	0	4	9
TOTAL PHYTOPLANKTON UNITS/L		86	70	82	94	92	22	99	104	100	97	114

Table 44: Quantitative Evaluation of Marine Phytoplankton in sub-surface samples from sampling locations of Vadinar area during spring tide

GENUS/ SPECIES		ABUNDANCE IN UNITS/CELLS / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING LOW TIDE PERIOD	ABUNDANCE IN UNITS/CELLS / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING HIGH TIDE PERIOD
		Vadinar Jetty	**Vadinar Jetty**
		VAD-1	**VAD-1**
	BLUE GREEN ALGAE		
B1	*Oscillatoria* sp.	6	10
B2	*Stigonema* sp	0	0
BLUE GREEN ALGAE Units/L		6	10
DIATOMS			
D1	*Planktoniella sp.*	0	0
D2	Thalassiosira sp	0	0
D3	*Coscinodiscus sp*	8	10
D4	Melosira sp	0	0
D5	*Biddulphia sp*	8	12
D6	Eucampia sp	9	7
D7	Bellerochea sp	6	4
D8	Rhizosolenia sp	24	20
D9	Guinardia sp	0	0
D10	*.Odontella SP.*	0	0
D11	Triceratium sp	0	0
D12	*Ditylum sp.*	0	0
D13	*Chaetoceros SP.*	0	0
D14	*Pleurosigma sp.*	0	0
D15	*Bacillariasp*	0	0
D16	*Nitzschia sp.*	0	0
D17	*Synedra sp*	12	10
D18	Licmosphenia sp	0	0
D19	*Thalassiothrix sp.*	9	14
D20	Thalassionema sp	0	0
DIATOMS TOTAL UNITS/L		76	77
DINOFLAGELLATES			
F1	*Protoperidinium SP.*	0	0
F2	*Ceratium furca*	4	2
DINOFLAGELLATES unit/L		4	2
TOTAL PHYTOPLANKTON UNITS/L		**86**	**89**

Table 45: Quantitative Evaluation of Marine Phytoplankton in sub-surface samples from sampling locations of Vadinar area during neap tide

GENUS/ SPECIES		ABUNDANCE IN UNITS/CELLS / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING LOW TIDE PERIOD	ABUNDANCE IN UNITS/CELLS / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING HIGH TIDE PERIOD
		Vadinar Jetty	**Vadinar Jetty**
		VAD-1	VAD-1
	BLUE GREEN ALGAE		
B1	*Oscillatoria* sp.	22	14
B2	*Stigonema* sp	14	20
BLUE GREEN ALGAE Units/L		36	34
DIATOMS			
D1	*Planktoniella sp.*	16	12
D2	Thalassiosira sp	20	18
D3	*Coscinodiscus sp*	12	10
D4	Melosira sp	4	8
D5	*Biddulphia sp*	32	24
D6	Eucampia sp	4	2
D7	Bellerochea sp	6	4
D8	Rhizosolenia sp	18	14
D9	Guinardia sp	4	8
D10	*.Odontella SP.*	7	9
D11	Triceratium sp	4	2
D12	*Ditylum sp.*	18	26
D13	*Chaetoceros SP.*	6	4
D14	*Pleurosigma sp.*	8	7
D15	*Bacillariasp*	4	6
D16	*Nitzschia sp.*	4	8
D17	*Synedra sp*	8	6
D18	Licmosphenia sp	4	5
D19	*Thalassiothrix sp.*	14	12
D20	Thalassionema sp	9	10
DIATOMS TOTAL UNITS/L		202	195
DINOFLAGELLATES			
F1	*Protoperidinium SP.*	6	8
F2	*Ceratium furca*	5	3
DINOFLAGELLATES unit/L		11	11
TOTAL PHYTOPLANKTON UNITS/L		249	240

Table 46: Systematic account of Zooplankton from the sampling locations in KPT harbour area, and nearby creeks during Spring tide and Neap tide

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#
TINTINIDS	PROTOZOA (CILIOPHORA)	SPIROTRICHEA	TINTINNIDA	Tintinnidiidae	*Leprotintinnus sp.*	*T1*
				codonellidae	*Tintinnopsisgracilis*	*T2*
					Tintinopsis radix	*T3*
					Tintinnopsis dadayi	*T4*
					Tintinnopsis failakkaensis	*T5*
COPEPODS	ARTHROPODA CRUSTACEA	SUB CLASS COPEPODA	CALANOIDA	Paracalanidae	*Acrocalanus sp*	*C1*
			CYCLOPOIDA	Oithonidae	*Oithona* sp.	*C2*
			HARPACTICOIDA	Ectinosomatidae	*Microstella sp.*	*C3*
				Euterpinidae	*Euterpina* sp.	*C4*
CRUSTACEAN LARVAE	ARTHROPODA CRUSTACEA				Nauplius larvae of Copepods	*C5*

Table 47: Systematic account of Zooplankton from the sampling locations in Vadinar area during spring tide & neap tide

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#
TINTINIDS	PROTOZOA (CILIOPHORA)	SPIROTRICHEA	TINTINNIDA	Tintinnidiidae	*Leprotintinnus sp.*	*T1*
				codonellidae	*Tintinnopsisgracilis*	*T2*
					Tintinopsis radix	*T3*
					Tintinnopsis failakkaensis	*T4*
COPEPODS	ARTHROPODA CRUSTACEA	SUB CLASS COPEPODA	Calanoida	Paracalanidae	*Acrocalanus sp*	*C1*
			Cyclopoida	Oithonidae	*Oithona* sp.	*C2*
			Harpacticoida	Euterpinidae	*Euterpina sp.*	*C3*
				Ectinosomatidae	*Microsetella* sp.	*C4*
DECAPODS	ARTHROPODA CRUSTACEA	Malacostraca	Decapoda	Penaeidae	*Penaeus sp.*	*D1*
CRUSTACEAN LARVAE					Nauplius larvae of Copepods	*L1*
Barnacles LARVAE	Arthropoda Crustacea	Maxillopoda Infra Class Cirripedia			Nauplius and Cyprids of Barnacles	*L2*
ZOE LARVAE					Zoea Larvae	*L3*
Polychaetes					Trachophore larvae	*L4*

Table 48: Quantitative evaluation of Marine Zooplankton in sub surface samples from sampling locations of KPT Harbour area creeks during spring tide

GENUS/ SPECIES		ABUNDANCE IN N / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING HIGH TIDE PERIOD						ABUNDANCE IN N / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING LOW TIDE PERIOD				
		KPT HARBOUR			CREEKS			KPT HARBOUR			CREEKS	
		KPT-1	KPT-2	KPT-3	KPT-4	KPT-5	KPT-6	KPT-1	KPT-2	KPT-3	KPT-4	KPT-5
TINTINIDS												
T1	*Leprotintinnus sp.*	4	2	2	4	2	0	8	4	6	5	4
T2	*Tintinnopsisgracilis*	6	8	10	4	7	2	14	9	10	8	6
T3	*Tintinopsis radix*	4	6	4	8	2	2	12	10	9	8	6
T4	*Tintinnopsis dadayi*	15	10	8	12	9	0	9	10	8	6	4
T5	*Tintinnopsis failakkaensis*	0	0	2	2	5	0	2	0	0	4	2
TINTINIDS TOTAL N/L		30	26	26	30	25	4	45	33	33	31	22
COPEPODS												
C1	*Acrocalanus sp*	0	0	0	0	0	0	0	0	0	0	0
C2	*Oithona* sp.	0	0	0	0	0	0	0	0	0	0	0
C3	*Microstella sp.*	8	10	9	8	7	2	14	9	12	10	16
C4	*Euterpina* sp.	0	0	0	0	0	0	0	0	0	0	0
COPEPODS TOTALN/L		8	10	9	8	7	2	14	9	12	10	16
LARVAL FORMS												
L1	Nauplius larvae of Copepods	18	22	10	20	16	8	18	24	16	20	21
Larval forms TOTAL N/L		18	22	10	20	16	8	18	24	16	20	21
TOTAL ZOOPLANKTON N /L		56	58	45	58	48	14	77	66	61	61	59

Table 49 Quantitative evaluation of marine zooplankton in sub surface samples from sampling locations of DPT harbour area and nearby creeks during neap tide

GENUS/ SPECIES		ABUNDANCE IN N / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING HIGH TIDE PERIOD						ABUNDANCE IN N / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING LOW TIDE PERIOD				
		KPT HARBOUR			**CREEKS**			**KPT HARBOUR**			**CREEKS**	
		KPT-1	**KPT-2**	**KPT-3**	**KPT-4**	**KPT-5**	**KPT-6**	**KPT-1**	**KPT-2**	**KPT-3**	**KPT-4**	**KPT-5**
TINTINIDS												
T1	*Leprotintinnus sp.*	8	4	6	2	4	0	8	9	5	4	4
T2	*Tintinnopsisgracilis*	4	8	7	4	7	2	5	7	6	8	4
T3	*Tintinopsis radix*	6	4	4	5	6	2	8	10	9	14	10
T4	*Tintinnopsis dadayi*	8	6	7	9	8	0	9	8	6	4	9
T5	*Tintinnopsis failakkaensis*	6	4	4	8	2	5	8	10	9	12	7
TINTINIDS TOTAL N/L		34	26	28	28	27	9	38	44	35	42	34
COPEPODS												
C1	*Acrocalanus sp*	8	6	7	9	10	0	8	9	7	6	9
C2	*Oithona* sp.	4	2	6	4	4	2	9	4	8	2	5
C3	*Microstella sp.*	12	17	16	10	12	2	16	9	12	10	14
C4	*Euterpina* sp.	4	2	4	2	6	0	6	2	2	4	5
COPEPODS TOTALN/L		28	27	33	25	32	4	39	24	29	22	33
LARVAL FORMS												
L1	Nauplius larvae of Copepods	24	32	12	20	16	8	19	24	26	20	18
Larval forms TOTAL N/L		24	32	12	20	16	8	19	24	26	20	18
TOTAL ZOOPLANKTON N/L		86	85	73	73	75	21	96	92	90	84	85

Table 50 Quantitative evaluation of marine zooplankton in sub surface samples from sampling locations of Vadinar area during spring tide

GENUS/ SPECIES		ABUNDANCE IN N / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING LO0W TIDE PERIOD	ABUNDANCE IN N/ L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING HIGH TIDE PERIOD
		Vadinar jetty	**Vadinar jetty**
		VAD-1	**VAD-1**
TINTINIDS			
T1	*Leprotintinnus sp.*	14	12
T2	*Tintinnopsisgracilis*	0	0
T3	*Tintinopsis radix*	8	9
T4	*Tintinnopsis failakkaensis*	0	0
Titinids N/L		22	21
COPEPODS			
C1	*Acrocalanus sp*	0	0
C2	*Oithona* sp.	0	0
C3	*Euterpina sp.*	0	0
C5	*Microsetella* sp.	12	10
COPEPODS TOTAL N/L		12	10
DECAPODS			
D1	*Penaeus sp.*	2	4
Total Deacapods N/L		2	4
LARVAL FORMS			
L1	Nauplius larvae of Copepods	*14*	12
L2	Nauplius and Cyprids of Barnacles	*8*	10
L3	Zoea Larvae	4	6
L4	Trachophore larvae	2	4
TOTAL LARVAL Forms N/L		28	32
TOTAL ZOOPLANKTON N/L		64	67

Table 51: Quantitative evaluation of marine zooplankton in sub surface samples from sampling locations of Vadinar area and nearby creeks during neap tide

GENUS/ SPECIES		ABUNDANCE IN N / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING LO0W TIDE PERIOD	ABUNDANCE IN N/ L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING HIGH TIDE PERIOD
		Vadinar jetty	**Vadinar jetty**
		VAD-1	**VAD-1**
TINTINIDS			
T1	*Leprotintinnus sp.*	14	8
T2	*Tintinnopsisgracilis*	12	10
T3	*Tintinopsis radix*	10	14
T4	*Tintinnopsis failakkaensis*	7	9
Titinids N/L		43	41
COPEPODS			
C1	*Acrocalanus sp*	12	8
C2	*Oithona* sp.	6	9
C3	*Euterpina sp.*	4	6
C5	*Microsetella* sp.	6	7
COPEPODS TOTAL N/L		28	30
DECAPODS			
D1	*Penaeus sp.*	6	4
Total Deacapods N/L		6	4
LARVAL FORMS			
L1	Nauplius larvae of Copepods	*24*	32
L2	Nauplius and Cyprids of Barnacles	*10*	12
L3	Zoea Larvae	4	2
L4	Trachophore larvae	6	4
TOTAL LARVAL Forms N/L		44	50
TOTAL ZOOPLANKTON N/L		115	121

Benthic Organisms

No Benthic organism was observed in the collected sediments by using the Van-veen grabs during the sampling conducted during spring tide period and Neap tide period from KPT harbour region and nearby creek. Vadinar jetty region during spring tide and neap tide no benthic organisms observed collected sediments.

7. Meteorological Data

Automatic Weather station have been installed in Seva Sadan -3 at the Kandla Port 3 which records the data on Temperature (°C), Humidity (%),Wind (mph), Dew Point (°C), Wind Direction (°), Pressure, Solar radiation, heat Index and UVI.

Temperature

The mean day time temperature for Kandla Port was 28.4 °C. The day-time maximum temperature was 36.2 °C. The mean night time temperature was 25.9 °C. The minimum mean night time temperature recorded was 18.0 °C.

Air Pressure

The mean absolute air pressure for the month of March was 1013.2 hpa, whereas the mean relative pressure was 1017.27 hpa. The maximum absolute air pressure recorded for the month of March was 1023.02 hpa.

Heat Index

The mean day-time heat index for the month of March was 28.98 ^{o}C. The maximum heat index recorded was 43^{o}C.

Solar Radiation

The mean Solar Radiation in March was 166.74 w/m^2. The maximum solar radiation recorded in the month of March was 292.3 w/m^2.

Humidity

The mean day-time humidity was 24.7 % for the month of March and mean night time humidity was 33.3%. Maximum humidity recorded during day-time was 92.0 % and maximum humidity recorded during night-time was 93.0%.

Wind Velocity and Wind Direction

The mean wind velocity for the entire month of March was 6.8 km/hour (i.e. 1.89 mtr/sec). Maximum wind velocity recorded was 38.2 Km/hr (10.6 mtr/sec). The wind direction was mostly N to NW.

Conclusive Summary and Remedial measures Suggested

- The AAQ monitoring at six locations of Deendayal Port indicates that the mean PM_{10} values at four locations viz. Coal storage area, Marine Bhavan and Oil Jetty area were found above the permissible standards (100 μg/m^3)and $PM_{2.5}$ was above permissible limits at Coal storage location(Limit 60 μg/m^3).

- Drinking water at all the twenty locations was found potable and was within permissible limits of BIS standards (IS 10500).

- Noise quality was also within the set permissible standards of an Industrial Area. The noise level observed during day time was >75 dB (A) and at night time was >70 dB (A) during the entire monitoring period.

- The sewage treated water of Deendayal Port Colony (Gopalpuri) was in line with the standards set by the Gujarat Pollution Control Board. The STP at Deendayal Port is not fully operational and STP at Vadinar Port was found non-operational.

Reasons for higher Values of PM_{10}

- Large amount of coal is handled at Berth No. 6, 7, 8 and 9. The unloading of coal directly in the truck, using grabs cause coal to spread in air as well as coal dust to fall on ground. This settled coal dust again mixes with the air while trucks travel through it.

- Also, the coal laden trucks are not always covered with tarpaulin sheets, and these results in spillage of coal from trucks/dumpers during its transit from vessel to yard or storage site. This also increased PM values around marine Bhavan.

- Coal handling at Tuna/Coal Jetty also contributes to higher PM_{10} values at Tuna Port as fine coal dust generated at Tuna Coal Jetty is carried by the wind for longer distance.

Remedial Measures

The values of PM_{10} during the month of March, 2021 were observed beyond the permissible limit at four locations mentioned above. Given below are the remedial measures suggest to minimize the Air pollution at Deendayal Port.

- Guidelines for Coal Handling by GPCB should be strictly followed. (http://gpcb.gov.in/pdf/coal-handling-guidelines.pdf)
- Sewage Treatment Plan at Vadinar Port is not working. Hence, it is recommended to commission the sewage treatment plant at Vadinar immediately.
- Except for the higher values of PM_{10} at Coal storage site, Oil Jetty, Tuna Port and Marine Bhavan locations, the monitoring results for the present month suggest that the overall Environment Quality of Deendayal Port for is satisfactory.

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ENVIRONMENTAL MONITORING REPORT
FOR
DEENDAYAL PORT TRUST

REPORT NO.	:	DCPL/DPT/20-21/13
Month	:	MAY 2021
Issue No	:	01
Revision No	:	00
Prepared by	:	DETOX CORPORATION PVT. LTD., SURAT

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Introduction

Monitoring of various environmental aspects of the Deendayal port by M/s Detox Corporation Pvt. Ltd. has been carried out through collection of samples, analysis of the same, comparing results with respect to the national standards and any other relevant standards by GBCB/CPCB/MoEF to identify non conformities in the Environment of the Deendayal Port. The results shall address the identified impacts and suggest measures to minimize the environmental impact due to various operations at Deendayal Port.

The environmental monitoring is carried out as per the Environment Management and Monitoring Plan submitted by Detox Corporation Pvt. Ltd.

1. Ambient Air Quality Monitoring

As per the Environmental Monitoring Plan of Deendayal Port Trust, Air monitoring was carried out at six identified locations at Deendayal Port and two locations at Vadinar Port.

1.1 Air Quality Monitoring Methodology

Air quality is measured in all the stations, for 24 hour for Total Suspended Particulate Matter (TSPM), PM_{10}, $PM_{2.5}$, SO_2, NO_X, NH_3 & Benzene, and Grab-sampling for CO & CO_2 measurements. The Air samplers are operated for a period of 24 hours and after a continuous operation of 8 hours of the sampler, the reagents were replaced to obtain 3 samples per day for each parameter namely, SO_2, NO_X. The EPM 2000 filter paper and PTFE Membrane bound filter paper are used for a period of 24 hours to obtain one sample each of TSPM, PM_{10} & $PM_{2.5}$.

The AAQ samples are collected twice a week from all the eight locations as per the EMP.

1.2 Results

The ambient air quality monitoring data for six stations, viz. Marine Bhavan, Oil Jetty, Port Colony,Gopalpuri Hospital,Tuna Port and Nr. Coal Storage Area for the month of May 2021 are given in Tables 1A to 6B. The ambient air quality monitoring data for two stations at Vadinar (Nr. Admin Building &Nr. Signal Building) are given in Tables 7A to 8B.

Location 1: Marine Bhavan (AL1)

Table 1 : Results of Air Pollutant Concentration at Marine Bhavan

	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period		24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit		NS	100 µg/m3	60 µg/m3		80 µg/m3		80 µg/m3		400 µg/m3
AL1 – 1	05.05.2021	407	395	27	10.55	14.65	22.87	27.52	5.62	5.28
					15.83		26.04		5.36	
					17.58		33.66		4.85	
AL1 – 2	07.05.2021	843	200	20	9.67	9.08	17.78	18.00	9.70	9.28
					9.23		22.23		7.91	
					8.35		13.97		10.21	
AL1 – 3	12.05.2021	795	653	74	2.20	5.28	37.47	22.02	13.02	12.51
					5.71		11.43		10.72	
					7.91		17.15		13.79	
AL1 – 4	14.05.2021	1164	927	46	5.71	8.50	20.33	21.38	31.91	41.70
					7.47		18.42		39.57	
					12.31		25.41		53.61	
AL1 – 5	19.05.2021	2190	1791	35	10.11	9.52	18.42	22.02	12.00	17.10
					5.71		26.04		22.72	
					12.75		21.60		16.59	
AL1 - 6	21.05.2021	770	229	12	8.79	7.91	20.33	21.60	16.59	23.66
					5.71		26.04		27.57	
					9.23		18.42		26.80	
AL1 - 7	26.05.2021	877	426	43	9.23	11.72	22.23	23.92	5.62	5.36
					13.19		31.12		5.87	
					12.75		18.42		4.60	
AL1 – 8	28.05.2021	682	234	70	8.35	7.03	12.70	13.97	35.74	29.27
					7.91		8.26		29.36	
					4.84		20.96		22.72	
Monthly Average		966	607	41		9.21		21.30		18.02
Standard Deviation		537	539	22		2.89		3.99		12.81

NS: Not Specified

Table 1B : Results of Air Pollutant Concentration at Marine Bhavan					
Parameter	Date	C_6H_6 [µg/m³]	HC* ppm	CO [mg/m³]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m³	NS	4.0 mg/m³	NS
AL1 – 1	05.05.2021`	1.23	BDL	1.36	518
AL1 – 2	07.05.2021	1.13	BDL	1.57	520
AL1 – 3	12.05.2021	1.04	BDL	1.56	503
AL1 – 4	14.05.2021	1.14	BDL	1.81	465
AL1 – 5	19.05.2021	1.12	BDL	1.51	480
AL1 - 6	21.05.2021	1.05	BDL	1.58	485
AL1 – 7	26.05.2021	1.04	BDL	1.68	527
AL1 – 8	28.05.2021	1.1	BDL	1.59	490
Monthly Average		**1.11**	-	**1.58**	**499**
Standard Deviation		**0.06**	-	**0.13**	**22**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC: 0.5ppm)
NS -Not Specified

At Marine Bhavan, the overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_X and NH_3 is attributed mainly by motor vehicle emission produced from various types of automobiles (both diesel and petrol driven). Moreover, the loading and unloading of Food Grains and Timber at Jetty no. 1 and 2 also contributes to the high levels of TSPM and PM_{10}. The mean TSPM value at Marine Bhavan was 966 µg/m³, The mean PM_{10} values were 607.0 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were below the permissible limit (mean = 41 µg/m³). The average values of SO_2, NO_x and NH_3 were within the permissible limit. The average values of SO_2, NO_x and NH3 were 9.21 µg/ m³, 21.30 µg/ m³ & 18.02 µg/ m³ respectively.These were within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Marine Bhavan. The mean Benzene concentration was 1.11 µg/m³,well below the

permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.58 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 2: Oil Jetty (AL2)

Table 2 : Results of Air Pollutant Concentration at Oil Jetty

	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period		24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit		NS	100 µg/m3	60 µg/m3		80 µg/m3		80 µg/m3		400 µg/m3
AL2 -1	05.05.2021	342	303	31	19.34	14.80	28.58	28.58	6.38	7.83
					13.19		22.87		7.40	
					11.87		34.30		9.70	
AL2 -2	07.05.2021	840	806	13	10.99	13.48	20.33	21.38	8.17	14.38
					12.75		25.41		16.59	
					16.70		18.42		18.38	
AL2 -3	12.05.2021	793	638	18	1.75	5.28	15.88	29.01	7.40	12.93
					5.71		32.39		11.49	
					8.35		38.74		19.91	
AL2 -4	14.05.2021	678	611	37	8.79	9.23	36.84	35.15	101.60	92.58
					8.35		25.41		57.69	
					10.55		43.19		118.45	
AL2 – 5	19.05.2021	1113	597	17	10.55	10.40	25.41	22.87	20.93	21.44
					8.79		19.69		26.80	
					11.87		23.50		16.59	
AL2 – 6	21.05.2021	634	561	23	8.35	8.50	25.41	23.50	22.72	39.74
					9.23		19.05		32.93	
					7.91		26.04		63.56	
AL2 – 7	26.05.2021	961	740	116	7.03	9.52	20.96	22.44	21.95	26.72
					11.43		20.33		17.36	
					10.11		26.04		40.84	
AL2 -8	28.05.2021	654	628	40	5.28	10.55	21.60	25.62	33.70	40.50
					12.75		38.11		41.36	
					13.63		17.15		46.46	
Monthly Average		752	611	37		10.22		26.07		32.02
Standard Deviation		233	148	33		2.94		4.62		27.25

NS: Not Specified

Table 2B : Results of Air Pollutant Concentration at Oil Jetty					
Parameter	Date	C_6H_6 [µg/m³]	HC* ppm	CO [mg/m³]	CO_2 [ppm]
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m³**	**NS**	**4.0 mg/m³**	**NS**
AL2 -1	05.05.2021	1.1	BDL	1.81	518
AL2 -2	07.05.2021	1.11	BDL	1.68	503
AL2 -3	12.05.2021	1.11	BDL	1.76	498
AL2 -4	14.05.2021	1.28	BDL	1.9	474
AL2 – 5	19.05.2021	1.09	BDL	1.9	491
AL2 – 6	21.05.2021	1.12	BDL	1.4	510
AL2 -7	26.05.2021	1.19	BDL	1.76	515
AL2 – 8	28.05.2021	1.08	BDL	1.65	498
Monthly Average		**1.14**	**-**	**1.73**	**501**
Standard Deviation		**0.07**	**-**	**0.16**	**14**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 0.5ppm)

NS- Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Oil Jetty area was mainly by motor vehicle emission produced from various types of vehicles Oil Jetty Area. The mean TSPM values at Oil Jetty were 752 µg/m³± 48 (SD), The mean PM_{10} values were 611 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 37 µg/m³).The average values of SO_2, NO_x and NH_3 were within the permissible limit; The mean concentration of SO_2, NO_x and NH3 were 10.22 µg/m³, 26.07 µg/m³ and 32.02 µg/m³ respectively.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Oil Jetty. The mean Benzene concentration was 1.14 µg/m³, HC's were below the detectable limit of 5.0 µg/m³. and Carbon Monoxide concentration was 1.73 µg/m³, well below the permissible limit of 4.0 mg/m³.

Location 3: Kandla Colony – Estate Office (AL-3)

Table 3 : Results of Air Pollutant Concentration at Estate Office

	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period		**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit		**NS**	**100 µg/m3**	**60 µg/m3**		**80 µg/m3**		**80 µg/m3**		**400 µg/m3**
AL3 – 1	05.05.2021	151	134	23	15.39	13.48	24.77	22.02	7.40	5.79
					12.31		19.69		5.36	
					12.75		21.60		4.60	
AL3 – 2	07.05.2021	511	352	14	12.75	9.96	22.23	19.69	11.23	9.10
					9.23		19.05		7.40	
					7.91		17.78		8.68	
AL3 – 3	12.05.2021	710	471	21	3.96	3.66	14.61	9.74	16.59	10.13
					3.08		6.99		8.17	
					3.96		7.62		5.62	
AL3 – 4	14.05.2021	557	782	78	5.71	8.79	18.42	24.77	88.33	55.14
					12.75		24.77		25.02	
					7.91		31.12		52.08	
AL3 – 5	19.05.2021	484	744	17	5.71	7.03	15.88	18.00	28.59	30.89
					9.23		18.42		22.72	
					6.15		19.69		41.36	
AL3 – 6	21.05.2021	979	971	106	4.84	5.71	41.29	29.64	28.34	42.29
					6.59		28.58		51.31	
					5.71		19.05		47.23	
AL3 – 7	26.05.2021	801	767	31	8.35	9.23	25.41	19.69	22.98	23.32
					10.99		20.33		15.83	
					8.35		13.34		31.14	
AL3 – 8	28.05.2021	370	252	31	9.23	9.52	15.88	20.33	25.02	28.51
					8.35		19.69		30.12	
					10.99		25.41		30.38	
Monthly Average		570	559	40		8.43		20.48		25.64
Standard Deviation		258	298	33		2.97		5.70		17.31

NS: Not Specified

Table 3B : Results of Air Pollutant Concentration at Kandla Port Colony					
Parameter	Date	C_6H_6 [µg/m^3]	HC*	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3	NS	4.0 mg/m^3	NS
AL3 -1	05.05.2021	1.06	BDL	1.69	503
AL3 -2	07.05.2021	1.03	BDL	1.76	528
AL3 -3	12.05.2021	1.13	BDL	1.64	527
AL3 -4	14.05.2021	1.01	BDL	1.59	502
AL3 – 5	19.05.2021	1.14	BDL	1.68	462
AL3 – 6	21.05.2021	1.14	BDL	1.65	480
AL3 – 7	26.05.2021	1.32	BDL	1.51	490
AL3 – 8	28.05.2021	1.16	BDL	1.53	488
Monthly Average		**1.12**	**-**	**1.63**	**498**
Standard Deviation		**0.10**	**-**	**0.08**	**23**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)
NS- Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Kandla Port Colony was attributed by vehicle emission produced from trucks and heavy duty vehicles that pass through the road outside Kandla Port Colony. The mean TSPMvalues at Oil Jetty were 570 µg/m^3, The mean PM_{10} values were 559µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 40 µg/m^3). The average values of SO_2, NO_x and NH3 were 8.43 µg/m^3, 20.48 µg/m^3 and 25.64 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Kandla Port Colony. The mean Benzene concentration was 1.12 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.63 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 4: Gopalpuri Hospital (AL-4)

Table 4 : Results of Air Pollutant Concentration at Gopalpuri Hospital										
	Date	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**	
Sampling Period		**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit		**NS**	**100 µg/m3**	**60 µg/m3**		**80 µg/m3**		**80 µg/m3**		**400 µg/m3**
AL4 -1	05.05.2021	126	125	21	20.66	15.68	30.49	24.77	4.60	5.53
					12.31		24.77		7.40	
					14.07		19.05		4.60	
AL4 -2	07.05.2021	289	241	15	7.91	9.52	15.88	18.21	10.72	11.49
					12.75		18.42		13.27	
					7.91		20.33		10.47	
AL4 -3	12.05.2021	425	265	16	5.28	5.28	16.51	20.11	14.30	13.44
					7.47		13.97		14.04	
					3.08		29.85		12.00	
AL4 -4	14.05.2021	281	195	30	9.67	9.08	20.33	20.96	16.59	16.85
					5.28		17.78		18.38	
					12.31		24.77		15.57	
AL4 – 5	19.05.2021	360	148	43	7.47	7.18	19.69	19.05	11.49	12.00
					8.35		18.42		14.04	
					5.71		19.05		10.47	
AL4 – 6	21.05.2021	478	139	29	9.67	8.65	22.23	18.84	14.04	17.87
					7.91		15.88		18.38	
					8.35		18.42		21.19	
AL4 – 7	26.05.2021	526	126	36	10.55	10.70	15.24	18.00	5.11	5.96
					13.19		18.42		7.91	
					8.35		20.33		4.85	
AL4 – 8	28.05.2021	334	168	25	10.99	9.82	20.33	16.94	11.49	15.91
					8.35		12.07		15.83	
					10.11		18.42		20.42	
Monthly Average		352	176	27		9.49		19.61		12.38
Standard Deviation		126	53	10		3.02		2.43		4.67

NS: Not Specified

Table 4B : Results of Air Pollutant Concentration at Gopalpuri Hospital					
Parameter	Date	C_6H_6 [µg/m^3]	HC*	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3	NS	4.0 mg/m^3	NS
AL4 -1	05.05.2021	1.19	BDL	1.53	491
AL4 -2	07.05.2021	1.14	BDL	1.46	498
AL4 -3	12.05.2021	1.37	BDL	1.36	491
AL4 -4	14.05.2021	1.16	BDL	1.68	520
AL4 – 5	19.05.2021	1.32	BDL	1.57	511
AL4 – 6	21.05.2021	1.23	BDL	1.85	465
AL4 – 7	26.05.2021	1.04	BDL	1.46	481
AL4 – 8	28.05.2021	1.19	BDL	1.35	488
Monthly Average		**1.21**	**-**	**1.53**	**493**
Standard Deviation		**0.10**	**-**	**0.17**	**17**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)
NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Gopalpuri Hospital was attributed by vehicle emission produced from light motor vehicles of the colony residents. The mean TSPMvalues at Oil Jetty were 352 µg/m^3, The mean PM_{10} values were 176 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean= 27 µg/m^3). The average values of SO_2, NO_x and NH_3 were 9.49 µg/m^3, 19.61 µg/m^3 and 12.38 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Gopalpuri Hospital. The mean Benzene concentration was 1.21 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.53 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 5: Coal Storage Area (AL-5)

Table 6 : Results of Air Pollutant Concentration at Coal Storage Area										
	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period		24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit		NS	100 µg/m3	60 µg/m3		80 µg/m3		80 µg/m3		400 µg/m3
AL6 – 1	05.05.2021	829	705	33	14.07	14.65	27.95	25.19	7.15	5.36
					18.90		20.96		4.60	
					10.99		26.68		4.34	
AL6 – 2	07.05.2021	814	654	47	12.31	9.23	24.77	19.27	7.40	10.55
					7.91		17.15		8.93	
					7.47		15.88		15.32	
AL6 – 3	12.05.2021	745	667	73	4.40	8.79	8.89	19.90	26.29	21.53
					12.31		24.77		16.59	
					9.67		26.04		21.70	
AL6 – 4	14.05.2021	1040	730	100	12.31	9.82	19.69	21.38	98.54	94.11
					8.79		25.41		57.44	
					8.35		19.05		126.36	
AL6 – 5	19.05.2021	2563	2516	95	7.47	10.84	25.41	25.19	21.95	18.29
					12.75		24.77		10.21	
					12.31		25.41		22.72	
AL6 – 6	21.05.2021	1726	1383	189	12.75	8.65	26.04	22.44	26.55	26.63
					5.71		22.87		27.06	
					7.47		18.42		26.29	
AL6 – 7	26.05.2021	1696	1350	146	12.31	12.16	31.12	23.92	10.72	11.32
					10.55		17.15		15.06	
					13.63		23.50		8.17	
AL6 – 8	28.05.2021	1311	1187	135	11.43	11.87	29.85	26.04	25.02	37.87
					9.23		24.77		42.12	
					14.95		23.50		46.46	
Monthly Average		1341	1149	102		10.75		22.92		28.21
Standard Deviation		627	634	52		2.07		2.57		28.54

NS: Not Specified

Table 5B : Results of Air Pollutant Concentration at Coal Storage Area					
Parameter	Date	C_6H_6 [µg/m³]	HC*	CO [mg/m³]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m³	NS	4.0 mg/m³	NS
AL5 – 1	05.05.2021	1.38	BDL	1.9	522
AL5 – 2	07.05.2021	1.29	BDL	1.59	494
AL5 – 3	12.05.2021	1.14	BDL	1.68	462
AL5 – 4	14.05.2021	1	BDL	1.50	470
AL5 – 5	19.05.2021	1.14	BDL	1.68	462
AL5 – 6	21.05.2021	1.3	BDL	1.6	491
AL5 – 7	26.05.2021	1.17	BDL	1.98	500
AL5 – 8	28.05.2021	1.06	BDL	1.55	490
Monthly Average		**1.19**	**-**	**1.69**	**486**
Standard Deviation		**0.13**	**-**	**0.17**	**21**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)
NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Coal Storage Area was comparatively highest among all the locations of Air Quality monitoring in Kandla Port. High values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_X at this location was due to lifting of coal with grab and other coal handling processes near Berth no. 6 & 7. Moreover, the traffic was also heavy around this place for transport of coal thus emissions produced from heavy vehicles. The mean TSPMvalues at Coal storage were 1341 µg/m³. The mean PM_{10} values were 1149 µg/m³, which is well above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 102 µg/m³). The average values of SO_2, NO_x and NH_3 were 10.75 µg/m³, 22.92 µg/m³ and 28.21 µg/m³ respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Coal Storage Area. The mean Benzene concentration was 1.19 µg/m³, well below the

permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.69 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 6: Tuna Port (AL-6)

Table 5 : Results of Air Pollutant Concentration at Tuna Port

	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period		24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit		NS	100 µg/m3	60 µg/m3		80 µg/m3		80 µg/m3		400 µg/m3
AL5 -1	05.05.2021	83	76	24	4.84	8.65	8.89	10.80	1.79	1.62
					8.35		12.07		2.04	
					12.75		11.43		1.02	
AL5 – 2	07.05.2021	148	121	5	3.08	2.78	11.43	10.59	4.60	5.70
					3.52		12.07		7.40	
					1.76		8.26		5.11	
AL5 – 3	12.05.2021	302	279	10	3.96	3.22	11.43	10.37	13.02	11.49
					3.52		7.62		14.04	
					2.20		12.07		7.40	
AL5 – 4	14.05.2021	208	154	27	3.08	2.93	18.42	14.19	3.06	5.87
					3.96		11.43		7.15	
					1.76		12.70		7.40	
AL5 – 5	19.05.2021	192	145	40	3.08	2.78	7.62	7.62	3.06	5.45
					3.96		8.26		7.40	
					1.32		6.99		5.87	
AL5 – 6	21.05.2021	391	150	25	1.32	2.49	11.43	12.07	6.38	9.62
					2.20		17.15		12.25	
					3.96		7.62		10.21	
AL5 – 7	26.05.2021	628	177	27	3.08	1.47	11.43	9.95	4.08	4.94
					0.44		6.35		7.40	
					0.88		12.07		3.32	
AL5 – 8	28.05.2021	230	178	23	4.84	3.52	11.43	9.95	5.62	6.98
					3.52		7.62		9.96	
					2.20		10.80		5.36	
Monthly Average		273	160	23		3.48		10.69		6.46
Standard Deviation		171	58	11		2.17		1.88		3.01

NS: Not Specified

Table 6B : Results of Air Pollutant Concentration at Tuna Port					
Parameter	Date	C_6H_6 [µg/m³]	HC*	CO [mg/m³]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m³	NS	4.0 mg/m³	NS
AL6 -1	05.05.2021	1.27	BDL	1.67	511
AL6 – 2	07.05.2021	1.01	BDL	1.56	527
AL6 – 3	12.05.2021	1.09	BDL	1.65	496
AL6 – 4	14.05.2021	1.21	BDL	1.57	456
AL6 – 5	19.05.2021	1.02	BDL	1.6	470
AL6 – 6	21.05.2021	1.1	BDL	1.81	462
AL6 – 7	26.05.2021	1.21	BDL	1.5	492
AL6 – 8	28.05.2021	1.26	BDL	1.66	486
Monthly Average		**1.15**	**-**	**1.63**	**488**
Standard Deviation		**0.10**	**-**	**0.09**	**24**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)

NS- Not Specified

The mean TSPM values at Tuna Port were 273 µg/m³, The mean PM_{10} values were 160 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were within the permissible limit (mean = 23 µg/m³ µg/m³). The average values of SO_2, NO_x and NH_3 were 3.48µg/m³, 10.69µg/m³ and 6.46µg/m³ respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Tuna Port. The mean Benzene concentration was 1.15µg/m³, well below the permissible limit of 5.0µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.63 mg/m³, well below the permissible limit of 4.0 mg/m³.

Location 7: Signal Building (Vadinar) (AL-7)

Table 7 : Results of Air Pollutant Concentration at Signal Building										
	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period		**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit			**100 µg/m3**	**60 µg/m3**		**80 µg/m3**		**80 µg/m3**		**400 µg/m3**
AL8 -1	05.05.2021	107	81	25	3.077	2.051	19.69	17.78	6.89	9.28
					1.758		13.97		9.96	
					1.319		19.69		10.98	
AL8 -2	07.05.2021	111	48	33	1.758	2.198	14.61	12.91	10.47	11.40
					1.319		12.70		12.76	
					3.517		11.43		10.98	
AL8 -3	12.05.2021	125	75	22	3.956	2.051	15.88	19.69	10.72	11.57
					0.879		24.14		9.45	
					1.319		19.05		14.55	
AL8 -4	14.05.2021	126	41	50	4.396	4.689	15.88	20.96	13.53	15.06
					3.956		19.69		15.32	
					5.715		27.31		16.34	
AL8 -5	19.05.2021	145	61	56	4.396	2.491	23.50	30.49	16.08	14.89
					0.879		34.30		13.53	
					2.198		33.66		15.06	
AL8 -6	21.05.2021	145	95	28	3.956	4.689	18.42	26.47	10.98	15.91
					5.715		36.20		16.08	
					4.396		24.77		20.68	
AL8 -7	26.05.2021	158	91	19	2.198	2.051	10.79776	20.11	13.52972	13.36
					2.638		24.13618		13.01917	
					1.319		25.4065		13.52972	
AL8 -8	28.05.2021	154	90	30	1.758	1.758	23.50102	15.24	11.23222	11.57
					1.319		9.527439		13.01917	
					2.198		12.70325		10.46639	
Monthly Average		**134**	**73**	**33**		**2.747**		**20**		**13**
Standard Deviation		**19**	**21**	**13**		**1.215**		**6**		**2**

NS: Not Specified

Table 7B : Results of Air Pollutant Concentration at Signal Building					
Parameter	Date	C_6H_6 [µg/m³]	HC*	CO [mg/m³]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m³	NS	4.0 mg/m³	NS
AL7 -1	05.05.2021	1.16	BDL	1.72	488
AL7 – 2	07.05.2021	1.11	BDL	1.66	492
AL7 – 3	12.05.2021	1.02	BDL	1.56	468
AL7 – 4	14.05.2021	1.13	BDL	1.62	477
AL7 – 5	19.05.2021	1.1	BDL	1.72	460
AL7 – 6	21.05.2021	1.22	BDL	1.46	498
AL7 – 7	26.05.2021	1.1	BDL	1.68	462
AL7 – 8	28.05.2021	1.25	BDL	1.5	465
Monthly Average		**1.14**	**-**	**1.62**	**476**
Standard Deviation		**0.07**	**-**	**0.10**	**15**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)

NS_ Not Specified

The mean TSPM values at Vadinar Port were 134 µg/m³. The mean PM_{10} values were 73 µg/m³, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 33 µg/m³ µg/m³). The average values of SO_2, NO_x and NH_3 were 2.74 µg/m³, 20 µg/m³ and 13 µg/m³ respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Vadinar Port. The mean Benzene concentration was 1.14 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.62mg/m³, well below the permissible limit of 4.0 mg/m³.

Location 8: Admin Building (Vadinar) (AL-8)

Table 8 : Results of Air Pollutant Concentration at Admin Building											
	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]		
Sampling Period		24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit			100 µg/m3	60 µg/m3		80 µg/m3		80 µg/m3		400 µg/m3
AL7 -1	05.05.2021	201	89	25	1.319	2.784	5.716	4.234	5.361	6.297
					3.077		5.081		7.658	
					3.956		1.905		5.871	
AL7 -2	07.05.2021	231	77	40	0.440	1.758	5.716	6.775	12.509	11.658
					1.758		8.257		11.232	
					3.077		6.352		11.232	
AL7 -3	12.05.2021	105	88	35	3.956	4.103	8.257	8.892	13.785	15.997
					4.835		8.892		16.083	
					3.517		9.527		18.125	
AL7 -4	14.05.2021	109	126	39	3.077	2.198	7.622	7.834	13.785	13.955
					1.319		8.892		13.019	
					2.198		6.987		15.061	
AL7 -5	19.05.2021	201	124	32	2.638	3.077	17.785	16.938	16.083	12.253
					3.956		15.879		9.956	
					2.638		17.149		10.722	
AL7 -6	21.05.2021	181	85	55	3.956	3.810	18.420	20.749	9.956	15.061
					4.396		19.690		14.551	
					3.077		24.136		20.678	
AL1 -5	26.05.2021	143	123	34	1.758	2.198	13.338	13.338	3.574	5.191
					3.077		9.527		7.148	
					1.758		17.149		4.850	
AL1-6	28.05.2021	119	76	24	2.198	2.344	22.231	15.456	5.361	6.807
					2.198		10.798		7.658	
					2.638		13.338		7.403	
Monthly Average		161	99	36		2.7840		11.777		10.90
Standard Deviation		48	22	10		0.8289		5.718		4.24

NS: Not Specified

Table 8B : Results of Air Pollutant Concentration at Admin Building					
Parameter	Date	C_6H_6 [µg/m³]	HC*	CO [mg/m³]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m³	NS	4.0 mg/m³	NS
AL8 -1	05.05.2021	1.13	BDL	1.88	478
AL8-2	07.05.2021	1.12	BDL	1.72	486
AL8 -3	12.05.2021	1.06	BDL	1.68	492
AL8-4	14.05.2021	1.15	BDL	1.55	482
AL8 -5	19.05.2021	1.02	BDL	1.69	466
AL8-6	21.05.2021	1.1	BDL	1.68	511
AL8-7	28.05.2021	1.08	BDL	1.98	474
AL8-8	30.05.2021	1.13	BDL	1.62	459
Monthly Average		**1.10**	**-**	**1.73**	**481**
Standard Deviation		**0.04**	**-**	**0.14**	**16**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)

NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Admin Building Vadinar was comparatively low among all the locations of Air Quality monitoring in Kandla Port and Vadinar Port. The mean TSPM values at Vadinar Port were 161 µg/m³. The mean PM_{10} values were 99 µg/m³, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 36.0 µg/m³). The average values of SO_2, NO_x and NH_3 were 2.78 µg/m³, 11.77 µg/m³ and 10.90 µg/m³ respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Admin Building, Vadinar Port. The mean Benzene concentration was 1.10 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.73 mg/m³, well below the permissible limit of 4.0 mg/m³.

1.4 Observations and Conclusion

During the monitoring period, the overall Ambient Air Quality of the port area was found to be well within the desired levels for various pollutants. However, Near Coal storage area, Marine Bhavan and Oil Jetty area, PM_{10} values was above the permissible standards. All other pollutants were recorded well below the prescribed limits.

2. Drinking Water Quality Monitoring

Drinking Water Quality Monitoring was carried out at twenty stations at Kandla, Vadinar & Township Area of Deendayal Port.

2.1 Drinking Water Monitoring Methodology

Drinking water samples were collected from 20 locations as prescribed in the tender document. Samples for physico-chemical analysis were collected in 1 liter carboys and samples for microbiological parameters were collected in sterilized bottles. These samples were then analyzed in laboratory for various drinking water parameters at Kandla Lab/Surat.

The Sampling and Analysis was done as per standard methods and CPCB/GPCB Guidelines and Standard Methods -APHA. The water samples were analyzed for various parameters, viz. Color , Odor, Turbidity , Conductivity , pH , Chlorides , TDS, Total Hardness, Iron , Sulphate , Salinity , DO, BOD, Na, K, Ca, Mg, F, NO_3, NO_2, Mn, Cr-6, Cu, Cd, As, Hg, Pb, Zn, Bacterial Count (cfu) .

2.2 Results

The Drinking Water Quality monitoring data for 20 stations are given in below from table No. 9 to Table No. 15

Table 9: Drinking Water Quality Monitoring Parameters for Nirman Building 1, P & C building & Main Gate (North) at Kandla

Sr. No.	Parameter	Unit	Nirman Building 1	P & C building	Main Gate North	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.15	7.26	7.21	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1150	1170	1160	500	2000
3	Turbidity	NTU	3	1	1	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	2475	2314	2614	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2.0	NS*	NS*
8	Chloride as Cl	mg/l	836.86	912.03	861.92	250.0	1000.0
9	Ca as Ca	mg/l	72.14	64.13	80.16	75.0	200.0
10	Mg as Mg	mg/l	72.90	70.47	70.47	30.0	100.0
11	Total Hardness	mg/l	480	450	490	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides as F	mg/l	0.09	0.08	0.12	1.0	1.5
14	Sulphate as SO4	mg/l	130.8	86.4	128.4	200.0	400
15	Nitrite as NO2	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate as NO3	mg/l	4.3648	5.3504	1.6896	45.0	No Relaxation
17	Salinity	‰	1.51	1.65	1.56	NS*	NS*
18	Sodium as Na	mg/l	316	332	558	NS*	NS*
19	Potassium as K	mg/l	6.21	7.08	5.32	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified, BDL : Below Detection Limit

Table 10: Drinking Water Quality Monitoring Parameters for Canteen, West Gate -I&Wharf Area at Kandla

Sr. No.	Parameter	Unit	Canteen	West Gate I	Wharf Area	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.36	7.22	7.84	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1180	1200	1180	500	2000
3	Turbidity	NTU	3	2	BDL	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	2458	2569	2413	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2.0	NS*	NS*
8	Chloride as Cl	mg/l	927.06	856.90	846.88	250.0	1000.0
9	Ca as Ca	mg/l	64.13	68.14	64.13	75.0	200.0
10	Mg as Mg	mg/l	75.33	70.47	70.47	30.0	100.0
11	Total Hardness	mg/l	470	460	450	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides as F	mg/l	0.31	0.59	0.46	1.0	1.5
14	Sulphate as SO4	mg/l	126	112.8	116.4	200.0	400
15	Nitrite as NO2	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate as NO3	mg/l	3.6608	4.7872	3.0976	45.0	No Relaxation
17	Salinity	‰	1.67	1.55	1.53	NS*	NS*
18	Sodium as Na	mg/l	452	306	292	NS*	NS*
19	Potassium as K	mg/l	5.2	6.08	4.30	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified, BDL: Below Detection Limit

Table 11: Drinking Water Quality Monitoring Parameters for Sewa sadan – 3, Workshop I&Custom Building at Kandla

Sr. No.	Parameter	Unit	SewaSadan – 3	Workshop	Custom Building	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.14	7.36	7.14	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1160	1150	1250	500	2000
3	Turbidity	NTU	2	2	BDL	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	2321	2412	2685	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2.0	NS*	NS*
8	Chloride	mg/l	891.98	796.77	891.98	250.0	1000.0
9	Ca as Ca	mg/l	76.15	60.12	64.13	75.0	200.0
10	Mg as Mg	mg/l	72.90	63.18	68.04	30.0	100.0
11	Total Hardness	mg/l	490	410	440	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.18	0.37	0.46	1.0	1.5
14	Sulphate	mg/l	141.6	267.6	278.4	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	5.91	7.32	13.79	45.0	No Relaxation
17	Salinity	‰	1.61	1.44	1.61	NS*	NS*
18	Sodium as Na	mg/l	303	323	299	NS*	NS*
19	Potassium as K	mg/l	4.8	5.4	5.20	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified,BDL: Below Detection Limit

Table 12: Drinking Water Quality Monitoring Parameters for Port Colony Kandla, Hospital Kandla & A.O. Building at Gandhidham

Sr. No.	Parameter	Unit	Port Colony Kandla	Hospital Kandla	A.O. Building	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.55	7.57	7.62	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1170	1170	1330	500	2000
3	Turbidity	NTU	BDL	BDL	1	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	2614	2328	2965	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2.0	NS*	NS*
8	Chloride	mg/l	977.17	746.66	937.08	250.0	1000.0
9	Ca as Ca	mg/l	68.14	72.14	72.14	75.0	200.0
10	Mg as Mg	mg/l	65.61	68.04	72.90	30.0	100.0
11	Total Hardness	mg/l	440	460	480	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.37	0.24	0.53	1.0	1.5
14	Sulphate	mg/l	96	240	250.8	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	2.63	2.33	1.38	45.0	No Relaxation
17	Salinity	‰	1.77	1.35	1.69	NS*	NS*
18	Sodium as Na	mg/l	330	363	441	NS*	NS*
19	Potassium as K	mg/l	4.4	5.30	6.2	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified, BDL: Below Detection Limit

Table 13: Drinking Water Quality Monitoring Parameters for School Gopalpuri, Guest House & E - Type Quarter at Gopalpuri, Gandhidham

Sr. No.	Parameter	Unit	School Gopalpuri	Guest House	E - Type Quarter	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.36	7.21	7.22	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1120	1260	1300	500	2000
3	Turbidity	NTU	1	1	1	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	2588	2463	2881	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2.0	NS*	NS*
8	Chloride	mg/l	896.99	957.13	731.63	250.0	1000.0
9	Ca as Ca	mg/l	68.14	72.14	68.14	75.0	200.0
10	Mg as Mg	mg/l	72.90	72.90	70.47	30.0	100.0
11	Total Hardness	mg/l	470	480	460	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.18	0.59	0.35	1.0	1.5
14	Sulphate	mg/l	238.8	78	67.2	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	12.32	2.112	2.44992	45.0	No Relaxation
17	Salinity	‰	1.62	1.73	1.32	NS*	NS*
18	Sodium as Na	mg/l	413	451	394	NS*	NS*
19	Potassium as K	mg/l	5.4	5.2	4.3	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 14: Drinking Water Quality Monitoring Parameters for F - Type Quarter, Hospital Gopalpuri & Tuna Port

Sr. No.	Parameter	Unit	F - Type Quarter	Hospital Gopalpuri	Tuna Port	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.12	7.28	7.40	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1240	1230	1020.0	500	2000
3	Turbidity	NTU	0	0	0	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Unit	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	2699	2414	1700.0	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	726.62	691.54	682.22	250.0	1000.0
9	Ca as Ca	mg/l	64.13	72.14	72.15	75.0	200.0
10	Mg as Mg	mg/l	80.19	70.47	32.16	30.0	100.0
11	Total Hardness	mg/l	490	470	322.0	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.44	0.57	0.48	1.0	1.5
14	Sulphate	mg/l	180	40.8	103.8	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	19.28	3.38	1.36	45.0	No Relaxation
17	Salinity	‰	1.31	1.25	1.23	NS*	NS*
18	Sodium as Na	mg/l	413	344	356	NS*	NS*
19	Potassium as K	mg/l	3.86	3.93	3.8	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 15: Drinking Water Quality Monitoring Parameters for Vadinar Jetty & Port Colony at Vadinar

Sr. No.	Parameter	Unit	Vadinar Jetty	Port Colony Vadinar	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.41	7.23	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	980	950	500	2000
3	Turbidity	NTU	BDL	BDL	1.0	5.0
4	Odor	-	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	2101	2039	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	NS*	NS*
8	Chloride	mg/l	636.41	596.33	250.0	1000.0
9	Ca as Ca	mg/l	60.12	48.10	75.0	200.0
10	Mg as Mg	mg/l	58.32	60.75	30.0	100.0
11	Total Hardness	mg/l	390.0	370.0	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.39	0.20	1.0	1.5
14	Sulphate	mg/l	30.12	27.72	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	2.89	0.92	45.0	No Relaxation
17	Salinity	‰	1.15	1.08	NS*	NS*
18	Sodium as Na	mg/l	314	299	NS*	NS*
19	Potassium as K	mg/l	6.3	5.9	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent

*NS: Not Specified, BDL: Below Detection Limit

2.3 Results & Discussion

The colour of all drinking water samples was < 5 Hazen unit and odour of the samples was also agreeable. All parameters are found to be within the specified limit of the Drinking water Standard.

pH

The limit of pH value for drinking water is specified as 6.5 to 8.5. pH value in the studied area varied from 7.12 to 7.84 pH unit. All the sampling points showed pH values within the prescribed limit by Indian Standards.

Total Dissolved Solids (TDS)

TDS values in the studied area varied between 1020 -1300 mg/l. None of the sampling points showed higher TDS values than the prescribed limit by Indian standards .

Conductivity

Electrical Conductivity is the ability of a solution to transfer (conduct) electric current. Conductivity is used to measure the concentration of dissolved solids which have been ionized in a polar solution such as water. The conductivity in the samples collected during the month of May ranged from 1700-3000 µs/cm. Electrical conductivity standards do not appear in BIS standards for drinking water.

BOD

BOD value in the studied area was less than 2.0 mg/L. Indian standards does not show any permissible limit for BOD in drinking water.

Chlorides

Excessive chloride concentration increase rates of corrosion of metals in the distribution system. This can lead to increased concentration of metals in the supply. Chloride value in the studied area varied between 680-980 mg/l and is found to be within the Permissible limit of the Drinking Water Standard.

Calcium

Calcium value in the studied area varied between 60 - 90 mg/l and is found to be within the Permissible limit of the Drinking Water Standard. If calcium is present beyond the maximum acceptable limit, it causes incrustation of pipes.

Magnesium

Magnesium value in the studied area varied between 60 – 81 mg/l. All the locations had Magnesium within the prescribed limits of 30-100 mg/L.

Total Hardness

Hardness value in the studied area varied between 322-490 mg/l and is found to be within the Permissible limit of the Drinking Water Standard.The prescribed limit by Indian Standards is 200-600 mg/L.

Iron

Iron value in the studied area was below 0.01mg/L and hence well below the permissible limit as per Indian Standards is 0.3 mg/L. The excess amount of iron causes slight toxicity; gives stringent taste to water.

Fluoride

Fluoride value in the studied area varied between 0.08 – 1.0 mg/l and hence well below the permissible limit as per Indian Standards is 1.0-1.5 mg/L. Moderate amounts lead to dental effects, but long-term ingestion of large amounts can lead to potentially severe skeletal problems.

Sulphates

Sulphate value in the studied area varied between 40 – 280 mg/l. All the sampling points showed sulphate values within the prescribed limits by Indian Standards (200-400 mg/L). Sulphate content in drinking water exceeding the 400 mg/L imparts bitter taste.

Nitrites (NO_2) and Nitrates (NO_3)

Nitrite values in all the water samples were <0.1. There are no specified standard values for Nitrites in Drinking water. The mean Nitrate values in drinking water of KPT was 4.10 mg/l which is well within the permissible limit of the Drinking water Standard.

Salinity

Salinity in drinking water in the present samples collected ranged from 1.2 to 1.8 ‰ . There are no prescribed Indian standards for salinity in Drinking water.

Sodium and Potassium Salts

Sodium values in the samples collected ranged from 290 - 560 mg/l and Potassium salts ranged from 3.8 to 7.1 mg/l. There are no prescribed limits of Sodium and Potassium in Indian standards for Drinking water.

Heavy Metals in Drinking Water

In the present study period drinking water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals were well below the permissible limits prescribed by the Indian Standards.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that Bacteria is not present and hence Bacterial count is in line with the permissible limit of drinking water. This shows that all the drinking water samples were safe from any bacteriological contamination.

2.4 Conclusions

These results are compared with acceptable limits as prescribed in IS 10500:2012 – Drinking Water Specification. It is seen from the analysis data that during the study period the water was safe for human consumption at all drinking water monitoring stations.

3. Noise Level Monitoring

Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships. Noise Monitoring was done at 13 stations at Kandla, Vadinar and Township area.

3.1 Method of Monitoring

Sampling was done at all stations for 24 hour period. Data was recorded using automated sound level meter. The intensity of sound was measured in sound pressure level (SPL) and common unit of measurement is decibel (Db).

3.2 Results

Table 16: Noise Monitoring data for ten locations of Deendayal Port and two locations of Vadinar Port

Sr. No.	Location	Day Time Average Noise Level (SPL) in dB(A)	Night Time Average Noise Level (SPL) in dB(A)
	Sampling Time	**6:00 am to 10:00 PM**	**10:00PM to 6:00 AM**
1	Marine Bhavan	61.45	57.15
2	Nirman Building 1	58.63	52.13
3	Tuna Port	52.15	46.13
4	Main Gate North	62.73	54.59
5	West Gate I	61.62	53.66
6	Canteen Area	58.43	47.39
7	Main Road	63.42	58.60
8	ATM Building	63.76	56.02
9	Wharf Area /Jetty Area	65.09	59.70
10	Port & Custom Office	57.12	50.16
	Vadinar Port		
11	Entrance Gate of Vadinar Port	49.64	48.4
12	Nr. Port Colony, Vadinar	53.12	52.52
13	Nr. Vadinar Jetty	54.4	54.6

3.3 Conclusions- Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships. The Day Time Average Noise Level (SPL)in all ten locations at Deendayal Port ranged from 56.25 dB(A) to 69.51 dB(A) and it was within the permissible limits of 75 dB(A) for the industrial area for the daytime. The Night Time Average Noise Level (SPL) in all ten locations of Deendayal Port ranged from 48.28 dB to 62.33 dB(A) and it was within the permissible limits of 70 dB(A) for the industrial area for the night time.

4. Soil Monitoring

Sampling and analysis of soil samples were undertaken at six locations within the study area (Deendayal Port and Vadinar Port) as a part of EMP. The soil sampling locations are initially decided based on the locations as provided in the tender document of the Deendayal Port.

4.1 Methodology

The soil samples were collected in the month of May 2021. The samples collected from the all locations are homogeneous representative of each location. At random locations were identified at each location and soil was dug from 30 cm below the surface. It was uniformly mixed before homogenizing the soil samples. The samples were filled in polythene bags, labeled in the field with number and site name and sent to laboratory for analysis.

4.2 Results

Table-17: Chemical Characteristics of Soil in the Study Area

Parameter	Unit	Station Name					
		SL1	SL2	SL3	SL4	SL5	SL6
		Tuna Port	IFFCO Plant	Khori Creek	Nakti Creek	KPT Admin Site	KPT Colony
		Near main gate of Port	10 m away from main gate	Sand from creek at low tide		Vadinar	
Texture		Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
pH	-	8.38	8.25	8.13	7.91	8.76	8.85
Electrical Conductivity	µs/cm	29,500.0	44,400.0	39,900.0	38,200.0	260.0	513.0
Moisture	%	14.0	20.91	28.10	26.2	7.26	6.35
Total Organic Carbon	%	0.94	1.52	1.70	1.58	1.16	1.71
Alkalinity	mg/kg	80.08	60.06	70.05	70.05	60.06	70.05
Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloride	mg/kg	7896.2	6866.3	7160.6	9416.7	29.43	40.09
Sulphate	mg/kg	2502.08	804.5	356.6	3966.5	23.2	4.02
Phosphorus	mg/kg	0.76	2.45	7.79	1.66	8.50	7.35
Potassium	mg/kg	1128.0	762.0	578.4	755.8	302.8	152.0
Calcium	mg/kg	320.64	661.32	460.92	821.64	1703.4	1463.0
Sodium	mg/kg	11092.4	5832.2	6336.6	6355.8	246.0	166.0
Copper as Cu	mg/kg	10.20	26.20	29.40	33.70	80.50	71.60
Lead as Pb	mg/kg	5.40	8.50	31.0	15.30	ND	ND
Nickel as Ni	mg/kg	16.70	2020	9.00	25.40	35.30	31.80
Zinc as Zn	mg/kg	22.60	89.10	95.80	87.30	33.20	33.50
Cadmium as Cd	mg/kg	ND	ND	ND	ND	ND	ND

4.3 Discussion

- The data shows that value of pH ranges from 7.91at Nakti Creek to 8.38 at Tuna Creek indicating that all soil sample sare neutral to basic. Iffco plant sampleshowed maximum conductivity of 44,400µmhos/cm, while Tuna port location showed minimum conductivity of 29000µmhos/cm. Conductivity at Vadinar Port was 260 and 513 µmhos/cm at Admin site and Vadinar Port colony respectively.

- Total organic Carbon ranged from 0.94 % to 1.7 at Deendayal Port. At Vadinar Port, organic carbon content ranged from 1.16 % and 1.71 %.

- The concentration of Phosphorus and Potassium in the soil samples varies from 0.76 to 8.0mg/kg and 150.0 to 1130 mg/kg respectively at Deendayal Port. The mean concentration of Phosphorous at Vadinar site was 7.93 mg/kg and mean concentration of Potassium at Vadinar site was 228.0 mg/kg.

These differences in NPK in soil at different locations are due to the dissimilar nature of soil at each of the locations. Samples SL3 & SL4 (Khori Creek & Nakti Creek) are of saline nature as they are coastal soil; where as other locations are inland locations and have different chemical properties.

Heavy Metals in the Soil

Traces of Copper, Lead, Nickel, Zinc were observed in the soil samples collected from all the four locations of Deendayal Port and two locations of Vadinar Port. Cadmium metal was not detected in the Soil.

4.4 Conclusion

The soils of Deendayal Port and Vadinar Port appears to be neutral to basic with varying levels of Chloride, Sulphate, NPK and Calcium. As the nature of soil at different locations are different with respect to its proximity to the sea, the samples showed high degree of variations in their chemical properties.

5. Sewage Treatment Plant Monitoring

This involves safe collection of waste water (spent/used water) from wash areas, bathroom, industrial units, etc., waste from toilets of various buildings and its conveyance to the treatment plant and final disposal in conformity with the requirement and guide lines of State Pollution Control Board and other statutory bodies.

5.1 Methodology for STP Monitoring

To monitor the working efficiency of Sewage Treatment Plant (STP), STP Inlet and Outlet Samples were collected once a week. Locations selected are namely Gopalpuri Township, Deendayal Port and Vadinar. Samples were collected in 1 lit. carboys and were analyzed in laboratory for various parameters.

5.2 Results

Kandla STP

Table 18: Sewage Water Monitoring at Kandla STP (1st Week)

	Date of Sampling		**05.05.21**	
Sr. No.	**Parameters**	**Unit**	**Results**	
			KPT STP I/L	**KPT STP O/L**
1	pH	pH unit	7.53	7.07
2	Total Suspended Solids	mg/l	453.9	95.6
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	373.5	50.5
5	BOD @ 27 °C	mg/l	118.0	14.0
Aeration Tank				
6	MLSS	mg/l	36.0	
7	MLVSS	%	88.0	

Table 19: Sewage Water Monitoring at Kandla STP (2nd Week)

Sr. No.	Parameters	Unit	Results	
	Date of Sampling		**15.05.21**	
			KPT STP I/L	**KPT STP O/L**
1	pH	pH unit	7.29	7.13
2	Total Suspended Solids	mg/l	229.5	50.1
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	434.3	30.3
5	BOD @ 27 °C	mg/l	138.0	8.0
Aeration Tank				
6	MLSS	mg/l	76.0	
7	MLVSS	%	64.0	

Table 20: Sewage Water Monitoring at Kandla STP (3rd Week)

Sr. No.	Parameters	Unit	Results	
	Date of Sampling		**20.05.21**	
			KPT STP I/L	**KPT STP O/L**
1	pH	pH unit	7.53	7.19
2	Total Suspended Solids	mg/l	162.2	84
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	393.9	70.7
5	BOD @ 27 °C	mg/l	122.0	18.0
Aeration Tank				
6	MLSS	mg/l	24.0	
7	MLVSS	%	98.0	

Table 21: Sewage Water Monitoring at Kandla STP (4th Week)

Sr. No.	Parameters	Unit	Results	
	Date of Sampling		**24.05.21**	
			KPT STP I/L	**KPT STP O/L**
1	pH	pH unit	7.64	7.2
2	Total Suspended Solids	mg/l	205.3	50.2
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	272.7	70.7
5	BOD @ 27 °C	mg/l	86.0	19.0
Aeration Tank				
6	MLSS	mg/l	60.0	
7	MLVSS	%	98.0	

Gopalpuri Colony STP

Table 22: Sewage Water Monitoring at Gopalpuri STP (1st Week)

Sr. No.	Parameters	Unit	Results	
	Date of Sampling		**05.05.21**	
			Gopalpuri STP I/L	**Gopalpuri STP O/L**
1	pH	pH unit	7.61	7.25
2	Total Suspended Solids	mg/l	204.7	23.9
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	343.4	70.7
5	BOD @ 27 °C	mg/l	102.0	20.0
Aeration Tank				
6	MLSS	mg/l	20.0	
7	MLVSS	%	88.0	

Table 23: Sewage Water Monitoring at Gopalpuri STP (2nd Week)

Sr. No.	Parameters	Unit	Gopalpuri STP I/L	Gopalpuri STP O/L
	Date of Sampling		**15.05.21**	
			Results	
1	pH	pH unit	7.73	7.21
2	Total Suspended Solids	mg/l	125.8	30.8
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	343.4	50.5
5	BOD @ 27 °C	mg/l	96.0	12.0
Aeration Tank				
6	MLSS	mg/l	13.0	
7	MLVSS	%	99.0	

Table 24: Sewage Water Monitoring at Gopalpuri STP (3rd Week)

Sr. No.	Parameters	Unit	Gopalpuri STP I/L	Gopalpuri STP O/L
	Date of Sampling		**20.05.21**	
			Results	
1	pH	pH unit	7.8	7.2
2	Total Suspended Solids	mg/l	114.3	28.9
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	353.5	50.5
5	BOD @ 27 °C	mg/l	106.0	14.0
Aeration Tank				
6	MLSS	mg/l	2.0	
7	MLVSS	%	99.0	

Table 25: Sewage Water Monitoring at Gopalpuri STP (4th Week)

	Date of Sampling		24.05.21	
Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.85	7.31
2	Total Suspended Solids	mg/l	401	38.7
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	292.9	111.1
5	BOD @ 27 °C	mg/l	94.0	
Aeration Tank				
6	MLSS	mg/l	40.0	
7	MLVSS	%	99.0	

Vadinar STP

Table 26: Sewage Water Monitoring at Vadinar STP (1st Week)

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.23	NOT WORKING
2	Total Suspended Solids	mg/l	160	
3	Residual Chlorine	mg/l	-	
4	COD	mg/l	70.7	
5	BOD @ 27 °C	mg/l	16.0	

Table 27: Sewage Water Monitoring at Vadinar STP (2nd Week)

Sample Collection Date:- 15.05.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	**Vadinar O/L**
1	pH	pH unit	7.31	NOT WORKING
2	Total Suspended Solids	mg/l	152.9	
3	Residual Chlorine	mg/l	-	
4	COD	mg/l	50.5	
5	BOD @ 27 °C	mg/l	14.0	

Table 28: Sewage Water Monitoring at Vadinar STP (3rd Week)

Date of Sampling			20.05.21	
Sr. No.	**Parameters**	**Unit**	**Results**	
			Vadinar STP I/L	**Vadinar O/L**
1	pH	pH unit	7.55	NOT WORKING
2	Total Suspended Solids	mg/l	325.4	
3	Residual Chlorine	mg/l	-	
4	COD	mg/l	56.56	
5	BOD @ 27 °C	mg/l	12.0	

Table 29: Sewage Water Monitoring at Vadinar STP (4th Week)

Date of Sampling			24.05.21	
Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/l
1	pH	pH unit	7.63	Not working
2	Total Suspended Solids	mg/l	102.6	
3	Residual Chlorine	mg/l	-	
4	COD	mg/l	136.4	
5	BOD @ 27 °C	mg/l	38.0	

5.3 Conclusions:

The GPCB standards of BOD, TSS and Residual Chlorine for STP outlet are 20 mg/lit, 30 mg/lit & 0.5 mg/lit respectively. It is suggested to do treatment on regular basis to avoid flow of contaminated/polluted water into the sea. Also, the STP at Vadinar is also non-functional and thus, steps should be taken to commission the STP at Vadinar Port. Hence, currently only inlet samples are collected and analysed.

6. Marine Water Monitoring

The Forty Second Amendment to the Constitution in 1976 underscored the importance of ‘green thinking’. Article 48A enjoins the state to protect and improve the environment and safeguard the forests and wildlife in the country. Further, Article 51A(g) states that the “fundamental duty of every citizen is to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures”.

Policy Statement for Abatement of Pollution (1992) has suggested developing relevant legislation and regulation, fiscal incentives, voluntary agreements and educational programs and information campaigns. It emphasizes the need for integration by incorporating environmental considerations into decision making at all levels by adopting frameworks namely, pollution prevention at source, application of best practicable solution, ensure polluter pays for control of pollution, focus on heavily polluted areas and river stretches and involve public in decision-making. The National Conservation Strategy and Policy Statement on Environment and Development, (1992) aimed at “integrating environmental concerns with developmental imperatives to meet the challenges by redirecting the thrust of our developmental process so that the basic needs of our people could be fulfilled by making judicious and sustainable use of natural resources.” The priorities mentioned in this policy document include the sustainable use of land and water resources, prevention and control of pollution and preservation of biodiversity.

The National Water Policy, (2002) contains provisions for developing, conserving, sustainable utilizing and managing this important water resources and need to be governed by national perspectives.

Marine Environment

On national and state levels, we have several policies and regulation like Water (Prevention and Control of Pollution) Act, 1974, to regulate pollution discharges and restore water quality of our aquatic resources including the prescription of monitoring activities. One of the important provisions of the Water Act, 1974, is to maintain and restore the 'wholesomeness' of our aquatic resources. Water quality monitoring is one of the first steps required in the rational development and management of water resources. In the field of water quality management, there has been a steady evolution in procedures for designing system to obtain information on the changes of water quality. The monitoring comprises all activities to obtain 'information' with respect to the water system.

Sampling Stations

The monitoring of marine environment for the study of biological and ecological parameters was carried out on 10th& 11th May -2021 in harbor regions of KPT and on 10th May-2021 at Vadinar during spring tide period of New moon phase of Lunar Cycle. The monitoring of marine environment for the study of biological and ecological parameters was repeated again on 21st& 22nd May 2021 in harbor regions of KPT. 21st May -2021 in Vadinar during Neap tide period first quarter of Lunar Cycle.

Plankton samples from sub surface layer was collected both during high tide period and low tide period from 3 water quality monitoring stations of KPT harbour area and two stations in Nakti creek and one station in Khori creek. The same sampling schedule was repeated during consecutive spring tide and neap tide in same month. Plankton samples from sub surface layer was collected both during high tide period and low tide period from 1 water quality monitoring stations near Vadinar jetty area during spring tide and neap tide in this month .Collected water samples were processed for estimation of Chlorophyll- a, Pheophytin- a, qualitative &quantitative evaluation of phytoplankton, qualitative &quantitative evaluation zooplanktons (density and their population).

Sampling Locations

Offshore monitoring requirement	Number of locations
Offshore Installations	3 in Kandla creek 2 in Nakti creek 1 in Khori creek 1 near Vadinar Jetty 1 near 1st SBM
Total Number of locations	**8**

6.1 Marine Water Quality

Marine water quality of marine waters of Deendayal Port Harbor waters, Khori and Nakti Creeks and two locations of Vadinar are monitored for various physico-chemical parameters during spring and neap tide of each month.

The results of marine water quality and Marine sediments are as below;

Table 30: Marine Water Quality Monitoring Parameters for location near KPT colony

Parameters	Unit	Kandla Creek Near KPT colony (1) 23°0'58"N 70°13'22."E			
		Spring Tide		Neap Tide	
Tide →		High Tide	Low Tide	High Tide	Low Tide
pH	pH unit	7.15	7.32	7.9	7.25
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	32.6	32.8	33.8	34.7
Turbidity	NTU	28	26	31	23
Total Dissolved Solids	mg/l	36116	39501	43116	46501
Total Suspended Solids	mg/l	189.59	168.55	440.9	423.2
Total Solids	mg/l	45554	42876	55500	63798
DO	mg/l	4.3	4.5	4.7	4.8
COD	mg/l	78.0	80.0	92.0	96.0
BOD	mg/l	<2.0	<2.0	<2.0	<2.0
Silica	mg/l	0.96	0.57	0.54	4.96
Phosphate	mg/l	0.23	0.16	0.21	0.36
Sulphate	mg/l	2532	2712	2532	2712
Nitrate	mg/l	10.63	7.04	1.58	8.02
Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01
Calcium	mg/l	440.88	521.04	521.04	440.88
Magnesium	mg/l	1652.4	1749.6	1846.8	1798.2
Sodium	mg/l	10250	12680	13300	12103
Potassium	mg/l	330	290	378	223
Iron	mg/l	1.76	1.56	1.68	1.83
Chromium	mg/l	0.12	0.10	0.13	0.16
Copper	mg/l	0.06	0.05	0.07	0.08
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.05	0.07	0.06	0.05
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.18	0.16	0.18	0.19
Zinc	mg/l	0.06	0.05	0.07	0.05

Table 31: Marine Water Quality Monitoring Parameters for location near passenger Jetty One at Kandla

Parameters	Unit	Near passenger Jetty One (2) 23° 0'18 "N 70°13'31"E			
		Spring Tide		Neap Tide	
Tide →		**High Tide**	**Low Tide**	**High Tide**	**Low Tide**
pH	pH unit	7.17	7.62	7.6	7.23
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	32.0	32.1	33.2	33.4
Turbidity	NTU	29.0	35.0	38.0	24.0
Total Dissolved Solids	mg/l	38894.0	39271.0	48894.0	49271.0
Total Suspended Solids	mg/l	220.25	268.89	399.6	660.8
Total Solids	mg/l	44586.0	46906.0	53718.0	56698.0
DO	mg/l	4.2	4.4	4.3	5.3
COD	mg/l	78.	80	92	90
BOD	mg/l	<2.0	<2.0	<2.0	<2.0
Silica	mg/l	0.55	0.50	0.76	1.47
Phosphate	mg/l	0.26	0.30	0.33	0.36
Sulphate	mg/l	2532	2412	2532	3420
Nitrate	mg/l	12.74	2.95	6.33	4.48
Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01
Calcium	mg/l	480.96	440.88	601.2	521.04
Magnesium	mg/l	1846.8	1652.4	1846.8	1773.9
Sodium	mg/l	11860.0	11210.0	11761.0	11197.0
Potassium	mg/l	370.0	362.0	355.2	345.0
Iron	mg/l	1.89	1.96	1.68	1.73
Chromium	mg/l	0.11	0.12	0.10	0.11
Copper	mg/l	0.05	0.06	0.05	0.07
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.06	0.05	0.07	0.05
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.17	0.14	0.15	0.18
Zinc	mg/l	0.05	0.05	0.07	0.06

Table 32: Marine Water Quality Monitoring Parameters for location NearCoalBerth

Parameters	Unit	Near Coal Berth 22°59'12"N 70°13'40"E			
		Spring Tide		Neap Tide	
Tide →		High Tide	Low Tide	High Tide	Low Tide
pH	pH unit	7.18	7.35	7.28	7.41
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	32.8	33.1	32.6	33.2
Turbidity	NTU	37.0	38.0	33.0	39.0
Total Dissolved Solids	mg/l	36926.0	36563.0	46926.0	46563.0
Total Suspended Solids	mg/l	391.19	163.3	636.7	719.8
Total Solids	mg/l	43904.0	43300.0	57984.0	53288.0
DO	mg/l	4.3	4.7	4	4.5
COD	mg/l	77.0	68.0	82.0	84.0
BOD	mg/l	<2.0	<2.0	<2.0	<2.0
Silica	mg/l	0.32	0.33	1.45	0.83
Phosphate	mg/l	0.23	0.21	0.36	0.42
Sulphate	mg/l	2136.0	3768.0	2136.0	3768.0
Nitrate	mg/l	8.51	10.91	3.37	2.71
Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01
Calcium	mg/l	561.12	521.04	480.96	561.12
Magnesium	mg/l	1822.5	1749.6	1749.6	1773.9
Sodium	mg/l	11143.0	11052.0	11114.0	10840.0
Potassium	mg/l	343.0	355.0	332.0	371.0
Iron	mg/l	1.56	1.36	1.62	1.53
Chromium	mg/l	0.10	0.11	0.12	0.14
Copper	mg/l	0.05	0.07	0.06	0.08
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.06	0.07	0.05	0.06
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.17	0.15	0.17	0.16
Zinc	mg/l	0.05	0.06	0.06	0.07

Table 33: Marine Water Quality Monitoring Parameters for location Khoricreek at Kandla

Parameters	Unit	KPT 4 Near 15/16 Berth			
		Spring Tide		Neap Tide	
Tide →		High Tide	Low Tide	High Tide	Low Tide
pH	pH unit	7.41	7.5	7.32	7.85
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	32.8	32.02	33.8	32.9
Turbidity	NTU	26.0	24.0	31.0	30.0
Total Dissolved Solids	mg/l	36050.0	35633.0	46050.0	45633.0
Total Suspended Solids	mg/l	245.7	360.56	335.5	637.9
Total Solids	mg/l	46180.0	43700.0	53124.0	50184.0
DO	mg/l	4.3	4.2	4.1	4.4
COD	mg/l	82.0	72.0	90.0	88.0
BOD	mg/l	<2.0	<2.0	<2.0	<2.0
Silica	mg/l	0.86	0.92	0.65	0.77
Phosphate	mg/l	0.46	0.33	0.30	0.38
Sulphate	mg/l	3876.0	3816.0	3876.0	3816.0
Nitrate	mg/l	7.04	9.29	2.31	0.11
Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01
Calcium	mg/l	480.96	561.12	521.04	521.04
Magnesium	mg/l	1822.5	1579.5	1822.5	1846.8
Sodium	mg/l	11000.0	10862.0	10386.0	10909.0
Potassium	mg/l	344.0	352.0	343.0	377.0
Iron	mg/l	1.69	1.36	1.46	1.63
Chromium	mg/l	0.10	0.11	0.13	0.11
Copper	mg/l	0.06	0.07	0.06	0.05
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.07	0.06	0.08	0.06
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.19	0.17	0.18	0.15
Zinc	mg/l	0.07	0.05	0.06	0.08

Table 34: Marine Water Quality Monitoring Parameters for location Nakti Creek near Tuna Port

Parameters	Unit	NaktiCreek NearTuna Port 22°57'49."N 70° 7'0.67"E			
		Spring Tide		Neap Tide	
Tide →		High Tide	Low Tide	High Tide	Low Tide
pH	pH unit	7.29	7.31	7.24	7.65
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	32.0	31.6	33.0	32.6
Turbidity	NTU	28.0	25.0	28.0	26.0
Total Dissolved Solids	mg/l	35493.0	35643.0	45493.0	45643.0
Total Suspended Solids	mg/l	335.59	274.11	513.3	377.0
Total Solids	mg/l	47840.0	47120.0	53992.0	54132.0
DO	mg/l	4.5	4.3	4.7	4.8
COD	mg/l	96.0	90.0	106.0	110.0
BOD	mg/l	<2.0	<2.0	<2.0	<2.0
Silica	mg/l	0.27	0.22	0.61	0.68
Phosphate	mg/l	0.36	0.38	0.46	0.40
Sulphate	mg/l	3348	3492	3348	3492
Nitrate	mg/l	9.5744	3.4496	2.14016	1.0208
Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01
Calcium	mg/l	440.88	521.04	561.12	521.04
Magnesium	mg/l	1798.2	1773.9	1749.6	1871.1
Sodium	mg/l	11062	11110.0	10931.0	10678.0
Potassium	mg/l	352.0	372.0	361.0	358.0
Iron	mg/l	1.71	1.56	1.49	1.53
Chromium	mg/l	0.12	0.13	0.11	0.14
Copper	mg/l	0.08	0.07	0.06	0.07
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.06	0.06	.07	0.05
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.14	0.16	0.15	0.13
Zinc	mg/l	0.06	0.07	0.05	0.05

Table 35: Marine Water Quality Monitoring Parameters for location Nakti Creek Near NH-8A at Kandla

Parameters	Unit	NaktiCreek NearNH-8A 23° 02'01"N 70° 09'31"E			
		Spring Tide		Neap Tide	
Tide →		High Tide	Low Tide	High Tide	Low Tide
pH	pH unit	7.83	Sampling not possible during Low Tide	7.55	Sampling not possible during Low Tide
Color	-	Colorless		Colorless	
Odor	-	Odorless		Odorless	
Salinity	ppt	32.2		33.6	
Turbidity	NTU	48.0		27.0	
Total Dissolved Solids	mg/l	40293.0		55593.0	
Total Suspended Solids	mg/l	733.38		510.6	
Total Solids	mg/l	47052.0		67651.0	
DO	mg/l	3.5		4.5	
COD	mg/l	106.0		100.0	
BOD	mg/l	<2.0		<2.0	
Silica	mg/l	0.95		1.67	
Phosphate	mg/l	0.68		0.72	
Sulphate	mg/l	2184		4584	
Nitrate	mg/l	15.2768		8.096	
Nitrite	mg/l	0.00425		0.009833	
Calcium	mg/l	521.04		480.96	
Magnesium	mg/l	1798.2		2016.9	
Sodium	mg/l	11412.0		11503.0	
Potassium	mg/l	386.0		395.0	
Iron	mg/l	1.62		1.59	
Chromium	mg/l	0.11		0.13	
Copper	mg/l	0.07		0.08	
Arsenic	mg/l	<0.01		<0.01	
Cadmium	mg/l	0.04		0.06	
Mercury	mg/l	<0.001		<0.001	
Lead	mg/l	0.18		0.17	
Zinc	mg/l	0.06		0.07	

Table 36: Marine Water Quality Monitoring Parameters for locations Nr. Vadinar Jetty

Parameters	Unit	Nr.VadinarJetty 22°26'25.26"N 69°40'20.41"E			
		Spring Tide		Neap Tide	
Tide →		High Tide	Low Tide	High Tide	Low Tide
pH	pH unit	7.21	7.51	7.25	7.32
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	32.2	31.8	32.4	32.6
Turbidity	NTU	3.0	8.0	26.0	23.0
Total Dissolved Solids	mg/l	30832.0	30960.0	40832.0	40960.0
Total Suspended Solids	mg/l	287.58	177.64	117.9	267.6
Total Solids	mg/l	48284.0	49576.0	49960.0	50155.0
DO	mg/l	5.2	5.0	5.1	5.2
COD	mg/l	82.0	78.0	86.0	82.0
BOD	mg/l	<2.0	<2.0	<2.0	<2.0
Silica	mg/l	0.15	0.17	0.22	0.22
Phosphate	mg/l	0.26	0.18	0.36	0.22
Sulphate	mg/l	3012.0	2772.0	2652.0	2460.0
Nitrate	mg/l	6.688	6.336	5.984	6.688
Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01
Calcium	mg/l	480.96	521.04	480.96	440.88
Magnesium	mg/l	1530.9	1603.8	1676.7	1749.6
Sodium	mg/l	11820.0	12060.0	11862.0	11960.0
Potassium	mg/l	338.0	346.0	356.0	333.0
Iron	mg/l	1.65	1.52	1.46	1.72
Chromium	mg/l	0.11	0.10	0.13	0.14
Copper	mg/l	0.06	0.05	0.07	0.05
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.04	0.06	0.05	0.07
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.14	0.17	0.15	0.16
Zinc	mg/l	0.06	0.07	0.05	0.06

Trace Metals

In the present study period water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals reported at trace levels.

6.1.1 Marine Sediments

Sediment samples were collected with Van Veen Grab from the six locations in Kandla Port Waters and two locations in Vadinar Port. Samples were collected and preserved in silver foil in ice box to prevent the contamination/decaying of the samples.

6.2 Results

The Sediment Quality results are given in below from table no. 33Table 34A: Results of Analysis of Sediment of Kandla & Vadinar Port (Spring Tide)

Sr. No.	Parameters	Unit	KPT - 1	KPT - 2	KPT - 3	Nakti Creek Near Tuna Port	Nakti - 1 (Near NH-8A)	Jetty
1	Texture		Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	mg/kg	0.86	1.88	1.20	1.96	1.78	1.36
3	Organic Carbon	mg/kg	0.86	0.96	0.87	0.65	0.83	0.68
4	Inorganic Phosphate	mg/kg	126.0	136.0	186.0	177.0	162.0	165.0
5	Moisture	%	16.60	17.36	18.20	20.2	17.52	24.62
6	Aluminium	mg/kg	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	33.0	26.0	44.0	56.0	42.6	43.6
8	Phosphate	mg/kg	11.52	10.52	11.02	9.56	10.62	18.00
9	Sulphate	mg/kg	258.0	272.0	168.0	186.0	162.0	152.0
10	Nitrite	mg/kg	0.1	0.15	0.13	0.12	0.11	0.12
11	Nitrate	mg/kg	11.20	8.42	11.82	9.04	16.02	8.52
12	Calcium	mg/kg	358.0	275.0	425.0	349.0	356.0	402.0
13	Magnesium	mg/kg	186.0	145.0	178.0	152.0	186.0	202.0
14	Sodium	mg/kg	8625.0	7952.0	9583.0	7789.0	9645.0	9785.0
15	Potassium	mg/kg	387.0	389.0	489.0	687.0	888.0	782.0
16	Chromium	mg/kg	135.03	186	142.2	135.6	87.6	175
17	Nickel	mg/kg	22.2	28.6	24.6	27	31	36
18	Copper	mg/kg	56	32.6	20.52	28.2	36.2	24.5
19	Zinc	mg/kg	36.25	42.00	34.50	42.00	35.00	38.00
20	Cadmium	mg/kg	ND	ND	ND	ND	ND	ND
21	Lead	mg/kg	3.06	2.6	7.2	6.2	7.2	6.2
22	Mercury	mg/kg	ND	ND	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND	ND	ND

*Grab samples could not be collected due high current at Vadinar SBM

Table 34B: Results of Analysis of Sediment of Kandla & Vadinar Port (Neap Tide)

Sr. No.	Parameters	Unit	KPT - 1	KPT - 2	KPT - 3	Nakti Creek Near Tuna Port	Nakti - 1 (Near NH-8A)	Jetty
1	Texture		Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
2	Organic Matter	mg/kg	1.03	1.78	1.07	1.78	0.77	1.08
3	Organic Carbon	mg/kg	0.59	1.03	0.62	1.03	0.44	0.86
4	Inorganic Phosphate	mg/kg	163.0	133.0	126.0	186.0	204.0	210.0
5	Moisture	%	14.94	13.40	14.26	18.84	18.45	19.62
6	Aluminum	mg/kg	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	20.62	23.33	30.6	31.52	33.50	33.61
8	Phosphate	mg/kg	11.2	16.64	9.39	12.30	17.70	16.22
9	Sulphate	mg/kg	359.8	281.0	252.0	248.0	266.0	325.0
10	Nitrite	mg/kg	0.10	0.11	0.1	0.12	0.14	0.15
11	Nitrate	mg/kg	11.3	8.9	10.02	11.52	12.62	11.66
12	Calcium	mg/kg	341.0	200.0	301.0	241.0	341.0	322.0
13	Magnesium	mg/kg	207.0	231.0	158.0	231.0	219.0	186.0
14	Sodium	mg/kg	11210.0	11524.0	11452.0	9312.0	9236.0	11120.0
15	Potassium	mg/kg	480.0	486.0	355.0	865.0	878.0	362.0
16	Chromium	mg/kg	165.5	179	134.4	88.7	61.22	210.4
17	Nickel	mg/kg	21.8	30.5	23.6	22	22.62	23.9
18	Copper	mg/kg	74.3	19.4	13.7	17.1	12.62	84.7
19	Zinc	mg/kg	24.00	39.40	34.50	33.50	49.29	84.70
20	Cadmium	mg/kg	ND	ND	1.39	1.22	1.35	ND
21	Lead	mg/kg	ND	4.2	4.4	4.4	6.66	ND
22	Mercury	mg/kg	ND	ND	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND	ND	ND

*Grab samples could not be collected due high current at KPT 2, Vadinar Jetty and Vadinar SBM

INTRODUCTION:

The Forty Second Amendment to the Constitution in 1976 underscored the importance of 'green thinking'. Article 48A enjoins the state to protect and improve the environment and safeguard the forests and wildlife in the country. Further, Article 51A(g) states that the "fundamental duty of every citizen is to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures".

Policy Statement for Abatement of Pollution (1992) has suggested developing relevant legislation and regulation, fiscal incentives, voluntary agreements and educational programs and information campaigns. It emphasizes the need for integration by incorporating environmental considerations into decision making at all levels by adopting frameworks namely, pollution prevention at source, application of best practicable solution, ensure polluter pays for control of pollution, focus on heavily polluted areas and river stretches and involve public in decision-making. The National Conservation Strategy and Policy Statement on Environment and Development, (1992)aimed at "integrating environmental concerns with developmental imperatives to meet the challenges by redirecting the thrust of our developmental process so that the basic needs of our people could be fulfilled by making judicious and sustainable use of natural resources." The priorities mentioned in this policy document include the sustainable use of land and water resources, prevention and control of pollution and preservation of biodiversity.

The National Water Policy, (2002) contains provisions for developing, conserving, sustainable utilizing and managing this important water resources and need to be governed by national perspectives.

MARINE ENVIRONMENT:

On national and state levels, we have several policies and regulation like Water (Prevention and Control of Pollution) Act, 1974, to regulate pollution discharges and restore water quality of our aquatic resources including the prescription of monitoring activities. One of the important provisions of the Water Act, 1974, is to maintain and restore the 'wholesomeness' of our aquatic resources. Water quality monitoring is one of the first steps required in the rational development and management of water resources. In the field of water quality management, there has been a steady evolution in procedures for designing system to obtain information on the changes of water quality. The monitoring comprises all activities to obtain 'information' with respect to the water system.

Sampling Stations:

The monitoring of marine environment for the study of biological and ecological Parameters was carried out on11thMay, 2021 in in harbour region of DPT, 12thMay,2020in creeks near by the port during spring tide .The monitoring of marine environment for the study of biological and ecological parameters was repeated again on 21stMay ,2020 in harbour region of DPT, 22nd May ,2021 in creeks near by the port .

Plankton samples from sub surface layer was collected both during high tide period and low tide period from 3 water quality monitoring stations of DPT harbour area andone stations in Nakti creek and one station in Khori creek. Sampling at second sampling station of Nakti creek was possible only during high tide period. Collected water samples were processed for estimation of Chlorophyll- a, Pheophytin- a, qualitative &quantitative evaluation of phytoplankton, qualitative &quantitative evaluation zooplanktons(density and their population).

TABLE #1 SAMPLING LOCATIONS

monitoring requirement	**Number of locations**
Kandla creek Nakti creek Khori Creek	3 in Kandla creek 2 in Nakti creek 1 in Khori creek
Total Number of locations	**6**

Sampling methodology adopted:

A marine sampling is an estimation of the body of information in the population. The theory of the sampling design is depending upon the underlying frequency distribution of the population of interest. The requirement for useful water sampling is to collect a representative sample of suitable volume from the specified depth and retain it free from contamination during retrieval.

Pump sampler was used to sample sea water from the sub surface. 500 litters of the water sample were collected from Sub surface by using pump sampler. The collected samples were first collected in a clean bucket to reduce the heterogeneity. From the collected water sample 1 litter of water sample were taken in an opaque plastic bottle for chlorophyll estimation, thereafter plankton samples were collected by using filtration assembly with nilyobolt cloth of 20µm mesh size.

Samples Processing for chlorophyll estimation:

Samples for the chlorophyll estimation were preserved in ice box on board in darkness to avoid degradation in opaque container covered with aluminium foil. Immediately after reaching the shore after sampling, 1 litter of collected water sample was filtered through GF/F filters (pore size 0.45 µm) by using vacuum filtration assembly. After vacuum filtration the glass micro fiber filter paper was grunted in tissue grinder, macerating of glass fiber filter paper along with the filtrate was done in 90% aqueous Acetone in the glass tissue grinder with glass grinding tube. Glass fiber filter paper will assist breaking the cell during grinding and chlorophyll content was extracted with 10 ml of 90% Acetone, under cold dark conditions along with saturated magnesium carbonate solution in glass screw cap tubes. After an extraction period of 24 hours, the samples were transferred to calibrated centrifuge tubes and adjusted the volume to original volume with 90% aqueous acetone solution to make up the evaporation loss. The extract was clarified by using centrifuge in closed tubes. The clarified extracts were then decanted in clean cuvette and optical density was observed at wavelength 664, 665 nm. By using corrected optical density, Chlorophyll-a value was calculated as given in (APHA, 1998).

PLANKTON:

The entire area open water in the sea is the pelagic realm. Pelagic organisms live in the open sea. In contrast to the pelagic realm, the benthic realm comprises organisms and zone of the bottom of the sea. Vertically the pelagic realm can be dividing into two zones based on light penetration; upper photic or euphotic zone and lower dark water mass, aphotic zone below the photic zone.

The term plankton is general term for organisms have such limited powers of locomotion that they are at the mercy of the prevailing water movement. Plankton is subdivided to phytoplankton and zooplankton. Phytoplankton is free floating organisms that are capable of photosynthesis and zooplankton is the various free floating animals.

Pelagic zone, represents the entire ocean water column from the surface to the deepest depths, is home to a diverse community of organisms. Differences in their locomotive ability categorize the organisms in the pelagic realm into two, ***plankton*** and ***nekton*** (Lalli and Parsons, 1997). ***Plankton*** consists of all organisms drifting in the water and is unable to swim against water currents, whereas ***Nekton*** includes organisms having strong locomotive power. Ecological studies on the plankton community, which form the base of the aquatic food chain, help in the better understanding of the dynamics and functioning of the marine ecosystem. The term 'Plankton' first coined by Victor Hensen (1887), Plankton, (Greek word: *planktos*meaning "passively drifting or wandering") is defined as drifting or free-floating organisms that inhabit the pelagic zone of water. Based on their mode of nutrition planktonic organisms are categorised into phytoplankton (organisms having an autotrophic mode of nutrition) and zooplankton (organisms having a heterotrophic mode of nutrition).

Phytoplankton in the marine environment:

Phytoplankton is free floating unicellular, filamentous and colonial eutrophic organisms that grow in aquatic environments whose movement is more or less dependent upon water currents. These micro flora acts as primary producers as well as the basis of food chain, source of protein, bio purifier and bio indicators of the aquatic ecosystems of which diverse array of the life depends .They are considered as an important component of aquatic flora, play a key role in maintaining equilibrium between abiotic and biotic components of aquatic ecosystem.

The phytoplankton includes a wide range of photosynthetic and phototrophic organisms. Marine phytoplankton is mostly microscopic and unicellular floating flora, which are the primary producers that support the pelagic food-chain. The two most prominent groups of phytoplankton are diatoms (Bacillariophyceae) and dinoflagellates (Dinophyceae).The phytoplankton those normally captured in the net from the Gulf of Kutch is normally dominated by these two major groups; diatoms and dinoflagellates. Phytoplankton also include numerous and diverse collection of extremely small, motile algae which are termed micro flagellates (naked flagellates) as well as and Cyanophytes (blue-green algae).

Algae are an ecologically important group in most aquatic ecosystems and have been an important component of biological monitoring programs. Algae are ideally suited for water quality assessment because they have rapid reproduction rates and very short life cycles, making them valuable indicators of short-term impacts.

Aquatic populations are impacted by anthropogenic stress, resulting in a variety of alterations in the biological integrity of aquatic systems. Algae can serve as an indicator of the degree of deterioration of water quality, and many algal indicators have been used to assess environmental status.

Zooplankton in the marine environment:

Zooplankton includes a taxonomically and morphologically diverse community of heterotrophic organisms that drift in the waters of the world's oceans. Qualitative and quantitative studies on zooplankton community is a prerequisite to delineate the ecological processes active in the marine ecosystem. Zooplankton community plays a pivotal role in the pelagic food web as the primary consumers of phytoplankton and act as the food source for organisms in the higher trophic levels, particularly the economically essential groups such as fish larvae and fishes. They also function in the cycling of elements in the marine ecosystem. The dynamics of the zooplankton community, their reproduction, growth and survival rate are all significant factors determining the recruitment and abundance of fish stocks as they form an essential food for larval, juvenile and adult fishes (Beaugrand et al., 2004). Zooplankton grazing in the marine environment controls the primaryProduction and helps in determining the pelagic ecosystem (Banse, 1995). Through grazing in surface waters and following the production of sinking faecal matters and also by the active transportation of dissolved and particulate matter to deeper waters via vertical migration, they help in the transport of organic carbon to deep ocean layers and thus act as key drivers of biological pump’ in the marine ecosystem. Zooplankton grazing and metabolism also, transform particulate organic matter into dissolved forms, promoting primary producer community, microbial demineralization, and particle export to the ocean’s interior.

The categorisation of zooplankton into various ecological groups is based on several factors such as duration of planktonic life, size, food preferences and habitat. As they vary significantly in size from microscopic to metazoic forms, the classification of zooplankton based on size has paramount importance in the field of quantitative plankton research.

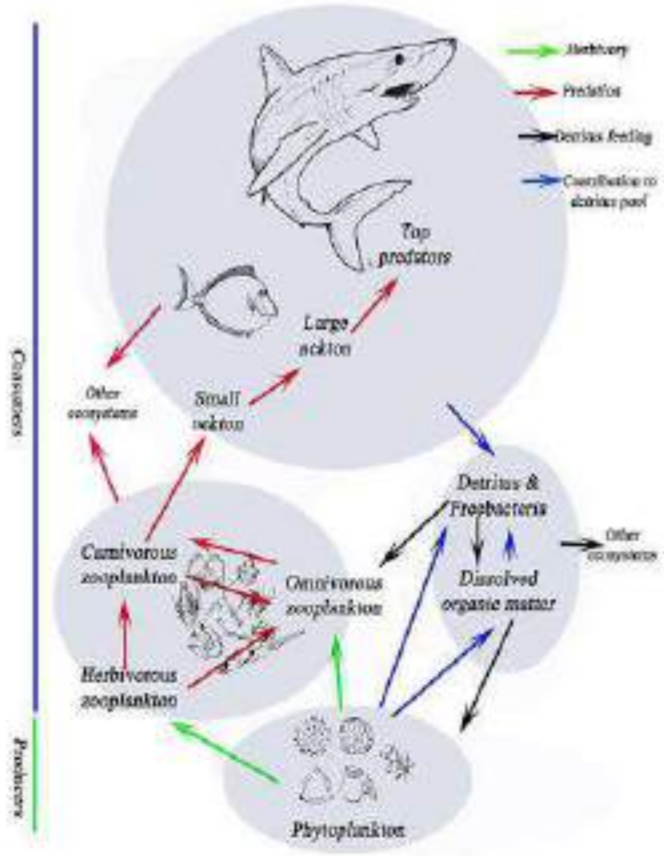
Based on the duration of planktonic life, zooplankton are categorised into Holoplankton (organisms which complete their entire lifecycle as plankton) and Meroplankton (organisms which are planktonic during the early part of their lives such as the larval stages of benthic and nektonic organisms). Tychoplankton are organisms which live a brief planktonic life, such as the benthic crustaceans (cumaceans, mysids, isopods) which ascend to the water column at night for feeding and certain ectoparasitic copepods, they leave the host and spend their life as plankton during their breeding cycle.

Zooplankton can be subdivided into holoplankton, i.e., permanent members of the plankton (e.g., Calanoid copepods), and meroplankton, i.e., temporary members in the plankton e.g., larvae of fish, shrimp, and crab). The meroplankton group consists of larval and young stages of animals that will adopt a different lifestyle once they mature. In contrast to phytoplankton which consist of a relatively smaller variety of organisms, Zooplankton are extremely divers, consist of a host of larval and adult forms representing many animal phylum.

Among the zooplankton one group always dominate than others; members of sub class copepods (Phylum Athropoda), and Tintinids (Phylum Protozoa) among the net planktons. These small animals are of vital importance in marine ecosystem as one of the primary herbivores animals in the sea, and it is they provide vital link between primary producer (autotrophs) and numerous small and large marine consumers.

As their community structure and function are highly susceptible to changes in the environmental conditions regular monitoring of their distribution as well as their interactions with various physicochemical parameters is inevitable for the sustainable management of the ecosystem (Kusum et al., 2014). Of all the marine zooplankton groups, copepods mainly calanoid copepods are the dominant groups in marine subtropical and tropical waters and exhibit considerable diversity in morphology and habitats they occupy (Madhupratap, 1991;)

It has been well established that potential of pelagic fishes viz. finfishes, crustaceans, molluscs and marine mammals either directly or indirectly depend on zooplankton. The herbivorous zooplankton is efficient grazers of the phytoplankton and is referred to as living machines transforming plant material into animal tissue. Hence they play an essential role as the intermediaries for nutrients/energy transfer between primary and tertiary trophic levels. Due to their large density, shorter lifespan, drifting nature, high group/species diversity and different tolerance to the stress, they used as the indicator organisms for the physical, chemical and biological processes in the aquatic ecosystem (Ghajbhiye, 2002).



Simplified marine food web

Spatial distribution of Plankton:

A characteristic of plankton population is that they tend to occur in patches, which are varying spatially on a scale of few meters to far as few kilometres in distance. They also vary in time scale, season as well as vertically in the water column. It is this patchiness and its constant changes in time and spot, that has made it so difficult for plankton biologist to learn about the ecology of plankton. The biological factors that causes this patchiness is due to the ability of zooplankton to migrate vertically and graze out the phytoplankton at a rapid rate that can create patchiness. Similarly the active swimming ability by certain zooplankton organisms can cause to aggregate in dense group.

At its most extreme, because the water in which plankton is suspended is constantly moving, each sample taken by the plankton biologists remain a different volume of water, so each sample is unique and replicate does not exist.

Plankton may also exhibit vertical patchiness. Physical factors contribute to this type of patchiness include light intensity, nutrients and density gradients in the water column. Phytoplankton in particular tends to be unequally distributed vertically, which leads to the existence of different concentration of a chlorophyll value between photic zone and below the photic zone.

Methodology adopted for Plankton sampling:

Mixed plankton sample were obtained from the sub surface layer at each sampling locations by towing the net horizontally with the weight .After the tow of about 15-30minutes, plankton net was pulled up and washed down to the tail and collected the plankton adhered to plankton net in the collection bucket at the bottom by springing outer and inner surface of the net with sea water, while the net was hanging with the mouth upward. For quantitative evaluation 100 L water samples were collected from subsurface layer and filtered through 20µm mesh size net by using pump and filtration assembly.

Preservation and storage:

Both filtered plankton and those collected from the plankton net were preserved with 5% buffered formalin and stored in 1L plastic container for further processing in the laboratory.

Sample concentration:

The collected plankton samples were concentrated by using centrifuge and made up to 50 ml with 5% formalin -Glycerine mixture.

Taxonomic evaluation:

Before processing, the sample was mixed carefully and a subsample was taken with a calibrated Stempel-pipette. 1 ml of the concentrated plankton samples were transferred on a glass slide with automatic pipette. The plankton sample on the glass slides were stained by using Lugol's iodine and added glycerine to avoid drying while observation. The plankton samples were identified by using Labex triangular Research microscope with photographic attachment. Microphotographs of the plankton samples were taken for record as well as for confirming the identification. The bigger sized zooplankton was observed through dissecting stereomicroscope with magnification of 20-30 x. Plankton organisms in the whole slide were identified to the lowest axon possible. A thorough literature search was conducted for the identification of the different groups of zooplankton that were encountered

Cell counts by drop count method:

The common glass slide mounted with a 1ml of concentrated phytoplankton/zooplankton sample in glycerol and covered with cover slip 22x 60mm was placed under the compound microscope provided with a mechanical stage. The plankton was then counted from the microscopic field of the left top corner of the slide. Then slide is moved horizontally along the right side and plankton in each microscopic field was thus counted. When first microscopic field row was finished the next consecutive row was adjusted using the mechanical device of the stage. In this way all the plankton present in entire microscopic field are counted. From this total number in 1ml of the concentrated plankton, total number of plankton in the original volume of sample filtered was calculated as units/L.

BENTHIC ORGANISMS:

Benthos is those organisms that are associated with the sea bed or benthic habitats. Epi-benthic organisms live attached to a hard substratum or rooted to a shallow depth below the surface. In fauna organisms live below the sediment–water interface. Interstitial organisms live and move in pore water among sedimentary grains.

Because the benthic organisms are often collected and separated on sieves, a classification based on the overall size is used. Macro benthos include organisms whose shortest dimension is greater than or equal to 0.5 mm. Meio benthos are smaller than 0.5mm but larger than 42µ in size.

The terms such as macro fauna and Meio fauna generally have little relevance with taxonomic classification. The terms Meio fauna and macro fauna depend on the size. Meio fauna were considered as good bioassay of community health and rather sensitive indicators of environmental changes

SAMPLING METHODOLOGY ADOPTED FOR SUB TIDAL REGION:

Van veen sampler ($0.0929m^2$) was used for sampling bottom sediments. Two sets of sediments were sampled from each location, one for macro fauna and other for Meio fauna. The macro fauna in the sediments were sieved on board to separate out the organisms. The fixation of Meio fauna is normally done by bulk fixation of the sediment sample. The bulk fixation is done by using 10% formalin (Buffered with borate). The organisms were preserved with seawater as diluting agent.

Sample sieving:

Sediments samples were sieved to extract the organisms. Sieving was performed carefully as possible to avoid any damage to the animals. The large portion of the sediment was split in to smaller portions and mixed with sea water in a bucket. The cohesive lumps were broken down by continuous stirring. The disaggregated sediments were then passed through the sieves.

Sample staining:

Sorting of the Meio fauna from the sieve is difficult task especially in the preserved material, because organisms are not easily detectable. To facilitate the animal detection the entire sample retained on the sieve after sieving operation were stained by immersing the sieve in a flat bottom tub with 1% Rose Bangal stain; a protein stain. A staining period of 10-30 minutes is sufficient for sample detection.

DIVERSITY INDICES:

On the whole, diversity indices provide more information about community composition than simply species richness (number of species present); they also, take the relative abundances of different species into account. Based on this fact, diversity indices therefore depend not only on species richness but on the evenness, or equitability, with which individuals are distributed among the different species (Magurram, A. E. (1988)

A diversity index is a measure of species diversity within a community that consists of co-occurring populations of several (two or more) different species. It includes two components: richness and evenness. Richness is the measure of the number of different species within a sample showing that more the types of species in a community, the higher is the diversity or greater is the richness. Evenness is the measure of relative abundance of the different species with in a community.

The basic idea of diversity index is to obtain a quantitative estimate of biological variability that can be used to compare biological entities composed of discrete components in space and time (Carol H.R. *etal*. 1998). Biodiversity is commonly expressed through indices based on species richness and species abundances (Whittaker 1972, Lande 1996, Purvis and Hector 2000). Biodiversity indices are a non-parametric tool used to describe the relationship between species number and abundance. The most widely used bio diversity indices are Shannon Weiner index and Simpson's index.

A diversity Index is a single statistic that incorporates in formation on richness and evenness. The diversity measures that incorporate the two concepts may be termed heterogeneity measures (Magurran, 2004).

Any study intended to interpret causes and effect of adverse impact on Biodiversity of communities require suitable measures to evaluate specie richness and Diversity. The former is number of species in community, while latter is a function of relative frequency of different species. Species richness is the iconic measure of biological diversity (Magurran, 2004). Several indices have been created to measure the diversity of species; however, the most widely used in the last decades are the Shannon (1948) and Simpson (1949) (Buzas and Hayek 1996; Gorelick 2006), with the components of diversity: richness (*S)* and evenness (*J)*

Simpson's diversity index

Simpson's index (**D**) is a measure of diversity, which takes into account both species richness, and evenness of abundance among the species present.. The Simson index is one of the meaningful and robust biodiversity measures available.(Magurran ,2004).

The formula for calculating D is presented as:

$$D = \frac{\sum n_i(n_i - 1)}{N(N-1)}$$

Where n_i = the total number of organisms of each individual species

N = the total number of organisms of all species

The value of D ranges from 0 to 1. With this index, 0 represents infinite diversity and, 1, no diversity. When D increases diversity decreases. Simpson's index is therefore usually expressed as 1-D or 1/D. (Magurran, 2004)

Low species diversity suggests:

- relatively few successful species in the habitat
- the environment is quite stressful with relatively few ecological niches and only a few organisms are really well adapted to that environment
- food webs which are relatively simple
- change in the environment would probably have quite serious effects

High species diversity suggests:

- a greater number of successful species and a more stable ecosystem
- more ecological niches are available and the environment is less likely to be hostile complex food webs
- environmental change is less likely to be damaging to the ecosystem as a whole

Species richness indices

The species richness***(S)*** is simply the number of species present in an ecosystem. Species richness Indices of species richness are widely used to quantify or monitor the effects of anthropogenic disturbance. A decline in species richness may be concomitant with severe or chronic human-induced perturbation (Fair Fair weather 1990,) Species richness measures have traditionally been the mainstay in assessing the effects of environmental degradation on the biodiversity of natural assemblages of organisms (Clarke &Warwick, 2001)

Species richness is the iconic measure of biological diversity (Magurran, 2004). The species richness***(S)*** is simply the number of species present in an ecosystem. This index makes no use of relative abundances. The term species richness was coined by

McIntosh (1967) and oldest and most intuitive measure of biological diversity (Magurran, 2004).

Margalef's diversity index is a species richness index. Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, were derived.

The value of a diversity index increases both when the number of types increases and when evenness increases. For a given number of types, the value of diversity index is maximised when all types are equally abundant (Rosenzweig, M. L. (1995).

Shannon-Wiener's index:

An index of diversity commonly used in plankton community analyses is the Shannon-Wiener's index **(H),** which emphasizes not only the number of species (richness or variety), but also the apportionment of the numbers of individuals among the species (Odum 1971 and Reish 1984). Shannon-Wiener's index **(H)** reproduce community parameters to a single numberby using an equation.

$$H' = -\sum_{i=1}^{s} \frac{n_i}{N} \ln\left(\frac{n_i}{N}\right)$$

Shannon and Weiner index represents entropy. It is a diversity index taking into account the number of individuals as well as the number of taxa. It varies from 0 for communities with only single taxa to high values for community with many taxa each with few individuals. This index can also determine the pollution status of a water body. Normal values range from 0 to 4. This index is a combination of species present and the evenness of the species. Examining the diversity in the range of polluted and unpolluted ecosystems, Wilham and Dorris (1968) concluded that the values of the index greater than 3 indicate clean water, values in the range of 1 to 3 are characterized by moderate pollution and values less than 1 are characterized as heavily polluted

RESULTS:

CHLOROPHYLL-a:

Water Samples for the chlorophyll estimation were collected from sub surface layer during high tide and low tide period of the tidal cycle for each sampling locations and analysed for Chlorophyll -a and after acidification for Pheophytin –a. Chlorophyll- a value was used as algal biomass indicator (APHA,1998) Algal biomass was estimated by converting Chlorophyll value.

In the sub surface water chlorophyll-a was varying from 0.291 -0.630mg/m^3.in harbour region of DPT during sampling done in spring tide period of May,2021. In the nearby creeks chlorophyll-a was varying from 0.476 -0.872 mg/m^3.Pheophytin –a level was below detectable limit- the all the sampling stations during spring in the harbour region of DPT.

In the sub surface water chlorophyll-a was varying from 0.526 -0.818 mg/m^3.in harbour region of DPT during sampling done in neap tide period of May ,2021. In the nearby creeks chlorophyll-a was varying from 0.399-0.743 mg/m^3.·Pheophytin –a level was below detectable limit- the all the sampling stations during spring in the harbour region of DPT

TABLE #2 VARIATIONS IN CHLOROPHYLL –A PHEOPHYTIN- A AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN MAY,2021

Sr.No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREA					
1	KPT1	High tide	0.3158	BDL	21.16
		Low tide	0.3069	BDL	20.56
2	KPT 2	High tide	0.3922	BDL	26.27
		Low tide	0.3061	BDL	20.51
3	KPT 3	High tide	0.2907	BDL	19.48
		Low tide	0.6300	BDL	42.21
CREEKS					
4	KPT-4 Khori-I	High tide	0.7647	BDL	51.25
		Low tide	0.5431	BDL	36.38
5	KPT-5 Nakti-I	High tide	0.8721	BDL	58.42
		Low tide	0.6292	BDL	42.14
6	KPT-5 Nakti-II	High tide	0.4762	BDL	31.89

BDL: Below Detectable Limit.

TABLE #3 VARIATIONS IN CHLOROPHYLL –A PHEOPHYTIN- A AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN MAY,2021

Sr.No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREA					
1	KPT1	High tide	0.7570	BDL	50.72
		Low tide	0.6541	BDL	43.81
2	KPT 2	High tide	0.8184	BDL	54.81
		Low tide	0.5261	BDL	35.24
3	KPT 3	High tide	0.6133	BDL	41.07
		Low tide	0.5559	BDL	37.18
CREEKS					
4	KPT-4 Khori-I	High tide	0.5587	BDL	37.39
		Low tide	0.7435	BDL	49.78
5	KPT-5 Nakti-I	High tide	0.4762	BDL	31.89
		Low tide	0.5451	BDL	36.52
6	KPT-5 Nakti-II	High tide	0.3999	BDL	26.73

BDL: Below Detectable Limit.

PHYTOPLANKTON POPULATION:

For the evaluation of the Phytoplankton population in DPT harbour area and within the immediate surroundings of the port, sampling was conducted from 5 sampling locations (3 in harbour area and two in Nakti creek) during high tide period and low tide period of spring tide. The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by,Diatoms and dinoflagellates during spring tide period.Diatoms were represented by 13 genera. Dinoflagellates wererepresented by two genera .during the sampling conducted in spring tide in May,2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 72-190 units/ L during high tide period and 73-204 units/ L during low tide of Spring Tide.

The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by blue green algae , Diatoms and dinoflagellates during spring tide period.Diatoms were represented by 13 genera. Dinoflagellateswere represented 2 genera and Blue green algae were represented by one genera eachduring the sampling conducted in Neap tide in May, 2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 75-173 units/ L during high tide period and 88-191 units/ L during low tide of Neap Tide.

Species Richness Indices and Diversity Indices :

Margalef's diversity index (Species Richness)S

At the organismal level, the most widely used biodiversity measures are those based on the number of species present, perhaps adjusted for the number of individuals sampled, Here Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, are derived.

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was varying from 2.295-2.806 with an average of 2.516 during the sampling conducted in High tide period of spring tide While .Margalef's diversity index (Species Richness) S of phytoplankton communities in the Kandla Harbour region and nearby creeks was varying from. 1.773-2.645 with an average of 2.063 during the consecutive in low tide period .

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was varying from 1.853-2.771 with an average of 2.472 during the sampling conducted in High tide period of Neaptide While .Margalef's diversity index (Species Richness) S of phytoplankton communities in the Kandla Harbour region and nearby creeks was varying from. 2.094-2.457 with an average of 2.303 during the consecutive in low tide period .

Shannon-Wiener’s index:

Shannon-Wiener’s Index (H) of phytoplankton communities in the sampling stations was in the range of 0.828-0.991 (H'(log10)) between selected sampling stations with an average value of 0.907. during high tide period of spring tide .Shannon-Wiener’s Index (H) of phytoplankton communities in the sampling stations was in the range of 0.645-0.897 (H'(log10)) between selected sampling stations with an average value of 0.775 during consecutive lowtide. Shannon-Wiener’s Index (H) of phytoplankton communities in the sampling stations was in the range of 0.814-0.959 (H'(log10)) between selected sampling stations with an average value of 0.904. during high tide period of neap tide . Shannon-Wiener’s Index (H) of phytoplankton communities in the sampling stations was in the range of 0.822-0.894 (H'(log10)) between selected sampling stations with an average value of 0.868. during consecutive low tide. Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon-Wiener’s index increases as both the richness and the evenness of the community increase. This result indicates that diversity of phytoplankton of Kandla Harbour region and nearby creeks is less but with abundant population of few, with relatively few ecological niches and only very few opportunist organisms are really well adapted to this environment and thrive better than other species.

Simpson’s diversity index:

Simpson’s index (D) is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. The Simson index is one of the meaningful and robust biodiversity measures available. (Magurran,2004).

Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in the Kandla Harbour region and nearby creeks, which was varying from 0.794- 0.8884 between selected sampling stations with an average of 0.842 during high tide period of spring tide . Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in the Kandla Harbour region and nearby creeks, which was varying from 0.707- 0.828 between selected sampling stations with an average of 0.780 during consecutive low tide . Low species diversity suggests a relatively few successful species in this habitat. The environment is quite stressful with relatively few ecological niches and only a few organisms are really well adapted to that environment. Any change in the environment would probably have quite serious effects.

Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in Kandla Harbour region and nearby creeks, during high tide period and low tide period during neap tide also, which was varying from 0.818-0.871 with an average value of 0.850 between selected sampling stations during high tide period and varying from 0.814-0.858 with an average value of 0.843 between selected sampling stations during consecutive low tide period Low species diversity suggests a relatively few successful species in this habitat.

Table # 4PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN MAY,2021

Tide	Sampling Station	Abundance In units/L	No of Species observed /total species	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	96	13/15	86.66	2.629	0.9387	0.8566
	2	102	12/15	80	2.378	0.8284	0.7936
	3	78	11/15	73.33	2.295	0.8771	0.8458
	4	177	14/15	93.33	2.512	0.9139	0.8378
	5	190	14/15	93.33	2.478	0.8926	0.8343
	6	72	13/15	86.66	2.806	0.9916	0.8846
LOW TIDE	1	91	9/15	60	1.773	0.6453	0.707
	2	73	10/15	66.66	2.098	0.773	0.7896
	3	109	10/15	66.66	1.918	0.7463	0.7586
	4	199	15/15	100	2.645	0.8973	0.8287
	5	204	11/15	73.33	1.88	0.8151	0.8194

Table # 5 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN MAY,2021

Tide	Sampling Station	Abundance In units/L	No of Species observed /total species	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	151	13/16	81.25	2.392	0.8834	0.818
	2	106	13/16	81.25	2.573	0.915	0.8571
	3	109	14/16	87.50	2.771	0.9452	0.8685
	4	171	15/16	93.75	2.723	0.959	0.8713
	5	173	14/16	87.50	2.523	0.9066	0.8567
	6	75	9/16	56.25	1.853	0.8139	0.8292
LOW TIDE	1	88	12/16	75	2.457	0.8941	0.8524
	2	91	11/16	68.75	2.217	0.8913	0.8579
	3	135	13/16	81.25	2.446	0.8225	0.8142
	4	191	12/16	75	2.094	0.8769	0.8528
	5	185	13/16	81.25	2.299	0.8554	0.8378

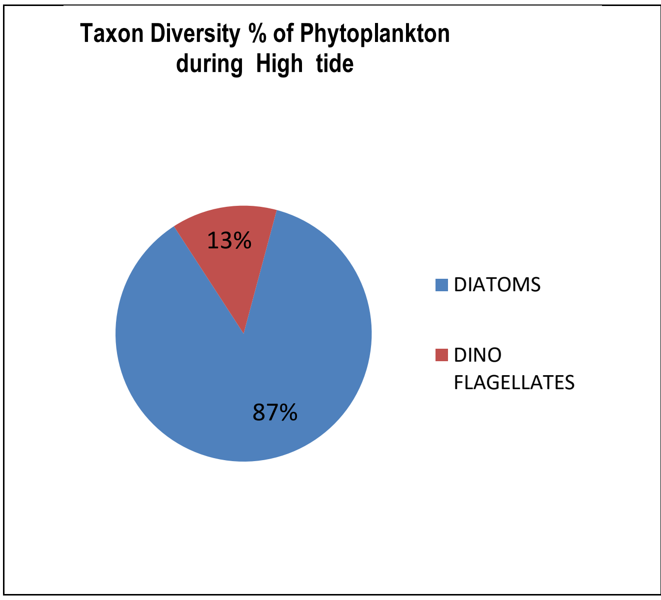
Table # 6 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING SPRING TIDE IN MAY,2021

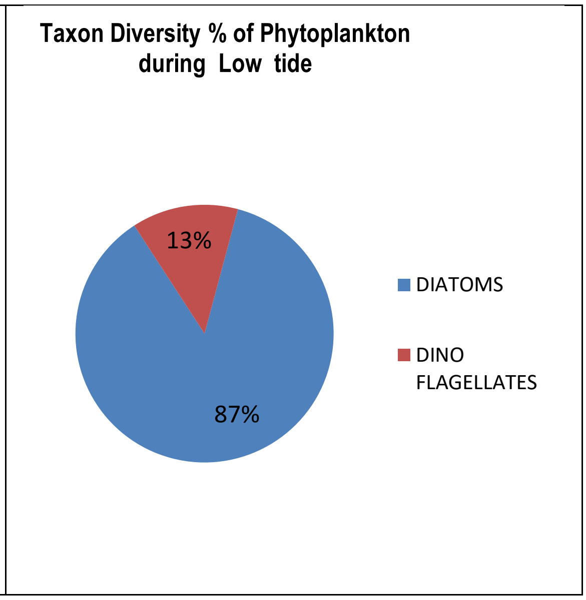
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	71-184	13/15	86.67
			DINO FLAGELLATES	0-6	2/15	13.33
			TOTAL PHYTO PLANKTON	72-190	15	-
LOW TIDE	Sub surface	5	DIATOMS	73-202	13/15	86.67
			DINO FLAGELLATES	0-3	2/15	13.33
			TOTAL PHYTO PLANKTON	73-204	15	-

Table # 7 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING NEAP TIDE IN MAY,2021

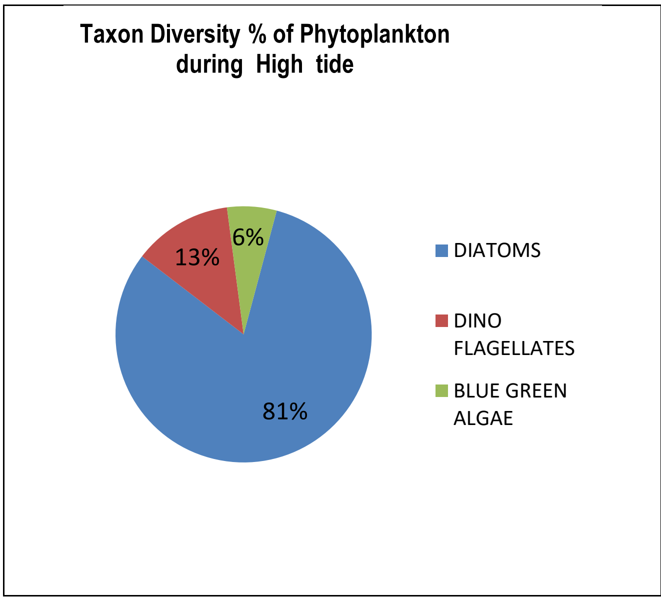
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	67-149	13/16	81.25
			DINO FLAGELLATES	0-2	2/16	12.5
			BLUE GREEN ALGAE	7-23	1/16	6.25
			TOTAL PHYTO PLANKTON	75-173	16	
LOW TIDE	Sub surface	5	DIATOMS	74-172	13/16	81.25
			DINO FLAGELLATES	3-4	2/16	12.5
			BLUE GREEN ALGAE	10-18	1/16	6.25
			TOTAL PHYTO PLANKTON	88-191	16	

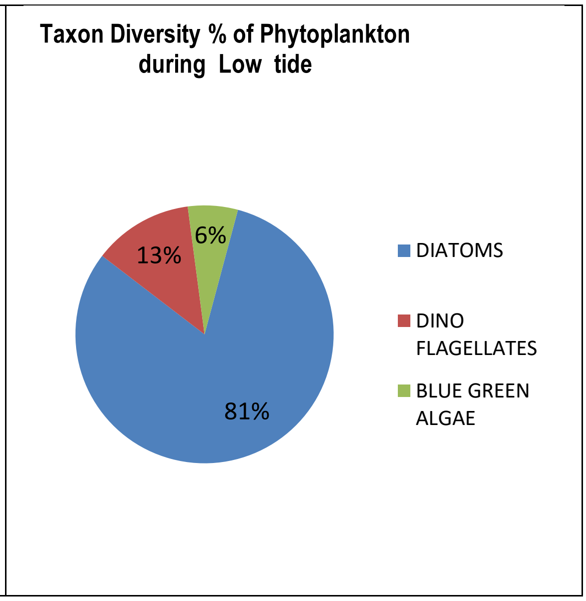
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide





Taxon Diversity % of Phytoplankton during High tide and Low tide period during Neap tide





ZOOPLANKTON POPULATION:

For the evaluation of the Zooplankton population in DPT harbour area and within the immediate surroundings of the port sampling was conducted from 6 sampling locations (3 in harbour area and two in Nakti creek and one in Khori creek) during high tide period and low tide period of spring tide and Neap tide in May 2021 . The Zooplankton community of the sub surface water in the harbour and nearby creeks during spring tide was represented by mainly three groups, Tintinids, Copepods, and larval forms of Crustacea, Polychates, Cyprids larvae of Barnacles and Cyphonautes larvae of Phylum Bryozoa. The Zooplankton community of the sub surface water in the harbour and nearby creeks during neap tide was represented by mainly three groups, Tintinids, Copepods, and larval forms of Crustacea, Polychates, Cyprids larvae of Barnacles and Cyphonautes larvae of Phylum Bryozoa.

Zooplankton of the sampling stations at sub surface layer in the DPT harbour area and nearby creek was varying from 30-125 x10^3 N/ m^3 during high tide and 35-135 N/ L during low tide of Spring Tide period. Zooplankton of the sampling stations at sub surface layer in the DPT harbour area and nearby creek was varying from 38-135x10^3 N/ m^3 during high tide and 60-120 N/ L during low tide of Neap Tide period.

Species Richness Indices and Diversity Indices:

Margalef's diversity index (Species Richness)S

At the organismal level, the most widely used biodiversity measures are those based on the number of species present, perhaps adjusted for the number of individuals sampled, Here Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, are derived.

Margalef's diversity index (Species Richness) S of Zooplankton communities in the stations Kandla Harbour region and nearby creeks was varying from 1.764-2.278 with an average of 1.950 during the sampling conducted in High tide period.varying from. 1.406-2.242 with an average of 1.884 during the sampling conducted in low tide period. during Spring tide.

Margalef's diversity index (Species Richness) S of Zooplankton communities in the Kandla Harbour region and nearby creeks sampling stations was varying from. 1.649 - 3.087 with an average of 2.717 during the sampling conducted in high tide and varying from. 2.298-3.162 with an average of 2.645 during the sampling conducted in low tide during Neap tide period .**Shannon-Wiener's index:**

Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.633-0.903 (H'(log10)) between selected sampling stations with an average value of 0.779 (H'(log10)) during high tide period of spring tide .Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of

0.660-0.921 (H'(log10)) between selected sampling stations with an average value of 0.803 (H'(log10)) during consecutive low tide period .

Shannon-Wiener’s Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.730-1.046 (H'(log10)) between selected sampling stations with an average value of 0.961 (H'(log10)) during high tide period of Neap tide . Shannon-Wiener’s Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.879-1.041(H'(log10)) between selected sampling stations with an average value of 0.960 (H'(log10)) during consecutive low tide period .Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon-Wiener’s index increases as both the richness and the evenness of the community increase. This result indicates that diversity of Zooplankton of Kandla Harbour region and nearby creeks stations is slightly high with very minimum diverse population but very few opportunist organisms are really well adapted to this environment and thrive better than other species.

Simpson’s diversity index:

Simpson’s index (D) is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. The Simson index is one of the meaningful and robust biodiversity measures available. (Magurran, 2004).

Simpson diversity index (1-D) of Zooplankton communities was below 0.9 at all sampling stations in the Kandla Harbour region and nearby creeksduring high tide and low tide of spring tide period, which was varying from 0.708-0.848 between selected sampling stations with an average of 0.794 during high tide period and was varying from 0.743-0.864 with an average value of 0.811 between selected sampling stations during low tide

Simpson diversity index (1-D) of Zooplankton communities was below 0.9 at all sampling stationsin the Kandla Harbour region and nearby creeks during high tide and except one during low tide of Neap tide, which was varying from 0.808-0.891 between selected sampling stations with an average of 0.872 during high tide period and was varying from 0.843- 0.906 with an average value of 0.875 between selected sampling stations during consecutive low tide

This low species diversity suggests a relatively low number of successful species in this habitat. Environment is quite stressful with relatively few ecological niches and only few organisms are really well adapted to that environment. Any change in the environment would probably have quite serious effects.

Table # 8 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN MAY,2021

Tide	Sampling Station	Abundance In No / m^3	No of Species/ groups observed /total species/group	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	47 $x10^3$	8/12	66.66	1.818	0.7544	0.8002
	2	50 $x10^3$	8/12	66.66	1.789	0.705	0.751
	3	57 $x10^3$	9/12	75	1.979	0.7907	0.812
	4	125 $x10^3$	12/12	100	2.278	0.9033	0.8486
	5	124 $x10^3$	11/12	91.66	2.075	0.8878	0.844
	6	30 $x10^3$	7/12	58.33	1.764	0.6331	0.708
LOW TIDE	1	35 $x10^3$	6/12	50	1.406	0.6609	0.7681
	2	54 $x10^3$	9/12	75	2.006	0.7286	0.7435
	3	69 $x10^3$	8/12	66.66	1.653	0.7883	0.824
	4	114 $x10^3$	11/12	91.66	2.111	0.917	0.8638
	5	135 $x10^3$	12/12	100	2.242	0.921	0.8593

Table # 9 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN MAY ,2021

Tide	Sampling Station	Abundance In No / m^3	No of Species/ groups observed /total species/group	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	62 $x10^3$	13/16	81.25	2.908	0.9868	0.881
	2	56 $x10^3$	13/16	81.25	2.981	0.9832	0.8857
	3	70 $x10^3$	13/16	81.25	2.825	0.9837	0.8787
	4	129 $x10^3$	16/16	100	3.087	1.046	0.8895
	5	135 $x10^3$	15/16	93.75	2.854	1.038	0.8913
	6	38 $x10^3$	7/16	43.75	1.649	0.7306	0.808
LOW TIDE	1	60 $x10^3$	11/16	68.75	2.442	0.9379	0.8785
	2	61 $x10^3$	14/16	87.50	3.162	1.041	0.906
	3	107 $x10^3$	12/16	75	2.354	0.9455	0.869
	4	112 $x10^3$	15/16	93.75	2.967	0.9985	0.8832
	5	120 $x10^3$	12/16	75	2.298	0.8795	0.8431

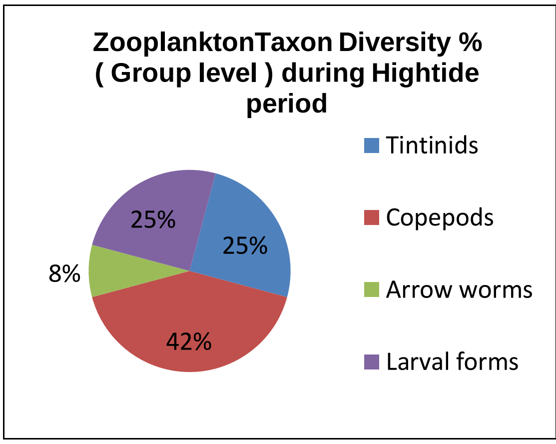
Table # 10 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN MAY,2021

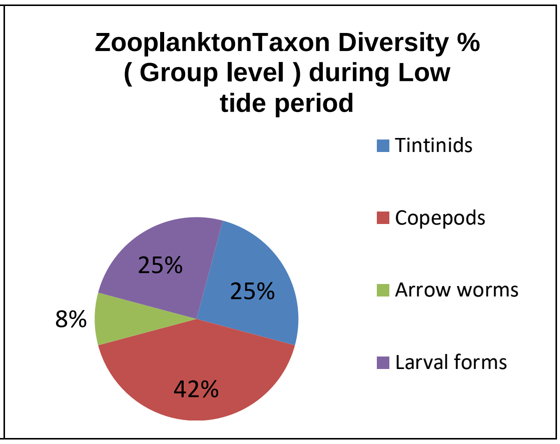
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton $x10^3$ Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	2-21	3/12	25
			Copepods	11-66	5/12	41.67
			Arrow worms	0-4	1/12	8.33
			Larval forms	17-45	3/12	25
			TOTAL ZOOPLANKTON NO/L	**30-122**	**12**	**-**
LOW TIDE	Sub surface	5	Tintinids	0-22	3/12	25
			Copepods	18-72	5/12	41.67
			Arrow worms	0-2	1/12	8.33
			Larval forms	16-41	3/12	25
			TOTAL ZOOPLANKTON NO/L	**34-133**	**12**	**-**

Table # 11 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA , NEAR BY CREEKS DURING NEAP TIDE IN MAY,2021

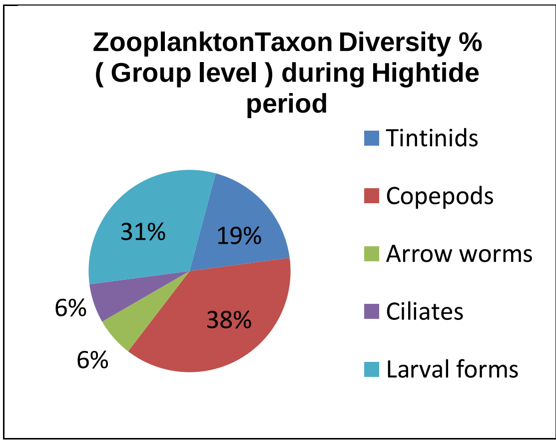
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton $x10^3$ Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	4-22	3/16	18.75
			Copepods	20-51	6/16	37.5
			Arrow worms	0-2	1/16	6.25
			Ciliates	2-12	1/16	6.25
			Larval forms	13-54	5/16	31.25
			TOTAL ZOOPLANKTON NO/L		**16**	
LOW TIDE	Sub surface	5	Tintinids	5-17	3/16	18.75
			Copepods	22-63	6/16	37.5
			Arrow worms	0-2	1/16	6.25
			Ciliates	0-4	1/16	6.25
			Larval forms	24-45	5/16	31.25
			TOTAL ZOOPLANKTON NO/L		**16**	

Taxon Diversity % of Zooplankton during High tide and Low tide period of Spring tide





Taxon Diversity % of Zooplankton during High tide and Low tide period of Neap tide



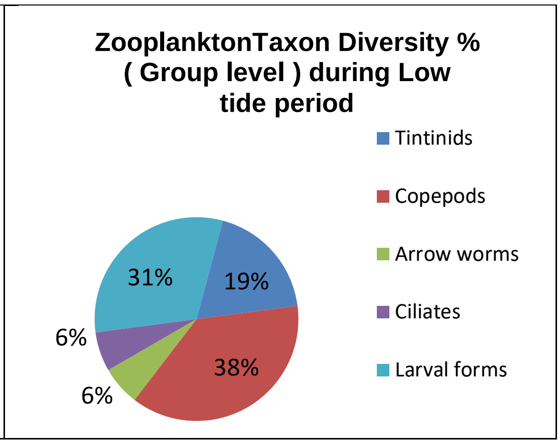


TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURINGSPRING TIDE OF MAY,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniellasp*	D1	Rare
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D2	Dominant
			Triceratiales	Triceratiaceae	*Odontellasp*	D3	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphiasp*	D4	Abundant
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D5	Frequent
			Chaetocerotales	Chaetocerotaceae	*Chaetocerossp*	D6	Occasional
			Lithodesmiales	Lithodesmiaceae	*Ditylumsp*	D7	Frequent
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigmasp*	D8	Rare
			Bacillariales	Bacillariaceae	*Bacillariasp.*	D9	Occasional
			Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D10	Frequent
					Thalassionema sp.	D11	Occasional
		Fragilariophyceae	Fragilariales	Fragilariaceae	*Fragilariasp*	D12	Rare
					Synedrasp	D13	Occasional

DINO FLAGELLATE S	Dinoflagellata / Dinozoa	Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium sp.*	DF1	Rare
			Gonyaulacales	Ceratiaceae	*Ceratiumfusus*	DF2	Rare

TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURING AND NEAP TIDE OF MAY,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALGAE	Cyanophyta	Cyanophyceae	Nostocales	Oscillatoriaceae	*Trichodesmiumsp.*	B1	Occasional
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniellasp*	D1	Rare
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D2	Frequent
			Triceratiales	Triceratiaceae	*Triceratiumsp*	D3	Rare
					Odontellasp	D4	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphiasp*	D5	Frequent
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D6	Occasional
			Chaetocerotales	Chaetocerotaceae	*Chaetocerossp*	D7	Occasional
			Lithodesmiales	Lithodesmiaceae	*Ditylumsp*	D8	Abundant
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigmasp*	D9	Rare
			Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D10	Dominant
					Thalassionema sp.	D11	Rare

		Fragilariophyceae	Fragilariales	Fragilariaceae	*Fragilaria*sp	D12	Rare
					*Synedra*sp	D13	Rare
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Gonyaulacales	Ceratiaceae	*Ceratiumfusus*	DF1	Rare
					Ceratiummacroceros	DF2	Rare

TABLE #13 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS IN DPT HARBOUR AREA, AND NEAR BY CREEKS DURING SPRING TIDE OF MAY,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Codonellidae	*Tintinnopsisfailakkaensis*	T1	Rare
					Tintinnopsisgracilis	T2	Occasional
				Xystonellidae	*Favella* sp.	T3	Rare
COPEPODS	ATHROPODA	Crustacea Sub class copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Frequent
				Temoridae	*Temora sp.*	C2	Rare
			Cyclopoida	Oithonidae	*Oithona sp.*	C3	Abundant
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C4	Occasional
				Euterpinidae	*Euterpina sp.*	C5	Frequent
ARROW WORMS	CHAETOGNATHA	Sagittoideae	Aphragmophora	Sagittidae	*Sagitta sp.*	A1	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant

BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L2	Occasional
CYPHONAUTES LARVAE	BRYOZOA				Cyphonautes larvae	L3	Rare

TABLE # 13 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS IN DPT HARBOUR AREA, AND NEAR BY CREEKS DURING NEAP TIDE OF MAY,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Rare
				Codonellidae	*Tintinnopsisfailakkaensis*	T2	Occasional
				Codonellopsidae	*Codonellopsis* sp.	T3	Rare
COPEPODS	ATHROPODA	Crustacea Sub class copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Occasional
				Acartiidae	*Acartia sp.*	C2	Rare
			Cyclopoida	Oithonidae	*Oithona sp.*	C3	Dominant
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C4	Frequent

				Euterpinidae	*Euterpina sp.*	C5	Rare
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C6	Rare
ARROW WORMS	CHAETOGNATHA	Sagittoideae	Aphragmophora	Sagittidae	*Sagitta sp.*	A1	Rare
CILIATES	CILIOPHORA	Oligohymenophorea	Sessilida	Zoothamniidae	*Zoothamniumsp.*	CI1	Occasional
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Abundant
POLYCHAETE LARVA	ANNELIDA	Polychaeta			Trochophore larvae	L2	Rare
BARNACLE LARVAE	ATHROPODA CRUSTACEA	Maxillopoda Thecostraca			Cirripede larvae	L3	Occasional
					Zoea larvae	L4	Occasional
CYPHONAUTES LARVAE	BRYOZOA				Cyphonautes larvae	L5	Rare

BENTHIC ORGANISMS:

No Benthic organism was observed in the collected sediments by using the Van-veen grabs during the sampling conducted during spring tide period and Neap tide from DPT harbour region and nearby creek.

7. Meteorological Data

Automatic Weather station have been installed in SevaSadan -3 at the Deendayal Port which records the data on Temperature (°C), Humidity (%),Wind (mph), Dew Point (°C), Wind Direction (°), Pressure, Solar radiation, heat Index and UVI.

Temperature

The mean day time temperature for Deendayal Port was 32.65 °C. The day-time maximum temperature was 37.3 °C. The mean night time temperature was 28.6 °C. The minimum mean night time temperature recorded was 27.5 °C.

Air Pressure

The mean absolute air pressure for the month of May was 1005.28 hpa, whereas the mean relative pressure was 1005.38 hpa. The maximum absolute air pressure recorded for the month of May was 1010.6 hpa.

Heat Index

The mean day-time heat index for the month of May was 38.09 ^{o}C. The maximum heat index recorded was 47^{o}C.

Solar Radiation

The mean Solar Radiation in May was 157.73 w/m^2. The maximum solar radiation recorded in the month of May was 383.3 w/m^2.

Humidity

The mean day-time humidity was 60.22 % for the month of May and mean night time humidity was 74.93%. Maximum humidity recorded during day-time was 82.0 % and maximum humidity recorded during night-time was 89.0%.

Wind Velocity and Wind Direction

The mean wind velocity for the entire month of May was 7.05 km/hour (i.e. 1.95 mtr/sec). Maximum wind velocity recorded was 29.2 Km/hr (8.11 mtr/sec). The wind direction was mostly S to SE.

Conclusive Summary and Remedial measures Suggested

- The AAQ monitoring at six locations of Deendayal Port indicates that the mean PM_{10} values at four locations viz. Coal storage area, Marine Bhavan and Oil Jetty area were found above the permissible standards (100 µg/m^3)and$PM_{2.5}$was above permissible limits at Coal storage location(Limit 60 µg/m^3).

- Drinking water at all the twenty locations was found potable and was within permissible limits of BIS standards (IS 10500).

- Noise quality was also within the set permissible standards of an Industrial Area. The noise level observed during day time was >75 dB (A) and at night time was >70 dB (A) during the entire monitoring period.

- The sewage treated water of Deendayal Port Colony (Gopalpuri) was in line with the standards set by the Gujarat Pollution Control Board. The STP at Deendayal Port is not fully operational and STP at Vadinar Port was found non-operational.

Reasons for higher Values of PM_{10}

- Large amount of coal is handled at Berth No. 6, 7, 8 and 9. The unloading of coal directly in the truck, using grabs cause coal to spread in air as well as coal dust to fall on ground. This settled coal dust again mixes with the air while trucks travel through it.

- Also, the coal laden trucks are not always covered with tarpaulin sheets, and these results in spillage of coal from trucks/dumpers during its transit from vessel to yard or storage site. This also increased PM values around marine Bhavan & Coal storage area.

Remedial Measures

AIR:

The values of PM_{10} during the month of May, 2021 were observed beyond the permissible limit at four locations mentioned above. Given below are the remedial measures suggest to minimize the Air pollution at Deendayal Port.

- Guidelines for Coal Handling by GPCB should be strictly followed. (http://gpcb.gov.in/pdf/coal-handling-guidelines.pdf)
- Except for the higher values of PM_{10} at Coal storage site, Oil Jetty, Tuna Port and Marine Bhavan locations, the monitoring results for the present month suggest that the overall Environment Quality of Deendayal Port is satisfactory.

SEWAGE WATER:

- Sewage Treatment Plan at Vadinar Port is not working. Hence, it is recommended to commission the sewage treatment plant at Vadinar immediately.

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ENVIRONMENTAL MONITORING REPORT
FOR
DEENDAYAL PORT TRUST

REPORT NO.	:	DCPL/DPT/20-21/14
Month	:	June 2021
Issue No	:	01
Revision No	:	00
Prepared by	:	DETOX CORPORATION PVT. LTD., SURAT

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Introduction

Monitoring of various environmental aspects of the Deendayal port by M/s Detox Corporation Pvt. Ltd. has been carried out through collection of samples, analysis of the same, comparing results with respect to the national standards and any other relevant standards by GBCB/CPCB/MoEF to identify non conformities in the Environment of the Deendayal Port. The results shall address the identified impacts and suggest measures to minimize the environmental impact due to various operations at Deendayal Port.

The environmental monitoring is carried out as per the Environment Management and Monitoring Plan submitted by Detox Corporation Pvt. Ltd.

1. Ambient Air Quality Monitoring

As per the Environmental Monitoring Plan of Deendayal Port Trust, Air monitoring was carried out at six identified locations at Deendayal Port and two locations at Vadinar Port.

1.1 Air Quality Monitoring Methodology

Air quality is measured in all the stations, for 24 hour for Total Suspended Particulate Matter (TSPM), PM_{10}, $PM_{2.5}$, SO_2, NO_X, NH_3 & Benzene, and Grab-sampling for CO & CO_2 measurements. The Air samplers are operated for a period of 24 hours and after a continuous operation of 8 hours of the sampler, the reagents were replaced to obtain 3 samples per day for each parameter namely, SO_2, NO_X. The EPM 2000 filter paper and PTFE Membrane bound filter paper are used for a period of 24 hours to obtain one sample each of TSPM, PM_{10} & $PM_{2.5}$.

The AAQ samples are collected twice a week from all the eight locations as per the EMP.

1.2 Results

The ambient air quality monitoring data for six stations, viz. Marine Bhavan, Oil Jetty, Port Colony,Gopalpuri Hospital,Tuna Port and Nr. Coal Storage Area for the month of June 2021 are given in Tables 1A to 6B. The ambient air quality monitoring data for two stations at Vadinar (Nr. Admin Building &Nr. Signal Building) are given in Tables 7A to 8B.

Location 1: Marine Bhavan (AL1)

Table 1 : Results of Air Pollutant Concentration at Marine Bhavan

Parameter	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**		**80 µg/m3**		**80 µg/m3**		**400 µg/m3**
AL1 – 1	02-06-2021	447	107	53	14.07	9.23	23.50	24.14	12.51	11.83
					9.23		20.33		10.72	
					4.40		28.58		12.25	
AL1 – 2	04-06-2021	399	135	46	12.75	11.28	20.33	22.87	12.51	11.74
					11.87		24.77		12.00	
					9.23		23.50		10.72	
AL1 – 3	09-06-2021	423	204	172	13.63	14.95	24.77	19.27	7.40	7.06
					18.46		17.15		7.91	
					12.75		15.88		5.87	
AL1 – 4	11-06-2021	223	58	149	5.71	6.59	16.51	13.76	9.19	9.62
					5.71		14.61		8.93	
					8.35		10.16		10.72	
AL1 – 5	16-06-2021	476	103	203	17.14	16.56	18.42	16.51	7.15	6.81
					14.07		16.51		6.89	
					18.46		14.61		6.38	
AL1 - 6	18-06-2021	268	111	116	9.23	10.55	26.68	25.41	12.00	12.42
					9.67		27.95		12.51	
					12.75		21.60		12.76	
AL1 - 7	23-06-2021	415	179	65	5.71	6.74	26.68	26.68	6.89	7.83
					6.15		28.58		5.87	
					8.35		24.77		10.72	
AL1 – 8	25-06-2021	341	141	57	11.87	13.48	17.15	23.29	10.98	10.98
					17.14		20.33		12.00	
					11.43		32.39		9.96	
Monthly Average		374	130	108		11.17		21.49		9.79
Standard Deviation		89	46	61		3.65		4.53		2.28

NS: Not Specified

Table 1B : Results of Air Pollutant Concentration at Marine Bhavan					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC* ppm**	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL1 – 1	02/06/2021	1.2	BDL	1.46	510
AL1 – 2	04/06/2021	1.23	BDL	1.3	519
AL1 – 3	09/06/2021	1.07	BDL	1.86	495
AL1 – 4	11/06/2021	1.06	BDL	1.84	476
AL1 – 5	16/06/2021	1.06	BDL	1.75	490
AL1 - 6	18/06/2021	1.11	BDL	1.62	489
AL1 – 7	23/06/2021	1	BDL	1.8	480
AL1 – 8	25/06/2021	1.07	BDL	1.71	476
Monthly Average		**1.10**	-	**1.67**	**492**
Standard Deviation		**0.08**	-	**0.20**	**16**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC: 0.5ppm)
NS -Not Specified

At Marine Bhavan, the overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_X and NH_3 is attributed mainly by motor vehicle emission produced from various types of automobiles (both diesel and petrol driven). Moreover, the loading and unloading of Food Grains and Timber at Jetty no. 1 and 2 also contributes to the high levels of TSPM and PM_{10}. The mean TSPM value at Marine Bhavan was 374 µg/m^3, The mean PM_{10} values were 130.0 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 108 µg/m^3). The average values of SO_2, NO_x and NH_3 were within the permissible limit. The average values of SO_2, NO_x and NH3 were 11.17 µg/ m^3, 21.49 µg/ m^3 & 9.79 µg/ m^3 respectively.These were within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Marine Bhavan. The mean Benzene concentration was 1.10 µg/m^3,well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and CarbonMonoxide concentration was 1.67 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 2: Oil Jetty (AL2)

Table 2 : Results of Air Pollutant Concentration at Oil Jetty										
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**	
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**	-	**80 µg/m3**	-	**80 µg/m3**	-	**400 µg/m3**
AL2 - 1	02-06-2021	283	68	120	9.23	11.72	20.33	23.08	13.27	10.47
					13.19		25.41		10.72	
					12.75		23.50		7.40	
AL2 - 2	04-06-2021	353	108	210	9.23	11.14	18.42	17.15	10.72	10.89
					14.07		14.61		11.23	
					10.11		18.42		10.72	
AL2 - 3	09-06-2021	275	42	137	17.58	13.19	17.15	20.54	9.96	8.25
					12.74		24.14		7.91	
					9.23		20.33		6.89	
AL2 - 4	11-06-2021	257	37	145	5.27	5.42	23.50	19.27	3.32	5.87
					5.71		18.42		4.85	
					5.27		15.88		9.45	
AL2 - 5	16-06-2021	532	84	117	12.75	12.02	17.15	18.21	7.15	6.98
					9.23		20.33		7.40	
					14.07		17.15		6.38	
AL2 - 6	18-06-2021	192	111	65	11.87	7.91	26.68	28.58	10.72	11.40
					8.35		27.95		12.51	
					3.52		31.12		10.98	
AL2 - 7	23-06-2021	346	79	80	5.71	6.30	15.88	16.73	9.45	8.85
					7.91		17.15		9.70	
					5.28		17.15		7.40	
AL2 - 8	25-06-2021	256	125	31	11.87	15.09	18.42	18.84	3.83	7.83
					13.63		18.42		8.93	
					19.78		19.69		10.72	
Monthly Average		312	82	113		10.35		20.30		8.82
Standard Deviation		103	32	55		3.43		3.90		1.97

NS: Not Specified

Table 2B : Results of Air Pollutant Concentration at Oil Jetty					
Parameter	Date	C_6H_6 [µg/m^3]	HC* ppm	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3	NS	4.0 mg/m^3	NS
AL2 -1	02/06/2021	1.11	BDL	1.78	482
AL2 -2	04/06/2021	1.06	BDL	1.77	496
AL2 -3	09/06/2021	1.22	BDL	1.8	480
AL2 -4	11/06/2021	1.05	BDL	1.75	484
AL2 – 5	16/06/2021	1.02	BDL	1.81	515
AL2 – 6	18/06/2021	1.07	BDL	1.78	496
AL2 -7	23/06/2021	1.09	BDL	1.88	491
AL2 – 8	25/06/2021	1.06	BDL	1.64	470
Monthly Average		**1.09**	**-**	**1.78**	**489**
Standard Deviation		**0.06**	**-**	**0.07**	**14**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC : 0.5ppm)

NS- Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Oil Jetty area was mainly by motor vehicle emission produced from various types of vehicles Oil Jetty Area. The mean TSPM values at Oil Jetty were 312 µg/m^3 The mean PM_{10} values were 82 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 113 µg/m^3).The average values of SO_2, NO_x and NH_3 were within the permissible limit; The mean concentration of SO_2, NO_x and NH3 were 10.35 µg/m^3, 20.30 µg/m^3 and 8.82 µg/m^3 respectively.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Oil Jetty. The mean Benzene concentration was 1.09 µg/m^3 .Well below the permissible limit of 5.0 µg/m^3. , HC's were below the detectable limit and Carbon Monoxide concentration was 1.78 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 3: Kandla Colony – Estate Office (AL-3)

Table 3 : Results of Air Pollutant Concentration at Estate Office											
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**		
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**	-	**80 µg/m3**	-	**80 µg/m3**	-	**400 µg/m3**	
AL3 – 1	02-06-2021	151	18	41	3.96	6.01	18.42	16.51	4.85	8.42	
					5.28		17.15		6.89		
					8.79		13.97		13.53		
AL3 – 2	04-06-2021	232	63	12	10.11	11.58	17.15	18.00	6.89	9.19	
					12.75		19.69		8.17		
					11.87		17.15		12.51		
AL3 – 3	09-06-2021	290	98	55	12.75	10.84	20.33	20.11	10.98	10.47	
					9.67		24.77		12.25		
					10.11		15.24		8.17		
AL3 – 4	11-06-2021	235	61	128	1.76	2.34	20.33	20.54	6.89	6.13	
					2.20		23.50		5.87		
					3.08		17.78		5.62		
AL3 – 5	16-06-2021	231	66	139	5.71	10.84	26.68	22.02	13.53	9.28	
					12.75		20.96		7.40		
					14.07		18.42		6.89		
AL3 – 6	18-06-2021	463	76	37	10.11	11.43	20.33	22.23	7.91	8.00	
					13.63		22.87		9.96		
					10.55		23.50		6.13		
AL3 – 7	23-06-2021	382	70	35	11.87	13.33	8.26	13.97	9.96	8.68	
					14.07		15.24		10.72		
					14.07		18.42		5.36		
AL3 – 8	25-06-2021	148	99	42	12.75	12.16	19.69	19.69	7.15	7.91	
					12.31		22.23		9.19		
					11.43		17.15		7.40		
Monthly Average		267	69	61		9.82		19.13		8.51	
Standard Deviation		109	25	46		3.70		2.83		1.27	

NS: Not Specified

Table 3B : Results of Air Pollutant Concentration at Kandla Port Colony					
Parameter	Date	C_6H_6 [µg/m^3]	HC*	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3	NS	4.0 mg/m^3	NS
AL3 -1	02/06/2021	1.07	BDL	1.72	489
AL3 -2	04/06/2021	1.1	BDL	1.82	502
AL3 -3	09/06/2021	1.07	BDL	1.74	482
AL3 -4	11/06/2021	1.16	BDL	1.61	480
AL3 – 5	16/06/2021	1.17	BDL	1.69	475
AL3 – 6	18/06/2021	1.1	BDL	1.7	489
AL3 – 7	23/06/2021	1.04	BDL	1.96	486
AL3 – 8	25/06/2021	1.04	BDL	1.59	464
Monthly Average		**1.09**		**1.73**	**483**
Standard Deviation		**0.05**		**0.12**	**11**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)
NS- Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Kandla Port Colony was attributed by vehicle emission produced from trucks and heavy duty vehicles that pass through the road outside Kandla Port Colony. The mean TSPMvalues at Oil Jetty were 267 µg/m^3, The mean PM_{10} values were 69µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were slightly above the permissible limit (mean = 61 µg/m^3). The average values of SO_2, NO_x and NH3 were 9.82 µg/m^3, 19.13 µg/m^3 and 8.51 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Kandla Port Colony. The mean Benzene concentration was 1.09 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.73 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 4: Gopalpuri Hospital (AL-4)

Table 4 : Results of Air Pollutant Concentration at Gopalpuri Hospital											
Parameter	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**		
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**	-	**80 µg/m3**	-	**80 µg/m3**	-	**400 µg/m3**	
AL4 -1	02-06-2021	115	40	15	3.96	2.64	13.34	15.46	5.11	5.28	
					3.08		14.61		4.85		
					0.88		18.42		5.87		
AL4 -2	04-06-2021	144	43	13	8.79	7.33	14.61	17.57	6.89	7.49	
					5.71		19.69		7.40		
					7.47		18.42		8.17		
AL4 -3	09-06-2021	157	49	34	2.64	3.37	14.61	20.96	6.89	7.40	
					3.52		29.85		7.40		
					3.96		18.42		7.91		
AL4 -4	11-06-2021	122	29	46	9.23	7.47	5.08	6.99	3.06	4.60	
					9.23		7.62		4.85		
					3.96		8.26		5.87		
AL4 – 5	16-06-2021	156	35	21	3.96	3.96	10.80	12.49	10.72	11.40	
					3.52		12.07		10.98		
					4.40		14.61		12.51		
AL4 – 6	18-06-2021	207	72	108	9.23	8.65	13.34	18.42	7.40	7.57	
					8.79		24.77		9.96		
					7.91		17.15		5.36		
AL4 – 7	23-06-2021	263	36	13	0.88	3.08	11.43	13.97	10.98	10.30	
					3.96		13.34		12.00		
					4.40		17.15		7.91		
AL4 – 8	25-06-2021	216	111	14	3.52	4.54	12.70	11.86	7.40	7.06	
					4.84		12.07		7.15		
					5.28		10.80		6.64		
Monthly Average		173	52	33		5.13		14.71		7.64	
Standard Deviation		51	27	33		2.33		4.39		2.28	

NS: Not Specified

Table 4B : Results of Air Pollutant Concentration at Gopalpuri Hospital					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC***	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL4 -1	02/06/2021	1.07	BDL	1.68	482
AL4 -2	04/06/2021	1.06	BDL	1.7	488
AL4 -3	09/06/2021	1.11	BDL	1.9	478
AL4 -4	11/06/2021	1.1	BDL	1.54	470
AL4 – 5	16/06/2021	1.21	BDL	1.58	455
AL4 – 6	18/06/2021	1.2	BDL	1.78	460
AL4 – 7	23/06/2021	1.19	BDL	1.94	481
AL4 – 8	25/06/2021	1.13	BDL	1.91	475
Monthly Average		**1.13**		**1.75**	**474**
Standard Deviation		**0.06**		**0.15**	**11**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)

NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Gopalpuri Hospital was attributed by vehicle emission produced from light motor vehicles of the colony residents. The mean TSPMvalues at Oil Jetty were 173 µg/m^3, The mean PM_{10} values were 52 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean= 33 µg/m^3). The average values of SO_2, NO_x and NH_3 were 5.13 µg/m^3, 14.71 µg/m^3 and 7.64 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Gopalpuri Hospital. The mean Benzene concentration was 1.13 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.75 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 5: Coal Storage Area (AL-5)

Table 5 : Results of Air Pollutant Concentration at Coal Storage Area

Parameters	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period	-	24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit	-	NS	100 µg/m3	60 µg/m3	-	80 µg/m3	-	80 µg/m3	-	400 µg/m3
AL5 – 1	02-06-2021	829	78	60	9.23	9.23	26.04	26.47	13.27	13.96
					12.75		28.58		15.32	
					5.71		24.77		13.27	
AL5 – 2	04-06-2021	332	104	97	5.71	7.77	20.33	21.60	12.51	12.00
					8.79		24.77		12.51	
					8.79		19.69		10.98	
AL5 – 3	09-06-2021	289	185	154	10.11	13.48	18.42	18.84	10.72	11.83
					12.75		17.78		12.51	
					17.58		20.33		12.25	
AL5 – 4	11-06-2021	280	70	162	9.23	13.19	12.07	13.55	10.98	10.64
					13.19		13.34		10.72	
					17.14		15.24		10.21	
AL5 – 5	16-06-2021	944	148	150	3.96	10.99	14.61	18.84	2.30	5.45
					19.78		10.80		6.89	
					9.23		31.12		7.15	
AL5 – 6	18-06-2021	603	145	234	10.11	9.23	26.68	24.56	13.53	13.96
					7.47		22.87		13.27	
					10.11		24.14		15.06	
AL5 – 7	23-06-2021	766	181	152	11.87	12.75	12.70	21.17	12.51	10.47
					14.07		17.15		10.72	
					12.31		33.66		8.17	
AL5 – 8	25-06-2021	728	208	94	13.63	11.72	18.42	15.03	12.51	9.53
					10.55		17.78		9.19	
					10.99		8.89		6.89	
Monthly Average		596	140	138		11.04		20.01		10.98
Standard Deviation		263	51	54		2.11		4.40		2.74

NS: Not Specified

Table 5B : Results of Air Pollutant Concentration at Coal Storage Area					
Parameter	Date	C_6H_6 [µg/m³]	HC*	CO [mg/m³]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m³	NS	4.0 mg/m³	NS
AL5 – 1	02/06/2021	1.08	BDL	1.78	482
AL5 – 2	04/06/2021	1.1	BDL	1.68	490
AL5 – 3	09/06/2021	1.24	BDL	1.64	462
AL5 – 4	11/06/2021	1.28	BDL	1.66	464
AL5 – 5	16/06/2021	1.31	BDL	1.66	460
AL5 – 6	18/06/2021	1.2	BDL	1.7	490
AL5 – 7	23/06/2021	1.33	BDL	1.74	464
AL5 – 8	25/06/2021	1.11	BDL	1.91	484
Monthly Average		**1.21**	**-**	**1.72**	**475**
Standard Deviation		**0.10**	**-**	**0.09**	**13**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)

NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Coal Storage Area was comparatively highest among all the locations of Air Quality monitoring in Kandla Port. High values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_X at this location was due to lifting of coal with grab and other coal handling processes near Berth no. 6 & 7. Moreover, the traffic was also heavy around this place for transport of coal thus emissions produced from heavy vehicles. The mean TSPMvalues at Coal storage were 596 µg/m³. The mean PM_{10} values were 140 µg/m³, which is well above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 138 µg/m³). The average values of SO_2, NO_x and NH_3 were 11.04 µg/m³, 20.01 µg/m³ and 10.98 µg/m³ respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Coal Storage Area. The mean Benzene concentration was 1.21 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.72 mg/m³, well below the permissible limit of 4.0 mg/m³.

Location 6: Tuna Port (AL-6)

Table 6 : Results of Air Pollutant Concentration at Tuna Port										
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**	
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**	-	**80 µg/m3**	-	**80 µg/m3**	-	**400 µg/m3**
AL6 -1	02-06-2021	72	72	37	0.44	1.76	17.15	16.73	4.60	6.72
					1.32		13.34		8.17	
					3.52		19.69		7.40	
AL6 – 2	04-06-2021	80	42	39	4.84	6.01	24.77	18.84	7.40	8.76
					3.96		13.34		9.45	
					9.23		18.42		9.45	
AL6 – 3	09-06-2021	122	38	31	9.23	12.45	17.78	16.94	7.40	8.76
					18.90		14.61		8.17	
					9.23		18.42		10.72	
AL6 – 4	11-06-2021	72	25	44	3.52	2.93	10.80	14.61	3.32	4.25
					1.32		14.61		4.85	
					3.96		18.42		4.60	
AL6 – 5	16-06-2021	86	78	12	8.79	11.72	15.24	19.69	9.45	9.19
					13.63		20.33		9.96	
					12.75		23.50		8.17	
AL6 – 6	18-06-2021	187	32	66	11.87	6.74	19.69	18.00	5.62	6.30
					3.96		17.78		6.13	
					4.40		16.51		7.15	
AL6 – 7	23-06-2021	261	73	8	11.87	12.75	20.33	18.42	8.17	9.87
					12.75		26.68		10.72	
					13.63		8.26		10.72	
AL6 – 8	25-06-2021	123	109	26	8.35	10.26	11.43	10.16	9.96	8.25
					9.23		6.99		9.45	
					13.19		12.07		5.36	
Monthly Average		125	59	33		8.08		16.67		7.76
Standard Deviation		67	29	18		4.33		3.06		1.86

NS: Not Specified

Table 6B : Results of Air Pollutant Concentration at Tuna Port					
Parameter	Date	C_6H_6 [µg/m^3]	HC*	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3	NS	4.0 mg/m^3	NS
AL6 -1	02/06/2021	1.2	BDL	1.72	489
AL6 – 2	04/06/2021	1.12	BDL	1.65	479
AL6 – 3	09/06/2021	1.03	BDL	1.71	466
AL6 – 4	11/06/2021	1.14	BDL	1.74	469
AL6 – 5	16/06/2021	1.05	BDL	1.71	490
AL6 – 6	18/06/2021	1.12	BDL	1.72	472
AL6 – 7	23/06/2021	1.29	BDL	1.7	470
AL6 – 8	25/06/2021	1.27	BDL	1.88	480
Monthly Average		**1.15**	**-**	**1.73**	**477**
Standard Deviation		**0.09**	**-**	**0.07**	**9**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)
NS- Not Specified

The mean TSPM values at Tuna Port were 125 µg/m^3, The mean PM_{10} values were 59 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were within the permissible limit (mean = 33 µg/m^3 µg/m^3). The average values of SO_2, NO_x and NH_3 were 8.08 µg/m^3, 16.67 µg/m^3 and 7.76 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Tuna Port. The mean Benzene concentration was 1.15 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.73 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 7: Signal Building (Vadinar) (AL-7)

Table 7 : Results of Air Pollutant Concentration at Signal Building										
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**	
Sampling Period	**-**	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	**-**	**NS**	**100 µg/m3**	**60 µg/m3**	**-**	**80 µg/m3**	**-**	**80 µg/m3**	**-**	**400 µg/m3**
AL7 -1	02-06-2021	56	27	27	3.517	4.396	10.98	9.96	17.15	17.57
					5.715		10.47		19.69	
					3.956		8.42		15.88	
AL7 -2	04-06-2021	59	16	29	3.517	2.051	7.91	10.13	10.80	12.70
					1.319		10.98		12.07	
					1.319		11.49		15.24	
AL7 -3	09-06-2021	51	41	26	2.198	1.905	6.13	6.30	10.80	14.19
					1.319		3.32		12.70	
					2.198		9.45		19.05	
AL7 -4	11-06-2021	49	38	63	3.956	3.077	7.15	9.53	9.53	10.80
					3.077		9.96		10.80	
					2.198		11.49		12.07	
AL7 -5	16-06-2021	62	51	24	1.758	3.810	10.98	9.10	10.80	11.43
					2.198		11.49		11.43	
					7.473		4.85		12.07	
AL7 -6	18-06-2021	68	29	58	11.869	6.447	6.89	13.96	15.88	16.94
					3.956		21.44		17.78	
					3.517		13.53		17.15	
AL7 -7	23-06-2021	63	41	24	10.110	10.843	3.318611	9.28	8.892276	10.37
					10.990		11.4875		10.79776	
					11.429		13.01917		11.43293	
AL7 -8	25-06-2021	66	23	55	0.879	1.612	6.8925	7.23	24.77134	22.44
					1.758		7.913611		23.50102	
					2.198		6.8925		19.05488	
Monthly Average		**59**	**33**	**38**		**4.268**		**9**		**15**
Standard Deviation		**7**	**11**	**17**		**3.098**		**2**		**4**

NS: Not Specified

Table 7B : Results of Air Pollutant Concentration at Signal Building					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC***	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL7 -1	02/06/2021	1.06	BDL	1.68	472
AL7 – 2	04/06/2021	1.11	BDL	1.72	468
AL7 – 3	09/06/2021	1.23	BDL	1.55	482
AL7 – 4	11/06/2021	1.07	BDL	1.69	492
AL7 – 5	16/06/2021	1.23	BDL	1.78	466
AL7 – 6	18/06/2021	1.21	BDL	1.92	478
AL7 – 7	23/06/2021	1.18	BDL	1.88	485
AL7 – 8	25/06/2021	1.14	BDL	1.68	488
Monthly Average		**1.15**	**-**	**1.74**	**479**
Standard Deviation		**0.07**	**-**	**0.12**	**10**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)
NS_ Not Specified

The mean TSPM values at Vadinar Port were 59 µg/m^3. The mean PM_{10} values were 33 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 38 µg/m^3 µg/m^3). The average values of SO_2, NO_x and NH_3 were 4.26 µg/m^3, 9 µg/m^3 and 15 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Vadinar Port. The mean Benzene concentration was 1.15 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.74 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 8: Admin Building (Vadinar) (AL-8)

Table 8 : Results of Air Pollutant Concentration at Admin Building										
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**	
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**	-	**80 µg/m3**	-	**80 µg/m3**	-	**400 µg/m3**
AL8 -1	02-06-2021	54	16	27	0.879	1.905	8.257	8.469	6.893	6.637
					1.758		8.257		7.148	
					3.077		8.892		5.871	
AL8 -2	04-06-2021	58	19	23	0.879	1.172	19.690	16.514	5.361	4.850
					1.758		17.149		4.850	
					0.879		12.703		4.340	
AL8 -3	09-06-2021	70	63	23	2.198	1.612	14.609	12.915	1.276	1.106
					1.319		8.257		1.021	
					1.319		15.879		1.021	
AL8 -4	11-06-2021	53	47	28	1.758	2.198	17.149	17.996	2.298	4.340
					2.198		13.338		6.382	
					2.638		23.501		4.340	
AL8 -5	16-06-2021	57	12	14	2.198	2.638	17.149	12.915	3.319	3.234
					2.638		12.703		3.063	
					3.077		8.892		3.319	
AL8 -6	18-06-2021	59	28	19	1.319	1.758	9.527	9.527	4.850	4.340
					1.758		8.257		4.340	
					2.198		10.798		3.829	
AL8 -5	23-06-2021	56	29	15	0.879	1.758	6.352	8.892	3.829	5.191
					1.319		9.527		4.340	
					3.077		10.798		7.403	
AL8-6	25-06-2021	73	51	28	0.440	0.733	13.974	15.667	7.914	8.084
					0.879		15.244		10.466	
					0.879		17.785		5.871	
Monthly Average		60	33	22		1.7217		12.862		4.72
Standard Deviation		7	18	6		0.5848		3.660		2.10

NS: Not Specified

Table 8B : Results of Air Pollutant Concentration at Admin Building					
Parameter	Date	C_6H_6 [µg/m^3]	HC*	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3	NS	4.0 mg/m^3	NS
AL8 -1	02/06/2021	1.21	BDL	1.78	496
AL8-2	04/06/2021	1.18	BDL	1.92	477
AL8 -3	09/06/2021	1.23	BDL	1.68	468
AL8-4	11/06/2021	1.16	BDL	1.77	484
AL8 -5	16/06/2021	1.25	BDL	1.84	477
AL8-6	18/06/2021	1.22	BDL	1.68	485
AL8-7	23/06/2021	1.16	BDL	1.62	476
AL8-8	25/06/2021	1.12	BDL	1.77	466
Monthly Average		**1.19**	**-**	**1.76**	**479**
Standard Deviation		**0.04**	**-**	**0.10**	**10**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)

NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Admin Building Vadinar was comparatively low among all the locations of Air Quality monitoring in Kandla Port and Vadinar Port. The mean TSPMvalues at Vadinar Port were 60 µg/m^3. The mean PM_{10} values were 33 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 22.0 µg/m^3). The average values of SO_2, NO_x and NH_3 were 1.72 µg/m^3, 12.86 µg/m^3 and 4.72 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Admin Building, Vadinar Port. The mean Benzene concentration was 1.19 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.76 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

1.4 Observations and Conclusion

During the monitoring period, the overall Ambient Air Quality of the port area was found to be well within the desired levels for various pollutants. However, Near Coal storage area, Marine Bhavan and Oil Jetty area, PM_{10} values was above the permissible standards. All other pollutants were recorded well below the prescribed limits.

2. Drinking Water Quality Monitoring

Drinking Water Quality Monitoring was carried out at twenty stations at Kandla, Vadinar & Township Area of Deendayal Port.

2.1 Drinking Water Monitoring Methodology

Drinking water samples were collected from 20 locations as prescribed in the tender document. Samples for physico-chemical analysis were collected in 1 liter carboys and samples for microbiological parameters were collected in sterilized bottles. These samples were then analyzed in laboratory for various drinking water parameters at Kandla Lab/Surat.

The Sampling and Analysis was done as per standard methods - CPCB/GPCB Guidelines and Standard Methods -APHA. The water samples were analyzed for various parameters, viz. Color , Odor, Turbidity , Conductivity , pH , Chlorides , TDS, Total Hardness, Iron , Sulphate , Salinity , DO, BOD, Na, K, Ca, Mg, F, NO_3, NO_2, Mn, Cr-6, Cu, Cd, As, Hg, Pb, Zn, Bacterial Count (cfu) .

2.2 Results

The Drinking Water Quality monitoring data for 20 stations are given in below from table No. 9 to Table No. 15

Table 9: Drinking Water Quality Monitoring Parameters for Nirman Building 1, P & C building & Main Gate (North) at Kandla

Sr. No.	Parameter	Unit	Nirman Building 1	P & C building	Main Gate North	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.1	7.3	7.8	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	570	590	610	500	2000
3	Turbidity	NTU	1	1	0	1.0	5.0
4	Odor	-	Odourless	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	1243.0	1150.0	1190.0	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2.0	NS*	NS*
8	Chloride as Cl	mg/l	513.19	457.02	561.25	250.0	1000.0
9	Ca as Ca	mg/l	48.10	44.09	48.10	75.0	200.0
10	Mg as Mg	mg/l	82.62	87.48	89.91	30.0	100.0
11	Total Hardness	mg/l	460.0	470.0	490.0	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides as F	mg/l	0.30	0.47	0.24	1.0	1.5
14	Sulphate as SO4	mg/l	232.8	180	258	200.0	400
15	Nitrite as NO2	mg/l	0.04	0.05	0.05	NS*	NS*
16	Nitrate as NO3	mg/l	0.77	9.15	28.16	45.0	No Relaxation
17	Salinity	%	0.93	0.83	1.01	NS*	NS*
18	Sodium as Na	mg/l	322.0	315.0	342.0	NS*	NS*
19	Potassium as K	mg/l	3.44	3.21	4.08	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 10: Drinking Water Quality Monitoring Parameters for Canteen, West Gate – I & Wharf Area at Kandla

Sr. No.	Parameter	Unit	Canteen	West Gate - I	Wharf Area	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.0	7.6	7.4	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	910.0	960.0	870.0	500	2000
3	Turbidity	NTU	0	1	0	1.0	5.0
4	Odor	-	Odourless	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	1703.0	1753.0	1630.0	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2.0	NS*	NS*
8	Chloride as Cl	mg/l	613.86	620.88	658.46	250.0	1000.0
9	Ca as Ca	mg/l	52.10	52.10	44.09	75.0	200.0
10	Mg as Mg	mg/l	72.90	80.19	77.76	30.0	100.0
11	Total Hardness	mg/l	430.0	460.0	430.0	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<.0.01	0.3	No Relaxation
13	Fluorides as F	mg/l	0.47	0.32	0.42	1.0	1.5
14	Sulphate as SO4	mg/l	156.0	300.0	366.0	200.0	400
15	Nitrite as NO2	mg/l	0.03	<0.01	0.03	NS*	NS*
16	Nitrate as NO3	mg/l	24.64	10.56	12.67	45.0	No Relaxation
17	Salinity	%	1.11	1.12	1.19	NS*	NS*
18	Sodium as Na	mg/l	333.0	362.0	412.0	NS*	NS*
19	Potassium as K	mg/l	3.78	3.99	4.11	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 11: Drinking Water Quality Monitoring Parameters for Sewa sadan – 3, Workshop I & Custom Building at Kandla

Sr. No.	Parameter	Unit	SewaSadan – 3	Workshop	Custom Building	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.3	7.4	7.8	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1090.0	830.0	935.0	500	2000
3	Turbidity	NTU	1	0	1	1.0	5.0
4	Odor	-	Odourless	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	1910.0	1600.0	1820.0	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2.0	NS*	NS*
8	Chloride	mg/l	743.65	571.77	550.72	250.0	1000.0
9	Ca as Ca	mg/l	52.10	56.11	48.10	75.0	200.0
10	Mg as Mg	mg/l	82.62	85.05	80.19	30.0	100.0
11	Total Hardness	mg/l	470.0	490.0	450.0	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.32	0.93	0.30	1.0	1.5
14	Sulphate	mg/l	190.8	172.8	195.6	200.0	400
15	Nitrite	mg/l	0.01	0.03	0.05	NS*	NS*
16	Nitrate	mg/l	13.37	6.33	12.67	45.0	No Relaxation
17	Salinity	%	1.34	1.03	0.99	NS*	NS*
18	Sodium as Na	mg/l	333.0	342.	392.0	NS*	NS*
19	Potassium as K	mg/l	3.88	3.71	4.12	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 12: Drinking Water Quality Monitoring Parameters for Port Colony Kandla, Hospital Kandla & A.O. Building at Gandhidham

Sr. No.	Parameter	Unit	Port Colony Kandla	Hospital Kandla	A.O. Building	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.2	7	7.2	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1200.0	1400.0	1090.0	500	2000
3	Turbidity	NTU	0	0	1	1.0	5.0
4	Odor	-	Odourless	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	2512.0	2830.0	1920.0	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2.0	NS*	NS*
8	Chloride	mg/l	763.70	794.77	838.86	250.0	1000.0
9	Ca as Ca	mg/l	56.11	48.10	60.12	75.0	200.0
10	Mg as Mg	mg/l	77.76	80.19	77.76	30.0	100.0
11	Total Hardness	mg/l	460.0	450.0	470.0	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.77	0.12	0.21	1.0	1.5
14	Sulphate	mg/l	202.8	261.6	372	200.0	400
15	Nitrite	mg/l	0.05	0.05	0.06	NS*	NS*
16	Nitrate	mg/l	5.63	12.67	16.89	45.0	No Relaxation
17	Salinity	%	1.38	1.44	1.52	NS*	NS*
18	Sodium as Na	mg/l	322.0	373.0	432.0	NS*	NS*
19	Potassium as K	mg/l	3.61	3.81	4.45	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 13: Drinking Water Quality Monitoring Parameters for School Gopalpuri, Guest House & E - Type Quarter at Gopalpuri, Gandhidham

Sr. No.	Parameter	Unit	School Gopalpuri	Guest House	E - Type Quarter	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.1	7.3	7.4	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	970.0	1010.0	1135.0	500	2000
3	Turbidity	NTU	0	1	0	1.0	5.0
4	Odor	-	Odourless	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	1850.0	1920.0	2210.0	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2.0	NS*	NS*
8	Chloride	mg/l	708.58	615.87	845.88	250.0	1000.0
9	Ca as Ca	mg/l	56.11	52.10	56.11	75.0	200.0
10	Mg as Mg	mg/l	82.62	85.05	85.05	30.0	100.0
11	Total Hardness	mg/l	480.0	480.0	490.0	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	1.37	0.89	0.33	1.0	1.5
14	Sulphate	mg/l	369.6	384	376.8	200.0	400
15	Nitrite	mg/l	0.04	0.06	0.04	NS*	NS*
16	Nitrate	mg/l	7.74	6.33	12.67	45.0	No Relaxation
17	Salinity	%	1.28	1.11	1.53	NS*	NS*
18	Sodium as Na	mg/l	392.0	320.0	332.0	NS*	NS*
19	Potassium as K	mg/l	4.11	3.11	3.29	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 14: Drinking Water Quality Monitoring Parameters for F - Type Quarter, Hospital Gopalpuri & Tuna Port

Sr. No.	Parameter	Unit	F - Type Quarter	Hospital Gopalpuri	Tuna Port	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7	7.3	7.38	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	890.0	950.0	1030.0	500	2000
3	Turbidity	NTU	1	0	0	1.0	5.0
4	Odor	-	Odourless	Odourless	Odorless	Agreeable	Agreeable
5	Color	Hazen Unit	Colourless	Colourless	Colorless	5.0	15.0
6	Conductivity	µs/cm	1700.0	2030.0	1920.0	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2	NS*	NS*
8	Chloride	mg/l	706.57	545.21	692.0	250.0	1000.0
9	Ca as Ca	mg/l	52.10	56.11	69.74	75.0	200.0
10	Mg as Mg	mg/l	85.05	85.05	38.39	30.0	100.0
11	Total Hardness	mg/l	480	490	332.0	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.65	1.00	0.39	1.0	1.5
14	Sulphate	mg/l	358.8	378	112.8	200.0	400
15	Nitrite	mg/l	0.06	0.04	<0.01	NS*	NS*
16	Nitrate	mg/l	9.856	11.264	1.42	45.0	No Relaxation
17	Salinity	%	1.28	0.98	1.23	NS*	NS*
18	Sodium as Na	mg/l	373.0	351.0	344	NS*	NS*
19	Potassium as K	mg/l	4.07	3.87	3.4	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 15: Drinking Water Quality Monitoring Parameters for Vadinar Jetty & Port Colony at Vadinar

Sr. No.	Parameter	Unit	Vadinar Jetty	Port Colony Vadinar	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.5	7.3	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	990.0	1010.0	500	2000
3	Turbidity	NTU	0.00	1.00	1.0	5.0
4	Odor	-	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	1830.0	1990.0	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	NS*	NS*
8	Chloride	mg/l	445.99	496.10	250.0	1000.0
9	Ca as Ca	mg/l	52.104	56.11	75.0	200.0
10	Mg as Mg	mg/l	80.19	80.19	30.0	100.0
11	Total Hardness	mg/l	460.0	470.0	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.82	0.94	1.0	1.5
14	Sulphate	mg/l	30.00	34.80	200.0	400
15	Nitrite	mg/l	0.04	0.04	NS*	NS*
16	Nitrate	mg/l	4.93	4.79	45.0	No Relaxation
17	Salinity	%	0.81	0.90	NS*	NS*
18	Sodium as Na	mg/l	311.0	306.0	NS*	NS*
19	Potassium as K	mg/l	4.3	4.9	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent

*NS: Not Specified

2.3 Results & Discussion

The colour of all drinking water samples was < 5 Hazen unit and odour of the samples was also agreeable. All parameters are found to be within the specified limit of the Drinking water Standard.

pH

The limit of pH value for drinking water is specified as 6.5 to 8.5. pH value in the studied area varied from 6.9 to 7.8 pH unit. All the sampling points showed pH values within the prescribed limit by Indian Standards.

Total Dissolved Solids (TDS)

TDS values in the studied area varied between 600 -1800 mg/l. None of the sampling points showed higher TDS values than the prescribed limit by Indian standards .

Conductivity

Electrical Conductivity is the ability of a solution to transfer (conduct) electric current. Conductivity is used to measure the concentration of dissolved solids which have been ionized in a polar solution such as water. The conductivity in the samples collected during the month of June ranged from 2000-3800 µs/cm. Electrical conductivity standards do not appear in BIS standards for drinking water.

BOD

BOD value in the studied area was less than 2.0 mg/L. Indian standards does not show any standard values for BOD in drinking water.

Chlorides

Excessive chloride concentration increase rates of corrosion of metals in the distribution system. This can lead to increased concentration of metals in the supply. Chloride value in the studied area varied between 380-960 mg/l and is found to be within the Permissible limit of the Drinking Water Standard.

Calcium

Calcium value in the studied area varied between 60 - 90 mg/l and is found to be within the Permissible limit of the Drinking Water Standard. If calcium is present beyond the maximum acceptable limit, it causes incrustation of pipes.

Magnesium

Magnesium value in the studied area varied between 25 – 90 mg/l. All the locations had Magnesium within the prescribed limits of 30-100 mg/L.

Total Hardness

Hardness value in the studied area varied between 312-520 mg/l and is found to be within the Permissible limit of the Drinking Water Standard.The prescribed limit by Indian Standards is 200-600 mg/L.

Iron

Iron value in the studied area was below 0.01mg/L and hence well below the permissible limit as per Indian Standards is 0.3 mg/L. The excess amount of iron causes slight toxicity; gives stringent taste to water.

Fluoride

Fluoride value in the studied area varied between 0.1 – 1.0 mg/l and hence well below the permissible limit as per Indian Standards is 1.0-1.5 mg/L. Moderate amounts lead to dental effects, but long-term ingestion of large amounts can lead to potentially severe skeletal problems.

Sulphates

Sulphate value in the studied area varied between 100 – 330 mg/l. All the sampling points showed sulphate values within the prescribed limits by Indian Standards (200-400 mg/L). Sulphate content in drinking water exceeding the 400 mg/L imparts bitter taste.

Nitrites (NO_2) and Nitrates (NO_3)

Nitrite values in all the water samples were <0.1. There are no specified standard values for Nitrites in Drinking water. The mean Nitrate values in drinking water of KPT was 4.10 mg/l which is well within the permissible limit of the Drinking water Standard.

Salinity

Salinity in drinking water in the present samples collected ranged from 0.6 to 1.8 % . There are no prescribed Indian standards for salinity in Drinking water.

Sodium and Potassium Salts

Sodium values in the samples collected ranged from 80 - 460 mg/l and Potassium salts ranged from 2.8 to 4.6 mg/l. There are no prescribed limits of Sodium and Potassium in Indian standards for Drinking water**.**

Heavy Metals in Drinking Water

In the present study period drinking water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals were well below the permissible limits prescribed by the Indian Standards.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that Bacteria is not present and hence Bacterial count is in line with the permissible limit of drinking water. This shows that all the drinking water samples were safe from any bacteriological contamination.

2.4 Conclusions

These results are compared with acceptable limits as prescribed in IS 10500:2012 – Drinking Water Specification. It is seen from the analysis data that during the study period the water was safe for human consumption at all drinking water monitoring stations.

3. Noise Level Monitoring

Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships. Noise Monitoring was done at 13 stations at Kandla, Vadinar and Township area.

3.1 Method of Monitoring

Sampling was done at all stations for 24 hour period. Data was recorded using automated sound level meter. The intensity of sound was measured in sound pressure level (SPL) and common unit of measurement is decibel (Db).

3.2 Results

Table 16: Noise Monitoring data for ten locations of Deendayal Port and two locations of Vadinar Port

Sr. No.	Location	Day Time Average Noise Level (SPL) in dB(A)	Night Time Average Noise Level (SPL) in dB(A)
	Sampling Time	**6:00 am to 10:00 PM**	**10:00PM to 6:00 AM**
1	Marine Bhavan	63.40	57.1
2	Nirman Building 1	57.8	53.9
3	Tuna Port	55.8	47.1
4	Main Gate North	57.1	52.8
5	West Gate I	62.1	54.6
6	Canteen Area	57.1	49.6
7	Main Road	60.0	57.8
8	ATM Building	63.5	56.2
9	Wharf Area /Jetty Area	67.1	57.8
10	Port & Custom Office	55.5	52.7
	Vadinar Port		
11	Entrance Gate of Vadinar Port	57.1	54.6
12	Nr. Port Colony, Vadinar	56.2	56.2
13	Nr. Vadinar Jetty	59.6	55.8

3.3 Conclusions- Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships. The Day Time Average Noise Level (SPL)in all ten locations at Deendayal Port ranged from 56.25 dB(A) to 69.51 dB(A) and it was within the permissible limits of 75 dB(A) for the industrial area for the daytime. The Night Time Average Noise Level (SPL) in all ten locations of Deendayal Port ranged from 48.28 dB to 62.33 dB(A) and it was within the permissible limits of 70 dB(A) for the industrial area for the night time.

4. Soil Monitoring

Sampling and analysis of soil samples were undertaken at six locations within the study area (Deendayal Port and Vadinar Port) as a part of EMP. The soil sampling locations are initially decided based on the locations as provided in the tender document of the Deendayal Port.

4.1 Methodology

The soil samples were collected in the month of June 2021. The samples collected from the all locations are homogeneous representative of each location. At random locations were identified at each location and soil was dug from 30 cm below the surface. It was uniformly mixed before homogenizing the soil samples. The samples were filled in polythene bags, labeled in the field with number and site name and sent to laboratory for analysis.

4.2 Results

Table-17: Chemical Characteristics of Soil in the Study Area

Sr. No.	Parameter	Unit	Station Name					
			SL1	SL2	SL3	SL4	SL5	SL6
			Tuna Port	IFFCO Plant	Khori Creek	Nakti Creek	KPT Admin Site	KPT Colony
			Near main gate of Port	10 m away from main gate	Sand from creek at low tide		Vadinar	
1	Texture		Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	pH	-	7.30	8.16	8.36	8.26	7.27	7.82
3	Electrical Conductivity	µs/cm	33400.0	48500.0	21800.0	37200.0	511.0	464.0
4	Moisture	%	21.45	13.94	18.82	14.26	6.28	4.56
5	Total Organic Carbon	%	0.31	0.19	0.26	0.24	0.15	0.11
6	Alkalinity	mg/kg	100.1	140.14	80.08	140.14	60.06	100.1
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
8	Chloride	mg/kg	6228.7	6032.5	2550.3	7160.6	68.66	78.47
9	Sulphate	mg/kg	2056.4	75.86	292.0	87.84	14.37	13.58
10	Phosphorus	mg/kg	0.97	1.41	0.79	1.59	0.97	0.97
11	Potassium	mg/kg	1161.0	592.2	700.2	765.0	626.4	876.4
12	Calcium	mg/kg	641.3	561.12	701.4	661.32	124.2	172.3
13	Sodium	mg/kg	10821.6	2992.8	3164.4	3736.8	2116.8	2565.0
14	Copper as Cu	mg/kg	11.21	27.22	28.20	31.78	82.66	72.42
15	Lead as Pb	mg/kg	3.10	6.20	23.0	11.4	ND	ND
16	Nickel as Ni	mg/kg	20.71	1823	7.80	15.10	25.46	27.73
17	Zinc as Zn	mg/kg	32.26	72.62	65.90	77.21	23.46	43.20
18	Cadmium as Cd	mg/kg	ND	ND	ND	ND	ND	ND

4.3 Discussion

- The data shows that value of pH ranges from 8.68at Nakti Creek to 9.02 at Tuna Creek indicating that all soil sample sare neutral to basic. Iffco plant samples howed maximum conductivity of 36,200µmhos/cm, while Nakti Creek location showed minimum conductivity of 4790µmhos/cm. Conductivity at Vadinar Port was 439 and 634 µmhos/cm at Admin site and Vadinar Port colony respectively.
- Total organic Carbon ranged from 0.7 % to 2.3 at Deendayal Port. At Vadinar Port, organic carbon content ranged from 0.8 % to 1.04 %.
- The concentration of Phosphorus and Potassium in the soil samples varies from 34.0 to 53.0mg/kg and 700.0 to 1100 mg/kg respectively at Deendayal Port. The mean concentration of Phosphorous at Vadinar site was 6.82 mg/kg and mean concentration of Potassium at Vadinar site was 176.5 mg/kg.

These differences in NPK in soil at different locations are due to the dissimilar nature of soil at each of the locations. Samples SL3 & SL4 (Khori Creek & Nakti Creek) are of saline nature as they are coastal soil; where as other locations are inland locations and have different chemical properties.

Heavy Metals in the Soil

Traces of Copper, Lead, Nickel, Zinc were observed in the soil samples collected from all the four locations of Deendayal Port and two locations of Vadinar Port. Cadmium metal was not detected in the Soil.

4.4 Conclusion

The soils of Deendayal Port and Vadinar Port appears to be neutral to basic with varying levels of Chloride, Sulphate, NPK and Calcium. As the nature of soil at different locations are different with respect to its proximity to the sea, the samples showed high degree of variations in their chemical properties.

5. Sewage Treatment Plant Monitoring

This involves safe collection of waste water (spent/used water) from wash areas, bathroom, industrial units, etc., waste from toilets of various buildings and its conveyance to the treatment plant and final disposal in conformity with the requirement and guide lines of State Pollution Control Board and other statutory bodies.

5.1 Methodology for STP Monitoring

To monitor the working efficiency of Sewage Treatment Plant (STP), STP Inlet and Outlet Samples were collected once a week. Locations selected are namely Gopalpuri Township, Deendayal Port and Vadinar. Samples were collected in 1 lit. carboys and were analyzed in laboratory for various parameters.

5.2 Results

- **Kandla STP**

Table 18: Sewage Water Monitoring at Kandla STP (1st Week)

Date of Sampling	05.06.21

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.62	7.23
2	Total Suspended Solids	mg/l	450	38.2
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	494.9	40.4
5	BOD @ 27 °C	mg/l	152.0	12.0
Aeration Tank				
6	MLSS	mg/l	40.0	
7	MLVSS	%	82.0	

Table 19: Sewage Water Monitoring at Kandla STP (2nd Week)

Date of Sampling	10.06.21

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.93	7.13
2	Total Suspended Solids	mg/l	268.3	58.3
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	289.87	63.63
5	BOD @ 27 °C	mg/l	94.0	16.0
Aeration Tank				
6	MLSS	mg/l	36.0	
7	MLVSS	%	74.0	

Table 20: Sewage Water Monitoring at Kandla STP (3rd Week)

Date of Sampling	15.06.21

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.43	7.23
2	Total Suspended Solids	mg/l	210.5	99
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	259.57	31.31
5	BOD @ 27 °C	mg/l	72.0	8.0
Aeration Tank				
6	MLSS	mg/l	36.0	
7	MLVSS	%	78.0	

Table 21: Sewage Water Monitoring at Kandla STP (4th Week)

Date of Sampling	21.06.21

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.71	7.02
2	Total Suspended Solids	mg/l	226.1	18.3
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	303.0	96.0
5	BOD @ 27 °C	mg/l	110.0	18.0
Aeration Tank				
6	MLSS	mg/l	20.0	
7	MLVSS	%	96.0	

- **Gopalpuri Colony STP**

Table 22: Sewage Water Monitoring at Gopalpuri STP (1st Week)

Date of Sampling	05.06.21

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.21	7.09
2	Total Suspended Solids	mg/l	166.7	54.9
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	383.8	84.4
5	BOD @ 27 °C	mg/l	124.0	16.0
Aeration Tank				
6	MLSS	mg/l	28.0	
7	MLVSS	%	86.0	

Table 23: Sewage Water Monitoring at Gopalpuri STP (2nd Week)

Date of Sampling	10.06.21

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.7	7.26
2	Total Suspended Solids	mg/l	95.21	41.9
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	431.27	109.8
5	BOD @ 27 °C	mg/l	138.0	19.0
Aeration Tank				
6	MLSS	mg/l	18.0	
7	MLVSS	%	96.0	

Table 24: Sewage Water Monitoring at Gopalpuri STP (3rd Week)

Date of Sampling	15.06.21

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.53	7.29
2	Total Suspended Solids	mg/l	52.9	20.1
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	230.28	57.57
5	BOD @ 27 °C	mg/l	76.0	15.0
Aeration Tank				
6	MLSS	mg/l	12.0	
7	MLVSS	%	92.0	

Table 25: Sewage Water Monitoring at Gopalpuri STP (4th Week)

Date of Sampling	21.06.21

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.25	7.12
2	Total Suspended Solids	mg/l	183.8	89
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	202	20.2
5	BOD @ 27 °C	mg/l	68.0	6.0
Aeration Tank				
6	MLSS	mg/l	38.0	
7	MLVSS	%	98.0	

- **Vadinar STP**

Table 26: Sewage Water Monitoring at Vadinar STP (1st Week)

Date of Sampling	05.06.21

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.26	NOT WORKING
2	Total Suspended Solids	mg/l	139.5	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	222.2	
5	BOD @ 27 °C	mg/l	86.0	

Table 27: Sewage Water Monitoring at Vadinar STP (2nd Week)

Date of Sampling	05.06.21

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.36	NOT WORKING
2	Total Suspended Solids	mg/l	108.8	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	353.5	
5	BOD @ 27 °C	mg/l	108.0	

Table 28: Sewage Water Monitoring at Vadinar STP (3rd Week)

Date of Sampling	15.06.21

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.14	NOT WORKING
2	Total Suspended Solids	mg/l	166.7	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	171.7	
5	BOD @ 27 °C	mg/l	52.0	

Table 29: Sewage Water Monitoring at Vadinar STP (4th Week)

Date of Sampling	21.06.21

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/l
1	pH	pH unit	7.26	Not working
2	Total Suspended Solids	mg/l	203.5	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	90.9	
5	BOD @ 27 °C	mg/l	28.0	

5.3 Conclusions:

The GPCB standards of BOD, TSS and Residual Chlorine for STP outlet are 20 mg/lit, 30 mg/lit & 0.5 mg/lit respectively. It is suggested to do treatment on regular basis to avoid flow of contaminated/polluted water into the sea. Also, the STP at Vadinar is also non-functional and thus, steps should be taken to commission the STP at Vadinar Port. Hence, currently only inlet samples are collected and analysed.

6. Marine Water Monitoring

The Forty Second Amendment to the Constitution in 1976 underscored the importance of 'green thinking'. Article 48A enjoins the state to protect and improve the environment and safeguard the forests and wildlife in the country. Further, Article 51A(g) states that the "fundamental duty of every citizen is to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures".

Policy Statement for Abatement of Pollution (1992) has suggested developing relevant legislation and regulation, fiscal incentives, voluntary agreements and educational programs and information campaigns. It emphasizes the need for integration by incorporating environmental considerations into decision making at all levels by adopting frameworks namely, pollution prevention at source, application of best practicable solution, ensure polluter pays for control of pollution, focus on heavily polluted areas and river stretches and involve public in decision-making. The National Conservation Strategy and Policy Statement on Environment and Development, (1992) aimed at "integrating environmental concerns with developmental imperatives to meet the challenges by redirecting the thrust of our developmental process so that the basic needs of our people could be fulfilled by making judicious and sustainable use of natural resources." The priorities mentioned in this policy document include the sustainable use of land and water resources, prevention and control of pollution and preservation of biodiversity.

The National Water Policy, (2002) contains provisions for developing, conserving, sustainable utilizing and managing this important water resources and need to be governed by national perspectives.

Marine Environment

On national and state levels, we have several policies and regulation like Water (Prevention and Control of Pollution) Act, 1974, to regulate pollution discharges and restore water quality of our aquatic resources including the prescription of monitoring activities. One of the important provisions of the Water Act, 1974, is to maintain and restore the 'wholesomeness' of our aquatic resources. Water quality monitoring is one of the first steps required in the rational development and management of water resources. In the field of water quality management, there has been a steady evolution in procedures for designing system to obtain information on the changes of water quality. The monitoring comprises all activities to obtain 'information' with respect to the water system.

Sampling Stations

The monitoring of marine environment for the study of biological and ecological parameters was carried out on 10^{th}& 11^{th} June -2021 in harbor regions of KPT and on 10^{th} June-2021 at Vadinar during spring tide period of New moon phase of Lunar Cycle. The monitoring of marine environment for the study of biological and ecological parameters was repeated again on 18^{th}& 19^{th} June 2021 in harbor regions of KPT. 18^{th} June -2021 in Vadinar during Neap tide period first quarter of Lunar Cycle..

Plankton samples from sub surface layer was collected both during high tide period and low tide period from 3 water quality monitoring stations of KPT harbour area and two stations in Nakti creek and one station in Khori creek. The same sampling schedule was repeated during consecutive spring tide and neap tide in same month. Plankton samples from sub surface layer was collected both during high tide period and low tide period from 1 water quality monitoring stations near Vadinar jetty area during spring tide and neap tide in this month .Collected water samples were processed for estimation of Chlorophyll- a, Pheophytin- a, qualitative &quantitative evaluation of phytoplankton, qualitative &quantitative evaluation zooplanktons (density and their population).

Sampling Locations

Offshore monitoring requirement	Number of locations
Offshore Installations	3 in Kandla creek 2 in Nakti creek 1 in Khori creek 1 near Vadinar Jetty 1 near 1^{st} SBM
Total Number of locations	**8**

6.1 Marine Water Quality

Marine water quality of marine waters of Deendayal Port Harbor waters, Khori and Nakti Creeks and two locations of Vadinar are monitored for various physico-chemical parameters during spring and neap tide of each month.

The results of marine water quality and Marine sediments are as below;

Table 30: Marine Water Quality Monitoring Parameters for location near KPT colony

Sr. No.	Parameters	Unit	Kandla Creek Near KPT colony (1) 23°0'58"N 70°13'22."E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.21	7.35	7.18	7.14
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.7	32.1	32.8	
5	Turbidity	NTU	29	28	28	24
6	Total Dissolved Solids	mg/l	31107.0	35947.0	37797.0	33665.0
7	Total Suspended Solids	mg/l	377.4	359.9	714.2	412.4
8	Total Solids	mg/l	31560.0	36800.0	38860.0	34260.0
9	DO	mg/l	4.9	4.6	3.5	3.3
10	COD	mg/l	78.0	82.0	72.0	76.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.23	0.25	0.56	0.38
13	Phosphate	mg/l	0.35	0.36	0.27	0.24
14	Sulphate	mg/l	3360	3156	2628	3216
15	Nitrate	mg/l	1.97	2.35	2.14	2.78
16	Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01
17	Calcium	mg/l	561.12	641.28	641.28	521.04
18	Magnesium	mg/l	1676.7	1676.7	1555.2	1725.3
19	Sodium	mg/l	11220.0	12080.0	8194.0	7418.0
20	Potassium	mg/l	380.0	390.0	372.0	414.0
21	Iron	mg/l	1.48	1.66	1.76	1.92
22	Chromium	mg/l	0.11	0.13	0.12	0.13
23	Copper	mg/l	0.05	0.06	0.06	0.07
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.06	0.08	0.05	0.06
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.15	0.17	0.16	0.18
28	Zinc	mg/l	0.06	0.07	0.05	0.06

Table 31: Marine Water Quality Monitoring Parameters for location near passenger Jetty One at Kandla

Sr. No.	Parameters	Unit	Near passenger Jetty One (2)			
			23° 0'18 "N 70°13'31"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.5	7.5	7.28	7.15
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.0	32.1	32.6	32.1
5	Turbidity	NTU	29	31	39	29
6	Total Dissolved Solids	mg/l	39865.0	39935.0	41765.0	36900.0
7	Total Suspended Solids	mg/l	366.8	414.5	404.0	477.9
8	Total Solids	mg/l	40212.0	40500.0	46018.0	37338.0
9	DO	mg/l	5.1	5.0	3.5	3.5
10	COD	mg/l	82.0	92.0	78.0	80.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.25	0.27	0.81	0.32
13	Phosphate	mg/l	0.35	0.32	0.20	0.33
14	Sulphate	mg/l	3120.0	3708.0	3336.0	2880.0
15	Nitrate	mg/l	6.0	2.54	1.35	4.33
16	Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01
17	Calcium	mg/l	721.44	601.2	681.36	561.12
18	Magnesium	mg/l	1701.0	1603.8	1676.7	1725.3
19	Sodium	mg/l	11460.0	13211.0	9929.0	10111.0
20	Potassium	mg/l	390.0	382.0	471.0	381.0
21	Iron	mg/l	1.76	1.56	1.72	1.80
22	Chromium	mg/l	0.13	0.11	0.14	0.12
23	Copper	mg/l	0.06	0.07	0.08	0.07
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.05	0.06	0.06	0.07
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.18	0.16	0.17	0.16
28	Zinc	mg/l	0.06	0.06	0.07	0.07

Table 32: Marine Water Quality Monitoring Parameters for location Near Coal Berth

Sr. No.	Parameters	Unit	Near Coal Berth			
			22°59'12"N 70°13'40"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.3	7.21	7.2	7.5
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.0	32.2	32.0	32.3
5	Turbidity	NTU	33.0	31.0	31.8	32.0
6	Total Dissolved Solids	mg/l	34545.0	37030.0	35312.0	35363.0
7	Total Suspended Solids	mg/l	275.3	344.5	563.5	603.2
8	Total Solids	mg/l	35266.0	38080.0	36540	36100.0
9	DO	mg/l	4.8	4.6	4.2	4.3
10	COD	mg/l	86.0	92.0	101.0	100.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.27	0.20	0.38	0.22
13	Phosphate	mg/l	0.28	0.30	0.22	0.21
14	Sulphate	mg/l	1344	1500	2436	3240
15	Nitrate	mg/l	5.56	5.70	2.45	2.27
16	Nitrite	mg/l	0.028	0.02	0.04	0.02
17	Calcium	mg/l	641.28	681.36	601.2	641.28
18	Magnesium	mg/l	1555.2	1676.7	1652.4	1725.3
19	Sodium	mg/l	12015.0	11852.0	9320.0	9481.0
20	Potassium	mg/l	343.0	355.0	491.0	512.0
21	Iron	mg/l	1.44	1.23	1.64	1.34
22	Chromium	mg/l	0.12	0.10	0.12	0.13
23	Copper	mg/l	0.06	0.05	0.06	0.06
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.05	0.06	0.06	0.07
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.18	0.12	0.16	0.14
28	Zinc	mg/l	0.06	0.06	0.05	0.06

Table 33: Marine Water Quality Monitoring Parameters for location Khori creek at Kandla

Sr. No.	Parameters	Unit	KPT 4			
			Near 15/16 Berth			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.43	7.59	7.21	7.39
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.2	33.1	31.8	31.6
5	Turbidity	NTU	37	35	25	47
6	Total Dissolved Solids	mg/l	40837.0	45070.0	33588.0	33133.0
7	Total Suspended Solids	mg/l	299.2	315.5	407.3	438.9
8	Total Solids	mg/l	42994.0	46208.0	34336.0	34040.0
9	DO	mg/l	4.7	4.5	4.4	3.6
10	COD	mg/l	86.0	92.0	78.0	80.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.24	2.34	0.63	0.41
13	Phosphate	mg/l	0.28	0.32	0.26	0.28
14	Sulphate	mg/l	2628	2124	2988	2148
15	Nitrate	mg/l	7.25	2.64	4.67	7.08
16	Nitrite	mg/l	0.02	0.02	0.02	0.02
17	Calcium	mg/l	641.28	601.2	641.28	601.2
18	Magnesium	mg/l	1628.1	1749.6	1676.7	1652.4
19	Sodium	mg/l	10920.0	10962.0	9381.0	9252.0
20	Potassium	mg/l	344.0	352.0	366.0	488.0
21	Iron	mg/l	1.72	1.49	1.56	1.66
22	Chromium	mg/l	0.12	0.11	0.12	0.10
23	Copper	mg/l	0.05	0.05	0.06	0.05
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.06	0.07	0.08	0.07
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.18	0.16	0.15	0.14
28	Zinc	mg/l	0.06	0.05	0.05	0.06

Table 34: Marine Water Quality Monitoring Parameters for location Nakti Creek near Tuna Port

Sr. No.	Parameters	Unit	Nakti Creek Near Tuna Port			
			22°57'49."N 70° 7'0.67"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.39	7.21	7.73	7.7
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.2	31.8	32.4	31.6
5	Turbidity	NTU	34	60	39	49
6	Total Dissolved Solids	mg/l	48922.0	26656.0	39244.0	26963.0
7	Total Suspended Solids	mg/l	287.3	243.68	326.4	214.2
8	Total Solids	mg/l	49728.0	27300.0	40996.0	27294.0
9	DO	mg/l	4.6	4.9	4.2	3.5
10	COD	mg/l	96.0	98.0	88.0	82.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.28	0.29	0.61	0.74
13	Phosphate	mg/l	0.35	0.37	0.18	0.18
14	Sulphate	mg/l	3480	2868	2316	3480
15	Nitrate	mg/l	5.28	2.80	4.50	4.58
16	Nitrite	mg/l	0.02	<0.01	<0.01	0.03
17	Calcium	mg/l	601.2	721.44	521.04	601.2
18	Magnesium	mg/l	1749.6	1628.1	1773.9	1773.9
19	Sodium	mg/l	12126.0	12102.0	10821.0	10728.0
20	Potassium	mg/l	352.0	372.0	521.0	510.0
21	Iron	mg/l	1.52	1.42	1.56	1.59
22	Chromium	mg/l	0.16	0.14	0.13	0.15
23	Copper	mg/l	0.07	0.08	0.07	0.07
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.08	0.07	0.07	0.07
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.14	0.12	0.12	0.13
28	Zinc	mg/l	0.05	0.06	0.06	0.07

Table 35: Marine Water Quality Monitoring Parameters for location Nakti Creek Near NH-8A at Kandla

Sr. No.	Parameters	Unit	Nakti Creek Near NH-8A			
			23° 02'01"N 70° 09'31"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.3	Sampling not possible during Low Tide	7.51	Sampling not possible during Low Tide
2	Color	-	Colorless		Colorless	
3	Odor	-	Odorless		Odorless	
4	Salinity	ppt	32.2		32.8	
5	Turbidity	NTU	37		38	
6	Total Dissolved Solids	mg/l	34970		35210.0	
7	Total Suspended Solids	mg/l	736.8		318.3	
8	Total Solids	mg/l	36048.0		36110.0	
9	DO	mg/l	5.1		3.9	
10	COD	mg/l	98.0		110.0	
11	BOD	mg/l	<2.0		<2.0	
12	Silica	mg/l	0.31		0.98	
13	Phosphate	mg/l	0.28		0.29	
14	Sulphate	mg/l	3720		2220	
15	Nitrate	mg/l	5.45		3.62	
16	Nitrite	mg/l	0.03		0.04	
17	Calcium	mg/l	721.44		681.36	
18	Magnesium	mg/l	1506.6		1749.6	
19	Sodium	mg/l	11622.0		10303.0	
20	Potassium	mg/l	486.0		495.0	
21	Iron	mg/l	1.49		1.62	
22	Chromium	mg/l	0.13		0.14	
23	Copper	mg/l	0.08		0.08	
24	Arsenic	mg/l	<0.01		<0.01	
25	Cadmium	mg/l	0.05		0.07	
26	Mercury	mg/l	<0.001		<0.001	
27	Lead	mg/l	0.19		0.14	
28	Zinc	mg/l	0.07		0.06	

Table 36: Marine Water Quality Monitoring Parameters for locations Nr. Vadinar Jetty

Sr. No.	Parameters	Unit	Nr.Vadinar Jetty 22°26'25.26"N 69°40'20.41"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.25	7.36	7.26	7.21
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.8	32.2	31.2	32.0
5	Turbidity	NTU	5	9	21	15
6	Total Dissolved Solids	mg/l	34444	31931	37088	41030
7	Total Suspended Solids	mg/l	258	482	405.5	399.5
8	Total Solids	mg/l	34948.0	32054.0	37892.0	41410.0
9	DO	mg/l	3.8	4.2	1.9	2.8
10	COD	mg/l	86.0	88.0	72.0	68.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.21	0.30	0.45	0.39
13	Phosphate	mg/l	0.28	0.30	0.16	0.14
14	Sulphate	mg/l	3012	3192	2388	1980
15	Nitrate	mg/l	5.7376	4.32256	0.07744	3.4496
16	Nitrite	mg/l	0.02	0.02	0.02	<0.01
17	Calcium	mg/l	561.12	521.04	561.12	521.04
18	Magnesium	mg/l	1409.4	1603.8	1579.5	1676.7
19	Sodium	mg/l	11720.0	12118.0	10062.0	10080.0
20	Potassium	mg/l	458.0	456.0	406.0	412.0
21	Iron	mg/l	1.77	1.56	1.66	1.62
22	Chromium	mg/l	0.13	0.12	0.16	0.15
23	Copper	mg/l	0.07	0.06	0.05	0.06
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.04	0.04	0.05	0.05
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.18	0.19	0.17	0.16
28	Zinc	mg/l	0.08	0.08	0.06	0.07

6.1.1 Marine Sediments

Sediment samples were collected with Van Veen Grab from the six locations in Kandla Port Waters and two locations in Vadinar Port. Samples were collected and preserved in silver foil in ice box to prevent the contamination/decaying of the samples.

6.2 Results

The Sediment Quality results are given in below from table no. 33

Table 34A: Results of Analysis of Sediment of Kandla & Vadinar Port (Spring Tide)

Sr. No.	Parameters	Unit	KPT - 1	KPT - 2	KPT - 3	Khori - 1	Nakti Creek Near Tuna Port	Nakti - 1 (Near NH-8A)	Jetty
1	Texture		Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	mg/kg	1.20	1.88	1.20	1.30	1.76	1.88	1.56
3	Organic Carbon	mg/kg	0.80	0.96	0.87	0.87	0.69	0.78	0.78
4	Inorganic Phosphate	mg/kg	132.0	126.0	156.0	177.0	167.0	182.0	175.0
5	Moisture	%	24.96	26.86	21.33	16.64	26.33	22.78	23.01
6	Aluminium	mg/kg	ND	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	23.0	22.0	26.0	28.0	32.0	36.0	40.0
8	Phosphate	mg/kg	10.80	11.50	11.77	12.71	9.24	9.88	10.20
9	Sulphate	mg/kg	218.0	252.0	138.0	225.2	239.0	280.0	252.0
10	Nitrite	mg/kg	0.1	0.12	0.13	0.12	0.13	0.12	0.13
11	Nitrate	mg/kg	9.20	7.22	10.42	8.88	8.02	7.89	6.88
12	Calcium	mg/kg	861.0	1102.0	801.0	862.0	922.0	1082.0	802.0
13	Magnesium	mg/kg	437.0	851.0	693.0	765.0	449.0	522.0	422.0
14	Sodium	mg/kg	2083.0	2387.0	1937.0	1859.0	2857.0	2034.0	2185.0
15	Potassium	mg/kg	707.0	918.0	954.0	774.0	1058.0	779.0	792.0
16	Chromium	mg/kg	123.0	180.0	140.0	138.2	146.0	92.0	145.0
17	Nickel	mg/kg	26.0	23.2	28.9	26.2	32.6	33.6	37.7
18	Copper	mg/kg	46	42.7	21.20	36.0	37.2	29.6	26.8
19	Zinc	mg/kg	32.35	38.30	36.70	40.	41.00	39.00	40.00
20	Cadmium	mg/kg	ND	ND	ND	ND	ND	ND	ND
21	Lead	mg/kg	2.86	2.8	5.2	5.0	4.2	5.6	7.2
22	Mercury	mg/kg	ND	ND	ND	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND	ND	ND	ND

*Grab samples could not be collected due high current at Vadinar SBM

Table 34B: Results of Analysis of Sediment of Kandla & Vadinar Port (Neap Tide)

Sr. No.	Parameters	Unit	KPT - 1	KPT - 3	Khori - 1	Nakti Creek Near Tuna Port	Nakti – 1 (Near NH-8A)	Jetty
1	Texture		Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
2	Organic Matter	mg/kg	1.46	1.22	1.66	1.55	1.46	1.35
3	Organic Carbon	mg/kg	0.84	0.69	0.48	0.90	0.96	0.78
4	Inorganic Phosphate	mg/kg	155.0	148.0	162.0	149.0	164.0	166.0
5	Moisture	%	24.9	22.05	28.4	30.08	28.62	20.30
6	Aluminium	mg/kg	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	23.8	22.5	21.82	33.6	32.8	26.0
8	Phosphate	mg/kg	8.53	7.97	9.80	8.62	9.88	11.06
9	Sulphate	mg/kg	196.6	163.89	184.45	140.0	152.0	171.88
10	Nitrite	mg/kg	0.11	0.13	0.14	0.12	0.14	0.12
11	Nitrate	mg/kg	6.42	7.77	6.88	6.89	7.02	8.88
12	Calcium	mg/kg	288.6	212.0	232.4	284.0	296.0	224.0
13	Magnesium	mg/kg	177.4	177.0	170.76	197.2	188.0	535.0
14	Sodium	mg/kg	2662.0	1216.0	990.0	828.0	910.0	1150.0
15	Potassium	mg/kg	200.0	106.0	50.2	79.0	89.0	110.0
16	Chromium	mg/kg	145.0	133.0	146.0	126.0	101.0	166.0
17	Nickel	mg/kg	31.2	26.6	20.3	28.2	27.8	20.9
18	Copper	mg/kg	54.2	26.5	16.2	12.10	11.02	42.0
19	Zinc	mg/kg	23.0	31.0	24.62	29.42	33.36	42.52
20	Cadmium	mg/kg	ND	ND	ND	ND	ND	ND
21	Lead	mg/kg	ND	4.2	4.0	4.2	4.2	3.8
22	Mercury	mg/kg	ND	ND	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND	ND	ND

*Grab samples could not be collected due high current at KPT 2, Vadinar Jetty and Vadinar SBM

REPORT

ON

ECOLOGICAL MONITORING

OF MARINE ENVIRONMENT

IN

DPT HARBOURAREA, NEAR BY CREEKS

For

DEENDAYAL PORT TRUST

JUNE, 2021

DCPL/DPT/20-21/14-June - 2021

***INTRODUCTION*:**

The Forty Second Amendment to the Constitution in 1976 underscored the importance of 'green thinking'. Article 48A enjoins the state to protect and improve the environment and safeguard the forests and wildlife in the country. Further, Article 51A(g) states that the "fundamental duty of every citizen is to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures".

Policy Statement for Abatement of Pollution (1992) has suggested developing relevant legislation and regulation, fiscal incentives, voluntary agreements and educational programs and information campaigns. It emphasizes the need for integration by incorporating environmental considerations into decision making at all levels by adopting frameworks namely, pollution prevention at source, application of best practicable solution, ensure polluter pays for control of pollution, focus on heavily polluted areas and river stretches and involve public in decision-making. The National Conservation Strategy and Policy Statement on Environment and Development, (1992)aimed at "integrating environmental concerns with developmental imperatives to meet the challenges by redirecting the thrust of our developmental process so that the basic needs of our people could be fulfilled by making judicious and sustainable use of natural resources." The priorities mentioned in this policy document include the sustainable use of land and water resources, prevention and control of pollution and preservation of biodiversity.

The National Water Policy, (2002) contains provisions for developing, conserving, sustainable utilizing and managing this important water resources and need to be governed by national perspectives.

MARINE ENVIRONMENT:

On national and state levels, we have several policies and regulation like Water (Prevention and Control of Pollution) Act, 1974, to regulate pollution discharges and restore water quality of our aquatic resources including the prescription of monitoring activities. One of the important provisions of the Water Act, 1974, is to maintain and restore the 'wholesomeness' of our aquatic resources. Water quality monitoring is one of the first steps required in the rational development and management of water resources. In the field of water quality management, there has been a steady evolution in procedures for designing system to obtain information on the changes of water quality. The monitoring comprises all activities to obtain 'information' with respect to the water system.

Sampling Stations:

The monitoring of marine environment for the study of biological and ecological Parameters was carried out on 10th June, 2021 in in harbour region of DPT, and on 11thJune, 2021 in creeks near by the port during spring tide .The monitoring of marine environment for the study of biological and ecological parameters was repeated again on 18th June, 2021 in harbour region of DPT and on19thJune, 2021 in creeks near by the port during neap tidal condition .

Plankton samples from sub surface layer was collected both during high tide period and low tide period from 3 water quality monitoring stations of DPT harbour area andone stations in Nakti creek and one station in Khori creek. Sampling at second sampling station of Nakti creek was possible only during high tide period. Collected water samples were processed for estimation of Chlorophyll- a, Pheophytin- a, qualitative &quantitative evaluation of phytoplankton, qualitative &quantitative evaluation zooplanktons (density and their population).

TABLE #1 SAMPLING LOCATIONS

monitoring requirement	**Number of locations**
Kandla creek Nakti creek Khori Creek	3 in Kandla creek 2 in Nakti creek 1 in Khori creek
Total Number of locations	**6**

Sampling methodology adopted:

A marine sampling is an estimation of the body of information in the population. The theory of the sampling design is depending upon the underlying frequency distribution of the population of interest. The requirement for useful water sampling is to collect a representative sample of suitable volume from the specified depth and retain it free from contamination during retrieval.

50 litters of the water sample were collected from Sub surface by using bucket. From the collected water sample 1 litter of water sample were taken in an opaque plastic bottle for chlorophyll estimation, thereafter plankton samples were collected by using filtration assembly with nilyobolt cloth of 20µm mesh size.

Samples Processing for chlorophyll estimation:

Samples for the chlorophyll estimation were preserved in ice box on board in darkness to avoid degradation in opaque container covered with aluminium foil. Immediately after reaching the shore after sampling, 1 litter of collected water sample was filtered through GF/F filters (pore size 0.45 µm) by using vacuum filtration assembly. After vacuum filtration the glass micro fiber filter paper was grunted in tissue grinder, macerating of glass fiber filter paper along with the filtrate was done in 90% aqueous Acetone in the glass tissue grinder with glass grinding tube. Glass fiber filter paper will assist breaking the cell during grinding and chlorophyll content was extracted with 10 ml of 90% Acetone, under cold dark conditions along with saturated magnesium carbonate solution in glass screw cap tubes. After an extraction period of 24 hours, the samples were transferred to calibrated centrifuge tubes and adjusted the volume to original volume with 90% aqueous acetone solution to make up the evaporation loss. The extract was clarified by using centrifuge in closed tubes. The clarified extracts were then decanted in clean cuvette and optical density was observed at wavelength 664, 665 nm. By using corrected optical density, Chlorophyll-a value was calculated as given in (APHA, 1998).

PLANKTON:

The entire area open water in the sea is the pelagic realm. Pelagic organisms live in the open sea. In contrast to the pelagic realm, the benthic realm comprises organisms and zone of the bottom of the sea. Vertically the pelagic realm can be dividing into two zones based on light penetration; upper photic or euphotic zone and lower dark water mass, aphotic zone below the photic zone.

The term plankton is general term for organisms have such limited powers of locomotion that they are at the mercy of the prevailing water movement. Plankton is subdivided to phytoplankton and zooplankton. Phytoplankton is free floating organisms that are capable of photosynthesis and zooplankton is the various free floating animals.

Pelagic zone, represents the entire ocean water column from the surface to the deepest depths, is home to a diverse community of organisms. Differences in their locomotive ability categorize the organisms in the pelagic realm into two, ***plankton*** and ***nekton*** (Lalli and Parsons, 1997). ***Plankton*** consists of all organisms drifting in the water and is unable to swim against water currents, whereas ***Nekton*** includes organisms having strong locomotive power. Ecological studies on the plankton community, which form the base of the aquatic food chain, help in the better understanding of the dynamics and functioning of the marine ecosystem. The term 'Plankton' first coined by Victor Hensen (1887), Plankton, (Greek word: *planktos*meaning "passively drifting or wandering") is defined as drifting or free-floating organisms that inhabit the pelagic zone of water. Based on their mode of nutrition planktonic organisms are categorised into phytoplankton (organisms having an autotrophic mode of nutrition) and zooplankton (organisms having a heterotrophic mode of nutrition).

Phytoplankton in the marine environment:

Phytoplankton is free floating unicellular, filamentous and colonial eutrophic organisms that grow in aquatic environments whose movement is more or less dependent upon water currents. These micro flora acts as primary producers as well as the basis of food chain, source of protein, bio purifier and bio indicators of the aquatic ecosystems of which diverse array of the life depends .They are considered as an important component of aquatic flora, play a key role in maintaining equilibrium between abiotic and biotic components of aquatic ecosystem.

The phytoplankton includes a wide range of photosynthetic and phototrophic organisms. Marine phytoplankton is mostly microscopic and unicellular floating flora, which are the primary producers that support the pelagic food-chain. The two most prominent groups of phytoplankton are diatoms (Bacillariophyceae) and dinoflagellates (Dinophyceae).The phytoplankton those normally captured in the net from the Gulf of Kutch is normally dominated by these two major groups; diatoms and dinoflagellates. Phytoplankton also include numerous and diverse collection of extremely small, motile algae which are termed micro flagellates (naked flagellates) as well as and Cyanophytes (blue-green algae).

Algae are an ecologically important group in most aquatic ecosystems and have been an important component of biological monitoring programs. Algae are ideally suited for water quality assessment because they have rapid reproduction rates and very short life cycles, making them valuable indicators of short-term impacts.

Aquatic populations are impacted by anthropogenic stress, resulting in a variety of alterations in the biological integrity of aquatic systems. Algae can serve as an indicator of the degree of deterioration of water quality, and many algal indicators have been used to assess environmental status.

Zooplankton in the marine environment:

Zooplankton includes a taxonomically and morphologically diverse community of heterotrophic organisms that drift in the waters of the world's oceans. Qualitative and quantitative studies on zooplankton community is a prerequisite to delineate the ecological processes active in the marine ecosystem. Zooplankton community plays a pivotal role in the pelagic food web as the primary consumers of phytoplankton and act as the food source for organisms in the higher trophic levels, particularly the economically essential groups such as fish larvae and fishes. They also function in the cycling of elements in the marine ecosystem. The dynamics of the zooplankton community, their reproduction, growth and survival rate are all significant factors determining the recruitment and abundance of fish stocks as they form an essential food for larval, juvenile and adult fishes (Beaugrand et al., 2004). Zooplankton grazing in the marine environment controls the primaryProduction and helps in determining the pelagic ecosystem (Banse, 1995). Through grazing in surface waters and following the production of sinking faecal matters and also by the active transportation of dissolved and particulate matter to deeper waters via vertical migration, they help in the transport of organic carbon to deep ocean layers and thus act as key drivers of biological pump' in the marine ecosystem. Zooplankton grazing and metabolism also, transform particulate organic matter into dissolved forms, promoting primary producer community, microbial demineralization, and particle export to the ocean's interior.

The categorisation of zooplankton into various ecological groups is based on several factors such as duration of planktonic life, size, food preferences and habitat. As they vary significantly in size from microscopic to metazoic forms, the classification of zooplankton based on size has paramount importance in the field of quantitative plankton research.

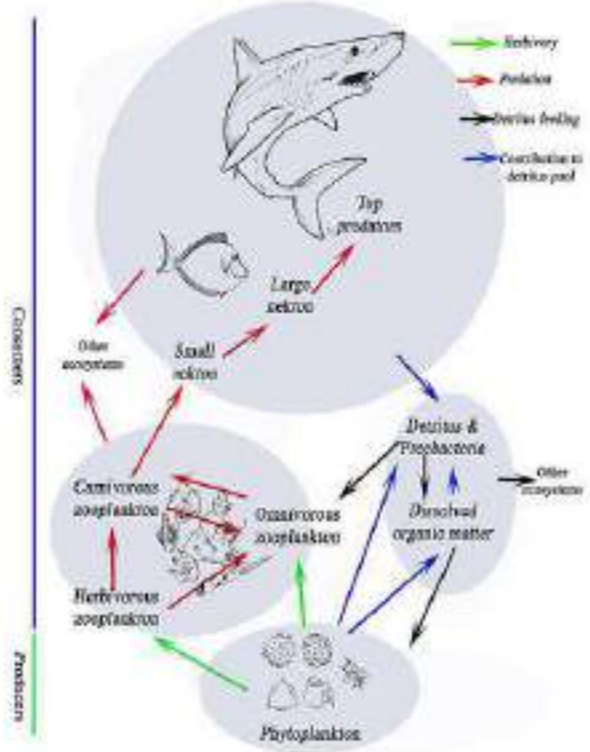
Based on the duration of planktonic life, zooplankton are categorised into Holoplankton (organisms which complete their entire lifecycle as plankton) and Meroplankton (organisms which are planktonic during the early part of their lives such as the larval stages of benthic and nektonic organisms). Tychoplankton are organisms which live a brief planktonic life, such as the benthic crustaceans (cumaceans, mysids, isopods) which ascend to the water column at night for feeding and certain ectoparasitic copepods, they leave the host and spend their life as plankton during their breeding cycle.

Zooplankton can be subdivided into holoplankton, i.e., permanent members of the plankton (e.g., Calanoid copepods), and meroplankton, i.e., temporary members in the plankton e.g., larvae of fish, shrimp, and crab). The meroplankton group consists of larval and young stages of animals that will adopt a different lifestyle once they mature. In contrast to phytoplankton which consist of a relatively smaller variety of organisms, Zooplankton are extremely divers, consist of a host of larval and adult forms representing many animal phylum.

Among the zooplankton one group always dominate than others; members of sub class copepods (Phylum Athropoda), and Tintinids (Phylum Protozoa) among the net planktons. These small animals are of vital importance in marine ecosystem as one of the primary herbivores animals in the sea, and it is they provide vital link between primary producer (autotrophs) and numerous small and large marine consumers.

As their community structure and function are highly susceptible to changes in the environmental conditions regular monitoring of their distribution as well as their interactions with various physicochemical parameters is inevitable for the sustainable management of the ecosystem (Kusum et al., 2014). Of all the marine zooplankton groups, copepods mainly calanoid copepods are the dominant groups in marine subtropical and tropical waters and exhibit considerable diversity in morphology and habitats they occupy (Madhupratap, 1991;)

It has been well established that potential of pelagic fishes viz. finfishes, crustaceans, molluscs and marine mammals either directly or indirectly depend on zooplankton. The herbivorous zooplankton is efficient grazers of the phytoplankton and is referred to as living machines transforming plant material into animal tissue. Hence they play an essential role as the intermediaries for nutrients/energy transfer between primary and tertiary trophic levels. Due to their large density, shorter lifespan, drifting nature, high group/species diversity and different tolerance to the stress, they used as the indicator organisms for the physical, chemical and biological processes in the aquatic ecosystem (Ghajbhiye, 2002).



Simplified marine food web

Spatial distribution of Plankton:

A characteristic of plankton population is that they tend to occur in patches, which are varying spatially on a scale of few meters to far as few kilometres in distance. They also vary in time scale, season as well as vertically in the water column. It is this patchiness and its constant changes in time and spot, that has made it so difficult for plankton biologist to learn about the ecology of plankton. The biological factors that causes this patchiness is due to the ability of zooplankton to migrate vertically and graze out the phytoplankton at a rapid rate that can create patchiness. Similarly the active swimming ability by certain zooplankton organisms can cause to aggregate in dense group.

At its most extreme, because the water in which plankton is suspended is constantly moving, each sample taken by the plankton biologists remain a different volume of water, so each sample is unique and replicate does not exist.

Plankton June also exhibit vertical patchiness. Physical factors contribute to this type of patchiness include light intensity, nutrients and density gradients in the water column.

Phytoplankton in particular tends to be unequally distributed vertically, which leads to the existence of different concentration of a chlorophyll value between photic zone and below the photic zone.

Methodology adopted for Plankton sampling:

Mixed plankton sample were obtained from the sub surface layer at each sampling locations by towing the net horizontally with the weight .After the tow of about 15-30minutes, plankton net was pulled up and washed down to the tail and collected the plankton adhered to plankton net in the collection bucket at the bottom by springing outer and inner surface of the net with sea water, while the net was hanging with the mouth upward. For quantitative evaluation 50 L water samples were collected from subsurface layer and filtered through 20µm mesh size net by using bucket and filtration assembly.

Preservation and storage:

Both filtered plankton and those collected from the plankton net were preserved with 5% buffered formalin and stored in 1L plastic container for further processing in the laboratory.

Sample concentration:

The collected plankton samples were concentrated by using centrifuge and made up to 50 ml with 5% formalin -Glycerine mixture.

Taxonomic evaluation:

Before processing, the sample was mixed carefully and a subsample was taken with a calibrated Stempel-pipette. 1 ml of the concentrated plankton samples were transferred on a glass slide with automatic pipette. The plankton sample on the glass slides were stained by using Lugol's iodine and added glycerine to avoid drying while observation. The plankton samples were identified by using Labex triangular Research microscope with photographic attachment. Microphotographs of the plankton samples were taken for record as well as for confirming the identification. The bigger sized zooplankton was observed through dissecting stereomicroscope with magnification of 20-30 x. Plankton organisms in the whole slide were identified to the lowest axon possible. A thorough literature search was conducted for the identification of the different groups of zooplankton that were encountered

Cell counts by drop count method:

The common glass slide mounted with a 1ml of concentrated phytoplankton/zooplankton sample in glycerol and covered with cover slip 22x 60mm was placed under the compound microscope provided with a mechanical stage. The plankton was then counted from the microscopic field of the left top corner of the slide. Then slide is moved horizontally along the right side and plankton in each microscopic field was thus counted. When first microscopic field row was finished the next consecutive row was adjusted using the mechanical device of the stage. In this way all the plankton present in entire microscopic field are counted. From this total number in 1ml of the concentrated plankton, total number of plankton in the original volume of sample filtered was calculated as units/L.

BENTHIC ORGANISMS:

Benthos is those organisms that are associated with the sea bed or benthic habitats. Epi- benthic organisms live attached to a hard substratum or rooted to a shallow depth below the surface. In fauna organisms live below the sediment–water interface. Interstitial organisms live and move in pore water among sedimentary grains.

Because the benthic organisms are often collected and separated on sieves, a classification based on the overall size is used. Macro benthos include organisms whose shortest dimension is greater than or equal to 0.5 mm. Meio benthos are smaller than 0.5mm but larger than 42µ in size.

The terms such as macro fauna and Meio fauna generally have little relevance with taxonomic classification. The terms Meio fauna and macro fauna depend on the size. Meio fauna were considered as good bioassay of community health and rather sensitive indicators of environmental changes

SAMPLING METHODOLOGY ADOPTED FOR SUB TIDAL REGION:

Van veen sampler (0.09m^2) was used for sampling bottom sediments. Two sets of sediments were sampled from each location, one for macro fauna and other for Meio fauna. The macro fauna in the sediments were sieved on board to separate out the organisms. The fixation of Meio fauna is normally done by bulk fixation of the sediment sample. The bulk fixation is done by using 10% formalin (Buffered with borate). The organisms were preserved with seawater as diluting agent.

Sample sieving:

Sediments samples were sieved to extract the organisms. Sieving was performed carefully as possible to avoid any damage to the animals. The large portion of the sediment was split in to smaller portions and mixed with sea water in a bucket. The cohesive lumps were broken down by continuous stirring. The disaggregated sediments were then passed through the sieves.

Sample staining:

Sorting of the Meio fauna from the sieve is difficult task especially in the preserved material, because organisms are not easily detectable. To facilitate the animal detection the entire sample retained on the sieve after sieving operation were stained by immersing the sieve in a flat bottom

tub with 1% Rose Bangal stain; a protein stain. A staining period of 10-30 minutes is sufficient for sample detection.

DIVERSITY INDICES:

On the whole, diversity indices provide more information about community composition than simply species richness (number of species present); they also, take the relative abundances of different species into account. Based on this fact, diversity indices therefore depend not only on species richness but on the evenness, or equitability, with which individuals are distributed among the different species (Magurram, A. E. (1988)

A diversity index is a measure of species diversity within a community that consists of co-occurring populations of several (two or more) different species. It includes two components: richness and evenness. Richness is the measure of the number of different species within a sample showing that more the types of species in a community, the higher is the diversity or greater is the richness. Evenness is the measure of relative abundance of the different species with in a community.

The basic idea of diversity index is to obtain a quantitative estimate of biological variability that can be used to compare biological entities composed of discrete components in space and time (Carol H.R. *etal*. 1998). Biodiversity is commonly expressed through indices based on species richness and species abundances (Whittaker 1972, Lande 1996, Purvis and Hector 2000). Biodiversity indices are a non-parametric tool used to describe the relationship between species number and abundance. The most widely used bio diversity indices are Shannon Weiner index and Simpson's index.

A diversity Index is a single statistic that incorporates in formation on richness and evenness. The diversity measures that incorporate the two concepts may be termed heterogeneity measures (Magurran, 2004).

Any study intended to interpret causes and effect of adverse impact on Biodiversity of communities require suitable measures to evaluate specie richness and Diversity. The former is number of species in community, while latter is a function of relative frequency of different species. Species richness is the iconic measure of biological diversity (Magurran, 2004). Several indices have been created to measure the diversity of species; however, the most widely used in the last decades are the Shannon (1948) and Simpson (1949) (Buzas and Hayek 1996; Gorelick 2006), with the components of diversity: richness (*S)* and evenness (*J)*

Simpson's diversity index

Simpson's index (**D**) is a measure of diversity, which takes into account both species richness, and evenness of abundance among the species present.. The Simson index is one of the meaningful and robust biodiversity measures available.(Magurran ,2004).

The formula for calculating D is presented as:

$$D = \frac{\sum n_i(n_i - 1)}{N(N-1)}$$

Where n_i = the total number of organisms of each individual species

N = the total number of organisms of all species

The value of D ranges from 0 to 1. With this index, 0 represents infinite diversity and, 1, no diversity. When D increases diversity decreases. Simpson's index is therefore usually expressed as 1-D or 1/D. (Magurran, 2004)

Low species diversity suggests:

- relatively few successful species in the habitat
- the environment is quite stressful with relatively few ecological niches and only a few organisms are really well adapted to that environment
- food webs which are relatively simple
- change in the environment would probably have quite serious effects

High species diversity suggests:

- a greater number of successful species and a more stable ecosystem
- more ecological niches are available and the environment is less likely to be hostile complex food webs
- environmental change is less likely to be damaging to the ecosystem as a whole

Species richness indices

The species richness***(S)*** is simply the number of species present in an ecosystem. Species richness Indices of species richness are widely used to quantify or monitor the effects of anthropogenic disturbance. A decline in species richness may be concomitant with severe or chronic human-induced perturbation (Fair Fair weather 1990,) Species richness measures have traditionally been the mainstay in assessing the effects of environmental degradation on the biodiversity of natural assemblages of organisms (Clarke &Warwick, 2001)

Species richness is the iconic measure of biological diversity (Magurran, 2004). The species richness***(S)*** is simply the number of species present in an ecosystem. This index makes no use of

relative abundances. The term species richness was coined by McIntosh (1967) and oldest and most intuitive measure of biological diversity (Magurran, 2004).

Margalef's diversity index is a species richness index. Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, were derived.

The value of a diversity index increases both when the number of types increases and when evenness increases. For a given number of types, the value of diversity index is maximised when all types are equally abundant (Rosenzweig, M. L. (1995).

Shannon-Wiener's index:

An index of diversity commonly used in plankton community analyses is the Shannon-Wiener's index **(H),** which emphasizes not only the number of species (richness or variety), but also the apportionment of the numbers of individuals among the species (Odum 1971 and Reish 1984). Shannon-Wiener's index (**H**) reproduce community parameters to a single numberby using an equation.

Shannon and Weiner index represents entropy. It is a diversity index taking into account the number of individuals as well as the number of taxa. It varies from 0 for communities with only single taxa to high values for community with many taxa each with few individuals. This index can also determine the pollution status of a water body. Normal values range from 0 to 4. This index is a combination of species present and the evenness of the species. Examining the diversity in the range of polluted and unpolluted ecosystems, Wilham and Dorris (1968) concluded that the values of the index greater than 3 indicate clean water, values in the range of 1 to 3 are characterized by moderate pollution and values less than 1 are characterized as heavily polluted

$$H' = -\sum_{j=1}^{s} \frac{n_j}{N} \ln\left(\frac{n_j}{N}\right)$$

RESULTS:

CHLOROPHYLL-a:

Water Samples for the chlorophyll estimation were collected from sub surface layer during high tide and low tide period of the tidal cycle for each sampling locations and analysed for Chlorophyll -a and after acidification for Pheophytin –a. Chlorophyll- a value was used as algal biomass indicator (APHA,1998) Algal biomass was estimated by converting Chlorophyll value.

In the sub surface water chlorophyll-a was varying from 0.314 -0.468mg/m^3.in harbour region of DPT during sampling done in spring tide period of June, 2021. In the nearby creeks chlorophyll-a was varying from 0.329-0.739 mg/m^3.Pheophytin –a level was below detectable limit- the all the sampling stations during spring in the harbour region of DPT.

In the sub surface water chlorophyll-a was varying from 0.527 -0.765 mg/m^3.in harbour region of DPT during sampling done in neap tide period of June, 2021 . In the nearby creeks chlorophyll-a was varying from 0.425- 0.850 mg/m^3. Pheophytin –a level was below detectable limit- the all the sampling stations during spring in the harbour region of DPT

TABLE #2 VARIATIONS IN CHLOROPHYLL –a PHEOPHYTIN- a AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN JUNE,2021

Sr.No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREA					
1	KPT1	High tide	0.381	BDL	25.53
		Low tide	0.440	BDL	29.48
2	KPT 2	High tide	0.314	BDL	21.04
		Low tide	0.417	BDL	27.94
3	KPT 3	High tide	0.468	BDL	31.36
		Low tide	0.424	BDL	28.41
CREEKS					
4	KPT-4 Khori-I	High tide	0.739	BDL	49.51
		Low tide	0.578	BDL	38.73
5	KPT-5 Nakti-I	High tide	0.637	BDL	42.68
		Low tide	0.409	BDL	27.40
6	KPT-5 Nakti-II	High tide	0.329	BDL	22.04

BDL: Below Detectable Limit.

TABLE #3 VARIATIONS IN CHLOROPHYLL –aPHEOPHYTIN- a AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN JUNE,2021

Sr.No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREA					
1	KPT1	High tide	0.631	BDL	42.28
		Low tide	0.765	BDL	51.25
2	KPT 2	High tide	0.731	BDL	48.98
		Low tide	0.614	BDL	41.14
3	KPT 3	High tide	0.527	BDL	35.31
		Low tide	0.615	BDL	41.21
CREEKS					
4	KPT-4 Khori-I	High tide	0.748	BDL	50.12
		Low tide	0.850	BDL	56.95
5	KPT-5 Nakti-I	High tide	0.715	BDL	47.90
		Low tide	0.715	BDL	47.90
6	KPT-5 Nakti-II	High tide	0.425	BDL	28.47

BDL: Below Detectable Limit.

PHYTOPLANKTON POPULATION:

For the evaluation of the Phytoplankton population in DPT harbour area and within the immediate surroundings of the port, sampling was conducted from 5 sampling locations (3 in harbour area and two in Nakti creek) during high tide period and low tide period of spring tide. The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by,Diatoms and dinoflagellates during spring tide period.Diatoms were represented by 14 genera. Dinoflagellates wererepresented by onegenera .during the sampling conducted in spring tide in June,2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 112-216 units/ L during high tide period and 147-172 units/ L during low tide of Spring Tide.

The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by Diatoms and dinoflagellates during spring tide period.Diatoms were represented by 15genera and Dinoflagellateswere represented onegenera during the sampling conducted in Neap tide in June, 2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 72-293 units/ L during high tide period and 202-375 units/ L during low tide of Neap Tide.

Species Richness Indices and Diversity Indices :

Margalef's diversity index (Species Richness)S

At the organismal level, the most widely used biodiversity measures are those based on the number of species present, perhaps adjusted for the number of individuals sampled, Here Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, are derived.

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was varying from 1.907-2.660 with an average of 2.381during the sampling conducted in High tide period of spring tide While .Margalef's diversity index (Species Richness) S of phytoplankton communities in the Kandla Harbour region and nearby creeks was varying from. 1.603-2.395 with an average of 2.140 during the consecutive in low tide period .

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was varying from 1.775-2.614 with an average of 2.212 during the sampling conducted in High tide period of Neaptide While .Margalef's diversity index (Species Richness) S of phytoplankton communities in the Kandla Harbour region and nearby creeks was varying from. 1.695-2.193 with an average of 1.966 during the consecutive in low tide period .

Shannon-Wiener's index:

Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.794-0.908 (H'(log10)) between selected sampling stations with an average value of 0.844. during high tide period of spring tide .Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.788-0.845 (H'(log10)) between selected sampling stations with an average value of 0.813 during consecutive lowtide. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.722-0.883 (H'(log10)) between selected sampling stations with an average value of 0.814. during high tide period of neap tide . Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.723-0.883 (H'(log10)) between selected sampling stations with an average value of 0.813 during consecutive low tide. Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon-Wiener's index increases as both the richness and the evenness of the community increase. This result indicates that diversity of phytoplankton of Kandla Harbour region and nearby creeks is less but with abundant population of few, with relatively few ecological niches and only very few opportunist organisms are really well adapted to this environment and thrive better than other species.

Simpson's diversity index:

Simpson's index (D) is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. The Simson index is one of the meaningful and robust biodiversity measures available. (Magurran,2004).

Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in the Kandla Harbour region and nearby creeks, which was varying from 0.796- 0.840 between selected sampling stations with an average of 0.815 during high tide period of spring tide . Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in the Kandla Harbour region and nearby creeks, which was varying from 0.790- 0.821 between selected sampling stations with an average of 0.803 during consecutive low tide . Low species diversity suggests a relatively few successful species in this habitat. The environment is quite stressful with relatively few ecological niches and only a few organisms are really well adapted to that environment. Any change in the environment would probably have quite serious effects.

Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in Kandla Harbour region and nearby creeks, during high tide period and low tide period during neap tide also, which was varying from 0.741-0.831 with an average value of 0.800

between selected sampling stations during high tide period and varying from 0.719-0.808 with an average value of 0.758 between selected sampling stations duringconsecutive low tide period Low species diversity suggests a relatively few successful species in this habitat.

Table # 4PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN JUNE,2021

Tide	Sampling Station	Abundance In units/L	No of Species observed /total species	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	158	14/15	93.33	2.568	0.89	0.8401
	2	151	14/15	93.33	2.591	0.8397	0.8165
	3	170	12/15	80	2.142	0.7942	0.7962
	4	216	14/15	93.33	2.418	0.8223	0.8042
	5	193	15/15	100	2.66	0.9078	0.8326
	6	112	10/15	66.66	1.907	0.8103	0.8029
LOW TIDE	1	156	13/15	86.66	2.376	0.8446	0.8209
	2	147	9/15	60	1.603	0.7909	0.8148
	3	152	12/15	80	2.19	0.8051	0.791
	4	172	12/15	80	2.137	0.788	0.7904
	5	150	13/15	86.66	2.395	0.8371	0.7996

Table # 5 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN JUNE,2021

Tide	Sampling Station	Abundance In units/L	No of Species observed /total species	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	240	15/16	93.75	2.554	0.883	0.8308
	2	248	12/16	75	1.995	0.7916	0.7925
	3	212	15/16	93.75	2.614	0.8664	0.8285
	4	293	15/16	93.75	2.465	0.8666	0.8224
	5	280	11/16	68.75	1.775	0.7227	0.7413
	6	72	9/16	56.25	1.871	0.7522	0.7891
LOW TIDE	1	278	11/16	68.75	1.777	0.7379	0.7658
	2	206	12/16	75	2.065	0.7625	0.784
	3	202	10/16	62.50	1.695	0.7941	0.8008
	4	375	14/16	87.5	2.193	0.7182	0.7189
	5	303	13/16	81.25	2.1	0.7164	0.7232

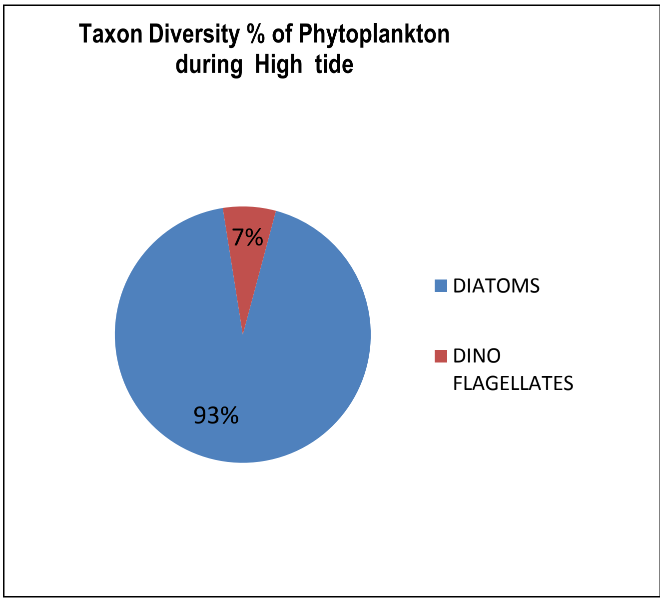
Table # 6 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING SPRING TIDE IN JUNE,2021

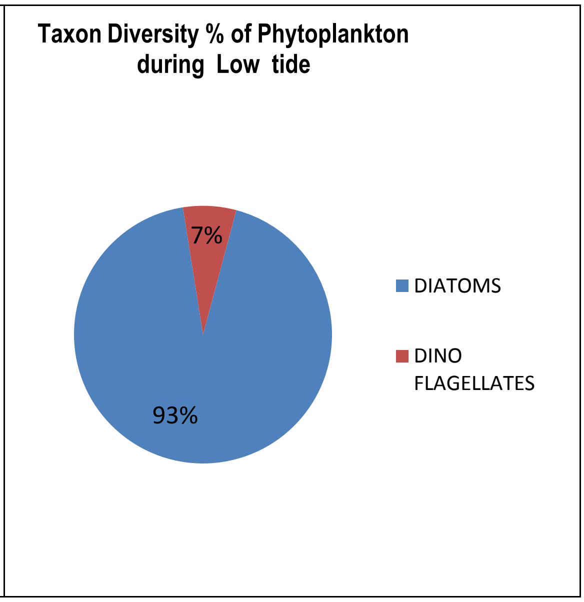
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	112-214	14/15	93.33
			DINO FLAGELLATES	0-2	1/15	6.67
			TOTAL PHYTO PLANKTON	112-216	15	-
LOW TIDE	Sub surface	5	DIATOMS	147-171	14/15	93.33
			DINO FLAGELLATES	0-2	1/15	6.67
			TOTAL PHYTO PLANKTON	147-172	15	-

Table # 7 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING NEAP TIDE IN JUNE, 2021

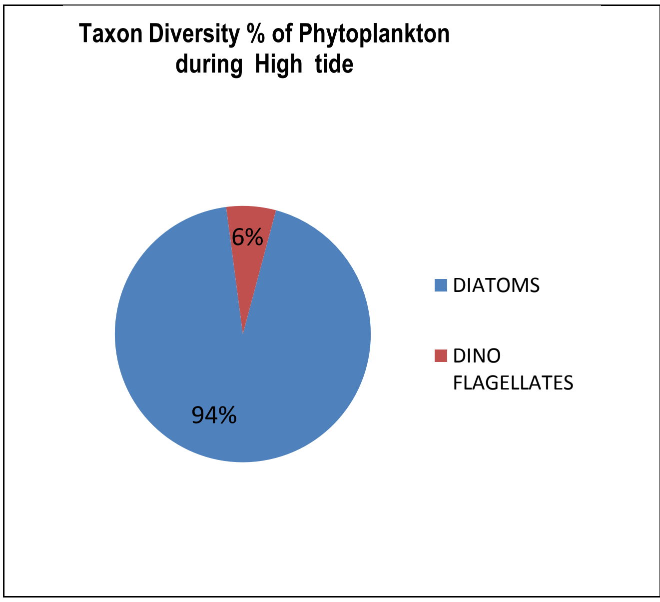
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	72-291	15/16	93.75
			DINO FLAGELLATES	0-2	1/16	6.25
			TOTAL PHYTO PLANKTON	72-293	16	-
LOW TIDE	Sub surface	5	DIATOMS	202-374	15/16	93.75
			DINO FLAGELLATES	0-1	1/16	6.25
			TOTAL PHYTO PLANKTON	202-375	16	

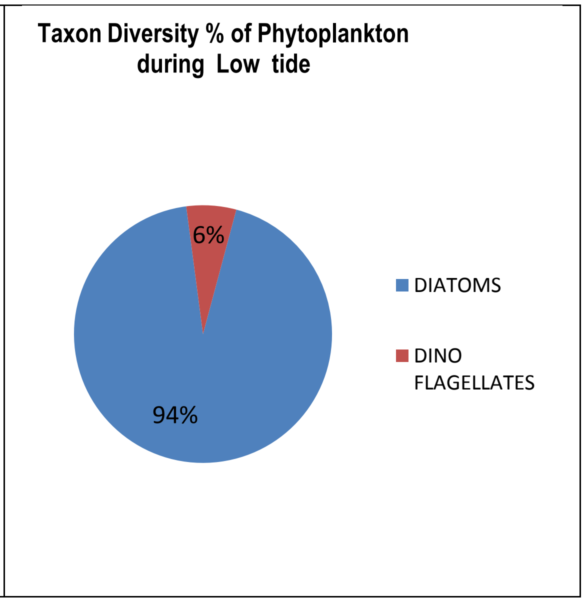
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide





Taxon Diversity % of Phytoplankton during High tide and Low tide period during Neap tide





ZOOPLANKTON POPULATION:

For the evaluation of the Zooplankton population in DPT harbour area and within the immediate surroundings of the port sampling was conducted from 6 sampling locations (3 in harbour area and two in Nakti creek and one in Khoricreek) during high tide period and low tide period of spring tide and Neap tide in June 2021 . The Zooplankton community of the sub surface water in the harbour and nearby creeks during spring tide was represented by mainly four groups, Tintinids, Copepods,Foraminiferans and larval forms of Crustacea, Molluscans. The Zooplankton community of the sub surface water in the harbour and nearby creeks during neap tide was represented by mainly five groups, Tintinids, Copepods, Arrow worms, Mysids and larval forms of Crustacea and Polychates,.

Zooplankton of the sampling stations at sub surface layer in the DPT harbour area and nearby creek was varying from 61-138x10^3 N/ m^3 during high tide and 78-112x10^3 N/ m^3during low tide of Spring Tide period. Zooplankton of the sampling stations at sub surface layer in the DPT harbour area and nearby creek was varying from 47-176 x10^3 N/ m^3 during high tide and80-157 N/ L during low tide of Neap Tide period.

Species Richness Indices and Diversity Indices:

Margalef's diversity index (Species Richness)S

At the organismal level, the most widely used biodiversity measures are those based on the number of species present, perhaps adjusted for the number of individuals sampled, Here Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, are derived.

Margalef's diversity index (Species Richness) S of Zooplankton communities in the stations Kandla Harbour region and nearby creeks was varying from 2.563-3.067 with an average of 2.804 during the sampling conducted in High tide period.Margalef's diversity index (Species Richness) S of Zooplankton communities varying from.2.136-2.875 with an average of 2.485 during the sampling conducted in low tide period during Spring tide.

Margalef's diversity index (Species Richness) S of Zooplankton communities in the Kandla Harbour region and nearby creeks sampling stations was varying from3.610-453 with an average of 4.016 during the sampling conducted in high tide and varying from. 2.755-4.747 with an average of 3.779 during the sampling conducted in low tide during Neap tide period.**Shannon-Wiener's index:**

Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.912-1.017 (H'(log10)) between selected sampling stations with an average value of 0.947 (H'(log10)) during high tide period of spring tide .Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.872-0.939 (H'(log10)) between selected sampling stations with an average value of 0.908 (H'(log10)) during consecutive low tide period .

Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.962-1.143 (H'(log10)) between selected sampling stations with an average value of 1.071 (H'(log10)) during high tide period of Neap tide . Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.952-1.168(H'(log10)) between selected sampling stations with an average value of 1.051 (H'(log10)) during consecutive low tide period .Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon-Wiener's index increases as both the richness and the evenness of the community increase. This result indicates that diversity of Zooplankton of Kandla Harbour region and nearby creeks stations is slightly high with very minimum diverse population but very few opportunist organisms are really well adapted to this environment and thrive better than other species.

Simpson's diversity index:

Simpson's index (D) is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. The Simson index is one of the meaningful and robust biodiversity measures available. (Magurran, 2004).

Simpson diversity index (1-D) of Zooplankton communities was below 0.9 at all sampling stations in the Kandla Harbour region and nearby creeksduring high tide and low tide of spring tide period except few during high tide period, which was varying from 0.838-0.904 between selected sampling stations with an average of 0.862 during high tide period and was varying from 0.838-0.865 with an average value of 0.849 between selected sampling stations during low tide

Simpson diversity index (1-D) of Zooplankton communities was below 0.9 at all sampling stationsin the Kandla Harbour region and nearby creeks during high tide and except one duringhigh tide of Neap tide, which was varying from 0.853-0.905 between selected sampling stations with an average of 0.886 during high tide period and was varying from 0.840- 0.909 with an average value of 0.881 between selected sampling stations during consecutive low tide

This low species diversity suggests a relatively low number of successful species in this habitat. Environment is quite stressful with relatively few ecological niches and only few organisms are really well adapted to that environment. Any change in the environment would probably have quite serious effects.

Table # 8 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN JUNE,2021

Tide	Sampling Station	Abundance In No / m^3	No of Species/groups observed /total species/group	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	96 X10^3	15/17	88.24	3.067	1.01	0.8836
	2	77 X10^3	13/17	76.47	2.763	0.9118	0.8506
	3	92 X10^3	14/17	82.35	2.875	0.9144	0.8385
	4	138 X10^3	14/17	82.35	2.638	0.9177	0.8445
	5	108 X10^3	13/17	76.47	2.563	0.9144	0.852
	6	61 X10^3	13/17	76.47	2.919	1.017	0.9038
LOW TIDE	1	78 X10^3	11/17	64.70	2.295	0.8723	0.8382
	2	92 X10^3	14/17	82.35	2.875	0.9395	0.8538
	3	105 X10^3	12/17	70.58	2.364	0.8972	0.8443
	4	112 X10^3	14/17	82.35	2.755	0.9159	0.8468
	5	108 X10^3	11/17	64.70	2.136	0.9189	0.8654

Table # 9 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN JUNE,2021

Tide	Sampling Station	Abundance In No / m^3	No of Species/groups observed /total species/group	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	111 X10^3	18/26	69.23	3.61	0.9985	0.8526
	2	100 X10^3	19/26	73.07	3.909	1.068	0.8846
	3	103 X10^3	22/26	84.61	4.531	1.129	0.905
	4	176 X10^3	24/26	92.31	4.448	1.143	0.904
	5	155 X10^3	21/26	80.77	3.966	1.13	0.9041
	6	47 X10^3	15/26	57.69	3.636	0.9622	0.8668
LOW TIDE	1	80 X10^3	16/26	61.54	3.423	1	0.8684
	2	103 X10^3	17/26	65.38	3.452	0.9526	0.8401
	3	112 X10^3	14/26	53.85	2.755	1.005	0.8795
	4	157 X10^3	25/26	96.15	4.747	1.168	0.9082
	5	130 X10^3	23/26	88.46	4.52	1.131	0.9095

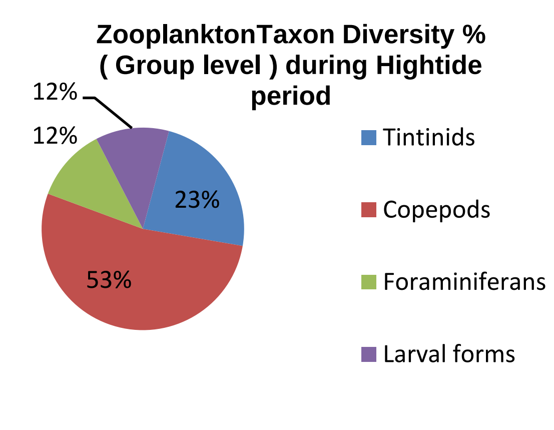
Table # 10 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN JUNE,2021

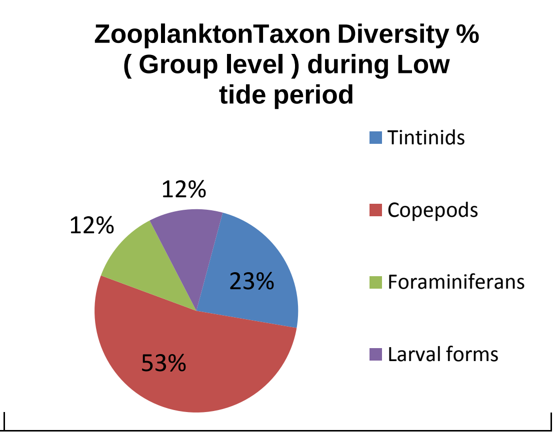
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	10-16	4/17	23.53
			Copepods	31-72	9/17	52.95
			Foraminiferans	0-4	2/17	11.76
			Larval forms	15-50	2/17	11.76
			TOTAL ZOOPLANKTON NO/L	**61-138**	**17**	**-**
LOW TIDE	Sub surface	5	Tintinids	8-15	4/17	23.53
			Copepods	45-57	9/17	52.95
			Foraminiferans	0-2	2/17	11.76
			Larval forms	25-43	2/17	11.76
			TOTAL ZOOPLANKTON NO/L	**78-112**	**17**	**-**

Table # 11 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA , NEAR BY CREEKS DURING NEAP TIDE IN JUNE,2021

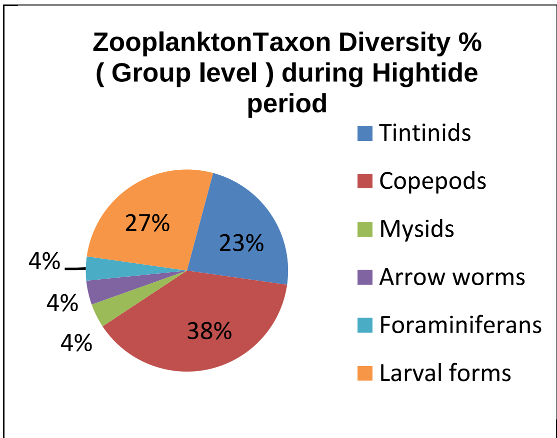
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	4-15	6/26	23.07
			Copepods	25-98	10/26	38.46
			Mysids	1-2	1/26	3.85
			Arrow worms	1-2	1/26	3.85
			Foraminiferans	0-2	1/26	3.85
			Larval forms	17-59	7/26	26.92
			TOTAL ZOOPLANKTON NO/L	**47-176**	**26**	**-**
LOW TIDE	Sub surface	5	Tintinids	4-15	6/26	23.07
			Copepods	38-85	10/26	38.46
			Mysids	0-2	1/26	3.85
			Arrow worms	0-2	1/26	3.85
			Foraminiferans	0-1	1/26	3.85
			Larval forms	37-52	7/26	26.92
			TOTAL ZOOPLANKTON NO/L	**80-157**	**26**	**-**

Taxon Diversity % of Zooplankton during High tide and Low tide period of Spring tide





Taxon Diversity % of Zooplankton during High tide and Low tide period of Neap tide



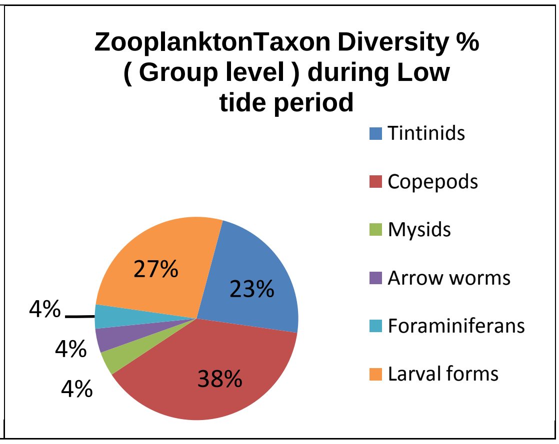


TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURINGSPRING TIDE OF JUNE,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Rare
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D2	Abundant
			Triceratiales	Triceratiaceae	*Odontella*sp	D3	Rare
					*Triceratium*sp.	D4	Occasional
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D5	Frequent
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D6	Occasional
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros*sp	D7	Occasional
			Lithodesmiales	Lithodesmiaceae	*Ditylum*sp	D8	Dominant
			Thalassiosirales	Thalassiosiraceae	*Thalassiosira*sp	D9	Rare
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*sp	D10	Rare
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D11	Frequent
					Thalassionema sp.	D12	Rare
			Fragilariales	Fragilariaceae	*Fragilaria*sp	D13	Occasional
					*Synedra*sp	D14	Frequent
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Gonyaulacales	Ceratiaceae	*Ceratiumfurca*	DF1	Rare

TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURING AND NEAP TIDE OF JUNE,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Occasional
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D2	Dominant
			Triceratiales	Triceratiaceae	*Triceratiumsp*	D3	Occasional
					Odontellasp	D4	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D5	Abundant
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D6	Rare
			Chaetocerotales	Chaetocerotaceae	*Chaetocerossp*	D7	Rare
			Lithodesmiales	Lithodesmiaceae	*Ditylumsp*	D8	Abundant
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigmasp*	D9	Occasional
			Bacillariales	Bacillariaceae	*Bacillaria* sp.	D10	Rare
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D11	Frequent
					Thalassionema sp.	D12	Rare
			Fragilariales	Fragilariaceae	*Fragilaria*sp	D13	Rare
					*Synedra*sp	D14	Frequent
					*Asterionella*sp	D15	Occasional
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium sp.*	DF1	Rare

TABLE #13 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS IN DPT HARBOUR AREA, AND NEAR BY CREEKS DURING SPRING TIDE OF JUNE,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Occasional
				Codonellidae	*Tintinnopsisfailakkaensis*	T2	Occasional
					Tintinnopsisgracilis	T3	Occasional
					Tintinnopsis radix	T4	Rare
COPEPODS	ATHROPODA	Crustacea Sub class copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Frequent
					Bestiolina sp.	C2	Rare
					Parvocalanus sp.	C3	Occasional
				Eucalanidae	*Pareucalanus sp.*	C4	Rare
				Clausocalanidae	*Clausocalanus sp.*	C5	Occasional
				Temoridae	*Temora sp.*	C6	Rare
			Cyclopoida	Oithonidae	*Oithona sp.*	C7	Abundant
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C8	Frequent
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C9	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L2	Occasional
FORAMINIFERA	FORAMINIFERA	Globothalamea	Rotaliida	Globigerinidae	*Globigerina* sp.	F1	Rare
				Rotalliidae	*Rotalia* sp.	F2	Rare

TABLE # 13 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS IN DPT HARBOUR AREA, AND NEAR BY CREEKS DURING NEAP TIDE OF JUNE,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Rare
				Codonellidae	*Tintinnopsisaccuminata*	T2	Occasional
					Tintinnopsisfailakkaensis	T3	Occasional
					Tintinnopsisgracilis	T4	Rare
					Tintinnopsis radix	T5	Rare
				Codonellopsidae	*Codonellopsis* sp.	T6	Rare
COPEPODS	ATHROPODA	Crustacea Sub class copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Abundant
					Parvocalanus sp.	C2	Rare
				Eucalanidae	*Pareucalanus sp.*	C3	Frequent
					Subeucalanus sp.	C4	Occasional
				Temoridae	*Temora sp.*	C5	Frequent
				Acartiidae	*Acartia sp.*	C6	Occasional
			Cyclopoida	Oithonidae	*Oithona sp.*	C7	Frequent
			Harpacticoida	Ectinosomatidae	*Microsetellasp.*	C8	Frequent
				Euterpinidae	*Euterpina sp.*	C9	Frequent
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C1 0	Rare
ARROW WORMS	CHAETOGNATHA	Sagittoideae	Aphragmophora	Sagittidae	*Sagitta sp.*	A1	Rare
MYSIDS	ATHROPODA CRUSTACEA	Malacostraca	Mysida, Decapoda	Penaeidae	*Metapenaeussp.*	M1	Rare

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
POLYCHAETE LARVA	ANNELIDA	Polychaeta			Trochophore larvae	L2	Occasional

BENTHIC ORGANISMS:

No Benthic organism was observed in the collected sediments by using the Van-veen grabs during the sampling conducted during spring tide periodfrom DPT harbour region and nearby creek except few dead shells. Benthic organisms form the sample collected during Neap tide is represented by mainly Polychates ,*Pontodra*sp. *Paronis* sp. and *Phalacophorus*sp and few Amphipods. The benthic organisms at subtidal region of harbour region and creek varies from 30-100 N/m^2

Table # 14 BENTHIC FAUNA IN THE SAMPLING LOCATIONS IN DPT HARBOUR AREA CREEKS DURING NEAP TIDE IN JUNE,2021

Benthic fauna	ABUNDANCE IN NO/M ^{2} DIFFERENT SAMPLING STATIONS REPRESENTATION BY GROUP						
	DPT HARBOUR			CREEKS			
POLYCHATES	KPT-1	KPT-2	KPT-3	KPT-4	KPT-5	KPT-6	
Family : Iospilidae *Pondodora sp.*	10	NS	0	20	30	NS	
Family : Syllidae *Syllis sp*.	20	NS	10	30	10	NS	
Family Glyceredae *Glycerasp.*	30	NS	0	0	0	NS	
Total Polychates N/M^2		NS				NS	
Un identified Nematode worms		NS		0		NS	
Amhipods Un identified	0	NS	0	50	0	NS	
TOTAL Benthic Fauna NUMBER/ M^2	60	NS	10	100	30	NS	

NS : No sample

7. Meteorological Data

Automatic Weather station have been installed in SevaSadan -3 at the Deendayal Port which records the data on Temperature (°C), Humidity (%),Wind (mph), Dew Point (°C), Wind Direction (°), Pressure, Solar radiation, heat Index and UVI.

Temperature

The mean day time temperature for Deendayal Port was 29.77 °C. The day-time maximum temperature was 34.1 °C. The mean night time temperature was 32.53 °C. The minimum mean night time temperature recorded was 28.2 °C.

Air Pressure

The mean absolute air pressure for the month of June was 1004.93 hpa, whereas the mean relative pressure was 1005.03 hpa. The maximum absolute air pressure recorded for the month of June was 1008.9 hpa.

Heat Index

The mean day-time heat index for the month of June was 35.20 ^{o}C. The maximum heat index recorded was 44^{o}C.

Solar Radiation

The mean Solar Radiation in June was 208.28 w/m^2. The maximum solar radiation recorded in the month of June was 654.8 w/m^2.

Humidity

The mean day-time humidity was 76.42 % for the month of June and mean night time humidity was 65.97%. Maximum humidity recorded during day-time was 84.0 % and maximum humidity recorded during night-time was 82.0%.

Wind Velocity and Wind Direction

The mean wind velocity for the entire month of June was 9.72 km/hour (i.e. 2.7 mtr/sec). Maximum wind velocity recorded was 46.8 Km/hr (13 mtr/sec). The wind direction was mostly S to SW.

Conclusive Summary and Remedial measures Suggested

- The AAQ monitoring at six locations of Deendayal Port indicates that the mean PM_{10} values at four locations viz. Coal storage area, Marine Bhavan and Oil Jetty area were found above the permissible standards (100 µg/m^3)and$PM_{2.5}$was above permissible limits at Coal storage location(Limit 60 µg/m^3).

- Drinking water at all the twenty locations was found potable and was within permissible limits of BIS standards (IS 10500).

- Noise quality was also within the set permissible standards of an Industrial Area. The noise level observed during day time was >75 dB (A) and at night time was >70 dB (A) during the entire monitoring period.

- The sewage treated water of Deendayal Port Colony (Gopalpuri) was in line with the standards set by the Gujarat Pollution Control Board. The STP at Deendayal Port is not fully operational and STP at Vadinar Port was found non-operational.

Reasons for higher Values of PM_{10}

- Large amount of coal is handled at Berth No. 6, 7, 8 and 9. The unloading of coal directly in the truck, using grabs cause coal to spread in air as well as coal dust to fall on ground. This settled coal dust again mixes with the air while trucks travel through it.

- Also, the coal laden trucks are not always covered with tarpaulin sheets, and these results in spillage of coal from trucks/dumpers during its transit from vessel to yard or storage site. This also increased PM values around marine Bhavan & Coal storage area.

Remedial Measures

The values of PM_{10} during the month of June, 2021 were observed beyond the permissible limit at four locations mentioned above. Given below are the remedial measures suggest to minimize the Air pollution at Deendayal Port.

- Guidelines for Coal Handling by GPCB should be strictly followed. (http://gpcb.gov.in/pdf/coal-handling-guidelines.pdf)

- Sewage Treatment Plan at Vadinar Port is not working. Hence, it is recommended to commission the sewage treatment plant at Vadinar immediately.

- Except for the higher values of PM_{10} at Coal storage site, Oil Jetty, Tuna Port and Marine Bhavan locations, the monitoring results for the present month suggest that the overall Environment Quality of Deendayal Port is satisfactory.

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ENVIRONMENTAL MONITORING REPORT
FOR
DEENDAYAL PORT TRUST

REPORT NO.	:	DCPL/DPT/20-21/15
Month	:	July 2021
Issue No	:	01
Revision No	:	00
Prepared by	:	DETOX CORPORATION PVT. LTD., SURAT

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Introduction

Monitoring of various environmental aspects of the Deendayal port by M/s Detox Corporation Pvt. Ltd. has been carried out through collection of samples, analysis of the same, comparing results with respect to the national standards and any other relevant standards by GBCB/CPCB/MoEF to identify non conformities in the Environment of the Deendayal Port. The results shall address the identified impacts and suggest measures to minimize the environmental impact due to various operations at Deendayal Port.

The environmental monitoring is carried out as per the Environment Management and Monitoring Plan submitted by Detox Corporation Pvt. Ltd.

1. Ambient Air Quality Monitoring

As per the Environmental Monitoring Plan of Deendayal Port Trust, Air monitoring was carried out at six identified locations at Deendayal Port and two locations at Vadinar Port.

1.1 Air Quality Monitoring Methodology

Air quality is measured in all the stations, for 24 hour for Total Suspended Particulate Matter (TSPM), PM_{10}, $PM_{2.5}$, SO_2, NO_X, NH_3 & Benzene, and Grab-sampling for CO & CO_2 measurements. The Air samplers are operated for a period of 24 hours and after a continuous operation of 8 hours of the sampler, the reagents were replaced to obtain 3 samples per day for each parameter namely, SO_2, NO_X. The EPM 2000 filter paper and PTFE Membrane bound filter paper are used for a period of 24 hours to obtain one sample each of TSPM, PM_{10} & $PM_{2.5}$.

The AAQ samples are collected twice a week from all the eight locations as per the EMP.

1.2 Results

The ambient air quality monitoring data for six stations, viz. Marine Bhavan, Oil Jetty, Port Colony,Gopalpuri Hospital,Tuna Port and Nr. Coal Storage Area for the month of July 2021 are given in Tables 1A to 6B. The ambient air quality monitoring data for two stations at Vadinar (Nr. Admin Building &Nr. Signal Building) are given in Tables 7A to 8B.

Location 1: Marine Bhavan (AL1)

Table 1 : Results of Air Pollutant Concentration at Marine Bhavan

Parameter	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period	-	24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit	-	NS	100 µg/m3	60 µg/m3		80 µg/m3		80 µg/m3		400 µg/m3
AL1 – 1	01.07.2021	417	302	96	3.08	2.78	59.07	48.70	13.53	15.32
					3.52		55.26		16.08	
					1.76		31.76		16.34	
AL1 – 2	05.07.2021	875	776	40	6.59	5.71	57.16	52.51	15.83	12.34
					5.71		47.64		10.21	
					4.84		52.72		10.98	
AL1 – 3	09.07.2021	769	693	11	8.79	7.62	33.03	34.30	13.79	13.87
					8.35		31.76		13.53	
					5.71		38.11		14.30	
AL1 – 4	14.07.2021	267	257	31	2.64	4.69	14.61	24.98	19.15	10.21
					5.28		28.58		5.11	
					6.15		31.76		6.38	
AL1 – 5	16.07.2021	234	143	8	10.55	10.11	13.34	20.11	9.19	12.34
					13.19		22.87		14.04	
					6.59		24.14		13.79	
AL1 - 6	21.07.2021	314	257	202	4.84	2.93	13.34	13.76	7.66	12.17
					1.32		15.24		12.25	
					2.64		12.70		16.59	
AL1 - 7	23.07.2021	387	256	163	1.76	3.08	38.11	28.16	16.34	61.10
					3.52		27.31		13.79	
					3.96		19.05		153.17	
AL1 – 8	27.07.2021	471	299	163	6.15	6.01	12.70	16.09	137.85	53.78
					6.59		18.42		10.98	
					5.28		17.15		12.51	
Monthly Average		467	373	89		5.37		29.83		23.89
Standard Deviation		234	230	78		2.58		14.43		20.85

NS: Not Specified

Table 1B : Results of Air Pollutant Concentration at Marine Bhavan					
Parameter	**Date**	**C_6H_6 [µg/m³]**	**HC* ppm**	**CO [mg/m³]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m³**	**NS**	**4.0 mg/m³**	**NS**
AL1 – 1	01.07.2021	1.13	BDL	1.46	508
AL1 – 2	05.07.2021	1.1	BDL	1.52	489
AL1 – 3	09.07.2021	1.04	BDL	1.36	512
AL1 – 4	14.07.2021	1.14	BDL	1.48	562
AL1 – 5	16.07.2021	1.12	BDL	1.52	496
AL1 - 6	21.07.2021	1.05	BDL	1.48	485
AL1 – 7	23.07.2021	1.04	BDL	1.78	508
AL1 – 8	27.07.2021	1.1	BDL	1.69	495
Monthly Average		**1.09**	**-**	**1.54**	**507**
Standard Deviation		**0.04**	**-**	**0.13**	**24**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC: 0.5ppm)
NS -Not Specified

At Marine Bhavan, the overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_X and NH_3 is attributed mainly by motor vehicle emission produced from various types of automobiles (both diesel and petrol driven). Moreover, the loading and unloading of Food Grains and Timber at Jetty no. 1 and 2 also contributes to the high levels of TSPM and PM_{10}. The mean TSPM value at Marine Bhavan was 467 µg/m³, The mean PM_{10} values were 373.0 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 89 µg/m³). The average values of SO_2, NO_x and NH_3 were within the permissible limit. The average values of SO_2, NO_x and NH3 were 5.37 µg/ m³, 29.83 µg/ m³ & 23.89 µg/ m³ respectively. These were within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Marine Bhavan. The mean Benzene concentration was 1.09 µg/m³,well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.54 mg/m³, well below the permissible limit of 4.0 mg/m³.

Location 2: Oil Jetty (AL2)

Table 2 : Results of Air Pollutant Concentration at Oil Jetty										
Parameters	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period	-	24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit	-	NS	100 µg/m3	60 µg/m3	-	80 µg/m3	-	80 µg/m3	-	400 µg/m3
AL2 – 1	01.07.2021	265	392	127	2.20	1.47	55.26	45.94	7.66	9.96
					0.88		52.72		10.98	
					1.32		29.85		11.23	
AL2 – 2	05.07.2021	812	737	42	0.88	2.93	44.46	47.64	13.53	13.96
					2.64		47.64		13.53	
					5.28		50.81		14.81	
AL2 – 3	09.07.2021	807	707	35	5.28	8.35	17.15	24.56	7.91	10.98
					10.11		24.77		12.76	
					9.67		31.76		12.25	
AL2 – 4	14.07.2021	602	280	5	3.08	3.37	19.05	20.33	15.32	16.59
					2.64		17.15		16.08	
					4.40		24.77		18.38	
AL2 – 5	16.07.2021	578	539	6	4.40	4.10	16.51	17.15	6.13	6.98
					3.52		17.15		5.11	
					4.40		17.78		9.70	
AL2 – 6	21.07.2021	867	772	10	4.84	5.13	29.22	28.16	10.98	13.36
					4.40		32.39		12.76	
					6.15		22.87		16.34	
AL2 – 7	23.07.2021	244	194	76	2.20	2.20	23.50	26.25	13.79	15.40
					1.76		26.68		15.83	
					2.64		28.58		16.59	
AL2 – 8	27.07.2021	448	350	76	6.15	6.45	23.50	18.84	12.00	12.59
					7.03		14.61		13.02	
					6.15		18.42		12.76	
Monthly Average		578	496	47		4.25		28.61		12.48
Standard Deviation		244	224	43		2.30		11.83		3.10

NS: Not Specified

Table 2B : Results of Air Pollutant Concentration at Oil Jetty					
Parameter	Date	C_6H_6 [µg/m^3]	HC* ppm	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3	NS	4.0 mg/m^3	NS
AL2 -1	01.07.2021	1.12	BDL	1.76	512
AL2 -2	05.07.2021	1.16	BDL	1.85	498
AL2 -3	09.07.2021	1.06	BDL	1.77	506
AL2 -4	14.07.2021	1.15	BDL	1.54	489
AL2 – 5	16.07.2021	1.14	BDL	1.78	490
AL2 – 6	21.07.2021	1.19	BDL	1.62	506
AL2 -7	23.07.2021	1.72	BDL	1.82	515
AL2 – 8	27.07.2021	1.58	BDL	1.78	510
Monthly Average		**1.27**	**-**	**1.74**	**503**
Standard Deviation		**0.24**	**-**	**0.11**	**10**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 0.5ppm)

NS- Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Oil Jetty area was mainly by motor vehicle emission produced from various types of vehicles Oil Jetty Area. The mean TSPM values at Oil Jetty were 578 µg/m^3 The mean PM_{10} values were 496 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were below the permissible limit (mean = 47 µg/m^3).The average values of SO_2, NO_x and NH_3 were within the permissible limit; The mean concentration of SO_2, NO_x and NH3 were 4.25 µg/m^3, 28.61 µg/m^3 and 12.48 µg/m^3 respectively.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Oil Jetty. The mean Benzene concentration was 1.27 µg/m^3 .Well below the permissible limit of 5.0 µg/m^3. , HC's were below the detectable limit and Carbon Monoxide concentration was 1.74 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 3: Kandla Colony – Estate Office (AL-3)

Table 3 : Results of Air Pollutant Concentration at Estate Office

Parameters	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**	-	**80 µg/m3**	-	**80 µg/m3**	-	**400 µg/m3**
AL3 – 1	01.07.2021	168	153	55	3.52	3.81	20.96	21.38	14.30	10.21
					5.28		27.31		9.45	
					2.64		15.88		6.89	
AL3 – 2	05.07.2021	467	373	21	3.52	2.49	21.60	23.50	14.04	15.91
					1.32		18.42		15.83	
					2.64		30.49		17.87	
AL3 – 3	09.07.2021	297	139	37	3.08	4.98	23.50	24.77	9.19	7.66
					6.15		29.85		6.38	
					5.71		20.96		7.40	
AL3 – 4	14.07.2021	292	121	80	4.84	5.86	21.60	19.27	14.55	72.33
					5.71		18.42		186.35	
					7.03		17.78		16.08	
AL3 – 5	16.07.2021	629	566	96	17.58	10.11	17.15	14.82	13.53	12.00
					7.91		15.24		9.70	
					4.84		12.07		12.76	
AL3 – 6	21.07.2021	721	668	57	3.96	2.49	6.99	14.82	20.42	18.98
					1.32		15.88		21.44	
					2.20		21.60		15.06	
AL3 – 7	23.07.2021	490	406	51	2.64	2.49	22.87	23.29	11.23	11.91
					3.08		19.69		9.70	
					1.76		27.31		14.81	
AL3 – 8	27.07.2021	640	500	51	1.76	3.66	20.96	18.00	11.23	10.04
					4.40		17.15		8.17	
					4.84		15.88		10.72	
Monthly Average		463	366	56		4.49		19.98		19.88
Standard Deviation		196	210	23		2.59		3.89		21.49

NS: Not Specified

Table 3B : Results of Air Pollutant Concentration at Kandla Port Colony					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC***	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL3 -1	01.07.2021	1.12	BDL	1.78	510
AL3 -2	05.07.2021	1.22	BDL	1.84	526
AL3 -3	09.07.2021	1.16	BDL	1.96	520
AL3 -4	14.07.2021	1.26	BDL	1.88	542
AL3 – 5	16.07.2021	1.18	BDL	1.78	533
AL3 – 6	21.07.2021	1.26	BDL	1.6	525
AL3 – 7	23.07.2021	1.21	BDL	1.58	542
AL3 – 8	27.07.2021	1.11	BDL	1.78	502
Monthly Average		**1.19**	**-**	**1.78**	**525**
Standard Deviation		**0.06**	**-**	**0.13**	**14**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)

NS- Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Kandla Port Colony was attributed by vehicle emission produced from trucks and heavy duty vehicles that pass through the road outside Kandla Port Colony. The mean TSPM values at Oil Jetty were 463 µg/m^3, The mean PM_{10} values were 366 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were slightly above the permissible limit (mean = 56 µg/m^3). The average values of SO_2, NO_x and NH3 were 4.49 µg/m^3, 19.98 µg/m^3 and 19.88 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Kandla Port Colony. The mean Benzene concentration was 1.19 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC’s were below the detectable limit and Carbon Monoxide concentration was 1.78 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 4: Gopalpuri Hospital (AL-4)

Table 4 : Results of Air Pollutant Concentration at Gopalpuri Hospital										
Parameter	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**	
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**	-	**80 µg/m3**	-	**80 µg/m3**	-	**400 µg/m3**
AL4 -1	01.07.2021	148	138	21	1.32	2.20	12.70	13.34	3.57	5.36
					2.20		13.34		7.40	
					3.08		13.97		5.11	
AL4 -2	05.07.2021	313	277	115	3.52	1.76	24.14	19.48	5.36	6.72
					1.32		13.34		8.42	
					0.44		20.96		6.38	
AL4 -3	09.07.2021	287	152	40	1.32	2.49	12.70	30.06	5.87	5.79
					2.64		22.23		5.11	
					3.52		55.26		6.38	
AL4 -4	14.07.2021	143	77	8	1.32	0.88	13.34	11.64	11.74	9.19
					0.88		11.43		8.17	
					0.44		10.16		7.66	
AL4 – 5	16.07.2021	196	119	83	1.32	2.93	20.33	15.24	5.62	7.49
					3.52		13.34		9.45	
					3.96		12.07		7.40	
AL4 – 6	21.07.2021	228	128	100	2.64	1.90	22.87	17.57	7.15	6.89
					1.32		13.34		7.40	
					1.76		16.51		6.13	
AL4 – 7	23.07.2021	338	200	109	0.88	1.32	19.05	26.25	7.15	9.36
					1.32		28.58		9.70	
					1.76		31.12		11.23	
AL4 – 8	27.07.2021	806	746	27	1.76	2.49	19.05	16.94	6.89	6.47
					2.20		14.61		6.38	
					3.52		17.15		6.13	
Monthly Average		307	230	63		2.00		18.82		7.16
Standard Deviation		214	217	43		0.67		6.34		1.46

NS: Not Specified

Table 4B : Results of Air Pollutant Concentration at Gopalpuri Hospital					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC***	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL4 -1	01.07.2021	1.22	BDL	1.62	502
AL4 -2	05.07.2021	1.16	BDL	1.48	499
AL4 -3	09.07.2021	1.32	BDL	1.62	501
AL4 -4	14.07.2021	1.28	BDL	1.78	489
AL4 – 5	16.07.2021	1.25	BDL	1.46	496
AL4 – 6	21.07.2021	1.18	BDL	1.62	510
AL4 – 7	23.07.2021	1.14	BDL	1.78	502
AL4 – 8	27.07.2021	1.23	BDL	1.48	496
Monthly Average		**1.22**	**-**	**1.61**	**499**
Standard Deviation		**0.06**	**-**	**0.13**	**6**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)

NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Gopalpuri Hospital was attributed by vehicle emission produced from light motor vehicles of the colony residents. The mean TSPMvalues at Oil Jetty were 307 µg/m^3, The mean PM_{10} values were 230 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were slight above the permissible limit (mean= 63 µg/m^3). The average values of SO_2, NO_x and NH_3 were 2.00 µg/m^3, 18.82 µg/m^3 and 7.16 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Gopalpuri Hospital. The mean Benzene concentration was 1.22 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.61 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 5: Coal Storage Area (AL-5)

Table 5 : Results of Air Pollutant Concentration at Coal Storage Area

Parameters	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period	-	24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit	-	NS	100 µg/m3	60 µg/m3	-	80 µg/m3	-	80 µg/m3	-	400 µg/m3
AL5 – 1	01.07.2021	428	158	47	3.08	3.37	42.56	48.70	15.83	14.04
					4.84		50.81		12.76	
					2.20		52.72		13.53	
AL5 – 2	05.07.2021	496	150	44	9.67	6.01	57.16	54.84	10.21	14.98
					4.84		49.54		13.53	
					3.52		57.80		21.19	
AL5 – 3	09.07.2021	222	135	76	9.67	7.62	60.98	50.60	16.85	17.44
					3.52		57.16		18.89	
					9.67		33.66		16.59	
AL5 – 4	14.07.2021	349	309	21	17.58	9.23	22.87	31.97	9.45	15.32
					4.84		32.39		21.70	
					5.28		40.65		14.81	
AL5 – 5	16.07.2021	264	123	12	9.67	11.87	16.51	21.38	12.00	14.21
					13.19		22.23		14.04	
					12.75		25.41		16.59	
AL5 – 6	21.07.2021	358	303	33	4.40	5.28	22.87	19.69	16.85	18.47
					6.15		19.05		16.34	
					5.28		17.15		22.21	
AL5 – 7	23.07.2021	268	194	45	4.40	5.28	27.95	23.71	12.76	16.76
					5.28		20.96		16.59	
					6.15		22.23		20.93	
AL5 – 8	27.07.2021	446	273	45	6.15	6.89	14.61	17.15	10.21	13.19
					7.03		22.23		14.04	
					7.47		14.61		15.32	
Monthly Average		354	206	40		6.94		33.50		15.55
Standard Deviation		98	77	19		2.65		15.50		1.84

NS: Not Specified

Table 5B : Results of Air Pollutant Concentration at Coal Storage Area					
Parameter	**Date**	**C_6H_6 [µg/m³]**	**HC***	**CO [mg/m³]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m³**	**NS**	**4.0 mg/m³**	**NS**
AL5 – 1	01.07.2021	1.28	BDL	1.82	526
AL5 – 2	05.07.2021	1.11	BDL	1.78	522
AL5 – 3	09.07.2021	1.16	BDL	1.88	520
AL5 – 4	14.07.2021	1.32	BDL	1.78	530
AL5 – 5	16.07.2021	1.28	BDL	1.82	536
AL5 – 6	21.07.2021	1.22	BDL	1.77	522
AL5 – 7	23.07.2021	1.18	BDL	1.86	526
AL5 – 8	27.07.2021	1.26	BDL	1.9	530
Monthly Average		**1.23**	**-**	**1.83**	**527**
Standard Deviation		**0.07**	**-**	**0.05**	**5**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)

NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Coal Storage Area was comparatively highest among all the locations of Air Quality monitoring in Kandla Port. High values of TSPM, PM10, $PM_{2.5}$, SO_2, NO_X at this location was due to lifting of coal with grab and other coal handling processes near Berth no. 6 & 7. Moreover, the traffic was also heavy around this place for transport of coal thus emissions produced from heavy vehicles. The mean TSPM values at Coal storage were 354 µg/m³. The mean PM_{10} values were 206 µg/m³, which is well above the permissible limit. $PM_{2.5}$ values were below the permissible limit (mean = 40 µg/m³). The average values of SO_2, NO_x and NH_3 were 6.94 µg/m³, 33.50 µg/m³ and 15.55 µg/m³ respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Coal Storage Area. The mean Benzene concentration was 1.23 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.83 mg/m³, well below the permissible limit of 4.0 mg/m³.

Location 6: Tuna Port (AL-6)

Table 6 : Results of Air Pollutant Concentration at Tuna Port											
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**	
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**	-	**80 µg/m3**	-	**80 µg/m3**	-	**400 µg/m3**
AL6 -1	01.07.2021	149	97	39	0.88	2.20	16.51	15.24	5.87	7.32
					2.20		17.15		7.91	
					3.52		12.07		8.17	
AL6 – 2	05.07.2021	270	169	97	2.20	2.20	13.97	17.36	12.76	12.00
					1.32		14.61		11.74	
					3.08		23.50		11.49	
AL6 – 3	09.07.2021	513	198	86	5.71	4.98	21.60	20.96	6.89	7.06
					6.15		17.15		6.64	
					3.08		24.14		7.66	
AL6 – 4	14.07.2021	230	97	98	2.20	3.08	8.26	9.53	7.40	8.76
					2.64		9.53		8.93	
					4.40		10.80		9.96	
AL6 – 5	16.07.2021	554	484	18	1.76	2.20	14.61	12.07	10.72	10.89
					3.52		12.07		10.98	
					1.32		9.53		10.98	
AL6 – 6	21.07.2021	405	302	98	2.20	2.64	6.35	9.95	16.34	14.89
					1.76		10.80		15.57	
					3.96		12.70		12.76	
AL6 – 7	23.07.2021	211	128	12	1.32	2.05	21.60	19.05	10.98	11.83
					2.20		13.34		13.27	
					2.64		22.23		11.23	
AL6 – 8	27.07.2021	645	524	12	0.88	2.05	14.61	18.84	10.21	9.36
					2.64		17.15		8.68	
					2.64		24.77		9.19	
Monthly Average		372	250	58		2.67		15.38		10.26
Standard Deviation		183	171	41		1.00		4.40		2.65

NS: Not Specified

Table 6B : Results of Air Pollutant Concentration at Tuna Port					
Parameter	Date	C_6H_6 [µg/m³]	HC*	CO [mg/m³]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m³	NS	4.0 mg/m³	NS
AL6 -1	01.07.2021	1.2	BDL	1.79	510
AL6 – 2	05.07.2021	1.11	BDL	1.84	502
AL6 – 3	09.07.2021	1.19	BDL	1.72	511
AL6 – 4	14.07.2021	1.15	BDL	1.69	496
AL6 – 5	16.07.2021	1.06	BDL	1.88	499
AL6 – 6	21.07.2021	1.11	BDL	1.87	502
AL6 – 7	23.07.2021	1.06	BDL	1.74	506
AL6 – 8	27.07.2021	1.15	BDL	1.7	512
Monthly Average		**1.13**	**-**	**1.78**	**505**
Standard Deviation		**0.05**	**-**	**0.08**	**6**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)
NS- Not Specified

The mean TSPM values at Tuna Port were 372 µg/m³, The mean PM_{10} values were 250 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were within the permissible limit (mean = 58 µg/m³ µg/m³). The average values of SO_2, NO_x and NH_3 were 2.63 µg/m³, 15.38 µg/m³ and 10.26 µg/m³ respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Tuna Port. The mean Benzene concentration was 1.13 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.78 mg/m³, well below the permissible limit of 4.0 mg/m³.

Location 7: Signal Building (Vadinar) (AL-7)

Table 7 : Results of Air Pollutant Concentration at Signal Building										
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**	
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**	-	**80 µg/m3**	-	**80 µg/m3**	-	**400 µg/m3**
AL7 -1	01.07.2021	119	72	37	3.20	3.08	8.05	8.26	4.41	4.34
					2.97		8.49		4.42	
					3.06		8.24		4.19	
AL7 -2	05.07.2021	104	81	30	3.40	3.52	13.07	12.70	5.45	5.36
					3.18		12.38		5.29	
					3.99		12.65		5.35	
AL7 -3	09.07.2021	62	73	42	4.28	3.96	6.35	6.35	6.09	5.87
					3.60		6.50		5.82	
					4.01		6.20		5.69	
AL7 -4	14.07.2021	104	74	110	4.18	3.96	6.24	6.35	18.21	17.88
					3.87		6.47		17.45	
					3.84		6.34		17.97	
AL7 -5	16.07.2021	96	63	40	2.82	2.64	20.65	20.33	9.23	8.93
					2.65		19.80		8.86	
					2.45		20.54		8.69	
AL7 -6	21.07.2021	102	68	12	8.02	7.47	5.73	5.72	2.71	2.81
					7.18		6.03		2.59	
					7.22		5.40		3.13	
AL7 -7	23.07.2021	143	95	35	5.17	4.84	33.65	33.57	3.29	3.57
					5.10		33.82		3.8	
					4.26		33.23		3.62	
AL7 -8	27.07.2021	107	74	18	7.26	7.46	31.49	31.46	4.5	4.45
					7.49		31.78		4.75	
					7.62		31.12		4.1	
Monthly Average		105	75	40		5		16		7
Standard Deviation		23	10	30		2		12		5

NS: Not Specified

Table 7B : Results of Air Pollutant Concentration at Signal Building					
Parameter	Date	C_6H_6 [µg/m³]	HC*	CO [mg/m³]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m³	NS	4.0 mg/m³	NS
AL7 -1	01.07.2021	1.1	BDL	1.56	489
AL7 – 2	05.07.2021	1.06	BDL	1.66	488
AL7 – 3	09.07.2021	1.02	BDL	1.72	479
AL7 – 4	14.07.2021	1.1	BDL	1.62	496
AL7 – 5	16.07.2021	1.11	BDL	1.68	488
AL7 – 6	21.07.2021	1.16	BDL	1.58	490
AL7 – 7	23.07.2021	1.12	BDL	1.66	481
AL7 – 8	27.07.2021	1.1	BDL	1.6	475
Monthly Average		**1.10**	**-**	**1.64**	**486**
Standard Deviation		**0.04**	**-**	**0.05**	**7**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)
NS_ Not Specified

The mean TSPM values at Vadinar Port were 105 µg/m³. The mean PM_{10} values were 75 µg/m³, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 40 µg/m³ µg/m³). The average values of SO_2, NO_x and NH_3 were 5.0 µg/m³, 16.0 µg/m³ and 7.0 µg/m³ respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Vadinar Port. The mean Benzene concentration was 1.10 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.64 mg/m³, well below the permissible limit of 4.0 mg/m³.

Location 8: Admin Building (Vadinar) (AL-8)

Table 8 : Results of Air Pollutant Concentration at Admin Building											
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**		
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**	-	**80 µg/m3**	-	**80 µg/m3**	-	**400 µg/m3**	
AL8 -1	01.07.2021	172	96	25	2.71	2.64	10.75	10.80	3.42	3.57	
					2.64		10.55		3.71		
					2.58		11.09		3.58		
AL8 -2	05.07.2021	121	100	16	4.05	3.96	8.89	8.89	4.51	4.85	
					3.95		8.81		5.18		
					3.88		8.96		4.86		
AL8 -3	09.07.2021	108	88	14	5.02	4.84	5.80	5.72	9.48	9.19	
					4.79		5.70		8.94		
					4.72		5.67		9.15		
AL8 -4	14.07.2021	169	68	84	6.74	6.59	5.76	5.72	22.65	22.61	
					6.16		5.52		23.06		
					6.88		5.89		22.12		
AL8 -5	16.07.2021	136	85	37	1.40	1.32	18.40	18.42	23.67	22.98	
					1.23		18.53		22.46		
					1.32		18.33		22.81		
AL8 -6	21.07.2021	140	65	87	9.58	9.67	9.04	8.89	6.65	6.63	
					9.80		8.86		6.72		
					9.62		8.76		6.52		
AL8 -5	23.07.2021	168	96	47	6.10	6.15	44.85	44.46	9.23	8.93	
					6.24		44.21		8.46		
					6.10		44.32		9.1		
AL8-6	27.07.2021	153	53	40	3.46	3.52	45.00	44.46	3.95	4.08	
					3.72		44.05		4.09		
					3.38		44.32		4.2		
Monthly Average		146	81	44		5		18		10	
Standard Deviation		24	17	28		3		17		8	

NS: Not Specified

Table 8B : Results of Air Pollutant Concentration at Admin Building					
Parameter	Date	C_6H_6 [µg/m^3]	HC*	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3	NS	4.0 mg/m^3	NS
AL8 -1	01.07.2021	1.1	BDL	1.56	489
AL8-2	05.07.2021	1.06	BDL	1.66	488
AL8 -3	09.07.2021	1.02	BDL	1.72	479
AL8-4	14.07.2021	1.1	BDL	1.62	496
AL8 -5	16.07.2021	1.11	BDL	1.68	488
AL8-6	21.07.2021	1.16	BDL	1.58	490
AL8-7	23.07.2021	1.12	BDL	1.66	481
AL8-8	27.07.2021	1.1	BDL	1.6	475
Monthly Average		**1.10**	-	**1.64**	**486**
Standard Deviation		**0.04**	-	**0.05**	**7**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)

NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Admin Building Vadinar was comparatively low among all the locations of Air Quality monitoring in Kandla Port and Vadinar Port. The mean TSPM values at Vadinar Port were 146 µg/m^3. The mean PM_{10} values were 81 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 44.0 µg/m^3). The average values of SO_2, NO_x and NH_3 were 5.0µg/m^3, 18.0 µg/m^3 and 10.0 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Admin Building, Vadinar Port. The mean Benzene concentration was 1.10 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.64 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

1.4 Observations and Conclusion

During the monitoring period, the overall Ambient Air Quality of the port area was found to be well within the desired levels for various pollutants. However, Near Coal storage area, Marine Bhavan and Oil Jetty area, PM_{10} values was above the permissible standards. All other pollutants were recorded well below the prescribed limits.

2. Drinking Water Quality Monitoring

Drinking Water Quality Monitoring was carried out at twenty stations at Kandla, Vadinar & Township Area of Deendayal Port.

2.1 Drinking Water Monitoring Methodology

Drinking water samples were collected from 20 locations as prescribed in the tender document. Samples for physico-chemical analysis were collected in 1 liter carboys and samples for microbiological parameters were collected in sterilized bottles. These samples were then analyzed in laboratory for various drinking water parameters at Kandla Lab/Surat.

The Sampling and Analysis was done as per standard methods - IS 10500:2012. The water samples were analyzed for various parameters, viz. Color , Odor, Turbidity , Conductivity , pH , Chlorides , TDS, Total Hardness, Iron , Sulphate , Salinity , DO, BOD, Na, K, Ca, Mg, F, NO_3, NO_2, Mn, Cr-6, Cu, Cd, As, Hg, Pb, Zn, Bacterial Count (cfu) .

2.2 Results

The Drinking Water Quality monitoring data for 20 stations are given in below from table No. 9 to Table No. 15

Table 9: Drinking Water Quality Monitoring Parameters for Nirman Building 1, P & C building & Main Gate (North) at Kandla

Sr. No.	Parameter	Unit	Nirman Building 1	P & C building	Main Gate North	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.7	7.4	7.6	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1290	1530	1180	500	2000
3	Turbidity	NTU	0	1	0	1.0	5.0
4	Odor	-	Odourless	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	2500	3010	2200	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/l	416	436	451	250.0	1000.0
9	Ca as Ca	mg/l	72.14	52.10	64.13	75.0	200.0
10	Mg as Mg	mg/l	51.03	68.04	65.61	30.0	100.0
11	Total Hardness	mg/l	390	410	430	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides as F	mg/l	0.26	0.47	0.21	1.0	1.5
14	Sulphate as SO4	mg/l	140.52	166.8	156	200.0	400
15	Nitrite as NO2	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate as NO3	mg/l	10.21	8.45	7.74	45.0	No Relaxation
17	Salinity	%	0.75	0.79	0.81	NS*	NS*
18	Sodium as Na	mg/l	170	168	148	NS*	NS*
19	Potassium as K	mg/l	2.2	2.3	2.8	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 10: Drinking Water Quality Monitoring Parameters for Canteen, West Gate – I & Wharf Area at Kandla

Sr. No.	Parameter	Unit	Canteen	West Gate - I	Wharf Area	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.5	7.3	7.6	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1590	1190	1670	500	2000
3	Turbidity	NTU	0	0	1	1.0	5.0
4	Odor	-	Odourless	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	3110	2330	3300	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/l	411	416	426	250.0	1000.0
9	Ca as Ca	mg/l	56.11	64.13	52.10	75.0	200.0
10	Mg as Mg	mg/l	60.75	48.60	63.18	30.0	100.0
11	Total Hardness	mg/l	390	360	390	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides as F	mg/l	0.18	0.53	1.05	1.0	1.5
14	Sulphate as SO4	mg/l	166.8	165.6	226.8	200.0	400
15	Nitrite as NO2	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate as NO3	mg/l	10.56	11.97	7.53	45.0	No Relaxation
17	Salinity	%	0.74	0.75	0.77	NS*	NS*
18	Sodium as Na	mg/l	133	168	156	NS*	NS*
19	Potassium as K	mg/l	3	2.2	2.4	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 11: Drinking Water Quality Monitoring Parameters for Sewa sadan – 3, Workshop I & Custom Building at Kandla

Sr. No.	Parameter	Unit	SewaSadan – 3	Workshop	Custom Building	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.7	7.9	7.3	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1490	1090	1330	500	2000
3	Turbidity	NTU	1	0	0	1.0	5.0
4	Odor	-	Odourless	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	2990	2090	2680	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	451	456	461	250.0	1000.0
9	Ca as Ca	mg/l	60.12	56.11	64.13	75.0	200.0
10	Mg as Mg	mg/l	60.75	63.18	53.46	30.0	100.0
11	Total Hardness	mg/l	400	400	380	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.93	0.70	1.45	1.0	1.5
14	Sulphate	mg/l	156	171.6	195.6	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	14.78	16.83	9.50	45.0	No Relaxation
17	Salinity	%	0.81	0.82	0.83	NS*	NS*
18	Sodium as Na	mg/l	162	152	162	NS*	NS*
19	Potassium as K	mg/l	2.3	2.4	2.8	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 12: Drinking Water Quality Monitoring Parameters for Port Colony Kandla, Hospital Kandla & A.O. Building at Gandhidham

Sr. No.	Parameter	Unit	Port Colony Kandla	Hospital Kandla	A.O. Building	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.8	7.7	7.0	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1210	1450	1010	500	2000
3	Turbidity	NTU	1	2	2	1.0	5.0
4	Odor	-	Odourless	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	2370	2880	2030	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	526	541	491	250.0	1000.0
9	Ca as Ca	mg/l	52.10	52.10	48.10	75.0	200.0
10	Mg as Mg	mg/l	58.32	68.04	75.33	30.0	100.0
11	Total Hardness	mg/l	370	410	430	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	1.05	1.16	0.93	1.0	1.5
14	Sulphate	mg/l	204	214.8	147.6	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	9.01	9.72	9.15	45.0	No Relaxation
17	Salinity	%	0.95	0.98	0.89	NS*	NS*
18	Sodium as Na	mg/l	178	160	180	NS*	NS*
19	Potassium as K	mg/l	2.7	2.3	2.8	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 13: Drinking Water Quality Monitoring Parameters for School Gopalpuri, Guest House & E - Type Quarter at Gopalpuri, Gandhidham

Sr. No.	Parameter	Unit	School Gopalpuri	Guest House	E - Type Quarter	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.1	7.3	7.2	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	990	1410	1330	500	2000
3	Turbidity	NTU	1	0	1	1.0	5.0
4	Odor	-	Odourless	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	1900	2900	2660	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	526	476	516	250.0	1000.0
9	Ca as Ca	mg/l	60.12	56.11	68.14	75.0	200.0
10	Mg as Mg	mg/l	55.89	53.46	53.46	30.0	100.0
11	Total Hardness	mg/l	380	360	390	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	1.08	0.82	1.14	1.0	1.5
14	Sulphate	mg/l	183.6	157.2	150	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	10.35	11.48	10.35	45.0	No Relaxation
17	Salinity	%	0.95	0.86	0.93	NS*	NS*
18	Sodium as Na	mg/l	196	203	200	NS*	NS*
19	Potassium as K	mg/l	2.4	2.3	2.6	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 14: Drinking Water Quality Monitoring Parameters for F - Type Quarter, Hospital Gopalpuri & Tuna Port

Sr. No.	Parameter	Unit	F - Type Quarter	Hospital Gopalpuri	Tuna Port	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.5	7.2	7.3	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1100	1020	1050	500	2000
3	Turbidity	NTU	1	1	0	1.0	5.0
4	Odor	-	Odourless	Odourless	Odorless	Agreeable	Agreeable
5	Color	Hazen Unit	Colourless	Colourless	Colorless	5.0	15.0
6	Conductivity	µs/cm	2200	2050	1940	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	506	546	592	250.0	1000.0
9	Ca as Ca	mg/l	64.13	72.14	72.14	75.0	200.0
10	Mg as Mg	mg/l	65.61	43.74	36.45	30.0	100.0
11	Total Hardness	mg/l	430	360	330	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.94	1.02	0.46	1.0	1.5
14	Sulphate	mg/l	165.6	159.6	120	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	10.63	9.36	1.33	45.0	No Relaxation
17	Salinity	%	0.91	0.99	0.92	NS*	NS*
18	Sodium as Na	mg/l	180	180	188	NS*	NS*
19	Potassium as K	mg/l	2.5	2.4	2.6	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 15: Drinking Water Quality Monitoring Parameters for Vadinar Jetty & Port Colony at Vadinar

Sr. No.	Parameter	Unit	Vadinar Jetty	Port Colony Vadinar	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.9	7.6	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	950.0	620.0	500	2000
3	Turbidity	NTU	ND	ND	1.0	5.0
4	Odor	-	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	1580.0	1030.0	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	NS*	NS*
8	Chloride	mg/l	445.99	466.04	250.0	1000.0
9	Ca as Ca	mg/l	60.12	52.10	75.0	200.0
10	Mg as Mg	mg/l	63.18	60.75	30.0	100.0
11	Total Hardness	mg/l	410	380	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.99	0.94	1.0	1.5
14	Sulphate	mg/l	16.80	17.64	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	11.48	9.50	45.0	No Relaxation
17	Salinity	%	0.81	0.84	NS*	NS*
18	Sodium as Na	mg/l	142.0	156.0	NS*	NS*
19	Potassium as K	mg/l	2.3	2.4	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent

*NS: Not Specified

2.3 Results & Discussion

The colour of all drinking water samples was < 5 Hazen unit and odour of the samples was also agreeable. All parameters are found to be within the specified limit of the Drinking water Standard.

pH

The limit of pH value for drinking water is specified as 6.5 to 8.5. pH value in the studied area varied from 7.0 to 7.9 pH unit. All the sampling points showed pH values within the prescribed limit by Indian Standards.

Total Dissolved Solids (TDS)

TDS values in the studied area varied between 600 -1800 mg/l. None of the sampling points showed higher TDS values than the prescribed limit by Indian standards .

Conductivity

Electrical Conductivity is the ability of a solution to transfer (conduct) electric current. Conductivity is used to measure the concentration of dissolved solids which have been ionized in a polar solution such as water. The conductivity in the samples collected during the month of July ranged from 1000-3300 µs/cm. Electrical conductivity standards do not appear in BIS standards for drinking water.

BOD

BOD value in the studied area was less than 2.0 mg/L. Indian standards does not show any standard values for BOD in drinking water.

Chlorides

Excessive chloride concentration increase rates of corrosion of metals in the distribution system. This can lead to increased concentration of metals in the supply. Chloride value in the studied area varied between 400-600 mg/l and is found to be within the Permissible limit of the Drinking Water Standard.

Calcium

Calcium value in the studied area varied between 45 - 80 mg/l and is found to be within the Permissible limit of the Drinking Water Standard. If calcium is present beyond the maximum acceptable limit, it causes incrustation of pipes.

Magnesium

Magnesium value in the studied area varied between 30 – 80 mg/l. All the locations had Magnesium within the prescribed limits of 30-100 mg/L.

Total Hardness

Hardness value in the studied area varied between 330-430 mg/l and is found to be within the Permissible limit of the Drinking Water Standard.The prescribed limit by Indian Standards is 200-600 mg/L.

Iron

Iron value in the studied area was below 0.01mg/L and hence well below the permissible limit as per Indian Standards is 0.3 mg/L. The excess amount of iron causes slight toxicity; gives stringent taste to water.

Fluoride

Fluoride value in the studied area varied between 0.1 – 1.4 mg/l and hence well below the permissible limit as per Indian Standards is 1.0-1.5 mg/L. Moderate amounts lead to dental effects, but long-term ingestion of large amounts can lead to potentially severe skeletal problems.

Sulphates

Sulphate value in the studied area varied between 100 – 330 mg/l. All the sampling points showed sulphate values within the prescribed limits by Indian Standards (200-400 mg/L). Sulphate content in drinking water exceeding the 400 mg/L imparts bitter taste.

Nitrites (NO_2) and Nitrates (NO_3)

Nitrite values in all the water samples were <0.1. There are no specified standard values for Nitrites in Drinking water. The mean Nitrate values in drinking water of KPT was 4.10 mg/l which is well within the permissible limit of the Drinking water Standard.

Salinity

Salinity in drinking water in the present samples collected ranged from 0.6 to 0.9 %. There are no prescribed Indian standards for salinity in Drinking water.

Sodium and Potassium Salts

Sodium values in the samples collected ranged from 100 - 2000 mg/l and Potassium salts ranged from 2.2 to 3.0 mg/l. There are no prescribed limits of Sodium and Potassium in Indian standards for Drinking water**.**

Heavy Metals in Drinking Water

In the present study period drinking water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals were well below the permissible limits prescribed by the Indian Standards.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that Bacteria is not present and hence Bacterial count is in line with the permissible limit of drinking water. This shows that all the drinking water samples were safe from any bacteriological contamination.

2.4 Conclusions

These results are compared with acceptable limits as prescribed in IS 10500:2012 – Drinking Water Specification. It is seen from the analysis data that during the study period the water was safe for human consumption at all drinking water monitoring stations.

3. Noise Level Monitoring

Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships. Noise Monitoring was done at 13 stations at Kandla, Vadinar and Township area.

3.1 Method of Monitoring

Sampling was done at all stations for 24 hour period. Data was recorded using automated sound level meter. The intensity of sound was measured in sound pressure level (SPL) and common unit of measurement is decibel (Db).

3.2 Results

Table 16: Noise Monitoring data for ten locations of Deendayal Port and two locations of Vadinar Port

Sr. No.	Location	Day Time Average Noise Level (SPL) in dB(A)	Night Time Average Noise Level (SPL) in dB(A)
	Sampling Time	**6:00 am to 10:00 PM**	**10:00PM to 6:00 AM**
1	Marine Bhavan	60.71	55.49
2	Nirman Building 1	58.02	52.12
3	Tuna Port	53.16	46.37
4	Main Gate North	56.47	53.21
5	West Gate I	61.41	53.6
6	Canteen Area	56.78	48.45
7	Main Road	59.41	56.44
8	ATM Building	63.81	55.02
9	Wharf Area /Jetty Area	65.66	56.59
10	Port & Custom Office	53.59	49.22
	Vadinar Port		
11	Entrance Gate of Vadinar Port	56.32	54.2
12	Nr. Port Colony, Vadinar	55.5	54.8
13	Nr. Vadinar Jetty	58.76	55.4

3.3 Conclusions- Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships. The Day Time Average Noise Level (SPL)in all ten locations at Deendayal Port ranged from 56.25 dB(A) to 69.51 dB(A) and it was within the permissible limits of 75 dB(A) for the industrial area for the daytime. The Night Time Average Noise Level (SPL) in all ten locations of Deendayal Port ranged from 48.28 dB to 62.33 dB(A) and it was within the permissible limits of 70 dB(A) for the industrial area for the night time.

4. Soil Monitoring

Sampling and analysis of soil samples were undertaken at six locations within the study area (Deendayal Port and Vadinar Port) as a part of EMP. The soil sampling locations are initially decided based on the locations as provided in the tender document of the Deendayal Port.

4.1 Methodology

The soil samples were collected in the month of July 2021. The samples collected from the all locations are homogeneous representative of each location. At random locations were identified at each location and soil was dug from 30 cm below the surface. It was uniformly mixed before homogenizing the soil samples. The samples were filled in polythene bags, labeled in the field with number and site name and sent to laboratory for analysis.

4.2 Results

Table-17: Chemical Characteristics of Soil in the Study Area

Sr. No.	Parameter	Unit	Station Name					
			SL1	SL2	SL3	SL4	SL5	SL6
			Tuna Port	IFFCO Plant	Khori Creek	Nakti Creek	KPT Admin Site	KPT Colony
			Near main gate of Port	10 m away from main gate	Sand from creek at low tide		Vadinar	
1	Texture		Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	pH	-	8.56	8.11	8.38	8.33	8.12	8.42
3	Electrical Conductivity	µs/cm	26,800.0	23,800.0	23,700.0	16,260.0	509.0	419.0
4	Moisture	%	23.66	22.09	24.41	23.65	9.44	7.59
5	Total Organic Carbon	%	0.16	0.24	0.32	0.10	0.20	0.12
6	Alkalinity	mg/kg	140.14	140.14	100.10	80.08	100.10	60.06
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
8	Chloride	mg/kg	3,908.6	4,309.5	6,114.0	3,959.0	39.3	68.7
9	Sulphate	mg/kg	203.0	177.9	113.8	93.8	13.4	15.5
10	Phosphorus	mg/kg	0.97	0.80	1.24	1.77	0.80	0.97
11	Potassium	mg/kg	779.4	644.4	1,135.8	766.8	129.6	180.0
12	Sodium	mg/kg	2,241.0	3,556.8	3,981.6	3,038.4	1,220.0	1,445.4
13	Calcium	mg/kg	144.29	128.22	168.30	224.40	104.20	56.11
14	Copper as Cu	mg/kg	42.6	61.2	38.2	22.6	16.2	23
15	Lead as Pb	mg/kg	4.2	3.2	3.6	3.8	ND	ND
16	Nickel as Ni	mg/kg	36.2	31.6	39.4	22.6	18.3	21.2
17	Zinc as Zn	mg/kg	58.60	39.25	52.4	46.60	46.80	38.20
18	Cadmium as Cd	mg/kg	ND	ND	ND	ND	ND	ND

4.3 Discussion

- The data shows that value of pH ranges from 8.11 at Nakti Creek to 8.56 at Tuna Creek indicating that all soil samples are neutral to slight basic. Tuna port samples howed maximum conductivity of 26,800µmhos/cm, while Nakti Creek location showed minimum conductivity of 16,260 µmhos/cm. Conductivity at Vadinar Port was 509 and 419 µmhos/cm at Admin site and Vadinar Port colony respectively.
- Total organic Carbon ranged from 0.1 % to 0.3 at Deendayal Port. At Vadinar Port, organic carbon content ranged from 0.1 % to 0.2 %.
- The concentration of Phosphorus and Potassium in the soil samples varies from 0.8 to 1.77 mg/kg and 600.0 to 1150 mg/kg respectively at Deendayal Port. The mean concentration of Phosphorous at Vadinar site was 0.89 mg/kg and mean concentration of Potassium at Vadinar site was 154.8 mg/kg.

These differences in NPK in soil at different locations are due to the dissimilar nature of soil at each of the locations. Samples SL3 & SL4 (Khori Creek & Nakti Creek) are of saline nature as they are coastal soil; where as other locations are inland locations and have different chemical properties.

Heavy Metals in the Soil

Traces of Copper, Lead, Nickel and Zinc were observed in the soil samples collected from all the four locations of Deendayal Port and two locations of Vadinar Port. Cadmium metal was not detected in the Soil.

4.4 Conclusion

The soils of Deendayal Port and Vadinar Port appears to be neutral to basic with varying levels of Chloride, Sulphate, NPK and Calcium. As the nature of soil at different locations are different with respect to its proximity to the sea, the samples showed high degree of variations in their chemical properties.

5. Sewage Treatment Plant Monitoring

This involves safe collection of waste water (spent/used water) from wash areas, bathroom, industrial units, etc., waste from toilets of various buildings and its conveyance to the treatment plant and final disposal in conformity with the requirement and guide lines of State Pollution Control Board and other statutory bodies.

5.1 Methodology for STP Monitoring

To monitor the working efficiency of Sewage Treatment Plant (STP), STP Inlet and Outlet Samples were collected once a week. Locations selected are namely Gopalpuri Township, Deendayal Port and Vadinar. Samples were collected in 1 lit. Carboys and were analyzed in laboratory for various parameters.

5.2 Results

- **Kandla STP**

Table 18: Sewage Water Monitoring at Kandla STP (1st Week)

Date of Sampling	05.07.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.5	7.8
2	Total Suspended Solids	mg/l	125.4	64.3
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	333.3	102
5	BOD @ 27 °C	mg/l	110.0	26.0
Aeration Tank				
6	MLSS	mg/l	18.0	
7	MLVSS	%	88.0	

Table 19: Sewage Water Monitoring at Kandla STP (2nd Week)

Date of Sampling	15.07.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.6	7.68
2	Total Suspended Solids	mg/l	350	46
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	585	98
5	BOD @ 27 °C	mg/l	196.0	26.0
Aeration Tank				
6	MLSS	mg/l	24.0	
7	MLVSS	%	82.0	

Table 20: Sewage Water Monitoring at Kandla STP (3rd Week)

Date of Sampling	20.07.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.73	7.61
2	Total Suspended Solids	mg/l	192.6	62
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	222	20
5	BOD @ 27 °C	mg/l	68.0	8.0
Aeration Tank				
6	MLSS	mg/l	16.0	
7	MLVSS	%	86.0	

Table 21: Sewage Water Monitoring at Kandla STP (4th Week)

Date of Sampling	26.07.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	Plant was not working	
2	Total Suspended Solids	mg/l		
3	Residual Chlorine	mg/l		
4	COD	mg/l		
5	BOD @ 27 °C	mg/l		
Aeration Tank				
6	MLSS	mg/l	-	
7	MLVSS	%	-	

- **Gopalpuri Colony STP**

Table 22: Sewage Water Monitoring at Gopalpuri STP (1st Week)

Date of Sampling	05.07.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.7	7.63
2	Total Suspended Solids	mg/l	408.3	38.3
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	262.6	102
5	BOD @ 27 °C	mg/l	82.0	28.0
Aeration Tank				
6	MLSS	mg/l	12.0	
7	MLVSS	%	92.0	

Table 23: Sewage Water Monitoring at Gopalpuri STP (2nd Week)

Date of Sampling	15.07.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.3	7.43
2	Total Suspended Solids	mg/l	333	69
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	444.4	103
5	BOD @ 27 °C	mg/l	142.0	28.0
Aeration Tank				
6	MLSS	mg/l	16.0	
7	MLVSS	%	89.0	

Table 24: Sewage Water Monitoring at Gopalpuri STP (3rd Week)

Date of Sampling	20.07.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.39	7.43
2	Total Suspended Solids	mg/l	166.6	36.7
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	230	58
5	BOD @ 27 °C	mg/l	70.0	19.0
Aeration Tank				
6	MLSS	mg/l	12.0	
7	MLVSS	%	92.0	

Table 25: Sewage Water Monitoring at Gopalpuri STP (4th Week)

Date of Sampling	26.07.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.28	7.4
2	Total Suspended Solids	mg/l	160	38
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	210	62
5	BOD @ 27 °C	mg/l	62.0	19.0
Aeration Tank				
6	MLSS	mg/l	11.0	
7	MLVSS	%	96.0	

- **Vadinar STP**

Table 26: Sewage Water Monitoring at Vadinar STP (1st Week)

Date of Sampling	05.07.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.23	NOT WORKING
2	Total Suspended Solids	mg/l	8	
3	Residual Chlorine	mg/l	70.0	
4	COD	mg/l	86.0	
5	BOD @ 27 °C	mg/l	27.0	

Table 27: Sewage Water Monitoring at Vadinar STP (2nd Week)

Date of Sampling	15.07.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.22	NOT WORKING
2	Total Suspended Solids	mg/l	62	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	82.0	
5	BOD @ 27 °C	mg/l	27.0	

Table 28: Sewage Water Monitoring at Vadinar STP (3rd Week)

Date of Sampling	20.07.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.22	NOT WORKING
2	Total Suspended Solids	mg/l	62	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	82.0	
5	BOD @ 27 °C	mg/l	27.0	

Table 29: Sewage Water Monitoring at Vadinar STP (4th Week)

Date of Sampling	26.07.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.18	NOT WORKING
2	Total Suspended Solids	mg/l	72	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	80.0	
5	BOD @ 27 °C	mg/l	26.0	

5.3 Conclusions:

The GPCB standards of BOD, TSS and Residual Chlorine for STP outlet are 20 mg/lit, 30 mg/lit & 0.5 mg/lit respectively. It is suggested to do treatment on regular basis to avoid flow of contaminated/polluted water into the sea. Also, the STP at Vadinar is also non-functional and thus, steps should be taken to commission the STP at Vadinar Port. Hence, currently only inlet samples are collected and analysed. And the sample of kandla stp was not collected in the last week of July 2021 as plant was not working.

6. Marine Water Monitoring

The Forty Second Amendment to the Constitution in 1976 underscored the importance of 'green thinking'. Article 48A enjoins the state to protect and improve the environment and safeguard the forests and wildlife in the country. Further, Article 51A(g) states that the "fundamental duty of every citizen is to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures".

Policy Statement for Abatement of Pollution (1992) has suggested developing relevant legislation and regulation, fiscal incentives, voluntary agreements and educational programs and information campaigns. It emphasizes the need for integration by incorporating environmental considerations into decision making at all levels by adopting frameworks namely, pollution prevention at source, application of best practicable solution, ensure polluter pays for control of pollution, focus on heavily polluted areas and river stretches and involve public in decision-making. The National Conservation Strategy and Policy Statement on Environment and Development, (1992) aimed at "integrating environmental concerns with developmental imperatives to meet the challenges by redirecting the thrust of our developmental process so that the basic needs of our people could be fulfilled by making judicious and sustainable use of natural resources." The priorities mentioned in this policy document include the sustainable use of land and water resources, prevention and control of pollution and preservation of biodiversity.

The National Water Policy, (2002) contains provisions for developing, conserving, sustainable utilizing and managing this important water resources and need to be governed by national perspectives.

Marine Environment

On national and state levels, we have several policies and regulation like Water (Prevention and Control of Pollution) Act, 1974, to regulate pollution discharges and restore water quality of our aquatic resources including the prescription of monitoring activities. One of the important provisions of the Water Act, 1974, is to maintain and restore the 'wholesomeness' of our aquatic resources. Water quality monitoring is one of the first steps required in the rational development and management of water resources. In the field of water quality management, there has been a steady evolution in procedures for designing system to obtain information on the changes of water quality. The monitoring comprises all activities to obtain 'information' with respect to the water system.

Sampling Stations

The monitoring of marine environment for the study of biological and ecological parameters was carried out on 10th& 12th July -2021 in harbor regions of KPT and on 10th July-2021 at Vadinar during spring tide period of New moon phase of Lunar Cycle. The monitoring of marine environment for the study of biological and ecological parameters was repeated again on 17th& 19th July 2021 in harbor regions of KPT. 17th July -2021 in Vadinar during Neap tide period first quarter of Lunar Cycle..

Plankton samples from sub surface layer was collected both during high tide period and low tide period from 3 water quality monitoring stations of KPT harbour area and two stations in Nakti creek and one station in Khori creek. The same sampling schedule was repeated during consecutive spring tide and neap tide in same month. Plankton samples from sub surface layer was collected both during high tide period and low tide period from 1 water quality monitoring stations near Vadinar jetty area during spring tide and neap tide in this month .Collected water samples were processed for estimation of Chlorophyll- a, Pheophytin- a, qualitative &quantitative evaluation of phytoplankton, qualitative &quantitative evaluation zooplanktons (density and their population).

Sampling Locations

Offshore monitoring requirement	Number of locations
Offshore Installations	3 in Kandla creek 2 in Nakti creek 1 in Khori creek 1 near Vadinar Jetty 1 near 1st SBM
Total Number of locations	**8**

6.1 Marine Water Quality

Marine water quality of marine waters of Deendayal Port Harbor waters, Khori and Nakti Creeks and two locations of Vadinar are monitored for various physico-chemical parameters during spring and neap tide of each month.

The results of marine water quality and Marine sediments are as below;

Table 30: Marine Water Quality Monitoring Parameters for location near KPT colony

Sr. No.	Parameters	Unit	Kandla Creek Near KPT colony (1)			
			23°0'58"N 70°13'22."E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.29	7.25	7.13	7.15
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.0	31.8	32.1	32.6
5	Turbidity	NTU	30	28	35	27
6	Total Dissolved Solids	mg/l	37802.0	23743	43720.0	43881.0
7	Total Suspended Solids	mg/l	624	412	409	261
8	Total Solids	mg/l	38426.2	24155.4	44129.0	44142.0
9	DO	mg/l	4.5	5	4.9	5.3
10	COD	mg/l	72.0	68.0	74.0	76.0
11	BOD	mg/l	<2	<2	<2	<2
12	Silica	mg/l	0.23	0.38	0.30	0.48
13	Phosphate	mg/l	0.31	0.28	0.19	0.35
14	Sulphate	mg/l	2856	2556	2076	2160
15	Nitrate	mg/l	2.10	2.04	2.40	2.04
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	521.04	561.12	521.04	440.88
18	Magnesium	mg/l	1798.2	1798.2	1773.9	1871.1
19	Sodium	mg/l	14122.0	14820.0	10110.0	10872.0
20	Potassium	mg/l	325.0	289.0	321.0	289.0
21	Iron	mg/l	1.12	1.42	1.52	1.45
22	Chromium	mg/l	0.12	0.13	0.12	0.11
23	Copper	mg/l	0.12	0.19	0.06	0.08
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.07	0.06	0.05	0.06
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.20	0.19	0.11	0.12
28	Zinc	mg/l	0.05	0.06	0.06	0.07

Table 31: Marine Water Quality Monitoring Parameters for location near passenger Jetty One at Kandla

Sr. No.	Parameters	Unit	Near passenger Jetty One (2)			
			23° 0'18 "N 70°13'31"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	5.3	4.7	7.3	7.27
2	Color	-	80.0	76.0	Colorless	Colorless
3	Odor	-	<2	<2	Odorless	Odorless
4	Salinity	ppt	0.32	0.68	33.0	32.6
5	Turbidity	NTU	0.32	0.26	22	28
6	Total Dissolved Solids	mg/l	2976	2748	46102.0	47052.0
7	Total Suspended Solids	mg/l	2.25	2.03	211	312
8	Total Solids	mg/l	<0.05	<0.05	46313.0	47364.0
9	DO	mg/l	521.04	521.04	4.6	4.9
10	COD	mg/l	1846.8	1773.9	86.0	79.0
11	BOD	mg/l	11052.0	13425.0	<2	<2
12	Silica	mg/l	325.0	306.0	0.39	0.72
13	Phosphate	mg/l	1.55	1.62	0.34	0.30
14	Sulphate	mg/l	0.12	0.14	1956	2520
15	Nitrate	mg/l	0.18	0.16	1.74	2.52
16	Nitrite	mg/l	<0.01	<0.01	<0.05	<0.05
17	Calcium	mg/l	0.07	0.05	480.96	480.96
18	Magnesium	mg/l	<0.001	<0.001	1822.5	1822.5
19	Sodium	mg/l	0.28	0.16	11011.0	10452.0
20	Potassium	mg/l	0.05	0.06	333.0	315.0
21	Iron	mg/l	5.3	4.7	1.56	1.89
22	Chromium	mg/l	80.0	76.0	0.16	0.14
23	Copper	mg/l	<2	<2	0.09	0.08
24	Arsenic	mg/l	0.32	0.68	<0.01	<0.01
25	Cadmium	mg/l	0.32	0.26	0.06	0.07
26	Mercury	mg/l	2976	2748	<0.001	<0.001
27	Lead	mg/l	2.25	2.03	0.16	0.19
28	Zinc	mg/l	<0.05	<0.05	0.06	0.08

Table 32: Marine Water Quality Monitoring Parameters for location Near Coal Berth

Sr. No.	Parameters	Unit	Near Coal Berth			
			22°59'12"N 70°13'40"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.51	7.30	7.29	7.5
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.6	32.8	32.4	33.1
5	Turbidity	NTU	35	47	35	47
6	Total Dissolved Solids	mg/l	40788	35363	41086.0	42830.0
7	Total Suspended Solids	mg/l	563	601	215	161
8	Total Solids	mg/l	41351.3	35964.2	41301.0	42991.0
9	DO	mg/l	4.8	5	4.8	5
10	COD	mg/l	88.0	70.0	90.0	79.0
11	BOD	mg/l	<2	<2	<2	<2
12	Silica	mg/l	0.30	0.34	0.42	0.36
13	Phosphate	mg/l	0.28	0.32	0.35	0.38
14	Sulphate	mg/l	2580	3444	3156	3240
15	Nitrate	mg/l	1.93	2.10	2.56	2.46
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	561.12	480.96	561.12	601.2
18	Magnesium	mg/l	1725.3	1798.2	1725.3	1725.3
19	Sodium	mg/l	15555.0	13252.0	11052.0	11412.0
20	Potassium	mg/l	389.0	296.0	315.0	296.0
21	Iron	mg/l	1.47	2.02	2.10	2.02
22	Chromium	mg/l	0.19	0.15	0.12	0.20
23	Copper	mg/l	0.14	0.12	0.06	0.10
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.04	0.06	0.08	0.07
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.20	0.18	0.10	0.12
28	Zinc	mg/l	0.08	0.06	0.07	0.06

Table 33: Marine Water Quality Monitoring Parameters for location Khori creek at Kandla

Sr. No.	Parameters	Unit	KPT 4			
			Near 15/16 Berth			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.25	7.20	7.39	7.45
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.4	32.8	32.4	32.2
5	Turbidity	NTU	50	29	51	55
6	Total Dissolved Solids	mg/l	35588	33113	43563.0	44059.0
7	Total Suspended Solids	mg/l	407	420	213	265
8	Total Solids	mg/l	35995.3	33533.4	43776.0	44324.0
9	DO	mg/l	5.2	4.8	5.3	4.7
10	COD	mg/l	68.0	79.0	76.0	86.0
11	BOD	mg/l	<2	<2	<2	<2
12	Silica	mg/l	0.81	0.29	0.79	0.37
13	Phosphate	mg/l	0.26	0.34	0.43	0.42
14	Sulphate	mg/l	2388	2652	2280	2376
15	Nitrate	mg/l	1.74	1.96	2.10	2.57
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	601.20	561.12	601.2	561.12
18	Magnesium	mg/l	1749.6	1822.5	1725.3	1798.2
19	Sodium	mg/l	10026.0	11252.0	10512.0	9899.0
20	Potassium	mg/l	302.0	378.0	266.0	275.0
21	Iron	mg/l	1.66	1.48	1.45	1.60
22	Chromium	mg/l	0.16	0.16	0.18	0.16
23	Copper	mg/l	0.15	0.10	0.12	0.10
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.07	0.06	0.06	0.05
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.16	0.2	0.08	0.10
28	Zinc	mg/l	0.07	0.08	0.05	0.05

Table 34: Marine Water Quality Monitoring Parameters for location Nakti Creek near Tuna Port

Sr. No.	Parameters	Unit	Nakti Creek Near Tuna Port			
			22°57'49."N 70° 7'0.67"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.29	7.35	7.2	7.28
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.6	33.2	33.6	33.0
5	Turbidity	NTU	35	29	29	29
6	Total Dissolved Solids	mg/l	38200	18212	46852.0	47695.0
7	Total Suspended Solids	mg/l	324	214	200	196
8	Total Solids	mg/l	38524.4	18426.2	47052.0	47891.0
9	DO	mg/l	5.1	5.1	4.9	5
10	COD	mg/l	80.0	68.0	89.0	78.0
11	BOD	mg/l	<2	<2	<2	<2
12	Silica	mg/l	0.26	0.29	0.62	0.30
13	Phosphate	mg/l	0.28	0.26	0.31	0.38
14	Sulphate	mg/l	2964	3408	3240	3156
15	Nitrate	mg/l	1.95	2.18	2.56	2.49
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	561.12	521.04	601.2	440.88
18	Magnesium	mg/l	1822.5	1749.6	1798.2	1822.5
19	Sodium	mg/l	11256.0	12625.0	11021.0	11425.0
20	Potassium	mg/l	302.0	366.0	396.0	378.0
21	Iron	mg/l	1.83	1.76	2.02	2.11
22	Chromium	mg/l	0.15	0.18	0.20	0.18
23	Copper	mg/l	0.12	0.11	0.16	0.10
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.04	0.06	0.07	0.08
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.18	0.19	0.12	0.16
28	Zinc	mg/l	0.06	0.05	0.06	0.07

Table 35: Marine Water Quality Monitoring Parameters for location Nakti Creek Near NH-8A at Kandla

Sr. No.	Parameters	Unit	Nakti Creek Near NH-8A			
			23° 02'01"N 70° 09'31"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.37	Sampling not possible during Low Tide	7.37	Sampling not possible during Low Tide
2	Color	-	Colorless		Colorless	
3	Odor	-	Odorless		Odorless	
4	Salinity	ppt	33.4		32.4	
5	Turbidity	NTU	27		33	
6	Total Dissolved Solids	mg/l	35166		42125.0	
7	Total Suspended Solids	mg/l	180		164.3	
8	Total Solids	mg/l	35346.3		42289.3	
9	DO	mg/l	5		5.5	
10	COD	mg/l	72.0		79.0	
11	BOD	mg/l	<2		<2	
12	Silica	mg/l	0.61		0.62	
13	Phosphate	mg/l	0.30		0.39	
14	Sulphate	mg/l	2988		3036	
15	Nitrate	mg/l	2.43		2.72	
16	Nitrite	mg/l	<0.05		<0.05	
17	Calcium	mg/l	601.20		521.04	
18	Magnesium	mg/l	1749.6		1749.6	
19	Sodium	mg/l	14485.0		11528.0	
20	Potassium	mg/l	396.0		311.0	
21	Iron	mg/l	1.52		2.06	
22	Chromium	mg/l	0.16		0.19	
23	Copper	mg/l	0.16		0.11	
24	Arsenic	mg/l	<0.01		<0.01	
25	Cadmium	mg/l	0.04		0.06	
26	Mercury	mg/l	<0.001		<0.001	
27	Lead	mg/l	0.17		0.10	
28	Zinc	mg/l	0.06		0.07	

Table 36: Marine Water Quality Monitoring Parameters for locations Nr. Vadinar Jetty

Sr. No.	Parameters	Unit	Nr.Vadinar Jetty 22°26'25.26"N 69°40'20.41"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.60	7.45	7.5	7.8
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	33.2	32.6	33.0	33.1
5	Turbidity	NTU	32	28	35	25
6	Total Dissolved Solids	mg/l	37530	35780	43940.0	46623.0
7	Total Suspended Solids	mg/l	327	417	405.5	399.5
8	Total Solids	mg/l	37856.5	36197.4	44345.5	47022.5
9	DO	mg/l	5.2	5.1	5.2	5.1
10	COD	mg/l	68.0	72.0	78.0	79.0
11	BOD	mg/l	<2	<2	<2	<2
12	Silica	mg/l	0.32	0.31	0.42	0.62
13	Phosphate	mg/l	0.26	0.26	0.35	0.33
14	Sulphate	mg/l	2136	2352	2220	2304
15	Nitrate	mg/l	2.72	2.80	2.09	2.44
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	480.96	561.12	561.12	521.04
18	Magnesium	mg/l	1749.6	1749.6	1579.5	1555.2
19	Sodium	mg/l	16458.0	15555.0	11425.0	12021.0
20	Potassium	mg/l	345.0	388.0	316.0	296.0
21	Iron	mg/l	2.06	2.10	2.45	2.3
22	Chromium	mg/l	0.16	0.20	0.15	0.16
23	Copper	mg/l	0.17	0.18	0.09	0.08
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.05	0.06	0.05	0.06
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.14	0.13	0.10	0.10
28	Zinc	mg/l	0.08	0.09	0.05	0.06

6.1.1 Marine Sediments

Sediment samples were collected with Van Veen Grab from the six locations in Kandla Port Waters and two locations in Vadinar Port. Samples were collected and preserved in silver foil in ice box to prevent the contamination/decaying of the samples.

6.2 Results

The Sediment Quality results are given in below from table no. 34 A & B.

Table 34A: Results of Analysis of Sediment of Kandla & Vadinar Port (Spring Tide)

Sr. No.	Parameters	Unit	KPT - 1	KPT - 2	Khori - 1	Nakti - 1 (Near NH-8A)	Jetty
1	Texture	-	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	mg/kg	0.64	1.12	0.39	1.03	1.06
3	Organic Carbon	mg/kg	0.37	0.65	0.22	0.60	0.52
4	Inorganic Phosphate	mg/kg	126.0	125.0	136.0	146.0	152.0
5	Moisture	%	11.70	18.10	6.60	26.1	23.50
6	Aluminium	mg/kg	ND	ND	ND	ND	ND
7	Silica	mg/kg	26.0	24.0	42.0	49.0	41.2
8	Phosphate	mg/kg	9.88	7.82	8.80	9.70	18.00
9	Sulphate	mg/kg	170.0	192.0	259.0	259.0	362.0
10	Nitrite	mg/kg	0.12	0.13	0.11	0.11	0.11
11	Nitrate	mg/kg	9.23	7.82	9.25	9.25	7.52
12	Calcium	mg/kg	144.3	148.0	132.0	124.0	169.0
13	Magnesium	mg/kg	165.2	214.0	122.0	136.0	162.0
14	Sodium	mg/kg	2221.0	1686.0	1882.0	1775.0	3785.0
15	Potassium	mg/kg	641.0	542.0	738.0	562.0	658.0
16	Chromium	mg/kg	123	145	126	130	162
17	Nickel	mg/kg	24.8	22.5	18.9	26.02	38
18	Copper	mg/kg	48	42	20.6	27.5	23.6
19	Zinc	mg/kg	32.60	36.00	30.40	36.00	32.00
20	Cadmium	mg/kg	ND	ND	ND	ND	ND
21	Lead	mg/kg	2.8	1.8	1.2	4.5	5.8
22	Mercury	mg/kg	ND	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND	ND

*Grab samples could not be collected due high current at KPT 3, Natki Creek Near Tuna port & Vadinar SBM

Table 34B: Results of Analysis of Sediment of Kandla & Vadinar Port (Neap Tide)

Sr. No.	Parameters	Unit	KPT - 1	KPT - 2	Jetty
1	Texture	-	Sandy loam	Sandy loam	Sandy loam
2	Organic Matter	mg/kg	0.74	1.10	1.10
3	Organic Carbon	mg/kg	0.52	0.62	0.63
4	Inorganic Phosphate	mg/kg	162.0	142.0	162.0
5	Moisture	%	15.62	14.20	21.52
6	Aluminium	mg/kg	ND	ND	ND
7	Silica	mg/kg	16.60	20.30	39.2
8	Phosphate	mg/kg	9.8	7.26	16.66
9	Sulphate	mg/kg	342.0	280.0	289.0
10	Nitrite	mg/kg	0.10	0.11	0.1
11	Nitrate	mg/kg	10.6	9.8	8.02
12	Calcium	mg/kg	141.0	152.0	178.0
13	Magnesium	mg/kg	156.0	214.0	206.0
14	Sodium	mg/kg	2210.0	1786.0	3682.0
15	Potassium	mg/kg	590.0	562.0	666.0
16	Chromium	mg/kg	136	149	158
17	Nickel	mg/kg	26.2	23.5	32
18	Copper	mg/kg	52	46	18.2
19	Zinc	mg/kg	33.20	34.00	22.00
20	Cadmium	mg/kg	ND	ND	ND
21	Lead	mg/kg	2.4	2.2	4.6
22	Mercury	mg/kg	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND

*Grab samples could not be collected due high current at KPT 3,Khori, Natki Creek Near Tuna Port, Vadinar Jetty and Vadinar SBM

REPORT

ON

ECOLOGICAL MONITORING

OF MARINE ENVIRONMENT

IN

DPT HARBOUR AREA, NEAR BY CREEKS

For

DEENDAYAL PORT TRUST

JULY, 2021

DCPL/DPT/20-21/15 -JULY - 2021

INTRODUCTION:

The Forty Second Amendment to the Constitution in 1976 underscored the importance of 'green thinking'. Article 48A enjoins the state to protect and improve the environment and safeguard the forests and wildlife in the country. Further, Article 51A(g) states that the "fundamental duty of every citizen is to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures".

Policy Statement for Abatement of Pollution (1992) has suggested developing relevant legislation and regulation, fiscal incentives, voluntary agreements and educational programs and information campaigns. It emphasizes the need for integration by incorporating environmental considerations into decision making at all levels by adopting frameworks namely, pollution prevention at source, application of best practicable solution, ensure polluter pays for control of pollution, focus on heavily polluted areas and river stretches and involve public in decision-making. The National Conservation Strategy and Policy Statement on Environment and Development, (1992)aimed at "integrating environmental concerns with developmental imperatives to meet the challenges by redirecting the thrust of our developmental process so that the basic needs of our people could be fulfilled by making judicious and sustainable use of natural resources." The priorities mentioned in this policy document include the sustainable use of land and water resources, prevention and control of pollution and preservation of biodiversity.

The National Water Policy, (2002) contains provisions for developing, conserving, sustainable utilizing and managing this important water resources and need to be governed by national perspectives.

MARINE ENVIRONMENT:

On national and state levels, we have several policies and regulation like Water (Prevention and Control of Pollution) Act, 1974, to regulate pollution discharges and restore water quality of our aquatic resources including the prescription of monitoring activities. One of the important provisions of the Water Act, 1974, is to maintain and restore the 'wholesomeness' of our aquatic resources. Water quality monitoring is one of the first steps required in the rational development and management of water resources. In the field of water quality management, there has been a steady evolution in procedures for designing system to obtain information on the changes of water quality. The monitoring comprises all activities to obtain 'information' with respect to the water system.

Sampling Stations:

The monitoring of marine environment for the study of biological and ecological Parameters was carried out on 10th July, 2021 in in harbour region of DPT, and on 12thJuly, 2021 in creeks near by the port during spring tide .The monitoring of marine environment for the study of biological and ecological parameters was repeated again on 17th July, 2021 in harbour region of DPT and on 19thJuly, 2021 in creeks near by the port during neap tidal condition.

Plankton samples from sub surface layer was collected both during high tide period and low tide period from 3 water quality monitoring stations of DPT harbour area andone stations in Nakti creek and one station in Khori creek. Sampling at second sampling station of Nakti creek was possible only during high tide period. Collected water samples were processed for estimation of Chlorophyll- a, Pheophytin- a, qualitative &quantitative evaluation of phytoplankton, qualitative &quantitative evaluation zooplanktons(density and their population).

TABLE #1 SAMPLING LOCATIONS

monitoring requirement	**Number of locations**
Kandla creek Nakti creek Khori Creek	3 in Kandla creek 2 in Nakti creek 1 in Khori creek
Total Number of locations	**6**

Sampling methodology adopted:

A marine sampling is an estimation of the body of information in the population. The theory of the sampling design is depending upon the underlying frequency distribution of the population of interest. The requirement for useful water sampling is to collect a representative sample of suitable volume from the specified depth and retain it free from contamination during retrieval.

50 litters of the water sample were collected from Sub surface by using bucket. From the collected water sample 1 litter of water sample were taken in an opaque plastic bottle for chlorophyll estimation, thereafter plankton samples were collected by using filtration assembly with nilyobolt cloth of 20µm mesh size.

Samples Processing for chlorophyll estimation:

Samples for the chlorophyll estimation were preserved in ice box on board in darkness to avoid degradation in opaque container covered with aluminium foil. Immediately after reaching the shore after sampling, 1 litter of collected water sample was filtered through GF/F filters (pore size 0.45 µm) by using vacuum filtration assembly. After vacuum filtration the glass micro fiber filter paper was grunted in tissue grinder, macerating of glass fiber filter paper along with the filtrate was done in 90% aqueous Acetone in the glass tissue grinder with glass grinding tube. Glass fiber filter paper will assist breaking the cell during grinding and chlorophyll content was extracted with 10 ml of 90% Acetone, under cold dark conditions along with saturated magnesium carbonate solution in glass screw cap tubes. After an extraction period of 24 hours, the samples were transferred to calibrated centrifuge tubes and adjusted the volume to original volume with 90% aqueous acetone solution to make up the evaporation loss. The extract was clarified by using centrifuge in closed tubes. The clarified extracts were then decanted in clean cuvette and optical density was observed at wavelength 664, 665 nm. By using corrected optical density, Chlorophyll-a value was calculated as given in (APHA, 1998).

PLANKTON:

The entire area open water in the sea is the pelagic realm. Pelagic organisms live in the open sea. In contrast to the pelagic realm, the benthic realm comprises organisms and zone of the bottom of the sea. Vertically the pelagic realm can be dividing into two zones based on light penetration; upper photic or euphotic zone and lower dark water mass, aphotic zone below the photic zone.

The term plankton is general term for organisms have such limited powers of locomotion that they are at the mercy of the prevailing water movement. Plankton is subdivided to phytoplankton and zooplankton. Phytoplankton is free floating organisms that are capable of photosynthesis and zooplankton is the various free floating animals.

Pelagic zone, represents the entire ocean water column from the surface to the deepest depths, is home to a diverse community of organisms. Differences in their locomotive ability categorize the organisms in the pelagic realm into two, ***plankton*** and ***nekton*** (Lalli and Parsons, 1997). ***Plankton*** consists of all organisms drifting in the water and is unable to swim against water currents, whereas ***Nekton*** includes organisms having strong locomotive power. Ecological studies on the plankton community, which form the base of the aquatic food chain, help in the better understanding of the dynamics and functioning of the marine ecosystem. The term 'Plankton' first coined by Victor Hensen (1887), Plankton, (Greek word: *planktos*meaning "passively drifting or wandering") is defined as drifting or free-floating organisms that inhabit the pelagic zone of water. Based on their mode of nutrition planktonic organisms are categorised into phytoplankton (organisms having an autotrophic mode of nutrition) and zooplankton (organisms having a heterotrophic mode of nutrition).

Phytoplankton in the marine environment:

Phytoplankton is free floating unicellular, filamentous and colonial eutrophic organisms that grow in aquatic environments whose movement is more or less dependent upon water currents. These micro flora acts as primary producers as well as the basis of food chain, source of protein, bio purifier and bio indicators of the aquatic ecosystems of which diverse array of the life depends .They are considered as an important component of aquatic flora, play a key role in maintaining equilibrium between abiotic and biotic components of aquatic ecosystem.

The phytoplankton includes a wide range of photosynthetic and phototrophic organisms. Marine phytoplankton is mostly microscopic and unicellular floating flora, which are the primary producers that support the pelagic food-chain. The two most prominent groups of phytoplankton are diatoms (Bacillariophyceae) and dinoflagellates (Dinophyceae).The phytoplankton those normally captured in the net from the Gulf of Kutch is normally dominated by these two major groups; diatoms and dinoflagellates. Phytoplankton also include numerous and diverse collection of extremely small, motile algae which are termed micro flagellates (naked flagellates) as well as and Cyanophytes (blue-green algae).

Algae are an ecologically important group in most aquatic ecosystems and have been an important component of biological monitoring programs. Algae are ideally suited for water quality assessment because they have rapid reproduction rates and very short life cycles, making them valuable indicators of short-term impacts.

Aquatic populations are impacted by anthropogenic stress, resulting in a variety of alterations in the biological integrity of aquatic systems. Algae can serve as an indicator of the degree of deterioration of water quality, and many algal indicators have been used to assess environmental status.

Zooplankton in the marine environment:

Zooplankton includes a taxonomically and morphologically diverse community of heterotrophic organisms that drift in the waters of the world's oceans. Qualitative and quantitative studies on zooplankton community is a prerequisite to delineate the ecological processes active in the marine ecosystem. Zooplankton community plays a pivotal role in the pelagic food web as the primary consumers of phytoplankton and act as the food source for organisms in the higher trophic levels, particularly the economically essential groups such as fish larvae and fishes. They also function in the cycling of elements in the marine ecosystem. The dynamics of the zooplankton community, their reproduction, growth and survival rate are all significant factors determining the recruitment and abundance of fish stocks as they form an essential food for larval, juvenile and adult fishes (Beaugrand et al., 2004). Zooplankton grazing in the marine environment controls the primaryProduction and helps in determining the pelagic ecosystem (Banse, 1995). Through grazing in surface waters and following the production of sinking faecal matters and also by the active transportation of dissolved and particulate matter to deeper waters via vertical migration, they help in the transport of organic carbon to deep ocean layers and thus act as key drivers of biological pump' in the marine ecosystem. Zooplankton grazing and metabolism also, transform particulate organic matter into dissolved forms, promoting primary producer community, microbial demineralization, and particle export to the ocean's interior.

The categorisation of zooplankton into various ecological groups is based on several factors such as duration of planktonic life, size, food preferences and habitat. As they vary significantly in size from microscopic to metazoic forms, the classification of zooplankton based on size has paramount importance in the field of quantitative plankton research.

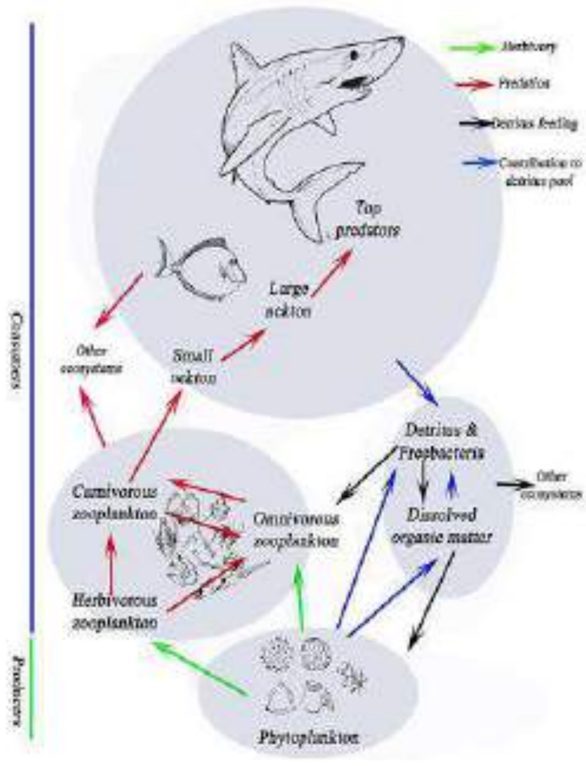
Based on the duration of planktonic life, zooplankton are categorised into Holoplankton (organisms which complete their entire lifecycle as plankton) and Meroplankton (organisms which are planktonic during the early part of their lives such as the larval stages of benthic and nektonic organisms). Tychoplankton are organisms which live a brief planktonic life, such as the benthic crustaceans (cumaceans, mysids, isopods) which ascend to the water column at night for feeding and certain ectoparasitic copepods, they leave the host and spend their life as plankton during their breeding cycle.

Zooplankton can be subdivided into holoplankton, i.e., permanent members of the plankton (e.g., Calanoid copepods), and meroplankton, i.e., temporary members in the plankton e.g., larvae of fish, shrimp, and crab). The meroplankton group consists of larval and young stages of animals that will adopt a different lifestyle once they mature. In contrast to phytoplankton which consist of a relatively smaller variety of organisms, Zooplankton are extremely divers, consist of a host of larval and adult forms representing many animal phylum.

Among the zooplankton one group always dominate than others; members of sub class copepods (Phylum Athropoda), and Tintinids (Phylum Protozoa) among the net planktons. These small animals are of vital importance in marine ecosystem as one of the primary herbivores animals in the sea, and it is they provide vital link between primary producer (autotrophs) and numerous small and large marine consumers.

As their community structure and function are highly susceptible to changes in the environmental conditions regular monitoring of their distribution as well as their interactions with various physicochemical parameters is inevitable for the sustainable management of the ecosystem (Kusum et al., 2014). Of all the marine zooplankton groups, copepods mainly calanoid copepods are the dominant groups in marine subtropical and tropical waters and exhibit considerable diversity in morphology and habitats they occupy (Madhupratap, 1991;)

It has been well established that potential of pelagic fishes viz. finfishes, crustaceans, molluscs and marine mammals either directly or indirectly depend on zooplankton. The herbivorous zooplankton is efficient grazers of the phytoplankton and is referred to as living machines transforming plant material into animal tissue. Hence they play an essential role as the intermediaries for nutrients/energy transfer between primary and tertiary trophic levels. Due to their large density, shorter lifespan, drifting nature, high group/species diversity and different tolerance to the stress, they used as the indicator organisms for the physical, chemical and biological processes in the aquatic ecosystem (Ghajbhiye, 2002).



Simplified marine food web

Spatial distribution of Plankton:

A characteristic of plankton population is that they tend to occur in patches, which are varying spatially on a scale of few meters to far as few kilometres in distance. They also vary in time scale, season as well as vertically in the water column. It is this patchiness and its constant changes in time and spot, that has made it so difficult for plankton biologist to learn about the ecology of plankton. The biological factors that causes this patchiness is due to the ability of zooplankton to migrate vertically and graze out the phytoplankton at a rapid rate that can create patchiness. Similarly the active swimming ability by certain zooplankton organisms can cause to aggregate in dense group.

At its most extreme, because the water in which plankton is suspended is constantly moving, each sample taken by the plankton biologists remain a different volume of water, so each sample is unique and replicate does not exist.

Plankton may also exhibit vertical patchiness. Physical factors contribute to this type of patchiness include light intensity, nutrients and density gradients in the water column.

Phytoplankton in particular tends to be unequally distributed vertically, which leads to the existence of different concentration of a chlorophyll value between photic zone and below the photic zone.

Methodology adopted for Plankton sampling:

Mixed plankton sample were obtained from the sub surface layer at each sampling locations by towing the net horizontally with the weight .After the tow of about 15-30minutes, plankton net was pulled up and washed down to the tail and collected the plankton adhered to plankton net in the collection bucket at the bottom by springing outer and inner surface of the net with sea water, while the net was hanging with the mouth upward. For quantitative evaluation 50 L water samples were collected from subsurface layer and filtered through 20µm mesh size net by using bucket and filtration assembly.

Preservation and storage:

Both filtered plankton and those collected from the plankton net were preserved with 5% buffered formalin and stored in 1L plastic container for further processing in the laboratory.

Sample concentration:

The collected plankton samples were concentrated by using centrifuge and made up to 50 ml with 5% formalin -Glycerine mixture.

Taxonomic evaluation:

Before processing, the sample was mixed carefully and a subsample was taken with a calibrated Stempel-pipette. 1 ml of the concentrated plankton samples were transferred on a glass slide with automatic pipette. The plankton sample on the glass slides were stained by using Lugol's iodine and added glycerine to avoid drying while observation. The plankton samples were identified by using Labex triangular Research microscope with photographic attachment. Microphotographs of the plankton samples were taken for record as well as for confirming the identification. The bigger sized zooplankton was observed through dissecting stereomicroscope with magnification of 20-30 x. Plankton organisms in the whole slide were identified to the lowest axon possible. A thorough literature search was conducted for the identification of the different groups of zooplankton that were encountered

Cell counts by drop count method:

The common glass slide mounted with a 1ml of concentrated phytoplankton/zooplankton sample in glycerol and covered with cover slip 22x 60mm was placed under the compound microscope provided with a mechanical stage. The plankton was then counted from the microscopic field of the left top corner of the slide. Then slide is moved horizontally along the right side and plankton in each microscopic field was thus counted. When first microscopic field row was finished the next consecutive row was adjusted using the mechanical device of the stage. In this way all the plankton present in entire microscopic field are counted. From this total number in 1ml of the concentrated plankton, total number of plankton in the original volume of sample filtered was calculated as units/L.

BENTHIC ORGANISMS:

Benthos is those organisms that are associated with the sea bed or benthic habitats. Epi- benthic organisms live attached to a hard substratum or rooted to a shallow depth below the surface. In fauna organisms live below the sediment–water interface. Interstitial organisms live and move in pore water among sedimentary grains.

Because the benthic organisms are often collected and separated on sieves, a classification based on the overall size is used. Macro benthos include organisms whose shortest dimension is greater than or equal to 0.5 mm. Meio benthos are smaller than 0.5mm but larger than 42µ in size.

The terms such as macro fauna and Meio fauna generally have little relevance with taxonomic classification. The terms Meio fauna and macro fauna depend on the size. Meio fauna were considered as good bioassay of community health and rather sensitive indicators of environmental changes

SAMPLING METHODOLOGY ADOPTED FOR SUB TIDAL REGION:

Van veen sampler ($0.09m^2$) was used for sampling bottom sediments. Two sets of sediments were sampled from each location, one for macro fauna and other for Meio fauna. The macro fauna in the sediments were sieved on board to separate out the organisms. The fixation of Meio fauna is normally done by bulk fixation of the sediment sample. The bulk fixation is done by using 10% formalin (Buffered with borate). The organisms were preserved with seawater as diluting agent.

Sample sieving:

Sediments samples were sieved to extract the organisms. Sieving was performed carefully as possible to avoid any damage to the animals. The large portion of the sediment was split in to smaller portions and mixed with sea water in a bucket. The cohesive lumps were broken down by continuous stirring. The disaggregated sediments were then passed through the sieves.

Sample staining:

Sorting of the Meio fauna from the sieve is difficult task especially in the preserved material, because organisms are not easily detectable. To facilitate the animal detection the entire sample retained on the sieve after sieving operation were stained by immersing the sieve in a flat bottom

tub with 1% Rose Bangal stain; a protein stain. A staining period of 10-30 minutes is sufficient for sample detection.

DIVERSITY INDICES:

On the whole, diversity indices provide more information about community composition than simply species richness (number of species present); they also, take the relative abundances of different species into account. Based on this fact, diversity indices therefore depend not only on species richness but on the evenness, or equitability, with which individuals are distributed among the different species (Magurram, A. E. (1988)

A diversity index is a measure of species diversity within a community that consists of co-occurring populations of several (two or more) different species. It includes two components: richness and evenness. Richness is the measure of the number of different species within a sample showing that more the types of species in a community, the higher is the diversity or greater is the richness. Evenness is the measure of relative abundance of the different species with in a community.

The basic idea of diversity index is to obtain a quantitative estimate of biological variability that can be used to compare biological entities composed of discrete components in space and time (Carol H.R. *etal*. 1998). Biodiversity is commonly expressed through indices based on species richness and species abundances (Whittaker 1972, Lande 1996, Purvis and Hector 2000). Biodiversity indices are a non-parametric tool used to describe the relationship between species number and abundance. The most widely used bio diversity indices are Shannon Weiner index and Simpson's index.

A diversity Index is a single statistic that incorporates in formation on richness and evenness. The diversity measures that incorporate the two concepts may be termed heterogeneity measures (Magurran, 2004).

Any study intended to interpret causes and effect of adverse impact on Biodiversity of communities require suitable measures to evaluate specie richness and Diversity. The former is number of species in community, while latter is a function of relative frequency of different species. Species richness is the iconic measure of biological diversity (Magurran, 2004). Several indices have been created to measure the diversity of species; however, the most widely used in the last decades are the Shannon (1948) and Simpson (1949) (Buzas and Hayek 1996; Gorelick 2006), with the components of diversity: richness (*S)* and evenness (*J)*

Simpson's diversity index

Simpson's index (**D**) is a measure of diversity, which takes into account both species richness, and evenness of abundance among the species present.. The Simson index is one of the meaningful and robust biodiversity measures available.(Magurran ,2004).

The formula for calculating D is presented as:

$$D = \frac{\sum n_i(n_i - 1)}{N(N-1)}$$

Where n_i = the total number of organisms of each individual species

N = the total number of organisms of all species

The value of D ranges from 0 to 1. With this index, 0 represents infinite diversity and, 1, no diversity. When D increases diversity decreases. Simpson's index is therefore usually expressed as 1-D or 1/D. (Magurran, 2004)

Low species diversity suggests:

- relatively few successful species in the habitat
- the environment is quite stressful with relatively few ecological niches and only a few organisms are really well adapted to that environment
- food webs which are relatively simple
- change in the environment would probably have quite serious effects

High species diversity suggests:

- a greater number of successful species and a more stable ecosystem
- more ecological niches are available and the environment is less likely to be hostile complex food webs
- environmental change is less likely to be damaging to the ecosystem as a whole

Species richness indices

The species richness ***(S)*** is simply the number of species present in an ecosystem. Species richness Indices of species richness are widely used to quantify or monitor the effects of anthropogenic disturbance. A decline in species richness may be concomitant with severe or chronic human-induced perturbation (Fair Fair weather 1990,) Species richness measures have traditionally been the mainstay in assessing the effects of environmental degradation on the biodiversity of natural assemblages of organisms (Clarke &Warwick, 2001)

Species richness is the iconic measure of biological diversity (Magurran, 2004). The species richness ***(S)*** is simply the number of species present in an ecosystem. This index makes no use of

relative abundances. The term species richness was coined by McIntosh (1967) and oldest and most intuitive measure of biological diversity (Magurran, 2004).

Margalef's diversity index is a species richness index. Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, were derived.

The value of a diversity index increases both when the number of types increases and when evenness increases. For a given number of types, the value of diversity index is maximised when all types are equally abundant (Rosenzweig, M. L. (1995).

Shannon-Wiener's index:

An index of diversity commonly used in plankton community analyses is the Shannon-Wiener's index **(H),** which emphasizes not only the number of species (richness or variety), but also the apportionment of the numbers of individuals among the species (Odum 1971 and Reish 1984). Shannon-Wiener's index **(H**) reproduce community parameters to a single numberby using an equation.

Shannon and Weiner index represents entropy. It is a diversity index taking into account the number of individuals as well as the number of taxa. It varies from 0 for communities with only single taxa to high values for community with many taxa each with few individuals. This index can also determine the pollution status of a water body. Normal values range from 0 to 4. This index is a combination of species present and the evenness of the species. Examining the diversity in the range of polluted and unpolluted ecosystems, Wilham and Dorris (1968) concluded that the values of the index greater than 3 indicate clean water, values in the range of 1 to 3 are characterized by moderate pollution and values less than 1 are characterized as heavily polluted

$$H' = -\sum_{j=l}^{s} \frac{n_j}{N} \ln\left(\frac{n_j}{N}\right)$$

RESULTS:

CHLOROPHYLL-a:

Water Samples for the chlorophyll estimation were collected from sub surface layer during high tide and low tide period of the tidal cycle for each sampling locations and analysed for Chlorophyll -a and after acidification for Pheophytin –a. Chlorophyll- a value was used as algal biomass indicator (APHA,1998) Algal biomass was estimated by converting Chlorophyll value.

In the sub surface water chlorophyll-a was varying from 0.511 -0.921mg/m^3.in harbour region of DPT during sampling done in spring tide period of July, 2021. In the nearby creeks chlorophyll-a was varying from 0.173-0.980 mg/m^3.Pheophytin –a level was below detectable limit- the all the sampling stations during spring in the harbour region of DPT.

In the sub surface water chlorophyll-a was varying from 0.391 -0.835mg/m^3.in harbour region of DPT during sampling done in neap tide period of July, 2021 . In the nearby creeks chlorophyll-a was varying from 0.308-0.991 mg/m^3. Pheophytin –a level was below detectable limit- the all the sampling stations during spring in the harbour region ofDPT

TABLE #2 VARIATIONS IN CHLOROPHYLL –a PHEOPHYTIN- a AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN JULY,2021

Sr.No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREA					
1	KPT1	High tide	0.629	BDL	42.14
		Low tide	0.921	BDL	61.71
2	KPT 2	High tide	0.745	BDL	49.92
		Low tide	0.558	BDL	37.39
3	KPT 3	High tide	0.511	BDL	34.24
		Low tide	0.598	BDL	40.06
CREEKS					
4	KPT-4 Khori-I	High tide	0.425	BDL	28.48
		Low tide	0.473	BDL	31.69
5	KPT-5 Nakti-I	High tide	0.714	BDL	47.84
		Low tide	0.980	BDL	65.66
6	KPT-5 Nakti-II	High tide	0.173	BDL	11.59

BDL: Below Detectable Limit.

TABLE #3 VARIATIONS IN CHLOROPHYLL –aPHEOPHYTIN- a AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN JULY,2021

Sr.No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREA					
1	KPT1	High tide	0.730	BDL	48.91
		Low tide	0.835	BDL	55.94
2	KPT 2	High tide	0.391	BDL	26.20
		Low tide	0.484	BDL	32.43
3	KPT 3	High tide	0.612	BDL	41.00
		Low tide	0.513	BDL	34.37
CREEKS					
4	KPT-4 Khori-I	High tide	0.385	BDL	25.80
		Low tide	0.497	BDL	33.30
5	KPT-5 Nakti-I	High tide	0.991	BDL	66.39
		Low tide	0.692	BDL	46.36
6	KPT-5 Nakti-II	High tide	0.308	BDL	20.64

BDL: Below Detectable Limit.

PHYTOPLANKTON POPULATION:

For the evaluation of the Phytoplankton population in DPT harbour area and within the immediate surroundings of the port, sampling was conducted from 5 sampling locations (3 in harbour area and two in Nakti creek) during high tide period and low tide period of spring tide. The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by,Diatoms andblue green algae during spring tide period.Diatoms were represented by 14 genera. Blue green wererepresented by onegenera .during the sampling conducted in spring tide in July,2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 68 -196 units/ L during high tide period and 171-212 units/ L during low tide of Spring Tide.

The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by Diatoms andBlue green algae during spring tide period.Diatoms were represented by 14genera and Blue green algae were represented two genera during the sampling conducted in Neap tide in July , 2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 86-224 units/ L during high tide period and 222-254 units/ L during low tide of Neap Tide.

Species Richness Indices and Diversity Indices :

Margalef's diversity index (Species Richness)S

At the organismal level, the most widely used biodiversity measures are those based on the number of species present, perhaps adjusted for the number of individuals sampled, Here Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, are derived.

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was varying from 1.896 -2.495 with an average of 2.315during the sampling conducted in High tide period of spring tide.While Margalef's diversity index (Species Richness) S of phytoplankton communities in the Kandla Harbour region and nearby creeks was varying from. 2.054-2.334 with an average of 2.170 during the consecutive in low tide period .

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was varying from 2.245-2.630 with an average of 2.495 during the sampling conducted in High tide period of Neaptide While .Margalef's diversity index (Species Richness) S ofphytoplankton communities in the Kandla Harbour region and nearby creeks was varying from. 2.003-2.709 with an average of 2.232 during the consecutive in low tide period .

Shannon-Wiener's index:

Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.878-0.959 (H'(log10)) between selected sampling stations with an average value of 0.905 during high tide period of spring tide .Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.863-0.904 (H'(log10)) between selected sampling stations with an average value of 0.892 during consecutive lowtide. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.960-1.025 (H'(log10)) between selected sampling stations with an average value of 0.990. during high tide period of neap tide . Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.969-1.008 (H'(log10)) between selected sampling stations with an average value of 0.990 during consecutive low tide. Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon-Wiener's index increases as both the richness and the evenness of the community increase. This result indicates that diversity of phytoplankton of Kandla Harbour region and nearby creeks is less but with abundant population of few, with relatively few ecological niches and only very few opportunist organisms are really well adapted to this environment and thrive better than other species.

Simpson's diversity index:

Simpson's index (D) is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. The Simson index is one of the meaningful and robust biodiversity measures available. (Magurran,2004).

Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in the Kandla Harbour region and nearby creeks, which was varying from 0.837- 0.878 between selected sampling stations with an average of 0.855 during high tide period of spring tide . Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in the Kandla Harbour region and nearby creeks, which was varying from 0.840- 0.856 between selected sampling stations with an average of 0.849 during consecutive low tide . Low species diversity suggests a relatively few successful species in this habitat. The environment is quite stressful with relatively few ecological niches and only a few organisms are really well adapted to that environment. Any change in the environment would probably have quite serious effects.

Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in Kandla Harbour region and nearby creeks, during high tide period and low tideperiod during neap tide also, which was varying from 0.872-0.891 with an average value of 0.881 between selected sampling stations during high tide period and varying from 0.882-0.889 with an average value of 0.885 between selected sampling stations during consecutive low tide period Low species diversity suggests a relatively few successful species in this habitat.

Table # 4PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN JULY,2021

Tide	Sampling Station	Abundance In units/L	No of Species observed /total species	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	183	14/15	93.33	2.495	0.906	0.8502
	2	154	13/15	86.66	2.382	0.8957	0.8537
	3	159	13/15	86.66	2.367	0.8948	0.8424
	4	188	13/15	86.66	2.292	0.8783	0.8372
	5	196	14/15	93.33	2.463	0.9587	0.8667
	6	68	9/15	60	1.896	0.899	0.8784
LOW TIDE	1	171	13/15	86.66	2.334	0.9041	0.8535
	2	212	12/15	80	2.054	0.8992	0.8565
	3	197	13/15	86.66	2.271	0.89	0.8406
	4	203	12/15	80	2.07	0.8634	0.8401
	5	179	12/15	80	2.121	0.9037	0.856

Table # 5 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN JULY2021

Tide	Sampling Station	Abundance In units/L	No of Species observed /total species	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	205	15/16	93.75	2.63	1.002	0.8735
	2	184	14/16	87.5	2.493	0.9603	0.872
	3	221	14/16	87.5	2.408	0.9762	0.8773
	4	213	15/16	93.75	2.611	1.025	0.8905
	5	224	15/16	93.75	2.587	1.011	0.8859
	6	86	11/16	68.75	2.245	0.9685	0.8914
LOW TIDE	1	243	12/16	75	2.003	0.9696	0.8823
	2	222	12/16	75	2.036	0.9893	0.8893
	3	222	13/16	81.25	2.221	1.001	0.8872
	4	254	16/16	100	2.709	1.008	0.883
	5	239	13/16	81.25	2.191	0.985	0.8864

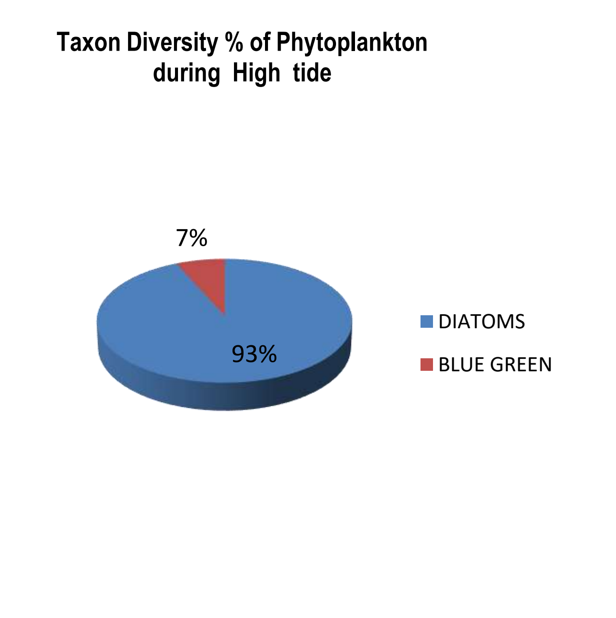
Table # 6 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING SPRING TIDE IN JULY,2021

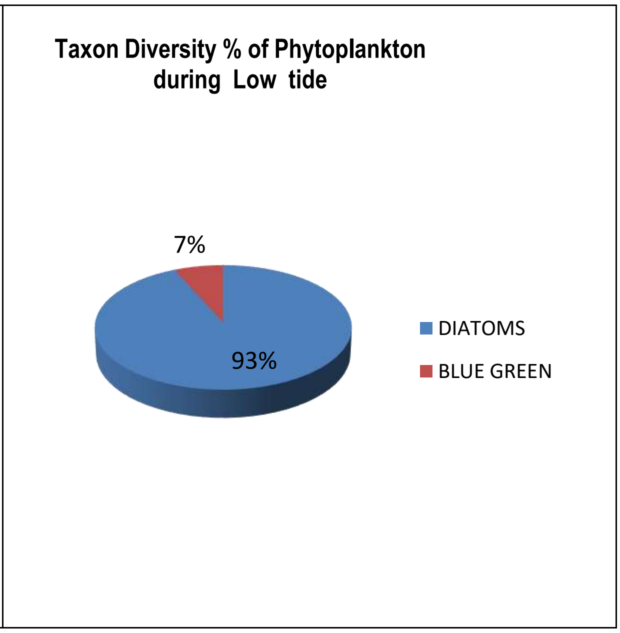
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	68-194	14/15	93.33
			BLUE GREEN	0-2	1/15	6.67
			TOTAL PHYTO PLANKTON	68-196	15	-
LOW TIDE	Sub surface	5	DIATOMS	170-211	14/15	93.33
			BLUE GREEN	0-1	1/15	6.67
			TOTAL PHYTO PLANKTON	171-212	15	-

Table # 7 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING NEAP TIDE IN JULY,2021

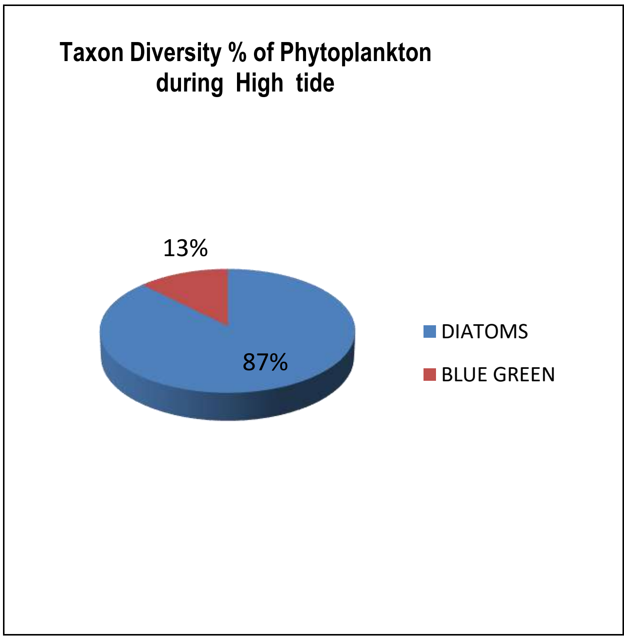
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	74-202	14/16	87.5
			BLUE GREEN	12-26	2/16	12.5
			TOTAL PHYTO PLANKTON	86-224	16	-
LOW TIDE	Sub surface	5	DIATOMS	201-236	14/16	87.5
			BLUE GREEN	16-21	2/16	12.5
			TOTAL PHYTO PLANKTON	222-254	16	-

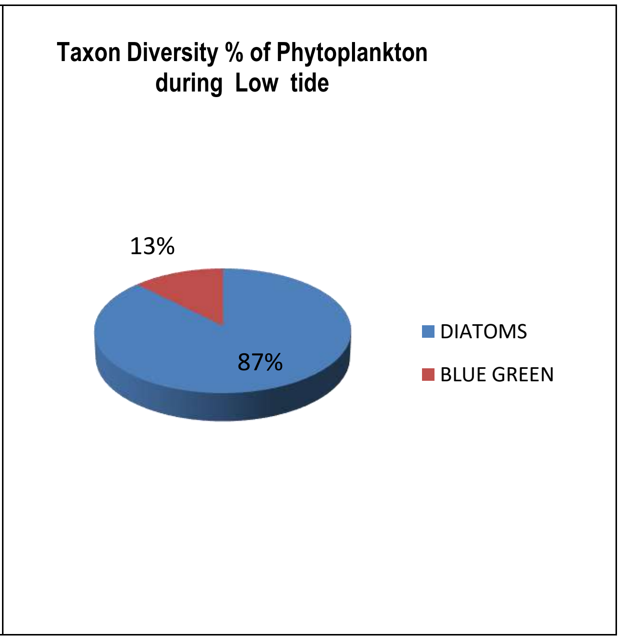
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide





Taxon Diversity % of Phytoplankton during High tide and Low tide period during Neap tide





ZOOPLANKTON POPULATION:

For the evaluation of the Zooplankton population in DPT harbour area and within the immediate surroundings of the port sampling was conducted from 6 sampling locations (3 in harbour area and two in Nakti creek and one in Khoricreek) during high tide period and low tide period of spring tide and Neap tide in July 2021 . The Zooplankton community of the sub surface water in the harbour and nearby creeks during spring tide was represented by mainly four groups, Tintinids, Copepods,Foraminiferans and larval forms of Crustacea, Molluscans and Polychates. The Zooplankton community of the sub surface water in the harbour and nearby creeks during neap tide was represented by mainly five groups, Tintinids, Copepods, Arrow worms, Mysids and larval forms of Crustaceans , Mollusacansand Polychates,.

Zooplankton of the sampling stations at sub surface layer in the DPT harbour area and nearby creek was varying from 59-142x10^3 N/ m^3 during high tide and 123 -147x10^3 N/ m^3during low tide of Spring Tide period. Zooplankton of the sampling stations at sub surface layer in the DPT harbour area and nearby creek was varying from 59-147x10^3 N/ m^3 during high tide and 141-164 N/ L during low tide of Neap Tide period.

Species Richness Indices and Diversity Indices:

Margalef's diversity index (Species Richness)S

At the organismal level, the most widely used biodiversity measures are those based on the number of species present, perhaps adjusted for the number of individuals sampled, Here Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, are derived.

Margalef's diversity index (Species Richness) S of Zooplankton communities in the stations Kandla Harbour region and nearby creeks was varying from 2.850 -3.366 with an average of 3.040 during the sampling conducted in High tide period.Margalef's diversity index (Species Richness) S of Zooplankton communities varying from.2.263-2.701 with an average of 2.562 during the sampling conducted in low tide period during Spring tide.

Margalef's diversity index (Species Richness) S of Zooplankton communities in the Kandla Harbour region and nearby creeks sampling stations was varying from3.188-4. 133 with an average of 3.754 during the sampling conducted in high tide and varying from.2.802 -4.314 with an average of 3.548 during the sampling conducted in low tide during Neap tide period**Shannon-Wiener's index:**

Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 1.011-1.080 (H'(log10)) between selected sampling stations with an average value of 1.050 (H'(log10)) during high tide period of spring tide .Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.953 -1.011 (H'(log10)) between selected sampling stations with an average value of 0.988 (H'(log10)) during consecutive low tide period .

Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.884-1.145 (H'(log10)) between selected sampling stations with an average value of 1.075 (H'(log10)) during high tide period of Neap tide. Shannon-Wiener's Index (H) of Zooplankton communities in the samplingstations in Kandla Harbour region and nearby creeks was in the range of 1.004- 1.177 (H'(log10)) between selected sampling stations with an average value of 1.056 (H'(log10)) during consecutive low tide period .Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon-Wiener's index increases as both the richness and the evenness of the community increase. This result indicates that diversity of Zooplankton of Kandla Harbour region and nearby creeks stations is slightly high with very minimum diverse population but very few opportunist organisms are really well adapted to this environment and thrive better than other species.

Simpson's diversity index:

Simpson's index (D) is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. The Simson index is one of the meaningful and robust biodiversity measures available. (Magurran, 2004).

Simpson diversity index (1-D) of Zooplankton communities was below 0.9 most of sampling stations except few in the Kandla Harbour region and nearby creeksduring high tide and low tide of spring tide period, which was varying from 0.882-0.911between selected sampling stations with an average of 0.899 during high tide period and was varying from 0.875- 0.888 with an average value of 0.882 between selected sampling stations during low tide

Simpson diversity index (1-D) of Zooplankton communities was below 0.9 at all sampling stationsin the Kandla Harbour region and nearby creeks during high tide and low tide period except few, which was varying from 0.829-0.907 between selected sampling stations with an average of 0.887 during high tide period and was varying from 0.872- 0.913 with an average value of 0.886 between selected sampling stations during consecutive low tide

This low species diversity suggests a relatively low number of successful species in this habitat. Environment is quite stressful with relatively few ecological niches and only few organisms are really well adapted to that environment. Any change in the environment would probably have quite serious effects.

Table # 8 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN JULY,2021

Tide	Sampling Station	Abundance In No / m^3	No of Species/groups observed /total species/group	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	125 X10^3	15/19	78.95	2.9	1.02	0.8906
	2	116 X10^3	16/19	84.21	3.156	1.08	0.9076
	3	116 X10^3	17/19	89.47	3.366	1.076	0.8961
	4	142 X10^3	16/19	84.21	3.027	1.011	0.8821
	5	136 X10^3	15/19	78.95	2.85	1.077	0.9077
	6	59 X10^3	13/19	68.42	2.943	1.037	0.9112
LOW TIDE	1	129 X10^3	12/19	63.16	2.263	0.9534	0.8751
	2	123 X10^3	14/19	73.68	2.701	0.9887	0.8835
	3	145 X10^3	14/19	73.68	2.612	1.011	0.8879
	4	147 X10^3	14/19	73.68	2.605	0.9919	0.8823
	5	140 X10^3	14/19	73.68	2.631	0.9951	0.8808

Table # 9 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN JULY,2021

Tide	Sampling Station	Abundance In No / m^3	No of Species/groups observed /total species/group	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	162 X10^3	19/23	82.61	3.538	1.094	0.895
	2	152 X10	20/23	86.96	3.782	1.088	0.8906
	3	146 X10	20/23	86.96	3.812	1.106	0.9011
	4	174 X10	22/23	95.65	4.071	1.134	0.9015
	5	161 X10	22/23	95.65	4.133	1.145	0.9069
	6	59 X10	14/23	60.86	3.188	0.8842	0.8299
LOW TIDE	1	141 X10	17/23	73.91	3.233	1.004	0.8719
	2	142 X10	18/23	78.26	3.43	1.022	0.8797
	3	148 X10	15/23	65.22	2.802	1.034	0.8911
	4	164 X10	23/23	100	4.314	1.177	0.9134
	5	156 X10	21/23	91.30	3.961	1.046	0.8781

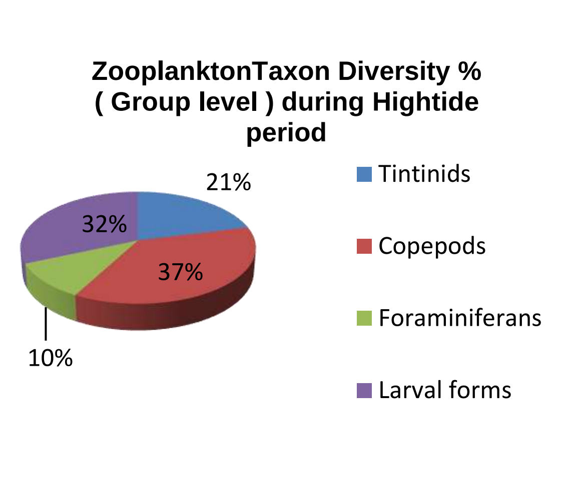
Table # 10 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN JULY2021

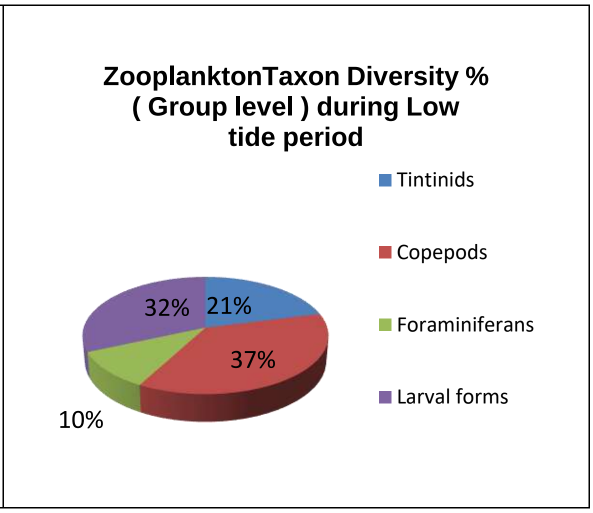
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	3-10	4/19	21.05
			Copepods	34-77	7/19	36.84
			Foraminiferans	2-6	2/19	10.53
			Larval forms	20-57	6/19	31.58
			TOTAL ZOOPLANKTON NO/L	**59-142**	**19**	**-**
LOW TIDE	Sub surface	5	Tintinids	3-8	4/19	21.05
			Copepods	76-80	7/19	36.84
			Foraminiferans	0-2	2/19	10.53
			Larval forms	40-63	6/19	31.58
			TOTAL ZOOPLANKTON NO/L	**123-147**	**19**	**-**

Table # 11 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA , NEAR BY CREEKS DURING NEAPTIDE IN JULY,2021

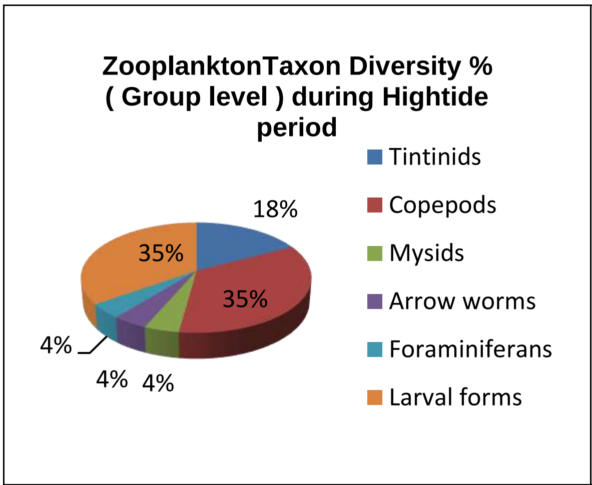
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	4-13	4/23	17.39
			Copepods	37-83	8/23	34.78
			Mysids	0-2	1/23	4.35
			Arrow worms	1-2	1/23	4.35
			Foraminiferans	0-4	1/23	4.35
			Larval forms	17-74	8/23	34.78
			TOTAL ZOOPLANKTON NO/L	**59-173**	**23**	**-**
LOW TIDE	Sub surface	5	Tintinids	3-13	4/23	17.39
			Copepods	70-84	8/23	34.78
			Mysids	0-2	1/23	4.35
			Arrow worms	0-2	1/23	4.35
			Foraminiferans	0-2	1/23	4.35
			Larval forms	60-70	8/23	34.78
			TOTAL ZOOPLANKTON NO/L	**140-164**	**23**	

Taxon Diversity % of Zooplankton during High tide and Low tide period of Spring tide





Taxon Diversity % of Zooplankton during High tide and Low tide period of Neap tide



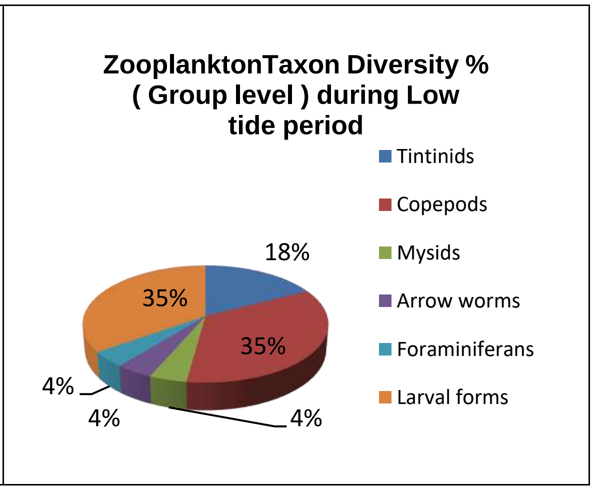


TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURINGSPRING TIDE OF JUlY,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALAGE	Cynophyta	Cynophyceae	Stigonematales	Stigonemataceae	*Stigonema*sp	**B1**	Rare
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Rare
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D2	Abundant
					*Palmeria*sp	D3	Occasional
			Triceratiales	Triceratiaceae	*Odontellasp*	D4	Frequent
					*Triceratium*sp.	D5	Frequent
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D6	Abundant
			Hemiaulales	Bellerocheaceae	Bellerocheasp	D7	Occasional
				Hemiaulaceae	*Eucampia*sp	D8	Rare
			Lithodesmiales	Lithodesmiaceae	*Ditylumsp*	D9	Frequent
			Thalassiosirales	Thalassiosiraceae	*Thalassiosira*sp	D10	Rare
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*sp	D11	Rare
			Bacillariales	Bacillariaceae	*Nitzschia*sp	D12	Rare
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D13	Dominant
			Fragilariales	Fragilariaceae	*Synedra*sp	D14	Occasional

TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURING AND NEAP TIDE OF JULY,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALAGE	Cynophyta	Cynophyceae	Chlorococcales	Chroococcaceae	*Microcystis* sp.	B1	Occasional
			Stigonematales	Stigonemataceae	*Stigonema*sp	B2	Frequent
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Rare
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D2	Abundant
					Palmeriasp	D3	Occasional
			Triceratiales	Triceratiaceae	*Odontella*sp	D4	Frequent
					*Triceratium*sp.	D5	Abundant
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D6	Dominant
			Hemiaulales	Bellerocheaceae	Bellerocheasp	D7	Occasional
				Hemiaulaceae	*Eucampia*sp	D8	Rare
			Lithodesmiales	Lithodesmiaceae	*Ditylum*sp	D9	Abundant
			Thalassiosirales	Thalassiosiraceae	*Thalassiosira*sp	D10	Frequent
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*sp	D11	Rare
			Bacillariales	Bacillariaceae	*Nitzschia*sp	D12	Rare
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D13	Frequent
			Fragilariales	Fragilariaceae	*Synedra*sp	D14	Frequent

TABLE #13 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS IN DPT HARBOUR AREA, AND NEAR BY CREEKS DURING SPRING TIDE OF JULY,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Rare
				Codonellidae	*Tintinnopsisfailakkaensis*	T2	Rare
					Tintinnopsisgracilis	T3	Rare
					Tintinnopsis radix	T4	Rare
COPEPODS	ATHROPODA	Crustacea Sub class copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Abundant
					Bestiolina sp.	C2	Rare
					Parvocalanus sp.	C3	Occasional
				Temoridae	*Temora sp.*	C4	Frequent
			Cyclopoida	Oithonidae	*Oithona sp.*	C5	Frequent
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C6	Abundant
				Euterpinidae	*Euterpina*	C7	Occasional
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
(Brachyuraian LARVAE	ARTHROPODA CRUSTACEA	DECAPODA (BRACHYURA)			Zoea larvae	L2	Rare
CYPHONAUTES LARVAE	BRYOZOA				Cyphonautes larvae	L3	Occasional
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L4	Rare
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L5	Rare
POLYCHAETE LARVAE	ANNELIDA				Trochophore larvae	L6	Frequent
FORAMINIFERA	FORAMINIFERA	Globothalamea	Rotaliida	Globigerinidae	*Globigerina* sp.	F1	Rare
				Rotalliidae	*Rotalia* sp.	F2	Rare

TABLE # 13 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS IN DPT HARBOUR AREA, AND NEAR BY CREEKS DURING NEAP TIDE OF JULY,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Rare
				Codonellidae	*Tintinnopsisfailakkaensis*	T2	Occasional
					Tintinnopsisgracilis	T3	Occasional
					Tintinnopsis radix	T4	Rare
COPEPODS	ATHROPODA	Crustacea Sub class copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Abundant
					Parvocalanus sp.	C2	Rare
				Eucalanidae	*Subeucalanus sp.*	C3	Frequent
				Temoridae	*Temora sp.*	C5	Frequent
				Acartiidae	*Acartia sp.*	C6	Occasional
			Cyclopoida	Oithonidae	*Oithona sp.*	C7	Frequent
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C8	Abundant
				Euterpinidae	*Euterpina sp.*	C9	Frequent
ARROW WORMS	CHAETOGNATHA	Sagittoideae	Aphragmophora	Sagittidae	*Sagitta sp.*	A1	Rare
MYSIDS	ATHROPODA CRUSTACEA	Malacostraca	Mysida, Decapoda	Penaeidae	*Metapenaeus sp.*	M1	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
POLYCHAETE LARVA	ANNELIDA	Polychaeta			Trochophore larvae	L2	Occasional
BARNACLE LARVAE	ATHROPODA CRUSTACEA	Maxillopoda Thecostraca			Cirripede larvae	L3	Rare
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L4	Occasional

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L5	Rare
BRACHYURAIAN LARVAE	ARTHROPODA CRUSTACEA	DECAPODA (BRACHYURA)			Zoea larvae	L6	Occasional
CYPHONAUTES LARVAE	BRYOZOA				Cyphonautes larvae	L7	Occasional
ECHINODERMATA larvae	ECHINODERMATA	Ophiuroidea			Ophiopluetus larvae	L8	Occasional
FORAMINIFERA	FORAMINIFERA	Globothalamea	Rotaliida	Rotalliidae	*Rotalia* sp.	F1	Rare

BENTHIC ORGANISMS:

No Benthic organisms were observed in the collected sediments by using the Van-veen grabs during the sampling conducted IN spring tide period as well as Neap tide period from DPT harbour region and nearby creek except few dead shells.

7. Meteorological Data

Automatic Weather station have been installed in SevaSadan -3 at the Deendayal Port which records the data on Temperature (°C), Humidity (%),Wind (mph), Dew Point (°C), Wind Direction (°), Pressure, Solar radiation, heat Index and UVI.

Temperature

The mean day time temperature for Deendayal Port was 28.5 °C. The day-time maximum temperature was 32.1 °C. The mean night time temperature was 30.3 °C. The minimum mean night time temperature recorded was 27.8 °C.

Air Pressure

The mean absolute air pressure for the month of July was 1002.4 hpa, whereas the mean relative pressure was 1000.2 hpa. The maximum absolute air pressure recorded for the month of July was 1004.1 hpa.

Heat Index

The mean day-time heat index for the month of July was 36.1 ^{o}C. The maximum heat index recorded was 43^{o}C.

Solar Radiation

The mean Solar Radiation in July was 158.4 w/m^2. The maximum solar radiation recorded in the month of July was 751.7 w/m^2.

Humidity

The mean day-time humidity was 80.3 % for the month of July and mean night time humidity was 71.2%. Maximum humidity recorded during day-time was 89.0 % and maximum humidity recorded during night-time was 85.0%.

Wind Velocity and Wind Direction

The mean wind velocity for the entire month of July was 11.72 km/hour (i.e. 2.7 mtr/sec). Maximum wind velocity recorded was 47.2 Km/hr (13 mtr/sec). The wind direction was mostly S to SW.

Rainfall

The mean Rainfall in July was 58.1 mm. The maximum Rainfall recorded in the month of July was 132.7 mm.

Conclusive Summary and Remedial measures Suggested

- The AAQ monitoring at six locations of Deendayal Port indicates that the mean PM_{10} values at four locations viz. Coal storage area, Marine Bhavan and Oil Jetty area were found above the permissible standards (100 µg/m^3)and$PM_{2.5}$was above permissible limits at Coal storage location(Limit 60 µg/m^3).

- Drinking water at all the twenty locations was found potable and was within permissible limits of BIS standards (IS 10500).

- Noise quality was also within the set permissible standards of an Industrial Area. The noise level observed during day time was >75 dB (A) and at night time was >70 dB (A) during the entire monitoring period.

- The sewage treated water of Deendayal Port Colony (Gopalpuri) was in line with the standards set by the Gujarat Pollution Control Board. The STP at Deendayal Port is not fully operational and STP at Vadinar Port was found non-operational.

Reasons for higher Values of PM_{10}

- Large amount of coal is handled at Berth No. 6, 7, 8 and 9. The unloading of coal directly in the truck, using grabs cause coal to spread in air as well as coal dust to fall on ground. This settled coal dust again mixes with the air while trucks travel through it.

- Also, the coal laden trucks are not always covered with tarpaulin sheets and these results in spillage of coal from trucks/dumpers during its transit from vessel to yard or storage site. This also increased PM values around marine Bhavan & Coal storage area.

Remedial Measures

The values of PM_{10} during the month of July, 2021 were observed beyond the permissible limit at four locations mentioned above. Given below are the remedial measures suggest to minimize the Air pollution at Deendayal Port.

- Guidelines for Coal Handling by GPCB should be strictly followed. (http://gpcb.gov.in/pdf/coal-handling-guidelines.pdf)

- Sewage Treatment Plan at Vadinar Port is not working. Hence, it is recommended to commission the sewage treatment plant at Vadinar immediately.

- Except for the higher values of PM_{10} at Coal storage site, Oil Jetty, Tuna Port and Marine Bhavan locations, the monitoring results for the present month suggest that the overall Environment Quality of Deendayal Port is satisfactory.

SOURCE OF LITERATURE AND ADDITIONAL REFERENCE FOR ECOLOGICAL STUDY

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ENVIRONMENTAL MONITORING REPORT
FOR
DEENDAYAL PORT TRUST

REPORT NO.	:	DCPL/DPT/20-21/16
Month	:	Aug 2021
Issue No	:	01
Revision No	:	00
Prepared by	:	DETOX CORPORATION PVT. LTD., SURAT

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Introduction

Monitoring of various environmental aspects of the Deendayal port by M/s Detox Corporation Pvt. Ltd. has been carried out through collection of samples, analysis of the same, comparing results with respect to the national standards and any other relevant standards by GBCB/CPCB/MoEF to identify non conformity in the Environment of the Deendayal Port. The results shall address the identified impacts and suggest measures to minimize the environmental impact due to various operations at Deendayal Port.

The environmental monitoring is carried out as per the Environment Management and Monitoring Plan submitted by Detox Corporation Pvt. Ltd.

1. Ambient Air Quality Monitoring

As per the Environmental Monitoring Plan of Deendayal Port Trust, Air monitoring was carried out at six identified locations at Deendayal Port and two locations at Vadinar Port.

1.1 Air Quality Monitoring Methodology

Air quality is measured in all the stations, for 24 hour for Total Suspended Particulate Matter (TSPM), PM_{10}, $PM_{2.5}$, SO_2, NO_X, NH_3 & Benzene, and Grab-sampling for CO & CO_2 measurements. The Air samplers are operated for a period of 24 hours and after a continuous operation of 8 hours of the sampler, the reagents were replaced to obtain 3 samples per day for each parameter namely, SO_2, NO_X. The EPM 2000 filter paper and PTFE Membrane bound filter paper are used for a period of 24 hours to obtain one sample each of TSPM, PM_{10} & $PM_{2.5}$.

The AAQ samples are collected twice a week from all the eight locations as per the EMP.

1.2 Results

The ambient air quality monitoring data for six stations, viz. Marine Bhavan, Oil Jetty, Port Colony,Gopalpuri Hospital,Tuna Port and Nr. Coal Storage Area for the month of August 2021 are given in Tables 1A to 6B. The ambient air quality monitoring data for two stations at Vadinar (Nr. Admin Building &Nr. Signal Building) are given in Tables 7A to 8B.

Location 1: Marine Bhavan (AL1)

Table 1 : Results of Air Pollutant Concentration at Marine Bhavan

Parameter	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**		**80 µg/m3**		**80 µg/m3**		**400 µg/m3**
AL1 – 1	04.08.2021	328	179	68	2.64	2.40	20.33	21.17	9.45	9.87
					0.62		19.05		9.70	
					3.96		24.14		10.47	
AL1 – 2	06.08.2021	659	211	75	7.03	6.15	14.61	20.11	13.79	13.70
					5.71		15.88		13.53	
					5.71		29.85		13.79	
AL1 – 3	11.08.2021	813	247	70	8.35	7.03	29.85	27.10	12.00	11.49
					7.91		31.76		13.02	
					4.84		19.69		9.45	
AL1 – 4	13.08.2021	549	272	89	2.20	2.05	18.42	17.15	14.55	15.68
					1.76		15.88		17.69	
					2.20		17.15		14.81	
AL1 – 5	18.08.2021	442	300	45	3.96	3.66	19.69	21.38	5.36	9.62
					4.40		20.33		12.00	
					2.64		24.14		11.49	
AL1 - 6	20.08.2021	360	299	88	3.08	3.22	17.78	16.51	10.47	6.13
					4.40		21.60		5.36	
					2.20		10.16		2.55	
AL1 - 7	25.08.2021	340	290	72	2.64	2.64	13.34	18.00	14.81	11.57
					3.52		22.23		10.47	
					1.76		18.42		9.45	
AL1 – 8	27.08.2021	471	299	63	3.08	2.93	27.31	26.25	10.98	7.83
					1.76		30.49		5.62	
					3.96		20.96		6.89	
Monthly Average		495	262	71		3.76		20.96		10.74
Standard Deviation		171	46	14		1.83		3.96		3.08

NS: Not Specified

Table 1B : Results of Air Pollutant Concentration at Marine Bhavan					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC* ppm**	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL1 – 1	04.08.2021	1.06	BDL	1.86	488
AL1 – 2	06.08.2021	1.22	BDL	1.74	496
AL1 – 3	11.08.2021	1.28	BDL	1.7	499
AL1 – 4	13.08.2021	1.2	BDL	1.68	501
AL1 – 5	18.08.2021	1.21	BDL	1.72	490
AL1 - 6	20.08.2021	1.06	BDL	1.62	497
AL1 – 7	25.08.2021	1.12	BDL	1.52	488
AL1 – 8	27.08.2021	1.06	BDL	1.72	496
Monthly Average		**1.15**	-	**1.70**	**494**
Standard Deviation		**0.09**	-	**0.10**	**5**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5ppm)

NS -Not Specified

At Marine Bhavan, the overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_X and NH_3 is attributed mainly by motor vehicle emission produced from various types of automobiles (both diesel and petrol driven). Moreover, the loading and unloading of Food Grains and Timber at Jetty no. 1 and 2 also contributes to the high levels of TSPM and PM_{10}. The mean TSPM value at Marine Bhavan was 495 µg/m^3, The mean PM_{10} values were 262.0 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were slightly above the permissible limit (mean = 71 µg/m^3). The average values of SO_2, NO_x and NH_3 were within the permissible limit. The average values of SO_2, NO_x and NH3 were 3.76 µg/ m^3, 20.96 µg/ m^3 & 10.74 µg/ m^3 respectively. These were within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Marine Bhavan. The mean Benzene concentration was 1.15 µg/m^3,well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.70 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 2: Oil Jetty (AL2)

Table 2 : Results of Air Pollutant Concentration at Oil Jetty											
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**		
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**	-	**80 µg/m3**	-	**80 µg/m3**	-	**400 µg/m3**
AL2 – 1	04.08.2021	299	222	55	3.52	3.81	18.42	16.30	13.53	14.81
					4.84		12.70		14.81	
					3.08		17.78		16.08	
AL2 – 2	06.08.2021	837	394	89	1.32	3.08	12.07	12.28	7.40	10.47
					3.08		10.80		11.74	
					4.84		13.97		12.25	
AL2 – 3	11.08.2021	403	350	49	8.35	9.38	33.66	25.62	4.08	6.89
					8.79		19.05		6.89	
					10.99		24.14		9.70	
AL2 – 4	13.08.2021	511	327	82	3.08	2.05	17.78	16.30	7.15	9.10
					1.76		15.88		10.72	
					1.32		15.24		9.45	
AL2 – 5	18.08.2021	567	281	75	3.08	2.20	17.15	18.63	9.70	7.83
					1.32		26.04		5.36	
					2.20		12.70		8.42	
AL2 – 6	20.08.2021	728	490	90	6.15	5.86	22.87	15.88	5.36	8.00
					7.91		8.89		8.42	
					3.52		15.88		10.21	
AL2 – 7	25.08.2021	344	237	67	0.88	1.17	24.14	20.75	9.96	10.38
					0.88		15.88		12.76	
					1.76		22.23		8.42	
AL2 – 8	27.08.2021	475	278	76	1.32	2.20	15.88	17.78	5.87	8.51
					1.76		24.14		9.19	
					3.52		13.34		10.47	
Monthly Average		520	322	73		3.72		17.94		9.50
Standard Deviation		186	88	15		2.70		3.95		2.47

NS: Not Specified

Table 2B : Results of Air Pollutant Concentration at Oil Jetty					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC* ppm**	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL2 -1	04.08.2021	1.22	BDL	1.86	492
AL2 -2	06.08.2021	1.06	BDL	1.72	496
AL2 -3	11.08.2021	1.26	BDL	1.76	489
AL2 -4	13.08.2021	1.23	BDL	1.66	500
AL2 – 5	18.08.2021	1.2	BDL	1.84	496
AL2 – 6	20.08.2021	1.16	BDL	1.74	489
AL2 -7	25.08.2021	1.18	BDL	1.76	476
AL2 – 8	27.08.2021	1.23	BDL	1.7	490
Monthly Average		**1.19**	**-**	**1.76**	**491**
Standard Deviation		**0.06**	**-**	**0.07**	**7**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 0.5ppm)

NS- Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Oil Jetty area was mainly by motor vehicle emission produced from various types of vehicles Oil Jetty Area. The mean TSPM values at Oil Jetty were 520 µg/m^3 .The mean PM_{10} values were 322 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were slightly above the permissible limit (mean = 73 µg/m^3).The average values of SO_2, NO_x and NH_3 were within the permissible limit; The mean concentration of SO_2, NO_x and NH3 were 3.72 µg/m^3, 17.94 µg/m^3 and 9.50 µg/m^3 respectively.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Oil Jetty. The mean Benzene concentration was 1.19 µg/m^3 .Well below the permissible limit of 5.0 µg/m^3. , HC's were below the detectable limit and Carbon Monoxide concentration was 1.76 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 3: Kandla Colony – Estate Office (AL-3)

Table 3 : Results of Air Pollutant Concentration at Estate Office

Parameters	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period	-	24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit	-	NS	100 µg/m3	60 µg/m3	-	80 µg/m3	-	80 µg/m3	-	400 µg/m3
AL3 – 1	04.08.2021	159	97	35	1.32	2.05	25.41	23.92	14.04	16.68
					2.20		33.66		17.36	
					2.64		12.70		18.64	
AL3 – 2	06.08.2021	473	176	60	3.96	9.96	12.70	13.13	8.68	7.40
					21.98		10.80		7.15	
					3.96		15.88		6.38	
AL3 – 3	11.08.2021	379	253	74	3.96	4.25	15.24	20.75	8.42	6.47
					5.28		20.96		7.15	
					3.52		26.04		3.83	
AL3 – 4	13.08.2021	652	331	67	4.84	2.49	9.53	9.32	12.76	9.62
					1.76		9.53		9.70	
					0.88		8.89		6.38	
AL3 – 5	18.08.2021	643	457	92	4.84	3.52	24.14	24.77	9.70	38.21
					3.52		34.30		10.47	
					2.20		15.88		94.45	
AL3 – 6	20.08.2021	721	389	75	4.84	4.25	20.96	20.96	10.21	8.25
					2.20		15.88		9.45	
					5.71		26.04		5.11	
AL3 – 7	25.08.2021	298	208	68	4.40	3.22	22.23	19.05	12.00	11.66
					3.52		17.78		12.00	
					1.76		17.15		10.98	
AL3 – 8	27.08.2021	574	300	96	2.64	2.93	16.51	17.57	11.49	8.76
					4.40		17.15		9.45	
					1.76		19.05		5.36	
Monthly Average		488	276	71		4.08		18.68		13.38
Standard Deviation		196	117	19		2.50		5.26		10.53

NS: Not Specified

Table 3B : Results of Air Pollutant Concentration at Kandla Port Colony					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC***	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL3 -1	04.08.2021	1.12	BDL	1.84	480
AL3 -2	06.08.2021	1.16	BDL	1.76	488
AL3 -3	11.08.2021	1.22	BDL	1.8	496
AL3 -4	13.08.2021	1.26	BDL	1.74	490
AL3 – 5	18.08.2021	1.2	BDL	1.79	496
AL3 – 6	20.08.2021	1.06	BDL	1.82	499
AL3 – 7	25.08.2021	1.11	BDL	1.8	500
AL3 – 8	27.08.2021	1.07	BDL	1.76	490
Monthly Average		**1.15**	**-**	**1.79**	**492**
Standard Deviation		**0.07**	**-**	**0.03**	**7**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)

NS- Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Kandla Port Colony was attributed by vehicle emission produced from trucks and heavy duty vehicles that pass through the road outside Kandla Port Colony. The mean TSPM values at Oil Jetty were 488 µg/m^3, The mean PM_{10} values were 276 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were slightly above the permissible limit (mean = 71 µg/m^3). The average values of SO_2, NO_x and NH3 were 4.08 µg/m^3, 18.68 µg/m^3 and 13.38 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Kandla Port Colony. The mean Benzene concentration was 1.15 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.79 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 4: Gopalpuri Hospital (AL-4)

Table 4 : Results of Air Pollutant Concentration at Gopalpuri Hospital

Parameter	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period	-	24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit	-	NS	100 µg/m3	60 µg/m3	-	80 µg/m3	-	80 µg/m3	-	400 µg/m3
AL4 -1	04.08.2021	128	77	28	3.08	3.08	7.62	12.70	9.70	8.76
					2.64		17.15		10.21	
					3.52		13.34		6.38	
AL4 -2	06.08.2021	180	115	38	3.52	2.05	6.35	10.16	5.36	5.02
					0.88		11.43		5.11	
					1.76		12.70		4.60	
AL4 -3	11.08.2021	228	110	48	1.76	3.08	11.43	9.95	4.34	4.85
					3.96		6.35		5.36	
					3.52		12.07		4.85	
AL4 -4	13.08.2021	327	260	60	3.08	3.08	11.43	9.74	7.15	5.62
					3.52		10.80		4.08	
					2.64		6.99		5.62	
AL4 – 5	18.08.2021	269	156	70	2.20	3.08	15.88	14.61	5.36	6.89
					3.96		8.89		8.93	
					3.08		19.05		6.38	
AL4 – 6	20.08.2021	228	113	86	3.52	2.34	13.97	12.91	5.36	9.02
					2.20		8.89		9.70	
					1.32		15.88		12.00	
AL4 – 7	25.08.2021	222	116	49	2.20	2.78	19.05	17.15	6.89	6.72
					3.52		14.61		8.42	
					2.64		17.78		4.85	
AL4 – 8	27.08.2021	249	119	30	2.64	3.08	12.07	12.07	7.91	8.93
					3.08		12.70		9.19	
					3.52		11.43		9.70	
Monthly Average		229	133	51		2.82		12.41		6.98
Standard Deviation		59	56	20		0.41		2.56		1.75

NS: Not Specified

Table 4B : Results of Air Pollutant Concentration at Gopalpuri Hospital					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC***	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL4 -1	04.08.2021	1.12	BDL	1.88	490
AL4 -2	06.08.2021	1.18	BDL	1.76	488
AL4 -3	11.08.2021	1.26	BDL	1.72	496
AL4 -4	13.08.2021	1.21	BDL	1.8	500
AL4 – 5	18.08.2021	1.28	BDL	1.79	482
AL4 – 6	20.08.2021	1.2	BDL	1.84	493
AL4 – 7	25.08.2021	1.18	BDL	1.86	498
AL4 – 8	27.08.2021	1.16	BDL	1.8	490
Monthly Average		**1.20**	**-**	**1.81**	**492**
Standard Deviation		**0.05**	**-**	**0.05**	**6**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)

NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Gopalpuri Hospital was attributed by vehicle emission produced from light motor vehicles of the colony residents. The mean TSPMvalues at Oil Jetty were 229 µg/m^3, The mean PM_{10} values were 133 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were slightly above the permissible limit (mean= 51 µg/m^3). The average values of SO_2, NO_x and NH_3 were 2.82 µg/m^3, 12.41 µg/m^3 and 6.98 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Gopalpuri Hospital. The mean Benzene concentration was 1.20 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.81 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 5: Coal Storage Area (AL-5)

Table 5 : Results of Air Pollutant Concentration at Coal Storage Area

Parameters	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period	-	24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit	-	NS	100 µg/m3	60 µg/m3	-	80 µg/m3	-	80 µg/m3	-	400 µg/m3
AL5 – 1	04.08.2021	312	167	69	3.08	3.66	22.23	22.23	9.45	9.53
					3.52		23.50		7.15	
					4.40		20.96		12.00	
AL5 – 2	06.08.2021	530	333	77	9.23	6.15	20.96	20.11	16.59	17.02
					5.71		24.77		17.87	
					3.52		14.61		16.59	
AL5 – 3	11.08.2021	759	394	92	10.99	9.23	24.14	27.74	8.42	7.74
					7.47		25.41		7.15	
					9.23		33.66		7.66	
AL5 – 4	13.08.2021	813	435	94	1.76	1.61	17.78	18.84	13.02	10.30
					1.32		19.05		8.93	
					1.76		19.69		8.93	
AL5 – 5	18.08.2021	700	471	79	4.40	3.96	21.60	22.02	12.00	11.66
					4.40		19.05		10.47	
					3.08		25.41		12.51	
AL5 – 6	20.08.2021	566	427	80	3.08	3.96	16.51	18.00	16.85	15.66
					3.52		15.24		16.34	
					5.28		22.23		13.79	
AL5 – 7	25.08.2021	456	224	76	3.96	4.10	13.97	17.15	10.47	7.04
					4.40		19.69		9.70	
					3.96		17.78		0.94	
AL5 – 8	27.08.2021	249	164	70	4.40	3.66	23.50	27.52	11.49	13.44
					3.52		28.58		14.04	
					3.08		30.49		14.81	
Monthly Average		548	327	80		4.54		21.70		11.55
Standard Deviation		204	125	9		2.26		4.07		3.60

NS: Not Specified

Table 5B : Results of Air Pollutant Concentration at Coal Storage Area					
Parameter	Date	C_6H_6 [µg/m^3]	HC*	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3	NS	4.0 mg/m^3	NS
AL5 – 1	04.08.2021	1.06	BDL	1.96	460
AL5 – 2	06.08.2021	1.11	BDL	1.88	458
AL5 – 3	11.08.2021	1.26	BDL	1.9	456
AL5 – 4	13.08.2021	1.3	BDL	1.82	460
AL5 – 5	18.08.2021	1.26	BDL	1.96	456
AL5 – 6	20.08.2021	1.22	BDL	1.93	474
AL5 – 7	25.08.2021	1.38	BDL	1.89	470
AL5 – 8	27.08.2021	1.30	BDL	1.9	468
Monthly Average		**1.24**	**-**	**1.91**	**463**
Standard Deviation		**0.11**	**-**	**0.05**	**7**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)

NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Coal Storage Area was comparatively highest among all the locations of Air Quality monitoring in Kandla Port. High values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_X at this location was due to lifting of coal with grab and other coal handling processes near Berth no. 6 & 7. Moreover, the traffic was also heavy around this place for transport of coal thus emissions produced from heavy vehicles. The mean TSPM values at Coal storage were 548 µg/m^3. The mean PM_{10} values were 327 µg/m^3, which is well above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 80 µg/m^3). The average values of SO_2, NO_x and NH_3 were 4.54 µg/m^3, 21.70 µg/m^3 and 11.55 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Coal Storage Area. The mean Benzene concentration was 1.24 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.91 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 6: Tuna Port (AL-6)

Table 6 : Results of Air Pollutant Concentration at Tuna Port

Parameters	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period	-	24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit	-	NS	100 µg/m3	60 µg/m3	-	80 µg/m3	-	80 µg/m3	-	400 µg/m3
AL6 -1	04.08.2021	133	75	26	3.96	2.93	22.23	15.46	15.06	12.17
					2.64		13.34		12.25	
					2.20		10.80		9.19	
AL6 – 2	06.08.2021	203	149	67	2.20	2.05	8.26	9.10	5.87	6.81
					2.20		10.16		6.38	
					1.76		8.89		8.17	
AL6 – 3	11.08.2021	316	166	44	5.28	4.40	17.78	18.63	6.89	6.47
					4.84		22.23		4.60	
					3.08		15.88		7.91	
AL6 – 4	13.08.2021	530	342	83	3.08	2.05	5.72	7.83	5.36	6.55
					1.32		9.53		7.91	
					1.76		8.26		6.38	
AL6 – 5	18.08.2021	468	291	84	0.88	2.05	20.96	17.15	12.76	12.08
					1.76		12.70		12.25	
					3.52		17.78		11.23	
AL6 – 6	20.08.2021	319	181	63	4.40	3.08	33.03	28.58	10.47	12.93
					1.32		22.87		15.57	
					3.52		29.85		12.76	
AL6 – 7	25.08.2021	256	156	58	3.08	3.22	15.88	17.15	9.96	10.21
					2.64		17.78		9.45	
					3.96		17.78		11.23	
AL6 – 8	27.08.2021	554	375	80	2.64	3.08	17.15	16.30	10.47	9.96
					3.08		12.07		8.42	
					3.52		19.69		10.98	
Monthly Average		347	217	63		2.86		16.28		9.65
Standard Deviation		155	106	20		0.81		6.35		2.71

NS: Not Specified

Table 6B : Results of Air Pollutant Concentration at Tuna Port					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC***	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL6 -1	04.08.2021	1.11	BDL	1.74	460
AL6 – 2	06.08.2021	1.26	BDL	1.89	470
AL6 – 3	11.08.2021	1.2	BDL	1.88	472
AL6 – 4	13.08.2021	1.16	BDL	1.9	466
AL6 – 5	18.08.2021	1.07	BDL	1.97	460
AL6 – 6	20.08.2021	1.11	BDL	1.89	451
AL6 – 7	25.08.2021	1.2	BDL	1.8	460
AL6 – 8	27.08.2021	1.21	BDL	1.82	470
Monthly Average		**1.17**	**-**	**1.86**	**464**
Standard Deviation		**0.06**	**-**	**0.07**	**7**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)

NS- Not Specified

The mean TSPM values at Tuna Port were 347 µg/m^3, The mean PM_{10} values were 217 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were slightly the permissible limit (mean = 63 µg/m^3). The average values of SO_2, NO_x and NH_3 were 2.86 µg/m^3, 16.28 µg/m^3 and 9.65 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Tuna Port. The mean Benzene concentration was 1.17 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.86 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 7: Signal Building (Vadinar) (AL-7)

Table 7 : Results of Air Pollutant Concentration at Signal Building											
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**		
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**	-	**80 µg/m3**	-	**80 µg/m3**	-	**400 µg/m3**	
AL7 -1	04.08.2021	144	97	30	3.08	3.08	7.62	11.86	7.66	5.53	
					2.64		14.61		5.36		
					3.52		13.34		3.57		
AL7 -2	06.08.2021	180	120	38	3.96	4.98	28.58	17.78	4.60	6.55	
					4.84		14.61		10.47		
					6.15		10.16		4.60		
AL7 -3	11.08.2021	148	85	29	2.20	2.34	8.89	16.51	5.36	8.68	
					3.08		26.04		11.49		
					1.76		14.61		9.19		
AL7 -4	13.08.2021	165	115	32	2.64	2.07	20.33	14.19	9.19	6.47	
					0.48		13.34		3.57		
					3.08		8.89		6.64		
AL7 -5	18.08.2021	151	99	35	4.84	3.96	14.61	16.30	8.93	7.49	
					3.08		21.60		6.38		
					3.96		12.70		7.15		
AL7 -6	20.08.2021	173	104	64	3.96	3.81	9.53	11.22	4.85	4.68	
					3.08		8.89		3.57		
					4.40		15.24		5.62		
AL7 -7	25.08.2021	168	114	44	3.96	1.67	13.34	13.55	16.85	10.89	
					0.44		6.99		12.00		
					0.62		20.33		3.83		
AL7 -8	27.08.2021	113	54	37	6.15	2.78	7.62	12.70	9.70	8.76	
					1.76		17.15		9.45		
					0.44		13.34		7.15		
Monthly Average		155	98	39		3.1		14.3		7.4	
Standard Deviation		21	21	11		1.1		2.4		2.0	

NS: Not Specified

Table 7B : Results of Air Pollutant Concentration at Signal Building					
Parameter	Date	C_6H_6 [µg/m^3]	HC*	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3	NS	4.0 mg/m^3	NS
AL7 -1	04.08.2021	1.11	BDL	1.9	460
AL7 – 2	06.08.2021	1.2	BDL	1.86	472
AL7 – 3	11.08.2021	1.18	BDL	1.79	460
AL7 – 4	13.08.2021	1.08	BDL	1.86	461
AL7 – 5	18.08.2021	1.12	BDL	1.96	456
AL7 – 6	20.08.2021	1.2	BDL	1.9	460
AL7 – 7	25.08.2021	1.18	BDL	1.88	470
AL7 – 8	27.08.2021	1.1	BDL	1.82	465
Monthly Average		**1.15**	**-**	**1.87**	**463**
Standard Deviation		**0.05**	**-**	**0.05**	**6**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)
NS_ Not Specified

The mean TSPM values at Vadinar Port were 155 µg/m^3. The mean PM_{10} values were 98 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 39 µg/m^3). The average values of SO_2, NO_x and NH_3 were 3.1 µg/m^3, 14.3 µg/m^3 and 7.4 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Vadinar Port. The mean Benzene concentration was 1.15 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.87 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 8: Admin Building (Vadinar) (AL-8)

Table 8 : Results of Air Pollutant Concentration at Admin Building										
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**	
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**	-	**80 µg/m3**	-	**80 µg/m3**	-	**400 µg/m3**
AL8 -1	04.08.2021	119	55	28	4.84	3.52	19.05	18.42	7.15	6.30
					2.64		22.87		6.64	
					3.08		13.34		5.11	
AL8 -2	06.08.2021	111	56	47	17.58	6.30	17.78	16.73	7.91	8.00
					0.44		19.05		5.62	
					0.88		13.34		10.47	
AL8 -3	11.08.2021	180	100	56	1.76	2.78	15.24	15.24	4.34	5.19
					3.52		22.87		4.85	
					3.08		7.62		6.38	
AL8 -4	13.08.2021	130	77	42	3.96	4.54	13.97	11.86	8.17	7.15
					6.15		10.16		10.47	
					3.52		11.43		2.81	
AL8 -5	18.08.2021	100	68	29	3.96	2.64	7.62	8.89	7.40	7.40
					0.88		8.89		9.45	
					3.08		10.16		5.36	
AL8 -6	20.08.2021	160	97	58	3.52	4.98	12.70	12.70	8.93	8.42
					5.28		10.80		9.19	
					6.15		14.61		7.15	
AL8 -5	25.08.2021	143	65	49	3.52	3.96	6.99	12.49	12.00	8.42
					3.96		17.15		4.34	
					4.40		13.34		8.93	
AL8-6	27.08.2021	160	100	53	2.20	2.93	7.62	11.43	8.17	6.30
					3.08		19.05		4.60	
					3.52		7.62		6.13	
Monthly Average		138	77	45		4.0		13.5		7.1
Standard Deviation		28	19	12		1.3		3.1		1.2

NS: Not Specified

Table 8B : Results of Air Pollutant Concentration at Admin Building					
Parameter	Date	C_6H_6 [µg/m^3]	HC*	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3	NS	4.0 mg/m^3	NS
AL8 -1	04.08.2021	1.12	BDL	1.96	460
AL8-2	06.08.2021	1.06	BDL	1.86	456
AL8 -3	11.08.2021	1.11	BDL	1.88	466
AL8-4	13.08.2021	1.18	BDL	1.9	470
AL8 -5	18.08.2021	1.26	BDL	1.92	466
AL8-6	20.08.2021	1.16	BDL	1.96	460
AL8-7	25.08.2021	1.2	BDL	1.86	456
AL8-8	27.08.2021	1.26	BDL	1.8	462
Monthly Average		**1.17**	**-**	**1.89**	**462**
Standard Deviation		**0.07**	**-**	**0.05**	**5**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)

NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Admin Building Vadinar was comparatively low among all the locations of Air Quality monitoring in Kandla Port and Vadinar Port. The mean TSPM values at Vadinar Port were 138 µg/m^3. The mean PM_{10} values were 77 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 45.0 µg/m^3). The average values of SO_2, NO_x and NH_3 were 4.0µg/m^3, 13.5 µg/m^3 and 7.1 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Admin Building, Vadinar Port. The mean Benzene concentration was 1.17 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.89 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

1.4 Observations and Conclusion

During the monitoring period, the overall Ambient Air Quality of the port area was found to be well within the desired levels for various gaseous pollutants. However, Particulate matter as PM_{10} and $PM_{2.5}$ was found to exceed the limits at locations like Near Coal storage area, Marine Bhavan, Estate Office , Tuna Port and Oil Jetty area.

2. Drinking Water Quality Monitoring

Drinking Water Quality Monitoring was carried out at twenty stations at Kandla, Vadinar & Township Area of Deendayal Port.

2.1 Drinking Water Monitoring Methodology

Drinking water samples were collected from 20 locations as prescribed in the tender document. Samples for physico-chemical analysis were collected in 1 liter carboys and samples for microbiological parameters were collected in sterilized bottles. These samples were then analyzed in laboratory for various drinking water parameters at Kandla Lab/Surat.

The Sampling and Analysis was done as per standard methods - IS 10500:2012. The water samples were analyzed for various parameters, viz. Color , Odor, Turbidity , Conductivity , pH , Chlorides , TDS, Total Hardness, Iron , Sulphate , Salinity , DO, BOD, Na, K, Ca, Mg, F, NO_3, NO_2, Mn, Cr-6, Cu, Cd, As, Hg, Pb, Zn, Bacterial Count (cfu) .

2.2 Results

The Drinking Water Quality monitoring data for 20 stations are given in below from table No. 9 to Table No. 15

Table 9: Drinking Water Quality Monitoring Parameters for Nirman Building 1, P & C building & Main Gate (North) at Kandla

Sr. No.	Parameter	Unit	Nirman Building 1	P & C building	Main Gate North	Acceptable Limits as per IS 10500 : 2012	Permissible Limits in the absence of Alternate Source as per IS 10500 : 2012
1	pH	pH Unit	7.4	7.3	7.2	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	930	1250	890	500	2000
3	Turbidity	NTU	0	1	0	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	1850	2460	1700	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/l	626	656	541	250.0	1000.0
9	Ca as Ca	mg/l	68.14	60.12	76.15	75.0	200.0
10	Mg as Mg	mg/l	58.32	72.90	68.04	30.0	100.0
11	Total Hardness	mg/l	390	410	430	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides as F	mg/l	0.34	0.41	0.13	1.0	1.5
14	Sulphate as SO4	mg/l	290.4	175.2	200.4	200.0	400
15	Nitrite as NO2	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate as NO3	mg/l	6.27	8.10	13.38	45.0	No Relaxation
17	Salinity	%	1.13	1.19	0.98	NS*	NS*
18	Sodium as Na	mg/l	160	178	150	NS*	NS*
19	Potassium as K	mg/l	2.2	2.3	2.8	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 10: Drinking Water Quality Monitoring Parameters for Canteen, West Gate – I &Wharf Area at Kandla

Sr. No.	Parameter	Unit	Canteen	West Gate – I	Wharf Area	Acceptable Limits as per IS 10500 : 2012	Permissible Limits in the absence of Alternate Source as per IS 10500 : 2012
1	pH	pH Unit	7.6	7.3	7.2	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1320	990	1030	500	2000
3	Turbidity	NTU	0	0	1	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	2590	1890	2010	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/l	717	596	616	250.0	1000.0
9	Ca as Ca	mg/l	64.13	60.12	56.11	75.0	200.0
10	Mg as Mg	mg/l	72.90	70.47	68.04	30.0	100.0
11	Total Hardness	mg/l	390	360	390	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides as F	mg/l	0.44	0.49	0.51	1.0	1.5
14	Sulphate as SO4	mg/l	190.8	198	289.2	200.0	400
15	Nitrite as NO2	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate as NO3	mg/l	8.80	10.42	9.50	45.0	No Relaxation
17	Salinity	%	1.29	1.08	1.11	NS*	NS*
18	Sodium as Na	mg/l	130	168	158	NS*	NS*
19	Potassium as K	mg/l	3	2.2	2.4	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 11: Drinking Water Quality Monitoring Parameters for Sewa sadan – 3, Workshop I &Custom Building at Kandla

Sr. No.	Parameter	Unit	SewaSadan – 3	Workshop	Custom Building	Acceptable Limits as per IS 10500 : 2012	Permissible Limits in the absence of Alternate Source as per IS 10500 : 2012
1	pH	pH Unit	7.3	7.8	7.4	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	950	1050	1100	500	2000
3	Turbidity	NTU	1	1	0	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	1890	2080	2150	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	742	692	576	250.0	1000.0
9	Ca as Ca	mg/l	76.15	60.12	52.10	75.0	200.0
10	Mg as Mg	mg/l	58.32	68.04	68.04	30.0	100.0
11	Total Hardness	mg/l	400	400	380	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.88	0.59	0.59	1.0	1.5
14	Sulphate	mg/l	219.6	207.6	174	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	13.73	10.21	12.88	45.0	No Relaxation
17	Salinity	%	1.34	1.25	1.04	NS*	NS*
18	Sodium as Na	mg/l	148	150	166	NS*	NS*
19	Potassium as K	mg/l	2.3	2.4	2.8	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 12: Drinking Water Quality Monitoring Parameters for Port Colony Kandla, Hospital Kandla & A.O. Building at Gandhidham

Sr. No.	Parameter	Unit	Port Colony Kandla	Hospital Kandla	A.O. Building	Acceptable Limits as per IS 10500 : 2012	Permissible Limits in the absence of Alternate Source as per IS 10500 : 2012
1	pH	pH Unit	7.5	7.4	7.1	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1080	1350	950	500	2000
3	Turbidity	NTU	0	0	1	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	2100	2670	1890	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	767	712	641	250.0	1000.0
9	Ca as Ca	mg/l	60.12	64.13	56.11	75.0	200.0
10	Mg as Mg	mg/l	70.47	72.90	82.62	30.0	100.0
11	Total Hardness	mg/l	370	410	430	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.85	0.65	0.93	1.0	1.5
14	Sulphate	mg/l	178.8	202.8	207.6	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	9.50	10.21	11.62	45.0	No Relaxation
17	Salinity	%	1.39	1.29	1.16	NS*	NS*
18	Sodium as Na	mg/l	170	164	178	NS*	NS*
19	Potassium as K	mg/l	2.7	2.3	2.8	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 13: Drinking Water Quality Monitoring Parameters for School Gopalpuri, Guest House & E - Type Quarter at Gopalpuri, Gandhidham

Sr. No.	Parameter	Unit	School Gopalpuri	Guest House	E - Type Quarter	Acceptable Limits as per IS 10500 : 2012	Permissible Limits in the absence of Alternate Source as per IS 10500 : 2012
1	pH	pH Unit	7.5	7.5	7.4	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1010	1350	1080	500	2000
3	Turbidity	NTU	1	0	1	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	1990	2670	2120	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	697	496	586	250.0	1000.0
9	Ca as Ca	mg/l	56.11	64.13	72.14	75.0	200.0
10	Mg as Mg	mg/l	70.47	53.46	58.32	30.0	100.0
11	Total Hardness	mg/l	380	360	390	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.58	0.80	1.05	1.0	1.5
14	Sulphate	mg/l	175.2	170.4	165.6	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	9.50	10.70	9.50	45.0	No Relaxation
17	Salinity	%	1.26	0.90	1.06	NS*	NS*
18	Sodium as Na	mg/l	190	186	189	NS*	NS*
19	Potassium as K	mg/l	2.4	2.3	2.6	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 14: Drinking Water Quality Monitoring Parameters for F - Type Quarter, Hospital Gopalpuri & Tuna Port

Sr. No.	Parameter	Unit	F - Type Quarter	Hospital Gopalpuri	Tuna Port	Acceptable Limits as per IS 10500 : 2012	Permissible Limits in the absence of Alternate Source as per IS 10500 : 2012
1	pH	pH Unit	7.7	7.5	7.32	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1050	1080	1020	500	2000
3	Turbidity	NTU	0	1	0	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Unit	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	1990	2150	2000	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	626	641	604	250.0	1000.0
9	Ca as Ca	mg/l	76.15	80.16	80.16	75.0	200.0
10	Mg as Mg	mg/l	51.03	60.75	60.75	30.0	100.0
11	Total Hardness	mg/l	430	360	330	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	1.05	0.92	0.46	1.0	1.5
14	Sulphate	mg/l	138	190.8	180	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	10.00	7.96	8.2	45.0	No Relaxation
17	Salinity	%	1.13	1.16	1.09	NS*	NS*
18	Sodium as Na	mg/l	190	186	188	NS*	NS*
19	Potassium as K	mg/l	2.5	2.4	2.6	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 15: Drinking Water Quality Monitoring Parameters for Vadinar Jetty & Port Colony at Vadinar

Sr. No.	Parameter	Unit	Vadinar Jetty	Port Colony Vadinar	Acceptable Limits as per IS 10500 : 2012	Permissible Limits in the absence of Alternate Source as per IS 10500 : 2012
1	pH	pH Unit	7.6	7.4	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1010	990	500	2000
3	Turbidity	NTU	ND	ND	1.0	5.0
4	Odor	-	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	210.0	990.0	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	NS*	NS*
8	Chloride	mg/l	476	491	250.0	1000.0
9	Ca as Ca	mg/l	64.13	56.11	75.0	200.0
10	Mg as Mg	mg/l	75.33	68.04	30.0	100.0
11	Total Hardness	mg/l	470	420	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.99	0.94	1.0	1.5
14	Sulphate	mg/l	16.80	17.64	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	11.48	9.50	45.0	No Relaxation
17	Salinity	%	0.86	0.89	NS*	NS*
18	Sodium as Na	mg/l	140.0	146.0	NS*	NS*
19	Potassium as K	mg/l	2.2	2.3	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent

*NS: Not Specified

2.3 Results & Discussion

The colour of all drinking water samples was < 5 Hazen unit and odour of the samples was also agreeable. All parameters are found to be within the specified limit of the Drinking water Standard.

pH

The limit of pH value for drinking water is specified as 6.5 to 8.5. pH value in the studied area varied from 7.0 to 8.0 pH unit. All the sampling points showed pH values within the prescribed limit by Indian Standards.

Total Dissolved Solids (TDS)

TDS values in the studied area varied between 600 -1800 mg/l. None of the sampling points showed higher TDS values than the prescribed limit by Indian standards .

Conductivity

Electrical Conductivity is the ability of a solution to transfer (conduct) electric current. Conductivity is used to measure the concentration of dissolved solids which have been ionized in a polar solution such as water. The conductivity in the samples collected during the month of August ranged from 1000-3300 µs/cm. Electrical conductivity standards do not appear in BIS standards for drinking water.

BOD

BOD value in the studied area was less than 2.0 mg/L. Indian standards does not show any standard values for BOD in drinking water.

Chlorides

Excessive chloride concentration increase rates of corrosion of metals in the distribution system. This can lead to increased concentration of metals in the supply. Chloride value in the studied area varied between 400-800 mg/l and is found to be within the Permissible limit of the Drinking Water Standard.

Calcium

Calcium value in the studied area varied between 45 - 80 mg/l and is found to be within the Permissible limit of the Drinking Water Standard. If calcium is present beyond the maximum acceptable limit, it causes incrustation of pipes.

Magnesium

Magnesium value in the studied area varied between 30 – 85 mg/l. All the locations had Magnesium within the prescribed limits of 30-100 mg/L.

Total Hardness

Hardness value in the studied area varied between 330-470 mg/l and is found to be within the Permissible limit of the Drinking Water Standard. The prescribed limit by Indian Standards is 200-600 mg/L.

Iron

Iron value in the studied area was below 0.01mg/L and hence well below the permissible limit as per Indian Standards is 0.3 mg/L. The excess amount of iron causes slight toxicity; gives stringent taste to water.

Fluoride

Fluoride value in the studied area varied between 0.1 – 1.0 mg/l and hence well below the permissible limit as per Indian Standards is 1.0-1.5 mg/L. Moderate amounts lead to dental effects, but long-term ingestion of large amounts can lead to potentially severe skeletal problems.

Sulphates

Sulphate value in the studied area varied between 10 – 300 mg/l. All the sampling points showed sulphate values within the prescribed limits by Indian Standards (200-400 mg/L). Sulphate content in drinking water exceeding the 400 mg/L imparts bitter taste.

Nitrites (NO_2) and Nitrates (NO_3)

Nitrite values in all the water samples were <0.1. There are no specified standard values for Nitrites in Drinking water. The mean Nitrate values in drinking water of KPT was 6.27 mg/l which is well within the permissible limit of the Drinking water Standard.

Salinity

Salinity in drinking water in the present samples collected ranged from 0.8 to 1.3 %. There are no prescribed Indian standards for salinity in Drinking water.

Sodium and Potassium Salts

Sodium values in the samples collected ranged from 100 - 2000 mg/l and Potassium salts ranged from 2.2 to 3.0 mg/l. There are no prescribed limits of Sodium and Potassium in Indian standards for Drinking water**.**

Heavy Metals in Drinking Water

In the present study period drinking water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals were well below the permissible limits prescribed by the Indian Standards.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that Bacteria is not present and hence Bacterial count is in line with the permissible limit of drinking water. This shows that all the drinking water samples were safe from any bacteriological contamination.

2.4 Conclusions

These results are compared with acceptable limits as prescribed in IS 10500:2012 – Drinking Water Specification. It is seen from the analysis data that during the study period the water was safe for human consumption at all drinking water monitoring stations.

3. Noise Level Monitoring

Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships. Noise Monitoring was done at 13 stations at Kandla, Vadinar and Township area.

3.1 Method of Monitoring

Sampling was done at all stations for 24 hour period. Data was recorded using automated sound level meter. The intensity of sound was measured in sound pressure level (SPL) and common unit of measurement is decibel (Db).

3.2 Results

Table 16: Noise Monitoring data for ten locations of Deendayal Port and two locations of Vadinar Port

Sr. No.	Location	Day Time Average Noise Level (SPL) in dB(A)	Night Time Average Noise Level (SPL) in dB(A)
	Sampling Time	**6:00 am to 10:00 PM**	**10:00PM to 6:00 AM**
1	Marine Bhavan	52.0	48.9
2	Nirman Building 1	52.7	46.9
3	Tuna Port	56.2	49.8
4	Main Gate North	66.8	60.7
5	West Gate I	70.4	63.0
6	Canteen Area	54.8	44.7
7	Main Road	65.9	51.1
8	ATM Building	66.4	56.6
9	Wharf Area /Jetty Area	72.2	67.7
10	Port & Custom Office	51.5	46.3
	Vadinar Port		
11	Entrance Gate of Vadinar Port	66.8	53.7
12	Nr. Port Colony, Vadinar	60.4	52.8
13	Nr. Vadinar Jetty	72.5	63.7

3.3 Conclusions- Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships. The Day Time Average Noise Level (SPL)in all ten locations at Deendayal Port ranged from 52.0 dB(A) to 72.2 dB(A) and it was within the permissible limits of 75 dB(A) for the industrial area for the daytime. The Night Time Average Noise Level (SPL) in all ten locations of Deendayal Port ranged from 44.7 dB to 67.7 dB(A) and it was within the permissible limits of 70 dB(A) for the industrial area for the night time.

4. Soil Monitoring

Sampling and analysis of soil samples were undertaken at six locations within the study area (Deendayal Port and Vadinar Port) as a part of EMP. The soil sampling locations are initially decided based on the locations as provided in the tender document of the Deendayal Port.

4.1 Methodology

The soil samples were collected in the month of August 2021. The samples collected from the all locations are homogeneous representative of each location. At random locations were identified at each location and soil was dug from 30 cm below the surface. It was uniformly mixed before homogenizing the soil samples. The samples were filled in polythene bags, labeled in the field with number and site name and sent to laboratory for analysis.

4.2 Results

Table-17: Chemical Characteristics of Soil in the Study Area

Sr. No.	Parameter	Unit	Station Name					
			SL1	SL2	SL3	SL4	SL5	SL6
			Tuna Port	IFFCO Plant	Khori Creek	Nakti Creek	KPT Admin Site	KPT Colony
			Near main gate of Port	10 m away from main gate	Sand from creek at low tide		Vadinar	
1	Texture		Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	pH	-	8.60	8.10	8.42	8.30	8.09	8.32
3	Electrical Conductivity	µs/cm	23,400.0	20,420.0	23,700.0	17,200.0	510.0	400.0
4	Moisture	%	20.42	21.16	23.22	20.12	9.04	8.22
5	Total Organic Carbon	%	0.18	0.18	0.25	0.11	0.21	0.16
6	Alkalinity	mg/kg	60.06	140.04	140.04	60.06	100.10	80.04
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
8	Chloride	mg/kg	4,010.0	4,324.0	5,982.0	4,001.0	42.2	67.8
9	Sulphate	mg/kg	188.0	179.2	110.0	100.0	14.0	16.2
10	Phosphorus	mg/kg	0.90	0.86	1.04	1.62	0.78	0.88
11	Potassium	mg/kg	786.0	656.0	1,162.0	780.0	130.0	182.0
12	Sodium	mg/kg	2,341.0	3,618.0	4,220.0	3,122.0	1,224.0	1,400.0
13	Calcium	mg/kg	160.00	130.00	170.00	220.00	110.00	68.00
14	Copper as Cu	mg/kg	32.2	58.2	42.2	23.4	17.4	23
15	Lead as Pb	mg/kg	3.8	3.8	3.6	4.1	BQL	BQL
16	Nickel as Ni	mg/kg	37.2	32.4	41.2	24.5	19.3	20.4
17	Zinc as Zn	mg/kg	59.36	38.32	53.4	48.50	49.20	40.40
18	Cadmium as Cd	mg/kg	ND	ND	ND	ND	ND	ND

4.3 Discussion

- The data shows that value of pH ranges from 8.42 at Nakti Creek to 8.60 at Tuna Creek indicating that all soil samples are neutral to slight basic. Tuna port samples showed maximum conductivity of 23,400µmhos/cm, while Nakti Creek location showed minimum conductivity of 17,200 µmhos/cm. Conductivity at Vadinar Port was 510 and 400 µmhos/cm at Admin site and Vadinar Port colony respectively.
- Total organic Carbon ranged from 0.1 % to 0.3 at Deendayal Port. At Vadinar Port, organic carbon content ranged from 0.1 % to 0.2 %.
- The concentration of Phosphorus and Potassium in the soil samples varies from 0.8 to 1.62 mg/kg and 600.0 to 1170 mg/kg respectively at Deendayal Port. The mean concentration of Phosphorous at Vadinar site was 0.80 mg/kg and mean concentration of Potassium at Vadinar site was 156 mg/kg.

These differences in NPK in soil at different locations are due to the dissimilar nature of soil at each of the locations. Samples SL3 & SL4 (Khori Creek & Nakti Creek) are of saline nature as they are coastal soil; where as other locations are inland locations and have different chemical properties.

Heavy Metals in the Soil

Traces of Copper, Lead, Nickel and Zinc were observed in the soil samples collected from all the four locations of Deendayal Port and two locations of Vadinar Port. Cadmium metal was not detected in the Soil.

4.4 Conclusion

The soils of Deendayal Port and Vadinar Port appears to be neutral to basic with varying levels of Chloride, Sulphate, NPK and Calcium. As the nature of soil at different locations are different with respect to its proximity to the sea, the samples showed high degree of variations in their chemical properties.

5. Sewage Treatment Plant Monitoring

This involves safe collection of waste water (spent/used water) from wash areas, bathroom, industrial units, etc., waste from toilets of various buildings and its conveyance to the treatment plant and final disposal in conformity with the requirement and guide lines of State Pollution Control Board and other statutory bodies.

5.1 Methodology for STP Monitoring

To monitor the working efficiency of Sewage Treatment Plant (STP), STP Inlet and Outlet Samples were collected once a week. Locations selected are namely Gopalpuri Township, Deendayal Port and Vadinar. Samples were collected in 1 lit. Carboys and were analyzed in laboratory for various parameters.

5.2 Results

- **Kandla STP**

Table 18: Sewage Water Monitoring at Kandla STP (1st Week)

Date of Sampling	05.08.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.9	7.5
2	Total Suspended Solids	mg/l	107	101
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	334	108
5	BOD @ 27 °C	mg/l	118.0	27.0
Aeration Tank				
6	MLSS	mg/l	12.0	
7	MLVSS	%	88.0	

Table 19: Sewage Water Monitoring at Kandla STP (2nd Week)

Date of Sampling	12.08.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.6	7.68
2	Total Suspended Solids	mg/l	193	101
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	414	104
5	BOD @ 27 °C	mg/l	136.0	27.0
Aeration Tank				
6	MLSS	mg/l	9.0	
7	MLVSS	%	97.0	

Table 20: Sewage Water Monitoring at Kandla STP (3rd Week)

Date of Sampling	19.08.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.86	7.48
2	Total Suspended Solids	mg/l	204	104
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	261	70
5	BOD @ 27 °C	mg/l	87.0	20.0
Aeration Tank				
6	MLSS	mg/l	10.0	
7	MLVSS	%	90.0	

Table 21: Sewage Water Monitoring at Kandla STP (4th Week)

Date of Sampling	23.08.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.43	7.16
2	Total Suspended Solids	mg/l	403.3	150.4
3	Residual Chlorine	mg/l	<1.0	<1.0
4	COD	mg/l	313.1	151.5
5	BOD @ 27 °C	mg/l	106.0	52.0
6.	Fecal Coliform	MPN Index / 100 ml	-	>1600
Aeration Tank				
7.	MLSS	mg/l	33.0	
8	MLVSS	%	81.0	

- **Gopalpuri Colony STP**

Table 22: Sewage Water Monitoring at Gopalpuri STP (1st Week)

Date of Sampling	05.08.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.76	7.34
2	Total Suspended Solids	mg/l	98.1	62.4
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	324	102
5	BOD @ 27 °C	mg/l	110.0	28.0
Aeration Tank				
6	MLSS	mg/l	12.0	
7	MLVSS	%	92.0	

Table 23: Sewage Water Monitoring at Gopalpuri STP (2nd Week)

Date of Sampling	12.08.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.72	7.37
2	Total Suspended Solids	mg/l	406	107
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	320	103
5	BOD @ 27 °C	mg/l	110.0	26.0
Aeration Tank				
6	MLSS	mg/l	14.0	
7	MLVSS	%	90.0	

Table 24: Sewage Water Monitoring at Gopalpuri STP (3rd Week)

Date of Sampling	19.08.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.71	7.34
2	Total Suspended Solids	mg/l	404	107
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	351	101
5	BOD @ 27 °C	mg/l	115.0	23.0
Aeration Tank				
6	MLSS	mg/l	16.0	
7	MLVSS	%	88.0	

Table 25: Sewage Water Monitoring at Gopalpuri STP (4th Week)

Date of Sampling	23.08.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.7	7.35
2	Total Suspended Solids	mg/l	405	107
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	242	101
5	BOD @ 27 °C	mg/l	80.0	23.0
6.	Fecal Coliform	MPN Index / 100 ml	-	>1600
Aeration Tank				
7.	MLSS	mg/l	18.0	
8.	MLVSS	%	88.0	

- **Vadinar STP**

Table 26: Sewage Water Monitoring at Vadinar STP (1st Week)

Date of Sampling	05.08.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.23	NOT WORKING
2	Total Suspended Solids	mg/l	18	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	89.0	
5	BOD @ 27 °C	mg/l	28.0	

Table 27: Sewage Water Monitoring at Vadinar STP (2nd Week)

Date of Sampling	12.08.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.28	NOT WORKING
2	Total Suspended Solids	mg/l	60	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	78.0	
5	BOD @ 27 °C	mg/l	28.0	

Table 28: Sewage Water Monitoring at Vadinar STP (3rd Week)

Date of Sampling	19.08.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.32	NOT WORKING
2	Total Suspended Solids	mg/l	60	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	80.0	
5	BOD @ 27 °C	mg/l	26.0	

Table 29: Sewage Water Monitoring at Vadinar STP (4th Week)

Date of Sampling	23.08.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.18	NOT WORKING
2	Total Suspended Solids	mg/l	72	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	80.0	
5	BOD @ 27 °C	mg/l	26.0	

5.3 Conclusions:

The GPCB standards of BOD, TSS and Residual Chlorine for STP outlet are 20 mg/lit, 30 mg/lit & 0.5 mg/lit respectively. It is suggested to do treatment on regular basis to avoid flow of contaminated/polluted water into the sea. Also, the STP at Vadinar is also non-functional and thus, steps should be taken to commission the STP at Vadinar Port. Hence, currently only inlet samples are collected and analysed.

6. Marine Water Monitoring

The Forty Second Amendment to the Constitution in 1976 underscored the importance of 'green thinking'. Article 48A enjoins the state to protect and improve the environment and safeguard the forests and wildlife in the country. Further, Article 51A(g) states that the "fundamental duty of every citizen is to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures".

Policy Statement for Abatement of Pollution (1992) has suggested developing relevant legislation and regulation, fiscal incentives, voluntary agreements and educational programs and information campaigns. It emphasizes the need for integration by incorporating environmental considerations into decision making at all levels by adopting frameworks namely, pollution prevention at source, application of best practicable solution, ensure polluter pays for control of pollution, focus on heavily polluted areas and river stretches and involve public in decision-making. The National Conservation Strategy and Policy Statement on Environment and Development, (1992) aimed at "integrating environmental concerns with developmental imperatives to meet the challenges by redirecting the thrust of our developmental process so that the basic needs of our people could be fulfilled by making judicious and sustainable use of natural resources." The priorities mentioned in this policy document include the sustainable use of land and water resources, prevention and control of pollution and preservation of biodiversity.

The National Water Policy, (2002) contains provisions for developing, conserving, sustainable utilizing and managing this important water resources and need to be governed by national perspectives.

Marine Environment

On national and state levels, we have several policies and regulation like Water (Prevention and Control of Pollution) Act, 1974, to regulate pollution discharges and restore water quality of our aquatic resources including the prescription of monitoring activities. One of the important provisions of the Water Act, 1974, is to maintain and restore the 'wholesomeness' of our aquatic resources. Water quality monitoring is one of the first steps required in the rational development and management of water resources. In the field of water quality management, there has been a steady evolution in procedures for designing system to obtain information on the changes of water quality. The monitoring comprises all activities to obtain 'information' with respect to the water system.

Sampling Stations

The monitoring of marine environment for the study of biological and ecological parameters was carried out on 9th& 10th August-2021 in harbor regions of KPT and on 9th August-2021 at Vadinar during spring tide period of New moon phase of Lunar Cycle. The monitoring of marine environment for the study of biological and ecological parameters was repeated again on 16th& 17th August 2021 in harbor regions of KPT. 16th August -2021 in Vadinar during Neap tide period first quarter of Lunar Cycle..

Plankton samples from sub surface layer was collected both during high tide period and low tide period from 3 water quality monitoring stations of KPT harbour area and two stations in Nakti creek and one station in Khori creek. The same sampling schedule was repeated during consecutive spring tide and neap tide in same month. Plankton samples from sub surface layer was collected both during high tide period and low tide period from 1 water quality monitoring stations near Vadinar jetty area during spring tide and neap tide in this month .Collected water samples were processed for estimation of Chlorophyll- a, Pheophytin- a, qualitative &quantitative evaluation of phytoplankton, qualitative &quantitative evaluation zooplanktons (density and their population).

Sampling Locations

Offshore monitoring requirement	Number of locations
Offshore Installations	3 in Kandla creek 2 in Nakti creek 1 in Khori creek 1 near Vadinar Jetty 1 near 1st SBM
Total Number of locations	**8**

6.1 Marine Water Quality

Marine water quality of marine waters of Deendayal Port Harbor waters, Khori and Nakti Creeks and two locations of Vadinar are monitored for various physico-chemical parameters during spring and neap tide of each month.

The results of marine water quality and Marine sediments are as below;

Table 30: Marine Water Quality Monitoring Parameters for location near KPT colony

Sr. No.	Parameters	Unit	Kandla Creek Near KPT colony (1) 23°0'58"N 70°13'22."E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.16	7.14	7.3	7.26
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.2	32.0	32.0	31.8
5	Turbidity	NTU	39	28	32	29
6	Total Dissolved Solids	mg/l	42660	41056	37802.0	43665.0
7	Total Suspended Solids	mg/l	675	979	614.2	372.4
8	Total Solids	mg/l	46346	44350	46346.0	44369.4
9	DO	mg/l	4.5	3.9	4.6	5.1
10	COD	mg/l	80.0	78.0	78.0	80.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	7.82	6.09	0.49	0.73
13	Phosphate	mg/l	0.57	0.14	0.16	0.17
14	Sulphate	mg/l	2628	1656	2352	2076
15	Nitrate	mg/l	2.22	2.03	2.53	3.77
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	1322.64	1242.48	601.2	480.96
18	Magnesium	mg/l	1239.3	1336.5	1749.6	1773.9
19	Sodium	mg/l	11012.0	10828.0	11022.0	10202.0
20	Potassium	mg/l	340.0	300.0	320.0	302.0
21	Iron	mg/l	1.32	1.40	1.20	1.30
22	Chromium	mg/l	0.16	0.14	0.12	0.11
23	Copper	mg/l	0.06	0.07	0.14	0.18
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.05	0.06	0.07	0.06
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.11	0.12	0.18	0.19
28	Zinc	mg/l	0.08	0.06	0.07	0.06

Table 31: Marine Water Quality Monitoring Parameters for location near passenger Jetty One at Kandla

Sr. No.	Parameters	Unit	Near passenger Jetty One (2)			
			23° 0'18 "N 70°13'31"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.28	7.25	7.39	7.42
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.7	32.6	32.0	32.2
5	Turbidity	NTU	37	27	42	47
6	Total Dissolved Solids	mg/l	41612	45181	41735.0	36900.0
7	Total Suspended Solids	mg/l	717	808	414	432.9
8	Total Solids	mg/l	47224	44028	37224.0	44028.0
9	DO	mg/l	4.4	4.1	5.4	4.8
10	COD	mg/l	90.0	86.0	86.0	82.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	9.44	7.84	0.53	0.64
13	Phosphate	mg/l	0.06	0.11	0.18	0.19
14	Sulphate	mg/l	2760	1572	2652	2616
15	Nitrate	mg/l	2.36	2.25	3.45	4.29
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	1202.40	1122.24	561.12	480.96
18	Magnesium	mg/l	1336.5	1385.1	1798.2	1749.6
19	Sodium	mg/l	11752.0	10652.0	11120.0	12120.0
20	Potassium	mg/l	306.0	290.0	289.0	322.0
21	Iron	mg/l	1.56	1.66	1.50	1.40
22	Chromium	mg/l	0.13	0.12	0.10	0.12
23	Copper	mg/l	0.08	0.09	0.15	0.16
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.06	0.07	0.07	0.08
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.10	0.09	0.18	0.17
28	Zinc	mg/l	0.07	0.06	0.08	0.06

Table 32: Marine Water Quality Monitoring Parameters for location Near Coal Berth

Sr. No.	Parameters	Unit	Near Coal Berth			
			22°59'12"N 70°13'40"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.30	7.51	7.53	7.32
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.0	32.5	32.0	31.8
5	Turbidity	NTU	33	25	37	45
6	Total Dissolved Solids	mg/l	48590	39430	45812.0	35363.0
7	Total Suspended Solids	mg/l	555	809	587.3	591.2
8	Total Solids	mg/l	45108	41100	41720.0	40200.0
9	DO	mg/l	3.8	4	4.9	5.1
10	COD	mg/l	88.0	90.0	90.0	82.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	5.98	3.98	0.42	0.85
13	Phosphate	mg/l	0.10	0.08	0.15	0.19
14	Sulphate	mg/l	2856	2988	2736	2208
15	Nitrate	mg/l	2.73	2.33	4.75	3.79
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	1362.72	1322.64	480.96	601.2
18	Magnesium	mg/l	1190.7	1239.3	1822.5	1846.8
19	Sodium	mg/l	11452.0	10890.0	11125.0	10890.0
20	Potassium	mg/l	311.0	269.0	345.0	400.0
21	Iron	mg/l	1.80	1.92	1.30	2.01
22	Chromium	mg/l	0.11	0.12	0.18	0.19
23	Copper	mg/l	0.07	0.06	0.18	0.16
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.05	0.06	0.06	0.07
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.10	0.11	0.20	0.19
28	Zinc	mg/l	0.08	0.06	0.07	0.06

Table 33: Marine Water Quality Monitoring Parameters for location Khori creek at Kandla

Sr. No.	Parameters	Unit	KPT 4			
			Near 15/16 Berth			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.37	7.42	7.26	7.22
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.6	31.6	31.8	31.6
5	Turbidity	NTU	45	37	52	28
6	Total Dissolved Solids	mg/l	42420	38440	33550.0	33133.0
7	Total Suspended Solids	mg/l	654	624	701.5	490.4
8	Total Solids	mg/l	44940	40080	44940.0	40080.0
9	DO	mg/l	4.4	4.3	5.3	5.9
10	COD	mg/l	92.0	88.0	88.0	92.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	2.45	7.45	0.69	0.51
13	Phosphate	mg/l	0.10	0.02	0.24	0.16
14	Sulphate	mg/l	1668	2268	2616	2580
15	Nitrate	mg/l	1.96	1.53	3.34	4.86
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	1242.48	1282.56	521.04	480.96
18	Magnesium	mg/l	1287.9	1336.5	1725.3	1725.3
19	Sodium	mg/l	12152.0	13020.0	12162.0	11782.0
20	Potassium	mg/l	288.0	316.0	389.0	380.0
21	Iron	mg/l	1.60	1.55	1.48	1.38
22	Chromium	mg/l	0.15	0.16	0.20	0.18
23	Copper	mg/l	0.08	0.10	0.15	0.11
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.08	0.06	0.08	0.07
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.09	0.11	0.18	0.17
28	Zinc	mg/l	0.07	0.05	0.08	0.06

Table 34: Marine Water Quality Monitoring Parameters for location Nakti Creek near Tuna Port

Sr. No.	Parameters	Unit	Nakti Creek Near Tuna Port 22°57'49."N 70° 7'0.67"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.18	7.30	7.3	7.37
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.6	33.0	31.8	31.6
5	Turbidity	NTU	36	48	36	28
6	Total Dissolved Solids	mg/l	47540	37880	38200.0	37205.0
7	Total Suspended Solids	mg/l	885	852	332.5	474
8	Total Solids	mg/l	46280	38780	38280.0	49040.0
9	DO	mg/l	4.2	4.3	5.3	5.2
10	COD	mg/l	76.0	78.0	90.0	92.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	4.33	2.45	0.91	0.73
13	Phosphate	mg/l	0.08	0.10	0.18	0.18
14	Sulphate	mg/l	2052	4500	2628	2268
15	Nitrate	mg/l	2.17	2.47	5.14	5.70
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	1362.72	1282.56	561.12	561.12
18	Magnesium	mg/l	1215	1239.3	1773.9	1773.9
19	Sodium	mg/l	11582.0	11262.0	10589.0	10110.0
20	Potassium	mg/l	326.0	366.0	347.0	311.0
21	Iron	mg/l	2.02	2.00	1.60	1.58
22	Chromium	mg/l	0.20	0.19	0.16	0.15
23	Copper	mg/l	0.10	0.08	0.12	0.10
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.06	0.07	0.08	0.06
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.11	0.12	0.32	0.62
28	Zinc	mg/l	0.06	0.07	0.07	0.06

Table 35: Marine Water Quality Monitoring Parameters for location Nakti Creek Near NH-8A at Kandla

Sr. No.	Parameters	Unit	Nakti Creek Near NH-8A			
			23° 02'01"N 70° 09'31"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.39	Sampling not possible during Low Tide	7.39	Sampling not possible during Low Tide
2	Color	-	Colorless		Colorless	
3	Odor	-	Odorless		Odorless	
4	Salinity	ppt	32.9		31.8	
5	Turbidity	NTU	36		35	
6	Total Dissolved Solids	mg/l	36020		35465.0	
7	Total Suspended Solids	mg/l	666		380.3	
8	Total Solids	mg/l	44660		46002.0	
9	DO	mg/l	4.7		5.5	
10	COD	mg/l	80.0		88.0	
11	BOD	mg/l	<2.0		<2.0	
12	Silica	mg/l	7.73		0.45	
13	Phosphate	mg/l	0.08		0.17	
14	Sulphate	mg/l	3660		2280	
15	Nitrate	mg/l	2.74		4.15	
16	Nitrite	mg/l	<0.05		<0.05	
17	Calcium	mg/l	1402.80		561.12	
18	Magnesium	mg/l	1190.7		1773.9	
19	Sodium	mg/l	13030.0		11120.0	
20	Potassium	mg/l	348.0		320.0	
21	Iron	mg/l	1.89		1.50	
22	Chromium	mg/l	0.17		0.17	
23	Copper	mg/l	0.09		0.11	
24	Arsenic	mg/l	<0.01		<0.01	
25	Cadmium	mg/l	0.08		0.07	
26	Mercury	mg/l	<0.001		<0.001	
27	Lead	mg/l	0.09		0.2	
28	Zinc	mg/l	0.08		0.08	

Table 36: Marine Water Quality Monitoring Parameters for locations Nr. Vadinar Jetty

Sr. No.	Parameters	Unit	Nr.Vadinar Jetty 22°26'25.26"N 69°40'20.41"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.60	7.90	7.38	7.25
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	33.0	32.5	32.0	32.0
5	Turbidity	NTU	48	37	47	40
6	Total Dissolved Solids	mg/l	38810	36220	37902.0	35080.0
7	Total Suspended Solids	mg/l	405	380	456.9	395.5
8	Total Solids	mg/l	42180	42020	38990.0	38620.0
9	DO	mg/l	4.3	4.7	4.5	4.9
10	COD	mg/l	90.0	88.0	82.0	78.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	6.00	7.65	0.76	0.93
13	Phosphate	mg/l	0.56	0.68	0.20	0.17
14	Sulphate	mg/l	2628	2268	2520	2376
15	Nitrate	mg/l	2.05	2.15	3.03	3.04
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	1242.48	1362.72	641.28	521.04
18	Magnesium	mg/l	1239.3	1239.3	1798.2	1798.2
19	Sodium	mg/l	14025.0	13879.0	11012.0	11212.0
20	Potassium	mg/l	326.0	300.0	342.0	333.0
21	Iron	mg/l	1.88	1.79	1.60	1.30
22	Chromium	mg/l	0.18	0.18	0.18	0.12
23	Copper	mg/l	0.08	0.08	0.18	0.20
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.06	0.07	0.06	0.07
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.10	0.09	0.16	0.2
28	Zinc	mg/l	0.06	0.06	0.06	0.07

6.1.1 Marine Sediments

Sediment samples were collected with Van Veen Grab from the six locations in Kandla Port Waters and two locations in Vadinar Port. Samples were collected and preserved in silver foil in ice box to prevent the contamination/decaying of the samples.

6.2 Results

The Sediment Quality results are given in below from table no. 34 A & B.

Table 34A: Results of Analysis of Sediment of Kandla & Vadinar Port (Spring Tide)

Sr. No.	Parameters	Unit	KPT - 1	KPT - 2	KPT – 3	KPT - 5	Jetty
1	Texture	-	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	mg/kg	1.20	1.08	1.20	1.86	1.46
3	Organic Carbon	mg/kg	0.70	0.96	0.87	0.65	0.68
4	Inorganic Phosphate	mg/kg	120.0	132.0	142.0	162.0	160.0
5	Moisture	%	20.20	23.10	21.88	21.2	23.80
6	Aluminium	mg/kg	ND	ND	ND	ND	ND
7	Silica	mg/kg	28.0	21.0	24.0	36.0	23.0
8	Phosphate	mg/kg	10.50	11.20	9.80	9.60	10.20
9	Sulphate	mg/kg	210.0	242.0	160.0	170.0	140.0
10	Nitrite	mg/kg	0.11	0.12	0.1	0.11	0.12
11	Nitrate	mg/kg	9.80	7.44	10.80	9.20	8.40
12	Calcium	mg/kg	342.0	270.0	325.0	309.0	322.0
13	Magnesium	mg/kg	186.0	145.0	178.0	152.0	202.0
14	Sodium	mg/kg	8824.0	7242.0	9452.0	7122.0	8777.0
15	Potassium	mg/kg	396.0	388.0	460.0	680.0	780.0
16	Chromium	mg/kg	88	60	72.2	68.8	70.2
17	Nickel	mg/kg	20.4	30.4	19.5	21.3	30
18	Copper	mg/kg	60	34	21.5	18.2	23.4
19	Zinc	mg/kg	30.20	32.50	33.20	40.00	28.00
20	Cadmium	mg/kg	ND	ND	ND	ND	ND
21	Lead	mg/kg	2.8	2.4	3.9	5.2	3.8
22	Mercury	mg/kg	ND	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND	ND

*Grab samples could not be collected due high current at KPT 3, Natki Creek Near Tuna port & Vadinar SBM

Table 34B: Results of Analysis of Sediment of Kandla & Vadinar Port (Neap Tide)

Sr. No.	Parameters	Unit	KPT - 1	KPT - 2	KPT - 3	KPT - 4	KPT - 5	Jetty
1	Texture	-	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
2	Organic Matter	mg/kg	1.20	1.12	1.20	1.80	1.62	1.10
3	Organic Carbon	mg/kg	0.69	0.65	0.69	1.04	0.94	0.64
4	Inorganic Phosphate	mg/kg	120.0	142.0	116.0	136.0	142.0	152.0
5	Moisture	%	20.08	21.52	23.05	24.55	28.88	22.02
6	Aluminium	mg/kg	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	21.20	18.88	21.0	18.8	16.20	13.60
8	Phosphate	mg/kg	8.8	8.9	7.70	8.20	8.40	6.2
9	Sulphate	mg/kg	180.0	196.0	142.0	166.0	120.0	210.0
10	Nitrite	mg/kg	0.1	0.11	0.1	0.12	0.11	0.13
11	Nitrate	mg/kg	9.80	6.89	8.99	8.80	7.93	10
12	Calcium	mg/kg	322.0	266.0	320.0	296.0	300.0	288.0
13	Magnesium	mg/kg	180.0	145.0	180.0	142.0	212.0	196.0
14	Sodium	mg/kg	8242.0	7002.0	8942.0	6641.0	8041.0	9424.0
15	Potassium	mg/kg	380.0	396.0	422.0	644.0	621.0	386.0
16	Chromium	mg/kg	79	54	74.2	64.7	58.4	66
17	Nickel	mg/kg	18.2	28.2	20.6	19.4	28.4	18.8
18	Copper	mg/kg	54	20	22.5	16.8	18.6	74.2
19	Zinc	mg/kg	28.20	18.80	28.40	34.50	18.60	75.00
20	Cadmium	mg/kg	ND	ND	ND	ND	ND	ND
21	Lead	mg/kg	2	2.1	2.8	3.8	2.4	ND
22	Mercury	mg/kg	ND	ND	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND	ND	ND

REPORT

ON

ECOLOGICAL MONITORING

OF MARINE ENVIRONMENT

IN

DPTHARBOURAREA, NEAR BY CREEKS

For

DEENDAYAL PORT TRUST

AUGUST,2021

Sampling Stations:

The monitoring of marine environment for the study of biological and ecological Parameters was carried out on9th August, 2021 in harbour region of DPT, and on 10thAugust,2021 in creeks near by the port during spring tide. The monitoring of marine environment for the study of biological and ecological parameters was repeated again on 15thAugust, 2021 in harbour region of DPT and on 16thAugust, 2021 in creeks near by the port during neap tidal condition.

Plankton samples from sub surface layer was collected both during high tide period and low tide period from 3 water quality monitoring stations of DPT harbour area andone stations in Nakti creek and one station in Khori creek. Sampling at second sampling station of Nakti creek was possible only during high tide period. Collected water samples were processed for estimation of Chlorophyll- a, Pheophytin- a, qualitative &quantitative evaluation of phytoplankton, qualitative &quantitative evaluation zooplanktons(density and their population).

TABLE #1 SAMPLING LOCATIONS

monitoring requirement	Number of locations
Kandla creek Nakti creek Khori Creek	3 in Kandla creek 2 in Nakti creek 1 in Khori creek
Total Number of locations	**6**

Sampling methodology adopted:

A marine sampling is an estimation of the body of information in the population. The theory of the sampling design is depending upon the underlying frequency distribution of the population of interest. The requirement for useful water sampling is to collect a representative sample of suitable volume from the specified depth and retain it free from contamination during retrieval.

50 litres of the water sample were collected from Sub surface by using bucket. From the collected water sample 1 litres of water sample were taken in an opaque plastic bottle for chlorophyll estimation, thereafter plankton samples were collected by using filtration assembly with nilyobolt cloth of 20µm mesh size.

Samples Processing for chlorophyll estimation:

Samples for the chlorophyll estimation were preserved in ice box on board in darkness to avoid degradation in opaque container covered with aluminium foil. Immediately after reaching the shore after sampling, 1 litres of collected water sample was filtered through GF/F filters (pore size 0.45 µm) by using vacuum filtration assembly. After vacuum filtration the glass micro fiber filter paper was grunted in tissue grinder, macerating of glass fiber filter paper along with the filtrate was done in 90% aqueous Acetone in the glass tissue grinder with glass grinding tube. Glass fiber filter paper will assist breaking the cell during grinding and chlorophyll content was extracted with 10 ml of 90% Acetone, under cold dark conditions along with saturated magnesium carbonate solution in glass screw cap tubes. After an extraction period of 24 hours, the samples were transferred to calibrated centrifuge tubes and adjusted the volume to original volume with 90% aqueous acetone solution to make up the evaporation loss. The extract was clarified by using centrifuge in closed tubes. The clarified extracts were then decanted in clean cuvette and optical density was observed at wavelength 664, 665 nm. By using corrected optical density, Chlorophyll-a value was calculated as given in (APHA, 1998).

PLANKTON:

The entire area open water in the sea is the pelagic realm. Pelagic organisms live in the open sea. In contrast to the pelagic realm, the benthic realm comprises organisms and zone of the bottom of the sea. Vertically the pelagic realm can be dividing into two zones based on light penetration; upper photic or euphotic zone and lower dark water mass, aphotic zone below the photic zone.

The term plankton is general term for organisms have such limited powers of locomotion that they are at the mercy of the prevailing water movement. Plankton is subdivided to phytoplankton and zooplankton. Phytoplankton is free floating organisms that are capable of photosynthesis and zooplankton is the various free floating animals.

Pelagic zone, represents the entire ocean water column from the surface to the deepest depths, is home to a diverse community of organisms. Differences in their locomotive ability categorize the organisms in the pelagic realm into two, ***plankton*** and ***nekton*** (Lalli and Parsons, 1997). ***Plankton*** consists of all organisms drifting in the water and is unable to swim against water currents, whereas ***Nekton*** includes organisms having strong locomotive power. Ecological studies on the plankton community, which form the base of the aquatic food chain, help in the better understanding of the dynamics and functioning of the marine ecosystem. The term 'Plankton' first coined by Victor Hensen (1887), Plankton, (Greek word: *planktos*meaning "passively drifting or wandering") is defined as drifting or free-floating organisms that inhabit the pelagic zone of water. Based on their mode of nutrition planktonic organisms are categorised into phytoplankton (organisms having an autotrophic mode of nutrition) and zooplankton (organisms having a heterotrophic mode of nutrition).

Phytoplankton in the marine environment:

Phytoplankton is free floating unicellular, filamentous and colonial eutrophic organisms that grow in aquatic environments whose movement is more or less dependent upon water currents. These micro flora acts as primary producers as well as the basis of food chain, source of protein, bio purifier and bio indicators of the aquatic ecosystems of which diverse array of the life depends .They are considered as an important component of aquatic flora, play a key role in maintaining equilibrium between abiotic and biotic components of aquatic ecosystem.

The phytoplankton includes a wide range of photosynthetic and phototrophic organisms. Marine phytoplankton is mostly microscopic and unicellular floating flora, which are the primary producers that support the pelagic food-chain. The two most prominent groups of phytoplankton are diatoms (Bacillariophyceae) and dinoflagellates (Dinophyceae).The phytoplankton those normally captured in the net from the Gulf of Kutch is normally dominated by these two major groups; diatoms and dinoflagellates. Phytoplankton also include numerous and diverse collection of extremely small, motile algae which are termed micro flagellates (naked flagellates) as well as and Cyanophytes (blue-green algae).

Algae are an ecologically important group in most aquatic ecosystems and have been an important component of biological monitoring programs. Algae are ideally suited for water quality assessment because they have rapid reproduction rates and very short life cycles, making them valuable indicators of short-term impacts.

Aquatic populations are impacted by anthropogenic stress, resulting in a variety of alterations in the biological integrity of aquatic systems. Algae can serve as an indicator of the degree of deterioration of water quality, and many algal indicators have been used to assess environmental status.

Zooplankton in the marine environment:

Zooplankton includes a taxonomically and morphologically diverse community of heterotrophic organisms that drift in the waters of the world's oceans. Qualitative and quantitative studies on zooplankton community are a prerequisite to delineate the ecological processes active in the marine ecosystem. Zooplankton community plays a pivotal role in the pelagic food web as the primary consumers of phytoplankton and act as the food source for organisms in the higher trophic levels, particularly the economically essential groups such as fish larvae and fishes. They also function in the cycling of elements in the marine ecosystem. The dynamics of the zooplankton community, their reproduction, growth and survival rate are all significant factors determining the recruitment and abundance of fish stocks as they form an essential food for larval, juvenile and adult fishes (Beaugrand et al., 2004). Zooplankton grazing in the marine environment controls the primaryProduction and helps in determining the pelagic ecosystem (Banse, 1995). Through grazing in surface waters and following the production of sinking faecal matters and also by the active transportation of dissolved and particulate matter to deeper waters via vertical migration, they help in the transport of organic carbon to deep ocean layers and thus act as key drivers of biological pump' in the marine ecosystem. Zooplankton grazing and metabolism also, transform particulate organic matter into dissolved forms, promoting primary producer community, microbial demineralization, and particle export to the ocean's interior.

The categorisation of zooplankton into various ecological groups is based on several factors such as duration of planktonic life, size, food preferences and habitat. As they vary significantly in size from microscopic to metazoic forms, the classification of zooplankton based on size has paramount importance in the field of quantitative plankton research.

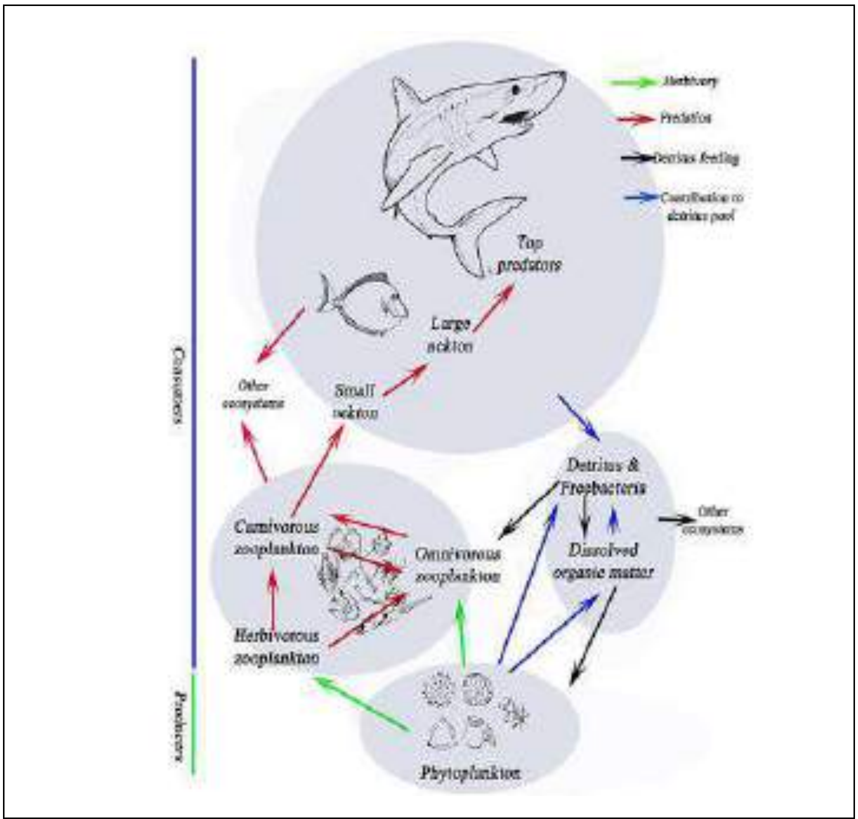
Based on the duration of planktonic life, zooplankton are categorised into Holoplankton (organisms which complete their entire lifecycle as plankton) and Meroplankton (organisms which are planktonic during the early part of their lives such as the larval stages of benthic and nektonic organisms). Tychoplankton are organisms which live a brief planktonic life, such as the benthic crustaceans (cumaceans, mysids, isopods) which ascend to the water column at night for feeding and certain ectoparasitic copepods, they leave the host and spend their life as plankton during their breeding cycle.

Zooplankton can be subdivided into holoplankton, i.e., permanent members of the plankton (e.g., Calanoid copepods), and meroplankton, i.e., temporary members in the plankton e.g., larvae of fish, shrimp, and crab). The meroplankton group consists of larval and young stages of animals that will adopt a different lifestyle once they mature. In contrast to phytoplankton which consist of a relatively smaller variety of organisms, Zooplankton are extremely divers, consist of a host of larval and adult forms representing many animal phylum.

Among the zooplankton one group always dominate than others; members of sub class copepods (Phylum Athropoda), and Tintinids (Phylum Protozoa) among the net planktons. These small animals are of vital importance in marine ecosystem as one of the primary herbivores animals in the sea, and it is they provide vital link between primary producer (autotrophs) and numerous small and large marine consumers.

As their community structure and function are highly susceptible to changes in the environmental conditions regular monitoring of their distribution as well as their interactions with various physicochemical parameters is inevitable for the sustainable management of the ecosystem (Kusum et al., 2014). Of all the marine zooplankton groups, copepods mainly calanoid copepods are the dominant groups in marine subtropical and tropical waters and exhibit considerable diversity in morphology and habitats they occupy (Madhupratap, 1991;)

It has been well established that potential of pelagic fishes viz. finfishes, crustaceans, molluscs and marine mammals either directly or indirectly depend on zooplankton. The herbivorous zooplankton is efficient grazers of the phytoplankton and is referred to as living machines transforming plant material into animal tissue. Hence they play an essential role as the intermediaries for nutrients/energy transfer between primary and tertiary trophic levels. Due to their large density, shorter lifespan, drifting nature, high group/species diversity and different tolerance to the stress, they used as the indicator organisms for the physical, chemical and biological processes in the aquatic ecosystem (Ghajbhiye, 2002).



Simplified marine food web

Spatial distribution of Plankton:

A characteristic of plankton population is that they tend to occur in patches, which are varying spatially on a scale of few meters to far as few kilometres in distance. They also vary in time scale, season as well as vertically in the water column. It is this patchiness and its constant changes in time and spot, that has made it so difficult for plankton biologist to learn about the ecology of plankton. The biological factors that causes this patchiness is due to the ability of zooplankton to migrate vertically and graze out the phytoplankton at a rapid rate that can create patchiness. Similarly the active swimming ability by certain zooplankton organisms can cause to aggregate in dense group.

At its most extreme, because the water in which plankton is suspended is constantly moving, each sample taken by the plankton biologists remain a different volume of water, so each sample is unique and replicate does not exist.

Plankton may also exhibit vertical patchiness. Physical factors contribute to this type of patchiness include light intensity, nutrients and density gradients in the water column.

Phytoplankton in particular tends to be unequally distributed vertically, which leads to the existence of different concentration of a chlorophyll value between photic zone and below the photic zone.

Methodology adopted for Plankton sampling:

Mixed plankton sample were obtained from the sub surface layer at each sampling locations by towing the net horizontally with the weight .After the tow of about 15-30minutes, plankton net was pulled up and washed down to the tail and collected the plankton adhered to plankton net in the collection bucket at the bottom by springing outer and inner surface of the net with sea water, while the net was hanging with the mouth upward. For quantitative evaluation 50 L water samples were collected from subsurface layer and filtered through 20µm mesh size net by using bucket and filtration assembly.

Preservation and storage:

Both filtered plankton and those collected from the plankton net were preserved with 5% buffered formalin and stored in 1L plastic container for further processing in the laboratory.

Sample concentration:

The collected plankton samples were concentrated by using centrifuge and made up to 50 ml with 5% formalin -Glycerine mixture.

Taxonomic evaluation:

Before processing, the sample was mixed carefully and a subsample was taken with a calibrated Stempel-pipette. 1 ml of the concentrated plankton samples were transferred on a glass slide with automatic pipette. The plankton sample on the glass slides were stained by using Lugol's iodine and added glycerine to avoid drying while observation. The plankton samples were identified by using Labex triangular Research microscope with photographic attachment. Microphotographs of the plankton samples were taken for record as well as for confirming the identification. The bigger sized zooplankton was observed through dissecting stereomicroscope with magnification of 20-30 x. Plankton organisms in the whole slide were identified to the lowest axon possible. A thorough literature search was conducted for the identification of the different groups of zooplankton that were encountered

Cell counts by drop count method:

The common glass slide mounted with a 1ml of concentrated phytoplankton/zooplankton sample in glycerol and covered with cover slip 22x 60mm was placed under the compound microscope provided with a mechanical stage. The plankton was then counted from the microscopic field of the left top corner of the slide. Then slide is moved horizontally along the right side and plankton in each microscopic field was thus counted. When first microscopic field row was finished the next consecutive row was adjusted using the mechanical device of the stage. In this way all the plankton present in entire microscopic field are counted. From this total number in 1ml of the concentrated plankton, total number of plankton in the original volume of sample filtered was calculated as units/L.

BENTHIC ORGANISMS:

Benthos is those organisms that are associated with the sea bed or benthic habitats. Epi- benthic organisms live attached to a hard substratum or rooted to a shallow depth below the surface. In fauna organisms live below the sediment–water interface. Interstitial organisms live and move in pore water among sedimentary grains.

Because the benthic organisms are often collected and separated on sieves, a classification based on the overall size is used. Macro benthos include organisms whose shortest dimension is greater than or equal to 0.5 mm. Meio benthos are smaller than 0.5mm but larger than 42µ in size.

The terms such as macro fauna and Meio fauna generally have little relevance with taxonomic classification. The terms Meio fauna and macro fauna depend on the size. Meio fauna were considered as good bioassay of community health and rather sensitive indicators of environmental changes

SAMPLING METHODOLOGY ADOPTED FOR SUB TIDAL REGION:

Van veen sampler (0.09m^2) was used for sampling bottom sediments. Two sets of sediments were sampled from each location, one for macro fauna and other for Meio fauna. The macro fauna in the sediments were sieved on board to separate out the organisms. The fixation of Meio fauna is normally done by bulk fixation of the sediment sample. The bulk fixation is done by using 10% formalin (Buffered with borate). The organisms were preserved with seawater as diluting agent.

Sample sieving:

Sediments samples were sieved to extract the organisms. Sieving was performed carefully as possible to avoid any damage to the animals. The large portion of the sediment was split in to smaller portions and mixed with sea water in a bucket. The cohesive lumps were broken down by continuous stirring. The disaggregated sediments were then passed through the sieves.

Sample staining:

Sorting of the Meio fauna from the sieve is difficult task especially in the preserved material, because organisms are not easily detectable. To facilitate the animal detection the entire sample retained on the sieve after sieving operation were stained by immersing the sieve in a flat bottom tub with 1% Rose Bangal stain; a protein stain. A staining period of 10-30 minutes is sufficient for sample detection.

DIVERSITY INDICES:

On the whole, diversity indices provide more information about community composition than simply species richness (number of species present); they also, take the relative abundances of different species into account. Based on this fact, diversity indices therefore depend not only on species richness but on the evenness, or equitability, with which individuals are distributed among the different species (Magurram, A. E. (1988)

A diversity index is a measure of species diversity within a community that consists of co-occurring populations of several (two or more) different species. It includes two components: richness and evenness. Richness is the measure of the number of different species within a sample showing that more the types of species in a community, the higher is the diversity or greater is the richness. Evenness is the measure of relative abundance of the different species with in a community.

The basic idea of diversity index is to obtain a quantitative estimate of biological variability that can be used to compare biological entities composed of discrete components in space and time (Carol H.R. *etal*. 1998). Biodiversity is commonly expressed through indices based on species richness and species abundances (Whittaker 1972, Lande 1996, Purvis and Hector 2000). Biodiversity indices are a non-parametric tool used to describe the relationship between species number and abundance. The most widely used bio diversity indices are Shannon Weiner index and Simpson's index.

A diversity Index is a single statistic that incorporates in formation on richness and evenness. The diversity measures that incorporate the two concepts may be termed heterogeneity measures (Magurran, 2004).

Any study intended to interpret causes and effect of adverse impact on Biodiversity of communities require suitable measures to evaluate specie richness and Diversity. The former is number of species in community, while latter is a function of relative frequency of different species. Species richness is the iconic measure of biological diversity (Magurran, 2004). Several indices have been created to measure the diversity of species; however, the most widely used in the last decades are the Shannon (1948) and Simpson (1949) (Buzas and Hayek 1996; Gorelick 2006), with the components of diversity: richness (*S)* and evenness (*J)*

Simpson's diversity index

Simpson's index (**D**) is a measure of diversity, which takes into account both species richness, and evenness of abundance among the species present.. The Simson index is one of the meaningful and robust biodiversity measures available.(Magurran ,2004).

The formula for calculating D is presented as:

$$D = \frac{\sum n_i(n_i - 1)}{N(N-1)}$$

Where n_i = the total number of organisms of each individual species

N = the total number of organisms of all species

The value of D ranges from 0 to 1. With this index, 0 represents infinite diversity and, 1, no diversity. When D increases diversity decreases. Simpson's index is therefore usually expressed as 1-D or 1/D. (Magurran, 2004)

Low species diversity suggests:

- relatively few successful species in the habitat
- the environment is quite stressful with relatively few ecological niches and only a few organisms are really well adapted to that environment
- food webs which are relatively simple
- change in the environment would probably have quite serious effects

High species diversity suggests:

- a greater number of successful species and a more stable ecosystem
- more ecological niches are available and the environment is less likely to be hostile complex food webs
- environmental change is less likely to be damaging to the ecosystem as a whole

Species richness indices

The species richness***(S)*** is simply the number of species present in an ecosystem. Species richness Indices of species richness are widely used to quantify or monitor the effects of anthropogenic disturbance. A decline in species richness may be concomitant with severe or chronic human-induced perturbation (Fair Fair weather 1990,) Species richness measures have traditionally been the mainstay in assessing the effects of environmental degradation on the biodiversity of natural assemblages of organisms (Clarke &Warwick, 2001)

Species richness is the iconic measure of biological diversity (Magurran, 2004). The species richness***(S)*** is simply the number of species present in an ecosystem. This index makes no use of relative abundances. The term species richness was coined by McIntosh (1967) and oldest and most intuitive measure of biological diversity (Magurran, 2004).

Margalef's diversity index is a species richness index. Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, were derived.

The value of a diversity index increases both when the number of types increases and when evenness increases. For a given number of types, the value of diversity index is maximised when all types are equally abundant (Rosenzweig, M. L. (1995).

Shannon-Wiener's index:

An index of diversity commonly used in plankton community analyses is the Shannon-Wiener's index **(H),** which emphasizes not only the number of species (richness or variety), but also the apportionment of the numbers of individuals among the species (Odum 1971 and Reish 1984). Shannon-Wiener's index **(H)** reproduce community parameters to a single numberby using an equation.

Shannon and Weiner index represents entropy. It is a diversity index taking into account the number of individuals as well as the number of taxa. It varies from 0 for communities with only single taxa to high values for community with many taxa each with few individuals. This index can also determine the pollution status of a water body. Normal values range from 0 to 4. This index is a combination of species present and the evenness of the species. Examining the diversity in the range of polluted and unpolluted ecosystems, Wilham and Dorris (1968) concluded that the values of the index greater than 3 indicate clean water, values in the range of 1 to 3 are characterized by moderate pollution and values less than 1 are characterized as heavily polluted

$$H' = -\sum_{j=1}^{s} \frac{n_j}{N} \ln\left(\frac{n_j}{N}\right)$$

RESULTS:

CHLOROPHYLL-a:

Water Samples for the chlorophyll estimation were collected from sub surface layer during high tide and low tide period of the tidal cycle for each sampling locations and analysed for Chlorophyll -a and after acidification for Pheophytin –a. Chlorophyll- a value was used as algal biomass indicator (APHA,1998) Algal biomass was estimated by converting Chlorophyll value.

In the sub surface water chlorophyll-a was varying from 0.305 -0.543mg/m^3.in harbour region of DPT during sampling done in spring tide period of August, 2021. In the nearby creeks chlorophyll-a was varying from 0.290-0.732 mg/m^3.Pheophytin –a level was below detectable limit- the all the sampling stations during springtide in the harbour region of DPT.

In the sub surface water chlorophyll-a was varying from 0.220 -0.748mg/m^3.in harbour region of DPT during sampling done in neap tide period of August, 2021 . In the nearby creeks chlorophyll-a was varying from BDL-0.862 mg/m^3.·Pheophytin –a level was below detectable limit- the all the sampling stations during neap tide in the harbour region of DPT.

TABLE #2 VARIATIONS IN CHLOROPHYLL –a PHEOPHYTIN- a AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN AUGUST,2021

Sr. No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREA					
1	KPT1	High tide	0.425	BDL	28.48
		Low tide	0.307	BDL	20.57
2	KPT 2	High tide	0.305	BDL	20.43
		Low tide	0.543	BDL	36.38
3	KPT 3	High tide	0.527	BDL	35.31
		Low tide	0.425	BDL	28.47
CREEKS					
4	KPT-4 Khori-I	High tide	0.543	BDL	36.38
		Low tide	0.527	BDL	35.31
5	KPT-5 Nakti-I	High tide	0.409	BDL	27.40
		Low tide	0.732	BDL	49.04
6	KPT-5 Nakti-II	High tide	0.290	BDL	19.43

BDL: Below Detectable Limit.

TABLE #3 VARIATIONS IN CHLOROPHYLL –a PHEOPHYTIN- a AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN AUGUST,2021

Sr. No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREA					
1	KPT1	High tide	0.220	BDL	14.74
		Low tide	0.308	BDL	20.64
2	KPT 2	High tide	0.748	BDL	50.11
		Low tide	0.731	BDL	48.98
3	KPT 3	High tide	0.307	BDL	20.56
		Low tide	0.221	BDL	14.81
CREEKS					
4	KPT-4 Khori-I	High tide	0.543	BDL	36.38
		Low tide	0.221	BDL	14.81
5	KPT-5 Nakti-I	High tide	0.862	BDL	57.75
		Low tide	0.216	BDL	14.47
6	KPT-5 Nakti-II	High tide	BDL	BDL	-

BDL: Below Detectable Limit.

PHYTOPLANKTON POPULATION:

For the evaluation of the Phytoplankton population in DPT harbour area and within the immediate surroundings of the port, sampling was conducted from 5 sampling locations (3 in harbour area and two in Nakti creek) during high tide period and low tide period of spring tide and neap tide.

The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by,Diatoms blue green algae and dinoflagellates during spring tide period.Diatoms were represented by 14genera. Blue green were represented by threegenera and two genera of Dinoflagellates during the sampling conducted in spring tide in August,2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 98-226 units/ L during high tide period and 191-259 units/ L during low tide of Spring Tide.

The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by Diatoms ,Blue green algae and Dinoflagellates duringNeap tide period.Diatoms were represented by 15genera and Blue green algae were represented two genera and Dinoflagellates were represented by three genera during the sampling conducted in Neap tide in August, 2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from65-307units/ L during high tide period and 238-281 units/ L during low tide of Neap Tide.

Species Richness Indices and Diversity Indices:

Margalef's diversity index (Species Richness)S

At the organismal level, the most widely used biodiversity measures are those based on the number of species present, perhaps adjusted for the number of individuals sampled, Here Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, are derived.

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was varying from 1.527-3.091 with an average of 2.420during the sampling conducted in High tide period of spring tide.While Margalef's diversity index (Species Richness) S of phytoplankton communities in the Kandla Harbour region and nearby creeks was varying from 1.679-2.621 with an average of 2.225 during the consecutive low tide period.

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was varying from 2.344 -3.188 with an average of 2.887 during the sampling conducted in High tide period of Neaptide While .Margalef's diversity index (Species Richness) S of phytoplankton communities in the Kandla Harbour region and nearby creeks was varying from. 2.526-3. 246with an average of 2.887 during the consecutive low tide period.

Shannon-Wiener's index:

Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.728 -0.860 (H'(log10)) between selected sampling stations with an average value of 0.807 during high tide period of spring tide .Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.726-0.836 (H'(log10)) between selected sampling stations with an average value of 0.773 during consecutive lowtide. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.880-0.959 (H'(log10)) between selected sampling stations with an average value of 0.909 during high tide period of neap tide. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.819-0.911 (H'(log10)) between selected sampling stations with an average value of 0.887 during consecutive low tide. Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon-Wiener's index increases as both the richness and the evenness of the community increase. This result indicates that diversity of phytoplankton of Kandla Harbour region and nearby creeks is less but with abundant population of few, with relatively few ecological niches and only very few opportunist organisms are really well adapted to this environment and thrive better than other species.

Simpson's diversity index:

Simpson's index (D) is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. The Simson index is one of the meaningful and robust biodiversity measures available. (Magurran,2004).

Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in the Kandla Harbour region and nearby creeks, which was varying from 0.785- 0.823 between selected sampling stations with an average of 0.801 during high tide period of spring tide . Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in the Kandla Harbour region and nearby creeks, which was varying from 0.770- 0.820 between selected sampling stations with an average of 0.787 during consecutive low tide . Low species diversity suggests a relatively few successful species in this habitat. The environment is quite stressful with relatively few ecological niches and only a few organisms are really well adapted to that environment. Any change in the environment would probably have quite serious effects.

Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in Kandla Harbour region and nearby creeks, during high tide period and low tide period during neap tide also, which was varying from 0.811-0.886 with an average value of 0.836 between selected sampling stations during high tide period and varying from 0.774-0.826 with an average value of 0.813 between selected sampling stations during consecutive low tide period Low species diversity suggests a relatively few successful species in this habitat.

Table # 4PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN AUGUST,2021

Tide	Sampling Station	Abundance In units/L	No of Species observed /total species	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	210	14/19	73.68	2.431	0.7923	0.7938
	2	177	17/19	89.47	3.091	0.8603	0.8182
	3	226	12/19	63.16	2.029	0.7883	0.7853
	4	221	17/19	89.47	2.964	0.8243	0.7993
	5	190	14/19	73.68	2.478	0.8531	0.8227
	6	98	8/19	42.11	1.527	0.7279	0.7886
LOW TIDE	1	191	13/19	68.42	2.285	0.7812	0.7901
	2	233	13/19	68.42	2.201	0.7658	0.7795
	3	209	15/19	78.94	2.621	0.8367	0.8208
	4	213	10/19	52.63	1.679	0.7264	0.7732
	5	259	14/19	73.68	2.339	0.7547	0.7702

Table # 5 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN AUGUST,2021

Tide	Sampling Station	Abundance In units/L	No of Species observed /total species	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	221	18/20	90	3.149	0.9462	0.8522
	2	283	19/20	95	3.188	0.8844	0.811
	3	268	17/20	85	2.862	0.899	0.8255
	4	256	14/20	70	2.344	0.8803	0.8328
	5	307	19/20	95	3.143	0.8857	0.8113
	6	65	12/20	60	2.635	0.9594	0.8861
LOW TIDE	1	238	15/20	75	2.558	0.8192	0.7738
	2	281	19/20	95	3.192	0.9106	0.8188
	3	256	19/20	95	3.246	0.9023	0.8241
	4	242	17/20	85	2.915	0.9102	0.8263
	5	255	15/20	75	2.526	0.8939	0.824

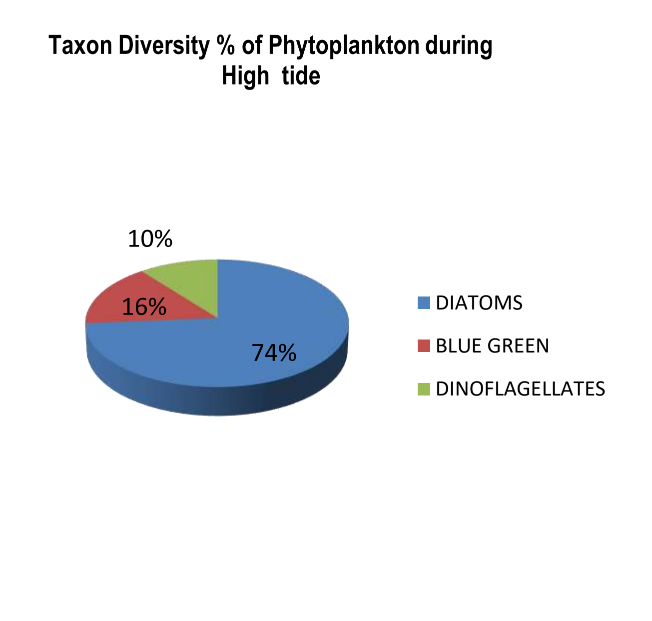
Table # 6 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING SPRING TIDEIN AUGUST, 2021

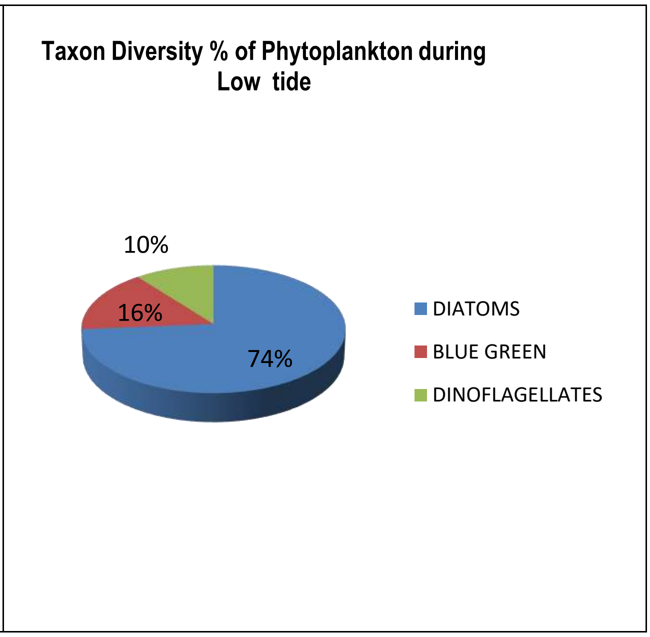
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	94-215	14/19	73.68
			BLUE GREEN	4-13	3/19	15.79
			DINOFLAGELLATES	0-1	2/19	10.53
			TOTAL PHYTO PLANKTON	98-226	19	-
LOW TIDE	Sub surface	5	DIATOMS	182-250	14/19	73.68
			BLUE GREEN	8-12	3/19	15.79
			DINOFLAGELLATES	0-1	2/19	10.53
			TOTAL PHYTO PLANKTON	191-259	19	-

Table # 7 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING NEAP TIDE IN AUGUST,2021

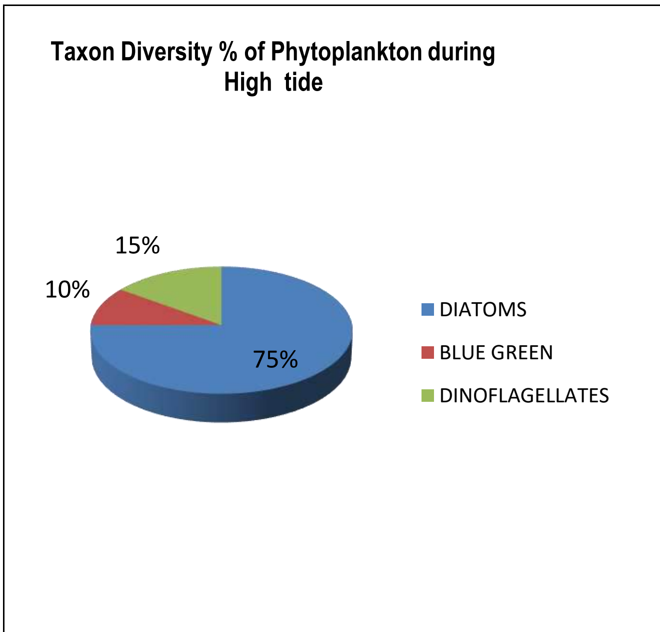
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	64-298	15/20	75
			BLUE GREEN	0-6	2/20	10
			DINOFLAGELLATES	0-5	3/20	15
			TOTAL PHYTO PLANKTON	65-307	20	-
LOW TIDE	Sub surface	5	DIATOMS	236-274	15/20	75
			BLUE GREEN	1-5	2/20	10
			DINOFLAGELLATES	0-4	3/20	15
			TOTAL PHYTO PLANKTON	238-281	20	-

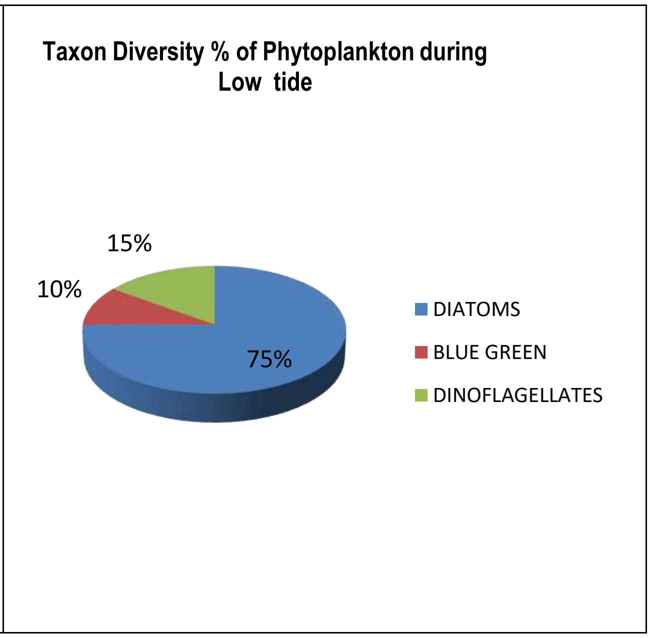
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide





Taxon Diversity % of Phytoplankton during High tide and Low tide period during Neap tide





ZOOPLANKTON POPULATION:

For the evaluation of the Zooplankton population in DPT harbour area and within the immediate surroundings of the port sampling was conducted from 6 sampling locations (3 in harbour area and two in Nakti creek and one in Khoricreek) during high tide period and low tide period of spring tide and Neap tide in August,2021. The Zooplankton community of the sub surface water in the harbour and nearby creeks during spring tide was represented by mainly five groups, Tintinids, Copepods, Ciliates Foraminiferans and larval forms of Crustacea, Molluscans and Polychaetes. The Zooplankton community of the sub surface water in the harbour and nearby creeks during neap tide was represented by mainly four groups, Tintinids, Copepods, Mysids and larval forms of Crustaceans , Molluscansand Polychaetes,.

Zooplankton of the sampling stations at sub surface layer in the DPT harbour area and nearby creek was varying from 34-109x10^3 N/ m^3 during high tide and 109-123 x10^3 N/ m^3during low tide of Spring Tide period. Zooplankton of the sampling stations at sub surface layer in the DPT harbour area and nearby creek was varying from 23-109 x10^3 N/ m^3 during high tide and86-103x10^3 N/ m^3during low tide of Neap Tide period.

Species Richness Indices and Diversity Indices:

Margalef's diversity index (Species Richness)S

At the organismal level, the most widely used biodiversity measures are those based on the number of species present, perhaps adjusted for the number of individuals sampled, Here Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, are derived.

Margalef's diversity index (Species Richness) S of Zooplankton communities in the stations Kandla Harbour region and nearby creeks was varying from 2.269-3.505 with an average of 3.009 during the sampling conducted in High tide period.Margalef's diversity index (Species Richness) S of Zooplankton communities varying from.2.701-3.354 with an average of 3.033 during the sampling conducted in low tide period during Spring tide.

Margalef's diversity index (Species Richness) S of Zooplankton communities in the Kandla Harbour region and nearby creeks sampling stations was varying from1.914- 3.962 with an average of 2.754 during the sampling conducted in high tide and varying from. 1.972-3.236 with an average of 2.640 during the sampling conducted in low tide during Neap tide period**Shannon-Wiener's index:**

Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.813-1.052 (H'(log10)) between selected sampling stations with an average value of 0.995 (H'(log10)) during high tide period of spring tide . Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.991-1.067(H'(log10)) between selected sampling stations with an average value of 1.035 (H'(log10)) during consecutive low tide period .

Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.696-1.007 (H'(log10)) between selected sampling stations with an average value of 0.897 (H'(log10)) during high tide period of Neap tide. Shannon-

Wiener’s Index (H) of Zooplankton communities in the samplingstations in Kandla Harbour region and nearby creeks was in the range of 0.785-0.983 (H'(log10)) between selected sampling stations with an average value of 0.883 (H'(log10)) during consecutive low tide period .Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon-Wiener’s index increases as both the richness and the evenness of the community increase. This result indicates that diversity of Zooplankton of Kandla Harbour region and nearby creeks stations is slightly high with very minimum diverse population but very few opportunist organisms are really well adapted to this environment and thrive better than other species.

Simpson’s diversity index:

Simpson’s index (D) is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. The Simson index is one of the meaningful and robust biodiversity measures available. (Magurran, 2004).

Simpson diversity index (1-D) of Zooplankton communities was below 0.9 most of sampling stations in the Kandla Harbour region and nearby creeksduring high tide and low tide of spring tide period, which was varying from 0.839-0.899between selected sampling stations with an average of 0.884 during high tide period and was varying from 0.887- 0.908 with an average value of 0.897 between selected sampling stations during low tide

Simpson diversity index (1-D) of Zooplankton communities was below 0.9 at all sampling stationsin the Kandla Harbour region and nearby creeks during high tide and low tide period except few, which was varying from 0.771-0.869 between selected sampling stations with an average of 0.833 during high tide period and was varying from 0.787- 0.863with an average value of 0.826 between selected sampling stations during consecutive low tide

This low species diversity suggests a relatively low number of successful species in this habitat. Environment is quite stressful with relatively few ecological niches and only few organisms are really well adapted to that environment. Any change in the environment would probably have quite serious effects.

Table # 8 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN AUGUST,2021

Tide	Sampling Station	Abundance In No / m^3	No of Species/groups observed /total species/group	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	93 $X10^3$	16/19	84.21	3.309	1.052	0.8955
	2	96 $X10^3$	17/19	89.47	3.505	1.032	0.8899
	3	105 $X10^3$	15/19	78.95	3.008	1.031	0.8958
	4	109 $X10^3$	15/19	78.95	2.984	1.037	0.8991
	5	109 $X10^3$	15/19	78.95	2.984	1.008	0.8865
	6	34 $X10^3$	9/19	47.37	2.269	0.8131	0.8396
LOW TIDE	1	110 $X10^3$	15/19	78.95	2.978	1.001	0.8881
	2	118 $X10^3$	17/19	89.47	3.354	1.067	0.8984
	3	123 $X10^3$	14/19	73.68	2.701	0.9911	0.887
	4	117 $X10^3$	16/19	84.21	3.15	1.065	0.9088
	5	109 $X10^3$	15/19	78.95	2.984	1.051	0.904

Table # 9 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN AUGUST,2021

Tide	Sampling Station	Abundance In No / m^3	No of Species/groups observed /total species/group	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	99 $X10^3$	14/20	70	2.829	0.9755	0.8695
	2	94 $X10^3$	19/20	95	3.962	1.007	0.8646
	3	91 $X10^3$	13/20	65	2.66	0.9544	0.8698
	4	101 $X10^3$	14/20	70	2.817	0.8993	0.8176
	5	109 $X10^3$	12/20	60	2.345	0.8501	0.8089
	6	23 $X10^3$	7/20	35	1.914	0.6965	0.7708
LOW TIDE	1	89 $X10^3$	11/20	55	2.228	0.8172	0.7878
	2	103 $X10^3$	16/20	80	3.236	0.9831	0.8633
	3	96 $X10^3$	14/20	70	2.848	0.92	0.8412
	4	86 $X10^3$	14/20	70	2.918	0.9071	0.8375
	5	96 $X10^3$	10/20	50	1.972	0.7875	0.7987

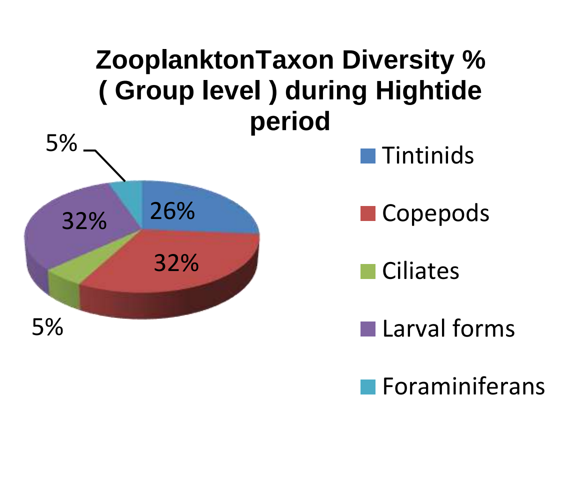
Table # 10 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN AUGUST,2021

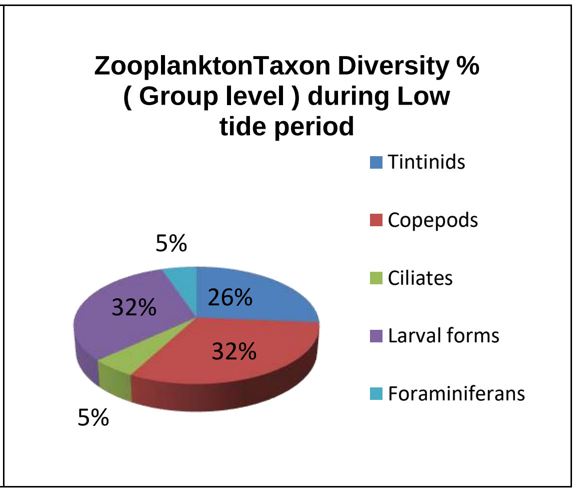
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton $x10^3$ Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	1-28	5/19	26.32
			Copepods	17-49	6/19	31.58
			Ciliates	1-6	1/19	5.26
			Larval forms	9-46	6/19	31.58
			Foraminiferans	0-2	1/19	5.26
			TOTAL ZOOPLANKTON NO/L	**34-109**	**19**	
LOW TIDE	Sub surface	5	Tintinids	20-27	5/19	26.32
			Copepods	39-55	6/19	31.58
			Ciliates	1-7	1/19	5.26
			Larval forms	40-46	6/19	31.58
			Foraminiferans	0-1	1/19	5.26
			TOTAL ZOOPLANKTON NO/L	**109-123**	**19**	

Table # 11 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA , NEAR BY CREEKS DURING NEAPTIDE IN AUGUST,2021

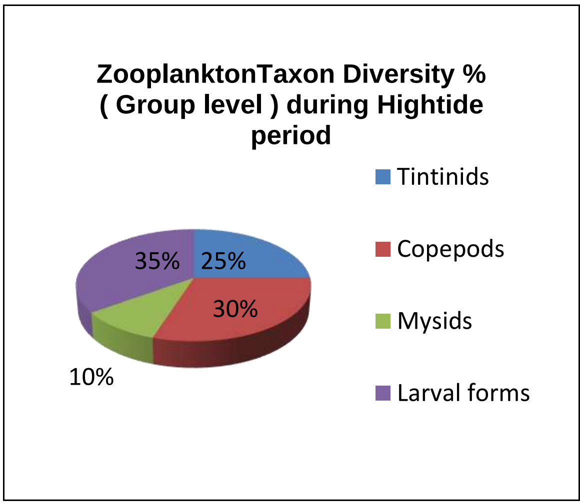
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton $x10^3$ Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	1-11	5/20	25
			Copepods	7-26	6/20	30
			Mysids	0-6	2/20	10
			Larval forms	15-84	7/20	35
			TOTAL ZOOPLANKTON NO/L	**23-109**	**20**	**-**
LOW TIDE	Sub surface	5	Tintinids	6-12	5/20	25
			Copepods	5-23	6/20	30
			Mysids	1-4	2/20	10
			Larval forms	57-74	7/20	35
			TOTAL ZOOPLANKTON NO/L	**86-103**	**20**	**-**

Taxon Diversity % of Zooplankton during High tide and Low tide period of Spring tide





Taxon Diversity % of Zooplankton during High tide and Low tide period of Neap tide



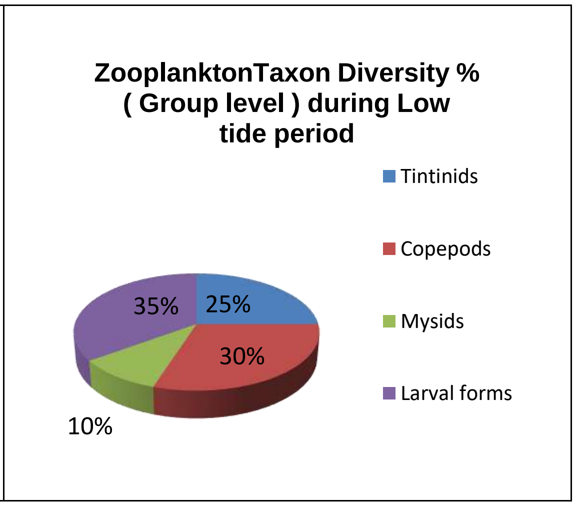


TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURINGSPRING TIDE OF AUGUST, 2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALGAE	Cyanophyta	Cyanophyceae	Nostocales	Oscillatoriaceae	*Arthospira*sp.	B1	Rare
					Lyngbya sp.	B2	Rare
			Stigonematales	Stigonemataceae	*Stigonema sp.*	B3	Occasional
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Rare
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D2	Abundant
			Triceratiales	Triceratiaceae	*Odontella*sp	D3	Occasional
					*Triceratium*sp.	D4	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D5	Dominant
			Hemiaulales	Bellerocheaceae	*Bellerochea*sp	D6	Rare
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros*sp	D7	Occasional
			Lithodesmiales	Lithodesmiaceae	*Ditylum*sp	D8	Abundant
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*sp	D9	Rare
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D10	Abundant
					Thalassionema sp.	D11	Rare
			Fragilariales	Fragilariaceae	*Asterionelopsis sp..*	D12	Rare
					*Fragilaria*sp	D13	Occasional
					*Synedra*sp	D14	Rare
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium sp.*	DF1	Rare
			Gonyaulacales	Ceratiaceae	*Ceratium*furca	DF2	Rare

TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURING AND NEAP TIDE OF AUGUST,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALGAE	Cyanophyta	Cyanophyceae	Nostocales	Oscillatoriaceae	*Oscillatoria* sp.	B1	Rare
			Stigonematales	Stigonemataceae	*Stigonema sp.*	B2	Rare
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D1	Dominant
			Triceratiales	Triceratiaceae	*Odontellasp*	D2	Occasional
					Triceratiumsp.	D3	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphiasp*	D4	Abundant
			Hemiaulales	Bellerocheaceae	*Bellerocheasp*	D5	Rare
			Chaetocerotales	Chaetocerotaceae	*Chaetocerossp*	D6	Occasional
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D7	Occasional
			Lithodesmiales	Lithodesmiaceae	*Ditylumsp*	D8	Abundant
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*sp	D9	Occasional
				Pinnulariaceae	*Pinnulariasp*	D10	Rare
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D11	Dominant
					Thalassionema sp.	D12	Rare
			Fragilariales	Fragilariaceae	*Asterionella sp.*	D13	Occasional
					Fragilariasp	D14	Frequent
					Synedrasp	D15	Rare
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium sp.*	DF1	Rare
			Gonyaulacales	Ceratiaceae	*Ceratiumfurca*	DF2	Rare
					Ceratiumtripos	DF3	Rare

TABLE #13 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS IN DPT HARBOUR AREA, AND NEAR BY CREEKS DURING SPRING TIDE OF AUGUST,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Frequent
				Codonellidae	*Tintinnopsisaccuminata*	T2	Rare
					Tintinnopsisfailakkaensis	T3	Rare
					Tintinnopsisgracilis	T4	Occasional
					Tintinnopsis radix	T5	Rare
COPEPODS	ATHROPODA	Crustacea Sub class copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Frequent
				Temoridae	*Temora sp.*	C2	Rare
			Cyclopoida	Oithonidae	*Oithona sp.*	C3	Frequent
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C4	Abundant
				Euterpinidae	*Euterpina sp.*	C5	Rare
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C6	Rare
CILIATES	CILIOPHORA	Oligohymenophorea	Sessilida	Zoothamniidae	*Zoothamniumsp.*	CI1	Occasional
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L2	Occasional
POLYCHAETE LARVA	ANNELIDA	Polychaeta			Trochophore larvae	L3	Occasional
BARNACLE LARVAE	ATHROPODA CRUSTACEA	Maxillopoda Thecostraca			Cirripede larvae	L4	Rare
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L5	Occasional
BRYOZOA					Cyphonautes larvae	L6	Occasional
FORAMINIFERA	FORAMINIFERA	Globothalamea	Rotaliida	Rotalliidae	*Rotalia* sp.	F1	Rare

TABLE # 13 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS IN DPT HARBOUR AREA, AND NEAR BY CREEKS DURING NEAP TIDE OF AUGUST,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Occasional
				Codonellidae	*Tintinnopsisaccuminata*	T2	Rare
					Tintinnopsisfailakkaensis	T3	Rare
					Tintinnopsisgracilis	T4	Occasional
					Tintinnopsis radix	T5	Rare
COPEPODS	ATHROPODA	Crustacea Sub class copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Frequent
				Temoridae	*Temora sp.*	C2	Rare
			Cyclopoida	Oithonidae	*Oithona sp.*	C3	Occasional
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C4	Occasional
				Euterpinidae	*Euterpina sp.*	C5	Rare
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C6	Rare
MYSIDS	ATHROPODA CRUSTACEA	Malacostraca	Mysida, Decapoda	Solenoceridae	*Solenocerasp.*	M1	Rare
				Penaeidae	*Metapenaeussp.*	M2	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L2	Occasional
POLYCHAETE LARVA	ANNELIDA	Polychaeta			Trochophore larvae	L3	Occasional
BARNACLE LARVAE	ATHROPODA CRUSTACEA	Maxillopoda Thecostraca			Cirripede larvae	L4	Rare
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L5	Abundant
CYPHONAUTES LARVAE	BRYOZOA				Cyphonautes larvae	L6	Occasional
ECHINODERMATA larave	ECHINODERMATA	Ophiuroidea			Ophiopluetus larvae	L7	Rare

BENTHIC ORGANISMS:

Few Benthic organisms were observed in the collected sediments by using the Van-veen grabs during the sampling conducted during spring tide period and Neap tide period from DPT harbour region and nearby creek.The benthic organisms during spring tide were represented by Polychaetes, Nematodes and Amphipods. The polychaetes were represented by *Syllis sp.* *Polydorasp* , and*Pondodorasp,* during spring tide sampling. The benthic organisms in the collected samples were varying from 0-300 N/M ^{2} during spring tide and 10-140 NO/M ^{2} during neap tide sampling

Table # 14 BENTHIC FAUNA IN THE SAMPLING LOCATIONS IN DPT HARBOUR AREA CREEKS DURING NEAP TIDE IN AUGUST ,2021

Benthic fauna	ABUNDANCE IN NO/M ^{2} DIFFERENT SAMPLING STATIONS REPRESENTATION BY GROUP						
	DPT HARBOUR			CREEKS			
POLYCHATES	KPT-1	KPT-2	KPT-3	KPT-4	KPT-5	KPT-6	
Family : Iospilidae *Pondodora sp.*	0	70	0	0	0	NS	
Family : Spionidae *Polydora sp..*	10	10	0	20	0	NS	
Family : Syllidae *Syllis sp*.	0	10	0	10	0	NS	
Total Polychates N/M^2	10	90	0	30	0	NS	
Un identified Nematode worms	40	200	0	10	30	NS	
Amhipods	0	10	0	10	0	NS	
TOTAL Benthic Fauna NUMBER/ M^2	50	300	0	50	30	NS	

NS : No sample

Table # 15BENTHIC FAUNA IN THE SAMPLING LOCATIONS IN DPT HARBOUR AREA CREEKS DURING NEAP TIDE IN AUGUST ,2021

Benthic fauna	ABUNDANCE IN NO/M ^{2} DIFFERENT SAMPLING STATIONS REPRESENTATION BY GROUP						
	DPT HARBOUR			CREEKS			
POLYCHATES	KPT-1	KPT-2	KPT-3	KPT-4	KPT-5	KPT-6	
Family : Spionidae *Polydora sp..*	20	10	0	40	20	NS	
Family : Syllidae *Syllis sp***.**	10	10	0	20	60	NS	
Total Polychates N/M^2	30	20	0	60	80	NS	
Un identified Nematode worms	40	30	10	40	40	NS	
Amhipods	10	10	0	10	20	NS	
TOTAL Benthic Fauna NUMBER/ M^2	80	60	10	110	140	NS	

NS : No sample

7. Meteorological Data

Automatic Weather station have been installed in SevaSadan -3 at the Deendayal Port which records the data on Temperature (°C), Humidity (%),Wind (mph), Dew Point (°C), Wind Direction (°), Pressure, Solar radiation, heat Index and UVI.

Temperature

The mean day time temperature for Deendayal Port was 30.5 °C. The day-time maximum temperature was 34.1 °C. The mean night time temperature was 27.4 °C. The minimum mean night time temperature recorded was 26.1 °C.

Air Pressure

The mean absolute air pressure for the month of August was 1004.7 hpa, whereas the mean relative pressure was 1001.2 hpa. The maximum absolute air pressure recorded for the month of August was 1008.3 hpa.

Heat Index

The mean day-time heat index for the month of August was 34.7 ^{o}C. The maximum heat index recorded was 42^{o}C.

Solar Radiation

The mean Solar Radiation in August was 232.4 w/m^2. The maximum solar radiation recorded in the month of August was 682.8 w/m^2.

Humidity

The mean day-time humidity was 73.0 % for the month of August and mean night time humidity was 83.2%. Maximum humidity recorded during day-time was 88.0 % and maximum humidity recorded during night-time was 90.0%.

Wind Velocity and Wind Direction

The mean wind velocity for the entire month of August was 10.8 km/hour. Maximum wind velocity recorded was 34.9 Km/hr . The wind direction was mostly S to SW.

Conclusive Summary and Remedial measures Suggested

- The AAQ monitoring at six locations of Deendayal Port indicates that the mean PM_{10} values at four locations viz. Coal storage area, Marine Bhavan and Oil Jetty area were found above the permissible standards (100 μg/m^3)and$PM_{2.5}$was above permissible limits at Coal storage location(Limit 60 μg/m^3).

- Drinking water at all the twenty locations was found potable and was within permissible limits of BIS standards (IS 10500).

- Noise quality was also within the set permissible standards of an Industrial Area. The noise level observed during day time was >75 dB (A) and at night time was >70 dB (A) during the entire monitoring period.

- The sewage treated water of Deendayal Port Colony (Gopalpuri) was in line with the standards set by the Gujarat Pollution Control Board. The STP at Deendayal Port is not fully operational and STP at Vadinar Port was found non-operational.

Reasons for higher Values of PM_{10}

- Large amount of coal is handled at Berth No. 6, 7, 8 and 9. The unloading of coal directly in the truck, using grabs cause coal to spread in air as well as coal dust to fall on ground. This settled coal dust again mixes with the air while trucks travel through it.

- Also, the coal laden trucks are not always covered with tarpaulin sheets and these results in spillage of coal from trucks/dumpers during its transit from vessel to yard or storage site. This also increased PM values around marine Bhavan & Coal storage area.

Remedial Measures

The values of PM_{10} during the month of August, 2021 were observed beyond the permissible limit at four locations mentioned above. Given below are the remedial measures suggest to minimize the Air pollution at Deendayal Port.

- Guidelines for Coal Handling by GPCB should be strictly followed. (http://gpcb.gov.in/pdf/coal-handling-guidelines.pdf)

- Sewage Treatment Plan at Vadinar Port is not working. Hence, it is recommended to commission the sewage treatment plant at Vadinar immediately.

- Except for the higher values of PM_{10} at Coal storage site, Oil Jetty, Tuna Port and Marine Bhavan locations, the monitoring results for the present month suggest that the overall Environment Quality of Deendayal Port is satisfactory.

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ANNEXURE E

Holistic Marine Ecological Monitoring in Deendayal Port Environment with Special reference to Biodiversity and Preparation of Management Plan – Phase II

Final Report
(May 2018 – May 2021)

Submitted to

DEENDAYAL PORT TRUST
New Kandla – 370210, Gandhidham
Kachchh, Gujarat

Submitted by

GUJARAT INSTITUTE OF DESERT ECOLOGY
Opp. Changleshwar Temple, Mundra Road
Bhuj-370 001, Kachchh, Gujarat.

May -2021

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Holistic Marine Ecological Monitoring in Deendayal Port Environment with Special reference to Biodiversity and Preparation of Management Plan – Phase II

Final Report

(May 2018 – May 2021)

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May - 2021

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Snapshot of the Project

"Holistic Marine ecological Monitoring of Deendayal Port Environment with Special reference to Biodiversity and Preparation of Management Plan- Phase II"

S. No	Components of the Study	Remarks
1	MoEF & CC Sanction Letter and Details	EC& CRZ clearance accorded by the MoEF & CC, GoI 19/12/2016 specific no. xviii.
2	Deendayal Port letter Sanctioning the Project	NO.EG/WK/4751/Part (EC & CRZ-1) Letter dated: 22/5/2018
3	Duration of the Project	Three years-from 24.05.2018 to 23.05.2021
4	Period Of Survey Carried Out For Various Components	October 2020 for the post-monsoon and March 2021 for winter
5	Survey Area Within The Port Limit	All major and minor creek systems from Tuna to Surajbari
6	Number Of Sampling Locations Within DPT Area	Twelve sampling locations
7	**Components of the report**	
7a	Mangroves and Mudflats	Overall average density of 2702 trees/ha of *A. marina* during post-monsoon (October 2020) and 3134 trees/ha during winter (March 2021) were recorded. The tree density ranged from 1687 (S-5) to 4352 (S-7). Phang creek site was with less dense mangrove trees. The variability in tree density between sites discloses the unevenness in mangrove formation in parity with the different geomorphology of the creek system in Kandla. During post-monsoon 2020 the highest TOC value was recorded at station S-5 (0.42 ±0.03%) followed by S-8 (0.35 ±0.03%). The lowest TOC values were reported at site S-3 and S-9. During winter the lowest TOC was recorded at S-5 (0.27 ±0.0.3%) and the highest at S-7 (0.99 ± 0.47%). However, the present study revealed that the intertidal faunal diversity of DPT mudflats is less than 2.0 which clearly indicates it to be biologically poor.
7b	Zooplankton	A total of 29 and 27 taxa were observed during post-monsoon 2020 and in winter 2021, respectively.

		Among crustaceans, the Copepods emerged as the dominant group with 10 genera (major ones were *Acartia*, *Acrocalanus*, *Calanus* and *Nannocalanus*) during post-monsoon 2020. Cyclopoida and Harpacticoida each was represented with 2 genera. During winter 2021 Copepods were represented by 12 genera (major genera were *Acrocalanus*, *Calanus, Centropages*, *Nannocalanus* and *Paracalanus*). During winter 2021, Cyclopoida and Harpacticoida were represented with 2 and 3 genera, respectively. Besides this, Cnidaria and Chaetognatha group were encountered for the first time during the study.
7c	Phytoplankton	During the post-monsoon 2020, a total of 23 genera of phytoplankton were recorded. The highest number of genera (23) was recorded at station S-1 and the lowest (15) at station S-5 and S-11. Likewise, during winter 2021, a total of 19 genera were observed and the highest number of genera (19) was recorded at station S-1 and the lowest (6) at station S-5 and S-7. During the winter season the centrales diatoms heavily dominated at station S-7.
7d	Intertidal Fauna, Mammals And Reptiles	A total of 10 and 12 genera of intertidal macrofauna were recorded during the post-monsoon 2020 and winter 2021, respectively. The intertidal fauna belonged to five groups namely Crustacea, Gastropoda, Bivalvia, Polychaeta and Fishes (mudskipper). During the post-monsoon the percentage composition was majorly by Crustaceans (76%) followed by Mollusca (19%), Mudskipper (4%) and Polychaetes (1%). In winter 2021 Crustaceans contributed 75% followed by Gastropod (18%) and Mudskipper (4%).
7e	Subtidal Fauna	The population density of benthic fauna in post-monsoon 2020 varied from 300 to 925 No/m^2 with the maximum at S-6 and minimum at S-11. During winter 2021, it varied from 200 to 1200 No/m^2 with the maximum at S-5 and minimum at S-7.

7f	Seaweeds and Seagrasses	A few species of drifted macroalgae namely, *Enteromorpha* sp., *Ulva lactuca*, *Ulva rigida*, *Ulva reticulate* and *Sargassum wightii* were observed in the intertidal belt near Kandla creek and Khari creek.
7g	Halophytes	Four species of halophytes namely *Sesuvium portulacastrum, Salvadora persica* and *Aeluropus lagopoides* and *Salicornia brachiata* were recorded inside the quadrates during post-monsoon 2020 and 03 species during winter 2021.
7h	Avifauna	A total of 69 species (post-monsoon 2020) and 96 species of avifauna (winter 2021) were recorded. Among these, 63 species were aquatic and 33 species were terrestrial.
7i	Fishes	In total 5 fish species were recorded during post-monsoon 2020 and 6 species during winter 2021. The Catch per Unit effort was low during the survey.

Snapshot of

Comparison Study of Marine Biodiversity of Deendayal Port (DPT) Since 2017

Habitat/Groups	**Major Taxa/Genera/Species**	**Year 2017-18**		**Year 2018-19**		**Year 2019-20**		**Inference**
Mangroves	*Avicennia marina*, *Ceriops tagal, Rhizophora mucronata, Aegiceras corniculatum*	4	4	4	4	4	4	The present study results were compared with the previous studies conducted by GUIDE (2017-2018) and (2018-2019). It was inferred that there was no significant variation with respect to taxa / genera / species composition as well as faunal density in all the sampling locations in the Deendayal port and it's surroundings.
Intertidal habitat	Gastropods, Bivalves, Crustaceans Polychaetes, fishes, amphipods and Isopods	22	23	20	24	19	10	
Subtidal habitat	Polychaetes, molluscs, crustaceans, echinoderms	27	29	24	31	26	28	
Phytoplankton	*Bacillaria, Navicula, Nitzschia, Chaetoceros, Coscinodiscus, Triceratium, Bidulphia, Melosira, Thassiosira*	9	18	20	24	32	26	
Zooplankton	Copepods, Harpacticoids, Cyclopoids. brachyurans, cirripedes, Bivalve veligers	14	19	23	27	33	36	
Seaweeds	Nil (Drifted tufts only)	Nil	Nil	Nil	Nil	Nil	Nil	
Sea grasses	Nil (Drifted tufts only)	Nil	Nil	Nil	Nil	Nil	Nil	
Halophytes (within quadrate)	*Sesuvium portulacastrum, Salvadora persica, Aeluropus lagopoides, Salicornia brachiata, Suaeda nudiflora* and *Trianthema portulacastrum*	4	9	7	7	3	4	
Avifauna	Charadriiformes, Columbiformes, Coraciiformes, Phoenicopteriformes, Pelecaniformes, Passeriformes	52	91	52	74	49	89	
Fishes	*Mugil cephalus,* Scienids, Clupeids, *Harpodon nehereus, Pampus argenteus, Hilsa, Engraulis, Coilia* sp. *Peneaus, Portunus*	11	15	11	11	10	8	

Marine Mammals	Dolphin, *Sousa plumbea*	Nil	1	1	1	1	1	
Reptiles in the mangroves	The saw-scaled viper, *Echis carinatus sochureki*	1	1	1	0	1	1	
Total biodiversity richness in Deendayal port		144	210	160	206	179	207	

1. Introduction

Marine environment, especially that of the Ports and harbors is multifaceted and complex due to inclusion of many ecosystems such as mangroves, mudflats, salt marshes, creek systems and coastal waters. This habitat supports a multitude of faunal and floral components. Deendayal Port Trust (DPT), a leading port of India, encompasses many of mangrove, creek system, mudflat, salt marsh and other habitats that are vulnerable to regular operation, maintenance and continuous development and expansion of port activities. The developmental activities like land reclamation, dredging and large-scale construction and its continuous expansion negatively affect marine ecosystem. The existence of sensitive habitats such as mangroves, mudflats, creek systems strongly underlines the need to pay attention to ensure their protection and conservation. Policies of Ministry of Environment, Forest and Climate Change (MoEF & CC), New Delhi also attest the fact that port development and marine environmental protection should go hand in hand. Thus, assessing and ensuring the environmental wellbeing of the port becomes imperative in this era of heightened environmental awareness. On their part, ports are legally mandated to render their operation environmentally benign and sustainable so as to increase their green competitiveness. World Commission on Environment and Development (WCED) argued that a substantial part of environmental damage is caused by the transportation industry. Many major ports of the world have now initiated their efforts to preserve their port environment. Even factors such as people, business, culture and history of a place are often included in addition to natural resources in evaluating the greenness of a port. Green port construction is a long, comprehensive, systematic and complex task, and is a matter concerning the overall situation and long term strategic perspective (Bailey & Solomon, 2004).

Deendayal Port in Kachchh District of Gujarat operated by Deendayal Port Trust (DPT) is a gateway Port to the hinterland in western and northern states of India. Around 95% of India's trading by volume and 70% by value is carried out through maritime transport with a major share contributed by DPT. It is one of the 12 major ports of India situated at latitude 23° 1’ N and longitude 70° 13’ E on Kandla creek at the inner end of Gulf of Kachchh (GoK), Gujarat. Since its formation in the 1950s, the Deendayal Port caters the maritime trade requirement of states such as Rajasthan, Madhya Pradesh, Uttar Pradesh, Haryana and Gujarat. Because of its proximity to the Gulf countries, large quantities of crude petroleum are imported through this port. About 35% of the country's total export takes place through the ports of Gujarat in which the Deendayal port has a considerable contribution.

An assortment of liquid and dry cargo is being handled at DPT Port. The dry cargo includes fertilizers, iron and steel, food grains, metal products, ores, cement, coal, machinery, sugar, wooden logs, etc. The liquid cargo includes edible oil, crude oil and other petroleum products. Cargo handling has increased from 41.55 million tons to 117.5 MMT during 2020-2021. Presently the Port has total 1-16 dry cargo berths for handling dry cargo, 6 oil jetties, one barge jetty at Bunder basin, dry bulk terminal at Tuna Tekra, barge jetty at Tuna and two SPMs at vadinar for handling oil. Regular expansion or developmental activities such as the addition of jetties, allied SIPC and ship bunkering facilities are underway in order to cope with the increasing cargo handling demand.

A developmental initiative of this magnitude is going on since the past 7 decades which will have its own environmental repercussions. Being located at the inner end of Gulf of Kachchh, Deendayal Port encompasses a fragile marine ecosystem that includes a vast expanse of mangroves, mudflats, creek systems and associated biota. Deendayal Port is a natural harbor located on the eastern bank of North-South trending Kandla creek at an aerial distance of 90 km from the mouth of Gulf of Kachchh. The Port's location is marked by a network of major and minor mangrove lined creek systems with a vast extent of mudflats. Coastal belt in and around the port has an irregular and dissected configuration. Due to its location at the inner end of Gulf, the tidal amplitude is elevated, experiencing 6.66 m during Mean High Water Spring (MHWS) and 0.78 m during Mean Low Water Spring (MLWS) with an MSL of 3.88 m. Commensurate with the increasing tidal amplitude, vast intertidal expanse are present in and around the port environment. This, along with the occurrence of mudflat enables mangrove formation at the intertidal belt. Contrary to the southern coast of Gulf of Kachchh, coral formations, seaweed and seagrass beds are absent due to high turbulence induced suspended sediment load in the water column, a factor again induced due to its conical Gulf geomorphology and surging tides towards its inner end.

1.1. Study Area

Deendayal port is located at Kandla, Gandhidham Taluka, Kachchh district, Gujarat. The coastal belt in and around DPT port jurisdiction is characterized by a network of creek systems and mudflats which are covered by sparse halophytic vegetation like scrubby to dense mangroves, creek water and salt-encrusted landmass which forms the major land component. The surrounding environment in a radius of 10 km from the port includes built-up areas, salt pans, human habitations and port related structures on the west and north and creek system, mangrove formations and mudflats in the east and south (Figure 1). The nearest major habitation is Gandhidham town about 12 km west with a population of 2, 48,705 (as per 2011 census).

1.2. Background of the Present Study

As part of its ongoing expansion, Deendayal Port authorities intend to develop seven (7) integrated facilities which include development of oil jetty and ship bunkering terminal at old Kandla, a multi-purpose oil terminal near Tuna, up-gradation of barge handling facility at Kandla, construction of one rail over bridge and strengthening of existing oil jetties. While according environmental clearance to these developmental initiatives, MoEF & CC, among other conditions, stipulated the following: *"**Marine Ecology shall be monitored Regularly also in terms of Seaweeds, Sea grasses, Mudflats, Fisheries, Echinoderms, Shrimps, Turtles, Corals, Coastal vegetation, Mangroves and other Biodiversity components as a part of the management plan. Marine ecology shall be monitored regularly also in terms of all Micro, Macro and Mega floral and faunal components of marine biodiversity**".*

In accordance with this directive, Deendayal Port Trust (DPT) assigned the task of carrying out a holistic marine ecological study to Gujarat Institute of Desert Ecology (GUIDE), Bhuj during May 2018. Since marine ecological components are to be studied regularly as stipulated by the Ministry, DPT authorities approached GUIDE to continue the study for another three years, i.e. 2018-2021.

The present report consolidates the third year seasonal results of the study carried out during post-monsoon (October - November 2020) and winter (February - March 2021) and its comparison with previous years.

1.3. Scope of the Work

The scope of the present investigation includes different marine biotic components as mentioned in the above stipulations of MoEF & CC. A detailed holistic approach to different components of marine biodiversity within the Deendayal Port area has been carried out. Based on the results obtained on different marine biological parameters, a detailed management plan has been drawn at the end of the project period. The biological variables investigated during the present study on seasonal basis were as follows:

- Mangroves - Overall vegetation structure including density, diversity, height, canopy and other vegetation characteristics.
- GIS and RS studies to assess different ecological sensitive land use and land cover categories within the Port area such as the extent of dense and sparse mangroves, mudflats, creek systems and other land cover categories within the port limits.
- Intertidal Fauna - Species composition, distribution, diversity, density and other characteristics, other mega faunal components such as mammals, reptiles and amphibians.
- Subtidal Fauna - Species composition, distribution, diversity, density and other characteristics were studied.
- Planktonology - Species composition, distribution, density and diversity of phyto- and zoo- plankton.
- Halophytes – Sea grasses, seaweeds and other coastal flora, their occurrence, distribution, abundance and diversity.
- Avifauna- Density, diversity, composition, habitat, threatened and endangered species and characters.
- Fishery Resources - Common fishes available, composition, diversity, Catch Per Unit Effort (CPUE) and other socio-economic information.

This study in short attempts the following, i). Developing a strong baseline of the port marine environment from the biological perspective which could be used to monitor changes in the future, and ii) formulating a management plan based on the baseline data in order to ensure long-term ecological health of the port environment. A better understanding of the marine ecology of the port and its processes has been attempted in this study which will assist in better management and conservation decisions to promote marine environmental health within the port limits.

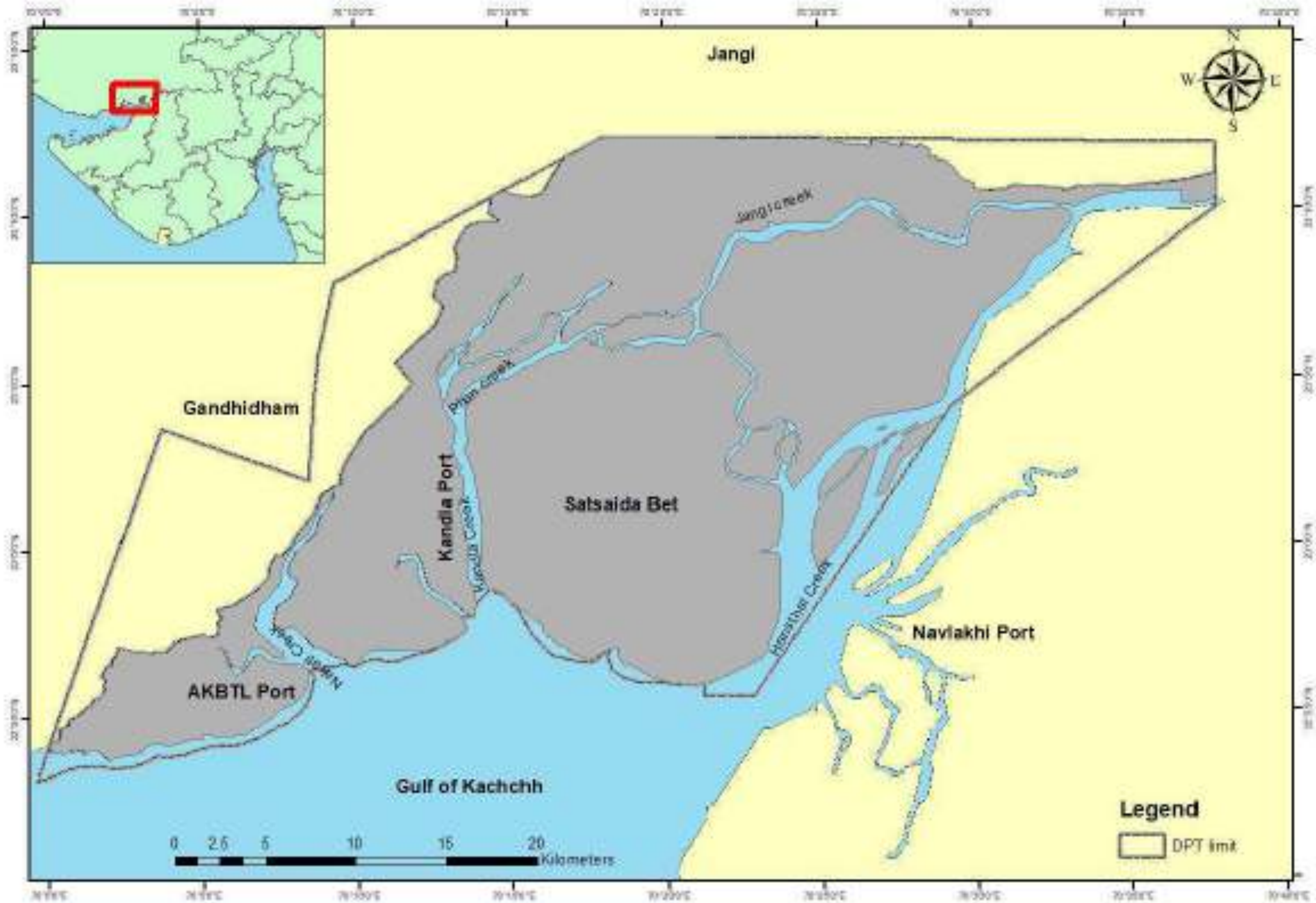


Figure 1. Deendayal Port jurisdictions and sampling location

2. Land Use and Land Cover Changes

In order to understand the spatial and temporal changes in the vicinity of Deendayal port jurisdiction area, Remote Sensing and GIS technique has been employed. Land cover classification was carried out using digital satellite imageries (IRS-R2A and IRS-R2) with Spatial Resolution of 5.8 m (Sensor: LISS IV). Images for Deendayal Port area were acquired for the period of 26/04/2017; 24/10/2019, 29/03/2020, 17/11/2020 and 10/04/2021 were used for the study. These were brought to UTM projection with spheroid and datum named WGS 84 in UTM zone 42 north.

2.1. Methodology

Training samples were collected from these imageries. Selecting training samples from these cloud-free mosaics was straightforward due to the very distinctive signature of mangrove area. High contrast with open water, saltpan and mudflat helped in selecting the training data successfully. Same training samples with slight modifications in each imageries mosaic (addition and removal of few training samples) were used for the classification of all different date images. Six major classes *viz*., mangrove, water, mudflat, other vegetation, salt pan and port were delineated. The tonal variation and pixel values in the imageries, a supervised Maximum Likelihood Classification (MLC) and NDVI (Normalised Differential Vegetative Index) methods were used for the classification.

ERDAS Imagine 9.3 was used for satellite image processing, classification and data transformation whereas ARC GIS 10.3 was used for the map formation. For graphs and databases processing MS WORD and MS EXCEL were used. Ground truth study comprises of data collection of ground features along with the respective geographical positions in terms of latitudes and longitudes with Garmin e-trex Vista GPS. Thus, the data were interpreted using all the collected information (Figure 2).

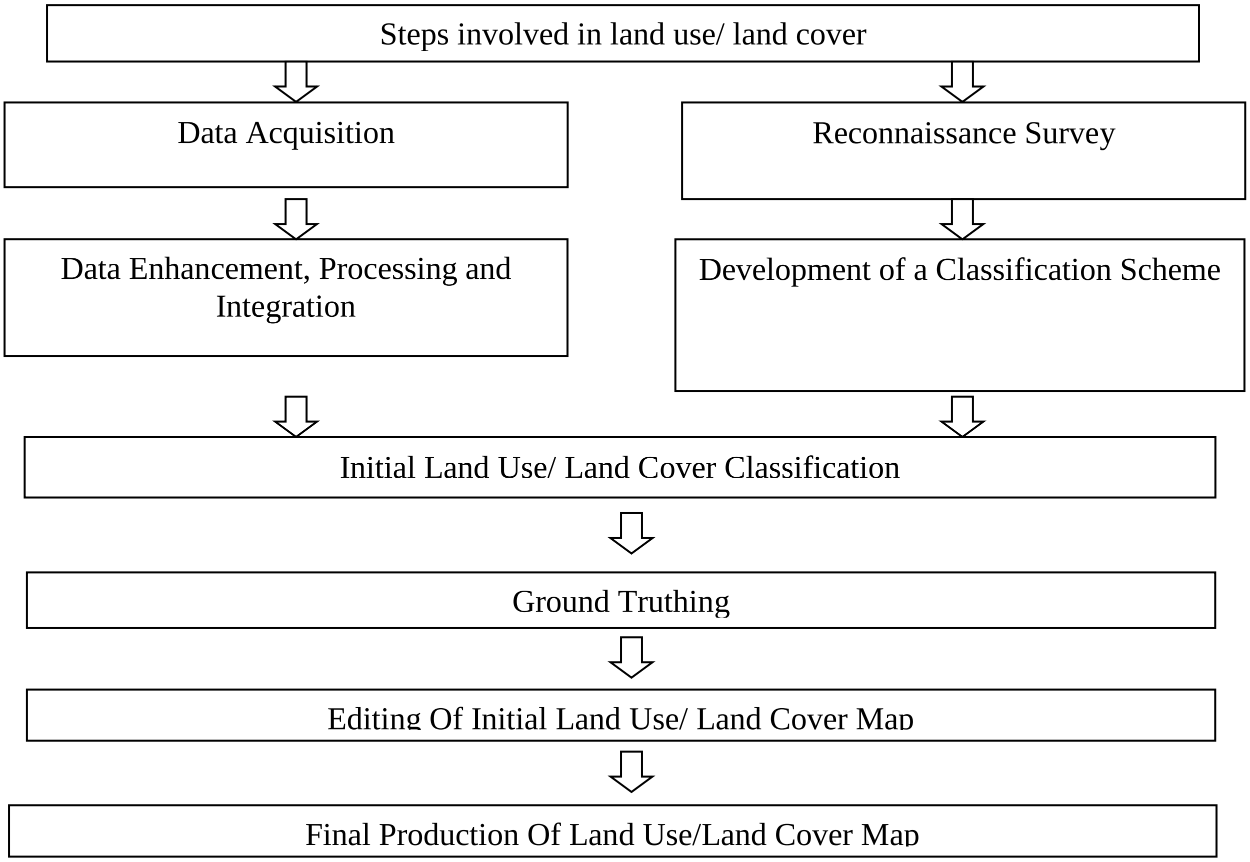


Figure 2. Methodology flowchart

2.1.1. Land Cover

Classified imageries are presented in Figure 3 to Figure 7and from Table 1 to

Table **6**.

2.1.2. Comparative analysis of Land use and Land cover study

During April 2017 to April 2021 the overall mangrove area increased from 19319 ha to 23967 ha, i.e. 4.6% of the total area under the DPT. Mangrove area has occupied the mudflat hence decreasing trend of the mudflats is evident from the Table 1 to

Table 6. However, But overall trends showed that mudflat has been replaced by mangroves. Though there was absence or poor monsoon during 2018, normal and prolonged monsoon during 2020, favourable environment has positively impacted the mangroves.

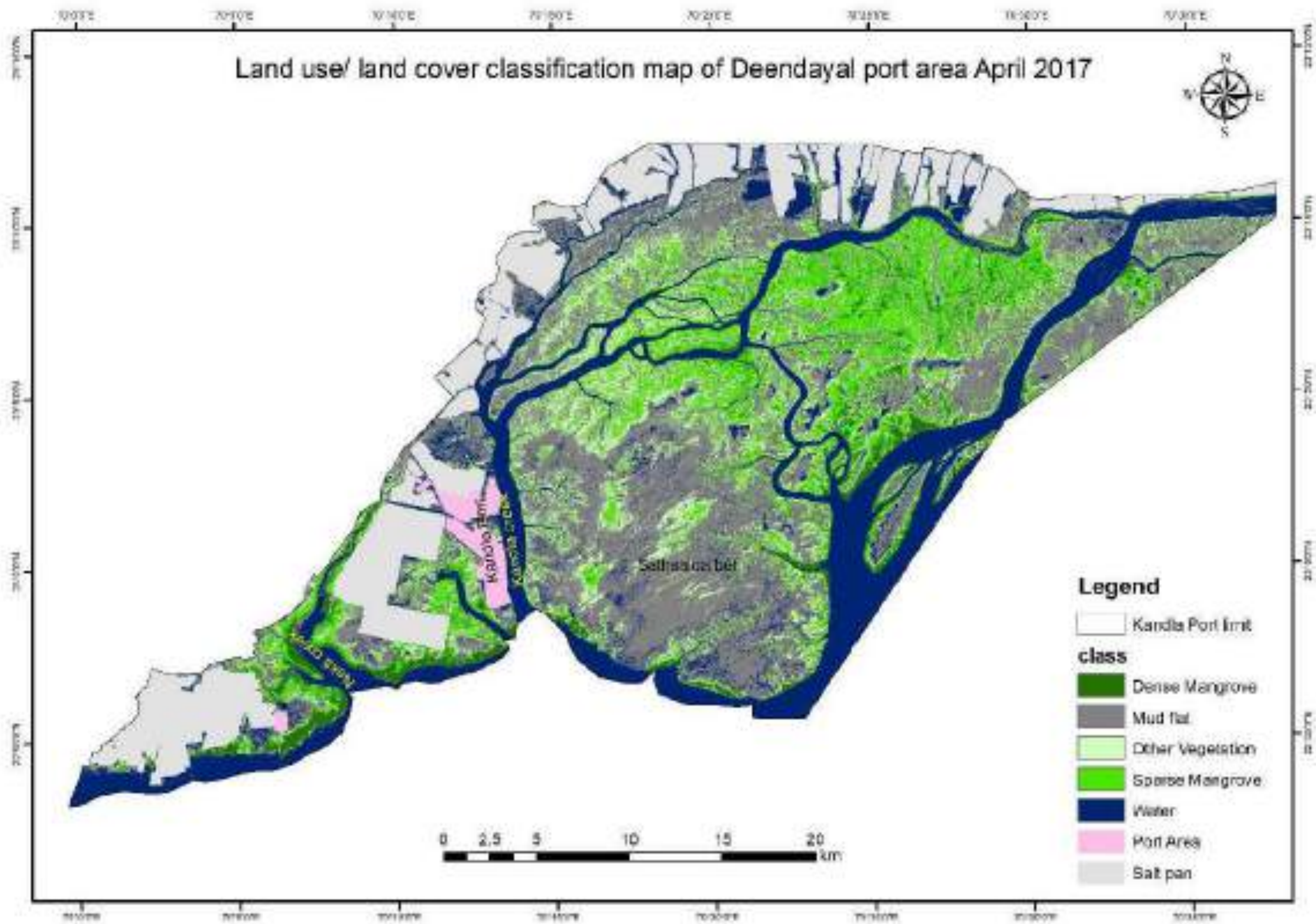


Figure 3 Land use/ Land cover classifcation in Deen Dayal port area- April-2017

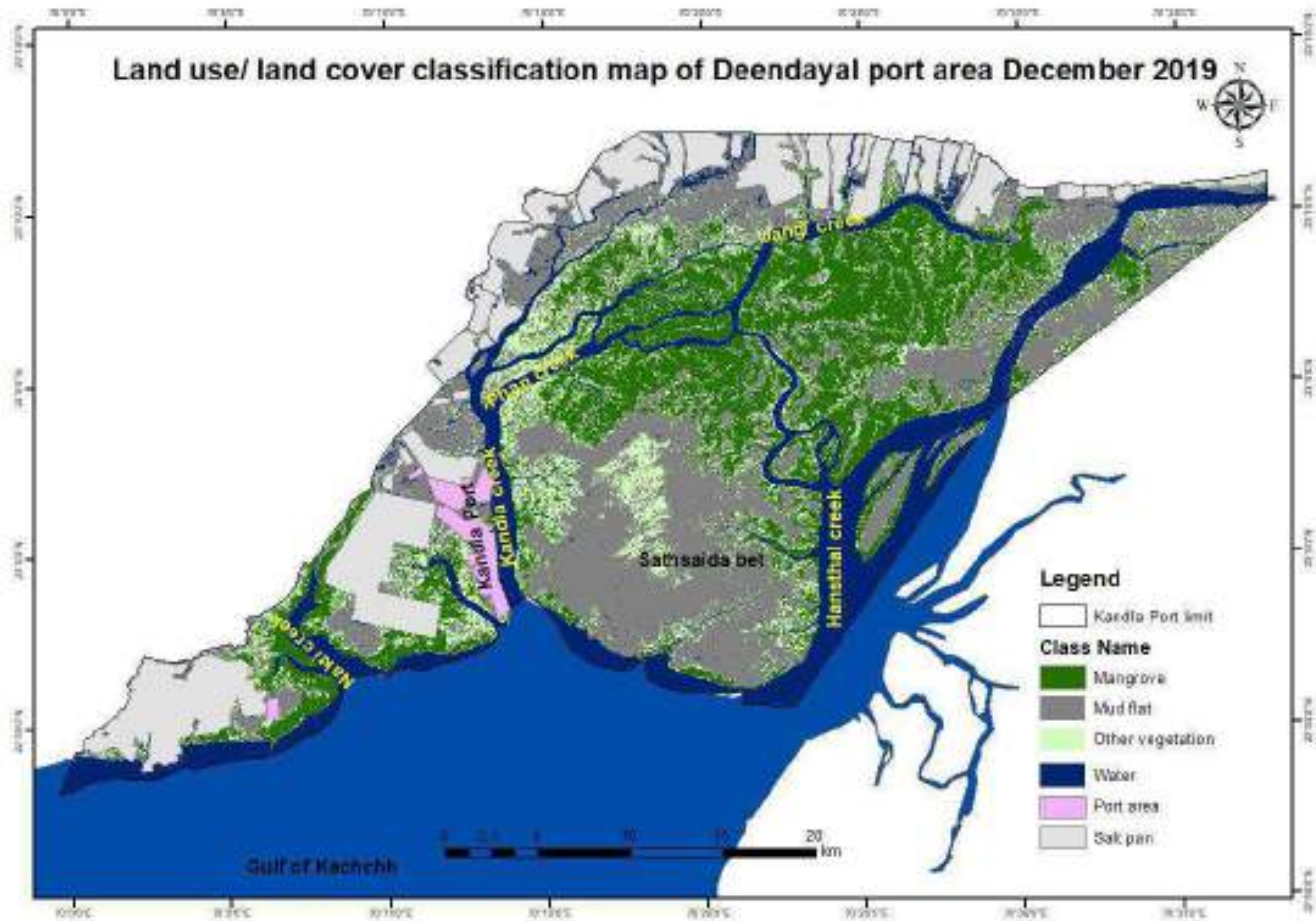


Figure 4 Land use/ land cover classifcation in DPT area December-2019

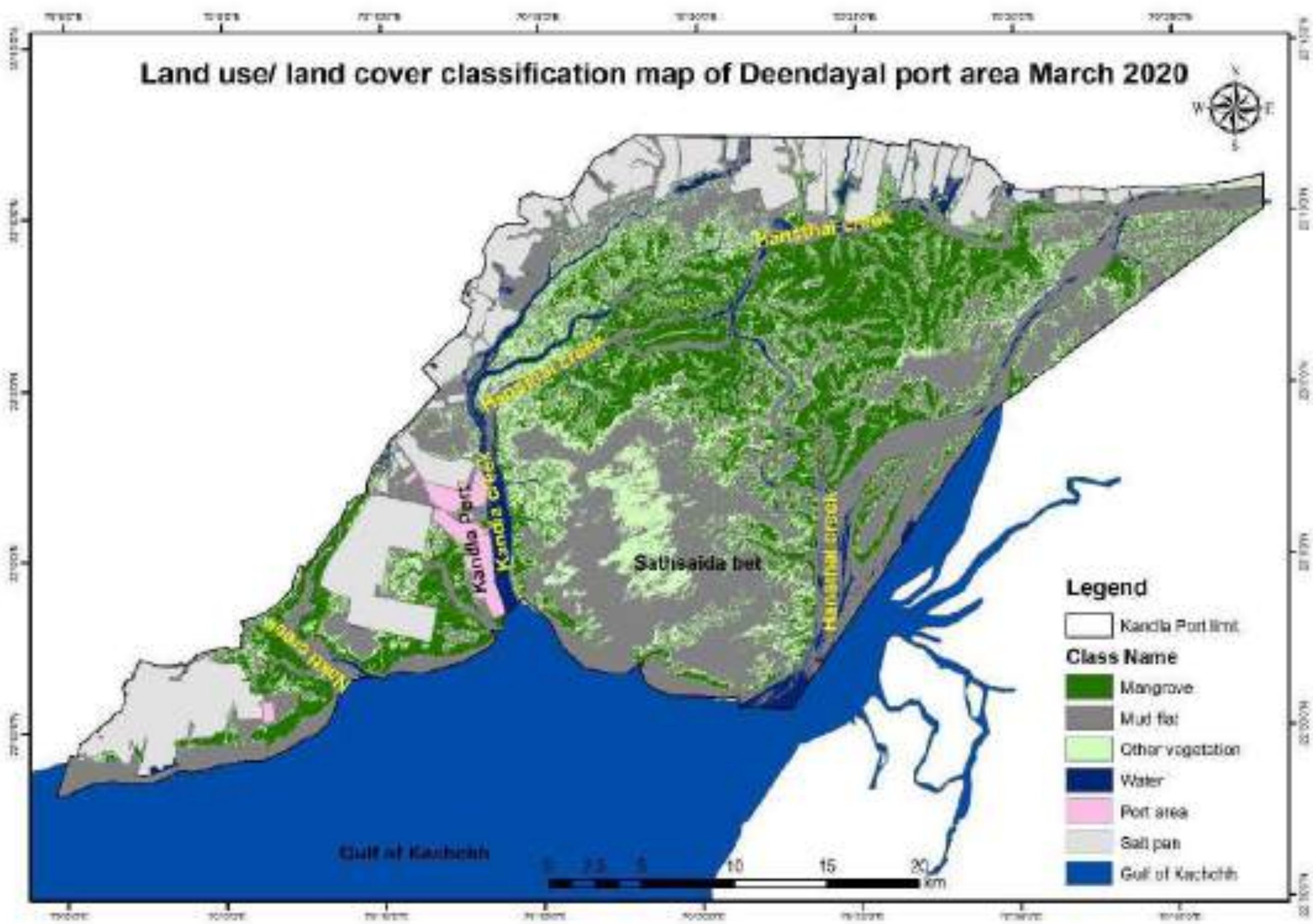


Figure 5 Land use/ land cover classifcation in Deen Dayal port area March-2020

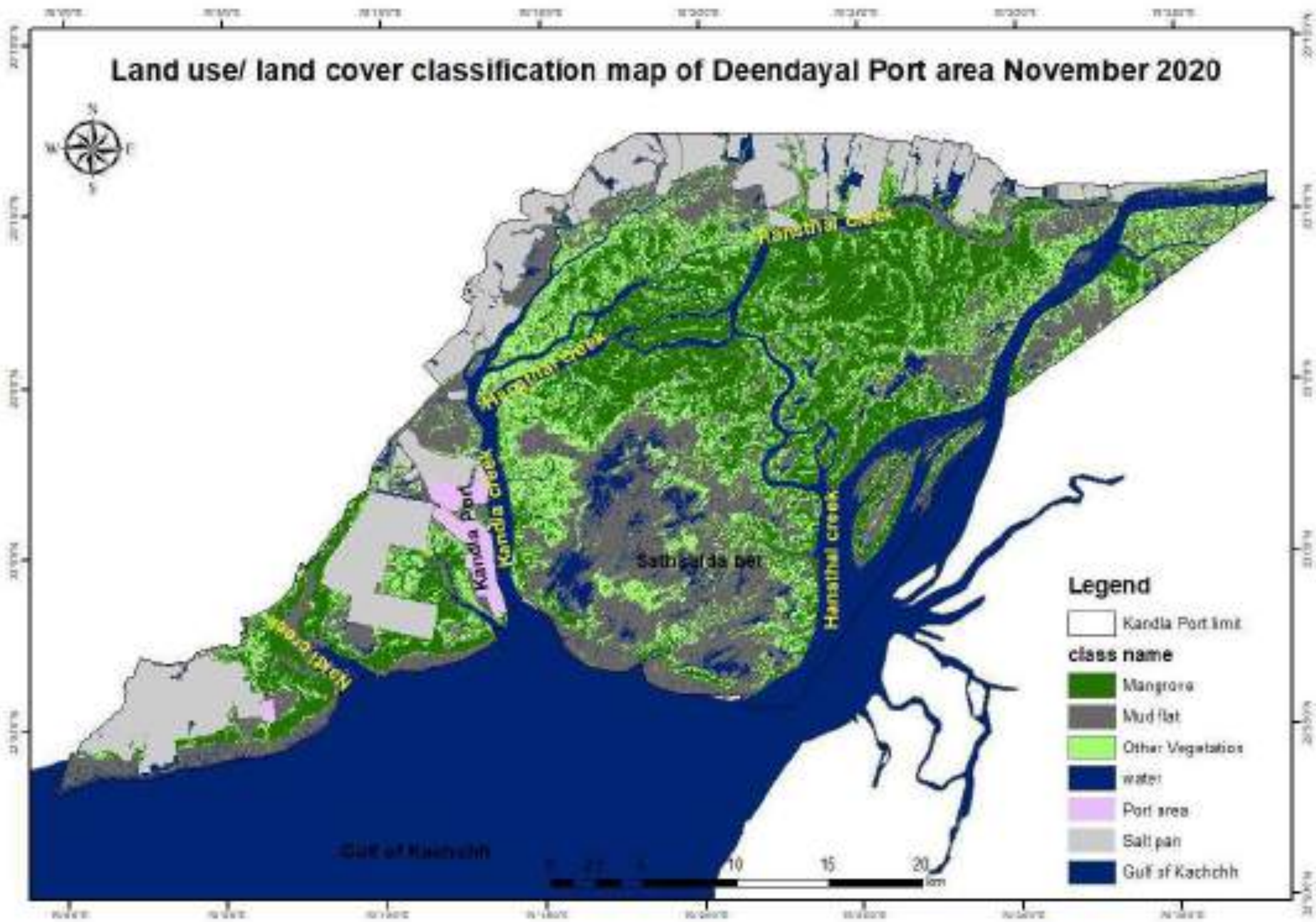


Figure 6 Land use/ land cover classifcation in Deendayal port area 2020

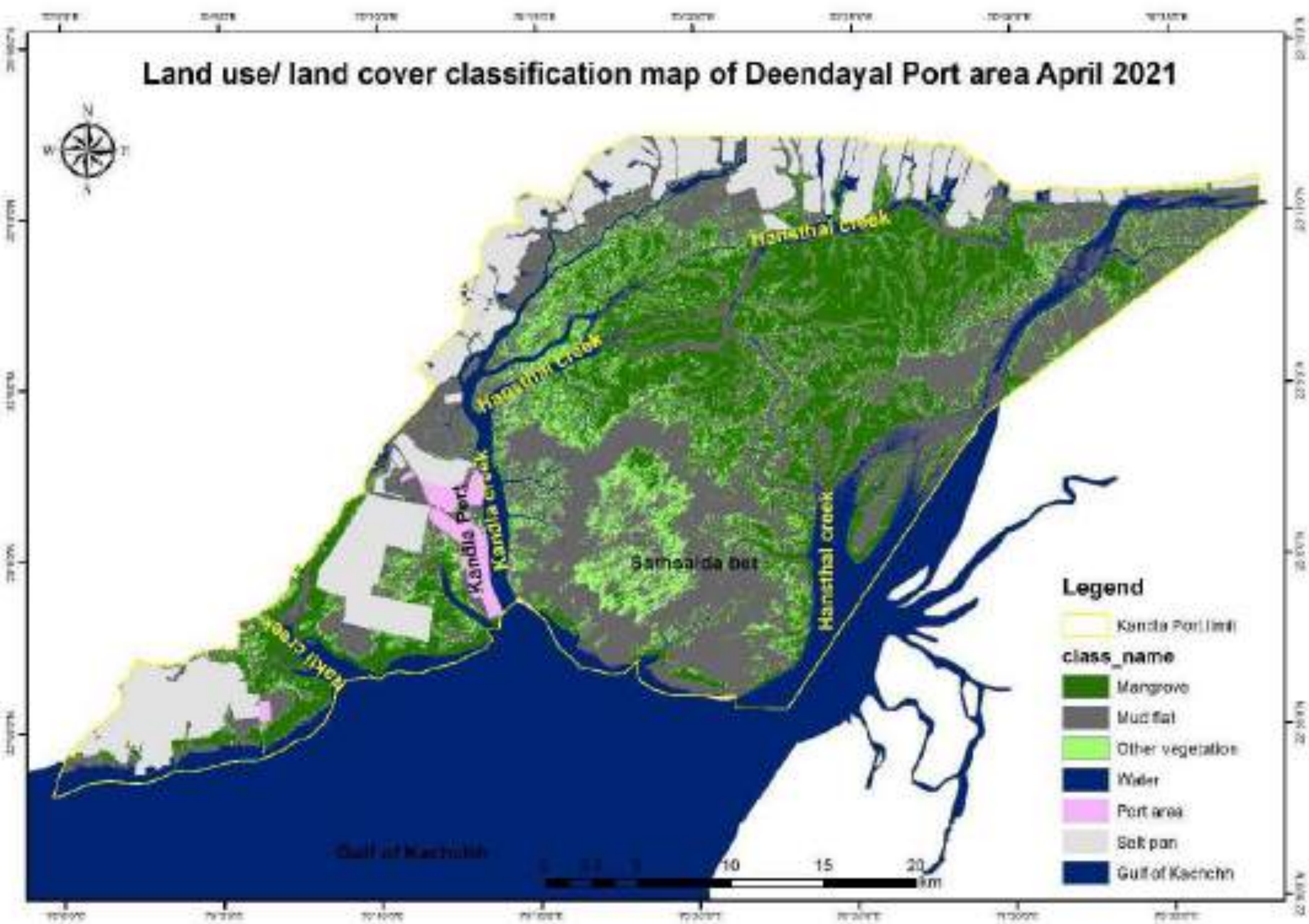


Figure 7 Land use/ land cover classifcation in Deendayal port area April-2021

Table 1. Land use /Land cover statistics in the DPT area - April-2017

Class Name	Area (ha)	Percentage
Mangrove (Dense + Sparse)	19319.71	19.32
Mud flat	31293.43	31.30
Other veg	12438.8	12.44
Port Area	1243.67	1.24
Salt pan	15016.1	15.02
Water	20674.3	20.68
Total	**99986.01**	**100.00**

Table 2. Land use /land cover statistics in the DPT area - December-2019

Class Name	Area (ha)	Percentage
Mangrove (Dense + Sparse)	23060.04	23.06
Mud flat	31179.87	31.18
Other vegetation	12333.21	12.33
Water	16953.68	16.96
Port area	1346.21	1.35
Salt pan	15113.00	15.12
Total	**99986.01**	**100.00**

Table 3. Land use /land cover statistics in the DPT area March-2020

Class name	Area (ha)	Percentage
Mangrove (Dense + Sparse)	23168.40	23.17
Mud flat	40714.60	40.72
Other vegetation	15991.69	15.99
Port area	1346.21	1.35
Salt pan	15054.50	15.06
Water	3710.61	3.71
Total	**99986.01**	**100.00**

Table 4. Land use /land cover statistics in the DPT area for November 2020

Class	Area (ha)	Percentage
Mangrove	23856.80	23.86
Mud flat	28764.60	28.77
Other Vegetation	16346.10	16.35
Port area	1346.21	1.35

Salt pan	15193.50	15.20
Water	14478.80	14.48
Total	99986.01	100.00

Table 5. Land use /land cover statistics in the DPT area for April 2021

Class name	Area (ha)	Percentage
Mangrove	23967.40	23.97
Mud flat	36909.30	36.91
Other vegetation	11230.40	11.23
Port area	1346.21	1.35
Salt pan	15236.60	15.24
Water	11296.10	11.30
total	**99986.01**	**100.00**

Table 6. Land use/land cover statistics in the vicinity of DPT area during 2017-2021

Month Year	April 2017	December 2019	March 2020	November 2020	March 2021
Class Name	**Area (Ha)**				
Mangrove	19319.71	23060.04	23168.4	23856.8	23967.40
Mud flat	31293.43	31179.87	40714.6	28764.6	36909.30
Other vegetation	12438.8	12333.21	15991.69	16346.1	11230.40
Port Area	1243.67	1346.21	1346.21	1346.21	1346.21
Salt pan	15016.1	15113	15054.5	15193.5	15236.60
Water	20674.3	16953.68	3710.61	14478.8	11296.10
Total	**99986.01**	**99986.01**	**99986.01**	**99986.01**	**99986.01**

3. Mudflats

Mudflats are sedimentary intertidal habitats created by deposition in low energy coastal environments, particularly estuaries and other sheltered areas. Their sediments consist mostly of silt and clay with high organic carbon content. Mudflats are intimately linked by physical processes and dependent on coastal habitats. They commonly appear in the natural sequence of habitats between subtidal channels and vegetated salt marshes. In some coastal areas, they may be several kilometers wide and commonly form the largest part of the intertidal area. Mudflats being intertidal areas, dissipate wave energy, thus reducing the risk of eroding salt marshes, damaging coastal defences and flooding low-lying land. The mud surface also plays an important role in nutrient chemistry of the near shore waters receiving pollution, organic contaminants and high concentrations of heavy metals.

Mudflats are characterized by high biological productivity and abundance of organisms, but low diversity with few rare species. The mudflat biota reflects prevailing physical conditions of the region. Intertidal mudflats can be separated into three distinct zones such as the lower tidal mudflats, middle mudflats and upper mudflats. The lower mudflats lie between mean low water neap and mean low water spring tide levels, and are often subjected to strong tidal currents. The middle mudflats are located between mean low water neaps and mean high water springs. The upper mudflats lie between the mean high water neap and mean high water springs. The upper mudflats are the least inundated part and are only submerged at high water by spring tides (Klein, 1985). Salt marsh vegetation may colonize as far seaward as mean high water neaps. Mudflats will often continue below the level of low water spring tides and form sub-tidal mudflats (McCann, 1980). The upper parts of mudflats are generally characterized by coarse clays, the middle mudflats by silts, and the lower mudflats by sandy mud (Dyer *et al.,* 2000). Mudflats are habitat for intertidal fauna, especially, clams, gastropods, mudskippers, avifauna, etc.

Deendayal Port Trust (DPT), Kandla jurisdiction includes mainly the port area, Tuna creek, Sat Saida bet and adjacent area of the port. Kandla creek on whose bank the port is located extends up to the Gulf of Kachchh at a distance of 90 nautical miles from the port. The width of the Gulf of Kachchh channel varies from 200 m to 1000 m. The contour depth along the shipping channel is around 10 m.

3.1. Methodology

3.1.1. Sampling locations

Sediment samples were collected from 12 sampling locations by using sediment corer. Sediment samples were collected in triplicates from 10 cm^3 and made into composite for analysis (

Plate **1**). The samples were packed in zip lock bags, stored in an icebox and shifted to the laboratory for subsequent analysis.

3.1.1.1. Total Organic Carbon Estimation

The organic carbon content of the mudflats was estimated to assess its biological productivity. Soil Organic Carbon (SOC) was estimated following the method of Walkley and Black (1934). In this method, organic matter (humus) in the soil gets oxidized by chromic acid (Potassium dichromate plus concentrated H_2SO_4) by utilizing the heat evolved with the addition of H_2SO_4. The unreacted dichromate is determined by back titration with Ferrous (ammonium) sulphate (redox titration). Organic carbon was determined by following the below given formula:

$$\text{Oxidizable organic carbon (\%)} = \frac{10\ (B - T)}{B} \times 0.003 \times \frac{100}{\text{wt. of soil}}$$

Where B = volume (mL) of Ferrous ammonium sulfate is required for blank titration. T = volume of Ferrous ammonium sulfate needed for soil sample. Wt. =weight of soil (g).

3.1.1.2. Estimation of Bulk Density (BD)

The soil under field condition exists as a three-phase system *viz.* solid (soil particles), liquid (water) and gas (mostly air). The soil organic matter contained in a unit volume of the soil sample is called its bulk density. Bulk density depends on the texture, structure and organic matter status of soils. High organic matter content lowers the bulk density, whereas compaction increases the bulk density. To determine the bulk density of the sediment samples collected during the present study, the oven-dry weight of a known sediment volume was considered, and mass per unit volume was calculated following Maiti (2012).

3.2. Results

3.2.1. Bulk density of the sediment samples

The data on the bulk density of the sediment samples are presented in Figure 8. The bulk density of mangrove soil at Kandla coastal region ranged from 1.0±0.02 g/m^2 to 1.14±0.07 g/m^2. The highest bulk density (1.14 g/cm^2) was noticed at site S-3 followed by S-6 and S-8 (1.13 ±0.02 g/m^2), respectively. The lowest bulk density (1.0±0.01 g/m^2) was recorded at site S-1 and S-7 located at Tuna creek and Khari creek, respectively. During the winter 2021, bulk density of mudflat sediment shown in Figure 9, the highest percentage of bulk density value was reported at S-9 (1.35±0.03 g/m^2) followed by S-12 (1.32±0.02 g/m^2) and S-1 (1.30±0.02 g/m^2).

3.2.2. Total Organic Carbon (TOC)

Soil organic carbon is dependent on living life forms and as there is variation in life forms in the mudflats so is the estimate of TOC. The highest TOC values (0.42 ±0.03%) were recorded at station S-5 followed by S8 (0.35 ±0.03%). Lowest TOC values were reported at site S-3 and S-9 (Figure 10). It is observed that TOC values show a significant difference among the sampling stations which means that organic carbon is dependent on the living life forms and variations in the life forms in the mudflats. During the winter 2021 percentage of total organic carbon concentration mudflat of the DPT is shown in Figure 11. The highest percentage of TOC value was reported at S-7 (0.99±0.47) followed by S-1 (0.84±0.56). Likewise, lowest TOC values was reported at S-5 (0.27±0.03) followed by S-4 (0.46±0.59).

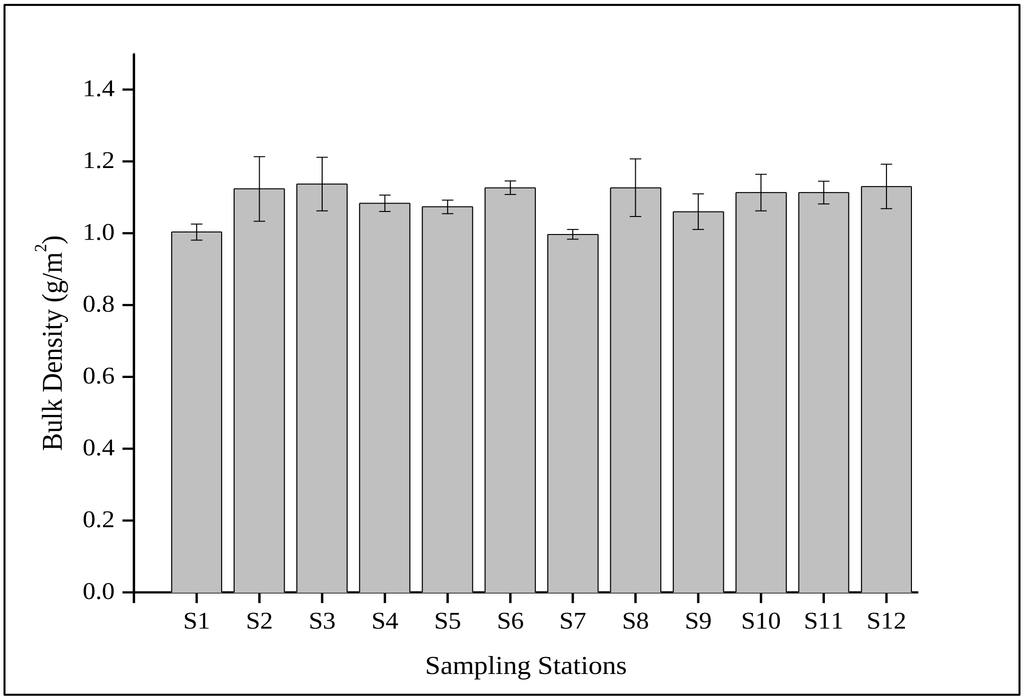


Figure 8. Bulk density of sediment samples during post-monsoon 2020

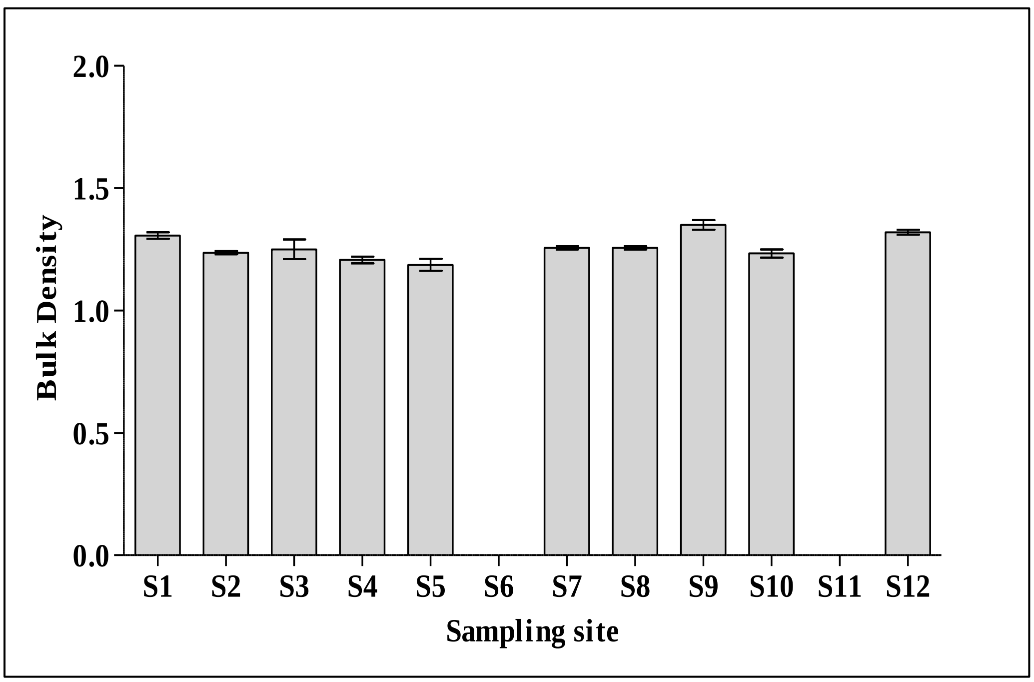


Figure 9. Bulk density of sediment samples during the winter (2021)

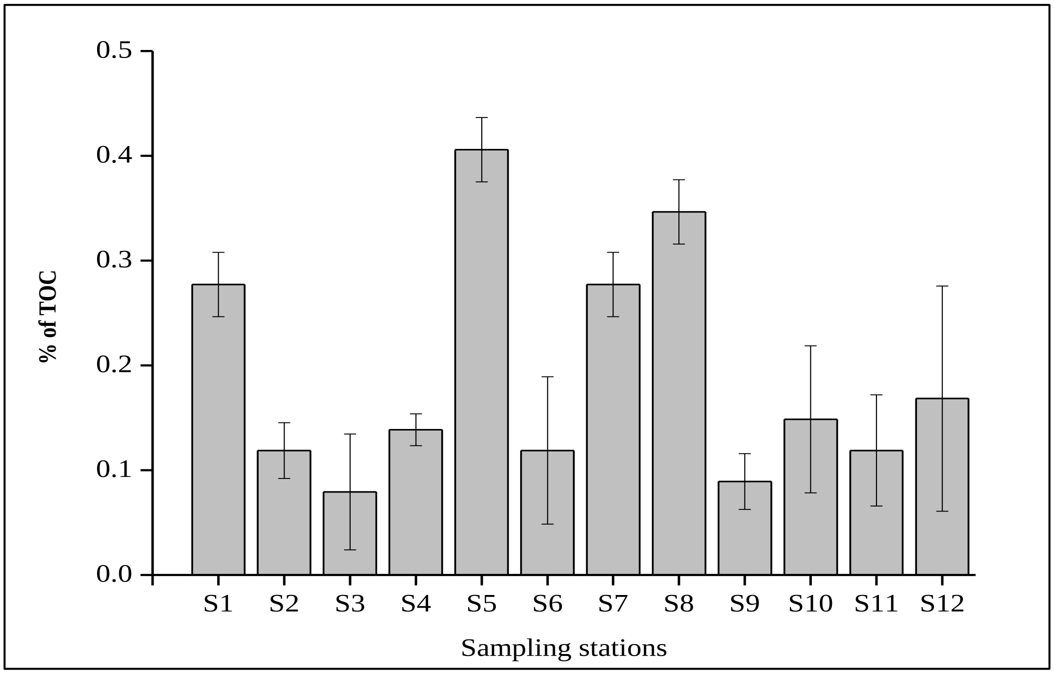


Figure 10. TOC (%) in mangrove soil during Post-monsoon 2020

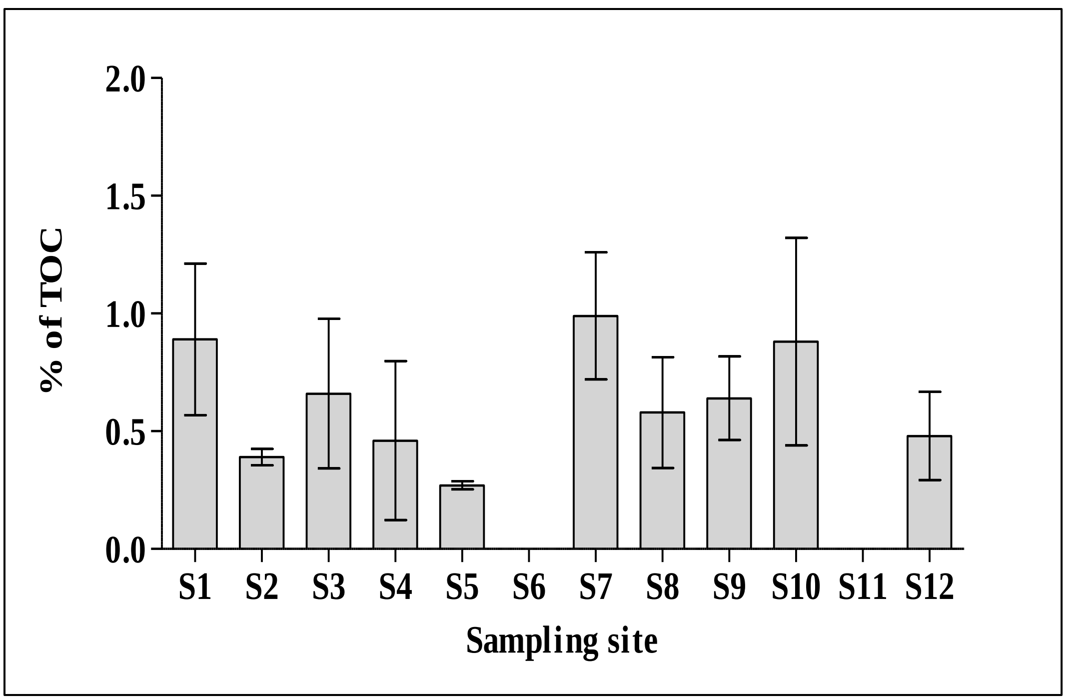


Figure 11 TOC (%) in mangrove soil during winter 2021

3.3. Discussion

Mudflats constitute a major ecosystem of the region and the significance of ecosystem services rendered by mudflat is endorsed in Coastal Regulation Zone (CRZ, 2011) as it accords special status to highly productive zone. Mudflat has an assemblage of plant-animal-geomorphological entities. DPT has been surrounded by two major ecosystems such as mangroves and mudflats which support a number of ecosystem services like nursery grounds for fish and shellfishes and breeding/feeding grounds for the birds (Spencer & Harvey, 2012). The TOC concentration is direct indicator of mudflat productivity and blue carbon sequestration. The data on the two seasonal samplings revealed that the different sampling sites of DPT port jurisdiction have considerable variations. In the present study the TOC values were higher at sampling stations S-5 and S-8 during post-monsoon. The sampling station S-3 and S-9, situated opposite to the Kandla port at Sat Saida bet, had shown the lowest TOC vales. It was inferred that the different locations of DPT have shown considerable variation in TOC values.

The comparative analyses of TOC (%) revealed that the values varied among the seasons during the entire period of the study (Table 7). The data showed that during post-monsoon highest TOC values were observed at all stations except station S-6 which had the lowest value. This site is characterized by extensive mudflat with sparse and patchy mangrove distribution. The high organic carbon during post-monsoon in Kachchh mangrove sediment was reported earlier (Saravanakumar *et al.*, 2008) suggesting the contribution of organic matter deposition from the mangrove and terrestrial detritus which are found as the suspended matter. In addition to this, an increase in organic matter content in the sediments may be due to the fine nature of sediments (clayey and silt) and high rate of sedimentation and decomposition of mangrove foliage and other vegetative remains in the sediments. Similarly, researchers have suggested the importance of terrestrial organic carbon flux; physical mixing and the primary producers in the marine environment are responsible for the TOC in mudflats.

The present study results were compared with the previous investigations conducted by GUIDE (2018 & 2020) on the TOC (%), and it was evident that the average soil organic carbon in the sampling sites was lower than the peaty soil values (0.38% to 13.38%)

reported by Moreno & Calderon (2011). Generally, organic carbon less than 1% in soil samples reflect poor biogenic carbon derived from plants which serves as energy source for the heterotrophic organisms including bacteria and intertidal fauna. In the case of DPT area mudflats, continuous oscillations of the waves on the exposed mudflats bordering the creeks wash off the surface layer of the substratum which is composed of fine sand fraction which do not hold the silt particles and contributes to the organic carbon pool in the soil. However, mudflats serves as habitat and feeding ground for many avifauna, crustaceans, gastropods, bivalves, polychaetes and fishes. Conversely, the results of Shannon biodiversity Index of the intertidal fauna in the sampling sites also indicates the productivity of the mudflat as low with low organic carbon content in the soil, less carbon content indicating the need for soil texture analysis at different depth and at tidal levels. The organic carbon content is closely associated with the soil texture which varies with space and time along with the physical characteristics of the shore.

Table 7. Comparative analysis of Total organic carbon (%) from 2017 to 2020

Stations	TOC (%) 2017-2018		TOC (%) 2018-2019		TOC (%) 2019-2020	
	Post-monsoon	Winter	Post-monsoon	Winter	Post-monsoon	Winter
S-1	2.85	Data Not available	2.9±0.2	0.68±0.02	0.98±0.18	0.15±0.0
S-2	1.38		10.1±0.4	3.70±0.03	0.12±0.0	0.52±0.13
S-3	1.26		1.3±0.3	0.31±0.02	0.25±0.11	0.51±0.12
S-4	1.2		1.2±0.2	0.32±0.04	0.38±0.03	0.55±0.03
S-5	1.35		1.4±0.2	0.31±0.05	0.30±0.00	0.22±0.26
S-6	0.3		0.3±0.1	0.37±0.03	0.28±0.20	0.07±0.01
S-7	1.8		1.8±0.2	0.72±0.16	0.31±0.18	0.41±0.07
S-8	3.63		3.6±0.2	0.45±0.03	0.24±0.05	0.27±0.06
S-9	3.73		3.7±0.1	0.73±0.02	0.23±0.03	0.25±0.08
S-10	3.26		3.3±0.1	0.26±0.02	0.16±0.03	0.10±0.05
S-11	1.95		2.0±0.2	0.40±0.03	0.27±0.16	0.33±0.18
S-12	1.95		2.7±0.4	0.37±0.03	0.27±0.03	0.49±0.05

Plate 1. Mudflats in the jurisdiction of DPT

(A) Extended mudflat during lowest low tide, (B) Sample collection using auger at different depth, (C) Mudflat an extension of Mangrove patches, and (D) Mudflat with extensive halophyte

4. Mangroves

Globally, mangroves are distributed in 123 tropical and subtropical countries which differ in species composition, biophysical and geomorphological settings. Their worldwide extent ranges from 10 to 24 million ha. Indian mangroves account for around 4% of global distribution with an extent of 4975 km^2. Out of which Gujarat coast accounts for 1177 km^2 (23.66%) under mangrove that is the second largest in the country and largest mangrove patch along the western coast. However, mangroves of Gulf of Kachchh are floristically poor with the predominance of single species known as *Avicennia marina*. Most of the mangrove stands within Deendayal Port are sparse in nature. Harsh environmental settings like arid hinterland, minimal annual rainfall of around 348 mm and extreme evapotranspiration rate have rendered these mangrove formations single species stands of *A. marina*, though sporadic occurrence of three more true mangrove species namely, *Rhizophora mucronata, Ceriops tagal* and *Aegiceras corniculatum* is occasionally noticed.

Mangrove environment is dynamic and undergoes morphological changes as a result of physical processes that involve tidal currents and associated sediment transport mediated by biological agents (Coco *et al*., 2013). The evolution of these tidal systems becomes complex when mangroves are present as they are capable of modifying its physical environment (Murray *et al*., 2008). In general, mangroves solely depend on the physical and chemical processes that govern and shape their structure, density, diversity and other ecological and biological attributes. Only few research studies have been done in the past in a holistic manner to understand the physical, chemical, biological interlinkage that shapes the evolution of this ecosystem and the morphological settling that host them (Van Maanen *et al.*, 2015). It was Wolanski *et al*. (1992) who first reviewed the physical processes acting on the mangrove ecosystem in the tropics. Even today, physical processes are generally under evaluated in terms of the factors that influence the mangrove ecosystem. Coastal belt within the port environs is heavily dissected leading to varied morphological pattern enabling formation and colonization of mangroves on creek banks, Islands and mudflats. While influenced by the prevailing physical processes such as tides, currents creek hydrodynamics, mangroves also alter the dynamics of tidal channel networks. Biologically, factors such as stand structure, species composition, and landward extent are some of the attributes that are influenced by physical processes such as tides.

This chapter presents the results of the study carried out on the mangrove vegetation attributes at 12 representative sampling locations within the DPT port area (Figure 12). The vegetation attributes such as density, diversity and younger classes were attempted. In addition to analyzing the vegetation characteristics of Deendayal port environments, this chapter also summarizes the physical processes influencing the mangrove ecosystem. This analysis is essential to draw a holistic preservation and management plan for the port authorities.

4.1. Methodology

Twelve sites were primarily considered which were widely distributed and covered the entire DPT jurisdiction. Together, all these 12 sites presumed to represent the status of mangroves of the Kandla covering a mosaic of environmental settings. The mangrove sites were named Tuna, Jangi, Kandla, Phan and Navlakhi based on the nearest location to their respective creek system (Fig 4.1). The vegetation structural attributes of all the mangrove stands were based on Point Centered Quadrate Method (PCQM). The methodology and measurement accuracy of Cintron & Novelli (1984) was adopted to study both measurements of density, height variations and basal area at each stand. A transect of a maximum of 200 m was laid out either perpendicular or parallel to the creek and sampling points at an interval of 10 m were fixed to record the vegetation structure of the stand. The orientation of the transect line was prefixed following the ease of mobility within the sites for data recording. The tree distance from the centre of the sampling point, tree height from the ground level and canopy cover were measured using a measuring ranging rod and the girth at root collar above the ground (*GRC*) was a measure for each sample grown above 1 m in height (Plate 2, Plate 3). Trees with either two or more stem emerging from the base of the substratum were considered multi-stem trees. Along the transects, sub-plots of 1×1 m^2 and 2×2 m^2 were laid randomly to enumerate regeneration and recruitment class, respectively. Seedlings with a height of <50 cm were considered as regeneration class, while recruitment class was well-established saplings >50cm in height.

Plate 2 Transects/Quadrates laid by the team in DPT jurisdiction

Figure 12 Mangrove sampling locations at DPT jurisdiction during 2020-2021

4.2. Results

The overall vegetation structure (Plate 4) attributes of mangroves within the Deendayal Port Trust area such as density, height, canopy crown cover and basal area are described below.

4.2.1. Tree Density

An average of 2702 trees/ha and 3134 trees/ha of *A. marina* were reported during the post-monsoon of October 2020 and winter March 2021, respectively from the 12 sampling stations. The study results revealed that the tree density was quite comparable to a typical mangrove ecosystem in India. During the post-monsoon 2020, the tree density ranged from 1687 trees/ha at S-5 (Table 8) to highest 4352 trees/ha at S-7. On the contrary, during winter 2021, the tree density ranged from 2260 trees/ha (S-6) to 5020 trees/ha at S-7 (Table 9) in the Khari creek near Kandla port. The results clearly disclose the variability in mangrove formation in accordance to the geomorphology and environmental characteristics of the sites.

The tree density variations indicates that the sampling points of mangroves chosen for two seasonal study are not exactly the same location and had been selected randomly to represent the whole area. As mentioned in the earlier reports the fringing and over wash mangrove formation in DPT is in response to the variability in environmental conditions. Following this variability, the vegetation structure also differs at sampling sites. As per the results, mangrove stand structure in the DPT area is moderate to dense along the fringes of the creeks while at the interior sites the plants were less dense to sparse in almost all the sampling sites.

4.2.2. Tree Height

The overall mean height of the mangroves was 1.36 m and 1.47 m in the post-monsoon 2020 and winter 2021, respectively. An increase in the plant height was noticed at all stations during winter 2021, and the mean tree height was maximum 2.0m at S-2. During winter 2021 the mean tree height was the highest (1.6m) at Phan creek sites followed by

Tuna and Jangi sites. The plants around the Navlakhi creek were the shortest, mean height (1.3m) during winter 2021.

4.2.3. Canopy Crown Cover

The overall canopy cover of the 12 stations exhibited wide variation between the two seasons. The canopy cover showed an increasing trend at all sites during winter. It was 2.54 m^2 (overall mean) in the post-monsoon 2020 and increased to 3.04 m^2 in winter 2021. The canopy crown cover was comparatively high in the Phan creek sites during the whole period of observation, 4.07 m^2 (post-monsoon) and 4.58 m^2 (winter). In general, the canopy cover was small for the plants grown in the Kandla and Navlakhi creek sites. Creek wise, the Phan creek had the highest average canopy crown cover of 4.07 m^2 and the Navlakhi mangrove with 1.35 m^2. The Tuna creek mangrove had a mean canopy crown cover of 2.09 m^2 on average between sites; this reveals that the canopy crown cover over Tuna creek is higher when compared to all other creek sites.

4.2.4. Basal Area

The overall average basal area (at D30) of the mangroves of the DPT area was 14.98 cm during the post-monsoon 2020 and it reached 21.82 cm in winter 2021. During the post-monsoon, the mangroves at Phan creek sites had the largest basal area (115 cm) whereas S-1 and S-4 the minimum (5 cm). Similarly, during the winter, maximum basal area was recorded at Phan creek (89.50 cm) followed by Kandla Creek whereas the lowest basal area was reported at S-12 (5 cm). Multi-stemming at the base or branching out from the soil substratum is an indication of the presence of continuous disturbance during the early growth of the stand.

4.2.5. Regeneration and Recruitment Class

An overall average ratio of both the absolute tree density to regeneration class was 18.01 during post-monsoon 2020 and 14.8 during winter 2021 and regeneration to recruitment class was comparatively high (1.9 during post-monsoon and 1.0 during winter). Tuna creek was well sheltered with negligible disturbance attributing to the establishment of luxuriant mangrove stand (Table 10, Table 11).

During the post-monsoon and winter, the ratio of regeneration to recruitment class in Kandla creek is comparatively low than that of other sites. This is an indication of the existence of a typical disturbance for the seed distribution, establishment and survival of mangroves. The higher ratio of tree density to regeneration class (23.6) in Jangi creek and Navlakhi sites (31.5) reveals higher the rates in seed productivity, higher are the chances of settlement within the stand. Similarly, the higher ratio of regeneration to recruitment class at site S-8 in Navlakhi is an indication of site suitability for further mangrove development in connection to the absence of disturbances except for routine direct tidal action which helps a lot for seed dispersion. A detailed study on seed production rate, cast away and distribution pattern within the stand, seed predation, wash-out by the wave action, re-settlement pattern, chances of successful establishment, rate of sapling dislodgment etc., would supplement to document the factors contributing to the natural establishment of the mangrove stand.

The complex hydro-edaphic conditions influence the mangrove stature and are substantiated with infrequent tidal coverage and high evapotranspiration. This severe condition leads to low soil-water potential and ionic imbalance at sites and impose typical stress on the mangroves. Similar dwarf stature of *Avicennia marina* mangrove is being observed in the DPT. It is likely that the functional role of these mangrove stands such as vegetation structure attributes differs across the region of sampling and may not appropriately treat the formation around the DPT area as uniform distribution.

Plate 3 Measuring the Basal girth of Mangrove tree

Plate 4 Other Mangrove species at Kandla area
(A) *Ceriops tagal* ; (B) *Aegiceras corniculatum*, (C): *Rhizophora mucronata*

Table 8 Mangrove vegetation structure at Kandla during post-monsoon of 2020

Sampling stations	Density (Tree/ha)	Tree height (m)			Canopy cover (m)			Basal Area (cm)		
		Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
Tuna creek										
S-1	3583	1.27	0.00	1.95	1.31	0.00	5.46	10.62	5.00	31.00
S-2	2816	1.93	1.00	4.40	3.85	0.20	27.29	17.80	6.00	94.00
S-12	3974	1.11	0.00	2.00	1.12	0.00	3.90	15.50	0.00	52.00
Mean	**3458**	**1.43**	**0.33**	**2.78**	**2.09**	**0.07**	**12.22**	**14.64**	**3.67**	**59.00**
Phan creek										
S-5	1687	1.00	0.00	2.30	2.57	0.00	15.20	15.43	0.00	101.00
S-10	1843	1.49	0.00	4.80	5.56	0.00	37.17	19.11	0.00	130.00
Mean	1765	1.24	0.00	3.55	4.07	0.00	26.19	17.27	0.00	115.50
Kandla creek										
S-3	3058	1.01	0.00	2.70	1.47	0.00	27.29	14.40	0.00	67.00
S-4	2547	1.46	1.00	2.20	1.94	0.20	8.27	16.26	5.00	60.00
S-7	4352	1.74	1.00	4.50	3.64	0.20	47.84	14.55	7.00	77.00
Mean	3319	1.40	0.67	3.13	2.35	0.13	27.80	15.07	4.00	68.00
Jangi creek										
S-6	2017	1.46	0.80	3.40	2.89	0.12	11.39	16.25	7.00	49.00
S-11	2525	1.33	0.00	4.00	2.81	0.00	13.60	12.17	0.00	43.00
Mean	2271	1.39	0.40	3.70	2.85	0.06	12.50	14.21	3.50	46.00
Navlakhi creek										
S-8	2940	1.22	0.00	2.10	1.63	0.00	5.50	16.20	0.00	71.00
S-9	2453	1.44	1.00	2.80	1.07	0.08	7.96	11.23	7.00	36.00
Mean	2697	1.33	0.50	2.45	1.35	0.04	6.73	13.72	3.50	53.50
Overall average	**2702**	**1.36**	**0.38**	**3.12**	**2.54**	**0.06**	**17.08**	**14.98**	**2.93**	**68.40**

Table 9 Mangrove vegetation structure at Kandla during the winter of 2021

Sampling stations	Density (Tree/ha)	Tree height (m)			Canopy cover (m)			Basal Area (cm)		
		Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
Tuna creek										
S-1	4043	1.4	1.0	1.9	1.1	0.2	2.9	16.2	7.0	39.0
S-2	2625	2.0	1.1	4.0	7.1	0.3	45.0	28.6	5.0	84.0
S-12	3215	1.1	0.0	2.7	1.9	0.0	7.5	25.3	0.0	60.0
Mean	**3294**	**1.5**	**0.7**	**2.9**	**4.5**	**0.2**	**26.3**	**26.9**	**2.5**	**72.0**
Phan creek										
S-5	3079	1.6	1.0	3.2	4.6	0.8	22.5	28.9	7.0	91.0
S-10	3143	1.6	1.0	4.0	4.5	0.1	35.8	26.5	7.0	88.0
Mean	3111	1.60	1.00	3.60	4.58	0.46	29.13	27.72	7.00	89.50
Kandla creek										
S-3	4158	1.32	1.00	1.75	1.48	0.20	14.80	15.25	6.00	83.00
S-4	2619	1.30	1.00	3.80	2.00	0.20	13.13	18.62	7.00	150.00
S-7	5020	1.30	1.00	3.30	1.09	0.90	4.40	10.14	7.00	29.00
Mean	3932	1.31	1.00	2.95	1.52	0.43	10.78	14.67	6.67	87.33
Jangi creek										
S-6	2315	1.45	1.00	3.40	2.36	0.12	8.40	15.37	6.00	46.00
S-11	2510	1.58	1.00	4.00	2.07	2.00	13.60	12.57	7.00	26.00
Mean	2413	1.52	1.00	3.70	2.21	1.06	11.00	13.97	6.50	36.00
Navlakhi creek										
S-8	3576	1.52	1.00	3.00	2.10	0.24	14.00	23.98	6.00	79.00
S-9	2260	1.41	1.00	2.10	2.57	0.50	5.98	27.63	7.00	48.00
Mean	2918	1.47	1.00	2.55	2.33	0.37	9.99	25.80	6.50	63.50
Overall average	**3134**	**1.47**	**0.94**	**3.13**	**3.04**	**0.50**	**17.43**	**21.82**	**5.83**	**69.67**

Table 10 Regeneration and Recruitment class mangroves at Kandla during Post-monsoon 2020

Sampling stations	Density No/ha (1)	Regeneration class Density-No/ha (2)	Recruitment class Density-No/ha (3)	Ratio of 1:3	Ratio of 2:3
Tuna Creek					
S-1	3583	9250	42500	11.9	0.2
S-2	2816	55286	46286	16.4	1.2
S-12	3974	171750	60375	15.2	2.8
Mean	3458	78762	49720	14.4	1.6
Kandla Creek					
S-3	3058	92250	32500	10.6	2.8
S-4	2547	139167	27000	10.6	5.2
S7	4352	41250	30000	6.9	1.4
Mean	3319	90889	29833	9.0	3.0
Phan Creek					
S-5	1687	22800	12800	7.6	1.8
S-10	1843	76364	28182	15.3	2.7
Mean	1765	49582	20491	11.6	2.4
Jangi area					
S-6	2017	52759	12069	6.0	4.4
S-11	2525	21667	95333	37.8	0.2
Mean	2271	37213	53701	23.6	0.7
Navlakhi area					
S-8	2940	38214	13214	4.5	2.9
S-9	2453	143056	143333	58.4	1.0
Mean	2697	90635	78274	**31.5**	**1.95**
Overall average	**2702**	**69416**	**46404**	**18.01**	**1.9**

Table 11 Regeneration and Recruitment class mangroves at Kandla during winter season 2021

Sampling stations	Density No/ha (1)	Regeneration class Density-No/ha (2)	Recruitment class Density-No/ha (3)	Ratio of 1:3	Ratio of 2:3
Tuna Creek					
S-1	4043	78000	94667	23.42	0.8
S-2	2625	36111	28889	11.01	1.3
S-12	3215	66111	37778	11.75	1.8
Mean	3294	60074	53778	16.32	1.1
Kandla Creek					
S-3	4158	17143	71071	17.09	0.2
S-4	2619	9677	23226	8.87	0.4
S-7	5020	43000	82500	16.43	0.5
Mean	3932	23273	58932	14.99	0.4
Phan Creek					
S-5	3079	58462	35385	11.49	1.7
S-10	3143	46667	39333	12.51	1.2
Mean	3111	52564	37359	12.01	1.4
Jangi area					
S-6	2315	32778	23889	10.32	1.4
S-11	2510	54444	51111	20.36	1.1
Mean	2413	43611	37500	15.54	1.2
Navlakhi area					
S-8	3576	82778	64444	18.02	1.3
S-9	2260	27222	23889	10.57	1.1
Mean	**2918**	55000	44167	15.14	1.2
Overall average	**3134**	**50850**	**51061**	**14.8**	**1.0**

Harsh environmental characteristics in Kachchh have resulted in monotypic strands of *A. marina* in Kandla. *Ceriops tagal, Aegiceras corniculatum* and *Rhizophora mucronata* (Plate 4) were also reported in site S-3, S-4, S-5, S-12, S-8 and S-10. The distribution pattern and related spatial arrangement of mangrove tree positions are determined by the aforementioned hydro-edaphic conditions. The random distribution of trees recorded around the DPT need to be studied in detail based on latitudinal and longitudinal or based on distance gradient from the sea. With the additional data by the next season approaching the gradient distribution pattern, it would be possible to analyze further in detail and come out with finite information about the mangrove formation over here.

4.2.6. A Comparative Analysis of the Mangrove around DPT

The biodiversity of the mangrove environment at twelve (S1-S12) sampling locations was carried out for three consecutive years during 2017-2021. Five sampling sites namely Tuna, Phan, Kandla, Jangi and Navlaki were fixed for the collection of relevant phyto-sociological parameters. The parameters considered were plant density, height, GBH, plant height, canopy cover, basal cover, recruitment and regeneration class density. The plant density was high during 2017-2018 and there was a noticeable reduction in the number of plants in the Tuna and Sat Saida and Kandla. However, the surveys during 2019-2020 periods showed a recovery in the plant density in the Tuna, Phan and Kandla while the Jangi and Navlaki persisted with little increment. The Tuna block which had the highest number of mangroves during 2017 later reduced considerably and is now recovering gradually and showed an increase in the number of plants at all the sites during February 2020 survey. On average there was a variation in the size of the plants located at all sites during the three years, from a maximum of 2.2 m to 1.5 m (Table 8, Table 9). At all the sampling sites at the highest canopy cover was reported in Tuna creek. At Tuna block, the recruitment plant density was the highest among all the sites in 2017-2018 and later it was reduced. However, the Navalaki block exhibited higher recruitment in February 2021. Similar to the recruitment density, the regeneration of plants was reduced invariably at all sites. The ratio of recruitment to regeneration density also resulted in distinct variations between sites as well as seasons.

5. Intertidal Fauna, Marine Mammals and Reptiles

Gulf of Kachchh (GoK) occupying an area of 7300 km^2 is biologically one of the most productive environments with diversified habitats along the west coast of India. The southern shore has numerous Islands and inlets which harbour vast areas of mangroves and coral reefs. The northern shore with numerous shoals and creeks also sustains large stretches of mangroves. A variety of marine wealth existing in the Gulf includes algae, mangroves, corals, sponges, molluscs, prawns, fishes, reptiles, birds and mammals. The marine environment is a complex system influenced by a variety of physical, chemical and biological processes and harbors broad assemblages of diversified fauna. Intertidal fauna represents species of invertebrates and chordate which are adapted to survive in this realm of the marine environment. They have an important role to play in the pelagic and benthic food chain at different trophic levels in the coastal environment. Hence, periodic environmental monitoring to assess abundance and diversity of macrofauna of this habitat is inevitable. The intertidal fauna was comparatively less mortality based on the condition of their habitat and many environmental impacts can be identified by following the changes in the assemblages of intertidal fauna. Therefore, macrofauna of the intertidal area throughout the world has received considerable attention in recent years. Rapid coastal industrialization in the recent years has underlined the importance of complete understanding and continuous monitoring of marine environments especially coastal stretches where human activity is intense to evaluate its stability and functioning. In ports, activities like dredging, frequent vessel movement and presence of human interference in large numbers have major impact on the living organisms in the intertidal zone. Assessment of these effects has usually targeted bottom substrata and the associated benthic fauna. Hence benthic communities are logical target whose density, diversity, community structure and seasonal shift will be a powerful tool to understand any marine environment.

The present investigation has dealt with composition, distribution and diversity of intertidal fauna at 12 sampling locations within the jurisdiction of DPT. Many of the intertidal sampling sites selected are inhabited by mangroves and hence the data includes mudflats intertidal zone having mangroves and non-mangrove area.

5.1. Methodology

Intertidal faunal assemblages were studied for their density, abundance and frequency of occurrence during post-monsoon (October 2020) and winter (February 2021) at the pre-fixed 12 sampling locations within DPT jurisdiction. Sample collection and assessment of intertidal communities were done in the intertidal zone during the low tide period. At each site, 1 m^2 quadrates were placed randomly and all visible macro-faunal organisms encountered inside the quadrate were identified, counted and recorded (Plate 5). At each site along the transects which ran perpendicular to the waterfront, three to six replicate quadrate samples were assessed for the variability in macro-faunal population structure and the density was averaged for the entire intertidal belt. Organisms, which could not be identified in the field were preserved in 5% formaldehyde, brought to the laboratory and identified using standard identification keys (Abott, 1954; Chapgar, 1957; Apte, 1998). Average data at each site were used to calculate the mean density (No/m^2).

Plate 5 Quadrate method for intertidal faunal sample collection

5.1.1. Statistical Analysis

Different diversity indices were calculated using PAST statistical software methods in order to understand the intertidal faunal community structures like diversity, species richness and species evenness.

5.2. Results

5.2.1. Intertidal Fauna: Composition, Distribution and Density

The seasonal variation of intertidal faunal community across 12 sampling site of DPT environment are presented in Table 12 to Table 16. A total of 10 genera of intertidal macrofauna were recorded during post-monsoon (October 2020). The intertidal fauna falls in to five majors groups i.e. crustaceans, gastropods, bivalves, polychaetes and fishes (mudskipper). During the present study crustaceans were the dominant group constituted by 5 species followed by Mollusca (3 species), polychaeta and mudskipper were represented by single species. Among the crustaceans, *Metopograpsus messor*, *Scylla serreta*, *Uca* crab and *Bolepthalamus* sp. were distributed in most of the sampling locations. Gastropods *Cerithedia cingulata* and *Nassarius* sp. were recorded from only four sampling locations. *Nereis* sp. (Polycheate) was present at sites S-4 and S-5.

During the winter (February, 2021) a total of 12 genera belonging to four groups Crustaceans, Gastropods, Polychaeta and fishes (Mudskipper) were observed. Among the groups, Crustaceans and gastropods were dominant with 6 and 4 species, respectively while Fishes and polychaetes were represented with single species. The mangrove tree trunk crab *M. messor* and *Uca lactea annulipes* were distributed at all the 12 sampling sites (Plate 7).

5.2.1.1. Percentage Composition of Intertidal Fauna

Highest percentage composition of intertidal macrofauna was shared by *Uca* crab (21.7%) followed by crab Juveniles (20.3%), mangrove crab *Metopograpsus messor* (19.1%) and mud crab *Scylla serrata* (13.4%). Group-wise percentage composition was in the order, Crustaceans (76%), Mollusca (19%), mudskipper (4%) and polychaetes (1%) (Figure 13).

The composition of intertidal fauna during winter 2021 is shown in Figure 14. Group wise, Crustaceans contributed the highest percentage (75%) followed by Gastropod (18%) and Mudskipper (4%). In terms of species composition, *M. messor* contributed the highest percentage (33.7%) followed by *Uca lactea annulipes* (21.6%), Juvenile crabs (14.0%) followed by *Boleopthalamus sp.* (6.7%).

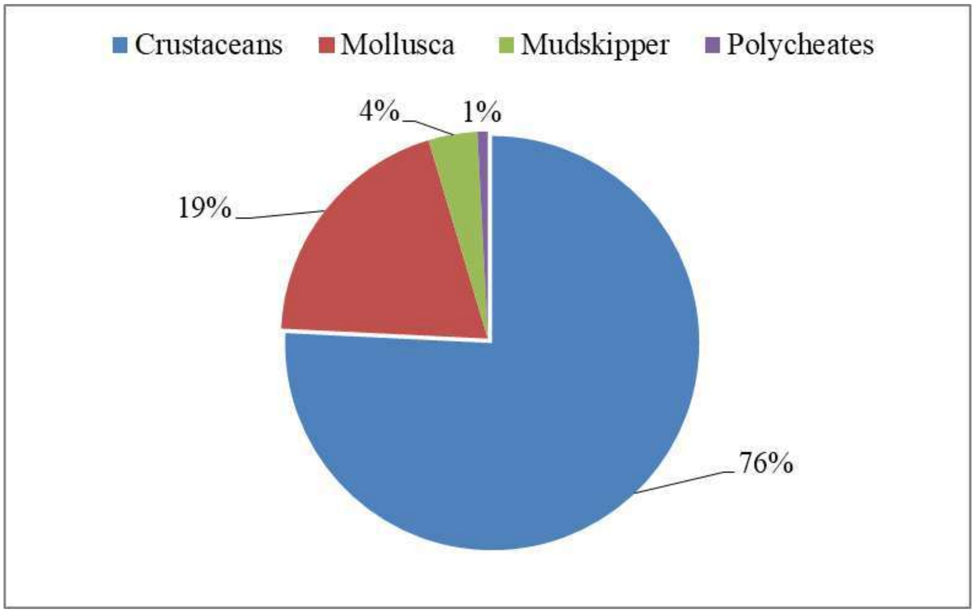


Figure 13 Composition of intertidal fauna during post-monsoon 2020

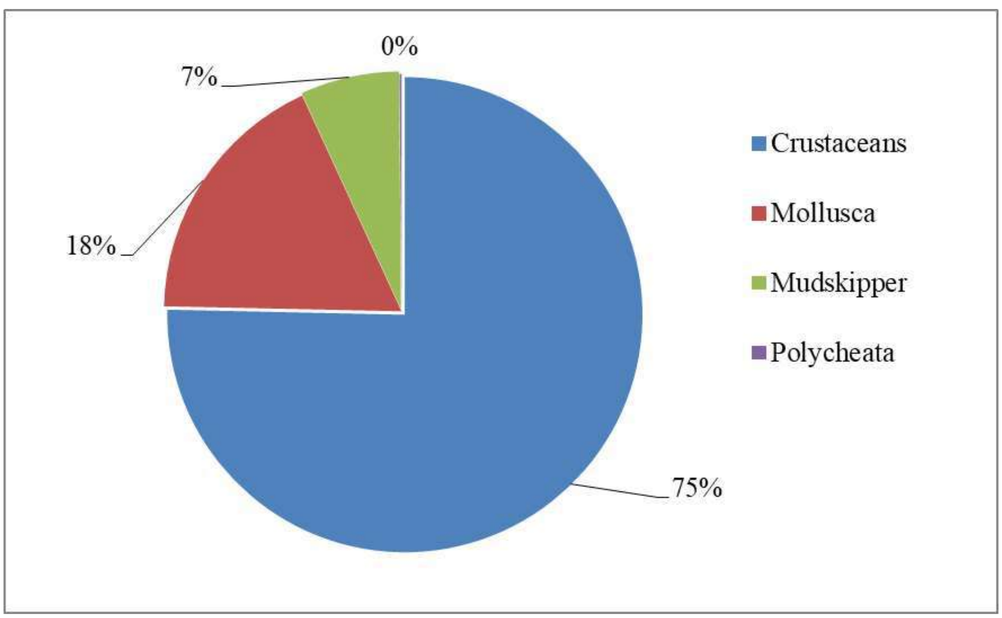


Figure 14 Composition of intertidal fauna during winter 2021

5.2.1.2. Diversity Indices

Species diversity is a basic measure of community structure and organization and the most important parameter to understand the health status of the ecosystem. Diversity indices help us to identify species richness; evenness and implies both species and numbers and how evenly they are distributed in the community (Prasad, 2003). Information on species diversity, richness and evenness of biological components of the ecosystem is essential to understand detrimental changes in the environment (Krishnamoorthy & Subramanian, 1999).

In the present study, the Shannon diversity index ranged from 1.06 to 1.55 (Table 14, Table 16). The highest Shannon diversity index was recorded at S-7 and the lowest at S-1. The highest species evenness (0.94) was noticed at S-7 while the lowest (0.54) from site S-1. The highest species richness was recorded at S-4 (1.47) while it was 0.63 at site S-10. In general, the distribution of intertidal communities at Deendayal Port is uneven and dominated by a few species. During winter the highest Shannon diversity index was reported at S-1 (1.54) followed by S-3 (1.53) and S-11 (1.50) while lowest was at S-5. The highest species richness was found at S-2 (1.38) followed by S-3 (1.30) and S-11 (1.21) and the lowest at S-5 (0.43). Highest species evenness was observed at S-12 (1.00) followed by S-1 and S-10 while lowest at S-11 (0.64). In general, the intertidal macrofaunal communities at Deendayal Port environment showed the uneven in distribution pattern and dominated by few species.

5.2.2. Marine Mammals and Reptiles

During the post-monsoon and winter (October 2020 and March 2021) field surveys, one reptilian species, the saw-scaled viper *Echis carinatus sochureki* (Plate 6) was recorded at S-10 located Northern part of Sat Saida bet along the Phan creek. This species was spotted on the branches of mangrove plants about one meter above from the ground. Though literature describes the species as aggressive and strikes at a lightning speed, the observed specimen was lethargic and slow in motion.

Plate 6. Saw-scaled viper observed during the field investigation

5.3. Discussion and Comparative Analysis of Intertidal Fauna

The diversity indices of the intertidal fauna were low in DPT port area with their lower population density during the seasonal study throughout the stations. Macrofaunal communities did not show much spatial and temporal variation in their components at all the 12 sampling locations. Distribution of intertidal fauna seems to be fully governed by the environmental parameters like physico-chemical and biological characteristics of ambient milieu. Generally, intertidal fauna in the Kachchh coast has to cope with a harsher environment with relatively high salinity, wide temperature fluctuations, and seasonal oscillation of different hydrological parameters and high rate of siltation. The suspended solids (SS) in the water were generally found due to the dispersion of fine sediment from the bed and the intertidal mudflats due to tidal movements at the mouth of Kachchh coast (Kandla). An earlier study by Saravanakumar *et al*. (2007) revealed the presence of five intertidal macrofauna in the mangrove environments along the Kachchh coast with diversity index ranging from 1.84 to 2.45. The species composition and diversity indices reported during 2018-2019, 2019-2020 and 2020-21 did not vary significantly at DPT port environment. It was understood that the intertidal macrofauna community in Kachchh mangrove has not varied much in terms of its species diversity. According to Magurran

(1991), Shannon diversity index of $\geq$3.0 is an indication of healthy coastal environment. However, intertidal macrofaunal diversity indices around the DPT coastal environment was <3.0 which indicates that the environment is unfavourable for the existence of diverse groups of intertidal macrofauna.

The intertidal fauna were sampled from select sites mainly including invertebrates such as Gastropods, bivalves, crustaceans, polychaeta and the vertebrate, fishes. Different groups were sampled from different tidal levels at each station following standard protocols. The total number of fauna obtained was represented as No/m^2 for comparative analysis. In general, the numerical abundance of all the groups declined gradually however; there was a large reduction in the number of crustacean fauna which were more abundant during 2017 to 2018 (Table 12). The isopods and Amphipods were reduced considerably at all the stations. There was also decline in the population of gastropods and bivalves. The climatic condition in the study area is generally categorized as typical arid with frequent droughts and extreme temperature. The monsoon season in the west coast, it was highly erratic in both quantity and duration since decades. These climatic conditions have led to increase in water temperature and salinity has impacted the occurrence of intertidal fauna especially the crustaceans and gastropods in the Kandla coast. The results of the population density of gastropods are in conformity that the density is inversely proportionate to the temperature gradient of the coastal water.

Table 12. Comparative analysis of intertidal fauna (2017 to 2021)

Year	Population Density (No/m^2)	Total No. of Species
Post-monsoon 2017	789 to 2893	27
Winter 2018	963 to 2728	29
Post-monsoon 2018	43 to 103	21
Winter 2019	5 to 304	31
Post-monsoon 2019	8 to 233	19
Winter 2020	6 to 80	10
Post-monsoon 2020	1 to 69	10
Winter 2021	1 to 65	12

Table 13. Distribution of intertidal fauna of Kandla coast during Post-monsoon 2020

Intertidal fauna	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11	S-12	Total	% Occurrence
Crustaceans														
Amphipods			13										13	1.2
Metopograpsus messor	8	8	18	32	35	9	31	8	15	26	16	5	211	19.1
Juveniles crab	4	4		7					75		65	69	224	20.3
Scylla serrata	8		21		28	13	19	4	4	37	0	14	148	13.4
Uca crab	22	15		6	8	28	19	15	17	50	16	43	239	21.7
Mollusca														
Telescopium telescopium	4	2		1			10					2	19	1.7
Micromolluscs- *Nassarius* sp.	63										32	44	139	12.6
Cerithedia cingulata			24	2			23				9		58	5.3
Mudskipper														
Bolepthalamus sp.	2	5	3	5		6		5	7	3	3	3	42	3.8
Polycheates														
Nereis sp.				7	2								9	0.8
Density (No/m^2)	111	34	79	60	73	56	102	32	118	116	141	180	1102	100.0

Table 14 Diversity indices of intertidal fauna during Post-monsoon 2020

Diversity indices	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11	S-12
Taxa_S	7	5	5	7	4	4	5	4	5	4	6	7
Dominance_D	0.37	0.29	0.24	0.33	0.39	0.34	0.22	0.32	0.45	0.34	0.29	0.27
Shannon_H	1.33	1.40	1.47	1.46	1.06	1.22	1.55	1.25	1.11	1.16	1.45	1.47
Evenness_e^H/S	0.54	0.81	0.87	0.61	0.72	0.85	0.94	0.87	0.61	0.80	0.71	0.62
Menhinick	0.66	0.86	0.56	0.90	0.47	0.53	0.50	0.71	0.46	0.37	0.51	0.52
Margalef	1.27	1.13	0.92	1.47	0.70	0.75	0.86	0.87	0.84	0.63	1.01	1.16

Table 15 Distribution of intertidal fauna of Kandla coast during winter 2021

Intertidal fauna	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11	S-12	Total	Occurrence	%
Crustaceans															**75.1**
Amphipods			11										11	1	
Juvenile crabs						39					65		104	2	
Metopograpsus messor	15	16	17	8	65	25	17	25	16	24	16	7	251	12	
Pistal shrimp		1											1	1	
Uca lactea annulipes	20		11	20	31	8	6	8	16	18	16	7	161	11	
Scylla serreta		3	2	6		13	5				2		31	6	
Mollusca															**17.7**
Ceretheridia cingulata	8	10					15				9		42	4	
Thais species								6	6				12	2	
Micro-Gastropod	14	6					5	2	2		32	7	68	7	
Telescopium telescopium	7								3				10	2	
Mudskipper															**6.7**
Bolepthalamus sp.		2	3	7	10	5		5	2	6	3	7	50	10	
Polychaeta															**0.1**
Polychaetes			3										3	1	
Total abundance (No/m^2)	**64**	**38**	**47**	**41**	**106**	**90**	**48**	**46**	**45**	**48**	**143**	**28**	**744**		
Taxa Richness	**5**	**6**	**6**	**4**	**3**	**5**	**5**	**5**	**5**	**3**	**7**	**4**	**12**		

Table 16 Diversity indices of intertidal fauna during winter 2021

Diversity Indices	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11	S-12
Taxa_S	5.00	6.00	6.00	4.00	3.00	5.00	5.00	5.00	6.00	3.00	7.00	4.00
Simpson_1-D	0.77	0.72	0.75	0.67	0.53	0.70	0.74	0.64	0.72	0.59	0.71	0.75
Shannon_H	1.54	1.46	1.53	1.25	0.88	1.37	1.46	1.28	1.46	0.97	1.50	1.39
Evenness_e^H/S	0.93	0.72	0.77	0.87	0.81	0.79	0.86	0.72	0.72	0.88	0.64	1.00
Margalef	0.96	1.38	1.30	0.81	0.43	0.89	1.03	1.05	1.31	0.52	1.21	0.90

Plate 7 Intertidal fauna on mangrove and mudflat
(A) *Telescopium telescopium*, (B) *Metopograpsus messor*, (C) Gastropod, (D) *Uca* sp., (E)Mudskipper, and (F) *Scylla serrata*

6. Subtidal Macro Benthic Fauna

Macrobenthic species, which obtain energy by feeding on other organisms or detritus, are major contributors to secondary development in the marine benthic domain (Elliot & Taylor, 1989). The accumulation of organic matter through the growth of somatic production or reproduction varies between species to increases the biomass of organisms. Somatic production refers to the amount of matter or energy that could be used as food for the next trophic stage, and is a vital part of energy flow and organic matter recycling. Secondary production is the process of non-photosynthetic species requiring organic substrate inputs producing new biomass over time (Maurer & Robertson, 1999). Secondary production must be quantified to evaluate population trends, anthropogenic impacts (pollution, eutrophication), climate change (variations in temperature, precipitation etc.), management of biological resources in natural habitats, energy and material movement (food web quantification, role of animals in ecosystem), biotic interactions (competition, prey-predator relationships), food provision services from an ecosystem, and environmental stress assessments, among other things (Dolbeth *et al.,* 2012).

Several environmental factors that have a direct impact on the physiology and behaviour of macrofaunal benthic communities are responsible for their structuring (Ramey and Snelgrove, 2003; McArthur *et al.,* 2010). Abiotic surrogates which include the environmental variables are divided into resource gradients (e. g. energy consumed by species), direct physical and chemical gradients (e. g. sediment grain size, temperature, salinity, oxygen, pressure), and indirect gradients (depth, latitude, etc.). The spatial variables like depth, latitude and longitude which are indirect gradients exert influence on the direct gradients like oxygen, temperature, salinity, sediment composition etc. (Snelgrove *et al*., 2001). Thus, the benthic communities living in sub-tidal habitats are logical subject of study in the port jurisdiction**.** Given this, the present study assessed benthic communities in 12 sites (S-1 to S-12) in the creeks of Deendayal port two phases during post-monsoon 2020 and winter 2021 to create a baseline on the benthic biodiversity within the port environment which will be useful to track changes in future and to initiate management efforts to ward off the impact.

6.1. Methodology

6.1.1. Sampling Strategies

The sampling methods and procedures were designed in such a way as to maximize the usefulness of the data obtained. For this, due attention was compensated to obtain specimens in the best possible condition. This helped in sorting, identifying, enumerating the organisms.

For studying the benthic organisms, triplicate samples were collected at each station using Van Veen grab which covered an area of $0.04m^2$. The wet sediment was passed through a sieve of mesh size 0.5 mm for segregating the organisms. The organisms retained in the sieve were fixed in 5-7% formalin and stained further with Rose Bengal solution for the ease of spotting at the time of sorting. The number of organisms in each grab sample was expressed as No./m^2. All the species were sorted, enumerated and identified by following available literature. The works of Fauvel (1953), Day (1967) were referred for polychaetes; Barnes (1980) and Lyla *et al*. (1999) for crustaceans; SubbaRao *et al.* (1991) and Ramakrishna (2003) for molluscs. Further, the data were treated with following univariate statistical methods in PRIMER (Ver. 6.) statistical software (Clark & Warwick, 2001).

a) **Shannon – Wiener Index**

In the present study, the data were analysed for diversity index (H') by following Shannon – Wiener's (1949) formula:

$$H' = -\sum^{S} Pi \log 2\ Pi \ldots\ldots. \qquad i = 1$$

Which can be rewritten as

$$H' = \frac{3.3219\,(N \log N - \sum ni - \log ni}{N}$$

where, H'= species diversity in bits of information per individual, ni = proportion of the samples belonging to the i^{th} species (number of individuals of the i^{th} species), N = total number of individuals in the collection, and ∑ = sum

b) Species Richness (S) was calculated following formula given by Margalef (1958)

c) **Margalef Index (d)**

d = (S-1) / log N

d) **Pielou's Evenness Index**

The equitability (J') was computed using the following formula of Pielou (1966):

$$J' = \frac{H'}{\log_2 S} \text{ or } \frac{H'}{\ln S}$$

Where J' = evenness, H' = species diversity in bits of information per individual, and S = total number of species.

e) Cluster Analysis

Cluster analysis was done to find out the similarities between the samples/ stations/regions. The most commonly used clustering technique is the hierarchical agglomerative method. The results of this are represented by a tree diagram or dendrogram with the x-axis representing the full set of samples and the y-axis defining the similarity level at which the samples or groups are fused. Bray – Curtis coefficient (Bray and Curtis 1957) was used to produce the dendrogram. The coefficient was calculated by the following formula:

$$S_{jk} = 100\left\{1 - \frac{\sum_{i=1}^{p} |y_{ij} - y_{ik}|}{\sum_{i=1}^{p} (y_{ij} + y_{ik})}\right\}$$

$$= 100 \frac{\sum_{i=1}^{p} 2\min(y_{ij}, y_{ik})}{\sum_{i=1}^{p} (y_{ij} + y_{ik})}$$

where, y_{ij} = represents the entry in the i^{th} row and j^{th} column of the data matrix i.e. the abundance or biomass for the i^{th} species in the j^{th} sample; y_{ik} = the count for the i^{th} species in the k^{th} sample; | ... | = the absolute value of the difference; 'min' = minimum of the two counts, and ∑ = overall rows in the matrix.

6.2. Results and Discussion

6.2.1. Species Composition of Subtidal Macrofauna

During the present two seasonal investigations, four groups of benthic organisms namely polychaetes, molluscs, crustaceans and “others” were noticed. The group “others” was formed of the larvae of the crabs and fishes. Of these, molluscs and polychaetes constituted the dominant group followed by crustaceans and “Others”. In the post-monsoon 2020, the molluscs (9) constituted the most dominant group followed by polychaetes (7), crustaceans (4), and “Others” (2). *Pholas* sp., *Telescopium* sp. and *Gonaida* sp. occurred in 8 sampling stations with a frequency of 66.67%. Forms such as *Angliera* sp*., Mitra* sp., occurred only in 2 sampling stations with 16.67% of the total organism (Annexure 1, Annexure 2). Likewise, in winter 2021, molluscs (10) remained in the top position in the list followed by polychaetes (9), crustaceans (4) and “Others” (2). The molluscs like *Pholas* sp. and *Telescopium* sp. ranked first with a frequency of 75% and 66.67%, respectively.

6.2.1.1. Subtidal population density

The population density of benthic fauna in post-monsoon 2020 varied from 300 to 925 No/m^2 with the maximum at S-6 and minimum at S-11 (Figure 15). During winter 2021 it varied from 200 to 1200 No/m^2 with the maximum at S-5 and minimum at S-7 (Figure 16).

6.2.1.2. Percentage Composition

In post-monsoon 2020, the molluscs constituted 57% of the overall population density of the subtidal benthic fauna followed by polychaetes (26%), crustaceans (12%) and “Others” (5%). Similarly, in winter 2021, molluscs constituted 61% followed by polychaetes (25%), crustaceans (9%) and “Others” (5%, Figure 17).

6.2.1.3. Diversity Indices

In post-monsoon 2020, the Shannon diversity indices values varied from 1.59 to 2.26 with the maximum at station S-1 and minimum at S-2. Margalef index, which is a measure of the richness of forms that take into account both the number of taxa and the number of individuals in taxa ranged from 1.85 to 3.40 with the maximum at S-1 and minimum at S-2. The evenness values varied from 0.59 to 0.96 with the maximum in S-7 and minimum in S-

4. Shannon diversity during winter 2021 varied from 1.49 to 2.31 with a maximum at station S-2 and minimum at S-7, evenness ranged from 0.50 to 0.92 with a maximum at S-8 and minimum at S-10. Margalef richness ranged between 2.87 and 3.68 with a maximum at S-2 and minimum at S-8 (Table 17).

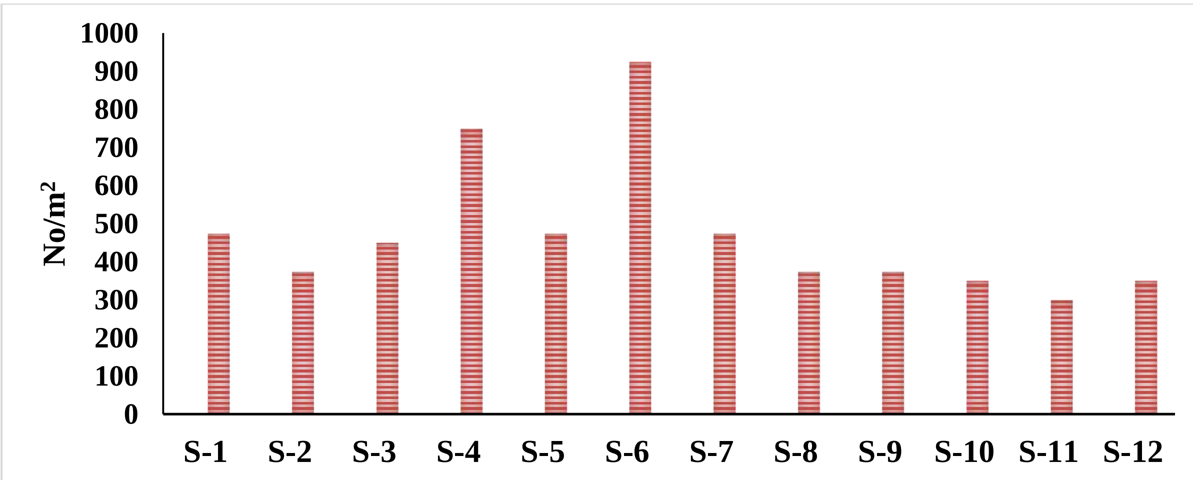


Figure 15. Population density of macrobenthos during post-monsoon 2020

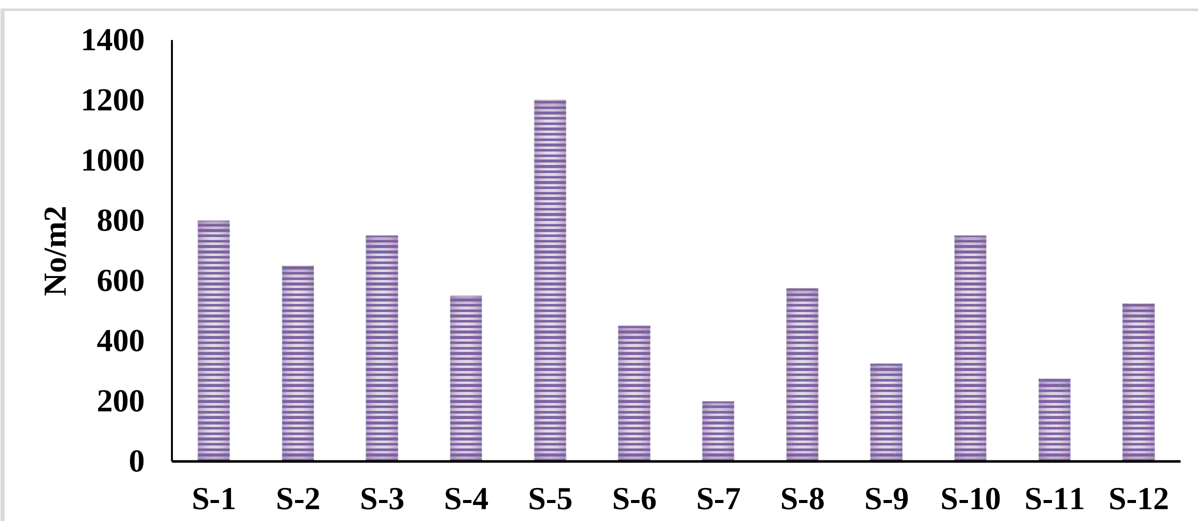


Figure 16 Population density of macro benthos port during winter 2021

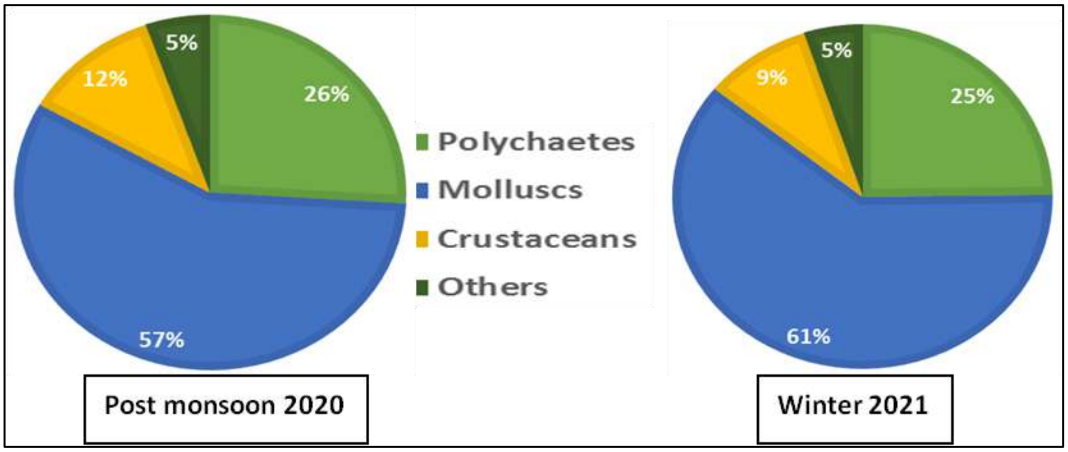


Figure 17. Composition of benthic fauna during post-monsoon 2020 and winter 2021

Table 17. Diversity indices during post-monsoon 2020 and winter 2021

Post-monsoon 2020												
	S-1	**S-2**	**S-3**	**S-4**	**S-5**	**S-6**	**S-7**	**S-8**	**S-9**	**S-10**	**S-11**	**S-12**
Taxa_S	11	6	9	9	9	12	9	8	8	8	7	7
Individuals	19	15	18	30	19	37	19	15	15	14	12	14
Shannon	2.26	1.59	2.06	1.68	1.91	2.21	2.16	1.89	1.99	1.97	1.82	1.77
Evenness	0.87	0.81	0.87	0.59	0.75	0.76	0.96	0.83	0.92	0.90	0.88	0.84
Margalef	3.40	1.85	2.77	2.35	2.72	3.05	2.72	2.59	2.59	2.65	2.42	2.27
Winter 2021												
Taxa_S	11	13	11	10	12	9	5	10	8	10	6	7
Individuals	32	26	30	22	48	18	8	23	13	30	11	21
Shannon_H	2.19	2.31	1.99	2.13	2.09	2.09	1.49	2.22	1.93	1.61	1.67	1.50
Evenness	0.81	0.77	0.67	0.85	0.67	0.90	0.89	0.92	0.86	0.50	0.89	0.64
Margalef	2.89	3.68	2.94	2.91	2.84	2.77	1.92	2.87	2.73	2.65	2.09	1.97

6.2.2. Cluster Analysis

Cluster analysis was performed to ascertain the similarity among the seasons during 2019 to 2021. The cluster analysis revealed that the macrobenthic abundance data collected at various seasons formed two major groups. Winter 2019 formed a single cluster while other seasons formed a separate cluster. The season's post-monsoon 2018, winter 2020 and winter 2021 formed a cluster at the highest level of similarity with 97% while other seasons i.e. monsoon 2019 and monsoon 2020 formed another group with similarity of 95% (Figure 18). This fact was further confirmed through MDS (Multi-Dimensional Scaling) analysis. The results revealed that winter 2019 formed a single cluster while others seasons form a separate cluster and it was confirmed in MDS analysis (Figure 19).

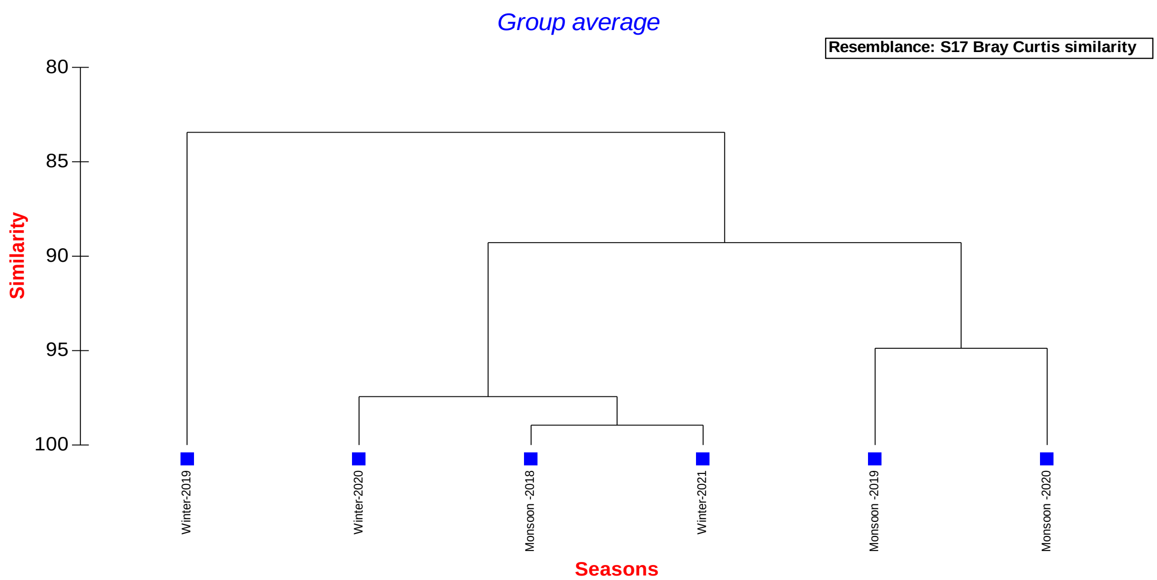


Figure 18 Cluster analysis for the benthic data collected during Post-monsoon 2019and winter 2021

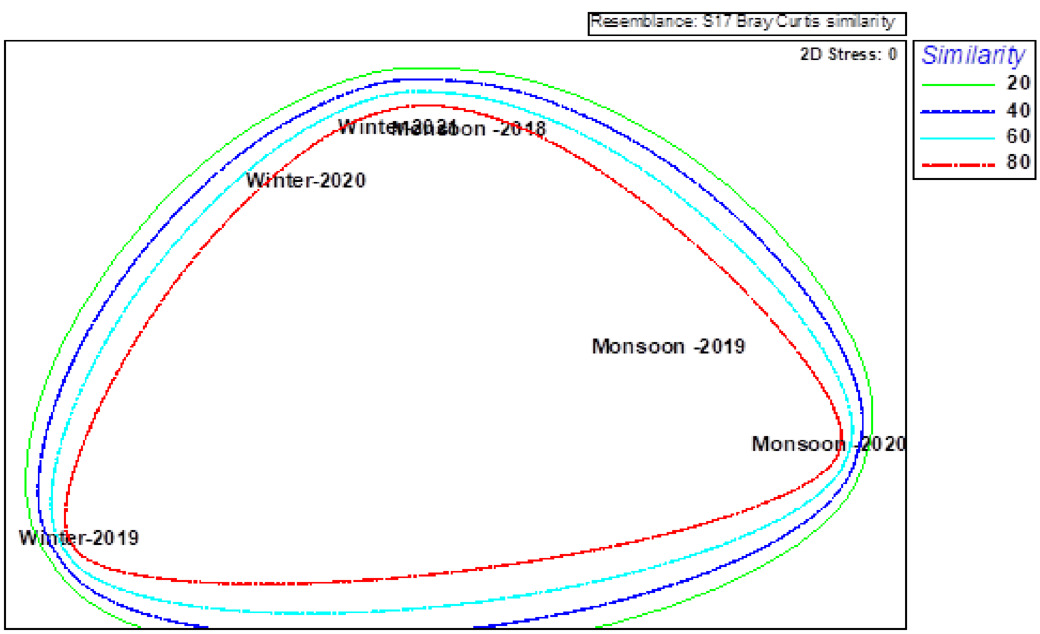


Figure 19. MDS analysis of benthic during postmonsoon2020 and winter2021

6.2.3. Comparison with previous studies conducted by GUIDE

The subtidal macrobenthic fauna did not vary much in terms of species composition and population density during the study period. The population density and the number of species during the two seasons did not show much variation however; the density and number of species that occurred during winter were high (Table 18). In general, the population density of the fauna decreased during post-monsoon (300 No/m^2 to 925 No/m^2) in 2021. These results on the number of species also showed a marginal decline in 2021 irrespective of the season. During 2018 post-monsoon 27 species were observed which declined to 21 species in 2019. There were fluctuations in the number of benthic fauna throughout the study duration.

Table 18. Comparative analysis of Macrobenthos in and around the DPT

Year of report	Study Year	Population density (No/m^2)	No. of species	Season
2018	2017	525 to 1050	27	Post-monsoon
	2018	775 to 1675	29	Winter
2019	2018	400 to 1175	21	Post-monsoon
	2019	300 to 1550	31	Winter
2020	2019	250 to 1025	26	Post-monsoon
	2020	300 to 1250	28	Winter
2021	2020	300 to 925	22	Post-monsoon
	2021	200 to 1200	25	Winter

6.2.4. Comparison with Other Coastal Waters

The population density observed in the present study (300 No/m^2 to 925 No/m^2 in post-monsoon 2020, and 200 No/m^2 to 1200 No/m^2 in winter 2021) is comparable with the observations made by Harkantra *et al.* (1980) along the east and west coasts of India. Mahapatro *et al*. (2011) studied the macrofaunal diversity in Bhitarkanika mangroves and reported 1870 No/m^2. Ramakrishna *et al.* (2011) reported the population density of 1015 No/m^2 in the Andaman and Nicobar Islands. The total benthic macrofauna consisting of 62 species in 5 groups, was recorded in western Kachchh mangroves with population density varying from 424 No/m^2 to 2393 No/m^2 by Saravanakumar *et al*. (2007). The benthic faunal composition in the Kachchh coast did not vary much and was represented by five groups namely, polychaetes, crustaceans, gastropods and bivalves and total of 34 taxa according to Shivanagouda and Bhat (2013). As regards to diversity indices, Musale and Desai (2011) documented benthic faunal diversity along the west coast of India along the Karnataka coast where the Shannon index was 0.37-1.18 and species richness was 1.18-1.28. The Shannon diversity values in post-monsoon 2020 varied from 1.59 (S-1) to 2.26 (S-2) whereas in winter 2021, it varied from 1.49 (S-2) to 2.31 (S-7). The species diversity values were not constant with respect to sampling sites as well as the seasons, indicating the spatial and temporal variation in the sediment and other hydrographical characteristics. Nair *et al*. (1983) stated that favourable hydrographic conditions and higher rate of primary productivity might be the key role of higher density of macrofauna. Besides, temperature, salinity, sediment composition, the organic carbon content in the sediment, and tidal activity are all factors that influence macrofauna population density (Maurer *et al*. 1978). Higher natural pressures in the coastal zone result in lower reference index values than in the deeper offshore areas, where natural pressures are low (Leonardsson *et al*., 2016). According to Shillabeer & Tapp (1989), the marine ecosystem is much more diverse, so there could be a wide variety of variations in the benthos diversity. As a result, differences in species diversity found in this study may be attributed to the marine environment's diverse existence.

6.3. Conclusions

Margelef diversity alone appeared to be the best. The sensitivity and precision of Margalef diversity were demonstrated for the anthropogenic pressures of organic enrichment, sedimentation and heavy metal pollution. The Shannon diversity index equal to 3.0 and above in the coastal environment indicated a healthy environment. Due to high turbidity, organic level, tidal flow, and high rate of siltation, the frequency of several species and diversity indices were low in the current investigation. The Kandla creek system, which is located at the inner end of the Gulf of Kachchh, has a high degree of turbidity and suspended solids, resulting in low sub-tidal biodiversity. These characteristics, in combination with port operations and the constant movement of cargo and container ships, may have a major impact on subtidal benthic fauna.

7. Phytoplankton

In a hydrological environment, the phytoplankton contributes a foremost role as the primary producer and take part in the biogeochemical cycling particularly calcification, silicification, dimethyl sulfide (DMS) production, and nitrogen-fixing in marine ecosystems. It initiates the marine food chain by the process of photosynthesis and serves as a primary food in the marine pelagic zone (Waniek & Holliday, 2006). As far as marine ecological health and management plan is concerned more attention is to be given to phytoplankton due to its key role in trophic chain, the formation of the biological community, and regulation of food chain (Monbet, 1992; Cloern, 1999; Sin *et al*., 1999).

Several anthropogenic activities such as introduction of sewage effluents and chemical compounds leads to intermittent eutrophication in the coastal water affecting the water quality and adversely affecting diversity for a considerable period which is detrimental for the fisheries. The pattern of dominant phytoplankton community structure is correlated with the environmental conditions (Cloern, 1996). In harbor or port areas the water quality rapidly changes due to human activities and is reflected by the community structure of the phytoplankton. It is imperative to investigate the phytoplankton diversity, abundance and distribution in the coastal waters where regular movements of cargo vessels, fishing trawlers and human interference in the port area are extreme and the scientific community recommends conducting regular monitoring to suggest effective management plans.

7.1. Methodology

Phytoplankton samples were collected from prefixed 12 sampling sites from DPT location along with data on water quality parameters during October 2020 (Post-monsoon) and February 2021 (winter). Plankton samples were collected using standard plankton net with a mesh size of 51μm and a mouth area of 0.1256 m^2 (20 cm radius). The net fitted with a flow meter (Hydrobios) was towed from a motorized boat at 2 nautical miles/hr. Plankton adhering to the net was concentrated in the net bucket by splashing seawater. The phytoplankton retained were transferred to a pre-cleaned and rinsed container and preserved with 5% neutralized formaldehyde and appropriately labelled indicating the details of the collection and transferred to the laboratory for further analysis.

The Quantitative analysis of phytoplankton (cell count) was carried out using a Sedgewick-Rafter counting chamber. Exactly 1 ml of the well mixed sample added to a Sedgwick counting chamber was observed under an inverted compound microscope. The number of cells present in individual cells of the counting chamber (1/1000) was noted and identified up to species level. Several observations were made to represent the entire quantity of the soup (generally >30 times) and the recorded data were used for further calculations with which density and diversity of the phytoplankton in l liter of the seawater were calculated. The density (No/l) was calculated using the formula: N=n×v/V (Where, N is the total no/liter, n is average no of cells in 1 ml, v is the volume of concentrate; V is the total volume of water filtered. To counter check the accuracy of the density and diversity of phytoplankton the same samples were used to estimate based on settlement method as well. One litre of seawater sample was taken in a clean high-density polyethylene container and was added with 5% neutral formalin and allowed to settle. The concentrated sample was observed under a microscope in a Sedgewick rafter and the final density was calculated and compared with earlier values obtained in the net method. The species diversity indices, univariate measures, Shannon-Wiener diversity index (H’, Margalef’s species richness (d), and Simpson dominance (D)] for the study period were determined using PAST software.

7.2. Results

7.2.1. Generic Status

During the Post-monsoon (October 2020), a total of 23 genera were recorded from 12 sampling sites (Table 20). The highest number of genera (23) was recorded at station S-1 and the lowest (15) at station S-5 and S-11. Likewise, during winter (February, 2021), a total of 19 genera were observed from the 12 sampling sites (Table 21) and the highest number of genera (19) was recorded at station S-1 and the lowest (6) at station S-5 and S-7 (Figure 20). During the winter season the centrales diatoms were heavily dominated at station S-7. The diversity of phytoplankton genera was more in post-monsoon season as compared to winter season. The group Cyanophyceae exhibited average dominance in all stations followed by Dinoflagellates.

7.2.2. Percentage Composition of Phytoplankton

During post-monsoon (October 2020), the percentage composition of phytoplankton genera varied from 0.6% to 15.8% (Table 19). The highest composition was contributed by *Coscinodiscus* (15.8%) followed by *Synedra* (12.19%) of Pennales diatom group (Figure 21). The lowest percentage (0.46%) was shown by *Odontella* (Centrales diatom). Likewise during winter (February 2021) the highest percentage composition of *Eucampia* (52.85%) was noticed followed by *Coscinodiscus* (13.36%) of Centrales diatom group. The lowest percentage (0.3%) was shown by *Planktoniella* (Centrales).

7.2.3. Density of Phytoplankton

Phytoplankton density in post-monsoon varied from 13,120 No/l to 22,400 No/l. The highest phytoplankton density was observed at S-1 and lowest at S-10 with an average of 17,568 No/l. Similarly, the phytoplankton density in winter varied from 22,635 No/l to 1,24,400 No/l. The highest phytoplankton density observed was at Station S-7 and lowest density at station S-4 and the average was 22,653 No/l. Even though the density of phytoplankton was minimal below 25,000 No/l during post-monsoon, the dominant genera were *Coscinodiscus*, *Melosira*, *Synedra* and *Microcystis*. Whereas during 2021 winter the density status of phytoplankton was in peak (1.24 lakh No/l) due to the blooming of *Eucampia* (centrale diatom) encountered along all the study stations (Figure 22).

7.2.4. Diversity Index

During October 2020 Shannon Wiener index ranged from 2.77 to 3.203 with average value of 2.96 (Table 22). The highest and lowest value was observed at S-5 and S-6, respectively. Margalef richness during post-monsoon 2020 ranged from 2.15 to 2.90 with average of 2.51 and the highest at S-6 and lowest value at S-5. Similarly in February 2021, the Shannon Wiener index ranged from 0.13 to 2.76 with average value of 2.05. The highest and lowest value was observed at S-1 and S-7, respectively. The Margalef richness during post-monsoon ranged from 0.43 to 1.94 with the average value of 1.31 and the highest and lowest value were observed at S-6 and S-5 respectively. The other diversity indices (Dominance, Simpson, Evenness and Menhinick) during October 2020 and February 2021 season are presented in Figure 23.

7.2.5. Genera Comparison with Post-monsoon and Winter of 2018 and 2019

7.2.5.1. Post-monsoon 2018 and 2019

During October 2018, station wise occurrence of genera varied from 11- 15 with an average of 12 genera. Among them, S-8 and S-12 constituted the highest genera of 15 followed by S-5 and S-10 represented with 14 genera. The Pennate group dominated with 9 genera, In October 2019 total number of genera varied from 19 to 29, the lowest number of genera was observed at station S-6. The Pennate diatoms were relatively high represented by 13-16 genera while the centrales constituted with 8-12 in the sampling stations. The distribution of genera also varied significantly among the stations in the two years.

7.2.5.2. Winter 2019 and 2020

During February 2019, a total of 24 genera were recorded of which the genera belonging to pennales was predominant ranging from 9 to 10. In February 2020, the total genera varied from 19 to 23, the highest number of genera was at station S-8, S-9 and S-10 and the lowest at S-2 and S-6. Among the groups, number of genera of pennate diatoms was highest at station S-1 and S-8, to S-10, and lowest at station S-2 and S-6. Similarly, among Centrales diatom the total number of genera varied from 4-6 and the lowest was at station S-11.

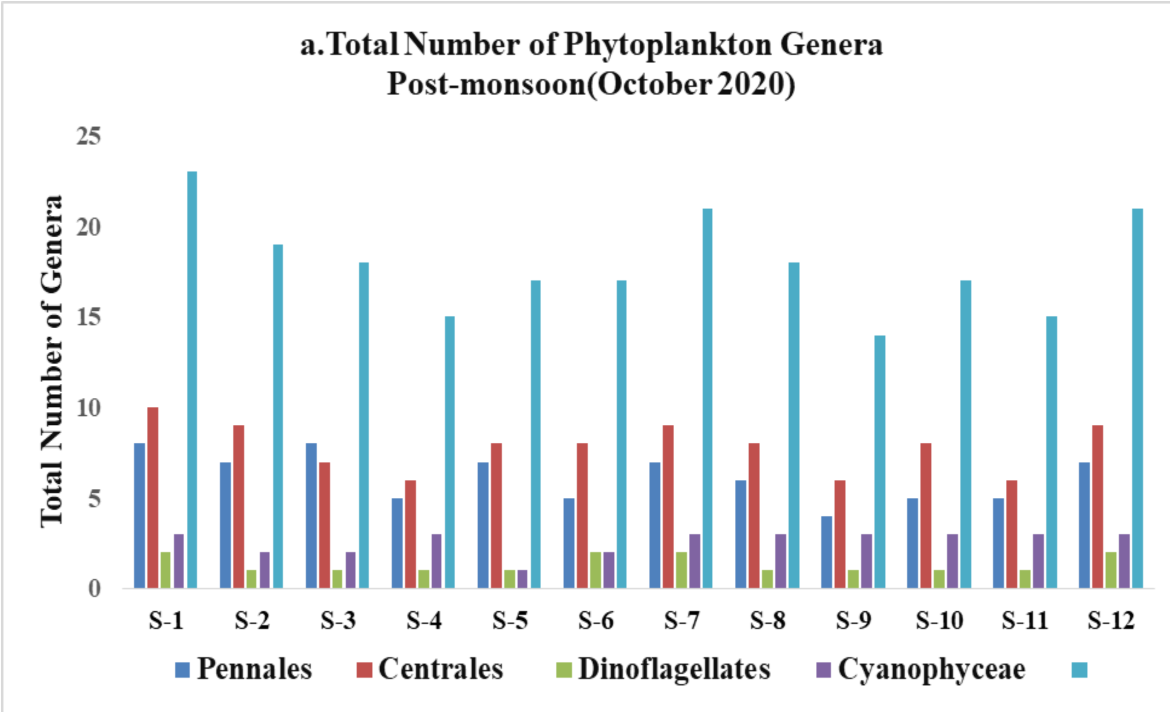
7.2.6. Density Comparison with Post-monsoon and Winter of 2018 and 2019

7.2.6.1. Post-monsoon 2018 and 2019

Phytoplankton density during October 2018 ranged from 12600 No/l to 18,200 No/l with an average of 14688 No/l. Station-wise, the highest density of phytoplankton was recorded at S-12. Likewise, in October 2019 the total density varied from 8000 No/l to 22,080 No/l.

7.2.6.2. Winter 2019 and 2020

During February 2019, the phytoplankton density varied from 10,208 No/l to 17,410 No/l with an average density of 13,509 No/l. Among the stations, the highest phytoplankton density was encountered at S-12 (17,410 No/l) and lowest was encountered at S-4 (10,208 No/l). In February 2020 the total density of phytoplankton varied from 15,540 No/l (S-3) to 30,256 No/l (S-2). The uniqueness of this result is due to the bloom of *Phaeocysts* sp. which could have increased the phytoplankton density of this station.



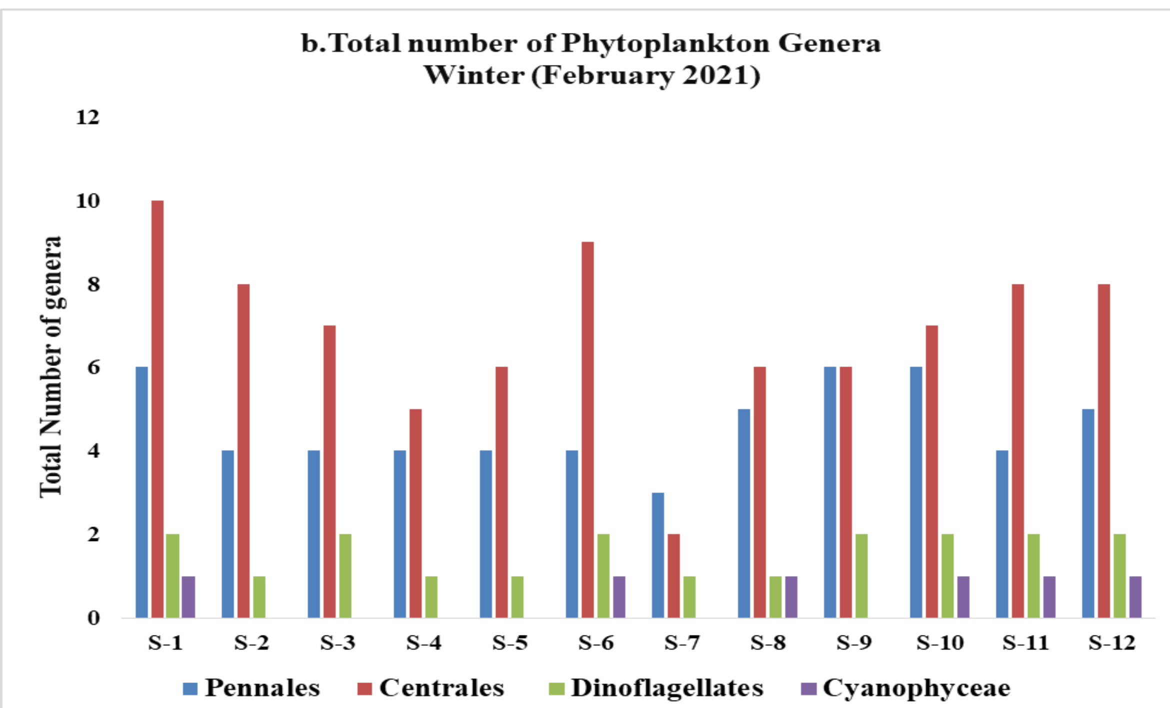
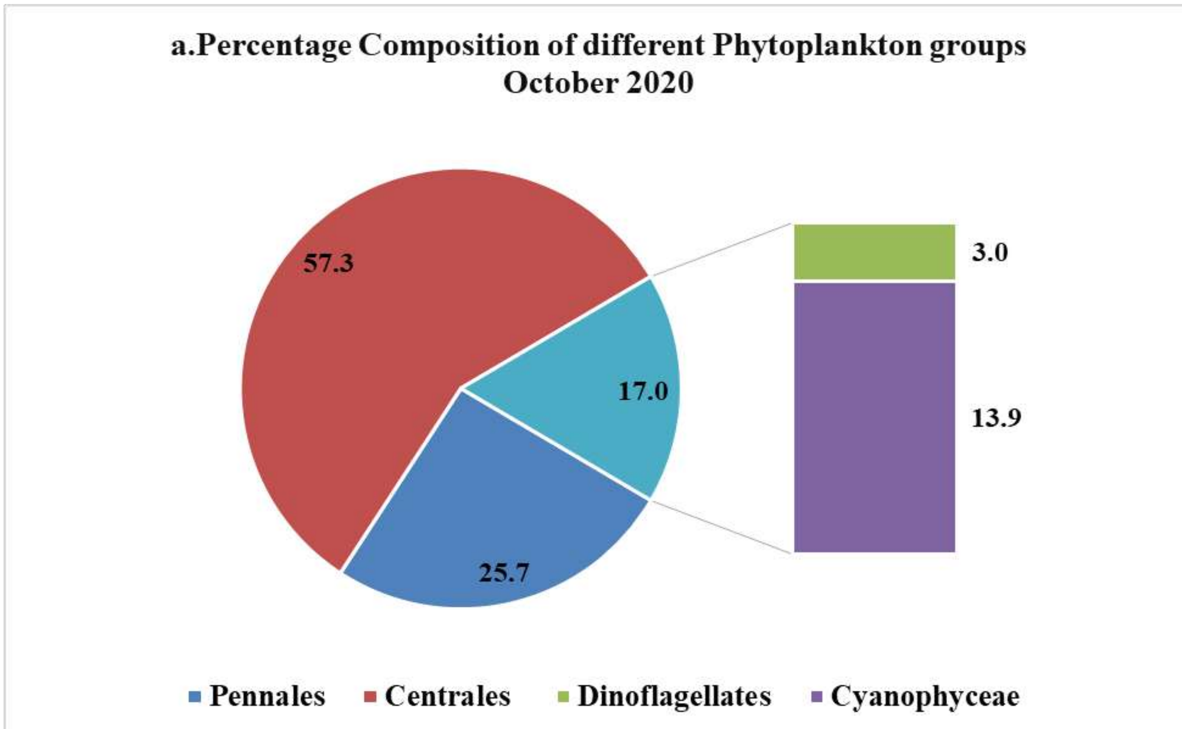


Figure 20. Occurrence of Phytoplankton in post-monsoon 2020 and winter 2021



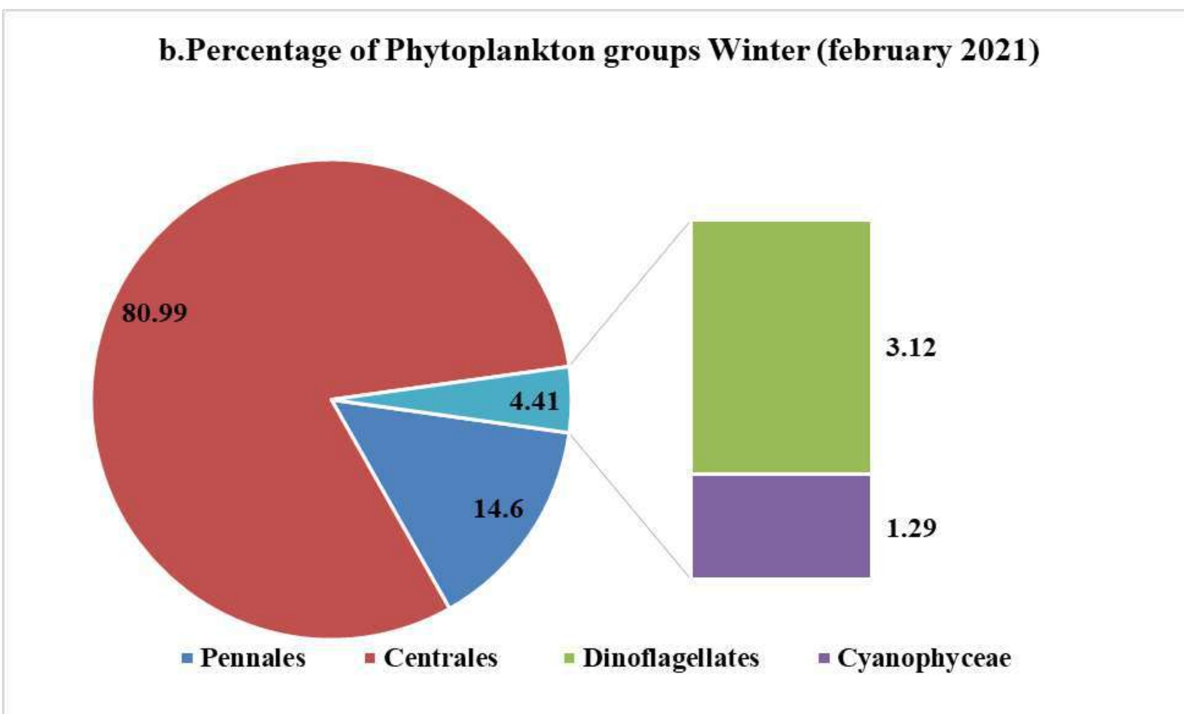


Figure 21. Composition of Phytoplankton group in post-monsoon 2020 and winter 2021

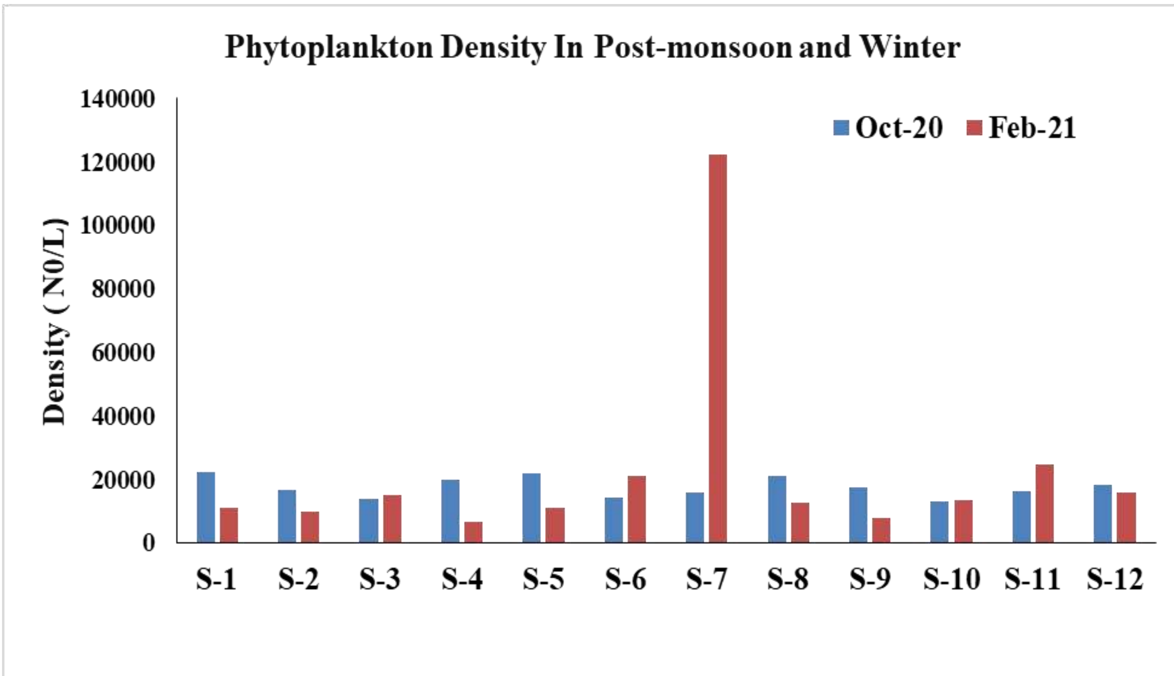


Figure 22. Phytoplankton density during post-monsoon 2020 and winter 2021

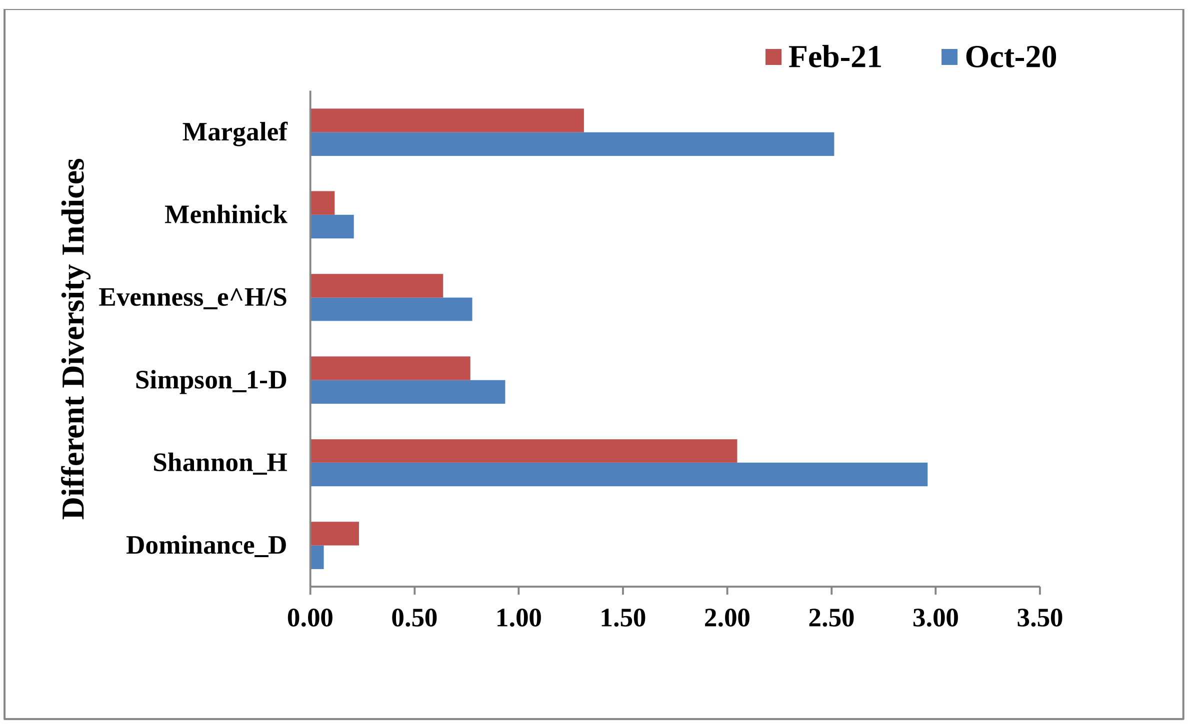


Figure 23. Phytoplankton diversity Indices during post-monsoon 2020 and winter 2021

7.3. Discussion

The number of phytoplankton genera declined from post-monsoon to winter while the density of the phytoplankton recorded was high during winter 2021. The increase in population density was attributed to the higher number of few genera such as *Eucampia* as well as due to zooplankton grazing pressure on the phytoplankton. Relatively high population density of zooplankton was noticed during winter with diverse groups which are filter feeders (*Paracalanus, Acrocalanus, Acartia*, Brachurian larvae and *Mysis* larvae). The predominance of *Eucampia* was noticed for the first time in the creek system. There are species of *Eucampia* which are known to be toxic to marine plants and cause fish mortality (Nishikawa *et al*., 2011). The species composition and cell density of phytoplankton in coastal environment are dependent on physical and chemical characteristics of water which are correlated with local climatic factors (Buzzi, 2002). In Gulf of Kachchh region most of the year wind and wave action is not stable due to this hydrographic variation, the phytoplankton composition was highly heterogeneous, and the phytoplankton was enriched with a large number of benthic and periphytic species (Noges & Noges, 1999). However, sediment resuspension due to wave action, was a limiting factor for contribution to density and generic status of phytoplankton along the Kandla region. Genera wise *Synedra* and *Coscinodiscus* were prominent which occurred in most of the seasons. The bloom forming genera such as *Trichodesmium, Noctiluca,* and *Phaeocystis* were mostly encountered during Post-monsoon 2020 and winter 2020. According to Prasanna & Prasad (1996) and MadhuPratap *et al.* (1996), the winter cooling phenomenon in the northern Arabian Sea occurs with the effect of dry cool continental air brought by the northeast monsoon winds. Further, it enhances evaporation, leading to surface cooling of the northern Arabian seawater. In the offshore region the bloom occurs towards the beginning of February because there the mixed layer detrains earlier than in the other region. This occurs when the mixed layer detrains after a period of entrainment, during which the layer thick enough to inhibit phytoplankton grows (Sarangi *et al.,* 2002). The Shannon H' and Margalef diversity indices indicated that decline in number of genera during February 2020 was mainly due to *Eucampia* blooming which affects other species growth, a temporary phenomenon associated with water quality parameters and the situation will be reverted once the bloom vanishes from the coast. Species diversity often increases with environmental complexity and such temporal heterogeneity in aquatic ecosystems plays an important role in providing diversity and life continuity (Odum *et al.,* 1995; Yamamoto & Hatta, 2004).

Table 19 Composition of Phytoplankton during post-monsoon 2020 and winter 2021

Group	Genus	Post-monsoon	Winter
		October 2020	February 2021
Pennales	*Amphora*	1.91	3.00
	Asterionella	1.24	0
	Bacillaria	2.99	3.65
	Nitzschia	1.61	1.24
	Navicula	6.91	0.88
	Pleurosigma	3.05	1.77
	Synedra	12.19	4.06
	Thalassionema	2.74	0
Centrales	*Cheatoceros*	0.56	2.41
	Coscinodiscus	15.82	13.36
	Cyclotella	1.11	1.24
	Eucampia	0	52.85
	Diploneis	2.63	0
	Ditylum	3.88	0
	Leptocylindricus	0	0.59
	Melosira	10.41	3.53
	Odontella	8.46	1.88
	Planktoniella	2.89	0.3
	Rhizosolenia	1.92	2.77
	Triceratium	2.74	2.06
Dinoflagellates	*Ceratium*	1.82	2.47
	Noctiluca	1.20	0.65
Cyanophyceae	*Trichodesmium*	6.91	1.29
	Microcystis	5.21	0
	Blue green algae	1.81	0
Average		**4.3**	**5.3**

Table 20 Abundance of phytoplankton group, genera and density during post-monsoon 2020

Genus/Groups	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11	S-12
Pennales												
Amphora	700	140	140	0	480	640	480	320	0	640	0	480
Asterionella	140	280	280	160	480	160	160	320	0	320	0	320
Bacillaria	1400	0	420	1120	640	480	160	640	0	640	320	480
Nitzschia	700	420	840	0	160	0	800	0	320	0	0	160
Navicula	2240	1400	1960	0	2880	1280	640	0	1600	640	960	960
Pleurosigma	560	700	840	1440	0	640	0	480	640	0	480	640
Synedra	3360	2520	140	2240	3200	2240	1600	2400	2080	800	2720	2400
Thalassionema	420	560	1120	640	640	0	160	0	480	640	480	640
Total	**8**	**7**	**8**	**5**	**7**	**6**	**7**	**5**	**5**	**6**	**5**	**8**
Centrales												
Cheatoceros	140	140	420	0	0	0	0	320	0	0	0	160
Coscinodiscus	4200	1400	2800	3840	2560	3200	3040	2880	1920	1920	2720	2880
Cyclotella	280	140	0	480	480	0	320	0	0	480	0	160
Diploneis	140	0	280	960	1440	320	160	800	640	320	480	0
Ditylum	700	700	700	1440	1120	640	480	480	0	0	640	1280
Melosira	2100	1400	840	2880	4000	1120	800	2720	1600	1760	1920	800
Odontella	840	1400	560	1920	640	640	2560	3840	3520	960	0	960
Planktoniella	560	420	0	0	1120	640	480	1280	480	320	0	800
Rhizosolenia	420	420	1120	0	960	0	160	640	0	0	320	0
Triceratium	700	280	0	0	0	480	640	1920	0	320	640	800
Total	**10**	**9**	**7**	**6**	**8**	**7**	**9**	**9**	**5**	**7**	**6**	**8**
Dinoflagellates												
Ceratium	840	1400	0	0	160	160	320	0	320	0	0	640
Noctiluca	140	0	140	160	0	160	160	160	0	320	480	800
Total	**2**	**1**	**1**	**1**	**1**	**2**	**2**	**1**	**1**	**1**	**1**	**2**
Cyanophyceae												

Trichodesmium	280	1680	280	1920	1120	1280	1600	800	2560	960	1440	640
Microcystis	1400	1400	980	480	0	0	800	480	960	1280	1440	1760
Blue green algae (Unidentified)	140	0	0	160	0	320	160	640	160	800	1120	320
Total Genera	**23**	**19**	**18**	**15**	**17**	**17**	**21**	**18**	**14**	**17**	**15**	**21**
Density (No./l)	**22400**	**16800**	**13860**	**19840**	**22080**	**14400**	**15680**	**21120**	**17280**	**13120**	**16160**	**18080**

Table 21 Abundance of phytoplankton group, genera and density during winter 2021

Genus/ Group	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11	S-12
Pennales												
Amphora	480	1920	480	0	640	800	480	640	800	1120	0	800
Bacillaria	800	1600	1600	320	320	480	320	320	480	800	1600	1280
Nitzschia	320	0	0	480	0	320	0	640	800	320	480	0
Navicula	320	0	0	800	0	0	0	320	160	320	0	480
Pleurosigma	640	480	480	0	800	0	0	0	320	640	320	1120
Synedra	480	320	320	1120	800	800	640	320	320	1600	2400	1920
Total	**6**	**4**	**4**	**4**	**4**	**4**	**3**	**5**	**6**	**6**	**4**	**5**
Centrales												
Cheatoceros	960	320	320	320	480	480	0	160	640	1120	480	1280
Coscinodiscus	1600	1920	7200	1600	4800	3200	800	5600	800	3200	3200	2400
Cyclotella	320	0	0	800	0	640	0	0	0	480	640	480
Eucampia	320	640	640	0	0	9600	120000	640	320	320	10400	800
Leptocylindricus	320	320	320	0	320	320	0	0	0	0	0	0
Melosira	480	0	0	480	800	800	0	2720	800	1600	800	1120
Odontella	1120	480	480	0	0	800	0	0	320	0	1120	800
Planktoniella	160	640	0	0	0	0	0	0	0	0	0	0
Rhizosolenia	800	640	640	640	800	1120	0	480	160	480	800	960
Triceratium	320	320	640	0	1120	640	0	480	0	320	960	800

Total		**8**	**7**	**5**	**6**	**9**	**2**	**6**	**6**	**7**	**8**	**8**
Dinoflagelates												
Ceratium	960	0	1600	160	160	160	160	160	1600	480	480	800
Noctiluca	160	160	160	0	0	320	0	0	160	320	320	160
Total	**2**	**1**	**2**	**1**	**1**	**2**	**1**	**1**	**2**	**2**	**2**	**2**
Cyanophyceae												
Trichodesmium	320	0	0	0	0	800	0	320	0	480	800	800
Total Genera	**19**	**13**	**13**	**10**	**11**	**15**	**6**	**12**	**14**	**15**	**14**	**15**
Total Density No/l	**10880**	**9760**	**14880**	**6720**	**11040**	**21280**	**122400**	**12800**	**7680**	**13600**	**24800**	**16000**

Table 22 Diversity indices of phytoplankton during post-monsoon 2020 and winter 2021

Diversity Indices	Post-monsoon (October 2020)												
	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11	S-12	Average
Taxa_S	30	27	23	24	29	21	22	26	28	22	27	22	25
Individuals	22080	13440	15040	16320	15680	10880	11680	16000	13760	11040	14880	14560	14613
Dominance_D	0.06	0.07	0.08	0.08	0.05	0.08	0.06	0.06	0.06	0.07	0.05	0.07	0.06
Shannon_H	3.03	2.94	2.82	2.86	3.23	2.77	2.93	3.03	3.07	2.87	3.10	2.89	2.96
Simpson_1-D	0.94	0.93	0.92	0.92	0.95	0.92	0.94	0.94	0.94	0.93	0.95	0.93	0.94
Evenness_e^H/S	0.69	0.70	0.73	0.73	0.87	0.76	0.85	0.79	0.77	0.80	0.82	0.82	0.78
Menhinick	0.20	0.23	0.19	0.19	0.23	0.20	0.20	0.21	0.24	0.21	0.22	0.18	0.21
Margalef	2.90	2.74	2.29	2.37	2.90	2.15	2.24	2.58	2.83	2.26	2.71	2.19	2.51
Diversity Indices	**Winter (February 2021)**												
	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11	S-12	Average
Taxa_S	19	13	13	10	11	16	6	13	14	16	15	16	13.5
Individuals	10880	9760	14880	6720	11040	21280	122400	12800	7680	13600	24800	16000	22653
Dominance_D	0.07	0.13	0.27	0.14	0.23	0.24	0.96	0.25	0.11	0.11	0.21	0.08	0.23
Shannon_H	2.76	2.28	1.87	2.13	1.92	2.02	0.13	1.87	2.42	2.48	2.07	2.64	2.05
Simpson_1-D	0.93	0.87	0.73	0.86	0.77	0.76	0.04	0.75	0.89	0.89	0.79	0.92	0.77
Evenness_e^H/S	0.83	0.76	0.50	0.84	0.62	0.47	0.19	0.50	0.80	0.75	0.53	0.88	0.64
Menhinick	0.18	0.13	0.11	0.12	0.10	0.11	0.02	0.11	0.16	0.14	0.10	0.13	0.12

8. Zooplankton

The zooplankton fauna of Indian waters is very diverse, which could be due to a series of environmental factors, most significantly ocean currents (Jagadeesan *et al*., 2013), upwelling (Madhupratap *et al*., 1990), high primary productivity (Smith & Madhupratap, 2005) and salinity. These studies also recorded species compositions of plankton community with marked spatial, seasonal, and diurnal fluctuations in both the Bay of Bengal and Arabian Sea. Zooplanktons are strongly responsive to environmental variables including light, temperature, salinity, pH, dissolved oxygen, turbulence, and food availability. In recognition of this multifaceted ecological and economic significance of zooplankton in marine environments, there has been a long emphasis on studying their systematics, ecology, and other biological aspects at different spatio temporal scales. Zooplankton plays a major role in the functioning and productivity of aquatic ecosystems through its impact on the nutrient dynamics and its unique position in the foodweb. Many species of zooplankton can be used as biological indicators for water pollution, water quality, and eutrophication. Zooplankton communities are highly influenced by spatio-temporal variations in hydrochemical parameters and physical forces. The spatio-temporal variations in zooplankton species composition and distribution in the Arabian Sea and Bay of Bengal have been extensively studied during the past 100 years and with more emphasis since 1950s. Copepods are the most dominant zooplankton group and the most diverse in species composition in the pelagic realm of the marine environment. The preponderance of copepods among the various taxonomic groups has been reported as a common feature in coastal and oceanic environments. As the study area of DPT is under the influence of various port and cargo handling activities, regular monitoring is highly essential to know the environmental pressures at the Kandla coast and its nearby creek environment with respect to plankton which supports the fishery resources and several ecological services

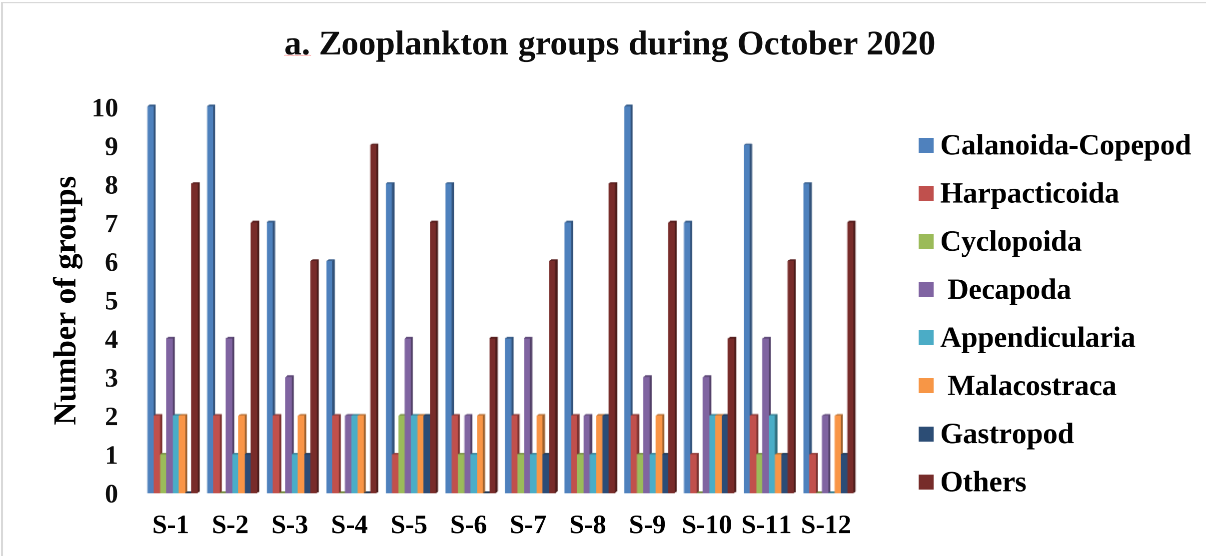
8.1. Methodology

The present investigation was carried out in the 12 sampling stations during the post-monsoon month of October 2020 and winter of February 2021. Zooplankton samples were collected using a standard zooplankton net with a 58 mouth area of 0.25 m^2 fitted with a flow meter. The net was towed from a boat for 5 min with a constant boat speed of 2 nautical miles/hr. The initial and final reading in the flow meter was noted down and the plankton concentrate collected in the bucket was transferred to appropriately labelled container and preserved with 5% neutralized formaldehyde. One ml of the zooplankton concentrate was added to a Sedgwick counting chamber and observed under a compound microscope. The group/taxa were identified using standard identification keys and their number was recorded. Random cells in the counting chamber were taken for consideration and the number of zooplankton was noted down along with their binomial name. This process was repeated for five times with 1 ml samples and the average value was considered for the final calculation. For greater accuracy, the final density values were counter-checked and compared with the data collected by the settlement method. Univariate measures such as Shannon-Wiener diversity index (H'), Margalef's species richness (d), and Pielou's evenness (J'), Simpson's dominance (D) were determined using PAST software.

8.2. Results

8.2.1. Group and Generic Status Zooplankton

The zooplankton status of DPT Kandla along the 12 sampling stations presented in Table 23 and Table 24 depicted that there were 7 major groups and 29 taxa observed during post-monsoon 2020 and 9 major groups and 27 taxa in winter 2021 were encountered. The Copepods among crustaceans emerged as the dominant group in terms of genera as well as the numerical density. Among the copepods, *Acartia*, *Acrocalanus*, *Calanus* and *Nannocalanus* were dominant during October 2020 represented with 10 genera and the other cyclopoida and harpacticoida each represented with 2 genera (). During February 2021 similar trend was observed but genera number was dominated by copepods such as *Acrocalanus*, *Calanus, Centropages*, *Nannocalanus Paracalanus* represented with 12 genera and the other *cyclopoida* and *Harpacticoida* each represented with 2-3 genera. Besides this the groups such as *Cnidaria* and *Chaetognatha* were encountered first time during the study (Figure 24).



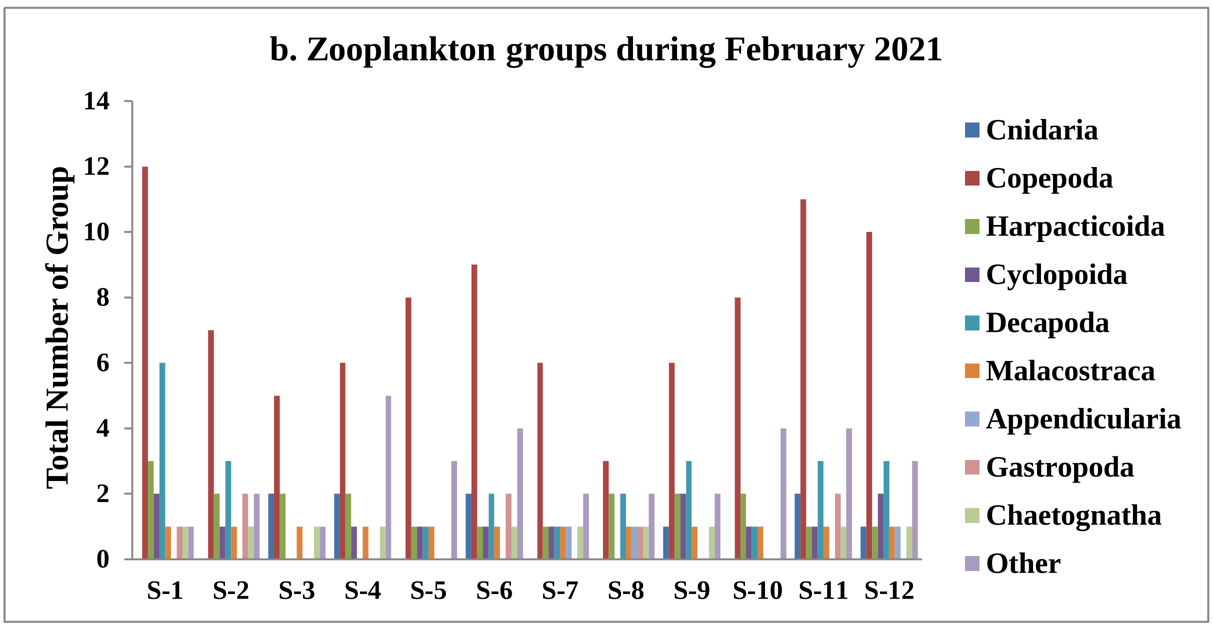


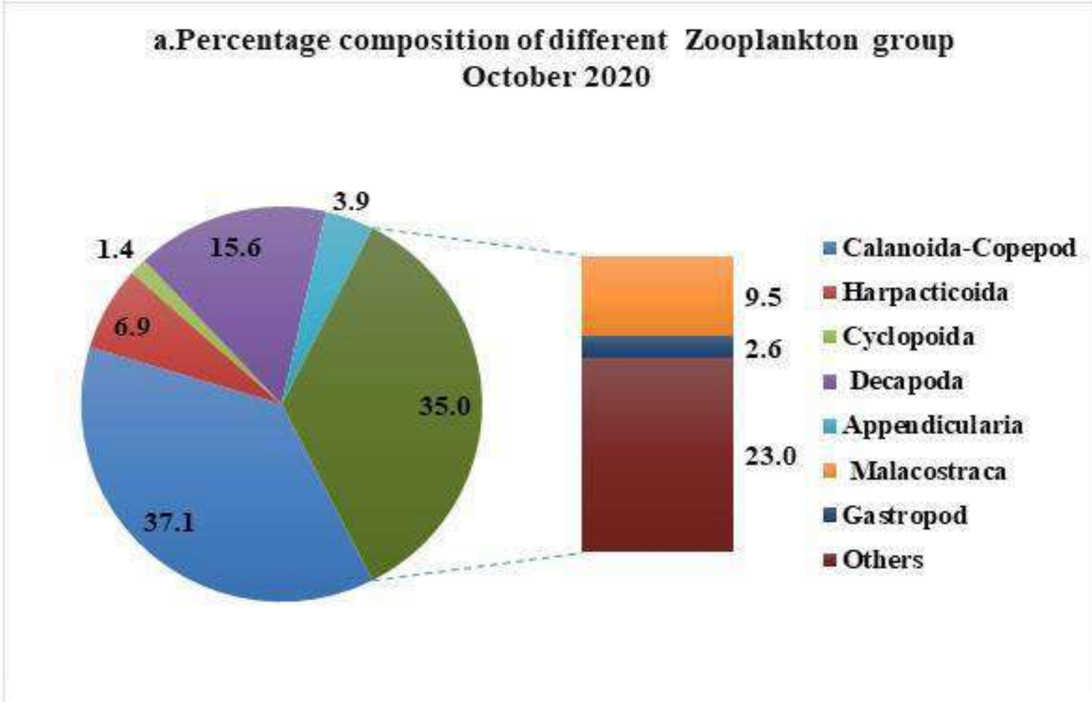
Figure 24 Zooplankton group during post-monsoon 2020 and winter 2021

8.2.2. Percentage Composition

The percentages composition of Zooplankton during October 2020 (Post-monsoon) varied from 0.46% to 13.50% with average of 2.94%. The highest percentage contribution was made by copepod (37.1%) followed by Decapod (15.6%). The major genera contributed by copepod were *Calanus* (13.50%). Similarly during February 2021 (winter) the percentage composition varied from 0.03% to 13.76 % with average of 2.53%. The highest percentage of contribution as made by copepod (46.7%) followed by *Malacostraca* (13.8 %) and *Chaetognath* (12.3%). The major genera contributed by copepod was *Para calanus* (11.38%) followed by *Sagita* (12.30%) (Figure 25).

8.2.3. Density of Zooplankton

Zooplankton density in October 2020, post-monsoon varied from 10.880 No/l to 22,080 No/l. The highest zooplankton density was observed at Station S-1 and lowest density was observed at station S-6 and the average density was 14,613 No/l. Similarly, the zooplankton density in February 2021, winter varied from 26,600 No/l to 76,320 No/l. The highest zooplankton density was observed at Station S-1 and lowest density was observed at station S-12 and the average density 41,630 No/l. Overall during post-monsoon period the density status of zooplankton was minimal below the range of 23,000 No/l and the dominant genera were *Calanus*, *Mysis* and *Brachyuran* larvae. Whereas during 2021 winter the density status of phytoplankton was in highest 80,000 No/l and the dominant genera were *Paracalanus, Microsetella, Brachyuran* larvae and *Sagita* which was encountered along all the study stations (Figure 26).



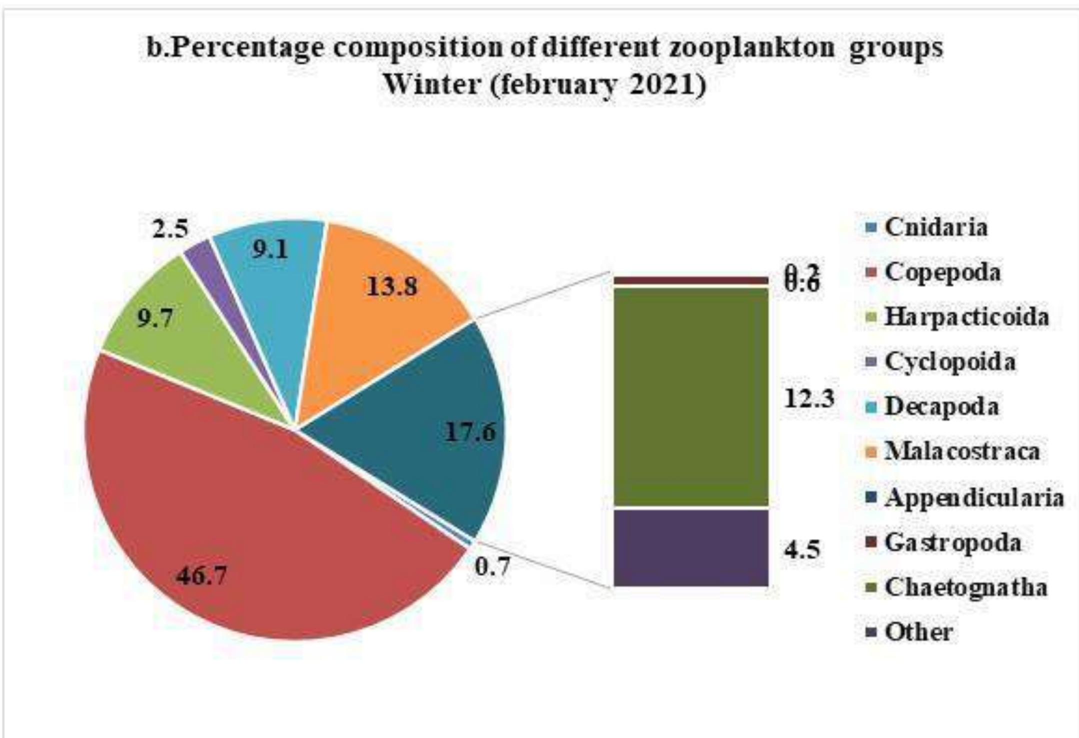


Figure 25. Composition of ooplankton during October 2020 and February 2021

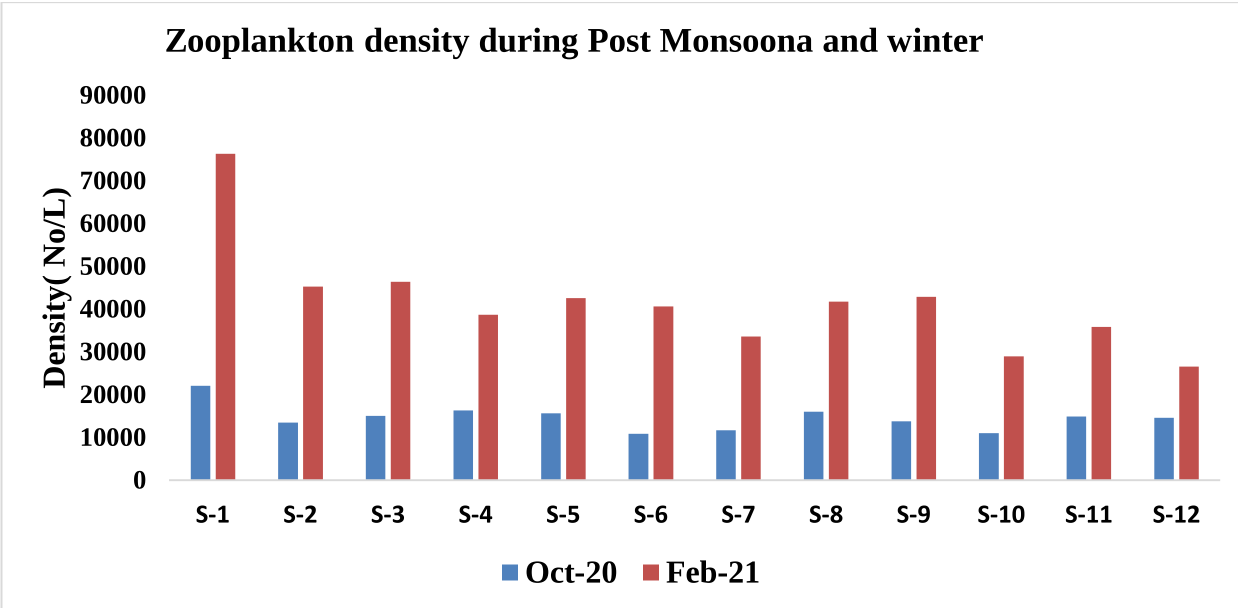


Figure 26. Zooplankton density during post-monsoon 2020 and winter 2021

8.2.4. Diversity Index

The Shannon Wiener index (H') and Margalef (M) were calculated for station S-1 to S-12 for the period of October 2020 and February 2021 (Table 25). During October 2020 Shannon Wiener index ranged from 2.77 to 3.23 with average value of 3.0. The highest and lowest value was observed at S-5 and S-6 . Margalef richness during 2020 ranged from 2.15 to 2.90 with average value of 2.5 and the highest and lowest value was observed at same station. Similarly in February 2021 Shannon Wiener index ranged from 0.56 to 3.05 with average value of 2.41. The highest and lowest value was observed at S-12 and S-8, respectively. Margalef richness during 2020 ranged from 1.02 to 2.38 with average value of 1.67 and the highest and lowest value was observed at S-11 and S-2 station. The other diversity indices such as Dominance, Simpson, Evenness and Menhinick during both October 2020 and February 2021 season are presented in Figure 26.

8.2.5. Genera comparison with Post-monsoon and Winter for 2018 and 2019

8.2.5.1. Post-monsoon 2018 and 2019

During October 2018, totally 23 genera of Zooplankton were recorded. At stations S-7, S-9, S-11 and S-12 the maximum of 13 genera were reported and the lowest of 9 genera were recorded at S-1 and S-2. The number of genera reported during October 2019 was 19, and the highest number was noticed at S-2 and S-7. The stations S-10, S-11 and S-12 showed minimum number (7 No.) of genera during the study period.

8.2.5.2. Winter 2019 and 2020

The number of genera represented during winter 2020 was higher than in 2019. The generic composition was relatively high than the post-monsoon of the previous years. A total of 27 genera were recorded in 2019 that belonged to major groups' *viz.*, *Decapoda*, *Calanoida*, *Harpacticoida*, *Copelata*, *Cyclopoida*, *Tintinnida* and *Annelida*. Highest number of genera was observed from S-5 (29 No.) followed by S-9 (26 No.) during February 2020.

8.2.6. Density comparison with Post-monsoon and Winter2018 and 2019

8.2.6.1. Post-monsoon 2018 and 2019

During October 2018 the density of zooplanktons ranged between 9800 No/l and 16,800 No/l with an average of 13,277 No/l. Station-wise, the highest density of 16,800 No/l was recorded in S-12 followed by S-8 (16,380 No/l) and lowest density was reported at S-10 (9800 No/l). Generally, the brachyuran larvae contributed much to the density at all stations along with the copepod *Centropages* sp. However, at S-12 the dominance was by *brachyuran* larvae and *Nannoclanus* sp.

The zooplankton density varied from 3640 No/l (S-8) to 28,840 No/l (S-7) in post-monsoon 2019. The highest density was found at S-7 mainly due to the presence of *Calanoid* copepods and the brachyuran larvae in good numbers. In general the population density of the zooplankton at locations S-8, S-10, S-11 and S-12 were very low during October 2019.

8.2.6.2. Winter 2019 and 2020

The population density of the zooplankton declined in general during the winter 2019 and varied between 9600 No/l and 18,600 No/l with an average density was 13,110 No/l. During February 2020 the population density ranged between 8,266No/l (S-3) and 15,267 No/l (S-2). Generally, density of *Brachyuran larvae*, *Euteripina* sp., *Microsetella* sp., *Centropages* sp. and *Tintinnopsis* sp. was higher in all sampling stations.

8.3. Discussion

Zooplankton community in the study sites indicated a strong seasonal pattern with a peak in the winter. In dry weather during winter, lower temperature and the shortest daylight hours coupled with water transparency might have reduced the secondary productivity and had a cascading effect as evident from diminished zooplankton abundance. Contrarily, high to moderate temperature, low salinity and availability of sufficient nutrients were the favourable conditions for increasing the zooplankton abundance during the wet season (Nandy *et al*., 2018). In the present study, a noticeable abundance of copepods was reported which makes them the most versatile due to the wide tolerance to salinity and temperature fluctuations in the aquatic systems. The temporal changes in the abundance of copepod community are generally influenced by the coastal upwelling and associated hydrographical changes (Jagadeesan *et al*., 2017).

The crustaceans such as copepods and decapods were significant in terms of population density in which the different larval stages contributed much. In general the copepods are the predominant taxa in the sea waters irrespective of the seasons and similar observation was made by Monolisha *et al*. (2018). The variations in the species composition and occurrence are also influenced by the hydrographic parameters such as upwelling, water movements, water quality, and availability of food (Sampey *et al*., 2007). The variations in the density of taxa depend on the reproductive periodicity of the adults which are considered as groups in this present study. From October 2020 and February 2021 results it as apparent that zooplankton diversity and density have increased in DPT environment.

Table 23. Abundance of zooplankton group, genera and density during post-monsoon 2020

Group	Genus	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11	S-12
Copepod	*Acartia*	480	160	160	320	800	320	800	960	160	480	800	480
	Acrocalanus	1280	320	480	0	640	160	320	0	480	0	640	640
	Aetideus	160	160	0	0	0	160	0	0	320	0	0	480
	Calanus	3200	1440	3840	1760	1120	1600	1600	2240	2560	1440	1280	1600
	Calanopia	800	480	160	0	0	320	0	320	320	800	800	800
	Centropages	480	320	480	480	640	640	0	800	640	480	1280	1120
	Nannocalanus	1120	800	480	480	480	480	0	480	640	1120	320	960
	Paracalanus	320	160	0	320	480	0	0	640	320	320	960	0
	Pseudocalanus	640	160	320	0	320	0	0	160	480	0	160	0
	Temora	320	160	0	160	480	800	320	0	320	640	320	480
Total genera		**10**	**10**	**7**	**6**	**8**	**8**	**4**	**7**	**10**	**7**	**9**	**8**
Harpacticoida	*Euterpina*	640	160	320	640	800	1440	320	480	960	1280	480	480
	Microsetella	160	160	800	800	0	320	640	320	320	0	640	0
Total genera		**2**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**1**	**2**	**1**
Cyclopoida	*Oithona*	0	0	0	0	320	160	480	480	160	0	0	0
	Oncaea	160	0	0	0	480	0	0	0	0	0	160	0
Total		**1**	**0**	**0**	**0**	**2**	**1**	**1**	**1**	**1**	**0**	**1**	**0**
Decapoda	*Caridean* larvae	480	480	320	480	160	320	160	800	320	160	320	320
	Nauplius larvae	1600	800	0	0	320	160	320	0	480	320	320	320
	Mysis	2880	1280	1280	3200	320	0	1280	1440	0	0	1440	0
	Lucifer	2240	480	640	0	480	0	640	0	160	480	160	0
Total		**4**	**4**	**3**	**2**	**4**	**2**	**4**	**2**	**3**	**3**	**4**	**2**
Appendicularia	*Oikopleura*	160	0	0	320	320	0	0	0	0	160	320	0
	Copelata	320	1280	160	960	480	480	640	800	160	160	160	0
Total		**2**	**1**	**1**	**2**	**2**	**1**	**1**	**1**	**1**	**2**	**2**	**0**
Malacostraca	*Brachyuran* larvae	640	800	1120	640	1600	1280	800	1280	1120	800	480	1920
	Euphasid nauplius	160	160	800	320	480	320	320	480	320	320	0	480

Total genera		**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**2**
Gastropod	*Creseissp*	0	0	0	0	320	0	0	160	0	640	0	0
	Gastropod larvae	0	160	480	0	640	0	640	320	320	320	160	320
Total		**0**	**1**	**1**	**0**	**2**	**0**	**1**	**2**	**1**	**2**	**1**	**1**
Other		**8**	**7**	**6**	**9**	**7**	**4**	**6**	**8**	**7**	**4**	**6**	**7**
Bivalvia	Bivalve larvae	160	480	0	640	0	0	0	320	160	160	0	160
Branchiopod	*Cladocera*	0	160	0	0	480	0	160	0	0	0	0	160
Tintinnida	*Tintinnopsis*	800	160	320	320	480	0	0	800	800	0	800	480
Hemichordata	*Tornaria* larva	0	160	320	320	0	320	0	0	0	320	640	800
Echinodermata	*Bipinaria* larva	480	160	160	640	480	160	320	160	160	0	0	0
Polychaete	Polychaete larva	160	0	480	320	480	0	800	160	160	0	0	320
Bryozoan	Cyphonutes larva	160	0	0	160	0	0	320	160	0	0	160	0
Foraminifera	*Globigerina*	480	640	320	480	800	0	640	480	320	480	800	640
Nematoda	*Nemadode*	160	0	0	640	160	160	0	480	160	0	320	0
Fish	Fish larvae	1440	1760	1600	1920	1120	1280	160	1280	1440	160	960	1600
Grand Total genera		**29**	**27**	**22**	**23**	**28**	**20**	**21**	**25**	**27**	**21**	**26**	**21**
Density (No/l)		**22080**	**13440**	**15040**	**16320**	**15680**	**10880**	**11680**	**16000**	**13760**	**11040**	**14880**	**14560**

Table 24. Abundance of zooplankton group, genera and density during winter 2021

Group	Genus	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11	S-12
Cnidaria	*Obelia*	0	0	320	480	0	320	0	0	320	0	160	400
	Physalia	0	0	480	160	0	480	0	0	0	0	320	0
Total		**0**	**0**	**2**	**2**	**0**	**2**	**0**	**0**	**1**	**0**	**2**	**1**
Copepoda	*Acartia*	800		0	0		800		800	320		640	1600
	Acrocalanus	6400	5600	0	4800	3200	4000	4000	0	4000	3200	2880	1800
	Aetideus	1920	800	0	0	800	0	0	0	0	800	800	1000
	Calanus	8000	4000	1120	5600	1920	4800	1600	0	0	1920	4000	0

	Calanopia	800	1600	1600	0	0	800	0	0	640	0	800	1700
	Centropages	2400	1280	1280	3200	1600	3200	3200	0	0	1600	1600	1300
	Eucalanus	1120	0	0	0	3200	1600	0	1600	0	3200	1280	600
	Labidocera	800	0	0	0	0	0	0	0	0	0	480	0
	Nannocalanus	3200	9600	8000	1600	2400	1920	800	0	0	1600	1280	800
	Paracalanus	2400	6400	11200	800	11200	3200	1920	3520	8000	4800	2400	1000
	Pseudodiaptomus	4800	0	0	320	0	1440	0	0	800	0	0	1000
	Temora	800	0	0	0	1600	0	1600	0	640	1600	2880	1400
Total		**12**	**7**	**5**	**6**	**8**	**9**	**6**	**3**	**6**	**8**	**11**	**10**
Harpacticoida	*Corycaeus*	800	0	0	0	0	0	0	0	0	0	0	1600
	Euterpina	1120	800	3200	800	0	0	0	640	800	640	0	0
	Microsetella	6400	4000	7200	6400	1600	1920	2400	1600	1920	1280	2400	1000
Total		**3**	**2**	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**1**
Cyclopoida	*Oithona*	2720	1600	0	800	800	480	320	0	640	800	480	1400
	Oncaea	640	0	0	0	0	0	0	0	320	0	0	1400
Total		**2**	**1**	**0**	**1**	**1**	**1**	**1**	**0**	**2**	**1**	**1**	**2**
Decapoda	*Caridean* larvae	1120	0	0	0	0	0	0	0	0	0	0	0
	Euphausia	1120	0	0	0	0	0	0	0	0	0	0	0
	Nauplius larvae	4800	2880	0	0	0	1600	0	800	1920	0	1600	1400
	Mysis	1600	1600	0	0	5600	3200	2400	1600	800	3200	3200	1000
	Phyllosoma	1120	320	0	0	0	0	0	0	640	0	320	0
	Lucifer	800	0	0	0	0	0	0	0	0	0	0	600
Total		**6**	**3**	**0**	**0**	**1**	**2**	**1**	**2**	**3**	**1**	**3**	**3**
Malacostraca	*Brachyuran* larvae	16000	0	9600	11200	8000	5600	4800	1920	1600	3200	4000	2800
	Euphasidnauplius	0	0	0	0	0	0	0	0	0	0	0	0
Total		**1**	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

Appendicularia	*Oikopleura*	0	0	0	0	0	0	320	480	0	0	0	400
	Copelata	0	0	0	0	0	0	0	0	0	0	0	0
Total		**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**1**
Gastropoda	*Creseissp*	320	160	0	0	0	320	0	0	0	0	320	0
	Gastropod larvae	0	160	0	0	0	480	0	800	0	0	480	0
Total		**1**	**2**	**0**	**0**	**0**	**2**	**0**	**1**	**0**	**0**	**2**	**0**
Sagita		3200	4000	1280	800	0	1280	9600	25600	14400	0	480	800
Other		**2**	**3**	**2**	**6**	**3**	**5**	**3**	**3**	**3**	**4**	**5**	**4**
Bivalve	Bivalve larvae	0	0	0	320	320	0	160	0	0	320	0	0
Branchiopoda	Cladocera	0	0	0	160	0	0	0	0	0	0	0	0
Tintinnida	*Tintinnopsis*	0	320	0	0	0	320	0	0	0	0	320	0
Hemichordata	*Tornaria* larvae	0	0	0	0	0	0	0	0	0	0	0	0
Echinodermata	*Bipinaria* larvae	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Polychaete larvae	0	0	1120	800	160	800	480	1920	3200	320	640	800
	Tomopteris	0	0	0	0	0	0	0	0	0	0	0	0
Bryozoan	*Cyphonutes* larvae	0	0	0	160	0	0	0	0	0	0	0	0
Foraminifera	*Globigerina*	0	0	0	320	0	480	0	480	0	320	480	600
Nematoda	Nemadodes	0	160	0	0	0	0	0	0	0	0	0	200
Fish	Fish larvae	1120	0	0	0	160	1600	0	0	1920	160	1600	0
Grand Total genera		**27**	**19**	**12**	**18**	**15**	**23**	**14**	**13**	**18**	**17**	**26**	**23**
Total density (No/l)		**76320**	**45280**	**46400**	**38720**	**42560**	**40640**	**33600**	**41760**	**42880**	**28960**	**35840**	**26600**

Table 25. Diversity indices of zooplankton during October 2020 and February 2021

	October 2020												
	S-1	**S-2**	**S-3**	**S-4**	**S-5**	**S-6**	**S-7**	**S-8**	**S-9**	**S-10**	**S-11**	**S-12**	**Average**
Taxa_S	30	27	23	24	29	21	22	26	28	22	27	22	25
Individuals	22080	13440	15040	16320	15680	10880	11680	16000	13760	11040	14880	14560	14613
Dominance_D	0.06	0.07	0.08	0.08	0.05	0.08	0.06	0.06	0.06	0.07	0.05	0.07	0.1
Shannon_H	3.03	2.94	2.82	2.86	3.23	2.77	2.93	3.03	3.07	2.87	3.10	2.89	3.0
Simpson_1-D	0.94	0.93	0.92	0.92	0.95	0.92	0.94	0.94	0.94	0.93	0.95	0.93	0.9
Evenness_e^H/S	0.69	0.70	0.73	0.73	0.87	0.76	0.85	0.79	0.77	0.80	0.82	0.82	0.8
Menhinick	0.20	0.23	0.19	0.19	0.23	0.20	0.20	0.21	0.24	0.21	0.22	0.18	0.2
Margalef	2.90	2.74	2.29	2.37	2.90	2.15	2.24	2.58	2.83	2.26	2.71	2.19	2.5
	February-2121												
0	**S-1**	**S-2**	**S-3**	**S-4**	**S-5**	**S-6**	**S-7**	**S-8**	**S-9**	**S-10**	**S-11**	**S-12**	**Average**
Taxa_S	27	18	12	18	15	23	14	13	18	17	26	24	18.8
Individuals	76320	45280	46400	38720	42560	40640	33600	41760	42880	28960	35840	26600	41630
Dominance_D	0.09	0.11	0.16	0.16	0.14	0.07	0.14	0.39	0.17	0.09	0.07	0.05	0.14
Shannon_H	2.83	2.41	2.02	2.18	2.22	2.81	2.21	1.56	2.22	2.53	2.92	3.05	2.41
Simpson_1-D	0.91	0.89	0.84	0.84	0.86	0.93	0.86	0.61	0.83	0.91	0.93	0.95	0.86
Evenness_e^H/S	0.62	0.62	0.63	0.49	0.61	0.72	0.65	0.37	0.51	0.74	0.71	0.88	0.63
Menhinick	0.10	0.08	0.06	0.09	0.07	0.11	0.08	0.06	0.09	0.10	0.14	0.15	0.09
Margalef	2.31	1.59	1.02	1.61	1.31	2.07	1.25	1.13	1.59	1.56	2.38	2.26	1.67

9. Marine Fishery

Gujarat is endowed with a wide range of marine and inland aquatic resources. The state has the longest coastline extending to 1640 km accounting for 19.7% of the total coastline of the country and about 46% of the western coastline of India. It has a continental shelf area of 0.18 million km^2, Exclusive Economic Zone (EEZ) of 0.214 million km^2, which occupies 32% of the continental shelf area and 10% of the total EEZ of India. The Gujarat coast, including the two Gulfs, is blessed with physical features congenial to the development of fisheries. The major fisheries resources of the state include Elasmobranches, Bombay ducks, Sciaenids, Shrimps, Seer fishes, Tunas, Threadfin Breams, Pomfrets, Catfishes, Lizard fishes, Bull's eyes, Carangids, Anchovies, Ribbon fishes, Croakers, Prawns, Lobsters and Cephalopods. Kachchh has the coast line of 406 km (25.45% of Gujarat coast). The fisheries related information is given in Table 26.

Table 26. Fishery related details of Kachchh District

Details	Kachchh	Gujarat
Fishing villages	73	247
Fishermen families	3650	62231
Total fishermen population	18664	336181
Active fishermen	10615	--
Mechanized fishing boats	1219	14330
Non-mechanized fishing boats	291	
Total fishing gear (nets)	25917	
No. of trawlers	11	
No of gill netters	188	
Others	1019	

Gujarat remained at the top position for the fifth consecutive year contributing 7.86 lakh tonnes (20.5% of total landings) fish catch followed by Tamil Nadu and Kerala. Out of the total production, nearly 60-70% is reported from Junagadh district alone. Unlike previous years, 2017 recorded a moderate increase in marine fish production. But the fishery scenario in and around Kandla is quite contrary. Waters of Kandla, Hansthal and Khari creeks used to yield diverse fishes such as Salmon, Croaker fishes, *Polynymus indicus, P. heptadactylus,* and *Pomadasys hasta* which have almost reduced or become non-existent.

This declining fish production and fishery resources of Kandla region appears to be due to combination of factors. Analysis of last decade's fish landing data shows that Catch Per Unit Effort (CPUE) and catch per boat is declining whereas numbers of boats are on the rise in Kandla. Landing of some species have dwindled enormously and some species have disappeared totally. It is apparent that destructive fishing gears like trawl nets and *perse seines* are the major culprits. The small mesh size (3-7 mm) of these mass harvesting gears destroy benthic habitats of several important marine organisms, which though do not form a commercial catch, are important for the population dynamics of commercially important fishery through ecological food chain relationships. In spite of the declining catch, Kachchh has a vibrant fishery industry and the fishery resource is the mainstay for 18,664 active fishermen in the district.

In the present study, fishery resources of the creek systems within Deendayal Port jurisdiction was analyzed through experimental fish catching in four major creek systems in order to document the fish diversity and their abundance. Fishery resources of this region were gathered from several secondary literatures as well. This study was conducted during October 2019 and February 2020 in four creek systems falling within the Deendayal Port jurisdiction.

9.1. Methodology

Fishery resources and diversity was assessed in four creek systems namely, Kandla, Hansthal, Nakti and Khori creeks during the month of October 2020 and March 2021. Samples of finfish and shell fish were collected using a gill net with 10 mm mesh size. The net was operated onto the water from the canoe or by a person standing in waist during the high tide start. For effective sampling, sampling points were fixed at regular distance in 12 sites close to areas where parameters such as plankton and subtidal fauna were investigated. In each sampling point, the gill net was deployed 5 times and the CPUE (Catch Per Unit Effort) was estimated per hour. The collected specimens were segregated into groups, weighed and preserved in 10% neutralized formalin solution. Finfishes were identified following Fischer & Bianchi (1984), Masuda *et al*. (1984), de Bruin *et al*. (1995) and Mohsin & Ambiak (1996). Relevant secondary information pertaining to fishery resources of Deendayal Port creek systems has been gathered through technical reports, district fisheries department, Government gazette and other research publications.

9.2. Results

A total of five species of fish species were recorded during the post-monsoon season of 2020. Among them, *Mugil cephalus* showed the highest density at Kandla creek and Navlakhi creek during the present study (Table 27, Plate 8). Diversity, abundance and CPEU in the present study were poor. The total catch quantity of all species from all the sampling locations was 133.82 kg with an average of 33.3 kg which indicates poor fishery resources of these creek systems during the sampling period.

During the winter 2021, a total of six finfish and shellfishes were collected from experimental fishing by using gill net at Tuna creek (Table 28). The total biomass of fish catch was 1.390 kg, which indicates poor fishery resources in tuna creek. Many of the sampling sites especially upstream creeks like Jangi, Phan creek we could not get fishes during the sampling period. Among all sampling sites Khari creek near the DPT port area have rich fishery population during the high tide period.

Table 27. Experimental Fish Catch in DPT during Post-monsoon season 2020

S. No	Species	Khari Creek	Tuna Creek	Navlakhi	Jangi creek	Total (kg)
1	*Mugil cephalus*	30.00	-	100.00	-	130.00
2	*Parapeneaus indicus*	0.200	-	0.500	-	0.720
3	*Thryssa* sp.	1.500	-	-	-	1.500
4	*Liza parsia*	1.500	-	-	-	1.500
5	*Puffer fish*	0.100				0.100
Total of weight (Kg)		**33.30**	**-**	**100.500**	**-**	**133.820**

Table 28 Experimental Fish Catch in DPT during winter season 2021

S. No	Species	Khari Creek	Tuna Creek (g)	Navlakhi	Jangi creek	Total (kg)
1	*Parapeneaus indicus*	-	500	-	-	0.500
2	*Chanos chanos*	-	250	-	-	0.250
3	*Mudskipper*	-	250	-	-	0.250
4	*Therapon fish*	-	100	-	-	0.100

5	*Portunus pelagicus*	-	250	-	-	0.250
6.	*Other crab species*	-	40	-	-	0.040
Total weight (Kg)		-	**890**	-	-	**1.390**

9.3. Discussion

Deendayal Port is at the tail end of Gulf of Kachchh experiencing very harsh environmental conditions. Elevated salinity, poor rainfall, very high suspended load in the water column in the range of 74 – 246 mg/l and 125 – 314 mg/l in offshore and creek water (GUIDE, 2020). Similarly, density and abundance of primary producers (phytoplankton) recorded in these two seasonal study is very poor attesting the poor productivity of these waters. High tidal movements and strong littoral currents make fishing through gill netting and trawling difficult in Kandla and adjacent creek systems. In addition, frequent vessel movement also limits fishing operation. As a result, no major commercial scale operations could be observed in the creek systems in and around Deendayal Port except for minor shore based hand netting and gill netting fishing operations. Small plank built traditional vessels such as sail boats and vessels locally called 'Machuva' are predominantly used for fishing in these waters. Gears like hand nets, drift nets and bag nets are predominantly used by the shore based fishermen.

About 1,450 fishing community are present in the villages in and around Kandla. There are about 465 motorized and 62 non-motorized fishing vessels are operated in 6 villages located around Kandla which are regularly engaged in fishing activity. However, almost all fishermen and fishing vessels in these villages go to regions 10-20 km away from Kandla - Tuna complex since fishery resources at the inner portion of Gulf of Kachchh is sparse due to a combination of natural and human induced factors. The adult fin fishes have been moved away from the zone of high suspended load and have migrated to areas of ambient suspended material load. However, abundance and diversity of finfishes in Kandla coast and creeks were low due to harsh prevailing milieu such as high suspended load, clocked gills and low dissolved oxygen levels. As a result of these low CPEU and poor fish diversity, commercial fishing operations are minimal as fishermen of this region generally operate about 10-20 km offshore for fishing.

Plate 8 Marine fishes at Kandla creeks
(A) Buffer Fish, (B) *Mugil cephalus*, (C) *Thryssa* sp., and (D) *Liza parasia*

10. Seaweeds, Sea Grasses and Halophytes

10.1. Seaweeds

Seaweeds are commercially important marine living and renewable resource and have been a part of human civilization since time immemorial. They support rich biodiversity by providing habitat for numerous estuarine and coastal fauna including fishes. Seaweeds have been exploited for various purposes as early as 2500 years ago (Tseng, 2004). Seaweeds grow abundantly in shallow waters of sea, backwaters and estuaries. They flourish wherever rocky, coral or suitable hard substrata are available for attachment. Based on pigmentation, morphological and anatomical characters, seaweeds belong to three groups namely, green (Chlorophyta), brown (Phaeophyta) and red (Rhodophyta).

Of 20,000 seaweed species distributed globally, about 1053 species are recorded in India (Oza & Zaidi, 2001; Anon, 2005). The coastal belt of Gujarat and Tamil Nadu are important seaweed culture sites in the country. Gujarat coast has the second largest seaweed diversity in India. Rocky beaches, estuaries, coral reefs and lagoons along the Indian coast provide ideal habitats for the growth of seaweeds (Rao & Mantri, 2006). Rich seaweed beds occur around Visakhapatnam, Mahabalipuram, Gulf of Mannar, Tiruchendur, Tuticorin, Kanyakumari, Kerala, Veraval, Gulf of Kachchh coast, Lakshadweep, and Andaman and Nicobar Islands (Manilal *et al.*, 2009; Paul & Raja, 2011; Satheesh & Wesley, 2012). Some seaweeds such as *Sargassum* sp., *Gracilaria corticata, Ulva* sp., *Enteromorpha* sp. and *Chaetomorpha* sp. are commonly distributed all along the intertidal rocky surfaces of the Gujarat coastline.

During the last seven decades, several studies have been carried out on seaweed diversity from various parts of the Indian coast. There are very few references available on diversity, biomass and conservation strategies of seaweeds in Gujarat. In the present study, an attempt was made to study the occurrence, diversity and other ecological features of seaweeds and sea grasses within Deendayal Port jurisdiction.

Seawater movement and the hydrological regime affect seaweeds. Stranded tufts of *Enteromorpha* sp., *Ulva lectuca*, *Ulva rigida*, *Ulva reticulate* and *Sargassum wightii* were seen in waters of DPT during the surveys. Given wind patterns and ocean currents, these strands could have possibly made their journey all the way from southern coast of Gulf of Khambat to Deendayal Port area. Usually seaweeds grow in the rocky intertidal and subtidal habitats that offer a hard substrate for attachment. Low turbidity and least suspended sediment load in the water column with high nutrient content is a major habitat requirement that enables photosynthesis. Suspended load in the Deendayal port creek water ranges from 800 to 1300 mg/l. This high suspended load curtails photosynthetic activity of seaweeds which are highly sensitive to light. Hence, seaweed formations are absent in the creek systems of the Deendayal Port except drifted/ stranded tufts.

10.2. Sea Grasses

Sea grasses grow in shallow marine and estuarine environments of all the continents except Antarctica. As flowering plants they form an ecological group and not a taxonomical group (Kou & Hartog, 2000). Sea grasses are unique because out of the estimated two to three hundred thousand species of flowering plants, they are the only angiosperms that have adapted to life in a submarine environment (Hemminga & Duarte, 2000). With only 12 genera and 54 described species, sea grasses are not taxonomically diverse compared to other benthic marine primary producers such as seaweeds and microalgae (Green & Short, 2003). Yet, seagrass beds can be long-lived and some are reportedly 1,000 years old (Reusch *et al.*, 1999). Despite their own limited taxonomic diversity, sea grasses are the only rooted plants in near shore region and they enhance biodiversity manifold by offering shelter to thousands of other taxa including vertebrate and invertebrate species besides being a foraging site, spawning habitat and nursery.

Similar to seaweeds, sea grasses were absent in the creek systems of Deendayal Port and in the adjacent coastal stretches of Kachchh due to inherent habitat conditions. Sea grasses generally thrive in shallow coastal waters and are adapted to live in submerged conditions from mid intertidal to depth as much as 50 m when light penetration is sufficient; conditions contrary to the one prevailing in Deendayal Port and the nearby creek systems explaining the total absence of sea grasses.

10.3. Halophytes

Halophytes complete their life cycle in a saline environment. The regions influenced by regular and occasional tidal flushing support obligate halophytes, and those with high salt-encrustation mostly remain devoid of vegetation. Such wetlands in India are largely found in Gulf of Kachchh and Tamil Nadu coasts. A comprehensive list of 1554 halophytes recorded across the world was prepared by James Aronson during 1980s. Halophytes are capable to grow from lower to higher saline conditions in coastal areas, wetlands and salt marshes (Ungar, 1991). While information on biology and eco-physiology of halophytes is extensive, only few studies are available on their coastal diversity (Miladi, 2015).

Halophytes are common along the coastal belt of Gujarat. Certain halophyte plants are also present in the inland parts of most of the Gujarat coastal areas where coastal water is accessible. Especially in Kachchh district, halophytes are common in moist and wetland areas, coastal belts and inland salt flats. In the present study, field investigations were carried out at 12 sampling sites (i.e. Site1 to Site 12) to study the halophyte diversity within the Deendayal Port jurisdiction. This chapter w.r.t. halophytes is presented into two sections i.e. i) findings of the study conducted during October 2020 and March 2021, and ii). comparison of results of 2018 to 2021 with earlier studies (2017- 2018).

10.4. Methodology

To quantify and document the halophytes at Deendayal Port region, quadrate method was followed. At each sampling location quadrates of various sizes were laid in each season. For trees, the quadrates of 10 x 10 m were laid. Quadrates of 5 x 5 m and 1 x 1 m were laid within each tree quadrate to record shrubs and herbs, respectively (Misra, 1968; Kershaw, 1973; Bonham, 1989). Four quadrates each for shrubs and herbs were laid in each tree quadrate to assess the halophytes in the study area. To enrich the species inventory, areas falling outside the quadrates were also explored and the observed species were recorded and photographed. Specimens of species were collected to know more information on habitat and for preparation of herbarium specimens. The species were identified using standard keys.

10.5. Results

10.5.1. Findings of October 2020 and March 2021

In total 10 species of halophytes (inside and outside the quadrates) were recorded during October 2020 and March 2021 in the DPT jurisdiction comprising of 01 tree species, 04 shrub species, 04 herb species and 01grass species. Of these, only 04 species (*Aeluropus lagopoides*, *Salicornia brachiata*, *Salvadora persica* and *Sesuvium portulacastrum*) occurred in the quadrates during October 2020 and 03 species (*Salicornia brachiata*, *Salvadora persica* and *Sesuvium portulacastrum*) during March 2021 (Table 29, Table 30). *Sesuvium portulacastrum* was the dominant species distributed at 09 stations during post-monsoon 2020 and at 10 stations in winter 2021 (Plate 9). No halophytes were recorded at S-8 site within the quadrates during October 2020. Interestingly, *Aeluropus lagopoides* was recorded only at site S-6 during October 2020.

Table 29 Halophytes recorded in the quadrates during October 2020 in DPT environ

Halophytes	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11	S-12
Aeluropus lagopoides						√						
Salicornia brachiata			√	√	√	√			√	√	√	
Salvadora persica			√	√	√							
Sesuvium portulacastrum	√	√		√	√	√	√			√	√	√
Note: S-1, S-2 and S-12: Nakti creek; S-7: Khari creek; Kandla creek/Phan creek; S-3,S-4, S-5 S-10; S-6 and S-11: Jangi creek; S8 and S9: Navlakhi creek												

Table 30 Halophytes recorded in the quadrates during March 2021 in DPT environ

Halophytes	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11	S-12
Salicornia brachiata			√	√	√	√	√	√	√	√	√	
Salvadora persica			√	√	√					√		
Sesuvium portulacastrum	√	√		√	√	√	√		√	√	√	√
Note: S-1, S-2 and S-12: Nakti creek; S-7: Khari creek; Kandla creek/Phan creek; S-3,S-4, S-5 S-10; S-6 and S-11: Jangi creek; S-8 and S-9: Navlakhi creek												

10.5.2. Overall findings during 2018 - 2021, and comparison with 2017 - 2018

A total of 14 halophyte species belonging to seven families and 12 genera were recorded during 2018 - 2021 from the DPT jurisdiction (Table 31). Highest number of halophyte (14 sp.) was recorded during post-monsoon of 2018 and winter 2019 and least during winter 2020 (09 sp.). Interestingly *A. lagopoides* was recorded during post-monsoon of 2020 from only S-6 site. *Salicornia brachiata* was the dominant species during the first two years (post-monsoon 2018 to winter 2020). However, in the last year (post-monsoon 2020 to winter 2021) it was replaced with *S. portulacastrum* (Table 32). The decline in halophyte diversity over the years was evident from the data. Sites S-4, S-5 and S-10 harbored more halophytes then the others.

Comparison of 2018 - 2021 findings with GUIDE (2018) reveals that *Sericostoma pauciflorum* and *Zygophyllum simplex* were absent during October 2018 - March 2021. Still, more halophyte species (14 sp.) were recorded during 2018 - 2021 then 2017 - 2018 results (09 sp.).

Table 31 List of Halophytes recorded from the DPT jurisdiction during 2018 - 2021

Sl. No.	Species	Family	Form
1	*Aeluropus lagopoides*	Poaceae	Grass
2	*Atriplex stocksii*	Amaranthaceae	Shrub
3	*Cressa cretica*	Convolvulaceae	Herb
4	*Haloxylon recurvum*	Amaranthaceae	Shrub
5	*Haloxylon salicornium*	Amaranthaceae	Shrub
6	*Heliotropium currasavicum*	Boraginaceae	Herb
7	*Salicornia brachiata*	Amaranthaceae	Shrub
8	*Salvadora persica*	Salvadoraceae	Tree
9	*Sesuvium portulacastrum*	Aizoaceae	Herb
10	*Suaeda fruticosa*	Amaranthaceae	Shrub
11	*Suaeda nudiflora*	Amaranthaceae	Shrub
12	*Tamarix stricta*	Tamaricaceae	Shrub
13	*Trainthema portulacsatrum*	Aizoaceae	Herb
14	*Urochondra setulosa*	Poaceae	Grass

Table 32 Details of halophytes recorded during 2018 - 2021 from DPT area

Year	Season	Total Sp.	Sp. within quadrate	Species within the quadrate		Dominant sp.
				Maximum sp.	Minimum sp.	
2018 - 2019	Post-monsoon 2018	14	07	S-4 (05 sp.)	S-12 (0 sp.)	*S. brachiata* & *S. persica*
	Winter 2019	14	07	S-4 & S-5 (05 sp.)	S-9 (01 sp.)	*S. brachiata*
2019 - 2020	Post-monsoon 2019	10	03	S-5 (03 sp.)	S-1, S-2 & S-7 (0 sp.)	*S. brachiata*
	Winter 2020	09	03	S-2, S-4 & S-10 (03 sp.)	S-7 (0 sp.)	*S. brachiata*
2020 - 2021	Post-monsoon 2020	10	04	S-4, S-5 & S-6 (03 sp.)	S-8 (0 sp.)	*S. portulacastrum*
	Winter 2021	10	03	S-4, S-5 & S-10 (03 sp.)	S-1, S-2, S8 & S-12 (01 sp.)	*S. portulacastrum*

10.6. Discussion

Halophytes had a dominant presence in this study falling within the premises of Deendayal Port Trust since habitat conditions suitable for halophytes are present within the port limits. In the mudflats and salt marshes of Deendayal Port area, halophytes were mostly found beyond highest high tide levels where spring tides reaches only occasionally and pore water salinity is often >90 ppt. Their presence was widely noticed intermingled with mangrove formations in all mudflats.

Several studies have been conducted on coastal flora of Gujarat. Shukla (2007) examined the ecophysiology of salt tolerance in select halophytes of Gujarat coast. Khot (2003) carried out ecophysicological studies on halophytes of Marine National Park in Jamnagar. Pawar (2012), Gohel (2013) and Gohel *et al.* (2015) studied the halophyte diversity along the Gujarat coast. Salvi *et al.* (2017) studied the halophyte diversity of Gulf of Kachchh. All these studies have well represented the importance of halophytes and coastal flora of

Gujarat coast and have stressed upon the importance of conserving these species. Studies elsewhere have suggested that pollutants from industrial sources may affect halophytes more than mangroves. Even though halophytes are known to have tolerance mechanisms *viz*., ions compartmentalization, compatible solutes; if metal contaminants enter the ecosystem, they tend to get distributed in sediments, pore water and plants. Thus, halophytes are key sinks for metal pollutants and their conservation is of significance. Given the scenario, regular monitoring of halophytes w.r.t. heavy metal accumulation is recommended.

Seed germination in halophyte decreases with the increase in salt concentration. As an adaptation halophytes tend to decline seed germination, as seedling stage is considered the most susceptible stage in the lifecycle of halophytes. From this it is evident that sites with more diverse halophytic species may be conserved through appropriate management actions in DPT jurisdiction.

Presence of *A. lagopoides* in the current study was reported from site S-6 along during post-monsoon. Vegetative propagation in *A. lagopoides* is by underground rhizomes after monsoon shower, whereas sexual reproduction is through seeds and flowers produced between April and October (Kumar *et al*., 2016). Studies elsewhere (Gulzar & Khan, 2001) have reported presence of *A. lagopoides* in high salinity habitats that are uninhabitable to several halophytic species. Due to structural adaptations and modifications, *A. lagopoides* is capable of expelling salt through glands on the leaves thus thriving in extreme high saline areas. It is suggested that more focused studies on halophytic adaptations in DPT jurisdiction may be helpful in better conservation and management of halophytes.

Saline environment in itself is a potential threat to halophytes due to osmoregulation and toxicity. The absorption of inorganic ions may relieve the osmotic gradient, but higher levels of inorganic ions could be toxic to halophytes. Species composition and diversity are dependent on several factors. The Deendayal Port area has been leased out to salt industries for several years. To initiate such projects the industries need clearing of ground vegetation including halophytes which will affect halophyte diversity and density and their local extinction in long term. In addition to this uncontrolled grazing of vegetation including halophytes is also a threat to their diversity. The halophytes such as *Salvadora persica* are food for certain bird species. Other halophyte species such as *Suaeda* sp., *Salicornia* sp., etc. in association with other vegetation are important foraging habitats for birds. Therefore, importance of coastal flora including halophytes through awareness campaigns to the local people, supervisory staff, labourers at Deendaya Port would help in conserving and protecting the biodiversity at Deendayal Port area. Though the present study reported 14 species of halophytes in the Deendayal Port area, the pointed/suggested threats need to be addressed in order to conserve halophyte diversity of the area.

10.7. Conclusions

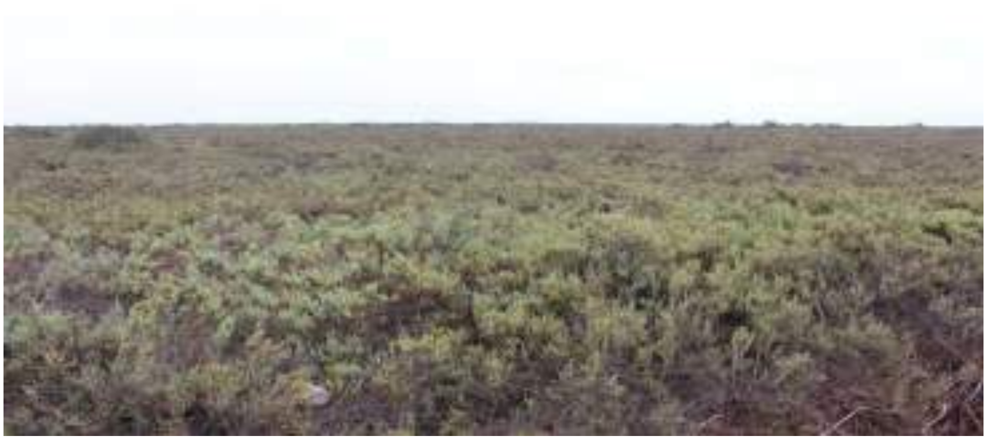
The present study revealed the absence of seaweeds and sea grasses, and the presence of 14 halophyte species belonging to 07 families and 12 genera from the 12 sampling locations at DPT. Absence of seaweeds and sea grasses in the study area are attributed to the inherent geological settings. From the present 03 year findings, it can be concluded that the halophyte species are remarkable in tolerating high salt content through various mechanisms. Researches in other parts of Gujarat have stressed upon the importance of conserving halophyte diversity and assessing associated threats. Given the current scenario of industrialization in Deendayal Port area, the halophyte diversity appears to be rich. It is apparent that the halophytes in this coastal and inland environment are proliferating well currently. Nevertheless, in long run halophytes at Deendayal Port area may face degradation due to industrial activities. Given the situation, regular monitoring of halophytes is recommended.

Aeluropus lagopoides

Cress cretica

Suaeda sp.

Heliotropium currasavicum



Bed of *Salicornia brachiata*

Atriplex stocksii *Salvadora persica*

Trianthema portulacastrum *Salicornia brachiata*

Sesuvium portulacastrum

Plate 9 Halophytes recorded from the Deendayal port environment

11. Avifauna

11.1. Introduction

Aquatic or coastal ecosystem serve as feeding, nesting, breeding and resting ground for resident and migratory water birds. Aquatic bird population parameters such as species richness, relative density and diversity of birds are frequently used as indicators of habitat quality (Sampath & Krishnamoorthi, 1990). All the aquatic birds are ecologically dependent on water are called waterfowl, especially of family Anatidae, ducks. The Ramsar Convention (Anon, 1972) includes traditionally recognized groups of waterfowl into; Gaviiformes, Podicipediformes, Pelecaniformes, Ciconiiformes, Anseriformes, Gruiformes, Ralliformes and Charadriiformes. Accordingly, a total of 273 species fall under waterfowl group in India (Ali & Ripley, 1987). In addition to these groups, there are other birds which also depend on water such as Kingfishers, Birds of Prey and Passerines. In India, 310 species of aquatic birds have been reported by Samant (1985). Among these, 51 species are listed under threatened category due to habitat losses (Rashid & Scott, 1988).

Coastal birds can be categorized into Shoreline predators, which include birds of prey and herons; Waders, such as sandpipers and plovers; and True seabirds, such as gulls, terns, gannets, and boobies (Sethuraman, 2000). Some of the world's highest bird diversity is found in coastal habitats (Kurosawa & Askins, 2003). Coastal environment also hosts some of the largest gatherings of migratory and breeding birds (Sethuraman & Subramanian, 1997). Mangrove forests are extremely essential for the survival of many bird species (Sethuraman, 2000), but information on birds associated with mangroves in India is scanty (Samant, 1985; Rashid & Scott, 1988; Sethuraman & Subramanian, 1997). A checklist of some birds associated with the mangroves of Ratnagiri has been prepared by Samant (1985) and in the same area Apate *et al*. (2005) reviewed the potential and prospects of estuarine ecotourism with special emphasis on mangrove birds.

Ali (1962, 1963) published ornithological check list based on his ornithological trip to the Gulf of Kachchh and Parasharya (1984) studied the coastal birds association with marine habitats with special reference to Reef Heron in the Saurashtra coast. Mundkur *et al*. (1988) reported the occurrence and distribution of the slender billed Gull *Larus genei* from various localities in the Gulf of Kachchh. Palmes and Briggs (1986) reported the Crab-Plover in the Gulf of Kachchh. Naik *et al*. (1991) studied the avifaunal assemblage of the Gulf coast covering different habitats namely intertidal mudflats, coral reefs, sand and rock beaches and mangrove forests. Urfi (2002) studied the costal warders in the Byet of Dwarka Island and reported that the mangroves were used by the waders during the high tide. Previous researchers suggest that although there are similar numbers of bird species found in mangroves throughout the world, the highest numbers of mangrove dependent bird species are found in Southeast Asia and Australia (Sethuraman & Subramanian, 1997). The majority of the mangrove restricted species (or species with at least one mangrove restricted subspecies) are located in Asia (26) and northern Australia (23), but the data on habitat association and utilization is scant (Lefebvre & Poulin, 1996; Panitz, 1997).

11.2. Methodology

The mangrove habitat along the Gulf of Kachchh was delineated into 12 major sites based on the subjective magnitude of anthropogenic pressure. In each project site creeks were of varying length from 2 to 5 km. These creeks were surveyed by using boat and adopting "line transect" method. A total of 12 boat transects (one at each site) were laid in the post-monsoon 2020 and winter 2021. Survey was done in both terrestrial habitats like natural mangrove and plantation adjoining the mudflats and wasteland, and aquatic habitats like creek area, rivers and wetland.

11.2.1. Boat Surveys

Mangrove bird diversity was calculated by using Boat Survey methods. The bird observation was carried out through point count method from an observation post aboard the boat which was given the greatest angle of clear view. Birds within a 100 m transect on one side of the boat were counted in 10 min interval of time (Briggs *et al*. 1985; van Franeker 1994). Detection of birds was done with a binocular (10 x 40) and counts were made: (1) continuously of all stationary birds (swimming, sitting on mangrove, or actively feeding) within the transect limits and (2) in a snap-shot fashion for all flying birds within the transect limits. The speed of the boat determines the forward limit of the snapshot area within a range of 100 m. Longer or shorter forward distances were avoided by adapting the frequency of the snapshot counts. Birds following and circling the boat were omitted from both snapshot and continuous counts. If birds arrived and followed the boat, they were included in the count only if their first sighting fell within a normal snapshot or continuous count of the transect area. For each bird observation species, number of individuals and activity at the time of sighting were recorded. Species richness and diversity index were calculated for different mangrove patches (12 sites) of the study sites in Deendayal port area in Gulf of Kachchh.

11.2.2. Data Analysis

Species composition, distribution and diversity

The systematic position of the birds, nomenclature and scientific names were confirmed following Praveen *et al.* (2016). Birds sighted during the survey were categorized as per their migratory status such as resident migratory (RM), resident (R), and migrant (M) by following Ali (2002). The birds were also categorized into various foraging guild such as insectivores, nectarivores, omnivores, scavengers, frugivores, carnivores, piscivores and granivores based on description provided by Wills (1979), Karr *et al*. (1990), Anjos (2001) and field observations on what the bird predominantly feeds on. Data collected from transect/point counts were used to calculate composition species diversity, richness. Data was analyzed using following formulae:

(A) **Shannon Weiner Diversity index (H') H'**= $\sum$ Pi x ln (Pi)

Where: H' = index of species diversity

pi = proportion of total sample belonging to the i^{th} species

ln = natural log1

(B) **Margalef's Richness index (Rl)**

Rl = S – 1/ln (n)

Where n= total number of individuals, S= total number of species

(C) **Equitability (El or J'):** Shannon diversity divided by the logarithm of number of taxa. This measures the evenness with which individuals are divided among the taxa present.

J' = H'/In(S), S= total number of species

11.3. Results and Discussion

Research on bird diversity emphasizes the general negative effects of land conversion to human dominated habitats (Brooks *et al*. 1997; Castelletta *et al*. 2000). Birds depend on the habitats where they occur, so the response of the species in particular habitat may always differ according to the habitat change (Cornelius *et al*., 2000; Zanette *et al*., 2000; Johnson & Igl, 2001; Beier *et al*., 2002; Tworek, 2002; Kurosawa & Askins, 2003). Recently human intervention has intensified on the coastal habitats and therefore the effect on birds can be very different from the past.

A total of 96 species belonging to nine orders, 34 families and 68 genera were recorded from the coastal area of Deendayal Port during this study (Annexure 3). Among these, 63 species were aquatic and 33 species were terrestrial, which included seven species listed as Near Threatened in the IUCN 2021, Red List.

Order Charadriiformes i.e. aquatic birds (including raptors and most water birds) constituted the predominant group representing 39% of all species recorded from the study area followed by the order Passeriformes (20%), i.e., perching birds (including babblers, drongos, mynas, sunbirds, doves, warblers, larks, chats, wagtails, robins). The families with more number of species were Scolopacidae (17 spp.), Laridae (10 Spp.), Ardeidae (8 spp.), Charadriidae (7 spp.), Hirundinidae (4 spp.), Columbidae (3 spp.) and Passeridae (one spp.). Of the recorded species, 38 species were migrants, 15 species were local migrants or resident migrants, and 43 species were breeding resident.

During the present investigation birds with diverse food habits were observed, *viz*., frugivore, nectorivore, piscivore, granivore, carnivore, insect and other terrestrial invertebrate feeder, plankton feeder, aquatic invertebrate feeder, amphibian feeder, ophidiovore, reptile feeder, weedivore, herbivore and predatory. Among these feeding guilds birds with aquatic invertebrate feeders were found high (40 spp.) followed by insectivore (16 spp.). The overall Shannon diversity (H') index was 4.21 with overall species richness index for study area is 1.8. The overall species evenness index value for study area was 0.71 with overall Equitability value of 0.92 (Table 33).

11.3.1. Status, Distribution and Diversity of Avifauna

Between the seasons maximum number of species (49 spp. in post-monsoon and 69 spp. in winter 2021) was found at S-1 followed by S-2 (48 spp. & 66 spp.), S-9 (41 spp. & 57 spp.) and S-7 (41 spp. & 55 spp.). At sampling location S-12, the least number (27 spp. & 38 spp.) were recorded during the post-monsoon and winter, respectively (Figure 27).

The maximum number of migratory species was found at S-1 and S-2 during both the seasons and the number was relatively high in winter. The migratory birds observed was maximum (26) at S-1 followed by S-9 (16) (Figure 28) The terrestrial avifaunal richness was also recorded from S-1 and S-2 (19 spp.) in post-monsoon and winter however it was slightly high at S-1 (26 spp.) than S-2 (23 spp.), The aquatic avifaunal species during monsoon was the highest at S-1 (30 spp.) followed by S-2 (29 spp.), S-9 (28 spp.) and S-7 (27 spp.) while during winter in S-1 and S-2 it increased to the maximum (43 spp.) followed by S-9 (38 spp.), S-7, S-10 (36 spp.) and S-11 (33 spp.) (Figure 29).

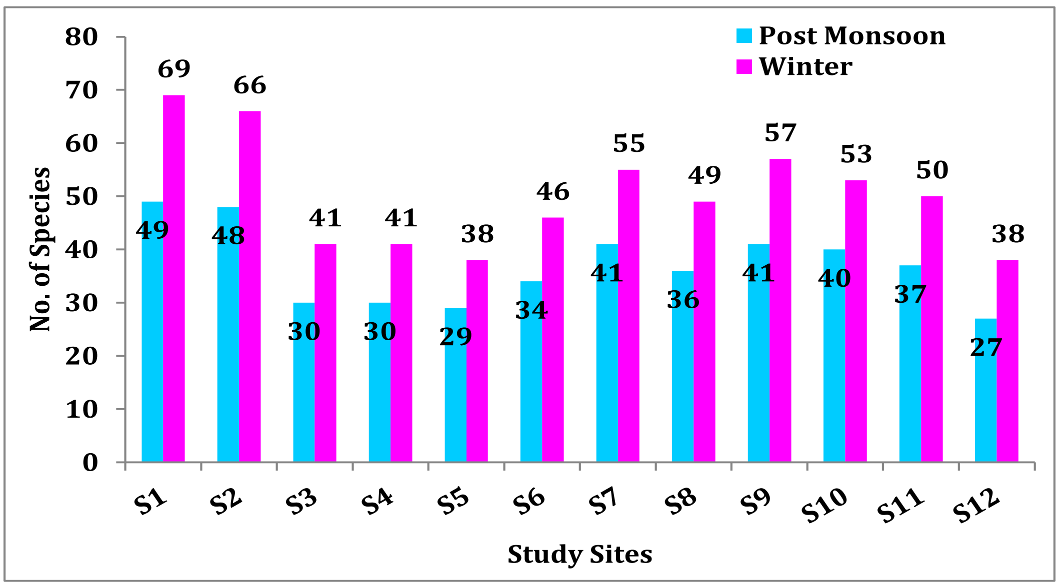


Figure 27 Number of species recorded from the Study sites

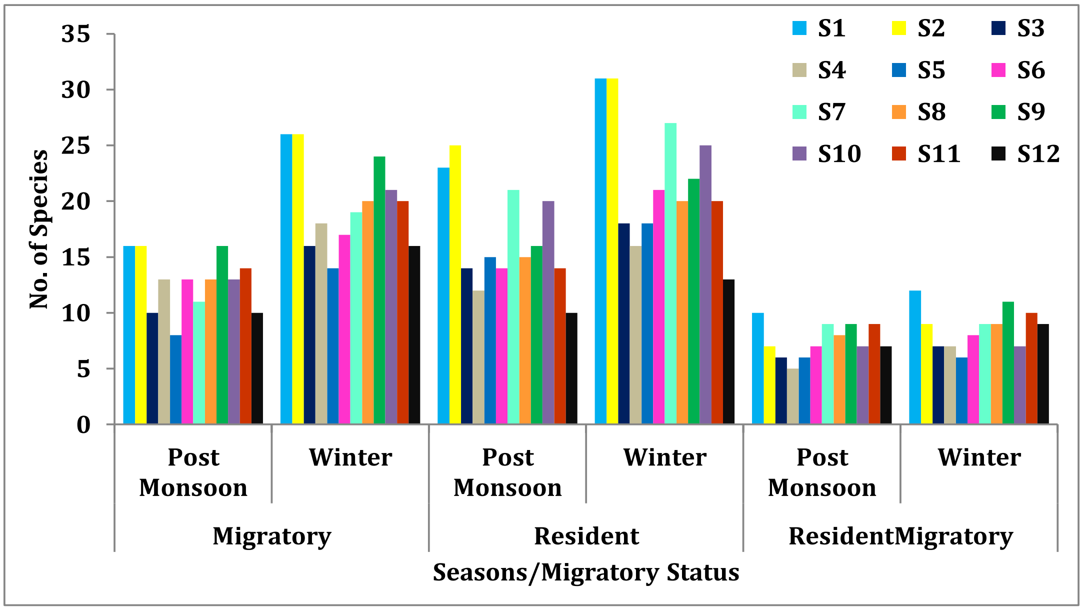


Figure 28 Migratory species recorded from the Study area.

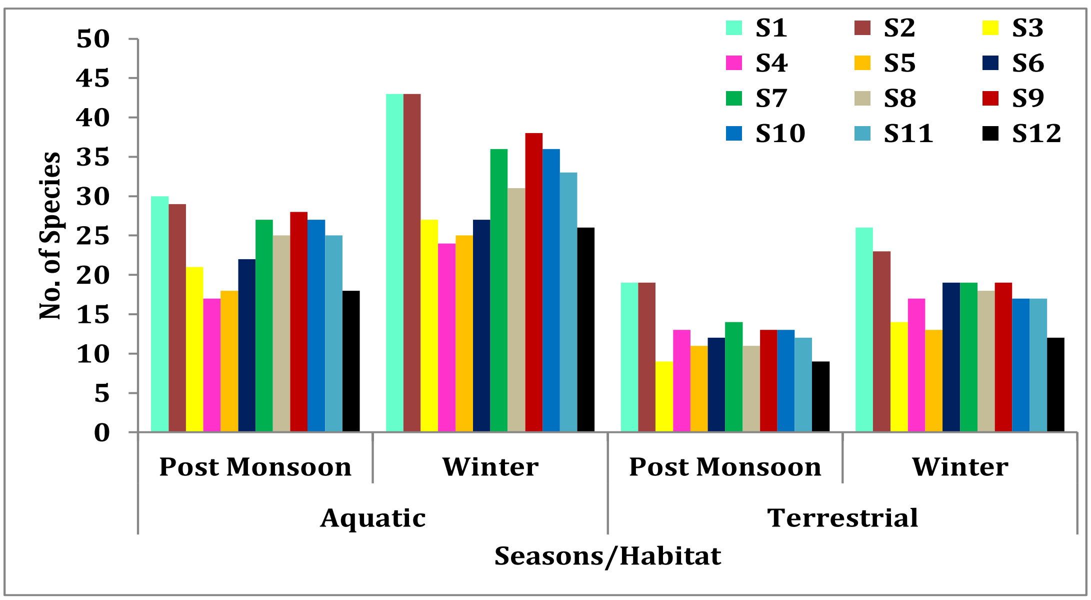


Figure 29 Terrestrial and Aquatic species recorded from the study area

During the present investigation birds (Plate 10) feeding on aquatic invertebrates were observed from all the 12 sampling locations and their number was relatively high (26) in winter at S-1. Insectivores feeding types (Maximum 12 & 18 spp.) were found at S-1 and S-2 while piscivores (maximum 4 and 8 spp.) were recorded from S-1. The birds belonging to the granivore (maximum 4 and 5 spp.) were recorded from S-1, S-3, S-6, S-8 and S-11) and least species were of frugivores, omnivores and nectorivores.

Data collected from point counts allow to calculate species diversity, richness and species composition. The results showed that the maximum diversity for the two was from S-1 (H' 3. 68 & 4.0) followed by S-2 (H' 3.56 & 3.89) and the minimum diversity was recorded from S-12 (H' 2.86 and 3.25) in post-monsoon and winter, respectively. The species richness was maximum at S-1 (3.60 sp. and 4.16 sp. and minimum at S-12 (2.35 spp. and 2.80 spp.) for the post-monsoon and winter, respectively.

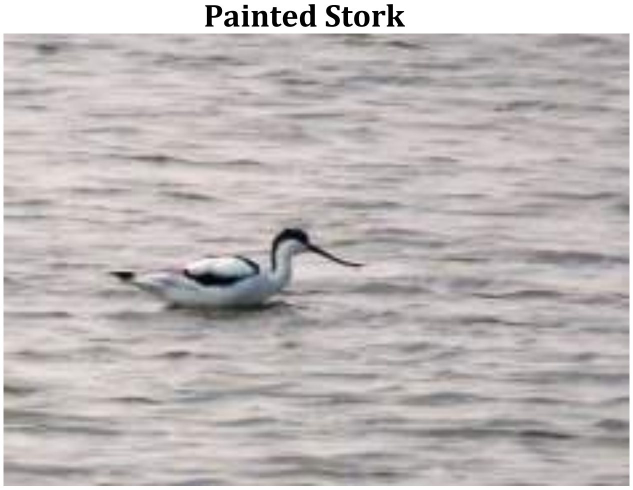
The changes in individual bird species abundance, whether they occur independently (Wiens, 1989) or are influenced by interactions with other bird species are governed by the degree of anthropogenic pressure including disturbance to the habitat of species (Block & Brennan, 1993). The distribution and abundance of many bird species are mainly determined by the configuration and composition of the vegetation that comprises a major element of their habitat (Cody, 1985). As vegetation changes along complex geographical and environmental gradients, particular bird species may appear, increase in abundance, decrease, and disappear, when habitat becomes more or less suitable for its persistence. Of the total, 16% species were considered rare as they were distributed infrequently while 36% species were very common in the study area. Aquatic invertebrate feeders and insectivores were the dominant feeding guilds (67%) while the frugivores, omnivores and nectarivores together formed about 12% of all species. Although majority of the birds observed from the study area were aquatic invertebrates and insectivores, competition for food was reduced as they occupied different habitat types within the macro ecosystem and also had distinct feeding behaviours. Insectivorous birds like babblers (Sylviidae) and drongos (Corvidae) feed on fruits and seeds of plants particularly during winter due to the shortage of insect food. Wetland birds were dominated largely by the aquatic invertebrates followed by insectivores and grainivores.

11.3.2. Comparison of Avifauna for Three Years

The analysis of the data for the three years indicated that there was no remarkable change in the total number of bird species in the study area (Table 34). However, the number species during post-monsoon 2019-2020 declined to 58 and later recovered in 2021. Comparatively the maximum number of species (96 species) was found in the winter season in year 2020-21 than the year 2019-20 (Table 35). Therefore, the three year of study results revealed that there were low species diversity and density variations from the study area.

Painted Stork

Citrine Wagtail



Pied Avocet

Western Reef Egret

Eurasian Curlew **Eurasian Spoonbill**

Great Cormorant **Great Egret**

Grey Heron **Indian Black Ibis**

Plate 10. Select bird species recorded from DPT environ

Table 33 Diversity indices recorded for post-monsoon 2020 and winter 2021

Diversity Indices	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11	S-12	Total
	Post-monsoon												
No. of Species	49	48	30	30	29	34	41	36	41	40	37	27	69
Individuals	185	235	120	93	124	136	268	168	231	146	162	131	1999
Shannon_H	3.68	3.56	3.12	3.26	2.80	3.37	2.58	3.29	3.15	3.49	3.33	2.86	3.86
Evenness	0.80	0.73	0.75	0.87	0.56	0.86	0.32	0.74	0.57	0.81	0.76	0.64	0.69
Richness	3.60	3.13	2.73	3.11	2.60	2.91	2.50	2.77	2.69	3.31	2.90	2.35	1.54
Equitability	0.94	0.91	0.91	0.95	0.83	0.95	0.69	0.91	0.84	0.94	0.92	0.86	0.91
	Winter												
No. of Species	69	66	41	41	38	46	55	49	57	53	50	38	96
Individuals	274	329	202	133	165	187	361	238	352	233	211	184	2869
Shannon_H	4.00	3.89	3.31	3.56	3.13	3.67	3.07	3.59	3.51	3.70	3.66	3.25	4.21
Evenness	0.79	0.74	0.67	0.86	0.60	0.85	0.39	0.74	0.58	0.76	0.77	0.68	0.70
Richness	4.16	3.63	2.88	3.55	2.95	3.36	2.89	3.17	3.03	3.47	3.44	2.80	1.79
Equitability	0.94	0.92	0.89	0.96	0.86	0.95	0.76	0.92	0.86	0.93	0.93	0.89	0.92

Table 34 Comparative status of avifaunal species diversity in the study area (2018-2021)

	S-1			S-2			S-3			S-4		
Years	**2018-2019**	**2019-2020**	**2020-2021**	**2018-2019**	**2019-2020**	**2020-2021**	**2018-2019**	**2019-2020**	**2020-2021**	**2018-2019**	**2019-2020**	**2020-2021**
Diversity Indices	**Post-monsoon**											
No. of Species	55	37	49	53	32	48	33	25	30	34	24	30
Individuals	203	141	185	257	201	235	129	97	120	115	66	93
Shannon_H	3.805	3.392	3.68	3.666	3.224	3.56	3.226	2.856	3.124	3.383	2.849	3.263
Evenness	0.816	0.882	0.809	0.737	0.741	0.732	0.763	0.79	0.757	0.866	0.824	0.870
Richness	3.86	3.163	3.603	3.306	2.427	3.131	2.905	2.272	2.739	3.171	2.532	3.111

Equitability	0.949	0.954	0.945	0.923	0.919	0.919	0.922	0.924	0.918	0.959	0.921	0.959
	Winter											
No. of Species	66	61	69	62	59	66	40	38	41	40	42	41
Individuals	254	230	274	249	254	329	194	165	202	144	139	133
Shannon_H	3.99	3.95	4	3.834	3.846	3.891	3.357	3.346	3.313	3.61	3.55	3.567
Evenness	0.818	0.814	0.791	0.744	0.755	0.742	0.75	0.71	0.670	0.89	0.87	0.863
Richness	4.204	4.188	4.168	3.578	3.604	3.639	3.01	2.998	2.885	3.512	3.482	3.555
Equitability	0.950	0.943	0.944	0.928	0.931	0.928	0.918	0.907	0.892	0.971	0.962	0.960

Table 34 (Cont.) Comparative status of avifaunal species diversity in the study area (2018-2021)

	S-5			**S-6**			**S-7**			**S-8**		
Years	**2018-2019**	**2019-2020**	**2020-2021**	**2018-2019**	**2019-2020**	**2020-2021**	**2018-2019**	**2019-2020**	**2020-2021**	**2018-2019**	**2019-2020**	**2020-2021**
Diversity Indices	**Post-monsoon**											
No. of Species	33	15	29	40	26	34	45	21	41	42	23	36
Individuals	136	136	124	170	106	136	282	112	268	199	110	168
Shannon_H	2.971	2.522	2.804	3.544	2.889	3.379	2.712	3.089	2.583	3.468	2.907	3.291
Evenness	0.591	0.729	0.569	0.864	0.78	0.863	0.334	0.79	0.323	0.763	0.755	0.746
Richness	2.83	2.547	2.604	3.068	2.391	2.915	2.68	2.51	2.504	2.977	2.344	2.777
Equitability	0.849	0.912	0.832	0.960	0.924	0.958	0.712	0.898	0.695	0.927	0.906	0.918
	Winter											
No. of Species	36	35	38	45	41	46	50	49	55	47	47	49
Individuals	141	144	165	191	178	187	304	301	361	221	213	238
Shannon_H	3.081	3.093	3.139	3.712	3.653	3.673	2.882	2.898	3.076	3.562	3.562	3.599
Evenness	0.602	0.612	0.607	0.868	0.857	0.855	0.358	0.362	0.394	0.75	0.75	0.745
Richness	2.927	2.939	2.958	3.324	3.308	3.364	2.759	2.799	2.895	3.162	3.162	3.176
Equitability	0.852	0.863	0.862	0.962	0.959	0.959	0.738	0.740	0.767	0.925	0.925	0.924

Table 34 (Cont.) Comparative status of avifaunal species diversity in the study area (2018-2021)

	S-9			S-10			S-11			S-12		
Years	**2018-2019**	**2019-2020**	**2020-2021**	**2018-2019**	**2019-2020**	**2020-2021**	**2018-2019**	**2019-2020**	**2020-2021**	**2018-2019**	**2019-2020**	**2020-2021**
Diversity Indices	**Post-monsoon**											
No. of Species	45	29	41	44	31	40	43	28	37	32	19	27
Individuals	246	131	231	168	105	146	189	101	162	149	82	131
Shannon_H	3.272	2.97	3.152	3.586	3.011	3.49	3.516	3.161	3.339	3.057	2.662	2.86
Evenness	0.585	0.697	0.57	0.820	0.742	0.819	0.782	0.852	0.762	0.664	0.785	0.646
Richness	2.869	2.451	2.698	3.395	2.494	3.31	3.128	2.374	2.907	2.622	2.156	2.359
Equitability	0.859	0.891	0.848	0.947	0.925	0.946	0.934	0.942	0.924	0.882	0.916	0.867
	Winter											
No. of Species	53	41	57	49	48	53	48	46	50	37	39	38
Individuals	332	318	352	221	210	233	217	208	211	176	174	184
Shannon_H	3.432	3.417	3.511	3.657	3.639	3.702	3.622	3.615	3.66	3.241	3.239	3.258
Evenness	0.577	0.574	0.587	0.786	0.776	0.764	0.775	0.773	0.777	0.691	0.689	0.683
Richness	2.972	2.963	3.038	3.413	3.406	3.472	3.371	3.361	3.442	2.854	2.846	2.801
Equitability	2.861	0.860	0.868	0.936	0.935	0.932	0.935	0.933	0.935	0.898	0.897	0.895

Table 35 Comparative status of avifauna density for the period 2018-2021

	Total			Total		
Years	**2018-19**	**2019-20**	**2020-21**	**2018-19**	**2019-20**	**2020-21**
Diversity Indices	**Post-monsoon**			**Winter**		
No. of Species	78	58	69	91	89	96
Individuals	2243	1388	1999	2647	2534	2869
Shannon_H'	4.018	3.554	3.867	4.172	4.152	4.216
Evenness	0.7124	0.7573	0.6925	0.721	0.701	0.706
Richness	1.647	1.439	1.543	1.782	1.768	1.792
Equitability	0.9222	0.9289	0.9132	0.9263	0.9221	0.9237

12. Conservation and Management of Marine Biodiversity in Deendayal Port

Conservation of biodiversity is an integral part of any commercial activity and infrastructure development in the marine environment. Emphasis is given towards the reinstatement of the physical, chemical and biological characteristics of the coastal ecosystem which are much complex and vulnerable on which the human are highly dependent. Management of the marine biodiversity is the prime concern in the development of Ports and harbours which occupy the fragile continental shelf which is highly productive and harbours numerous living resources. Hence Environmental Management Plan (EMP) is considered as an important component in any developmental activity with sustainable management goals which are to be fulfilled within a time frame. Thus, EMP aims to suggest concrete measures that would mitigate the impacts paving way for maintaining the integrity of the project environment.

Development of ports involves effective management plan towards environmental wellbeing that guarantees both sustainable port growth and a healthy ecosystem functioning in its vicinity. There is a need for innovative solutions for port development which are in harmony with the ecosystem and which are robust or adaptable under change. The recent trends like growth of global trade, increasing vessel movements and size, modernize port facilities, driving urgent investments in ports has been negatively impact water quality and marine flora and fauna. This simultaneously calls for sustainable and inclusive development which ensures productive nature of its marine environment.

The port authorities mandate to their activities environmentally sustainable and benign need to understand the marine ecological setting of their ports including water quality, biotic components and the factors that impact them. In spite of all the pressures, the ecosystem continues to deliver many services which are often intangible. In order to maintain these services intact, it is imperative that different biotic and abiotic components of the port environment are sustainably managed in the long run.

Accordingly Deendayal Port has initiated several environmental management measures as mandated by the MoEF &CC from time to time with the purpose of maintaining and preserving its terrestrial and coastal environmental integrity. The following measures have been taken by the port authorities:

12.1. Ongoing Environment Management Measures by DPT

i. A holistic and comprehensive study on the marine ecology of the port including different marine faunal and floral components and preparation of management plan has been initiated as per the specific condition No. xviii of the EC & CRZ Clearance accorded by the MoEF & CC, GoI dated 19/12/2016. The results of the seasonal observations on the environmental characteristics and biodiversity of the intertidal zones have been compiled along with the conservation plan recommendation for three consecutive years (2017 to 2021).

ii. Mangrove plantation has been carried out to the tune of 900 ha in Sat Saida Island, 150 ha in Nakti creek, 450 ha in Kantiyajal (Table 36) by Deendayal Port. The black mangrove *A. marina* was used in these plantation activities as this species is more suitable to the existing environmental condition in this coast.

Table 36. Details of mangrove plantation carried out by Deendayal Port

S. No	Year of Plantation	Area (ha)	Species	Implementing Agency	Survival (%)
1	2005-2006	20	*Avicenna marina*	Gujarat Institute of Desert Ecology (GUIDE)	98
2	2008-2009	50	*A. marina*	Gujarat Ecology Commission (GEC)	71
3	2010-2011	100	*A. marina, R. mucronata, C. tagal*	Gujarat Ecology Commission (GEC)	68
4	2011-2012	200	*A. marina*	Gujarat State Forest Department, Kutch	74
5	2012-2013	300	*A. marina*	Gujarat State Forest Department, Kutch	71
6	2013-2014	330	*A. marina*	Gujarat State Forest Department, Kutch	69
7	2016-2017	300	*A. marina*	Gujarat Ecology Commission (GEC)	62
8	2018-2020	100	*A. marina*	Gujarat Ecology Commission (GEC)	-

9	2020-21	100	*A. marina*	Gujarat Ecology Commission (GEC)	
	Total	**1500 ha**			

Based on the information gathered through the seasonal studies on the different biotopes and the biodiversity along with the mangrove, macrofauna, plankton density and diversity, productivity of mudflat and avifauna for the period 2018-2021 within the limits of the Deendayal port, it is evident that the impact is insignificant since management action plans are showing positive responses to a large extent in spite of the climate change induced impacts on the marine ecosystem. This project aims to draw a holistic management framework for conserving the Marine Biodiversity and Ecology of the DPT port marine environment which include many biotopes such as mangroves, intertidal and subtidal realms, mudflats and salt marshes, each serving as an abode for a variety of fauna and flora. Given the economic importance of DPT port and the increasing national and global demand for sustainability, it is planned to study the marine ecology of this port seasonally, with the long term objective of rendering the port existence and operations environmentally sustainable.

The proceeding section outlines management initiatives to be undertaken by the port authorities for holistic management of marine biodiversity within the port limits envisaging several facilities will be built within port premises in the future.

12.2. Intertidal and Subtidal Biodiversity Management

The intertidal zone constitutes the coastal environment where land and sea meet, i.e., the area between extreme high water springs (EHWSs) and extreme low water springs (ELWSs). The subtidal zone lies below the lowest water level beyond the intertidal zone. Both these zone provides numerous ecosystem for marine fauna and needs to be managed effectively for the overall wellbeing of the ecosystem. In addition, ecosystems located in the intertidal zone are experiencing degradation and an accelerating loss of biodiversity, which might potentially affect ecosystem goods and services and human well-being. In the DPT vicinity, intertidal and subtidal zones are mostly muddy-silt in nature lacking rocky or sandy formations. Intertidal belts of the study area support many biological elements indicating overall ecosystem health. The intertidal zone may be susceptible to natural and anthropogenic pressures such as soil erosion, industrial pollution, continuous dredging and sedimentation. Intervention is often required to mitigate or support the natural recovery of the intertidal zone in a port environment.

The marine biodiversity study conducted from 2018-2021, the results showed the crustaceans (crabs) and mudskippers are the dominant groups throughout the year along all twelve sampling sites. It's imperative to take measures to conserve and promote the intertidal biodiversity of DPT coastal / creek environments. The majority of the intertidal fauna were associated in the mangrove and halophyte habitats and many of them are true mangrove species. Mangroves provide natural habitats for variety of intertidal macrofauna likes crabs, gastropods, saw scale viper and avifauna. Hence, promoting mangrove plantation or increasing mangrove cover would help to conserve the intertidal macrofauna.

Soil erosion is another major threat to the intertidal habitats in DPT port jurisdiction. Often the threat of erosion is severe in a port environment due to vessel movement, altered hydrological regime and other natural causes. During the present study it was noticed that few creek stretches in Kandla are susceptible to erosion due to high water currents and tides. The dual purpose of controlling erosion and promoting intertidal biodiversity could be best achieved by installation of artificial reef structures.

Artificial coastal structures are cheap and installation is easy and adaptable and for better result it can be supplemented with the addition of a substrate that will support marine organisms as that of the natural intertidal and sub tidal environment. The structural diversity of the artificial reef will determine the diversity of marine organisms utilizing the created habitat. Artificial reefs once built will last for decades and would enrich marine biodiversity in short period of time by providing ideal habitat. Natural materials such as dead gastropod and bivalve shells may be used for building artificial reefs and these materials are environment-friendly.

Reef balls are another form of artificial reef increasingly used in western waters to create sustainable marine reef habitat which may be easily attempted in Deendayal port. Both reef balls and artificial reefs being inexpensive and locally available, can be built in different creek systems of the port.

12.3. Phyto- and Zoo- plankton, and Productivity

Planktonic community and productivity were studied in creek waters of Deendayal port jurisdiction. Diversity and density of phytoplankton community in DPT port creek environment is moderate as only 30 and 24 genera were reported during post-monsoon and winter, respectively. Similarly, 35 genera of zooplankton have been reported during post-monsoon and winter. The productivity of the water column is also low (Chlorophyll 'a' <1 mg/m^3). High turbidity of the water column is attributed to this low phytoplankton abundance and productivity. Nevertheless, it is imperative to ensure that ongoing developmental activities do not add up to the already high suspended load in the water column. Dredging is the major activity that increases water turbidity and suspended load thereby impacting plankton and primary productivity. Hence, very high prevailing sedimentation in the Kandla region necessitates huge quantity of maintenance dredging.

Efforts to trap run-off slurry and sediment plume from the dredging area by means of silt traps and turbidity curtains may be attempted and the trapped sediments should be disposed at pre-designated sites.

Similar to silt traps, turbidity curtains are increasingly used during dredging operations which could be tried based on its operational convenience. Turbidity curtains allow suspended sediments to settle out of the water column in the dredging spot thus minimizing sediment transport towards the shore.

12.4. Mangrove Management

DPT has around 23.967km^2 of mangroves cover in their jurisdiction which consists of many major and minor creek systems within its limit, port infrastructure occupies only ~1% of the total area, establishment of facilities is a continuous process and the expansion of infrastructure over the coming years will bring remarkable changes in the landscape and seascape in and around the port area. Long term human centred activity of this magnitude will have repercussions on its natural resources and ecosystems. Mangroves, mudflats and intertidal creeks are the major ecological entities within the port boundary and they function in close synchrony with each other, thus their conservation and management calls for a holistic approach.

12.4.1. Conservation of Islands

Islands support a rich marine fauna, flora and avifauna diversity and deserve special conservation efforts. Land cover classification of Sat Saida Island using GIS tool revealed that sparse and dense mangroves, mudflats and halophytic vegetation other than mangroves are other prominent land cover categories.

Though equipped with all the features to support a dense mangrove formation, the mangroves of Sat Saida Island are rather sparse and scrubby and confined mostly to creek banks. Different elevation features of the Island render the tidal flooding and hydroperiod in the interior region poor resulting in sparse and open mangrove formations. This Island could be an ideal site for mangrove plantations while implementing ministry's mandated plantation activities, other mangrove restoration and rehabilitation activities with bio-physical amendments such as desilting existing creeks, joining existing minor creeks could be taken up which will increase the mangrove cover in this Island. These physical activities in the mangrove lined minor creeks will increase tidal flooding and hydro-period and convert sparse mangroves into dense mangroves in due course of time. Deendayal port has already carried out 1400 ha of mangrove plantation since 2006 with good success rate in various locations and additional 100 ha is in progress.

12.4.2. Co-Management with the Community

Management program for mangroves is feasible in the case of Deendayal port since all the mangrove formations are under its legal control and hence any management program could be implemented without any sectoral conflicts with forest or any other government departments. It was proven in many instances that involving the stakeholder communities in the surrounding villages will yield better results in mangrove management. Though the population in the port surroundings has different livelihood activities, fishermen community could be targeted to involve in community based mangrove management.

These fishermen communities living in the villages such as Vera, Khari Rohar, and Tuna close to the port could be involved by forming "*Samithies*" for the conservation of mangroves with possible funding resource. The community based organization (*Samithi*) whose responsibilities and roles are well defined in the specific task of conserving mangrove patches in their vicinity could play a seminal role in conserving these mangrove patches. Their resource dependency, perception towards mangroves, level of involvement in such resource management activities are to be assessed before forming such community based organization. They could be assigned the specific task of conserving these mangroves by involving them in mangrove plantation/restoration activities, physical protection and other conservation measures. This could be taken up as part of the port's CSR activity.

12.4.3. Physical Protection

The most common method of conserving mangrove ecosystem is by creation of protected areas. Presently, the whole port limit is under the protection of Central Industrial Security Force (CISF). Thus, CISF personnel could be imparted with the ecological significance of mangroves through special awareness program and mangrove patrolling by them can be instituted for physical protection to mangroves.

Employees of Deendayal Port environmental and ecological significance of mangroves and other coastal resources. Licenses for salt works and other port allied industries are awarded by port authorities without understanding the ecological and environmental rules and regulations governing them which often lead to legal and environmental bottleneck at a later stage. Short term awareness programs to port employees by marine/mangrove ecologists will be beneficial in several counts.

12.4.4. Identification of Stress Factors

Mangrove environment will continue to be stable and balanced if there are no external stressors such as change in hydrology, elevation and slope, soil and water salinity and pH, soil texture and wave energy are maintained in a natural condition without alteration. In addition, human centred stress factors such as resource collection, tree felling and other habitat modification activities will act as major stressors.

12.4.5. Changes in Hydrology

The most important factor in conserving any mangrove formation seems to be maintaining the original hydrology and tidal flow including depth, duration and frequency of tidal flooding. Understanding the existing mangrove hydrology at micro level and applying this knowledge to protect mangroves and cost-effective restoration and regeneration is important. In majority of mangrove degradation instances, it is the modified hydrology and the resultant reduced tidal flushing and subsequently the critical period of dryness and flushing that determine health of a mangrove forest. Mostly, micro-topography controls the distribution and wellbeing of mangroves and physical processes play a dominant role in the formation and functioning of mangrove ecosystem. Even disturbed by human impact, mangrove forest has got the ability to self-repair over a period of time provided that the normal tidal hydrology is not disrupted and the availability of water borne seeds are not blocked. Regular monitoring of mangrove hydrology through simple scientific methods will go a long way in maintaining ecosystem balance.

12.4.6. Promoting Natural Regeneration

Promoting natural regeneration where the mangrove stand has got the capacity to self-sustain will ensure wellbeing of the stand. Natural regeneration capacity of the stand is to be assessed by quantifying the degree and extent of entrance of younger classes such as saplings into mature tree category. Ratio between these different size classes will indicate the dynamic state of the mangrove forest. The observation that natural seedling recruitment is occurring normally will indicate that the system is functioning normally. Only if the natural seedling recruitment is not occurring, the system requires an assisted recovery by plantation and physical amendments. The present study shows that natural regeneration in the studied mangrove formations is normal as indicated by the entry of younger classes into adult categories.

12.4.7. Mangrove Biodiversity Enhancement

Deendayal port is regularly undertaking mangrove plantation in a massive manner since 2006. However, only *A. marina* plantation was attempted due to adverse environmental conditions. Within DPT limits, three additional mangrove species have been recorded sporadically namely, *Rhizophora mucronata, Ceriops tagal* and *Aegiceras corniculatum*. It is strongly recommended that in all future plantation efforts, these additional species which are naturally occurring in this region could be used in large scale. Planting these additional species is expected to create a seed bank for these species, converting the stand into multi-species formation in due course of time.

12.4.8. Management Plan for Marine Fisheries

Regular dredging activities in the Port area have the potential to impact marine fauna through physical contact with dredging equipment and also indirectly through changes to noise and vibrations levels, water quality and loss of habitat and food sources. The most important potential impact would be the rise in suspended solid load which hinders the photosynthesis of the producer communities, especially the phytoplankton and affecting the food chain. The high turbidity due to heavy suspended solids load during dredging and reclamation can result in clogging of gills of filter thereby causing asphyxiation. But since fishes in the water column are free swimming in nature, they will tend to avoid turbid areas and move to safer zones. Once the turbidity increase gets reversed due to sedimentation and dispersion by current and wave influences, the fishes are expected to come back. Hence, there will be virtually no impact on fishes due to dredging in the long term. As the area does not have any breeding ground for fisheries, no significant impact on marine ecology is anticipated during dredging phase.

A single species of marine mammal of common dolphin, *Sousa plumbea* along the creek waters of Deendayal port during the field investigations. The reptile species of saw-scaled viper, *Echis carinatus sochureki* are reported in the mangroves of DPT port jurisdiction.

12.5. Seaweeds and Sea grasses and Corals

Along the coastal environment of DPT port jurisdiction corals, seaweeds and seagrass formations were not observed. The intertidal area of Kandla is largely muddy in nature. Coral growth in the sub-tidal region is unlikely in view of the high suspended solids in the water column and also not conducive for the growth of the benthic macro algae which need hard substratum to attach the rhizoids. The seagrasses also prefer sand admixed soil and shallow bottom with low suspended matter in the water. The texture of the soil in the study sites were dominated with clay fraction which may not support the growth of sea grass communities.

12.6. Conservation Status – Avifauna

12.6.1. Terrestrial birds

Out of 33 terrestrial bird species reported in the study area only Black-headed Ibis fall under Near Threatened category of IUCN (2021) list. This species was represented by 16 individuals from nine different sites in the study area. No Endangered/Schedule I terrestrial bird species was observed in the study area during both the monsoon and winter.

12.6.2. Aquatic Birds

The present seasonal study revealed occurrence of 63 species of aquatic birds from the whole the study area of which six species were in near threatened category and the rest in least concerned (as per IUCN 2021 list). Among the six species, lesser flamingos were abundant, a maximum of 81 birds were reported during winter. No endangered aquatic birds were reported from the study area.

12.7. Impact Identification and Evaluation

12.7.1. Direct and Indirect Impact on Ecologically Sensitive Ecosystems

12.7.1.1. Impact-I

Location of the Deendayal port Site in the close vicinity of ecologically sensitive terrestrial ecosystem (Sanctuary, National Park, Biosphere Reserve and migratory route, breeding and nesting sites of avifauna) may impact the overall biodiversity values due to project associated activities.

A. *Habitat degradation due to pollution*

B. *Loss of habitat and population of faunal groups*

C. *Overall impact on biodiversity of the protected area*

Evaluation: The coastal ecosystems investigated during 2018 to 2021 are located within the jurisdiction of Deendayal Port surrounded by the port associated industrial sectors and predominately salt industries. There are no ecologically sensitive ecosystems (Protected Areas) located within the 10 km radius of the project site. As per the existing land use no impact on the protected areas was foreseen. Further, the study area is not identified as migratory route of any major animal group as well as nesting and breeding sites of avifauna.

12.7.1.2. Impact II. Direct loss of inter-tidal habitat will impact the floral and faunal species

Loss of inter-tidal habitat (mangrove) and degradation due to project associated activities will affect the overall population status of threatened aquatic avifauna

Evaluation: Of the total 2534 bird individuals, only seven species were threatened species (Painted Stork–24 individuals, Lesser flamingo-68 individuals, bar tailed Godwit-18 individuals, Black-tailed Godwit-11 individuals, Black-headed Ibis - 38 individuals, Darter-6 individuals and Eurasian Curlew-5 individuals) belong to Near threatened category and counted few individuals within study area. Further, no endangered aquatic birds were reported from the study area.

Since the study area is quite wide and located close to the (2 km) large stretches of salt pans and other inland wetlands which support a number of aquatic birds, the overall impact on few aquatic threatened avifauna reported in the study area would be minimal. In this regard proper mangrove restoration and conservation activity would facilitate to overcome the habitat degradation and related impacts on the biodiversity can be successfully managed.

12.8. Mitigation and Management Plan

12.8.1. Direct and Indirect Impact on Ecologically Sensitive Ecosystems

The Deendayal Port area is surrounded by a large number of port associated industries and salt industries. Since no Protected Area exists within 10 km radius of the DPT port Jurisdiction, impacts on sensitive ecosystem was not visualized.

12.8.2. Loss of Inter-tidal habitats - Coastal

- The project proponent should take up compensatory mangrove and associated plantation in and around the project area.
- The plantation needs to be carried out with fourfold density of seedlings compared to the natural mangrove density of the Kandla creek area.
- This mangrove plantation is expected to support mangrove associated bird species and thereby enhance the avifauna diversity of the local environment.
- Since the intertidal (mangrove and creeks) and salt pan habitats support few thousands of aquatic and migratory bird species, the project proponent should plan the establishment /construction activities (if any) other than the migratory season (November – February) to avoid disturbance to the migratory species.
- The above suggested mangrove plantation needs to be monitored for next five years till it attains maturity. The growth rate and enhancement and assemblage of associated faunal species should be studied.
- Since the area located in the intertidal habitat and adjacent areas support thousands of aquatic avifauna, the project proponent should take up long-term (five years) ecological monitoring program of the adjacent creek, mangrove and salt pan habitats to assess the change in avifaunal diversity due to any developmental activities taking place in the future.

13. Summary and Conclusions

Kandla Port in Kachchh District of Gujarat State operated by Deendayal Port Trust (DPT) is one of the major public sector ports of India. It is located on the eastern bank of North-South trending Kandla creek at an aerial distance of 90 km from the Gulf's mouth. Since its formation, this port serves the maritime trade requirement of many north Indian states. About 35% of the country's total export takes place through Gujarat ports of which the share of DPT port is considerable. An assortment of liquid and dry cargo including fertilizers, iron and steel, food grain, metal products, ores, cement, coal, machineries, sugar, wooden logs, etc., are being handled through this port. Regular expansion/developmental activities such as addition of jetties, industrial parks and ship bunkering facilities are underway in order to cope with the increasing cargo handling demands. Being located at the tail end of Gulf of Kachchh, Deendayal port has a fragile marine ecosystem that includes vast expanse of mangroves, mudflats and creek systems and allied biota. As part of its ongoing expansion, Deendayal Port authorities intend to develop seven integrated facilities. Since, developmental initiatives of this magnitude will have its own environmental repercussions, Ministry of Environment, Forests and Climate Change (MoEF & CC), while according environmental clearance to these developmental initiatives directed the port authorities to carry out a holistic and comprehensive study on the marine ecology of the port in order to document the present status of the marine environment and to conserve its fragile ecosystem through appropriate management plan. The task of studying the marine environment with its entire biotic components was assigned to Gujarat Institute of Desert Ecology, Bhuj.

13.1. Intertidal Fauna

Intertidal faunal composition, density and diversity were studied at 12representative sampling locations within the Deendayal port limits. A total of 10 genera of intertidal macrofauna were recorded during post-monsoon 2020. The intertidal fauna belonged to five groups *viz*., crustaceans, gastropods, bivalves, polychaetes and fishes (mudskipper). Among these, crustaceans was the dominant group constituted by 5 species followed by Mollusca (3 species) polychaeta (1 species) and mudskipper (1 species). Among the crustaceans, *Metopograpsus messor*, *Scylla serreta*, *Uca* crab and *Bolepthalamus* sp. were distributed in all the sampling locations. However, gastropods *Cerithedia cingulata* and the *Nassarius* sp. were distributed in four sampling locations. *Nereis* sp. (Polychaete) was present at sites S-4 and S-5. Similarly, in winter 2021 a total of 12 genera belonging to four groups Crustaceans, Gastropods, Poychaete and fishes (Mudskipper) were observed. Among the groups, Crustaceans and gastropods were dominant with 6 and 4 species, respectively while Fishes and polychaetes were represented with single species. The mangrove tree trunk crab *M. messor* and *Uca lactea annulipes* were distributed at all the 12 sampling sites.

In the present study, the highest Shannon diversity index was recorded at S-7 and the lowest at S-1. The highest species evenness (0.94) was noticed at S-7 while the lowest (0.54) from site S-1. The highest species richness was recorded at S-4 (1.47) while it was 0.63 at site S-10. During winter the highest Shannon diversity index was reported at S-1 (1.54) followed by S-3 (1.53) and S-11 (1.50) while lowest indices were at S-5. In general, the intertidal macrofaunal communities at Deendayal Port environment showed uneven distribution pattern and species diversity. Shannon diversity indices ranging >4 indicates high, 4-3 indicates good, 3-2 indicates moderate, 2-1 indicates poor and <1 indicates bad ecological quality. Whereas the present study, the intertidal faunal diversity of DPT mudflats clearly indicates the biologically poor.

13.2. Subtidal Fauna

During the present study, four groups of benthic organisms namely polychaetes, molluscs, crustaceans and “others” were noticed. The group “others” was formed of the larvae of the crabs and fishes. Of these, molluscs and polychaetes constituted the dominant group followed by crustaceans and “Others”. In the post-monsoon 2020, the molluscs (9) constituted dominant group followed by polychaetes (7), crustaceans (4), and “Others” (2). Among the macrobenthic fauna *Pholas* sp., *Telescopium* sp., *Gonaida* sp., occurred in 8 sampling stations with a frequency of 66.67%. Forms such as *Angliera* sp., *Mitra* sp., occurred only in 2 sampling stations with 16.67% of the total organism. Likewise, in winter 2021, molluscs (10) remained in the top position followed by polychaetes (9), crustaceans (4) and “Others” (2). The molluscs like *Pholas* sp. and *Telescopium* sp., ranked first with a frequency of 75% and 66.67%, respectively.

The Shannon diversity indices values varied from 1.59 to 2.26 with the maximum at station S-1 and minimum at S-2. Margalef index, which is a measure of the richness of forms that take into account both the number of taxa and the number of individuals in taxa ranged from 1.85 to 3.40 with the maximum at S-1 and minimum at S-2. The evenness values varied from 0.59 to 0.96 with the maximum in S-7 and minimum in S-4. Concerning winter 2021, the Shannon diversity varied from 1.49 to 2.31 with a maximum at station S-2 and minimum at S-7, evenness ranged from 0.50 to 0.92 with a maximum at S-8 and minimum at S-10 and Margalef richness ranged between 2.87 and 3.68 with a maximum at S-2 and minimum at S-8.

13.3. Mangrove Environment

Mangroves in Kachchh are constituted by four true species namely, *Avicennia marina, Ceriops tagal, Rhizophora mucronata* and *Aegiceras corniculatum*. Among them, *A. marina* was the dominant. The remaining three species occur sporadically in few places at Sat Saida Bet. During the post-monsoon 2020, the *A. marina* tree density ranged from 1687 trees/ha (S-5) to 4352 trees/ha (S-7). On the contrary, during winter 2021, the tree density ranged from 2260 trees/ha (S-6) to 5020 trees/ha at S-7 in the Khari creek.

13.4. Seaweeds, Seagrasses and Coral habitat

Seaweeds are usually found in coastal stretches characterized by low turbidity and suspended sediment load in the water column with high nutrients content contrary to conditions prevailing in the study site. Hence, the present field survey was conducted during winter (March 2021). A few species of drifted (due to wave action) macroalgae namely, *Enteromorpha* sp., *Ulva lactuca*, *Ulva rigida*, *Ulva reticulate* and *Sargassum wightii* were observed in the intertidal belt near Kandla creek and Khari creek near DPT port.

Coral ecosystem is not present in the northern shore of Gulf of Kachchh. The study site located at the Nakti creek in Kandla region is at the inner portion of the Gulf with high turbidity and suspended sediment load in the water column rendering it highly unsuitable for coral formation

13.5. Halophytes

Halophytes are predominantly present in the premises of Deendayal Port since habitat conditions are suitable for halophytes at the inner part of Gulf of Kachchh. Halophytes are mostly found beyond highest high tidal levels where spring tides reach occasionally and pore-water salinity often reaches >90 ppt. Their presence is widely noticed intermingled with mangrove formations in all the mudflats. During post-monsoon 2020 and winter 2021, 4 and 3 halophyte species, respectively were recorded within the quadrates from 12 sampling locations.

13.6. Avifauna

A total of 96 species belonging to nine orders, 34 families and 68 genera were recorded from the coastal area of Deendayal Port during this study. Among these, 63 species were aquatic and 33 species were terrestrial, which included seven species listed as Near Threatened in the IUCN 2021, Red List. Order Charadriiformes i.e. aquatic birds (including raptors and most water birds) constituted the predominant group representing 39% of species recorded from the study area followed by the order Passeriformes (20%), i.e., perching birds (including babblers, drongos, mynas, sunbirds, doves, warblers, larks, chats, wagtails, robins). The families with more number of species were Scolopacidae (17 spp.), Laridae (10 Spp.), Ardeidae (8 spp.), Charadriidae (7 spp.), Hirundinidae (4 spp.), Columbidae (3 spp.) and Passeridae (one spp.). Of the recorded species, 38 species were migrants, 15 species were local migrants or resident migrants, and 43 species were breeding resident. During the present investigation birds with diverse food habits were observed, *viz*., frugivore; nectorivore; piscivore; granivore; carnivore; insect and other terrestrial invertebrate feeder; plankton feeder; aquatic invertebrate feeder; amphibian feeder; ophidiovore; reptile feeder; weedivore; herbivore and predatory. Among these feeding guilds birds with aquatic invertebrate feeders were more (40 spp.) followed by insectivore (16 spp). Overall Shannon diversity (H') index was 4.21 with overall species richness index as 1.8. The overall species evenness index value for study area was 0.71 with overall Equitability value of 0.92.

13.7. Mudflats

Mudflats are a major ecological entity within DPT Port limits next to mangroves covering 31% of the total area as per GIS-RS study. Often they are an integral part of mangrove system. The current study focuses on the productivity of the mudflat using Total organic carbon (TOC) as an indicator. The highest TOC values (0.42 ±0.03%) were recorded at station S-5 followed by S-8 (0.35 ±0.03%). Lowest TOC values were reported at site S-3 and S-9. It is observed that TOC values show a significant difference among the sampling stations which means that organic carbon is dependent on the living life forms and variations in the life forms in the mudflats. During the winter 2021, the highest percentage of TOC value was reported at S-7 (0.99±0.47%) followed by S-1 (0.84±0.56%). Likewise, lowest TOC values was reported at S-5 (0.27±0.03%) followed by S-4 (0.46±0.59%). Shannon diversity indices ranging >4 indicates high, 4-3 indicates good, 3-2 indicates moderate, 2-1 indicates poor and <1 indicates bad ecological quality. However, the present study revealed that the intertidal faunal diversity of DPT mudflats is less than 2.0 which clearly indicates it to be biologically poor.

13.8. Conclusion

It is imperative to create a strong baseline data on the marine environment in the port vicinity in tune with the spatial extent of developmental activities. Continuous marine ecological monitoring study (2018- 2021) focused on biological and productivity of mudflat. Based on the detailed investigations of marine ecological components and the possible impacts of the DPT port environment, it could be concluded that the effects on the various biotic components are minimal and confined to high activity area only with limited impacts in the surroundings. In order to ward-off the predicted impacts in certain components of the marine biota, appropriate mitigation and management plan is suggested. Given the vastness of the Gulf, the predicted impact will be negligible and the baseline background limits of different parameters will be regained on secession of dredging and disposal activities in and around the port area.

In addition to biological parameters, we suggest to the port authorities to cover essential physico-chemical parameters like water turbidity, suspended load, sediment texture, soil organic carbon for bottom sediment and water nutrients like nitrate, nitrite, silicate and phosphate and include heavy metals and petroleum hydrocarbons.

Both biological and physico-chemical data will be essential for tracking changes during yearly monitoring. Periodic yearly monitoring will reveal the deviation from the previously recorded status of the marine environment. This periodic marine monitoring assessment should be regular at specific time interval and should be recorded in a time series manner to track the changes happening in the immediate marine ecosystem during operation phase. This will help the port managers to take remedial measures at later stage.

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Annexure 1 Occurrence of macrofauna during post-monsoon 2020

Sl.	Marine Benthos	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11	S-12	Occurr. (%)	Group (%)
	Polychaetes														
1	*Capitella* sp.	1	1				2	1			1			41.67	
2	*Glycera* sp.			1	2		3			1				33.33	
3	*Gonaida* sp.	2			2	2		2	1		3	1	2	66.67	
4	*Notomastus* sp.					1		2		3				25	
5	*Nephtys homebergi*		3	1			3				2			33.33	
6	*Nephtys* sp.			1			1		2			1	2	41.67	
7	*Sternapsis* sp.	1		3	2			2		1				41.67	
	Total	**4**	**4**	**6**	**6**	**3**	**9**	**7**	**3**	**5**	**6**	**2**	**4**		26% (59)
	Molluscs														
8	*Argopectin* sp.	2					3	2			3			33.33	
9	*Barbatia* sp.					1			2			1	2	33.33	
10	*Cerithidea* sp.	1		1		1	2							33.33	
11	*Crassostrea* sp.	1			2	3				2				33.33	
12	*Turritella* sp.			2	1			2	5	3	1			50	
13	*Telescopium* sp.	4	1	4			3	3	1			1	5	66.67	
14	*Mitra* sp.									2		3		16.67	
15	*Pholas* sp.	3	6		15	7	12	3	1		1			66.67	
16	*Unbonium* sp.		2		4		3		2				1	41.67	
	Total	**11**	**9**	**7**	**22**	**12**	**23**	**10**	**11**	**7**	**5**	**5**	**8**		57% (130)
	Crustaceans														
17	Isopods	1	2			1	2			2				41.67	
18	*Angliera* sp.						2				1			16.67	
19	Copepods	2		3					1			2		33.33	
20	*Penaeus* sp.			2		2		2					1	33.33	
	Total	**3**	**2**	**5**		**3**	**4**	**2**	1	**2**	**1**	**2**	**1**		12% (26)
	Others														

21	Mud crab veliger	1			1						2	3		33.33	
22	Fish larvae				1	1	1			1			1	41.67	
	Total	**1**			**2**	**1**	**1**			**1**	**2**	**3**	**1**		5% (12)
	Grand Total	**19**	**15**	**18**	**30**	**19**	**37**	**19**	**15**	**15**	**14**	**12**	**14**		
	Density (No/m²)	**475**	**375**	**450**	**750**	**475**	**925**	**475**	**375**	**375**	**350**	**300**	**350**		

Annexure 2 Occurrence of macrofauna during winter 2021

Sl.	Marine Benthos	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11	S-12	Occurr. (%)	Group (%)
	Polychaetes														
1	*Ancistrosyllis* sp.		1								1		1	25.00	
2	*Capitella* sp.		2		1				2	2				33.33	
3	*Glycera* sp.	2		1		3	1							33.33	
4	*Gonaida* sp.			2				1	1					25.00	
5	*Lumbrineries* sp.	1			1	3					2			33.33	
6	*Notomastus* sp.		2	2			2		2	1	1	3	1	66.67	
7	*Nephtys dibranchis*	3	1						2					25.00	
8	*Nephtys* sp.					1	3			1				25.00	
9	*Nereis* sp.	3	1	1	3	5			2		2			58.33	
	Total	**9**	**7**	**6**	**5**	**12**	**6**	**1**	**9**	**4**	**6**	**3**	**2**		**70 (25%)**
	Molluscs														
10	*Anadara* sp.			1		2			2			3		33.33	
11	*Argopectin* sp.		1				2			1			2	33.33	
12	*Barbatia* sp.						2				1		2	25.00	
13	*Cerithidea* sp.		1	2	1	3								33.33	
14	*Crassostrea* sp.	2	4	2							2			33.33	
15	*Turritella* sp.	6			2				2		1	1	3	50.00	
16	*Telescopium* sp.			4	4	3	4	1	5	1			1	66.67	
17	*Mitra* sp.	2								4				16.67	

18	*Pholas* sp.	8	7	12	5	18			3		17	1	11	75.00	
19	*Unbonium* sp.	2				5	1	2						33.33	
	Total	**20**	**13**	**21**	**12**	**31**	**9**	**3**	**12**	**6**	**21**	**5**	**19**		**172 (61%)**
	Crustaceans														
20	Amphipods	1	1	1	2	2					2			50.00	
21	*Angliera* sp.					2						1		16.67	
22	Copepods			2				3		1				25.00	
23	*Penaeus* sp.		2		2		2		2					33.33	
	Total	**1**	**3**	**3**	**4**	**4**	**2**	**3**	**2**	**1**	**2**	**1**	**0**		**26 (9%)**
	Others														
24	Mud crab veliger		2					1		2	1	2		41.67	
25	Fish larvae	2	1		1	1	1							41.67	
	Total	**2**	**3**	**0**	**1**	**1**	**1**	**1**	**0**	**2**	**1**	**2**	**0**		**14 (5%)**
	Grand Total	**32**	**26**	**30**	**22**	**48**	**18**	**8**	**23**	**13**	**30**	**11**	**21**		
	Density (No/m^2)	**800**	**650**	**750**	**550**	**1200**	**450**	**200**	**575**	**325**	**750**	**275**	**525**		

Annexure 3 Checklist of avifauna recorded from the study area

Sr. No.	Order, Family, Common & Scientific Name	MS	Habitat	Feeding Guild	IUCN-2021	Post monsoon	Winter
	Accipitriformes						
	Accipitridae						
1	Black-winged Kite *Elanus caeruleus*	R	T	C	LC	*	*
2	Western Marsh Harrier *Circus aeruginosus*	M	T	P,A,C,PD	LC	*	*
3	Montagu's Harrier *Circus pygargus*	M	T	P,A,C,PD	LC		*
4	Shikra *Accipiter badius*	R	T	C	LC	*	*
	Pandionidae						
5	Osprey *Pandion haliaetus*	RM	T	P	LC	*	*
	Caprimulgiformes						
	Apodidae						
6	Indian House Swift *Apus affinis*	M	T	I	LC	*	*
	Charadriiformes						
	Burhinidae						
7	Eurasian Thick-knee *Burhinus oedicnemus*	R	A	IN	LC	*	*
	Charadriidae						
8	Common Ringed Plover *Charadrius hiaticula*	RM	A	IN	LC	*	*
9	Little Ringed Plover *Charadrius dubius*	M	A	IN	LC	*	*
10	Kentish Plover *Charadrius alexandrinus*	M	A	IN	LC	*	*
11	Lesser Sand Plover *Charadrius mongolus*	M	A	IN	LC	*	*
12	Greater Sand Plover *Charadrius leschenaultii*	M	A	IN	LC	*	*
13	Yellow-wattled Lapwing *Vanellus malabaricus*	R	T	I,IN	LC	*	*
14	Red-wattled Lapwing *Vanellus indicus*	R	T	I,IN	LC	*	*
	Dromadidae						
15	Crab-plover *Dromas ardeola*	M	A	IN	LC		*
	Laridae						
16	River Tern *Sterna aurantia*	R	A	P	LC	*	*

Sr. No.	Order, Family, Common & Scientific Name	MS	Habitat	Feeding Guild	IUCN-2021	Post monsoon	Winter
17	Lesser Black-backed Gull *Larus fuscus*	M	A	P	LC	*	*
18	Black-headed Gull *Chroicocephalus ridibundus*	M	A	IN	LC	*	*
19	Brown-headed Gull *Chroicocephalus brunnicephalus*	M	A	IN	LC		*
20	Slender-billed Gull *Chroicocephalus genei*	M	A	IN	LC		*
21	Little Gull *Hydrocoloeus minutus*	M	A	IN	LC	*	*
22	White-winged Tern *Chlidonias leucopterus*	M	A	IN	LC		*
23	Common Tern *Sterna hirundo*	M	A	IN	LC		*
24	Little Tern *Sternula albifrons*	M	A	IN	LC	*	*
25	Caspian Tern *Hydroprogne caspia*	M	A	IN	LC	*	*
	Recurvirostridae						
26	Black-winged Stilt *Himantopus himantopus*	R	A	IN	LC	*	*
27	Pied Avocet *Recurvirostra avosetta*	M	A	IN	LC		*
	Scolopacidae						
28	Black-tailed Godwit *Limosa limosa*	M	A	IN	NT	*	*
29	Common Sandpiper *Actitis hypoleucos*	R	A	IN	LC	*	*
30	Whimbrel *Numenius phaeopus*	M	A	IN	LC	*	*
31	Marsh Sandpiper *Tringa stagnatilis*	M	A	IN	LC	*	*
32	Dunlin *Calidris alpina*	M	A	IN	LC	*	*
33	Little Stint *Calidris minuta*	M	A	IN	LC	*	*
34	Sanderling *Calidris alba*	RM	A	P	LC	*	*
35	Eurasian Curlew *Numenius arquata*	RM	A	IN	NT	*	*
36	Bar-tailed Godwit *Limosa lapponica*	M	A	IN	NT		*
37	Ruddy Turnstone *Arenaria interpres*	M	A	IN	LC		*
38	Ruff *Calidris pugnax*	M	A	IN	LC		*
39	Temminck's Stint *Calidris temminckii*	M	A	IN	LC		*
40	Terek Sandpiper *Xenus cinereus*	M	A	IN	LC		*
41	Spotted Redshank *Tringa erythropus*	M	A	IN	LC		*

Sr. No.	Order, Family, Common & Scientific Name	MS	Habitat	Feeding Guild	IUCN-2021	Post monsoon	Winter
42	Common Greenshank *Tringa nebularia*	M	A	IN	LC	*	*
43	Common Redshank *Tringa totanus*	M	A	IN	LC	*	*
44	Wood Sandpiper *Tringa glareola*	M	A	IN	LC	*	*
	Columbiformes						
	Columbidae						
45	Rock Pigeon *Columba livia*	R	T	G	LC	*	*
46	Laughing Dove *Streptopelia senegalensis*	R	T	G	LC	*	*
47	Eurasian Collared Dove *Streptopelia decaocto*	R	T	G	LC	*	*
	Coraciiformes						
	Alcedinidae						
48	Common Kingfisher *Alcedo atthis*	R	A	P,A,IN	LC	*	*
49	White-throated Kingfisher *Halcyon smyrnensis*	R	A	P,A,IN	LC	*	*
50	Pied Kingfisher *Ceryle rudis*	R	A	P,A,IN	LC	*	*
	Coraciidae						
51	Indian Roller *Coracias benghalensis*	M	T	I,RP	LC		*
52	European Roller *Coracias garrulus*	M	T	I,RP	LC		*
	Meropidae						
53	Green Bee-eater *Merops orientalis*	R	T	I	LC		*
	Gruiformes						
	Rallidae						
54	Watercock *Gallicrex cinerea*	R	A	IN	LC		*
55	Common Moorhen *Gallinula chloropus*	R	A	H,I,IN	LC		*
56	Common Coot *Fulica atra*	R	A	IN,W,H	LC		*
	Passeriformes						
	Alaudidae						
57	Crested Lark *Galerida cristata*	R	T	G,I	LC	*	*
	Cisticolidae						

Sr. No.	Order, Family, Common & Scientific Name	MS	Habitat	Feeding Guild	IUCN-2021	Post monsoon	Winter
58	Plain Prinia *Prinia inornata*	R	T	I	LC	*	*
	Corvidae						
59	House Crow *Corvus splendens*	R	T	O	LC	*	*
	Dicruridae						
60	Black Drongo *Dicrurus macrocercus*	R	T	I	LC	*	*
	Estrildidae						
61	Indian Silverbill *Euodice malabarica*	R	T	G	LC	*	*
	Hirundinidae						
62	Wire-tailed Swallow *Hirundo smithii*	R	T	I	LC	*	*
63	Red-rumped Swallow *Cecropis daurica*	R	T	I	LC	*	*
64	Dusky Crag Martin *Ptyonoprogne concolor*	R	T	I	LC	*	*
65	Streak-throated Swallow *Petrochelidon fluvicola*	M	T	I	LC		*
	Motacillidae						
66	Western Yellow Wagtail *Motacilla flava*	RM	A	I	LC		*
67	Citrine Wagtail *Motacilla citreola*	RM	A	I	LC		*
68	White-browed Wagtail *Motacilla maderaspatensis*	M	A	I	LC		*
	Muscicapidae						
69	Indian Robin *Saxicoloides fulicatus*	R	T	I	LC	*	*
	Nectariniidae						
70	Purple Sunbird *Cinnyris asiaticus*	R	T	N	LC	*	*
	Passeridae						
71	House Sparrow *Passer domesticus*	R	T	G	LC	*	*
	Ploceidae						
72	Baya Weaver *Ploceus philippinus*	R	T	G	LC	*	*
	Pycnonotidae						
73	Red-vented Bulbul *Pycnonotus cafer*	R	T	FU,I,H	LC	*	*
74	White-eared Bulbul *Pycnonotus leucotis*	R	T	FU,I	LC	*	*

Sr. No.	Order, Family, Common & Scientific Name	MS	Habitat	Feeding Guild	IUCN-2021	Post monsoon	Winter
	Sturnidae						
75	Rosy Starling *Pastor roseus*	M	T	O	LC	*	*
76	Common Myna *Acridotheres tristis*	R	T	O	LC	*	*
	Pelecaniformes						
	Anhingidae						
77	Oriental Darter *Anhinga melanogaster*	R	A	P,A,OP	NT		*
	Ardeidae						
78	Grey Heron *Ardea cinerea*	RM	A	P,A	LC	*	*
79	Great Egret *Ardea alba*	RM	A	P,A	LC	*	*
80	Little Egret *Egretta garzetta*	R	A	I,P,A	LC	*	*
81	Indian Pond Heron *Ardeola grayii*	R	A	I,P,A	LC	*	*
82	Purple Heron *Ardea purpurea*	RM	A	P,A,OP	LC	*	*
83	Intermediate Egret *Ardea intermedia*	R	A	I,P,A	LC	*	*
84	Western Reef Egret *Egretta gularis*	R	A	I,P,A	LC	*	*
85	Cattle Egret *Bubulcus ibis*	R	T	I,P,A	LC	*	*
	Ciconiidae						
86	Painted Stork *Mycteria leucocephala*	RM	A	P,IN	NT	*	*
87	Black-necked Stork *Ephippiorhynchus asiaticus*	RM	A	P,IN	NT		*
	Pelecanidae						
88	Great White Pelican *Pelecanus onocrotalus*	RM	A	P	LC	*	*
	Phalacrocoracidae						
89	Little Cormorant *Microcarbo niger*	R	A	P	LC	*	*
90	Indian Cormorant *Phalacrocorax fuscicollis*	R	A	P	LC	*	*
91	Great Cormorant *Phalacrocorax carbo*	R	A	P	LC		*
	Threskiornithidae						
92	Black-headed Ibis *Threskiornis melanocephalus*	RM	A	A,IN,I,W	NT	*	*
93	Eurasian Spoonbill *Platalea leucorodia*	RM	A	A,IN,I,W	LC	*	*

Sr. No.	Order, Family, Common & Scientific Name	MS	Habitat	Feeding Guild	IUCN-2021	Post monsoon	Winter
94	Indian Black Ibis *Pseudibis papillosa*	R	T	I,G,RP	LC	*	*
	Phoenicopteriformes						
	Phoenicopteridae						
95	Lesser Flamingo *Phoeniconaias minor*	RM	A	PL	NT	*	*
96	Greater Flamingo *Phoenicopterus roseus*	RM	A	PL,IN	LC		*

RM = Resident Migrant; R = Resident; M = Migratory; T = Terrestrial; A = Aquatic; FU = Frugivore; N = Nectorivore; P = Piscivore; G = Granivore; C = Carnivore; I = Insect and other terrestrial invertebrate feeder; PL = Plankton Feeder; IN = Aquatic Invertebrate feeder; A = Amphibian feeder; OP = Ophidiovore; RP = Reptile Feeder; W = Weedivore; H = Herbivore; PD = Predatory; NT = Near Threatened; LC = Least Concern, * Presence of birds

ANNEXURE F

DEENDAYAL PORT TRUST
(Erstwhile: KANDLA PORT TRUST)

Administrative Office Building
Post Box NO. 50
GANDHIDHAM (Kutch).
Gujarat: 370 201.
Fax: (02836) 220050
Ph.: (02836) 220038

www.deendayalport.gov.in

NO.EG/WK/4751/Part (Marine Ecology Monitoring)/11 Dated : 3/5/2021

M/S Gujarat Institute of Desert Ecology,
P.O.Box No. 83,
Opp.Changleshwar Temple, Mundra Road,
Bhuj (Kachchh)- 370 001,Gujarat (India).
Tel.: 02832-329408, 235025.
Tele/Fax: 02832-235027
Email: desert_ecology@yahoo.com.

Kind Attn.: Dr.V.Vijay Kumar, Director, GUIDE, Bhuj.

Sub: Regular Monitoring of Marine Ecology in and around the Deendayal Port Trust and Continuous Monitoring Programme covering all seasons on various aspects of the Coastal Environs covering Physico-chemical parameters of marine water and marine sediment samples coupled with biological indices, as per the requirements of EC & CRZ Clearances accorded by the MoEF&CC,GoI to the various projects of the Deendayal Port Trust (for three years (2021-2024)) reg.

Ref.: 1) DPT request vide email dated 10/4/2021.
2) M/s GUIDE,Bhuj letter no. GUIDE/DPT/Offer/Mar. Ecol. & Cont. Monit. Prog./18 /2021-22 dated 16/4/2021.

Sir,

Your offer for the subject work submitted vide above referred letter dated 16/4/2021 amounting to Rs. 1,41,57,000.00 + 18% GST (for three years i.e. 2021-2024) - per year cost Rs.47,19,000.00) (Rupees One crore forty one lakh and fifty seven thousand only plus eighteen percent GST) including all terms & conditions mentioned in the offer letter, has been accepted.

.... cont............

2. The terms of payment:

For the period (2021-22) (Monitoring Period 24/5/2021 to 23/5/2022):

1) 20% of the project budget (Rs.47,19,000.00 /year) should be paid within 15 days from the date of submission of Inception report by GUIDE.
2) 20% of the project budget (Rs.47,19,000.00 /year) should be paid within 15 days from the date of submission of First Season report by GUIDE.
3) 20% of the project budget (Rs.47,19,000.00 /year) should be paid within 15 days from the date of submission of Second Season report by GUIDE.
4) 20% of the project budget (Rs.47,19,000.00 /year) should be paid within 15 days from the date of submission of Third Season report by GUIDE.
5) 20% of the project budget (Rs.47,19,000.00 /year) should be paid within 15 days from the date of submission of Final report by GUIDE.

For the period (2022-23) (Monitoring Period 24/5/2022 to 23/5/2023):

1) 20% of the project budget (Rs.47,19,000.00 /year) should be paid within 15 days from the date of submission of Inception report by GUIDE.
2) 20% of the project budget (Rs.47,19,000.00 /year) should be paid within 15 days from the date of submission of First Season report by GUIDE.
3) 20% of the project budget (Rs.47,19,000.00 /year) should be paid within 15 days from the date of submission of Second Season report by GUIDE.
4) 20% of the project budget (Rs.47,19,000.00 /year) should be paid within 15 days from the date of submission of Third Season report by GUIDE.
5) 20% of the project budget (Rs.47,19,000.00 /year) should be paid within 15 days from the date of submission of Final report by GUIDE.

For the period (2023-24) (Monitoring Period 24/5/2023 to 23/5/2024) :

1) 20% of the project budget (Rs.47,19,000.00 /year) should be paid within 15 days from the date of submission of Inception report by GUIDE.
2) 20% of the project budget (Rs.47,19,000.00 /year) should be paid within 15 days from the date of submission of First Season report by GUIDE.
3) 20% of the project budget (Rs.47,19,000.00 /year) should be paid within 15 days from the date of submission of Second Season report by GUIDE.
4) 20% of the project budget (Rs.47,19,000.00 /year) should be paid within 15 days from the date of submission of Third Season report by GUIDE.
5) 20% of the project budget (Rs.47,19,000.00 /year) should be paid within 15 days from the date of submission of Final report by GUIDE.

..........Cont.......

3. Scope of work :

1) Regular Monitoring of Marine Ecology in terms of sea weeds, sea grasses, mudflats, sand dunes, fisheries, echinoderms, shrimps, turtles, corals, coastal vegetation, mangroves and other marine biodiversity components as part of the management plan. Marine ecology shall be monitored regularly also in terms of all micro, macro and mega floral and faunal components of marine biodiversity.

   Ref.: (i) EC & CRZ clearance granted by the MoEF&CC,GoI dated 19/12/16 - Dev. Of 7 Integrated facilities – **Specific condition no. xviii.**
   (ii) EC & CRZ Clearance granted by the MoEF&CC,GoI dated 18/2/2020 – Dev. Remaining 3 integrated facilities - **Specific condition xxiii.**
   (iii) EC & CRZ Clearance granted by the MoEF&CC,GoI dated 19/2/2020 – Dev. Integrated facilities (Stage II- 5 projects – **Specific condition xv.**
   (iv) EC & CRZ Clearance granted by the MoEF&CC,GoI dated 20/11/20 – Creation of water front facilities (OJ 8 to 11) ... - **Para VIII Marine Ecology, Specific condition iv).**

2) A continuous monitoring programme covering all the seasons on various aspects of the coastal environs need to be undertaken. The monitoring should cover various physico-chemical parameters coupled with biological indices such as sand dune vegetation, mangroves, sea grasses, macrophytes and phytoplankton on a periodic basis during construction and operation phase of the project. Additionally primary productivity will also be carried out. Any deviations in the parameters shall be given adequate care with suitable measures to conserve the marine environment and its resources.

   Ref.: (i) EC & CRZ Clearance granted by the MoEF&CC,GoI dated dated 18/2/2020 – Dev. Remaining 3 integrated facilities - **Specific Condition xix.**
   (ii) EC & CRZ Clearance granted by the MoEF&CC,GoI dated dated 19/2/2020 – Dev. Integrated facilities (Stage II- 5 projects) - **Specific Condition xiv.**

4. Obligation of KPT :

- Assistance regarding the statutory clearance from authorities concerned to be rendered by DPT for field visits.
- Study area map along with GPS coordinates is to be provided by the DPT.

5. Time Period : Three years i.e. 2021-24 (per year three monitoring all three seasons).

..........Cont..........

6. Kindly send the acknowledgement of this work order & start the work w.e.f. 24/5/2021.

Thanking you.

Yours faithfully,

3/5/21

Superintending Engineer (PL)& EMC (i/c)
Deendayal Port Trust

Annexure G

DEENDAYAL PORT TRUST
(Erstwhile: KANDLA PORT TRUST)

Administrative Office Building
Post Box NO. 50
GANDHIDHAM (Kutch).
Gujarat: 370 201.
Fax: (02836) 220050
Ph.: (02836) 220038

www.deendayalport.gov.in

EG/WK/4751/Part (CCA Renewal) 14

Date: 30/04/2021
04/05/21

To,
The Member Secretary
Gujarat Pollution Control Board
Paryavaran Bhavan,
Sector 10A, Gandhinagar - 382010

Sub: Submission of Environmental statement in format form V for the financial year 2020-21 reg.

Ref.: 1) KPT letter no. MR/GN/1527(Part I)/535 dated 16/6/2012
2) KPT letter no. MR/GN/1527(Part I)/2011 dated 20/5/2013
3) KPT letter no. MR/GN/1527(Part I)/337 dated 17/05/2014
4) KPT letter no. MR/GN/1527/ (Part I)/dated 27/04/2015
5) KPT letter no. EG/WK/EMC/CCA (Part II)/218 dated 27/6/2016
6) KPT letter no. EG/WK/EMC/CCA (Part II)/214 dated 19/6/2017
7) DPT letter no. EG/WK/EMC/CCA (Part II)/294 dated 13/6/2018
8) DPT letter no. EG/WK/EMC/CCA (Part II) dated 27/5/2019
9) DPT letter no. . EG/WK/4751 (CCA Renewal) dated 22/5/2020

Sir,

It is requested to kindly refer above cited references for the said subject.

In this connection, it is to state that, the GPCB has renewed the Consolidated Consent & Authorization granted to Deendayal Port Trust and issued CCA Order No. AWH-110594 vide no. PC/CA-KUTCH-812 (5)/GPCB ID 28494/581914 dated 22/1/2021, valid up to 22/07/2025 .

In this regard, as per statutory requirement, the DPT has regularly submitted Environmental Statement in Form V to the GPCB (as mentioned in references above).

Now please find the enclosed herewith Environmental Statement in Form V for the year 2020-21.

This is for kind information and record please.

Encl : As above

Yours faithfully

5/5/21
SE(D) & EMC (I/C)
Deendayal Port Trust

Enclosure – A

Environmental Statement (Form V)
For Deendayal Port Trust, Kandla
For the FY @ 2020-2021

"FORM-V"
(See rule -14)

From:
Deendayal Port Trust,
Administrative Office Building,
Post Box No.: 50, Gandhidham,
Dist.: Kutch – 370 207. Gujarat State.
Tel No.: O: 02836-220038
Fax No.: 02836-220050

To,
The Member Secretary,
Gujarat Pollution Control Board,
Paryavaran Bhavan, Sector - 10A,
Gandhinagar – 382043

Environmental statement for the financial year ending the 31st March, 2020

"PART-A"

1) Name and Address of the owner/occupier of the industry or process		
➢ NAME	:	Mr. R Murugadoss Chief Engineer
➢ ADDRESS	:	**Deendayal Port Trust** Administrative Office Building, Post Box No.: 50, Gandhidham, Dist.: Kutch – 370 207. Gujarat State. Tel No.: O: 02836-220038 Fax No.: 02836-220050
➢ Industry Category Primary – (STC code) Secondary – (STC code)	:	Major port under the administrative control of Ministry of shipping, GOI.
➢ Year of Establishment	:	8th April 1955
➢ Date of the last Environment audit report submitted	:	27th June, 2016

"PART-B"

WATER AND RAW MATERIAL CONSUMPTION

Sr.No.	WATER CONSUMPTION	(M^3/DAY)
1.	Process	436458.0 KL
2.	Cooling	
3.	Domestic Purpose	

I. Water Consumption

Sr. No.	Name of Products	Process water consumption per unit of products output in M^3/ Annum	
		During the previous Financial Year 2019-20	**During the current financial year 2020-21**
01.	Dry Cargo Handling	122.606 MMT	117.558 MMT
02.	Liquid Cargo Handling		
Details of the water consumption for the financial year 2020-21 please refer Annexure-1			

II. Raw material Consumption

Sr.No.	Name of Raw Material	Name of Products	Consumption of Raw material per unit of output	
			During the previous Financial Year 2019-20	**During the current financial year 2020-21**
1.	Deendayal Port Trust has only loading & unloading activities for dry cargo and liquid cargo. Hence consumption of raw material per unit of output with respective to production is not applicable			

<u>“PART-C”</u>

POLLUTION DISCHARGED TO ENVIRONMENT/UNIT OF OUTPUT (PARAMETERS AS SPECIFIED IN THE CONSENT)

Pollutant	Quantity of Pollutant Discharged (mass/day)	Concentration of Pollution in Discharge (mass/volume)	% of Variation from prescribed standard with reasons
Please Refer Annexure -II for Environmental Monitoring Reports of • Ambient Air Quality Monitoring • Drinking Water Quality Monitoring • Marine Water Monitoring • Noise Level Monitoring			

<u>“PART-D”</u>

HAZARDOUS WASTE

[AS SPECIFIED UNDER HAZARDOUS WASTE (MANAGEMNET AND HANDLING) RULES -1989 & AMENDMENT RULES -2008]

Sr.No.	Hazardous Waste	Total Quantity in MT/Year	
		During the previous Financial Year 2019-20	During the current financial year 2020-21
1.	5.1- Waste Residue containing Oil	6717.69	9874.84
2.	5.2- Used Spent Oil		
• Details of Hazardous Waste generated during the financial year 2020-21 please refer Annexure-III			
a. From Process: NA b. From Pollution Control facility: NA			

"PART-E"
SOLID WASTE

Sr.No.	Solid Waste	Total Quantity in MT/year	
		During the previous Financial Year 2019-20	**During the current financial year 2020-21**
1.	From Process	Nil	Nil
2.	From pollution Control Facility	Nil	Nil
a.	Quantity Recycled or Reutilized within the unit	Nil	Nil
b.	Sold	Nil	Nil
c.	Disposed Off	1084.29 MT	817.94 MT
Details of Solid Waste (Non-Hazardous Waste) generated during the financial year 2020-21 please refer Annexure-IV			

“PART-F”

PLEASE SPECIFY THE CHARACTERISTICS (IN TERMS OF CONCENTRATION AND QUANTUM) OF HAZARDOUS AS WELL AS SOLID WASTES AND INDICATE DISPOSAL PRACTICE ADOPTED FOR BOTH THESE CATEGORIES OF WASTES.

Hazardous Waste:
Companies authorized by Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB) have been awarded the work of collection, transporting and disposal of hazardous Waste by the Deendayal Port Trust. The same will be hand over to authorize parties for further Treatment & disposal.

Solid Waste:
Garbage facility is provided as per MARPOL Act 73/78 to the vessel berthed at Deendayal Port Trust. Companies authorized by Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB) have been awarded the work of collection, transporting and disposal of solid waste by the Deendayal Port Trust. The same will be hand over to authorize parties for further treatment and

“PART-G”

IMPACT OF THE POLLUTION ABATEMENT MEASURES TAKEN ON CONSERVATION OF NATURAL RESOURCES AND ON THE COST OF PRODUCTION.

DPT has awarded Environmental Monitoring Contract to Detox Corporation Pvt. Ltd., Surat for regularly monitoring of ambient air quality monitoring, Noise level monitoring, waste water and Marine water and sediment. Detox is a private laboratory and approved by MoEF & NABL. As per the stipulated conditions mentioned in the EC & CRZ Clearance accorded by the MoEF&CC, GoI dated 19/12/2016, DPT entrusted work for regular monitoring of Marine Ecology to M/s GUIDE, Bhuj (2017-21) and the reports have been regularly submitted to the Regional Office of the MoEF&CC,GoI and copy to GPCB & CPCB, RO.

“PART-H”

ADDITIONAL MEASURES / INVESTMENT PROPOSAL FOR ENVIRONMENTAL PROTECTION INCLUDING ABATEMENT OF POLLUTION, PREVENTION OF POLLUTION

Please Refer Annexure-V For details of Silent features of the Environmental Statement Plan.

“PART-I”

ANY OTHER PARTICULAR FOR IMPROVING THE QUALITY OF THE ENVIRONMENT

1. DPT has planted 7500 trees in Deendayal port trust area during the year 2014-15 6000 trees during financial year 2016-17 and the same has been regularly maintained.
2. DPT has planted 4000 trees at A.O building, Gopalpuri residential colony and along the road side at Kandla. Further, approximately 885 no. of trees have been planted since September 2015 onwards.
3. The work related to construction of protection wall with wind screen to prevent coal dust deposition in building has already been completed during the year 2011-2012
4. Continuous water sprinkling has been carried out on the top of the heap of coal, at regular intervals to prevent dusting, fire and smoke. DPT already installed sprinkling system inside Cargo Jetty area for coal dust suppression in coal yard (40 Ha. Area) at the cost of Rs. 14.44 crores.
5. Deendayal port trust (traffic department) issued a Circular (SOP) to the trade with regard to control of dust pollution arising out of coal handling and ensuring safety in coal handling. In case of any violations of SOP, provision of impose of penalty of Rs. 10000/- has been made and if violation is repeated thrice, the same will lead to ban of concerned party into port area. The DPT is taking all the measures to reduce coal dust by implementing the coal handling guidelines through port users.
6. All trucks before leaving the storage yard have been covered with tarpaulin and also trucks are also not over loaded as well as there is no spillage during transportation and there is adequate space for movement of vehicles at the surrounding area.
7. DPT has constantly improving the house keeping in the dry cargo storage yard and nearby approved areas leading to roads. Adequate steps under the provisions of air prevention and control of pollution Act 1981, Environmental Protection Act 1986 are taken.
8. DPT appointed M/s. Detox Corporation, Surat for continuous monitoring of Environmental parameters (Air, Water, Noise etc)
9. DPT commissioned STP (Replacement of existing STP) of capacity 1.5 MLD for treatment of domestic waste water for entire DPT area.
10. Deendayal Port Trust had carried out mangrove plantation in an area of 1350 ha. through various government agencies like Gujarat Ecology Commission, State Forest Department. The mangrove plantation in an area of 50 ha. is in progress by GEC.

11. It is also relevant to mention here that, DPT entrusted work to Forest Department, GoG (Social Forestry Division, Bhuj) during August, 2019 for green belt development in and around port area 31.942 hectares (approx. 35200 plants at various locations) at a cost of Rs. 352.32 lakhs. The work is in progress.
12. As per the stipulated conditions mentioned in the EC and CRZ clearances accorded by the MoEF&CC, GOI, DPT appointed renowned agency i.e M/s. GUIDE, Bhuj for following.
    a. Comprehensive & integrated Conservation plan for DPT marine environment.
    b. Studies on dredged material for presence of contaminants.
    c. Regional Strategic Impact Assessment study (Work in Progress)
    d. Biodiversity Action Plan for DPT Area.

ANNEXURE – 1

WATER CONSUMPTION DETAIL (APRIL 2020 to MARCH 2021)

Statement Showing The Quantity
Of Water Consume For GWS & S.B
For April 2020 to march 2021 @ Kandla

Month	Total Qty. Consume
Apr-20	39976.00
May-20	34850.00
Jun-20	29756.00
Jul-20	43626.00
Aug-20	43566.00
Sep-20	20990.00
Oct-20	33180.00
Nov-20	47480.00
Dec-20	50430.00
Jan-21	51110.00
Feb-21	25980.00
Mar-21	15514.00
Total	**436458.00** KL

27/4/21

SE (D) & EMC (I/C)

SE(PL)

ANNEXURE – 2

DETOX MONITORING REPORT (APRIL 2020 to MARCH 2021)

ENVIRONMENT MONITORING REPORT
OF
DEENDAYAL PORT TRUST

(Annual Report)
(March 2020 to February 2021)

(Report No - DCPL/DPT(19-22)/AMR/20-21/01)

Submitted to

Deendayal Port Trust

Prepared by

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1. Introduction

The environmental Monitoring plan is the key document in the environmental management system and sets out the detailed targets, objectives and procedures that will be adopted in order to achieve the goals set out in the environmental policy. EMP document is a collation of background information relevant to the Kandla Port Environmental Management and Monitoring Plan (EMMP).

1.1. The Environment (Protection) Act, 1986

The EPA 1986 came into force in all of India in November of 1986, under an official notification. The Act contains 26 sections divided into 4 chapters. The Act has its genesis in Indian Constitution's Article 48(A) and Article 51(A)g. The Act is a part of Article 253 of the Indian Constitution.

The rules of Environment protection came into force on 19th November 1986 and these rules provide for the following:

- The standards of quality of air, soil and water for various areas and purposes of environment.
- The standard set up to know about the limits of the environmental pollutants.
- Rules include the procedure and safeguards needed to handle the hazardous substance.
- Restrictions and some prohibitions on handling the hazardous substances in different areas and premise
- The procedures and safeguards required for the prevention of accidents which may cause environmental pollution and also the remedies for it.
- The prohibition and restrictions possessed on the location of industries in different areas.

1.2. EIA and CRZ Notification

The Ministry of Environment, Forests & Climate Change (MoEF & CC), Government of India, exercising the powers conferred upon it under the provisions of the Environment (Protection) Act, 1986, issued the Environment Impact Assessment Notification, 2006 and its subsequent amendments.

1.2.1. EIA Notification

The basic objective of the Environment Impact Assessment is to identify, predict, mitigate and communicate the possible impacts due the proposed project to the Government authority and people likely to be affected and incorporate the conditions for construction, operation, maintenance and waste disposal phases of the project to mitigate the negative (adverse) impacts and enhance the positive impacts for the sustainable development of the region.

Environmental Impact Notification S.O.1533 (E), dtd.14th September 2006 as amended 2009, issued under Environment (Protection) Act 1986, has made it mandatory to obtain prior environmental clearance (EC) for scheduled development projects. The notification has classified projects under two categories A & B. Category A projects (including expansion and modernization of existing projects) require clearance from The Ministry of Environment, Forests & Climate Change (MoEF & CC), Govt. of India (GoI) and for category B from State Environmental Impact Assessment Authority (SEIAA), constituted by Govt. of India.

Some important features of the said Notification are:

I. Prior Environmental Clearance (EC) is required by all new projects or activities listed in the Schedule of the EIA Notification 2006 and subsequent amendments thereafter. EC is required before

commencement of any construction work or preparation of land by the project management.

II. Prior EC is also required by the existing projects or activities if its capacity is likely to exceed the threshold limit mentioned in the said Schedule.

III. All category B projects where general condition does not apply, the project proponents are required to apply to the SEAC who will hear the case according to the procedure laid down in the EIA notification and based on whose recommendation, EC may be granted or rejected by the SEIAA.

IV. For all category A projects and also category B projects where general condition applies, the project proponents are required to apply directly to The Ministry of Environment, Forests & Climate Change (MoEFCC), Government of India, who would consider the project for grant or rejection of the EC based on the recommendation of the Expert Appraisal Committee at the central level.

V. If projects attract CRZ clearance, then clearance under CRZ rules is also required.

1.2.2. Coastal Regulation Zone (CRZ)

The Union Cabinet approved the Coastal Regulation Zone (CRZ) Notification, 2018 which were last reviewed and issued in 2011. The notification was released after a series of representations received by the Ministry of Environment, Forest & Climate Change (MoEF&CC) from various Coastal States/UTs for a comprehensive review of the provisions of the CRZ Notification, 2011.

1.2.2.1. Classification of CRZ

For the purpose of conserving and protecting the coastal areas and marine waters, the CRZ area shall be classified as follows, namely: -

CRZ-I A

CRZ-I A shall constitute the ecologically sensitive areas (ESAs) and the geomorphological features which play a role in maintaining the integrity of the coast viz.: Mangroves, corals, biologically active mudflats, Marine national parks, turtle nesting grounds etc.

CRZ-I B

The intertidal zone i.e. the area between Low Tide Line and High Tide Line shall constitute the CRZ-I B.

CRZ-II

CRZ-II shall constitute the developed land areas up to or close to the shoreline, within the existing municipal limits or in other existing legally designated urban areas, which are substantially built-up with a ratio of built-up plots to that of total plots being more than 50 per cent and have been provided with drainage and approach roads and other infrastructural facilities, such as water supply, sewerage mains, etc.

CRZ-III

Land areas that are relatively undisturbed (viz. rural areas, etc.) and those which do not fall under CRZ-II, shall constitute CRZ-III, and CRZ-III shall be further classified into following categories: -

CRZ-III A

Such densely populated CRZ-III areas, where the population density is more than 2161 per square kilometer as per 2011 census base, shall be designated as CRZ-III A and in CRZ-III A, area up to 50 meters from the HTL on the landward side shall be earmarked as the 'No Development Zone (NDZ)', provided the CZMP as per this notification, framed with due consultative process, have been approved, failing which, a NDZ of 200 meters shall continue to apply.

CRZ-III B

All other CRZ-III areas with population density of less than 2161 per square kilometer, as per 2011 census base, shall be designated as CRZ-III B and in CRZ-III B, the area up to 200 meters from the HTL on the landward side shall be earmarked as the 'No Development Zone (NDZ)'.

Land area up to 50 meters from the HTL, or width of the creek whichever is less, along the tidal influenced water bodies in the CRZ III, shall also be earmarked as the NDZ in CRZ III.

CRZ- IV

The CRZ- IV shall constitute the water area and shall be further classified as under:

- **CRZ- IVA**

The water area and the sea bed area between the Low Tide Line up to twelve nautical miles on the seaward side shall constitute CRZ-IV A.

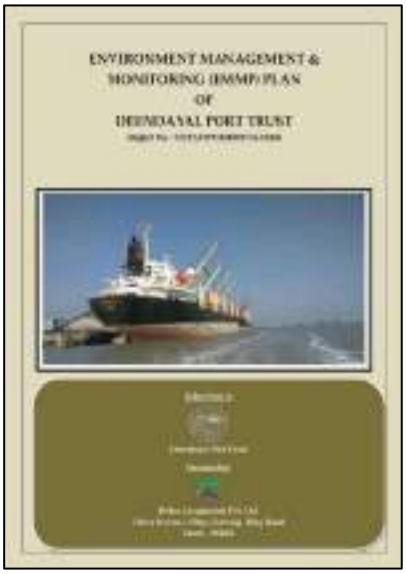
- **CRZ- IVB**

CRZ-IV B areas shall include the water area and the bed area between LTL at the bank of the tidal influenced water body to the LTL on the opposite side of the bank, extending from the mouth of the water body at the sea up to the influence of tide, i.e., salinity of five parts per thousand (ppt) during the driest season of the year.

1.2.3. EMMP Plan

As per the guidelines of Ministry of Environment Forests and Climate Change and also as per the environment management plans submitted by various agencies during their EIA studies, DPT has appointed M/s. Detox Corporation Pvt. Ltd. for the work of "Preparing and Monitoring of Environmental Management Plan for Deendayal Port Trust at Kandla vide Work Order No. EG/WK/EMC/11023/2011/IV/213 Dated-07/12/2019.

As part of this assignment, M/s. Detox Corporation Pvt. Ltd. prepared an Environmental Management and Monitoring Plan (EMMP) and submitted this EMMP prior to commencement of the Environment Monitoring of Deendayal Port in February 2020. The EMMP summarized the background information as a resource to develop Environment Monitoring Plan, based on the results of the EIA studies carried out at Deendayal Port by several agencies.



This environmental Management and Monitoring Plan (EMMP) plan submitted in February 2020 was the key document in the environmental management system and set out the detailed targets, objectives and procedures that are adopted in order to achieve the goals to efficiently manage the environmental policy of Deendayal Port Trust.

2. DEENDAYAL PORT TRUST

Deendayal Port is one of the most important ports of India. This port is situated at Latitude 23° 01′ N and Longitude 70° 13′ E on the shores of the Kandla Creek. The Deendayal Port came into existence in the year 1931 with a single Pier construction. Later on with the loss of Karachi port to Pakistan during partition, after independence the Government of India chose Kandla as an ideal sea outlet. Thus the Deendayal Port was developed and since then Deendayal Port has played a pivotal role in enhancing country`s maritime trade.

The Port of Kandla was declared a major port in 1955. The Deendayal Port Trust was created by law in 1963 to manage the new port. In 1978, The Deendayal Port had commissioned the off-shore Oil Terminal facilities at Vadinar jointly with Indian Oil Corporation, by providing Single Buoy Mooring (SBM) system, having a capacity of 54 MMTPA, which was first of its kind in India. Further, significant quantum of infrastructure up-gradation has been effected, excellent maritime infrastructure has been created having capacity of 32 MMTPA by M/s Essar Oil Refinery in Jamnagar district.

The port governed by Deendayal Port Trust (DPT) is a gateway port to the hinterland in western and northern states of Jammu & Kashmir, Delhi, Punjab, Himachal Pradesh, Haryana, Rajasthan, Gujarat and parts of Madhya Pradesh, Uttaranchal and Uttar Pradesh. It is in the district of Kutch and is located on the west bank of Kandla creek which runs into the Gulf of Kutch at a distance of 90 nautical miles from the Arabian Sea. The Port is well connected by the network of rail and road and is a gateway port for export and import of goods for northern states (Map 1). The width

of the channel varies from 200 meters to 1,000 meters. The contour depth along the shipping channel is around 10 meters. The total length of the Deendayal Port approach Channel is around 23 kms. Presently, the Port has sixteen cargo berths for handling dry cargo traffic, six oil jetties for handling Petroleum Oil products and other liquid cargo traffic at Kandla Creek and 3 Single Buoy Mooring (SBM) at Vadinar for handling crude oil and two product jetties for handling petroleum products.

2.1. The Physical Environment

Deendayal Port (23^0 02′ 29.92″ N, 70^0 13′ 08.99″ E) is located at the tail end of Gulf of Kachchh (GoK), an east west oriented Gulf system in the western part of Gujarat. It is about 90 nautical miles from the open waters of Arabian Sea. Kandla creek harboring the Deendayal Port is one of the major creeks of the inner Gulf of Kachchh. Gulf of Kachchh (GoK) is 75 km wide at its mouth and after running about 170 km away from the Arabian sea towards east, narrows down into a constriction at 70^0 20′ E at *Sat Saida* Bet and then bifurcates into many creek systems (Map 1). The Little Rann at the tail end of GoK has a network of many small and large creeks, intermingling with marshy tidal flats rich in fine clays. Kandla creek is one of the major tributaries of this creek system, which empties into the inner GoK. All these creeks bring water from the Little Rann into Kandla creek, which has a fairly good depth and stable banks.

Coastal and inland environmental setting of Kandla, similar to other parts of Kachchh, has marked climatological peculiarities like aridity, geomorphology and coastal and terrestrial ecosystems. Annual rainfall in Kachchh district was 458 mm during 2001- 10 whereas it was 443 mm at Gandhidham taluka during the same period which is often irregular. Rain during monsoon is confined to only 15-20 days and occurs as an instant downpour. The mean rainfall in year 2019 was 194 mm.

On the terrestrial side there are no major rivers or rivulets or freshwater streams. Winter and summer temperatures range from 7^{o}- 47^{o}C with a yearly average humidity of 60% which increases to 80% during southwest monsoon and decreases to 50% during November-December. Average wind speed is 4.65 m/s with a maximum of 10.61 m/s during June. Drought is a common phenomenon in Kachchh with 2 drought year in a cycle of 5 years. Annual temperature fluctuation in the district is extreme, ranging from 4^{o}C to 47.5^{o}C.

2.2. Biophysical Environment

a. Creek system

The creek system consists of 3 main creeks the Nakti, the Kandla and the Hansthal, and the Little Gulf of Kutch interconnecting through many other big and small creeks, all along the coast. Very few rivers drain into the Gulf and they carry only a small quantity of freshwater, except during the brief monsoon. They are broad-valleyed and their river bed is mostly composed of coarse sand and gravel. The Gulf is uniquely characterized by numerous hydrographic features like pinnacles, as much as 10 m high. The southern shore has numerous islands and inlets covered with mangroves and surrounded by coral reefs. The northern shore is predominantly sandy or muddy confronted by numerous shoals.

The Marine water of Gulf of Kutch and its creeks like Kandla creek, Nakti creek and Khori creek are providing the suitable habitat for marine vegetation. The Gulf abounds in marine wealth and is considered as one of the biologically rich marine habitat along the west coast of India. The marine vegetation is highly varied, which includes sand dune vegetation, mangroves, sea grasses, macrophytes and phytoplankton. The dominant species of sand dune flora are *Euphorbia caudicifolia, E. nerifolia, Aloevera sp, Ephedra foliata, Urochodra setulosa, Sporobolus maderaspatenus,*

Eragrostis unioloides, Calotropis procera, Fimbristylis sp, *Indigofera* sp and *Ipomoea pescaprae*. The common sea grasses found growing on the mud flats are *Halophila ovata* and *H.beccarii*.

b. Mangroves

Deendayal Port Trust (DPT) is one of the largest ports of India in terms of volume of cargo handled. Among Indian ports, this port also has the largest coastal habitats such as mangroves (193.1 km2) and mudflats (312.9 km2). DPT has implemented mangrove plantation in 1300 ha during 2005 - 2017 through various implementing agencies at Sat Saida Bet, Nakti creek and Kantiyajal. The Deendayal Port Trust has entrusted the task of evaluating 1300 ha of mangrove plantation in these three locations to Gujarat Institute of Desert Ecology (GUIDE), Bhuj.

Coastal belt in and around Kandla region is characterized by a network of creek systems and mudflats which are covered by sparse halophytic vegetation like scrubby to dense mangroves, creek water and salt encrusted land mass which forms the major land component. The surrounding environment in a radius of 10 km from the Port is mostly built up areas consisting salt works, human habitations and Port related structures on west and north, creek system, mangrove formations and mudflats in the east and south. Deendayal Port and its surroundings have mangroves, mudflats and creek systems as major ecological entities.

Mangrove plantation activity by DPT was initiated in 2005 as mandated by the Ministry of Environment, Forests & Climate Change (MoEF&CC). Subsequently, 1300 ha of mangrove plantation has been completed till the end of 2017 in different years in order to meet the legal mandate of Ministry of Environment, Forests and Climate Change (MoEF & CC). The mangrove plantation activities were carried out at Sat Saida Bet, Nakti creek and Kantiyajal of Bharuch district in South Gujarat. At Sat Saida Bet,

plantation activities were carried out in phased out manner i.e. 20 ha during 2005-2006, 200 ha during 2011-2012, 300 ha during 2012-2013, and 330 ha during 2013-2014 (Plate1). At Nakti creek plantation was carried out during 2008-2009 and 2010-2011 in 50 ha and 100 ha, respectively (GUIDE, 2018).

A. marina was the preferred species for plantation activities in all the three locations due to prevailing high salinity and high success rate of this species. At Nakti creek *Rhizophora mucronata* and *Ceriops tagal* were also planted in small numbers along with *A. marina*. Likewise, at Kantiyajal attempts were made for planting *R. mucronata* along with *A. marina*.

c. Marine Fauna

In the marine environment of Deendayal Port, there are eleven species of mollusca, seven species of shrimps (Prawn) and seven species of annelids. Besides these, there are twelve groups of phytoplankton, 7 groups of zooplanktons. The density of meio-fauna ranged from 382 to 670 nos/10 cm^2. The density of benthic macro fauna ranged from 952 to 1092 no/m^2. The dominant macro-faunal group was porifera (Mantec, 2014).

d. Terrestrial Biodiversity

Sensitive ecological habitats like forest, grassland, agricultural land, wetlands are absent within and in the proximity of the Deendayal Port due to its highly built-up nature. The species richness and abundance of aquatic birds and terrestrial fauna (reptiles, mammals) in the port environ and its surrounding was low with least conservation significance.

There are 11 species of herpetofauna (reptiles and amphibians), 53 species of terrestrial birds, 49 species of aquatic birds in the Port Environs. Due to absence of forest habitat in the immediate vicinity of Deendayal Port, only nine species of mammals were recorded with very low abundance.

Map 1: Deendayal Port and its Physical Environs

3. Environment Management Plan

Port activities can often affect the quality of air, noise and marine water in the surrounding areas due to the wide range of port operation activities. For the determination of environment quality, need for identification of sources, control and disposal of waste from various point and non-point sources and for prediction of various parameters of sound environmental quality, regular monitoring and assessment are required.

The Environment management plan is the key document in the environmental management system and sets out the detailed targets, objectives and procedures that will be adopted in order to achieve the goals set out in the environmental policy.

It is extremely essential that port and harbour projects should have an environmental management plan (EMP), which also incorporates monitoring of air, noise, soil and marine water quality along with the collection of meteorological data.

Deendayal Port Trust targets the achievement of high environmental standards and strives to ensure that activities within the Port are environmentally and ecologically sustainable and have minimal impact on the natural environment.

Several developmental projects have been initiated and EIAs have been carried out for the said projects. These EIA studies have also submitted the suggestions on the environmental management of the project area and Deendayal Port in general. These suggestions and mitigation measures have also been considered in framing the current environment management plan.

The present Environment Management Plan summarizes the suggestions of the ECs received from the Ministry of Environment, Forests & Climate Change (MoEF & CC), and consents granted by Gujarat Pollution Control Board (GPCB).

The projects for which ECs were granted and which formed the framework of the present EMP are as below;

- EC and CRZ Clearance for Construction of 13th to 16th Cargo berth at Kandla in year 2008
- EC & CRZ clearance for development of plots for construction of liquid storage tank farms at Kandla , district Kutch in year 2009
- Environmental and CRZ Clearance to DPT for development of plots for construction of warehouses/Godowns (stage II) in year 2012.
- Environmental and CRZ clearance for Single Point Mooring (SPM) and Allied facilities off Veera in the Gulf of Kachchh for handling Crude Oil on BOT basis in year 2013.
- Developing seven integrated facilities within the Existing Kandla port at Kandla, Gujarat –December 2016
- Proposed Smart Industrial Port City (SIPC) at green Field Site 1 (Adipur side –Northeast of Antarjaal, South of Tagore Road, 580 Acres), Gandhidham, Kutch -Gujarat" - October 2017
- Proposed Smart Industrial Port City (SIPC) at Green Field Site 2 (DPT Complex, 849.96 Acres), Gandhidham, Kutch –Gujarat. – October 2017.

Based on the suggestions of the above referred EIAs, following environmental parameters have been suggested to be monitored.

3.1. Air Quality

Air quality in a port area can be affected by dust and particulates from traffic (re-suspension of road dust), site clearing, loading and un-loading of cargo, construction activity and emissions from vehicles bringing materials to the site and from ships and construction equipments. The

photochemical reactions (complex chain reactions between sunlight and gaseous pollutants), emissions from burning waste materials and escaping dust (due to handling of fine-particulate materials such as fertilizers and minerals) are also major sources of air pollution in port areas. Air quality can also be affected by secondary developments such as modernization and increased vehicular traffic.

Besides day to day port activities, ship emissions are the main source of SO in harbour areas. Emissions from port activities account for about 4.5% of total shipping emissions.

In Deendayal Port, major source of air pollution are large volumes of dry cargo especially coal handled at berths and their loading and unloading during transportation.

i. During Construction Phase

- Generation of dust due to handling and transport in uncovered trucks on dusty roads. Fugitive dust, emissions and dust generation due to concrete mixing, cement handling, welding operation of construction machinery.
- Combustion emissions from ships propulsion and auxiliary engines and boilers, followed by combustion source emissions from vehicles and land-based engines and boilers. Storage and handling of dry bulk cargo and vehicle traffic on unpaved roads, may also contribute to particulate matter emissions.

Measures to be taken

i. During Construction Phase

- Water sprinklers shall be used; Improperly functioning vehicles & equipment shall be removed; Vehicle engines shall not be left running when not in use; Prudent and good construction practices shall be used to minimize the spread of sediments;
- Vehicle trips to be minimized to the extent possible
- Any dry, dusty materials should be stored in sealed containers or

prevented from blowing

- Stack emissions from DG sets to be monitored
- Ambient air quality within the premises of the proposed project to be monitored.
- Exhaust from vehicles to be minimized by use of fuel-efficient vehicles and well maintained vehicles having PUC certificate.
- Compaction of soil during various construction activities
- Ambient air quality within the premises of the proposed project to be monitored.
- The ambient air quality will conform to the standards for PM_{10}, $PM_{2.5}$, SO_2 and NOx.

ii. During Operation Phase

- Emissions of NOx and Sox shall be maintain within the limits established by international regulations (MARPOL)
- Low-sulfur fuels shall be used in port
- Encouraging storage planning to avoid or minimize re storage and reshuffling of cargo
- Transfer equipment (e.g. cranes, forklifts, and trucks) shall be kept in good working condition
- Dust suppression mechanisms (e.g. water spray or covered storage areas) shall be used

3.1.1. Air Quality Management

The air quality at most of the locations in port areas and in residential areas should be within the norms as specified by the National Ambient Air Quality Standards barring particulate matter. However, day to day operations in the dry cargo berth areas produce more particulate matter.

The following measures are being undertaken to control fugitive dust:

- To control dust from operations at the existing dry cargo berths, especially where dusty cargo is handled, water should be sprinkled on the berths to suppress fugitive dust. Treated sewage should be utilized for dust suppression operations.
- Protection wall with wind screen should be set up to prevent spread

of fugitive dust from coal wagon loading yard.

- To reduce fugitive dust generation from transport roads, the roads from the berths to the national road network should be always kept in good repair. This would also reduce emissions from trucks' engines due to lower fuel consumption.
- Swiping of dust on routine basis should be carried out on these roads.
- Wherever possible dry bulk cargo should be transported by trucks covered with tarpaulin sheets.
- Coal dispatched in wagons should also be properly covered with tarpaulin sheets.
- Gaseous pollutants in the exhaust fumes generated by diesel powered machinery should be minimized by ensuring vigorous maintenance adhering to stringent overhaul schedules.
- Green belt should be developed along the side of the roads, railway lines and stack-yards to screen fugitive dust generated from the roads.

3.2. Noise Quality

Ports contain several noise sources in various sectors with different characteristics. Sources include, ships, trade operations, loading and unloading of the cargo, transportation and movement of heavy vehicles. Such activities strongly impact the environment of the surrounding area and, as a consequence, port workers.

i. During Construction Phase

- Vehicular noise, use of excavation equipment; Use of construction equipment and power tools; Use of pile drivers, boring equipment, power tools, drill bits, etc.

ii. During Operation Phase

- Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships.

- Generation of vehicular noise

Measures to be taken

i. During Construction Phase

- During night time transportation activities shall not be allowed
- Adequate silencers must be attached with all vehicles to reduce the noise
- Machineries/equipment causing high noise level shall not be operated during the night time
- Construction machinery shall be in good working condition and engines turned off when not in use.
- Suitable mufflers on engine exhausts and compressor components shall be installed
- Acoustic enclosures for equipment casing radiating noise shall be installed
- Vibration isolation for mechanical equipment shall be installed
- Personal Protective Equipments shall be provided for eardrum protection of the workers as well as visitors
- Periodical maintenance of all equipments and transport vehicles shall be done.
- Implement good working practices (equipment selection and siting) to minimize noise and reduce its impacts on human health (ear muffs, safe distances, and enclosures).
- Noise to be monitored in ambient air within the project premises.
- All equipment operated within specified design parameters.
- Vehicle trips to be minimized to the extent possible

ii. During Operation Phase

- Suitable mufflers on engine exhausts and compressor components shall be installed
- Acoustic enclosures for equipment casing radiating noise shall be installed
- Vibration isolation for mechanical equipment shall be installed
- noise sources shall be relocated to less sensitive areas to take advantage of distance and shielding
- Periodical maintenance of all equipments and transport vehicles shall be done.

3.2.1. Noise Quality Management

At the port, noise is generated due to operation of high capacity liquid cargo pumps, diesel powered trucks, cranes and other material handling equipment, diesel powered railway locomotives, railway wagons, and ships' horns (occasionally). The following measures shall be implemented to control noise:

- High capacity liquid cargo pumps, diesel powered mobile cargo handling equipment, should be properly maintained as per maintenance schedule to reduce noise. Attention should be paid towards rigorous maintenance of the silencers of diesel engines.
- Operators should be issued earmuffs. Wearing personal protective equipment should be compulsory and the Safety Officer / Supervisor should carry out regular inspections to this effect. Duty hours of operators of noisy machinery may be regulated to keep their noise exposure levels within limits.
- The dust barriers comprising of high-walls also act as a noise barrier.
- Dispatch of materials by trucks should be regulated such that, the traffic is evenly distributed. This will avoid congestion and consequent excessive noise and vehicular emissions.

3.3. Water Quality

Deendayal Port is one of the largest port of the country and thus, is engaged in wide variety of activities such as movement of large vessels, oil tankers and its allied small and medium vessels and handling of dry cargo several such activities whose waste if spills in water, can cause harmful effects to marine water quality. Regardless of their size, the environmental impact of seaports largely depends on these commercial activities. In port areas or in their vicinity, several activities, such as fisheries, industrial installations, storage of hazardous materials, may cause further environmental impacts.

i. During Construction Phase

- Turbidity level may increase in the water body due to dredging and other construction activity which may lead to the considerable impacts on marine resources. Increase turbidity may affect the rate of the photosynthetic activity of the aquatic life.

ii. During Operation Phase

- Water effluents associated with port activities may include storm water and sewage from port operations, as well as sewage, ballast water, bilge water, and vessel cleaning wastewater from ships.

Measures to be taken

i. During Construction Phase

- Excavation and dredging methods will be selected to minimize suspension of sediments
- Care should be taken that no construction material shall fall in the water
- Plastics sheet or tarpaulin shall be provide in order to avoid any chance of dumping of construction materials into the water
- Storage area of the construction material shall be at adequate distance from the coastal area.
- No untreated discharge to be made to surface water, groundwater or soil.
- The discharge point should be selected properly and sampling and analysis should be undertaken prior to discharge
- Take care in disposal of wastewater generated such that soil and groundwater resources are protected.
- Ensure drainage system and specific design measures are working effectively.

ii. During Operation Phase

- No untreated discharge to be made to surface water, groundwater or soil.
- Take care in disposal of wastewater generated such that soil and groundwater resources are protected
- Installation of storm drainage catch basins to avoid discharge directly into surface waters

- Oil /water separators and trapping catch basins shall be provided
- The capacity of oily waste collection shall be established based on applicable MARPOL provisions
- Wastewater with noxious chemicals from bulk tank cleaning shall be collected through appropriate on-site or off-site treatment prior to discharge.
- Drinking water parameter will be monitored as per requirement of GPCB/MoEF & CC

3.4. Impact on Marine Fauna (Planktons & Benthos)

i. During Construction Phase

- Pilling & dredging may lead to increased turbidity, less penetration of light and hence less photosynthesis and resulting less primary productivity. Due to this fishes and other fauna may migrate.

ii. **During Operation Phase**

- Spillage of Oil & wastes from Ships may impact on the creek biota, especially mangroves and fishes.

Measures to be taken

i. During Construction Phase

- Pilling and dredging shall be done by such methods so as to reduce the impact.

- Silt curtain shall be used to reduce the impact of turbidity and thus reducing the loss of primary productivity and subsequent impact on food chain

ii. During Operation Phase

- No discharge from ships shall be allowed, MARPOL norms shall be complied.
- Due care shall be taken from spillage of the oil and other chemicals during loading or unloading.

3.5. Hazardous Waste / Oil Spills

- Spills may occur due to accidents (e.g. collisions, groundings, fires), equipment failure (e.g. Pipelines, hoses, flanges), or improper

operating procedures during cargo transfer or fueling.

Measures to be taken

- Oil and chemical-handling facilities shall be located with consideration of natural drainage systems and environmentally-sensitive areas
- Hazardous materials storage and handling facilities shall be constructed away from active traffic
- DPT shall follow the spill prevention, control, and countermeasure plan consistent with the IMO Manual on Oil Pollution Section II-Contingency Planning.
- Implement waste management plan that identifies and characterizes every waste arising associated with proposed activities and which identifies the procedures for collection, handling and disposal of each waste arising.

3.6. Hazardous Waste Management

Hazardous waste means any waste which by reason of characteristics such as physical, chemical, biological, reactive, toxic, flammable or corrosive, causes danger to health or environment. It comprises the waste generated during the manufacturing processes of the commercial products such as industries involved in petroleum refining, production of pharmaceuticals, petroleum, paint, aluminum, electronic products, etc. Management of hazardous waste mainly includes two components viz. i) Collection, Waste handling and Segregation 7 ii)Treatment, Storage and Disposal.

Disposal of solid waste generated by ships calling at DPT has been outsourced and the collection & disposal are undertaken by the Licensed Agencies. The removal of hazardous and non-hazardous wastes such as garbage, food waste, plastic, metal, batteries, etc., are done in accordance with the provisions of the Hazardous Waste (Management & Handling

Rules) and in compliance of the guidelines of Pollution Control Boards, MARPOL 73/78 and other Statutory Authorities.

The Companies authorized by the Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB) have been awarded the work of collection, transportation and disposal of hazardous Wastes by the Deendayal Port Trust. The same is handed over to authorize parties for further Treatment & disposal.

3.6.1. Policy and Management

Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs) together form the regulatory and administrative core of the waste management sector in India. At the state level, the management of solid waste is the responsibility of Urban Local bodies. Industries generating hazardous wastes must seek permission from the respective SPCB. A key issue is that municipal authorities do not possess the budgets to adequately cover the costs associated with developing effective waste management systems. The lack of strategic plans, as well as systems for governance (particularly waste collection/segregation) and regulation are major barriers to achieving effective Solid Waste Management (SWM) in India.

3.6.2. Deendayal Port Trusts' Policy on Waste Management

Deendayal Port Trust should appoint recognized consultancy firm in the field of Environmental Planning & advisory services (NABET–accredited agency in sector Ports, harbours, jetties, terminals, break water and dredging), for–preparation of waste management plan of–entire DPT–area considering various rules/regulations in force with following objectives;

- Identification & categorization of various Wastes, into hazardous & non-hazardous Biodegradable wastes , Solid wastes including C & D Wastes, Biomedical Waste ,plastic waste, E- waste etc. with assessment of quantity & disposal.

- Separate identification of Ship waste into hazardous, non-hazardous & Biodegradable waste as per the MARPOL 73/78 (as amended) and other conventions of IMO as applicable for Port and Harbour.
- Preparation of Training Module for Port officers & Employees.
- The consultant shall have to coordinate with all concerned departments of DPT for collection of required details/information/data.
- The selected consultant shall have to provide comprehensive reception and safe disposal facilities plan with subsequent monitoring plan including provision for engagement external agencies/private operators.
- The selected consultant is required to list out requirement & procedure for obtaining necessary clearance/license from statutory authorities under respective category of waste management rules.
- Review Procedure with respect to Audits/Inspection reports of licensed contractors.
- Consultant shall have to assist DPT in implementation of waste management plan during the contract period.
- Considering above all, the consultant shall have to prepare & submit detailed waste management plan covering all wastes and also shall have to prepare & submit waste management plan of each waste, separately, as under:
  - ✓ Solid waste management plan including C & D wastes as per Municipal solid wastes (management & handling) rules, 2000 & C & D wastes management rules 2016 (GSR 317 E dated 29/3/2016).
  - ✓ Plastic waste Management Plan as per plastic waste management Rules 2016 (GSR 320 (E) dated 18/3/2016).
  - ✓ E wastes management plan as per e waste management rules 2016 (GSR 337 E dated 23/3/2016).
  - ✓ Biomedical waste management plan as per Bio medical wastes management rules 2016 & its subsequent amendment in 2019.
  - ✓ Hazardous & other wastes (Management & trans-boundary

movement) Rules, 2016 & subsequent amendment in 2019.

3.6.2.1. Measures taken by Deendayal Port Trust

- DPT obtained authorization from the GPCB vide Consent (Consolidated Consent & Authorization) Order no. AWH -72820 date of Issue: 31/08/2015, valid up to 21/7/2020.
- Deendayal Port Trust is maintaining the records for collection and disposal of Wastes generated from Port area etc.
- Deendayal Port Trust is regularly submitting the Hazardous Waste Statement in From – IV every financial year to the Gujarat Pollution Control Board, Gandhinagar.
- A report on collection and disposal of the wastes from ships is submitted by the licensees to Deendayal Port and GPCB.
- The DPT officials inspect each vessel calling at the Port with reference to the Garbage Record Book in accordance with the MARPOL 1973/78.

3.6.3. Bio-medical Waste Management

To protect the environment and human health from infectious bio-medical waste, Ministry of Environment, Forest and Climate Change, vide Notification G.S.R. 234(E) dated March 16, 2018 made amendments to Bio-Medical Waste Management Rules (1998), to improve compliance and strengthen the implementation of environmentally sound management of biomedical waste in India.

Salient features of Bio-Medical Waste Management (Amendment) Rules, 2018 are as follows:

1) Bio-medical waste generators including hospitals, nursing homes, clinics, dispensaries, veterinary institutions, animal houses, pathological laboratories, blood banks, health care facilities, and clinical establishments will have to phase out chlorinated plastic bags (excluding blood bags) and gloves by March 27, 2019.

2) All healthcare facilities shall make available the annual report on its website within a period of two years from the date of publication of the Bio-Medical Waste Management (Amendment) Rules, 2018.
3) Operators of common bio-medical waste treatment and disposal facilities shall establish bar coding and global positioning system for handling of bio-medical waste in accordance with guidelines issued by the Central Pollution Control Board by March 27, 2019.
4) The State Pollution Control Boards/ Pollution Control Committees have to compile, review and analyze the information received and send tis information to the Central Pollution Control Board in a new Form (Form IV A), which seeks detailed information regarding district-wise bio-medical waste generation, information on Health Care Facilities having captive treatment facilities, information on common bio-medical waste treatment and disposal facilities.
5) Every occupier, i.e. a person having administrative control over the institution and the premises generating biomedical waste shall pre-treat the laboratory waste, microbiological waste, blood samples, and blood bags through disinfection or sterilization on-site in the manner as prescribed by the World Health Organization (WHO) or guidelines on safe management of wastes from health care activities and WHO Blue Book 2014 and then sent to the Common bio-medical waste treatment facility for final disposal.

3.6.4. Plastic Waste Management

The Government has notified the Plastic Waste Management Rules, 2016, in suppression of the earlier Plastic Waste (Management and Handling) Rules, 2011.The draft rules, namely the Plastic Waste Management Rules, 2015 were published by the Government of India vide G.S.R. 423(E), dated the 25th May, 2015 in the Gazette of India, inviting public objections and suggestions. The Plastic Waste Management Rules, 2016 aim to:

- Increase minimum thickness of plastic carry bags from 40 to 50 microns and stipulate minimum thickness of 50 micron for plastic sheets also to facilitate collection and recycle of plastic waste,

- Expand the jurisdiction of applicability from the municipal area to rural areas, because plastic has reached rural areas also;
- To bring in the responsibilities of producers and generators, both in plastic waste management system and to introduce collect back system of plastic waste by the producers/brand owners, as per extended producers responsibility;
- To introduce collection of plastic waste management fee through pre-registration of the producers, importers of plastic carry bags/multilayered packaging and vendors selling the same for establishing the waste management system;
- To promote use of plastic waste for road construction as per Indian Road Congress guidelines or energy recovery, or waste to oil etc. for gainful utilization of waste and also address the waste disposal issue; to entrust more responsibility on waste generators, namely payment of user charge as prescribed by local authority, collection and handing over of waste by the institutional generator, event organizers.

3.6.5. E-Waste Management

Ministry for Environment, Forest and Climate Change, has amended the E-waste (Management) Rules vide notification G.S.R. 261(E), dated March 22, 2018 in supersession of the e-waste (Management & Handling) Rules, 2011. The amendment was done to facilitate and effectively implement the environmentally sound management of e-waste in India with the objective of channelizing the E-waste generated in the country towards authorized dismantlers and recyclers in order to formalize the e-waste recycling sector.

Some of the salient features of the E-waste (Management) Amendment Rules, 2018 are as follows:

1) The e-waste collection targets under Extended Producer Responsibility (EPR) have been revised and will be applicable from 1 October 2017. The phase-wise collection targets for e-waste in weight shall be 10% of the quantity of waste generation as indicated in the EPR Plan during 2017-18, with a 10% increase every year until 2023. After 2023 onwards,

the target has been made 70% of the quantity of waste generation as indicated in the EPR Plan.

2) Separate e-waste collection targets have been drafted for new producers, i.e. those producers whose number of years of sales operation is less than the average lives of their products. The average lives of the products will be as per the guidelines issued by CPCB from time to time.

3) Producer Responsibility Organizations (PROs) shall apply to the Central Pollution Control board (CPCB) for registration to undertake activities prescribed in the Rules.

4) Under the Reduction of Hazardous Substances (RoHS) provisions, cost for sampling and testing shall be borne by the government for conducting the RoHS test. If the product does not comply with RoHS provisions, then the cost of the test will be borne by the Producers.

3.6.6. E-waste Management at Deendayal Port Trust

"E-Waste (Management & Handling) Rules, 2011 were notified in 2011 and had come into force since 1st May, 2012. In order to ensure effective implementation of E-Waste Rules and to clearly delineated the role of producers in EPR, MoEF&CC, Government of India in supersession of E-Waste (Management and Handling) Rules, 2011 has notified the E-Waste (Management) Rules, 2016 vide G.S.R. 338(E) dated 23.03.2016 which will be effective from 01-10-2016.

Over a period of 20 years several IT items and consumables got accumulated and during *Swachh Bharat Abhiyan* conducted by the Port during 2017, the E-waste (viz. CPU, Monitor, Keyboards, Printers, Mouse, UPS, Stabilizer, etc.) were accumulated and were disposed off and stored at one location in the Port for E-waste disposal as per regulations.

3.7. Dredging Management

The present guidelines for dredging management has been suggested by the Ministry of Shipping in the report titled "Guidelines on undertaking dredging at major Ports" released in November, 2015.

When the major ports plan to take up a capital dredging project irrespective of the size of the project, the following actions have to be taken up by the ports simultaneously so that proposal can be taken to approval stage at the earliest possible time.

I. Engaging Marine survey, Geo technical/Geo physical survey agencies to carry out bathymetric surveys, geo technical investigations etc., if the same is not available with the port

II. Preparation of Detailed Project Report/Feasibility Report/other port specific investigation required if any by consultants or by Port themselves.

III. Engaging Agencies wherever required as per the provision, for preparation of Environment Impact Assessment

3.7.1. Deendayal Port Trusts' Policy on Dredging Management

The Ministry of Environment, Forest and Climate Change (MoEF & CC), had asked DPT to carry out the *"Study on Dredged Material for presence of contaminants"* as accorded by the MoEF & CC, GoI dated 19/12/2016.

Based on the above condition, DPT should assign the task of carrying out the study *"Studies on Dredged materials for the presence of contaminants and suggesting suitable disposal options"* to Gujarat Institute of Desert Ecology (GUIDE), Bhuj for the period of Nov 2018 to October 2021, with following objectives;

- To monitor the locations where dredged materials are dumped will be conducted.
- Dredged materials in the area will be analyzed for the presence of contaminants in two different locations.
- Detailed assessment of the dredged materials for physical, chemical and biological characteristics will be studied.
- Suggesting suitable disposal options for the dredged material will be made.

Further, the study will envisage the evaluation of physico-chemical constituents in the dredged materials in the dumped locations in the study area.

3.7.2. Managing Dredging Impacts

(As suggested by GUIDE vide their report on "*Studies on Dredged materials for the presence of contaminants and suggesting suitable disposal options*")

Some measures to be taken to prevent the reach of dredged materials reach to nearby sensitive environment are listed below:

- In order to ameliorate the likely impacts due to sediment load through changes in operational procedure such as appropriately timing the operation in tune with tides and tidal current direction) may be considered.

- Efforts may be attempted in disposing the trapped sediments only in pre-designated sites.

- Turbidity curtains, nowadays, are increasingly used during dredging operations as suggested by Researchers (Sawaragi, 1995; Elander and Hammar, 1998; Otoyo, 2003; Dreyer, 2006; Guo *et a!.,* 2009; Ishizaki and Rikitake, 2010; Ueno, 2010, Trang and Keat, 2010) which could also be attempted based on its operational convenience. Moreover various other factors such as current speed, water depth and wave heights to be considered as these also play role in the efficiency of Turbidity curtains. Turbidity curtains allow suspended sediments to settle out of the water column in the dredging spot thus minimizing sediment transport towards the shore. Constructed with thermoplastic material, they serve as a primary method to control turbidity in dredging sites. There are various types of curtains like floating, hanging, solid diversion baffles and permeable and impermeable screens. However, they have proved to be an effective method to contain sediment load in ecologically sensitive areas such as mangroves and corals during dredging operations.

- Many management measures such as enhancing the biodiversity of the intertidal/sub tidal areas by means of artificial reef structures and controlling water column turbidity by deploying mechanisms to trap silts arising out of dredging activity may be better options which can be implemented by the port authorities.

3.8. Other Important International Treaties and Indian acts supporting EMP

Shipping is an international activity and hence national specifications and regulations relating to loading and safety at sea are largely based on international agreements and conventions. International regulations relevant to port and harbors are given herein. India is a signatory to these International agreements/conventions.

3.8.1. Shipping

i. International Maritime Dangerous Goods Code (IMDG-code)

The IMDG code relates to methods of safe transport of dangerous cargoes and related activities. It sets out procedures for documentation, storage, segregation, packing, marking and labelling of dangerous goods (http://hazmat.dot.gov.imdg.html).

ii. International Convention for the Prevention of Pollution from ships (MARPOL)

The main objectives of this convention are to prevent the pollution of the marine environment by the operational discharges of oil and other harmful substances and the minimization of the accidental discharges of such substances. Further details are available at www.imo.org/imo/convent/pollute.html.

iii. United Nations Convention on the Law of the Sea (UNCLOS), 1982

The main objective is the obligation to prevent pollution damage by addressing particular sources of pollution, including those from land based activities, seabed activities, dumping, vessels and from or through the atmosphere. (www.tufts.edu/departments/fletcher/multi/texts/BH825.txt).

3.8.2. Other International Conventions

i. Ramsar Convention on Wetlands

The Convention on Wetlands, called the Ramsar Convention, is an inter-governmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources (http://www.ramsar.org).

ii. Convention in International Trade in Endangered Species (CITES)

CITES is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival (http://www.cites.org).

3.8.3. Indian Acts

- The Indian Ports Act, 1908 and amendments thereon
- The Wildlife (Protection) Act, 1972 and amendments thereon
- The Water (Prevention & Control of Pollution) Act, 1974 and amendments thereon
- The Water (Prevention & Control of Pollution) Cess Act, 1977 and amendments thereon
- The Forest (Conservation) Act, 1980 and amendments thereon
- The Air (Prevention & Control of Pollution) Act, 1981 and amendments thereon
- The Environmental (Protection) Act, 1986 and amendments thereon
- The Public Liability Insurance Act, 1991 and amendments thereon
- The Biological Diversity Act, 2002 and amendments thereon (http://envfor.nic.in)
- The Indian Explosives Act, 1884 and amendments thereon (http://explosives.nic.in)

3.9. General Considerations for Environment Management of Deendayal Port

During the developments of key projects for Kandla Port, as the guidelines of the Ministry of Environment, Forests & Climate Change (MoEFCC), (Govt. of India), Central Pollution Control Board and Gujarat Pollution Control Board, DPT with reputed EIA consultants carried out comprehensive EIA and reports were submitted to respective departments. Based on these EIA studies, several key considerations for the management of Environment were suggested which are listed as below as per the category.

3.9.1. Construction and Operation Phase

- Heavy vehicles shall be covered with tarpaulin sheets to minimize fugitive dust from moorum during transportation
- There shall be regular emission checks on vehicles
- Wherever required, culverts, road crossings may be provided for uninterrupted flow of creek waters
- Storage areas shall be lined to prevent any leaching. The yards shall be covered to prevent any dust emission from the stored cargo
- Solid wastes generated shall be collected and disposed appropriately
- Movement of construction barges, ships, machinery etc should be restricted to the pre-decided operational area, to avoid disturbance to larger marine area
- There shall be bunding around the proposed construction site to prevent leaching of material from the site into the coastal waters
- It shall be ensured that construction debris is cleared by the contractor after completion of work

3.9.2. Control of Discharge

- All liquids containing oil shall pass into the sea only via oil separation systems (MARPOL Regulation 9 & 12).

- Sludge shall not be discharged. The sludge and the separated oil residues are either to be incinerated on board in special furnaces or discharged in port to the oil collection facilities.
- Adequate facilities for discharging oily residues shall be provided and effective supervision and monitoring of adherence to the regulations shall be done.
- The servicing yards shall be provided with appropriate facilities for receiving oily residues and other solid wastes such as batteries etc.
- Channels of minimum 1m widths and frequent intervals shall be provided around the plots to provide drainage in the event of tidal ingress in the creek.
- Proper drainage shall be designed and provided for flushing out tidal inflows

3.9.3. Control of Exhaust Emissions from Vessels

- Exhausts shall be frequently cleaned
- Correct adjustment and maintenance of engines and boilers shall be ensured.
- Mechanical precautions (like safety valves) shall be included to ensure the containment of the gases which escape during loading and discharge operations
- There shall be a reporting structure and responsibility for handling spills; Emergency numbers for contact during emergencies shall be readily available at the harbour.
- Fuel storage tanks shall be frequently monitored for leakages
- Fuel lines shall be adequately protected from being tampered

3.9.4. Compensatory Afforestation

- DPT shall be responsible for compensatory afforestation for mangroves lost due to proposed developmental activities. This shall be carried out in consultation with organizations like Gujarat

Department of Forest Department / various agencies and with mangrove experts.

4. Environment Management Policy of Deendayal Port Trust

In 2013, the DPT achieved certification of its Environmental Management System to ISO 14001. In 2019, DPT obtained ISO 14001:2015 certifications. One of the key requirements of the ISO 14001 series is that the systems, plans and controls are under the operational control of the entity committed to managing the activity. The DPT also manages environmental risk to land and marine areas under its control arising from third party industrial activities. While these parties and the associated risks are covered in the risk register, the controls are managed by standalone EMP's of the third party in accordance with the DPT development Approval Process and /or through direct state or central Government requirements as part of an:

- Environmental Clearance, CRZ Clearance, in the case of a new project; and
- Consent to Establish /NOC for an establishment, and Consent to Operate/NOC for operation of the projects.

4.1. The Key Objectives of Deendayal Port Trust

- To provide our Clientele, efficient and economical Port services. To render value for money and value added services to our Customers to their utmost satisfaction.
- To create facilities of international standards, and facilitate quicker turnaround of vessels. To maintain peaceful industrial relations by recognizing our work force as an asset and develop them to adopt to the changing Port scenario.
- To participate in social development by contributing our mite to the society at large.
- To be Environment friendly.

4.2. QHSE Policy of Deendayal Port

Quality, Occupational health, Safety and Environmental Policy (QHSE) of Deendayal Port Trust is the statement of its intentions, principles & commitment in relation to its overall QHSE performance, which provides a frame work for the action and for the setting of QHSE objectives & targets. QHSE policy has been developed through initial status review of quality, Occupational health, Safety and Environment Management comprising of following key areas namely;

- Legislative, regulatory and other requirements
- Identification of equipment and services supporting quality of final services.
- Identification of significant OH&S risks and Environmental aspects.
- Examination of all existing environmental & Occupational health and safety management practices and procedures.
- Evaluation and feedback from the investigation of previous incidents and accidents.

The QHSE policy of Deendayal Port Trust has been communicated at all levels through display in all the relevant places. The policy has also been communicated to external parties by way of displaying it at the main gate of Deendayal Port Trust in Hindi/ English / local (vernacular) language.

Management representative of Deendayal Port Trust has established, implemented and maintaining the QHSE management system and continually improves its effectiveness by regular monitoring in accordance with the requirements of this international standard. MR has identified the various processes needed for the QHSE management system and their application throughout the organization.

The sequence and interrelation of these processes are determined to control the effectiveness of these processes & operations. The criteria &

methods are determined necessary resources & information/details are made available at the point of use so that operations & processes can be monitored. (Ref: Department Operational Manual and their Process Flow Chart).

Measurement of these processes are timely analyzed and the relevant actions are implemented to achieve planned results & for continual improvement.

QHSE Policy

Kandla Port Trust

QHSE Policy

We At Kandla Port Trust are commited to providing maritime service timely, of best quality with cost effectiveness & matching the expectation of customers with professionalism with commitment to managing environmental matters as an integral part of our business. In particular, it is our policy to assure the environmental integrity of our processes and facilities at all times and at all places. We will do so by adhering to the following principles :

Compliance

Comply with applicable laws and regulations and will implement programs and procedures to assure compliance. Compliance with environmental standards will be a key ingredient in the training, Performance reviews and motivations of all employees.

Risk Reduction, Prevention and Resource Management

Seek opportunities, beyond compliance requirement, for reducing risk to the environment, establish and meet our own quality standards where appropriate, employ management systems and procedures specifically designed to prevent activities and/or conditions that pose a threat to the environment. Look for ways to minimize risk and protect our employees and the communities in which we operate by employing clean technology, including safe technologies and operating Procedures, as well as being prepared for emergencies.

Strive to minimize release to the air, land or water through use of cleaner technologies and the safer Handling, Minimize the amount and toxicity of waste scarce resource such as water, energy, land and forests in an environmentally sensitive manner.

Communications

Communicate our commitment to our employees, vendors and customers. Solicit their input in meeting our EMS goals.

Continuously Improvement

Continuously measure our progress. We will review our progress at least on an annual basis. Continuously seek opportunities to improve our adherence to these principles and will periodically report progress to our stakeholders. Comply the requirement of International Standard for continual improvement.

5. Environment Monitoring Plan

Environment Monitoring Plan is very important for monitoring the environmental status of the port for sustainable development. The EMP mainly consists of monitoring of the Air quality, Marine water quality, Ecological and Biological quality and Noise quality of the Deendayal Port area. The monitoring programme is also required to suggest suitable mitigation measures for the deviation found in the results of the monitoring, so as to keep the pollution level within control.

The list of main elements for which Environmental monitoring is carried out is mentioned below.

- Air Quality Monitoring
- Drinking Water Monitoring
- Noise Monitoring
- Marine Water Monitoring
- Soil Monitoring
- Sewage Treatment Plant Monitoring
- Meteorological Monitoring

M/s Detox Corporation Pvt. Ltd. appointed by Deendayal Port Trust will carry out monitoring of the various environmental aspects of the port with following objectives;

- To review the locations of ambient air and marine water quality monitoring stations within the impacted region in and around DPT establishment, in view of the developmental projects.
- To assess the ambient air quality and marine water quality at selected stations in terms of gases and particulate matter, physical, chemical and biological parameters for the assignment period.
- To assess the marine water quality in terms of aquatic flora and fauna and sediment quality in terms of benthic flora and fauna.
- To assess the trends of air and water quality by comparing the data

collected over a specified time period.

- To assess the trends of water quality in terms of marine ecology by comparing the data collected over a specified time period.
- To review the results and to check compliance with environmental quality standards.
- To suggest mitigation measures, if necessary, based on the findings of this study.
- To recommend future action plans on air and marine water quality monitoring programme based on the findings of this study.
- Drinking Water samples at twenty stations will also be monitored for various physical, chemical and biological parameters viz., color, odor, turbidity, conductivity, pH, total dissolved solids, chlorides, hardness, total iron, sulfate, NH4, +-N, PO4, and bacterial count on a monthly basis.
- Every week a sample (inlet and outlet) of the Sewage Treatment Plant (STP) shall be analyzed to see the water quality being discharged by DPT. However, the results will be submitted every month. If in a particular month any deviation is observed, the same shall be submitted immediately to the Employer.
- Noise monitoring will be carried out twice a day at the representative stations for a period of 24 hours. A report of the same will be submitted to DPT.
- Meteorological parameters are very important from air pollution point of view and precise and continuous data collection is of utmost importance. The data collected is analyzed as per the standards. Meteorological data on wind speed, wind direction, temperature, relative humidity, solar radiation and rainfall will be collected from one permanent station at DPT and one permanent station at Vadinar.
- All Locations & Monitoring parameters are tentative and subject to change as per GPCB/CPCB/MoEF&CC Guideline.

5.1. Selection of Sampling Locations

Sampling locations have been selected by Deendayal Port Trust considering various activities of Deendayal Port Trust and its environs and various Environment Impact Assessment Studies carried out in Deendayal Port. The sampling locations of various air, water and marine water surveys will be reviewed periodically and may be altered if required as per the suggestions/discussions with the Deendayal Port Authority and Environmental consultants engaged by the Deendayal Port Trust.

The major components of the monitoring are:

5.1.1. Air Quality Monitoring

Air Monitoring is done at eight fixed locations in port area. The description of stations is depicted in Table 1. The monitoring cycle at all eight monitoring stations is twice in a week.

Method of Monitoring

Sampling and analysis will be carried out as per CPCB guidelines for Ambient Air Quality monitoring. The monitoring is carried-out for air quality parameters mentioned in the National Ambient Air Quality Standards (NAAQS), CPCB Notification published in 2009. Sampling for Particulate Matter (PM_{10}) and Total Suspended Particulate Matter (TSPM) is done for a twenty four hour period.

Frequency of AAQ Monitoring

The monitoring cycle at all eight monitoring Stations is twice in a week. Sampling for Particulate matter (PM_{10}, $PM_{2.5}$) and total suspended particulate matter is done for a twenty four hour period. Sampling for gaseous samples like SO_x, NOx will be done for a twenty four hour period with sample collection at every eight hour. Table 1 gives description of Ambient Air Monitoring Stations.

Table 1: Ambient Air Monitoring Stations

Sr. No.	Location	Station Description	Location Codes
1	6 Stations at Kandla	Marine Bhavan	AL- 1
2		Oil Jetty	AL -2
3		Kandla Port Colony	AL-3
4		Gopalpuri Hospital	AL -4
5		Coal Storage Area	AL- 5
6		Tuna Port	AL-6
7	2 Stations at Vadinar	Signal Building	AL-7
8		Vadinar Colony	AL- 8

Map 2: Ambient Air Monitoring stations at Deendayal Port

5.1.2. Monitoring of Drinking Water Quality

Method of Monitoring

The sampling and analysis will be done as per standard methods and CPCB/GPCB Guidelines. The water samples will be analysed for various parameters viz; Color, Odor, Turbidity, Conductivity, pH, Chlorides, TDS, Total hardness, Iron, Sulphate, Salinity, Biological Oxygen Demand (BOD), Chlorides, Sodium(Na), Potassium(as K+), Calcium (as Ca), Magnesium (Mg), Fluorides (F), Nitrate (NO_3), Nitrite (NO_2), Manganese (Mn), Iron (Fe), Chromium (Cr_6+), Copper(as Cu), Cadmium (Cd) , Arsenic (As),Mercury (Hg), Lead (Pb), Zinc (Zn), CFU, & bacterial count. The method will be manual at all monitoring stations.

Frequency of Drinking Water Monitoring:

The monitoring at all twenty drinking water stations will be done once a month.

Drinking Water Monitoring Stations

A list of locations for collecting the drinking water samples is depicted in Table 2.

Table 2: Monitoring locations for Drinking Water

Sr. No	Monitoring Locations	Location Code
Location at Kandla		
1	Nirman Building 1	DW -1
2	P & C Building	DW -2
3	Main Gate (North)	DW -3
4	Canteen	DW -4
5	West gate I	DW -5
6	Wharf area	DW -6
7	Sewasadan-3	DW -7
8	Workshop	DW -8
9	Custom building	DW -9
10	Port Colony Kandla	DW -10
11	Hospital Kandla	DW -11
12	A.O. Building	DW -12
13	School Gopalpuri	DW -13
14	Guest House	DW -14
15	E- Type quarter	DW -15
16	F-type quarter	DW -16
17	Hospital Gopalpuri	DW -17
18	Tuna Port	DW -18
Locations at Vadinar		
19	Nr. Vadinar Jetty	DW -19
20	Port colony	DW -20

5.1.3. Monitoring of Marine Water Quality and Biological Parameters

Methodology for Physico-chemical Monitoring

Water samples will be collected for analyzing physico-chemical and biochemical parameters viz. pH, Temperature, Colour, Odour, Salinity, Turbidity, SS, TDS, TS, DO, COD, BOD, Silicate, PO_4, SO_4, NO_3, NO_2, Ca, Mg, Na, K, Iron (as Fe), Chromium (as Cr), Copper (As Cu), Arsenic (as As), Cadmium (as Cd), Mercury (Hg), Lead (as Pb), Zinc (as Zn), petroleum hydrocarbons, trace metals total coliform & fecal coliform.

Methodology for Biological Monitoring

Sampling will be conducted from sub surface layer in high tide period and low tide period of the tide from all sampling stations during consecutive spring tide and neap tide.

Net sampling for qualitative evaluation of mixed plankton will be conducted only once during between maximum high water and slack water and maximum low water and Slack water.

Sediment sampling for qualitative and quantitative evaluation of benthic organisms will be conducted only once during one tidal cycle during maximum low water and slack water.

The collected samples will be first collected in a clean bucket to reduce the heterogeneity. From the collected water sample 1 liter of water sample will be taken in an opaque plastic bottle for chlorophyll estimation. Quantitative plankton samples will be collected by filtering rest of the water sample using plankton net of 20μm mesh size.

Methodology adopted for Plankton sampling

Mixed plankton sample for qualitative evaluation will be obtained from the sub surface layer, at each sampling locations by towing the net horizontally with the weight during highest high tide and slack period and lowest low

tide and slack period .After the tow of about 15-20 minutes at speed of 1-1.5 m/s. For quantitative evaluation 50 L sample will be collected from the sub surface during high tide and low tide period will be filtered through 20μm mesh size net assembly.

Methodology adopted for benthic fauna sampling

Van veen sampler (0.1 m^2) will be used for sampling bottom sediments during lowest low tide. The fixation of benthic fauna will be normally done by bulk fixation of the sediment sample. The bulk fixation will be done by using 10% formalin (buffered with borate) with Rose Bengal as stain. The organisms will be preserved with seawater as diluting agent.

Frequency

Phytoplankton (Qualitative & Quantitative) Zooplankton (Qualitative & Quantitative) & Benthos (Qualitative & Quantitative) samples will be collected during high tide and low tide during each spring and neap tides of the month.

Sampling Stations

The monitoring of marine environment for the study of biological and ecological parameters will be carried out in harbour regions of DPT (Table 3) during Spring tide period of full moon phase of Lunar Cycle.

Table 3: Sampling Locations for Marine Monitoring

Sr. No	Monitoring locations	Location Code
Locations at Kandla		
1	Near passenger Jetty One	ML -1
2	Near Berth No. 8 & 9	ML -2
3	Kandla Creek Near KPT colony	ML -3
4	Near 13th & 14th Berth	ML -4
5	Nakti Creek Near Tuna Port	ML -5
6	Nakti Creek Near NH-8A Bridge	ML -6
Locations at Vadinar		
7	Nr. SBM 2	ML -7
8	Nr. Vadinar Jetty	ML -8

Map 1.3 Marine Sampling Locations at Deendayal Port

Map 1.4 Marine Sampling Locations at Vadinar Port

5.1.4. Noise Monitoring

Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading of cargo to/from ships. Noise Monitoring will be done at 13-stations at Kandla, and three locations in Vadinar.

Method and Frequency of monitoring

Sampling will be done at all stations for 24 hour period once in month. Data will be recorded using automated sound level meter. The intensity of sound will be measured in sound pressure level (SPL) and common unit of measurement is decibel (Db).

Sampling Stations

The sampling locations for noise monitoring as listed in table 4.

Table 4: Locations for Noise Monitoring

Sr. No	Name of locations	Location Code	Sr. No	Name of locations	Location Code
Locations at Kandla			8	Nirman Building 1	NL - 8
1	West Gate no 1	NL -1	NL -	Tuna Port	NL - 9
2	Main gate (North)	NL -2	NL -	Port & customs office	NL - 10
3	Wharf area/Jetty Area	NL -3	**Location at Vadinar**		
4	Main road/ Central Road	NL -4	11	Nr. Port Gate - Vadinar	NL - 11
5	Canteen Area	NL -5	12	Nr. Vadinar Jetty	NL - 12
6	ATM building	NL -6	13	Port colony Vadinar	NL - 13
7	Marine Bhavan	NL -7			

5.1.5. Soil Quality Monitoring

Soil quality monitoring is important for evaluating the effects of environment management practices of a region/area.

Method of Monitoring

The soil samples will be collected from four locations in Kandla and two locations in Vadinar Port. The soil samples will be filled in polythene bags,

labeled in the field with number and site name and taken to the laboratory for analysis (as per IS 2720). Physical and chemical properties of soil at selected locations will be studied.

Frequency of monitoring

Sampling will be done at all stations in Kandla and Vadinar once in a month.

Soil quality Monitoring Stations

List of the locations for collecting the soil samples are as per Table 5:

Table 5: List of sampling locations for Soil Quality Monitoring

Sr. No	Name of locations	Location Code
Locations at Kandla		
1	Tuna Port	SL -1
2	IFFCO Plant	SL -2
3	Khori Creek	SL -3
4	Nakti creek bridge at NH-8A	SL -4
Location at Vadinar		
5	Nr. Vadinar Port Office	SL -5
6	Nr. Vadinar Colony	SL -6

Map 1.5A Soil Sampling Locations in Deendayal Port

Map 1.5B Soil Sampling Locations in Vadinar Port

5.1.6. Monitoring of performance of the Sewage Treatment Plant (STP) at Gopalpuri Township, Deendayal Port & Vadinar

The principal objective of wastewater treatment is generally to allow human and industrial effluents to be disposed off without danger to human health or unacceptable damage to the natural environment.

Method of Monitoring

The parameters monitored will be pH, BOD, COD, residual chlorine, MLSS, MLVSS and TSS. The data collected will be analyzed as per the standards. The performance of the Sewage Treatment plant will be studied by collecting samples of the influent, aeration tank and effluent tank.

Frequency of monitoring

Sampling will be done at all stations from inlet, aeration tank and outlet of an STP once in week.

Monitoring Stations:

Lists of the location for collecting the STP samples are as per table 6.

Table 6: List of sampling locations for STP

Sr. No	Sampling location
1	STP at Kandla
2	STP at Gopalpuri
3	STP At Vadinar

6. Monitoring Results

Based on the EMMP submitted, M/s Detox Corporation Pvt. Ltd. carried out monitoring of the following environmental aspects of the port for the period of March 2020 to February 2021. However, due to nationwide lockdown imposed by Government of India from 23rd March to 14th April and subsequent lockdown imposed by state government *(Circular No. 13/NCV/102020/SFS-1/G)* till 17th May 2020, the sample collection was not possible.

1 Ambient Air

The monitoring was carried out twice a week. The results obtained from the sampling and analysis is submitted to Deendayal Port authority on monthly basis. The monthly averaged and annual results for the ambient air monitoring are given in the sections followed.

I. Total Suspended Particulate Matter (TSPM)

The frequency of sampling was twice a week for every sampling station.

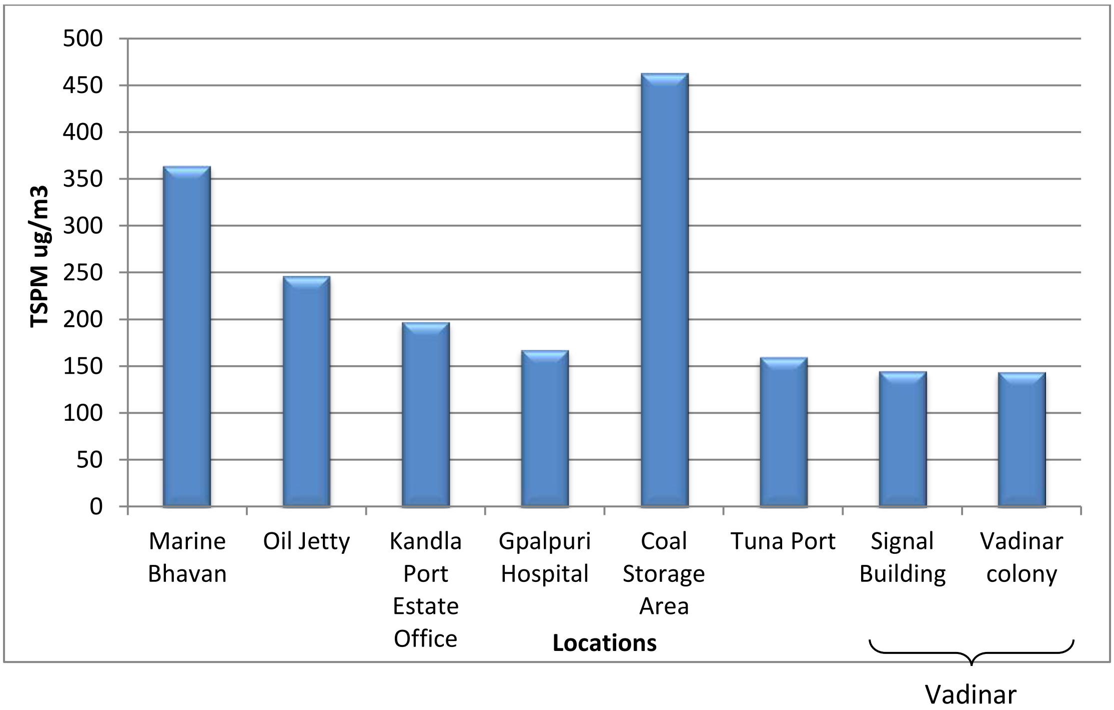
Table 6.1 TSPM (in µg/m^3) values at monitoring locations in Kandla and Vadinar Port

Months	Marine Bhavan	Oil Jetty	Kandla Estate Office	Gopalpuri Hospital	Coal Storage Area	Tuna Port	Signal Building	Vadinar colony
Mar-20	325.9	171.1	155.9	151.4	347.4	173.4	129.1	132.9
Apr-20	**COVID-19 Lockdown**							
May-20	**COVID-19 Lockdown**							
Jun-20	207.2	180	164	153	319	169	148	157
Jul-20	233	197	188	164	276	171	152	147
Aug-20	349	260	162	133	506	93	133	152
Sep-20	405	257	130	155	459	204	151.4	145
Oct-20	313	204	152	122	436	70	124.6	122.9
Nov-20	364	287	245	182	505	167	151	149.9
Dec-20	635	323	321	208	621	179.4	156.6	174
Jan-21	387	261	165	165	438	236	157	154
Feb-21	422	329	296	247	723	140	148	163
Annual Mean	**364.1**	**246.9**	**197.9**	**168.1**	**463.0**	**160.3**	**145.1**	**154.5**

The mean TSPM values were highest at Coal Storage location and Marine Bhavan, followed by Oil Jetty. TSPM values were least at both the locations of Vadinar Port. The major cause of TSPM values at Coal Storage and Marine Bhavan is large amount of coal is handled at Berth No. 6, 7, 8 and use of grabs for unloading of coal directly in the truck cause coal to spread in air as well as coal dust to fall on ground. This settled coal dust again mixes with the air during trucks movement through it.

Also, the coal laden trucks are not always covered with tarpaulin sheets and these results in spillage of coal from trucks/dumpers during its transit from vessel to yard or storage site.

Fig 6.1 Observed values (annual mean) of TSPM at all eight monitoring stations



Interpretation of Results

- Maximum TSPM of 723.0 µg/m^3 was recorded in the month of February' 21 at Coal storage site and the minimum value was recorded in the month of October '20 at Tuna Port 70.1 µg/m^3.

- At Vadinar, maximum TSPM of 157 µg/m^3 was recorded in the month of January at Vadinar signal building site and the minimum value was recorded in the month of October'20 at Vadinar Port colony (122 µg/m^3).

II. Particulate Matter (PM_{10})

PM_{10} is particulate matters which are 10 micrometers or less in diameter. The frequency of sampling was twice a week for every sampling station.

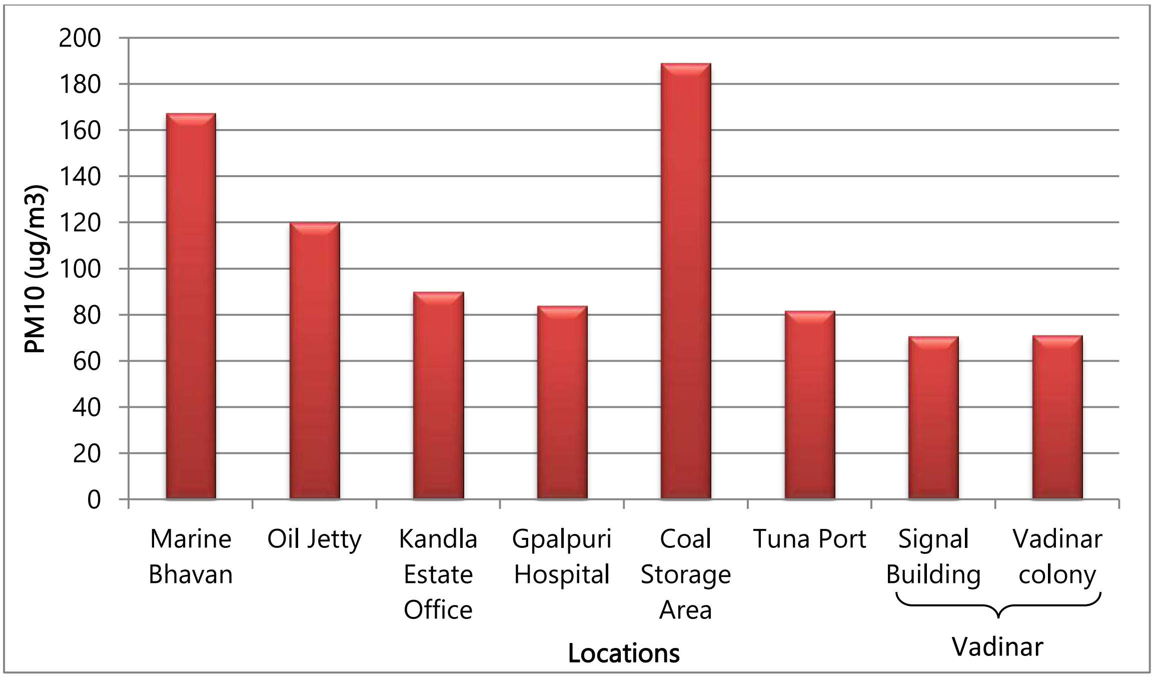
Table 6.2 PM_{10} (in µg/m^3) values at monitoring locations in Kandla and Vadinar Port

Months	Marine Bhavan	Oil Jetty	Kandla Estate Office	Gopalpuri Hospital	Coal Storage Area	Tuna Port	Signal Building	Vadinar colony
Mar-20	175.9	116.3	87	74.9	162.6	88	74.4	54.6
Apr-20	**COVID-19 Lockdown**							
May-20								
Jun-20	81.9	81.6	79.8	87	108.8	72	59.8	52.9
Jul-20	89.1	85.6	81.6	81.6	110.6	73	77.6	72.6
Aug-20	191.7	99.7	86.6	93	184.6	54	75	72.6
Sep-20	254	154	79	91	266	86	82.5	81
Oct-20	96.4	91.1	73	63.6	112.4	49	63.5	67.8
Nov-20	103	87.8	81.3	78.4	242.3	97.4	56.5	67.3
Dec-20	297	167	144	104	233	92.4	51.5	79
Jan-21	232	153	91	91	261	134	85	83
Feb-21	153	166	96	73	208	71	81	79
Annual Mean	**167.4**	**120.2**	**89.9**	**83.8**	**188.9**	**81.7**	**70.7**	**71.0**

The mean PM_{10} Values were highest at Coal Storage location and Marine Bhavan, followed by Oil Jetty. PM_{10} values were least at both the locations of Vadinar Port. Higher PM_{10} values at Coal Storage and Marine Bhavan is a result of large amount of coal handling and its inappropriate transportation methods.

Coal laden trucks are seldom covered with tarpaulin sheets and these results in spillage of coal from trucks/dumpers resulting into higher PM_{10} values.

Fig 6.2 Observed values (annual mean) of PM_{10} at all eight monitoring stations



Interpretation of Results

- Maximum value of PM_{10} of 297 µg/m^3 was recorded in the month of December'20 at Coal storage site and the minimum value was recorded in the month of October at Tuna Port 49.0 µg/m^3.

- In Vadinar, maximum value of PM_{10} of 85 µg/m3 was recorded in the month of March at Port admin building site and the minimum value was recorded in the month of December at Vadinar Port signal building (51.5 µg/m^3).

III. Particulate Matter ($PM_{2.5}$)

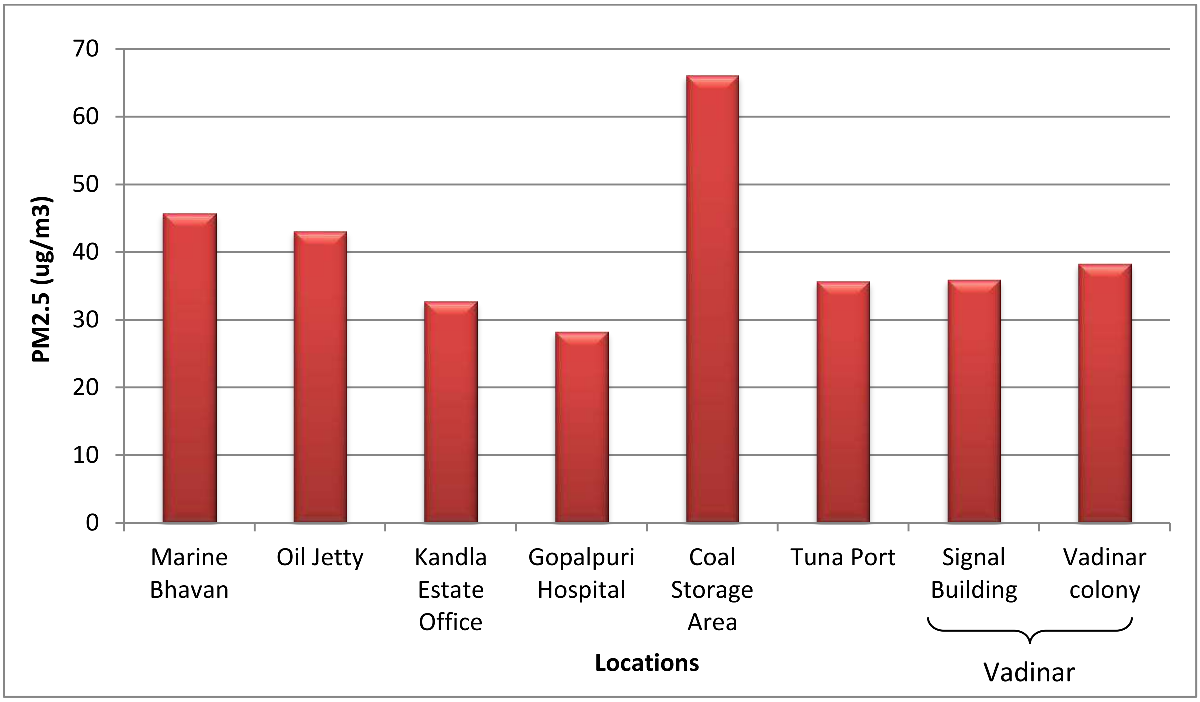
$PM_{2.5}$ particles are air pollutants with a diameter of 2.5 micrometers or less, small enough to invade even the smallest airways. $PM_{2.5}$ was also monitored twice a week for every sampling station.

Table 6.3 $PM_{2.5}$ (in µg/m^3) values at monitoring locations in Kandla and Vadinar Port

Months	Marine Bhavan	Oil Jetty	Kandla Estate Office	Gopalpuri Hospital	Coal Storage Area	Tuna Port	Signal Building	Vadinar colony
Mar-20	32.9	46.6	45.1	38.3	75.1	37.5	32.4	30.8
Apr-20	**COVID-19 Lockdown**							
May-20								
Jun-20	32.8	22	25	23	62.5	22	38.8	38.3
Jul-20	27	28.6	36.3	25	42	26	40	41
Aug-20	25	27	19	19	68.4	22	32	41
Sep-20	55	49	37	47	53	46	37.3	39
Oct-20	39	21	28	14	63.1	17	35.6	36.3
Nov-20	57.3	43.9	31.4	27	90.5	49.6	28.6	32.3
Dec-20	55	71	24	23	67	52.6	30.6	41
Jan-21	51	49	41	41	55	50	44	42
Feb-21	82	73	40	25	84	34	40	41
Annual Mean	**45.7**	**43.1**	**32.7**	**28.2**	**66.1**	**35.7**	**35.9**	**38.3**

Average $PM_{2.5}$ values were highest at Coal Storage location (mean = 66.1 µg/m^3) followed by Marine Bhavan (mean = 45.7 µg/m^3) and Oil Jetty (mean = 43.1 µg/m^3). $PM_{2.5}$ values At Vadinar Port the $PM_{2.5}$ values were significantly lower.

Fig 6.3 Observed values (annual mean) of $PM_{2.5}$ at all eight monitoring stations



Interpretation of Results

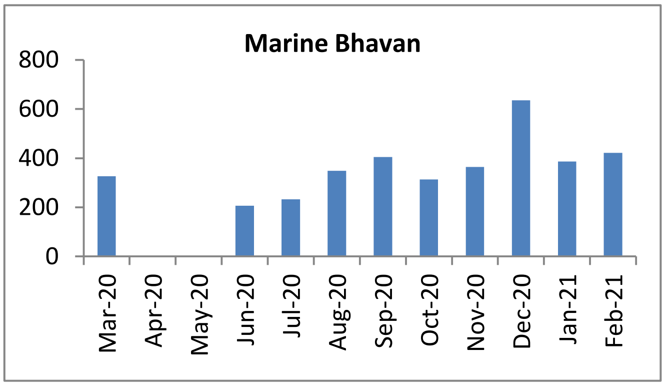
- Maximum value of $PM_{2.5}$ (90.5 µg/m^3) was recorded in the month of November at Coal storage site and the minimum value was recorded in the month of August at Gopalpuri Hospital (14.0 µg/m^3).

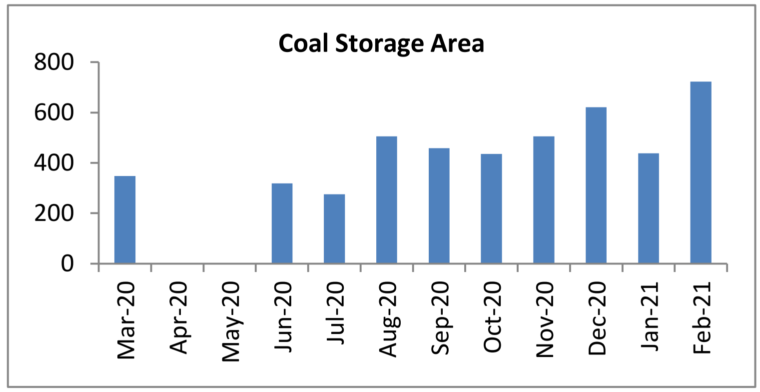
- Annual mean values of $PM_{2.5}$ was highest at Coal Storage Area (66.1 µg/m^3).

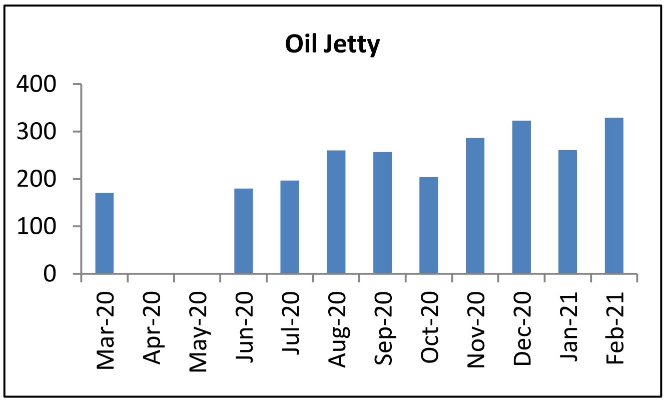
- In Vadinar, maximum value of $PM_{2.5}$ of 44.0 µg/m^3 was recorded in the month of January' 21 at Signal building site and the minimum value was recorded in the month of November at Vadinar Port colony (28.6 µg/m^3).

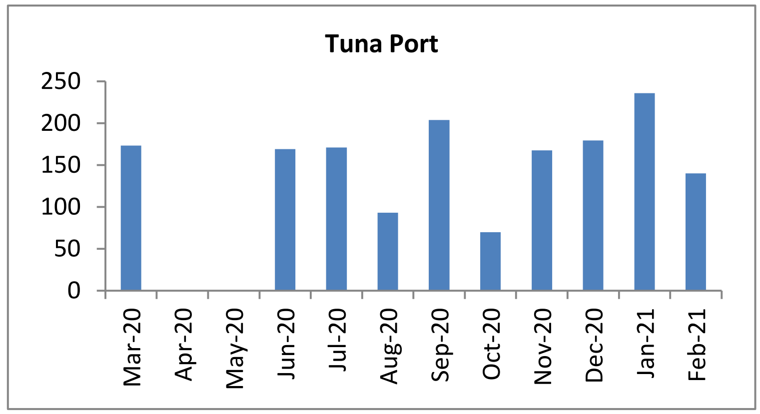
Location wise graphs depicting trends in TSPM, PM_{10} and $PM_{2.5}$ in all locations of Kandla and Vadinar Port are depicted in Fig 5.1 to 5.6.

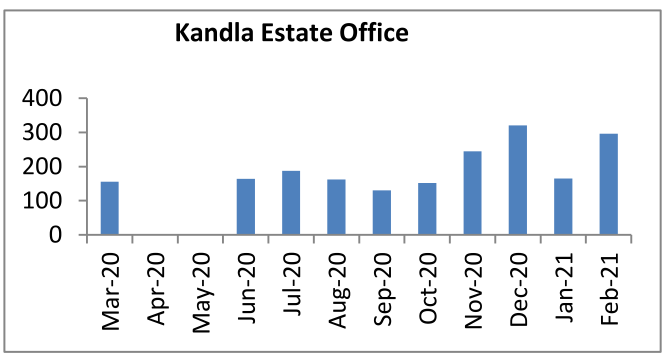
Trend in TSPM values of various AAQ Monitoring Locations

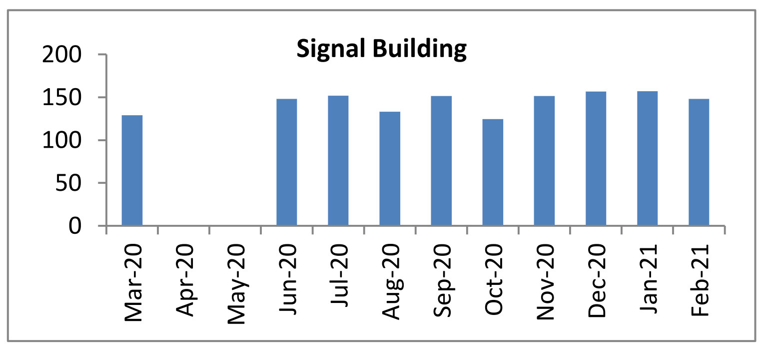


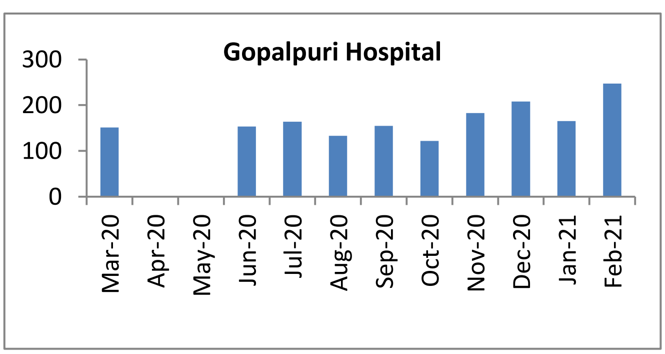


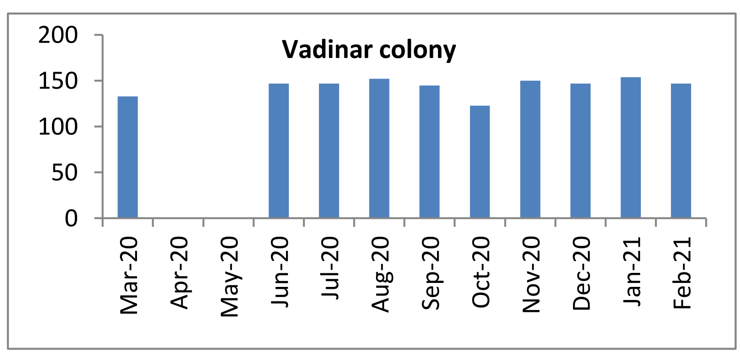




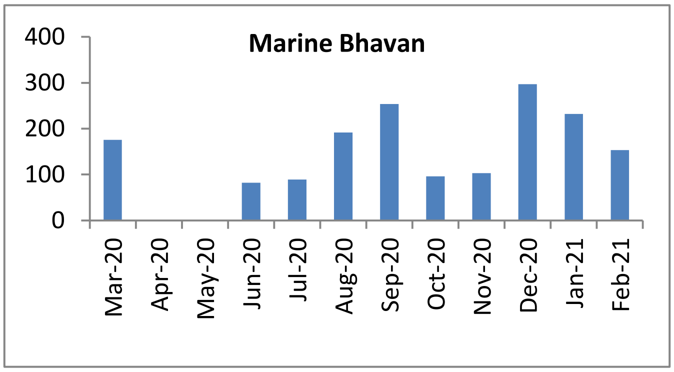


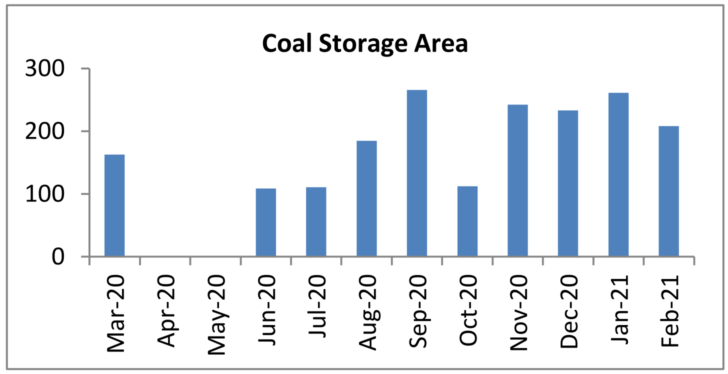


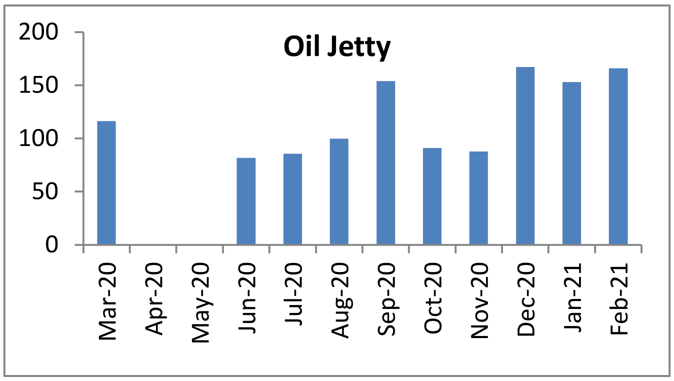


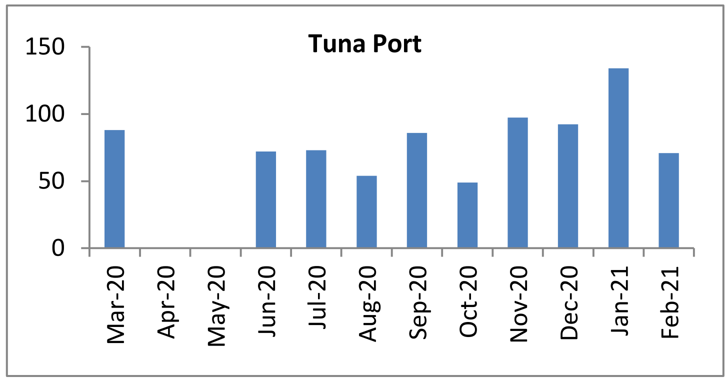


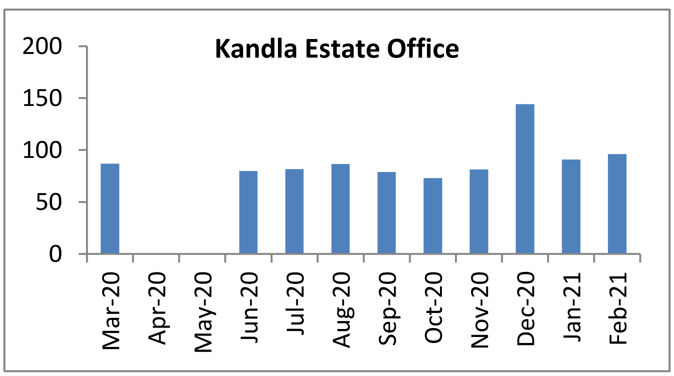
Trend in PM_{10} values of various AAQ Monitoring Locations

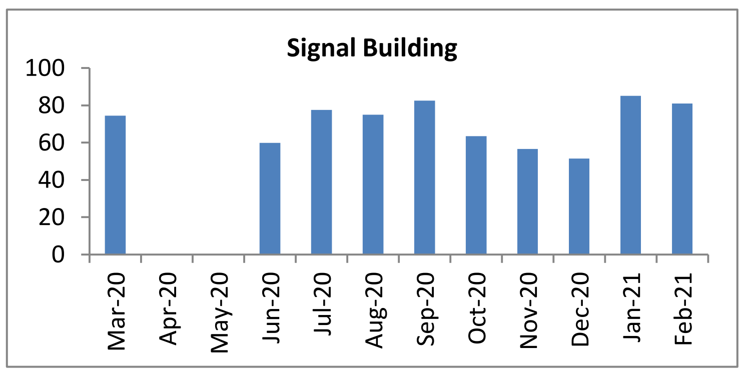


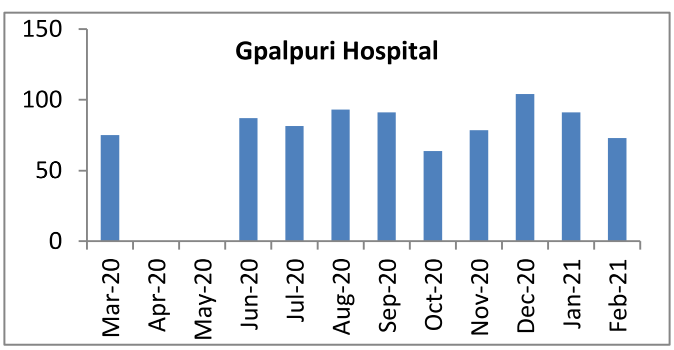


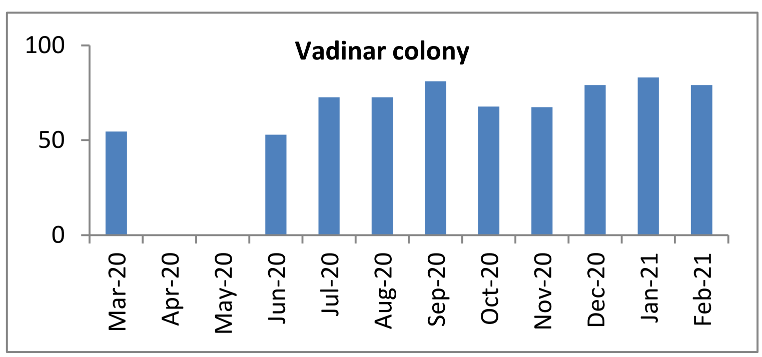




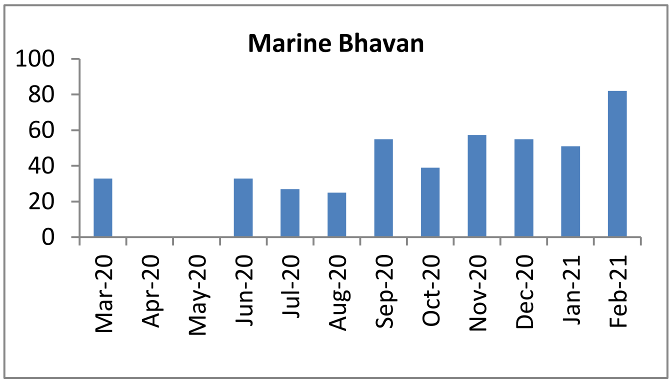


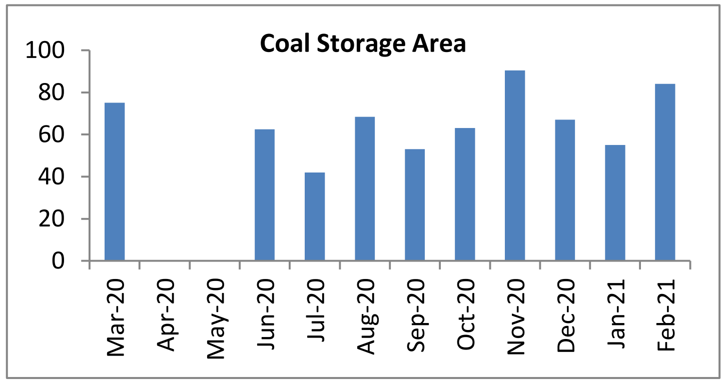


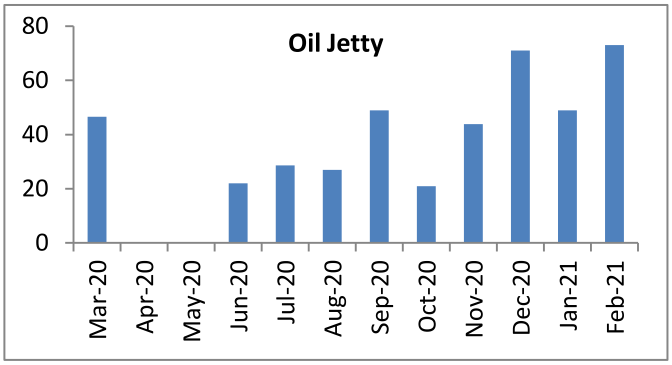


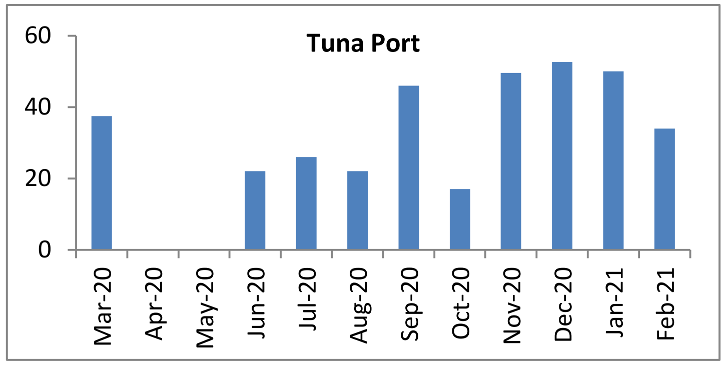


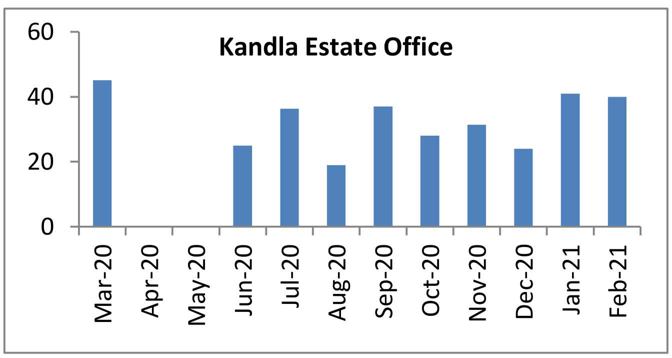
Trend in $PM_{2.5}$ values of various AAQ Monitoring Locations

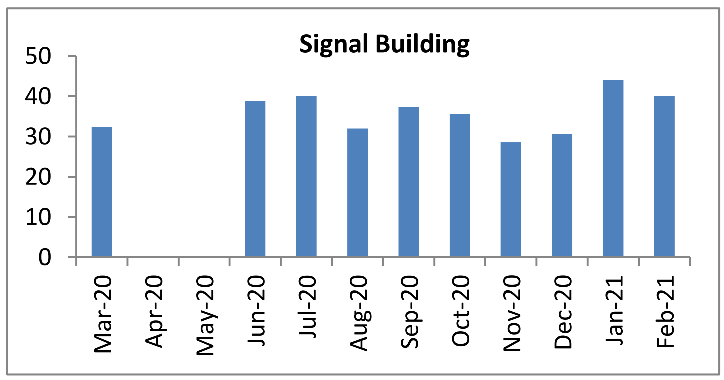


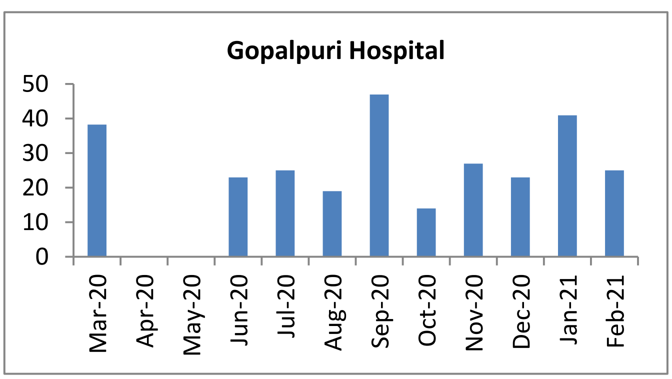


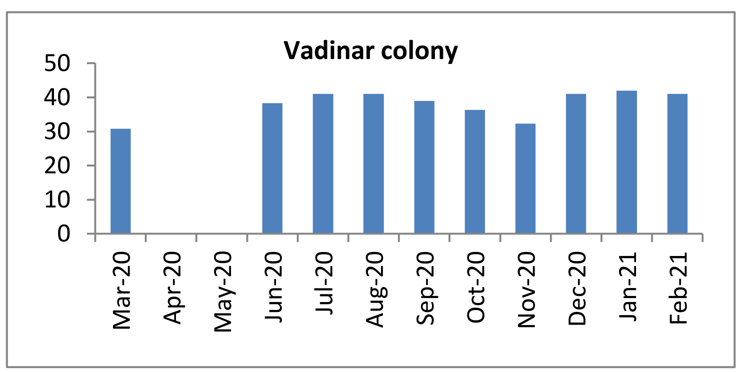












2. Drinking Water Quality Monitoring

Drinking Water Quality Monitoring was carried out at twenty stations at Kandla, Vadinar & Township Area of Deendayal Port.

Drinking water samples are collected from 20 locations (18 locations in Kandla and 2 locations in Vadinar). Samples for physico-chemical analysis are collected and analysed in laboratory for various parameters, viz. Color, Odor, Turbidity, Conductivity, pH, Chlorides, TDS, Total Hardness, Iron, Sulphate, Salinity, DO, BOD, Na, K, Ca, Mg, F, NO3, NO2, Mn, Cu, Cd, As, Hg, Pb, Zn, Bacterial Count (CFU).

Monitoring Results

Mean values of drinking water of Deendayal Port Locations are given in table 5.1. The values shown are the annual average of all the locations of Deendayal Port Colony, Port and Harbor area as well as Deendayal Port Trust office buildings.

Table 6.4: Annual average values of Drinking water at Deendayal Port Trust

Sr. No.	Parameter	Unit	1st quarter Mean	2nd quarter Mean	3rd quarter Mean	Value (Annual Avg.)	Acceptable Limits	Permissible Limits
1	pH	pH Unit	7.9	7.5	7.4	7.5	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/L	669.4	386.7	1117.0	794.6	500	2000
3	Turbidity	NTU	83.1	55.3	0.4	43.6	1	5
4	Odor	-	Odorless	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	Colorless	5	15
6	Conductivity	μs/cm	1248.0	809.9	2278.7	1630.5	NS*	NS*
7	Bio.Oxygen Demand	mg/L	<2	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/L	234.8	417.7	631.5	504.0	250	1000
9	Ca as Ca	mg/L	103.0	98.4	66.9	80.5	75	200
10	Mg as Mg	mg/L	23.2	50.0	54.5	51.0	30	100
11	Total Hardness	mg/L	248.6	308.2	391.0	354.4	200	600
12	Iron as Fe	mg/L	0.1	0.1	<0.01	0.1	0.3	1
13	Fluorides as F	mg/L	0.5	0.8	0.5	0.6	1	1.5

Sr. No.	Parameter	Unit	1st quarter Mean	2nd quarter Mean	3rd quarter Mean	Value (Annual Avg.)	Acceptable Limits	Permissible Limits
14	Sulphate as SO_4	mg/L	143.0	94.8	178.3	168.4	200	400
15	Nitrite as NO2	mg/L	209.4	209.4	<0.1	209.4	NS*	NS*
16	Nitrate as NO3	mg/L	11.8	7.2	10.4	8.8	45	100
17	Salinity	%	1.7	1.6	1.1	1.3	NS*	NS*
18	Sodium as Na	mg/L	90.8	230.8	265.3	234.0	NS*	NS*
19	Potassium as K	mg/L	52.9	37.3	3.1	18.7	NS*	NS*
20	Manganese	mg/L	<0.04	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/L	<0.03	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/L	<0.05	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/L	<0.002	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/L	<0.01	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/L	<0.001	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/L	<0.01	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/L	<0.1	<0.1	<0.1	<0.1	5	15
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent	Absent

NS = Not specified, ND= Not detected

Discussion

The colour of all drinking water samples was < 5 Hazen unit and odour of the samples was also agreeable. The values of turbidity, Iron as Fe and Ammonia as NH_3-N were observed to be below detection limits of measurement i.e. <0.1 NT, <0.03 mg/L and <0.1 mg/L respectively. Apparently these parameters were not at alarming levels. Some important parameters for drinking water are discussed below in detail;

pH

pH value in the studied area varied from 7.3 to 8.2 pH unit during the first year of monitoring. The limit of pH value for drinking water is specified as 6.5 to 8.5. All the sampling points showed pH values within the prescribed limit by Indian Standards.

Total Dissolved Solids (TDS)

TDS values in the studied area varied between 140-1647 mg/L. The mean TDS value was 776.7 mg/L. None of the sampling points showed higher TDS values than the prescribed limit by Indian standards which are 500-2000 mg/L.

Conductivity

Conductivity is used to measure the concentration of dissolved solids which have been ionized in a polar solution such as water. The conductivity in the samples collected during the month of June ranged from 796-2841 µs/cm. Electrical conductivity standards do not appear in BIS standards for drinking water.

Chlorides

Chloride values in drinking water for the present year varied between 215-895 mg/L. Excessive chloride concentration increase rates of corrosion of metals in the distribution system. This can lead to increased concentration of metals in the supply.

Calcium

Calcium value in drinking water for the present year the studied area varied between 25.7 – 124.1 mg/L. The mean Ca was observed to be 83.7 mg/L. If calcium is present beyond the maximum acceptable limit, it causes incrustation of pipes.

Magnesium

Magnesium value in the studied area for the present year varied from 10.6 mg/L to 69.7 mg/L. All the locations had Magnesium within the prescribed limits of 30-100 mg/L.

Total Hardness

Total Hardness value in the studied area for the present year varied between 188-510 mg/L. The prescribed limit by Indian Standards is 200-600 mg/L.

Fluoride

Fluoride value in the studied area varied between 0.3 – 1.4 mg/L. The permissible limit as per Indian Standards is 1.0-1.5 mg/L. Moderate amount of fluoride in water lead to dental effects, but long-term ingestion of large amounts can lead to potentially severe skeletal problems.

Sulphates

Sulphate value in the studied area varied between 32 –315 mg/L. All the sampling points showed 67ulphates values within the prescribed limits by Indian Standards (200-400 mg/L). Sulphate occurs naturally in water as a result of leaching from gypsum and other common minerals. Sulphate content in drinking water exceeding the 400 mg/L imparts bitter taste.

Nitrites (NO_2)

Nitrite values in all the water samples were observed to be <0.1 mg/L. There are no specified standard values for Nitrites in drinking water. Groundwater contains nitrate due to leaching of nitrate with the percolating water and by sewage and other wastes rich in nitrates.

Salinity

Salinity in drinking water in the present samples collected ranged from 0.4 to 1.1 %. There are no prescribed Indian standards for salinity in Drinking water**.**

Heavy Metals in Drinking Water

In the present study period drinking water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals were well below/ the permissible limits of the Indian Standards for drinking water.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that total Coliform values is observed to be 0.1 to cfu/100 ml. total Coliform and E-Coli values showed that all the drinking water samples were safe from any bacteriological contamination.

Conclusion

The results are compared with acceptable limits as prescribed in IS 10500:2012 – Drinking Water Specification. It was observed from the data analysis that during the first year (March '20 to February '21) the drinking water was safe for human consumption at all drinking water monitoring stations.

Fig 6.7 Annual average values of TDS at all the drinking water monitoring stations

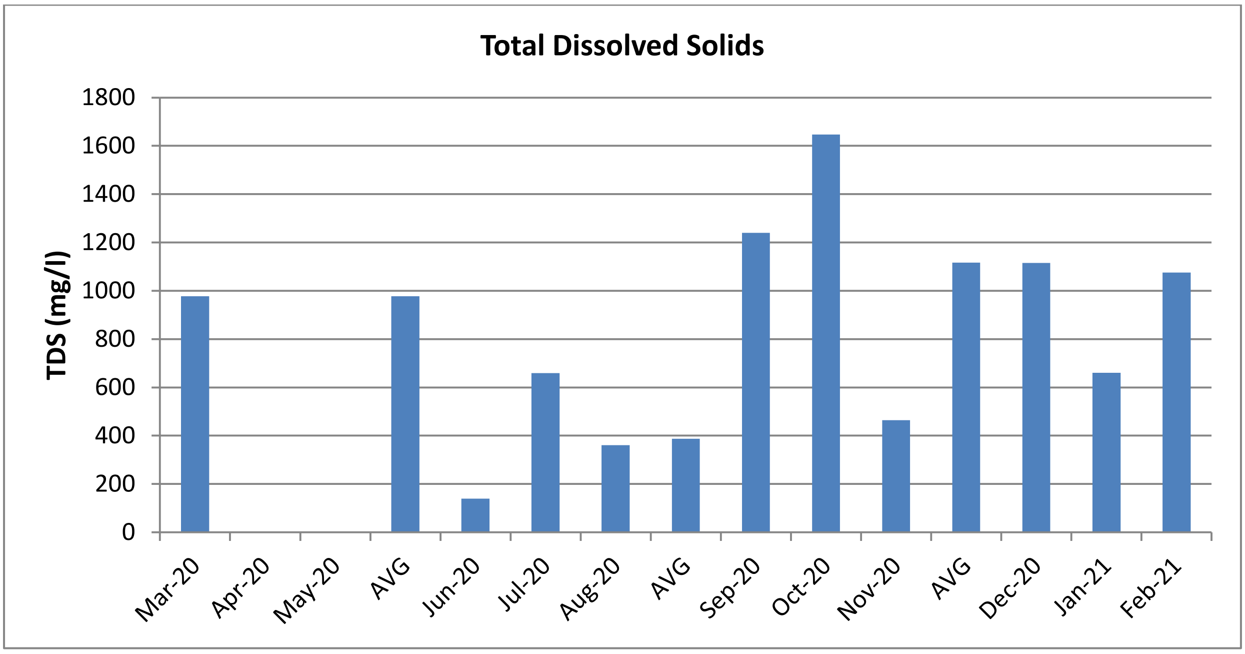


Fig 6.8 Yearly trends in mean annual average values of TDS at all the drinking water monitoring stations

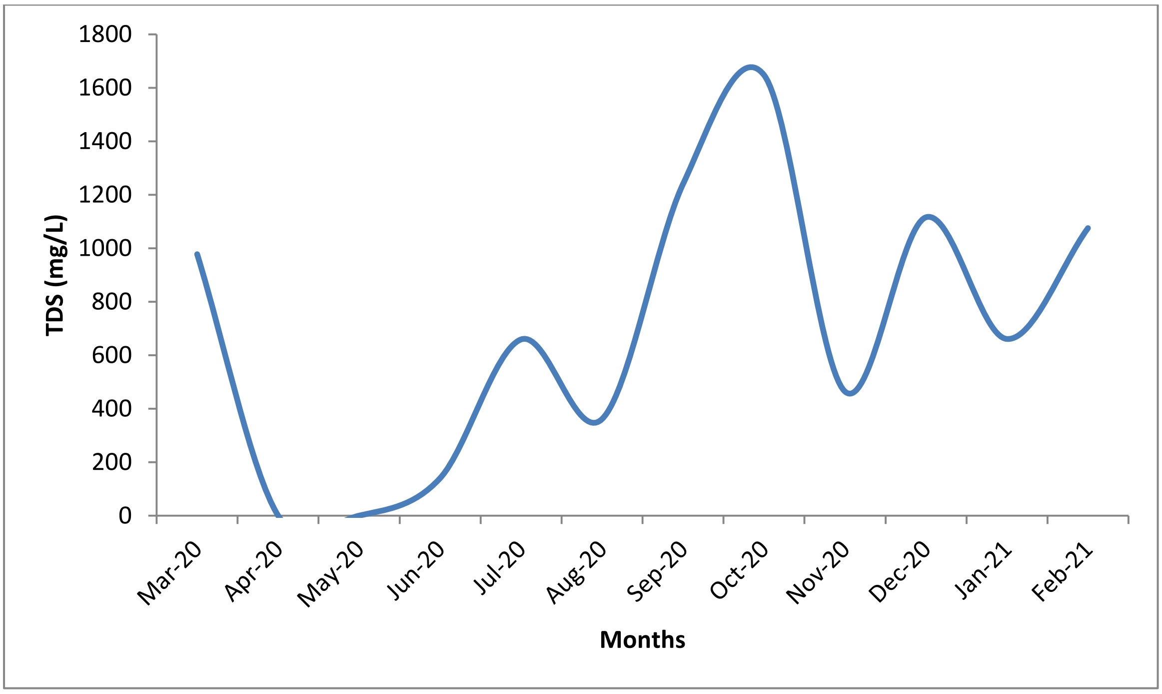


Fig 6.9 Annual average values of Total Hardness at all the drinking water monitoring stations

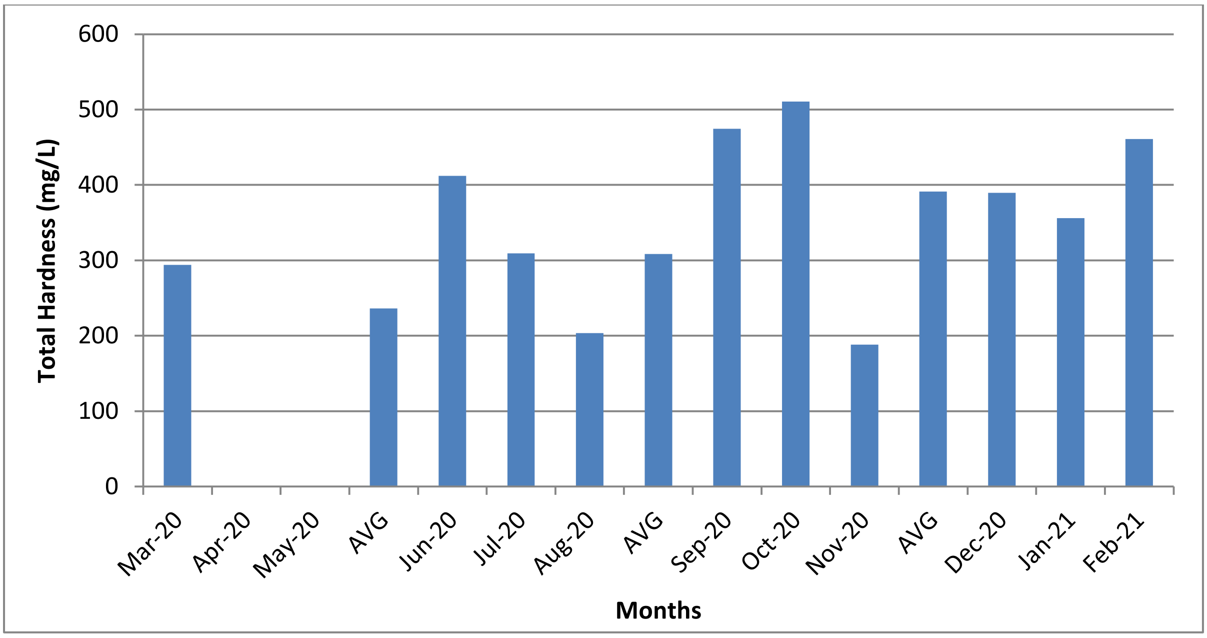
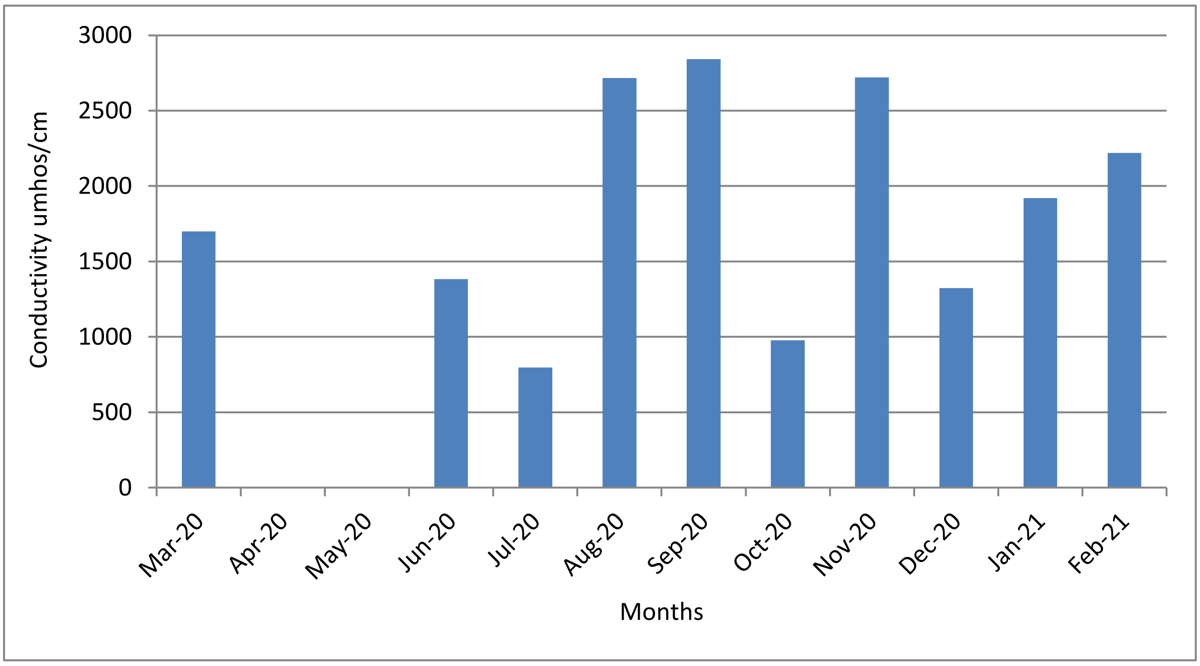


Fig 6.10 Annual average values of Conductivity at all the drinking water monitoring stations



3. Marine Water Monitoring

Marine Water Monitoring was carried out at six stations at Deendayal Port and two locations at Vadinar Port.

Water samples were analyzed for physico-chemical and Biochemical parameters. Besides these, Phytoplankton (Qualitative & Quantitative) Zooplankton (Qualitative & Quantitative) & Benthos (Qualitative & Quantitative) samples were collected during spring tide and neap tide from all the eight fixed monitoring stations.

Results

The annual average values of monitored parameters for marine waters of DPT are given as per table 6.3.

Table 6.3 Annual average values of various physico-chemical parameters at Deendayal Port during neap tide

Sr. No.	Parameters	Unit	1st quarter Mean	2nd quarter Mean	3rd quarter Mean	4th Quarter Mean
1	pH	pH unit	7.9	7.6	7.6	7.5
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	odorless	odorless	odorless	odorless
4	Salinity	ppt	33.3	33.1	33.1	33.4
5	Turbidity	NTU	66.6	70.2	60.6	68.2
6	Total Dissolved Solids	mg/L	36790.0	35760.1	34897.8	35509.6
7	Total Suspended Solids	mg/L	114.5	100.0	95.9	98.9
8	Total Solids	mg/L	36904.6	35860.1	34993.7	35608.5
9	DO	mg/L	5.7	5.6	5.9	5.4
10	COD	mg/L	99.1	91.3	89.6	85.6
11	BOD	mg/L	<2	<2	<2	<2
12	Silica	mg/L	1.4	1.4	1.5	1.2
13	Phosphate	mg/L	0.6	0.5	0.1	0.2
14	Sulphate	mg/L	3206.6	3469.2	2394.7	3459.0
15	Nitrate	mg/L	3.4	4.0	4.6	6.1
16	Nitrite	mg/L	<0.1	<0.1	<0.1	<0.1
17	Calcium	mg/L	661.1	642.4	445.5	505.0
18	Magnesium	mg/L	1709.6	1841.3	1225.7	1656.0

Sr. No.	Parameters	Unit	1st quarter Mean	2nd quarter Mean	3rd quarter Mean	4th Quarter Mean
19	Sodium	mg/L	10982.2	11125.1	9724.8	12467.6
20	Potassium	mg/L	391.0	442.2	327.0	400.9
21	Iron	mg/L	1.6	1.8	1.7	2.4
22	Chromium	mg/L	0.2	0.2	0.1	0.2
23	Copper	mg/L	0.1	0.1	0.1	0.1
24	Arsenic	mg/L	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/L	<0.001	<0.001	<0.001	<0.001
26	Mercury	mg/L	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/L	0.2	0.2	0.2	0.2
28	Zinc	mg/L	0.1	0.1	0.1	0.1

Discussion

Coastal ecosystems are characterized by daily fluctuations, driven by tidal amplitude, wind direction and also on the anthropogenic activities carried out on the coasts. Marine water parameters at Kandla Harbor and creek waters also showed an high array of fluctuations in several of its parameters such as TDS, TSS, salinity and salts.

Some of the important parameters are explained below;

pH

The pH of all marine water samples collected from Deendayal Port varied from 7.5 to 7.9 pH Unit. The mean pH of all samples was 7.64 pH unit.

Salinity

Salinity in the DPT marine water ranged from 32.9 ppt to 33.5 ppt. The mean salinity at was recorded to be 33.2 ppt.

Turbidity

Turbidity in the DPT marine water ranged from 60.2 – 73.1 NTU. The mean turbidity of all the locations of Deendayal Port was 66.4 NTU. Turbidity at Vadinar port was <1.0 NTU.

Total Dissolved Solids (TDS)

TDS values varied from 34411 to 37022 mg/L at all locations of Deendayal Port. Mean TDS values at Deendayal Port was 35739 mg/L.

Dissolved Oxygen (DO)

DO value in the studied area varied between 5.4 – 6.0 mg/L. The mean DO values of Kandla Marine waters were 5.7 mg/L.

Nitrates (NO3)

The mean Nitrate values in all the marine water samples were of Deendayal Port was 4.5 mg/L at DPT waters. Nitrite was rarely detected from marine waters of Vadinar.

Sodium (Na)

Sodium value in the Deendayal Port marine waters varied between 9675-12913 mg/L. The mean Na recorded at DPT waters was 11074.9 mg/L.

Trace Metals

In the present study period water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals reported below trace levels.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that total Coliform values is observed to be 0.1 to cfu/100 ml.

3.1 Productivity Study

Chlorophyll-A

Water Samples for the chlorophyll estimation collected from sub surface layer during high tide and low tide period of the tidal cycle for each sampling locations and analysed for Chlorophyll -a and after acidification for Pheophytin –a.

In the sub surface water chlorophyll-a was varying from 0.25 to 1.26 mg/m^3 in harbour region of DPT during sampling done in from March 2020 to February 2021. In the nearby creeks chlorophyll-a was varying from 0.31-1.93 mg/m^3.

In the sub surface water chlorophyll-a was varying from 0.807 – 4.718 mg/m3 at Vadinar jetty and 0.731 mg/m3 to 3.210 mg/m3near SPM during sampling done spring tide period and during Neap tide.

Algal Biomass

Chlorophyll- a value was used as algal biomass indicator (APHA 1998). Algal biomass was estimated by converting Chlorophyll value.

In the sub surface water algal biomass was varying from 16.5 to 84.6 mg/m^3 in harbour region of DPT during sampling done in from March 2020 to February 2021. In the nearby creeks Algal Biomass was varying from 20.5 to 102.7 mg/m^3.

Fig 6.11 Annual average values of Chlorophyll-a in harbor waters of DPT

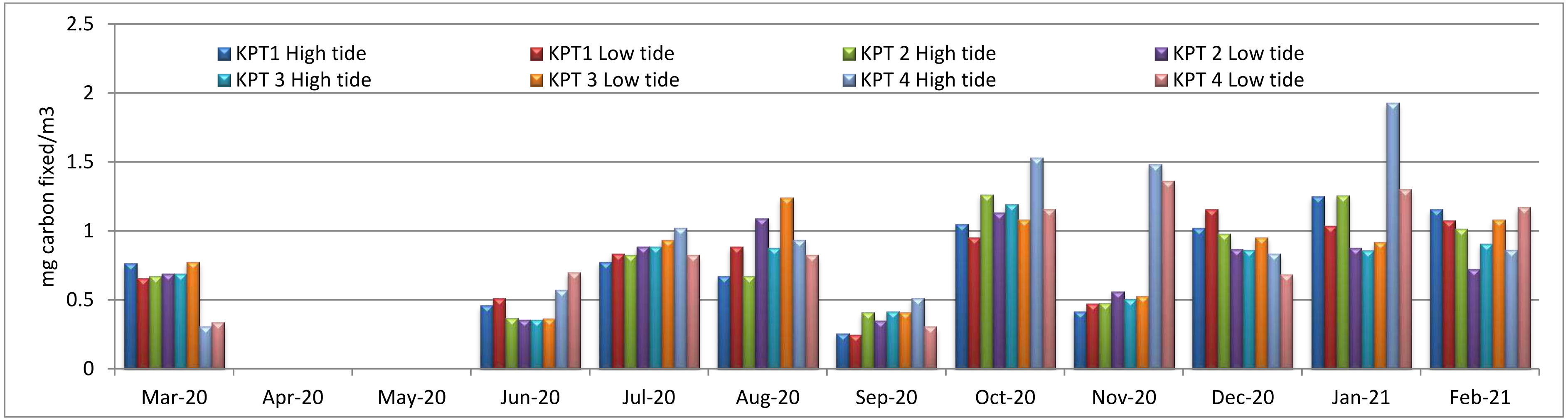
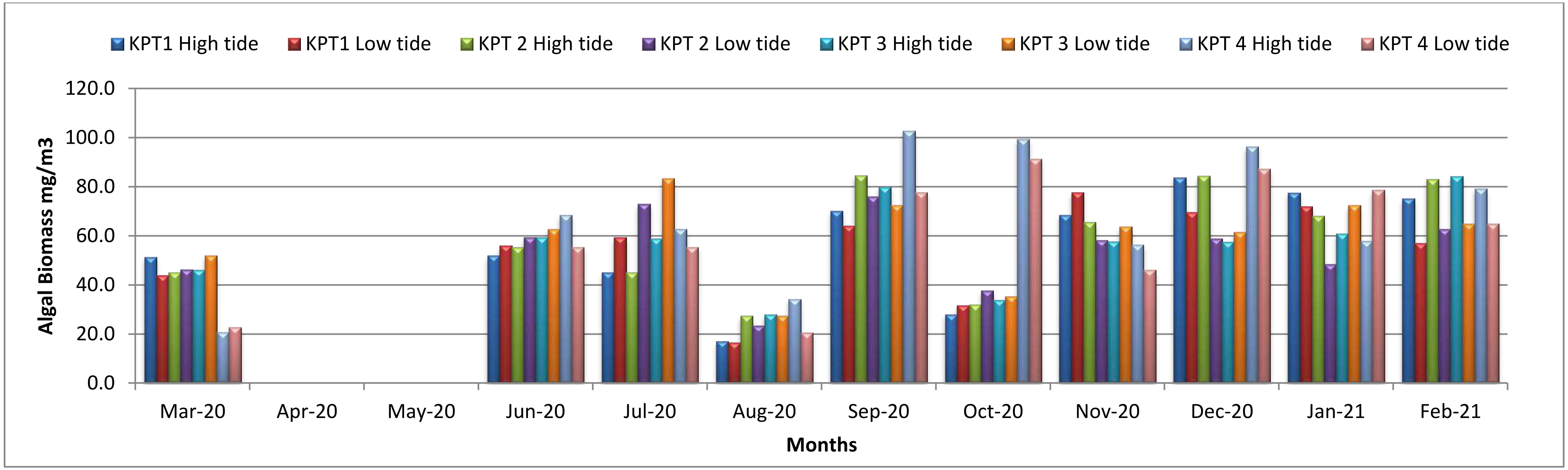


Fig 6.12 Annual average values of Algal Biomass in harbor waters of DPT



3.2 Phytoplankton and Zooplankton

The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by Blue green algae and diatoms during spring tide period and neap tide period. Diatoms were represented by 13 genera belonging to 3 classes, 9 orders and 12 families.

The Zooplankton community of the sub surface water in the harbour and nearby creeks is comparatively low and represented by mainly four groups Tintinids, Copepods, Foramiferans, and larval forms of Crustaceans.

However, Vadinar waters were observed to be rich in terms of diversity and abundance of phytoplankton and zooplanktons.

4. Noise Monitoring

Noise monitoring is carried out as per 'Noise Pollution (Regulation and Control) Rules, 2000. The results of noise monitoring results are annual mean of each location of Kandla and Vadinar Port (Table 5.3).

Table 5.3 Annual avg. of noise level at locations of Kandla (10 locations) and Vadinar (3 locations) Port

Sr. No.	Locations	Day Time Average Noise Level(SPL) in dB(A)	Night Time Average Noise Level(SPL) in dB(A)
	Time	**6 am. And 10 pm.**	**10 pm. To 6 am**
1	Marine Bhavan	67.8	59.8
2	Nirman Building 1	67.2	62.5
3	Tuna Port	53.0	48.7
4	Main Gate North	64.6	60.4
5	West Gate I	70.0	66.1
6	Canteen Area	68.8	58.7
7	Main Road	66.9	59.4
8	ATM Building	61.3	62.3
9	Wharf /Jetty Area	66.2	63.6
10	Port & Custom Office	58.9	52.2
	Vadinar Port		
11	Nr. Vadinar Port Gate	51.8	49.7
12	Port Colony Vadinar	51.5	50.6
13	Nr. Vadinar Jetty	54.1	47.5

Observations:

- The Day Time Average Noise Level in all ten locations at Deendayal Port ranged from 53.0 dB to 70.0 dB
- The noise levels were within the day time limits (75 dB (A)) of industrial area.
- The Night Time Average Noise Level in all ten locations of Deendayal Port ranged from 48.7 dB to 66.1 dB and it was within the permissible limits of 70 dBA for the industrial area for the night time.

- The mean day time noise levels at Vadinar were 52.5 dB and the mean noise levels at night hours was 49.3 dB.

5. Soil Monitoring

Sampling and analysis of soil samples was undertaken at six locations within the study area (Deendayal Port and Vadinar Port). The soil monitoring locations are coastal soils and exhibits saline soil characteristics, typical of a muddy shore.

The texture of soil of all locations was Sandy Loam. The soil at all the locations is saline in nature. The mean pH of the soil at all the locations of Kandla was 8.08 pH unit suggesting it to be slightly to medium alkaline.

Electrical conductivity of the soil was high with low moisture and organic carbon indicating less productivity of the soil and its unsuitability for any agriculture activities.

Other metals like copper, nickel and lead were detected in traces or within permissible limits. The overall surrounding soils were found to be less in essential nutrients, hence less suitable for plant growth.

6. Sewage Treatment Monitoring

This involve safe collection of waste water (spent/used water) from wash areas, bathroom, cargo operational units, etc., waste from toilets of various buildings and its conveyance to the treatment plant and final disposal in conformity with the requirement and guide lines of State Pollution Control Board and other statutory bodies.

The waste water is let into sewer network (network of pipes and manholes) and let by gravity and intermittent pumping stations to the main Sewage Treatment Plant (STP).

The Sewage Treatment Monitoring is carried out at Deendayal Port Colony

(Gopalpuri), Vadinar Port and Deendayal Port.

STP at Gopalpuri Port Colony

Gopalpuri STP is working properly and overall performance of the existing STP was found satisfactory. The removal efficiency of BOD, TSS was in order. The individual units were also performing well and their removal efficiencies are satisfactory. Thus with the sample tested in laboratory the plant is working satisfactory and the individual units are also working well.

STP at Kandla Port

STP with improved capacity of 1.5 MLD at Deendayal Port is operational. The newly installed sewage treatment plant has 1500 cum/day fluidized media reactor based STP to treat domestic waste water generated from the campus and treated water will be utilized for gardening and plantation purpose.

7. Conclusion

i. Ambient Air

Ambient Air Quality monitoring results for the first year shows TSPM, PM_{10} and $PM_{2.5}$ concentrations of the ambient air were within the permissible limits as per the National Ambient Air Quality Standards (NAAQS 2009). The concentration of PM_{10} was above the permissible limit at Coal Storage Area, Marine Bhavan and occasionally at Oil Jetty Area and Tuna Port area at some occasions.

Deendayal Port has handled 305.480 Lakh tonne of dry cargo and in 2017-18, DPT handled 310.038 Lakh tonne dry cargo. This huge volume of dry cargo handled at DPT along with high winds in coastal areas causes slight rise in the Ambient Air Quality near coal berth.

Very high volume of dry cargo is being handled (especially coal) at berth no. 7, 8 and 9. Besides handling of coal, thousands of vehicles laded with coal and other dry cargo criss-cross the port/harbour roads causing the rise in suspended particles in the air.

ii. Drinking Water Quality

The results of the current year monitoring suggest that, the drinking water parameters of all the locations (18 at Kandla and 2 at Vadinar Port) were found within the permissible limits as per the BIS 10500 (2012) drinking water specification.

iii. Noise Quality

The day and night time noise quality was found within the permissible limits of the Noise Pollution (regulation and control) rules, 2000. The Day Time and Night Time Average Noise Level (SPL) in all ten locations at Deendayal

Port were within the permissible limits of 75 dBA (for day time) and 70 dBA (for the night time) for an industrial area.

iv. Marine Water Quality

The marine water samples were collected from the harbour area and the creek area and were monitored for 28 different parameters. The mean DO levels of DPT waters ranged from 4.9 mg/L to 6.0 mg/L (mean = 5.6 mg/L), which is normal for marine waters of ports and harbors.

Evaluation of the Phytoplankton and Zooplankton population in DPT harbour area and within the immediate surroundings of the port suggests that the Kandla waters harbours low to moderate diversity and abundance of phytoplankton and zooplanktons.

v. Sewage Treatment Plant

Gopalpuri STP is working properly and overall performance of the existing STP was found satisfactory.

A new STP with improved capacity of 1.5 MLD at Deendayal Port is operational which is working as per the standards of CPCB/GPCB.

At Vadinar Port, sewage water released into septic tank for treatment and then released. Immediate actions should be taken to commission a full fledge STP plant at Vadinar.

7.1. Steps taken by Deendayal Port to improve Environment

- ‘Safety Week’ is being celebrated in Kandla Port by demonstrating mock drill, firefighting, emergency preparedness, health checkup program etc.
- Regular Safety training and mockdrill are being carried out and awareness is being created by lectures among the workers of the Port.
- Personal Protective Equipments (PPE) like ear plugs, helmets, safety suits, etc are being used during Port Operational work.
- Sewage generated at Port Area as well as in Port colonies is being properly treated through Sewage Treatment Plants at outside Port area at Kandla and Port colony at Gopalpuri. However, DPT is planning to construct a new STP with the latest technology as the existing one is very old.
- Deendayal Port Trust have planted about one lakhs trees in road side dividers, colony areas at Kandla and Gopalpuri, in green belt area of Gandhidham & Adipur Township, Sewage Treatment Plants at Gopalpuri & Kandla and some green belt development plans initiated at different locations in Town ship areas.
- Deendayal Port Trust also carries out Environmental Auditing every year through recognized environmental auditor (Schedule I) of Gujarat Pollution Control Board from the year 2010 .Three Audit Reports for the year 2010, 2011 and 2012 were already submitted to GPCB as per the norms.
- DPT planted Mangroves in an area of 1350 hectares from 2005 to 2019:

Mangrove Plantation Plan carried out in following phases;

1) Year 2005-06 – 20 hectares
2) Year 2008-09 - 50 hectares
3) Year 2010-11 – 100 hectares
4) Year 2011-12 – 200 hectares
5) Year 2012-13 – 300 hectares
6) Year 2013-14- 330 hectares
7) Year 2015-17 - 300 hectares
8) Year 2018-19 - 50 hectares

Total - 1350 hectares

- Water sprinkling on coal is regularly done to prevent coal dust pollution in the port area.
- To control the dust from bulk cargo like fertilizer, coal, sulphur, etc, the Port-users are encouraged to use hopper during discharge from vessels.
- Annual maintenance contracts have been awarded for garbage collection, cleaning of buildings and roads.
- Deendayal Port Trust is maintaining the records for collection and disposal of Solid Wastes generated from Port area, Residential area and Office Buildings.
- Deendayal Port Trust is regularly submitting the Hazardous Waste Statement in From – IV and Form V in environment sheet every financial year to the Gujarat Pollution Control Board, Gandhinagar.
- A report on collection and disposal of the wastes from ships is submitted by the licensees to Deendayal Port and GPCB. A monthly report is given to the DG (Shipping) also.
- All trucks before leaving the storage yards are covered with tarpaulin and not over loaded as well as there is no spillage during transportation.
- Sewage generated at Port area and Port colonies is being properly treated through Sewage Treatment Plants outside Port area at Kandla and Port Colony at Gopalpuri.
- Deendayal Port has engaged CPCB/GPCB authorized agencies for the disposal of Hazardous waste (spent / used oil from ships) as per the Hazardous Wastes (Management and Handling) Rules.
- Pollution under Control (PUC) Certificate is mandatory for vehicles and equipments operating in the Port.
- Deendayal Port has awarded several projects to M/s Gujarat Institute of Desert Ecology (GUIDE), Bhuj relating to monitoring of Marine environment viz;
    - Regular Monitoring of Marine Ecology of Kandla Port Area since 2017-18
    - Creek Bathymetry
    - Analysis of dredging contaminants

- Strategic Regional Impact Assessment Studies
- Assessment and Monitoring of Mangrove Plantation in 1300 Ha area.
- Biodiversity Action Plan for DPT and its surrounding areas

7.1.1. ISO 14001:2015 - Environmental Management System of Deendayal Port Trust

Deendayal port has appointed QMS India Ltd. as for Continual Improvement of ISO 14001:2015 - Environmental Management System with following scope;

- Review of environmental aspect-impacts,
- Review and monitoring of legal requirement
- Review and monitoring of emergency preparedness
- Management review by every six months
- Training of internal auditors and EMC members
- Active participation during external audit.

7.1.2. Green Ports Initiative

Deendayal Port is committed to sustainable development and adequate measures are being taken to maintain the Environmental well-being of the Port and its surrounding environs. Weighing in the environmental perspective for sustained growth, the Ministry of Shipping had started 'Project Green Ports' which will help in making the Major Ports across India cleaner and greener. 'Project Green Ports' will have two verticals - one is 'Green Ports Initiatives' related to environmental issues and second is 'Swachh Bharat Abhiyaan'.

The Green Port Initiatives include twelve initiatives such as preparation and monitoring plan, acquiring equipments required for monitoring environmental pollution, acquiring dust suppression system, setting up of sewage/waste water treatment plants/ garbage disposal plant, setting up Green Cover area, projects for energy generation from renewable energy

sources, completion of shortfalls of Oil Spill Response (OSR) facilities (Tier-I), prohibition of disposal of almost all kind of garbage at sea, improving the quality of harbour wastes etc.

Deendayal port has also appointed GEMI as an Advisor for "Making Deendayal Port a Green Port - Intended Sustainable Development under the Green Port Initiatives.

- Deendayal Port has also signed MoU with Gujarat Forest Department in August 2019 for Green Belt Development in an area of 31.942 Ha of land owned by Deendayal Port Trust. The plantation is being carried out by the Social Forestry division of Kachchh.

8. Suggestions

8.1. Ambient Air Quality

PM_{10} values at Coal storage area, Marine Bhavan, Oil Jetty and Tuna Port were occasionally found above the permissible standards and $PM_{2.5}$ was occasionally found above permissible limits at Coal storage area. (100 $\mu g/m^3$ for PM_{10} & 60 $\mu g/m^3$ for $PM_{2.5}$). The principle reason for higher PM_{10} values at Coal Storage and Marine Bhavan are bulk handling of coal, other dry cargo and heavy traffic of transport vehicles.

8.1.1. Sprinkling

- Heavy duty Water sprinklers should be used inside port where large scale dry cargo is handled.
- Mobile air Sprinklers should also be procured, which suppresses the fine dust from blowing during handling of dry cargo.

8.1.2. Enclosed conveyors

- Port users should be motivated to use enclosed conveyors which prevents secondary dust emissions due to wind in the port area.

8.1.3. Mechanized handling systems

- This involves using screw type unloaders which results in much less spillage and loss of material as compared to bucket unloaders. Mechanized systems can also use pre-packed containers for ease and pollution free loading unloading. Diligent use of various systems can keep the pollution due to ports at minimum level.

Besides these prevention measures, Gujarat Pollution Control Board (GPCB) has also issued guidelines for handling of Coal. Guidelines for Coal Transport, Storage and Handling given below should be strictly followed; (*https://gpcb.gujarat.gov.in/uploads/coal-handling-guidelines1.pdf)*

8.2. GPCB Guidelines for Coal handling units:

(A) Location criteria

- In case of coal handling activities at the ports and jetties or extension thereof, the distance and land use criteria may be relaxed and compensated by advanced/sophisticated pollution control measures and mechanization & thick plantation, however all such ports and jetties, where coal handling is carried out, shall provide closed conveyor belt and mechanization for handling of coal

(B) Storage and handling criteria

- Coal handling unit/Agency shall store coal in such a way that coal heap should not be higher than 5 meter and clear distance between two adjoining heaps at G.L. should be 5 meters, so that in case of fire, approach is available.

- There should be mechanized loading/unloading system from the loading /unloading area to the stacking yards and in to the vehicles.

- Coal handling unit/Agency shall take all corrective steps to resolve the issue of air pollution at permitted coal storage/handling area where coal is being stored.

(C) Transport criteria

- Coal handling unit/Agency shall ensure that all trucks before leaving the storage yard shall be showered with water with adequate system, Shall be covered with tarpaulin or any other effective measure/device completely and also that trucks are not over loaded as well as there is no spillage during transportation.

- The vehicle carrying the coal should not be overloaded by raising the height of carriage. Weigh scale shall be provided within the loading area only and port / coal park authority shall ensure that no overloading is done.

- The top of the vehicle should be covered with fixed cover to avoid spillage or dusting of coal.

(D) Pollution prevention criteria

- Coal handling unit/Agency shall provide paved approach with adequate traffic carrying capacity
- Coal handling unit/Agency shall construct compound wall all along periphery of the premises with minimum 9 meters height
- Continuous water sprinkling shall be carried out on the top of the heap at regular intervals to prevent dusting, fire & smoke. To prevent fugitive emission during loading/unloading, fixed pipe network with sufficient water storage and pump shall be installed. Water sprinkling shall be carried out at each and every stage of handling to avoid generation of coal dust or other dust within premises
- Coal handling unit/Agency shall ensure regular sweeping of coal dust from internal and main road and also ensure that there is adequate space for free movement of vehicles.
- The following adequate Air Pollution Control Measures shall be installed and to be operated efficiently.
- Dust containment cum suppression system for the coal stack, loading and unloading.
- Construction of effective wind breaking wall suitable to local condition to prevent the suspension of particles from the heaps.
- Construction of metal road & RCC Pucca flooring in the plot area/godown etc.
- System for regular cleaning and wetting of the floor area within the premises.
- Entire coal storage area/godown should be covered with permanent weather shed roofing and side walls i.e., in closed shed, in case of crushing/sieving/grading activity is carried out (i.e. G. I. Sheet) along with adequate additional APCM should be installed.

- Coal handling unit/Agency shall carryout three rows plantation with tall growing tress all along the periphery of the coal handling premises, inside & outside of the premises along with road.

- Proper drainage system shall be provided in all coal storage area so that water drained from sprinkling & runoff is collected at a common tank and can be reused after screening through the coal slit or any other effective treatment system.

- All the engineering control measures and state of art technology including covered conveyer belts, mechanized loading and unloading, provision of silo etc. shall be provided in addition to the measures recommended in the environmental guidelines for curbing the pollution.

(E) Safety requirement

- Coal handling unit/Agency shall provide adequate fire-fighting measure to avoid any fire or related hazards including adequate water storage facility, and the premises shall be exclusively used for storage of the coal.

- An onsite emergency plan shall be prepared and implemented by coal handling unit.

(F) Legal criteria

- Necessary permission from all the applicable regulatory authorities and adequate steps under the provisions of applicable environmental acts/ rules shall be taken.

- Coal handling unit/Agency shall prepare EMP (Environment Management Plan) and implement the same in true spirit and thus maintain overall environment of that area.

- Coal handling unit/Agency shall not carry out the operation of loading/unloading of coal/coal dust at any place, till adequate air pollution control equipment for dust control/suppression are installed and efficiently operated and the consent under the provisions of Air (Prevention & Control of Pollution) Act, 1981 is obtained by the coal

yard owners/ Coal handling unit/Agency / coal importers.

- Coal handling unit/Agency shall operate continuous Ambient Air Quality Monitoring Stations as per CPCB guideline.
- In case of port which provides the facility to individual developers an agreement/MoU shall be made between port authority and developer for curtailment of pollution. Port authority shall be responsible for supervising and controlling the pollution control related activities and implementation of the environmental guidelines.

8.3. Sewage Treatment Plant at Vadinar

- At Vadinar, the sewage waste water from the colony is drained into septic tank and later, is released for plantation/gardening. Till the new STP is commissioned; operation of the existing unit should be maintained.

ANNEXURE- I-A

Ambient Air Quality Standards (NAAQS)

Pollutants	Time weighted average	Concentration in Ambient air µg/m^3		
		Industrial Areas	Resi. rural & other areas	Sensitive Areas
Suspended Particulate Matter (SPM)	Annual Average*	360	140	70
	24 hours**	500	200	100
Respirable Particulate Matter (size >10 mm) (RPM)	Annual Average*	120	60	50
	24 hours**	150	100	75
Carbon Monoxide (CO)	8 hours**	5.0	2.0 mg/ m^3	1.0 mg/
	1 hour	10.0 mg/ m^3	4.0 mg/ m^3	2.0 mg/ m^3

- Annual arithmetic mean of minimum of 104 measurements in a year taken twice a week. 24 hourly at uniform interval

- 24 hourly / 8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days

Note:

- National Ambient Air Quality Standard: The levels of air quality with an adequate margin of safety, to protect the public health, vegetation and property.

- Wherever and whenever two consecutive values exceeds the limit specified above for the respective category, it would be considered adequate reason to institute regular/continuous monitoring and further investigations.

- The State Government / State Board shall notify the sensitive and other

areas in the respective states within a period of six months from the date of Notification of National Ambient Air Quality Standards.

[{S.O. 384 (E), Air (Prevention & Cont. of Pollution) Act, 1981 dated April 11, 1994]

ANNEXURE- I-B

Drinking Water Standards (BIS)

Sr. No.	Parameter	Unit	Acceptable Limits	Permissible Limits
1	pH	pH Unit	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	500	2000
3	Turbidity	NTU	1.0	5.0
4	Odor	-	Agreeable	Agreeable
5	Color	Hazen Units	5.0	15.0
6	Conductivity	µs/cm	NS*	NS*
7	Dissolved Oxygen	mg/l	NS*	NS*
8	Biochemical Oxygen Demand	mg/l	NS*	NS*
9	Chloride as Cl	mg/l	250.0	1000.0
10	Ca as Ca	mg/l	75.0	200.0
11	Mg as Mg	mg/l	30.0	100.0
12	Total Hardness	mg/l	200.0	600.0
13	Iron as Fe	mg/l	0.3	1.0
14	Fluorides as F	mg/l	1.0	1.5
15	Sulphate as SO4	mg/l	200.0	400
16	Nitrite as NO2	mg/l	NS*	NS*
17	Nitrate as NO3	mg/l	45.0	100
18	Salinity	%o	NS*	NS*
19	Sodium as Na	mg/l	NS*	NS*
20	Potassium as K	mg/l	NS*	NS*
21	Manganese	mg/l	0.1	0.3
22	Hexavalent Chromium	mg/l	NS*	NS*
23	Copper	mg/l	0.05	1.5
24	Cadmium	mg/l	0.003	0.003
25	Arsenic	mg/l	0.01	0.05
26	Mercury	mg/l	0.001	0.001
27	Lead	mg/l	0.01	0.01
28	Zinc	mg/l	5.0	15.0
29	Bacterial Count	CFU/100ml	Absent	Absent

(BIS specifications (IS 10500-1991)

Bacteriological Standards (for Drinking water)

	Organisms	Requirements
All water intended for drinking		
	(a) E. coli or thermo-tolerant Coliform bacteria	Shall not be detectable in any 100 ml sample
Treated water entering the distribution system		
	a) E. coli or thermo-tolerant Coliform bacteria	Shall not be detectable in any 100 ml sample
	b) Total Coliform bacteria	Shall not be detectable in any 100 ml sample
Treated water in the distribution system		
	a) E. coli or thermo-tolerant Coliform bacteria	Shall not be detectable in any 100 ml sample
	b) Total Coliform bacteria	Shall not be detectable in any 100 ml sample

(BIS specifications (IS 10500-1991)

ANNEXURE- I-C

Noise Quality Standards

Area Code	Category of Area	Limits in dB(A) Leq	
		Day Time	Night Time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

- Day Time is recorded in between 6 a.m. and 9 p.m.
- Night time is recorded in between 9 p.m. to 6 a.m.
- Silence zone is defined as areas up to 100 meters around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by the Competent Authority.
- Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.
- Mixed categories of areas should be declared as one of the four above mentioned categories by the Competent Authority and the corresponding standards shall apply.

[Source: EPA Notification [G.S.R. 1063 (E) dt. 26.12.1989 published in the Gazette No. 643 dt. 26.12.1989.]

ANNEXURE-3

DETAILS OF HAZARDOUS AND NON-HAZARDOUS WASTE

MARINE DEPARTMENT

Sub : Annual Return Showing the collection & disposal of Hazardous and Non-Hazardous wastes carried out by various parties for the year 20-21.

With reference to the above subject, the annual return showing the collection and disposal of Hazardous and Non-Harzardous Wastes carried out by various parties for the year FY 20-21 of Marine Department is enclosed herewith.

Encl : As above

Deputy Conservator

Environmental Cell – thru' SE(D) & EMC (I/C)

No. MR/WK/1124/ dated 29.04.2021

DEENDAYAL PORT TRUST

MARINE DEPARTMENT

Statement of Hazardous & Non Hazardous Waste disposal from the vessels at Kandla & Vadinar Port

YEAR 2020-21

Sr. No.	MONTH	YEAR	Hazardous (Sludge) in MT	Non Hazardous (Garbage) in MT
1	APRIL	2020	125.81	14.25
2	MAY	2020	521.71	2.24
3	JUNE	2020	852	72.32
4	JULY	2020	779.46	70.666
5	AUGUST	2020	1080.96	112.71
6	SEPTEMBER	2020	692.59	79.48
7	OCTOBER	2020	899.92	0.3
8	NOVEMBER	2020	963.29	45.62
9	DECEMBER	2020	1092.877	124.43
10	JANUARY	2021	1022.63	104.44
11	FEBRUARY	2021	715.62	67.67
12	MARCH	2021	1127.97	123.81
	TOTAL		**9874.837**	**817.936**

Deputy Conservator
Deedayal Port Trust

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Marine Department

Statement showing the Collection and disposal of Hazardous and Non-Harardous Wastes carried out by various parties from 04/2020 to 03/2021

Sr. No.	Name of Party	Type of License	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Total
1	Alkyl Organic Industries Limited	Hazardous	-	-	46.96	-	-	-	-	-	-	-	-	-	46.96
2	Atlas Organics Pvt. Ltd	Hazardous	-	-	-	-	225.09	37.25	97.95	-	23.20	24.82	-	40.21	448.52
3	Fine Refiners Pvt. Ltd	Hazardous	18.25	102.88	-	42.46	53.38	-	30.67	31.16	9.70	68.20	34.10	59.99	448.99
4	Industrial Esters & Chemicals Pvt. Ltd	Hazardous	-	-	285.10	-	-	-	-	-	-	-	-	-	285.10
5	Kutch Petrochem Pvt. Ltd	Hazardous	-	-	-	-	-	-	-	-	-	-	-	-	-
6	Priyansi Corporation	Hazardous	-	21.02	64.12	-	28.71	-	-	-	-	-	-	-	113.85
7	Shana Oil Process	Hazardous	-	-	-	-	23.26	-	-	-	-	-	-	-	23.26
8	United Shipping Company	Hazardous	-	92.58	44.08	215.05	161.81	-	112.41	211.65	561.06	314.05	329.26	244.60	2,286.55
9	Revolution Petrochem LLP	Hazardous	109.56	305.23	411.74	521.95	588.71	656.34	658.69	720.48	496.92	615.56	352.26	783.17	6,221.61
10	R V BIO Coal	Hazardous	-	-	-	-	-	-	-	-	-	-	-	-	-
11	Chitrakut Trading & Industries	Non-Hazardous	7.77	-	-	-	-	-	-	-	-	0.10	-	-	7.87
12	Golden Shipping Services	Non-Hazardous	-	-	38.00	28.38	20.62	70.55	-	-	32.95	28.40	29.23	32.84	280.97
13	Harish A. Pandya	Non-Hazardous	-	-	-	3.38	-	8.93	0.30	2.42	8.81	9.71	-	4.37	28.86
14	Naaz Shipping Services Enterprise	Non-Hazardous	-	2.24	-	30.41	15.20	-	-	-	-	14.25	8.20	-	70.30
15	Omega Marine Services	Non-Hazardous	-	-	10.70	5.76	70.92	-	-	-	48.11	39.74	16.29	35.49	226.92
16	Vishwa Trade-link Inc.	Non-Hazardous	-	-	23.62	2.74	5.97	-	-	-	-	21.24	14.04	17.29	84.90
17	Shana Oil Process	Non-Hazardous	6.48	-	-	-	-	-	-	45.20	34.56	-	-	33.88	118.12
		Hazardous - Total	125.81	521.71	852.00	779.46	1,080.96	693.59	899.92	963.29	1,092.88	1,022.63	715.62	1,127.97	9,874.84
		Non-Hazardous - Total	14.25	2.24	72.32	70.57	112.71	79.48	0.30	45.62	124.43	104.44	67.67	123.81	817.94

Deputy Conservator
Deendayal Port Trust
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Marine Department

Statement showing the Collection and disposal of Hazardous and Non-Harardous Wastes carried out by various parties in Deendayal Port Trust and registered in Swachh Sagar Portal

Sr. No.	Type	Company	Email Address	Phone Number	Mode	Actions
1	Hazardous	Shana Oil Process	shanaoil0891@gmail.com	9824286952	Truck	
2	Hazardous	United Shipping Company	unitedshipping46@gmail.com	9978732672	Truck	
3	Hazardous	Alicid Organic Industries Limited	alicidorganic@gmail.com	9825604120	Truck	
4	Hazardous	Kutch Petrochem Pvt. Ltd	kutchppl@rediffmail.com	9638141414	Truck	
5	Hazardous	Priyansi Corporation	operation.priyansicorporation@gmail.com	9825226095	Truck	
6	Hazardous	Industrial Esters & Chemicals Pvt. Ltd	sludgeoil16@yahoo.co.in	9879072262	Truck	
7	Hazardous	Fine Refiners Pvt. Ltd	info@finerefiners.com	9825209314	Truck	
8	Hazardous	ATLAS ORGAINCS PVT LTD	atlasorgaincs@yahoo.com	9825063459	Truck	
9	Hazardous	Revolution Petrochem LLP	revolutionpetrochem@gmail.com	9824286952	Truck	
10	Hazardous	R V BIO COAL	biocoalrv@gmail.com	9904474477	Truck	
11	Non-Haz	Naaz Shipping Services Enterprise	naazshippingservice@yahoo.co.in	9825724120	Truck	
12	Non-Haz	Omega Marine Services	operations@omegamarineservices.com	9537329203	Truck	
13	Non-Haz	Vishwa Trade-link Inc.	vishwatradelink@gmail.com	9879595087	Truck	
14	Non-Haz	Golden Shipping Services	bharat.ahir8686@gmail.com	9638808551	Truck	
15	Non-Haz	Harish A. Pandya	kandla@harishpandya.com	9426218125	Truck	
16	Non-Haz	Chitrakut Trading & Industries	kandla@chitrakutshippingservices.com	9426218125	Truck	
17	Non-Haz	Shana Oil Process	shanaoil0891@gmail.com	9824286952	Truck	

Deputy Conservator
Deedayal Port Trust

Marine Department

STATEMENT SHOWING DEENDAYAL PORT REGISTERED PARTIES FOR REMOVAL OF GARBAGE, USED OIL/WASTE OIL ETC.

Sr. No.	Name of Party	Licensce of Removal	Last Validity of License	Remarks
1	**M/s. Alicid Organic Industries Ltd** Office No. 35, First Floor, Grain Marchan Association Building, Plot No. 297, Ward 12/B, Near Old Court, Gandhidham Email: naazshipping service@yahoo.com Phone: 02836- 237106	Hazardous	24-Sep-21	
2	**M/s. Atlas Organics Pvt. Ltd** Office No. 204-206, Elisbridge Shopping Center, Opp. Town Hall, Ashram Road, Ahmedabad - 380006 Email : atlasorganics@yahoo.com Mobile : 9825063459 / 9909723532	Hazardous	13-Sep-21	
4	**M/s. Fine Refiners Pvt. Ltd** Plot No. 40, GIDC, Chitra Vartej, Bhavanagar - info@finerefiners.com Mobile : 9825209314 / 9979898686	Hazardous	23-Jun-21	
5	**M/s. Industrial Esters & Chemicals Pvt. Ltd** Plot No. BF, 102 -Nr. Nehru Park, Bharat Nagar, Gandhidham - Kutch Email: sludgeoil16@yahoo.co.in Mob: 09879072262 - 9904897422	Hazardous	**22-Jan-21**	
6	**M/s. Kutch Petrochem Pvt. Ltd.** Office : Plot No. 121, Sector No. 9/C, Behind Ashok Leyland, Post Box No. 166 Gandhidham - Kutch 370201 Email: kutchppl@rediffmail.com Mob: 9638141414	Hazardous	**27-Jun-20**	
7	**M/s. Priyansi Corporation** C-1, 804 - 806, GIDC, Bamanbore, Ta. Chotila, Dist - Surendranagar Email: operation.priyansicorporation@gmail.com Mob: 09825226095	Hazardous	19-Oct-21	

Marine Department

STATEMENT SHOWING DEENDAYAL PORT REGISTERED PARTIES FOR
REMOVAL OF GARBAGE, USED OIL/WASTE OIL ETC.

Sr. No.	Name of Party	Licensce of Removal	Last Validity of License	Remarks
8	**M/s. SHANA OIL PROCESS** New Good Luck Market, Nr. Aksha Masjid Chandola Lake, Narol Raod, Ahmedabad Email: kandla_sludgeremoval35@gmail.com Mob : 09824286952	Hazardous	11-Feb-22	
9	**M/s. United Shipping Company** Rising House -I, Ground Floor, Plot No. 82, Sector No. 1/A, Gandhidham - Kutch 370201 Email: sunil@risinggroup.co Phone : 02836 - 233060	Hazardous	30-Aug-21	
10	**M/s. Revolution Petrochem LLP** Office No. C-214, 2nd Floor, Shop No. 234-235, Kutch Arcade Platinum, Mithirohar **Gandhidham - 370201**	Hazardous	21-Mar-22	
11	**M/s. R. V. Bio Coal,** Shop No. 205, Paike, 8-B, National Highway, Opposite Hotel Allkh, Gomta, Taluka Gondal, Dist: Rajkot **Gujarat – 360311.**	Hazardous	**19-Mar-21**	
12	**M/s. Chitrakut Trading & Industries** 15, Brahm Samaj Building, Plot No. 106, Sector No. 8, Behind OSLO Cinema, Gandhidham - Kutch 370201. Email: info@harishpandya.com Mob: 09426218125	Non-Hazardous	19-Oct-21	
13	**M/s. Golden Shipping Services** Kidana Nirmal Nagar, Survey No. 133, Plot No. 83 Gandhidham - Kutch	Non-Hazardous	07-Jun-21	

Marine Department

STATEMENT SHOWING DEENDAYAL PORT REGISTERED PARTIES FOR REMOVAL OF GARBAGE, USED OIL/WASTE OIL ETC.

Sr. No.	Name of Party	Licensce of Removal	Last Validity of License	Remarks
14	**M/s. Harish A. Pandya** 15, Brahm Samaj Building, Plot No. 106, Sector No. 8, Behind OSLO Cinema, Gandhidham - Kutch 370201. Email: info@harishpandya.com Mob: 09426218125	Non-Hazardous	11-Feb-21	
15	**M/s. Naaz Shipping Services Enterprise** Office No. 35, First Floor, Grain Marchan Association Building, Plot No. 297, Ward 12/B, Near Old Court, Gandhidham Email: naazshipping service@yahoo.com Phone: 02836- 237106	Non-Hazardous	15-Jun-21	
16	**M/s. Omega Marine Services** Reg. Office No. 2, Plot NO. 106, Sector - 8, Braham Samaj Building Gandhidham - Kutch Email: operations@omegamarineservices.com Mob: 9537329203 - 9727589185	Non-Hazardous	01-Jul-21	
17	**M/s. VISHWA TRADE-LINK INC.** 214, 2nd Floor, "Kutch Arcade" - Platinium Building Mithi Rohar Road, NH 8/A, GANDHIDHAM Email : vishwatradelink@gmail.com Mob: 09879595087 - 02836-283261	Non-Hazardous	19-Oct-21	
18	**M/s. SHANA OIL PROCESS** New Good Luck Market, Nr. Aksha Masjid Chandola Lake, Narol Raod, Ahmedabad Email: kandla_sludgeremoval35@gmail.com Mob : 09824286952	Non-Hazardous	21-Mar-22	

Deputy Conservator
Deedayal Port Trust
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Annexure -II

Monitoring the Implementation of Environmental Safeguards
Ministry of Environment & Forest
Regional Office,
(Period UptoMay, 2021)
DATA SHEET

1.	Project type: River - valley/ Mining / Industry / Thermal / Nuclear / Other (specify)		:	Infrastructure & miscellaneous projects + CRZ
2.	Name of the project		:	Development of 7 Integrated facilities (Stage I) within existing KPTby Deendayal Port Trust (Erstwhile: Kandla Port Trust).
3.	Clearance letter (s) / OM No. and Date		:	Environment and CRZ clearance by Moef& CC vide file no. 11-82/2011-IA III dated 19/12/2016.
4.	Location		:	
	a.	District (S)	:	Kutch
	b.	State (s)	:	Gujarat
	c.	Latitude/ Longitude	:	$23^0$01' N, $70^0$13' E
5.	Address for correspondence			
	a.	Address of Concerned Project Chief Engineer (with pin code & Telephone / telex / fax numbers	:	Chief Engineer, Deendayal Port Trust, A.O.Building, Gandhidham- 370 201. P.O.Box no. 50. Phone: 02836 233192 02836 220050
	b.	Address of Project: Engineer/Manager (with pin code/ Fax numbers)	:	Same as above
6.	Salient features			
	a.	of the project	:	1) Development of oil jetty to handle liquid cargo and ship bunkering terminal at old Kandla on BOT Basis (jetty: 300m x 15m, back up area 5.5 HA, capacity – 3.39 MMTPA, capital dredging 1,73,660 m^3 maintenance dredging 1,56,294 m^3 Estimated cost : 276.53 Crore 2) Multipurpose cargo Terminal at Tekra off Tuna on BOT basis (T shape jetty 600m X 80 m Capacity 18MMTPA, back up area 101 Ha capital dredging 1,26,57,175 m^3 maintenance dredging 18,98,576. 25 m^3m^3 Estimated cost : 1686.66 Crore 3) Up gradation of Barge handling capacityat Bundar basis at Kandla capacity 3.33 MMTAback up area 5 Ha, Estimated cost : 109.59 Crore

				4) Construction of Rail over Bridge at NH 8 A near Nakti Bridge(crossing of NH 8 A Estimated cost : 32.17 Crore) 5) Mechanization of Dry Cargo handling capacity at Kandla Port (Berth 7 and 8 capacity 7.35 MMTPA estimated cost 80.61 Crore 6) Strengthening of Oil jetty 1 (Estimated cost : 7.5 Crore) 7) Modification and strengthening of Cargo berth No. 6 at Kandla Port Estimated cost : 11.5 Crore
	b.	of the environmental management plans	:	The salient features of the EMP had already been communicated in earlier compliance reports submitted.
7.	Breakup of the project area		:	~111.5 Ha
	a.	submergence area forest & non-forest	:	NIL
	b.	Others	:	NIL
8.	Breakup of the project affected Population with enumeration of Those losing houses / dwelling units Only agricultural land only, both Dwelling units & agricultural Land &landless labourers/artisan		:	NIL
	a.	SC, ST/Adivasis	:	NIL
	b.	Others (Please indicate whether these Figures are based on any scientific And systematic survey carried out Or only provisional figures, it a Survey is carried out give details And years of survey)	:	NIL
9.	Financial details		:	
	a.	Project cost as originally planned and subsequent revised estimates and the year of price reference :		
	1.	Estimated Cost of the Project	:	Total Rs. 2204.56 Crore 1) Development of oil jetty to handle liquid cargo and ship bunkering terminal at old Kandla on BOT Basis - Estimated cost: 276.53 Crore. 2) Multipurpose cargo Terminal at Tekra off Tuna on BOT basis -

				Estimated cost : 1686.66 Crore. 3) Up gradation of Barge handling capacityatBundar basis at Kandla :Estimated cost : 109.59 Crore 4) Construction of Rail over Bridge at NH 8 A near Nakti Bridge(crossing of NH 8 A - Estimated cost : 32.17 Crore 5) Mechanization of Dry Cargo handling capacity at Kandla Port (Berth 7 and 8)- Estimated cost 80.61 Crore. 6) Strengthening of Oil jetty 1 (Estimated cost: 7.5 Crore). 7) Modification and strengthening of Cargo berth No. 6 at Kandla Port Estimated cost : 11.5 Crore
	b.	Allocation made for environ-mental management plans with item wise and year wise Break-up.	:	The allocation made under the scheme of "Environmental Services & Clearance thereof other related Expenditure" during BE 2020-21 is Rs. 271 Lakhs & BE 2021-22 is Rs. 266 Lakhs. In the EIA Report of this proposal, an amount of Rs. 8,28,750/- has been earmarked for environmental management plan.
	c.	Benefit cost ratio / Internal rate of Return and the year of assessment	:	1) Development of oil jetty to handle liquid cargo and ship bunkering terminal at old Kandla (Project IRR 14.01 % and EIRR 14.53%). 2) Multipurpose cargo Terminal at Tekra off Tuna on BOT basis (Project IRR 16.03% and equity IRR 17.4%). 5) Mechanization of Dry Cargo handling capacity at Kandla Port (Project IRR 18.3% and equity IRR23.6%). Rests of the projects are of up-gradation/strengthening/modification.
	d.	Whether (c) includes the Cost of environmental management as shown in the above.	:	Yes

	e.	Actual expenditure incurred on the project so far	:	Out of total 7 project activities, construction activities of 4 projects (project at Sr. No. 3, 5, 6 & 7 mentioned in the EC & CRZ Clearance), have already been completed. However, for rest three projects, construction activity yet not started.
	f.	Actual expenditure incurred on the environmental management plans so far		The expenditure made under the scheme of "Environmental Services & Clearance thereof other related Expenditure" is Rs. 4,98,43,704.70/- for the period 2020-21 upto May, 2021. The activities already performed are as under: • Comprehensive and Integrated Conservation Plan (Cost : Rs. 69,25,680.00), • Regular Monitoring of Marine Ecology (Cost : 23.46 lakhs work completed + for further three years 2018-21 – 70.38 lakhs work completed. DPT again assigned work to M/s GUIDE, Bhuj for 2021-2024 (three years) at a cost of Rs. 1,41,57,000.00 - work in progress. • Studies on Dredged Material for presence of contaminants (Cost : Rs.39,65,190.00 work completed + for further three years 2018-21 : Rs. 1,18,95,570.00 work in progress), • Biodiversity Action Plan for KPT (Cost : 20 lakhs) and its surrounding areas (Mandatory requirement to enhance Environmental Quality of KPT area) – work completed. • Mangrove Monitoring Report of 1300 Ha. (Cost : 25,02,500) Plantation, Monitoring of Environmental Parameters – work completed. For further Monitoring, DPT assigned work to M/s GUIDE,bhuj (1400 Ha. Mangrove) at the cost of Rs. 28 Lakhs- work in progress. • Mangrove Plantation 100 Ha. (Cost

				: 45 lakhs) as per EC condition completed . • RSIA Study (Cost : 62 lakhs work in progress) etc.
10.	Forest land requirement		:	
	a.	The status of approval for diversion of forest land for non-forestry use	:	NIL
	b.	The status of clearing felling	:	NIL
	c.	The status of compensatory afforestation, it any	:	NIL
	d.	Comments on the viability & sustainability of compensatory afforestation program in the light of actual field experience so far	:	NIL
11.	The status of clear felling in Non-forest areas (such as submergence area of reservoir, approach roads), it any with quantitative information		:	NIL
12.	Status of construction		:	
	a.	Date of commencement (Actual and/or planned)	:	**1)** Development of oil jetty to handle liquid cargo and ship bunkering terminal at old Kandla – Award of concession granted on 11/12/2020 and accordingly M/s KOTPL (Concessionaire) may start the project implementation. 2) Multipurpose cargo Terminal at Tekra off Tuna on BOT basis - Construction activity not started yet – **Project under various stages of approval..** 3) Up gradation of Barge handling capacityat Bundar basis at Kandla – Work Completed. 4) Construction of Rail over Bridge at NH 8 A near Nakti Bridge - Construction activity not started yet . 5) Mechanization of Dry Cargo handling capacity at Kandla Port – Work completed.

				6) Strengthening of Oil jetty 1 – Work Completed. 7) Modification and strengthening of Cargo berth No. 6 at Kandla Port – Work completed.
	b.	Date of completion (Actual and/or planned)	:	**1)** Development of oil jetty to handle liquid cargo and ship bunkering terminal at old Kandlaon BOT basis. – Construction activity not started yet – **Date of completion two years from date of award of concession i.e. 10/12/2022.** 2) Multipurpose cargo Terminal at Tekra off Tuna on BOT basis - Construction activity not started yet – **Project under various stages of approval. (Two years from date of award)** 3) Up gradation of Barge handling capacityatBundar basis at Kandla – **Work Completed. (May,2017).** **4)** Construction of Rail over Bridge at NH 8 A near Nakti Bridge - Construction activity not started yet .- **Date of completion one year from date of award)** 5) Mechanization of Dry Cargo handling capacity at Kandla Port– work completed **(April,2017).** 6) Strengthening of Oil jetty 1 – Work Completed**.(May,2017)** 7) Modification and strengthening of Cargo berth No. 6 at Kandla Port – Work completed**.(May,2017).**
13.	Reasons for the delay if the Project is yet to start		:	Out of total 7 project activities, construction activities of 4 projects (project at Sr. No. 3, 5, 6 & 7 mentioned in the EC & CRZ Clearance), have already been completed. However, Project at Sr.No. 1 Award of

			concession granted on 11/12/2020 and accordingly, M/s KOTPL may start project implementation.Project at Sr. No. 2 & 4 are still under planning stage.

14. Date of site visited a) The dates on which the project was monitored by the regional office on pervious occasion. if any b) The date site visit for this monitoring report.	------------- -------------

Annexure –B

EC & CRZ Compliance Report (File no. 11-70/2006-IA-III, dated 2008) sent on 07/10/2021

DEENDAYAL PORT TRUST
(Erstwhile: KANDLA PORT TRUST)

Administrative Office Building
Post Box NO. 50
GANDHIDHAM (Kutch).
Gujarat: 370 201.
Fax: (02836) 220050
Ph.: (02836) 220038

www.deendayalport.gov.in

EG/WK/4660(EC) Part -V/ 92 Date: 07 10 ~~/09~~/2021

To,
The Deputy Director General of Forest (Central),
Ministry of Environment, Forests & Climate Change,
Integrated Regional Office, Gandhinagar
Kendriya Paryavaran Bhavan
Link Road No.3, Ravi Shankar Nagar,
Bhopal- 462 016 (M.P.).
Email: rowz.bpl-mef@nic.in, eccompliance-guj@gov.in

Kind Attn.: Dr. S. K. Lal, Scientist C, MoEF&CC, GoI, Bhopal.

Sub: "Construction of 13th to 16th Cargo Berths at Kandia" by M/s Deendayal Port Trust (Erstwhile Kandia Port Trust) – Compliance Report of conditions stipulated in **Environ mental & CRZ Clearance and Monitoring Report in Data Sheet reg.**

Ref.: **1) Ministry's letter No: 6-37/2008(ENV)/1989 dated 5/8/2009.**
2) KPT letter no.EG/WK/4660 (EC)/654 dated 6/10/2010.
3) KPT letter no.EG/WK/4660 (EC)/ 112 dated 4/2/2012.
4) KPT letter no. EG/WK/4660(EC)/223 dated 4/9/2012.
5) KPT letter no. EG/WK/4660(EC)/144 dated 16 (17) /5/2013.
6) KPT letter no. EG/WK/4660 (EC)/Part 111/1087 dated 9/12/2013.
7) KPT letter no. EG/WK/4660 (EC)/Part 111/250 dated 17/05/2014.
8) KPT letter no. EG/WK/4660 (EC)/Part 111/198 dated 14/11/2014.
9) KPT letter no. EG/WK/4660 (EC)/Part 111/256 dated 11/05/2015.
10) KPT letter no. EG/WK/4660 (EC)/Part 111/162 dated 15/10/2015.
11) KPT letter no. EG/WK/4660 (EC)/Part 111/133 dated 09/05/2016.
12) KPT letter no. EG/WK/4660 (EC)/Part IV/167 dated 26/12/2016.
13) DPT letter no. EG/WK/4660 (EC)/Part IV/325 dated 26/06/2018.
14) DPT letter no. EG/WK/4660 (EC)/Part V/53 dated 14(16)/2/2019.
15) DPT letter no. EG/WK/4660 (EC)/Part V/205 dated 30 (6)/11 (12)/2019.
16) DPT letter no. EG/WK/4660 (EC)/Part V/ dated 15/01/2021.

Sir,

It is requested to kindly refer above cited references for the said subject.

In this connection, it is to state that, as directed under above referred letter dated 5/8/2009 of MoEF, Regional Office, Bhopai, Deendayal Port Trust (Erstwhile Kandia Port Trust) vide above referred ietters had reguiariy submitted compiiance report of stipuiated conditions and Monitoring report in Data Sheet, in connection with subject project.

........cont.....

Now, as directed in above referred letter dated 5/8/2009 of MoEF, GoI, please find enclosed herewith point wise compliance to various stipulation in Environmental & CRZ Clearance granted by MoEF, GoI vide letter 11-70/2006 - IA.III dated Sept.2008 (**Annexure A**) & Monitoring Report in Data Sheet (**Annexure 8**), for the period up to May, 2021, for kind information and record please.

Further, as per the MoEF&CC, Notification S.O.5845 (E) dated 26.11.2018, stated that ***"In the said notification, in paragraph 10, in sub-paragraph (ii), for the words "hard and soft copies" the words "soft copy" shall be substituted".*** Accordingly, we are submitting herewith soft copy of the same via e-mail ID rowz.bpl-mef@nic.in & eccompliance-guj@gov.in.

This has the approval of the Chief Engineer, Deendayal Port Trust.

Thanking You.

Yours faithfully,

30/9/21

Superintending Engineer (PL) & EMC (I/c)
Deendayal Port Trust

Copy along with point wise compliance of stipulated conditions, to :

1) Shri Amardeep Raju, MoEF&CC,GoI and Member Secretary (EAC-Infra.1),
Indira Paryavaran Bhavan,
Ministry of Environment, Forest and Climate Change
Jor Bagh Road, Aliganj,
New Delhi-110003.
Email: ad.raju@nic.in

2) Shri Prasoon Gargav,
Scientist E & Regional Director,
Central Pollution Control Board,
Parivesh Bhawan,
Opp. VMC Ward Office No.10, Subhanpura,
Vadodara – 390 023.
Email: prasoon.cpcb@nic.in

3) Smt. Urvashi Upadhyay,
Environment Engineer,
Unit Head, Kachchh,
Gujarat Pollution Control Board,
Paryavaran Bhavan,
Sector 10A, Gandhinagar- 382 010.
Email-kut-uh-gpcb@gujarat.gov.in

4) The Regional Officer,
Gujarat Pollution Control Board,
Regional Office (East Kutch),
Administrative Office Building,
Deendayal Port Trust, Gandhidham.
Email Id. ro-gpcb-kute@gujarat.gov.in

Annexure A

Compliance Report for the Period Up to May, 2021.

Subject: - Compliance of stipulations made by the Ministry of Environment & Forests, GoI in Environmental & CRZ Clearance granted for "Construction of 13th to 16th Cargo Berths at Deendayal Port Trust (Erstwhile: Kandla Port Trust)".

- The MoEF, GoI granted Environmental & CRZ Clearance for the subject project vide no. F.No. 11-70/2006-IA-III dated 1/10/2008.

- 7/2/2014 – The MoEF&CC, GoI extended the validity period of Environmental &CRZ Clearance for a further period of 5 year i.e. up to 30/9/2018.

STATUS OF Berths:

13th Cargo Berth:	Under operation
15th Cargo Berth:	Under Operation
14th Cargo Berth:	Under Operation
16th Cargo Berth:	Under Operation

CONSENT TO OPERATE :

Consolidated Consent & Authorization (CC&A) issued by the GPCB (Consent Order no-AWH-110594 dated of issue-8/12/2020, with a validity period upto 21/7/2025)– Detailed Order issued by the GPCB vide outward no. 581914 dated 22/1/2021 & subsequently, issued Correction in CC&A order vide letter no. PC/CCA-KUTCH-812(5)/GPCB ID 28494/588116 dated 9/4/2021.

Sr. No.	Conditions	Remarks
A	**Specific Condition**	
1	All measures indicated in the letter dated4/8/2008 shall be strictly complied with	Compliance Report of stipulated conditions mentioned in the CRZ recommendation granted by Forest & Environment Department, GoG on 14/02/2008 is placed at **Annexure – I.**
2	Necessary clearances from the Gujarat State Pollution Control Board shall be obtained before initiating the project.	All 4 berths are under operation. The Copy of detailed Consent to Operate (renewal) issued dated 22/1/2021 by the GPCB is enclosed herewith as **Annexure II.**
3	The project proponent shall not undertake any destruction of mangroves during construction and operation of project.	**Status of Berths: All 4 berths are under operation. (Drawing showing all the berths is attached as Annexure I of Monitoring report Datasheet.** As per the directions of the GCZMA and MoEF&CC,GoI, till date, DPT has undertaken Mangrove Plantaion in an area of 1500 Hectares at various locations **(Statement – Annexure III).** It is also relavent to submit here that, as per the direction of the Gujarat Cosatl Zone Management Authority, DPT had already prepared & submitted a report on mangrove conservation and management plan formulated by Gujarat Institute of Desert Ecology during the study period of Jan-April, 2015 (Report already submitted alongwith earlier compliance reports submitted). Further, DPT appointed M/s GUIDE,Bhuj vide work order dated 1/9/2017 for "Regular Monitoring of Mangrove Plantation (1300 Ha.) carried out by DPT" (period 15/9/2017 to 14/9/2018) . DPT had already submitted final reort (September, 2018) alongwith last complience report submitted dated 30/11/2019. For regular monitoring, DPT vide work order dated 3/5/2021 **(Annexure IV)** has assigned work to M/s GUIDE,Bhuj for Monitoring of mangrove plantation carried out by DPT

		(Period from 24/5/2021 to 23/5/2022) . The work is in progress.
4	Sewage arising in the Port area shall be treated to conform to the standards stipulated by Gujarat State Pollution Control Board and shall be utilized/recycled or gardening, plantation and irrigation.	DPT is having STP (1.5 MLD capacity) for treatment of sewage generated. In addition to that, it also has septic tanks at places where STP is inaccessible. The treated sewage is being used for gardening, plantation purpose.
5	Project proponent shall prepare a Disaster Management Plan covering emergency evacuation mechanisms etc. deal with natural disaster events and regularly update from time to time.	DPT is already having a Disaster Management Plan **(Copy placed at Annexure V).**
6	There shall be no withdrawal of ground water in COASTAL REGULATION ZONE area, for this project. The proponent shall ensure that as a result of the proposed constructions, ingress of saline water into ground water does not take place. Piezometers shall be installed for regular monitoring for this purpose at appropriate locations on the project site.	All the 4 berths are under operation.
7	The facilities to be constructed in the COASTAL REGULATION ZONE area as part of this project shall be strictly in conformity with the provisions of the COASTAL REGULATION ZONE Notification, 1991 as amended subsequently.	All the 4 berths are under operation.
8	Green belt area shall be developed along the project and budget earmarked.	DPT had entrusted the work to Forest Department, Gujarat for developing green belt in and around Port area at a cost of Rs. 352 lakhs in an area of about 32 hectares and the work already completed.
9	No product other than those permissible in the COASTAL REGULATION ZONE Notification, 1991 shall be stored in the COASTAL REGULATION ZONE area.	Point Noted. Only permissible cargo is being stored at all berths viz. 13th to 16thCB, as per the EC & CRZ Clearance accorded by the MoEF, GoI.

B	**General Conditions**	
I	Construction of the proposed structures shall be undertaken meticulously conforming to the existing Central/Local rules and regulations including COASTAL REGULATION ZONE Notification, 1991 & its amendments. All the construction design/drawings relating to the proposed construction activities must have approvals of the concerned State Government Department/Agencies.	All the 4 berths under operation.
II	Adequate provisions for infrastructure facilities such as water supply, fuel, sanitation etc. shall be ensured for construction workers during the construction phase of the project so as to avoid feeling of trees / mangroves and pollution of water and surroundings.	All the 4 berths under operation.
iii	The project authorities must make necessary arrangement for disposal of solid wastes and for the treatment of Effluents by providing a proper wastewater treatment plant outside the COASTAL REGULATION ZONE area. The quality of treated effluents, solid wastes and noise level etc. must conform to the standards laid down by the competent authorities including the Central/State Pollution Control Board and the Union Ministry of Environment and Forests under the Environment (Protection) Act, 1986, whichever are more stringent.	DPT is having STP (1.5 MLD capacity) for treatment of sewage generated in the project site. In addition to that, it also has septic tanks at places where STP is inaccessible. Further, solid wastes are being dumped in identified site. The Environmental Monitoring Reports as submitted by M/s Detox Corporation is enclosed herewith as **Annexure VI**.
Iv	The proponents shall provide for a regular monitoring mechanism as to ensure that the treated effluents conform to the prescribed standards. The records of analysis reports must be properly maintained and made available for inspection to the concerned State/Central officials during their visits.	The Environmental Monitoring Reports as submitted by M/s Detox Corporation is already enclosed at **Annexure VI.**
V	In order to carry out the	DPT appointed M/s Detox corporation for

	environmental monitoring during the operational phase of the project, the project authorities shall provide an environmental laboratory well equipped with standard equipment and facilities and qualified manpower to carry out the testing of various environmental parameters.	monitoring of Environmental parameters. For the purpose, well equipped laboratory has already been established by M/s Detox Corporation at DPT.
vi	The sand dunes if any on the site shall not be disturbed in any way.	No sand dunes at project site prevail.
Vii	A copy of the clearance letter will be marked to the concerned Panchayat/local NGO, if any from whom any suggestion/representation has been received while processing the proposal.	N/A
Viii	The Gujarat Pollution Control Board shall display a copy of the clearance letter at the Regional Office, District Industries Centre and Controller's Office/Tehsildar's Office for 30 days.	N/A
ix	The funds earmarked for environment protection measures shall be maintained, in a separate account and there shall be no diversion of these funds for any other purpose. A year-wise expenditure on environmental safeguards shall be reported to this Ministry's Regional Office at Bhopal and the State Pollution Control Board.	The allocation made under the scheme of “Environmental Services & Clearance thereof other related Expenditure” during BE 2020-21 is Rs. 271 Lakhs & BE 2021- 22 is Rs. 266 Lakhs. The expenditure made under the scheme of “Environmental Services & Clearance thereof other related Expenditure” is Rs. 4,98,43,704.70/- for the period 2020-21 upto May, 2021.

X	Full support shall be extended to the officers of this Ministry's Regional Office at Bhopal and the officers of the central and State Pollution Control Board by the project proponents during their inspection for monitoring purpose, by furnishing full details and action plans including the action taken reports in respect of mitigate measures and other environment protection activities.	DPT had given required support to the officer of Ministry's Regional Office, Bhopal during site inspection carried out on 29/12/2016 for the purpose of certifying EC Conditions. DPT has also given required support to the officials of Gujarat Pollution Control Board during their visits to DPT for inspection etc. Further, it is also assured that DPT shall extend full support in future also to the officials of Ministry's Regional Office at Bhopal and the officers of the central and State Pollution Control Board during their inspection.
xi	In case of deviation of alteration in the project including the implementing agency, a fresh reference shall be made to this Ministry for modification in the clearance conditions or imposition of new ones for ensuring environment protection.	Point Noted.
Xii	This ministry reserves the right to revoke this clearance, if any of the conditions stipulated are not complied with to satisfaction of this ministry.	Point Noted.
Xiii	This Ministry or any other competent authority may stipulate any other additional conditions subsequently, if deemed necessary, for environment protection, which shall be complied with.	Point Noted.
Xiv	The project proponent shall advertise in at least two local newspapers widely circulated in the region around the project, one of which shall be in the vernacular language of the locality Concerned, informing that the project has been accrued environment clearance and copies of clearance letters are available with the State Pollution Control Board and may also be seen at website of the Ministry of Environment & Forests at http;//www.envfornic.in. The advertisement shall be made within 7 days from the date of	Advertisement had already been made in Kutch Mitraon 21/10/2008 and Kutch Uday on 22/10/2008.Further, Newspaper cuttings had already been sent to Regional office, MoEF Bhopal vide KPT letter No.: EG/WK/4660(EC)/01 dated 31/10/2008.

	issue of the clearance letter and a copy of the same shall be forwarded to the Regional office of this Ministry at Bangalore.	
xv	The project proponent shall inform the Regional office at Bhopal as well as the Ministry the date of financial closer and final approval of the Project by the concerned authorities and the date of Start of Land Development work.	The necessary details have already been provided by the DPT from time to time along with the earlier compliance reports submitted. Now, all the 4 berths are under operation.
10	The above mentioned stipulations will be enforced among others under the water (Prevention and Control of Pollution) Act, 1974, the Air (Prevention and Control of Pollution) Act, 1981, the Environment (Protection) Act 1986, the Hazardous Chemicals (Manufactures, storage and Import) Rules, 1989, the Coastal Regulation Zone Notification, 1991 and its subsequent amendments and the Public Liability Insurance Act, 1991 and the Rules made there under from time to time. The project proponents shall also ensure that the proposal complies with the provisions of the approved Coastal Zone Management Plan of Gujarat State.	The Monitoring report of Environmental parameters prepared by M/s Detox Corporation is enclosed at **Annexure VI**. Deendayal Port Trust had already obtained Coastal Regulation Zone Recommendations dated 14/02/2008 from State Forest &Environment Department, Government of Gujarat for the project. All the 4 berths are under operation.

Site Observations made during the inspection carried out on 29/12/2016 :

Observation	Compliance
During the site visit, it is noted that KPT had signed Concession Agreement with M/s RAS Infraport Pvt. Ltd. for 13th CB and with M/s JRE Infra. Pvt. ltd. for 15th CB. While visiting the 13th CB it has been observed that the plantation around the boundary line of 13th CB was	The Concession Agreement signed with 13th Cargo Berth (M/s RAS Infra. Port Pvt. Ltd.) & 15th Cargo Berth (M/s JRE Infra. Pvt. Ltd.) both stand terminated on 29/9/2017.The BOT operators of 13th& 15thCB handed over the possession of the 13th& 15th Berths & DPT started operation on the same. **GREEN BELT**: DPT has already developed sufficient greenbelt area for 13th to 16th CB. Further, Deendayal Port Trust had take up

scanty. It has been instructed to BOT Operator that they have to develop a greenbelt around the boundary within their campus. Further, it has been observed that the stocking of coal and iron ore were being carried out in the CB No.13. Strom water drainage system is found to be inadequate and coal & iron ore fines runoff with storm water cannot be ruled out during monsoon season. Adequate control measures shall be put in place to prevent run-off contaminated with coal/iron ore fines. Septic tanks were observed in every check post and admin building at 13th CB. Further, continuous sprinkling were suggested at the coal stack yard. Again at 15th CB, there were scanty plantation were observed and instruction has been given to BOT operator that they have to develop a greenbelt around the boundary within their campus. BOT operator of 15th CB is found handling dray cargo (wind mill machinery).	massive greenbelt development activities in and around Kandla, Residential colony, Administrative building etc. **DPT had entrusted the work to Forest Department, Gujarat for developing green belt in and around Port area at a cost of Rs. 352 lakhs in an area of about 32 hectares and the work is completed.** **<u>Strom Water Drainage</u>**: As far as storm water drainage system is concerned, necessary improvement measures have already been taken by DPT to prevent runoff contaminated with coal/iron ore fines. Pre monsoon cleaning of SWD 13th CB was carried out. The necessary action has already been taken for development of Basic amenities/facilities including SWD network in the back up area of the 13th to 16th CB. **<u>SPRINKLING SYSTEM :</u>** It is also to informed that, DPT has already installed continuous sprinkling system in coal stack yard in DPT (40 ha. area) for to prevent dust pollution. Further, to control dust pollution in other area, regular sprinkling through tankers on roads and other staking yards is being done. Regular sweeping of spilled cargo from roads is done by parties on regular basis.
Although Environmental Management cell is in place for monitoring of berths under the control of KPT, the same is not available in respect of the BOT operators. Further, the EMC headed by Superintending Engineer (Design) having environmental qualifications is found to be in place, the other members of EMC are hired on contractual basis for a short period. This inadequacy of regular staff with environmental expertise in EMC is reflected in a number of shortcomings in the implementation of EC conditions. A dedicated Environmental Management Cell with dedicated and regular manpower with environmental expertise shall be put in place for better management of	As per the Government guidelines/norms, there is no new recruitment will be permitted in the Government Organization. Hence, KPT appointed consultants (accredited with NABET/QCI) from time to time under Environmental Management Cell with expertise in the field of Environment. Recently, DPT is already having Environment Management cell. Further, DPT has also appointed expert agency for providing Environmental Experts from time to time. Recently, DPT appointed M/s Precitech Laboratories, Vapi for providing Environmental Experts vide work order dated 5/2/2021 **(Copy of work order & scope of work attached as Annexure VII).**

environment in the Kandla Port Area within 6 months period and an action taken report shall be submitted to MoEF&CC, RO Bhopal. The EMC shall be made responsible for the strict compliance of each and every EC condition stipulated by MoEFCC/SEIAA.	

Annexure -I

DEENDAYAL PORT TRUST
(Erstwhile: KANDLA PORT TRUST)

Administrative Office Building
Post Box NO. 50
GANDHIDHAM (Kutch).
Gujarat: 370 201.
Fax: (02836) 220050
Ph.: (02836) 220038

www.deendayalport.gov.in

EG/WK/4660 (EC)/ Part V

Dated:30/09/2021

To,
The Additional Secretary& Director (Environment),
Govt. of Gujarat,
Forest & Environment Department,
Block No.14, 8th floor, Sachivalaya,
Gandhinagar – 382 010.

Sub: Construction of 13th to 16th Cargo Berth at Deendayal Port – **Point wise Compliance to the stipulations in CRZ Recommendations reg.**

Ref.: 1) Director (Env.)'s letter no.ENV-10-2006-138- P dated 14/2/2008
2) KPT letter no. EG/WK/4660 (EC)/Part III/1088 dated 9/12/2013
3) KPT letter no. EG/WK/4660 (EC)/Part III/252 dated 19/5/2014
4) KPT letter no. EG/WK/4660 (EC)/Part III/199 dated 14/11/2014
5) KPT letter no. EG/WK/4660 (EC)/Part III/255 dated 11/05/2015
6) KPT letter no. EG/WK/4660 (EC)/Part III/163 dated 15/10/2015
7) KPT letter no. EG/WK/4660 (EC)/Part III/132 dated 09/05/2016
8) KPT letter no. EG/WK/4660(EC)/Part IV/168 dated 26/12/2016
9) DPT letter no. EG/WK/4660(EC)/Part V/324 dated 26/06/2018
10) DPT letter no. EG/WK/4660(EC)/Part V/54 dated 14(16)/02/2019
11) DPT letter no. EG/WK/4660(EC)/Part V/206 dated 30(6)/11(12)/2019
12) DPT letter no. EG/WK/4660(EC)/Part V/108 dated 15/01/2021

Sir,

It is requested to kindly refer the above cited references for the said subject.

In this connection, it is to state, that Director (Environment), Forest & Environment Department, GoG vide above referred letter dated 14/2/2008 had granted CRZ Recommendations for the subject proposal. Accordingly, Deendayal Port Trust (Erstwhile Kandla Port Trust) had regularly submitted point wise compliance report to the stipulated conditions in CRZ Recommendations.

In this regard, as requested under General condition no. 21 in the above referred letter dated 14/2/2008. i.e. A six monthly report on compliance of the conditions mentioned in this letter shall have to be furnished by the DPT on a regular

...Cont.....

basis to this Department and MoEF, GoI, **please find enclosed herewith compliance report of Deendayal Port Trust along with necessary annexure for the period upto May, 2021.**

Further, as per the MoEF&CC, Notification S.O.5845 (E) dated 26.11.2018, stated that ***"In the said notification, in paragraph 10, in sub-paragraph (ii), for the words "hard and soft copies" the words "soft copy" shall be substituted".*** Accordingly, we are submitting herewith soft copy of the same via e-mail ID gczma.crz@gmail.com & direnv@gujarat.gov.in.

This is for kind information and record please.

Yours faithfully,

30/9/21

Superintending Engineer (PL) & EMC (I/C)
Deendayal Port Trust

Copy to:
Shri Amardeep Raju,
Scientist E, Ministry of Environment Forests & Climate change,
&Member Secretary (EAC-Infra 1),
Indira Paryavaran Bhavan,
3rd Floor, Vayu Wing, Jor Bagh Road, Aliganj,
New Delhi – 110 003.
Email Id: ad.raju@nic.in

Compliance Report For the Period up to May, 2021.

Name of Work: Construction of 13th to 16th Cargo Berth at Kandla, District Kachchh.

CRZ Recommendations: Letter No. ENV-I0-2006-138-P February 14, 2008 of Director (Environment), Forest & Environment Department, GoG.

STATUS OF Berths:

13thCargo Berth:	Under operation.
15thCargo Berth:	Under Operation.
14th Cargo Berth:	Under Operation.
16th Cargo Berth:	Under Operation.

CONSENT TO OPERATE:

Consolidated Consent & Authorization (CC&A) issued by the GPCB (Consent Order no-AWH-110594 dated of issue-8/12/2020, with a validity period upto 21/7/2025)– Detailed Order issued by the GPCB vide outward no. 581914 dated 22/1/2021 & subsequently, issued Correction in CC&A order vide letter no. PC/CCA-KUTCH-812(5)/GPCB ID 28494/588116 dated 9/4/2021.

Sr. No.	Conditions in CRZ Recommendation Letter	Compliance
Specific Conditions		
1	The provisions of the CRZ notification of 1991 and subsequent amendments issued from time to time shall be strictly adhered to by the KPT. No activity in contradiction to the Provisions of the CRZ Notification shall be carried out by the KPT.	All the 4 berths are under operation. The provisions of the CRZ notification of 1991 and subsequent amendments issued from time to time are being strictly followed by Deendayal Port Trust.
2	The KPT shall participate financially for installing and operating the Vessel Traffic Management System in the Gulf of Kachchh and shall also take lead in preparing and operational sing and updating regularly after getting it vetted by the Indian Coast Guard.	As informed earlier also, Deendayal Port Trust had already contributed an amount of Rs. 41.25 Crores i.e 25% of the total project cost of 165 crores for installing and operating the VTMS in Gulf of Kachchh. VTMS has been handed over to Directorate General of Lighthouse and Lightships, Ministry of Shipping, GoI for operating and updating regularly to statutory authorities.
3	The KPT shall strictly ensure that no creeks or rivers are blocked due to any activity at Kandla.	All the 4 berths are under operation.
4	Mangrove plantation in an area of 1000 ha. Shall be carried out by the KPT within 5 years in time bound manner on Gujarat coastline either within or outside the Kandla port Trust area at an appropriate place in consultation with the Forest and Environment Department. A six monthly compliance report along with the satellite images shall be submitted to the Ministry of Environment and Forest as well as to this Department without fail.	Status of Berths: All 4 berths are under operation. As per the directions of the GCZMA and MoEF&CC,GoI, till date, DPT has undertaken Mangrove Plantaion in an area of 1500 Hectares at various locations **(Statement – Annexure I).** It is also relavent to submit here that, as per the direction of the Gujarat Cosatl Zone Management Authority, DPT had already prepared & submitted a report on mangrove conservation and management plan formulated by Gujarat Institute of Desert Ecology during the study period of Jan-April, 2015 (Report already submitted along with earlier compliance reports submitted). Further, DPT appointed M/s GUIDE,Bhuj vide work order dated 1/9/2017 for "Regular Monitoring of Mangrove Plantation (1300 Ha.) carried out by DPT " (period 15/9/2017 to 14/9/2018) . DPT had already submitted final reort (September, 2018) alongwith

		compliance report submitted dated 30/11/2019. For regular monitoring, DPT vide work order dated 3/5/2021 (Annexure III) has assigned work to M/s GUIDE,Bhuj for Monitoring of mangrove plantation carried out by DPT (Period from 24/5/2021 to 23/5/2022) . The work is in progress.
5	No activities other than those permitted by the competent authority under the CRZ Notification shall be carried out in the CRZ area.	All the 4 berths are under operation.
6	No ground water shall be tapped for any purpose during the proposed expansion modernization activities.	All the 4 berths are under operation.
7	All necessary permissions from different Government Departments / agencies shall be obtained by the KPT before commencing the expansion activities.	DPT had already obtained the Environment & CRZ Clearance from the MoEF&CC, New Delhi on September, 2008 and the MoEF&CC, New Delhi vide letter dated 7/02/2014 had extended the validity period of EC/ CRZ Clearance for a further period of five year i.e. up to 30/9/2018. NOC had been obtained from Gujarat State Pollution Control Board vide letter dated 09/01/2009. GPCB has granted extension of validity (for 14th&16thCargo Berth) to DPT up to 13/07/2020. **All the 4 berths are under operation.**
8	No effluent or sewage shall be discharged into the sea/creek or in the CRZ area and It shall be treated to conform to the Norms prescribed by Gujarat Pollution Control Board and would be reused/recycled within the plant premises to the extent possible.	DPT is having STP (1.5 MLD capacity) for treatment of sewage generated. In addition to that, it also has septic tanks at places where STP is inaccessible. The treated sewage is being used for gardening, plantation purpose.
9	All the recommendations and suggestion given by the NIOT in their Comprehensive Environment Impact Assessment report for conservation / protection and betterment of environment shall be implemented strictly by the KPT.	All the 4 berths are under operation.

10	The construction activities and dredging shall be carried out only under the constant supervision and guidelines of the NIOT.	All the 4 berths are under operation.
11	The KPT shall contribute financially for any common study or project that may be proposed by this Department for environmental management / conservation / improvement for the Gulf of Kachchh.	All the 4 berths are under operation. It is assured that, Deendayal Port Trust will contribute financially for any common study or project that may be proposed by statutory authorities for environmental management / conservation / improvement for the Gulf of Kachchh.
12	The construction debris and / or any other of waste shall not be disposed of into the sea, creek or the CRZ areas. The debris shall be removed from the construction site immediately after the construction is over.	All the 4 berths are under operation.
	General Conditions	
13	The construction camps shall be located outside the CRZ area and the construction labour shall be provided with the necessary amenities, including sanitation, water supply and fuel and it shall be ensured that the environmental conditions are not deteriorated by the construction labours.	All the 4 berths are under operation.
14	The KPT shall bear the cost of the external agency that may be appointed by this Department for supervision / monitoring of proposed activities and the environmental impacts of the proposed activities.	All the 4 berths are under operation.
15	The KPT shall take up massive greenbelt development activities in and around Kandla and also within the KPT limits.	Deendayal Port Trust had taken up massive greenbelt development activities in and around Kandla, Residential colony, Administrative building etc. DPT had entrusted the work to Forest Department, Gujarat during August, 2019 for developing green belt in and around Port area at a cost of Rs. 352 lakhs in an area of about 32 hectares and the work is completed.
16	The KPT shall have to contribute financially for talking up the socio-economic upliftment activities in this region in construction with the Forest and Environment Department and the District Collector / District Development Officer.	CSR works are being attended by DPT. Copy of CSR works is enclosed as **Annexure–II.**

17	A separate budget shall be earmarked for environmental management and socioeconomic activities and details there of shall be furnished to this Department as well as the MoEF, GOI. The details with respect to the expenditure from this budget head shall also be furnished.	The allocation made under the scheme of “Environmental Services & Clearance thereof other related Expenditure” during BE 2020-21 is Rs. 271 Lakhs & BE 2021-22 is Rs. 266 Lakhs. The expenditure made under the scheme of “Environmental Services & Clearance thereof other related Expenditure” is Rs. 4,98,43,704.70/- for the period 2020-21upto May, 2021. .
18	A separate environmental management cell with qualified personnel shall be created for environmental monitoring and management during construction and operational phases of the project.	DPT is already having Environment Management cell. Further, DPT has also appointed expert agency for providing Environmental Experts from time to time. Recently, DPT appointed M/s Precitech Laboratories, Vapi for providing Environmental Experts vide work order dated 5/2/2021 **(Copy of work order & scope of work attached as Annexure III).**
19	An Environmental reports indicating the changes, if any, with respect to the baseline environmental quality in the coastal and marine environment shall be submitted every year by the KPT to this Department as well as to the MoEF, GOI.	DPT appointed M/s DETOX Corporation, Surat for regular monitoring of Environmental parameters **(Copy of monitoring report – Annexure IV).**
20	The KPT shall have to contribute financially to support the National Green Corps Scheme being implemented in Gujarat by the GEER Foundation, Gandhinagar, in construction with Forests and Environment Department	It is assured that, Deendayal Port Trust will contribute financially to support the National Green Corps Scheme being implemented in Gujarat by the GEER Foundation, Gandhinagar, in construction with Forests and Environment Department.
21	Six monthly reports on compliance of the conditions mentioned in this letter shall have to be furnished by the KPT on regular basis to this department/ MoEF, GOI.	DPT has regularly submitted six monthly compliance reports to F & E Dept. & to the MoEF&CC,GoI.
22	Any other condition that may be stipulated by this department from time to time for environmental protection/management purpose shall also have to be complied with by the KPT.	It is assured that, Deendayal Port Trust shall also comply with any other condition that may be stipulated by statutory authorities from time to time for environmental protection/management purpose.

Annexure -II

GPCB

GUJARAT ROLLUTION CONTROL BOARO

PARYAVARAN BHAVAN
Sector-10-A, Gandhinagar-382 010
Phono : (079) 23226295
Fax : (079) 23232156
Website : www.gpcb.gov.in

By R.P.A.D

In exercise of the power conferred under section-25 of the Water (Prevention and Control of Pollution) Act-1974, under section-21 of the Air (Prevention and Control of Pollution)-1981 and Authorization under rule 6(2) of the Hazardous and Other Waste (Management and Trans boundary) Rules, 2016 framed under the Environmental (Protection) Act-1986.

And whereas Board has received consolidated consent application inward No.176457 dated 22/09/2020 for the **Renewal of Consolidated Consent and Authorization (CC&A)** of this Board under the provisions / rules of the aforesaid Acts. Consents & Authorization are hereby granted as under:

CONSENTS AND AUTHORISATION:
(Under the provisions /rules of the aforesaid environmental acts)

To,
M/s. Deendayal Port Trust, (New name) (ID-28494)
M/s. Kandla Port Trust, (Old name),
Kandla, A.O Building Gandhidham,
Tal: Gandhidham, Dist: Kutch - 370201

1. **Consent Order No. AWH-110594 Date of issue: 08/12/2020.**
2. The consents shall be valid upto **21/07/2025** for the use of outlet for the discharge of trade effluent and emission due to operation of industrial plant for manufacturing of the following items/ products:

Sr. No	Product/Services	Quantity
1	Dry Cargo Handling	26,54,00,000 MT/Month
2.	Liquid Cargo Handling	54,64,00,000 MT/Month
3.	Loading and unloading operation at 13th Berth	2 MMTPA
4.	Loading and unloading operation at 15th Berth	2 MMTPA

<u>Subject to specific condition:</u>

1. Unit shall strictly adhere to compliance ministry in its Clearance letter file no. 11-82/2011-IA-III, dated 19/12/2016.
2. Unit shall also strictly adhere to all conditions of Environment and CRZ Clearance issued by MoEF vide letter no. F. no. 11-70/2006-IA-III dated 01/10/2006.
3. Applicant shall comply with Manufacture, Storage and Import of Hazardous Chemicals Rules-1986 (MSIHC) as amended time to time.
4. Applicant shall ensure that all storage terminal located within DPT area shall strictly comply with MSIHC Rules including site notification & submit details periodically to board with relevant details.
5. Applicant shall renew Public Liability Insurance time to time & submit a copy to this Board.

6. Unit shall notify site under MSIHC Rule-1989 from competent authority as mentioned in schedule-5 of MSIHC Notifications.
7. Industry shall not withdraw groundwater without prior NOC from CGWA as per Hon. National Green Tribunal order.
8. Industry shall manage Solid Wastes generated from industrial activities as per Solid Waste Management Rules-2016 (solid waste as defined in Rule-3(46)).
9. Industry shall comply with Plastic Waste Management Rules– 2016 and amendments made therein.
10. Industry shall strictly comply with coal handling guideline of this board.
11. Industry shall provide dedicated storage facility for dry cargos & ensure to take adequate measures to prevent dusting.
12. Applicant shall ensure that there shall be no damage to the existing mangrove patches near site and also ensure the free flow of water to avoid damage to the mangroves.
13. Applicant shall ensure as per EC condition that no creeks or rivers are blocked due to any activities at the site and free flow of water is maintained.
14. Applicant shall provide proper system for collection, storage & treatment & disposal of waste water generated by vessel as per MARPOL & maintain records.
15. Applicant shall install storm drainage catch basin to avoid directly discharge into surface water.
16. Waste efficant accumulated with port activities including storm water & sewage from port operation including sewage ballast water, bilge water & clean waste water from ships shall be as per MARPOL norms.
17. Applicant shall make separate records regarding generation, collection, transportation & disposal of waste generation from ship & maintain its records.
18. Applicant shall made necessary arrangement for the plastic Waste, Solid Waste of other waste generation due to port activities & for facilitation of reception facilities under MARPOL & Environment (Protection) Act-1986 rules etc.
19. Ports shall obtain approval of their oil spill contingency plan (OSCP) as required under national oil spill disaster contingency plan (NOS-DCP) of coast guard, ministry of defence, govt. of India.
20. Best environmental practices by ports maybe uploaded on "Indian ports Association" as well as the same maybe linked to websites of CPCS and respective SPCBs.
21. Manually handling of cargo should be converted into mechanized system, in time pound manner.

3. **Conditions under the Water act-1974:**
   3.1 Source of Water: - GWIL,
   3.2 There shall be no industrial water consumption and waste water generation from manufacturing process and other ancillary operations.
   3.3 The quantity of the fresh water consumption for domestic purpose shall not exceed 1300 KLD.
   3.4 The quantity of domestic waste water shall not exceed 800 KLD.

GPCB

GUJARAT POLLUTION CONTROL BOARD

PARYAVARAN BHAVAN
Sector-10-A, Gandhinagar-382 010
Phone : (079) 23226295
Fax : (079) 23232156
Website : www.gpcb.gov.in

3.5 Domestic effluent shall be treated in existing STP & treated effluent conforming to following norms shall be discharged on land within premises strickly for gardening end plantation porpose & no sewage shall pe disposed outside premises in any manner.

PARAMETERS	PRESCRIBED LIMITS
pH	6.5 to 8.5
BOD (3 days at 27° C)	30 mg/L
Suspended Solid	100 mg/L
Fecal Coli form	< 1000 MPN/ 100 ml

3.6 Treated domestic effluent confirming to above norms shall be discharge on land only for gardening & plantation within premises.

3.7 Unit shall provide flow meter at inlet & outlet of STP & maintain its record.

3.8 Disposal system for storm water shall be provided seperately. In no case storm water & sewage from port facility shall not ha discharge into surface water.

4. **Conditions under the Air Act-1981:**

4.1. The following shall be used as a fuel in D.G. Sets:

Sr. No.	Utility	Fuel	Quantity
1	D.G. Sets	HSD	500 Ltr/Hr

4.2. The applicant shall install & operate air pollution control system efficiently in order to achieve prescribed norms.

4.3. The flue gas emission through stack attached to D.G. Sets shall conform to the following standards

Sr. No.	Stack attached to	Stack height in Meter	APCM	Parameter	Permissible Limit
1 & 2	DG sets (2 nos.) (1010 KVA)	15 each	--	PM SO_2 NO_X	150 mg/NM³ 100 ppm 50 ppm

4.4. There shall be no process gas emission from manufacturing process and other ancillary operations.

4.5. The concentration of the following parameters in the ambient air within the premises of the industry and a distance of 10meters from the source) other than the stack/vent) shall not exceed the following levels.

Sr. No.	Pollutant	Time Weighted Average	Concentration in Ambient air in µg/M³
1.	Sulphur Dioxide (SO_2)	Annual 24 Hours	50 80
2.	Nitrogen Dioxide (NO_2)	Annual 24 Hours	40 80
3.	Particulate Matter (Size less than 10 µm) or PM_{10}	Annual 24 Hours	60 100
4.	Particulate Matter (Size less than 2.5 µm) or $PM_{2.5}$	Annual 24 Hours	40 60

4.6. The applicant shall provide portholes, ladder, platform etc at chimney(s) for monitoring the air emissions and the same shall be open for inspection to/and for use of Board's staff. The chimney(s) vents attached to various sources of emission shall be designed by numbers such as S-1, S-2, etc. and these shall be painted/displayed to facilitate identification.

4.7. The industry shall take adequate measures for control of noise levels from its own sources within the premises so as to maintain ambient air quality standards in respect of noise to less than 75dB(A) during day time and70 dB (A) during night time. Daytime is reckoned in between 6a.m. and10 p.m. and nighttime is reckoned between 10 p.m. and 6 a.m.

5. AUTHORIZATION as per HAZARDOUS AND OTHER WASTE (MANAGEMENT AND TRANSBOUNDARY) RULES, 2016 Form-2 [See rule 6 (2)]

Form for grant of authorization for occupier or operator handling Hazardous waste

5.1 Authorization order no:-**AWH-110594Date of issue**: 06/12/2020.

5.2 **M/s. Kandla Port Trust** is hereby granted an authorization to operate facility for following hazardous wastes on the premises situated at Kandla, A.O Building Gandhidham, Tal: Gandhidham, Dist : Kutch.

Sr. No.	Waste	Quantity/ Year	Schedule &Category	Facility
1	Used Spent Oil	1125 MT	I-5.1	Collection, Storage, Transportation and disposal by selling to authorized recycler.
2	Waste Residue Containing Oil	3344.43 MT	I-5.2	Collection, Storage, Transportation and disposal by selling to authorized recycler.

5.3 The authorization shall be valid up to **21/07/2025**.

5.4 The authorization is subject to the conditions stated below and such other conditions as may be specified in the rules from time to time under the Environment (Protection) Act-1986.

5.5 The authorization is granted to operate a facility for collection, storage within factory premises transportation and ultimate disposal of Hazardous wastes as per condition no 5.2 to the industry having valid CCA of this Board.

5.6 **TERMS AND CONDITIONS OF AUTHORISATION**

1. The applicant shall comply with the provisions of the Environment (Protection) Act-1986 and the rules made there under.
2. The authorization or its renewal shall be produced for inspection at the request of an officer authorized by the Gujarat Pollution Control Board.
3. The persons authorized shall not rent, lend, sell, and transfer or otherwise transport the hazardous wastes without obtaining prior permission of the Gujarat Pollution Control Board.

4. Any unauthorized change in personnel, equipment or working conditions as mentioned in the authorization order by the persons authorized shall constitute a beach of this authorization.
5. The person authorized shall implement Emergency Response Procedure (ERP) for which this authorization is being granted considering all site specific possible scenarios such as spillages, leakages, fire etc. and their possible impacts and also carry out mock drill in this regard at regular interval of time;
0. The person authorized shall comply with the provisions outlined in the Central Pollution Control Board guidelines on "Implementing Liabilities for Environmental Damages due to Handling and Disposal of Hazardous Wastes and Penalty"
7. It is the duty of the authorized person to take prior permission of the Gujarat Pollution Control Board to close down the facility.
8. An application for the renewal of an authorization shall be made as laid down in rules 6(2) under Hazardous and Other Waste Rules, 2016.
9. The imported hazardous and other wastes shall be fully insured for transit as well as for any accidental occurrence and its clean-up operation.
10. The record of consumption and fate of the imported hazardous and other wastes shall be maintained.
11. The hazardous and other wastes which gets generated during recycling or reuse or recovery or pre-processing or utilization of imported hazardous or other wastes shall be treated and disposed of as per specific conditions of authorization.
12. The importer or exporter shall bear the cost of import or export and mitigation of damages if any.
13. Any other conditions for compliance as per the Guidelines issued by the Ministry of Environment, Forest and Climate Change or Central Pollution Control Board from time to time.
14. The waste generator shall ha totally responsible for (i.e. collection, storage, transportation and ultimate disposal) the wastes generated.
15. Records of waste generation, its management and annual return shall be submitted to Gujarat Pollution Control Board in Form-4 by 30th day of June of every year for the preceding period April to March.
16. In case of any accident, details of the same shall be submitted on Form-11 to Gujarat Pollution Control Board.
17. As per "Public Liability Insurance Act-91" company shall get Insurance Policy, if applicable.
18. Empty drums and containers of toxic and hazard material shall be treated as per guideline published for "Management & Handling of discarded containers". Records of the same sholl be maintained end forwarded to Gujarat Pollution Control Board regularly.
19. In case of transport of hazardous wastes to a facility for (i.e. treatment, storage end disposal) existing in a State other than the State where hazardous wastes are generated, the occupier shall obtain 'No Objection Certificate' from the State Pollution Control Board or Committee of the concerned State of Union Territory Administration where the facility exists.
20. Unit shall take all concrete measures to show tangible results in waste generation, reduction, avoidance, reuse and recycle. Actions taken in this regard shall be submitted within three months and also along with Form-4.

21. Industry shall have to display the relevant information with regards to hazardous waste as indicated in the Hon. Supreme Court's Order in W.P. No.657 of 1995 dated 14th October 2003.
22. Industry shall have to display on-line data outside the main factory gate with regard to quantity sho nature of hazardous chemicals being handled in the plant, including wastewater and air emissions and solid hazardous wastes generated within the factory premises.

6. **SPECIFIC CONDITIONS:-**
   6.1 The authorized actual user of hazardous and other wastes shall maintain records of hazardous end other wastes purchased in a passbook issued by the State Pollution Control Board along with the authorization.
   6.2 Handling over of the hazardous and other wastes to the authorized actual user shall be only after making the entry in the passbook of the actual user.
   6.3 In case of renewal of authorization, a self-certified compliance report in respect of effluent, emission standards and the conditions specified in the authorization for hazardous and other wastes shall be submitted to SPCB.
   6.4 The occupier of the facility shall comply Standard operating procedure/guidelines published by MOEF&CC or CPCB or GPCB from time to time.
   6.5 Unit shall comply provisions of E-Waste Management Rules-2016.
   6.6 The disposal of Hazardous Waste shall be carried out as per the waste Management hierarchy.
   5.7 The occupiers of facilities shall not store the hazardous and other wastes for a period not exceeding ninety days. Prior permission of the Board shall be obtained for extension of the storage period.
   6.6 The occupier shall maintain the records of generation, sale, storage, transport, recycling, co processing and disposal of hazardous waste and make available during the inspection.
   6.9 The transportation of the hazardous waste shall be carried out in GPS mounted dedicated vehicles.

7. **GENERAL CONDITIONS: -**
   7.1 Any change in personnel, equipment or working conditions as mentioned in the consents form/order should immediately be intimated to this Board.
   7.2 Applicant shall also comply with the general conditions given in annexure I.
   7.3 Whenever due to accident or other unforeseen act or ever, such emissions occur or is apprehended to occur in excess of standards laid down such information shall be forthwith reported to Board, concerned Police Station Office of Directorate of Health Service, Department of Explosives, Inspectorate of Factories and local body.
   7.4 In case of failure of pollution control equipments, the production process connected to it shall be stopped. Remedial actions/measures shall be implemented immediately to bring entire situation normal.

7.5 The Environmental Management Unit/Cell shall be setup to ensure implementation on and monitoring of environmental safeguards and other conditions stipulated by statutory authorities. The Environmental Management Cell/Unit shall directly report to the Chief Executive of the organization and shall work as a focal point for imentalizing environmental issues. These cells/units also coordinate the exerciseof environthental audit and preparation of environmental statements.

7.6 The Environmental audit shall he carried out yearly and the environmental statements pertaining to the previous year shall be submitting to this State Board latest by 30th September every year.

7.7 The Board reserves the right to review and/or revoke the consent and/or make variations in the conditions, which the Board deems, fit in accordance with Section 27 of the Act.

7.8 In case of change of ownership/management the name and address of the new owners/ partners/directors/proprietor should immediately be intimated to the Board.

7.9 Industry shall have to display the relevant information with regard to hazardous waste as indicated in the Hon. Supreme order in w.p. no. 657 of 1995 dated 14th October 2003.

For and on behalf of
GUJARAT POLLUTION CONTROL BOARD

(Smt. U.K. Upadhyay)
Environment Engineer

NO: GPCB/CCA-Kutch-812(5)/ID-26494/ Date:-
Issued to:
M/s. Deendayal Port Trust, (New name),
M/s. Kandla Port Trust, (Old name),
Kandla, A.O Building Gandhidham,
Tal: Gandhidham, Dist: Kutch - 370 201

GPCB

GUJARAT POLLUTION CONTROL BOARD

PARYAVARAN BHAVAN
Sector-10-A, Gandhinagar-362 010
Phone : (079) 23226205
Fax : (079) 23232155
Website : www.gpcb.gov.in

By R.P.A.D.

NO: PC/ CCA- KUTCH-612(5)/ GPCB ID: 28494/ **Date: -**

Correction in Consolidated Consent & Authorization order no AWH-110594 date of issue 22/01/2021 (Under the provisions/rules of Environmental acts)

To,

M/s. Deendayal Port Trust, (New name)
M/s. Kandla Port Trust, (old name),
Kandla, A.O Building Gandhidham,
Tal:-Gandhidham,
Dist: Kutch – 370 201.

Subject : Correction of Consolidated Consent and Authorization (CC& A) of this Board

Reference : 1) CCA issued vide order no. PC/ CCA- KUTCH-612(S)/ GPCB ID: 28494/ 581914 dated 22/01/2021.
2) Your letter dated 25/01/2021.

In exercise of the power conferred under section-27 of the Water (Prevention and Control of Pollution) Act-1974, under section-21 of the Air (Prevention and Control of Pollution)-1981 and Authorization under rule 6(2) of the Hazardous & Other Waste (Management &Transboundary Movement) Rules-2016 & as amended framed under the Environmental (Protection) Act-1986 and without reducing your responsibility under the said Acts/Rules in anyway. The Board had granted CCA vide order no. AWH-110594 dated 22/01/2021.

ANDWHEREAS the Board is empowered to amend CCA conditions. Accordingly, considering your request for corrected & after care full consideration, the CCA order no. AWH-110594 is hereby corrected/ amended as below;

1. The condition no. 2 of the said CCA order shall be corrected as below;
   2. The consent shall be valid upto 21/07/2026 for the use of outlet for the discharge of trade effluent and emission due to operation of industrial plant for manufacturing of the following items/ products:

Sr No.	Product	Quantity
1.	Dry Cargo Handling	26,54,00,000 MT/Month
2.	Liquid Cargo Handling	54,64,00,000 MT/Month
3.	Loading and unloading operation of 13th and 15th berth	2 MMTPA(Each)
4.	Loading and unloading operation of 14th and 16th berth	4.5 MMTPA (Each)

2. All other terms and condition mentioned in AWH – 110594 issued vide CCA letter PC/ CCA- KUTCH-612(5)/ GPCB ID: 28494/581914 dated 22/01/2021 shall remain unchanged.

For and on behalf of
Gujarat Pollution Control Board

(Smt. D. K. Upadhyay)
Environment Engineer

Annexure -III

DEENDAYAL PORT TRUST

DETAILS OF MANGROVE PLANTATION CARRIED OUT BY DEENDAYAL PORT TRUST :

Sr. No.	Reference of condition stipulated in EC & CRZ Clearance/CRZ Recommendation by GCZMA to Various Projects of DPT	Mangrove Plantation carried out in Hectares	Year of Plantation and Location & Name of agency
1	DEENDAYAL PORT TRUST (CRZ Recommendation 13th to 16th CB issued by the GCZMA) (Total 1000 ha.)	20 Hectares 50 Hectares 100 Hectares 200 Hectares 300 Hectares 330 Hectares **Total 1000 Ha.**	2005-06 Satsida Bet,Kandla, by GUIDE,Bhuj 2008-09 Nakti Creek,Kandla by Patel Construction 2010-11 Nakti Creek ,Kandla by GEC. 2011-12 by Forest Department, GoG at Satsaida Bet 2012-13 by Forest Department, GoG at Satsaida Bet 2013-14 by Forest Department, GoG at Satsaida Bet
2	Creation of Berthing & allied Facilities off- tekra near Tuna (Outside Kandla Creek) – EC & CRZ Clearance. MOU signed with GEC during Vibrant Gujarat Summit 2015 for 300 Ha.	**300 Ha.**	2015-17 by GEC at Kantiyajal, Bharuch District
3.	EC & CRZ Clearance dated 19/12/2016 for Developing 7 integrated facilities (Condition 100 Ha)	**100 Ha**	2018- 20 by GEC (At Satsaida bet : 50 Ha. And At Kantiyajal 50 Ha Taluka : Hansot, District : Bharuch)

4.	Development of Integrated facilities (Stage-II) within the existing Deendayal Port Trust (Erstwhile Kandla Port Trust) at District Kutch, Gujarat. (1. Setting up of Oil Jetty No.7 ; 2. Setting up of Barge jetty at Jafarwadi ; 3. Setting up of Barge port at Veera; 4. Administrative office building at Tuna Tekra; 5. Road connecting from Veera barge jetty to Tuna gate by M/s Deendayal Port Trust (Erstwhile : Kandla Port Trust) - **Environmental & CRZ Clearance accorded by the MoEF&CC,GoI dated 19/12/2020.** Development of 3 Remaining Integrated Facilities (stage I) within the existing Deendayal Port Trust (Erstwhile : Kandla Port Trust) at Gandhidham, Kutch, Gujarat - **Environmental & CRZ Clearance accorded by the MoEF&CC,GoI dated 18/2/2020.**	**100 Ha.**	**2020-21 GEC,Gandhinagar** (At Kantiyajal 50 Ha and At Aliya Bet 50 Ha.) Taluka : Hansot, District : Bharuch

TOTAL : 1500 Ha. Mangrove Plantation carried Out by DPT

Annexure -IV

DEENDAYAL PORT TRUST

Administrative Office Building
Post Box NO. 50
GANDHIDHAM (Kutch).
Gujarat: 370 201.
Fax: (02836) 220050
Ph.: (02836) 220038

www.deendayalport.gov.in

NO.EG/WK/4751/Part (Marine Ecology Monitoring)/10 Dated : 03/05/2021

M/S Gujarat Institute of Desert Ecology,
P.O.Box No. 83,
Opp. Changleshwar Temple, Mundra Road,
Bhuj (Kachchh)- 370 001,Gujarat (India).
Tel.: 02832-329408, 235025.
Tele/Fax: 02832-235027
Email: desert_ecology@yahoo.com

Kind Attn.: Dr.V.Vijay Kumar, Director, M/s GUIDE, Bhuj.

Sub: Regular Monitoring of Mangrove Plantation (1400 Ha.) carried out by Deendayal Port Trust (Statutory Requirement) reg.

Ref.:1) DPT request vide email dated 10/4/2021.
2) M/s GUIDE, Bhuj offer vide letter no. GUIDE/DPT/Offer/Mangrove Monit./19 /2021-22 dated 16/4/2021.

Sir,

Your offer for the subject work submitted vide above referred letter dated 16/4/2021 amounting to Rs. 28,00,000.00 + 18% GST (Rupees Twenty Eight lakhs only plus eighteen percent GST) with all terms & conditions mentioned in the offer letter, has been accepted.

2. The terms of payment :

1) 50 % of the project budget should be paid within 15 days from the date of Submission of Inception Report by GUIDE,Bhuj.
2) 25% of the project budget should be paid within 15 days from the date of submission of Draft report by GUIDE,Bhuj.
3) 25% of the project budget should be paid within I5 days from the date of submission of Final report by GUIDE,Bhuj.

Cont...........

3. Scope of work :

Regular Monitoring of Mangrove Plantation (1400 Ha) carried out by DPT on yearly basis. The monitoring study will cover components such as density, diversity and abundance. Other variables such as canopy cover, GBH, height, along with the recruitment and regeneration classes will also be investigated. Additionally, carbon sequestration potential of the plantation will also be studied in view of Climate Change mitigation measures.

4. Obligation of KPT :

- Assistance regarding the statutory clearance from authorities concerned to be rendered by DPT for field visits.
- Study area Map along with GPS Co-ordinates to be provided by the DPT.

5. Time Period : One year (One time monitoring in a year).

6. Kindly send the acknowledgement of this work order & start the work w.e.f. 24/05/2021.

Thanking you.

Yours faithfully,

3/5/21

Superintending Engineer (PL) & EMC (I/c)
Deendayal Port Trust

Annexure -V

Disaster Management Plan

(UPDATED MAY 2019)

for

DEENDAYAL PORT TRUST

ISO 9001:2008 & ISO 14001:2004 Certified Port

Post Box No: 50

Gandhidham (Kutch) – 370201

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1 PREFACE

The Disaster Management Plan (DMP) for Kandla Port has been developed to provide procedures for the implementation and continual development of the Internal Action Plan.

The Internal Action Plan is an interactive document which will be continuously refined and updated every year.

This plan has been formulated to fulfil the requirements of the relevant standards and guidelines set forth by the National Diaster Plan 2016.

It should be noted that the findings and recommendations of the study are based on the data provided and discussions held during the site visit with the port personnel at the time of the site visit on 18th & 19th August 2010 and updated in the Month of July 2016. FOLLOWED BY MAY 2019

National Disaster Management Plan, 2016. A publication of the National Disaster Management Authority, Government of India. May 2016, New Delhi

Documents provided by DEENDAYAL PORT TRUSTfor reference are:-

1. DEENDAYAL PORT TRUST– Internal action plan up dated July 2018.
2. DMP – DEENDAYAL PORT TRUST– Originally Prepared by Tata AIG Risk Management in the year 1999. Updated by A R Jadeja, Signal Supdt. KPT 2016
3. Copies of DMP of chemical / POL Terminals on Kandla Port Property.
    a) JRE tank terminal (P) Ltd.
    b) CRL
    c) BPCL

d) United storage and tank terminals Ltd – Liquid Terminal

e) United storage and tank terminals Ltd – Liquefied Gas Storage and handling terminals.

f) Indo Nippon chemical Company Ltd.

g) Rishi Kiran Logistics (P) Ltd,

h) INEOS ABS (India) Ltd

i) Friends oil and chemical terminals (P) Ltd

j) Indian oil (LPG)

k) Indian Oil

l) IOC Marketing Division

m) HPCL

n) Friends salt works and allied industries

o) IFFCO

4. Layout Map of DEENDAYAL PORT TRUST– DRG. NO: KPH/09
5. Layout of Fire fighting line at DEENDAYAL PORT TRUST
6. Layout of proposed oil pipe line at oil jetty DEENDAYAL PORT TRUST

We have exercised all reasonable skill, care and diligence in carrying out the study. This report / document is

not deemed to be any undertaking, warranty or certificate.

2 INTRODUCTION

The important aspect in emergency management is to prevent by Technical & Organizational measures, the unintentional escape of hazardous materials out of the facility and minimize accidents and losses.

Emergency planning also demonstrates the organizations commitment to the safety of employees and public and increases the organizations safety awareness.

The format and contents of the Disaster Management Plan (DMP) have been developed taking into consideration the guidelines of National Disaster Management Authority & Plan, and other accepted industry good practice principles formulated as a result of lessons learned in actual emergencies requiring extensive emergency response.

This master document is to be studied in advance and used for training purpose also. This master document will be upgraded once in every three years by reviewed annually.

2.1 Objectives of DMP

The objective of DMP is to describe the facility emergency response organization, the resources available and response actions applicable to deal with various types of emergencies that could occur at the facility with the response organization structure being developed in the shortest time possible during an emergency. Thus, the objectives of emergency response plan can be summarized

- ③ Rapid control and containment of the hazardous situation.
- ③ Minimizing the risk and impact of event / accident.
- ③ Effective rehabilitation of the affected persons and preventing of damage to property.

In order to effectively achieve the objectives of the emergency planning, the critical elements that form the backbone of the DMP are

- ③ Reliable and early detection of an emergency and careful planning.
- ③ The command co – ordination and response organization structure along with efficient trained personnel.
- ③ The availability of resources for handling emergencies.
- ③ Appropriate emergency response actions.
- ③ Effective notification and communication facilities ③ Regular review and updating of the DMP ③ Proper training of the concerned personnel.

FOREWORD

"The document On-site Disaster Management Plan is prepared with the objective of defining the functions and responsibilities of all concerned managerial, operational and supporting services department personnel with respect to detection and effective implementation of action plan. The ultimate goal is the effective containment of the emergency situation by proper mitigative action at the place of occurrence, cautioning people in adjoining affected locations, prompt rescue and medical aid to affected persons and communication to civil authorities for rushing in help from outside. All concerned are hereby requested to carefully study and thoroughly familiarize themselves with it in order to ensure its effectiveness in times of emergency"

Chairman

DEENDAYAL PORT TRUST

Date: ___/___/2019

2.2 Responsibility Nodal officer

Responsibility for establishing and maintaining a state of emergency preparedness belongs to the DC. He is responsible for maintaining distribution control of the plan, and for ensuring that the plan and applicable implementing procedures are reviewed annually. The Fire Safety In charge is responsible for the training of personnel to ensure that adequate emergency response capabilities are maintained in accordance with the plan. He is also responsible for ensuring the adequacy of the conduct of drills, as outlined in the On-site Disaster Management Plan. All employees of various departments are responsible for carrying out their responsibilities, as defined in this Plan.

Contact details of Deputy Conservator as a NODAL OFFICER for any port related contingencies/ incidents are as under

Name Capt T Srinivas

Phone : 02836-233585

Fax : 02836-233585

Cell : 9825232982

E mails : dyconservator@deendayalport.gov.in , srini_takes@yahoo.com , signalkpt@gmail.com

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3 FACILITY DESCRIPTION PORT PROFILE

3.1 Introduction

3.1.1 Unique Location

The Major Port of Kandla situated about 90 km off the mouth of Gulf of Kachchh in the Kandla Creek at Latitude 23 degree 1minute North and Longitude 70 degree 13 minutes east, is the lone Major Port on the Gujarat coast line along the West Coast of the country. Amongst the 12 Major Ports in the country, Kandla occupies an enviable position, both in terms of international maritime trade tonnage handled and financial stability and self-sufficiency attained year after year. A gateway to the north-western part of India consisting of a vast hinterland of 1 million sq. km stretched throughout 9 states from Gujarat to Jammu & Kashmir, the Port has a unique location advantage. The Port's hinterland is well connected with infrastructural network of broad gauge and railway system as well as State and National Highways

3.1.2 The Evolution

January 20, 1952, Pandit Jawaharlal Nehru, the then Prime Minister of India, laid the foundation stone at Kandla for the new port on the western coast of India. It was declared as a Major Port on April 8, 1955 by Late Lal Bahadur Shastri, the then Union Minister for Transport. The DEENDAYAL PORT TRUSTwas constituted in 1964 under the Major Port Trusts Act, 1963. Since then, this Major Port of Kandla has come a long way in becoming the 'Port of the New Millennium'.

3.1.3 The Strengths to Anchor On

Excellent infrastructural facilities, well-connectivity with the rest of the country by road and rail networks, all-round services provided with efficiency and transparency, lowest port tariff and the envious cost-effectiveness are the major strengths of Kandla Port.

3.1.4 Vision

"To be Asia's Supreme Global Logistic Hub"

3.1.5 Mission

To transform the Port of Kandla into a most globally competitive logistics hub with international excellence leaving imprints in the international maritime arena by exploring its fathomless growth potentialities.

HAZARD RISK VULERNABILITIES

3.2 Business Horizon

As the portal to the West and North India and due to its unique location advantage, a vast hinterland of 1 million sq. km can be assured for from Kandla.

The hinterland of the Kandla Port consists of the states of J &K, Punjab, Himachal Pradesh, Haryana, Rajasthan, Delhi, Gujarat and parts of Madhya Pradesh, Uttaranchal and Uttar Pradesh.

Kandla Port is the gateway port for the vast granaries of Punjab and Haryana and the rich industrial belt of West and North India.

3.2.1 **Advantage Deendayal Port**

- ISO 9001 – 2008& ISO 14001:2004 Certified Port.
- All weather port – 365 days, 24 hours.
- Protected and safe harbor.
- 16 berths stretching 2.55 km in a straight line
- Facilities for liquid cargo, POL products, chemicals and edible oil.
- Storage facility for LPG to the tune of 30,000 cu.m.

Port with highest liquid storage capacity in the country.

Excellent road and rail connectivity.

High capacity cranes for dry cargo.

Transparent and notified tariff.

13 meter draught.

Security by CISF. ISPS Compliant

3.3 Port Logistics

3.3.1 Navigation Facilities

- Round-the-clock navigation.
- Permissible draught 13 meters.
- Ships with 330 meters length overall and 75,000 DWT are accommodated presently.
- Safe, protected and vast anchorage at outer harbour for waiting and lighter age purpose.
- 22 lighted navigational buoys with solar lights, as per IALA system, are provided in the navigational channel.
- VTS PMS & Pillot Personal Unit as an aid for night navigation.
- Fully equipped signal stations operational round-the-clock. With VTS GOK Port Monitoring Stations

3.3.2 Flotilla

10 Harbor tugs of various sizes. (inclusive Vadinar

2 high speed pilot launches.

One state of the art fully computerized survey launch
FRP mooring launches.
Four general service launches.

One heave up barge for maintenance of navigational aids.

3.4 Strategic & Climatic Advantage

- All-weather port.
- Tropical and dry climatic conditions to handle any type of cargo throughout the year.
- Temperature varying from 25 degree Celsius to 47 degree Celsius.
- Scanty rainfall facilitates round-the-year operations.
- Uninterrupted and smooth port operations on 365 days a year.
- No adverse wave effect, being a protected and sheltered harbour situated in the Creek.
- The only Indian Major Port nearest to the Middle East and Europe.

3.5 Port Location

- Latitude: $23^{o}01''$N
- Longitude: $70^{o}13''$E

Kandla Port is situated in the Kandla Creek and is 90km from the mouth of the Gulf of Kutch.

3.5.1 Location - Latitude : 23^{o} 1' N, Longitude : 70^{o} 13' E

Figure 1 – Over view of DEENDAYAL PORT TRUST

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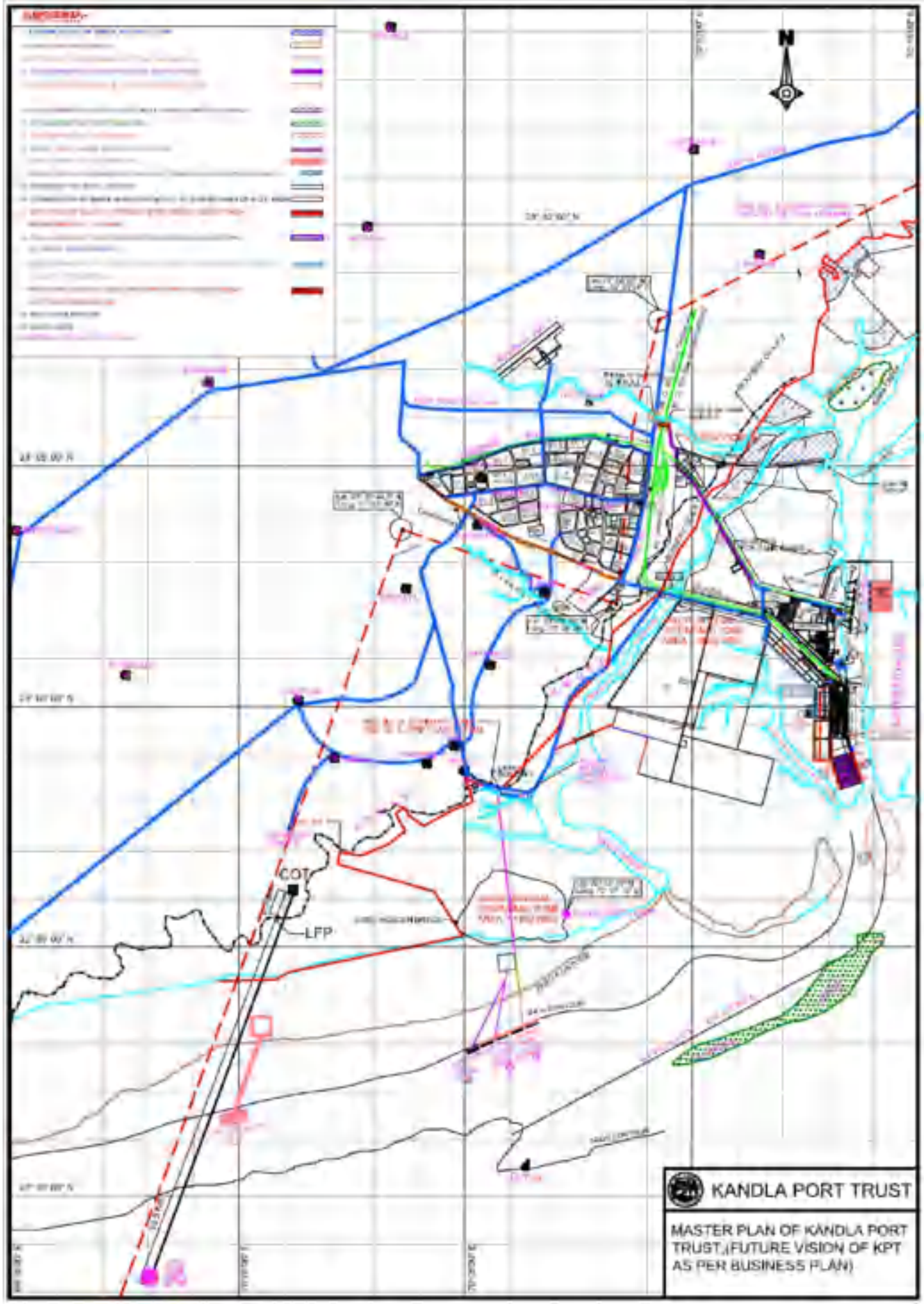
3.6 Future Vision of KPT as per Business Plan


N
COT
LFP
KANDLA PORT TRUST
MASTER PLAN OF KANDLA PORT TRUST.(FUTURE VISION OF KPT AS PER BUSINESS PLAN)

3.7 Steel Floating Dry Dock

The existing steel floating dry dock caters to the need of Port crafts as well as outside organizations and has capacity to accommodate vessels of following parameters.

- LOA maximum up to 95 meters.
- Breadth maximum up to 20 meters.
- Draught maximum up to 4.5 meters.
- Lift displacement maximum up to 2700 tones.

3.8 Infrastructure Advantages at Kandla Port

- 16 dry cargo berths are available, with quay length of 2532 meter.
- Six oil jetties.
- Total custom bonded port area inside the custom fencing is 253 hectares.
- THREE cargo moorings in the inner harbor area for stream handling.

3.8.1 Chemical & Liquid handling Complex

- Total storage capacity : 21.89 Lakh KL
  - Private sector storage terminals – 9.81 Lakh KL.
  - Public sector and cooperative undertaking – 12.08 Lakh KL.
- Loading arms for simultaneous loading and unloading.
- Near zero waiting period for vessels.
- Capacity utilization at international levels ensuring demurrage free handling.
- Excellent discharge rates and faster turnaround.
- Lowest vessel related charges and wharfage charges.
- Suitable for A, B, C. LG, NH, EO classes of liquid and chemicals.

Chemical storage tank farms in the vicinity of liquid jetties.

Tanks for storage of all categories of liquid cargoes like chemicals LPG, cryogenic cargoes, ammonia, acids, petroleum products, edible oils. Etc.

- Efficient handling ensuring minimum losses.
-
- Sophisticated pipeline network (including stainless steel pipes) Sufficient parking space inside and outside the storage facilities.

3.9 Road Network

- Four lane National Highway No: 8-A extended right up to the Ports main gates.
- Fully developed road network, both in and around the Port area to facilitate faster movement of cargo.

○ Inside Cargo Jetty Area – 30 km. ○ Outside Cargo Jetty Area – 31 km. ○ Railway Inside Cargo Jetty Area – 13 km.

3.10 Storage Facilities

Kandla Port offers excellent and vast dry cargo storage facilities inside the custom bonded area for storage of import and export cargoes.

The existing storage facilities at the dry cargo jetty area are:

Sr No	Description	No	Area (Sq MTRS)	Capacity in (Tones)
01	Warehouses	35	2.03 Lakhs	6.47 Lakh
02	Open storage space	67	16.63 Lakhs	36.27 Lakh

3.10.1 Private Sector Liquid Storage Facilities

Sr No	Name of the Terminal Operator	No of Tanks	Capacity in (KL)

01	CRL (Chemicals & Resins Ltd)	112	247000
02	FSWAI (Friend Salt Works & Allied Industries)	132	271650
03	Kesar Enterprise	44	90081
04	N P Patel Pvt Ltd	09	38497
05	FOCT (Friend Oil & Chemicals Terminal	21	39263
06	USTTL – Liquid Terminal	22	63038
07	Agencies & Cargo Care Limited	27	50000
08	J K Synthetics	14	25176
09	IMC Limited	04	25288
10	J R Enterprises	15	25320
11	Indo Nippon Chemicals Ltd	10	17200
12	Liberty Investment	06	16016
13	Bayer ABS Ltd	11	13310
14	Deepak Estate Agency	09	13212
15	Tejmalbhai & Company	08	12577
16	Avean International Care Ltd	11	12160
17	USTTL Gas Terminal	04	5720
18	Parker Agrochem Export Ltd	06	15000
	Total Capacity	465	980508

3.10.2 Public Sector Liquid Storage Facilities

Sr No	Name of the Terminal Operator	No of Tanks	Capacity in (KL)
01	Indian Oil Corporation	38	575838
02	Bharat Petroleum Corporation	21	230000
03	Hindustan Petroleum Corporation	28	204000
04	IOC – LPG	02	30000
05	IFFCO	11	110000
06	NDDB	09	58530
	Total Capacity	109	1208360

3.11 Container Handling Facilities HAS BEEN AWARDED TO KANDLA INTERNATIONAL CONTAINER TERMINAL : OPERATIONAL

Fully operational Container Terminal Operated by KICT

3.12 Port Equipments

3.12.1 Wharf Cranes

- 12 wharf cranes of the following capacities:
  - Two of 12 tones.
  - Four of 16 tones.
  - Six of 25 tones.

- 2 MOBILE CRANES OF 63 TONNES EACH

- The rated capacity of the 16 ton crane is 400 tones / hour.
- The rated capacity of the 25 ton crane is 400 tones / hour.

3.12.2 Weighbridges

- Nine weighbridges inside the port, which includes:
  - Two Weighbridge of 40 MT capacities.
  - ○ One Weighbridge of 50 MT capacity
  - ○ Two Weighbridge of 60 MT capacity
  - ○ Two Weighbridge of 80 MT capacity
  - ○ Three Weighbridge of 100 MT capacities.

3.12.3 Other Support Equipment

- Easy availability of other support loading equipments such as Forklifts, Tractor - Trailers, Pay-loaders of various capacities.

- Private handling, equipments like Mobile Cranes, Top lifters, pay-loaders, Forklifts, Heavy-duty Trailers etc. available on hire at competitive rates.

3.13 Berths at Kandla Port

3.13.1 Details of Draught

Sr No	Name of Berth	Draught (in Meters)	DWT (In Metric Tons)
1	Cargo Berth No.1	10.0	45000

2	Cargo Berth No.2	9.80	45000
3	Cargo Berth No.3	9.80	45000
4	Cargo Berth No.4	9.80	45000
5	Cargo Berth No.5	10.0	35000
6	Cargo Berth No.6	12.0	35000
7	Cargo Berth No.7	12.00	55000
8	Cargo Berth No.8	12.00	55000
9	Cargo Berth No.9	12.00	55000
10	Cargo Berth No.10	12.00	55000
11	Cargo Berth No.11	13.00	65000
12	Cargo Berth No.12	13.0	65000
13	Cargo Berth No.13	13.0	75000
14	Cargo Berth No. 14	13.0	75000
15	Cargo Berth No.15	13.0	75000
16	Cargo Berth No. 16	13	75000
15	Oil Jetty No. 1 (Nehru Jetty)	10.0	40000
16	Oil Jetty No. 2 (Shastri Jetty)	09.00	52000
17	Oil Jetty No. 3 (Indira Jetty)	09.80	40000
18	Oil Jetty No. 4 (Rajiv Jetty)	10.70	56000
19	Oil Jetty No. 5 (IFFCO)	10.10	45000
18	Oil Jetty No. 6 (IOCL)	10.10	45000

3.13.2 Details of Berths

No of Berth	No of Bollard		No of Panels	Length of Each Panel	Length of Berth (m)	Draught (in Meters)	DWT (In Metric Tons)
1	1 to 8	08	08	22.866	182.93	9.80	45000
2	8 to 16	08	08	22.866	182.93	9.80	45000
3	17 to 24	08	08	22.866	182.93	9.80	45000
4	25 to 32	08	08	22.866	182.93	9.80	45000
5	33 to 41	09	09	22.866	205.79	9.10	35000
6	42 to 50	09	09	22.866	205.79	9.10	35000
7	51 to 58	08	08	(30.440 x 7) + 22.56 + (3.00)	238.64	12.00	55000
8	59 to 68	10	06	(45.72 x 3) + 30.44 + 27.44 + (18.00)	213.04	12.00	55000
9	69 to 76	08	05	(45.72 x 3) + 25.72 + (18.05)	182.93	12.00	55000
10	77 to 85	09	05	(59.10 x 2) + (43.20 x 2) + (4.81)	209.41	12.00	55000
11	86 to 98	13	05	(59.00 x 4) + (45.00)	281.00	12.50	65000
12	-----	---	---		264.00	12.50	65000
13						13.0	75000
14						13.0	75000
15						13.0	75000
16						13.0	75000

3.13.3 Details of Existing Godown

Sr No	Godown No	Size of Godown (in M)	Area in Sq Meters	Capacity in (Tons)
1	Godown – 1 (WH-A)	152.44 x 36.59	5578	9817
2	Godown – 2 (WH-B)	152.44 x 36.59	5578	10500
3	Godown – 3 (W.H -C)	152.44 x 36.59	5578	10500
4	Godown – 4 (W.H.D)	152.44 x 36.59	5578	10500
5	Godown – 6 (C.F.S. - II)	90.00 x 36.00	3240	12400
6	Godown – 7 (C.F.S. – I)	90.00 x 36.00	3240	12400
7	Godown – 8 (F.B.S.S)	236.00 x 30.00	7080	13300
8	Godown – 9 (Bagging Plant)	287.00 x 19.20	5510	10400
9	Godown – 10	132.00 x 22.50	2970	11400
10	Godown – 11	186.00 x 22.50	4185	7900
11	Godown – 12	170.00 x 22.50	3825	7200
12	Godown – 13	162.00 x 22.50	3645	6900
13	Godown – 14	192.00 x 22.50	4320	8100
14	Godown – 15	162.00 x 22.50	3645	6900
15	Godown – 16	192.00 x 22.50	4320	9100
16	Godown – 17	174.00 x 22.50	3915	15000
17	Godown – 18	138.00 x 45.00	6210	23800
18	Godown – 19	192.00 x 22.50	4320	8100
19	Godown – 20	192.00 x 22.50	4320	8100
20	Godown – 21	192.00 x 22.50	4320	8100

21	Godown – 22	192.00 x 22.50	4320	8100
22	Godown – 23	174.00 x 22.50	3915	7400
23	Godown – 24	156.00 x 45.00	7020	26900
24	Godown – 25	132.00 x 22.50	2970	5600
25	Godown – 26	99.06 x 36.55	3621	13900
26	Godown – 27		1943	6995
27	Godown – 28	173.88 x 30.50	5503	19092
28	Godown – 29	137.55 x 50.00	6888	24797
29	Godown – 30	126.00 x 49.00	6174	22226
30	Godown – 31	140.00 x 50.00	7000	25200
31	Godown – 32	307.45 x 40.00	12298	44273
32	Godown – 33	133.00 x 40.00	5320	19152
	Total Available Presently		158349	434052

3.14 Various Private Terminal Storages at Kandla & the chemicals POL products handled.

3.14.1 Bharat Petroleum Corporation Ltd

- Motor Spirit (MS)
- HSD – High Speed Diesel
- SKO – Superior Kerosene Oil
- Ethanol (Ethyl Alcohol)
- Naphtha
- LDO – Light Diesel Oil

3.14.2 **CRL**

- Benzene
- Toluene
- Aniline
- Butanol (Butyl Alchol)
- H Phenol
- CTC – Carbon Tetra Chloride
- Caster Oil
- CPS
- Phenol
- De Alcohol (Denatured Alcohol)
- IPA – Iso Propyl Alcohol

Butyl Acetate

MEK (Methyl Ethyl Ketone)

Methyl Alcohol / Methanol

Hexane

Vinyl Acetate

MIBK

- BAM
- Propylene
- Cyclo Hexane
- Caustic Soda (Sodium Hydroxide)
- Acetic Acid

Nonene

EDC (Ethylene Di Chloride)

3.14.3 United Storage & Tank Terminals Ltd

- LPG – Liquefied Gas Storage & Handling terminal
- 1:3 Butadiene
- Crude C 4 Mix
- Butane – 1

3.14.4 Indo Nippon Chemicals Co Ltd

- ISO Butanol
- A – Olefin
- Waksol (Parafin)
- VAM – Vinyl Acetate Monomer
- MDC – (Methyle Metacrylate)
- Toluene
- Naphtha
- IPA

3.14.5 Rishi Kiran Logistics (P) Ltd

- Butyl Cellsolve
- Chloroform
- DO Wanol
- HNP
- N – Parafin
- Methanol
- Polyether Polyol
- Papi 27 Polymeric
- Tri chloric ethylene Vinyl chloride monomer.

3.14.6 Ineos ABS (India) Ltd

Chemicals Stored

- Styrene
- ACN
- Chloroform
- Parafin

Chemicals Proposed

- Methyl Ethyl Ketone (MEK)
- Benzene
- Methanol
- HNP
- Acetone
- Butyl Acrylate
- Butanol
- 1 – Butanol
- CTC (Carbon Tetra Chloride)
- Cyclo Hexonol
- Cyclo Hexanone
- Cumene
- Di Octylphthalate
- Ethanol – IPA (Mix)
- Ethanol
- Ethyl Hexonol
- Ethyl Benzene
- Hexane
- Heptane
- Iso Propanol

P – Xylene

Propylene Trimer

C – 9 – Hydrocarbons

Toluene

Vinyl Acetate

Mixed xylene

N – Tetra Decane

Polvoal

3.14.7 Friends Oil & Chemical Terminal (P) Ltd

- Furnace Oil
- Styrene
- C – Palm Oil
- Mix – HSD & Naphtha
- CPO (NEG) – Crude Palm Oil
- Acrylate Bam
- Butyle Glycol
- Mosstanoll
- Butyl Glycol

Cubutol

Methyl Methacr

ISO Nanano

CDSBO

3.14.8 Indian Oil (LPG)

- LPG

3.14.9 Indian Oil FST

- Motor Spirit (MS)
- High Speed Diesel (HSD)
- SKO (Superior Kerosene Oil)

LAN

3.14.10 Hindustan Petroleum Company Limited

- Furnace Oil (FO)
- High Speed Diesel (HSD)
- Light Diesel Oil (LDO)
- SKO (Superior Kerosene Oil)
- Motor Spirit (MS)

3.14.11 Friends Salt Works & Allied Industries

- Naptha
- Toluene
- N – Proanol
- HNP
- Mixed Parafin
- Solvent – CS
- Iso Prophyl Alcohol (IPA)
- Methenol
- N – Parafin C9 – C
- M – xylene
- High Speed Diesel (HSD)

Mosstanol

Methylene Chloride

Ethyl Acetate

Vinyl Acetate

HA – 100

MEK

Acetone

Crude Benzene

Heavy Aromatics

Butyl Acrylate

Shell Sarasol – 4

Carbon Tetra Chloride (CTC)

HA – 170

MBK

De Natured Spirit

Nonene

Condensate

Caradol SC- 56 – 0

N – Parafin

Butyl Acetate

- LAB
- Naptha
- Hexane
- ISO – Decyl Alcohol
- Sodium Hydroxide (Caustic Soda)
- Methyl Met
- Butyl Arylate
- MIBK

DHSO – But

Crude PEG

CPKO Crude
PNEG

3.14.12 IFFCO

- Anhydrous Liquid Ammonia
- Phosphoric Acid
- Potosh
- Urea
- Hydrochloric Acid
- Sulphuric Acid
- LSHS Furnace Oil

3.14.13 IOC (Marketing)

No list of chemicals is provided

3.14.14 JRE Tank Terminal (P) Ltd (Liquid Storage Terminal)

No list of chemicals is provided

3.14.15 United Storage & Tank Terminals Ltd (Liquid Terminal)

No list of chemicals is provided

3.15 Offshore Oil Terminal (OOT) Vadinar

KPT had commissioned off shore oil terminal facilities at Vadinar in 1978, jointly with Indian Oil Corporation, by providing single bouy mooring (SBM) system having capacity of 54 MMTPA, which was the first of its kind in India. A significant quantum of infrastructural up gradation has since been effected and excellent maritime infrastructure created for the 32 MMTPA Essar Oil Refinery at Vadinar.

- A draught of up to 33 meters at SBMs and lighterage point operations (LPO) Three SBMs available.
- 2 Oil Handlling Berths of 1,00,000 DWT draft of 20 mtrs
-
- Handling VLCCs of 300000 DWT and more.

Providing crude oil for the refineries of Koyali (Gujarat), Mathura (UttarPradesh), Panipat (Haryana) and Essar Refinery, Jamnagar (Gujarat) 2nd SBM was commissioned in the year 1998.

- 3rd SBM at Vadinar is for importing crude for the oil refinery of Essar Oil.
- Simultaneous handling of three VLCCs possible at the SBMs. 3 SBMs interconnected by sub-sea
- pipeline
-

Vast crude tankage facility.

Two 35 tone and four 50 tone state of art BP SRP pull back tugs are available for smooth and simultaneous shipping operations on the SBMs and product jetty.

- Excellent infrastructure and tranquil waters facilitate transshipment operations even during the monsoon.

4 IDENTIFICATION OF EMERGENCIES

4.1 Overall Methodology

In order to undertake this study DPT has used ALOHA (Aerial Locations of Hazardous Atmospheres) a computer program designed especially for use by people responding to chemical releases, as well as for emergency planning and training. ALOHA models key hazards — toxicity, flammability, thermal radiation (heat), and overpressure (explosion blast force) — related to chemical releases that result in toxic gas dispersions, fires, and /or explosions.

4.1.1 Dispersion Modeling

ALOHA air dispersion model is intended to be used to estimate the areas near a short-duration chemical release where key hazards—toxicity, flammability, thermal radiation, or overpressure—may exceed user-specified Levels of Concern (LOCs).

(Note: If the released chemical is not flammable, toxicity is the only air dispersion hazard modeled in ALOHA.)

ALOHA is not intended for use with radioactive chemical releases, nor is ALOHA intended to be used for permitting of stack gas or modeling chronic, low-level ("fugitive") emissions. Other models are designed to address larger scale and/or air quality issues (Turner and Bender 1986). Since most first responders do not have dispersion modeling backgrounds, ALOHA has been designed to require input data that are either easily obtained or estimated at the scene of an accident. ALOHA's on-screen help can assist you in choosing inputs.

4.1.1.1 What is Dispersion

Dispersion is a term used by modelers to include advection (moving) and diffusion (spreading). A dispersing vapor cloud will generally move (advent) in a downwind direction and spread (diffuse) in a crosswind and vertical direction (crosswind is the direction perpendicular to the wind). A cloud of gas that is denser or heavier than air (called a heavy gas) can also spread upwind to a small extent.

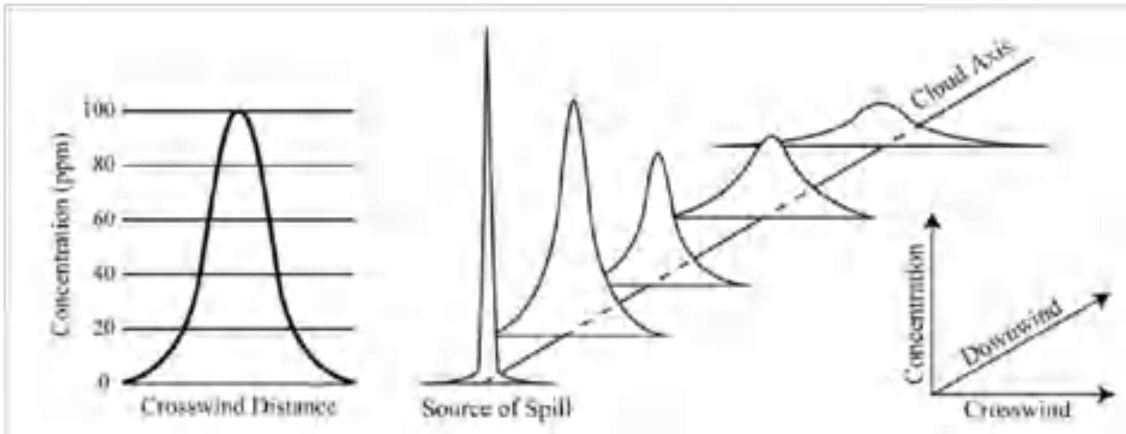
ALOHA can model the dispersion of a cloud of pollutant gas in the atmosphere and display a diagram that shows an overhead view of the regions, or threat zones, in which it predicts that key hazard levels (LOCs) will be exceeded. This diagram is called a threat zone plot. To obtain a threat zone estimate, you must first choose at least one LOC. (ALOHA will suggest default LOCs, and you may keep those or choose up to three other LOCs.) For toxic gas dispersion scenarios, an LOC is a threshold concentration of the gas at ground level—usually the concentration above which a hazard is believed to exist. The type of LOC will depend on the scenario. For each LOC you choose, ALOHA estimates a threat zone where the hazard is predicted to exceed that LOC at some time after a release begins. These zones are displayed on a single threat zone plot. If three LOCs are chosen, ALOHA will display the threat zones in red, orange, and yellow. When you use ALOHA's default LOCs, the red zone represents the worst hazard.

There are two separate dispersion models in ALOHA: Gaussian & Heavy Gas.

4.1.1.2 Gaussian Model:

ALOHA uses the Gaussian model to predict how gases that are about as buoyant as air will disperse in the atmosphere. Such neutrally buoyant gases have about the same density as air. According to this model, wind and atmospheric turbulence are the forces that move the molecules of a released gas through the air, so as an escaped cloud is blown downwind, "turbulent mixing" causes it to spread out in the crosswind and upward directions. According to the Gaussian model, a graph of gas concentration within any crosswind slice of a moving pollutant cloud looks like a bell-shaped curve, high in the center (where concentration is highest) and lower on the sides (where concentration is lower), At the point of a release, the pollutant gas concentration is very high, and the gas has not diffused very far in the crosswind and upward directions, so a graph of concentration in a crosswind slice of the cloud close to the source looks like a spike. As the pollutant cloud drifts farther downwind, it spreads out and the "bell shape" becomes wider and flatter.

Gaussian distribution (left) & Gaussian Spread (right)



4.1.1.3 Heavy gases:

When a gas that is heavier than air is released, it initially behaves very differently from a neutrally buoyant gas. The heavy gas will first "slump," or sink, because it is heavier than the surrounding air. As the gas cloud moves downwind, gravity makes it spread; this can cause some of the vapor to travel upwind of its release point. Farther downwind, as the cloud becomes more diluted and its density approaches that of air, it begins behaving like a neutrally buoyant gas. This takes place when the concentration of heavy gas in the surrounding air drops below about 1 percent (10,000 parts per million). For many small releases, this will occur in the first few yards (meters). For large releases, this may happen much further downwind.

Cloud spread as a result of gravity.

The heavy gas dispersion calculations that are used in ALOHA are based on those used in the DEGADIS model (Spicer and Havens 1989), one of several well-known heavy gas models. This model was selected because of its general acceptance and the extensive testing that was carried out by its authors.

4.1.1.4 Classification of Heavy Gases:

A gas that has a molecular weight greater than that of air (the average molecular weight of air is about 29 kilograms per kilomole) will form a heavy gas cloud if enough gas is released. Gases that are lighter than air at room temperature, but that are stored in a cryogenic (low temperature) state, can also form heavy gas clouds. If the density of a gas cloud is substantially greater than the density of the air (the density of air is about 1.1 kilograms per cubic meter), ALOHA considers the gas to be heavy.

4.1.2 Fires & Explosions

ALOHA version 5.4, can model fire and explosion scenarios as well as toxic gas dispersion scenarios. This section provides information about fires and explosions, and then explains how to model fires and explosions in ALOHA.

ALOHA allows to model chemical releases from four types of sources: Direct, Puddle, Tank, and Gas Pipeline.

- ③ Direct: chemical release directly into the atmosphere (bypassing ALOHA's source calculations).
- ③ Puddle: chemical has formed a liquid pool.
- ③ Tank: chemical is escaping from a storage tank.
- ③ Gas Pipeline: chemical is escaping from a ruptured gas pipeline.

ALOHA Sources & Scenarios

Source	Toxic Scenarios	Fire Scenarios	Explosion Scenarios
Direct			
Direct Release	Toxic Vapor Cloud	Flammable Area (Flash Fire)	Vapor Cloud Explosion
Puddle			
Evaporating	Toxic Vapor Cloud	Flammable Area (Flash Fire)	Vapor Cloud Explosion
Burning (Pool Fire)		Pool Fire	
Tank			
Not Burning	Toxic Vapor Cloud	Flammable Area (Flash Fire)	Vapor Cloud Explosion
Burning		Jet Fire or Pool Fire	
BLEVE		BLEVE (Fireball and Pool Fire)	
Gas Pipeline			
Not Burning	Toxic Vapor Cloud	Flammable Area (Flash Fire)	Vapor Cloud Explosion
Burning (Jet Fire)		Jet Fire	

4.1.2.1 Fire

A fire is a complex chain reaction where a fuel combines with oxygen to generate heat, smoke, and light. Most chemicals fires will be triggered by one of the following ignition sources: sparks, static electricity, heat, or flames from another fire. Additionally, if a chemical is above its auto ignition temperature it will spontaneously catch on fire without an external ignition source.

There are several properties that measure how readily—that is, how easily—a chemical will catch on fire. Here we'll discuss three of these properties: volatility, flash point, and flammability limits. Volatility is a measure of how easily a chemical evaporates. A flammable liquid must begin to evaporate—forming a vapor above the liquid—before it can burn. The more volatile a chemical, the faster it evaporates and the quicker a flammable vapor cloud is formed. The flash point is the lowest temperature where a flammable liquid will evaporate enough to catch on fire if an ignition source is present. The lower the flash point, the easier it is for a fire to start. Flammability limits, called the Lower Explosive Limit (LEL) and the Upper Explosive Limit (UEL), are the boundaries of the flammable region of a vapor cloud. These limits are percentages that represent the concentration of the fuel—that is, the chemical—vapor in the air. If the chemical vapor comes into contact with an ignition source, it will burn only if its fuel-air concentration is between the LEL and the UEL. To some extent, these properties are interrelated—chemicals that are highly volatile and have a low flash point will usually also have a low LEL.

Once the chemical catches on fire, three things need to be present to keep the fire going: fuel (the chemical), oxygen, and heat. This is often referred to as the fuel triangle. If any one of those components is eliminated, then the fire will stop burning.

Like other reactions, a fire can also generate byproducts—smoke, soot, ash, and new chemicals formed in the reaction. Some of these reaction byproducts can be hazardous themselves. While ALOHA cannot model all the complex processes that happen in a fire (like the generation and distribution of byproducts), it can predict the area where the heat radiated by the fire—called thermal radiation—could be harmful.

Thermal radiation is the primary hazard associated with fires. However, it is also important to consider the hazards associated with any secondary fires and explosions that may occur.

4.1.2.2 Thermal Radiation Levels of Concern:

A Thermal Radiation Level of Concern (LOC) is a threshold level of thermal radiation, usually the level above which a hazard may exist. When you run a fire scenario, ALOHA will suggest three default LOC values. ALOHA uses three threshold values (measured in kilowatts per square meter and denoted as kW/m2) to create the default threat zones:

- ③ Red: 10 kW/m^2 (potentially lethal within 60 sec);
- ③ Orange: 5 kW/m^2 (second-degree burns within 60 sec); and
- ③ Yellow: 2 kW/m^2 (pain within 60 sec).

The thermal radiation effects that people experience depend upon the length of time they are exposed to a specific thermal radiation level. Longer exposure durations, even at a lower thermal radiation level, can produce serious physiological effects. The threat zones displayed by ALOHA represent thermal radiation levels; the accompanying text indicates the effects on people who are exposed to those thermal radiation levels but are able to seek shelter within one minute.

ALOHA's default thermal radiation values are based on a review of several widely accepted sources for this topic (e.g., American Institute of Chemical Engineers 1994, Federal Emergency Management Agency et al. 1988, and Lees 2001).

Thermal Radiation Burn Injury Criteria.

Radiation Intensity (kW/m^2)	Time for Severe Pain (S)	Time for 2^{nd} Degree Burns (S)
1	115	663
2	45	187
3	27	92
4	18	57
5	13	40
6	11	30
8	7	20
10	5	14
12	4	11

Note: The durations that correspond to effects like pain or second-degree burns can vary considerably, depending on circumstances. The effects above were observed on bare skin that was exposed directly to the thermal radiation. Some types of clothing can serve as a protective barrier against thermal radiation and can affect the exposure duration. However, exposure duration should be kept to a minimum, even at low levels of thermal radiation.

4.1.3 Overpressure

A major hazard associated with any explosion is overpressure. Overpressure, also called a blast wave, refers to the sudden onset of a pressure wave after an explosion. This pressure wave is caused by the energy released in the initial explosion—the bigger the initial explosion, the more damaging the pressure wave. Pressure waves are nearly instantaneous, traveling at the speed of sound.

Although a pressure wave may sound less dangerous than a fire or hazardous fragments, it can be just as damaging and just as deadly. The pressure wave radiates outward like a giant burst of air, crashing into anything in its path (generating hazardous fragments). If the pressure wave has enough power behind it, it can lift people off the ground and throw them up against nearby buildings or trees. Additionally, blast waves can damage buildings or even knock them flat— often injuring or killing the people inside them. The sudden change in pressure can also affect pressure-sensitive organs like the ears and lungs. The damaging effects of the overpressure will be greatest near the source of the explosion and lessen as you move farther from the source.

ALOHA predicts an explosion's effects, assess the surroundings at the explosion site as you interpret ALOHA's threat zone plot. Large objects (like trees and buildings) in the path of the pressure wave can affect its strength and direction of travel. For example, if many buildings surround the explosion site, expect the actual overpressure threat zone to be somewhat smaller than ALOHA predicts. But at the same time, more hazardous fragments could be generated as the blast causes structural damage to those buildings.

4.1.3.1 Overpressure Levels of Concern

An Overpressure Level of Concern (LOC) is a threshold level of pressure from a blast wave, usually the pressure above which a hazard may exist. When you run a vapor cloud explosion scenario, ALOHA will suggest three default LOC values. ALOHA uses three threshold values to create the default threat zones:

③ Red: 8.0 psi (destruction of buildings);

③ Orange: 3.5 psi (serious injury likely); and

③ Yellow: 1.0 psi (shatters glass).

ALOHA's default overpressure values are based on a review of several widely accepted sources for this topic (e.g., American Institute of Chemical Engineers 1994, Federal Emergency Management Agency etal. 1988, and Lees 2001).

Explosion Overpressure Damage Estimates

Overpressure* (psig)	Expected Damage
0.04	Loud noise (143 dB); sonic boom glass failure.
0.15	Typical pressure for glass failure.
0.40	Limited minor structural damage.
0.50-1.0	Windows usually shattered; some window frame damage.
0.70	Minor damage to house structures.
1.0	Partial demolition of houses; made uninhabitable.
1.0-2.0	Corrugated metal panels fail and buckle. Housing wood panels blown in.
1.0-8.0	Range for slight to serious laceration injuries from flying glass and other missiles.
2.0	Partial collapse of walls and roofs of houses.
2.0-3.0	Non-reinforced concrete or cinder block walls shattered.
2.4-12.2	Range for 1-90% eardrum rupture among exposed populations.
2.5	50% destruction of home brickwork.
3.0	Steel frame building distorted and pulled away from foundation.
5.0	Wooden utility poles snapped.
5.0-7.0	Nearly complete destruction of houses.
7.0	Loaded train cars overturned.
9.0	Loaded train box cars demolished.
10.0	Probable total building destruction.
14.5-29.0	Range for the 1-99% fatalities among exposed populations due to direct blast effects.

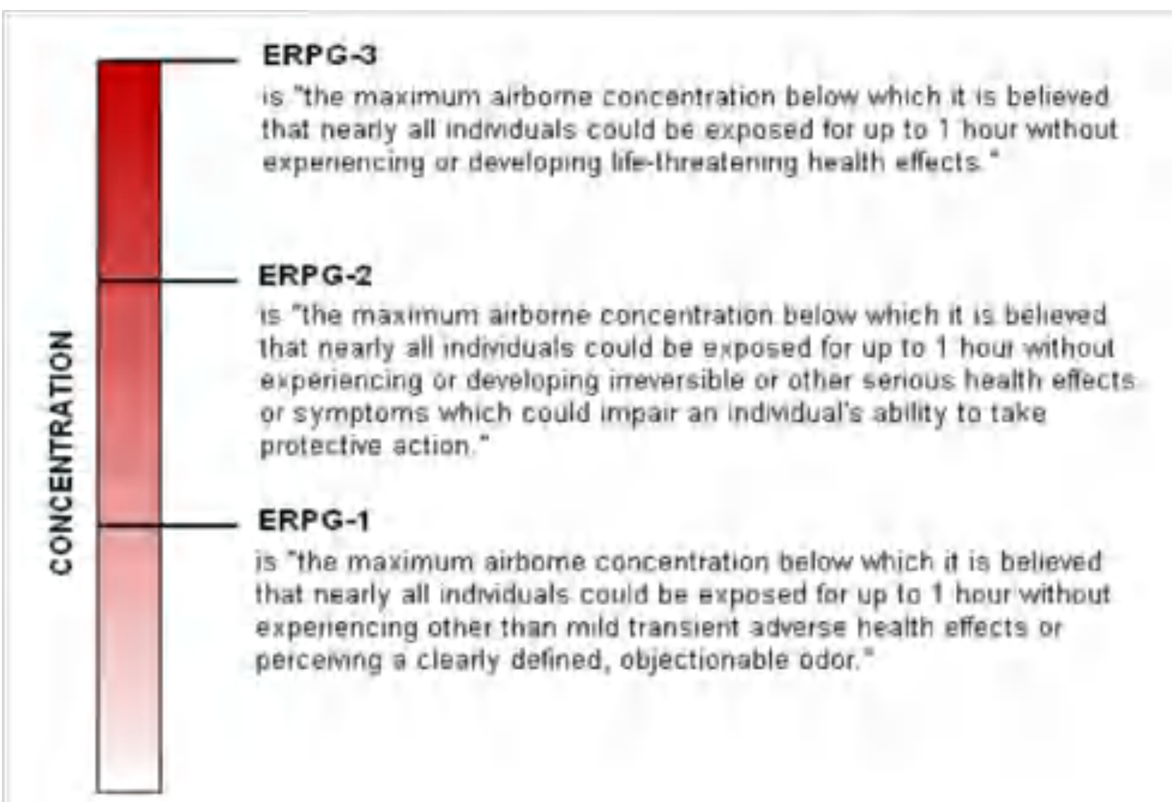
* These are peak pressures formed in excess of normal atmospheric pressure by blast and shock waves.

4.2 Effect at different Heat Radiations & Overpressure

4.2.1 Emergency Response Planning Guidelines (ERPGs)

ERPGs were developed as planning guidelines, to anticipate human adverse health effects caused by exposure to toxic chemicals.

The ERPGs are three-tiered guidelines with one common denominator: a 1-hour exposure period. The tiers are defined as follows:



Interpreting ERPG:

The ERPG guidelines do not protect everyone. Hypersensitive individuals would suffer adverse reactions to concentrations far below those suggested in the guidelines.

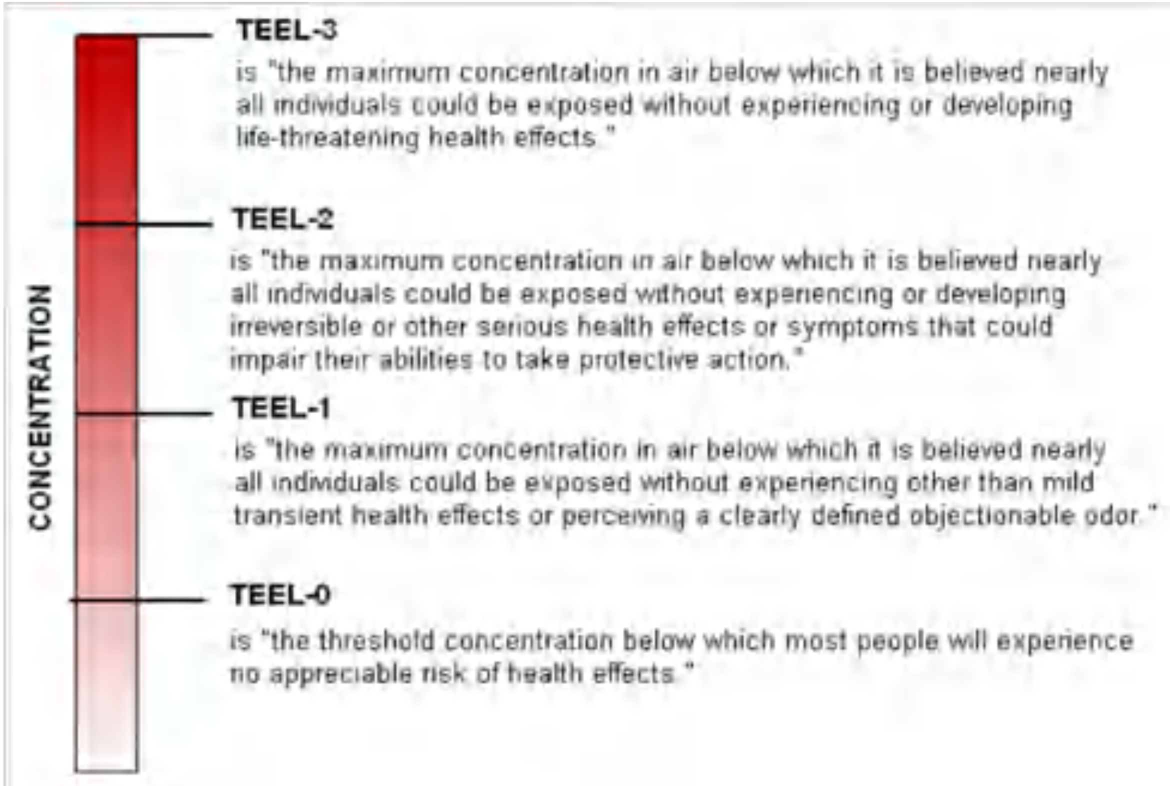
The guidelines are focused on one period of time: 1 hour. Exposure in the field may be longer or shorter. However, the ERPG committee strongly advises against trying to extrapolate ERPG values to longer periods of time.

ERPGs do not contain safety factors usually incorporated into exposure guidelines such as the TLV. Rather, they estimate how the general public would react to chemical exposure. Just below the ERPG-1, for example, most people would detect the chemical and may experience temporary mild effects. Just below the ERPG-3, on the other hand, it is estimated that the effects would be severe, although not lifethreatening. The TLV, on the other hand, incorporates a safety factor to prevent ill effects to exposed workers.

4.2.2 Temporary Emergency Exposure Limit (TEEL)

TEELs are temporary levels of concern designed to be used as toxic exposure limits for chemicals for which Acute Exposure Guideline Levels (AEGLs) or Emergency Response Planning Guidelines (ERPGs) have not yet been defined. Like AEGLs and ERPGs, they are designed to represent the predicted response of members of the general public to different concentrations of a chemical during an incident.

Each TEEL includes four tiers, defined as follows:



4.3 Various emergencies that may be expected at the port area

- Leak / Spill and fire and explosion at the chemical jetties of hazardous chemicals. Fire at Berth/Storage area/warehouse/goodowns
- Medical Injury
- Terrorism/Sabotage
- Civil disturbance
- Hostage situation
- Severe Weather

Earthquake

Tsunami

Ships Accidents in the channel.

4.4 Leak / Spill and Fire & Explosion of Hazardous Chemicals at the Jetties

Consequence analysis of impact distances for selected maximum credible loss scenarios of some selected chemicals handled at the chemical berths. The distance worked are indicative and to be used as a guide line.

4.5 Important assumptions considered for the Study

1. Representative chemicals have been chosen at each jetty. The distance shown in the table / map are applicable to any jetty (1 to 6) where the same chemical could be handled.

   If the port is ready to handle the indicated distances for the chosen chemicals, then it can handle any other chemical emergency also under any weather conditions except storm / cyclone etc.

2. Wind speed 10m/sec from SW at 3 meter height.
3. Ground roughness – Open / Concrete
4. Cloud cover – Partial (5 Tenths)
5. Ambient Temperature – 40 degree C Average
6. Atmospheric stability Class "C"
7. Relative Humidity – 50%
8. Leak of 1000 litres of chemical
9. State of chemical at the time of leak – Liquid
10. Source: Direct Source
11. Source: Evaporating Puddle
    - Downwind toxic effects
    - Vapour cloud flash fire
    - Overpressure from vapour cloud explosion
12. Source: Burning Puddle
    - Thermal Radiation

13. Puddle diameter Average – 10 M

14. Puddle volume 1000 Litres.

4.6 Maximum Credible Loss Scenarios

The Maximum Credible Loss Scenarios (MCLS) give the possible failure scenarios, which takes into account the maximum inventory that can get released at the time of such a failure considering the intervention time based on safety systems provided at the facility.

The most hazardous chemicals taken into consideration for the study are:

Berth No: 1 – LPG & Toluene

Berth No: 2 – Benzene, ACN & Aniline

Berth No: 3 – Methanol, 1,3 Butadiene & Acetone

Berth No: 4 – VCM & Propylene

Berth No: 5 – Ammonia & HSD

Berth No: 6 – Motor Spirit & SKO

4.7 Impact Distances for MCLS under study

4.7.1 Jetty No – 1 Instantaneous Release / Evaporation Puddle / Burning Puddle for LPG

Chemical		Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance for		
		TEEL - 3 33000 ppm	TEEL - 2 17000 ppm	TEEL - 1 5500 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	$10.0 kW/m^2$	$5.0 kW/m^2$	$2.0 kW/m^2$
		m	m	m	m	m	m	m	m	m	m	m
Jetty One	LPG (Instantaneous Release)	31	46	88	68	204	LOC not exceeded	48	61	-----	------	-----
	LPG (Evaporation Puddle)	13	24	54	35	130	LOC not exceeded	21	42	-----	------	-----
	LPG (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	34	42	57

- Emergency equipment should be placed more than 60 meters away from the unloading hoses / source of leak to prevent damage to them due to over pressures.
- All fire fighting operation should be carried out from a 57 meter distance from the unloading hose, unless fire suits and close proximity suits are used by the fire fighting personnel.
- Whatever is the emergency (fire) at the berth, the sprinklers / water curtain at the berth edge should be activated. • All persons not directly connected with the operation should be moved beyond 88 meters from the fire / leak
- There should be no source of ignition in the chemical jetty (1 to 6) areas.
- The complete chemical jetty complex is a flame proof zone at all times.

4.7.2 Jetty No – 1 Instantaneous Release / Ev TOLUENE

Chemical	Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance For		
	ERPG - 3 1000 ppm	ERPG – 2 300 ppm	ERPG – 1 50 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	10.0kW/m^2	5.0kW/m^2	2.0kW/m^2
	m	m	m	m	m	m	m	m	m	m	m

Jetty One	TOLUENE (Instantaneous Release)	208	395	1.0Km	71	233	LOC not exceeded	52	72	-----	------	-----
	TOLUENE (Evaporation Puddle)	< 10	21	73	< 10	< 10	No part of the cloud was above the LEL	No part of the cloud was above the LEL	No part of the cloud was above the LEL	-----	------	-----
	TOLUENE (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	29	35	47

- All emergency equipment should be placed more than 72 meters away from the source of leak.
- Fire fighting should be carried out from a distance of more than 47 meter unless fire suits / fire proximity suits are worn by the fire fighting personnel.
- All persons not directly connected with the emergency operation should be moved more than 1 km away from the source of leak.
- All other fire fighting precautions should be adhered to.

4.7.3 ACRYLONITRILE (ACN)

Chemical		Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance For		
		ERPG - 3 75 ppm	ERPG - 2 35 ppm	ERPG – 1 10 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	10.0kW/m^2	5.0kW/m^2	2.0kW/m^2
		m	m	m	m	m	m	m	m	m	m	m
Jetty Two	ACN (Instantaneous Release)	1.0 Km	1.5 Km	2.8 Km	62	211	LOC not exceeded	41	61	-----	------	-----
	ACN (Evaporation Puddle)	49	76	148	< 10	< 10	No part of the cloud was above the LEL	No part of the cloud was above the LEL	No part of the cloud was above the LEL	-----	------	-----
	ACN (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	19	23	30

- In case of an emergency involving Acrylonitrile in the form of a major leak with or without a fire, all fire fighters handling the emergency must wear Breathing apparatus, in addition to the usual fire suits.
- All persons not connected with the emergency operation should move beyond 2.8Km distance.

- All supporting personnel must be ready with BA sets.
- The nearby shanty should be evacuated.
- All security staff must have respiratory protection.
- All persons handling the emergency should be sent to the Kandla Port Hospital for checking for CAN poisoning.

4.7.4 ANILINE

Chemical		Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance For		
		TEEL – 3 20 ppm	TEEL – 2 12 ppm	TEEL – 1 8 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	10.0kW/m^2	5.0kW/m^2	2.0kW/m^2
		m	m	m	m	m	m	m	m	m	m	m
Jetty Two	**ANILINE** (Instantaneous Release)	1.8 Km	2.3 Km	2.7 Km	72	237	LOC not exceeded	53	73	-----	------	-----
	ANILINE (Evaporation Puddle)	12	20	29	< 10	< 10	No part of the cloud was above the LEL	No part of the cloud was above the	No part of the cloud was above the	-----	------	-----

								LEL	LEL			
	ANILINE (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	20	23	31

- All persons handling the emergency must wear full protection suits to avoid skin contact. BA should be worn by the persons handling the emergency.
- The adjoining shanty should be evacuated.
- Persons handling the emergency should check up if their nails, lips, earlobes have turned blue. If so, immediately move them to Kandla Port hospital.

4.7.5 BENZENE

Chemical	Dispersion Distances	LEL Distances	Overpressure Distances	Pool Fire Heat Radiation Distance For

		ERPG - 3 1000 ppm	ERPG - 2 150 ppm	ERPG -1 50 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	$10.0kW/m^2$	$5.0kW/m^2$	$2.0kW/m^2$
		m	m	m	m	m	m	m	m	m	m	m
Jetty Two	BENZENE (Instantaneous Release)	228	625	1.1 Km	80	265	LOC not exceeded	61	76	-----	------	-----
	BENZENE (Evaporation Puddle)	23	81	145	< 10	20	No part of the cloud was above the LEL	No part of the cloud was above the LEL	No part of the cloud was above the LEL	-----	------	-----
	BENZENE (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	29	35	47

- A Benzene fire gives out dense black smoke which could reduce the visibility. All fire fighters must wear a chemical protection suit while handling the emergency, wear BA.

- All those not connected with the emergency handling should move beyond 1.1 km up wind.
- Initial fire fighting should be from a distance of 47 meter, unless fire suits, proximity suits are worn. All security staff must have respiratory protection.
- All persons handling the emergency should be sent to the Kandla Port hospital for urine test to check for Benzene poisoning.

4.7.6 1:3, BUTADIENE

Chemical		Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance For		
		ERPG - 3 5000 ppm	ERPG - 2 200 ppm	ERPG - 1 10 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	10.0kW/m^2	5.0kW/m^2	2.0kW/m^2
		m	m	m	m	m	m	m	m	m	m	m
Jetty Three	1:3, BUTADIENE (Instantaneous Release)	92	524	2.4 Km	62	206	LOC not exceeded	48	63	-----	------	-----

	1:3, BUTADIENE (Evaporation Puddle)	22	157	736	13	53	LOC not exceeded	< 10	21	-----	------	-----
	1:3, BUTADIENE (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	34	42	57

- Initial fire fighting should be from a distance of more than 57 meters. The fire fighters should wear BA sets and chemical protection suits.
- The shanty should be evacuated beyond 2.4 Km distance.

4.7.7 ACETONE

Chemical		Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance For		
		TEEL - 3 5700 ppm	TEEL - 2 3200 ppm	TEEL - 1 200 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	$10.0kW/m^2$	$5.0kW/m^2$	$2.0kW/m^2$
		m	m	m	m	m	m	m	m	m	m	m
Jetty Three	**ACETONE** (Instantaneous Release)	97	134	591	56	190	LOC not exceeded	40	56	-----	------	-----
	ACETONE (Evaporation Puddle)	10	17	111	< 10	22	No part of the cloud was above the LEL	No part of the cloud was above the LEL	No part of the cloud was above the LEL	-----	------	-----

	ACETONE (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	20	24	32

- Fire fighters should note that acetone and methanol fires are non luminescent and there could be a tendency to go nearer to the puddle /pool on fire. This should be done by fire fighters fully equipped with fire suits / proximity suits. Acetone / Methanol are water soluble, which is advantageous for fire fighting.

4.7.8 METHANOL

Chemical	Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance		
	ERPG - 3 5000 ppm	ERPG - 2 1000 ppm	ERPG-1 200 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	10.0kW/m^2	5.0kW/m^2	2.0kW/m^2

		m	m	m	m	m	m	m	m	m	m	m
Jetty Three	**METHANOL** (Instantaneous Release)	178	431	1.0 Km	49	190	LOC not exceeded	LOC not exceeded	33	-----	------	-----
	METHANOL (Evaporation Puddle)	< 10	33	89	< 10	< 10	No part of the cloud was above the LEL	No part of the cloud was above the LEL	No part of the cloud was above the LEL	-----	------	-----
	METHANOL (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	11	12	15

- Fire fighters should note that acetone and methanol fires are non luminescent and there could be a tendency to go nearer to the puddle /pool on fire. This should be done by fire fighters fully equipped with fire suits / proximity suits. Acetone / Methanol are water soluble, which is advantageous for fire fighting.

4.7.9 Jetty No – 4 Instantaneous Release / Ev PROPYLENE

Chemical		Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance For		
		TEEL - 3 20000 ppm	TEEL- 2 10000 ppm	TEEL -1 1500 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	10.0kW/m^2	5.0kW/m^2	2.0kW/m^2
		m	m	m	m	m	m	m	m	m	m	m
Jetty Four	**PROPYLENE** (Instantaneous Release)	51	80	233	74	253	LOC not exceeded	52	66	-----	------	-----
	PROPYLENE (Evaporation Puddle)	30	53	163	51	194	LOC not exceeded	29	52	-----	------	-----
	PROPYLENE (Burning	-----	------	-----	-----	------	-----	-----	------	33	41	55

	Puddle)											

- All emergency handling should be from a distance of more than 66 meters unless full fire suits / proximity suit is worn.
- All personnel not directly connected with the emergency should be moved beyond 233 meters form the leak area.

4.7.10 Jetty No – 4 Instantaneous Release / Ev VINYL CHLORIDE (VCM)

	Chemical	Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance		
		ERPG - 3 5000 ppm	ERPG - 2 1000 ppm	ERPG - 1 200 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	$10.0 kW/m^2$	$5.0 kW/m^2$	$2.0 kW/m^2$
		m	m	m	m	m	m	m	m	m	m	m
Jetty Four	**VCM** (Instantaneous Release)	47	108	376	45	152	LOC not exceeded	30	48	-----	------	-----
	VCM (Evaporation Puddle)	< 10	15	52	< 10	23	No part of the cloud was above the LEL	No part of the cloud was above the LEL	No part of the cloud was above the LEL	-----	------	-----

	VCM (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	< 10	< 10	< 10

- VCM is highly toxic, hence all persons handling the emergency involving VCM should wear full respiratory protection (BA sets) and handle the emergency from a distance of more than 48 meters.
- Nearby shanty should be put on the alert for evacuation in case emergency evacuation is needed.
- All persons handling the emergency should be sent to the Kandla Port hospital for VCM poisoning check up.

4.7.11 Jetty No – 5 Instantaneous Release / Ev AMMONIA

Chemical	Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance For		
	AEGL - 3 1100 ppm	AEGL - 2 160 ppm	AEGL - 1 30 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	10.0kW/m^2	5.0kW/m^2	2.0kW/m^2

		m	m	m	m	m	m	m	m	m	m	m
Jetty Five	**AMMONIA** (Instantaneous Release)	219	589	1.4 Km	33	80	LOC not exceeded	LOC not exceeded	26	-----	------	-----
	AMMONIA (Evaporation Puddle)	96	260	617	< 10	16	No part of the cloud was above the LEL	No part of the cloud was above the LEL	No part of the cloud was above the LEL	-----	------	-----
	AMMONIA (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	< 10	11	13

- Emergencies involving Ammonia will be mostly leakage / spillage.
- Ammonia is flammable with difficulty.
- Ammonia emergencies should be handled by wearing BA sets.
- Ammonia is soluble in water, which will make it easier to handle the emergency.
- Do not direct water jet onto the liquid ammonia puddle, this could cause spurting of the liquid. Let the ammonia vapours come into the water spray / fog.

AEGLs represent threshold exposure limits for the general public and are applicable to emergency exposure periods ranging from 10 minutes to 8 hours. AEGL-2 and AEGL-3, and AEGL-1 values as appropriate will be developed for each of five exposure periods (10 and 30 minutes, 1 hour, 4 hours, and 8 hours) and will be distinguished by varying degrees of severity of toxic effects. It is believed that the recommended exposure levels are applicable to the general population including infants and children, and other individuals who may be susceptible.

The three AEGLs have been defined as follows:

AEGL-1 is the airborne concentration, expressed as parts per million or milligrams per cubic meter (ppm or mg/m3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

AEGL-2 is the airborne concentration (expressed as ppm or mg/m3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

AEGL-3 is the airborne concentration (expressed as ppm or mg/m3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

Airborne concentrations below the AEGL-1 represent exposure levels that can produce mild and progressively increasing but transient and nondisabling odor, taste, and sensory irritation or certain asymptomatic, nonsensory effects. With increasing airborne concentrations above each AEGL, there is a progressive increase in the likelihood of occurrence and the severity of effects described for each corresponding AEGL. Although the AEGL values represent threshold levels for the general public, including susceptible subpopulations, such as infants, children, the elderly, persons with asthma, and those with other illnesses, it is recognized that individuals, subject to unique or idiosyncratic responses, could experience the effects described at concentrations below the corresponding AEGL.

4.7.12 Jetty No – 5 Instantaneous Release / Evaporation Puddle / Burning Puddle for HSD

Chemical		Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance For		
		TEEL 8600 ppm	TEEL 3300 ppm	TEEL 400 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	10.0kW/m^2	5.0kW/m^2	2.0kW/m^2
		3	2	1								
		m	m	m	m	m	m	m	m	m	m	m
Jetty Five	**HSD** (Instantaneous Release)	59	112	370	73	240	LOC not exceeded	53	71	-----	------	-----
	HSD (Evaporation Puddle)	<10	15	85	14	48	LOC not exceeded	10	19	-----	------	-----

	HSD (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	35	42	58

- High Speed Diesel fires should be handled with care, by wearing fire suits / proximity suits.
- Foam should be used for fire fighting.

4.7.13 Jetty No – 6 Instantaneous Release / Evaporation Puddle / Burning Puddle for MOTOR SPIRIT

Chemical	Dispersion Distances	LEL Distances	Overpressure Distances	Pool Fire Heat Radiation Distance

		TEEL - 3 1500 ppm	TEEL - 2 610 ppm	TEEL - 1 610 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	$10.0kW/m^2$	$5.0kW/m^2$	$2.0kW/m^2$
		m	m	m	m	m	m	m	m	m	m	m
Jet ty Six	**MOTOR SPIRIT** (Instantaneous Release)	159	258	258	68	227	LOC not exceeded	51	66	-----	------	-----
	MOTOR SPIRIT (Evaporation Puddle)	51	85	85	16	70	LOC not exceeded	11	24	-----	------	-----
	MOTOR SPIRIT (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	37	45	61

- Motor spirit fires should be handled with care, by wearing fire suits / proximity suits.
- Foam should be used for fire fighting.

4.7.14 Jetty No – 6 Instantaneous Release / Evaporation Puddle / Burning Puddle for SKO

Chemical	Dispersion Distances			LEL Distances		Overpressure Distances			Pool Fire Heat Radiation Distance For		
	TEEL – 3 1250 ppm	TEEL – 2 1000 ppm	TEEL - 1 600 ppm	60%	10%	8 psi	3.5 psi	1.0 psi	10.0kW/m^2	5.0kW/m^2	2.0kW/m^2
	m	m	m	m	m	m	m	m	m	m	m

Jet ty Six	**SKO** (Instantaneous Release)	141	159	209	74	239	LOC not exceeded	54	73	-----	------	-----
	SKO (Evaporation Puddle)	< 10	< 10	< 10	< 10	< 10	No part of the cloud was above the LEL	No part of the cloud was above the LEL	No part of the cloud was above the LEL	-----	------	-----
	SKO (Burning Puddle)	-----	------	-----	-----	------	-----	-----	------	28	35	48

- SKO fires should be handled with care, by wearing fire suits / proximity suits.
- Foam should be used for fire fighting.

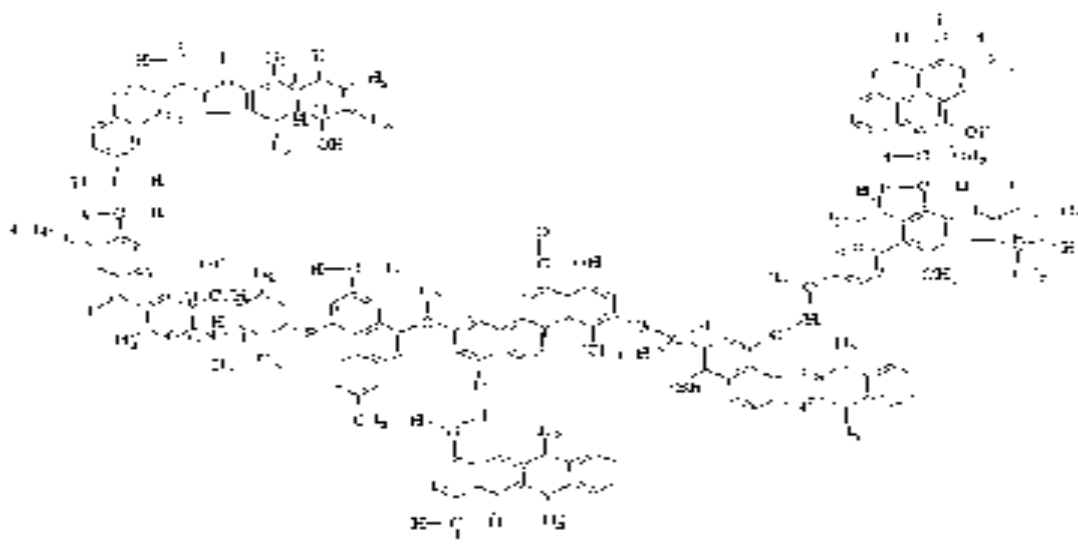
4.8 Coal Storage at Open Yard

4.8.1 General Characteristics of Coal

Coal is a fossil fuel extracted from the ground by underground mining or open pit mining. It is a readily combustible, black or brownish – black sedimentary rock. It is composed primarily of carbon along with assorted other elements.

Carbon forms more than 50% by weight and more than 70% by volume of coal.

Coal usually contains a considerable amount of incidental moisture, which is the water trapped within the coal in between the coal particles. The structure of a coal molecule is represented as follows:



Methane gas is another component of coal. Methane in coal is dangerous as it can cause explosion and may cause the coal to spontaneously combust.

4.8.2 Effects of Coal Burning

Combustion of coal, like any other compound containing carbon, produces CO_2, along with minor amount of SO_2.

Coal can be set on fire by spontaneous combustion

4.8.3 Spontaneous Combustion in Coal

The risk from fire exists where significant amounts of coal are in use of storage. Coal is a combustible material, making it susceptible to a variety of ignition scenarios. One of the most frequent and serious causes of coal fires is spontaneous combustion, which has been responsible for a number of incidents within the department in recent years.

Preventing spontaneous combustion coal fires involves attention to many different factors. Among the most critical are the type, age and composition of coal, how it is stored and how it is used. Given the right kind of coal, oxygen, and a certain temperature and moisture content, coal will burn by itself.

Spontaneous combustion has long been recognized as a fire hazard in stored coal. Spontaneous combustion fires usually begin as “hot spots” deep within the reserve of coal. The hot spots appear when coal absorbs oxygen from the air. Heat generated by the oxidation can initiate the fire.

Such fires can be very stubborn to extinguish because of the amount of coal involved (often hundreds of tons) and the difficulty of getting to the seat of the problem. Moreover, coal in either the smouldering of flaming stage may produce copious amounts of methane and carbon monoxide gases. In addition to their toxicity, these gases are highly explosive in certain concentrations, and can further complicate efforts to fight this type of coal fire.

Even the most universal fire fighting substance, water, cannot be used indiscriminately, because of the remote possibility of a steam explosion; it is advisable that water be applied carefully and from a safe distance. Certain chemicals such as carbon dioxide or nitrogen may mitigate fire effects, but their use has had mixed success from a DOE (Department of Energy) perspective. The above information suggests that coal fires require awareness and prior planning to extinguish efficiently, completely, and safely.

4.8.4 Causes of Spontaneous Coal Fires

The following general factors have been mentioned as contributing causes:

③ Coal handling procedures allowed for long-time retention of coal, which increases the possibility of heating

- ③ New coal added on top of old coal created segregation of particle sizes, which is a major cause of heating
- ③ Too few temperature probes installed in the coal bunker resulted in an excessive period of time before the fire was detected.
- ③ Failure of equipment needed to fight the fire
- ③ Ineffective capability and use of carbon dioxide fire suppression system
- ③ Delay in the application of water

4.8.4.1 Preventing Spontaneous Combustion in Stored Coal

High quantities of coal are stored in bunkers, silos, hoppers and open air stockpiles. How susceptible such stocks of coal are to fire from spontaneous combustion depends on a number of factors, from how new the coal is to how it is piled.

4.8.5 Recommendations for Coal Storage

- ③ Storing coal with low sulphur content is helpful. Sulphur compounds in coal liberate considerable heat as they oxidize.

- ③ Air circulating within a coal pile should be restricted as it contributes to heating; compacting helps seal air out.

- ③ Moisture in coal contributes to spontaneous heating because it assists the oxidation process. Moisture content should be limited to 3 %; sulphur content should be limited to 1 %, “as mined.” Coal having high moisture content should be segregated and used as quickly as possible. Efforts should be made to keep stored coal from being exposed to moisture.

- ③ Following the “First in, First out” rule of using stock reduces the chance for hot spots by helping preclude heat build up for portions of stock which remain undisturbed for a long term. The design of coal storage bins is important in this regard.

③ A high ambient temperature aids the spontaneous heating process. Remove coal as quickly as possible. The longer large coal piles are allowed to sit, the more time the spontaneous process has, to work.

③ The shape and composition of open stock piles can help prevent fires. Dumping coal into a big pile can lead to problems. Rather, coal should be packed in horizontal layers (opinions range from 1 ½' to 3' high) which are then levelled by scraping and compacted by rolling. This method helps distribute the coal evenly and thus avoids breakage and segregation if fine coal. Segregation of coal particles by size should be avoided, as it may allow more air to enter the pile and subsequent heating of finer sizes.

③ The height of the coal pile/stock is also important; limit un - layered, un - compacted high grade coal to a height of 15' maximum height.

③ Properly inspect, test and maintain installed fire protection equipment.

③ Maintain an updated pre-fire plan and encourage regular visits to coal facilities by the site or local emergency response force.

4.8.6 Roll Packing

Roll packing helps to exclude O_2 and thus to prevent fires by discouraging spontaneous combustion. Coal is distributed by a grab bucket or by other means in a uniform layer. The layer is then levelled by scraping and compacted by rolling. Distributing the coal evenly avoids breakage and segregation of the coal. The firm packing helps shed water.

4.8.7 Checking Temperature

Steam rising from a pile or the odour of burning coal is an indication of spontaneous heating, but an earlier or more reliable indication is obtained by checking the temperature/ hot spots/CO detection.

Rise of temperature can be noted by use of thermocouples. Hot spots can be detected by use of IR coal fire monitors. CO detectors can indicate that coal combustion has started.

4.9 Risk Analysis for Coal Fires in Storage Yard Berth 14

Data used for calculation of impact distance for coal fires. Type of coal – Bituminous (Medium Volatile)

Emissivity Constant (ε)	=	0.9 for Bituminous Coal
Stefan Boatmen constant	=	5.6 x 10^{-8} KW/m^2K^4

FQ 4Π*K* 4.9.1 Formula used for Calculation of Impact Distance (D) =

Where D	=	Distance from flame centre to receiving point.
Where F	=	Fraction of heat radiation = 0.15 (Conservative)
Where Q	=	Total Heat Generated /Emitted by Coal
Where K	=	Thermal Radiation level

Maximum temperature attained by flame of Coal Tf = 900DegC = 1173K

Ambient surrounding temperature Ta= 27DegC to 35DegC = 300K – 308K

$Q = \sigma A \varepsilon (T f^4 - T_a^4)$

σ = 5.68 x 10 -8 kW/m2K4

$T f^4 = (1173)^4$ K

$T_a^4 = (300)^4$ K

For active coal burning area = $10 m^2$

$Q = 5.6 \times 10^{-8} \times 0.9 \times 10 (1173^4 - 300^4)$

Q = 950 kW

For Heat radiation 4 kW/m^2 impact distance D

$D = \sqrt{(950 \times 0.15)/(4 \times 3.14 \times 4)} = 1.68 = 1.7 m$

For Heat radiation 12.5 kW/m^2 impact distance D

$D = \sqrt{(950 \times 0.15)/(4 \times 3.14 \times 12.5)} = 0.9527 = 1 m$

For Heat radiation 37.5 kW/m^2 impact distance D

$D = \sqrt{(950 \times 0.15)/(4 \times 3.14 \times 37.5)} = 0.55 m$

For active coal burning area – 100 m^2

$Q = 5.6 \times 10\text{-}8 \times 0.9 \times 100 (1173^4 - 300^4)$

$= 9500$ kW/m2

For Heat radiation 4 kW/m2 impact distance D

$D = \sqrt{(9500 \times 0.15)/(4 \times 3.14 \times 4)} = 5.32 m$

For Heat radiation 12.5 KW/m2 impact distance D

D = $\sqrt{(9500 \times 0.15)/(4 \times 3.14 \times 12.5)}$ = 3.012 m

For Heat radiations 37.5 KW/m2 impact distance D

D = $\sqrt{(9500 \times 0.15)/(4 \times 3.14 \times 37.5)}$ = 1.74 m

The Damage Effects Due to Thermal Radiation of Varying Intensity

Incident Radiation Intensity (kW/m^2)	Type of Damage
37.5	Sufficient to cause damage to process equipment unless the equipment is fully thermally fire protected (Insulation, fire proofing, sprinkler protection etc)
12.5	Minimum energy required for piloted ignition of wood, melting plastic tubing, etc.
4.5	Sufficient to cause pain to personnel if unable to reach within 20 seconds, blistering of skin (1st degree burns) is likely.

4.9.2 Summary:

Heat Radiation Impact distance for	Active Burning Coal Area	
	$10\ m^2$	$100\ m^2$
$4\ kW/m^2$	1.7 m	5.3 m
$12.5\ kW/m^2$	1.0 m	3.0 m

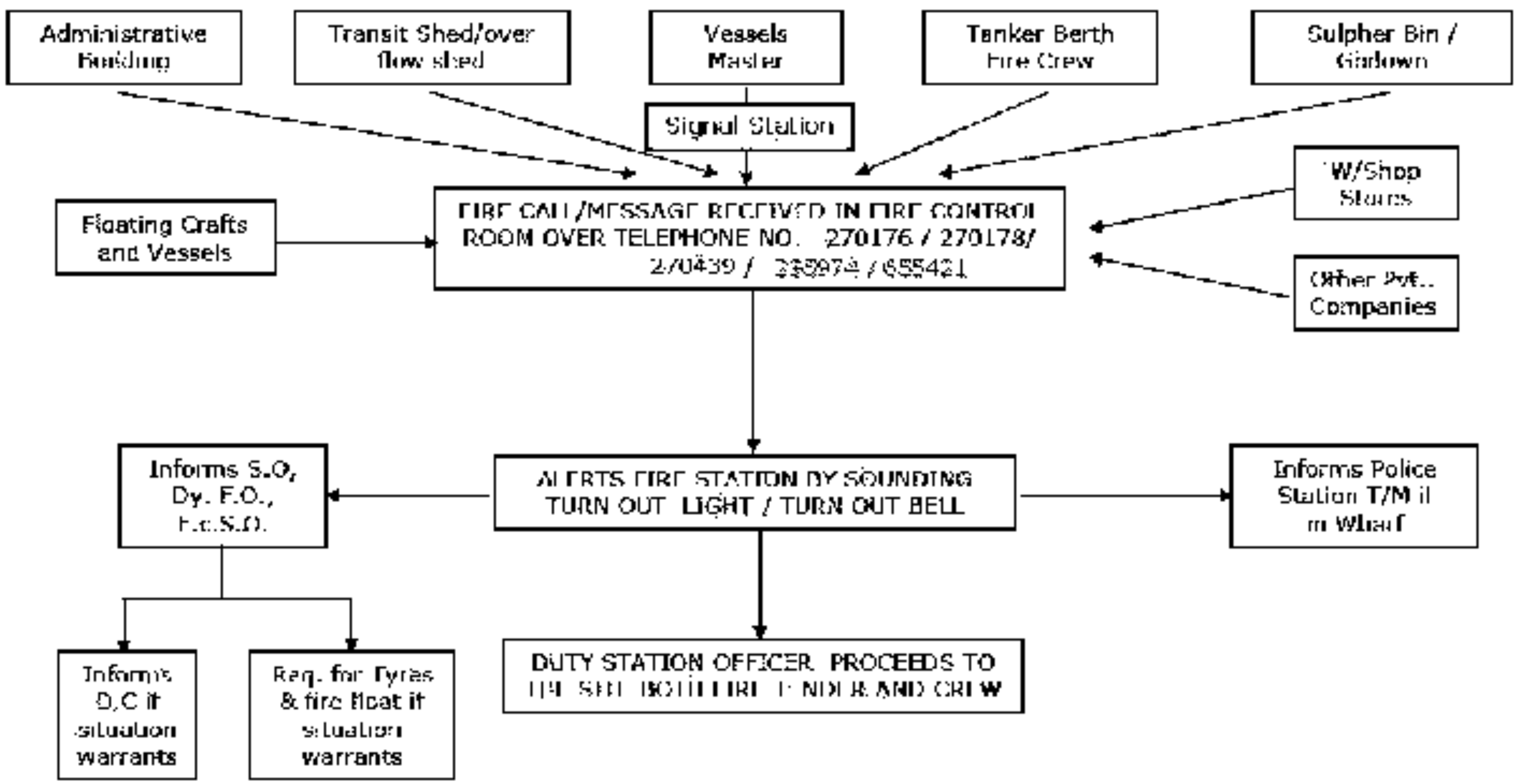
37.5 kW/m^2	0.5 m	1.74 m

Assuming that $100m^2$ surface area of the coal stack is smouldering no person should approach the stock within 6 m distance.

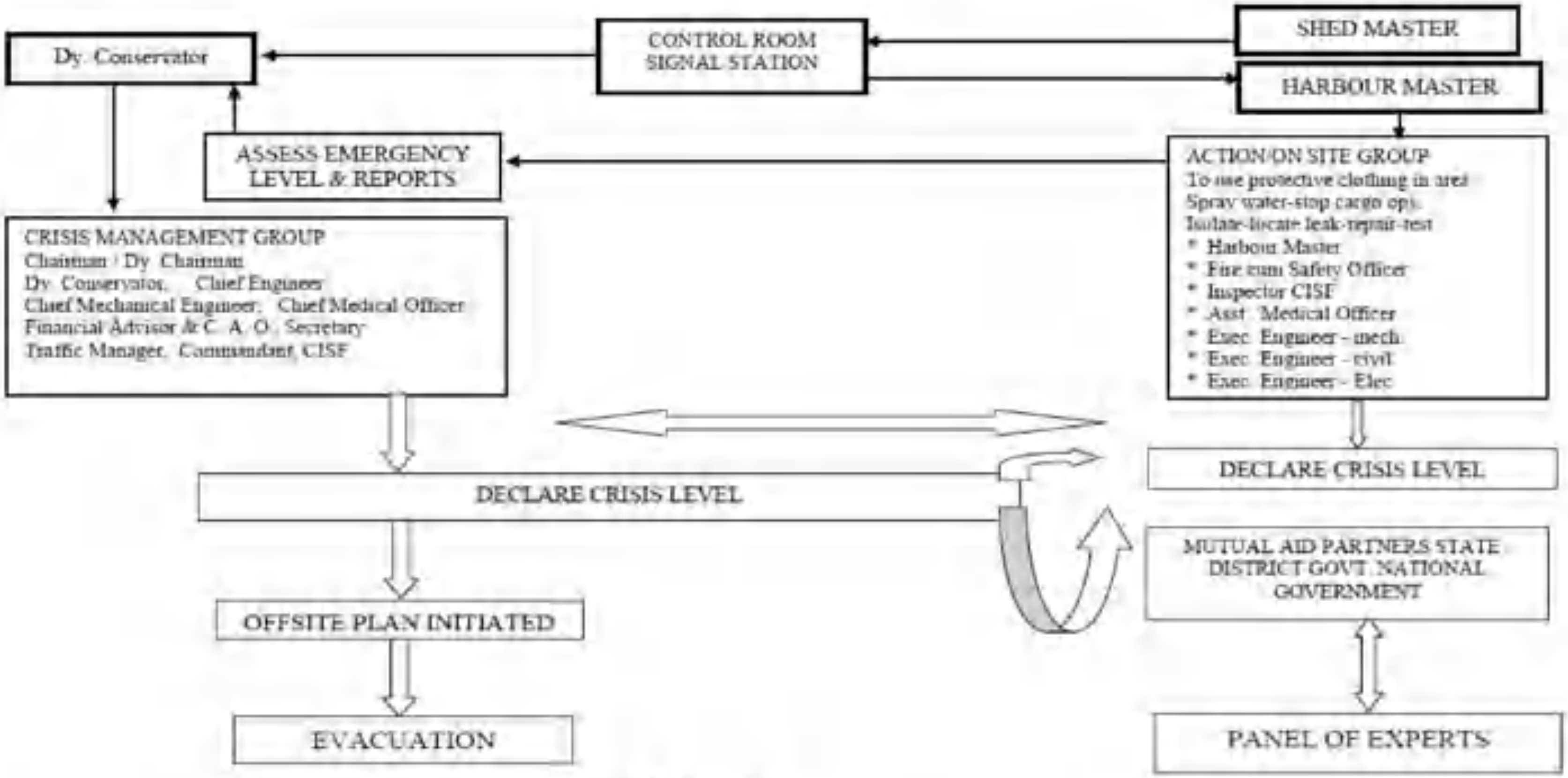
All fire fighting should be done from more than 5.3 m away from the affected coal stack unless the fire fighter is fully clothed with fire protective clothing and respiratory protection

Please note that CO could also be emitted during a coal fire due to incomplete combustion. Hence adequate respiratory protection should be used like canister gas mask or Self Contained Breathing Apparatus –SCBA

4.10 Fire & Explosion Response Plan



4.11 Fire & Toxic Leakage



PROCESS

(1) Master or informer raises alarm
(2) Informs control room at the Fire Station
(3) Advises D.C. and H.M and Action Group
(4) Action group commences to use protective clothing in area -Spray water-stop cargoes/Isolate – locate leak-repair test
(5) Declare crisis level
(6) Crisis level endorsement by crisis management group
(7) If crisis level declared is greater
(8) Mutual aid partners contacted and district emergency plan initiated
(9) If necessary evacuation commenced partial or full

4.12 Details of Fire Fighting Equipment available at Kandla Port

4.12.1 Fire Water Tender – 6 Nos

Water Tank Capacity: 6000 liters. (Discharge Capacity 2250 liters/PER MIN at 7.5kg/cm^2 & 300 liters at 40kg/cm^2).

Fire Monitor Discharge capacity 2750 lpm at 7kg/cm2 with effective throw/Jet of minimum 45 meters.

Fire Fighting Equipments:

- RRL Hose 15mtrs X 63mm (ID)
- Foam AFFF 3%
- Various type of Branches
- Hose Fittings
- Small Gears
- Personnel Protective equipment (PPE)
- Additional Foam Fighting System
- Communication System
- Public Address system
- Extension Ladder

4.12.2 Foam Fire Tender – 3 Nos

Water Tank Capacity: 5000 liters. (Discharge Capacity 2250 liters at 7.5kg/cm^2 & 300 liters at 3.5kg/cm^2).

Foam Tank Capacity: 1000 liters.

Fire Monitor Discharge capacity 2750 lpm at 7kg/cm^2 with effective throw/Jet of minimum 45 meters.

Additional CO_2 Extinguishing System.

Fire Fighting Equipments:

- RRL Hose 15mtrs X 63mm (ID)
- Foam AFFF 3%
- Various type of Branches
- Hose Fittings
- Small Gears
- Personnel Protective equipment (PPE)
- Additional Foam Fighting System
- Communication System
- Public Address system
- Extension Ladder

4.12.3 Multi Purpose Fire Tender – 1 No

Water Tank Capacity: 5000 liters. (Discharge Capacity 2000 liters at 10kg/cm^2 & 300 liters at 3.5kg/cm^2).

Foam Tank Capacity: 1000 liters.

Fire Monitor Discharge capacity 2750 lpm at 7kg/cm^2 with effective throw /Jet of minimum 45 meters.

Additional CO_2 Extinguishing System.

Additional Dry Chemical Powder Extinguishing System.

Fire Equipments:

- RRL Hose 15mtrs X 63mm (ID)
- Foam AFFF 3%
- Various type Branches
- Hose Fittings
- Small Gears
- Personnel Protective equipment (PPE)
- Addition Foam Fighting System
- Communication System
- Public Address system
- Extension Ladder

4.12.4 SURVEYED OFF NEW PROCUREMENT IN PROCESS

4.12.5 Tank Lorry - 01 No.

- Tank Capacity 12,000 liters.
- Anti Pollution Scheme.

4.12.6 Fire Jeep – 01 No.

Pump Discharge Capacity 1800 liters at 7kg/cm^2.

Fire Fighting Equipments:

- RRL Hose 15mtrs X 63mm (ID)
- Various type of Branches
- Hose Fittings
- Small Gears
- Personnel Protective equipment (PPE)
- Communication System
- Public Address system
- Extension Ladder

4.12.7 Safety Jeep – 01 No.

For proper Coordination, Inspection, in around the Port (Oil & Chemical Tank Farm & Administrative Works).

Fire Fighting Equipments:

- Small Gears
- Personnel Protective equipment (PPE)
- Communication System
- Public Address system

4.12.8 Ambulance – 01 No.

For Transportation of Injured Ship Official, Ship Crews and Victims.

4.13 Station wise Manpower Break Up (Manned Round The Clock)

4.13.1 Emergency Response Centre / Old Kandla Fire Station (Liquid Cargo Jetty)

- Fire cum Safety Officer – 01
- Deputy Fire Officer – 01
- Station Officers – 02 Nos
- Leading Fireman– 02 Nos
- Pump Operator cum Driver – 03 Nos
- Fireman – 08 Nos

Oil Jetty No. 1 (LPG Jetty)

- Leading Fireman – 01
- Pump Operator cum Driver – 01
- Fireman– 04 Nos

Oil Jetty No. 2

- Leading Fireman– 01
- Fireman– 04 Nos
- Pump Operator cum Driver – 01

Oil Jetty No. 3

- Leading Fireman – 01
- Fireman– 04 Nos

Oil Jetty No. 4

- Leading Fireman – 01

- Pump Operator cum Driver – 01
- Fireman– 04 Nos

Oil Jetty No. 5 (IFFCO Jetty)

- Leading Fireman – 01
- Pump Operator cum Driver – 01
- Fireman– 04 Nos

While LPG Tanker is discharging the LPG at Oil Jetty No.1, a Station Officer shall be in charge till the unberthing of LPG Vessel.

Above Fire Crews will be posted at Oil Jetties depending upon the Nature of Risk Cargo Handled.

4.13.2 Tilak Fire Station (Dry Cargo Jetty).

- Station Officers– 01 No
- Leading Fireman– 01 No
- Pump Operator cum Driver– 02 Nos
- Fireman – 04 Nos

For Running & Maintenance of First Aid, Fire Equipments installed at various work places of Kandla Port.

- Leading Fireman– 01 No
- Fireman – 02 Nos

4.13.3 Azad Fire Station (Dry Cargo Jetty).

- Station Officers– 01 Nos

- Leading Fireman– 01 No
- Pump Operator cum Driver– 02 Nos
- Fireman – 04 Nos

4.14 Fire fighting facility at Chemical / Oil Handling Berths

4.14.1 Oil Jetty No: 1

Fixed 2 nos water/foam monitors mounted on towers at each end of each berth.

There are three vertical turbine pumps each of 500m3/hr capacity. One each of Electrical Fire Water Pumps, Diesel Engine Fire water pumps, Electrical flushing pumps.

Jetty one LPG side – 12 DCP – 5Kg Fire Extinguishers, 2 DCP – 150 Kg Trolley mounted fire extinguishers.

4 Fire suits, 2 BA sets with 2 spare respirable air cylinders.

Fire equipment Room:

- Foam / DCP – 15 Nos fire extinguishers
- Helmets – 6 Nos
- Hose length (15 meters) 10 Nos
- Manual Siren – 1No
- Gum Boots – 6 Pairs
- Ropes
- Foam compound 1000 Liters
- Hose fittings
- Branch Pipes
- Fire Axe

- Safety shower – 1 No
- Water curtains
- Fire suits – 2 Nos
- Canister gas mask – 1 No
- Telephone
- Mobile foam trolley – 100 Liters

4.14.2 Oil Jetty No: 2

Fixed foam / water remote controlled monitors mounted on towers at each end of each berth.

There are two vertical turbine pumps each of 800m^3/hr capacity, two jockey pumps of 25m^3/hr capacity, two foam pumps each of 22m^3/hr capacity, two foam /water remote controlled tower monitors, and six jumbo curtains installed at the jetty face.

Fire equipment Room:

- Foam /DCP – 10 Nos each fire extinguishers
- Helmets – 6 Nos
- Fire Hoses - 10 Nos
- BA set – 1No
- Gum Boots – 6 Pairs
- Foam making branch pipes – 2 Nos
- Female coupling –8 Nos
- Jet branch pipes –5 Nos
- Fire suits -2 Nos
- Foam compound - 50 x 30 Liters
- Chemical Suits- 2 Nos
- Fire Axe- 1No
- DCP Fire extinguishers – 10 Nos

- Foam Fire extinguishers – 10 Nos
- Fire Buckets – 10 Nos
- Oil Dispersant – 10 x 20 Liters
- Rubber hand gloves – 6 Nos
- Hose length – 15 meters (10 Nos)

4.14.3 Oil Jetty No: 3, 4 & 5

In Oil Jetty No: 3, there are two foam pumps, with foam tank, 2 remote controlled tower monitors for foam / water spray, 2 sets of jumbo curtains at jetty face, one flame detection system, one 50KW DG set and control console.

Oil Jetty No: 4, there are three vertical turbine pumps each of 500m^3/hr capacity, 2 foam pumps with foam tank, 2 remote control tower monitors of capacity 3000 liters per minute of water, 3 jumbo curtains at jetty face, 50 KW DG set and control console.

Oil Jetty No: 5, there are two fire water pumps each of 270m^3/hr capacity, (One electrical driven pump, and one diesel engine pump each).

Fire equipment Room:

- Fire buckets – 8 Nos
- Manual Fire Sirens – 1 No
- Foam branch pipes – 4 Nos
- Mechanical foam generator – 2Nos
- Foam compound – 1000 Liters
- BA set – 1 No
- Gum Boots – 6 Pairs
- Helmets – 6 Nos
- Hose length (15 Meters) – 10 Nos
- DCP fire extinguishers – 10 Nos

- Foam fire extinguishers – 5 Nos
- Fire suits – 2 Nos
- Dispersant chemicals - 6 x 20 Lets
- Double female couplings – 8 Nos
- Male coupling – 2 Nos
- Diffuser – 2 Nos
- Water Curtain – 1 No
- Jet Branch Pipe – 2Nos
- Canister Gas Masks – 1 No
- Portable foam / water monitor – 1 No
- Mobile foam generator
- Safety Shower – 1No

4.14.4 Oil Jetty No: 6

- 2 – Nos Diesel engine fire water pumps 820m^3/hour each.
- 1 – HP Jockey pump electrical 80m^3/hour
- Fire blankets (water jel)
- Smoke detectors in fire pump house
- Hand tool set
- Water curtains nozzles – 2 Nos • AFFF foam
- DCP fire extinguishers – 6 Nos
- Trolley mounted DCP fire extinguishers – 4 Nos
- CO_2 fire extinguishers – 6 Nos
- Foam fire extinguishers – 6 Nos

4.15 General Fire fighting guidelines at the Oil Jetty

1. Stop all loading / unloading operations and close valves.

2. All fire fighters will be apprised of the chemicals and POL products normally handled at the jetties. A set of MSDS is available at the fire station.

3. As a general rule all fire fighting will be carried out from a distance of 60 meter (Average heat radiation experience of $2kw/m^2$). If the fire fighters are required to go closer to the fire then fire suits / close proximity suit must be worn. If necessary, water cover could be provided to the fire fighters going closer to the fire.

4. The water curtain along the edge of the berth will be activated for fire / leak / spill emergency at the berth.

   and any available tug should be immediately put on s/by.

5. All emergency equipment should be placed beyond the over pressure distance of about 60 meters (Average overpressure distance for 1.0 psi experience) to avoid damage to them.

6. The remote water / foam monitor should be operated to control the fire at the jetty. If properly used the fire will be immediately controlled.

7. All persons not connected with handling the emergency should be moved beyond the TEEL – 1 / ERPG – 1 level distance which is an average distance of 1 Km. But if toxic chemical release takes place then the people from the shanty should be moved beyond 3 Km distance of the fire.

8. All security staff (CISF) should also have access to respiratory protection as they may not be able to leave their post.

9. External help should be obtained as soon as it is felt that the emergency is grave.

10. CISF guards will keep note of all incoming aid equipment.

11. After the emergency is over the Deputy Conservator / Harbour Master will assign a senior management team to verify that there is no longer a threat of further fire / leak / spill, to assess damage and initiate repairs

    as needed.

12. Any emergency at the chemical jetties or at the dry cargo berths will be informed to the Deputy Conservator / Harbour Master, who will activate the DMP if necessary.

4.16 General guidelines in case of Toxic Chemical spill / leak

1. Stop all loading / unloading operations and close valves.

2. All emergency operation should be carried out from up wind direction. This may always not be possible. All persons handling a chemical leak / spill should wear chemical protection suit and respiratory protection like gas mask / BA sets.

3. any available tug should be put on alert or pressed into operation.

4. Deputy Conservator / Harbour Master should be informed of a chemical spill however small it may be.

5. CISF should have access to respiratory protection as they may not be able to leave their post.

6. In case of a major chemical leak / spill the neighbouring shanty should be evacuated especially if chemicals like, Acrylonitrile, Benzene, Aniline, 1:3 Butadiene, Vinyl Chloride, Styrene has spilled.

7. Attempts could be made to salvage the spilled chemical or dispersant could be applied to the spill.

8. The chief fire officer should be kept informed of the chemicals being loaded / unloaded at the port chemical berths on a daily basis.

Important fire fighting methods and spill handling methods of the concerned chemicals should be then informed to the fire fighters. They should also be apprised of the health effects and water solubility of the concerned chemicals.

IDENTIFICATION OF EMERGENCIES AT THE OIL & CHEMICAL FACILITIES AROUND THE KANDLA PORT

5.1 Impact Distances

Under the Risk Assessment Study for the DEENDAYAL PORT TRUSTcarried out by Tata AIG Risk Management Services Ltd in the year 1999, various failure scenarios have been identified for different facilities around the port and these have been simulated using Phast / Safeti software. These failure scenarios have been categorized into Maximum Credible Loss Scenarios (MCLS) and Worst Case Scenarios (WCS).

These failures can be due to number of reasons like material failure, human error. The failures could also be on account of natural disasters like earthquake, flood etc or they could be due to external factors like missile attack or terrorist attack. On failure due to any account mentioned above and depending on the extent of damage, there can be partial or total loss of confinement of hazardous materials handled in the port.

5.2 Maximum Credible Loss Scenarios (MCLS) considered for the study

5.2.1 Scenario 1 – Butadiene Sphere of United Storage and Tank Terminals Ltd.

There are 4 Butadiene Spheres in the terminal. We have considered the 1000 M.T. sphere for the study. Butadiene is stored at 3 to 4 Degree C and pressure in the sphere is maintained at 0.8 bar. The temperature of Butadiene is controlled by brine chillers cooled by Freon refrigeration system. The probability of BLEVE is very remote, considering there are two compressors and DG set is provided to take care of full power load of terminal in case of power failure. However, for Consequence Analysis study, we have considered BLEVE of 1000 M.T. Butadiene Sphere. It is assumed that the catastrophic rupture of the sphere takes place at a pressure of 25 bar.

Initial temperature (K) : 395. Initial pressure (bar (g))
: 25.0

5.2.1.1 Radiation Effects: Bleeve / Fire Ball

Sr. No.	Radiation levels (Kw/sq m)	Distance in meters	
		5m/s C	2m/s D
1.	4	1558	1558
2.	12.5	919	919
3.	37.5	526	526

5.2.1.2 Explosion Effects

Sr. No.	Over pressur e		Distance in meters	
	BAR(g)	PSI (g)	5.0m/s;C	2.0m/s; D
1.	0.0207	0.3	3246	3246
2.	0.1379	2	841	841
3.	0.2068	3	650	650

Comments:

1. In case of BLEVE a radius of 526 m. could be subjected to heat radiation, intensity of 37.5 kw/m^2. This would affect the facilities of Synthetics and chemicals, Indo Nippon, Kesar Enterprises, Bayer ABS & Chemicals and Resins. A portion of IFFCO facility (boundary) would also be subject to 37.5 KW per m^2 radiation intensity. This could cause fires in the neighbouring areas and this is likely to lead to domino effect. Employees within a radius of 1.5 km. from the sphere would suffer burn injuries.

2. Structural damage is likely within a radius of 650 m. from the sphere. This would damage nearby tanks, buildings and is likely to lead to domino effect which could aggravate the emergency. Upto a distance of 3.2 k.m there would be window glass breakage.

3. The possibility of BLEVE is less likely as the Horton spheres are maintained at low temperatures and at low temperature. There is also a standby DG set to take care of 100% electrical load of the terminal. The spheres are protected by water spray ring system along with a hydrant system.

5.2.2 Scenario 2 - Phenol storage of United Storage and Tank Terminals Ltd.

In the United storage terminal there is a phenol storage tank. In the event of bottom nozzle rupture or a large overflow from the tank, phenol would spill out and the contents would be within the dyke.

5.2.2.1 Dispersion Distance for PHenol

Sr. No.	Concentration of interest ppm	Dispersion Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	100	103	90

5.2.2.2 Radiation Effects – Pool Fire

Sr. No.	Radiation levels (Kw/sq m)	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	4	32	32
2.	12.5	25	22
3.	37.5	12	12

Comments:

Phenol has IDLH of 100 ppm concentration and the vapours are toxic. Toxic vapour of 100 ppm. Concentration would disperse upto 90 to 103 meters in the downward direction. This scenario may have a moderate off site implication due to toxic vapours.

5.2.3 Scenario 3 - Toluene storage of United Storage and Tank Terminals Ltd.

It is assumed that the tank has a diameter of 15 m. and dyke dia of 30 meters. In case of bottom nozzle failure of large overflow toluene would accumulate in the dyke. In case, the pool encounters the source of ignition, a pool fire would result.

5.2.3.1 Dispersion Distance for Toluene

Sr. No.	Concentration of interest Vol %	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	1.2 (LEL)	63	72

5.2.3.2 Radiation Effects – Pool Fire

Sr. No.	Radiation levels (Kw/sq m)	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	4	59	44
2.	12.5	25	22
3.	37.5	20	19

5.2.3.3 Flash Fire

Sr. No.	Distance (m)	Distance in meters (1/2 LEL Distance)	
		5.0m/s;C	2.0m/s; D

1.	Furthest extent (m) for flash fire	111	121

Comments:

In case of a pool fire, the radiation effect is likely to be contained within the site. A flash fire distance is approximately 120 m. This means that a flammable cloud could cause a flash fire due to source of ignition within 120 m. in the downward direction. The flash fire would result in a pool fire.

The terminal has its own independent fire protection and fire fighting system which can reduce the affected distance by immediate actions like spray of foam compound over the pool formed in the dyke to prevent ignition and reduce the rate of evaporation.

5.2.4 Scenario 4 – Acrylonitrile storage of Bayer ABS

Acrylonitrile polymerises in the presence of light and at high temperature. If polymerization takes place in the tank, it could explode resulting in large release of Acrylonitrile. Acrylonitrile could also be released in the event of bottom nozzle failure of tank or overflow into the dyke.

5.2.4.1 Dispersion Distance for Acrylonitrile

Sr. No.	Concentration of interest ppm	Dispersion distance in meters	
		5.0m/s;C	2.0m/s; D
1.	4 (IDLH)	4026	12000

5.2.4.2 Radiation Effects – Pool Fire

Sr. No.	Radiation levels (kW/sq m)	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	4	80	85

2.	12.5	57	53
3.	37.5	42	32

5.2.4.3 Flash Fire

Sr. No.	Distance (m)	Distance in meters (1/2 LEL Distance)	
		5.0m/s;C	2.0m/s; D
1.	Furthest extent (m) for flash fire	118	125

Comments:

1. Acrylonitrile has boiling point of 77Degree C and IDLH 4 ppm concentration. However, it should be noted that on polymerization and in fire condition, Acrylonitrile would decompose to release hydrogen cyanide and NOx.

2. The dispersion distance for 4 ppm concentration of Acrylonitrile vapours could be 12 kms if the wind speed is 2 m/sec and atmospheric stability D. However, this distance could be reduced if timely action is taken.

3. Bayer ABS maintains a good safety code of practice. They have conducted various safety studies and have a good maintenance system. Moreover the emergency management plan is well prepared and rehearsed in house. The standard of housekeeping in the terminal is good. The personnel working in the terminal have a good knowledge of the actions to be taken in the event of an emergency.

5.2.5 Scenario 5 - Styrene storage of Bayer ABS

Bayer ABS has a 1210 KL styrene tank. Styrene can undergo violent polymerization above 65 degree C, which could be explosive. It is assumed that the tank diameter is 12.5 m. and bund is 22.5 x 22.5 m^2. In case of bottom nozzle failure, overflow, shell rupture, the material would accumulate in the dyke and if it would encounter the source of ignition, a pool fire would result.

5.2.5.1 Radiation Effects

Sr. No.	Radiation levels (Kw/sq m)	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	4	52	43
2.	12.5	26	21
3.	37.5	23	17

<u>Comments:</u>

1. The radiation effect would be restricted to the site and is not likely to have off site implication. However, on polymerization and fire condition, styrene generates enormous quantity of soot and splinter could fly off. This could affect neighboring areas.

2. The high safety standards maintained and observed at site would go a long way in preventing catastrophic scenarios.

5.2.6 Scenario 6 - Benzene storage of Indo Nippon

In Indo Nippon terminal Benzene is stored in an 1800 KL tank. Pool fire scenario has been considered for the tank assuming tank diameter as 12 m. and dyke dia as 25 m.

5.2.6.1 Dispersion Distance for Benzene

Sr. No.	Concentration of interest Vol%	Dispersion Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	1.3	119	120

5.2.6.2 Radiation Effects: Pool Fire

Sr. No.	Radiation levels (Kw/sq m)	Distance in meters	
		5.0m/s;C	2.0m/s; D

1.	4	55	42
2.	12.5	23	20
3.	37.5	20	16

5.2.6.3 Flash Fire

Sr. No.	Distance (m)	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	Furthest extent (m) for flash fire	175	175

<u>Comments</u>

In case of pool fire radiation effect would be restricted to site.

5.2.7 Scenario 7 - Methanol storage of Indo Nippon

Methanol is stored in 2500 KL tank, dyke dia is assumed as 30 m. And tank dia as 15 m.

5.2.7.1 Dispersion Distance for Methanol

Sr. No.	Concentration of interest Vol%	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	6	36	47

5.2.7.2 Radiation Effects: Pool Fire

Sr. No.	Radiation levels (Kw/sq m)	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	4	66	73

2.	12.5	48	48
3.	37.5	37	34

5.2.7.3 Flash Fire

Sr. No.	Dispersion (m)	Dispersion Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	Furthest extent (m) for flash fire	172	83

5.2.7.4 Explosion Effects – Late Ignition

Sr. No.	Over pressure		Distance in meters	
	BAR(g)	PSI (g)	5.0m/s;C	2.0m/s; D
1.	0.0207	0.3	110	137
2.	0.1379	2	80	95
3.	0.2068	3	78	91

Comments:

1. In case of pool fire, the radiation effect would be restricted to the site.

2. Methanol has a low boiling point i.e. (65oC.), hence if timely action is not taken, a large amount of Methanol would vaporize and unconfined vapour cloud would be formed which if it encounters a source of ignition would explode.

3. In case of unconfined vapour cloud explosion there may be a moderate implication on the surrounding facilities (Synthetics & chemicals and J R Enterprises).

5.2.8 Scenario 8 - Refrigerated Butadiene storage tank of Synthetics and chemicals

There are two atmospheric storage tanks of Butadiene having capacity of 2000 MT each. The storage temperature is maintained at minimum 8oC. Ammonia is used as refrigerant. The tank is double walled tank, catastrophic rupture of the tank is improbable. It is assumed that if the roof of the tank fails and a pool fire has taken place whose diameter equals the diameter of the tank.

5.2.8.1 Radiation Effects: Pool Fire

Sr. No.	Radiation levels (Kw/sq m)	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	4	46	74
2.	12.5	41	41
3.	37.5	33	19

5.2.8.2 Flash Fire

Sr. No.	Distance (m)	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	Furthest extent (m) for flash fire	97	4

<u>Comments:</u>

The radiation distance would be contained within the site.

5.2.9 Scenario 9 - IFFCO Ammonia Sphere

IFFCO has refrigerant ammonia storage tanks. There are two 1500 m/tons Horton Spheres. In case of external fire, the sphere would be heated up. The external fire would cause the shell above the liquid level to get weakened.

5.2.9.1 Dispersion Distance for Ammonia

Sr. No.	Concentration of interest ppm	Distance in meters	
		5.0m/s;C	2.0m/s; D

1.	500 (IDLH)	10440	9908

Comments:

1. A toxic ammonia cloud of IDLH concentration (500 ppm would disperse upto 10 km. in the downward direction.

2. Considering that ammonia is highly soluble in water and it is a light gas, the severity of the scenario could be greatly reduced by timely action. I.e. application of water spray to ammonia cloud.

3. The ammonia storages are well protected. The company has its own fire and safety department with fire engines and fire fighting personnel on duty round the clock. The company has a good preventive maintenance programme. Safety training is given to all employees.

5.2.10 Scenario 10- Phenol storage of Kesar Enterprises

Kesar Enterprises terminal phenol is stored in a 566 KL steam jacketed tank. In case of overflow or bottom nozzle failure, phenol would accumulate in the dyke.

5.2.10.1 Dispersion Distance for Phenol

Sr. No.	Concentration of interest ppm.	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	100 (IDLH)	103	90

5.2.10.2 Radiation Effects: Pool Fire

Sr. No.	Radiation levels (kW/sq m)	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	4	32	32
2.	12.5	25	22
3.	37.5	12	12

Comments:

1. Phenol vapour of IDLH 100 ppm would disburse upto 131 to 197 m. in downward direction. This may have a moderate off-site implication.

5.2.11 Scenario 11 - Acrylonitrile storage of Kesar enterprises.

In Kesar terminal, Acrylonitrile is stored in a 2526 KL tank. Acrylonitrile polymerises in the presence of light and at high temperature. In case of polymerization, the distances affected could be as follows.

5.2.11.1 Dispersion Distance for Acrylonitrile

Sr. No.	Concentration of interest ppm	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	4	4075	12150

5.2.11.2 Radiation Effects: Pool Fire

Sr. No.	Radiation levels (kW/sq m)	Distance in me ters	
		5.0m/s;C	2.0m/s; D
1.	4	91	96
2.	12.5	65	58
3.	37.5	46	35

5.2.11.3 Flash Fire

Sr. No.	Distance (m)	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	Furthest extent (m) for flash fire	119	126

Comments

1. The dispersion distance for Acrylonitrile for a cloud of 4 ppm concentration is approximately 12 km in the downwind direction, if the wind speed is 2 m/s at atmospheric stability is D. However, this would be greatly reduced if timely action is taken.

2. The polymerization products include Hydrogen Cyanide and Nox.

5.2.12 Scenario 12 - Aniline storage - JK Synthetics Terminal

Aniline is stored in the JK Terminal. The tank diameter is considered 12m and dyke diameter as 25m.

5.2.12.1 Dispersion Distance for Aniline

Sr. No.	Concentration of interest ppm	Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	100	92	177

Comments:

1. In case of overflow of tank or bottom nozzle rupture aniline would accumulate in the dyke.

2. Aniline has an IDLH value of 100 ppm. Toxic vapour of aniline would disperse upto 177 m. in the downwind direction, if the wind speed is 2m/sec.

   an atmospheric stability D.

3. The rate of evaporation could be reduced by blanketing with water.

5.2.13 Scenario 13 - BLEVE of LPG road tanker

LPG Road Tankers are filled up at the IOCL terminal. In case of over pressurization of the bullets a BLEVE could take place. Over pressurization could take place because of external fire. In case of an accident of the road tanker on the road, LPG would spill out and could result in an unconfined vapour cloud explosion. One 10 ton LPG road tanker has been considered for the study.

5.2.13.1 Radiation Effects – Bleeve / Fireball

Sr. No.	Radiation levels (Kw/sq m)	Distance in meters	
		5m/sC	2m/s D
1.	4	345	345
2.	12.5	196	196
3.	37.5	108	108

5.2.13.2 Explosion Effects

Sr. No.	Over pressure		Distance in mete rs	
	BAR(g)	PSI (g)	5.0m/s;C	2.0m/s; D
1.	0.0207	0.3	707	707
2.	0.1379	2	183	183
3.	0.2068	3	141	141

5.2.14 Scenario 14 - Naphtha storage of BPCL

In case of a dyke fire or tank roof fire of a naphtha storage tank in BPCL terminal the damage distances would be as follows.

Sr No	Commodity	Scenario	Wind Speed (M/S)	Damage Distance for Pool fire(Meters)		
				4 kW/m 2	12.5 kW/m2	37.5 kW/m2
1.	Naphtha	Dyke fire	3	205	71	31
2.	Naphtha	Tank Roof	3	188	65	29

		Fire					

5.2.15 Scenario 15 - Catastrophic rupture of 15000 MT cryogenic LPG tank of IOCL

The possibility of catastrophic rupture of the cryogenic LPG tank is very remote. However in case of such a scenario the damage distances would be as follows.

5.2.15.1 Explosion Effects

Sr. No.	Over pressure		Distance in meters	
	BAR(g)	PSI (g)	5.0m/s;C	2.0m/s; D
1.	0.0207	0.3	316	302
2.	0.1379	2	169	176
3.	0.2068	3	157	166

5.2.16 Scenario 16 - Catastrophic rupture of ammonia road tanker

In case of catastrophic rupture of ammonia road tanker the damage distances would be as follows.

5.2.16.1 Dispersion Distance for Ammonia

Sr. No.	Concentration of interest ppm	Dispersion Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	500	1866	1592

5.2.17 Scenario 17 - Leak from Acrylonitrile road tanker

In case of leak from one compartment (Capacity 3 tons) from an Acrylonitrile road tanker, the affected distances would be as follows.

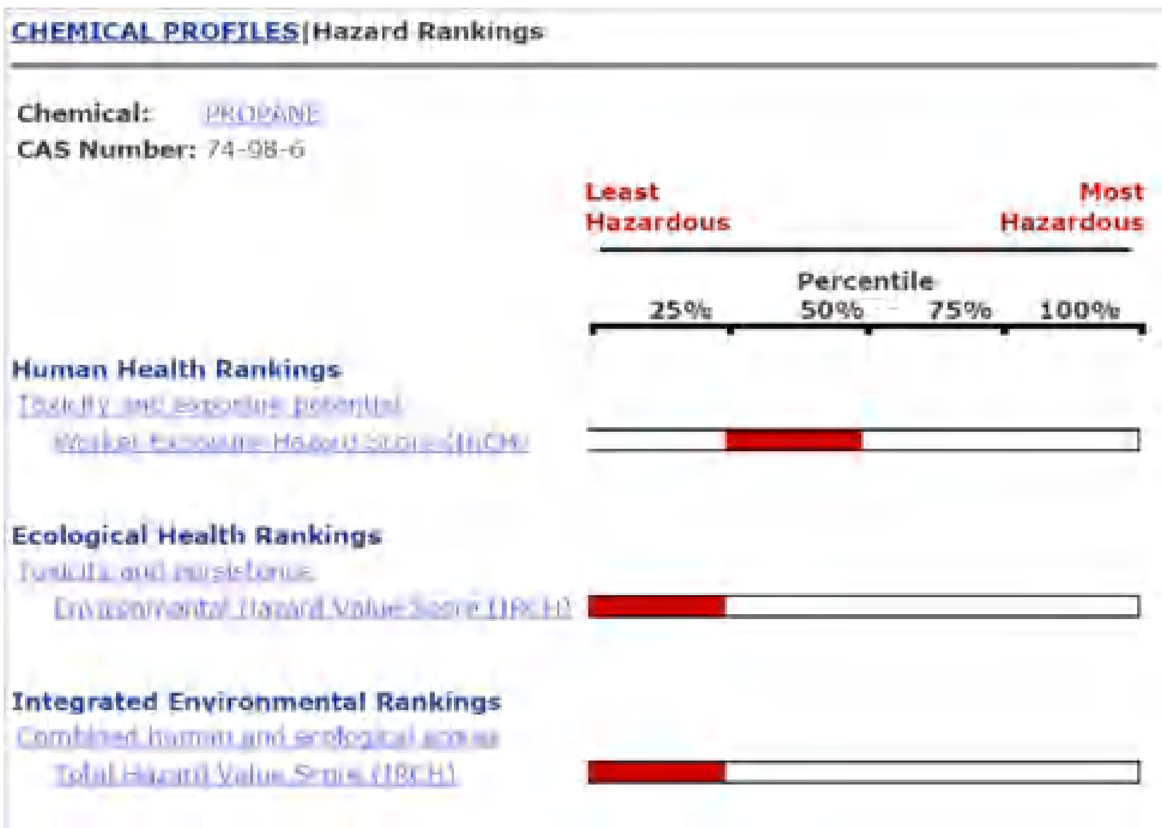
5.2.17.1 Dispersion Distance for Acrylonitrile

Sr. No.	Concentration of interest ppm	Dispersion Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	400	574	1508

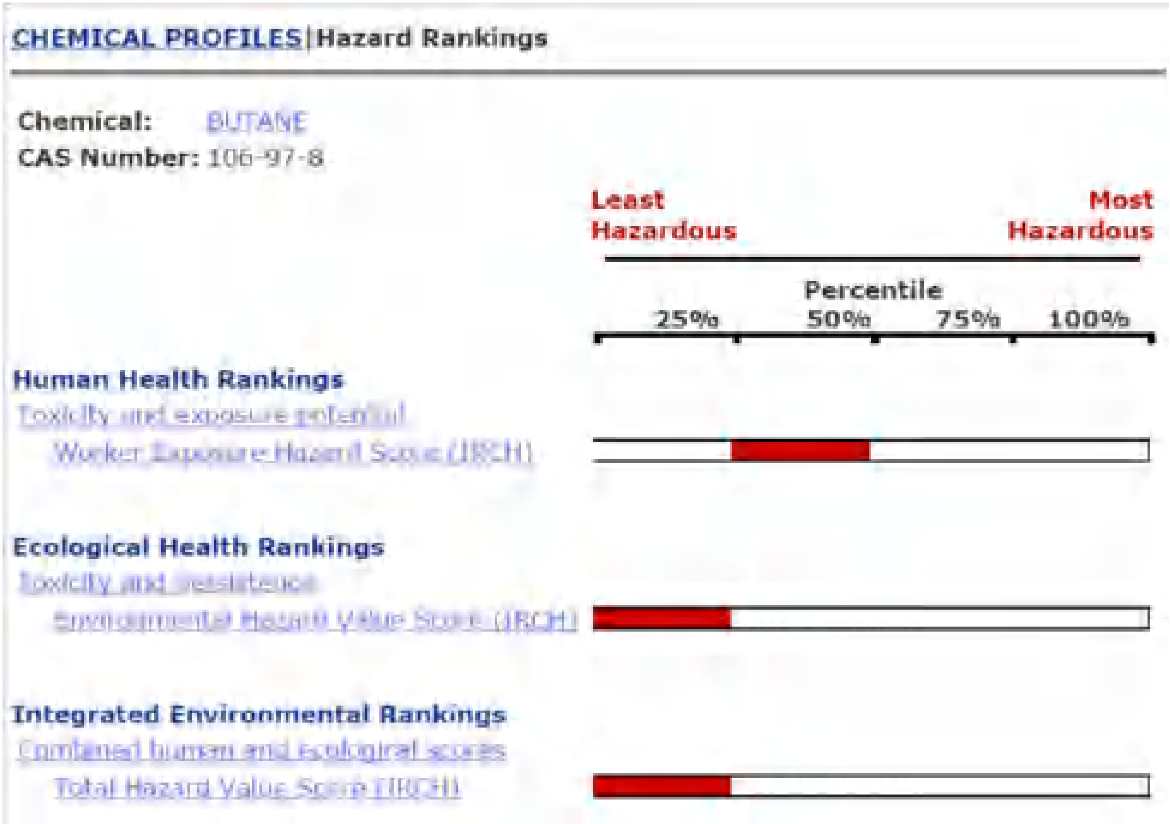
6 TOXIC HAZARD RANKING FOR HAZARDOUS CHEMICALS HANDLED AT PORT PREMISES

6.1 Hazard Ranking

6.1.1 Propane



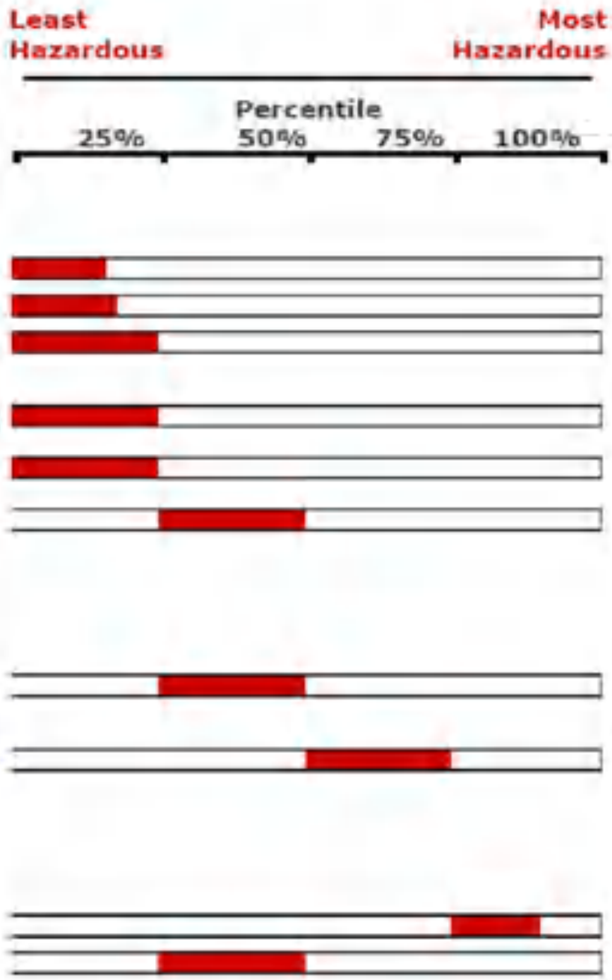
6.1.2 Butane



6.1.3 Toluene

CHEMICAL PROFILES|Hazard Rankings

Chemical: TOLUENE
CAS Number: 108-88-3



Human Health Rankings

Toxicity only

- Ingestion Toxicity Weight (RSEI)
- Inhalation Toxicity Weight (RSEI)
- Human Health Effects Score (UTN)

Toxicity and exposure potential

- Noncancer Risk Score - Air Releases (EDF)
- Noncancer Risk Score - Water Releases (EDF)
- Worker Exposure Hazard Score (IRCH)

Ecological Health Rankings

Toxicity only

- Ecological Effects Score (UTN)

Toxicity and persistence

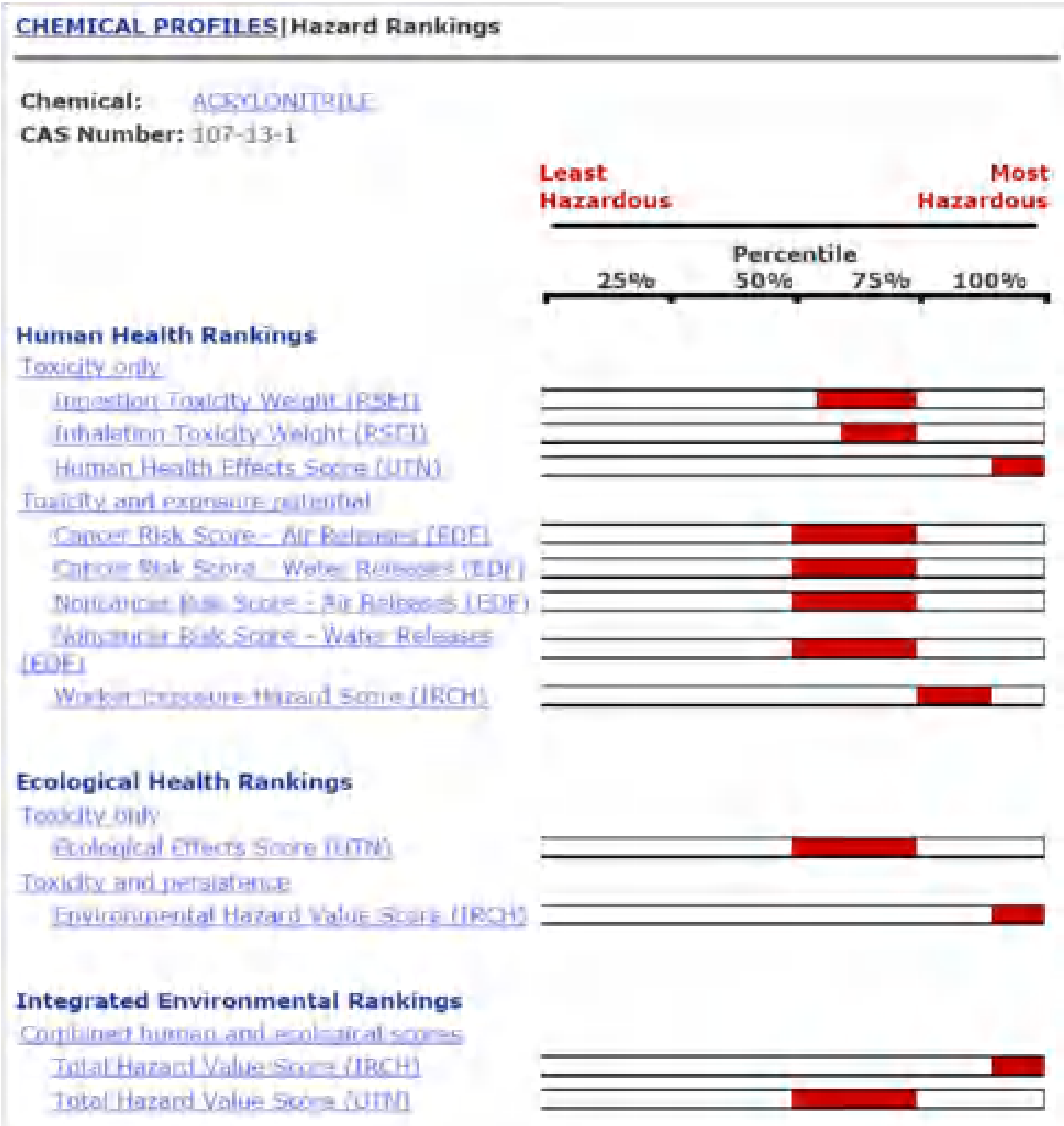
- Environmental Hazard Value Score (IRCH)

Integrated Environmental Rankings

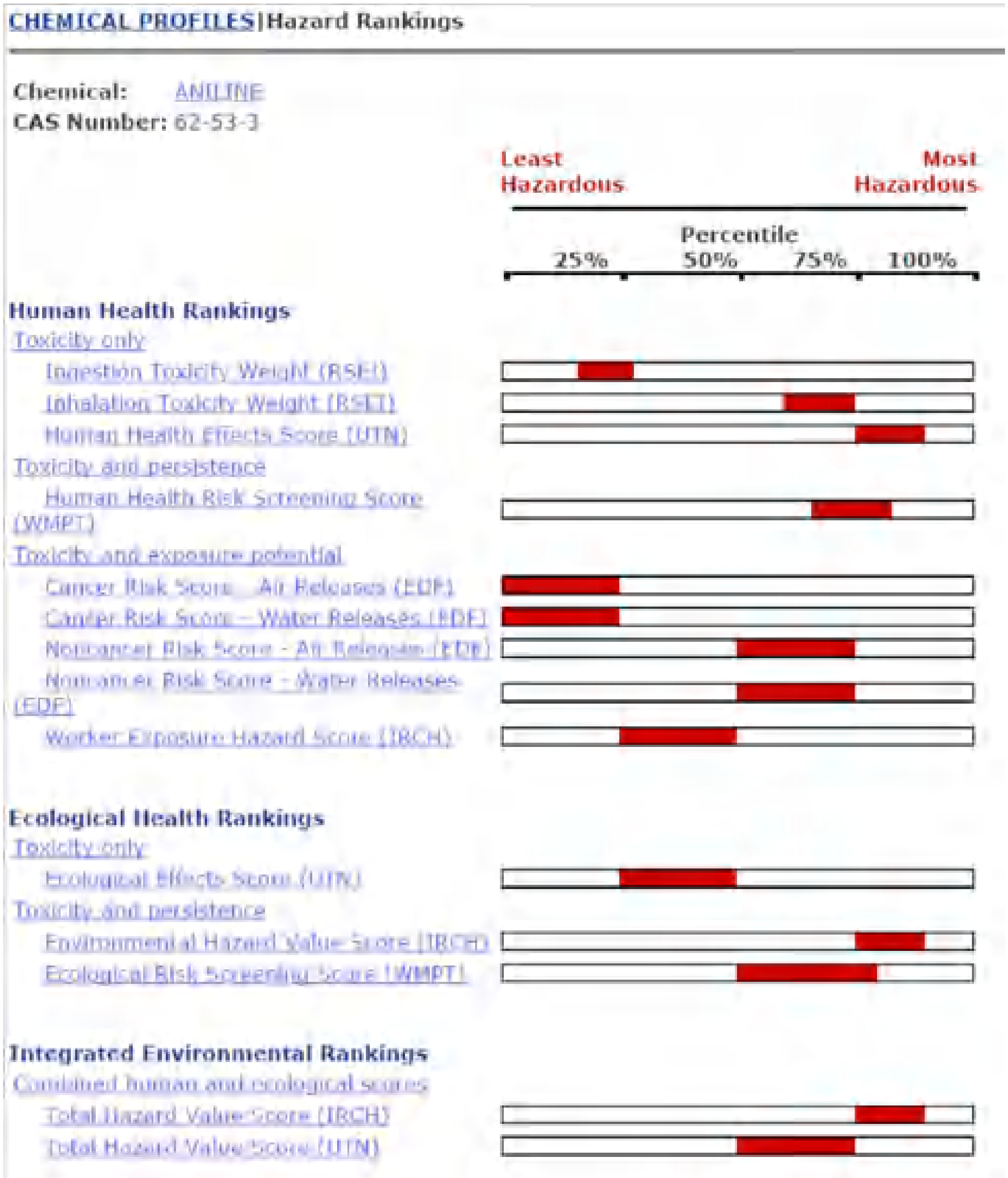
Combined human and ecological scores

- Total Hazard Value Score (IRCH)
- Total Hazard Value Score (UTN)

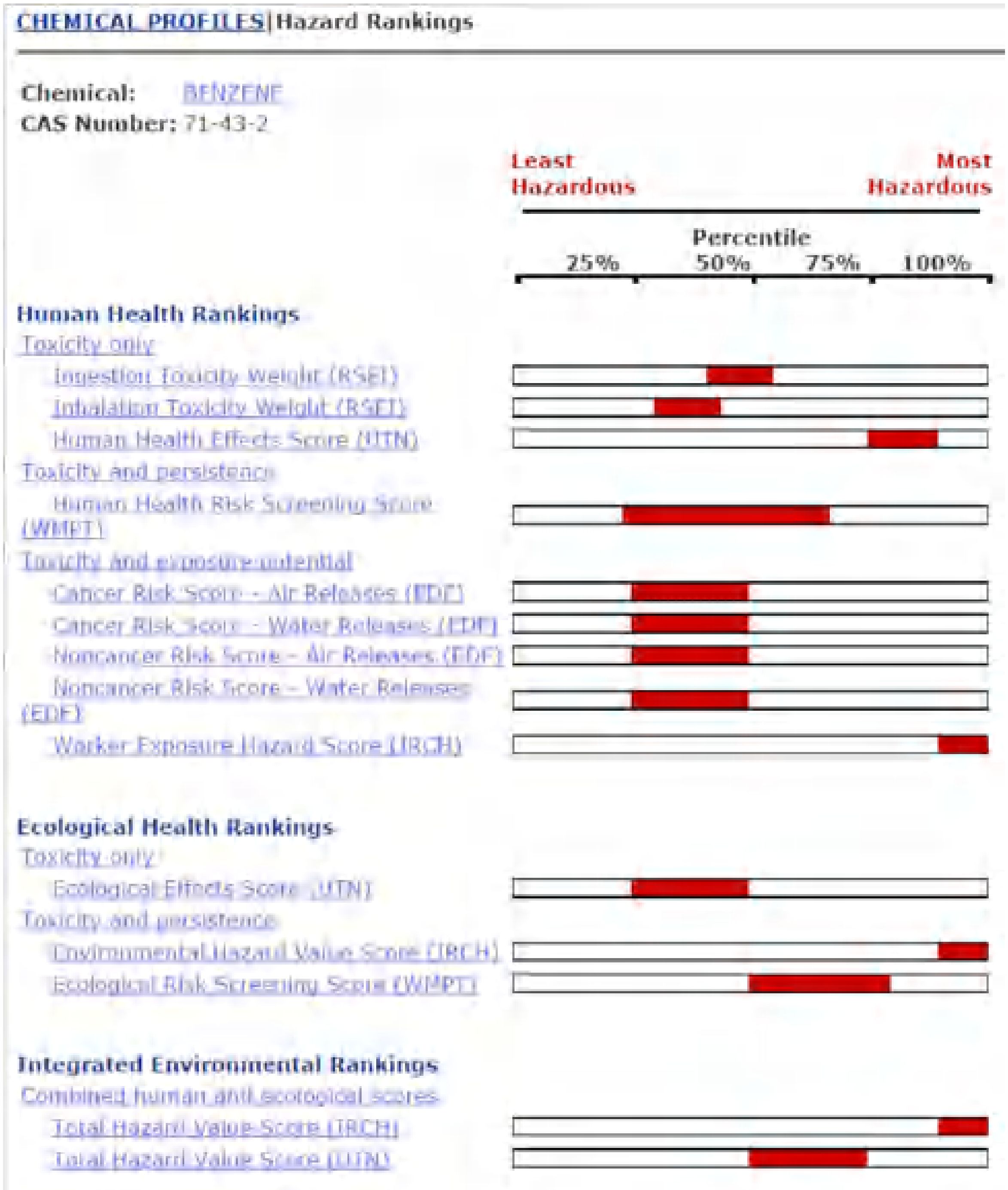
6.1.4 Acrylonitrile



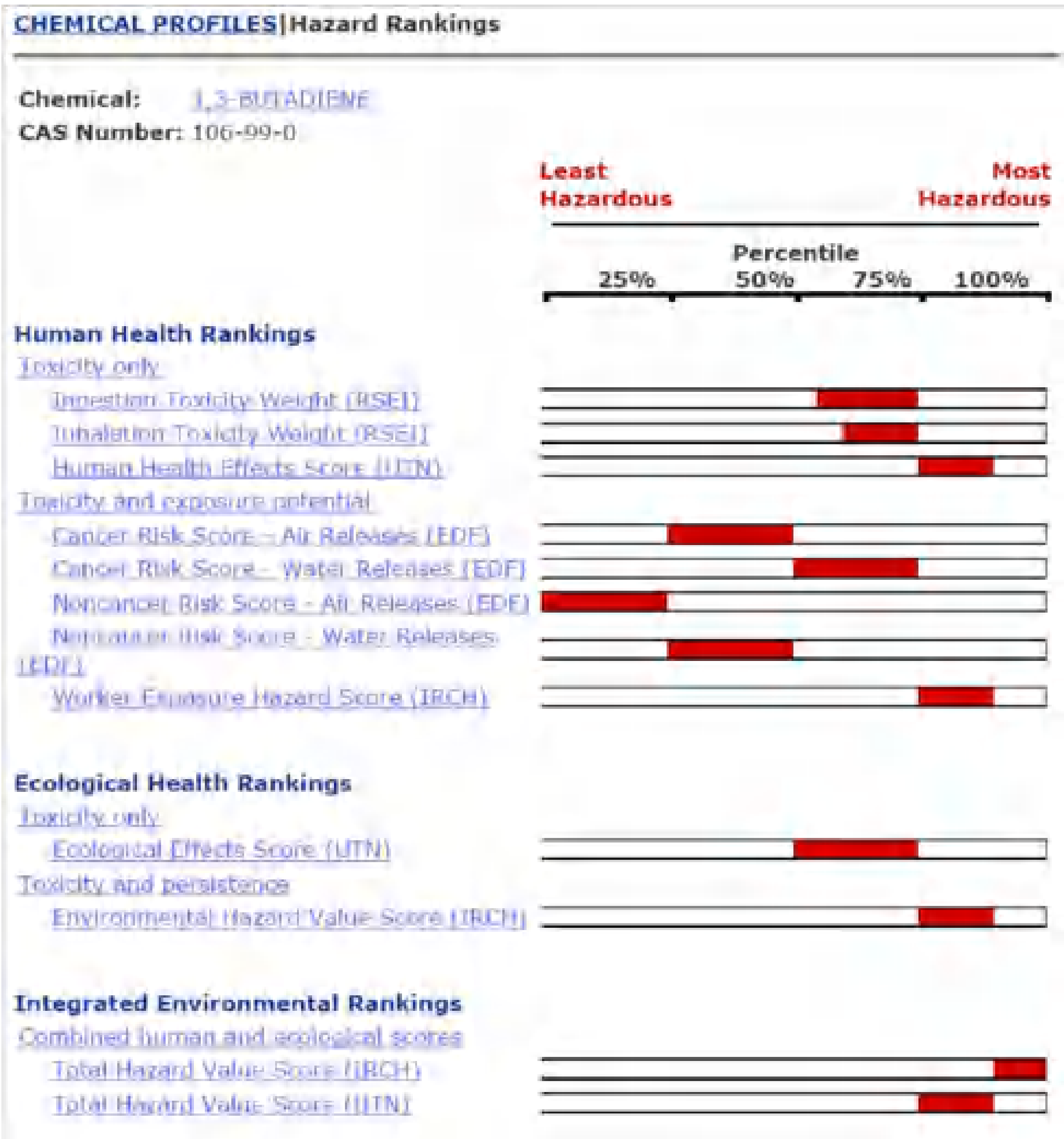
6.1.5 Aniline


CHEMICAL PROFILES|Hazard Rankings
Chemical: ANILINE
CAS Number: 62-53-3
Least Hazardous
Most Hazardous
Percentile
25%
50%
75%
100%
Human Health Rankings
Toxicity only
Ingestion Toxicity Weight (RSEI)
Inhalation Toxicity Weight (RSEI)
Human Health Effects Score (UTN)
Toxicity and persistence
Human Health Risk Screening Score (WMPT)
Toxicity and exposure potential
Cancer Risk Score - Air Releases (EDF)
Cancer Risk Score - Water Releases (EDF)
Noncancer Risk Score - Air Releases (EDF)
Noncancer Risk Score - Water Releases (EDF)
Worker Exposure Hazard Score (IRCH)
Ecological Health Rankings
Toxicity only
Ecological Effects Score (UTN)
Toxicity and persistence
Environmental Hazard Value Score (IRCH)
Ecological Risk Screening Score (WMPT)
Integrated Environmental Rankings
Combined human and ecological scores
Total Hazard Value Score (IRCH)
Total Hazard Value Score (UTN)

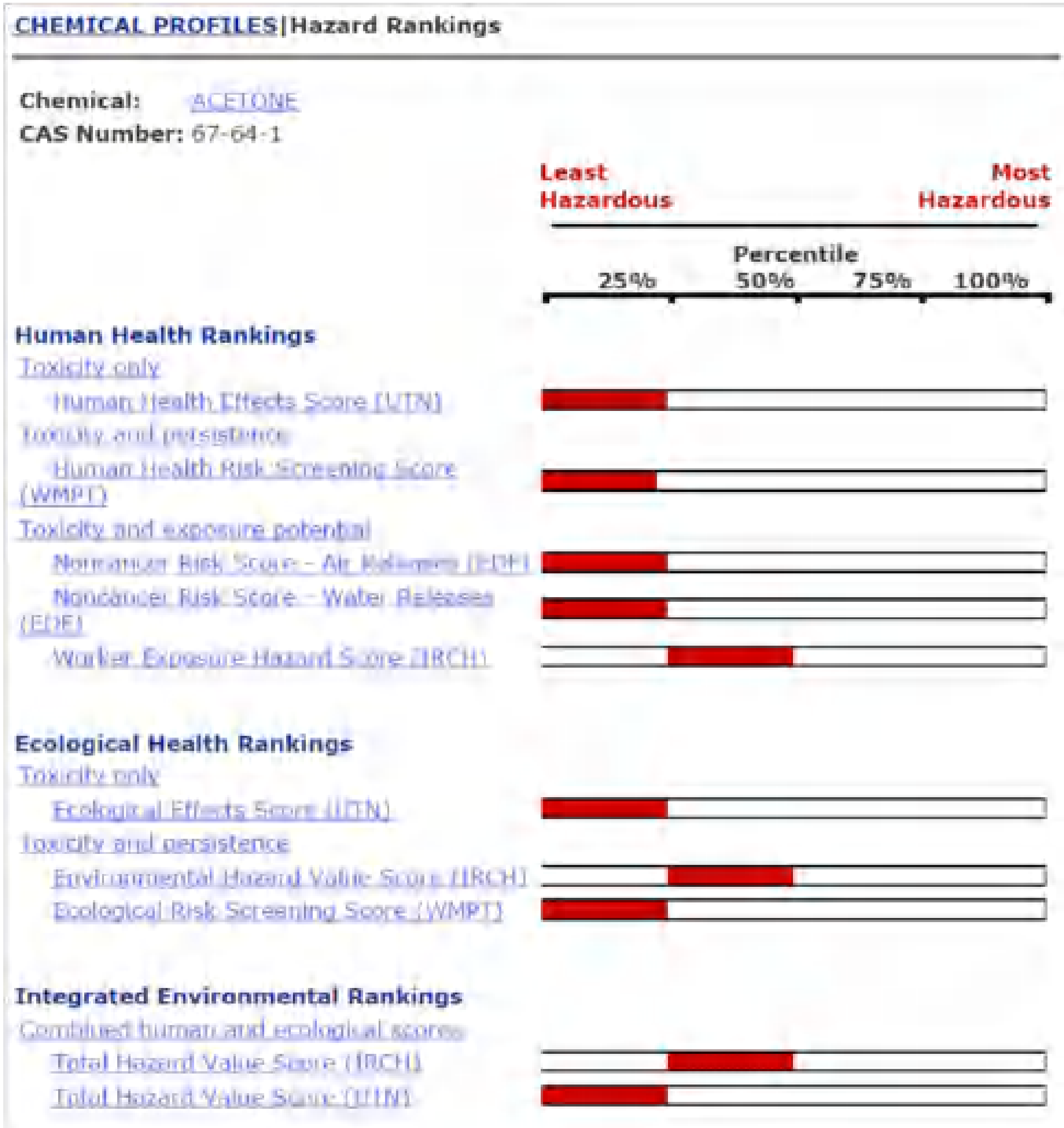
6.1.6 Benzene


CHEMICAL PROFILES | Hazard Rankings
Chemical: BENZENE
CAS Number: 71-43-2
Least Hazardous
Most Hazardous
Percentile
25%
50%
75%
100%
Human Health Rankings
Toxicity only
Ingestion Toxicity Weight (RSEI)
Inhalation Toxicity Weight (RSEI)
Human Health Effects Score (UTN)
Toxicity and persistence
Human Health Risk Screening Score (WMPT)
Toxicity and exposure potential
Cancer Risk Score - Air Releases (EDF)
Cancer Risk Score - Water Releases (EDF)
Noncancer Risk Score - Air Releases (EDF)
Noncancer Risk Score - Water Releases (EDF)
Worker Exposure Hazard Score (IRCH)
Ecological Health Rankings
Toxicity only
Ecological Effects Score (UTN)
Toxicity and persistence
Environmental Hazard Value Score (IRCH)
Ecological Risk Screening Score (WMPT)
Integrated Environmental Rankings
Combined human and ecological scores
Total Hazard Value Score (IRCH)
Total Hazard Value Score (UTN)

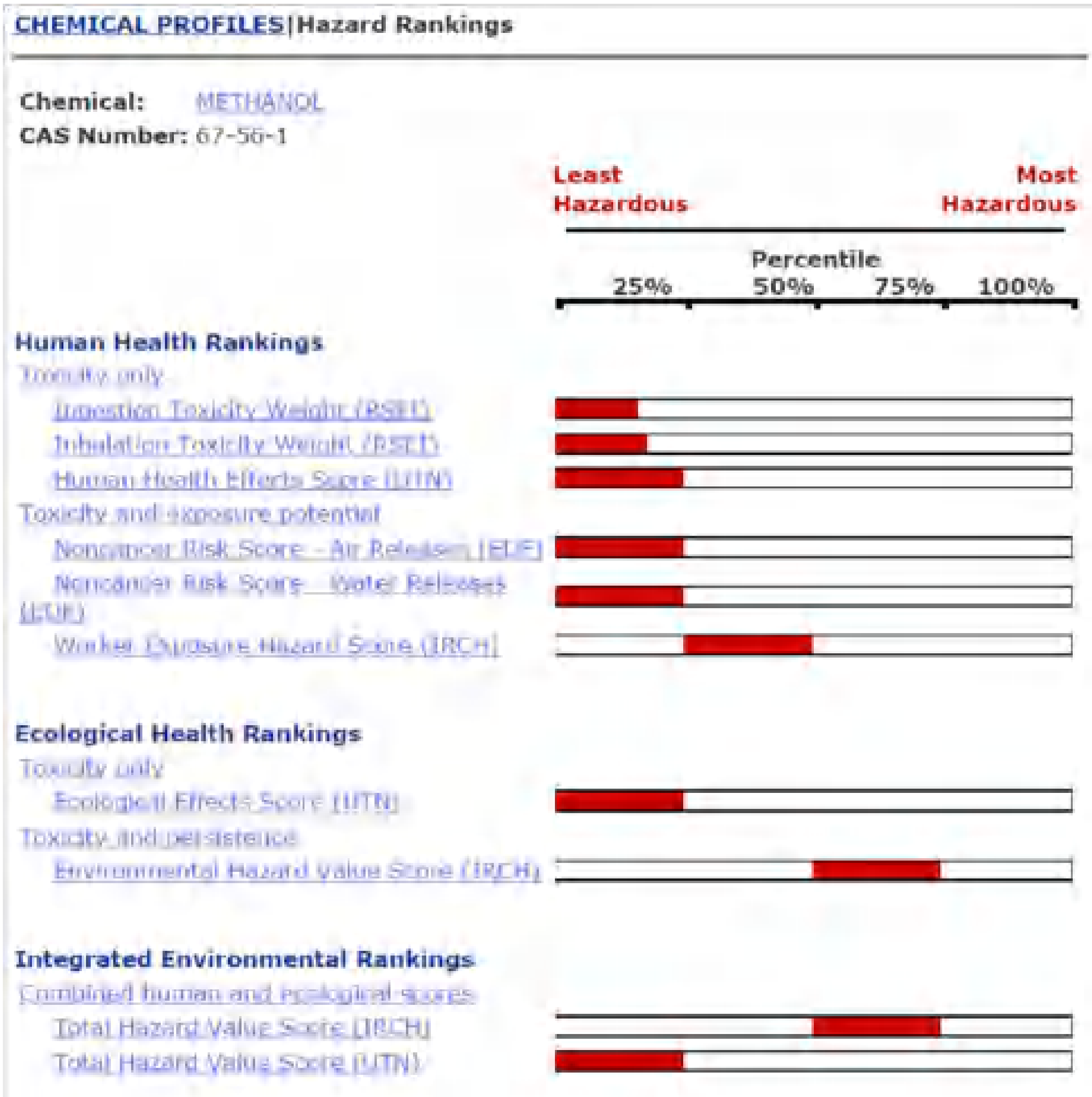
6.1.7 1: 3, Butadiene



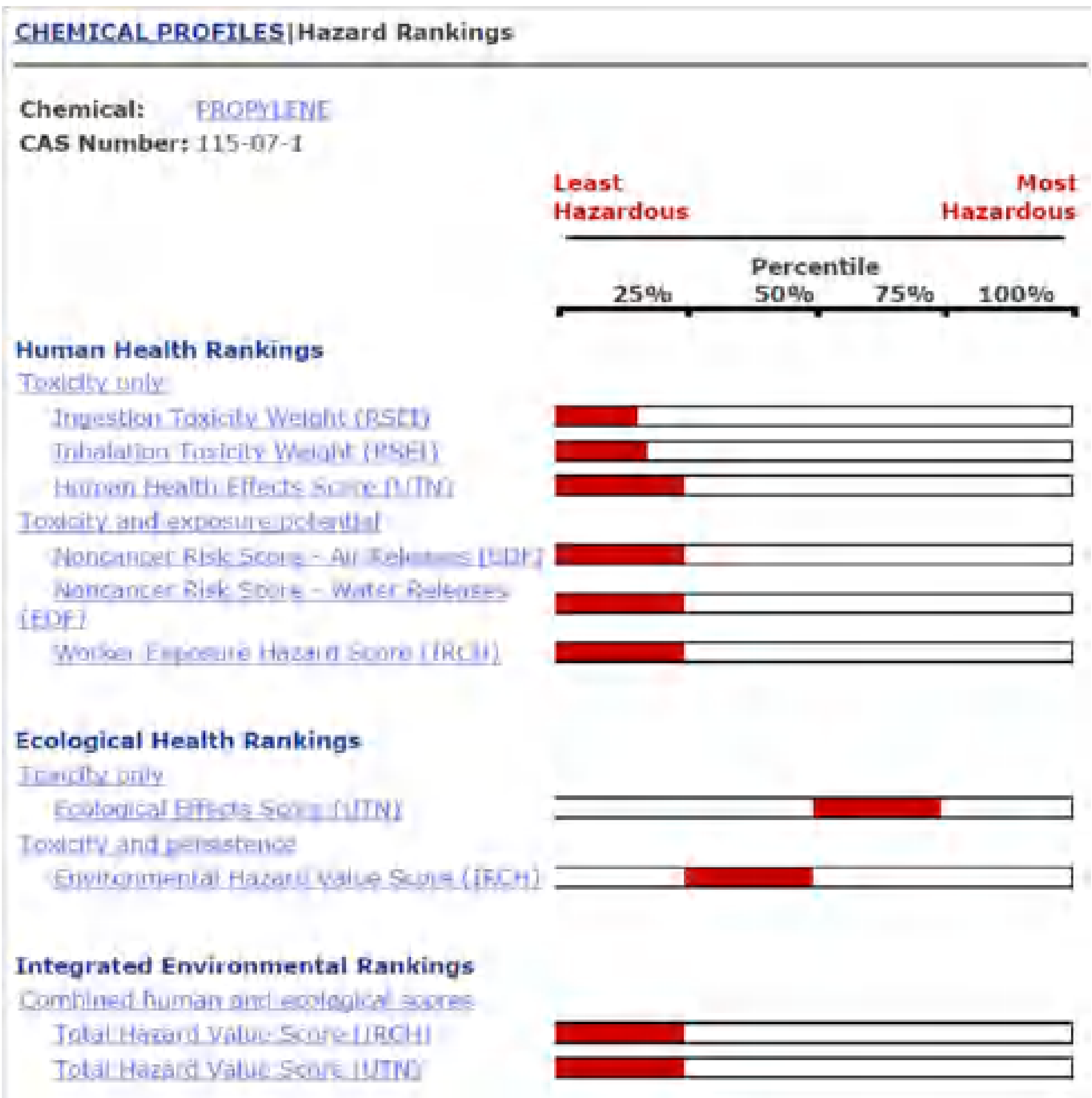
6.1.8 Acetone


CHEMICAL PROFILES|Hazard Rankings
Chemical: ACETONE
CAS Number: 67-64-1
Least Hazardous
Most Hazardous
Percentile
25%
50%
75%
100%
Human Health Rankings
Toxicity only
Human Health Effects Score (UTN)
Toxicity and persistence
Human Health Risk Screening Score (WMPT)
Toxicity and exposure potential
Noncancer Risk Score - Air Releases (EDF)
Noncancer Risk Score - Water Releases (EDF)
Worker Exposure Hazard Score (IRCH)
Ecological Health Rankings
Toxicity only
Ecological Effects Score (UTN)
Toxicity and persistence
Environmental Hazard Value Score (IRCH)
Ecological Risk Screening Score (WMPT)
Integrated Environmental Rankings
Combined human and ecological scores
Total Hazard Value Score (IRCH)
Total Hazard Value Score (UTN)

6.1.9 Methanol



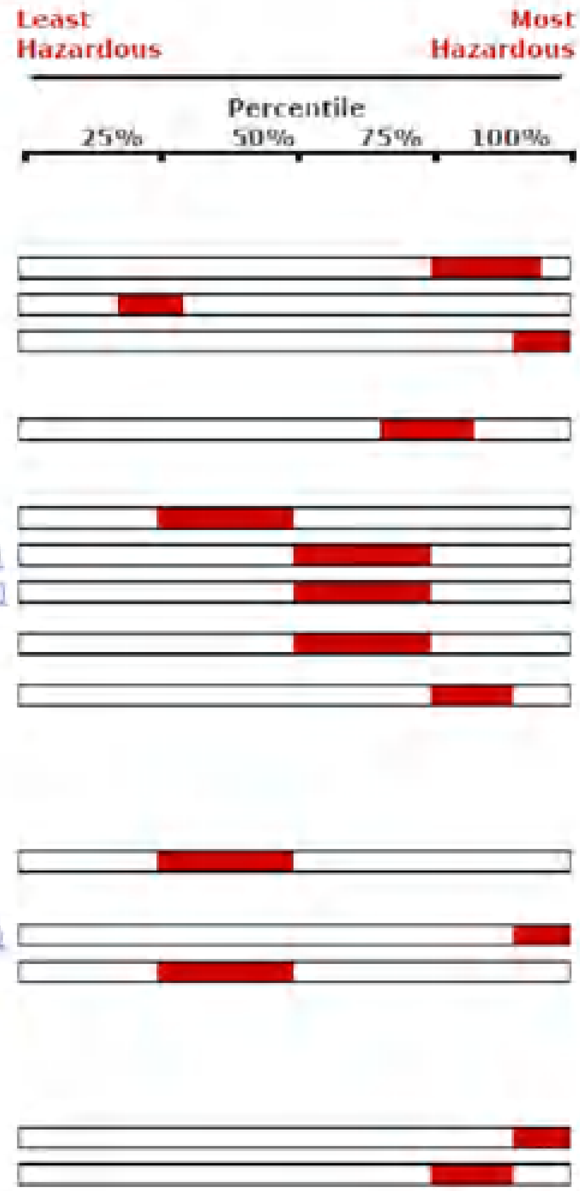
6.1.10 Propylene



6.1.11 Vinyl Chloride

CHEMICAL PROFILES|**Hazard Rankings**

Chemical: VINYL CHLORIDE
CAS Number: 75-01-4



Human Health Rankings

Toxicity only

- Ingestion Toxicity Weight (RSEI)
- Inhalation Toxicity Weight (RSEI)
- Human Health Effects Score (UTN)

Toxicity and persistence

- Human Health Risk Screening Score (WMPT)

Toxicity and exposure potential

- Cancer Risk Score - Air Releases (EDF)
- Cancer Risk Score - Water Releases (EDF)
- Noncancer Risk Score - Air Releases (EDF)
- Noncancer Risk Score - Water Releases (EDF)
- Worker Exposure Hazard Score (IRCH)

Ecological Health Rankings

Toxicity only

- Ecological Effects Score (UTN)

Toxicity and persistence

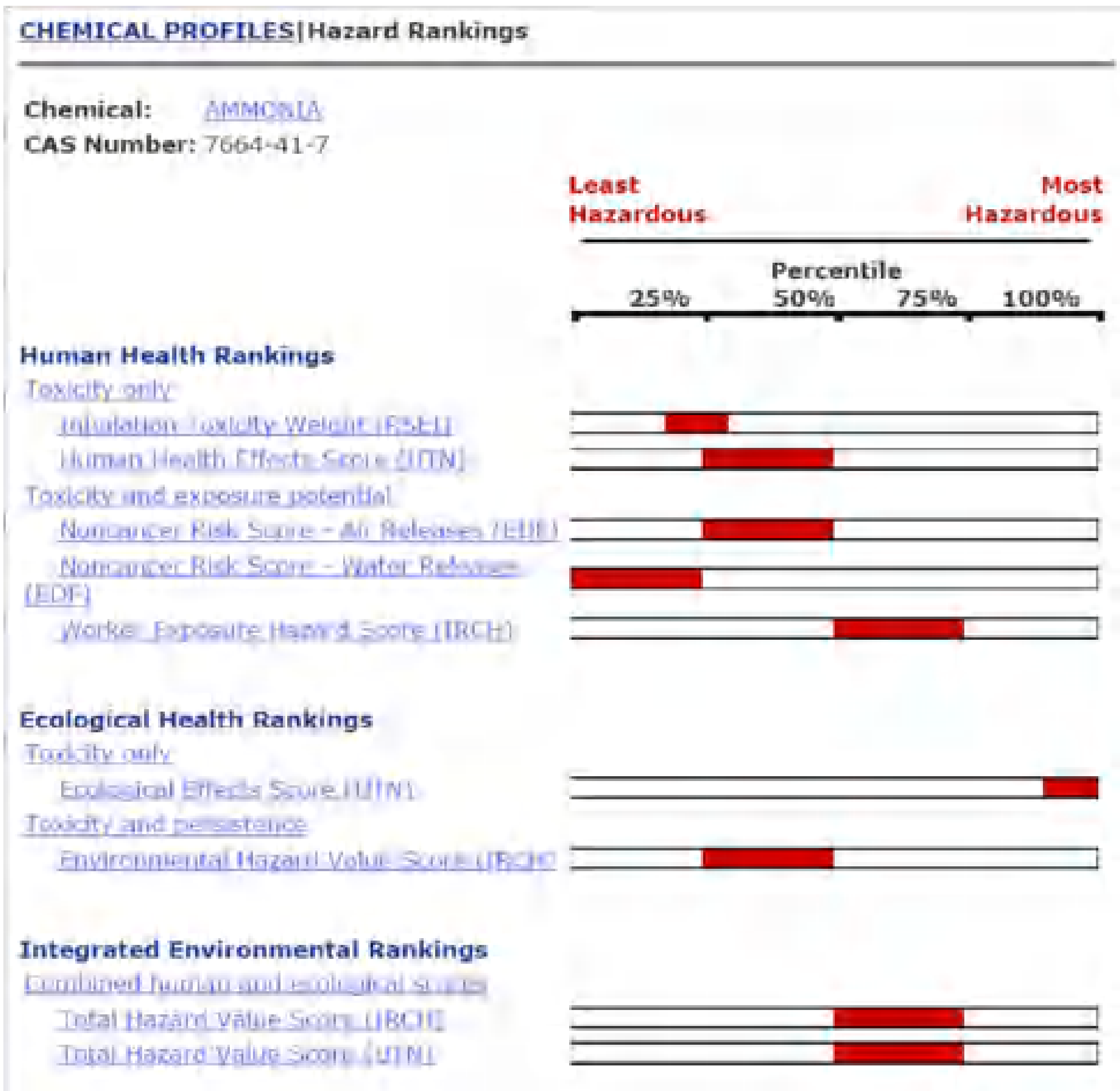
- Environmental Hazard Value Score (IRCH)
- Ecological Risk Screening Score (WMPT)

Integrated Environmental Rankings

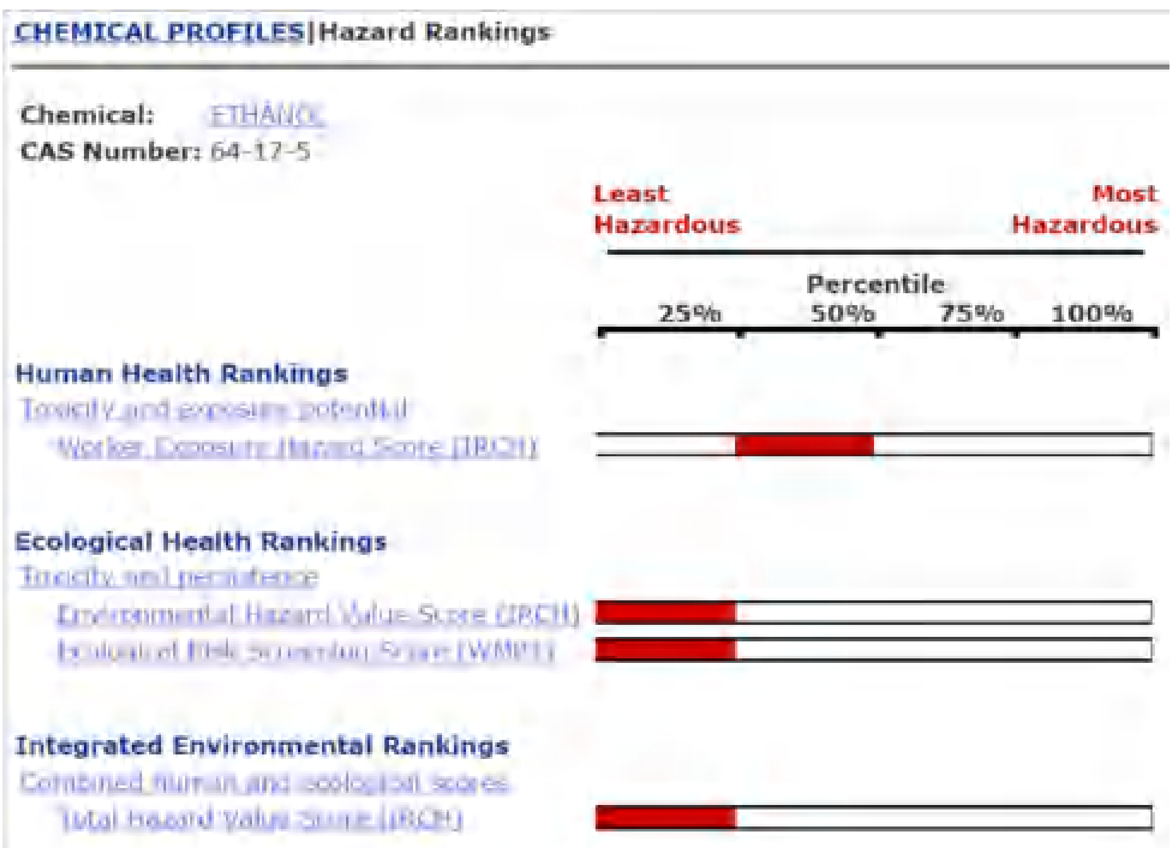
Combined human and ecological scores

- Total Hazard Value Score (IRCH)
- Total Hazard Value Score (UTN)

6.1.12 Ammonia



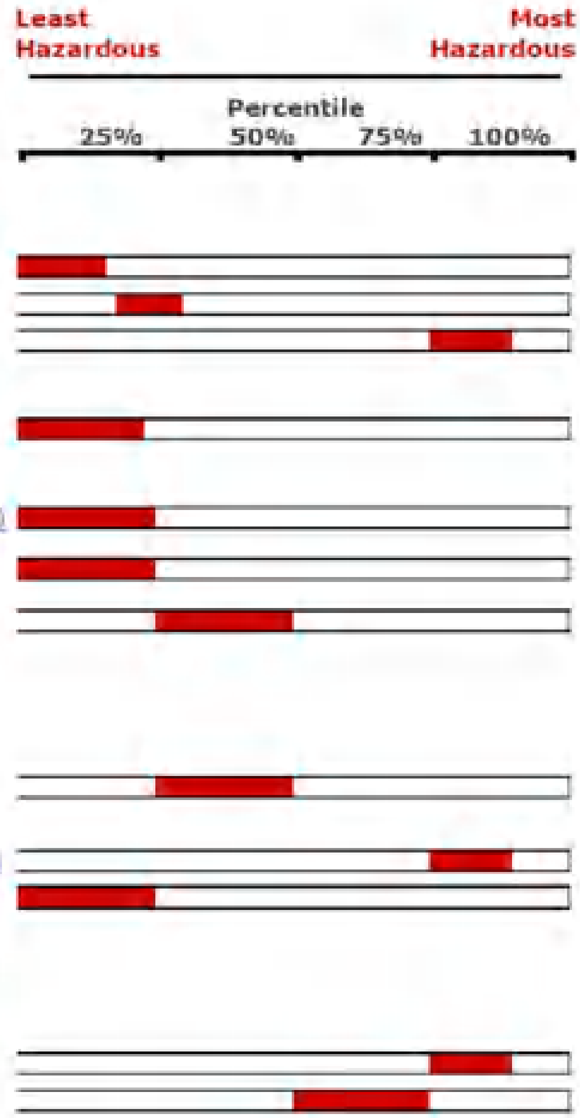
6.1.13 Ethanol



6.1.14 Phenol

CHEMICAL PROFILES|Hazard Rankings

Chemical: PHENOL
CAS Number: 108-95-2



Human Health Rankings

Toxicity only

- Ingestion Toxicity Weight (RSEI)
- Inhalation Toxicity Weight (RSEI)
- Human Health Effects Score (UTN)

Toxicity and persistence

- Human Health Risk Screening Score (WMPT)

Toxicity and exposure potential

- Noncancer Risk Score - Air Releases (EDF)
- Noncancer Risk Score - Water Releases (EDF)
- Worker Exposure Hazard Score (IRCH)

Ecological Health Rankings

Toxicity only

- Ecological Effects Score (UTN)

Toxicity and persistence

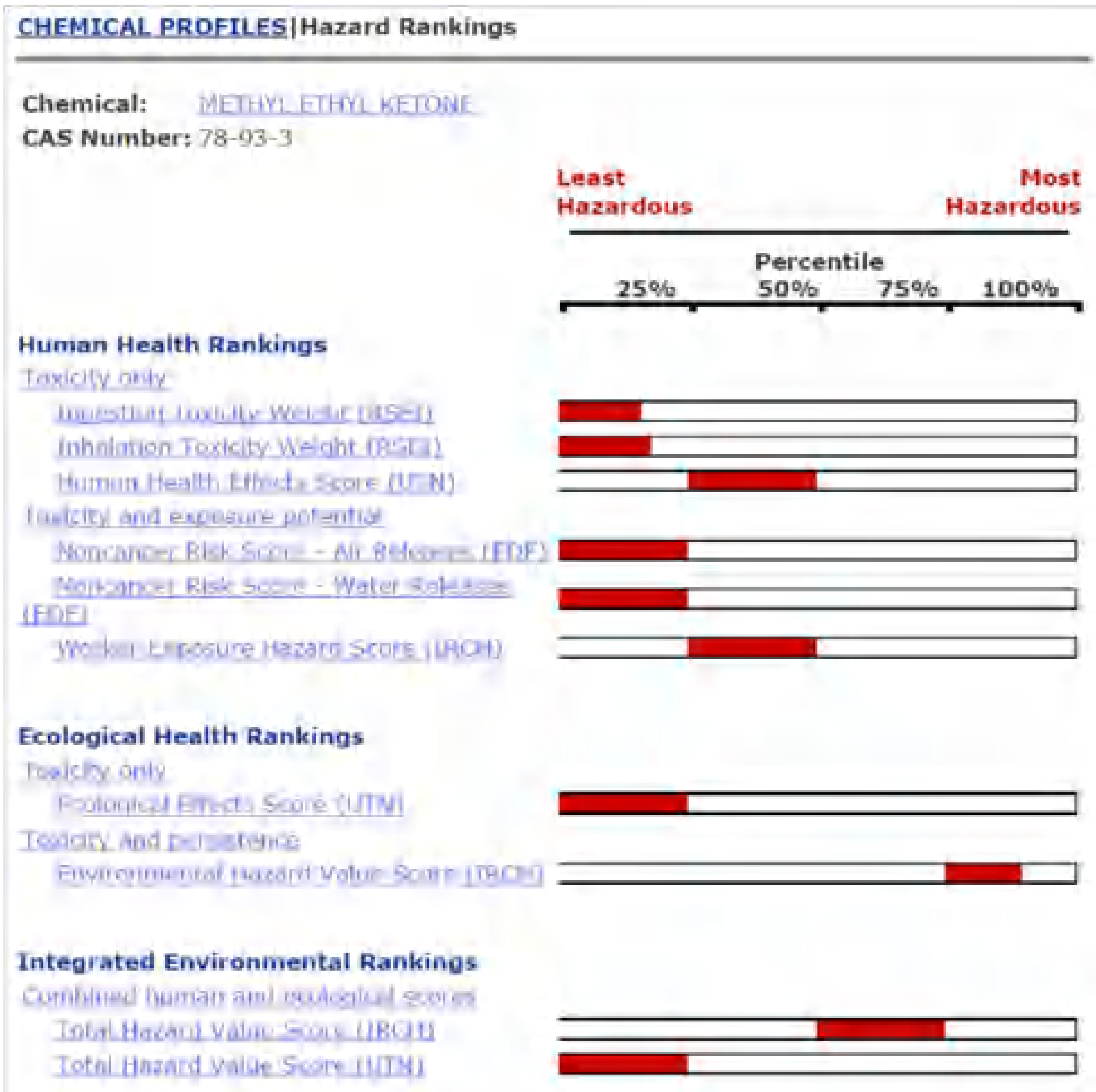
- Environmental Hazard Value Score (IRCH)
- Ecological Risk Screening Score (WMPT)

Integrated Environmental Rankings

Combined human and ecological scores

- Total Hazard Value Score (IRCH)
- Total Hazard Value Score (UTN)

6.1.15 Methyl Ethyl Ketone

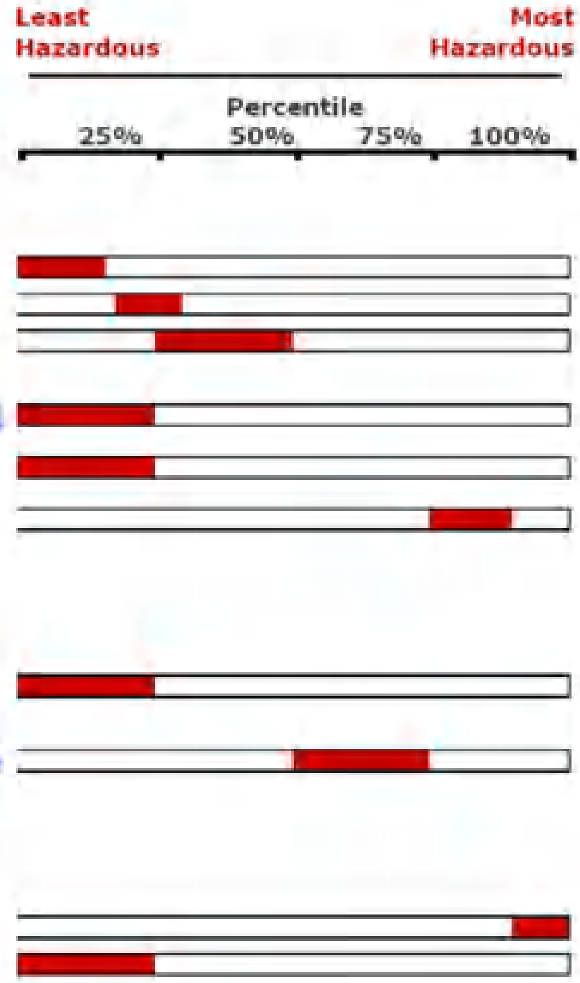


6.1.16 Vinyl Acetate

CHEMICAL PROFILES|**Hazard Rankings**

Chemical: VINYL ACETATE

CAS Number: 108-05-4



Human Health Rankings

Toxicity only

Ingestion Toxicity Weight (RSEI)

Inhalation Toxicity Weight (RSEI)

Human Health Effects Score (UTN)

Toxicity and exposure potential

Noncancer Risk Score - Air Releases (EDF)

Noncancer Risk Score - Water Releases (EDF)

Worker Exposure Hazard Score (IRCH)

Ecological Health Rankings

Toxicity only

Ecological Effects Score (UTN)

Toxicity and persistence

Environmental Hazard Value Score (IRCH)

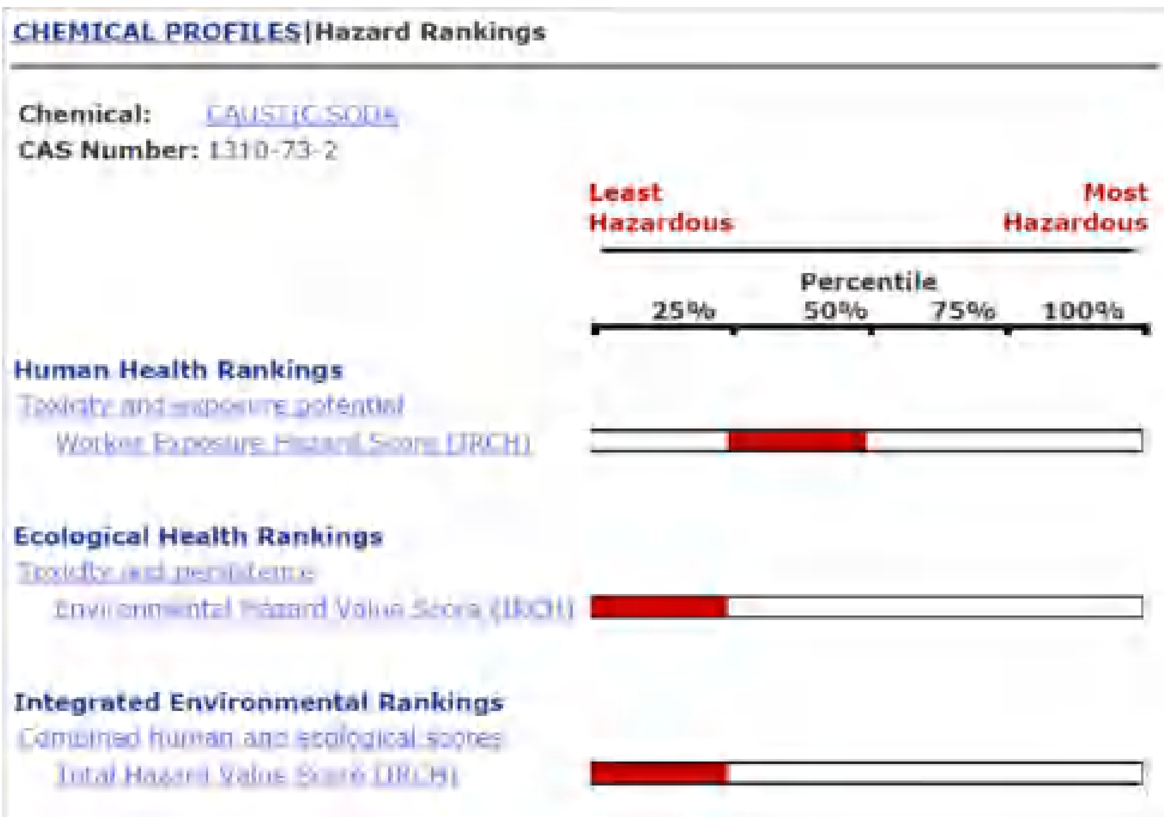
Integrated Environmental Rankings

Combined human and ecological scores

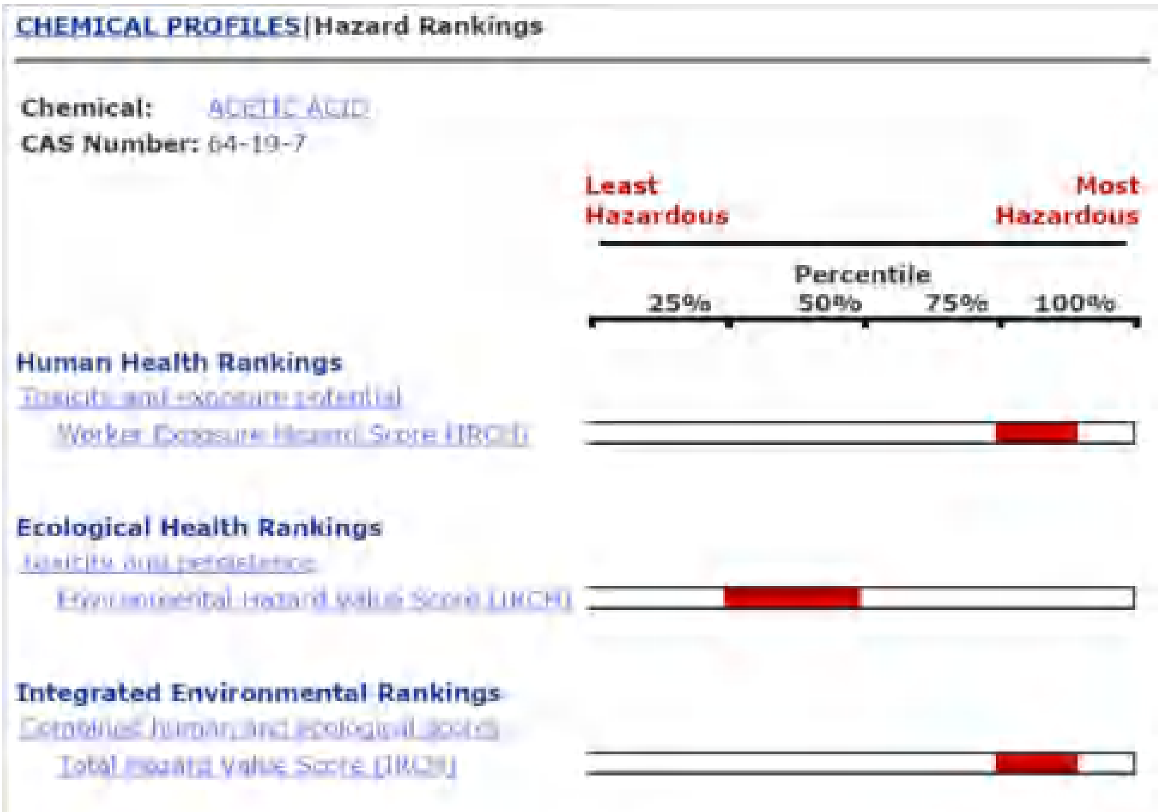
Total Hazard Value Score (IRCH)

Total Hazard Value Score (UTN)

6.1.17 Caustic Soda



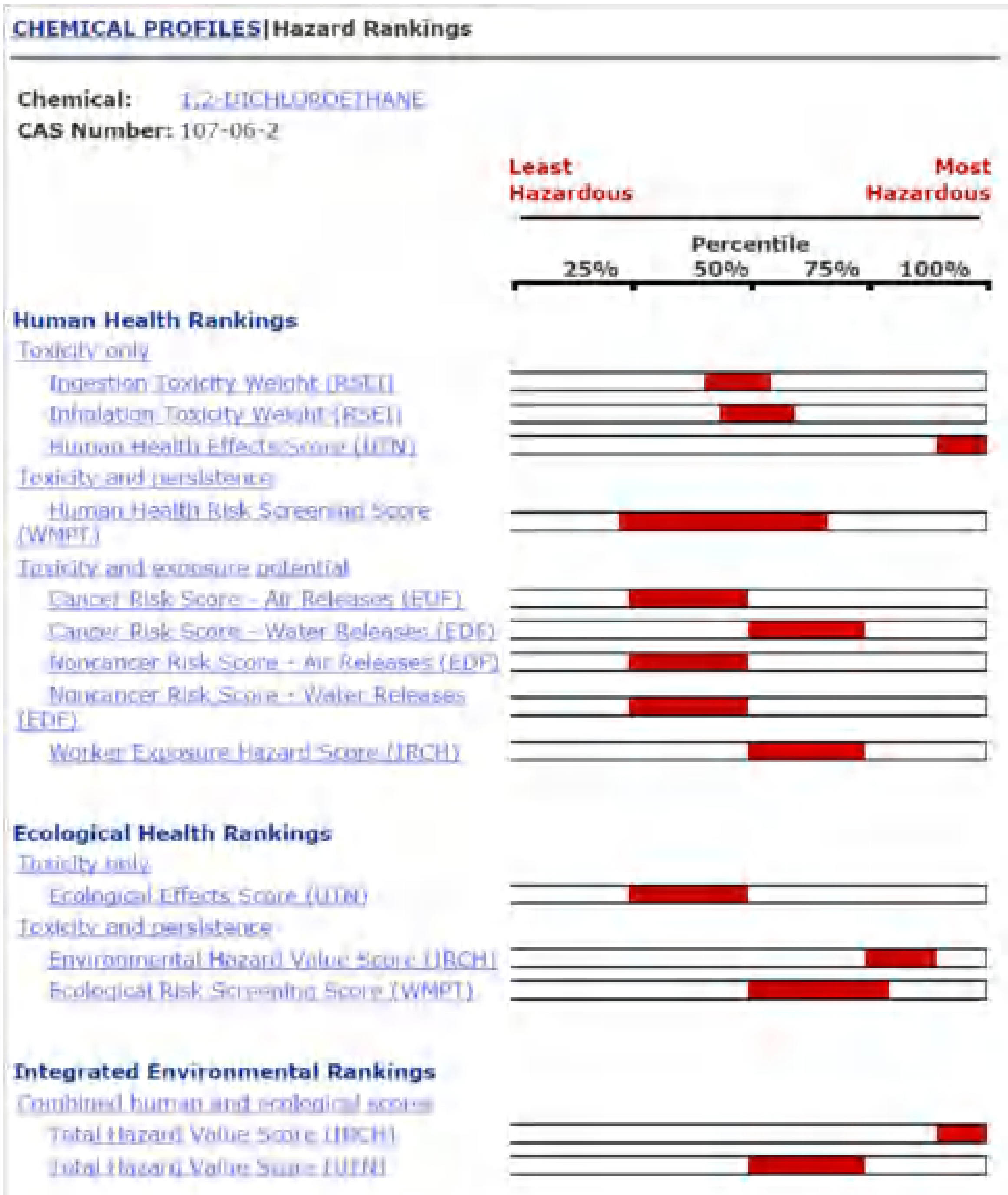
6.1.18 Acetic Acid


CHEMICAL PROFILES|Hazard Rankings
Chemical: ACETIC ACID
CAS Number: 64-19-7
Least Hazardous
Most Hazardous
Percentile
25% 50% 75% 100%
Human Health Rankings
Toxicity and exposure potential
Worker Exposure Hazard Score (IRCH)
Ecological Health Rankings
Toxicity and persistence
Environmental Hazard Value Score (IRCH)
Integrated Environmental Rankings
Combined human and ecological scores
Total Hazard Value Score (IRCH)

6.1.19 Nonene


CHEMICAL PROFILES|Hazard Rankings
Chemical: NONENE
CAS Number: 27215-95-8
Least Hazardous
Most Hazardous
Percentile
25% 50% 75% 100%
Ecological Health Rankings
Toxicity and persistence
Ecological Risk Screening Score (WMPT)

6.1.20 Ethyl Di Chloride (EDC)



Reference: http://www.scorecard.org/chemical-profiles/hazard-indicators

7 SABOTAGE & CIVIL DISTURBANCE

Access to the Kandla Port is controlled by walls / fence. The entrances are manned by CISF guards.

If a civil disturbance or sabotage threatens or actually damages the port property – the Harbour Master will communicate with local civil authorities or will request immediate assistance from police, coast guard, navy / air force.

7.1 Bomb Emergency Management

In the event of receiving a bomb threat by telephone call, the following should be asked and noted for relaying it to the army/air force/navy:

In view of the high priority given to Ports, they have high risk of becoming targets of the terrorist groups. Therefore the possibility of receiving bomb threats cannot be ruled out. The golden rule is consider all bomb threats as genuine and act accordingly keeping in mind the safety of the people in the Port and the property.

The objective is:

a) To avoid/minimize any loss or damage to lives and property

b) To eliminate panic and build up confidence.

c) To be prepared for proper handling of any critical situation.

7.2 Immediate actions:

a) Bomb threats may be received in writing email, SMS or may be received on phone.

b) When the call is received on phone, keep the caller on the line as long as possible. Request him to repeat the message, listen carefully as every word spoken by the person has to be recorded mentally and penned down.

c) If the caller does not indicate the location of the bomb or the time of possible detonation, it is advisable to try to ask him for this information.

d) Inform the caller that the port area is occupied and the detonation of a bomb would result in death or serious injury to many innocent persons.

e) Pay particular attention to peculiar background noises such as motors running, background music and any other noise which may give a clue as to from where the call is being made.

f) Listen closely to the voice (male, female), voice quality (calm, excited), accents and speech impediments. Immediately after the caller hangs up report should be made to the security officer on duty about all the above details.

g) Fill up the bomb threat call details in the format as given below.

h) Call all identified personnel (As indicated for any emergency)

i) As soon as an emergency is envisaged /occurs the Emergency chief or his alternate shall promptly communicate the information by a telephone or any other quickest mode of communication to the Inspector of Police, highest administrative officer, fire brigade and the nearby installations. The

information should include the location of the installation and the degree of emergency (anticipated, eminent or actual).

7.3 Bomb Threat Report Form

7.3.1 Actions on Receiving Bomb Threat Call

1. Do not put down receiver or cut off caller
2. Put on tape-recorder /USE CELL PHONE RECORDING
3. Alert nearest colleague
4. Keep Form and pen ready to fill
5. Note time and duration correctly
6. Obtain as much information as possible
7. Keep caller engaged in conversation as long as possible

(Apologise for bad line, ask him to speak up etc.)

Time of call......... Date........... Exact words of caller.......................

Was any one called for by name or designation () Yes () No. If so, who?

7.3.2 Questions to Ask Caller

1. Who is calling from where?
2. When is the bomb set to go off?
3. Where is the bomb placed?
4. What kind of bomb is it?
5. How does it look like?
6. Why are you doing this?
7. Whom do you represent?
8. How do you know so much about the bomb?
9. How can we get rid of the bomb?
10. Do you know that the bomb will kill innocent people?

7.3.3 Details of Caller

- Sex: () Male () Female   Approximate age: ......years.
- Origin of call: () inside plant, () outside local, () outside long distance.
- Voice characteristic: () fast, () slow, () stutter, () distinct, () disguised, () educated, () uneducated, () loud, () soft.
- Language used ...., accent ...., manner: ()calm, ()angry,

  ()emotional, ()laughing, ()deliberate, ()normal, ()abnormal, ()other
- Is voice familiar? () yes, () no.
- Background sound: ()street, ()telephone booth, ()airport, () railway station, ()residence, ()cannot identify, ()others

CISF Commandant/Officer informed at: Name of the person receiving call .... signature............

(Keep these forms with all Telephone Operators/All designations having direct line?)

7.4 Responsibility of the CISF Commandant / Officer of Kandla port

a) Advise the Emergency chief (Chairman/Dy. Chairman/Dy. Conservator/Harbour Master) and keep him appraised of the actions being taken.

b) Immediately make elaborate preparations near the threatened area for

- Fire fighting
- Casualty handling
- Rescue operations
- Search operations

c) Prepare for partial/total evacuation if required. Emergency chief or his alternate will authorize these activities.

d) Designate the team for bomb search. Initiate search operations with Fire and safety/security officers if time is available.

7.5 Action Plan

Two situations are possible.

a) When no time limit is given.

b) When bomb threat call has time limit specified.

As soon as the call is received the concerned area-in-charge will make fire fighting/first aid preparations immediately.

1. In the first case if there is no time limit specified for bomb explosion, as soon as the Emergency chief gives a clearance the following action should be initiated.

- Emergency shutdown of the Port sections likely to be affected.
- Evacuation of the employees and visitors to safer locations.
- Bomb search taking all the precautions.

7.5.1 Action plan when time limit is specified:

In such case the concerned officers should search the area along with safety and security officers.

7.5.2 Search procedures:

- Search must be conducted by employees of the concerned department since they are familiar with the area and would be in a better position to notice a foreign object faster.
- Two teams could be formed to search various parts of the area. Stand quietly for some moments to listen for any clockwork device before starting the search.
- As far as practical do not cause any disturbance in the environment till the search is over.
- Do not go into dark rooms and turn on lights. Use a flashlight instead.
- If any foreign or suspicious object is located, do not move or touch it. The removal/disarming of a bomb must be left to professionals. Report the location and description of the object immediately to the emergency control centre/Security gate.
- If possible place sand bags or mattresses around the bomb. Do not cover it.
- Identify the danger area and block it off with clear zone of at least 100 meter.

7.6 Important Telephone Nos of Police Authorities

Name and Designation of Officer	Fax	Telephone Nos. (Office)	Telephone Nos. (Residence)
District Collector, Bhuj. 9978406212	250430	(02832) 250020	02832-250350
Resident Add. Collector, Bhuj Mob.9978405099	250430	250650	
Parixita Rathore (IPS) S. P.-(East),9978405690		280233	
Mr. Dy. SP (Anjar)9825304239	243254		
Mr. Dy. SP(HQ)9825225071			
Mr.) Dy. SP.9824543004	0837-224040		
Control Room(DC-5)Purab	280287		

Mr. Vinod Chawda, M.P.,Kachchh		(m)	
Dy.Collector, Anjar Mob. 9825228049		243345	243363
Mamlatdar, Anjar Mob. 9879278174		242588	243362
Mamlatdar, Gandhidham 7567003975		250475 250270	222875 250475
Collector, Jamnagar		2555869	2554059
Collector's Control Room, Bhuj.		2252347 2231733	-
Dy. Mamlatdar, Gandhidham		250475 250270	9427719800
Civil Defence, Gandhidham		220221	
PGVCL, Gandhidham		221728 222809	
GW&SB, Gandhidham		220975	
GSRTC, Gandhidham		220198	
Duty Officer, All India Radio, Bhuj		221412	
State Information Dept. (Shri Sony) (m) 9879012714		224859 250954	253034 252855
Air Force,Duty Officer, Bhuj		252501 252502	
Air Force, Bhuj		223450	
Air Port, Bhuj		254550	
Aerodrame Officer, Kandla		238370	223247
Indian Navy, Jamnagar		550263 to 5	550825
Airforce, Jamnagar		550245 to 7	550247

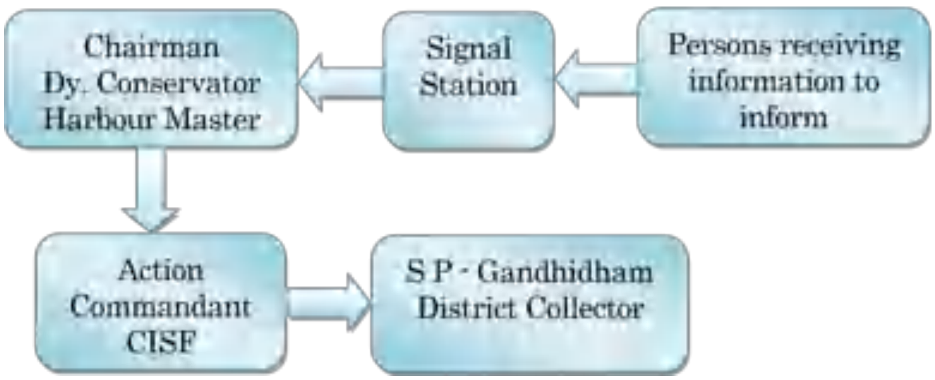
S. No	Designation	Present incumbent	Contact Telephone Numbers

			Office	Res	Mobile
01	CISF Commandant		271037	229140	9825227282
02	CISF Dy. Commandant		271036	220192	9825227045
03	Asst. Commandant		270440	271041	8000954482
04	Control Room		271040		
05	North Gate		270440		
06.	West Gate – I		271039		
07.	West Gate II		270876		

7.6 Contact Telephone Nos of Bomb Detection & Disposal Squad

Sr. No	Area	Telephone
01	GNADHIDHAM	9979928800
02	Rajkot	0281 – 245777
03	Ahmadabad	079 – 2210019

8 HOSTAGE SITUATION



8.1 Commandant CISF Responsibilities

- Apprise - Chairman, Deputy Chairman, Deputy Conservator, Harbour Master of contemplated action.
- Prepare threatened area for fire fighting, casualty handling, search and rescue operations
- Inform Police and requisition help with regard to negotiators/snipers, etc.
- CISF to cordon off area and deny access to persons hampering operations especially media and onlookers.
- Buy time for negotiators to arrive or for formalizing proper plan of action.
- Police/CISF shall assess the situation and based on the assessment, Chairman may permit operation deemed fit to free hostages.

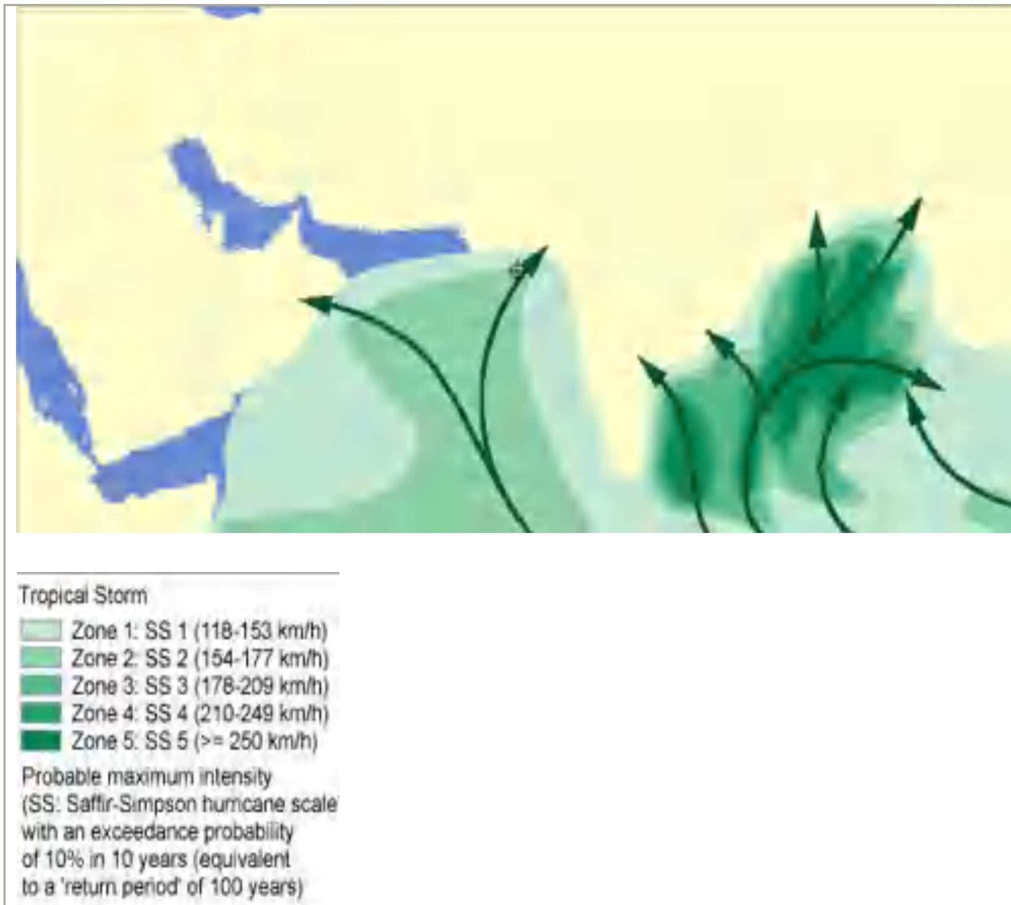
9 9 SEVERE WEATHER SITUATION

9.1 Act of God Perils (Cyclones Tsunami

9.1.1 Storms / Cyclone

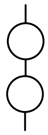
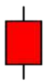
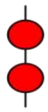
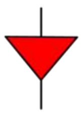
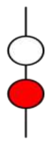
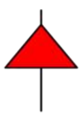
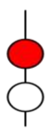
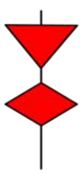
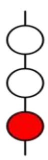
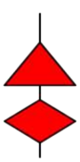
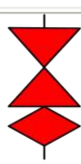
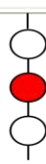
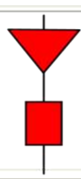
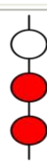
Even though Kandla is within the cyclone area of storms originating in the Arabian Sea and those that enter across the Indian Peninsula from the Bay of Bengal, cyclones are not as severe or frequent as in the Bay of Bengal. Historically, there has been major cyclone in the region in the year 1998.

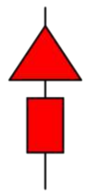
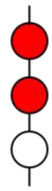
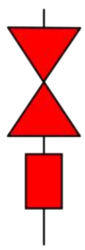
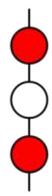
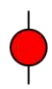
Hence the exposure to this peril is High.

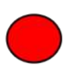


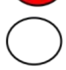
9.1.1.1

Signal No.	Symbol Day	Symbol Night	Type of Warning	Description

I			Cautionary	There is a region of squally weather in which a storm may be forming.
II			Warning	A storm has formed.
III			Cautionary	Port is threatened by squally weather.
IV			Warning	The Port is threatened by storm, but it does not appear that the danger is as yet sufficiently great justifying extreme measures of precautions.
V			Danger	The Port will experience severe weather from a storm of slight or moderate intensity that is expected to cross the coast to the south of the port.
VI			Danger	The Port will experience severe weather from a storm of slight or moderate intensity that is expected to cross the coast to the north of the port.
VII			Danger	The Port will experience severe weather from a storm of slight or moderate intensity that is expected to cross over or near to the port.
VIII			Great danger	The Port will experience severe weather from a storm of great intensity that is expected to cross to the south of the port.

IX			Great danger	The Port will experience severe weather from a storm of great intensity that is expected to cross the coast to the north of the port.
X			Great danger	The Port will experience severe weather from a storm of great intensity that is expected to cross over or near to the port.
XI			Failure of communication	Failure of Communication with Meteorological head quarters has broken down and the local officer considers that there is danger of bad weather.

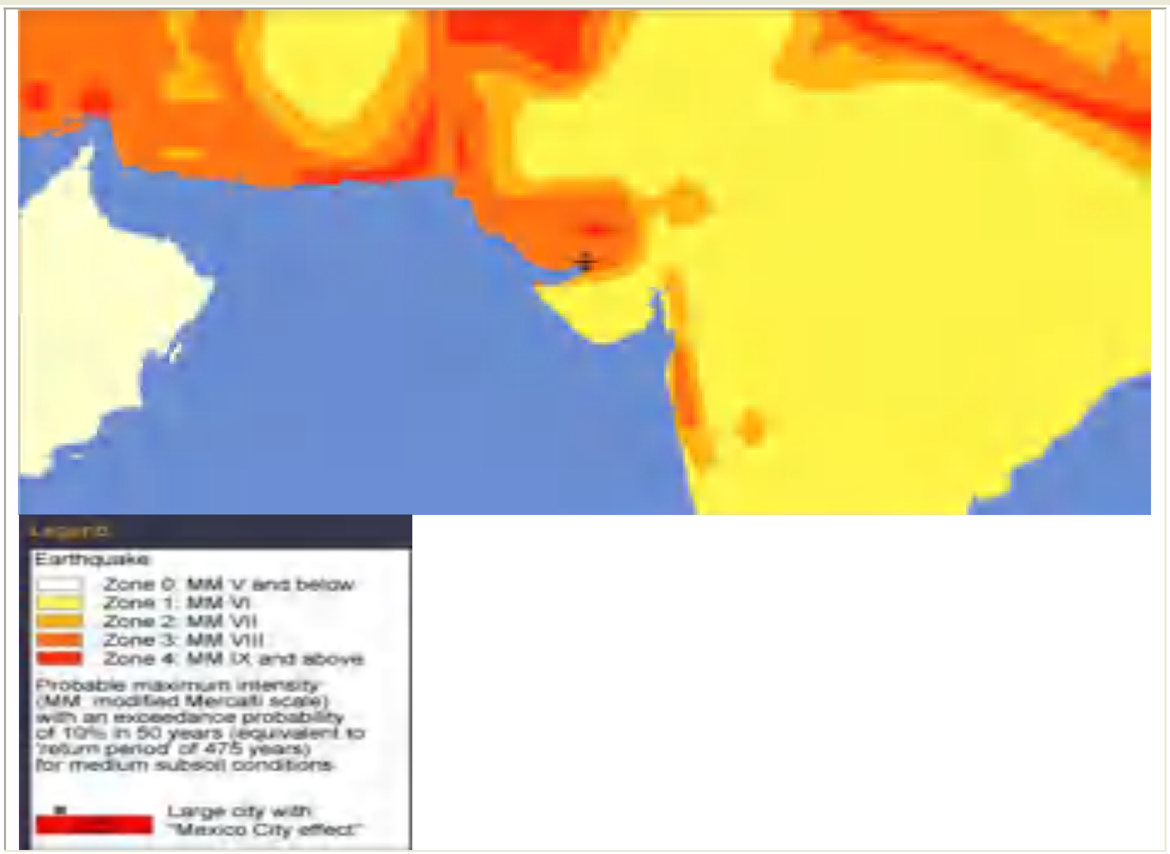
 Red Light,

 White Light

9.1.2 Earthquake

As per Munich Re world map for Natural hazards the Gandhidham region comes under the Zone III of the earthquake classification as per Indian Standards which is relatively high. However, seismic experts have opined that the Indian land mass is being constantly compressed between the sea and Himalayas and thus the developed stresses are being released in the form of earthquakes in the least expected areas.

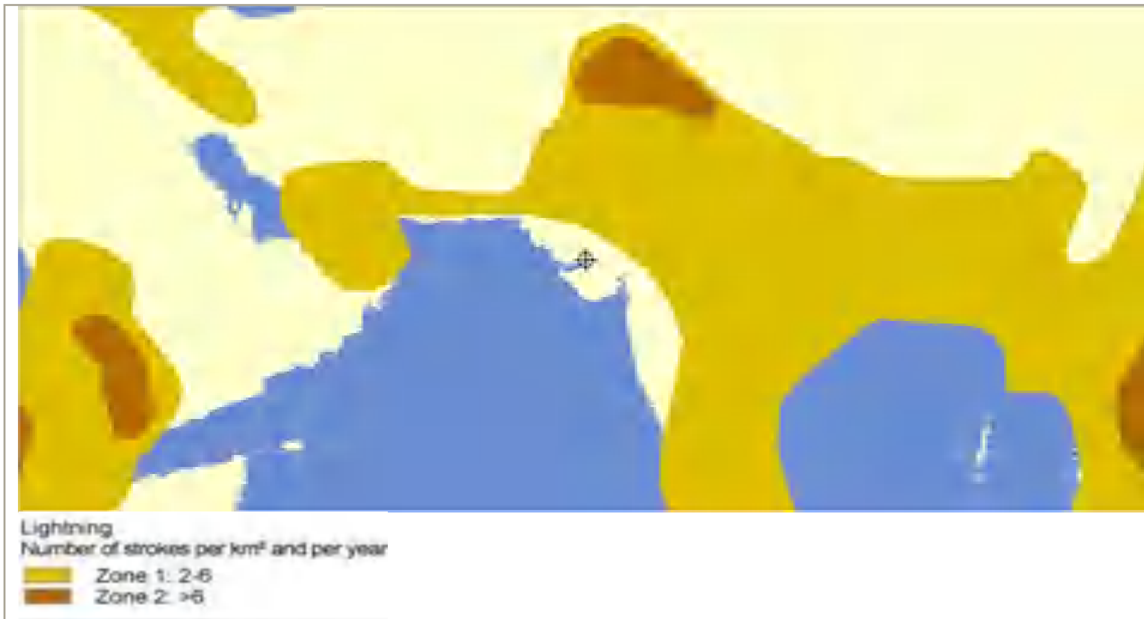
Thus taking the dynamic seismic scenario in to consideration risk exposure can be considered as High.



9.1.3 Lightning

As per Munich Re World Map for Natural hazards, Gandhidham region is in Zone – I which means on an average there are 2 - 6 lightning strikes per km^2 area per year which signifies moderate risk exposure.

Thus risk exposure can be considered as moderate.



9.1.4 Tsunami

Tsunami is large submarine earthquake or large submarine landslides, which are often triggered by earthquakes, and volcanic eruption in the sea or on the coast. The waves spread out in all directions and at great speed, which increases with the depth of water. In great ocean basins the average speed is about 700km/h.

Thus risk exposure can be considered as moderate.

Gujarat is prone to tsunami risk due to its long coastline and probability of occurrence of near and offshore submarine earthquakes in the Arabian Sea. Makran Subduction Zone (MSZ) - South West of Karachi is an active fault area which may cause a high magnitude earthquake under the sea leading to a tsunami. In past, Kandla coast was hit by a Tsunami of 12 mtrs height in 1945, due to an earthquake in the Makran fault line. Tsunami prone areas in the State include coastal villages of Kutch, Jamnagar, Rajkot, Porbandar, Bhavnagar, Anand, Ahmedabad, Bharuch, Surat, Navsari and Valsad districts.

When severe weather is predicated or threatened preparation is made by site personnel.

The most probable severe weather events at the Kandla Port will involve High winds, Heavy rains, Cyclone, Storm, Tsunami, and Lightning & Earthquake.

There is a possibility of surface water accumulation and ingress into buildings and equipment. In addition the above severe hazard conditions can create significant personnel hazards loss of power.

PREPAREDNESS & RESPONSE

9.2 Internal Action Plan in case of Cyclone / Flood & Any other Natural Calamity

As soon as the message on anticipated cyclone/flood/natural calamity is received from the State Government Authority/Indian Meteorological Department/Cyclone Warning Centre/Indian Navy, etc. by any official of the Port Trust, the same shall immediately be informed to the Deputy Conservator (Nodal Officer), who in turn shall get such message confirmed from the above sources and apprise the Chairman and Dy. Chairman accordingly. On approval of Chairman, the Action Plan as stipulated hereunder shall be put into operation for which the Deputy Conservator shall inform all the officers-in-charge of the Control Rooms as well as the Heads of Departments, including Chief Operation Manager, OOT, and Vadinar about the decision of the Chairman as per Point No: 9.2.1.

9.2.1 Particulars of the Action Plan Committee Members

Sl No	Name	Designation	Telephone Nos.			
			Office	Residence.	Fax	Mobile
1	Mr. SANJAY MEHTA,IFS	Chairman	02836-233001 234601	02836-233002	235982	
2	Mr.	Dy. Chairman	234121 236323	234218 236346	236323	

3	Capt. T Srinivas	Deputy Conservator	233585 220235	232806	233585	9825232982
4	Mr. A Krishnan	Deputy FA&CAO	220214	223854		9825227036
5	Mr. Ajay Gupta	Sr. DD(EDP)	239623	234116		9825227095
6	Mr Bimal Kumar Jha	Secretary	220167	231939	233172	8141084794
7	Mr. Suresh Balan	Sr.Dy. Secy (G)	221375	236086		9825227044
8	Mr. Rajendra Singh	Dy. Secy	220033			9422056830
9	Mr. Deepak Rane	Sr. Asst. Secy	221679	234691		8238057380
10	Mr. N M Parmar	SE(C-I)		252624		9825227046
11	Mr. Y K Singh	PO.	223828	228584		9825227079
12	Mr.	Traffic Manager	270625 270246	263006	270475	
13	Mr. Krupananda Swami	Sr. Dy Traffic Manager	270270	235100		9825227049
14	Mr. D N Sondhi	FA&CAO	233174		220047	9825214726
15	Capt. S K Pathak	Harbour Master I/C	270201	231310		9825503499
16	Mr	Dy.Hydl. Engr	270277	225389		9825227201
17	Mr. Sunil Kumar	Flotilla Supdt.	270280	226121		7874627756
18	Mr. K Varughese	FCSO	270176 270178	227512	270176	9825227041

19	Mr. SSP PATIL	Chief Engineer	233192	228777	220050	9825227243
20	Mr. MANOJ MISHRA	Dy. CE	233569			7420027171
21	Mr. K J Todarmal	Exe Eng (R)	236165	220670		8980049099
22	Mr. N M Parmar	SE (PL)	222535	252624		9825227046
23	Mr. V R Reddy	DY.CE (G)	270429	228869		9825227038
24	Mr.B. Rajendra Prasad	Exe Eng (D), ENVIRONMENT	220038	232880		9725338260
25	Mr.	CME	270632 270184	231043	270184	9825226944
26	Shri S C NAHAK	Dy CME	270426	226067		9825235196
27	Mr. P Srinivasu	SE (E)	271010			9825204316
28	Mr. B J Solanki	SE (M)	270352			9726188222
29	Dr. Kalindi Gandhi	CMO	225767 220072	234598		9825505795
30	Dr CHELLANI	Sr Dy CMO	236346	220558		9825505796
31	Dr S B Suryavanshi	AMO	220072	233099		9687606995
32	Dr. Mahesh Bapat	A.M.O	220072	228167		9687607528
33	Mr.	Comdt. CISF	271037	229140		9825227282

Based on the past experience, after detailed discussions and experience sharing process, the actions suggested in the plan have to be taken immediately by the concerned staff members/officials as shown against their names/Designations as soon as the warning of cyclone or any other natural calamity is issued. All staff members/officials should know that they shall come into action on their own as soon as the warning is issued, without waiting for any further instructions. Failure on the part of any employees/officials to carry out the earmarked action plan shall attract severe consequences, which all must note.

9.3 Control Room

There shall be three control rooms, one at Kandla atSignal Station Seva-Sadan-III, and second one at AO Building, Gandhidham and third at A O Building Off Shore Oil Terminal, and Vadinar. The Control Room at Kandla shall be under the direct supervision Harbour Master, whereas Dy. Secy. (G) will be the overall in charge of the control room at A O Building, Gandhidham. XEN (M&E) will be the overall in charge of control room at Vadinar. They shall rush to the respective control rooms as soon as the action plan is put into force. The officials named in the duty roaster of various departments elsewhere in this Action Plan shall also report to the respective HODs for coordination and to perform duties as may be assigned by the higher authorities. The overall in charge should draw up roster of the said employees and assign duties for the coming five days. The staff should report to the respective control rooms. The Radio Radar Technician will remain in control room to attend all communication equipments.

9.3.1 Duty Roster for Staff of General Administrative Department

01	Mr. Kamalesh S Bajaj, Senior Clerk	220416		
02	Assistant	220010		
03	Assistant	220010		
04	Senior Clerk	220010		
05	Sr. Clerk	220010		
06	Junior Clerk	220010		
07	Messanger	220010		
08	. Junior Clerk	220010		
09	, LWA	270872		

List of Duty Roster of Marine Department (Ministerial Staff)

Sr No	Name	Office	Residence / Mobile
01	PA to DC	220235	9428032483
02	Mr. AR Jadeja, Signal Supdt	270549	9825427400
03	Office Supdt.	221971	
04	Assistant	221971	
05	Sr. Clerk	221971	
06	Messenger	221971	

9.3.2 Pilots

Sr No	Name	Residence	Mobile
01	Shri. S. K. Pathak	231310	9825803499
02	Capt V Tyagi		7065965924
03	Capt. A K Sharma	238154	9879603642
04	Capt. Vipul M. Madaan	221478	9879603643

9.3.3 List of Telephone Nos & Address of DC, HM & Pilots

Sr No	Name of Officer / Pilots	Address of Gandhidham Res	Tel Nos: Cell / Landline

01	Capt T Srinivas DC	A – 7, Gopalpuri	9825232982 232806
02	Shri S K Pathak HM	C – 32, Gopalpuri	9825803499 231310
03	Capt S K Pathak Pilot		
04	Capt D C Bhatt. Pilot	C – 38, Gopalpuri	9879603641 235653
05	Capt A K Sharma Pilot	C – 40, Gopalpuri	9879603642 238154
06	Capt V Madaan, Pilot	C – 31, Gopalpuri	9879603643 221478
07	AVAILABLE CONTRACT PILOTS WILL BE CONTACTED BY THE SIGNAL STATION.		
08			
09			
10			

9.3.4 Contract / Empanelled Pilots

Sr No	Name	Mobile
01	AVAILABLE CONTRACT PILOTS WILL BE CONTACTED BY SIGNAL STATION	

9.3.5 List of Duty Roster of Mechanical Engineering Department

Designation	Office
CME	270632

Addl. CME	270426
PA to CME	270184
SE(Electrical)	270209
SE (M)	270354
Dy M M	234114
XEN(E)	270469
XEN(DD) I/C	270285
AXEN(M)	270285
Asstt. Engr (M)	234199
AXEN	270165
AXEN (E)	
AE(E)	270322
Office Supdt	270245
Div. Accountant	270245
Div. Accountant	270342
Steno	270184
Junior Clerk	270245
AE(E)	270469
AE(E)	270458
AE(M)	270010
AE(M)	270370
JE(M)	270127
Head Clerk	270342
Head Clerk	270498

Div. Accountant	270498
Head Clerk	270484
Div. Accountant	270484

9.3.6 List of Duty Roster of Civil Engineering Department

Designation	Office	Mobile
Chief Engr	233192	9825227243
Supdt. Engr.(P)	233569	9825325390
Supdt. Engr.(C)	270787	9825227038
Supdt. Engineer (Const)	270419	9825227203
PA To CE (T)	220016	--
P.A. To CE	220050	9426737553
Supdt Engineer (Harbour)	270429	9825227046
Exe. Engr (R)	236165	9825706255
Exe. Engineer (Design)	220038	9725338260
Ex.Engr (TD)	223912	9427205610
Dy.Secretary(E)	221758	9825227044

Asst.Estate Manager	221598	

9.4Kandla Control Room

Designation	Office	Residence	Fax No	Mobile
Harbour Master	270201	231310	270624	9825232982
Signal Supdt	270549, 270194	232551	270624	9825427400
Signalman at Signal Station	270549, 270194		270624	9825227246

9.5 A.O. Building, Control Room (Gandhidham)

Designation	Office	Residence	Fax No	Mobile
Dy. Secretary (G)	221375	236990	------	9825505969
Accounts Officer	220908	226199	-----	------
DMM	231362			

9.4 Vadinar Control Room

Designation	Office	Residence	Fax No	Mobile
Signalman	0288-2573026			9825212359
Exe. Engineer	0288-			

(E&M)	2573005			
A. F. S.	0288			9712824782
Pilot in Station				

The overall in charge of the Control Rooms shall ensure the presence of the staff, to which various duties have been assigned. They should attend the meetings as and when called. In case of absence of the staff, the matter should be informed to the disciplinary authority, who shall take disciplinary action against the erring employees.

9.5 The Control Room shall have the following Facilities

Control Room	Telephone Nos	Fax No	VHF
Kandla	02836 – 270549/270194, Cell 9825227246	02836-270624	8,10,12,16
Gandhidham	02836 – 238055/239055	02836-239055	------
Vadinar	0288-2573026, 9825212359		12, 16, 8, 10

The above facilities will remain as permanent assets of the Control Rooms. The overall in charge for setting up of Control Room at Kandla will be Dy. Conservator and Secretary for A. O. Building, Gandhidham. They should ensure setting up the Control Rooms at the respective places within two hours of warning and the matter reported to Chairman/Deputy Chairman.

Commandant, CISF to remain in contact with In charge of Control Room at Kandla regarding the positions of the Cyclone.

9.6 Functions of the Control Room

1. It shall remain in touch with the Indian Meteorological Department (Telephone numbers given at Point No: 11.8.1) and also offices and officials as at Point No: 9.8.2, 9.8.3, 9.8.4, 9.8.5 & 9.8.6 on need basis.

9.8.1 Important Telephone Numbers of Indian Meteorological Department

Designation	Address	Office	Resi.	Fax
Director (ACWC)	-do-	022- 22150405	022- 22150452	
Director (I/c)	Met Center Ahmadabad	07922865012 22865165		07922865449 22865012 22861413
Met I/C	MET Centre, Ahmadabad	22861413		
Duty Officer		22865012		
Meteorologist	Ahmadabad	22861413		

Websites

www.imd.gov.in

9.8.2 The Telephone Numbers of Some of the VIP s

Sr. No.	Name and Designation	Fax	Telephone (Office)	Telephone (Resi)
1	District Collector, Bhuj	02832-250430	250020	250350
2	Dy. Collector, Mob. Bhuj 9825300729	02832-252704	250650	
3	Add. Collector, Bhuj Mob. 9825049360	02832-252704	252704	251348
4	Superintendent Police, of Ghandidham,	9978405690	227934	
5	Asstt. Supdt. Of Police		253405	250850
6	Dy. Collector, Anjar		243345	243363
7	Dy. S. P., Anjar		243254	242596
8	Mamlatdar, Gandhidham	9879278174	242588	243362
9	Mamlatdar, Gandhidham		250475 250270	222875 250475
10	Port Co-coordinator, OCC		234313	232808
11	Terminal Manager, IOC	234396	231871	236442
12	Air Force Commander, Jamnagar		2550245	-
13	Collector, Jamnagar		555869	554059
14	Station Commander, Air Force, Bhuj		244005 to 244010	
15	Commandant, B Gandhidham		223845	

9.8.6 Gujarat State Disaster Management Authority Telephone Numbers of Senior Officials

24 hrs 079- 23251900 - 20

Sr.No	Name of Officers	Designation	Contact No
1	Anuradha Mall, IAS	CEO	079-23259502
2	Shri L.G.Ambujakshan	PS to CEO	079-23259276
3	Shri G. C. Brahmbhatt, IAS	Addl. CEO	079-23259451
4	Shri P.B.Thakar, IAS	Addl. CEO	079-23259292
5	Shri G B Mungalpura, GAS	Director (Admin)	079-23259292
6	Shri J. J. Shelat	Director Finance	079-23259278
7	Shri H.K.Chauhan	Controller of Account	079-23259219
8	Shri Nisarg Dave	Deputy Director	079-23259501
9	Shri Sumedh Patil	Deputy Director	079-23259279
10	Shri Piyush Ramteke	Sector Manager	079-23259283
11	Shri Santosh Kumar	Sector Manager	079-23259220
12	Shri Ankit Jaiswal	Sector Manager	079-23259246
13	Shri Anil Kumar	Sector Manager	079-23259220
14	Ms. Akanksha Jain	Sector Manager	079-23259306
15	Ms. Ambika Dabral	Sector Manager	079-23259246
16	Mr. Bhushan Rauisinghani	Sector Manager	079-23259283
17	Ms. Disha Dwivedi	Sector Manager	079-23259283
18	Shri Nehal Desai	Asst. Manager (Admin)& Asst. Director- H & L (i/c)	079-23259286

2. Information from the above Offices/Officers will be collected and transmitted to the overall in charge of Control Rooms/ Dy. Conservator/Harbour Master/ Traffic Manager/Senior Commandant, CISF/Chief Mechanical Engineer on hourly basis. The information should also be passed on to Secretary/Dy. Chairman/Chairman on every 03 hours.

3. Two telephones should be kept in the Control Rooms, one for receiving and the other for outward calls.

4. Each control room will enter messages in Log Books continuously and simultaneously report to the overall in charge after every one-hour. The information shall be passed on to Chairman/Deputy Chairman directly depending upon the importance. It shall be the responsibility of the Control Room Staff to ensure that timely information is passed on and timely proper monitoring done.

9.9 Continuous Monitoring Process

Immediately after the initial signal for Cyclone storm is received, the following officials shall continuously monitor the movement of Cyclone on hourly basis.

Sr. No.	Designation	Office	Mobile
1	Dy. Conservator	233585 / 220235	9825232982
2	Harbour Master	270201	9825803499
3	Pilot	270549	
4	Signal Supdt	270194, 9825227246	9825427400

These officials shall obtain the information from the following sources and The Telephone Numbers of I.M.D. is given in (Point No: 9.8.1)

1. State Meteorological Control Room, Ahmadabad,.

2. Meteorological Control Room, Delhi.

The information so collected shall be maintained by making hourly log entry in a register.

9.10 Monitoring Through Internet

1. As soon as the cyclone warning Signal No. 5 or above is hoisted, the HM nd Pilot should monitor it through internet and give two hourly print out to Dy. Conservator, Secretary, Chief Engineer, FA & CAO, Dy. Chairman and Chairman. Dy. Director (EDP) along with Junior Engineer (PMC) and Mr. B. Rajendra Prasad Exe. Engineer (Design) will monitor the website in the A. O. Building, Gandhidham.

The following are the website codes, through which the required information regarding the position of the Cyclone can be ascertained:

1. www.imd.gov.in

9.11 Inmarsat Mini – M – Terminal Kandla - 00873762092789

9.11.1 Control Room, Gandhidham

1	IDS No	762092789	-	VOICE
		762092790	-	FAX
		762092791	-	DATA

9.11.2 Control Room, Vadinar

1	IDS No	762092777	-	VOICE
		762092778	-	FAX
		762092779	-	DATA

9.12 Plotting of Information on Map

The following officers shall be deputed in the Control Room immediately on starting of the control room with relevant charts.

Sr. No.	Designation	Office	Residence	Mobile
1	Harbour Master	270201	231310	9825803499
2	Pilot			
4	Signal Supdt.	270549 / 270194	232551	9825427400 / 9825227246

The above persons shall immediately reach the Control Room and stay there till the emergency is called off. They shall plot the movement of cyclone on hourly basis and bring the position to the notice of Traffic Manager, Chief Mechanical Engineer, Dy. Conservator and Dy. Chairman/Chairman.

After scrutinizing the movement of Cyclone on the Charts, Dy. Conservator shall, in consultation with Chairman / Dy. Chairman, if required, take a decision for evacuation of ships immediately as soon as the Cyclone is in close proximity to the danger line as defined above.

All pilots should remain stand by as soon as the warning of Cyclone No. 5 level and above is received. All pilots shall be stationed at Kandla and shall not leave the port without prior permission.

Dy. Conservator shall station himself at Control Room at Kandla and remain continuously in touch with the pilots. The pilots should be in a position to mobilize themselves for evacuation of vessels and securing all Port crafts at shortest possible time.

9.13.1 Leave for Class 1 Class II Officers

All Class-I & Class-II Officers, the Technical Staff, the essential staff and other persons assigned with specific functions under this plan who wants to avail leave in the month of May, June and July should invariably submit their leave program in April every year. Secretary shall issue a circular in the first week of April every year to all the Class-I and Class-II Officers and ascertain the period for which officers would like to proceed on leave during the months of May, June and July of that year.

9.13.2 Immediate stopping of operations at the Port

All the Pilots of the Port should reach Kandla immediately in case of emergency. Any Pilot not traceable in emergency shall be liable for disciplinary action.

Dy. Conservator/Harbour Master/Pilots should be available at Kandla during emergency. (i) Removal of vessels whenever the Cyclone is located in close proximity to the danger line plotted between 65 degree E Longitude 18.2 degree N Longitude and 73 degree E Longitude 18.2 degree N Longitude. Map showing the above position is given at (Annexure XXX (to be inserted by KPT).

i. Under such a situation, the ships shall be removed during the first/next available tide. It will be the duty of Harbour Master and Dy. Conservator to ensure that the ships are removed during the first/next available tide as soon as the storm approaches in the close proximity to the danger line as defined above without seeking any further instructions from higher authorities. This action shall be taken automatically and suo-motto without any confusion and for this purpose Traffic Manager shall stop all loading and unloading operations immediately upon instructions from Dy. Conservator so as to enable him to remove the vessels in time. The removal shall be done with the help of all the available pilots plus all contract/empanelled pilots together at one go in the shortest possible time so as to ensure that all the vessels cross the bar before

   the tide restriction sets in.

ii. Dy. Conservator shall ensure that all ships are moved out of the Harbour at the earliest. All pilots shall immediately report at Kandla and stay there till the Action Plan is in operation. Dy. Conservator/Harbour Master shall immediately plan removal of vessels to the OTB as soon as the Action Plan is put into operation irrespective of the signal number, which must be hoisted. If it is impossible to remove them, then all other steps should be taken to ensure safety of the vessels at the Port, as also it would not cause any damage to the Port.

iii. S E (M) shall enlist the Engine side staff of the Floating crafts to be kept stand by for shifting of crafts to safer places. He will be the in charge of manning these crafts as per the requirement.

For shipping tugs, Marine Engineer / Engineer In charge (Tugs) / will be the in charge for manning the engine side staff for operation of the shipping tugs as per the requirement. Assistant Engineer (DT) and, Assistant Executive Engineer (FC) shall co-ordinate with Marine Engineer / Engineer In charge (Tugs).

iv. After the Cyclone warning Signal No. 5 or above is hoisted at the Port Traffic Manager shall ensure that the loading/unloading operations at the Port are stopped immediately, hatches closed, ships' derricks properly secured and all labourers evacuated from the port area. Public address system shall be installed at the cargo jetty area, which shall be under the charge of TM. He shall use it for necessary arrangements relating to the evacuation. Senior Commandant, CISF shall ensure that Public Address System is fitted on jeeps provided to CISF.

Traffic Manager should ensure that responsible persons make announcements in a proper way so as not to create any misunderstanding / panic.

9.14 Securing of Cranes

Chief Mechanical Engineer shall ensure that immediately the cranes are secured and properly locked after closing of loading and unloading operations from ships as per procedure and report submitted to Chairman/Dy. Chairman after the operation of this action plan.

The following officers shall constantly monitor the safety of Cranes:

Sr. No.	Designation	Office	Residence	Mobile
1	S E (M)	270354	222771	9825227255
2	S E (E)	271010	229038	9427205563

The above officials and, Assistant Engineer (Elec.) shall arrange to secure all the cranes and keep them properly locked as per the procedure and send a report to the Chief Mechanical Engineer.

Executive Engineer (Dry Dock) and, AE (Mech) shall arrange to secure the cranes at maintenance Jetty as well as Bunder Area.

9.14.1 Securing of all Crafts

Dy. Conservator/Harbour Master shall immediately arrange for securing all the Port Crafts at safer places so that there is no loss to the port and send a report to the Chairman/Dy. Chairman as early as possible after operation of this action plan. Flotilla Superintendent shall be overall in charge of each craft for ensuring their safety.

For parking of crafts in emergency, there places are mainly identified, viz. Bunder Basin, Launch Jetty and maintenance Jetty (As per):

1. Maximum number of crafts such as Mooring Launches, G. S. Launches, and Pilot Launches will be placed in Bunder Basin.
2. In the inner side of Passenger Jetty, one Pilot Launch and one G.S. Launch will be kept.
3. Three Tugs will be kept in the inner side of Maintenance Jetty.

Priority will be given to the Port Crafts for parking in the Bunder Basin and other areas. Rest of the places available in the northern side of Bunder basin area will be allotted to the self propelled barges and private crafts. Dumb barges will be allowed on the beach between maintenance jetty and oil jetty area.

Berthing Supervisor will render all possible assistance to FS, being the overall in charge of the crafts. The following flotilla staff will take care of;

1	Mr. T. Sunil Kumar	F.S
2	Mr JAYDEEPSINH GOHIL	B.S
3	Mr. R B Chauhan	AFS
4	Mr. KENIYA	AFS

9.15 Private Barges / Crafts

The parties who have been given license by the Dy. Conservator to keep their barges and crafts inside the Port limit are given below:

9.15.1 **ALL** HARBOUR CRAFT License Holders to keep their Crafts inside the Port Area

Necessary instructions shall be issued to all those people have valid license immediately. The work of informing these parties will be carried out by Office Superintendent of Dy. Conservator's Office and will personally ensure that the instructions are carried out and report to HM within two hours of the Action Plan coming into operation. The representatives of the above parties shall reach Kandla at once, failing which Dy. Conservator shall cancel the license granted to them and take over the barges/crafts of the party who violate the instructions.

9.16 Evacuation of People from Kandla Area during Emergency – Action Plan

In Kandla Area, there is Residential Habitation in the following areas:

9.16.1 Places of Habitation

9.16.1.1 Saltpan Units

Considerable numbers of Salt Workers are engaged in the following Salt Manufacturing Units.

1. Kutch Salt Works.
2. New Kandla Salt Works.
3. Vijay Salt Works.
4. Friends Salt Works.

5. united Salt Works on KPT Land.

6. United Salt Works on State Government Land.

7. Small Salt Works of State Government, Near Nakti Creek.

The approximate number of Salt Workers that are being engaged/ residing in these Salt Works will be around 2575.

9.16.1.2 Sirva Labour Camp

Plots in Shirva Labour Camps (Near Mosque) have been allotted by DEENDAYAL PORT TRUSTon L&L Basis. Population: 450 (approx). There are also some un-authorized hutments in the area.

9.16.1.3 Sirva Railway Hutments

The Shirva Railway Hutments (alongside Main Road) is a cluster of un-authorized Hutments erected on the Railway Land: Population 700 (approx).

9.16.1.4 G – Type Quarters & Housing Societies

The G-Type Quarters are constructed by DEENDAYAL PORT TRUSTin early 1950s and were allotted to some persons who were engaged in Port related activities in those days.

DEENDAYAL PORT TRUSThas allotted land to Two Housing Societies known as Kandla Port Workers Co-operative Society and Dr. Jaynat Khatri Co-operative Housing Society in Kandla area. Population: 1000 (approx).

9.16.1.5 New Kandla Port Colony P & T & Customs Colonies

The KPT employees, Customs employees etc are residing in these areas.

9.16.1.6 Hutments in the Land of PGVCL

There is a cluster of unauthorized Hutments to the Northern side of wahiya creek and southern side of M/s ABS Bayers Limited and this land belongs to PGVCL. Population: 100 (approx).

9.16.1.7 Banna Fishermen Hutments

There are unauthorized Fisherman hutments situated on the Bank of Kandla Creek towards Southern side of NDDB Colony. Population: 800 (approx).

9.16.1.8 Hutments near IFFCO Plant

There is a cluster of unauthorized hutments near IFFCO Plant. Population: 500 (approx).

9.17 Population of Kandla

The population of Kandla Area is basically a mixture of people from various places and they can been generally divided in the following three groups;

People belonging to nearby villages like (i) Tuna (ii) Kharirohar (iii) Mithirohar (iv) Chirai and (v) Gandhidham City.

People belonging to other States like (i) Andhra Pradesh (ii) Rajasthan(iii) Uttar Pradesh and (iv) Bihar.

People working in Government establishments residing in the colonies of their organizations.

Most of the people residing in Shirva Labour Camp, Shirva Railway Hutments and Thermal Hutments etc are engaged as Private Labours in the Port and Port related ancillary activities and petty business.

9.17.1 People of Nearby Villages

People of the Port and nearby lease areas belonging to nearby villages like (i) Tuna (ii) Kharirohar (iii) Mithirohar (iv) Chirai and (v) Gandhidham City will have to be sent back to their respective village by providing them Trucks and/or ST Bus facilities in consultation with State Govt. Agencies.

9.17.2 People of Other States

People belonging to other States like (i) Andhra Pradesh (ii) Rajasthan (iii) Uttar Pradesh and (iv) Bihar may not have any relatives or other accommodations facilities in the nearby places like Gandhidham, Adipur.

Hence, they will have to be provided Temporary Shelter in the Schools/community centres as may declared as Temporary Rehabilitation Centre/ Temporary shelters by the State Govt. Authorities.

9.17.3 Action Plan for Evacuation of People from Kandla

On Hoisting of No. 5 Signal or above in Kandla Port, immediately action shall have to be initiated for evacuation of people in the following areas by the persons responsible as mentioned hereunder:-

The evacuation of the inhabitants of the following areas at Kandla is to be done as these areas are sensitive and prone to natural calamities like cyclone, high-tide and other disaster like Gas Leak, etc.

OSD(Estate) and Mr. Bhatia, Asst. Engineer (C) shall ring up all salt lease holders directing them to evacuate their people from their Kandla sites and a report thereof submitted to the Chairman/ Dy Chairman. The Dy Secretary (Estate) will be overall in-charge of the proposed action.

9.17.3.1 List of Salt Lessees

Sr. No	Name of Salt Works	Contact Person	Tel. No. Office	Tel. No. Residence
1	Asstt. Salt Commissioner, Gandhidham	Mr. Jagdish Tripathi	233670	263690
2	M/s. Kanoria Chemicals and Ind. Ltd., Plot No.220, Sector –4, Gandhidham	Mr. B. N. Singh, Mr. J. Singh Factory -	229470	283325 9825225841
3	Shree Krishna Salt Industries, Central Bank	Mr. Kantibhai Thakkar Mr. Vikash Patel	234727 233990	235315 234089

	Compound, Gandhidham	Mb: 9825206214		
4	M/s. Chirai Salt Works, DBZ-S-46, Jawahar Chock, Gandhidham.	Mr.Sureshbhai Mr.Parasbhai Mb: 9825225181 Mr.Mayajar	221109 221267 9826214709	234386 233081
5	M/s. Bhuveneshwari Salt Works, TCX-S-62, Gandhidham	Mr.Sreechandji Jain 9825222269	237114 235203	233605 236860
6	M/s. Dungershee Salt Works, Shop No. D-93, P.B.No.9, Gandhidham	Mr.Hiralal Parekh Mb: 9825019661 Mr. R.B.Agrawal Mb: 9825019662 Mr. Bhikhabhai (Salt Area)	222765 223440 9825225667	232767
7	M/s. Shree Laxmi Salt Allied Ind., "Shree Sadan", 207 / 12-B, Gandhidham	Mr. Rajubhai Rathi Mr. Rameshbhai Rathi Mob.: 9824214901	232167	232167 235482
8	M/s. Jyoti Salt Industries, "Sukh Sadan", Opp. Hotel President, Gandhidham	Mr.Acharya Sukhdevbhai Mr. Sukhdevbhai Acharya Mb: 9825226075	223776 221082 221089 223094	221876

9	M/s. New Kandla Salt and Chemical Co., "Maitri Bhavan", Plot No.18, Sector 8, Gandhidham	Mr. Babulalji Sanghvi 9825226091 Mr. Sukhrajbhai 98252 26011	232227 231588 234087	234325 231814 232122
10	M/s. Kutch Salt Works, New Kandla	Mr. Mitenbhai Mb: 9825225990 Mr. S.P.Giria, Works Manager, Mb: 9825228085	234659 02222040561 22041598 270371	238633

11	M/s. Vijay Salt Works and Allied Industries, "Friends House", P.No. 50, Sector –1A, P.B.No.106, Gandhidham	Mr. Harishbhai Chaturani Mb: 9825064241 Mr. Babulal Nahata	231119 252247 223743	234856 9825228398
12	M/s. Rajesh Salt Works, "Chandan Chambers" National Highway, Plot No.18, 12/A, Gandhidham.	Mr. Kishorbhai Thakkar Mob: 9825177081 Mr. Rameshbhai Mb: 9825226026	220586 221048 222301	234387
13	M/s. Western Chemical, DBZ-S-151, Gandhidham	Mr. Naranbhai Mb: 9825226092	233185 230913	230141
14	M/s. Urvakunj Nicotine Ltd., Central Bank Compound, Plot No.31, Sector No.9, Gandhidham	Mr. Mahendrabhai Patel – 9825206214	234727	234480

		Mr. Vikash Patel Mb: 9825226214		
15	M/. Friends Salt Works, "Maitri Bhavan", Plot No.18, Sector No.8, Gandhidham	Mr. Babulalji Mb: 9825226015 Mr. Ashokbhai Mb: 9825226091 Mr. Sukhrajbhai Mb: 9825226011	232227 231588 234087	231646 231814
16	Smt. Savitri H.Pandya, DBZ-N-21/A, GIM	Mr. Jagdihbhai	220212 238112	255612
17	Smt. Vimlaben.H. Pandya, DBZ-N-21/A, Gandhidham	Mr. Jadishbhai Mr.Amritlal Pandya Mb: 9825225212	220212/238 112 238212 255612 /	-
18	M/s. Rajendra Salt Works, D-125, Jawahar Chowk, Gandhidham	Mr. Tarachand	-	-
19	Mr. Natwarlal Agrawal, TCX-S-75, Gandhidham	Mr. Natwarlal Mb: 9825393555	222672	231564
20	Mr. Indrumal Khubchand, C/o Gulab Salt Works, D-125, Jawahar Chowk, Gandhidham.	Mr. Tarachand	233041 234388	234937
21	Mr. Virji Khimji C/o Ajit Salt works, D-75, Gandhidham	Mr. Kirtibhai	220310	-

22	Mr. Girdharilal.S. Agrawal, Plot No.126, Ward – 12/B, Gandhidham	Mr. Girdharilal	232862	234755
23	Mr. Vijay Kumar.D. Palan & Mri Jagdish Kumar.D.	Mr. Navrotambhai Palan	220310	-
24	M/s. Satya Salt Works, DBZ-S-183, Gandhidham	Mr. Candubhai Mb: 9825225911	224055 221445	234739 234469
25	Shri Premji Gangji Soni, DBZ-S-183, Gandhidham	Mr. Mahes Soni	221263	-
26	Smt. Geetadevi Chaturani Plot No.13, Sector 1, Gandhidham	Mr. Romesh / Ashwin Mr. Dayalbh Chaturani, Mb:9825064245	221048 256713 220586 256706 Fax: 222930	-
27	Shri Rashmin A.Pandya DBZ-N-21/A, Gandhidham	Mr. Jagdis Pandya	220212 238112 238212	-
28	M/s. Neelkant Enterprise, DBZ-S-60, Gandhidham	Mr. Shamjibhai Mb: 9825 25711	220421 220103 Fax: 223560	231485
29	Dayalal G.Chaturani Shop No.1 to 4, "Chandan Chamber" Plot No.18, Ward No.12, Gandhidham	Mr. Dayal	221048 220588	-

30	Shri Chaganlal Punamchand, DBZ-N-197, Gandhidham	Mr. Chaganlal	220545	-

Safety Officer & Librarian shall inform the Public/Private Sector Tank Farms in Kandla about the situation and advise them to shift their people out of the respective areas to safe places.

9.17.3.2 List of Private / Public Tank Farm Owners

Sr. No.	Tank Farm Owners	Persons to be contacted in case of emergency		
		Name and Position	Telephone No.	Mobile No.
1	Kesar Enterprises Ltd., Near Oil Jetty, Old Kandla (Kutch)-370210	Mr. R.K. Gupta Gen. Manager	270435 (O) 295676 (R)	9375349181
2	Kessar Enterprises Ltd, Terminal II, Plot No. 5 &6 Old Kandla	Mr. R.K. Gupta G.M	270435 (O) 270177 (O)	9375349181

3	Chemical & Resins Pvt. Ltd Terminal –I, Near Oil Jetty, Old Kandla, Kutch Terminal – II, Near West Gate, New Kandla – Kutch	Lt. Col. Pramod Kumar (Retd), GM,	270505(O) 236831(R) 270916 (O)	9825225676
4	Indo-Nippon Co. Ltd., Plot No.2, K.K.Road, Old Kandla,	Mr. R.N. Pathak Asst. Terminal Manager	270795(O) 235818(R) 270295(O)	9879571295
5	J. R. Enterprise, Plot No.3, Old Kandla,	Mr. Devendra Dadhich, Terminal In-charge	653528 (O) 257152 ®	9898238380
6	Friends Oil & Chemical Terminals Pvt. Ltd., Near Booster Pump Station, Old Kandla, Kutch	Mr.S.Ramakrishnan Terminal Manager	270987 (O) 257249 ®	9879572107

7	Indian Oil Corporation Ltd., Main Terminal, GIM Foreshore Terminal, Kandla KBPL LPG Import Plant	Mr. AK. Khanna Sr. Term. Manager Mr. KS Rao, Sr.TM Mr. PS Negi Plant Manager	233274 (O) 229002 (R) 270394 (O) 270628 (O) 270477 (O) 233359 ® 270978 (O) 236944	9427216637 9426416108 9426725342
8	United Storage & Tank Ltd Near IOC Foreshore Terminals, New Kandla Gas Terminal, Plot No. 4 Old Kandla	Mr. Manoj Gor Terminal Manager Mr. G. Chudasama	270609 (O) 653525 (O) 651238 ® 653529 (O)	989850029 9904366855
9	IFFCO Kandla Unit, Kandla, Kutch	Mr. L. Murugappan, G.M.(NPK-I) Mr. Brahmbatt Manager (F & S)	270711 270352(O) 270381 (O)	982506922 9099019861

10	BPCL, KK Road, GIM	Mr. RG. Dekate Sr. Manager Operations	234313 (O) 223235 (R)	9099929634
11	HPCL KK Road, GIM	Mr. Murthy Manager (Installation)	230936 (O) 220084 (O) 233078 Ext	
12	INEOS ABS (I) Ltd Plot No. 8 Old Kandla	Mr. Vineeth Nair Dy. Manager	270087 (O) 234409 (R)	9825237029
13	Liberty Investments Pvt. Ltd., Plot No. 1 & 2, Block 'H', New Kandla	Mr. Jitendra Vaidya Terminal Manager	270151 (O) 270464 (O) 270468 (R)	9825025645
14	Avean International Pvt. Ltd., Liquid Storage Tank Terminal, Plot No. B-1, New Kandla	Mr. Bharat Rathod Terminal Manager	270537 (O)	9375310260

15	Rishi Kiran Logistics Pvt Limited, Plot No. 7, Link Road Old Kandla	Mr. RH. Pandya GM (Terminal)	270223 (O) 270443 (O)	9879104556
16	N.P.P. Pvt. Ltd., Old Kandla	Mr. MD.Nagvekar	270347 (O) 257807 ®	9825227649
17	Friends Salt Works and Allied Industries, KK Road, Old Kandla	Mr. NJ.Zinduwadia Sr. Manager Mr. HA. Mehta,S.M	270814 (O) 262698 (R) 271260 (O)	9825506361 9825506360
18	IMC Ltd, Cargo Jetty New Kandla	Mr. Anil Brahmbhat	270369(O) 653524 (O) 296079 (R)	9898126243
19	Agencies & Cargo Care Ltd., Plot No.3, New Kandla.	Mr.Shivkumar Menon, Terminal Manager	270714 (O)	9825226765

20	Dipak Estate Agency Plot No. 5-6, Block – A New Kandla	Mr. Narendra Thacker	270375 (O)	9879611243
21	Parker Agrochem Exports Ltd, Plot No. 3 –4,Block- H New Kandla	Mr. Bharat Thacker	270486 (O) 270528 (O) 231876 (R)	9825238260
22	Tejmalbhai & Co New Kandla	Mr. Ankitbhai Chandan	271330 (O) 230090 (R)	9825225101
23	Parker Agrochem Product Pvt. Ltd, Plot 7-9/A,N.Kandla	Mr. Raja Babu Dy Manager	270528 (O) 231876 (R)	9979158543
24	Mother Dairy Fruit & Vegetable Pvt. Ltd, Near Oil Jetty, Old Kandla	Mr. Saju Therattu	270654 (O) 270655 (O) 230979(R)	9974022681

Traffic Manager/ Additional Traffic Manager shall arrange to inform all the Stevedores / Agents and other Stakeholders to remove their workers from the operational areas at Kandla.

9.17.3.3 List of Stevedores in the Port

Sr. No.	Name	Address	Fax No.	Telephone Nos.	
				Office	Resi.

1	M/s. Cargo Movers	"Cargo House" BBZS-32A, Gandhidham	231687	220453 231365	261280
2	M/s. DBC & Sons (P) Ltd.	Seva Sadan-II, Room No. 303 / 304, New Kandla	270631	270503 270263 270348	-
3	M/s. A.V.Joshi & Co.	Plot No. 18, Sector-8, Maitry Bhavan, Nr. Post Office, Gandhidham – Kutch	233924	231070 232227 231588	234909
4	M/s. ACT Shipping P. Ltd	Seva Sadan-II, Room No. 206/207, New Kandla	232175	270111 270112 270015 229967	261308 231416
5	M/s. Cargo Carriers	214/215, Rishab Corner, Plot 93, Sector- 8, GIM	230030	220816 231649 230030	231694
6	M/s. Cargo Clearing Agency (Gujarat)	Plot No. 271, Ward 12-B, Gandhidham	233034	221721 220655	231452
7	M/s. Chotalal Premji Stevedores Pvt. Ltd	C-8, Shaktinagar, GIM	231509	270009	-
8	M/s. Hiralal Maganlal & Co.	C-11, GIDC Area, Gandhidham – Kutch	223914	223914 231832	223878 232430

9	M/s. New Dholera Shipping Company	Goyal Commerce Centre Building - 1, Plot No.259, Ward 12B, Gandhidham - Kutch	-	222637 232267	237284
10	M/s. J.M. Baxi & Co.	Seva Sadan – II, Room No. 301 / 306, New Kandla	270646	270630 270550 270448	260427
11	M/s. Pestonjee Bhicajee (Kutch)	Seva Sadan-II, 203, New Kandla	270650 270556	270257 270367	262914
12	M/s. OTA Kandla Pvt. Ltd.	BBZ-N-324, Gandhidham	223241	220145 270560	223241
13	M/s. Purshotamdas Jeramdas & Co.	5, Vaswani Chamber, 16, Sector-8, GIM	222850	238242 222598	220598
14	M/s. R. Tulsidas & Co.	Ahit Building , Plot No.323, Gandhidham – Kutch	232308	222717 221943	-
15	Rishi Shipping	Plot 50, Sector 1/A GIM	238943	229830 229831	
16	M/s. Vinsons	BBZ-S-25, Gandhidham – Kutch	231948	220466	222395 239460
17	Sical Logistics Ltd	403, 4th Floor, Madhuban Compex, OSLO, GIM	234416	234646 234194	

18	Parekh Marine Agency	C-8, Shaktinagar GIM	231509	229297 221158	
19	Krishna Shipping and Allied Services	Transport Nagar, NH GIM	233135	230501 223814 229085	
20	Kevar Carrier Handling & Transport	Shop 24, Tolani Chamber, Sector –8,GIM	228298	228298	
21	Trinity Shipping & Allied Industries	Trinity House, Plot 46 Sec 1/A, GIM	232060	230911 230910	
22	Velji P & Sons(P)Ltd	2nd Floor, Deepak Compex, 315, 12/B GIM	236168	231545 231546 225466	
23	Asean Marine Services	Ashit Bldg, Plot 33 Sector 1/A, GIM	232308	222717 221943 222145	
24	Rishikiran Roadlines	Kiran House, Plot 8 Sector 8, GIM	231422	231894 234108	
25	Universal Shipping Services	Hotel Sea Bird, Plot 173, Sector 1/A,GIM	235251	230663 226050 226037	
26	Seaways Shipping (P) Ltd	2nd Floor, Plot 351 Ward 12/B, GIM		226183 237147	

27	Seacrest Shipping Services Pvt. Ltd	216, 2nd Floor Om Corner, Plot 336 Ward 12/B, GIM	227028	233325	
28	Shree Maruti Shipping Services	18/21, Swaminarayan Bldg, Sector 9, GIM	234107 250690	233245 237247 250690	
29	Liladhar Pasoo Forwarders P.Ltd	Plot 4, Sector –1 KASEZ, GIM	252383 253506	252286 252297 252612	
30	Shree Radhey Shipping Company	14-16/C, GF Green Park, GIM	232967	222919 228919 238883	
31	Pearl Shipping	220, Rishab Corner, Plot 93, Sector 8 GIM	235570	225283 225284	
32	Patel Shipping Agency	Patel Avenue, Floor 2,Plot 170, Sector 1/A, GIM	231143	224024	
33	Ashirvad Shipping	18-21, Swaminarayan Bldg, Sector- 9, GIM	250690	233245 237247 222822	
34	M/s. Swaminarayan Vijay Trade	1st Floor, H-6, Op. Tejas Society, Ghatlodia,	079- 231983	231981, 231982	

	Carriar	Ahmadabad			

9.17.3.4 List of Liner & Steamer Agents at Kandla Port

Sr. No.	Name	Fax No.	Tele. No.	Mobile
01	M/s ACT Shipping Ltd Mr. Harshad Gandhi	232175/ 270597	270111 270115-6 229967 231734	9825226141
02	M/s Admiral Shipping Ltd	233596	230552 232823	
03	M/s Areadia Shipping Ltd	232542	234254 223486	
04	M/s Ambica Maritime Ltd Mr. Amit Vyas	252447	252479 252349	9825225210
05	M/s APL (India) Pvt Ltd., Mr. Murli Krishnan	236361	224601/2 236357 236355	9825225753
06	M/s Arebee Star Maritime Agencies Pvt Ltd. Mr. Anil Talwar	235831	220465 235832	9824229109
07	M/s Ashit Shipping Ser. Pvt Ltd. Mr. Sanjay Thakkar	232308	221943 222717 222145	9825225698
08	M/s Atlantic Shipping Pvt Ltd	223372	230552	
09	M/s Asia Shipping Services. Mr. Mohan Karia239326	231285	234526 230954	

10	M/s Bayland Freight Systems Pvt Ltd., Mr. Danendran Gopalan	239326	225522/ 23	9825230880
11	M/s B D Vithlani Shipping Services Pvt Ltd.	234104	232220 221081	
12	M/s Cargo Conveyors Mr. Shekhar Ayachi Mob. 9825226102	233034	221460 220655	
13	M/s CCA Shipping Services Mr. K C Varghese	233034	221721 220655	9825225217
14	M/s Chowgule Brothers Mr. C R Soman	229227	278521 225051 232365	9825361782
15	M/s Coastline Services (India) Pvt Ltd.	221137	232095 222853	
16	M/s Container Marine Agency Pvt Ltd	234541	230026 220416	
17	M/s Conftreight Shipping Agency (India) Pvt Ltd. Mr. K T R Nair	-	233615 236157	
18	M/s Cresent Shipping Agency (India) Pvt Ltd Mr. Sanjay Salve.	224506	221290 221957	9825227311
19	M/s DBC Freight International	230832	230832 230639	
20	M/s DBC Sons (Gujarat) Pvt Ltd. Mr. R C Vazirani	270631	270263 270503	
21	M/s Depe Global Shipping Agency Pvt Ltd. Mr. Jaydeep Roy	232079	231528 233608 234582	9825228121

22	M/s Evershine Shipping Services. Mr. Kishan Motwani	234083	221588 237408	
23	M/s Forbes Gokak Ltd	231464	222634 235004	
24	M/s Freight Connection (India) Pvt Ltd	231357 270726	222247 222545 270727	
25	M/s GAC Shipping (India) Pvt Ltd. Mr. V C Rao	231429	231427 237244	9825225136
26	M/s Ganges Liners Pvt Ltd	233437	231608 233436	
27	M/s German Exp. Shipping Agency Pvt Ltd	236040	223269 236040	
28	M/s Goodrich Maritime Pvt Ltd	222875	222882 222883	
29	M/s G P Dave & Sons (Shipping)	234382	234288 234382	
30	M/s Greenways Shipping Agencies Pvt Ltd	232079	233608 234585	
31	M/s K. Shipping Services Pvt Ltd	233632	231933	
32	M/s Halar Ship & Freight Forwarders. Mr. Tejas Shrma	270224	270192 270568	9825212646
33	M/s Hind Shipping Agencies. Mr. Mahesh Vyas	234795	232710 235375	
34	M/s Hindustan Shipping Services. Mr. M D Sorathiya	239110	239110 222821	9824214994

35	M/s Interocean Shipping India Pvt Ltd. Mr. Suresh Tripathy	232579	235201 230589	9825225583
36	M/s Intra Trade Pvt Ltd. Mr. B P Vasavda	233295	233313 231255	9825226129
37	M/s Trades Shipping Pvt Ltd	231463	235572 233606	
38	M/s James Mackintosh Marine (A) Pvt Ltd. Mr. Satish Nair	270793	270792 270846	9825226077
39	M/s J MBaxi & Co. Mr. D P Mitra	270646	270630 270635 270525	9825225107
40	M/s Kutch Shipping Agency Pvt Ltd. Mr. Azad Khan	233339	221148 250226/ 7/8	
41	M/s Liladhar Passop Forwarders Pvt Ltd. Mr. S. Chakraborthy	252383	252297 252402 252288	9825020523
42	M/s Maersk (India) Ltd. Mr. Dinesh Joshi	231388	231387 236192 233963	9825270419
43	M/s Maheshwari Handling Agency Pvt Ltd. Mr. Chaggan Maheshwary	230575 234633	223228 230393	9825227111
44	M/s Maltrans Shipping Agencies India Pv Ltd.	230606	220147 230336 235022	
45	M/s Mathurdas N. & Sons Forwarders Ltd.	252221	252224 252350	

46	M/s Meridian Shipping Agency Pvt Ltd	230212	220305 230220	
47	M/s Mitsutor Shipping Agency Pvt Ltd	230411	220110	
48	M/s M M Shipping Services	235255	231385 238385	
49	M/s Modest Shipping Agency Pvt Ltd	-	230576	
50	M/s NLS Agency India Pvt Ltd. Mr. Sanjay Salve	232413	231318 220305	9825237311
51	M/s Orient Express Lines Ltd	230359	232186 232805	
52	M/s Orient Ship Agency Pvt Ltd. Mr. H G Digrani	233518	223430 223487	9824214801
53	M/s Oscar Shipping Agencies.	231812	226959/6 0 232123	
54	M/s Parekh Marine Agencies Pvt Ltd. Mr. Mitesh Dharamshi	231509	221409 235341	9825226557
55	M/s Patel Handling Agency (Capt. Kalra)- 9825062912	231143	224024 231004 221718	
56	M/s Patvolk (Mr. Shreekumar Nair)	231464	222624 235004	
57	M/s Pearl Shipping Agency. Capt. Kalra	231143	224024 221718	9825062912
58	M/s Penguin Shipping Agencies Pvt Ltd.	230606	230336 220147	

59	M/s Pestonjee Bhieajee (Kutch) Mr. R K Kewalramani	270650 270556	270221 270257 270367	9825226962
60	M/s Prudential Shipping Agencies Pvt Ltd. Mr. Siddharth Mishra	232911	230479 233982	9825226477
61	M/s P&R Nedlloyed India Pvt Ltd	232207	224906/7 232128	
62	M/s R T Bhojwani & Sons Mr. Gopichand Bhijwani	232423	223831 220839	9825225639
63	M/s Sahasu Shipping Services Pvt Ltd	236358	225224 237854	
64	M/s Sai Shipping Co. (P) Ltd Mr. S T Hingorani	231972	221369 231739	9825228681
65	M/s Samrat Shipping Co Pvt Ltd	232890	231983 222939	
66	M/s Samsara Shipping Pvt Ltd. Mr. Pranesh Rathod	233165	228602	9825225755
67	M/s Scorpio Shipping Agency	-	223085	
68	M/s SDS Shipping Pvt Ltd	231542	221326 221087	
69	M/s Seanay Shipping Pvt Ltd	270026	270788	
70	M/s Seabridge Maritime Agencies Pvt Ltd	231509	221409 221158	
71	M/s Seafreight Pvt Ltd	222850	233530 222393	

72	M/s Sealand Agencies India Pvt Ltd	230584	231179 230584	
73	M/s Seamar Shipping India	255563	-	
74	M/s Seatrade Shipping	234171	233810	
75	M/s Sentrans Maritime Pvt Ltd	236129	230002 220702	
76	M/s South India Corporation (Agencies) Ltd Mr. Antony	234416	221276 234646 231494	9825226256
77	M/s Spoonbill Maritime Agencies Pvt Ltd	234167	221049 222058 234454	
78	M/s Star International	231395	233948 232402	
79	M/s Taipan Shipping Pvt Ltd	236040	223269 227010	
80	M/s Taurus Shipping Services. Mr. Sukhveersingh	231266	221334 223074	9825227325
81	M/s Oceanic Shipping Agency Pvt Ltd	270631	270263 270503	
82	M/s TICC Container Line (Kandla) Pvt Ltd	237854	237854	
83	M/s Total Transport Systems Pvt Ltd	231463	222634	
84	M/s Transocean Shipping Agency Pvt Ltd	-	230832	
85	M/s Transworld Shipping Services India Pvt Ltd Mr. Sandeep Rajvanshi	231913	229824 221290	9825225733
86	M/s Trinity Shipping & All. Services Pvt Ltd Mr. Soly	222060	230911 223703	9825225245

87	M/s Unimarine Agencies (Gujarat). Mr. Jaikumar Ramdasani	224633	224631/ 32 223113	9825225216
88	M/s Unique Shipping Services Pvt Ltd	-	232729 232730	
89	M/s United Liner Agencies of India Pvt Ltd Capt Rakesh Kumar	236040	227779 223269	9825225741
90	M/s Universal Freight Systems	252383	252288 252297	
91	M/s Universal Shipping Services Mr. Anil Pillai	235251	230663 231708	9824215168
92	M/s Velhi P. Sons (Agencies) Pvt Ltd	255328	255327 231545	
93	M/s Vibhuti Shipping Pvt Ltd Mr. Vinod	236219	236719 230035 232424	9825226536
94	M/s Worldwide Cargo Care Pvt Ltd	231913	221290 221479	

9.18 Core Team

Asstt. Commandant-CISF, OSD (Estate), Ex. Engineer (Roads)-KPT, Executive Magistrate of State Govt. of Gujarat i.e. the Mamlatdar, Gandhidham and Police Inspector, Kandla shall jointly ensure evacuation of people from Kandla areas. The persons entrusted with the evacuation programme as indicated here below will have to report the progress in evacuation to the Dy. Secretary (E) who shall appraise all developments in this regard to Chairman and Dy. Chairman, KPT over telephone from time to time.

The Evacuation of People from different areas at Kandla shall be looked after by the officers named below.

9.18.1 Banna Fishermen Hutments

ACTION BY, Junior Engineer, and CISF

9.18.2 Saltpans (Including Major & Minor)

ACTION BY: Asstt. Estate Manager, Mr. AB Pradhan, Labour Officer and CISF.

9.18.3 Sirva Camp & Sirva Railway Hutments

ACTION BY: OSD (Estate), Estate Inspector and CISF

9.18.4 G Type Quarters of DEENDAYAL PORT TRUST

ACTION BY: Assistant Engineer and CISF

9.18.5 New Kandla KPT Colonies, Customs & Hutments in PGVCL Land

ACTION BY: Assistant Engineer/InspectorVigilance with CISF

9.18.6 Hutments near IFFCO Plant

ACTION BY: Junior Engineer and CISF

9.18.7 Cargo Jetty & Oil Jetty Areas

ACTION BY: Traffic Manager – Private Workers/ Shore Workers

AAO, CHD - CHD Workers

HOD/Dos - The Employees of their respective deptt.

The Traffic Manager/ Commandant CISF shall ensure that the Cargo/ Oil Jetties are completely evacuated and there is no fresh entry into the operational areas.

9.19 Public Announcement

The Public Announcement for faster evacuation is to be made by (a) CISF on behalf of DEENDAYAL PORT TRUSTand (b) Police Inspector, Kandla Police Station in consultation with KPT officials.

9.20 Temporary Shelters

The Temporary Evacuation Centres (TEC) will be set up in the Gandhidham area in places like Schools/ Community centres etc as may be decided in consultation with the State Govt. Officials.

Executive Engineer (TD) will have to ensure the following;

Opening cleaning and providing water facility in the Temporary Shelters at Gandhidham in premises coming under the administrative jurisdiction of Kandla Port that may be identified for the purpose by the Collector/Mamalatdar/concerned state govt. authority. The toilet blocks attached to these buildings are to be kept in usable condition.

Executive Engineer (Electrical) shall ensure providing of lights and continuous electric supply in the Temporary Shelters as mentioned above.

Mr. A B Pradhan, Labour Officer and the Head Master of BVM School will have to ensure opening of the School and shifting of school furniture as may be directed.

The requirement of amenities/ medical aid etc in the Temporary Evacuation Centres will be taken care of by the Executive Engineer(TD)/ (R), Senior Engineer (PL), updt Engineer (E) and Doctors of Medical Department.

9.21 Transport Facility

The Traffic Manager shall provide sufficient number of Trucks and Dumpers as may be requested by Dy. Secretary (E) for evacuation purpose.

The hired buses of KPT shall be deployed for evacuation. In case of additional requirement the Dy. Secretary (G) will co-ordinate with Mamlatdar, Gandhidham for obtaining sufficient number of ST Buses for evacuation purpose.

Secretary shall co-ordinate the above activities.

Ensuring the functioning of TELEPHONES

The name and telephone No. of the Officer Telephone Department to be contacted in case of any problem:

1. General Manager, Bhuj(O) 231201/231648 (R)

2. District Engineer, Bhuj(O) 525410

3. SDO (P), Gandhidham(O) 232453/229666 (R)

Dy. Secretary (Personnel) shall ensure that the telephone of all the Head of Departments and other responsible officers of different Departments are functioning properly by ringing personally. In case any of the telephones does not function or give satisfactory service, he shall take up the matter with the higher authorities immediately.

9.22 Traffic Movement

Commandant, CISF with the help of Police shall ensure that all incoming traffic to the Port is stopped except those which are coming for rescue operations and essential services at three places i.e. KASEZ Junction, Railway crossing and Kharirohar Road. He shall immediately erect two temporary tents and post sufficient number of personnel of CISF in coordination with Police, who shall identify which person has to be allowed. Commandant, CISF shall also ensure that those allowed do not cause any hindrance for those who are supposed to function as per the Internal Action Plan.

Staff Attendance

From experience it is observed that several times many officials do not turn up for work under one or the other pretext. This would be viewed very seriously. Immediately on operationalising this Action Plan, even if, it is a Public Holiday, the following staff shall report for duty.

All Operational Staff particularly those of Floating craft Section and Power Supply Section.

All Head of Departments and all Class-I & Class-II Officers shall be present in their office timings. Besides, a list of very essential officers, who will be required to be present even beyond the normal duty hours, as and when required, shall be prepared.

All P.A.s/Stenographers/Peons of Head of Departments and Deputies.

All Office Superintendents/Superintendents (Accounts)

All Head Clerks and Divisional Accountants.

The above officials shall be present in the office, unless otherwise directed.

The Staff attendance on days when the Action Plan is in the operation shall be collected from P.A. to HODs and compiled by Asstt. Secretary (G). The daily position will be reported to Chairman/Dy. Chairman every day with separate list of absentees. Assistant Secretary (G) should ensure presence of staff by following the required action.

All Head of Departments may hold a meeting with Class-I, & Class-II and staffs and explain their functions as per the provisions of Action Plan during the Natural Calamity and submit a Compliance Report to Chairman/Dy. Chairman on priority basis.

The following officers will ensure timely supply of Drinking Water/Food Packets to the staff during the operation of the Action PLAN:

Asstt. Executive Engineer- For the staff of Traffic/Mech./Civil

Engineering Department

AFS- For the Flotilla Staff /SIGNAL STATION

Company Commander, CISF- CISF

FcSO- For Fire Brigade Staff

The above officers shall be responsible for placing order for procurement of Food Packets. They should ensure that there is no shortage on this account. They shall come in to action on their own. They are also responsible for placing advance order, preparation of food packets, transportation, and distribution in time and report compliance to Secretary for the previous day.

9.24 Sanction of Advance

All Head of Departments would make a judicious assessment regarding the requirement of funds by them to meet the different exigencies, which they may have to handle on account of the Natural Calamity situation. The HoDs would inform the FA&CAO on telephone or in writing or through a messenger regarding their requirement of advances. The FA&CAO in turn would examine the advances sought by the Head of Departments and sanction the advances early without any delay. The FA&CAO would keep the Chairman and Dy. Chairman informed about the amount released by him and seeks approval.

9.25 Vehicle Pool

As soon as this Action Plan comes into force, the vehicle pool stands formed; the vehicle pool shall be controlled by Senior Engineer (Pipeline) and Senior Labour Officer. The following vehicles will be there in the Pool:

All Ambulances Under CMO

9.26 Private Vehicles Buses { To be arranged by Labour Section}

9.26.1 List of Civil, Electrical & Mechanical Contractors

Sr. No	Name & Address of Contractor			
		Office	Resi	
1	Mr. Dilip Bhandbe, M/ Mukund Ltd.	223412		
2	M/s. Maheshwari Const. Co., SDX-N-5, Gandhidham-Kutch Mr. Rameshbhai	232134		
3	M/s. Apex Engineers, Bajaj Chambers, 12/B, Gandhidham – Kutch (Mr. Vishal)	222002 222223	___	9898226666
4	M/s. Gadhvi Constructions, Plot No.524, Sector – 5, Gandhidham – Kutch	235772	___	9426215258
5	M/s. Advance Builders Contractors, B-23, Apnanagar, Gandhidham – Kutch.		232864 234242	9825255934
6	M/s. Mohan Construction Co., 415, 2/B, Adipur (Mr. Mohan)	____	264140	9825174351
7	M/s. Star Decorators, 17, Plot No.5, 12/A, National Highway, Gandhidham – Kutch (Mr. Vinod Bajaj)	221450	____	____

8	M/s. Kamal P. Chellani, DBZ-S-81-A, GandhidhamKutch (Mr. Kamal)	______	______	9825221542
9	M/s. K.K.Construction, E-71, Gujarat Housing Society, Devi Krupa, Sector –5, Gandhidham (Mr. Milanbhai)			230064
10	M/s. Mepabhai Madan, Plot No. 21/22, Sector-9, Opp. KPT Office, Gandhidham Mr. Rajubhai	222209 222210		233627
11	M/s. S. B. Singh, B-110, Sapna Naga Gandhidham – Kutch	239351	______	______
12	M/s. Dipesh Construction Co., 11, Apurva Chambers, Ganga Gate, Anjar – Kutch. (Mr. Parth) (Mr. Sukhdevbhai)	242997	243319	9824294260 9825179040
13	M/s. Raj Construction Co., Deepak Complex, Plot No.315, Ward 12/B, Gandhidham-Kutch Mr. Rajesh Makhijani	220911		
14	M/s. M. V. Rajani,444, 2/B, Matruchhaya,Rambaugh Road, Adipur – Kutch (Mr. Narayan)	260800 262920	_____	9825225690

15	M/s. Bhimji Velji Sorathia, 21, Nilesh Park, Plot No.80, Sector – 8, Near New Court Building, Gandhidham – Kutch (Mr. Bhimji Velji)	231383	____	9825225948
16	M/s. Sollone & Parco Engg. Co., CCX-165, Adipur – Kutch (Mr. Ravi Solanki)	261298 263248		9825222919
17	M/s. Mahesh Construction, Plot No. 415, 2/B, Adipur- Kutch (Mr. Mahesh)	______	264140	9825091599
18	M/s. Patel Construction Co. Zanda Chowk, Gandhidham (Mr. Tejabhai Kangad)	220421	______	9825227199
19	M/s. M. G. Bhavnani, Plot No.102, Sector 1/A, Gandhidham – Kutch	______	_____	9825191636
20	M/s. Patel Engineering Works, Gandhidham	231832		
21	M/s. H.M.G. Gandhidham	235710 234609		
22	M/s. Mukund Limited Mumbai	022- 25347373		
23	M/s. Bajaj Electric Mumbai	022- 23724192		
24	M/s. Mishra Brothers Gandhidham			

		221172		
25	M/s. Sonu Electricals 18, K.P.Shopping Centre, Near Jivan Bharati School, Karelibaug, Vadodara-390018 Shri Jayendrasingh.B. Thakker	02652464108	2647886	
26	M/s. Ravi Electronics, "Prashant", 20, New Jagnath Rajkot – 360 001 Mr. G.K.Patel	465256 460 253		
27	M/s Megha Technicals, CCX - 165, Adipur - Kutch (Mr. Ravi Solanki)	261298 263248	____	9375320232
28	M/s Maruti Construction, Gandhidham – Kutch	___	_____	9824893851
29	M/s Ramesh Meghji Sorathia, Anjar – Kutch	____	____	9825225948
30	M/s Mohit Construction, B-168, Shaktinagar, Gandhidham - Kutch	____	____	9825227072

Senior Engineer (Pipeline) should ensure the availability of the Drivers and the Vehicles and report to the Secretary. All Vehicles whether it is of KPT or hired should be parked in the location as decided by the Senior Engineer (PL) and Senior Labour Officer(PO), from where it can be taken for immediate use as soon as the people move into action. The list of travel agencies is given below:

9.26.2 The list of Travel Agencies

Sr. No.	Name of Agency	Phone No.	
01	M/s. Rathod Tours and Travels, Gandhidham	222444	222959
02	M/s. Gayatri Tourist, plot No. 720/721, Valmikinagar, Bharatnagar, Gandhidham.		231715 230252
03	M/s. Panch Tirth Tours, BBZ-S12, Gandhidham	232215 230760	9825234455
04	M/s. Maheshwari Travels, Plaza Centre, Shop No. 110, Ist floor, Plot No. 110, Sector No.8, Gandhidham	232211 234455	252120 253433
05	M/s. Titan Travels, Behind Shyam Electric Stores, Jhanda Chowk, Gandhidham	222832	236911
06	M/s. Rohit Enterprises, Plot No. 99, Sector No. 4, Near IOB, Gandhidham	228550 237538 237547	234140 9825225121
07	M/s. Jai Somnath Travels, Mr. Mishra		9727304414
08	M/s. Agrawal Tourists, Gandhidham	221311 220068	
09	M/s. Ashirwad Travels Gandhidham. Shri Laxman Singh	225608 225609	9825225608
10	M/s. Krishna Travels Gandhidham	220683 234838	
11	M/s. Shiv Tourists, Gandhidham	221454	

12	M/s. Thakker Gandhidham Travels,	225097	9825271072

9.27 Contact with Railway & GSRTC

Secretary, Dy. Secretary (G) & Dy. Secretary (P) should ensure for the smooth movement of workers/employees for which he may get in touch with the following officers of Western Railway/GSRTC and apprise them about the situation so that the movement of Staff is not suffered.

Transport	Contact Person	Telephone Nos.	
		Office	Residence
Western Railway	Area Manager	221340	236237
	Control Room	232578	
	Enquiry	131/220011	
GSRTC, Anjar	Depot Manager	241192	243746
GSRTC, Bhuj	Depot Manager	220002/220102	
GSRTC, G'dham	Depot Manager	220198	

9.28 Generator Sets

Generators of following capacities have been installed at Kandla, Gandhidham, and Gopalpuri to supply power to various installations in case of power failure:

1. Cargo Jetty Area - 2 Nos of 1000 KVA EACH:

These Generators can cater power inside Cargo Jetty Area, Seva Sadan-III, Nirman Building, and Old C.D.C. Building restricted up to 2000 KVA.

2. Kandla Hospital - 25 KVA
3. A O Building- 200 KVA
4. Gopalpuri Hospital- 45 KVA
5. Guest House- 25 KVA
6. Old Kandla Fire Brigade- 5 KVA

In addition to above, if any additional Generator Sets are required at Kandla or Gopalpuri, the following officers shall be contacted who shall immediately hire/procure or provide in whatever manner the D.G. Sets giving preference to the operational area.

(i) Deputy Chief Mechanical Engineer

(ii) S E (Electrical)

(iii) Executive Engineer (Mechanical)

(iv) Asstt. Executive Engineer (Electrical) Shri AK Sharma

The above officers shall also be responsible for operation and maintenance of Generators provided at various locations and submits daily report to the Chief Mechanical Engineer about the working of Generators.

Additional requirement will be assessed by Dy CME/S.E (Electrical) and submitted to Chief Mechanical Engineer for approval. Necessary Fuel (POL) shall be procured and stored in advance by the concerned officials of Mechanical Engineering department.

9.29 Fire Dewatering Pumps

There are 10 Nos. of Dewatering Fire Pumps available with Fire-Cum-SafetyOfficer at various points. The details of which are as under:-

Dewatering Pump	Old Kandla Fire Station	Tilak Fire Station (West Gate-I)	Azad Fire Station (West Gate -II)

Portable Fire Pump Capacity:270 LPM	04	01	01
Trailer Fire Pump Capacity:1800 LPM	-	01	01
Trailer Fire Pump Capacity:2250 LPM	02	-	-

The Portable Fire Pump single delivery having capacity of 270 litre per minute are useful for dewatering the congested places like ship holds, barges and other intricate areas.

All the above Fire Pumps will be operated by the Fire-Cum-Safety-Officer. The maintenance of major nature and breakdown will be attended by Executive Engineer (Mechanical).

Fire cum Safety Officer(O) 270176 Mob: 98252-27041

Dy. Fire Officer (O) 270176/270178 (R) 226478

9.30 Shipping Navigational Aid Section

Executive Engineer (Dry -dock) shall ensure that heave-up barge "Bhimsen" is shifted to Bunder area and secured properly; Assistant Engineer (Mechanical) shall attend the above work.

Steel Floating Dry Dock

Executive Engineer (Dry Dock) and AE(DD) shall ensure that the Steel Floating Dry Dock and the Electric Wharf Cranes at the maintenance jetty are properly secured as per procedure and compliance reported to Chief Mechanical Engineer and Dy. Chief Mechanical Engineer shall monitor the safety of the Steel Floating Dry Dock.

9.31 Periodical Reporting by all HODS

All Head of Departments shall have to send Action Taken Report to the Secretary / Control Rooms in writing by Fax or through telephone with regard to the action taken by them as per the Action Plan. If the report is not received from the Head of Departments, the Officer In-charge, Control Room shall obtain the information, compile it and submit the same to the Chairman / Dy. Chairman on 12 hourly basis i.e. twice a day.

9.31.1 Chief Engineer

The Chief Engineer shall ensure through Superintending Engineers that all Road Blockades are not cleared as also he should ensure that blockades caused in Port quarters due to the falling of trees, walls, sheds, etc. are got removed immediately. He will ensure that the colonies are got cleared and wherever logging of water is found, the water is pumped out and disinfected. A report shall be submitted to the Chairman / Dy. Chairman every day.

9.31.2 Chief Mechanical Engineer

Chief Mechanical Engineer, Dy. CME/S.E (E) shall ensure that all Generator Sets are properly functioning at A.O. Building, Seva Sadan-III, P&C Building, Hospitals, and Guest House. They will ensure quick restoration of Power supply arrangements by keeping close liaison with the officials of Pachim Gujarat Vija Co. Ltd. They will report to the Chairman / Dy. Chairman every day.

9.31.3 Action Plan – Land Fire Station

The Port Fire Brigade has its Head Quarter at Old Kandla Oil Jetty area with two Sub- Stations at Dry Cargo Jetty at New Kandla.

The contact Numbers are as under:

Main Station (Emergency Response Centre) - 270176, 270178, 271377

Cargo Jetty – West Gate No. 1- 270439

Cargo Jetty – West Gate No. II - 295974

Fire cum Safety Officer - 270176 (O))/ 98252 27041(M)

Dy. FcSO- 270178(O) / 226478 (R)

9.31.4 Resources Available

Refer 4.12 to 4.14.4

In case of any fire, or other crisis an information is received through telephone - or VHF channel - Fire Station Control Room, the Duty telephone attendant raises the fire alarm bell and lights the vehicle indicating light (turn-out bell and Turn out light)

The Duty Station Officer proceeds to the scene of fire with fire Tenders and crew. Station Telephone Attendant should inform other officers like Fire-cum-SafetyOfficer, Dy. Conservator and Port Control. Telephone Attendant should inform hospital and if fire is in wharf should inform Traffic Manager. Fire cum Safety Officer after apprising the situation should inform Deputy Conservator directly or through the Telephone Attendant immediately.

9.31.5 Ensuring the Functioning of Telephones

The name and telephone No. of the Officer Telephone Department to be contacted in case of any problem:

1. General Manager, Bhuj(O) 231201/231648 (R)

2. District Engineer, Bhuj(O) 525410

3. SDO(P), Gandhidham(O) 232453/229666 (R)

Dy. Secretary (Personnel) shall ensure that the telephone of all the Head of Departments and other responsible officers of different Departments are functioning properly by ringing personally. In case any of the telephones does not function or give satisfactory service, he shall take up the matter with the higher authorities immediately.

9.32 Accidents in the Channel

9.32.1 Fire on Board Tanker / Anchor / OTB

The Ship Master - Pilot should raise & alarm and inform Kandla Tower/SIGNAL STATION on VHF Channel 8 or 16 about the intensity and location of fire.

Kandla Tower will inform the Dy. Conservator, Harbour Master and FCSO. & TM

Master should immediately ensure that the loading/discharging operation is suspended and all the connected valves are closed.

Master of the vessel should immediately gear up his firefighting equipment and post his staff for extinguishing the fire. CO_2 should be injected in the affected compartments.

Dy. Conservator after contacting the ship will inform Chairman and Dy. Chairman about the situation.

Harbour Master, will arrange for availability of chemical dispersant and its equipments and keep them in readiness in case of any oil spillage.

TUGS, with personnel and equipments should immediately start for tanker. Harbour Master on board Tug also to reach the tanker.

Dy. Conservator to remain in constant touch with the Master/Pilot of the Tanker to assess the situation.

In case no power is available on deck, the floating hoses connected on board can be disconnected by means of mechanical puller. Hose can be heated up slightly and the weight can be taken off. The Special Clamps on the flange can be removed. This operation takes about 20 Meters for each hose.

If it found necessary to safeguard jetty and the tanker is required to be removed from the jetty, one tug should remain near to tow the tanker and when given orders should pick up the fire spring and take the weight off the moorings. Master and the Pilot should take due precautions and safety measures and by using Fireman's suits to send the personnel to forward of the vessel for unmooring the tanker. Two lines to be passed on to the Tug for towing to a safe anchorage. In case, the magnitude of fire is more and beyond the control, other agencies such as Indian Coast Guard, ONGC to be called for assistance.

9.32.2 Grounding of a Tanker

Master or Pilot of the vessel should immediately contact Kandla Tower on VHF Channel 8 or 16 and give the detailed information and the seriousness of grounding. Kandla Tower Signal Station will in turn inform Traffic Manager, Dy. Conservator and Harbour Master, Kandla Port Trust. Dy. Conservator will inform Chairman/Dy. Chairman.

Harbour Master will immediately proceed to site and will immediately board the vessel and after assessing the situation will inform Dy. Conservator about the seriousness of the crisis.

Dy. Conservator in the meantime will remain at Kandla Tower and will be in constant touch with the vessel and if required give necessary guidance to Master/Pilot.

Dy. Conservator to direct Sr. Hydrographic Surveyor to proceed to grounded vessel and check the exact position of the ship and also the grounding around.

Tugs and Launches available at Kandla should remain in readiness and wait for the order of action from Dy. Conservator /Harbour Master.

Fire-Cum-Safety-Officer along with staff and equipment salvage pumps etc to remain on board fire float.

Master of vessel to obtain soundings of all the tanks and to maintain a record of the same to ensure any leakage. He should also take hand lead surroundings around the ship and plot them on the chart.

Master should inform his Chief Engineer to change over to high sea suction for cooling water.

If found necessary, Dy. Conservator can decide and ask for a small tanker/salvage tug which can be brought alongside of the grounded ship and part of cargo can be discharged to this daughter ship. This will help to lighten the grounded ship.

Master should instruct his staff to prepare all her ropes including insurance wire for towing, pulling operation.

Tug to immediately to proceed to grounded vessel and take towlines and start pulling the vessel under the instruction of Harbour Master. If required, Dy. Conservator can decide and send more than one Tug also to the grounded ship for assistance. In case the vessel cannot be re-floated within a day, a navigational warning should be sent to the Chief Hydrographer, Dehradun and the same will be transmitted through Mumbai Radio and Navtex.

9.32.3 Breaking / Ground of a Ship outside Kandla Port Limit

Kandla Port has not had any major incident of grounding/sinking or breaking of a ship in recent past. However, minor incidence of grounding could be tackled by Port's own personnel and equipments.

If there is any major breaking or grounding of a ship outside the limits of Kandla Port, the Port can activate its own crisis management plan to deal with the situation. On receiving message from the Master of the Vessel/ or from PrincipalOfficer, MMD or Coast Guard, Mumbai, Dy. Conservator/Harbour Master, KPT will immediately inform Chairman/Dy. Chairman, Kandla Port Trust.

Harbour Master will instruct Flotilla Superintendent/Tug Master, Fire-Cum-SafetyOfficer to keep the tugs, launches in readiness. Crafts with chemical dispersant spraying system at Kandla and Vadinar should rig the booms etc, Store enough stock of chemical dispersant and stay in readiness. In case, there is any major oil spillage port to activate its oil spill crisis management plan.

Port Signal Station to be made Control Room and to remain in constant touch with the Ship. Master should immediately send messages and inform nearest Port or Coast Guard about the latest situation of the Ship.

Port command team headed by Dy. Conservator will mobilize the resources available with Port to help the Ship.

Indian Coast Guard, to utilize the services of Helicopter and indicate the location and magnitude of the oil spill. They should keep the nearest port informed about the oil spill/sleek.

If the oil sleek is dangerous/approaching the limits of Kandla Port Trust, the Harbour Master along with one Senior Pilot and Safety Inspector (antipollution Scheme) to proceed on chemical dispersant Spraying craft and to reach oil sleek and under his guidance all available port crafts can spray chemical dispersant. They can go up & down and try to stop/minimize the oil sleek danger to port, Harbour Master to keep Dy. Conservator informed about the situation.

Indian Coast Guard, IOC, ONGC and other agencies who have the system to recover the floating oil should he directed with oil recovery vessel to the area.

If it is necessary, Dy. Conservator can requisition a privately owned small tanker or tank barge, which can recover the oil, store it fro-eventual disposal ashore. If the oil sleek is very large and beyond the control of the Port, the Chairman should inform the Ministry and seek their guidance for mobilizing equipments from outside Parties.

STRENGTHNING DISASTER RISK GOVERNANCE

9.33 Contingency plans in grave situation

Immediately on the occurrence of a crisis, the local Internal Action Plan under the Disaster Management Act, 2005 would be put into effect by the local/District and the state authorities. If the situation has wider ramifications and warrants response at the State/National level, the Chairman/ Deputy Chairman will contact the Nodal Ministry of the State / Central Government and seek the required help. The concerned authorities would activate its control room, call for a meeting of the Crisis Management Group and put into operation its contingency Plan.

9.33.1 First Information

As and when a critical crisis situation develops, the first information would be sent by the Chairman/Deputy Chairman to the State/Central Nodal Ministry through Wireless/Cellular Mobile Phone/Fax/e-mail or any other quickest possible means.

Security measures at Vital Installations are inspected by I.B. periodically. The Deputy Conservator and Traffic Manager shall implement the recommendations of I.B. with the help of CISF, made from time to time for beefing up/strengthening the security at important vital installations.

9.33.2 Authorities responsible for sending of First Information

Crisis	Authorities responsible for reporting	Remarks
Natural Disasters	District Magistrate or District Collector Indian Meteorological Department State/Central Water Commission	Information relating to forecasting/warning of the natural calamity will be sent by the IMD, State/Central Water Commission to the Relief Commissioner as laid down in the contingency Action Plan of the State/Central Ministry.
Chemical/Biol Ogical/RADIO ACTIVVE Disasters	Chairman / Deputy Chairman	The Chief of the Public Sector/Undertakings would be equally responsible to send the first information through his channel to the Nodal Ministry.
Major Disaster having off-site implications	Chairman/Deputy Chairman	
Break-down in Power Generation/Su pply	Chief Mechanical Engineer and Executive Engineer (Electrical) through Gujarat Electricity Board Authority.	

An Oil Installation	Chief or In-charge of the Oil Installation through his channel to the Nodal Ministry.	
Hijack of an Indian Merchant ship or Indian Crew in a Foreign ship	Chairman/Deputy Chairman	Commandant of CISF, Traffic Manager, Deputy Conservator would inform to Chairman/Deputy Chairman immediately.

9.33.3 List of Members NDMA

Contact Details of NDMA Officers

Name	Office	Fax	Mob.	E.mail id
Shri R K Jain, IAS (Retd), Member	011-26701710	011-26701716		secretary@ndma.gov.in

Sh. S K Gulati, PPS	011-26701711,	011-26701716		
Mr. D S Butola PA	011-26701713			-
Lt Gen (Retd) N C Marwah, PVSM, AVSM, Member	011-26701775	011-26701783		marwahnc.ndma@nic.in
Smt Seetha Mahesh, PS to Member	011-26701721	011-26701783		seetham.ndma@nic.in
Shri Vijaya Kumaran, PA to Member	011-26701782	011-26701783		
Dr. D N Sharma, Member	011-26701738	011-26701767		dnsharma@ndma.gov.in
Smt. Shashi A Kumar PSO to Member	011-26701761	011-26701767		
Shri Kamal Kishore, Member	011-26701740	011-26701754	9818143429	kkishore@ndma.gov.in
Shri Harish Kumar Arora PPS to Member	011-26701751	011-26701754	9910226153	
Shri Basudev Rajbhar PA to Member	011-26701753		8285642447	

JOINT SECRETARIES

Name	Office	Fax	Mob.	E.mail id
Shri B Pradhan, IAS, JS (Admin & Capacity Building and Training)	011-26701780	011-26701795		jsadm@ndma.gov.in b.pradhan@nic.in
M.Mushtaq, PPS	011-26701876			
Shri A.K.Sanghi,ITS JS (Mitigation, IT& Comn)	011-26701718	011-26701864		mitigation@ndma.gov.in
Shri Munendar Kumar, PA	011-26701720			
Maj Gen Anurag Gupta, Advisor (Ops)	011-26701886	011-26701742	8527892258	advopscomn@ndma.gov.in

Ms Archana, PA	011-26701267			
Ms. Mamta Kundra, Joint Secretary (Policy & Plan)(Additional Charge)	011-26701777	011-26701816	09599946299	jspp@ndma.gov.in
Ms Indira, PA	011-26701747			
M.Sanjay Singh, PA	011-26701816		9899403773	

FINANCIAL ADVISOR

Name	Office	Fax	Mob.	E.mail id
Smt. Aastha S Khatwani, FA,	011-26701709	011-26701715		fa@ndma.gov.in
Sh. Bharat Bhushan, PPS	011-26701712			

JOINT ADVISORS

Name	Office	Resi	Mob.	E.mail id
Lt Col Vikrant Lakhanpal, JA (IT & Comn)	011-26701743			jaitcomn@ndma.gov.in,vikrant.lakhanpal@ndma.gov.in
Col Ranbir Singh, JA (CBT)	011-26701823			ranbir@ndma.gov.in
Vinay Kajla, JA (RR & NDRF)	011-26701815			vinay.kajla@ndma.gov.in,
Dhirendra Singh Sindhu, JA (OPS)	011-26701218			dssindhu@ndma.gov.in
Sachida Nand Singh, JA(MP & P)	011-26701798			jampp@ndma.gov.in
Alice Kujur, DIR (PP)	011-26701722			
S K Singh, Dir (Finance)	011-26701778			
Yogeshwar Lal,	011-26701833			

DS (Admin)				
Bhupinder Singh, DS (PR & AG)	011-26701878			

NCRMP

Name	Office	Fax	Mob.	E.mail id
Ms. Mamta Kundra Project Director	011-26701777 011-26714321			pd.ncrmp@gov.in
Shri S.S. Jain Dy. Project Director	011-26701792			dpd.ncrmp@gov.in
Shri Ashok Kumar Sarkar, Project Accountant cum Admn. Officer	011-26701744			adm.ncrmp@gov.in

NDMA CONTROL ROOM

Name	Office	Fax	Mob.	E.mail id
Control Room	011-26701728 011-1078	011-26701729	9868891801 9868101885	controlroom@ndma.gov.in, ndmacontrolroom@gmail.com,

10 PRESS MANAGEMENT

A Cell shall be created and headed by TP&PRO. The following staff member shall remain in the Press Cell.

(1) Dy. Secretary. (P) (2) PRA (3) Sr. Clerk (BDC) (4) Photographer

The Press Room shall come into operation immediately in the chamber of BDC. The Press Cell shall issue Daily Bulletin at 2:00pm and 07:00pm every day. The photographer should collect photos and develop every day, which will depict the situation as well as the work done by the Officers. P.R.A will accompany the photographer and bring the photos to the Cell every evening. He shall also bring daily Paper cuttings of reports. All Media people, Press, Journalists, etc. shall be attended to by the Dy. Secretary (P).

BDC Section will hire videographers and keep them standby for videography. They will accompany Chairman and Dy. Chairman also. One videographer will be placed at Kandla and another at Gandhidham. Similarly, BDC section will also ensure to keep one additional photographer at Kandla for taking photographs and these people should be hired as soon as Signal No. 5 is hoisted.

Secretary will be the overall In-charge of Liaison work with the Central / State Government officials / IMD, Ahmadabad / Pune Laboratory / Delhi Laboratory in which he can take the help of Dy. Secretary (P), Assistant Secretary (P) and report the matter to Chairman / Dy. Chairman immediately. They shall remain present in all the meetings relating to the Action Plan and report the proceedings of the Meeting to the Chairman/Dy. Chairman. They shall also communicate the action to be taken to the concerned Head of Departments. List of IMD Telephone is given below:

10.1 Important Telephone Numbers of Indian Meteorological Department Ahmedabad

Director Incharge,
Meteorological Centre,
RS/RW building
Airport colony
Ahmedabad, - 382745

Phone - Weather enquiry : (i) Interactive voice response system : 1800 180 1717

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�Director I/C : 22865165

�Meteorologist : 22865012 , Fax : 22865449

E-Mail : (i) Dr. Jayanta Sarkar:- j.sarkar@imd.gov.in

����������������� (ii) Mrs. Manorama Mohanty:- m.mohanty@imd.gov.in

Websites - www.imd.gov.in http://www.imdahm.gov.in/index.html

11 DEPARTMENT WISE ACTION PLAN

11.1 General Administration Department

The overall in charge for setting up control room at Gandhidham will be the Secretary. He shall ensure setting up the control room at AO Building within two hours of warning and the matter reported to the Chairman/Dy. Chairman. Two telephones should be kept in the control room, one for receiving and the other for outward calls. Tel. No. 238055 will be used for incoming calls and 239055 for outgoing calls.

Labour Officer (Mr. Pradhan), and the Head Masters of BVM School shall reach and open the schools/community hall etc, and keep them ready for accommodating the shifted people.

The OSD (Estate), Land Section and, Asstt. Estate Manager should ring up major salt leaseholders and advising them to evacuate their labourers and report the action to the Chairman within two hours. Action taken should be confirmed in writing thereafter, Dy. Secretary (G) will guide them and will do the overall supervision of this job.

Librarian shall ring up all the private/public sector companies of the area and inform them about their situation and tell them to evacuate their people and take necessary steps. List of private/public sector companies is as shown in Point No:

9.17.3.2

Senior Labour Officer, Labour Officer along with Executive Engineer (R) and Headmasters of BVM School shall ensure that temporary evacuation centers are established in the school/community center of Gandhidham-Kandla area.

11.1.1 List of Schools in Gandhidham – Kandla Complex

Sr. No.	Name of School	Contact Person	Telephone No.
1	Dr. C. G. High School	Principal	220271
2	SVP Gujarat Vidhyalaya	Principal	220242
3	M.P. Patel Kanya Vidhyalaya	Principal	220705
4	Adarsh Maha Vidhyalaya	Principal	234172
5	Adarsh Kanya Vidhyalaya	Principal	220175
6	Bhartiya Vidhya Mandir, Kandla Bhartiya Vidhya Mandir, Gopalpuri	Head Master Head Master	271049 233684
7	Central School, (IFFCO)	Principal	221288
8	Central School (Railway)	Principal	220657
9	Modern School	Principal	220284
10	Mount Carmel School	Principal	234262
11	Aum Vidhyalaya, IFFCO	Principal	221104
12	Saint Xavier's School, Adipur	Principal	260265
13	Maitri Maha Vidhyala, Adipur	Principal	260445
14	Maitri Kanya Vidhyalaya, Adipur	Principal	260612

15	Model Excelsior High School, Adipur	Principal	260707
16	Gujarat Vidhyalaya, Adipur	Principal	261312
17	Nagarpalika High School, Anjar	Principal	242510
18	Adarsh Nivasi School, Gandhidham	Principal	223246
19	P.N.Amersey School	Principal	223646
20	Shree Gurunanak English School	Principal	238421
21	Swaminarayan Gurukul	Principal	228098
22	Kairali English School	Principal	221050
23	Sarvodaya Pradhamic Shala Near Oslo Cinema, Gandhidham	Mr. Kangodia	227958
24	Ganeshnagar Pr.Shala, G'nagar	Mr. Kangodia	
25	Jagjivan Pra. Shala, Sapnanagar, Gandhidham	Mr. Kangodia	
26	Cargo Pra. Shala, Sapnanagar, Gandhidham	Mr. Kangodia	
27	Old & New Sunderpuri Schools	Mr. Srimali, HM	224867
28	G'dham Pr. Shala, Near Shivaji Park, Gandhidham	Mrs. Arunaben.	229255
29	Adipur Prathmic Shala, Adipur	Mr.C.M.Rami	264525 264181
30	Kandla Pr. Shala, Shirva Camp & Thermal Colony & United Salt Works	Mrs. Shantaben	253198

Dy. Secretary (P) shall ensure that the telephone of all the Head of Departments and other responsible officers of different Department are functioning properly by ringing personally. In case of any of the telephone does not function or gives satisfactory service; he shall take up the matter with the Higher Authority of Telephone Department.

The staff attendance on days when the Action Plan is in operation shall be collected from PA to HoDs and complied by Asstt. Secretary and reported to Chairman/Dy. Chairman every day with separate list of absentees. Secretary will do the overall supervision of the work and report compliance to the Chairman/Dy. Chairman within two hours of the warning received.

Secretary will be the overall in charge for liaison work with central/state government officials/IMD, Ahmadabad/Pune Laboratory/ Delhi Laboratory in which he can take the help of Dy. Secretary (P) and Dy. Hydraulic Engineer and report the matter to the Chairman/Dy. Chairman immediately. They shall remain present in all the meetings relating to the Action Plan and report the proceedings of the meetings to the Chairman/Dy. Chairman. They shall also communicate the action to be taken to the concerned Head of Departments. List of IMD telephone numbers is shown below:

11.1.2 List of Important Telephone Nos of Indian Meteorological Department

Websites – www.imd.gov.in, http://www.imdahm.gov.in/index.html

All Head of Department shall have to send Action taken report to the Secretary/Control rooms in writing by fax or on telephone with regard to the action required of them as per the Action Plan. If the report is not received from any of the HoDs, the Officer In charge, Control Room shall obtain the information, compile it and submit the same to the Chairman/Dy. Chairman on 12 hourly bases i.e. twice a day.

11.2 Contacts of Officials of GAD following nodal officer will form a team

Sr. No.	Designation	Present incumbent	Contact Telephone Numbers		
	Mr Bimal Kumar Jha	Secretary	220167	231939	233172
01	Mr. Suresh Balan	Dy. Secy (G)	221375	236086	
02	Mr. DEEPAK RANE	Sr. Dy. Secy	220033	234730	

11.3 Duty Roster for Staff of General Administrative Department

AS ABOVE

11.4 Central Industrial Security Force (CIF)

The Sr. Commandant shall remain in contact with in charge of control room at Kandla (HARBOUR Master) regarding the position of the cyclone / calamity.

The Sr. Commandant shall ensure that Public Address System is fitted on Jeeps provided to CISF. He will make arrangements for announcements, with the coordination of police through Public Address System mounted on at least 03 vehicles. The CISF personnel will procure truck with the help of TM. The list of fleet owners and major lift operators are given below:

11.4.1 List of Major Heavy Lift Operators at KPT

Name of Party	Name of Contact Person	Phone Number
Swastik Heavy Lifters	Mr. Jigneshbhai Mr. Aslambhai	9825758151 9825228421
Kutch Carrier Transport Co	Mr. C. R. Thackar	9825225591
Agarwal Handling Agency	Mr. Rakesh Thackar	9426928728
Active Cargo Movers	Mr. Narendra	9825220411
Raghuvirsingh & Sons	Mr. Harcharan	9879104853
Thacker Brothers	Mr. Kamleshbhai	9825296107
Kiran Roadlines	Mr. Pankaj Gadvi	9879104552
Regal Shipping	Mr. Ashok Dudi	9825326328
Rathore Freight Carriers		220759/ 220380

11.4.1.1 Additional list of firms for pay loaders / cranes

M/s Mahalaxmi Transport Co., Plot No. 35, Sector No. 8, Behind Hotel Fun & Food, Gandhidham	Mr. H K Rathod	(O)222387 (R)233500
M/s Kandla Earth Mover, DBZ-S-151, Gandhidham	Mr. Sanjay Goyal	(O)221759 (R)222338 (M) 9825020550

Mr. Lalji Bhavanji Sathwara, Laljibhai Sathwara, Plot No. 27, Shop No.5, Sector9/A, Gandhidham		(O)234118 (R)232566 (M) 9825225957

11.4.1.2 Equipments available with ABGKCTL TABE REMOVED

11.4.2 List of Fleet Owners at KPT

Sl. No.	Name of Company	Contact Person	Tel. Office	Tel. Resi.	Mobile
01	M/s A V Joshi & Company	Mr. Ramesh Singhvi Mr. Thacker MR. Harshandhu	231386 232605 233147	234176 221451 234325	98251 91325 98252 26105 98252 26013
02	M/s Rishi Shipping	Mr. B. K. Manshukhani Mr. Manoj Manshukhani	220843 229830 238943	234889 235587	98252 25170
03	M/s Maheshwari Handling Agency	Mr. C. P. Maheshwari Mr. Chandan Maheshwari	223228 230393	222339	98252 27111
04	M/s ABC	Mr. Latif Mr. Mithu Mr. Kasam	220483 221390 270190	234163 231477 251684	98252 26707
05	M/s Ganesh Transport	Mr. Hira Rabari Mr. Visa Rabari	223638 223915	260425	
06	M/s Kewar Carrier		220483 227553	234163	

07	M/s Krishna Transport Service	Mr. K. M. Thakker Mr. Pankaj Thacker	223814 224938	220998 234988	98250 19699 98252 25228
08	M/s Gautam Freight Ltd	Mr. Ramesh Singhvi	220163 230345	230328 234176	98251 91325

11.5 Contact Nos of CISF Officials

S. No	Designation	Contact Telephone Numbers		
		Office	Res	Mobile
01	Commandant	271037	229140	9825227282
02	Dy. Commandant	271036	220192	9825227045
03	INSPECTORS			8500495813, 9045696584
04	Control Room	271040		
05	North Gate	270440		
06.	West Gate – I	271039		
07.	West Gate II	270876		

11.6 Finance Department

As soon as the Calamity/Cyclone warning Signal No. 5 is hoisted the Dy. Director (EDP) should monitor it through Internet and give two hourly printouts to Dy. Conservator, Secretary, Chief Engineer, FA&CAO, Dy. Chairman and Chairman. And Dy. Director (EDP) will monitor the website in the A O Building, Gandhidham.

All Head of Departments would make a judicious assessment regarding the requirement of funds by them to meet with the different exigencies, which they may have to handle on account of the Cyclone/Calamity situation. The Head of Departments would inform the FA&CAO on telephone or in writing or through a Messenger regarding the requirement of advances. The FA&CAO in turn would examine the advances sought by the Head of Departments and sanction the advances early without any further delay. The FA&CAO would keep the Chairman and Dy. Chairman informed about the amount released by him and seeks approval.

11.7 Medical Department

Two Casualty Emergency Wards, one at Gopalpuri and other at Kandla Hospital shall start functioning as soon as warning of Cyclone is received. Chief Medical Officer will ensure that no Doctor is given leave during the emergency period. These casualty emergency wards will function round the clock with posting of Doctors and Staff round the clock. Chief Medical Officer will ensure the functioning of casualty emergency wards at Gopalpuri and Kandla. A Register shall be maintained at both the places where in the record of patients attended would be maintained. Adequate number of chlorine pills should be distributed after Cyclone to avoid epidemic from spreading. Chief Medical Officer shall submit a report every evening to Chairman/Dy. Chairman.

11.8 During Disaster

1. Maximum alertness of staff members for their safety.
2. Ambulances/vehicles with Drivers to be kept standby awaiting further orders.
3. Liaison with: - Control Room, Disaster Site/Spot, P.A.s to all HoDs, New Kandla Hospital.

(Action: P.A. to CMO)

11.9 Post Disaster Phase

11.9.1 Tackling of Patients

1. Use of ambulance will be purely on priority basis. The A.C. Ambulance can be used as an Emergency Mobile Van for carrying medicines along with a doctor and other essential Para-medical staff, to the site of crisis.

(Action: Dr. Sunil Suryavanshi)

2. Line of treatment to be decided by attending Doctors, such as Indoor/Outdoor/Under observation etc.

(Action: All Doctors)

3. Cases will be attended depending upon the gravity of injury/condition of case, i.e. very serious, stable. (Action: All Doctors)

4. To ensure supply of adequate medicines and any other items. (Action: AMO Stores / S P S K)

5. Dead bodies to be shifted to Govt. Hospital, Rambaug promptly for identification, disposal, and issue of death certificate etc.

(Action: Mamlatdar/PSI/Medical Supdt. Rambaug Hospital/PA to CMO)

6. If needed be, liaison with local Medical Practitioners, Local Hospitals, etc. (Action: P. A. to CMO.)

7. If need be, to arrange for outside ambulance, in consultation with FA&CAO to whom details have been submitted earlier.

(Action: P. A. to CMO.)

8. Transfer of serious patients to Govt. Hospital/Private hospitals , Bhuj/ Rajkot/ Jamnagar be made but such transfer to be restricted.

(Action: All Doctors on approval by CMO)

9. To mobilize additional nursing /Para-medical staff to cope with additional workload.

(Action: CMO PA tto CMO)

10. Re-deployment of Manpower from Gopalpuri Port Hospital to Kandla Hospital and vice versa.

(Action: C.M.O.)

11.10 Prevention of Epidemics

1. Chlorination of drinking water at source. (Action: Sr. Engr. (P/L) & Estate office In-charge)

2. Mass Survey of residents of Port Colonies at Kandla and adjoining areas. (Action: Dr. Malik & Volunteers)

3. To get chlorine tablets from DHO-Bhuj and arrange for distribution thereof. (Action: Dr. S. B. Suryawanshi and Volunteers)

4. To educate residents/public to promote hygienic condition in and around their dwelling place, use boiled water

(Action: C.M.O. and Volunteers)

5. To shift cases afflicted by contagious or infectious diseases to Govt. Hospital / Private hospitals and notify such cases to the notice of State Authorities.

(Action: C.M.O.)

6. To ensure hygienic condition/cleanliness in both hospitals and colony in coordination with concerned staff of respective Estate Office.

(Action: Dr. Suryavanshi & Dr.Malik with in charges of respective Estate Officers)

7. In Rehabilitation Centre, Medical care will be looked after by Dr. Mahesh P Bapat & AMO besides supply of Chlorine Tablets.

8. To provide on the spot medical-aid at New/Old Kandla Port colonies. (Action: SMO In

9. Antidotes of all the poisonous gases to be kept ready. (M.O. (P)/Safety Officers/AMO)

10. Any further actions depending upon the conditions and restoration in the matter being decided by Administration.

11. Re-deployment on services as mentioned before.

12. In life threatening condition of Staff members - their evacuation.

11.11 Marine Department

As soon as warning of Cyclone Signal No. 5 or above is received, following measures shall be taken:

- Setting up of Control Room at Signal Station.

- Pilots and other Supervisory personnel in Flotilla Section should reach Kandla even if they are on leave, to tackle emergency, if any.

- Evacuation of Ships and securing all Port Crafts at Shortest possible time.

- Essential Staff (Fire Brigade) will not be given any kind of leave.

- The following personnel of Marine Department will not be granted any leave and they shall report for duty including holidays, during such time when Action Plan is put into operation.

  ⇒ All Operational Staff in Flotilla Section and Signal Station.

  ⇒ Ministerial Personnel at Point No: 11.11.1

11.11.1 Particulars of the Action Plan Committee Members

- For dewatering, if required, Fire-Cum-Safety-Officer will make arrangements by operating the dewatering Fire Pumps available with him.

11.12 Ships

- All the Pilots of the Port should reach Kandla immediately in case of emergency.

- Dy. Conservator/Harbour Master/Pilots should be available at Kandla during emergency.

- Removal of vessels whenever the cyclone is located in close proximity to the danger line plotted between 65 degree E longitude 18.2 degree N latitude and 73 degree E longitude 18.2 degree N latitude. Map showing the above position is given at Annexure-XXX.

Under such a situation the ships shall be removed during 1st/next available tide. It will be the duty of Harbour Master and DC to ensure that the ships are removed during 1st/next available tide as soon as the storm reaches to close proximity to the danger line as defined above without seeking any further instruction from the higher authorities. This action shall be taken automatically and suo-moto without any confusion and for which purpose Traffic Manager shall stop all loading and unloading operations immediately upon instructions from Dy. Conservator, so as to enable him to remove the vessels in time. The removal shall be done with the help of all the available Pilots plus all empanelled Pilots together at one go in the shortest possible time, so as to ensure that all the vessels cross the bar before the tide restriction sets in.

Dy. Conservator shall ensure that all ships are moved out of the Harbour at the earliest. All pilots shall immediately report at Kandla and stay there till the Action Plan is in operation. Dy. Conservator/Harbour Master shall immediately plan removal of vessels to the OTB as soon as the Action Plan is put into operation irrespective of the Single number, which must be hoisted. If, it is impossible to remove them, all other steps should be taken to ensure safety of the vessels at the Port as also it would not cause any damage to the Port. Dy. Conservator shall also ensure adequate stock of fuel for all crafts.

11.13 Securing of all Crafts

Dy. Conservator /Harbour Master shall immediately arrange for securing all the Port Crafts at safer places, so that there is no loss to the Port and send a report to the Chairman/Dy. Chairman as early as possible after operation of this Action Plan. Flotilla Supdt. (Mr. I. D. Bhagchandani) shall be overall in charge of each craft for ensuring their safety.

For parking of crafts in emergency, three places are mainly identified, viz. Bunder Basin, Launch Jetty and Maintenance Jetty as per:

11.13.1 Placement of Port Crafts on Cyclone Warning

(A)	Shipping Tugs	All 35 BP tugs and Hired tugs	Bunder Area
			Maintenance Jetty (West side)
(B)	Pilot Launches & Survey Launches	All Launches	Floating Crafts Jetty Inside area
			Bunder Basin
			Inside Bunder Area North

			Side.
(C)	G.S. Launches & Mooring Launches	M. L. Mrinal	Inside Bunder Area North Side on Pilot Launches
		M.L. Vaishali M L Alli M L Thamrai	Inner Side of Floating Craft Jetty
		M. L. Vijay M. L. Priyadashani PL Prahari, Rakshak	Inside Bunder Area North on G. S. and Pilot Launches.

Maximum number of crafts such as mooring launches, GS launches and pilot launches will be placed in Bunder Basin.

In the inner side of Passenger Jetty, one pilot launch and one G S launch will be kept.

Three tugs will be kept in the inner side of maintenance jetty.

Priority will be given to the Port crafts for parking in the bunder basin and other areas. Rest of the places available in the Northern side of bunder basin area will be allowed to the self propelled barges and private crafts. Dumb barges will be allowed on the beach between maintenance jetty and oil jetty area.

BS will render all possible assistance to FS, being the overall in charge of the crafts. The following flotilla staff will take care of the crafts.

11.13.2 Flotilla Staff Will be decided by FS as per available team with mooring crew

11.14 Private Barges / Crafts

The parties who have been Harbour Crafts License by the DC have to keep their barges and crafts inside the port limits being earmarked for the purpose.

Necessary instructions shall be issued to all these people having valid license immediately. The work of informing these parties will be carried out by the Office Supdt. of Dy. Conservator's office and will personally ensure that the instructions are carried out and reported to Harbour Master within two hours of the Action Plan coming into operation. The representatives of the above parties shall reach Kandla at once, failing which the Dy. Conservator will cancel the license granted to them and take over the barges/crafts of the party who violates the instructions.

The position shall be appraised to Chairman / Dy. Chairman within two hours of the receipt of warning and at frequent intervals.

11.14.1 List of Duty Roster of Marine Department (Ministerial Staff)

Sr No	Name	Office	Residence / Mobile
01	PA to DC	220235	9428032483
02	Mr. AR Jadeja, Signal Supdt	270549	9825427400
03	Office Supdt.	221971	
04	Assistant	221971	
05	Sr. Clerk	221971	
06	Messenger	221971	

11.14.2 List of Telephone Nos & Addresses of DC, HM & Pilots

Sr No	Name of Officer / Pilots	Address of Gandhidham Res	Tel Nos: Cell / Landline
01	Capt T Srinivas DC	A – 7, Gopalpuri	9825232982 232806
02	Shri S K Pathak HM	C – 32, Gopalpuri	9825803499 231310
04			
05	Capt A K Sharma Pilot	C – 40, Gopalpuri	9879603642 238154
06	Capt V Madaan, Pilot	C – 31, Gopalpuri	9879603643 221478
07	ALL AVAILABLE CONTRACT PILOTS WILL BE CONTACTED THROGH SIGNAL STATION		
08			
09			
10			
11			
12			
13			
14			
15			
16			

11.14.3 Contract / Empanelled Pilots WILL BE CONTACTED BY SIGNAL STATION

11.14.4 Sections

1. Flotilla Section 270280

,

Mr. Sunil Kumar	Flotilla Supdt.	270280	226121		7874627756

2. Signal Station270549/270194/9825227246 Fax 270624

3. Fire Station270176/270178/270439/550421/271244/271377

In case of Natural Calamity, first start with rescue operations, restoration activities on war footing on the advice of Chairman/Dy. Chairman, Dy. Conservator/ Harbour Master/Fire-Cum-Safety-Officer/Flotilla Supdt as the case may be.

11.15 Traffic Department

After, the warning of Cyclone or any other Natural calamity is issued at the Port, Traffic Manager shall ensure that the loading/unloading operations at the Port are stopped immediately, hatches closed, ships derricks properly secured and all labourers evacuated from the Port Area. Public Address System shall be installed at the Cargo Jetty Area, which shall be under the charge of Traffic Manager. He shall use it for necessary arrangements relating to evacuation. Traffic Manager should also ensure that responsible persons make announcements in a proper way, so as not to create any misunderstanding/panic.

Notwithstanding above, Traffic Manager shall stop all loading and unloading operations immediately upon instructions from Dy. Conservator, so as to enable the latter to remove the vessels in time.

The responsibility of evacuating the Port Shore Workers and Private Shore Labourers rest with Traffic Manager. He along with, Dy. Traffic Manager, Mr. Gulrajani, Safety Officer and Dy. Commandant, CISF should ensure that the Port is completely evacuated and there is no fresh entry in the Custom bounded area. Dy. Traffic Manager should get in touch with the Main Contractors in the regard.

Traffic Manager shall render necessary help to procure requisite number of Trucks for Public Announcement and evacuation.

Traffic Manager shall inform all the Stevedores List given below:

11.15.1 List of Stevedores

Sr. No.	Name	Address	Fax No.	Telephone Nos.	
				Office	Resi.
1	M/s. Cargo Movers	"Cargo House" BBZS-32A, Gandhidham	231687	220453 231365	261280
2	M/s. DBC & Sons (P) Ltd.	Seva Sadan-II, Room No. 303 / 304, New Kandla	270631	270503 270263 270348	-
3	M/s. A.V.Joshi & Co.	Plot No. 18, Sector-8, Maitry Bhavan, Nr. Post Office, Gandhidham – Kutch	233924	231070 232227 231588	234909
4	M/s. Agarwal Handling Agencies	DBZ-N-47, Gandhidham – Kutch	232749	220282 233187	232749
5	M/s. ACT Shipping P. Ltd	Seva Sadan-II, Room No. 206/207, New	232175	270111 270112 270015 229967	261308 231416

		Kandla			
6	M/s. Cargo Carriers	214/215, Rishab Corner, Plot 93, Sector- 8, GIM	230030	220816 231649 230030	231694
7	M/s. Cargo Clearing Agency (Gujarat)	Plot No. 271, Ward 12-B, Gandhidham	233034	221721 220655	231452
8	M/s. Chotalal Premji Stevedores Pvt. Ltd	C-8, Shaktinagar, GIM	231509	270009	-
9	M/s. Hiralal Maganlal & Co.	C-11, GIDC Area, Gandhidham – Kutch	223914	223914 231832	223878 232430
10	M/s. New Dholera Shipping Company	Goyal Commerce Centre Building - 1, Plot No.259, Ward 12B, Gandhidham - Kutch	-	222637 232267	237284
11	M/s. J.M. Baxi & Co.	Seva Sadan – II, Room No. 301 / 306, New Kandla	270646	270630 270550 270448	260427
12	M/s. Pestonjee Bhicajee (Kutch)	Seva Sadan-II, 203, New Kandla	270650 270556	270257 270367	262914

13	M/s. OTA Kandla Pvt. Ltd.	BBZ-N-324, Gandhidham	223241	220145 270560	223241
14	M/s. Purshotam das Jeramdas & Co.	5, Vaswani Chamber, 16, Sector-8, GIM	222850	238242 222598	220598
15	M/s. R. Tulsidas & Co.	Ahit Building , Plot No.323, Gandhidham – Kutch	232308	222717 221943	-
16	M/s. Robinsons	101 / 102, Maritime House, Plot No.45, Sector – 9A, Gandhidham – Kutch	234394	221578 223836	231767
17	Rishi Shipping	Plot 50, Sector 1/A GIM	238943	229830 229831	
18	M/s. Vinsons	BBZ-S-25, Gandhidham – Kutch	231948	220466	222395 239460
19.	Sical Logistics Ltd	403, 4th Floor, Madhuban Compex, OSLO, GIM	234416	234646 234194	
20	Parekh Marine Agency	C-8, Shaktinagar GIM	231509	229297 221158	

21	Krishna Shipping and Allied Services	Transport Nagar, NH GIM	233135	230501 223814 229085	
22	Kevar Carrier Handling & Transport	Shop 24, Tolani Chamber, Sector –8,GIM	228298	228298	
23	Trinity Shipping & Allied Industries	Trinity House, Plot 46 Sec 1/A, GIM	232060	230911 230910	
24	Velji P & Sons(P) Ltd	2nd Floor, Deepak Compex, 315, 12/B GIM	236168	231545 231546 225466	
25	Asean Marine Services	Ashit Bldg, Plot 33 Sector 1/A, GIM	232308	222717 221943 222145	
26	Rishikiran Roadlines	Kiran House, Plot 8 Sector 8, GIM	231422	231894 234108	
27	Universal Shipping Services	Hotel Sea Bird, Plot 173, Sector 1/A,GIM	235251	230663 226050 226037	
28	R.T.Bhojwa ni &Sons	DBZ –S- 146, GIM	232423	222211 221831	
29	Logistic Enterprises (P) Ltd	C-8, Shaktinagar, GIM	231509	235341 230587	

30	Seaways Shipping (P) Ltd	2nd Floor, Plot 351 Ward 12/B, GIM		226183 237147	
31	Seacrest Shipping Services Pvt. Ltd	216, 2nd Floor Om Corner, Plot 336 Ward 12/B, GIM	227028	233325	
32	Shree Maruti Shipping Services	18/21, Swaminarayan Bldg, Sector 9, GIM	234107 250690	233245 237247 250690	
33	Liladhar Pasoo Forwarders P.Ltd	Plot 4, Sector –1 KASEZ, GIM	252383 253506	252286 252297 252612	
34	Shree Radhey Shipping Company	14-16/C, GF Green Park, GIM	232967	222919 228919 238883	
35	Pearl Shipping	220, Rishab Corner, Plot 93, Sector 8 GIM	235570	225283 225284	
36	Patel Shipping Agency	Patel Avenue, Floor 2,Plot 170, Sector 1/A, GIM	231143	224024	
37	Ashirvad Shipping	18-21, Swaminarayan Bldg, Sector- 9, GIM	250690	233245 237247 222822	

38.	M/s. Swaminara yan Vijay Trade Carriar	1st Floor, H-6, Op. Tejas Society, Ghatlodia, Ahmadabad	079- 231983	231981, 231982	

11.16 Mechanical Engineering Department

- Marine Engineer/Engineer In charge should be available in emergency cell and remain in constant touch with Chief Mechanical Engineer/Signal Station and Assistant Engineers posted on Shipping Tugs.

- All Assistant Engineers (D/T &F/C) should be available on operational tugs irrespective of their duties. They should keep main engines and associated equipment in readiness all the times.

- Assistant Engineers posted in tugs should contact Superintending Engineer (Mech)/ Engineer In-charge for all technical & personal problems.

- Assistant Engineer (F/C) will be responsible for timely supply of food packets and drinking water to officers and staff of tugs.

- SE (Electrical) will be responsible for Securing Cranes at Cargo Jetty. He may, if need be inform about requirement of advance and to draw accordingly. He will be responsible to run 2 X 1000 KVA Generator Sets at Cargo Jetty Area in case of Power failure and also maintain additional Generator sets required at Kandla/Gopalpuri and Attending work of maintenance of major nature and breakdown.

- Asstt. Executive Engineer (Mech.) and JE (Mech) will be responsible for timely supply of Drinking Water/Food Packets to the staff of Mechanical Engineering Department during operation of the action plan.

- Assistant Engineer (Mech.) will be responsible to attend breakdown of Fire Fighting Pumps and DG Sets of 2 X 1000 KVA at Kandla.

- Steel Floating Dry Dock and one Electric Wharf Crane at maintenance jetty and one crane at bunder area are to be properly secured by Executive Engineer (Dry Dock) with help of his team mentioned below, as per prescribed procedure and concerned officers shall constantly monitor the safety of the

Steel Floating Dry Dock and Electric Wharf Cranes in side Bunder Area. He shall ensure all the required wedges, wire ropes, shackles etc.. and other fixtures as required to be kept ready so that the same can be fixed without loss of time & to check the site for the requirement, from time to time.

Action: XEN (DD) and Asstt. Engineer (FC) will lead the team of JE(Mech) and will be in contact with Executive Engineer (Mech) and Chief Mechanical Engineer/Deputy Chief Mechanical Engineer.

- All the V.H.F. and other Wireless Sets, and other required equipments of VHF Unit, including the sets kept at S.F.D.D. should be kept in perfectly working condition and the batteries are fully charged and to be kept in ready position and staff will remain in touch with control room till the emergency is called off to attend all communication equipments. It shall be responsibility of the Control Room Staff to ensure that timely information is passed on and timely and proper monitoring is done.

  Action:, Assistant Engineer (DD) and R./R. Technician will render all possible assistance to Ex. Engineer(DD) during the course of calamity period.

- All the vehicles belonging to the Mechanical Engineering Department to be kept in perfectly working condition and sufficient stock of fuel and lubricant to be kept in ready position.

  Action: Assistant Engineer (Mech.) with the help of Junior Engineer (Mech.) Garage

- During the course of calamity all the vehicles lying inside the premises of Auto Workshop should be kept in the parking ways meant for parking the individual vehicles and inside the shed. No vehicle is to be parked under any tree or under any such structure where there is possibility of falling such structure or tree over the vehicles. All the concerned drivers to be informed accordingly well advance to avoid such possible damage to vehicles and to remain present at duty place in consultation, Vehicle –in-charge of Pipeline Division.

  Action: Assistant Engineer (Mech) with the help of Junior Engineer (Mech) Garage.

- Record of attendance of the employees during these periods to be kept ready and to be fed to the Control Room or any official responsible for such duties.

  Action: Assistant Executive Engineer (Mech), Assistant Engineer (Mech) with the help of Head Clerk (Mechanical Division) and Divisional Accountant for all sections.

- Assistant Engineer (DD) to remain in Control Room at New Kandla to attend the communications with help of R/R Technician.

- Assistant Executive Engineer (Mech) and, Assistant Engineer (Mech) are to be associated with Executive Engineer (M) to constantly monitor the safety of the Port Crafts.

- The heave up water barge "BHIMSEN" is shifted to Bunder Area and secured properly in Naval Aid Salvage Section and Floating Craft. Absent/Present report of the above staff will be reported to the concerned section immediately on

  starting of each shift and maintenance of major and breakdown etc… Action: Mr. Manohar Dana, Assistant Engineer (Mech)

- All the telephones and intercom telephones and their allied communication systems and equipments should be kept in perfect working condition to ensure that timely information is passed on and timely and proper monitoring done till the emergency is called off. He will ensure quick restoration of telephones by keeping close liaison with the concerned personnel. He will report to the Executive Engineer (Electrical) every day and to carry out all work assigned by the Executive Engineer (E) in case of emergency.

  Action: Assistant Engineer (Instru).

- SE (E) and Executive Engineer (E) shall be responsible for liaison with the PGVCL for receiving power in case of power failure. In the event of disturbance in the distribution network necessary arrangements shall be made by them as per the requirement depending upon the situation.

- If any additional Generator Sets are required at Kandla or Gopalpuri, the following officers shall be contacted who shall immediately hire/procure or provide in whatever manner the DG Sets giving preference to the operational area.

  1. Superintending Engineer(E)

  2. Executive Engineer (Electrical)

  3. Executive Engineer (Mechanical)

  4. AXEN(E)

The above officers shall also be responsible for operation and maintenance of Generators provided at various locations and submits daily report to the Chief Mechanical Engineer about the working of Generators.

Additional requirements, if any, will be assessed by Dy. CME and the same shall be submitted to Chief Mechanical Engineer for hiring, well in advance so that XEN (E) can take necessary action for hiring, installation etc…

- After the warning of Cyclone or any other Natural Calamity is issued at the Port, Chief Mechanical Engineer shall ensure immediately that the cranes are secured and properly locked as per procedure and report submitted to the Chairman/Deputy Chairman after the operation of the Action Plan.

The following officers shall constantly monitor the safety of the cranes;

1. Executive Engineer (Electrical)

2. Executive Engineer (Mechanical)

The responsibility of evacuating all Mechanical/Electrical and Civil workers rests with Chief Mechanical Engineer with the assistance of respective Executive Engineers.

The maintenance of major nature and de-watering fire pumps operated by FireCum-Safety-Officer will be attended by Executive Engineer (Mech).

Executive Engineer (Dry Dock) and, AE(DD) shall ensure that the Steel Floating Dry Dock and Electric Wharf Cranes at the maintenance jetty are properly secured as per the procedure and compliance reported to the Chief Mechanical Engineer immediately. SE (Mech) shall monitor the safety of Steel Floating Dry Dock.

The following staffs have to report for duty even if it is a public holiday to actively participate in the Action Plan and they shall be responsible for record keeping of attendance, preparation, and submission of reports etc.

1. P A to CME

2. Office Superintendent

3. Superintendent Accounts

4. Sr. Clerk

5. Junior Clerk

11.16.1 List of Duty Roster of Mechanical Engineering Department As formed by CME on available officers

Name of Officer	Designation	Office	Resi.	Fax
Mr. SAROJ DAS	CME	270632 270184	231043	270184
Shri A Ramaswami	Dy CME	270426	226067	
Mr. P Srinivasu	SE (E)	271010		
Mr. B J Solanki	SE (M)	270352		
ABOVE OFFICERS WILL BE FORMULATING A TEAM				

11.17 Civil Department

Based on the practical experience and seriousness of the two Natural Calamities - the devastating Cyclone in 9th June 1998 and the Earthquake on 26th January 2001, the following Action Plan for Civil Engineering Department, is proposed to be implemented.

As soon as the message on anticipated Cyclone/Natural Calamity is received from concerned authorities, the same will be intimated to all the concerned under the Civil Engineering Department and will be instructed to be alert. All the staff members/officers should note that they will come into action on their own as soon as the Warning is issued without waiting for any further instructions. Failure on the part of any employee/officer to carry out the earmarked Action Plan shall attract severe consequences.

Immediately after receiving the information on the Natural Calamity, nobody will be granted any kind of leave and the persons who are already on leave will be called back after canceling the leave.

Absent/Present report of the staff and the officers will be reported to the concerned Section immediately on starting of each shift for this purpose, Sectional Heads of all Divisions will be responsible to report the matter to P. A. to Chief Engineer for compilation of the information and onward transmission to General Administration Department.

The Engineering Department will assist in shifting of the persons to safe places in the event of such action is required.

Water Supply arrangements will be made to various colonies/sites of work/camps where the workers are shifted, etc. The Senior Engineer (Pipeline) will be the in charge for supply of water to various destinations.

Sufficient number of vehicles will be arranged for transportation workers/staff/officers. This arrangement will also be made by the Senior Engineer (Pipeline).

The Engineering Department will ensure that all Road blockades are got cleared as also blockades caused in Port Quarters due to failing of trees, walls, shed, etc. are got removed immediately. Further, it will be ensured that the colonies are got cleared and whatever logging of water is found is pumped out and disinfected. A report will also be submitted to Chairman/Dy. Chairman.

11.17.1 The following officers are to be contacted in the event of any such problems

Area	Designation	Office	Resi.	Mobile
New Kandla Gopalpuri	XEN(R) XEN (TD)	236165 223912	222056 235683	9913949700 9427205610
Old Kandla	Senior Engineer (Pipe Line)	220013	232880	9825225962

Cargo Jetty	Executive Engineer (Harbour)	270429	252624	9825227046

11.17.2 List of Duty Roster of Civil Engineering Department   CE will form a team as per

Mr. SSP PATIL	Chief Engineer	233192	228777	220050	9825227243
Mr. . V R Reddy	Dy. CE	270429	228869		9825227038
Mr. K J Todarmal	Exe Eng (R)	236165	220670		8980049099
Mr.	SE (PL)	220013	229164		9825225962
Mr	SE (H)				
Mr.B. Rajendra Prasad	Exe Eng (D)	220038	232880		9725338260

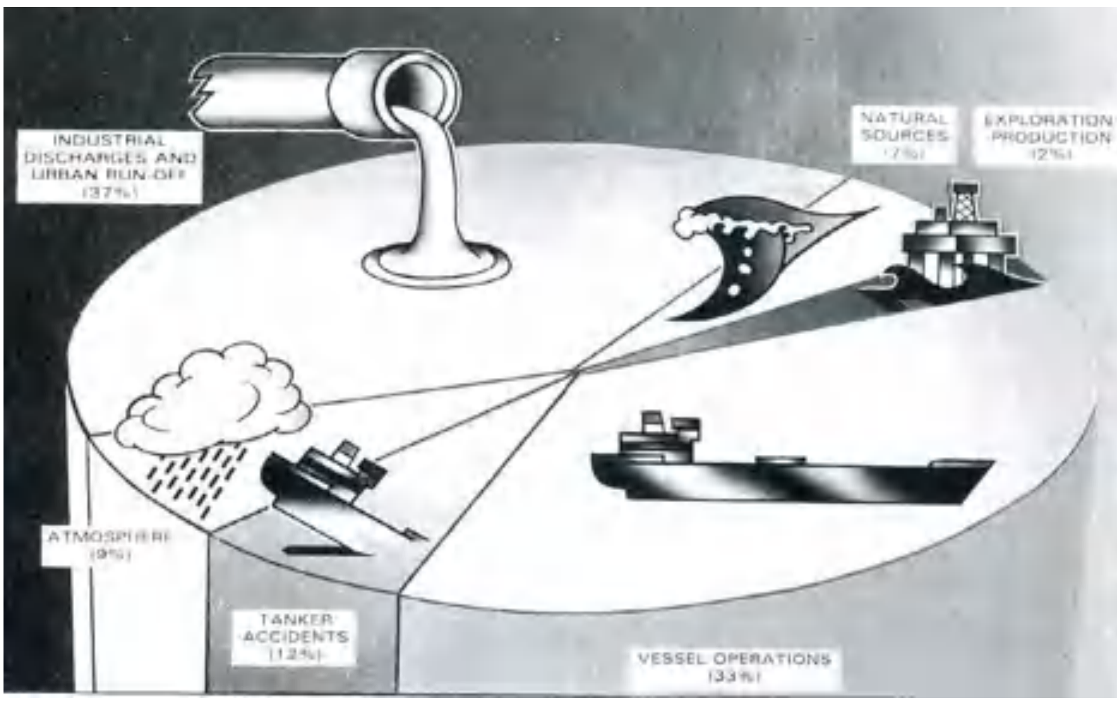
Periodical Meetings will be conducted with the Executive Engineer's/ DSOs/Staff Member to assess the progress made during the day and to instruct further course of action in the matter.

12 RESPONSE TO MARINE OIL SPILLS

12.1 Sources of Petroleum Hydrocarbons

The best estimate for the total input of petroleum to marine environment from all sources is some 3.2 million metric tons per year. By far the biggest contribution comes from terrestrial sources, mainly in the form of municipal and industrial wastes. Accidental spills from ships, together with offshore exploration and production activities, account for about 0.47 million metric tons which is a relatively small amount considering the worlds current production of three million metric tons, half of which is transported by sea.

Major Inputs of Petroleum to the Marine Environment. (Figure)



12.1.1 Accident Spills from Tankers

Accidental spills from tankers contribute an estimated 4, 00,000 tones annually. Analysis of tanker spills occurring throughout the world shows that the majority (some 75%) occur in port during routine ship operations such as loading, discharging and bunkering. Most of these spills are, however, relatively small: over 92% are less than 7 tones given in the table below and probably, in total, contribute less than 20,000 tons annually. In comparison, accidents such as collisions and groundings give rise to less than 10% of all spills from tankers, but a quarter of these are larger than 700 tones given in the table below. In fact, a few large accidents give rise to the majority of the oil spilt and hence there is considerable annual variation in this figure below:

Comparison of Incidence of World Oil Spills from Tankers, 1974 – 1985, resulting from Routine Operations & Major Accidents

	< 7 Tones)	7 – 700 (Tones)	> 700 (Tones)	Total
Loading / Discharging	2236 (90%)	227 (9%)	11 (1%)	2474 (100%)
Bunkering	442 (95%)	22 (5%)	-------	464 (100%)
Collision	39 (17%)	134 (59%)	54 (24%)	227 (100%)
Grounding	69 (25%)	134 (49%)	70 (26%)	273 (100%)
Total	2786 (81%)	517 (15%)	135 (4%)	3438 (100%)

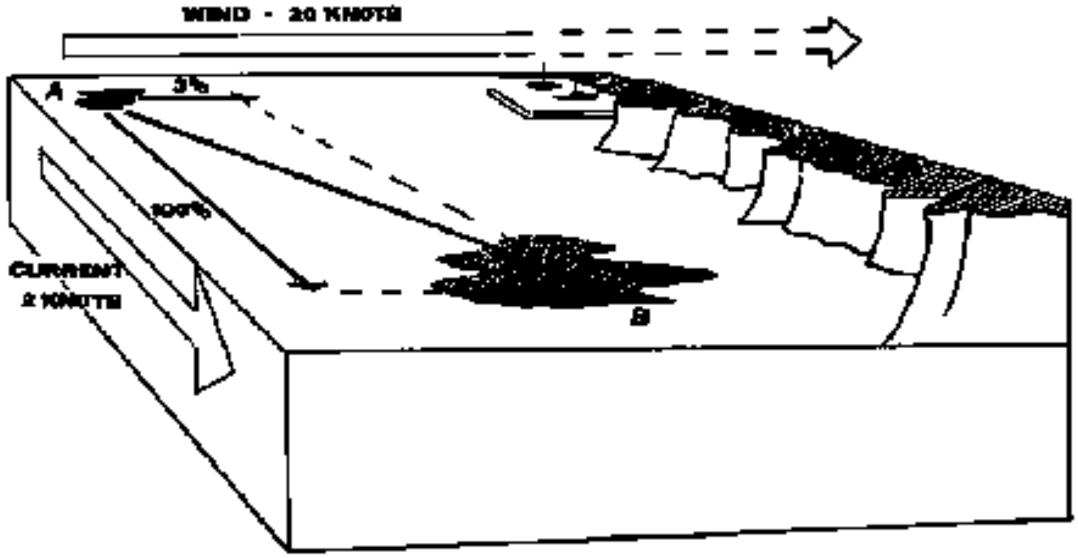
12.2 Forecasting Slick Movement

It is equally important to be able to forecast the probable movement of a slick as well as the likely changes in the properties of oil after it has been spilled. This allows sensitive resources in the path of the slick to be identified and, if appropriate, response measures to be put into effect. The task of forecasting the position of the oil can only be accomplished if data on winds and currents are available since both contribute to the movement of floating oil.

12.2.1 Effect of wind, Tidal currents

It has been found empirically that floating oil will move downwind at about 3% of the wind speed. In the presence of surface water currents, an additional movement of the oil equivalent to the current strength will be superimposed on any winddriven motion. Close to land, the strength and direction of any tidal currents must be taken into account but further out to sea their contribution is usually less significant because they are cyclic and so tend to cancel out over time. Thus, with knowledge of the prevailing winds and currents, it is possible to predict the rate and direction of movement of floating oil from a known position, as shown in Figure given below, overleaf.

The influence of 3% of the wind speed combined with 100% of the current speed results in the movement of oil from A to B



12.2.1.1 Computer Models

This simple calculation can be easily done by hand but becomes very timeconsuming if tidal currents have to be taken into account since it must be recalculated at regular intervals as currents change. Computers can be used to speed up such calculations by storing information on water movement and coastal outline for a specific geographic area. Wind data and the spill location are then the only additional information required at the time of a spill. The reliability of such models depends upon the accuracy of water movement and wind data. Often they are combined with mathematical models simulating weathering processes to provide a forecast of the overall fate of a spill.

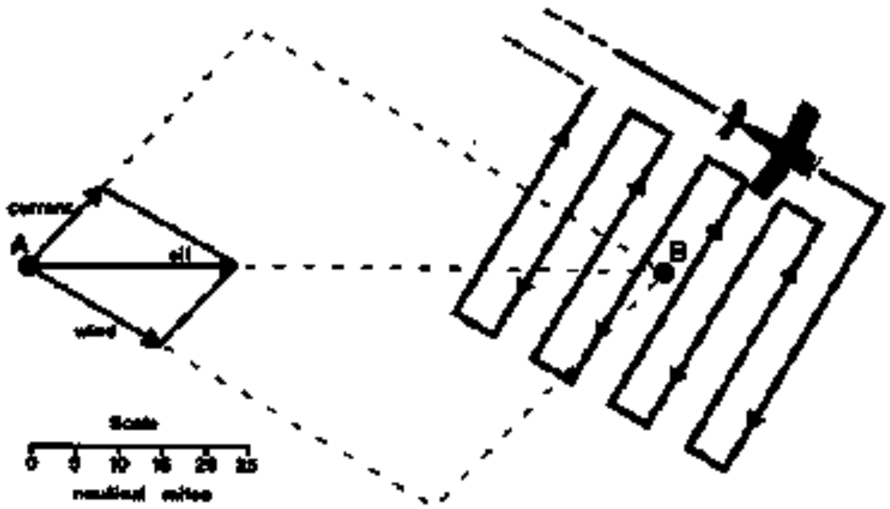
12.3 Aerial Surveillance at Sea

However reliable an oil spill model may be predictions of the fate and movement of oil slicks at sea should be verified through regular surveillance of the oil. This should be conducted from the air since observation from a vessel is highly inefficient.

12.3.1 Search Pattern

12.3.1.1 Ladder Search

A ‘ladder search’ is frequently the most economical method of surveying a large sea area. Since floating oil has a tendency to become aligned in long narrow windrows parallel to the direction of the wind, a ladder search across the wind will increase the chances of oil detection.



Movement of oil from A to position B three days later, predicted by combining 100% of the current speed and 3% of the wind speed as shown. The arrows from A represent current, wind and oil movement for one day. A cross-wind ladder search pattern is shown over position B.

12.4 Effect of Sunlight, Search Altitude

Haze and dazzle off the sea often affects visibility and the position of the sun may dictate the best direction to fly a search pattern. Sun glasses can give some relief from eye strain caused by strong light. Polarizing lenses can assist the detection of oil at sea under certain light conditions due to the differences in light reflected from oil and water. The search altitude is generally determined by the visibility. In clear weather 500 meters (1600 feet) frequently proves to be optimum for maximizing the scanning area without losing detail.

12.4.1 Navigation

However, it is necessary to drop to half this height or lower in order to confirm any sightings of floating oil or to examine its appearance. Over the open sea, away from any obvious reference points, it is easy to become disoriented. Ideally an observer will be able to consult the aircraft instrumentation for speed, direction and position, but it is worth ensuring beforehand that the instruments can be read without difficulty. In the absence of such aids, an observer with a suitable chart can keep track of course changes and positions by communicating with the pilot using the aircraft intercom.

12.5 Visual Quantification of Floating Oil

It is important that the port personnel estimate the amount of release for planning mitigating measures and allocating resources effectively. An accurate assessment of the quantity of floating oil is virtually impossible due to the difficulty of gauging its thickness. At best, the correct order of magnitude can be estimated by considering certain factors. Oil spreads rapidly and most liquid oils will soon reach an average thickness of about 0.1 mm, characterized by a black or dark brown appearance. Similarly, the color of sheen roughly indicates its thickness.

12.5.1 Appearance versus thickness, Cold water effects

A reliable estimate of water content in a 'mousse' is not possible without laboratory analysis but accepting that figures of 50% to 80% are typical, approximate calculations of oil quantities can be made, given that most typical floating 'mousses' are 1 mm or more thick. However, it should be emphasized that the thickness of 'mousse' and other viscous oils is particularly difficult to gauge because of their limited spreading. Indeed in cold waters some oils with high pour points will solidify into unpredictable shapes and the appearance of the floating portions will belie the total volume of oil present.

12.5.1.1 A Guide to the Relation between Appearance, Thickness and Volume of Floating Oil

Oil Type	Appearance	Approximate Thickness (mm)	Approximate Volume (m^3/km^2)
Oil sheen	Silvery	0.0001	0.1
Oil sheen	Irridescent	0.0003	0.3
Crude and fuel oil	Black/dark brown	0.1	100
Water-in-oil emulsions ('mousse')	Brown/orange	>1	>1000

12.5.2 Surface area, Percentage cover

In order to estimate the amount of floating oil it is necessary not only to gauge thickness, but also to determine the percentage area of the sea surface covered by oil, water-in-oil emulsion and sheen. Again, accurate estimates are complicated by the patchy incidence of floating oil. To avoid distorted views, it is necessary to look vertically down on the oil when assessing its distribution. By estimating the percentage coverage of each form of oil, the area covered relative to the total sea area affected can be calculated from timed overflights at constant speed or from position fixing equipment.

12.6 Spill Control Management

12.6.1 Contingency Planning

12.6.1.1 Tankers

Plans covering areas where a wide range of oil types are handled or where tankers pass in transit, cannot anticipate the impact of a spill. It is therefore important that the type of oil spilled is established at the earliest opportunity so that its fate can be predicted and the appropriate clean-up techniques employed.

12.6.2 Fixed Installations

For oil terminals where a limited number of oil types are involved, an appreciation of the likely fate of potential spills is valuable when drawing up contingency plans. Information on the prevailing winds and currents throughout the year will indicate the resources where oil spill impact is most likely. Data on the types of oil handled can enable predictions to be made regarding the lifetime of slicks and the quantity and nature of the residue, which may require a clean-up response. It will also assist in the selection of appropriate clean-up equipment to be held in readiness for spills.

12.6.3 Priorities for protection, Sensitivity maps

Because of the difficult decisions that will be required during an oil spill in order to mitigate damage and to resolve conflicts of interest, much can be done at the contingency planning stage to identify sensitive areas and to determine priorities for protection. The mapping of sensitive areas can be a useful starting point. Detailed consideration should be given to the likely impact that a spill would have on each habitat or activity, taking into account any seasonal variability. Attention should then be given to identifying areas to be protected and their order of priority. This will never be easy since the value of each resource to the community will depend upon the weight given to environmental, recreational, economic and political considerations. This may require a wide range of data to be gathered and evaluated.

If properly conducted, such studies of the resources at risk in an area can also form a basis for quantifying any damage caused by a spill at risk in an area can also form a basis for quantifying any damage caused by a spill.

12.6.4 Response decisions

Having determined priorities for protection, attention can be given to designating appropriate clean-up measures. It is necessary to make a realistic assessment of the feasibility of employing various techniques since a recommendation to avoid the more ecologically damaging response options may result in the adoption of ineffective techniques and greater damage to other habitats or activities.

12.6.5 Containment

The containment of floating oil for subsequent recovery or its diversion away from sensitive areas calls for the use of some form of barrier. Many different types of oil barriers have been developed. These include commercially available floating booms, netting systems, sorbent booms, improvised booms and barriers, bubble barriers and chemical barriers. Selection of the most appropriate barrier will depend upon the particular conditions as well as availability. Since commercially available booms are the most common form of barrier used in oil spill control they are described in greatest detail in this section.

12.7 Commercially Available Booms

Design features

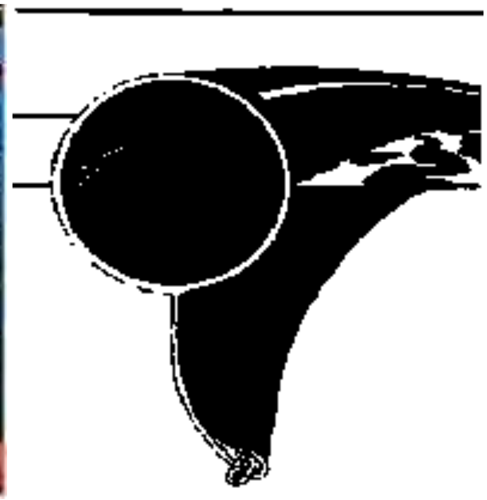
Designs vary considerably but all normally incorporate the following features:

1. Freeboard to prevent or reduce splash over;
2. Sub-surface portion (skirt) to prevent or reduce escape of oil under the boom;
3. Floatation by air or some buoyant material;
4. Longitudinal tension component (chain, wire or boom fabric itself) to withstand effects of winds, waves and currents.

Boom designs fall into two broad categories:

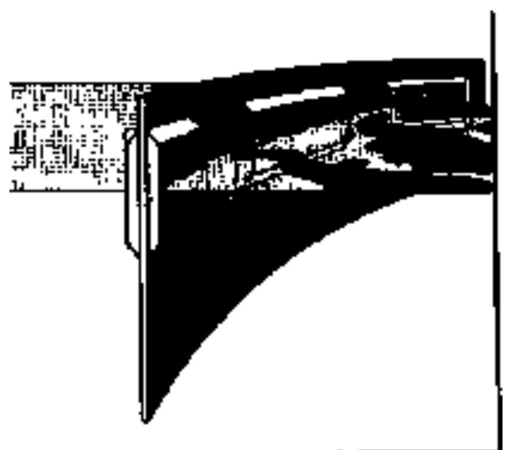
12.7.1 Curtain Booms

Curtain Booms provide a continuous sub-surface skirt or flexible screen supported by a solid or air floatation chamber usually of circular cross-section. Air floatation booms take up only a small storage area when deflated, whereas solid floatation booms, although more resistant to damage, are bulky in storage. Curtain booms generally have good wave-following capabilities, moderate escape velocities and are reasonably easy to clean.



12.7.2 Fence Booms

Fence Booms with a flatter cross-section are held vertically in the water by integral or external buoyancy. Solid floatation is most frequently used for fence booms but if external floats are used, turbulence may be generated leading to escape of oil at low water velocities. Such designs are bulky in storage and difficult to clean. In general, fence booms are more suitable for calmer waters where current velocities are low.



12.7.2.1 Common features

Many curtain and fence booms have similar features including bracing struts and/or integral ballast to keep them upright in the water, connectors for joining sections together as well as towing and anchoring points.

12.7.3 Performance/Limitations

12.7.3.1 Currents, Wind, Waves, Turbulence

The most important characteristic of a boom is its oil containment or deflection capability, determined by its behavior in relation to water movement. It should be flexible to conform to waves yet be sufficiently rigid to retain as much oil as possible. No boom can contain oil against water velocities much above 1 knot (0.5 meters per second) acting at right angles to it. The way in which oil escapes, and its relation with water velocity is as much a function of oil type as boom design. Low viscosity oils escape at lower velocities than more viscous materials. With the latter, the oil tends to accumulate at the boom face and to flow vertically down and under the skirt whereas low viscosity oils are carried under the boom as droplets sheared from the underside of the oil layer. Besides river and tidal currents, wind and waves can generate water velocities in excess of the escape velocity as well as causing splash over of contained oil. Oil escape can also result from turbulence along a boom and therefore a uniform profile without projections is desirable.

Escape of oil from a boom:

1. Splash over by wave action
2. Flow down the face of the boom
3. Droplets sheared from the underside of the contained slick

12.7.3.2 Boom size

The size and length of boom sections are also important considerations. The optimum size of a boom is largely related to the sea state in which it is to be used. As a general rule, the minimum freeboard to prevent oil splash over should be selected. The depth of skirt should be of similar dimensions to the freeboard. While short section lengths can make booms easier to handle and can protect the integrity of the boom as a whole should one section fail, these advantages must be weighed against the difficulty and time taken to connect sections effectively. Connections interrupt the boom profile and, wherever possible, should not coincide with the point of heaviest oil concentrations. The design of connectors should allow easy fastening and unfastening during deployment and whilst the boom is in the water.

12.7.3.3 Strength, Ease of deployment

Other important characteristics are strength, ease and speed of deployment, reliability, weight and cost. A boom must be sufficiently robust for its intended purpose and it must tolerate inexpert handling, since trained personnel are not always available. Structural strength and durability are required particularly to withstand the forces of water and wind on a boom when it is either towed or moored. Ease and speed of deployment combined with reliability are clearly very important in a rapidly changing situation and may strongly influence the choice made.

12.8 Netting Systems

12.8.1 Advantages

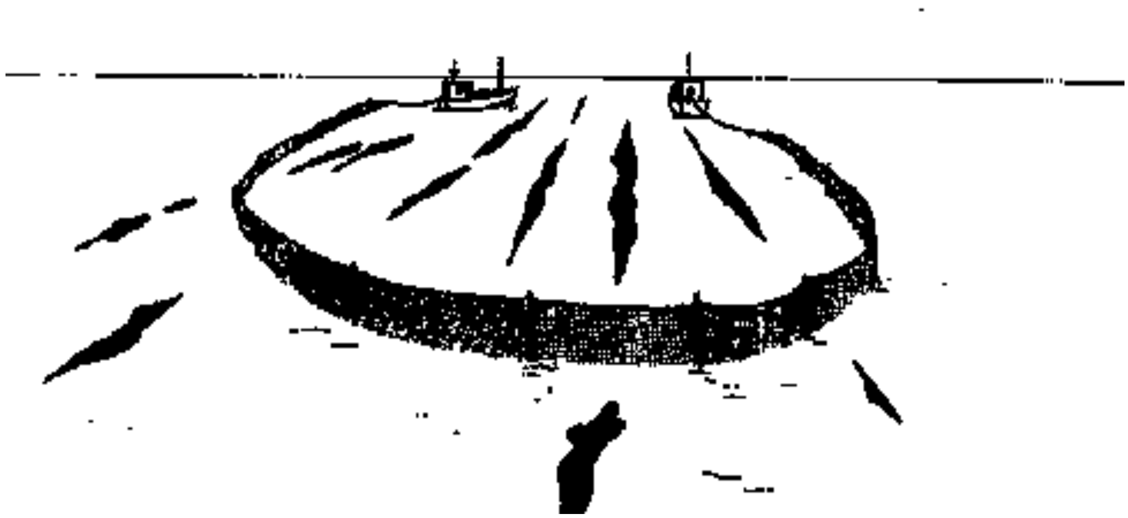
The use of nets to recover solid tar balls is an obvious application and the extension of their use to contain viscous oils theoretically presents a number of advantages over the use of conventional booms. In particular, the open structure should offer less resistance to water movement so that light but strong sections could be manufactured which might realistically be long enough to enclose oil scattered over a wide area of sea. As a result of the lower resistance of nets to movement through the water, it should also be possible to operate in faster currents or to sweep or trawl the sea surface at higher speeds than can be achieved with conventional booms.

12.8.2 Designs

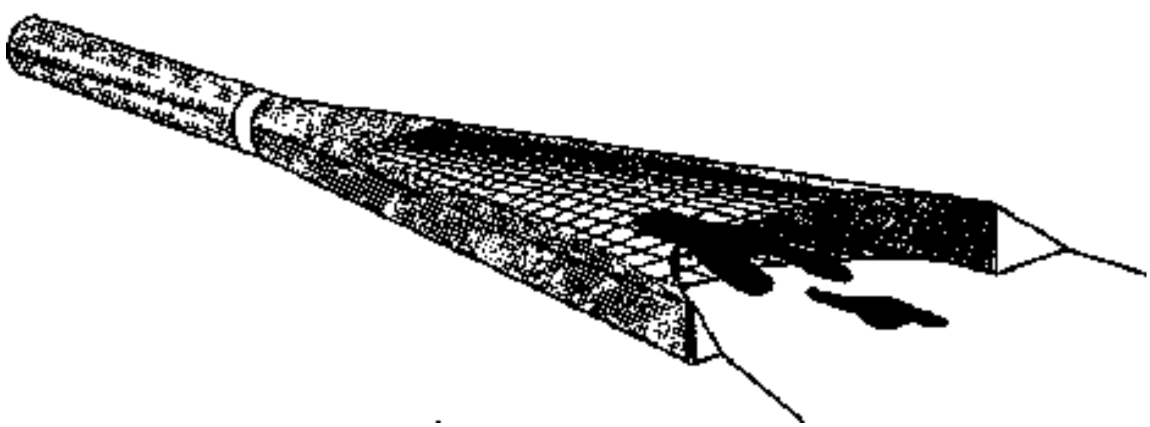
Two basic designs of net have so far been developed which draw on experience from the fishing industry a long double net based on the purse seine method of fishing which can be used to corral or collect floating oil or which can be moored to protect sensitive areas; and a trawl net with a detachable 'cod-end' which can be towed along the sea surface.

12.8.3 Experience

Although neither design has yet been fully evaluated during an actual oil spill, large scale field trials show some promise, especially in the case of the purse seine type when used to corral and retain floating oil. However, once oil has been adsorbed onto the net the mesh becomes blocked and the oil retention capabilities are similar to conventional booms.



Netting system of the purse seine type for oil containment and recovery using two vessels to corral floating oil.



Oil trawl for collecting floating solid oil into a detachable cod-end.

12.9 Sorbent Booms

12.9.1 Construction, Uses

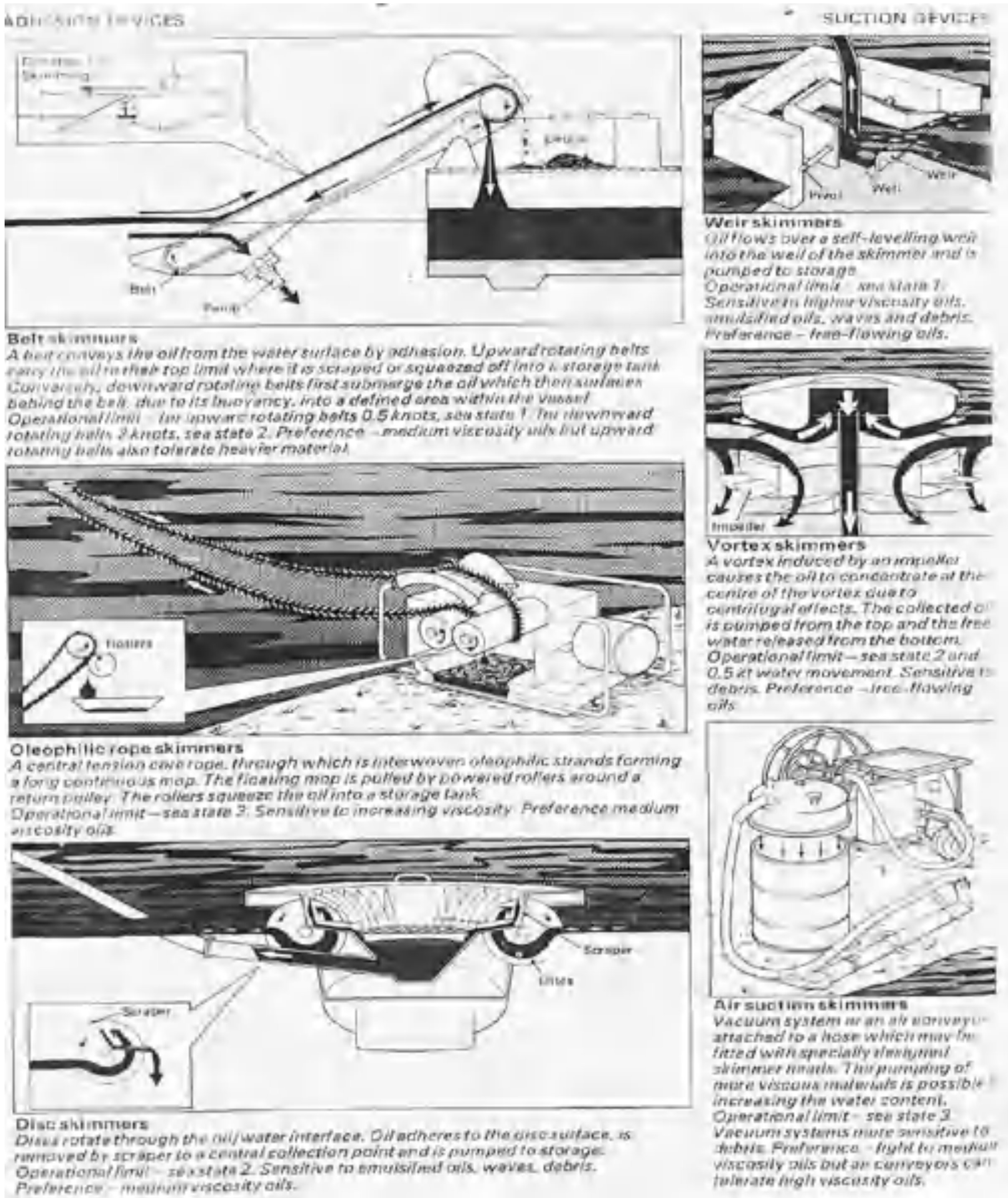
Sorbent booms usually consist of a tube of netting or some other fabric filled with a synthetic or natural sorbent material. Booms constructed of sorbent material have little inherent strength and, in some application, may require additional support. Some also need extra floatation to prevent them sinking when they become saturated with oil and water. They are normally only used in areas of low current velocity to collect thin films of oil, since their recovery efficiency decreases rapidly once the outer layers of the sorbent material become saturated with oil. The handling and disposal of oil-soaked sorbent booms can also cause considerable problems. The use of sorbents is further discussed in the section on Recovery.

Fixed oil barrier constructed with straw bales and wire netting nailed to wooden stakes.

12.9.1.1 Recovery

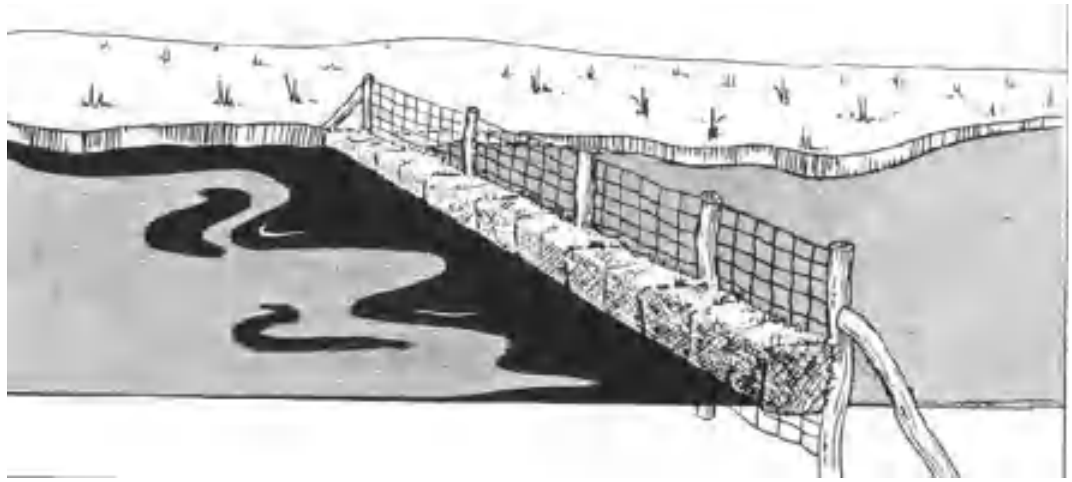
The rapid recovery of contained oil is vital to prevent its escape and the contamination of other areas. Recovery can be achieved using skimmers, pumps, sorbents, manual techniques and non-specialized mechanical equipment, such as vacuum trucks.

12.10 Skimmers



12.10.1 Design features

All skimmers incorporate an oil recovery element, some form of floatation or support arrangement and a pump to transfer collected material to storage. More complicated designs may be self-propelled and may have several recovery elements, integral storage tanks or oil/water separation facilities.



12.10.2 Suction skimmers

Two basic approaches can be recognized: SUCTION and ADHESION. The simplest concept is a suction device whereby oil is collected by a pump or air suction system from the water surface directly or via a weir. These designs tend to collect large volumes of water together with the oil. This can be an advantage when recovering viscous oils since the presence of excess water helps to maintain the flow of oils which would otherwise tend to block hoses and pipe work. Large storage is required to receive and separate the water which frequently represents more than 90% of the collected material. For oil spill control purposes, simple gravity separation in settling tanks is adequate.

12.10.3 Adhesion skimmers, Oil types

In contrast, skimmers which incorporate oleophilic materials into belts, drums, discs or synthetic ropes often achieve a higher ratio of recovered oil in relation to water. In general, they work best with medium viscosity oils between 100 and 2000 centistokes although skimmers with toothed discs or chain link belts have been designed specifically for the recovery of heavy oils. These high viscosity oils, such as heavy bunker oil, are extremely sticky and can prove difficult to remove from the adhesion surfaces, whereas, in contrast, viscous water-in-oil emulsions can be almost non-adhesive. Although low viscosity oils like diesel and kerosene can be collected, they do not accumulate on the oleophilic surfaces of skimmers in sufficiently thick layers for high recovery rates to be obtained.

12.10.4 Waves /swell, Currents

Skimmers are designed so that the oil recovery element is positioned at the oil/water interface. This is usually achieved by a self-levelling arrangement and although swell alone does not generally affect performance, none is effective in steep waves.

Small units are easily swamped and pitched around, whilst larger skimmers have greater inertia and cannot follow the wave profiles. The performance of skimmers is also adversely affected by currents in much the same way as for booms. This limitation is partly overcome in some self-propelled skimmers where a sorbent mop array or belt is rotated so that its velocity relative to the floating oil effectively reduced when the vessel is underway.

12.10.5 Self-propelled skimmers

Other designs of self-propelled skimmers can be effective in the calmer waters of ports and harbours. Because they are comparatively expensive they often combine some secondary function such as debris or waste oil collection. Such vessels are often an integral part of response arrangements for oil terminals and refineries where the pollution risk is more predictable.

12.10.6 Power source

Skimmers require power for the recovery element or for transferring the collected oil to a storage tank. Many systems are designed with an integral power pack. Diesel power can be used directly or to drive electric, hydraulic or pneumatic systems. All except petrol engines can be built to conform with safety regulations imposed in refineries, tank farms and other restricted areas where there may be a risk of fire and explosion. When used in potentially dangerous atmospheres, regular tests should be carried out with explosion meters to ensure safe operating conditions, since spark sources can never be completely eliminated.

13 ROLE OF INDUSTIRAL TERMINALS ON KPT LAND

13.1 Roles & Responsibility

Sr. No.	Tank Farm Owners	Persons to be contacted in case of emergency		
		Name and Position	Telephone No.	Mobile No.
1	Kesar Enterprises Ltd., Near Oil Jetty, Old Kandla (Kutch)370210	Mr. R.K. Gupta Gen. Manager	270435 (O) 295676 (R)	9375349181
2	Kessar Enterprises Ltd, Terminal II, Plot No. 5 &6 Old Kandla	Mr. R.K. Gupta G.M	270435 (O) 270177 (O)	9375349181
3	Chemical & Resins Pvt.Ltd Terminal –I, Near Oil Jetty, Old Kandla, Kutch Terminal – II, Near West Gate, New Kandla – Kutch	Lt. Col. Pramod Kumar (Retd), GM,	270505(O) 236831(R) 270916 (O)	9825225676
4	Indo-Nippon Co. Ltd., Plot No.2, K.K.Road, Old Kandla,	Mr. R.N. Pathak Asst. Terminal Manager	270795(O) 235818(R) 270295(O)	9879571295
5	J. R. Enterprise, Plot No.3, Old	Mr. Devendra Dadhich,	653528 (O) 257152 ®	9898238380

	Kandla,	Terminal In-charge		
6	Friends Oil & Chemical Terminals Pvt. Ltd., Near Booster Pump Station, Old Kandla, Kutch	Mr.S.Ramakrishnan Terminal Manager	270987 (O) 257249 ®	9879572107
7	Indian Oil Corporation Ltd., Main Terminal, GIM	Mr. AK. Khanna Sr. Term. Manager Mr. KS Rao, Sr.TM	233274 (O) 229002 (R) 270394 (O)	9427216637 9426416108

	Foreshore Terminal, Kandla KBPL LPG Import Plant	Mr. PS Negi Plant Manager	270628 (O) 270477 (O) 233359 ® 270978 (O) 236944 ®	9426725342

8	United Storage & Tank Ltd Near IOC Foreshore Terminals, New Kandla Gas Terminal, Plot No. 4 Old Kandla	Mr. Manoj Gor Terminal Manager Mr. G. Chudasama	270609 (O) 653525 (O) 651238 ® 653529 (O)	989850029 9904366855
9	IFFCO Kandla Unit, Kandla, Kutch	Mr. L. Murugappan, G.M.(NPK-I) Mr. Brahmbatt Manager (F & S)	270711 270352(O) 270381 (O)	982506922 9099019861
10	BPCL, KK Road, GIM	Mr. RG. Dekate Sr. Manager Operations	234313 (O) 223235 (R)	9099929634
11	HPCL KK Road, GIM	Mr. Murthy Manager (Installation)	230936 (O) 220084 (O) 233078 Ext	
12	INEOS ABS (I) Ltd Plot No. 8 Old Kandla	Mr. Vineeth Nair Dy. Manager	270087 (O) 234409 (R)	9825237029
13	Liberty Investments Pvt. Ltd., Plot No. 1 & 2, Block 'H', New Kandla	Mr. Jitendra Vaidya Terminal Manager	270151 (O) 270464 (O) 270468 (R)	9825025645

14	Avean International Pvt. Ltd., Liquid Storage Tank Terminal, Plot No. B-1, New Kandla	Mr. Bharat Rathod Terminal Manager	270537 (O)	9375310260
15	Rishi Kiran Logistics Pvt Limited, Plot No. 7, Link Road Old Kandla	Mr. RH. Pandya GM (Terminal)	270223 (O) 270443 (O)	9879104556
16	N.P.P. Pvt. Ltd., Old Kandla	Mr. MD.Nagvekar	270347 (O) 257807 ®	9825227649
17	Friends Salt Works and Allied Industries, KK Road, Old Kandla	Mr. NJ.Zinduwadia Sr. Manager Mr. HA. Mehta,S.M	270814 (O) 262698 (R) 271260 (O)	9825506361 9825506360
18	IMC Ltd, Cargo Jetty New Kandla	Mr. Anil Brahmbhat	270369(O) 653524 (O) 296079 (R)	9898126243
19	Agencies & Cargo Care Ltd., Plot No.3, New Kandla.	Mr.Shivkumar Menon, Terminal Manager	270714 (O)	9825226765
20	Dipak Estate Agency Plot No. 5-6, Block – A New Kandla	Mr. Narendra Thacker	270375 (O)	9879611243

21	Parker Agrochem Exports Ltd, Plot No. 3 –4,Block- H New Kandla	Mr. Bharat Thacker	270486 (O) 270528 (O) 231876 (R)	9825238260
22	Tejmalbhai & Co New Kandla	Mr. Ankitbhai Chandan	271330 (O) 230090 (R)	9825225101
23	Parker Agrochem Product Pvt. Ltd, Plot 7-9/A,N.Kandla	Mr. Raja Babu Dy Manager	270528 (O) 231876 (R)	9979158543
24	Mother Dairy Fruit & Vegetable Pvt. Ltd, Near Oil Jetty, Old Kandla	Mr. Saju Therattu	270654 (O) 270655 (O) 230979(R)	9974022681

The individual terminal will have to ensure the following in the event of emergencies arising out of:

a) Natural disaster

b) Toxic release

c) Flammable vapour release

d) Road tanker / Rail tank truck transportation accident

e) Fire

f) Flooding

13.1.1 Natural Disasters

- Ensure that adequate staff are posted at the terminal to meet any eventuality
- Ensure all operations are shut down
- If possible, ensure disconnecting pipelines
- Provide 48 hours food supply as well as portable water supply at the terminal

13.1.2 Toxic Release

- Ensure that the staff is evacuated in the direction opposite or as far as possible at 90 degree to the direction of the wind
- The staff located at the site to ensure safe operation, should be provided with gas masks
- Do's and Don'ts should be posted outside the control room to ensure minimum loss to life

13.1.3 Flammable Vapour Release

- It should be ensured that all possible help is rendered to the affected site / terminal
- The fire and safety officer at Kandla Port fire station should be informed
- Information pertaining to fire should be relayed to Main Emergency Control room at Gandhidham
- Information regarding fire incident should also be relayed to Kandla Free Trade Zone fire station
- Security personnel of the individual terminals should also be on standby to assist in fire fighting if the need be
- Mutual Aid Agreement should be signed between all the terminals as well as the KPT
- IOC LPG terminal should assist the affected terminal by way of sharing their experience in terms of plugging a chemical/gas leak
- The terminal Manager of the terminal next to the affected terminal should also inform the CISF

13.1.4 Road Tanker / Rail Tank truck transportation accident

- The dispatch terminal to whom the cargo belongs is responsible for attending to the mishap
- The dispatcher has to inform the exact location of the accident to the Main Emergency Control Centre as well as to the local emergency control room at Kandla
- CISF Commandant has to be informed by the dispatcher of the site of accident
- The Fire and Safety Officer stationed at Kandla Port should also be informed with specific name of the chemical
- In case the road tanker involved happens to be containing POL products then HPCL, BPCL and IOCL should be contacted immediately
- Accident involving rail tank truck i.e. LPG should be informed to the IOCL LPG Terminal Manager immediately
- In case of any leakage reported from LPG road tanker or rail tank truck the same should be arrested by the IOCL team

13.1.5 Fire

- Inform the Kandla Port Fire and Safety Officer
- Ensure that information pertaining to the Chemical involved in fire is passed to the Main Emergency Control Centre at Gandhidham as well as Kandla
- Information should be relayed to CISF regarding the fire
- In case it is a fire related to POL product then the oil majors i.e. HPCL, BPCL and IOCL should be contacted
- In the event of chemical fire it would be the collective responsibility of the DEENDAYAL PORT TRUSTas well as the dispatcher to ensure that the spill is controlled and collected

13.1.6 Flooding

- Terminal should have trolley mounted pumps preferably of flame proof type to ensure dewatering of the site
- Gum boots should be supplied the staff at the terminal
- The electricity supply to the terminals should be shut off to avoid short circuit
- The trolley mounted pump should have DC supply in order to ensure continues operation
- It should be ensured that all the drains should be cemented and free of any debris which could hamper the flow of water

The following occupiers shall be a part of the emergency team for rendering expert advice. (This composition may be changed once in three years on rotation basis.)

13.2 Toxic Team

- IFFCO
- Chemical & Resins Ltd.
- United Storage & Tank Terminals Ltd.
- Bayer ABS

13.3 Fire Team

- Kesar Terminal I
- Indo Nippon

- Friends Oil & Chemicals Ltd. (FOCL)
- Friends Salt Works & Allied Industries Ltd. (FSWAI)

13.4 Transportation Team

- IOCL POL TERMINAL
- HPCL
- BPCL

13.5 Natural Disaster Team

- J. R. Enterprise
- J. K. Synthetics
- Synthetic Chemicals

Individual terminals shall be responsible for ensuring that safe shut down has been affected aftermath of a disaster in the neighborhood.

In case of dry docks KPT shall assume the charge of the emergency controller along with P&O to ensure that all the staff is evacuated from the area barring the security and the emergency team.

The emergency team would be drawn essentially from CISF and Marine Department i.e. at the behest of Harbour Master as well as P&O. In the event of an impending natural disaster like cyclone only CISF personnel to be stationed at the wharf. For the ships berth at the dock please refer to the cyclone disaster plan as annexed.

The emergency team should have the following:

a) Chemical data sheet

b) Protective clothing

c) Breathing Apparatus

d) Safety Harness

e) General tools and flash light

f) Leak plugging equipment like wood plugs

g) Analytical equipment like explosivemeter

h) Flood light with generator

i) First Aid kit

j) Portable diesel operated fire water pump

The responsibility of the various teams mentioned above would be to follow the following procedure:

a) Keep people away

b) Inform incident Controller i.e. at Main Control Room

c) Contain the chemicals

d) Avoid igniting the chemicals by ensuring muffler on the exhaust

e) Obtain chemical data sheet

The communication parameters which need to be relayed to the Emergency Control Centre

a) Place and time of the incident

b) Chemicals involved

c) Condition of the container

d) Injuries or deaths

e) Area surrounding (open country, town)

f) Weather conditions

g) Assistance available (police, fire services)

h) Means of maintaining contact

Logistic Team

The function of Logistic Team is to ensure necessary supplies are available to Response Team during the emergency. In addition to above mentioned, the function is also responsible for organising and maintaining the staging area where emergency material and equipment is to be temporarily stored and assembled before rapid deployment. The Logistic Coordinator will be reporting to the Emergency Chief Incident Controller and keep him updated on the availability of supplies and equipment or of any anticipated need.

Typical list of emergency equipment and material is given below:

- Fire extinguishers
- Fire fighting agents
- Fire hoses an nozzles
- Personal protection apparatus like fire suit (proximity suit)
- Chemical resistance protective clothing
- Self contained breathing apparatus
- Respirators
- Emergency lights
- Power generators
- Portable radios and cellular mobile phones
- Spill control agents for decontamination of toxic spills
- Plastic containers and lining material for diking and damming
- Earth moving machinery
- Fuel and gasoline for operation of vehicles and machinery

14 LINKS BETWEEN THE ARMY, COAST GUARD & AIR FORCE

Aftermath of any disaster the recovery and relief operations are conducted on a war footing.

The task involved usually demands rough and tough and dedicated personnel who are trained professionals to meet any challenge be it evacuating people marooned due to flood or making shelters or transporting relief to inaccessible areas. It is for this purpose that the army, air force and the coast guard would be required to assist the Kandla Port Administration.

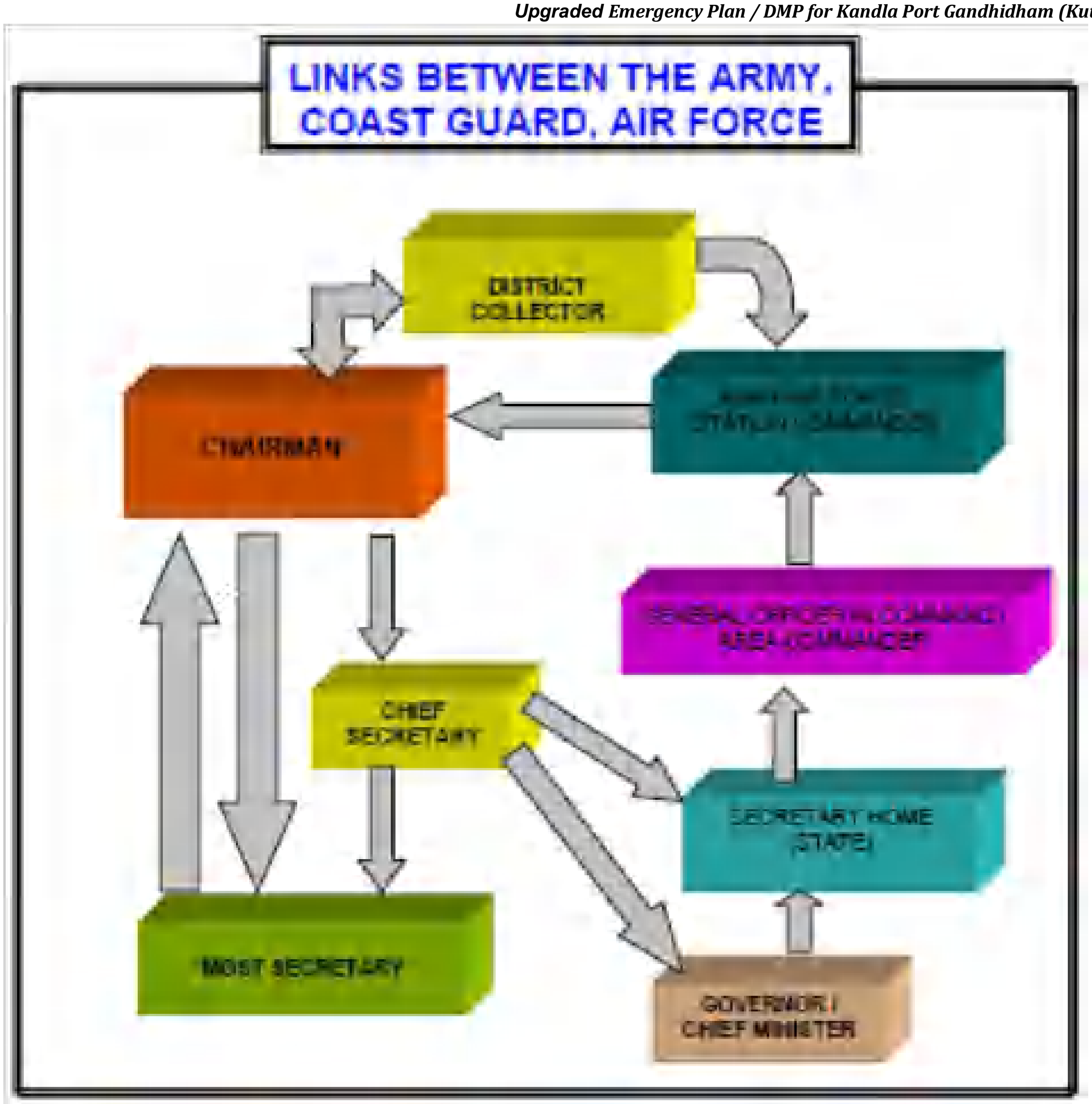
The Chairman / Deputy Chairman would be the coordinating officials for liaisoning with the Station Commander (army, navy as well as air force) after consulting the District Administration.

While seeking assistance from the army, air force or the coast guard the following documents should be kept ready for reference:

- Overall plot plan of the Kandla Port
- Clear demarcation of the affected area on the plot plan
- VHF link frequency for establishing contacts with the signal room as well as CISF commandant.
- List of all the important telephone numbers.
- In the event of Cyclone, keep the task force updated on the weather condition.
- Ensure that the emergency team is extending their full co-ordination to the task force.
- For ready reference the Secretary should nominate a person who should be made responsible to taking notes on what is happening and what sequence.
- The areas, which could be used as temporary shelters should be indicated to them.
- Open space which can be used as staging area should be indicated to them.
- All the medical staff should be kept on standby and they should be asked to act after consulting the Army or the Air force teams.
- In the event of air evacuation requirement it should be ensured that the people being evacuated are listed and the number of sorties required is noted.
- In the event of a cyclone and an resultant Ammonia Gas leak it should be noted that the Army and the Air force should be provided with gas mask (if the need be).
- Data pertaining to the number people in the affected areas (an approximate) should be made available to the Army / Air force.

The flow of information for co-ordination:

Chairman District Collector Chief Secretary Secretary - Ministry of Surface Transport Governor / Chief Minister of the state ARMY/AIRFORCE.



15 PROCEDURE FOR CO-ORDINATION

The overall responsibility of the Emergency management lies with the Chairman, Kandla Port. He assumes the responsibility of Chief Site Controller on receipt of the information of an emergency or an impending emergency.

Some of the critical functions are:

- Activation of the emergency response organization
- An ongoing emergency assessment, including upgrading or downgrading of the emergency alarm level
- Notification of outside governmental agencies
- The decision to ask for outside help and resources
- The decision to evacuate the people
- Decisions involving the safety of off-site vulnerable points (e.g. recommendations to evacuate or take shelter, in the case of a toxic vapour release).
- Decisions to shut down/restart the Port.

The Chairman i.e. the Chief Site Controller shall be responsible for designating the Incident Controller, the Field Controller as well as the Liaison Officer as well as Public Relations Officer.

Functions like

- Communication
- Fire, Safety and Rescue
- Special hazard
- Utilities
- Engineering / technical function
- Medical function
- Logistic function
- Security function

③ Administrative function

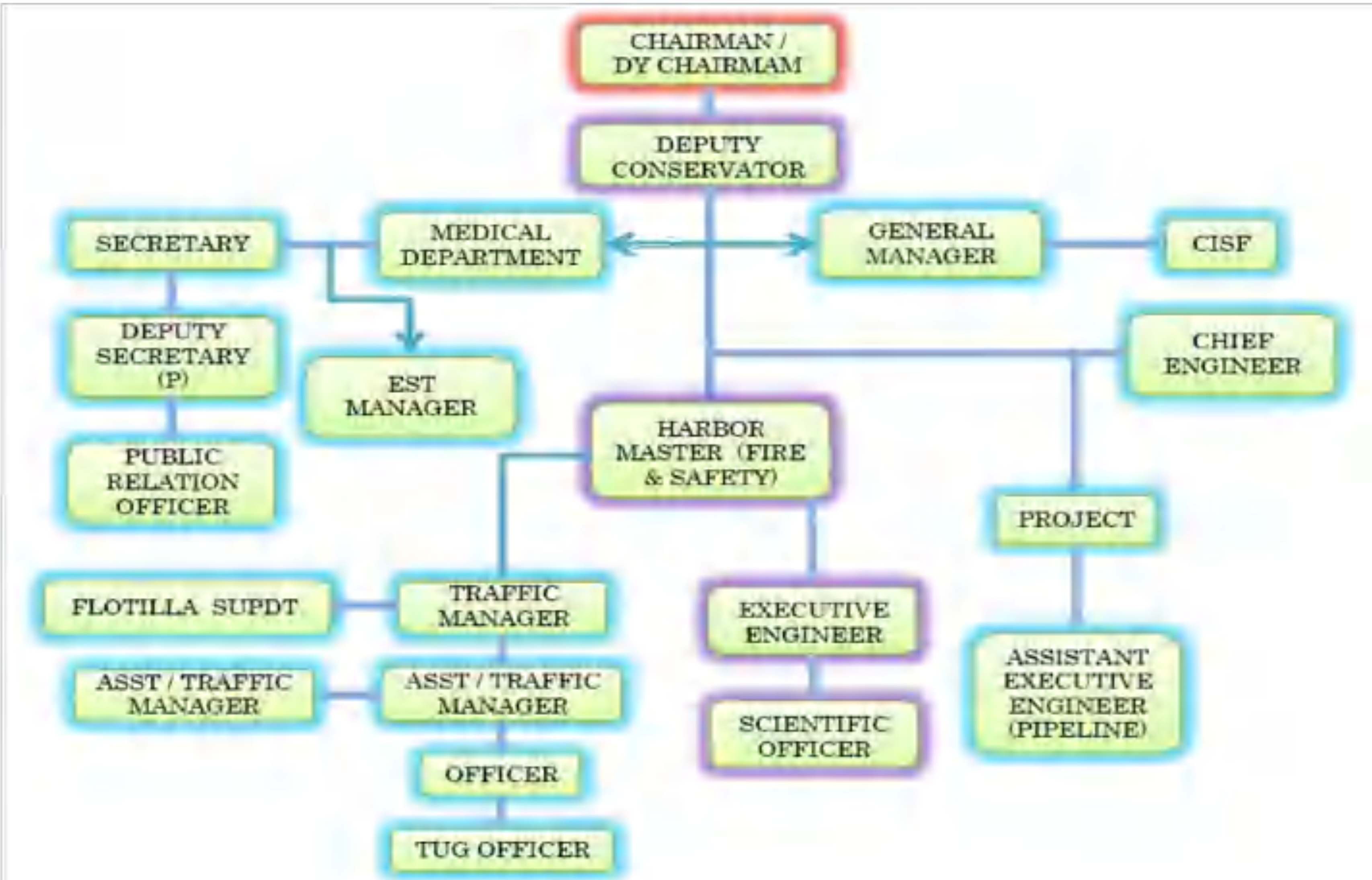
EMERGENCY NOTIFICATION SHEET	
1.	Plant / Location Name ____________________ Unit ____________________ Address of Plant / Site ____________________
2.	Date ____________________ Time of Call ____________________
3.	Caller's Name ____________________ Caller's Position ____________________ Caller's Telephone Number ____________________
4.	Time (or Anticipated Time) of Accident / Emission ____________________ Projected Duration of Accident / Emission ____________________

5.	Type of Accident / Emission ____________________
6.	Emergency Alert Level (EAL) : Check One ALERT [ ] SITE EMERGENCY [ ] GENERAL EMERGENCY [ ]
7.	In case of Toxic Release :
	Chemical Name of Substance Released____________________ Amount and/or Rate of Release ____________________ Estimated Duration of Release ____________________ Type of Release (Gas, Liquid or Solid) ____________________ Toxicity / Flammability ____________________ Potential Impact on Offsite Area ____________________ Estimated Area Affected by the Release ____________________

8.	Weather Condition ____ Wind Speed ____
9.	Casualties / Damages ____
10.	Brief Description of the Accident ________________________________ ____ ____
11.	Assistance Requested ____ ____ ____ ____
12.	Signature ______________ Date ______________ Time ____________

15.1 Procedure for Co – ordination


CHAIRMAN / DY CHAIRMAN
DEPUTY CONSERVATOR
CISF
SECRETARY
HARBOUR MASTER
CHIEF ENGINEER
PUBLIC RELATION OFFICER
DEPUTY HYDRAULIC ENGINEER
EXECUTIVE ENGINEER PIPELINE
TRAFFIC MANAGER
FIRE SAFETY
CIVIL TRANSPORTERS


CHAIRMAN / DY CHAIRMAM
DEPUTY CONSERVATOR
SECRETARY
MEDICAL DEPARTMENT
GENERAL MANAGER
CISF
DEPUTY SECRETARY (P)
EST MANAGER
CHIEF ENGINEER
PUBLIC RELATION OFFICER
HARBOR MASTER (FIRE & SAFETY)
PROJECT
FLOTILLA SUPDT
TRAFFIC MANAGER
EXECUTIVE ENGINEER
ASSISTANT EXECUTIVE ENGINEER (PIPELINE)
ASST / TRAFFIC MANAGER
ASST / TRAFFIC MANAGER
SCIENTIFIC OFFICER
OFFICER
TUG OFFICER

16 ASSEMBLY POINTS & ESCAPE ROUTES

1. There are two main escape routes from the port side i.e. by land:

- Kharirohar road.
- Main NH 8 i.e. leading to Gandhidham.

2. The sea route would be the Kandla creek and other creeks i.e. Phang creek, Sara Creek or Rohar Crek or Nakti Creek connecting the same.

3. Air evacuation can be undertaken by Helicopter or from Kandla Aerodrome.

4. KPT to prepare list of all the personnel in their port colony and have it posted at the assembly area.

5. The assembly points in the Cargo Dock for the workers in the area between the North Gate and the plot number five would be the area in front of the Railway Station.

6. The assembly point for the port township could be between block E&D and at the intersection of Block 'B'.

7. The assembly point for each of the adjoining berth would be on the road i.e. used for moving between the warehouse A,B,C,D and the berthing area.

8. However for the workers working in the warehouses as mentioned above the assembly point would be the central road between the two streams of warehouses.

9. The workers working in the bins i.e. open storage the assembly point would be the area in front of the West Gate # 2.

10. For bins closer to the West Gate #2 fire brigade station the staging area for the fire station would be used as assembly point.

11. Computer should be installed in the rooms next to the assembly point connected to the time office for a list of people inside the port and the same should be made available at the railway station.

12. Railway station should have emergency evacuation counter all the personnel being evacuated from the area should be asked to check-in at the counter before they board the train.

13. The PA system at the assembly area should be used to announce "do not carry any luggage or belongings just carry as much is bare essential in clothing".

14. The point of departure from the Dry cargo area would be West Gate 1 & 2 as well as North Gate and in an extreme case one would have to use the jetty being used by the pilots for evacuation by sea.

RECOVERY AND BUILDING BACK

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17 RECOVERY FACILITY RE-ENTRY &

RESTORATION OF SERVICES

The recovery and re-entry phase will begin after the declaration of termination of emergency situation. This determination would be made by the Chief Incident Controller. The recovery plan would be flexible enough to adapt to existing conditions. All of the conditions that may be encountered in an emergency situation cannot be anticipated in advance. Detailed plans and procedures for recovery operations would be prepared at the time they are needed.

Re-entry operations would be performed by the Re-entry Team, which would be same as that of green team under the leadership of the Chief Incident Controller.

The team shall consist of personnel knowledgeable in procedures and facility layout. In the Re-entry planning process, the team will gather available information on the nature of the emergency and its present status by methods such as discussions with the operations personnel on-shift. Necessary protective clothing and equipment would be available for the team before re-entry is authorized.

Specific procedures for recovering from an emergency and re-entering the facility can hardly be provided, since they will have to be determined on a case by case basis, depending on the type of accident and the severity of the damage suffered. However, provision would be made for the following:

- Organising a re-entry team
- Inspecting the damaged area
- Declaring the emergency concluded and making the "all clear" known to the facility employees and the community
- Deciding which employees would report to work and notifying them
- Beginning an investigation into the causes of the emergency
- Assessing the damage to the facility
- Transferring necessary operations to alternative locations
- Decontaminating the damaged area
- Restoring services to the damaged area
- Clearing up the debris
- Salvaging material and equipment affected by the emergency
- Restoring the parts of the facility affected by the emergency
- Determining responsibilities and instituting possible insurance and damage claims

In case of an aftermath of a toxic release, it should be ensured that Chief Incident Controller and the party carrying out the recee to ascertain the termination of emergency, should be carrying self-contained breathing apparatus as well respiratory masks.

Please note in the event of a natural disaster the recovery team would involve the usage of ARMY or other paramilitary forces the same would be under the control of the station commander and the overall Controller shall be the District Collector.

CAPACITY DEVELOPMENT

18 MAINTAINING CAPABILITES EMERGENCY RESPONSE

In order to ensure a prompt and professional emergency response capability, port personnel are required to be knowledgeable of the possibility of various emergencies and emergency actions. General safety training should be provided to all employees to familiarize them with alarms, evacuation routes, safe assembly points, etc. In addition, personnel who are a part of the Emergency Response Organization are required to have additional training and should participate in periodic drills and exercises.

18.1 Training & Education

Regular training should be provided to all personnel who have a role in planning and operational response to an emergency. The main goal of training for emergencies is to enable the participants to understand their roles in the response organization, the tasks associated with each position and the procedures for maintaining effective communications with other response functions and individuals.

The training objectives are:

1. To familiarize personnel with the contents and manner of implementation of the Plan and its procedures.

2. To train personnel in the performance of the specific duties assigned to them in the plan and in the applicable implementing procedures.

3. To keep personnel informed of any changes in the plan and the implementing procedures.

4. To maintain a high degree of preparedness at all levels of the Emergency Response Organization.

5. Train new personnel who may have moved within the organization.

6. Test the validity, effectiveness, timing and content of the plan.

7. Update and modify the plan on the basis of experience acquired through exercises and drills.

Selected port personnel should receive instruction in the use of the fire fighting and emergency equipment available at the site. All personnel working at the site should receive instructions in fire prevention and in basic fire fighting techniques. Periodic refresher training should be provided and supplemented by fire drills.

Crews of tugs, which can be used for fire fighting, should receive instruction and training in fighting petroleum fires in co-operation with land based fire-fighting services. In order to utilize fully the tugs firefighting equipment and capability during an emergency, it may be necessary to supplement the crew with trained shore personnel. Opportunities should be provided at frequent intervals for combined practices involving the tugs and shore fire fighting services. Opportunities may arise whereby a combined fire practice or conference can be arranged between shore personnel and crew members of tanker at berth without imposing an operational delay on either the berth or the tanker. This should help make the tanker personnel familiar with the firefighting equipment ashore. Shore personnel should also have the opportunity of becoming familiar with the types and locations of firefighting equipment on and of being instructed in any design features on tankers which may require special attention in case of fire.

18.2 Drills & Exercises

Emergency drills and integrated exercises have the following objectives. These constitute another important component of emergency preparedness. They refer to the re-enactment, under the assumption of a mock scenario, of the implementation of response actions to be taken during an emergency.

1. To test the adequacy of the effectiveness, timing, and content of the plan and implementing procedures.

2. To ensure that the emergency organization personnel are familiar with their duties and responsibilities by demonstration.

3. Provide hands-on experience with the procedures to be implemented during emergency.

4. Maintain emergency preparedness.

The frequency of the drills should vary depending on the severity of the hazard. However, drills should be conducted once in a year. Scenarios may be developed in such a manner as to accomplish more than one event objective.

Drills and exercises will be conducted as realistically as is reasonably practicable.

Planning for drills and exercises should include:

- The basic objectives
- The dates, times and places
- The participating organizations
- The events to be simulated
- An approximate schedule of event
- Arrangements for qualified observers
- An appropriate critique of drills/exercises with participants

Evaluation of drills and exercises should be carried out which should include comments from the participants and observers. Discrepancies noted by the drill observers during the drill shall be pointed out during the drill. A written evaluation of the drill or exercise should be prepared by the individual responsible for conducting the drill or exercise. The evaluation should include assessments and recommendations on:

- Areas that require immediate correction.
- Areas where additional training is needed.
- Suggested modifications to the plan or procedures.
- Deficiencies in equipment, training, and facilities.

The evaluation of a drill or exercise shall be submitted to the Main Controller for review and acceptance who shall then determine the corrective actions to be taken and assign the responsibility to appropriate personnel.

The Chief Fire Officer should track all approved drill and exercise corrective actions as a means of assuring that corrections are made in a reasonable amount of time, and shall advise Main Controller of the status of implementation of corrective actions.

Records of drills, exercises, evaluations, and corrective actions should be duly maintained.

18.3 Review of the plan

The Plan and associated implementing procedures should be reviewed to ensure compliance with relevant regulations and applicable state and local emergency plans and written agreements with mutual aid companies also.

The plan should be reviewed under the direction of the Chairman who should encompass the plan, response procedures, equipment, training, drills and interfaces with local emergency management agencies. The need for changes is based upon the following aspects:

- Written evaluations of drills and exercises which identify deficiencies or more desirable methods, procedures, or organizations.
- Changes in key personnel involved in the organization.
- Changes in the facility organization structure.
- Changes in state regulations.
- Modifications to the facility which could affect emergency planning.
- Recommendations received from other organizations and state agencies.

18.4 Emergency Control Center

The Emergency Control Centre is located in the Board Room of Administrative Office Annexure Building at First Floor.

This room will have seating arrangements for all members of Disaster Management Group.

It will have the following:

1. Adequate number of telephones. One of these telephones shall be used for outgoing telephone calls only.

2. Internal telephones, telex, fax.

3. VHF transceiver having marine band capable of being operated by mains or battery.

4. Hot line linking deputy commissioner of the district.

5. Internal and external telephone directories.

6. Emergency manuals.

7. Emergency light.

8. Wind direction and speed indicator.

9. Plan of the port showing:

③ Berths/Areas where hazardous materials are handled

③ Sources of safety equipment’s

③ Personal protective equipment such as aprons, gloves, gum boots, etc. ③ The fire fighting system

③ Stocks of other fire-extinguishing materials

③ Site entrance and roadways, updated at the time of the emergency to indicate roads which are to be used and which are not to be used.

③ Assembly points and routing ③ Medical centers.

③ Layout of pipelines in the Port area

- ③ Lorry parks and rail sidings
- ③ Port location in relation to the surrounding community (5 km map)

19 DEENDAYAL PORT TRUSTOFF SHORE OIL TERMINAL – VADINAR PORT

19.1 Vadinar Port Information

Vadinar Port is an important port in DEENDAYAL PORT TRUSTGroup of ports under the control of Kandla Port Trust, Kandla. The port is just 55 Kms from Jamnagar city.

Latitude: 22 Degree 26’25’ North

Longitude: 69 Degree 40’ 15’ East

Charts – Gulf of Kutch Chart No: 203

19.1.1 Metrological Data

1. Temperature: Summer Maximum 38Degree C, Minimum 19Degree C
2. Temperature: Winter Maximum 36Degree C, Minimum 14Degree C
3. Annual rainfall: Average 241.2 mm
4. Average Wave Height: 30 Centimeter (Summer)
5. Average Wave Height: 25 Centimeter (Winter)
6. Maximum Wave Height: 45 Centimeter
7. Maximum Tide – 6.12 Meter
8. Minimum Tide – 0.02 Meter
9. Wind Speed – Average Wind Speed – 16 knots/hour
   - Summer – 25 knots / hour
   - Winter – 18 knots /hour

10. Anchorage: Anchorage areas are about 4.5 miles from shore.

19.1.2 Off Shore Oil Terminal (O O T) Vadinar

The DEENDAYAL PORT TRUSThas commissioned the off shore oil terminal facilities in 1978 jointly with Indian Oil Corporation by providing Single Buoy Mooring (SBM) system having a capacity of 10MMTPA was first of its kind in India. The following are the salient features of the operations at OOT Vadinar.

- A draft of upto 30 meters at SBMs and Lighterage Point Operations (LPO) • The Single Buoy Moorings can handle vessels having length of 335 meters. 2 NOS OF OIL BERTHS OF NAYRA(EX ESSAR)
- Handling VLCCs upto 3,00,000 DWT
- Providing crude oil intake for the refineries of M/s. IOCL at Koyali (Gujarat), Mathura (UttraPradesh), and Panipat (Haryana). & VADINAR OIL REFINERY OF NAYRA (EX ESSAR)
- Commissioned the first SBM on 27th August 1978.
- M/s. IOCL Commissioned the second SBM on 25th October 1997.
- Commissioned the third SBM (Essar) on 29th December 2006.
- Simultaneous handling of 3 vessels at three of SBMs
- Vast crude tankage facility of M/s. IOCL having capacity of 11, 44,000 KL.
- 4 High powered Tug of 50 Ton BP.
- Two Tugs of 35 ton BP &
- Two 50 Ton BP tugs for smooth operation is being acquired.

19.1.3 Export Jetty (Essar)

- One Ro - Ro / Lo - Lo Jetty for handling of project cargo / construction material / spare parts.
- Product Jetties (Private Berths at the Port)
- Essar Jetties are used for tankers Loading of POL product cargo by alongside.
- The Jetty No 1 – commissioned on 6th December 2006.
- The Jetty No 2 – commissioned on 29th December 2009.

19.2 Control Room –Vadinar Port

There is one control room at A.O. Building, Vadinar Jetty under the direct supervision of Pilot, stationed at Vadinar. In absence of Pilot, the other Pilot posted at Vadinar and XEN (M&E) shall be responsible for the direct supervision of the Control room at Vadinar, in association with Marine Engineers Grade - II. They shall rush to the Control room as soon as the Action plan is put into force. Two persons viz. one Assistant, Flotilla Supervisor and one Signalman shall report for duty to the In-Charge of Control Room immediately, as soon as the Control room comes into operation. The In-Charge should draw-up rosters of the said employees shift-wise and assign duties to them. The In-Charge shall ensure the presence of the staff as to whom various duties have been assigned. They should attend the meetings as and when called. In case of absence of the staff, the matter should be informed to the C.O.M. (OOT), who shall take disciplinary action against the erring employees.

The Control room has the following assets

Telephone	Fax	VHF Signal
0288-2573026		Marine Channel 12,16,8,10
Mobile Phone Nos. 9825212359 / 9825212360 /		
Xerox Machine / STD telephone		

Inmarsat Mini M. Terminal and / or V.Sat Terminal Antenna are required to be set up and installed at Vadinar.

Manning at Vadinar Control Room Jetty

Any one of the AVAILABLE Contract Pilots is available at Vadinar

Designation
XEN(M&E)
M.E. Grade-II
Office Supdt
A.F.S

A.F.S
Signalman
Signalman
Signalman
Signalman

19.2.1 Obtain Information from following Sources

1. State Meteorological Control Room, Ahmadabad

2. Control Room, KPT, Kandla / Gandhidham 9. Meteorological Section, New Kandla,

3.sIgnal station, New Kandla.

The information so collected shall be maintained by making hourly log entry in a register.

19.2.3 Control Room Assets

1. Xerox machine
2. STD telephone
3. Fax machine
4. Inmarsat Mini M. Terminal / and or V. Sat Terminal antenna, are required to be set up at Vadinar jetty

The In-Charge of Control room should ensure setting up of the Control room at Vadinar jetty immediately on receiving warning and matter be reported to C.O.M. who in turn apprise the Dy. Chairman and Chairman, KPT.

The control room shall remain in touch with various authorities / agencies like State Govt. / Distt. Authorities / and local authorities. Besides, Naval Authority OkhaPorbundar should also be contacted on VHF/UHF frequency, round the clock. In the prevailing set up of CISF Security control staff at Vadinar, Officer-in-charge of C.I.S.F. Unit of KPT Vadinar along with his entire CISF Security Personnel will remain in contact with In-charge of Control Room for posting of CISF Security Personnel at various locations as per the requirements and they will carry out the duties and responsibilities as required & assigned under this Action Plan.

In case the Marine Signal No.8 is issued, the Vadinar jetty area will be evacuated including the Control Room, which shall be shifted to Room No.5 of Port Guest house at Vadinar colony. In this regard, XEN (E&M) shall pre-plan installation of VHF Antenna and drawing extension line of there available Telephone Nos. (02833)-256533 / 256714 at Port Guest House at Colony and ensure laying of cable with suitable connectors with the Wireless Sets duly tested and thereafter to be set up there at Guest House.

19.3 Functions of Control Room –Vadinar Port

Control room shall remain in touch with State level / District level Meteorological Department / Masters of ships at Vadinar, Navy / Coast Guard at Porbandar / Vadinar and also with the Control Room of KPT at Kandla/Gandhidham.

Telephone numbers of concerned contact persons are as under:

STD code: Jamnagar (0288), Vadinar (0288)

Sr. No	Name of Organization / Contact person	Office	Residence
01	Chairman, Mutual Aid District Collector, Jamnagar	2555869	2554059
02	Joint Chair Person, Mutual Aid Commissioner, JMC, Jamnagar	Fax No.2554454 2552321	2552372
03	Distt. Supdt. of Police, Jamnagar	2554203	2555868
04	Police Control Room, Jamnagar	2550200	
05	Police Control Room, Sikka	2344249	
06	The Dy. Chief Controller, Civil Defense, Jamnagar	2540371 2674758	2671828
07	Control Room, Collector Office Jamnagar	2553404	
08	Port Officer, GMB, Jamnagar.	2712815 Mobile:9426239289	2554942

09	Commandant, Home Guard, Jamnagar	2553862	
10	Mamlatdar, Khambhalia	234788	234736
11	Dy. Collector, Khambhalia	234577	
12	Police Station, Khambhalia	234735	
13	Fire Officer, Fire Station, Jamnagar	2662690 Mobile:9879531101	2550340
14	DEAN, Irwin Group Hospital, Jamnagar (Now Guru Gobind Sing Hospital)	2553515	2553676
15	Indian Air Force, Jamnaga Extension: 222/257 Wing Commander	2720003 to 009 2720004-2720005	
16	Duty Officer, INS, Valsura Jamnagar	2550263-222 extn.	
17	CISF, Coast Guard, Vadinar		
18	DGM, IOC, Vadinar	02833-256527	02833- 256567
19	Chief Operation Manager, IOC, Vadinar	02833-256984	02833- 256559
20	Dy. Manager (operation), IOC, Vadinar	02833-256545	02833- 256530
21	Fire Brigade, IOC, Vadinar	02833-256542	02833- 256559
22	Main Board of M/s Essar Oil Limited, Vadinar	02833-241444	
23	Security Control Room, Essar, Vadinar.	02833-241917	02833- 241191

24	Vice President, (P&Admr ESSAR Vadinar Refinery.	02833-241107 02833-241167	028332550976 028332662856
25	M/s. Reliance Petro. Ltd., Moti Khavdi	0288-6610101	

Information from the above officers will be collected and transmitted to the C.O.M. (OOT) on hourly basis between 0800 to 2000 hours & 2000 hours to 0800 hours respectively. The said information shall be passed on to Dy. Chairman / Chairman on three hourly basis.

The Vadinar control room shall maintain logbook of messages received from and to Control Room at Gandhidham continuously and report to the COM (OOT) every hour. The information shall be passed on to Dy. Chairman / Chairman depending upon the importance. It shall be the responsibility of the Control Room staff to ensure that the information is passed on timely and proper monitoring is done.

The following are the Website addresses through which the required information regarding the position of the Cyclone can be ascertained.

http://www.imd.gov.in/ http://www.supertyphoon.com/indian.html
http://www.npmoc.navy.mil/products
http://www.solar.ifa.hawai.edu/tropical/tropical.html
http://www.wunderground.com/tropical

19.4 Stopping of Port Operations

In case of emergency situation, local port authorities like COM (OOT) will decide about the stoppage of the port operations which will be stopped after consulting DGM, IOC / Essar, and ordered by Dy. Chairman / Chairman. In case COM (OOT) is not available in the emergency situation, senior most Executive Engineer is authorized to take such decisions in consultation with Gandhidham officials. Under such situation COM (OOT) in co-ordination with officials of Indian Oil Corporation Ltd. and M/s. Essar, shall get the operation at all three SBMs stopped and also get the hoses dis-connected from the tanker berthed at SBMs and un-berth tanker from Product jetty of Essar. Pilot of KPT on board the tankers will immediately take action to castoff the tanker from SBMs/Product berths and tankers will be directed to go to suitable safer place in that situation. All the ships waiting at own anchorage or working at anchorage will be asked by Vadinar control to go off in open sea at least 5 Nautical miles away from SBM. The tankers carrying out transshipment operation at LPO (Lighterage point), will be asked to stop the operation immediately and be on their own power to be away from other ships in the vicinity.

19.5 Securing of Ships / Crafts / Tugs etc

Pilot / M.E. Grade-II / both the AFS, should be available at Vadinar in case of Action Plan is in operation and situation like emergency. Immediate action for stopping the shipping operation should be taken by informing concerned agencies like IOC, ESSAR, and Shipping Agencies and also to KPT Tug / Craft working for the shipping operations at SBMs / LPO point and Product berth of Essar at Vadinar.

Both the AFS and AXEN (Mech.) should ensure that all the big crafts are moved out of Pathfinder Creek and all Port crafts & small crafts of private parties are placed at inner and outer side of the Vadinar Berthing Jetty or any other suitable location pre-decided and notified. If it is impossible to remove them, then all other steps should be taken to ensure safety of vessel / crafts at the Vadinar port, as also it would not cause any damage to the port. For the purpose of securing of ships / all crafts, pilots assisted by Marine Engineers Grade-II and XEN (E&M) will jointly assess the situation and get the crafts/tugs secured accordingly. The Pull Back tugs shall be secured safely at the Berthing Jetty and Crafts/dumb barge of outside agencies will be placed at safer places in this area. Both AFSs, will ensure while directing all the flotilla staff to take care of the safety of Floatilla. They will look after Pull back tugs and all other Masters will look after the Port flotilla with the help of team of Lascars, Serangs, Quarter Masters and Engine staff. The private Tugs & dump barges engaged by M/s. Essar and M/s. IOC and placed at approach jetty or RO-RO LO-LO jetty shall be ensured to secure at a place decided well in advance by XEN (E&M) and AFS after consulting authority of M/s. Essar and M/s. IOC. A compliance report of securing all crafts at safe places should be furnished to Control Room immediately on issuance of Cyclone Signal No.5.

Both the AFS should ensure the sufficient stock of mooring ropes and heaving lines, etc. to meet operational requirements during the emergent situation and sufficient number of life buoy, life jackets, etc. kept in easily accessible places in each crafts and at various other places on shore too.

19.6 Communication

XEN(E&M) and XEN (Civil-II) shall ensure on hourly basis by ringing personally that the telephones of signal station, AO Building, Estate Office, Hospital, Electric and Water supply are functioning, failing which they shall take up the matter with concerned BSNL authorities. In case of any difficulty in communication system, COM (OOT) should be contacted.

The satellite phone or V-Sat communication network should be established and put into operation at the earliest, by the following Signalmen:

1. Shri P.C. Kothari.
2. Shri Krishna Prajapati.

They will ensure the charging of walkie-talkie, Mobile telephones, as well as satellite phone available at the Signal Station, Vadinar.

The staff at Jamnagar Liaison office shall remain present on 12 hourly shift basis round the clock; to carry out the liaison work during the Action Plan is in operation and any other work as may be assigned during the period of Calamity. S/Shri V.M. Mehta, Assistant shall communicate with the Gandhidham/Kandla officials in case Vadinar communication is cut off from that of Gandhidham/Kandla

Traffic Movement & Security

XEN(C-II) and In-charge of CISF (KPT) Vadinar unit shall ensure that all incoming traffic to the Port jetty of Vadinar is stopped except those which are coming for rescue operations and essential services. They shall ensure posting of adequate security personnel, at various security points in co-ordination with the local police authority. XEN (Civil-II) and S.I. (W&W) should ensure safety of essential service premises like water overhead tanks / Main Store / Electric Station at colony. In addition, the in-charge of CISF Unit (KPT) Vadinar in co-ordination with XEN (Civil-II) shall ensure the posting of Security personnel with arms at all strategic locations, such as Control Station room at Jetty & Port Colony, Water supply tower, etc.

Medical Aid at Vadinar Port Health Center

Medical Officer (O.O.T.) being Officer in-charge at Health Center, Vadinar & other complete Health Center staff will remain in state of readiness to deal with any casualty by setting up a Casualty Emergency Room at the Health center, Port Colony, Vadinar. The Casualty Emergency Room shall start functioning as soon as Action Plan is put in operation and warning of the calamity is received. No staff of the Health center will be given leave during the period and Casualty Emergency room will function round the clock with posting of Doctor and staff round the clock. Medical Officer shall remain present and, apart from attending the patients, will allocate various duties to the available medical & Para-medical staff, such as maintaining records of patients attended and preparing a report thereof. Adequate number of chlorine pills should be distributed after the calamity is over, to avoid epidemic from spreading. M.O. (OOT), being Officer in-charge shall pre-plan for assessment & urgent requirements of all kind of the medicines to meet with the situation which may arise in case of any Natural Calamity. He should arrange to obtain the advance approval for immediate procuring of such medicines and the same should be procured & stocked readily available in advance.

Action to be taken by Pilots

In case of receiving cyclonic weather warning i.e. on declaration Weather Warning signal No.5 at Port, Pilot on the Board at SBM should un-moor the tankers and direct the Master of vessel to move the vessels to safer places i.e. away from the SBM. While returning to the Jetty by the Port craft, the Pilot should ensure that all the Port crafts are secured properly and safely at both inner and outer sides of the jetty. He should also ensure that ropes are doubled up and the tugs are manned at all times and engines are kept in readiness to move out in case of emergency.

Meanwhile, till the time the Pilot returns to the Jetty, the AFS on duty will not waste time and initiate action to secure the smaller crafts, which will further be inspected by the Pilots. Masters of all the smaller crafts should also be directed to ensure proper fendering arrangements are provided and if required extra fendering to the crafts may be provided. AFS shall ensure that the proper fendering arrangements are provided to all crafts before on set of inclement weather. Port crafts will get the priority over the private crafts to come alongside jetty. If any space is available, the private crafts can be allowed to come alongside the jetty.

After observing/monitoring weather conditions, intensity, speed and direction of propagation of Cyclone, necessary arrangement for abandoning the crafts may be made and on declaration of weather warning Signal No.8, the Vadinar jetty area will be evacuated including jetty Control Room, which shall be shifted to Room No.5 at Port Guest House at Vadinar Colony. In the month of April every year, Signalmen under guidance of XEN (M&E), shall inspect & ensure working of all the equipments meant for Control Room of Jetty as also readiness of all the electric connections / charging points at the above alternate location of Control Room at Colony.

Generator Set

Wherever Generator sets are required due to power failure at Port Jetty and colony, AXEN (Electrical), JE (Electrical) shall be contacted who shall immediately arrange to provide the DG set already procured & available with Electrical section, giving preference to the operational area. However COM (OOT) shall be free to hire additionally required DG sets for a suitable period, if the same is not found adequate available in store.

AXEN (E), JE (Elect.) shall prepare a roster of staff of Electrical section for putting the D.G. sets installed & commissioned at the following destinations in operation and attending faults, if any occurs, during the operation of Action Plan and ensure readiness for meeting with emergency situation in case of power failure. Diesel oil drums, connecting cables with lugs etc. and any other such materials are to be kept readily available/accessible for use.

1. Jetty
2. Colony
3. Guest House
4. Health Center
5. Water supply complex at colony

Provision of sufficient emergency spares and cables, terminals, portable lights (Handle torch, emergency lights), tools, tackles, etc. should be ensured well in advance in planned manner to combat the situation. All precautionary measures should be taken to protect the D.G. sets from detrimental effect of thunderstorm, heavy rain showers and such cyclonic conditions. Sufficient stock of waterproof spread sheets, tarpaulins, canvas, etc. to protect the electrical gear from water showers/moistures, etc. should be planned, procured and kept at easily accessible place for instant use.

Power supply staff should be well equipped with jigs and fixtures, such as portable tower ladders, insulated axe, gumboots, hand gloves, shockproof accessories. All the above urgent items should be got procured & kept readily available, well in advance in association with Assistant Executive Engineer (Mech), to cater for emergent situations. XEN (E&M) shall take advance action for procurement of one No. DeWatering Pump (Diesel Driven) and the same should be kept stand-by along with its suction & discharge hoses connected for use

Vehicle Pool

As soon as the Action plan comes into force, the vehicle pool shall be formed and vehicles as allocated as per (List of Vehicles available with Chief Operations Manager (OOT) Vadinar) shall remain stationed at the said places along with operating staff. The pool shall be controlled by Assistant Executive Engineer (M) / AXEN (E) to be assisted by Junior Engineer (Mech) / (Elect), and following staff will render their services for posting of drivers and allocating of vehicles as per (List of Vehicles available with Chief Operations Manager (OOT) Vadinar)

Apart from the above, XEN (E&M) / XEN (Civil-II), shall hire vehicles, if needed for emergency work, from the private vehicle contractors. The list of private vehicles contractors is shown as Annexure – VII. Assistant Executive Engineer (M) / AXEN (E) should ensure the availability of drivers and vehicles and submit compliance report to the COM (OOT). All hired vehicles should be stationed at the location as decided by XEN (E&M) / AXEN (M), from where it can be taken for immediate use at the required places.

Temporary Evacuation Centre

The temporary evacuation center shall be looked after by XEN (Civil-II) and Assistant Executive Engineer (Civil) who will be assisted by the Principal of St. Ann's School & his staff and the following KPT staff members assisted by the volunteer's employees as mentioned in the Annexure-III, for setting up temporary evacuation centers and rendering required services for the same. They shall ensure that temporary evacuation centers are established immediately, in the school and staff club of Vadinar Port colony. Port vehicles such as Trucks, Buses, Ambulances, etc. will be put into operation for immediate evacuation of people from Port Jetty as well as colony, as the need be.

1. Sr. Clerk
2. Assistant
3. Junior Clerk
4. Junior Engineer (Civil)
5. Junior Engineer (Civil)
6. Junior Engineer (Civil)
7. Junior Engineer (Civil)

Assistant Engineer (Water Supply sub division, Vadinar) shall ensure for providing adequate quantity of water supply at all the temporary evacuation centers.

Medical Officer (O.O.T) with the help of internees and staff of Health Centre shall ensure to provide necessary medicines / medical assistance to affected persons and ensure about the hygienic conditions at the temporary evacuation centers.

XEN(Civil-II) being Officer-in-Charge of Temporary Evacuation Centre, with the assistance of following staff members and volunteers employees mentioned in the Annexure-III, shall take care of the requirements of food/water etc. and supply the same for the evacuees in the temporary evacuation centers.

1. Senior Clerk.
2. Electrician.
3. Junior Clerk.

4. Lascar.
5. Chowkidar.

The Officer-in-charge of C.I.S.F. Unit of O.O.T. Vadinar and SI(W/W) should arrange to make announcements regarding cyclone warnings with the co-ordination of local police, by vehicles mounted with public address systems and also should arrange for requisitioning and providing trucks for shifting peoples, as soon as Internal Action Plan comes in action.

Spray of Dis-infecticides / BHC powder etc will be looked after by Assistant Engineer (Civil) Building Sub. Division along with staff of Estate office i.e. Jr. Engineers and other staff.

19.13 Press & Media Management

There will be a Press cell headed by C.O.M. (OOT). The following officers/employees shall remain in the Press cell.

1	XEN (M&E), as Officer-in-Charge
2	PA to COM
	Signalman

The press cell shall come into operation in the chamber of COM (OOT). The press cell shall issue daily press note with the knowledge and approval of Chairman / Dy. Chairman. If needed, a photographer be engaged, who will take photograph / video shooting everyday, which will depict the situation as well as the relief work undertaken by the officers. All media people of press, journalist etc. shall be taken care of by XEN (Civil-II).

As regards to their transportation, lodging / boarding and other hospitality, he shall take required advance amount from Accounts Officer (O.O.T.) and submit the bills thereof subsequently. Accounts Officer (O.O.T.) along with Superintendent of Accounts / D.A. will be the custodian of cash drawn and kept in their custody for the disbursement for various emergency payments to the designated Officers and the record of such advances to such individual Officers.

XEN (Civil-II), Vadinar and Pilot posted at Vadinar, shall remain present in all KPT meetings relating to the Action Plan. XEN (Civil-II) and Pilot in-charge shall remain in touch with State Governments / District Authority and Mutual aid scheme members, on daily basis, for sorting out the difficulty / problems of cyclone/calamity relief work in consultation with COM (OOT).

19.14 Action to be taken by Accounts Officer (OOT)

As soon as the Cyclonic Weather warning Signal No. 5 is declared, Accounts Officer (OOT) shall arrange for the cash amount to be disbursed as advances to various officers. All Officers-in-charge, should make a judicious assessment regarding requirement of funds by them to meet with different exigencies which they may have to handle on account of the situation arises due to Cyclone / natural calamity. A.O. (OOT) in turn, would examine the advances sought by the officers and disburse the advances immediately without delay and intimate C.O.M (OOT) and F.A & C.A.O about amount released by him and obtain sanction thereof.

19.15 Advance Planning

19.15.1 For stocking required equipments / machinery / material & medicines

Assistant Engineer (Civil) in association with Store Keeper, should ensure the advance stocking of Diesel, Petrol, Kerosene, Lubricant Oil, Emergency lights as well as Torches & Cell, required tools & tackles, jigs and fixtures etc. in sufficient quantity to meet with the emergency requirements of Vehicles, Generators as stipulated under action at Sr. No.8 & 10 above and all such other services. All the Officers-in-Charge, must list out the materials required well in advance, to facilitate procurement & stocking in, sufficient quantity of the same by Assistant Engineer

(Civil).

19.15.2 For securing of ships / crafts / tugs etc

A safe place to secure ships/crafts/tugs etc. on issuance of Cyclone Signal No. 5, should be decided & notified well in advance (By April end) by XEN (E&M), in association with both Assistant Flotilla Supervisors. The sequences of operations for shifting of all crafts shall be planned in advance by all the Masters along with related Marine staff, under the guidance & instructions of above officials.

19.15.3 Post Calamity Operations

19.15.3.1.1 Marine Operations

Immediately after the Calamity subsides, Marine Engineers Grade-II along with both the Assistant Flotilla Supervisors & related Marine staff shall carry out the inspection of all the Floating Crafts and check if the crafts can be put into operation for checking the condition of SBMs and hoses. Accordingly, a report to that effect, shall be submitted by both Marine Engineers Grade-II, to the Control Room at Vadinar, who in turn, after taking approval of C.O.M., will transmit the same to the Dy. Chairman/Chairman at Gandhidham/Kandla. C.O.M. shall co-ordinate with officials of M/s. IOC/Essar Vadinar, for their all Okey reports or otherwise, as regard to SBMs/Product Berth, Pipelines and their clearance for resumption of shipping operation & project works at Vadinar.

19.15.3.1.2 Other than Marine Operations

XEN (Civil-II), after taking the stock of situations, arrange for all relief/restoration measures for the damages caused during the Calamity. An advance planning of work-force (Work team/Volunteers by name), list of materials required and the arrangement of effecting the relief/restoration, shall be checked out & notified to all the connected persons in this operations.

For coping up with the immediate restoration work in Post-calamity period, an advance approval of Chairman, KPT, shall be obtained by XEN (Civil-II) by processing the case file, for authorizing the Chief Operations Manager (OOT) to engage Daily rated labour of various discipline in Un-Skilled, Semi-Skilled and Skilled category, at the fixed daily wage for each category personnel.

Further, to hire equipments such as Vehicles/Mobile cranes / Dumpers / JCBs / Pay Loaders etc. for immediate relief/restoration work at the required places at Vadinar, XEN (Civil-II) shall also process case file in advance, for obtaining approval of Chairman, KPT, to hire such equipments, for immediate restoration work in PostCalamity period at Vadinar.

19.16 Action Plan – Land Fire Station

In case of any fire, the Control Room shall immediately establish a communication with C.I.S.F., Fire Brigade of M/s. IOCL and M/s. Essar Oil Ltd., Vadinar and immediately summon CISF In-charge of OOT to directly reach the site of the fire along with his Security Personnel & co-ordinate with fire fighters, for cordoning the site of fire and take actions to provide rescue and containment of fire.

CISF In-charge of KPT (OOT) Dept., Vadinar should keep informing the Control Room and C.O.M (OOT) from time to time about the gravity of situation and extent of control over the situation.

19.16.1 List of all the officers in charge & designated officers & employees covered

Sr. No.	Name & Designation	Tele. No. at Office	Tele. No. a Residence
1.	C.O.M.	0288-2573001 0288-2573031 FAX	
2.	, XEN(M&E)	0288-2573005	
3.			
4.	XEN(Civil)	0288-257006	
5.	AXEN(E)	0288-2573011	
6.	Shri NAYAK, M.E. Gr.II	0288-2573007	
7.	A.O.(OOT)	0288-257008	
8.	Dr Medical Officer.	256313 (Vadinar)	
9.	AXEN (Civil)		
10.	A.E.©		
11.	A.E.©		-----
12.	Shri A.XEN.(Mech)		2915231 (Jamnagar)
13.	PA to COM		
14.	O.Supdt.		256483 (Vadinar)

15	Supdt. A/cs.		
16.	(Store Keeper)		
17.	A.F.S.		256517 (Vadinar)
18.	, AFS		256817 (Vadinar)
19	Signalman		
20.			
21.	Signalman		
22.	Signalman		
23.	J.E.©		
24.	J.E. © Gr-1.		
25.	J.E.©		
26.	KPT Guest House at colony.		
27.	Shed Master		
28.	Assistant,KPT Liaison office at Jamnagar		
29.	Time Keeper		
30.	(Clerkcum-Time keeper).		
31.	, Maistry		

19.16.2 List of Press Reporters & News Services at Jamnagar

Sr.No	News Service	Name and address	Telephone nos.
01	District Information Officer, Jamnagar.	Shri K. A. Karamata, District Information Center, Jamnagar.	2556827 2672939
02	Times of India, PTI	Shri Darshan Thakar, Journalist society, Jamnagar	2555731 9824232632
03	Indian Express, Jansatta & Financial Express	Shri Bipin Sukhpariya Limda lane, Jamnagar	2553717
04	Phulchaab	Shri Dinesh Vora,	2550320
		Nr. Old Railway station, Jamnagar	
05	Sandesh	Smt. Bhavnaben Soni, Opp. Apsara Talkies, Jamnagar	2553106 9825280456
06	Jay Hind	Shri Bharatbhai Raval, Nr. Old Railway station, Jamnagar	2557447
07	Sanj Samachar	Shri Mukeshbhai Joiser, Near Old Rly. Station, Jamnagar	2554109 9824219999
08	Bhoomi	Shri Dolarbhai Raval, Limda lane, Jamnagar	2679080
09	Nobat	Shri Pradeep Madhwani, Pancheshwar tower road, Jamnagar	2555924 2670924 2553752 (Fax)

10	Gujarat Samachar	Shri Vipul Hindocha Opp. Madras hotel, Teen batti Jamnagar	2670634
11	Ajkal	Shri Praful Tankaria, City Point, Near Town Hall, Jamnagar	2665602 2665603
12	Lokvat	Shri Jay C. Chauhan, New Super Market, Jamnagar	3092114
13	Sahara Samay	Shri Darshan Thakar, Journalist Society, Jamnagar	2555731
14.	Divya Bhaskar	Shri Mukesh Joiser, Near Old Rly. station, Jamnagar	9824219999

19.16.3 List of School & Buildings available at Vadinar for Shelter purpose

1. St. Ann's School, Vadinar Port colony Telephone No. 256568 / 256514
2. Staff club, Vadinar Port Colony.

19.16.4 List of volunteers employees at Vadinar (Dist Jamnagar) To be formed by COM

19.16.5 List of Vehicles available with Chief Operations Manager (OOT) Vadinar : To be arranged by XEN (M&E) as per availibility

Name of Driver (Motor) & their Residence Telephone No : To be arranged by XEN (M&E) as per availibility

19.16.6 Names of local contractors working at OOT Vadinar

1. Rajlaxmi Construction, P.O. Vadinar. Phone No. 02833-256789/256505 - Contact person: Shri C.R. Jadeja.

2. Shree Shakti Construction, P.O. Meghpar (Padana) Ph. No. 246314 / 246411 Contact Person: Shri Pradumansinh G. Zala.

3. M/s Jai Chamunda Enterprises, Vadinar 361010 Contact person: Ranmal Vira, Ph. No. 02833-256719

4. Shri Kama Mala, Vadinar 361010.

5. Shri M. B. Jadeja, Vadinar 361010.

6. Shri Ganesh Construction, Village-Kajurda, Tal. Khambhalia Contact person: Shri Kherajbhai

7. Shri Hira Punja Rathod, Vadinar 361010

8. M/s. Shiraji Construction, Vadinar.

9. Shree Ashapura & Co Vadinar 361010 Ph No. 02833-256711

10. M/s. Bariya & Co., Near KPT colony, Vadinar.

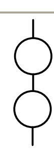
19.16.7 Important Telephone Nos of IMD http://www.imdahm.gov.in/index.html

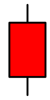
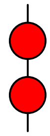
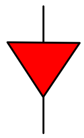
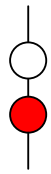
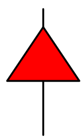
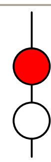
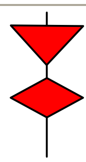
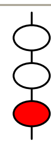
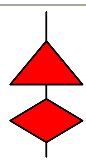
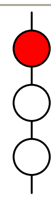
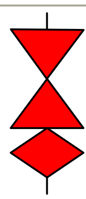
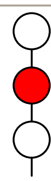
19.16.8 List of Vehicle Hire / Transport Travel Contractors at Jamnagar

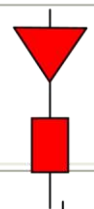
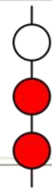
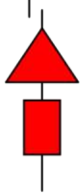
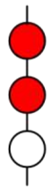
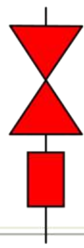
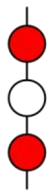
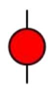
Sr.No	Name and address of Transport / traveler	Telephone
1	Pavan Travels, Pancheshwar tower, Jamnagar	2552002
2	Patel Travels, Pancheshwar tower. Jamnagar	2552419 /

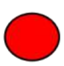
		2660243
3	Ashwamegh Travels, Jamnagar	2670613
4	Sheenath Travels, Jamnagar	2663315 / 2662215
5	Royal Travels, Opp. Town Hall, Jamnagar	2553333 / 2553636
6	Pruthvi Travels, Sikka Patia, SIKKA (Jamnagar.)	244466
7	Shree Divya Travels, Jamnagar	2677601
8	Payal Travels, Jamnagar	2551514 / 2551415
9	Gujarat Travels, Jamnagar	2664315
10	Abhishek Travels, Jamnagar	2564380
11	Shiv Shakti Travels, Jamnagar	2566611
12	Sapan Travels, Jamnagar	2558558
13	Tulshi Travels, Jamnagar	2541054
14	Samay Travels, Jamnagar	2551925

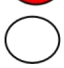
19.16.9 Chart of Weather Warnings

Signal No.	Symbol Day	Symbol Night	Type of Warning	Description
I			Cautionary	There is a region of squally weather in which a storm may be forming.

II			Warning	A storm has formed.
III			Cautionary	Port is threatened by squally weather.
IV			Warning	The Port is threatened by storm, but it does not appear that the danger is as yet sufficiently great justifying extreme measures of precautions.
V			Danger	The Port will experience severe weather from a storm of slight or moderate intensity that is expected to cross the coast to the south of the port.
VI			Danger	The Port will experience severe weather from a storm of slight or moderate intensity that is expected to cross the coast to the north of the port.
VII			Danger	The Port will experience severe weather from a storm of slight or moderate intensity that is expected to cross over or near to the port.

VIII			Great danger	The Port will experience severe weather from a storm of great intensity that is expected to cross to the south of the port.
IX			Great danger	The Port will experience severe weather from a storm of great intensity that is expected to cross the coast to the north of the port.
X			Great danger	The Port will experience severe weather from a storm of great intensity that is expected to cross over or near to the port.
XI			Failure of communication	Failure of Communication with Meteorological head quarters has broken down and the local officer considers that there is danger of bad weather.

 Red Light,

 White Light

19.17 Vadinar Oil Terminal Limited (VOTL) of Essar

19.17.1 Facility Description

Vadinar Oil Terminal Limited (VOTL) is a wholly owned subsidiary of Essar Shipping & Logistics (ESLL) with a focus on investment in crude and product terminals. VOTL has set up a 32 Million tone terminal with crude reception and crude and product storage facility at Vadinar, Gujarat, India.

The VOTL facilities serve the following functions:

- Receiving crude oil from tankers at an SPM located in the Gulf of Kutch, with transfer of crude oil via pipeline to the VOTL crude storage facility, located within the fence – line of the EOL refinery;

- Receiving product from the refinery into a product tank farm, also located inside the Refinery fence-line for loading into tankers at the marine terminal jetty;

- Receiving seawater from the intake well that is pumped via pipeline to the EOL refinery, and then discharging seawater via the seawater outfall located near the location of the SPM.

The crude oil tank and product tank farms, which are located inside the fence - line of the EOL refinery, while owned by VOTL, are actually operated and maintained by the Refinery, and were not covered by this HAZID or the ERA. (These tanks farms have been risk assessed separately).

The areas where the Marine Terminal and the SPM are located in the Gulf of Kutch are part of a designated and controlled marine park and represent a sensitive marine environment. The on-land pipelines pass through low lying areas which consist of some farming land and are adjacent to several villages.

The VOTL marine terminal facility consists of the following systems for supporting the aforementioned functions:

- A Single Point Mooring (SPM) and Subsea Line for loading crude:

  The SPM buoy is the gateway for crude oil input to the EOL refinery. The SPM is anchored to the seabed in the Gulf of Kutch, in around 35 m of water. Tankers are secured to the buoy via mooring hawsers. The tanker is held off the SPM by a pull-back tug. The offloaded crude oil is pumped by the crude tanker pumps through the floating hose(s), through the SPM, and then via flexible catenary hoses into the 48'' rigid subsea pipeline, through a PLEM and then flows directly to the crude oil tank farm located within the EOL refinery. The SPM is located roughly 4Km from the Marine Terminal and 8Km from the crude oil pipeline landfall.

- Seawater Intake Unit and Outfall system:

  Seawater is pumped from the seawater intake facility (located at pathfinder Creek, adjacent to the jetty) and delivered to meet the water needs of the refinery. Seawater flows through two filter packages in the seawater intake well and is then pumped to a seawater storage reservoir located in the Refinery via a 48'' GRP pipeline. Chlorine is added to the seawater downstream of the pumps at the intake facility for prevention of marine growth in the pipeline and the Refinery seawater reservoir.

  The seawater outfall dispose of waste brine (high salinity water) generated from different Refinery units through a diffuser located on the seabed close to the location of SPM. The seawater outfall flow is pumped from a seawater return reservoir at the Refinery through an on-land 48'' GRP pipeline and then via an 8Km subsea pipeline.

- A jetty including three (3) Loading Arms:

The jetty is located at the inlet to pathfinder Creek, and is situated between two coral reefs which are part of a declared “Marine National Park”. The jetty is used for shipping of refined white and black products to vessels. The jetty is connected with the refinery through 3 x 32’’ diameter pipelines which bifurcate into 7 x 24’’ lines on the trestle and finally culminate into three (3) loading arms. Each o the 7 x 24’’ lines are allocated to each of the seven (7) products handled at the jetty, namely: ATF (aviation turbine fuel), kerosene, MS 87 (motor spirit), MS 95 (motor spirit), naphtha, diesel and VGO / FO (vacuum gas oil and fuel oil). Tanker at the jetty is located via pipelines connected through three sets of loading arms with Quick Connector Disconnector Coupling.

- A pig station with three (3) Pig Receivers / Launchers and Terminal Area Slop Tank:

  Pigging is carried out for clearing any previous pipeline content, separation of cargoes, cleaning inside pipeline coating and assessing any leak- buckle or damage- deformation in the internal section of pipelines (intelligent pigging). Products for export are pumped from the refinery to the jetty through 3 x 32’’ diameter cross- country pipelines. There are two (2) pipelines for white products (naphtha, MS, ATF, Kerosene, and diesel), and other is for black products (VGO / FO). To enable the flexibility of these pipelines to carry different products, pigging is carried out between the Refinery and the Marine Terminal Pigging station, where each line has its own pig receiving and launching facilities (total of 3 pig receivers / Launchers).

  A slop tank is also provided for the pig stations to contain / collect liquid product drained from the pig station, and it is also used for transfer of products drained into the jetty Slop Tank (which are transferred by pump). Products drained into the slop tank are removed as required by an educator truck and taken back to the EOL Refinery where they are reprocessed.

- Pipelines between Terminal and Refinery (including crude oil and seawater lines) include the following:

  - 3x 32’’ diameter cross- country pipelines (two (2) pipelines for white products, and one for black products) between refinery and marine terminal (around 18 km in length)

  - Crude oil pipeline (48’’) between refinery and landfall (13 Km), and then a further 8Km of 48’’ subsea pipeline to the PLEM on the seabed below the SPM

  - Seawater intake (48’’) between marine terminal and refinery (17Km), and seawater outfall (48’’) between refinery and landfall (13 Km) plus 8Km of subsea line to the outfall diffuser.

All pipelines are buried on land within an earthen berm. Steel lines are wrapped and cathodic protected (crude / product lines). The seawater lines are GRP. There are no flanges or connections on crude / product lines on –land (other than at marine terminal for product), and only air vents are provided along the seawater lines. The subsea crude oil pipeline is concrete encased, with the only flanges at the point of landfall and at the subsea PLEM.

- Buildings including the Main Terminal Control Building (MTCB) and two substations (main substation located near the seawater intake station, and jetty substation).

The response strategy for the VOTL plan has been developed taking into account the spill risks, and possible sources of spillage associated with Marine Terminal operations including those at the SPM and Jetty berths and facilities within the Port.

The geographical area of operations is bound by, but not limited to, one mile either side of the line joining following coordinates.

SPM	:	690 39’ 35’’ E
		220 30 14’’N
LFP	:	690 43’ 26’’E
		220 27’ 59’’N
Berth B (North End)	:	690 40’ 10.26’’E
		220 27’ 15.25’’N
Berth A (South End)	:	690 40’ 11’’E
		220 26’ 54’’N
Sea Water Intake	:	690 40’ 32’’E
		220 26’ 11’’ N

19.17.2 Oil Spill Risks

19.17.2.1 Identification of activities and risks

Oil spills will be categorized in accordance with the internationally recognized three tier classification system

Tier One	100 - 700 T
Operational spillages which can be dealt with using the resources immediately available	
Tier Two	700 – 10000 T
Medium size spillages which exceed VOTL resources and which require District and/or Regional assistance	
Tier Three	10000 > T
Large spillages which exceed the full resources of the District/Region and which may require National assistance and/or the implementation of the NOS - DCP	

19.17.2.2 Types of Oil likely to be spilled

No.	Oil Type	Strategy Figure	Specific Gravity	Genre	Characteristics	Examples
1	Light Oil	5.1	< 0.84	White oils	Non-persistent, Volatile	Aviation fuel, Kerosene, Motor spirit, Naphtha, HSD
2	Crude	5.2	> 0.84	Black	Persistent,	Arabian Light,
	Oil			oils	Viscous, Emulsion. Fresh oil amenable to dispersants	Arabian Heavy, etc.
3	Heavy Oil	5.3	> 0.95	Black oils	Persistent, Viscous, Emulsion. Generally not amenable to dispersants	Fuel Oils, LSWR

Probable fate of spilled Oil

19.17.3 Preliminary Assessment

The ICG Coordinator will make a preliminary assessment of the incident by contacting the person reporting the spill, governmental officials, and the responsible party.

- Evaluating the magnitude and impact of the discharge or threat of discharge on the public health, welfare, and the environment;
- Determining in which jurisdiction the incident occurred;
- Determining or confirming the responsible party;
- Determining or confirming the source of the spill;
- Determining whether the spill has been stopped or is ongoing, and if ongoing, how quickly it can be controlled;
- Assessing the need for state assistance; and
- Assessing the feasibility of removal and determining the equipment needed to remove the oil.

19.17.4 Containment & Control

Clean-up actions must begin as soon as possible to minimize the effect on natural and economic resources. These actions may include locating the source of the discharge and preventing any further spillage, placement of containment boom to control the spread of oil and to protect sensitive areas, measuring and sampling, physical removal of the oil from water and land, the use of chemicals to herd or disperse the oil, and in situ burning.

19.17.5 Development of Oil Spill scenarios

VOTL is operating 02 Nos. Berths (A & B) for product evacuation & 01 No SPM for crude intake.

The VOTL is capable of accepting vessels ranging from 25000 to 100,000 DWT each at berth A & B and Vessels ranging from 87,000 to 325,000 DWT at SPM.

The Marine Terminal is located within an area which has been declared as a Marine National Park / Marine Sanctuary.

The mean tidal range is approximate 6 meters and current speed in excess of 2 knots may be experienced alongside jetty.

19.17.6 Port Operations

19.17.6.1 Pilotage

Pilotage is compulsory for all vessels. Pilotage and auxiliary support craft services are provided by Kandla Pot Trust (KTP).

19.17.6.2 Main Approach Channel

The least depth in the main approach channel to the tanker jetty is 13 meters; the maximum acceptable draft alongside jetty berths is 15 meters. A minimum under keel clearance of 6% of vessel's maximum sea going draft plus 0.60 meters is applied to all vessels under way.

While the risk of grounding is low, it cannot be wholly eliminated. The most likely cause is steering or propulsion system failure which could result in grounding on the channel margins with consequent damage to the bottom and/of the mid body plating. The potential spill quantities depend upon the size / type of tanker and the area of impact damage.

The vessels calling the product terminal, in bound and out bound will be escorted by minimum two tugs in fair weather condition. This considerably reduces the risk of the vessel running aground in the channel.

19.17.6.3 Approach to SPM Berth

Tankers bound for SPM will follow the deep water route. Berthing and un-berthing of the Tankers on the SPM will be done by KPT Pilots. Charted depth at SPM location is 34.5 meters. Grounding of Tankers in the SPM area is considered as very remote.

19.17.7 Oil Spill scenarios

19.17.7.1 Collision between Vessels Underway

The control which will be imposed on ship movements within terminal are designed to ensure that any risk or collision is minimized. For example, inward / outward bound ships will have sole occupancy of the approach channel to the jetty berth; additionally all departing vessels will remain under Pilotage up to the western limit of the terminal area. It is thus considered that the likelihood of collision between vessels underway within the terminal is remote. There is perhaps a greater risk of collision between vessels maneuvering to the SPM and the jetty anchorage position without Pilotage assistance.

19.17.7.2 Berthing incident (Jetty)

Oil spills can occur as a result of hull contact with the corners of breasting dolphins during ship berthing or un-berthing maneuvers. Such incidents are generally due to failure of a vessel's main propulsion or steering systems, loss of control onboard an attendant tug or pilot error or misjudgment. The potential spill quantities involved depend on the vessel type and the location and extent of the impact damage.

19.17.7.3 Tug impact

There are well documented incidents where cargo or bunker oil has been released as a result of hull impact damage by tugs. This can occur when tugs are approaching a vessel underway prior to berthing, or when coming alongside a moored vessel prior to un-berthing. The potential spill quantities again depend on the location and the extent of the impact.

Adequate fenders shall reduce the level of risk.

19.17.7.4 Cargo Transfer Operations (SPM Berth)

This section considers the potential sources of oil spills during the discharge of crude oil cargoes and is based on oil industry data and ITOPF statistics. It should be noted that the ITOPF statistics demonstrate that most oil spill incidents occur during routine cargo handling operations and that some 91% of these incidents resulted in spillages of less than 7 tones.

19.17.7.5 Connection of Floating Hose String

After the floating hoses have been lifted on board, blank flanges are unbolted from the ends of the hoses prior to connecting them to the ship's presentation flanges. Small spillages frequently occur during the removal of the blank flanges; these are caused by surging of the line contents as the floating hose sections follow the wave pattern. While in most cases such spillages are contained within the ship's manifold drip tray, there are recorded incidents where oil has escaped overboard via scuppers, which have not been effectively plugged. Spillages of this nature should not exceed 1 m3.

19.17.7.6 Snapping of 24'' diameter Floating Hose

Spillage of crude oil due to snapping of a floating hose, during crude oil unloading operations @ 10000 m3/hr. estimated time taken for response is two minutes. Snapping of hose may occur due to accidental drifting of tanker, collision with SPM, the hose getting entangled due to movement of a tug boat very near to the SPM / Tanker, due to rough weather condition. Theoretically the quantity spilled would be 142 tons. Chances of a full bore snapping of the hose are classified as a rare phenomenon.

19.17.7.7 Sea and Overboard Discharge Valves

Oil can escape to the sea via sea or overboard discharge valves which are directly connected to the cargo pipeline system due to either incorrect line setting or defective valves. The likelihood of this occurring is considerably less on SBT vessels.

19.17.7.8 Slop Tank Overflow

Crude Oil Washing (COW) of cargo tanks will be undertaken during bulk cargo discharge; this operation entails the transfer of tank bottoms and washing oil back to back to the vessel's slop tank(s). The overflow of slop tanks as a result of instrumentation failure or operator error during this process is not uncommon. Checks on the system and operation, pre, during and post COW will considerably lower the associated risk.

19.17.7.9 Vessel Breakout

Other than a sudden and catastrophic failure of the mooring hawser leading to rupture of the floating hose string, it can be reasonably assumed that cargo discharge will have been suspended in weather conditions which approach the established environmental limits. It would also be normal practice to station a crewmember on the forecastle head to maintain a mooring watch. Under most circumstances, therefore, early warning of a potential breakout situation can be anticipated.

In any event, an emergency stop button for the main cargo pumps will be located at the ship's manifold and the deck watch keeper would initiate an ESD immediately the hose string parts.

A vessel breakout and loss of integrity of the floating hose string could result in a spill quantity of some 142 m3. This quantity is based on the following assumptions:

- Bulk flow rate
- Reaction time
- ESD activation time
- Hose contents

In case of undue stresses experienced by the floating hose string, the breakaway couplings will get activated. These are designed to seal both ends on activation.

19.17.7.10 Hull Failure

The incidence of oil pollution due to hull failure is low and some 84% of the incidents attributed to this cause by ITOPF involved spill quantities of less than 7 tones; these spills were caused mainly by minor hull fractures and weld failures. The potential for more serious incidents with spill quantities in excess of 700 tones must, however, be acknowledged.

19.17.7.11 Fire and Explosion

Fires and explosions onboard ship represent a safety hazard with the risk of oil pollution as a secondary impact. All tankers engaged for trading to the SPM facility will be equipped with inert gas systems; gives the control which will be imposed and enforced by VOTL in respect of the oxygen content of cargo tanks, the risk of fire and / or explosion in the cargo spaces must be regarded as minimal.

Strict monitoring and control of the main cargo pump room atmosphere will minimize the fire and explosion risks associated with this space.

Fires resulting from uncontrolled smoking in the accommodation, organization hot work such as welding and engine room fires can spread rapidly if not dealt with swiftly and give rise to incidents of a very serious nature.

While the likelihood of fire or explosion occurring onboard vessels berthed at the SPMs is low, the risk is nevertheless acknowledged. Such an incident could give rise to a spillage of 700 tons or more.

19.17.7.12 Spillages of Fuel Oil

Fuel oil bunkers will not be supplied to tankers moored to the SPM. It may, therefore, be necessary for vessels to undertake the internal transfer of fuel oil for trim or other operational reasons. A bunker tank overflow during such operations could result in spillages of < 1 ton.

Cargo Transfer Operation (Jetty Berth)

19.17.7.13 Ballast Discharge

Only fully SBT (Segregated Ballast Tank) vessels shall be chartered for trading to the Marine terminal; those ships which load refined products will also discharge their segregated ballast water concurrent with the loading operation.

Under fair weather and operational conditions, tankers at SPM will not engage in de-ballasting activity.

On some older designs of SBT tankers, the ballast pipelines pass through the cargo tanks and vice versa, any loss of ballast line integrity can result in the entrainment of cargo oil in the ballast water discharge. Industry records indicate that the spill quantity from this cause on board product carriers should not exceed 25 tones.

19.17.7.14 Loading Arms

The operation of loading arms can lead to minor releases of oil. Common sources are vent valves, swivel joints and hydraulic lines. Loading lines are equipped with PERC (Powered Emergency Release Coupling) and with DDV (Double Disk Valve)

19.17.7.15 Cargo Tank Overflow

Cargo tank overflows can occur on board loading vessels; spills of this nature can be due to instrumentation failure or human error. The spill quantity is a function of the flow rate and also the number of tanks being loaded at the time of the incident. Some of the oil will be retained on deck but in a worst case scenario, some oil could go overboard.

19.17.7.16 Hull Failure - Fire and Explosion

The risks of hull failure - fire and explosion are also similar to those for SPM vessels with the attendant spill quantities being proportional to the tanker size.

19.17.7.17 Effluent Discharges

Treated effluent from the refinery is discharged into the sea area. The discharge consent levels are set and monitored by the State Pollution Control Board and VOTL regularly tests for effluent quality.

Instrumentation malfunction, failure of in-line samplers or operator error can result in the entrainment of oil in the final discharge to harbor waters. Most spillages of this nature are not substantial, and based on industry experience elsewhere, are unlikely to exceed 5m3 in volume.

19.17.7.18 Special Equipment which may be used

- Workboats
- Trucks / cars (four wheel drive)
- Radio transmitter / receivers
- Workshop / repair facilities
- Bulldozers, mechanical scarpers and similar earthmoving equipment
- Vacuum trucks
- Tank trailers
- Life vests
- Explosive meters

19.18 Fire Fighting Facilities at Vadinar Oil Terminal Limited (VOTL) of Essar

19.18.1 Fire water supply pumps at Sea Water Intake

Fire pumps are vertical turbine type as per IS 1710

Dedicated fire pumps are provided for:

1. Fire Tower monitor system
2. Fire Hydrant System (There is no interconnection between two header)

19.18.2 Fire water Pump for Tower Monitor – 4 Nos

a. Main Motor Driven Pump – 1 No (Discharge capacity $792m^3/hr$ at 15 kg/cm^2).
b. Engine driven – 1 No (Discharge capacity 822m3/hr (standby).
c. Jockey Pump (Discharge capacity $33m^3/hr$ at 10.5 kg/cm^2).

19.18.3 Fire water Pump for Hydrant System – 4 Nos

a. Main Motor Driven Pump – 1 No (Discharge capacity $792m^3/hr$ at 15 kg/cm^2).
b. Engine driven – 1 No (Discharge capacity $822m^3/hr$ (standby).
c. Jockey Pump (Discharge capacity $33m^3/hr$ at 10.5 kg/cm^2).

19.18.4 Fire Hydrant & Jumbo Curtain

Fire Hydrants is located at different section of premises to be protected depending upon nature of fire hazard, fire hydrants are double outlet type.

Each outlet capacity is 900 lpm at 7.5 kg/cm^2
The flow rate of hydrant is 1800 lpm at 7.5 kg/cm^2

19.18.5 Fire Hydrant Point – 31 Nos

a. Berth A - 4 Nos
b. Berth B – 4 Nos
c. Pig area / cross country / MTCB – 16 Nos
d. SWI – 03 Nos
e. Between Berth A & B – 4 Nos

19.18.6 Jumbo Curtain at Berth A

The Jumbo curtains nozzle shall have discharge capacity of 3000 lpm of sea water at 7.5 kg/cm2.

Total – 6 Nos of Jumbo Water Curtain

The nozzle shall be able to produce 14 meters. Vertical plane & 20 meters horizontal radius dense water curtain through 160 degree angle – 04Nos at jetty to protect loading arms and – 2 Nos one each at the breasting dolphin to protect tower monitors from the radiant heat in case of fire on tankers.

19.18.7 Jumbo Curtain at Berth B

The Jumbo curtains nozzle shall have discharge capacity of 3000 lpm of sea water at 7.5 kg/cm2.

Total – 02 Nos of Jumbo Water Curtain

The nozzle shall be able to produce 13.5 meters. Vertical plane & 22 meters horizontal radius dense water curtain through 180 degree angle – 02Nos at jetty to protect loading arms.

19.18.8 Water / Foam Tower Monitor at Berth A

The monitor shall be suitable for both sea water and foam, each monitor shall be capable of discharging 6000 lpm of sea water and 36000 lpm of expanded foam at 10 Kg.cm2 over a range of 100 meters in horizontal direction and 40 meters range in vertical direction. The monitor shall be capable of producing good quality of finished foam.

Horizontal range with water – 100 meters Horizontal
range with foam - 90 meters

The monitor shall be capable of 360 degree rotation in either direction in horizontal plane and 60 degree elevation 70 degree depressions in vertical plane. The monitors shall be achieved by remote control from control room.

Two nos of positive displacement pump have been provided. At a time one pump will be running and other will be acting as stand by. The Capacity of each pump 21.6 m^3/hr at 16kg/cm^2

19.18.9 Foam Compound Induction

Foam compound induction system is in line with balanced pressure proportioning type to ensure proper mixing of foam concentrate and right proportion and supply the same to the monitor line depending upon the water flow rate necessary automatic valve, spool valve and duplex pressure gauge have been provided to ensure 0 to 6% of foam compound induction.

Induction rate is set at 3% foam compound induction.

19.18.10 Water / Foam Tower Monitor at Berth B

The monitor shall be suitable for both sea water and foam, each monitor shall be capable of discharging 6000 lpm of sea water and 36000 lpm of expanded foam at 7 Kg.cm2 over a range of 75 meters in horizontal direction and 35 meters range in vertical direction. The monitor shall be capable of producing good quality of finished foam.

Horizontal range of monitor – 75 meters

The monitor shall be capable of 360 degree rotation in either direction in horizontal plane Elevation – (+) 85 and (-) 45. The monitors shall be achieved by remote control panel near pantry in open area.

19.18.11 Foam supply system at Berth B

Foam supply system shall be operated by manually, located near Foam Tank, Foam supply system located at approximately 50 meters away from Berth B central platform. Since the pipeline will always be under pressure for throwing water / foam through the monitor:

One No foam solution storage tank is provided at south side of berth B with capacity of 16KL.

Foam pumps – 2 Nos (01 No stand by)
Each pump discharge capacity is – 37m^3/hr

Two nos of positive displacement pump have been provided. At a time one pump will be running and other will be acting as stand by. The Capacity of each pump 37 m^3/hr at 16kg/cm^2

19.18.12 Foam Compound Induction

Foam compound induction system is in line with balanced pressure proportioning type to ensure proper mixing of foam concentrate and right proportion and supply the same to the monitor line depending upon the water flow rate necessary automatic valve, spool valve and duplex pressure gauge have been provided to ensure 0 to 6% of foam compound induction.

Induction rate is set at 3% foam compound induction.

19.18.13 Foam Trolley

Foam trolley is firefighting equipment ready to use initial level in case of fire, oil spillage in dyke.

Foam trolley capacity – 200 liters Discharge
capacity – 225 lpm

Total – 8Nos of foam trolley available in field.

- Berth A – 2 Nos
- Berth B – 2 Nos
- Pig Area – 3 Nos
- SWI - 1 No

19.18.14 Ground Fixed Water cum Foam Monitors

Fixed foam monitors are ready for instant use in case of emergency and are able to discharge dense foam from orifice type foam nozzle. The discharge capacity of monitor is
2850 lpm
Monitor having facility to discharge water for cooling purpose, all fixed foam monitors are having 200 liters foam drum ready to use by monitor pick up tube.

Total – 4 Nos

- Pig Area – 2 Nos
- Berth B – 2 Nos

19.18.15 Fire Extinguisher

Portable Fire Extinguishers are the first aid of fire fighting equipments. All fire extinguishers installed in the jetty premises are clearly visible and accessible.

At Berth A

- DCP 75 Kg –4 Nos • DCP 50 Kg –2 Nos • DCP 10 Kg –6 Nos

At Berth B

- DCP 75 Kg –4 Nos
- DCP 10 Kg –6 Nos
- CO2 6.5 Kg –2 Nos

Other jetty area locations are also equipped with fire extinguishers

19.18.16 Innergen Total Flooding System

Innergen Total Flooding System has been designed for protection of MTCB floor underneath cabling and DCS instrument panels. It is automatic fire extinguishing flooding system. The contents of gas are (52% nitrogen gas, 40% argon gas, 8% CO_2 gas)

The system is kept in both auto / manual mode operation. There are 12 Innergen gas cylinders which are pressurized to 200 bar at 20 Degree Centigrade for fire protection system.

Innergen Total Flooding system is divided in five different Zones.

Zone 01 & 02: is instrumentation room, Ground Floor MTCB (There are 6 Nos discharge nozzle of Innergen System)

Zone 3: is panel room right side (There is 1 No discharge nozzle of Innergen System)

Zone 4: is panel room left side (There is 1 No discharge nozzle of Innergen System)

Zone 5: is Battery Room Ground Floor MTCB (There is 1 No discharge nozzle of Innergen System)

The system has been put in manual mode.

19.18.17 Manual Call Point (MCP)

MCPs have been installed in premises in different accessible & visible locations like:

- Berth A
- Pig Station
- Around MTCB Building
- SIW & Berth
- All MCP are indentified with Zebra cross red and yellow

In case of Emergency Alarm to be raised MCP glass should be used.
Total 69 Nos of MCPs are in premises connected to DCS panel. On activation of any one MCP alarm will be blow on DCS

- Berth A – 13 Nos
- Berth B – 6 Nos
- Pig Area – 7 Nos
- MTCB – 6 Nos
- SWI / SS – 12 Nos
- Road / Tresle / KPT – 25 Nos

19.18.18 Smoke Detectors

Smoke detectors have been provided inside building (MTCB) cable cellar room, electrical panel room, instrument panel room.

Due to availability smoke particles detector will get activated. Fed Red Becon & hooter will start and on DCS alarm will be sounded repeatedly.

Total No of Smoke Detectors – 68 Nos

19.18.19 Fixed Gas Detectors

Fixed gas detectors have been installed in the jetty premises where most critical hazardous zone is identified.

Fixed hydrocarbon detector detects the hydrocarbon vapours available in the atmosphere and it gives pre explosion alarm. The alarm is set at 10% of LEL.

Total No of Gas detectors – 25 Nos

- Berth A – 6 Nos
- Berth B – 6 Nos
- Pig Area – 5 Nos
- SWI / (H2)/ MTCB – 8 Nos

19.18.20 Life Saving Appliances

1. Life Buoy Ring – Life buoy ring with 30 meters 8 Inch Nylon rope have been installed in entire jetty premises. Total No of Life Buoy – 29 Nos

2. Life Work West – Life work vest have been installed in emergency almirah at berth A and Berth B and also installed at central platform of berth and SWI. Total No of Life Work Vest – 18 Nos

3. Life Jacket – Life jacket is available with the terminal whenever persons go to the SPM / Sea shore side life jacket has to be worn. Total No of Life jacket – 12 Nos

19.18.21 Emergency Escape Breathing Device (EEBD)

Emergency Escape Breathing Device is used to escape from place where emergency arises and it is difficult to reach a muster point / safe place, same shall be used in such emergency.

EEBD is ready to use for 15 minutes to see the person can be reached to safest place with normal breath.

Total Nos of EEBD – 5 Nos

- Berth A – 1 No
- Berth B – 1 No
- Pig Area – 1 No
- SWI – 1 No
- Store – 1 No

19.18.22 Breathing Apparatus Set (BA Set)

B A set is to be used in such emergency where it is difficult to breath during rescue operation. Fire Fighting, Toxic gas release, and Flammable gas in atmosphere.

B A set has been installed in jetty premises where it is most hazardous so it can be used immediately whenever necessary.

Total No of B A set – 6 Nos & 2 Nos Spare Air Cylinder

Emergency Almirah Berth A – 2 Nos

- SWI – 2 Nos
- MTCB – 1 No
- Store – 1 No

19.18.23 First Aid Box

First Aid Box is distinctively marked with a red cross on a white background. First aid box is kept in prominent place. Custodians of the first aid boxes are qualified first abiders only.

The names of the first aiders are displayed at the notice board of the control room.

The first aiders are available in each shift.

First aid box available at site – 8 Nos

First box location available in jetty premises and their locations are:

- MTCB – 1 No
- Berth A – 1 No
- Berth B – 2 Nos
- SWI – 1 No
- Security Gate – 1 No
- 70 – 1 – 1 No • 76 – 2 – 1 No

19.18.24 Portable Safety Instrument

1. Area Monitor – Area monitor is available in control room. It is used for continuous monitoring of hydrocarbon vapors in atmosphere. The area monitor lowest alarm is set at 5% of LEL on reaching this range area monitor will be sounding with high volume.

   Area monitor is used in hot work area where the most critical hazardous area are identified such as Berth A / Berth B

2. Portable Multi Gas Detector – Multi gas detector is always available in control room and in the field with the fire men. Whenever any hot work permit is issued by SIC, Safety team checks the area and residual hazardous of concerned location and ensures that no hydrocarbon vapor is in the atmosphere. Stand by fire man continuously monitors and makes sure that the LEL always is 0%.

3. Chlorine Meter – The device is widely used for check the work environment before entering the chlorination room / area.

4. H_2S Meter – Very useful device for working crew for confined space work. I.e. Vessel, Tank & nearby hazardous area for continuous monitoring work environment.

5. Oxygen Resuscitator – It is a medical equipment and to give oxygen to casualty by trained person.

19.18.25 Chlorination System at SWI

Chlorine gas is most toxic and corrosive gas. In case of leak and in coming in contact with the skin irritation starts, inhalation is most dangerous if more than 15ppm it will be IDLH (Immediate Danger Life & Health)

Chlorine tonners have been laid down at chlorination system for chlorine injection in sea water line which is going to refinery.

3 Nos of fixed chlorine detectors have been provided at three different locations.
1 No Caustic Soda Tank capacity 8000 Liters with blower and hood

Hood provided on running cylinder, the detector laid would sense 0.5ppm in case of a leak. The blower starts automatically.

Chlorine containment kit & 2 Nos BA set is available in the SWI store.

19.18.26 Chlorine Kit

It is used for containment of chlorine gas in case chlorine leakage from the tonner valve assembly, plug or from body.

Work Permit System

Any routine work, testing of equipment, inspection, schedule maintenance, concern has to take work permit for particular job. SIC will make sure that before issuing work permit receiver must have completed TBRA & TBEA and also tool box talk.

- Hot work permit
- Cold work permit
- Electrical Isolation & restoration
- Confined space entry permit
- Vehicle entry check sheet
- Photography permit check sheet
- Isolation of fire fighting network
- Radiography check sheet.

19.19 Off Shore DMP of Indian Oil Corporation (Vadinar)

19.19.1 Introduction of Facility

Indian Oil Corporation (IOC) Ltd (Pipelines Division) owns and operates two offshore oil terminals in the Gulf of Kutch at Vadinar. The terminals are intended to handle the combined throughput requirement of its three refineries at Koyali, Mathura and Panipat. The oil terminal facilities comprise of two nos. Single Point Mooring (SPM) systems for moorings of tankers, off-shore /on-shore pipelines, the shore terminal comprising of 13 nos. of floating roof tanks with the total storage capacity of about one million tone and originating pumping station through which crude is pumped to the refineries at Koyali, Mathura and Panipat through the Salaya -Viramgam, Viramgam - Koyali, Viramgam-Chaksu, Chaksu-Mathura and Chaksu-Panipat pipeline system.

The offshore oil facilities are connected to the shore tanks by means of 1067 mm (42”) dia. submarine pipeline of about 5.3 KM for SPM-I and 6.3 Km for SPM-II followed by twin 1067 mm (42”) dia. onshore pipelines of 5.7 KM length each. Another 2.1 Km loop line of 1067 mm (42”) dia. is also laid to interconnect the Pipe Line End Manifolds (PLEM) of both SPMs to facilitate shore based pigging operation of both offshore and onshore pipeline. A sketch showing the above is enclosed as Annexure-I. For operational flexibility, sub-sea isolation valves are provided at suitable locations. The tankers berthed at SPMs discharge the crude oil through two strings of floating hoses connected between the tanker manifold and SPMs, and two strings of submarine hoses connected between SPMs and the PLEM located at the end of the submarine pipeline at the seabed.

This off shore oil terminal in Gulf of Kutch near Vadinar together with its cross-country pipeline system to the refineries can be termed as a vital energy artery of the Western Region catering to the energy requirement of the entire Northwest region of the country.

19.19.2 Location of the SPM Terminal

The SPM facilities are situated within the territorial water of DEENDAYAL PORT TRUST(KPT). SPM-I is situated at Latitude 20o 30' 34" N and Longitude 69o 42' 04" E and SPM-II is situated at Latitude 220 30' 14.36" N and longitude 69o 40' 53.60" E.

The drafts available at SPMs are 34.9 meters and 32.5 meters for SPM-I & SPM-II respectively. The KPT provides the infra structure as well as Pilotage facility for operating this terminal. The entry channel of approximately 126 km (70 Nautical miles) in the Gulf of Kutch is identified for the navigation of vessels by KPT.

A zone of 3.6 Km (2 nautical miles) around each SPM has been declared as the "No Anchorage Zone" and no vessel is allowed to anchor in this area to prevent fouling of their anchors with our SPM anchor chains or sub-sea hoses and the pipeline.

Hardware Details of SPM System at Vadinar

Sr No	**Parameters**	**SPM – 1**	**SPM – 1**
1	Capacity of Tankers to be	3,00,000 DWT	3,15,000 DWT
	handled		
2	Mean Sea Level	34.9 MTR	32.5 MTR
3	Geographical Co – ordinates	LAT: 20º 30’ 34 “ N LONG: 69º 42’ 04 “ E	LAT: 22 º 30’ 14.36 “ N LONG: 69º 40’ 53.6 “ E
4	Year of Commissioning	August - 1978	March - 1997
5	Off - Shore Line	5.3 KM	6.3 KM
	Loop Line Between SPM-I & SPM-II Is 2.1 Kms		
Hose Configuration			
(A) Floating Hose			
1	24” X 40’ Half Float Hose	01 No in each String	01 No in each String
2	24” X 40’ Decreasing Stiffness Hose	01 No in each String	01 No in each String
3	24” X 40’ Standard Full Float Hose	21 Nos in STBD String & 22 Nos in Port String	20 Nos in STBD String & 21 Nos in Port String
4	Metallic Reducer	01 No in each String	01 No in each String
5	20” X 40’ Full Float Hose	01 No in each String	01 No in each String
6	20”-16” X 40’ Tapered Hose	01 No in each String	01 No in each String
7	16” X 35’ Full Float Hose	02 Nos in each String	02 Nos in each String
8	16” X 30’ Tanker Rail Hose	01 No in each String	01 No in each String

	Total Length in Meters in each string	Port STR: 331.83 STBD STR: 324.11	Port STR: 336.32 STBD STR: 324.13
(B) Submarine Hoses			
1	20" X 40' Carcass Double Submarine Hose	------	04 Nos in each String
2	20" X 37.5' Carcass Double Submarine Hose	04 Nos in each String	------
3	20" X 35' Carcass Double Submarine Hose	04 Nos in each String	04 Nos in each String
	Total Length in Meters in each String	OFF.SH : 44.20 ON. SH : 44.20	OFF.SH : 45.72 ON. SH : 45.72
	Type of Plem Valve Actuator	Rotary Vane	Spring Loaded

19.19.3 Tanker Operation

Tankers can be unloaded simultaneously from both the SPMs and any one SPM. The details of tanker operation are described below:

Pilots of KPT bring the tanker near SPM. There are two strings of floating hoses of 610 mm (24") dia for each SPM which are lifted by the crane of the tanker for connecting to tanker manifold. When the tankers are not there, these floating hoses are floating on sea and at the ends of the strings, butterfly valves are used to close/ blind the line and additionally blinds are fitted to avoid spillage of oil. Once the floating hose strings are connected to the tanker, the system is ready for discharge of cargo through SPM system.

Before commencement of discharge of the tankers, ullaging of the tanker is done and in the meanwhile shore tanks are also aligned and tank valves are operated for receipt of cargo into shore tanks. The inlet and outlet valves of the shore tanks are motor operated and can be closed within five minutes in case of any emergency or after the discharge of the tanker is over. KPT provides the tug for pull back operation to avoid tankers overriding the SPM buoy, under buoy hoses etc. to prevent damage to the buoy and oil pollution.

Further during the operation of the tanker, there is a constant watch on the SPM system and the hoses for any leakage or burst and the operating parameters are kept well within the designed limits besides observing all safety aspects for the safety of the tanker, buoy and its accessories. The work of connecting and disconnecting hoses and repair of lines has been given on contract. During discharge operations technical personnel from following agencies are always available:

- DEENDAYAL PORT TRUST
- IOC Salaya Mathura Pipeline (SMPL), Vadinar.

- M/S Underwater Services, Mumbai
- Crude Oil Tanker

There are isolating valves provided for isolation of the floating strings and under buoy hose strings for use in any emergency arising out of failure of hose or burst of hose during operation to prevent oil loss, pollution and to sustain operation through the other string. Thus by meticulously following the international marine standards of operations and maintenance the entire tanker discharge operation is kept totally spill proof.

Further the entire off-shore facilities are subjected to stringent inspection checks as per Oil Companies International Marine Forum (OCIMF) guidelines and rigorous preventive and schedule maintenance for the upkeep of the facilities/ equipment is done in order to avoid any unforeseen instances of hose burst, leaks or any other eventualities which may result in either small or large scale oil spills in the ocean.

19.19.4 Definition of Oil Spill Management

Accidental and unwanted discharge of crude oil in the sea during the operation of SPM system including accidental spillage, if any, from the oil tankers may be termed as an oil spill resulting into pollution of marine environment.

The oil spill may be minor, intermediate or major in nature depending upon the source and duration of the oil spill.

19.19.5 Oil Spill Classification

Oil spill can be broadly categorized into three categories depending upon the volume and area of oil spill, which has taken place. These three categories of oil spill are generally classified as Tier one, two and three and each Tier will require response strategies to suit its magnitude and manifestations as mentioned below:

TIER ONE

This would be a spill of a magnitude the local resources could respond to, successfully without assistance from other agencies.

TIER TWO

This would be a spill of a magnitude that would outstrip the local resources and would require assistance on a regional basis. This would either come from local/central Government or Local Industries Mutual Aid arrangement.

TIER THREE

This would be a spill of a magnitude that would surpass the capabilities of Tier one and Tier two. Additional resources would be required on a national and international level.

Clearly Tier one and Tier two levels of response equipment and manpower resources are governed by a number of criteria. These criteria are such as location, logistics for national and international assistance, nearby sensitivities and many others.

The following classification has been made as per OISD norms:

Tier Level	**Volume**
Tier –1	Up to 100 MT
Tier – 2	100 MT – 1000 MT
Tier – 3	More than 1000 MT

19.19.6 Risk Analysis & Causes of Spill

Accidental spill from tankers contribute an estimated 0.4 million tons annually globally. Analysis of tanker spills occurring throughout world shows that the majority occurs in port during routine ship operations such as loading, discharge and bunkering. The most of these spills are, however, relatively small. Over 92% are less than 7 tones and probably in total, contribute less than 20000 ton annually. In comparison, accidents, such as collisions and grounding give rise to less than 10% of oil spills from tankers, but a quarter of these are larger than 700 tons.

19.19.7 Spills Due to Collision

The statistical data shows that as a percentage of the total no. of incident, collision account for 5% of oil spill regardless of the quantity of oil released. The classification based on size of the spill shows more alarming statistics with 29% of all large spills (> 700 tons) being due to a collision. Almost 21% of the sizable spills involving the release of between 7 and 700 tons are due to collisions. Small spills of less than 50 barrel (7 tons) from a collision account for less than 2% of total.

19.19.8 Spills Due to Grounding

A similar analysis of statistical data shows that although as a percentage of the total incidence spills due to grounding are rather small, accounting for only 5.2 %. A different picture emerges when the quantities involved are scrutinized. Large spills of more than 700 tones caused by grounding account for 33% of all releases of that magnitude. Off the sizable spill between 7 - 700 tones about 18 % are a direct result of grounding. The small spills of up to 7 tones are fairly insignificant and are 2.7 % of the total spills in that category.

It is prudent to assume that in any collision or grounding, spill quantity may be more than 700 tones.

19.19.9 Most Likely Spills

The most likely maximum spill can result from a central compartment of a tanker being ruptured at the bottom of the hull releasing most of its contents. Quantities in the order of 7000 tones are therefore more probable due to the release of an assumed 90 % of the contents of a center tank of a typical 175,000 DWT single skin fully laden tanker ruptured due to grounding.

19.19.10 Collision with another Vessel

A collision with another vessel causing a tank to rupture will release only the contents of the tank above the water line. The ensuing spill caused by a gash in the tank resulting from a surface collision will release near about 1750 tones. Therefore the spill quantities in both the above scenarios pertaining to rupture due to collision and a bottom gash resulting from grounding are to be 1750 - 7000 tones when a single tank has been damaged.

19.19.11 Oil Spilled into Sea

Oil spilled into the sea undergoes a number of physical and chemical changes, some of which lead to its disappearances from the sea surface whilst others cause it to persist. The time taken depends primarily upon the physical and chemical characteristics of the oil, as well as the quantity involved, the prevailing climate and sea conditions and whether the oil remains at sea or is washed ashore.

In considering the fate of spilled oil at sea, a distinction is frequently made between nonpersistent oil, which tend to disappear rapidly from the sea surface, and persistent oil, which in contrast, dissipates more slowly and usually requires a clean-up response. Most crude oils and refined residual oils have varying degree of persistent depending upon their physical properties and size of the spill. The main physical properties, which affect the behavior of oil spilled at sea, are specific gravity, distillation characteristics, viscosity and pour point.

19.19.12 Most Small Oil Spills

Most spills will in fact be small, involving less than two tones and will occur mostly when the hose system failed at the terminal. This can usually be dealt with swiftly and efficiently by the terminal operator. Major spills are fortunately considered rare with estimated probabilities between one in 100 years to One in 220 years. In the event of such a large spill at the Gulf of Kutch efforts can be made either to contain and collect the oil using booms and skimmers, or to disperse it using chemical dispersant which are spread either from marine craft using side booms or aircraft (similar to crop spraying).

If oil is washed ashore on a hard sand beach, for instance, it can be quickly and effectively cleared by manual labour with the aid of trucks and bulldozers.

In some cases, bio-degradation method may be applied using bacteria to digest the oilwhich can halve the time that natural forces would take to achieve the same result. However, natural forces usually degrade any oil, which cannot be cleaned up, and such forces are exceptionally strong at the Gulf of Kutch and the effects of a pollution incident are rarely long term.

19.19.13 Impact of Second SPM at Vadinar

The second SPM was commissioned during March'97 at Vadinar location. Obviously this has an impact on the requirement for pollution preparedness.

It is felt that there will be an increase in the likelihood of a spill rather than the possible volume of oil spill. This position comes from the facts mentioned below:

Increase in vessel traffic.

Doubling of hoses, joints and other possible points of failure and Increases in connections and disconnection of hoses etc.

19.20 Responsibility during Emergency

The basic responsibility of combating oil spill disaster and marine pollution lies with the local port authority within its port jurisdiction and the defaulter companies/ organizations.

19.21 Chief Coordinator (Location Head, WRPL Vadinar)

a. On getting information of oil spill, he will report to KPT authority and other resource agencies.

b. He will co-ordinate all activities through Chief Operation Manager and Maintenance Manager (Marine).

c. He will ensure that appropriate response and techniques are in action to clean up pollutants.

d. He will ensure that all the resource agencies have been duly reported about incident.

e. He will apprise Head of WRPL about the incident and actions undertaken.

f. He will make arrangements for disposal of oil as per the directive of Regional Commander (West).

g. He will be responsible for the resumption of Operations at SPM terminal.

h. He will contact IOC (Shipping) and seek assistance required to meet the emergency.

19.22 Roles of IOC in Controlling Oil Spill Disaster

19.22.1 IOC Vadinar

a. To assist KPT off shore oil terminal, and Coast Guard Vadinar action group, in implementation of local action plan.

b. To assist KPT, Vadinar and Coast Guard Vadinar in obtaining additional available equipment and chemicals from identified resources if and when required.

c. To assist in chartering/hiring of tankers to undertake transportation/ transshipment operation if so required by KPT.

d. To arrange for storage of oil transshipped as above.

e. To make assessment of the value of the oil transshipped.

19.22.2 IOC Shipping New Delhi

a. To arrange for chartering tankers for Vadinar as required.

19.22.3 Indian Coast Guard – Central Coordinating Authority

a. To receive the report of significant spillage of oil at sea.

b. To keep the Ministry of Defense apprised of the development on receipt of information about oil spill.

c. To decide upon the nature and extent of actions required and to advise the Regional Headquarters/Local Action Groups/authorities concerned regarding the action to be taken by the latter in consultation with Apex Committee on Control of Marine Pollution/Task Force on oil spills.

d. To arrange for chartering of any tankers for oil transshipment operations, if required.

e. If the resources available with the Regional Headquarters / Port authorities/other agencies, Local Action Group/authorities are inadequate, to mobilize all available and necessary resources and direct the same towards the concerned Regional Headquarters/Local Action Groups/authorities.

Regional Coast Guard Commanders (RCC)

a. Receiving reports of oil pollution at sea.

b. Coordinating the activities of RCC when activated.

c. Keeping the Director General, Coast Guard apprised of developments.

d. Processing and coordinating claims of the affected parties and participating agencies with a view to compilation for processing by Director General Shipping.

e. Mobilizing Coast Guard resources to support On Scene Commander (OSC) action at spill area.

f. Maintaining the Regional Contingency Plan (RCP) and forward revised plans to members as may be required by RCC.

g. Receiving periodic reports from resource agencies on account of Pollution Equipment and material with a view to have an upto date inventory list in the Coast Guard western Region, Eastern Region and Andaman and Nicobar Region.

h. Providing the administrative infrastructure to the RCC for conduct of routine and operational tasks.

i. Providing additional sampling effort during spills when requested by OSC.

j. Maintaining a list of national and international agencies that may be called upon to assist for pollution response at the discretion of RCC.

k. Arranging for periodical exercise in pollution response.

l. Providing sensor data to RCC/OSC as required.

m. Pre-designating a Coast Guard OSC.

19.22.4 Responsibility of Port Authority

The port authorities will be responsible for response to accident / oil spill within Port Limits keeping the coast guard regional commander informed and request for any additional assistance through the Regional Communication/Operations Centers. The detailed responsibilities are as follows:

a. To arrange for the preparation of a local contingency plan in consultation with Regional Head Quarter/Central Coordinating Authority.

b. To identify a suitable sea going tug when required for operations

c. To identify surface crafts

- On which dispersant spraying equipment can be mounted and
- Which can be used for rigging the booms

d. To ensure that the purpose of part-XIII of Merchant Shipping Act, 1958, actions are taken by the various authorities under the overall legal receiver of the wrecks and dock concerned.

e. To ensure that at least following minimum equipment is kept available locally at all time:

Inflatable booms

Dispersant spraying equipments capable of being mounted on surface craft.

Suitable dispersant chemicals of the nature and quantity estimated as requirement of Local Action Group as part of the local contingency plan.

Oil skimmer equipment

a. Surface crafts on which above dispersant equipment can be mounted and which can be used for rigging booms etc.

b. To arrange for training of personnel expected to be engaged in above operation.

c. To arrange for periodic exercise under the guidance of the RCC to keep equipment and personnel on continuous readiness for oil spill response operation.

d. To consult the Coast Guard or Director General Shipping or any other authority, when further advice/assistance is required.

e. To keep the Coast Guard appraised of actions being taken.

19.22.5 Responsibility of Boarding Officer

a. Inform Chief Crisis Coordinator / Alternate Chief Crisis Coordinator, Maintenance Manager (Marine), IOC Control room, Marine Department about the oil spill incident.

b. Stop the cargo or slow down the cargo as may be the case and accordingly isolate the affected portion causing the oil spill.

c. Instruct the O&M contractor to fight the oil spill & locate the source of oil spill and coordinate with various agencies for oil spill containment.
d. To carry out the water flushing of the SPM system as per the requirement in coordination with IOC control room.

19.22.6 Reporting & Alerting Procedure

After knowing major oil spill, Chief Coordinator, IOCL is to report the same immediately to KPT authority who in turn will inform Commander Coast Guard Region (West). Besides informing KPT, Chief Coordinator, IOCL should inform DC, Jamnagar, Forest Department Jamnagar and Gujarat Pollution Control Board Jamnagar, Gandhinagar regarding the incident.

19.22.7 Handling SPM Emergency

In case of any burst or leakage in floating / under buoy hoses or in any system of SPM, is noticed by the master or Deputy Officer or Our Boarding officer or any other person, the above incident should be immediately brought to the notice of Master/ Deputy Officer of the Ship. On getting the information, the discharging operation should be immediately stopped and the IOC control room at Vadinar should be informed through VHF channel 12 and 07 (US) about the stoppage of oil discharge. The master of the ship/ IOC Boarding officer with the help of crew members of ship and supporting contract vessel of IOC should try to assess where the spill is coming from and try to contain the spill by means of deploying booms available with the ship/contract vessels of IOC. Procedure to be adopted in case of leakage from following is as detailed below:

19.22.8 Floating Hose

- Stop discharge.
- Close the butterfly valve near tanker manifold and isolation valve near SPM.
- Contain the leak
- Further operation can be done only after replacement of burst/leaked hose or hoses

19.22.9 Under Bouy Hose

- Stop discharge.
- Close the PLEM valve of the leaking line.
- Contain the leak
- Further operation can be done only after replacement of burst/leaked hose or hoses.

19.22.10 Central Swivel Leak

If the leak is not controllable then

- Cast-off the vessel.
- Contain the leak.
- Arrest the leak.
- Re-berth the vessel.
- Restart operation.

19.22.11 Central Swivel Leak

The officer on board of the vessel can decide in consultation with pilot/master of the vessel whether the ship can continue at berth. If necessary, arrangement should be made to replace the damaged mooring rope.

19.22.12 Damage to Buoy

It is due to overriding of tanker. The officer on board of the vessel can decide in consultation with the pilot/master of the vessel whether the ship can continue at berth.

19.22.13 Pollution Control near SPM

a. The master of the vessel will be informed about the oil spillage by boarding officer. The master in turn will contact the port signal station, which is provided with VHF channels 16, 12, 10 and 07 (US) and give a detailed report of the incidence to KPT.

b. The signal station in turn will inform the Chief Operation Manager (COM) Offshore Oil Terminal (OOT) KPT.

c. Boarding officer will also inform IOC shore control room/ marine department through VHF and IOC control room in turn will inform the incident to CMNM / Chief Coordinator, IOCL, Vadinar.

d. Upon receipt of information from port signal station, COM, KPT will direct all the crafts presently posted at Vadinar to combat the oil spill within port limit.

e. The tug / launches of KPT should carry sufficient quantity of dispersant before leaving Vadinar jetty.

f. Since the flow of underwater current around Vadinar coast is very high, usage of oil skimmer to recover oil from any leakage from SPM and other floating hoses is not much effective, hence the pollution control near SPM done presently is limited to spray of dispersant.

19.22.14 Typical Case of Oil Spill Combating at Vadinar

In case of any accidental oil spill in and around SPM following action plan is to be brought to effect immediately in line with the disaster plan in association with KPT.

1. Reporting:

a. On getting any information about oil spill noticed by the Master or the Duty Officer of the vessel, or Boarding Officer of IOC on board, working SPM Maintenance Contractor, Coast Guard patrol party, KPT pilot or any other person, the above incident should be brought to the notice of the Master / Duty Officer of the ship. On getting any such information, the discharging operation should immediately be suspended and the IOC tank farm which is also available on VHF channel 12 and 07 (US) should be immediately informed about the stoppage of discharge.

b. On getting such information from Boarding Officers, the shift in charge in IOC shore control room shall inform the incident to Chief Coordinator, IOCL, Vadinar and the necessary line isolation from ship to shore tank farm should be ensured by closing necessary valves.

c. The master or the Boarding Officer of the vessel should contact the Port Signal Station which is provided with VHF channel 16,12,10 and 07 (US) and give a detailed first hand information report of the incident.

d. The Signal Station, in turn, should inform the COM, KPT. COM, KPT may in turn pass on the information to their authorities and Coast Guard etc.

e. IOC officer on board should also pass on the information to location head Vadinar through IOC control room on VHF channel and check back with COM, KPT for confirmation of the message receipt through Port Signal Station.

f. Chief Coordinator, IOCL, Vadinar will immediately establish contact with ED WRPL Gauridad and pass on the first hand information report besides informing the incident to statutory bodies like Gujarat Pollution Control Board (GPCB) and Forest Department / National Marine Park authorities.

2. Alerting:

a. COM, KPT will direct the crafts posted at Vadinar to proceed to SPM and during the passage rig-up the dispersant spraying booms.

b. IOC, Vadinar should ask its maintenance contract vessel to be ready for deployment of spill combating facilities on board at short notice on demand from COM, KPT.

c. Small tug available with SPM maintenance contractor should also be put on alert for deployment, if so demanded by KPT for replenishment of oil dispersant and other support services.

3. Operational Requirements:

a. In view of the strong current experienced at Vadinar only dispersant may be sprayed by 3 tugs of KPT while the fourth craft would be busy in replenishing her stock of dispersant chemicals from the storage provided at Vadinar jetty.

b. The Master of harbour tugs / launches should ensure that sufficient quantity of dispersant chemical is carried out on board prior to leaving the jetty.

c. In view of the strong currents experienced at Vadinar and the location of the SPM, Commander TMS Hayes, Advisor on Marine Pollution, International Maritime Organization in his Mission Report has indicated that it will not be possible to contain the oil spill and use a skimmer to collect oil. He therefore has recommended that the KPT should equip at least three crafts with dispersant spraying units. Accordingly, the Port had provided only the dispersant spraying equipments for use at Vadinar.

4. Execution:

The craft should move downstream of the oil spill and then start streaming up against the current while carrying out spray of dispersant chemicals with a systematic run over the oil spill, till the total spill gets dispersed.

5. Support Services:

IOC shall assist KPT and Coast Guard in

a. Implementing the local action plan.

b. In obtaining additional equipments and chemicals from HQs of KPT and Coast Guard, if and when required.

c. Chartering of tankers to undertake transportation / transshipment operation if so required by KPT.

d. Arranging for the storage of oil transported at shore and

e. Making assessment of the value of the oil transshipped.

6. Claims:

In case the oil spill in and around SPM terminal is due to any problem of tanker or any negligence from tanker operation crew, following steps should be taken for claim, which will be done by DC / COM, KPT.

COM, KPT should inform the Master of the Vessel holding him responsible for the spillage/pollution and also steps taken by the Port to combat the oil spill and for cleaning operations and the charges thereof as per rules.

Record of all expenditures towards the use of port craft / tugs / dispersant chemicals / port vehicles and any other material should be maintained by the DC / COM, KPT for subsequent recovery from the Master/Agent of the ship, prior to her departure.

7. Final Report :

The detailed report of the oil spill in chronological order supported with available data/records will be prepared by KPT and sent to respective Organizations including IOC. However necessary reports for informing IOC official should be prepared by Chief Coordinator, IOCL, and Vadinar. He will also submit necessary reports to statutory bodies like Gujarat Pollution Control Board, Forest Department/National Marine Park authorities.

19.22.15 Relationship with Coast Guard & Port Trust

The Indian Coast Guard and Port Trust along with IOC would be among the main organization involved in the more practical aspects of oil spill response at Vadinar terminal.

It has been therefore, the endeavor of KPT / IOCL / ESSAR / Indian coast Guard to ensure that good working relationship, understanding of individuals, operating procedure are developed and understood before the high pressure environment of spill response prevents the building of such ties.

All relationship with the Indian Coast Guard has been undertaken with the knowledge that in the National Disaster Plan it states that ICG is the controlling body for all oil spill response activities.

19.23 Oil Spill Equipment Available with IOCL Vadinar

Sr.No	Item Description	Qty
01	Inter Tidal Boom	600 mm
02	Coastal Boom	600 mm
03	Disc Skimmer	1No
04	Mop Skimmer	1No

05	Dispersant Spray Sets	2 Sets
06	On Shore Cleaning System	1 No
07	Floating Tank $25m^3$	2 Nos
08	Floating Tank $12.5m^3$	4 Nos
09	Off Loading Pump	1 No

19.24 Oil Spill Consumables Available with IOCL Vadinar

Sr.No	Item Description	Qty
01	Oil Spill Dispersant	9800 Liter
02	Oil absorbent pillow (1.5'x1'x5")	72 Nos
03	Oil absorbent boom (length-10'x dia-7")	120 Nos
04	Oil absorbent sheet (1.5'x1.5')	760 Nos

19.25 Imp Telephone Nos of Govt Officials related to Oil Spill Combating

Sr No	Description	Telephone No		Fax Number
		Office	Residence	
1	District Collector Jamnagar (0288)	2555869	2554059 09427306210	
2	Collector Office Jamnagar (0288)	2557601 – 5	------	2555899
3	Superintendent of Police Jamnagar (0288)	2554203	2555868 09427305071	2556382
4	Municipal Fire Station Jamnagar (0288)	2550101	------	------
5	Regional Officer Gujarat Pollution Control Board Jamnagar (0288)	2752366	2540741	2753540
6	Conservator of Forest Jamnagar (0288)	2552077	2553327 09425049064	2679371

7	Police outpost Vadinar (02833)	256541	------	------
8	KPT Control Tower Vadinar (02833)		------	------
9	Deputy Superintendent of Police, Khambalia (02833)	234262	234726	234262
10	Deputy Collector, Khambalia (02833)	234577	234714	234577
11	Commander Coast Guard, Porbandar (0286)	2241794 /2240958	2244234	2244056
12	Gujarat Pollution Control Board, Gandhinagar, (079)	23222756 /23222095	------	23232156
13	Chief Conservator of Forest Gandhinagar, (079)	23254123	------	23229917
14	Director Environment, Govt. of Gujarat. Gandhinagar, (079)	23251062	------	23252156
15	CG, Station Vadinar	256560 /256579	256534	256560
16	COM, KPT, Vadinar	256749	256522	256540
17	Head (Environment), RIL, (Mr. Kannan)	95288-3012152		952833-3012199
18	RPL, Port Operation Center			
19	Mundra (Port operation Center)	02838288201 to 288207, 02838220033		95288-288270

19.26 Important Telephone Nos of VOTL Marine Operations

Sr No	NAME	DESIG	TEL (OFF)	MOBILE NO.
1.	Capt Deepak Sachdeva	Chief Operations Officer	02833-241777	9925153618
2.	Capt. Alok Kumar	Port Captain		9909908611
3.	Commandt. Raghuvanam	Head- Port Facility Security	02833-241780	9909021183
4.	V. Gopalakrishnan	Admin Officer	02833-241779	9979891335
5.	Control room	Shift -in charge	02833-241775	9979868460
6.	Control room fax		02833-241779	

19.27 Emergency Telephone Nos of outside agencies including District Authorities

19.27.1 Fire Station

SL No	Dept. Name / Officer's Name	Office	Resident
1	Inspector CISF (02833)	256542	-

2	Municipal Jamnagar (0288)	2550340 2550101 2675091 101	2550340

19.27.2 SHO (Police)

SL No	Dept. Name / Officer's Name	Office	Resident
1	District Superintendant of Police	2554203	2555868
2	Deputy Superintendant of Police	2552940	2542970
3	Police Control Room	100 2550200	-
4	Police Inspector, City 'A' Division	2550243	2676667
5	Police Inspector, City 'B' Division	2550244	2550315
6	Police Inspector, Panchkoshi 'A' Division	2550359	-
7	Police Inspector, Panchkoshi 'B' Division	2676556	-
8	Dhrol	02897- 222033	-
7	Dy. SP Khambhaliya Police Inspector Circle	234726	
8	Office, Khambhaliya	234744	

19.27.3 Collectorate

SL No	Dept. Name / Officer's Name	Office	Resident
1	Collector Shree & District Magistrate Shree	2555869	2554059
2	Additional Collector Shree	2550284	2672131
3	Resident Deputy Collector Shree	2553183	2556102

4	Sub divisional Magistrate Shree	2552130	2552807
5	Mamlatdar Shree (City)	2674575	2660950
6	Collector Control Room	2553404	-
7	Circuit House, Lal Bungalow	2550237-38	-
8	Deputy Collector, Khambhaliya	234577	

19.27.4 District Authority

SL No	Dept. Name / Officer's Name	Office	Resident
1	District Development Officer	2553901	2552402
2	Deputy District Development Officer	2550221	2755070
3	District Health Officer	2671097	2756252

19.27.5 Forest Department

SL No	Dept. Name / Officer's Name	Office	Resident
1	Conservator of Forest Marine National Park	2552077	2552327
2	Deputy Conservator of Forest Marine National Park	2552077	2679374
3	Deputy Conservator of Forest (Distribution)	2553664	2559787
4	Deputy Conservator of Forest (Common)	2553026	2554387

19.27.6 Port Department

SL No	Dept. Name / Officer's Name	Office	Resident
1	Port Officer - Bedi Port	2670207	2556106
2	Port Office - Okha	262001	262010

19.27.7 Railway Station

SL No	Dept. Name / Officer's Name	Office	Resident
1	Railway Inquiry - Jamnagar	2755222	-
2	Railway Inquiry - Hapa	2570410	-
3	Officer, Railway Station - Jamnagar	2755169	-
4	Officer, Railway Station - Hapa	2570410	-

19.27.8 Airport Office

SL No	Dept. Name / Officer's Name	Office	Resident
1	Airport Officer	2712187 2712413	2560252 2560262
2	Indian Airlines - Jamnagar	2550211	2554768

19.27.9 Station Transport

SL No	Dept. Name / Officer's Name	Office	Resident
1	S.T.Inquiry	2550270	-
2	Manager, S.T.Depo	2676904	-
3	Divisional Director - Jamnagar	2570608	2570486

19.27.10 Hospitals, Ambulance Sevas, Blood Banks & NGO's

Sr No	Dept. Name / Officer's Name	Telephone No

		Office	Residence
Hospital			
1	Guru Govindsinh Hospital (Emergency)	2661087 2550204-06	------
2	Samarpan Hospital	25566423 2712728	------
3	Mental Hospital	2712728	------
4	Dental Hospital	2750218	------
5	Ayurvedic Hospital	2550368	------
6	City Dispensary – Ranjit Road	2676456	------
7	Oswal Hospital	2562705 2566833 2676521	------
8	Adarsh Hospital	2665566	------
9	Jivandep Healthcare Pvt Ltd	2558176 2558275	------
10	KPT Primary Health Centre, Vadinar	256539	------
Ambulance Seva			
1	Fire Branch, Jamnagar Mahan agar Palikir	102	------
2	Aaryasamaj	2550220	------
3	Guru Govindsinh Hospital	2541081	------
4	Jilla Panchayat, Jamnagar	2550221	------
5	Taxi Association, Jamnagar	2560547	------
6	Mahavir Samaj Sevak Dal	2550225	------
Blood Bank			
1	Guru Govindsinh Hospital	2550227	------
2	J.H.M. Blood Bank	2550208	------

3	Deepchand Gardy Memorial Blood Bank	2672529	------
4	Omkar Charitable Trust Blood Bank	2673339	------
NGO			
1	Aandabawa Seva Sanstha	2540155	------
2	Kabir Ashram	2558049	------
3	Shree Pranami Seva Sanstha	2551353	------
4	Nawanagar Chamber of Commerce	2550250	------
5	Youth Hostel Association of India	2558040	------
6	Jamnagar Factory Owners Association	2560002	------
7	Jamnagar Brass Foundry Association	2730271	------
8	M.P.Shah Udyognagar Association	2550960	------
9	Kasturba Stree Vikasgruh	2751730	------
10	Indian Road Cross Society	2553583	------
11	Rotary Club	2550348	------
12	Lions Club	2673193	------
13	Jamnagar Vepari Mahamandal	2533185	------

19.28 Mutual Aid Members

Sr.No	Name of Mutal-Aid-Scheme Member	Telephone No. Office	Residence/ Mobile Nos.
1	Chairman - Collector	2555869 9978406210	2554059
2	Addl. Collector	2550284 99784 05182	2672131
3	Jt.Chairman - Commissioner,JMC	2552321	2552372

4	MR Prajapati - Secretary, MAS, GSFC	2432216	2712768/ 9979853306
5	RN Shah - Treasurer-MAS, GSFC	2432242	9979862520

6	MAS OFFICE	2542764	
7	Office of Supdt. of Police	2554203	2555868
8	Police Control Room - Jamnagar	2550200	2344249(Sikka) 2846125(Padana)
9	District Disaster Control Room	2553404 / 2541485/ 1077 (Toll Free)	9426950783 (DDMO) Mr.Yaswant Sinh Parmar
10	PB Shah ,Asst. DISH - Jamnagar	2678206	9824583767
11	Mr. Desai -Home Guard Jamnagar	2553862	
12	Dr. Gosai RMO - GG Hospital	2550240 /2541081	2551689 / 9824258885
13	Control Room GMB - Jamnagar	2711805 / 2756909	
14	KK Bisnoi - JMC CFO	2550340/101 (2662691)	9879531101
15	Indian Coast Guard - Vadinar	02833 - 256579	1090 (Terror Helpline Toll free)
16	Sanjay Goyal -IOCL Vadinar	02833 - 256330	9909909016
17	P Palanivelu- Jt. Secretary MAS,EOL	02833 - 241892	9825210517
18	PK Prasad - IOCL Theba	2570712	9426911475
19	HS Modha - Fire Officer	2344116	9925214054
20	Chetansinh Jadeja - Fire	2344272 -75/	9099038083

	Officer, SDCC	2439322 (Fire)	
21	V.Koti, VP(Fire) RIL	6611193	9998972008
22	D K Thakur Jt. Secretary-MAS-TCL	02892 - 665247	9227676113
23	Mr. Dipak Roy, Mgr.(O&M) - K Kumar AM - GSPL	9925013159 9879599464	
24	MJ Sunaria - Digjam Ltd.	2712972/73/74	
25	PB Sakharkar -GAIL	6611437	9624089696
26	Indian Navy- Valsura	2550263-357	
27	Indian Air Force, Jamnagar	2720007, Extn.4222(fire)	2550245
28	PR Thatte, VP Bharat Oman Refinery	02833 -256450	9427206501
29	MU Khan - Cairn India		966253945
30	For any Emergency Ambulance / Fire		108

19.29 Details of Fire Fighting Equipment at Vadinar

Sr.No	Description of system	Quantity
1	**Water Cum Foam Monitors**	
	Fixed Monitors	05 Nos.
	(1200/1500/1800/2580/3840) LPM	2138 lpm (475 gpm)
	Portable Monitors	02 Nos. (Fire Station)
	(1200/1500/2580/3840) LPM	1000 gpm (4500 lpm)
	Foam trolley tank capacity and Qty of AFFF in it.	3 No. of trolleys with 200 liters each.
2	**Hoses /Nozzles /Accessories**	
	Hose	152 No.

	Type	Type B
	Nozzles	
	Universal (Triple purpose) nozzle	33 No. Diffuser branches
	Jet nozzle (Standard branch)	60 Nos. of Aluminium and 6 no. of Gunmetal
	Fog nozzle	11 Nos.
	Foam branch (FB-5X)	07 Nos.
	Water curtain nozzle	01, Good
	Hose Boxes	64 Nos.
	Foam Concentrate (AFFF)	28000Ltrs(Min)
FIRE SIREN		
	Hand operated	02 Nos
	Electrical	03 Nos.
	Sand buckets with cover	30 Nos.
	Manual fire call points	13 Nos.
3	**Safety Equipment**	
	Explosimeter (make)	02 Nos (ENDEE GP200L)
	Fire proximity suit	11 Nos.
	Water gel blanket (expiry date)	01 No. (Expiry date Feb. 2010)
	Safety torch	10 Nos.
	Safety goggles	30 Nos.
	Red and Green Flags for drill	01 No each
	Breathing Apparatus Set (Indicate make)	07 Nos make DRAGER
	Spare Breathing Apparatus cylinder	06 Nos
4	**Fire Extinguishers**	
	CO_2 Type	66 Nos.
	2.0 Kg	28 Nos

	3.2Kg	10 Nos.
	4.5 Kg.	23 Nos.
	6.8 Kg.	05 Nos.
	DCP Type	148 Nos.
	5.0 Kg	28 Nos.
	10.0 Kg	116 Nos.
	75 Kg	04 Nos.
5	**Fixed Fire Fighitng Facilities**	
	Fire water pond/tank (no. and capacity)	3 no. ponds 6000 KL each.
	Foam tender with accessories	3 Nos
6	**Fire Fighting Engines**	
	Engine driven FF pump a) 385KL/Hr @ 88m b) 350 KL/Hr @ 88m	4 Nos 2 Nos
	Motor Driven FF pumpa) 385 KL/Hr @ 91mb) 350 KL/Hr @ 91m	1 No 2 Nos
	Jockey Pump 60 KL/Hr @ 120m	2 Nos

19.30 Details of Fire Fighting Equipment at Jamnagar

Sr.No	Description of system	Quantity
1	**Water Cum Foam Monitors**	
	Fixed Water Monitors	03 Nos.
	(1200/1500/1800/2580/3840) LPM	3500 lpm
	Fixed Water Cum Foam Monitors	03 Nos.
	(1200/1500/2580/3840) LPM	1200 lpm
2	**Hoses /Nozzles /Accessories**	

	Hose	15 Nos.
	Type	Type B
	NOZZLES	
	Universal (Triple purpose) nozzle	04 Nos. Diffuser branches
	Jet nozzle (Standard branch)	03 Nos.
	Fog nozzle	03 Nos.
	Foam branch (FB-5X)	03 Nos.
	Water curtain nozzle	02 Nos
	Hose Boxes	10 Nos.
	Foam Concentrate (AFFF)	5100 Liters
	Fire Siren	
	Hand operated	01 No.
	Electrical	01 No.
	Sand buckets with cover	24 No.
	Manual fire call points	06 Nos.
3	**Safety Equipment**	
	Explosimeter (make)	01 No. (ENDEE GP200L)
	Fire proximity suit	1 No.
	Water gel blanket (Expiry date)	01 No. (Expiry date Feb. 2010)
	Safety torch	02 Nos.
	Safety goggles	1 No.
	Red and Green Flags for drill	01 no. each
	Sand scoops	04 Nos.
	Stretcher	01 No.
	Breathing Apparatus Set (Indicate make)	01 No., make DRAGER
	Spare Breathing Apparatus cylinder	01 No.
4	**Fire Extinguishers**	

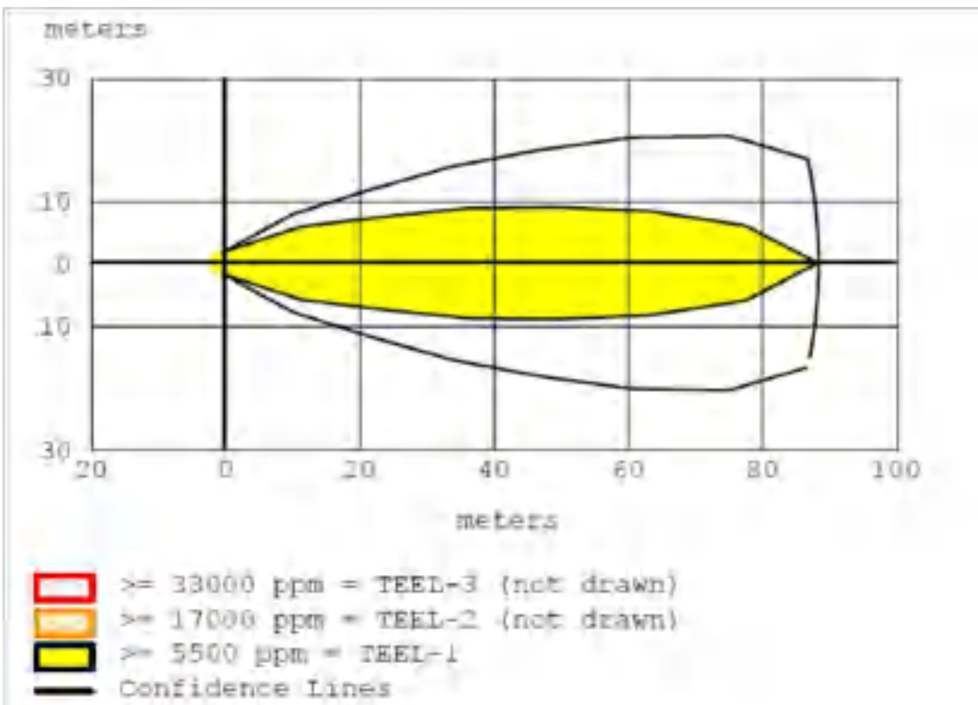
	CO_2 Type	33 Nos.
	2.0 Kg	13 Nos.
	3.2Kg	Nil
	4.5 Kg.	15 Nos.
	6.8 Kg.	05 Nos.
	DCP Type	27 Nos.
	5 Kg	01 No
	10 Kg	20 Nos.
	75 Kg	06 Nos.
5	**Fixed Fire Fighitng Facilities**	
	Fire Water Mains (size) and date of Pressure Testing	8" Dia tested on July'10
	Fire water pond/tank (no. and capacity)	2 nos above ground tanks of 700 KL each.
	Mainline pump shed fixed foam flooding system (Manual/auto)	Auto with UV/IR detectors
6	**Fire Fighting Engines**	
	Engine driven FF pumps (150 kl/hr @ 100M)	2 Nos
	Motor Driven FF pump (150 kl/hr @ 100M)	1 No
	Jockey Pump(10 kl/hr @ 100M)	1 No

20 ANNEXURES - GRAPHS

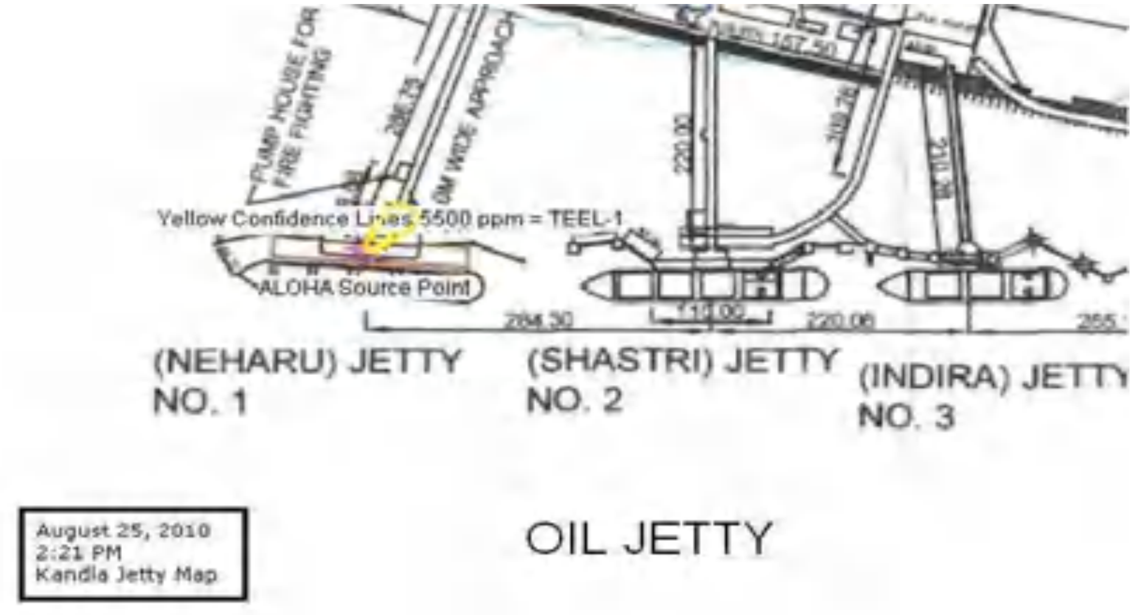
20.1 Graphs & Contours of various MCLS worked out at Jetty (Refer Chapter 4.7)

20.1.1 Jetty One – LPG

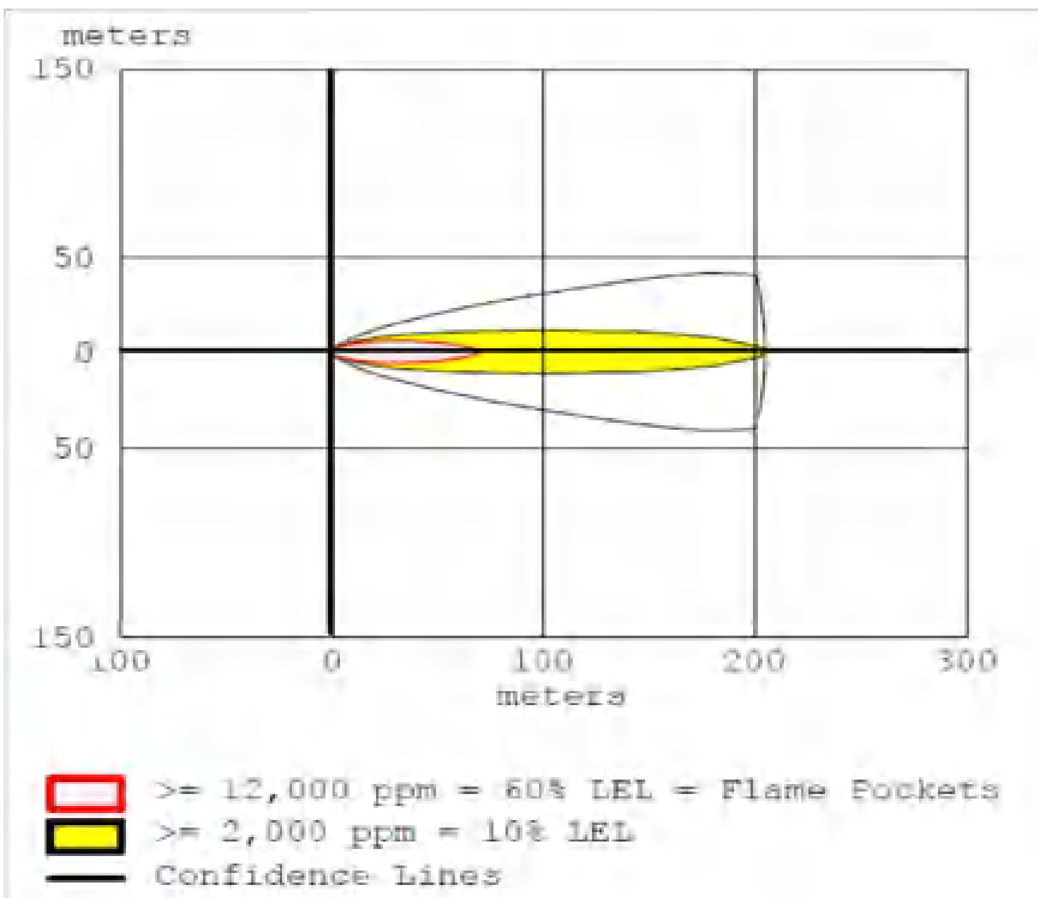
20.1.1.1 Instantaneous Release – Toxic Threat Zone (Graph)



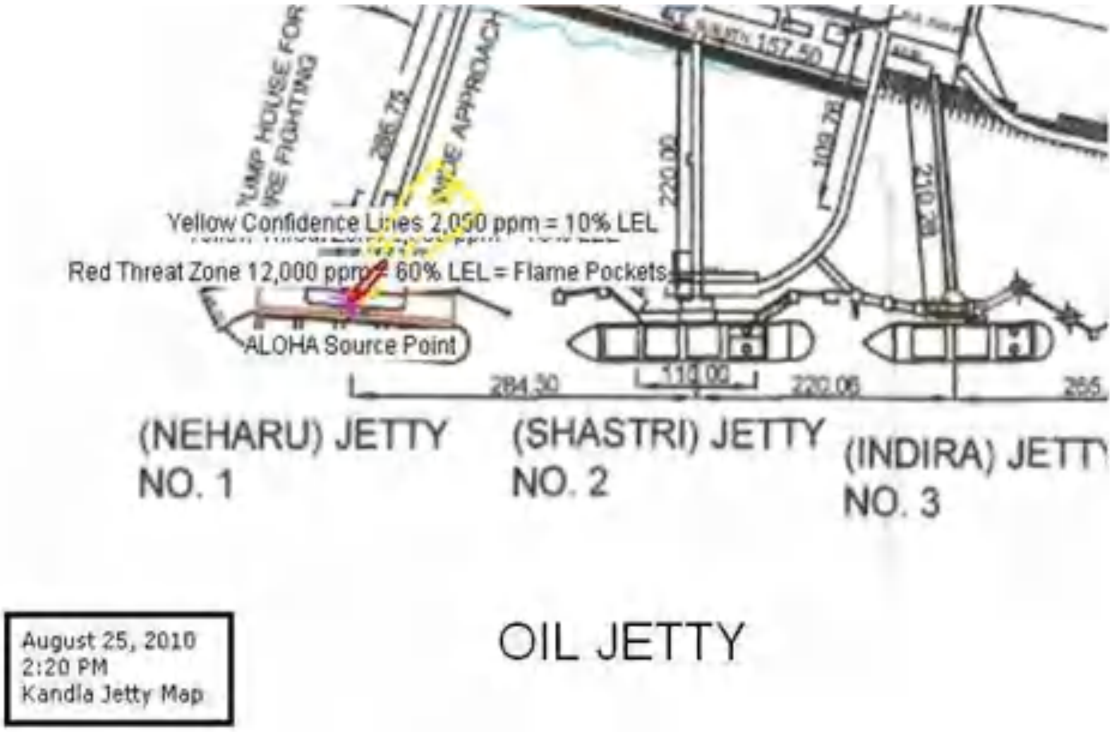
20.1.1.2 Instantaneous Release – Toxic Threat Zone (Contour)



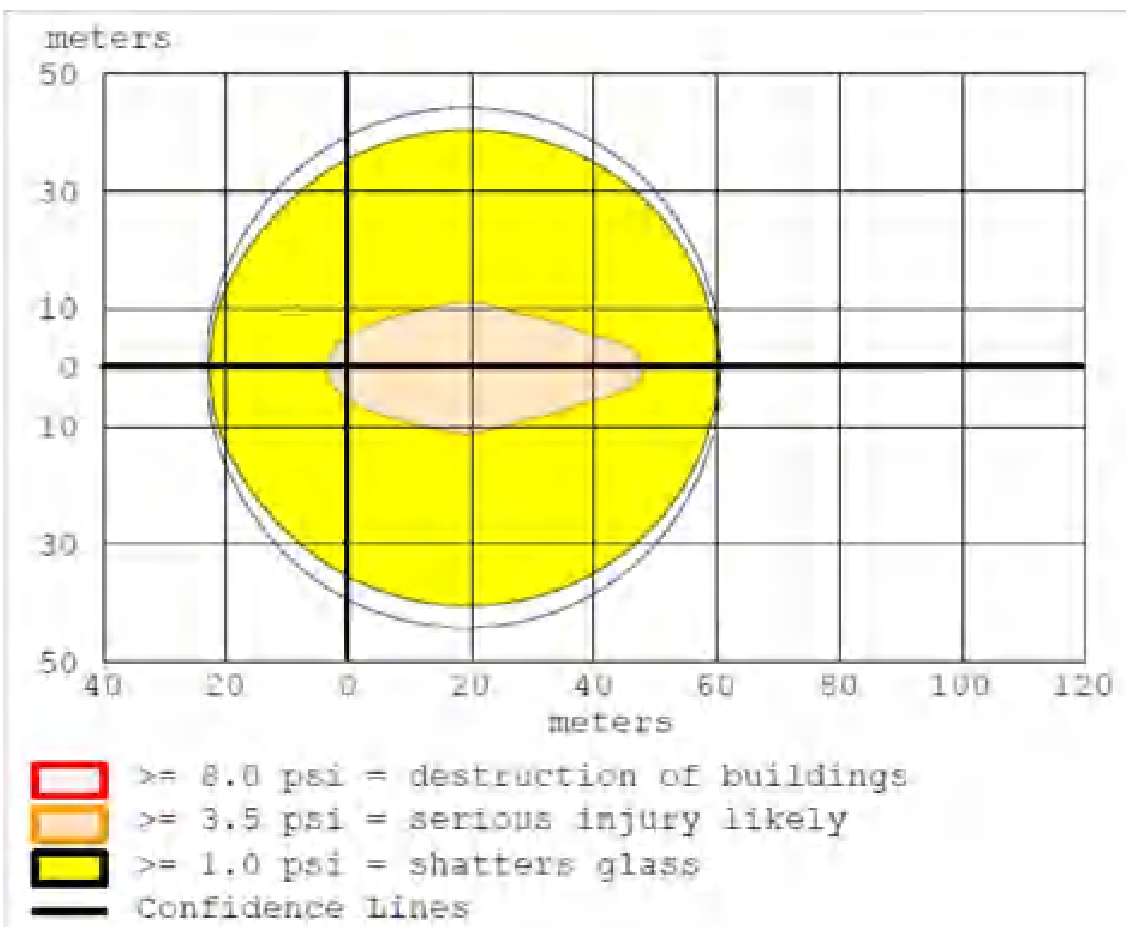
20.1.1.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



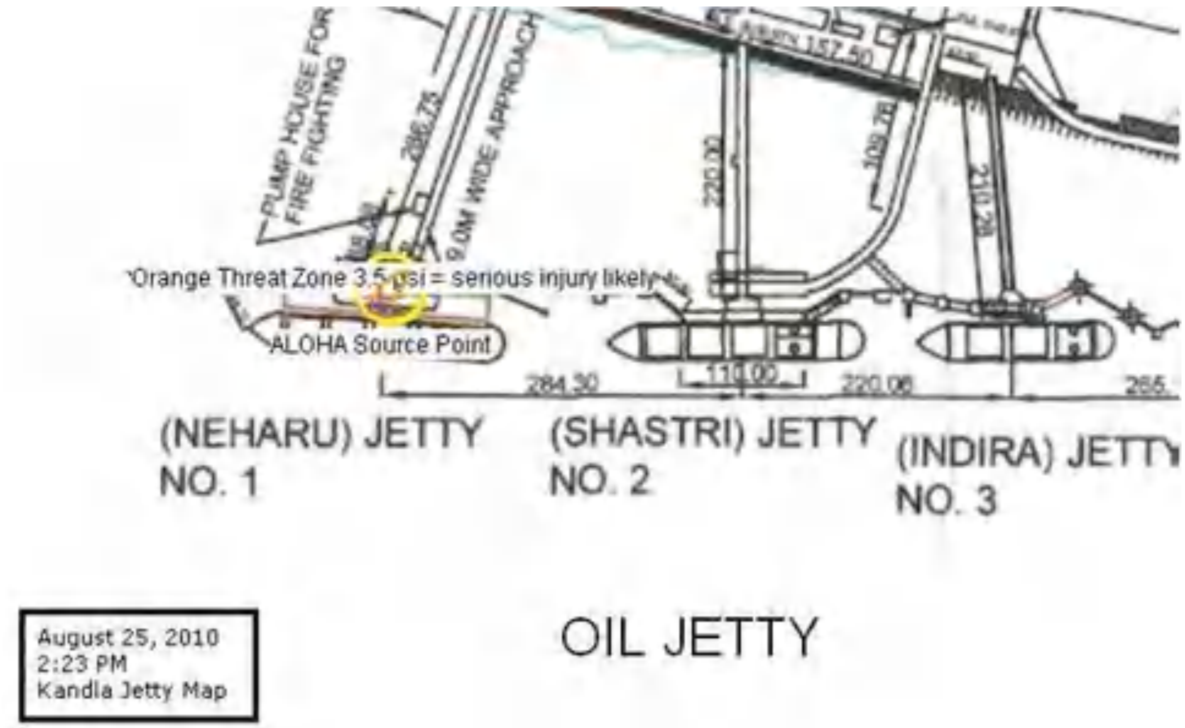
20.1.1.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



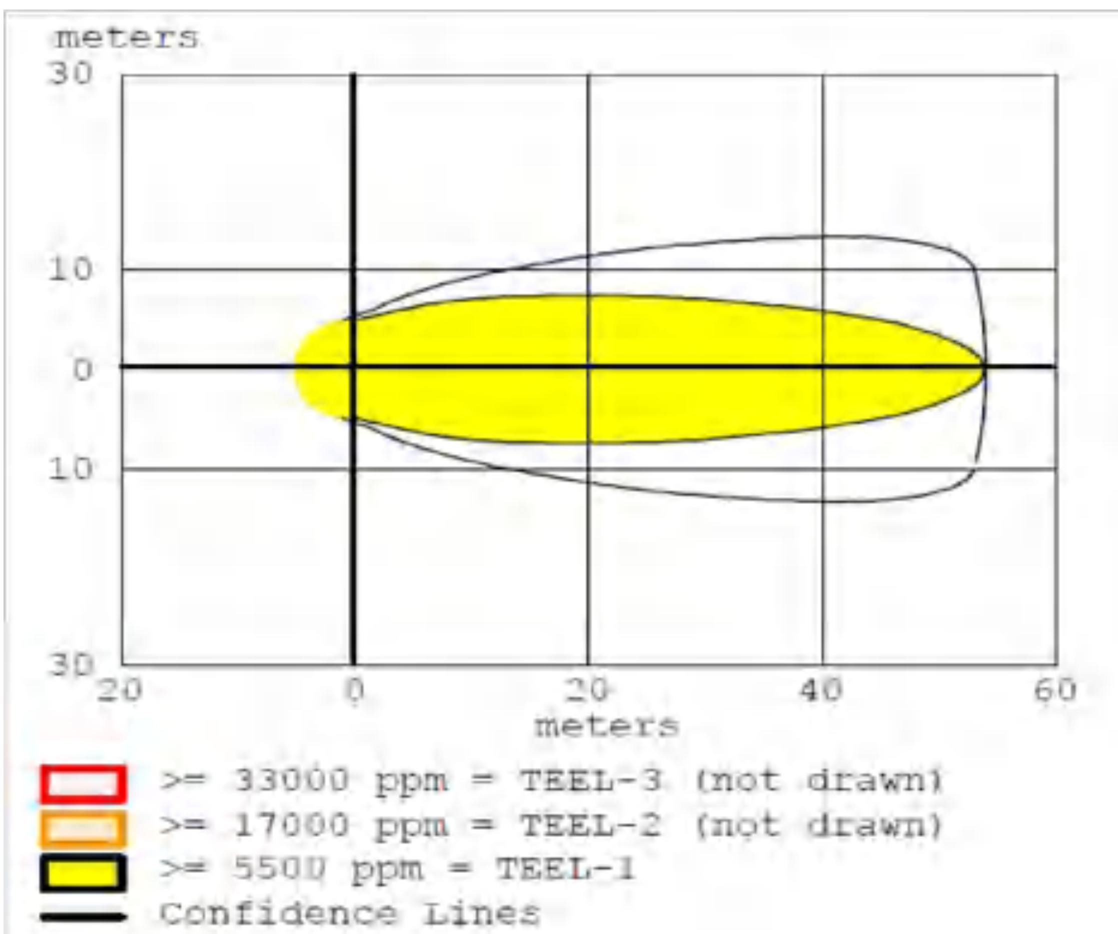
20.1.1.5 Instantaneous Release – Overpressure (Graph)



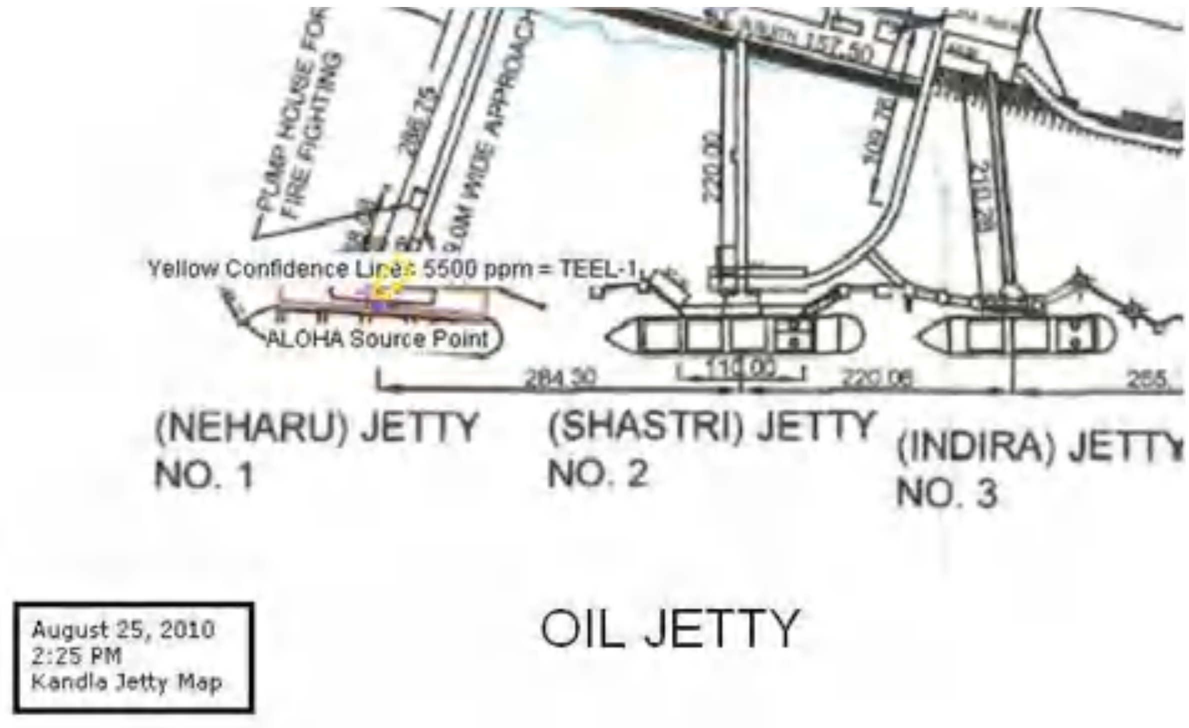
20.1.1.6 Instantaneous Release – Overpressure (Contour)



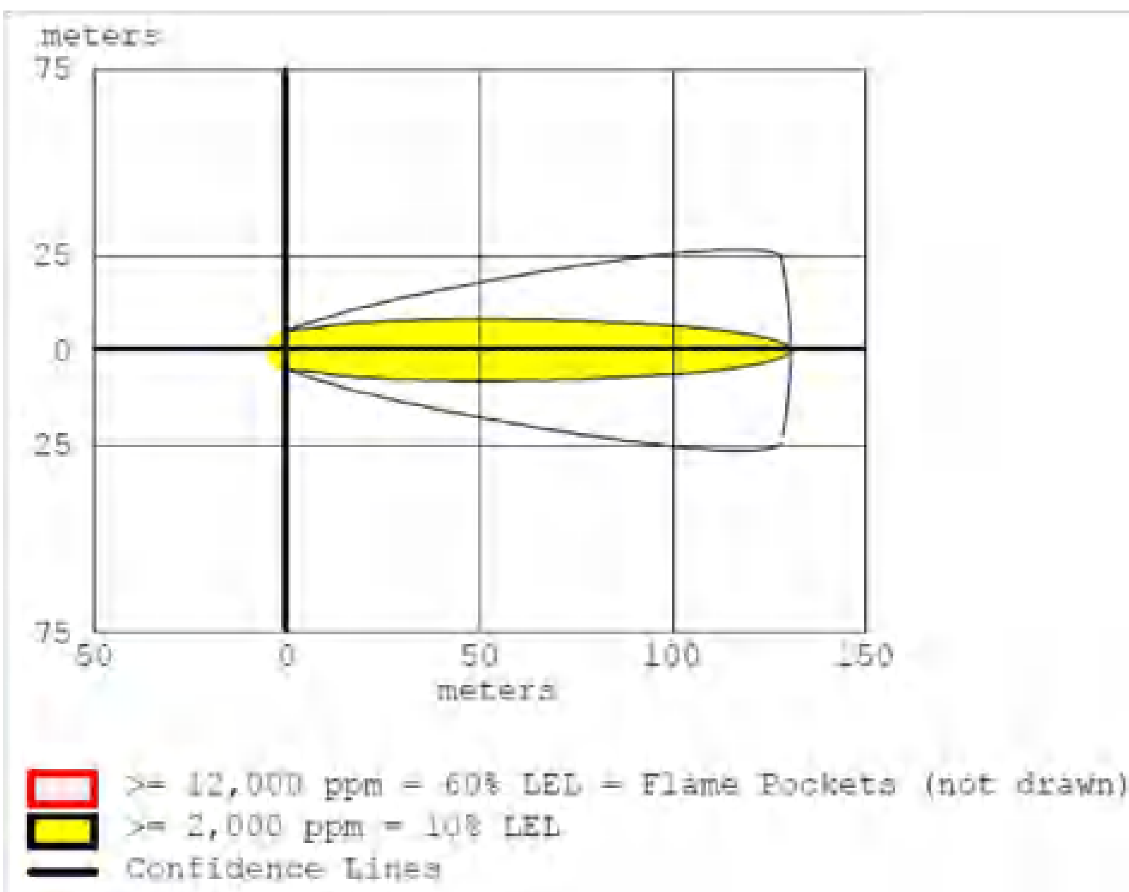
20.1.1.7 Evaporating Puddle – Toxic Threat Zone (Graph)



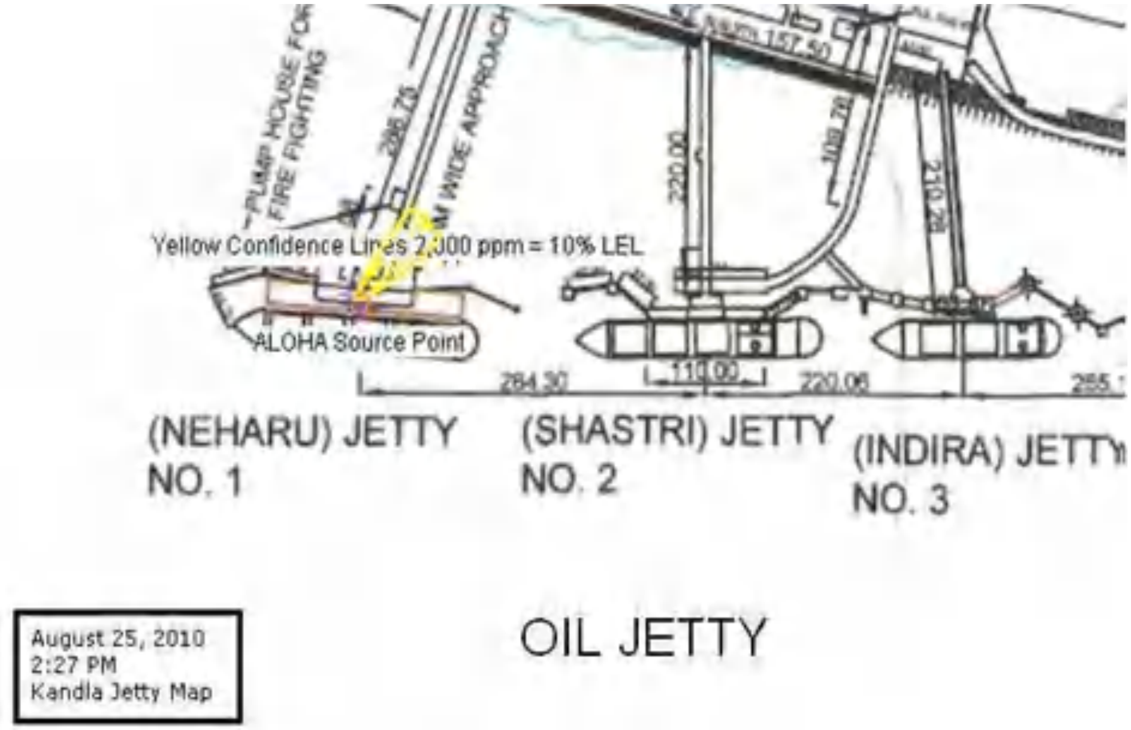
20.1.1.8 Evaporating Puddle – Toxic Threat Zone (Contour)



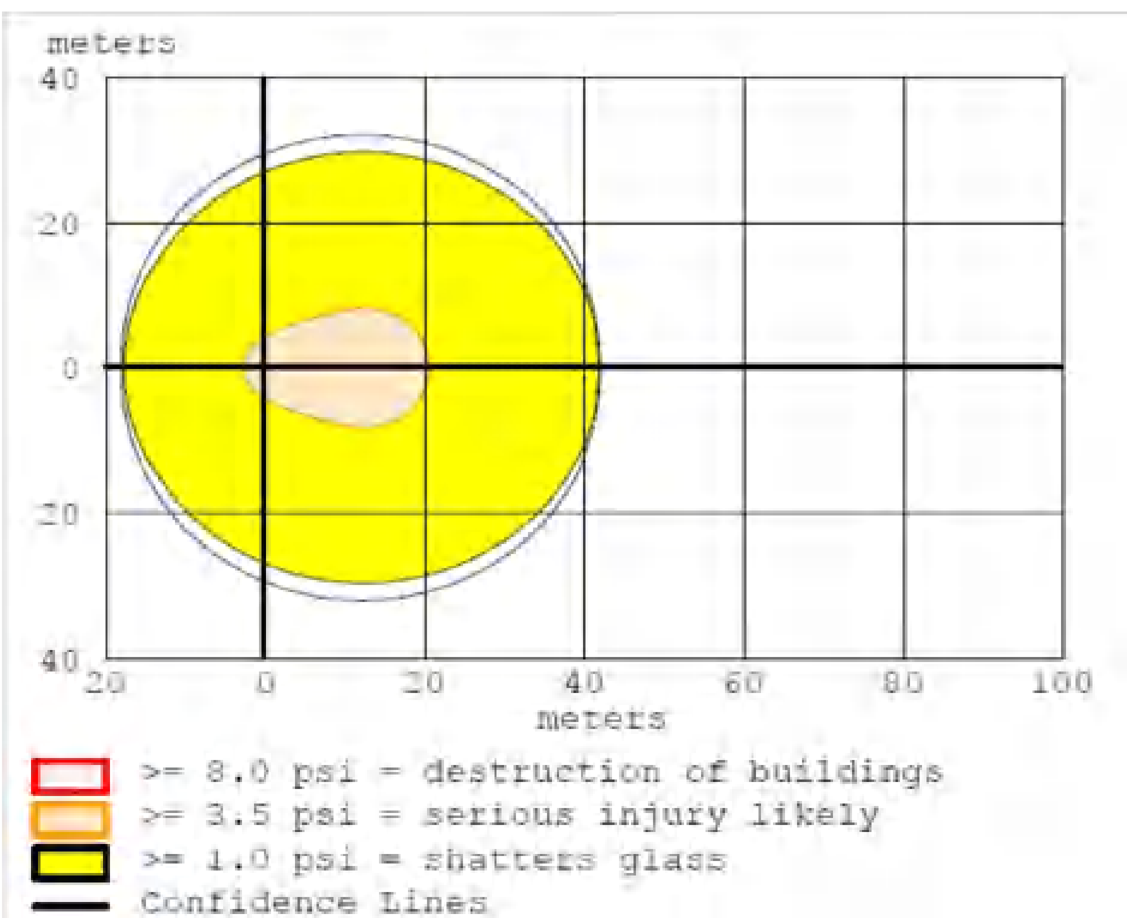
20.1.1.9 Evaporating Puddle – Flammable Area of Vapor Cloud (Graph)



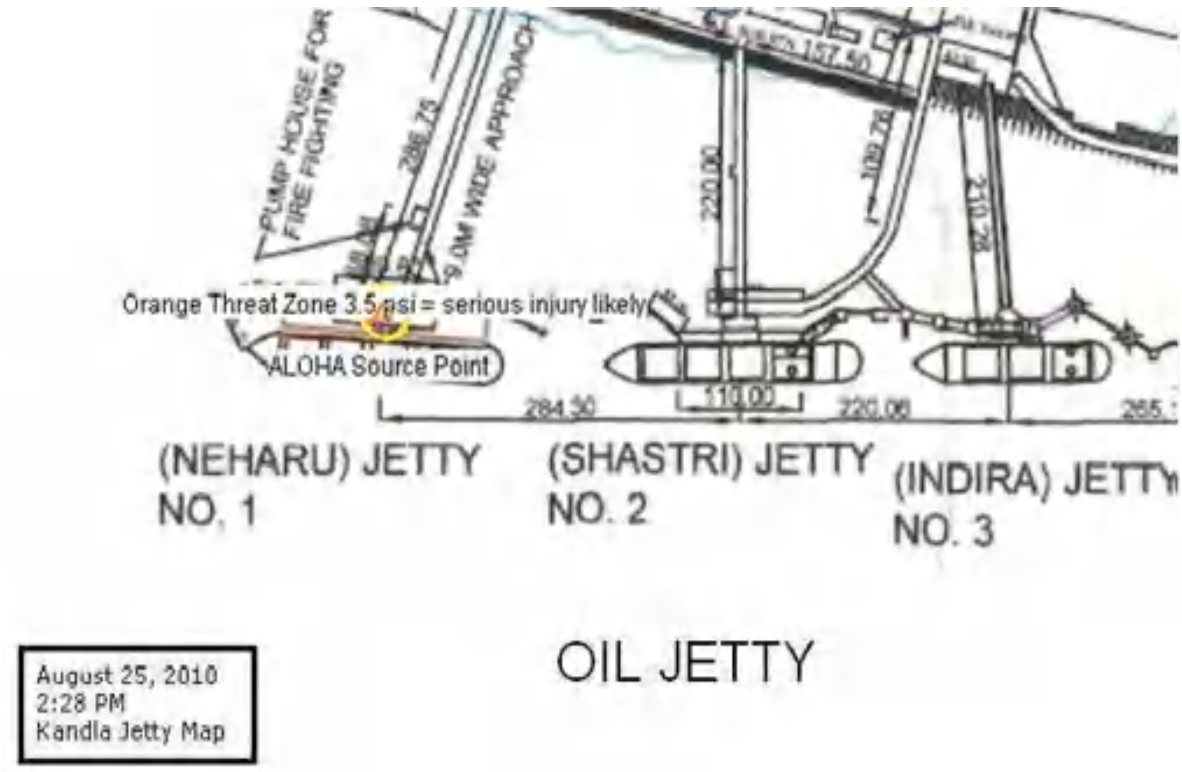
20.1.1.10 Evaporating Puddle – Flammable Area of Vapor Cloud (Contour)



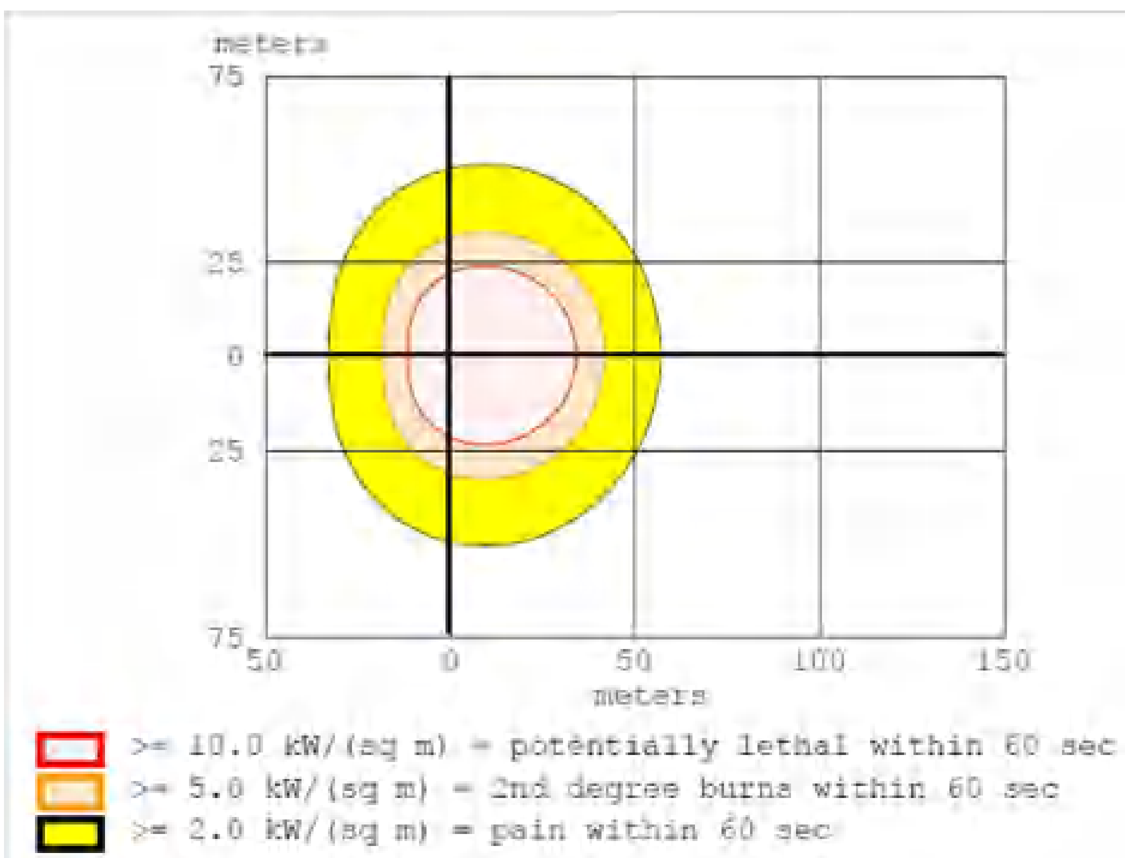
20.1.1.11 Evaporating Puddle – Overpressure (Graph)



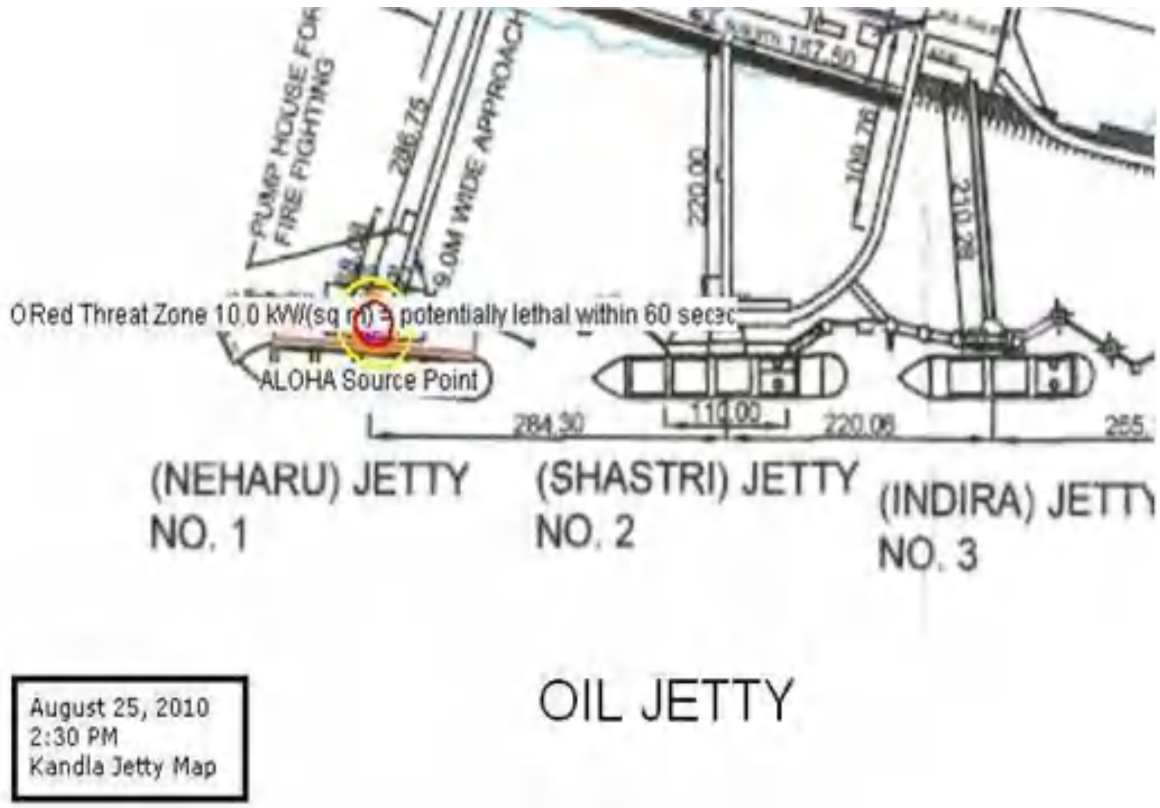
20.1.1.12 Evaporating Puddle – Overpressure (Contour)



20.1.1.13 Burning Puddle – Thermal Radiation (Graph)

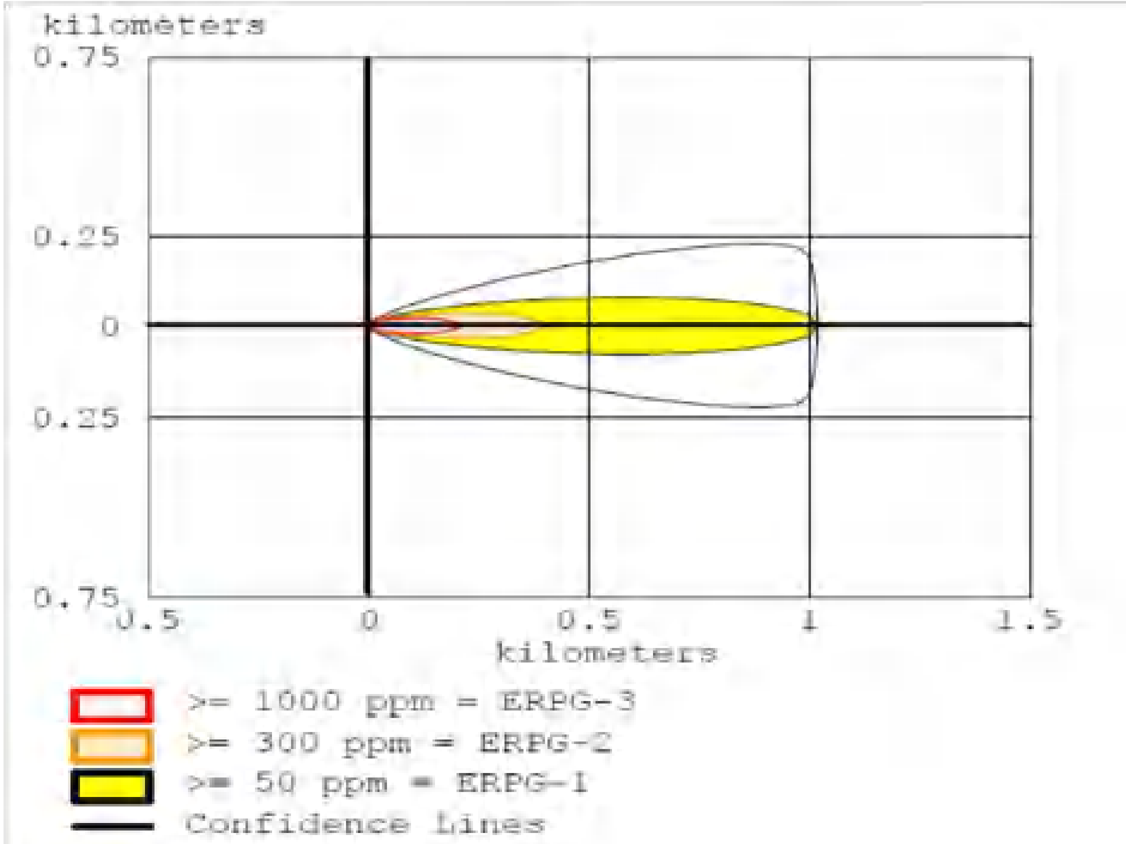


20.1.1.14 Burning Puddle – Thermal Radiation (Contour)

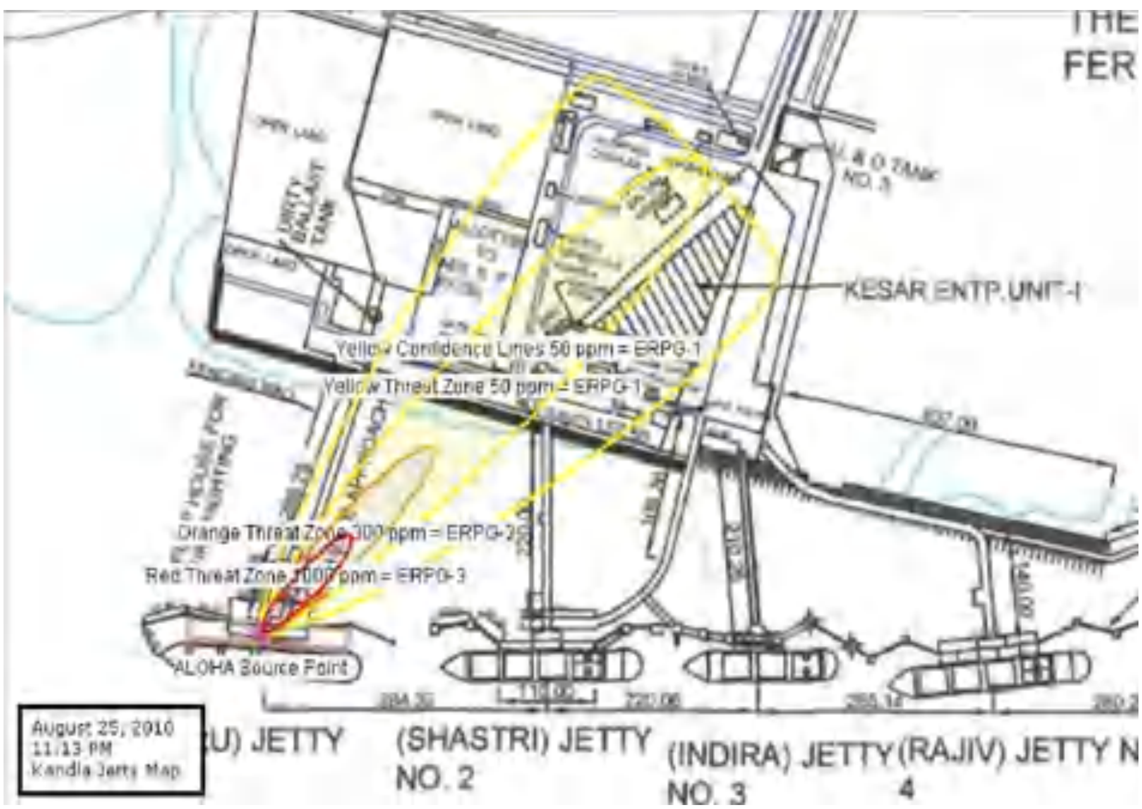


20.1.2 Jetty One – Toluene

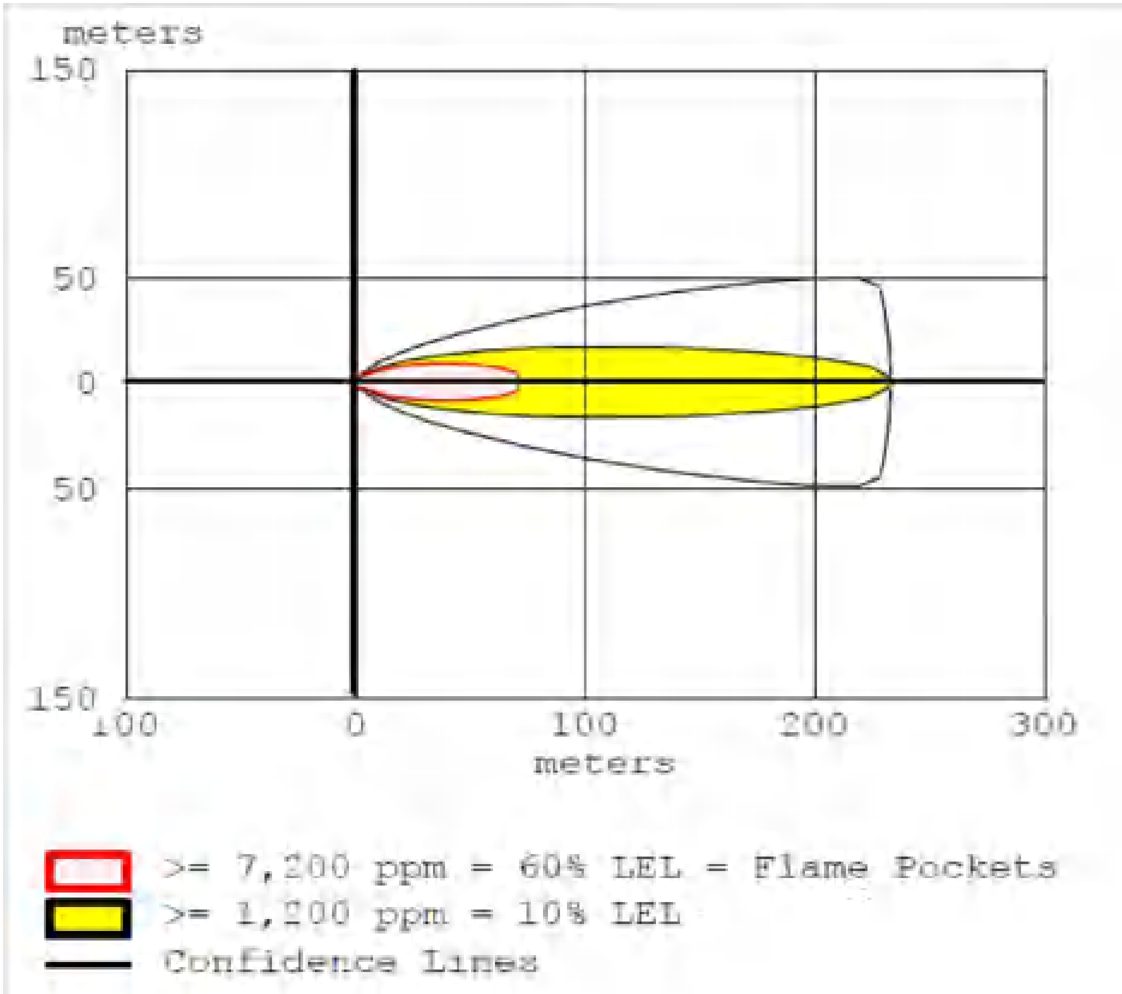
20.1.2.1 Instantaneous Release – Toxic Threat Zone (Graph)



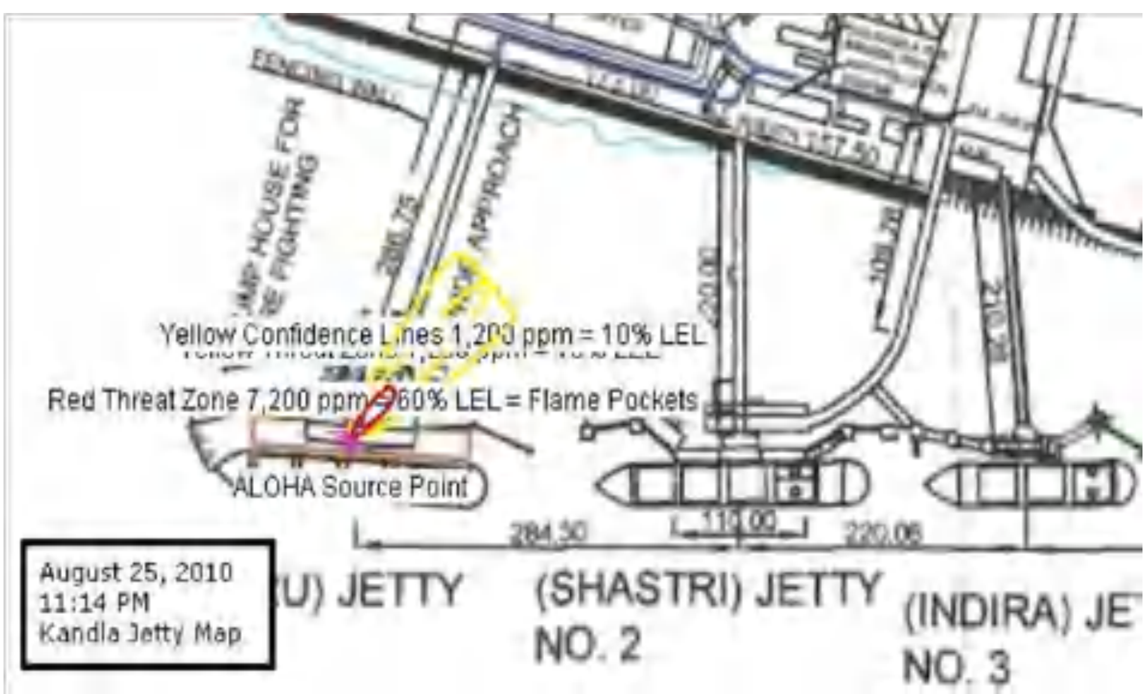
20.1.2.2 Instantaneous Release – Toxic Threat Zone (Contour)



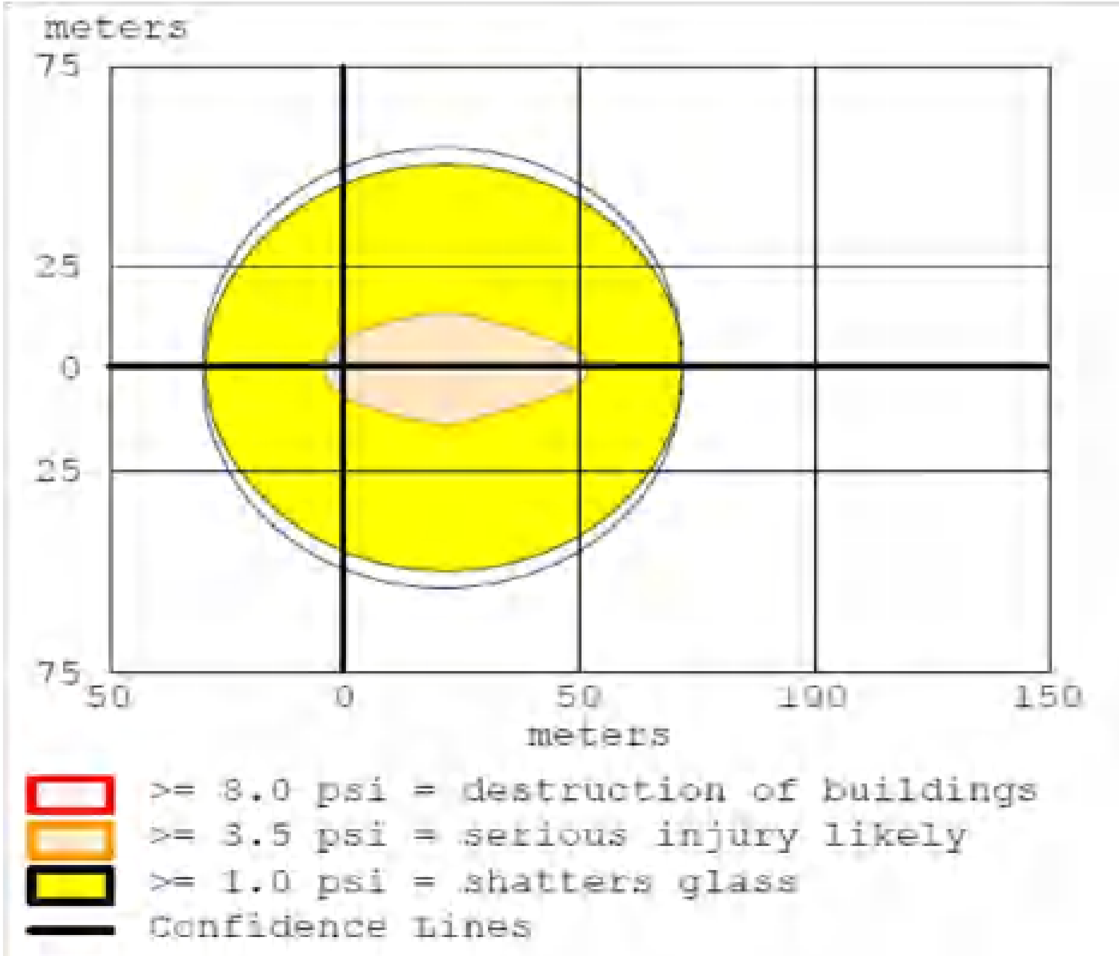
20.1.2.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



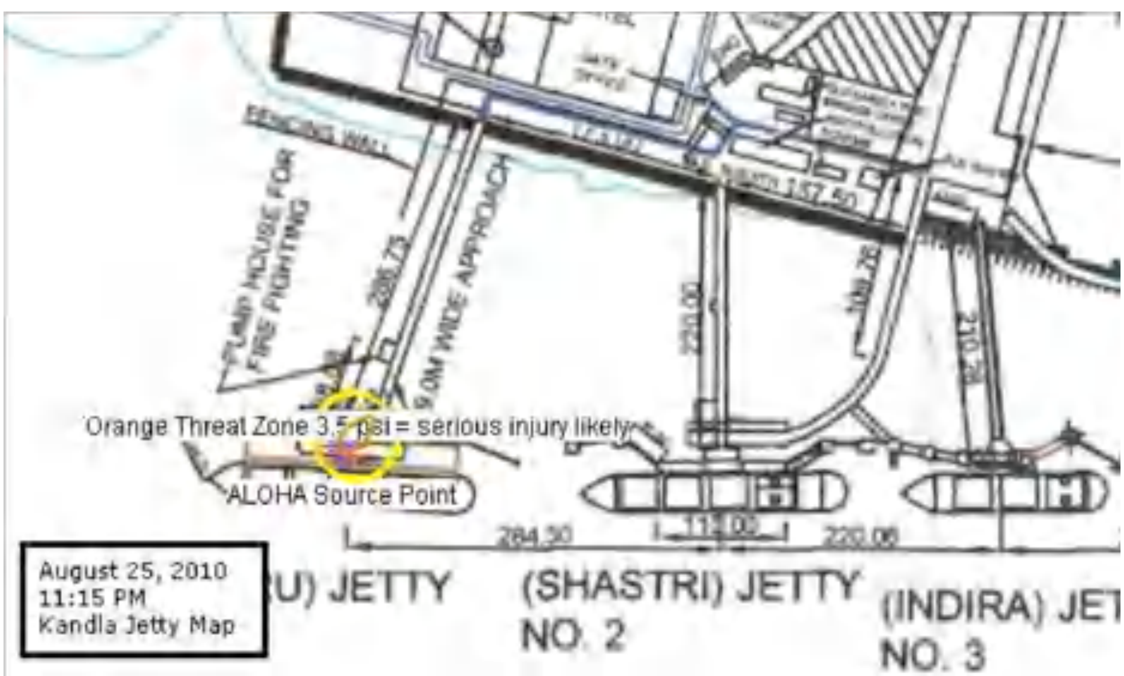
20.1.2.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



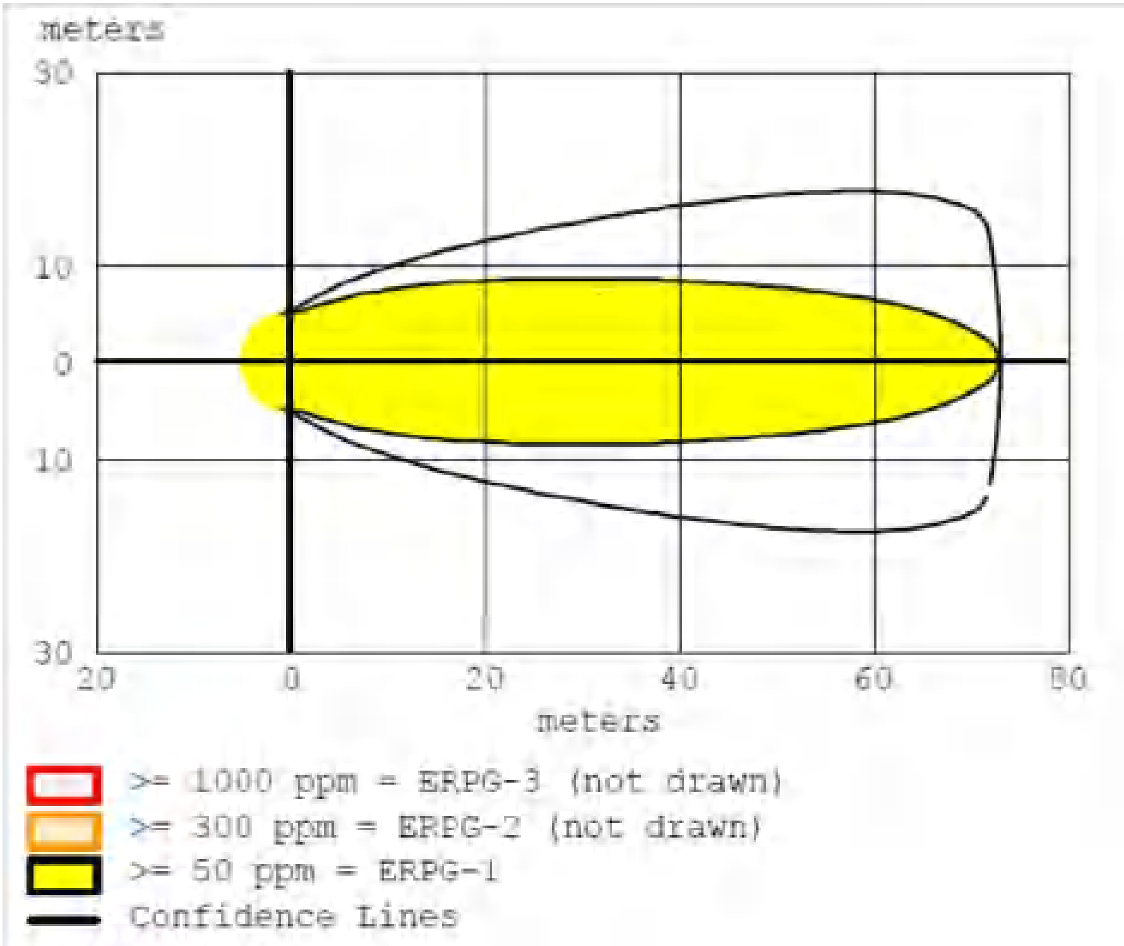
20.1.2.5 Instantaneous Release – Overpressure (Graph)



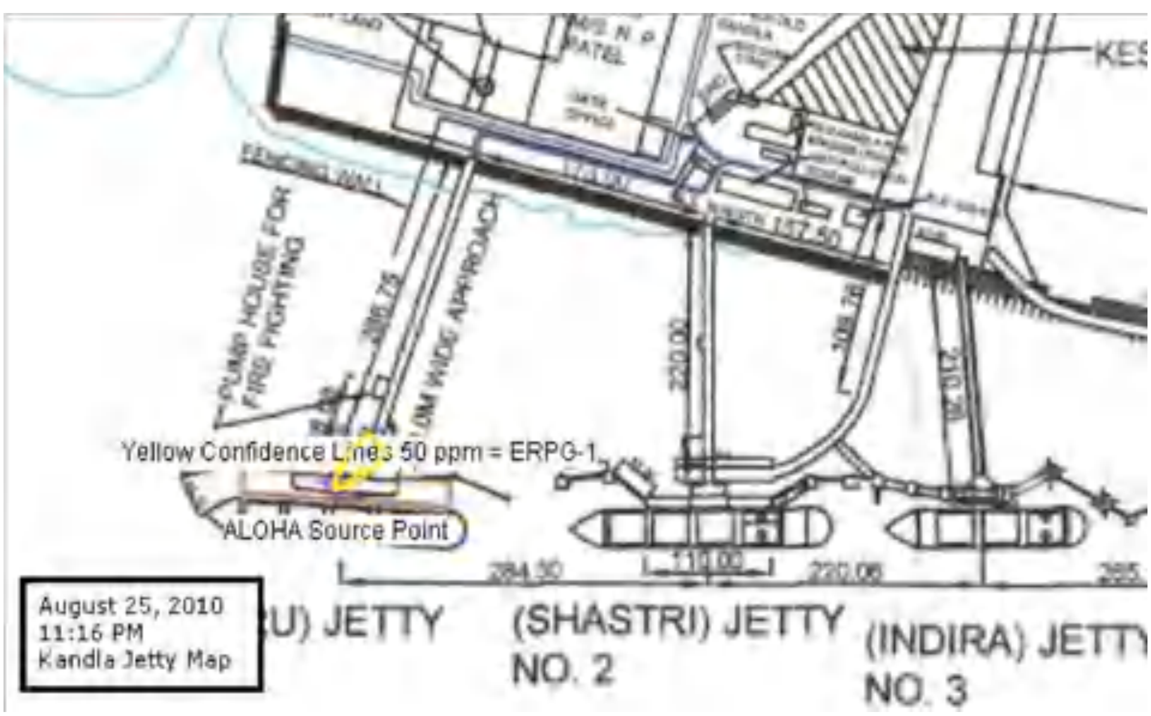
20.1.2.6 Instantaneous Release – Overpressure (Contour)



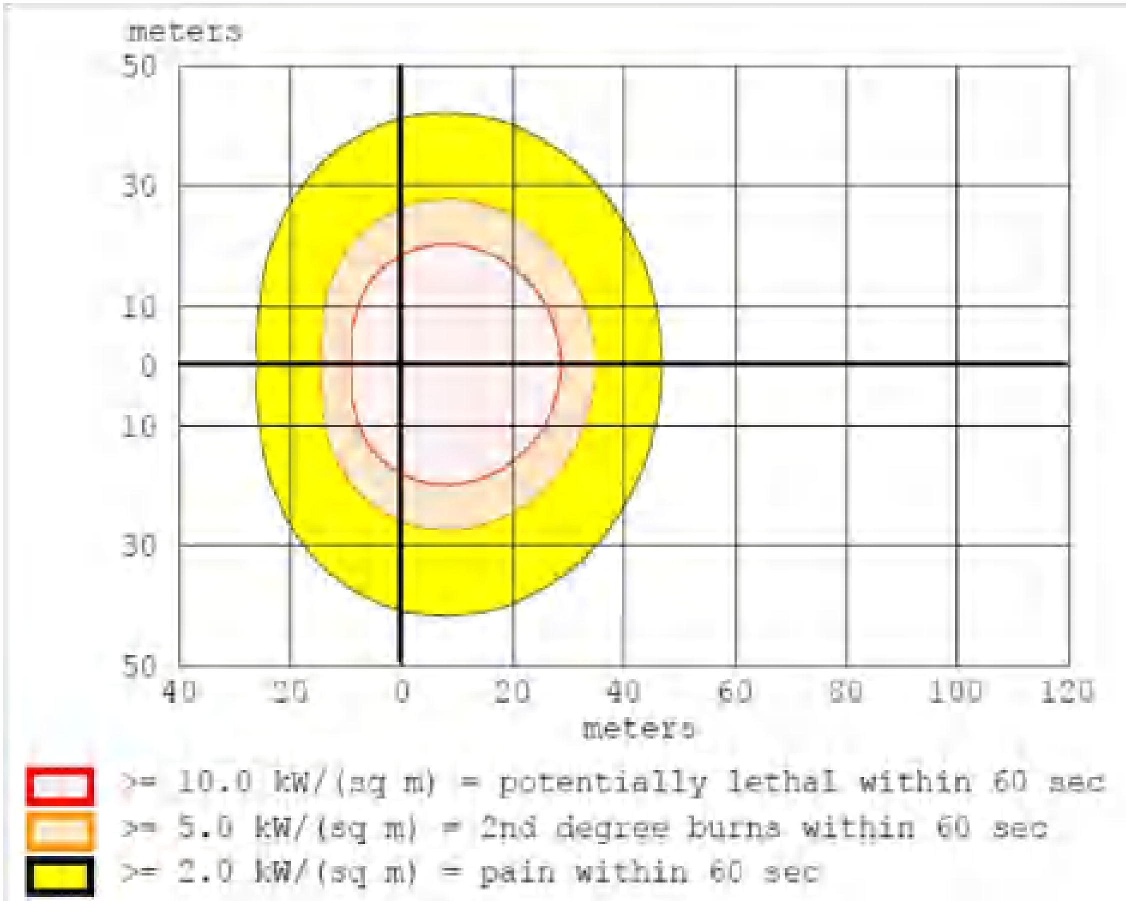
20.1.2.7 Evaporating Puddle – Toxic Threat Zone (Graph)



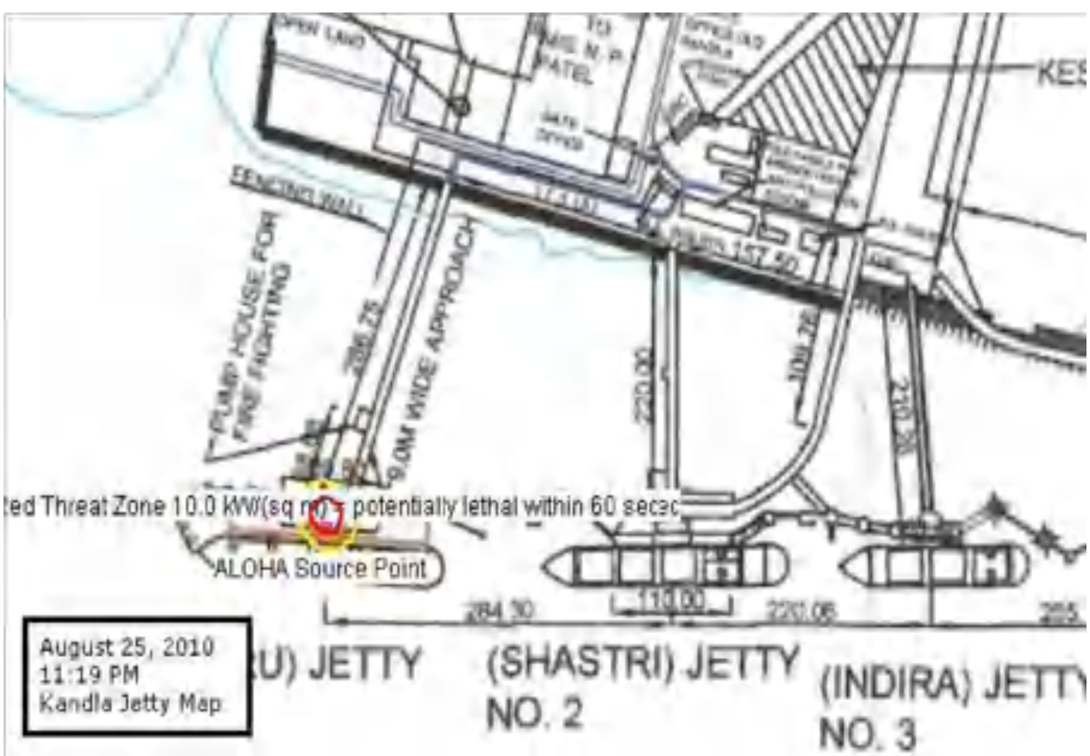
20.1.2.8 Evaporating Puddle – Toxic Threat Zone (Contour)



20.1.2.9 Burning Puddle – Thermal Radiation (Graph)

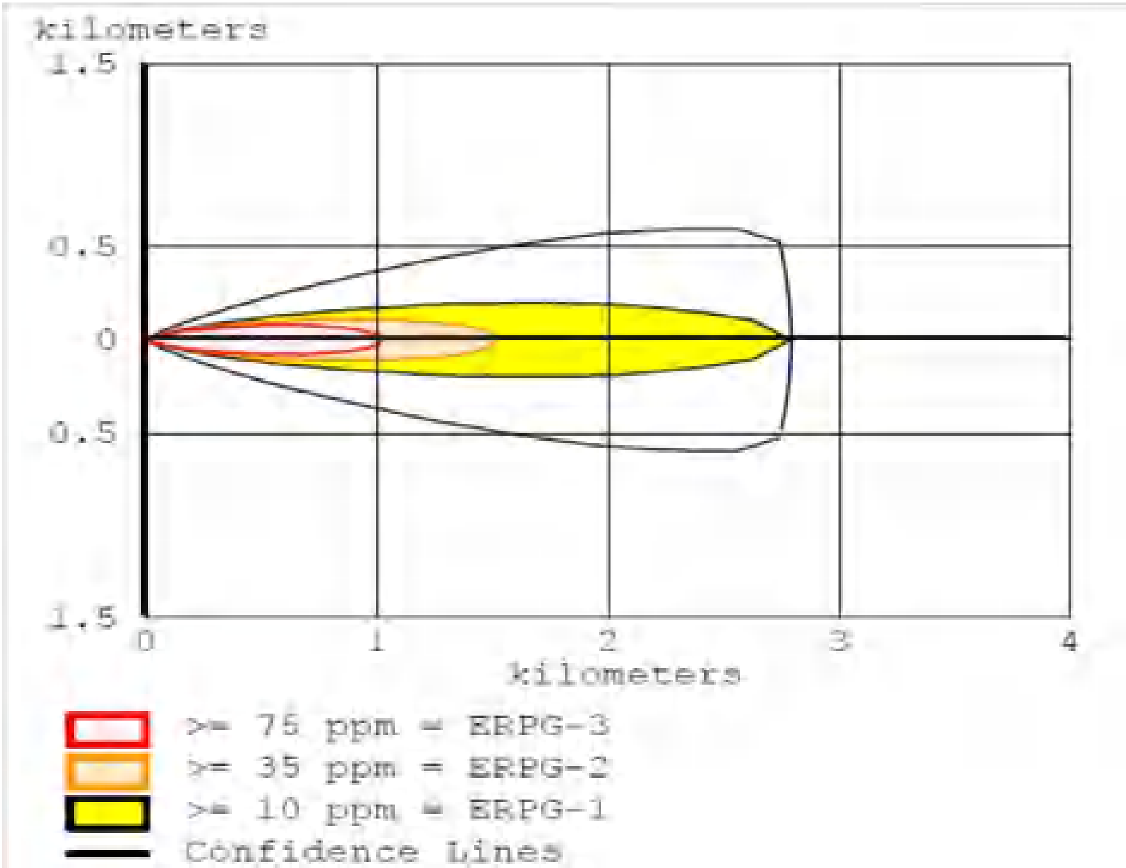


20.1.2.10 Burning Puddle – Thermal Radiation (Contour)

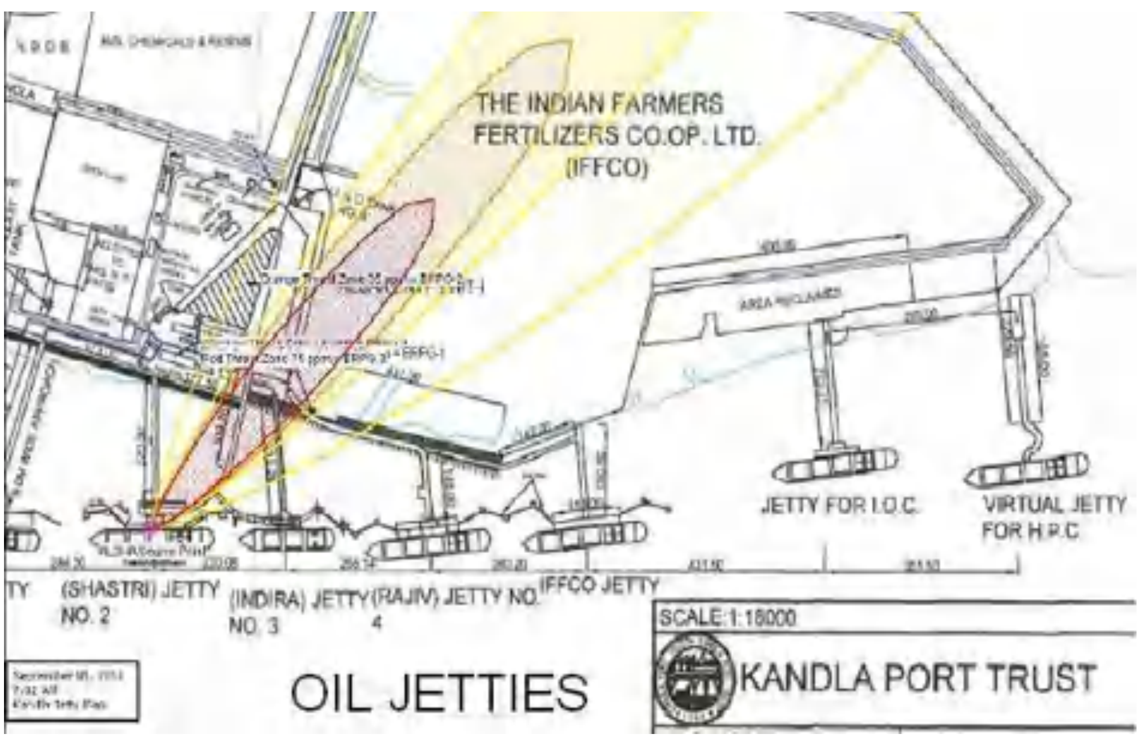


20.1.3 Jetty Two – Acrylonitrile

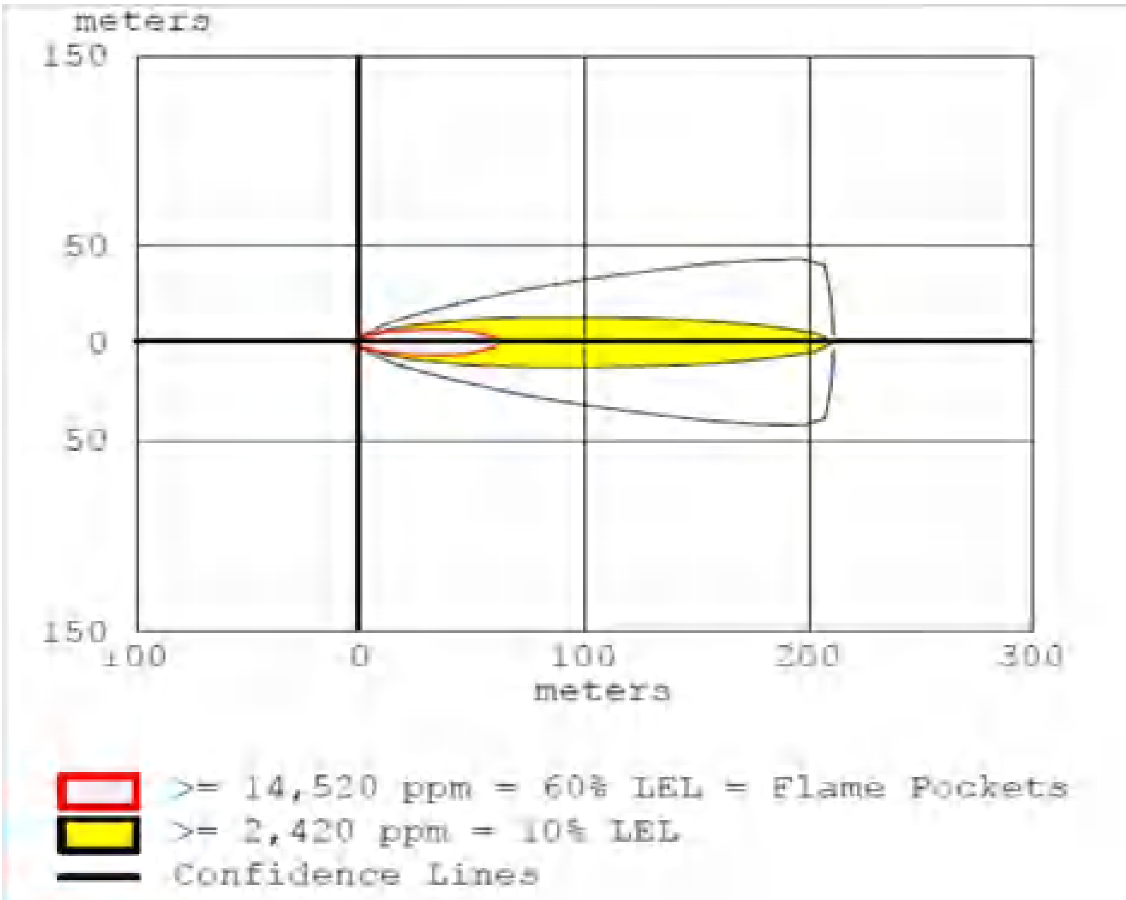
20.1.3.1 Instantaneous Release – Toxic Threat Zone (Graph)



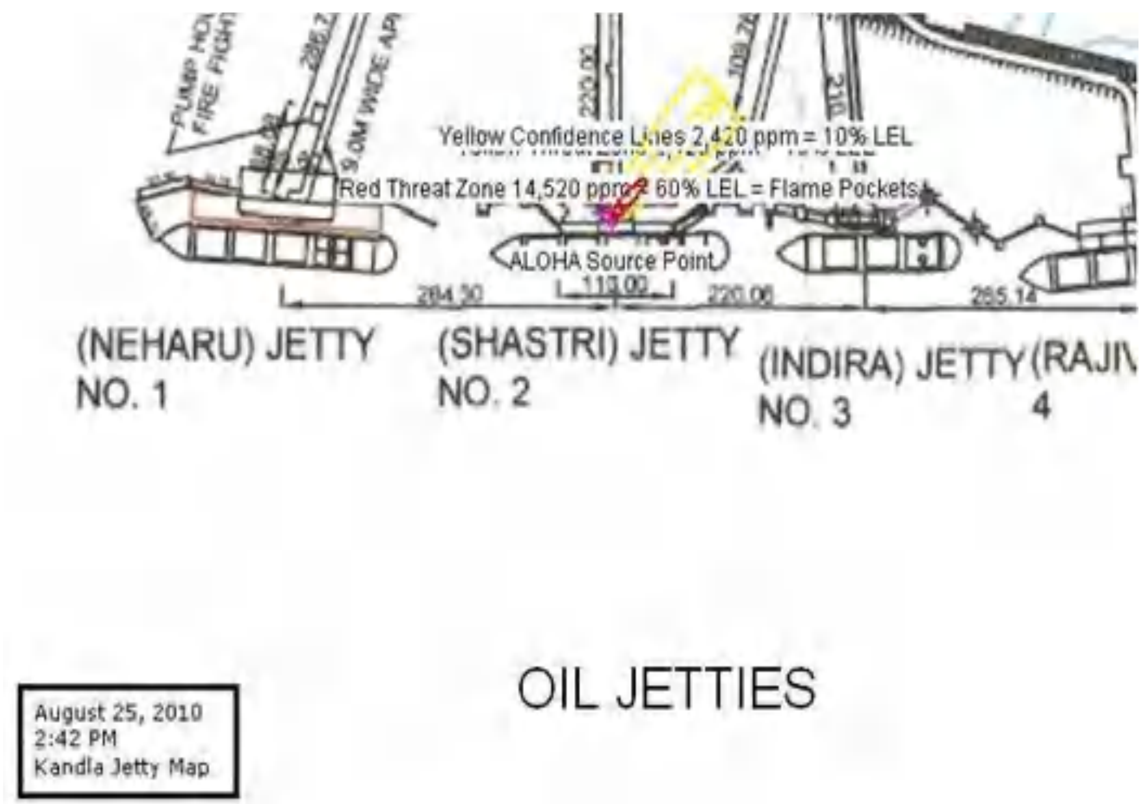
20.1.3.2 Instantaneous Release – Toxic Threat Zone (Contour)



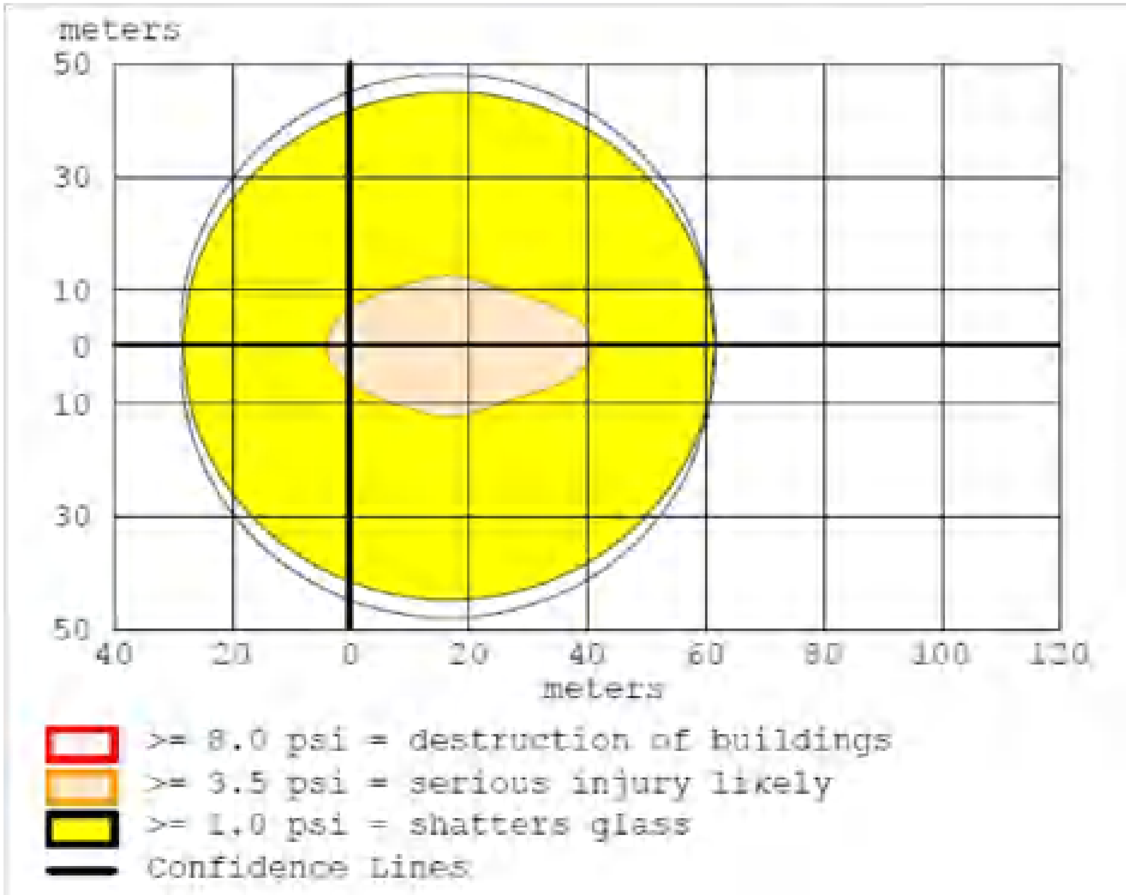
20.1.3.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



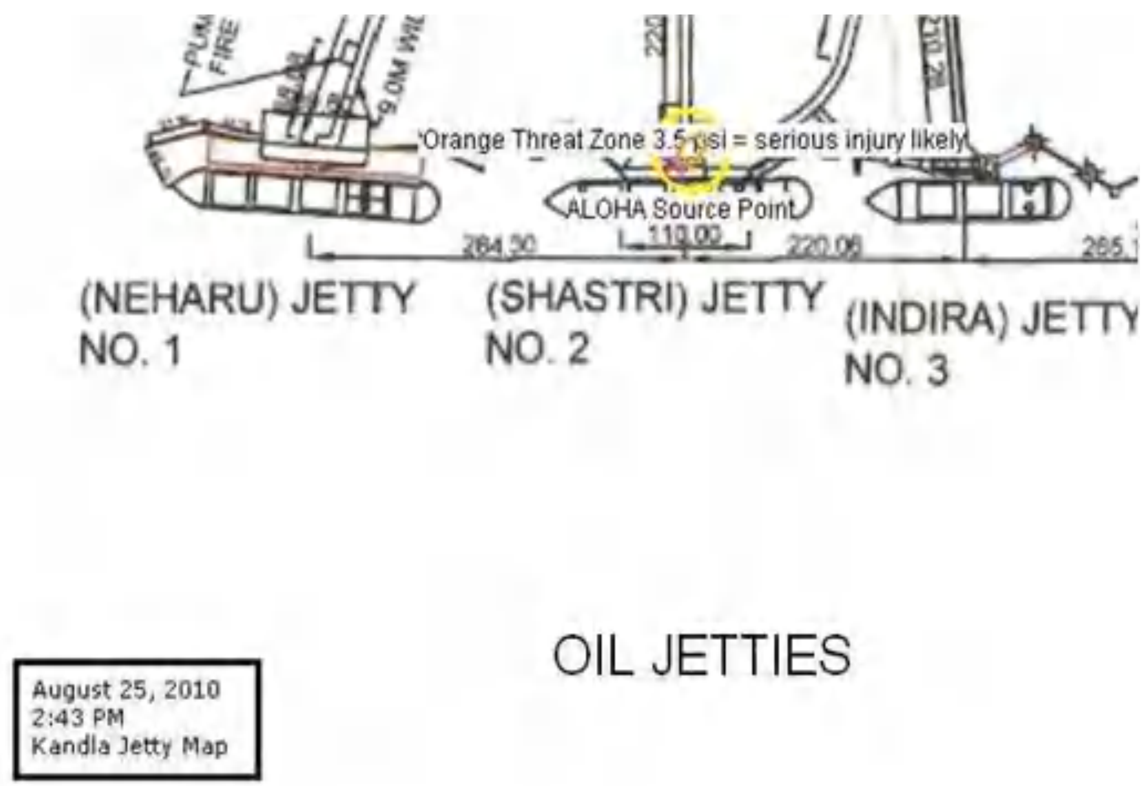
20.1.3.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



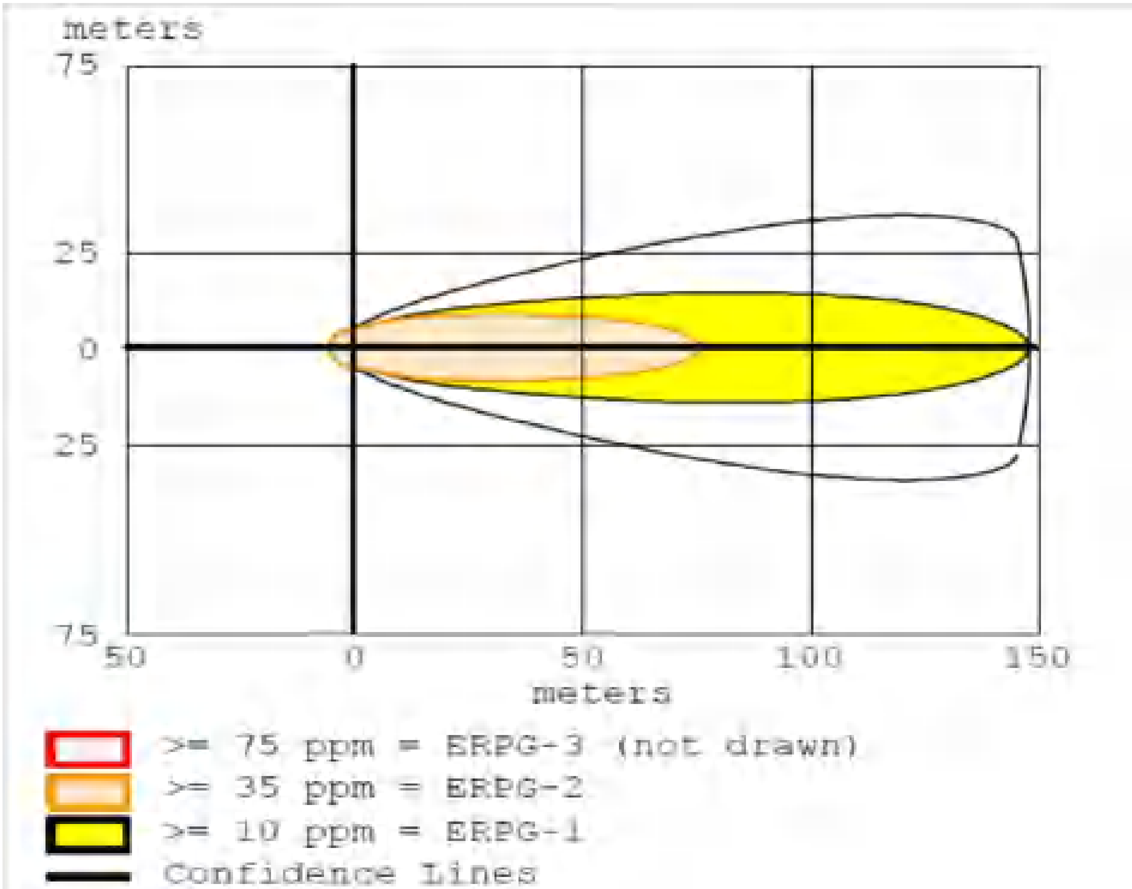
20.1.3.5 Instantaneous Release – Overpressure (Graph)



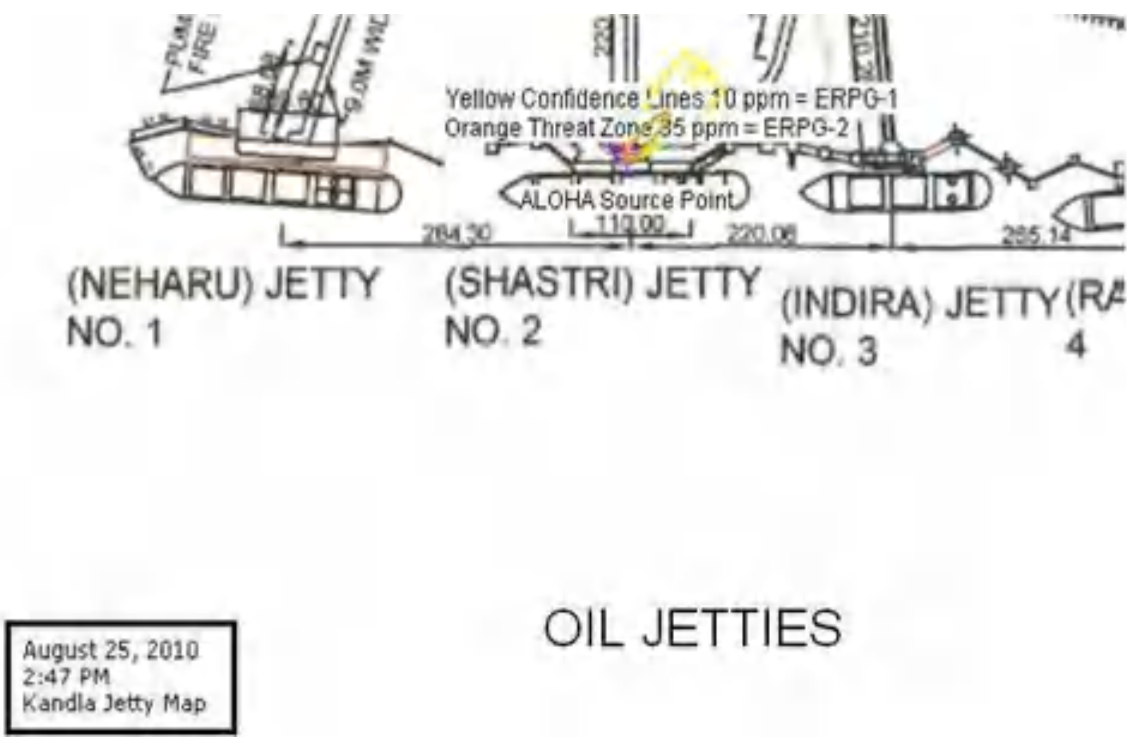
20.1.3.6 Instantaneous Release – Overpressure (Contour)



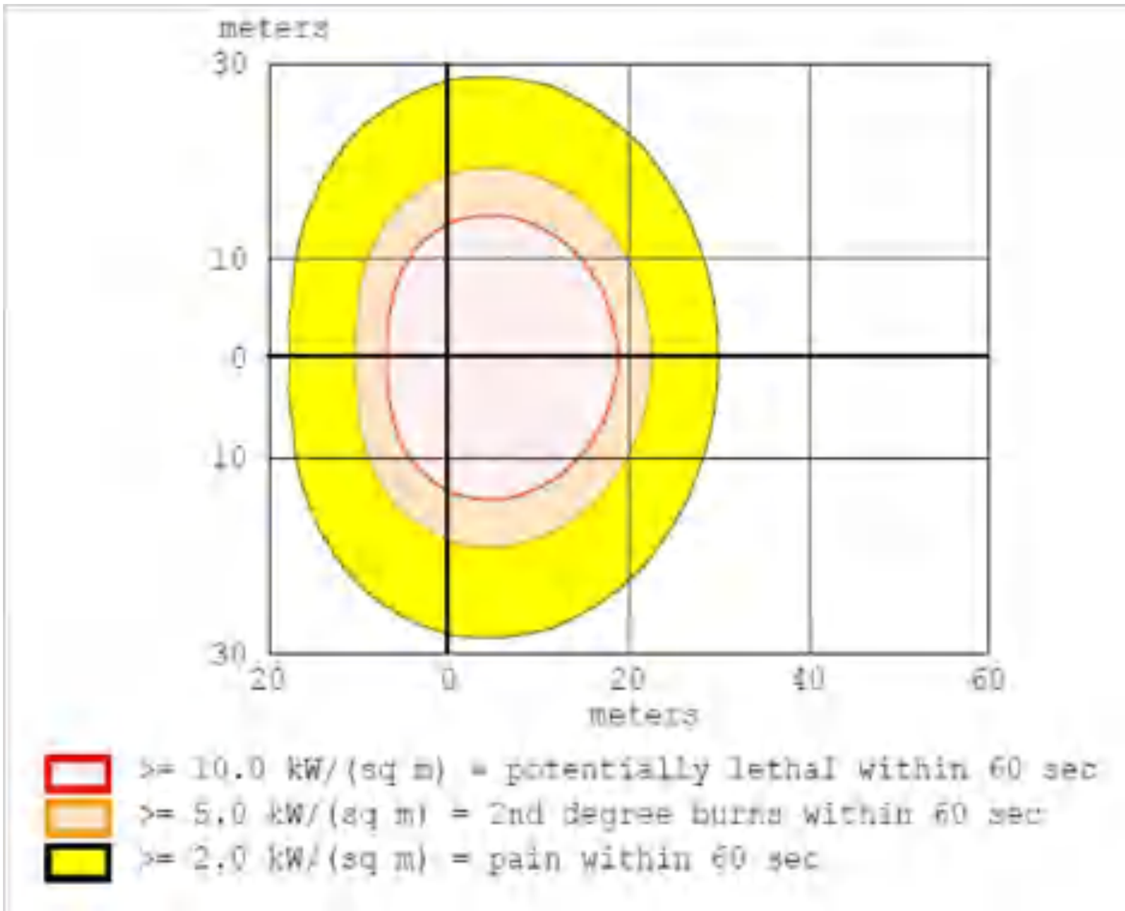
20.1.3.7 Evaporating Puddle – Toxic Threat Zone (Graph)



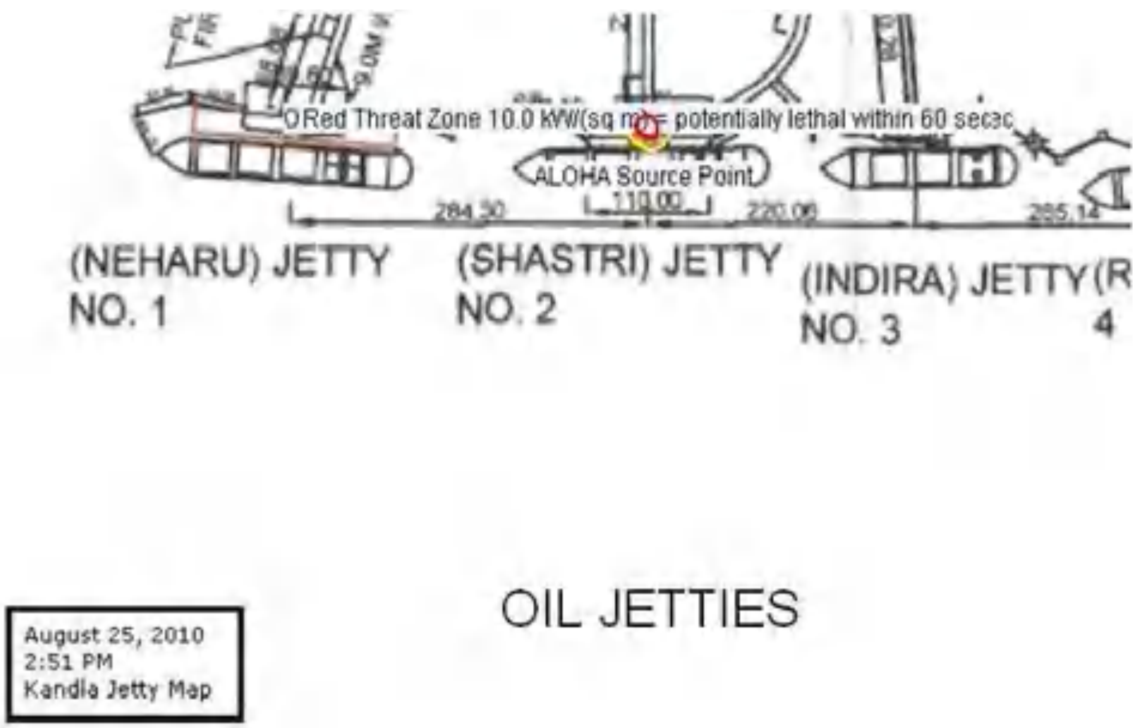
20.1.3.8 Evaporating Puddle – Toxic Threat Zone (Contour)



20.1.3.9 Burning Puddle – Thermal Radiation (Graph)

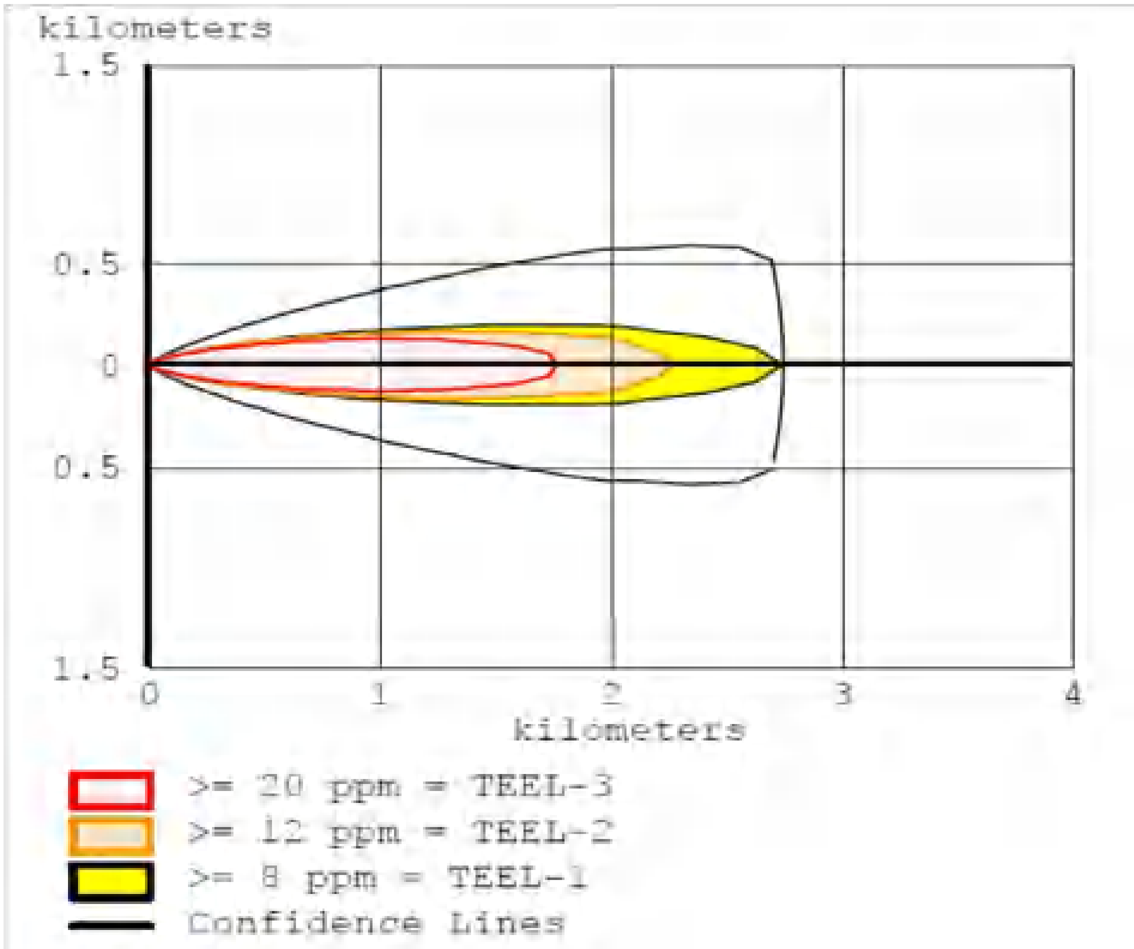


20.1.3.10 Burning Puddle – Thermal Radiation (Contour)



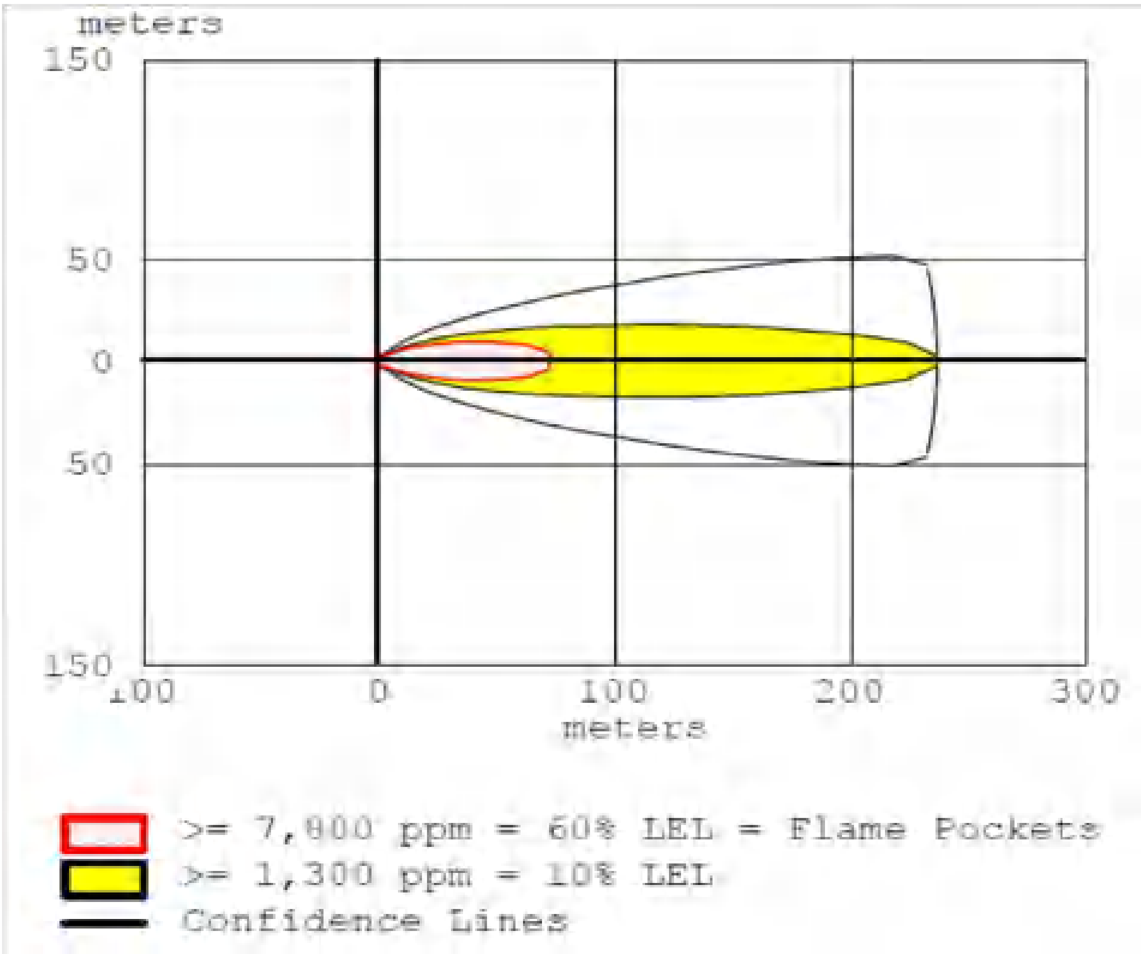
20.1.4 Jetty Two – Aniline

20.1.4.1 Instantaneous Release – Toxic Threat Zone (Graph)

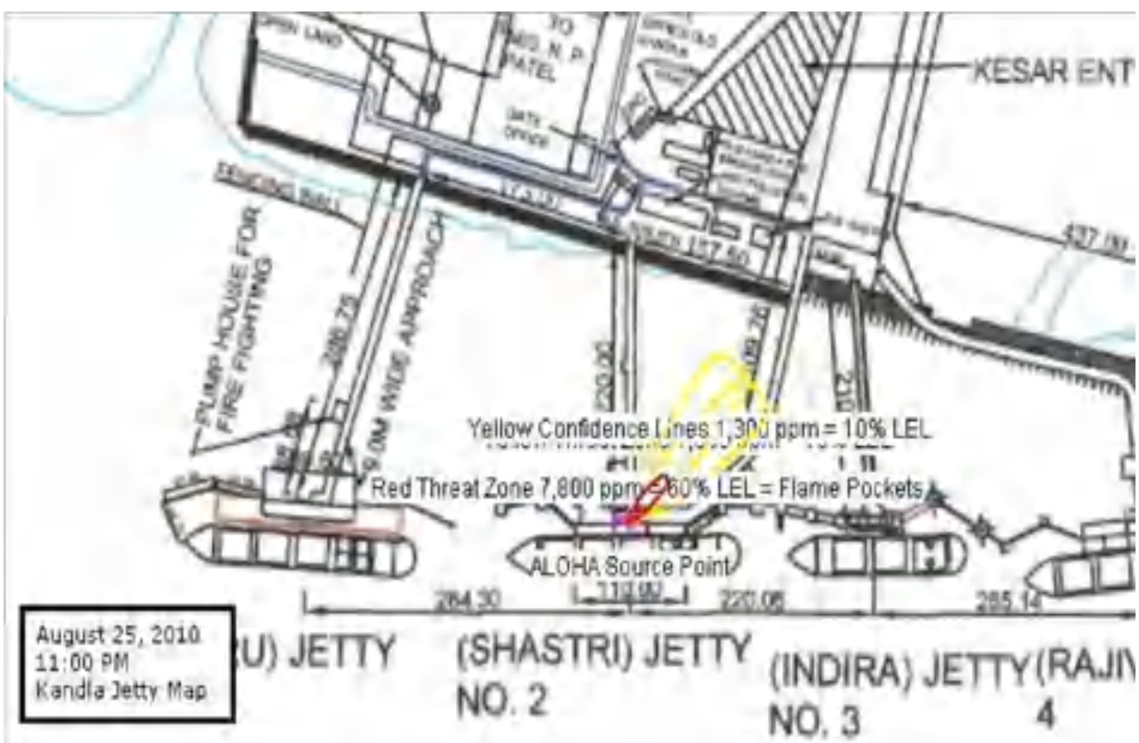


20.1.4.2 Instantaneous Release – Toxic Threat Zone (Contour)

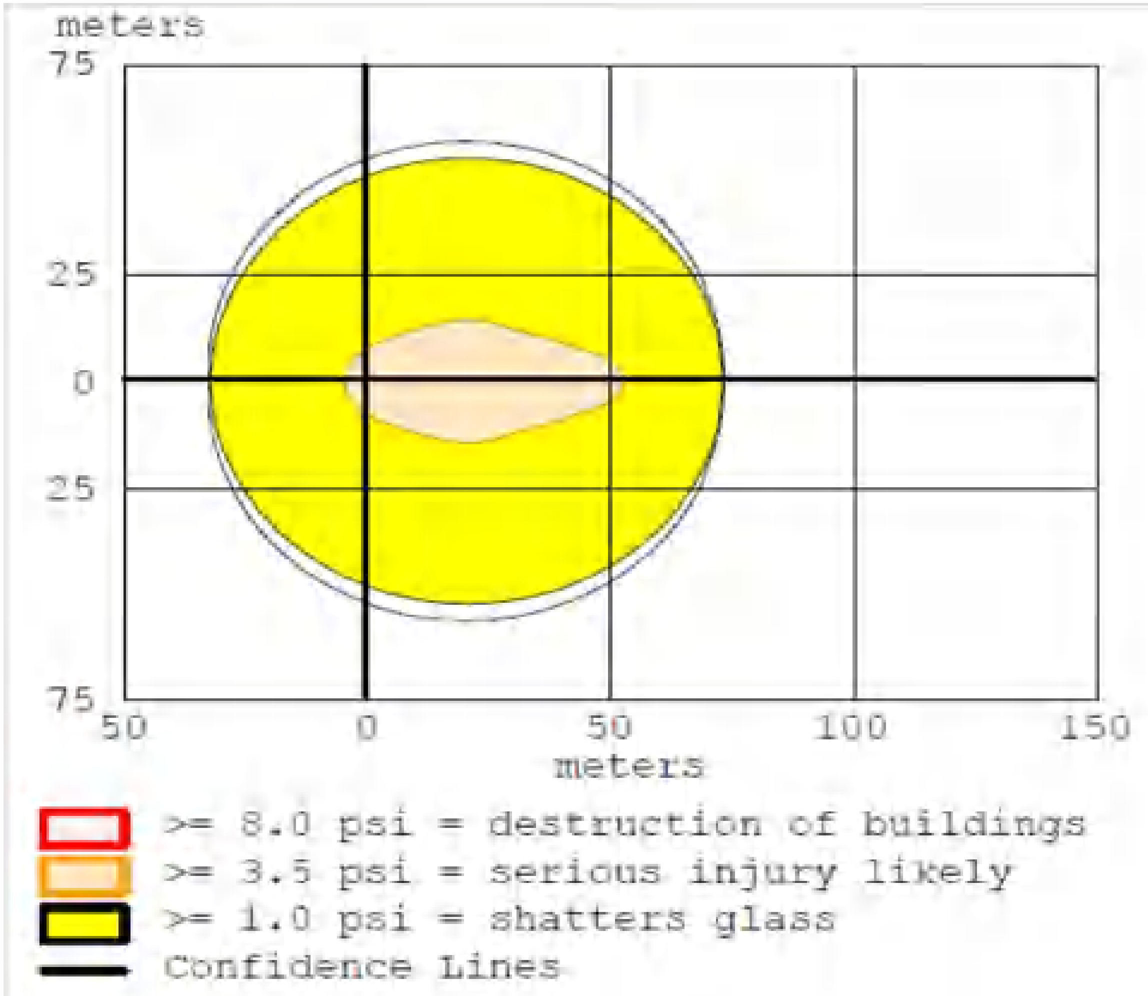
20.1.4.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



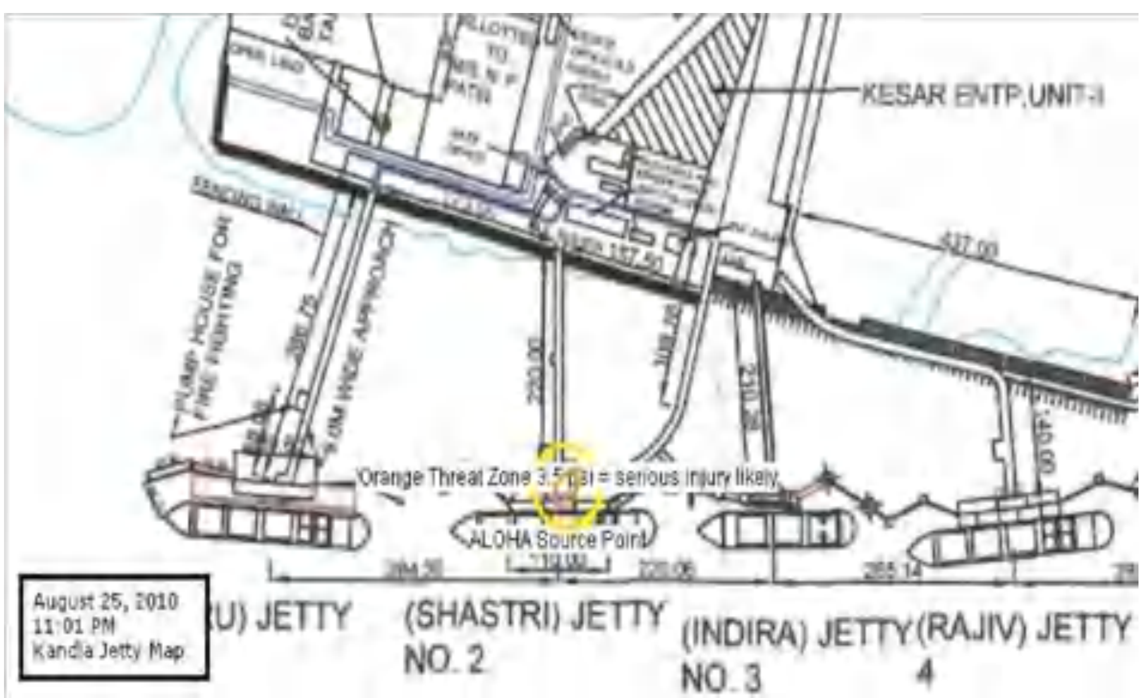
20.1.4.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



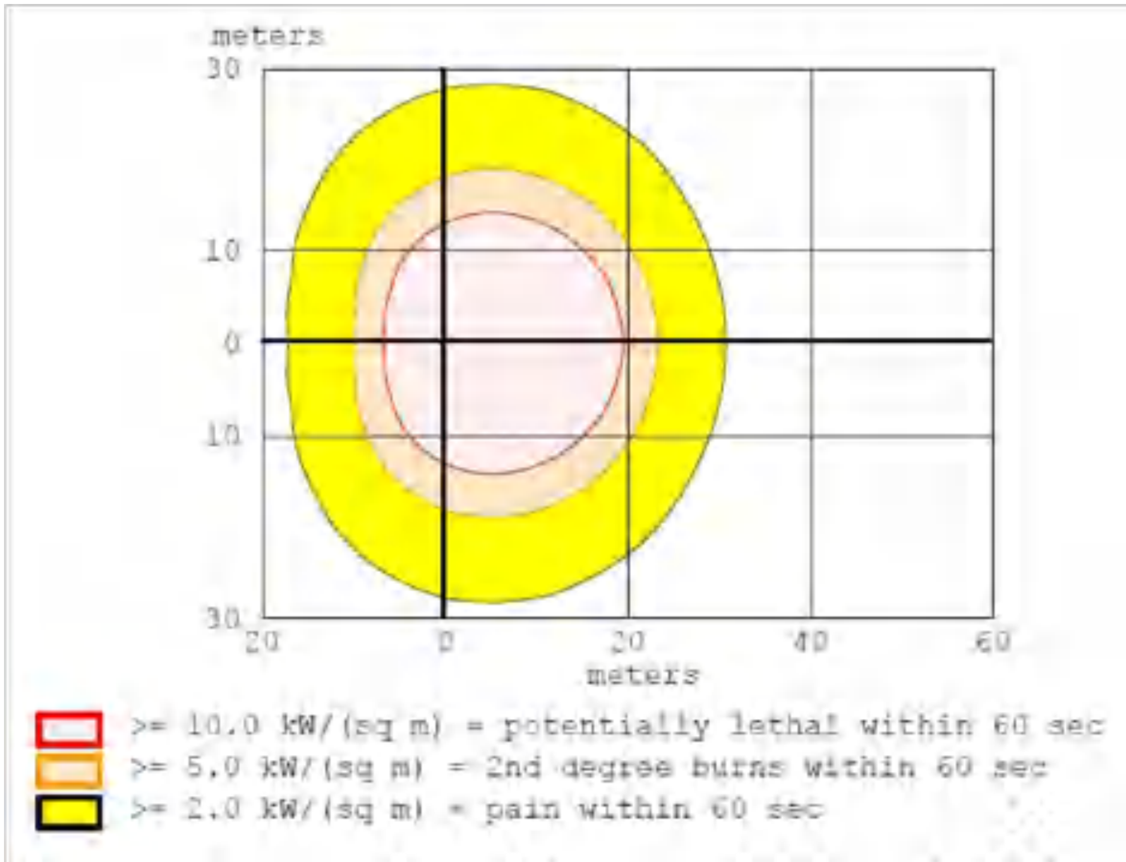
20.1.4.5 Instantaneous Release – Overpressure (Graph)



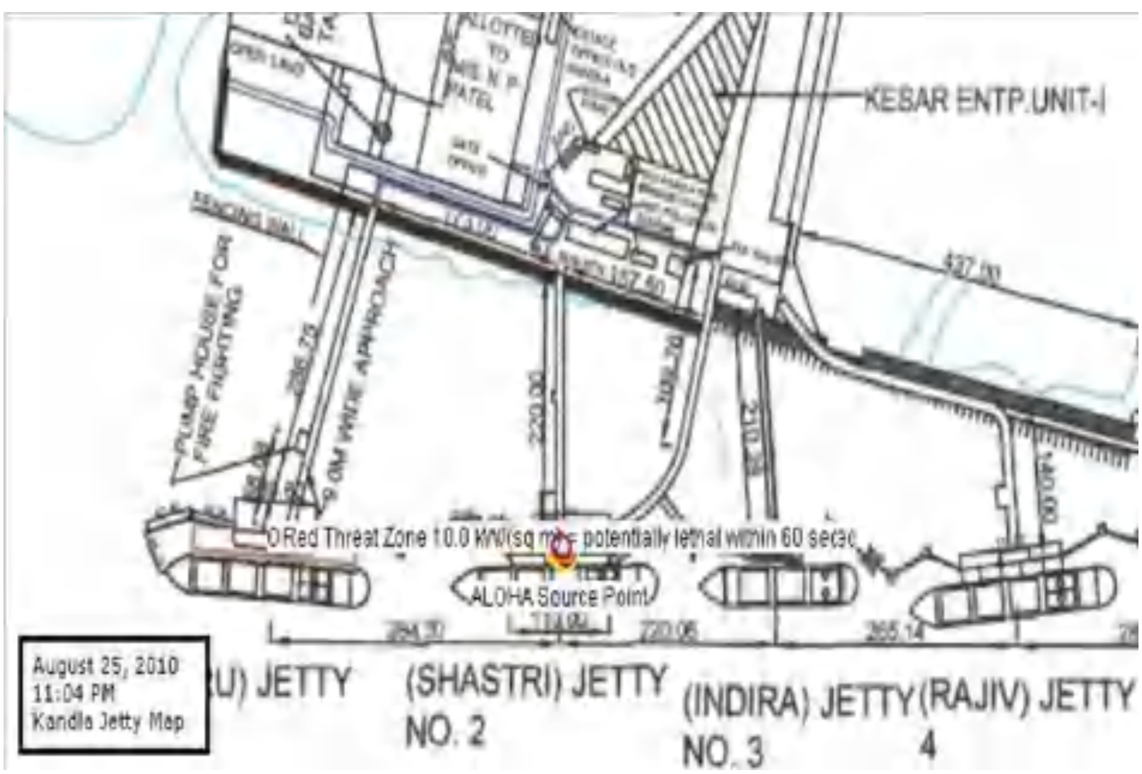
20.1.4.6 Instantaneous Release – Overpressure (Contour)



20.1.4.7 Burning Puddle – Thermal Radiation (Graph)

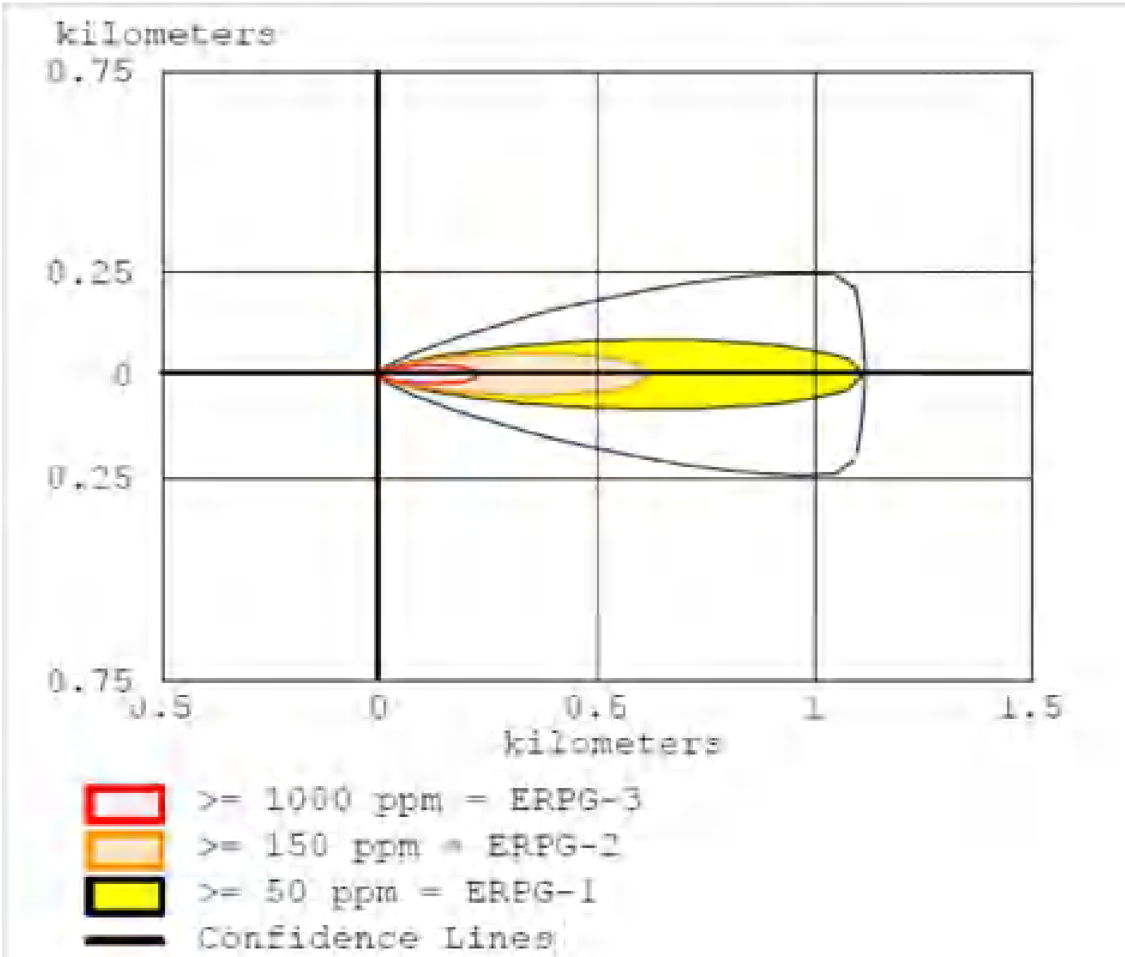


20.1.4.8 Burning Puddle – Thermal Radiation (Contour)

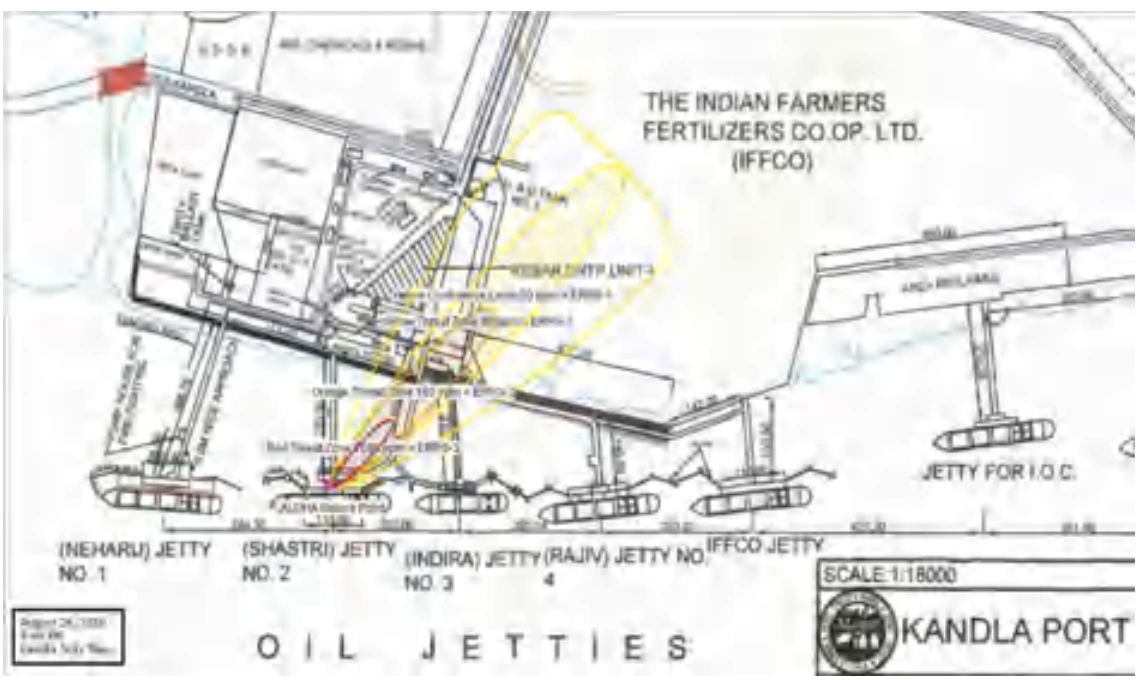


20.1.5 Jetty Two – Benzene

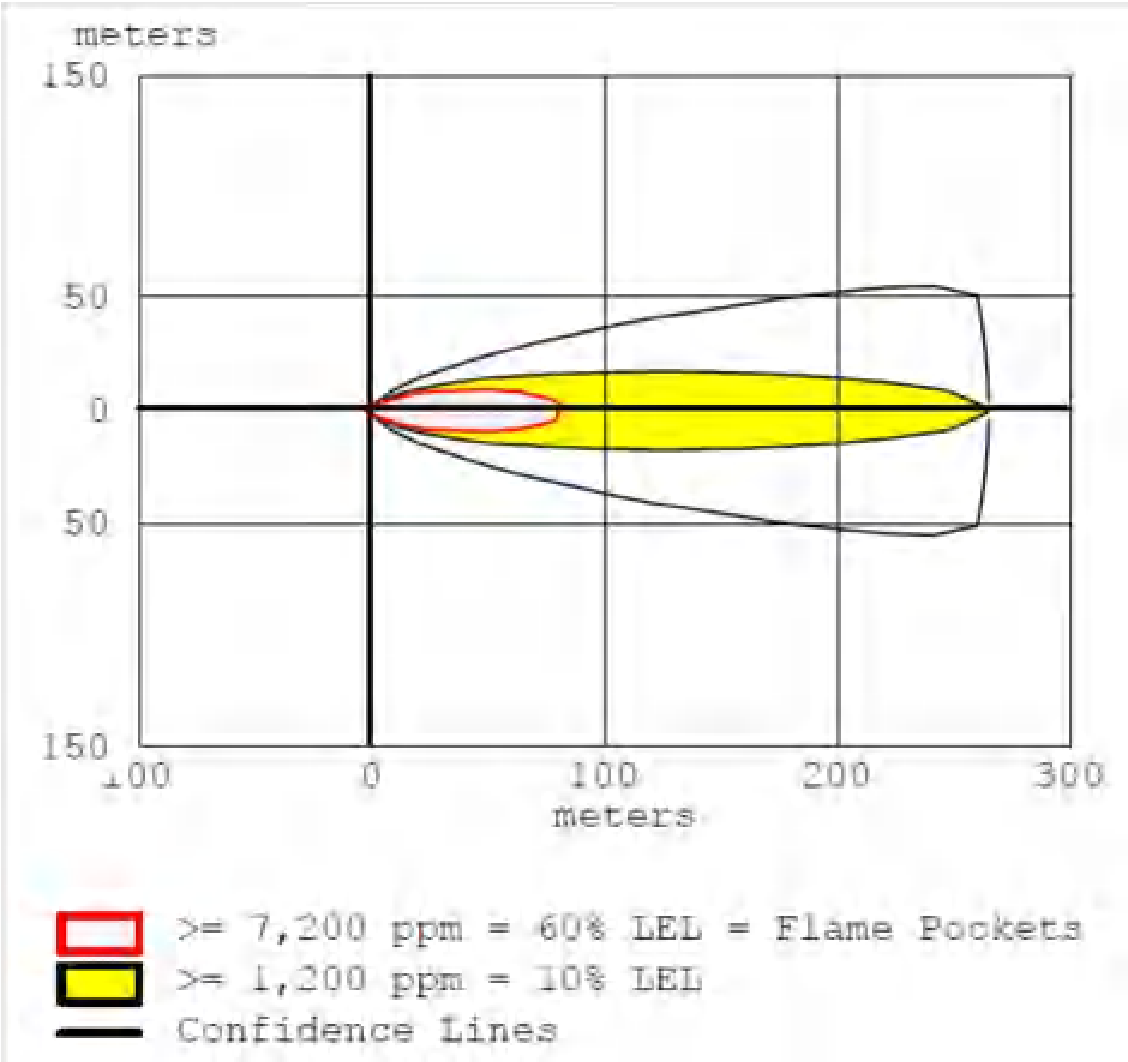
20.1.5.1 Instantaneous Release – Toxic Threat Zone (Graph)



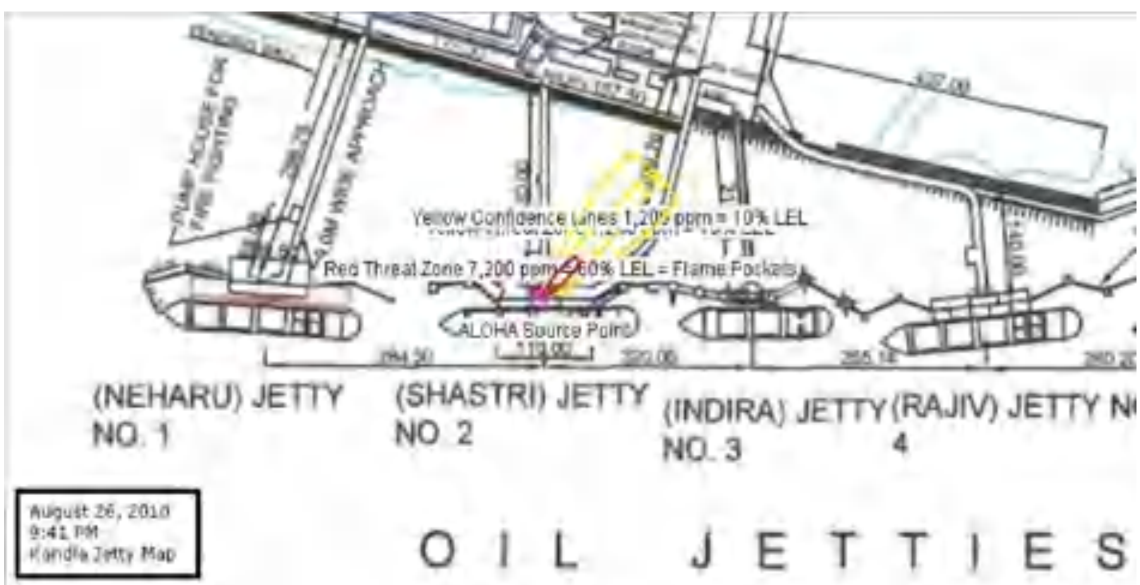
20.1.5.2 Instantaneous Release – Toxic Threat Zone (Contour)



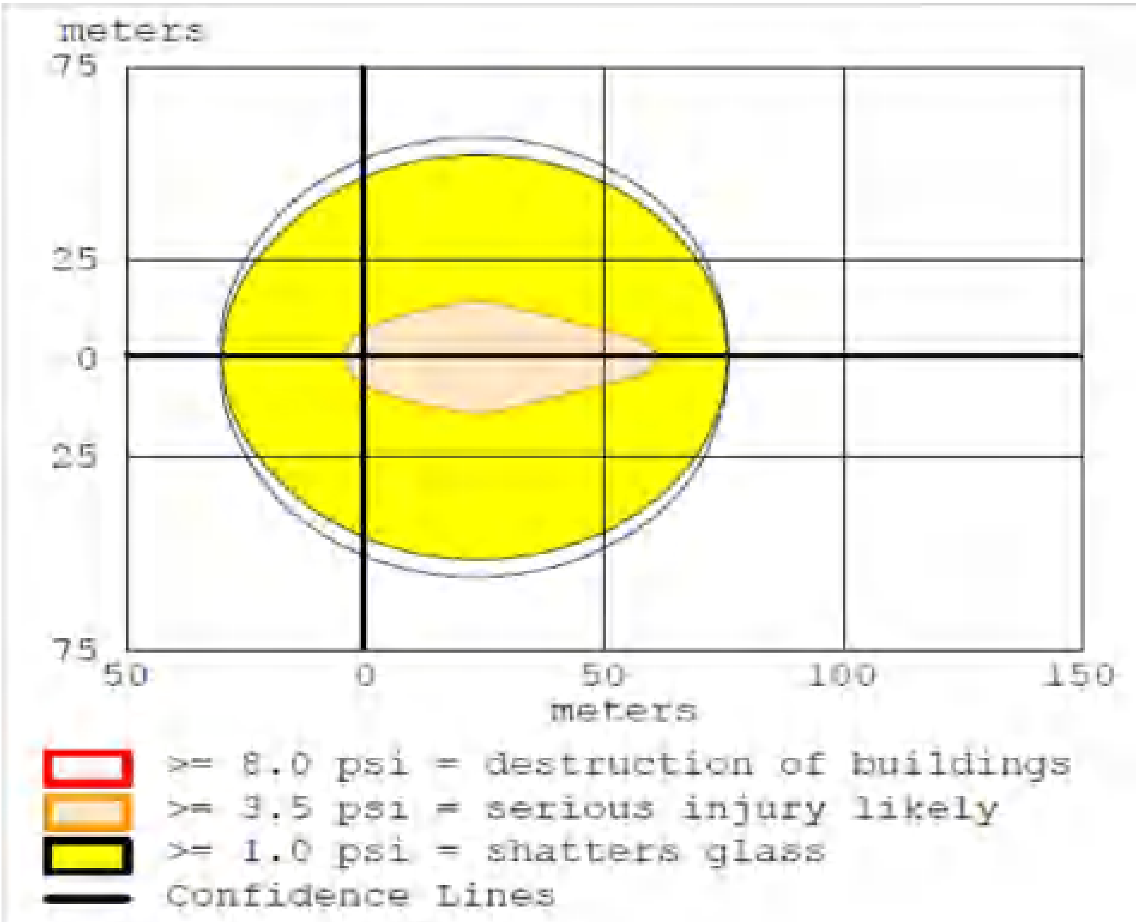
20.1.5.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



20.1.5.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)

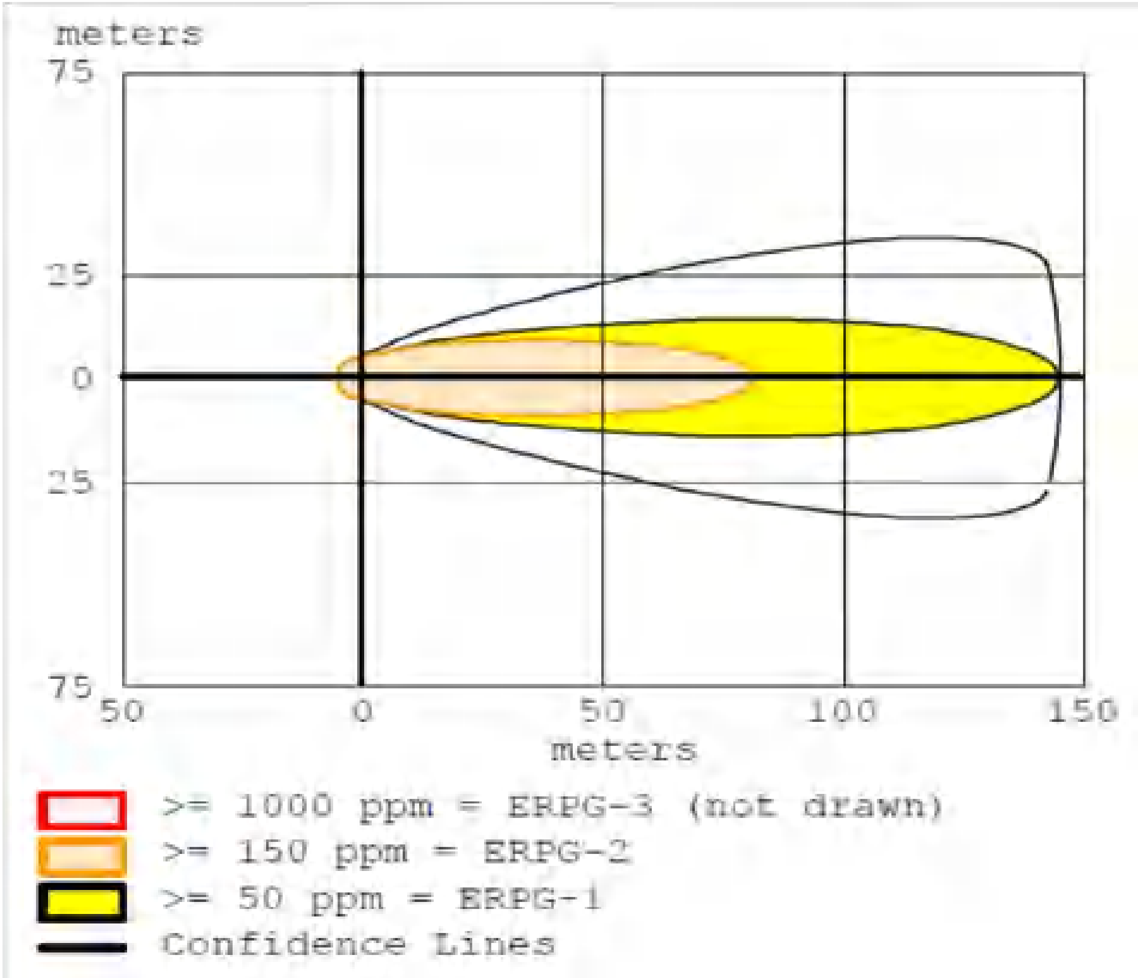


20.1.5.5 Instantaneous Release – Overpressure (Graph)

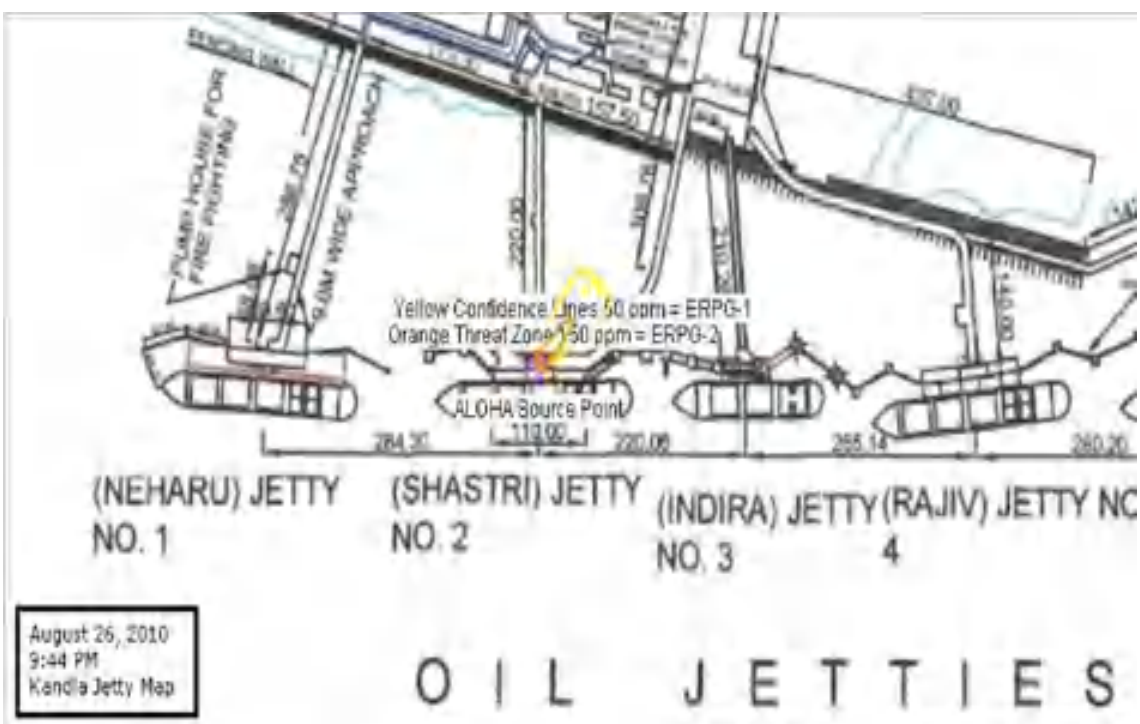


20.1.5.6 Instantaneous Release – Overpressure (Contour)

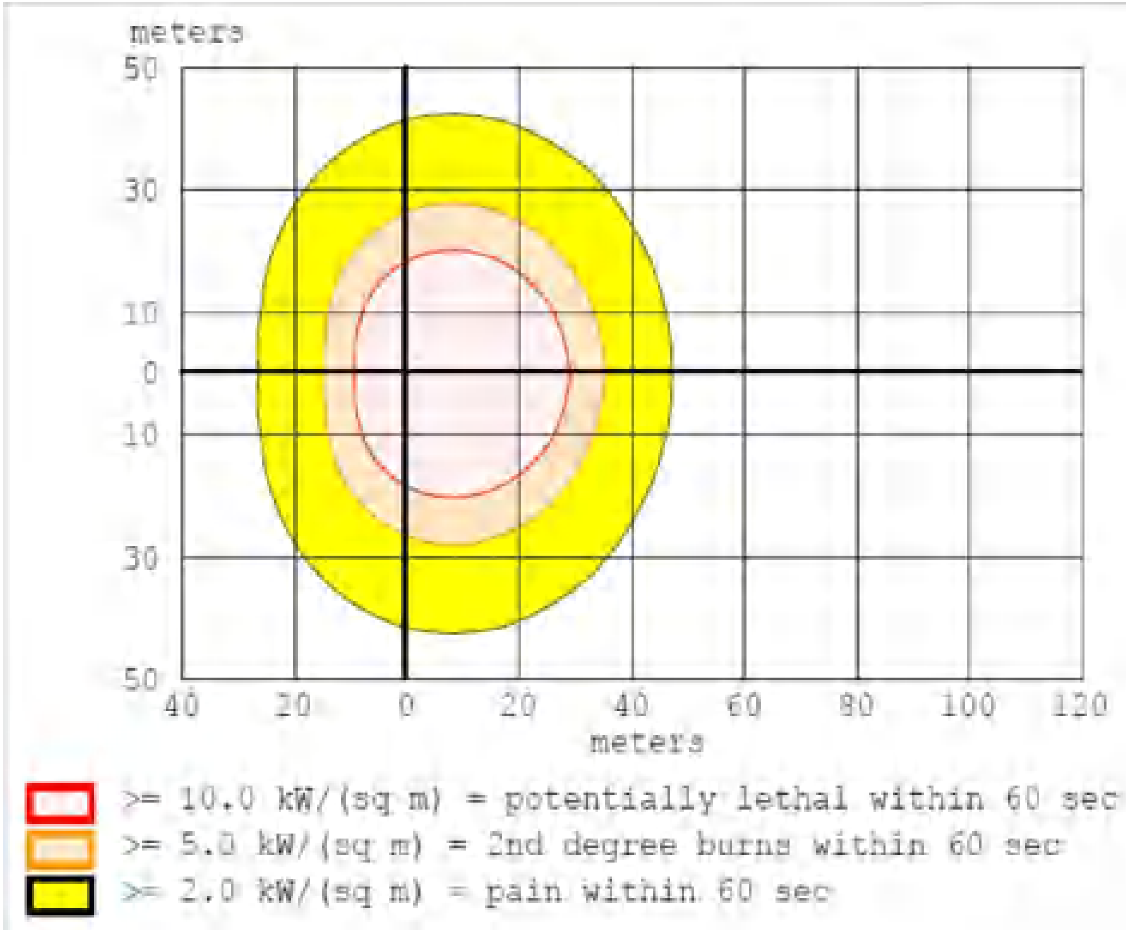
20.1.5.7 Evaporating Puddle – Toxic Threat Zone (Graph)



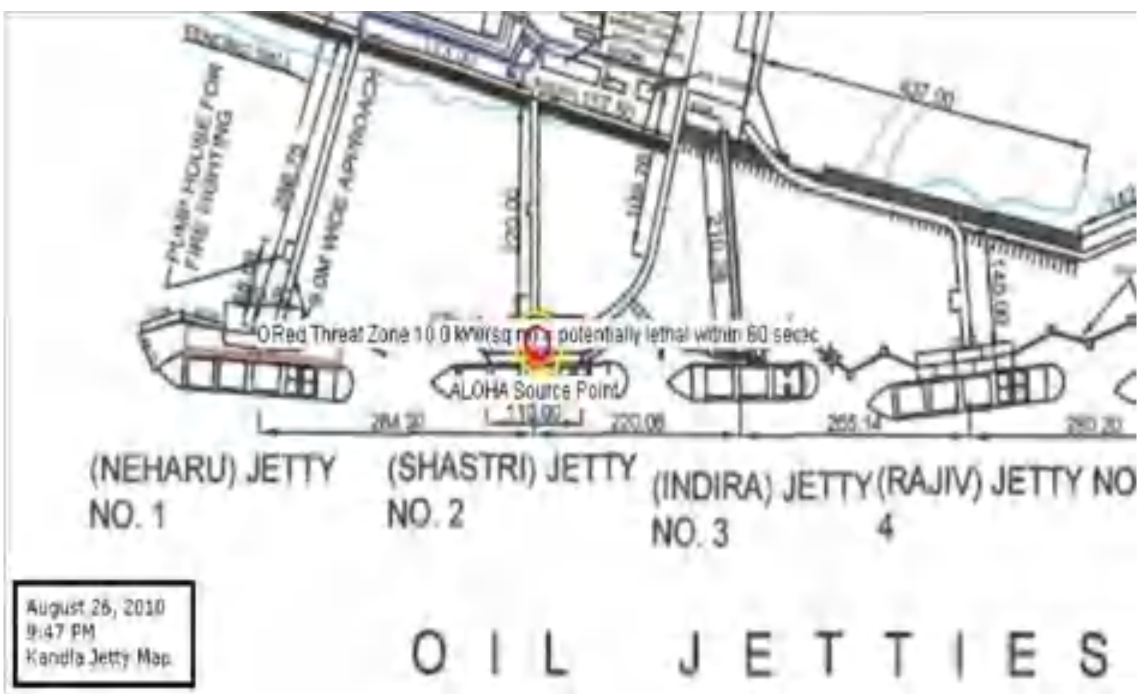
20.1.5.8 Evaporating Puddle – Toxic Threat Zone (Contour)



20.1.5.9 Burning Puddle – Thermal Radiation (Graph)

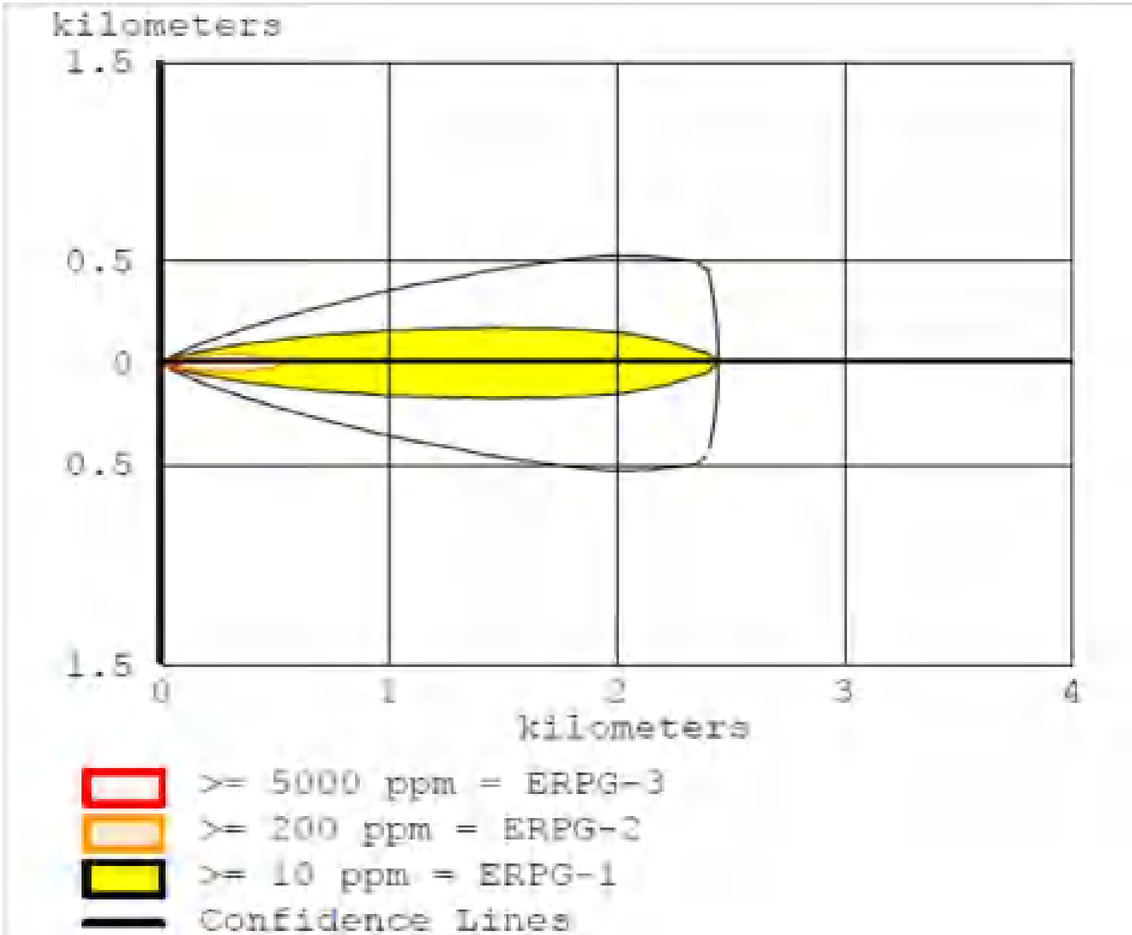


20.1.5.10 Burning Puddle – Thermal Radiation (Contour)

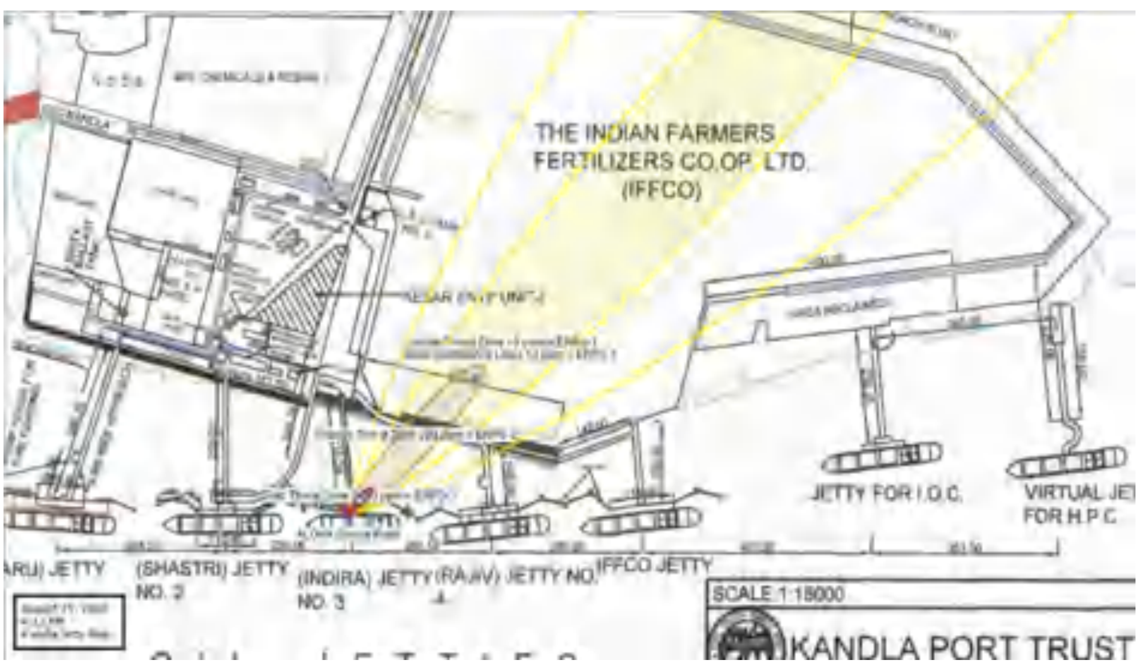


20.1.6 Jetty Three – 1:3, Butadiene

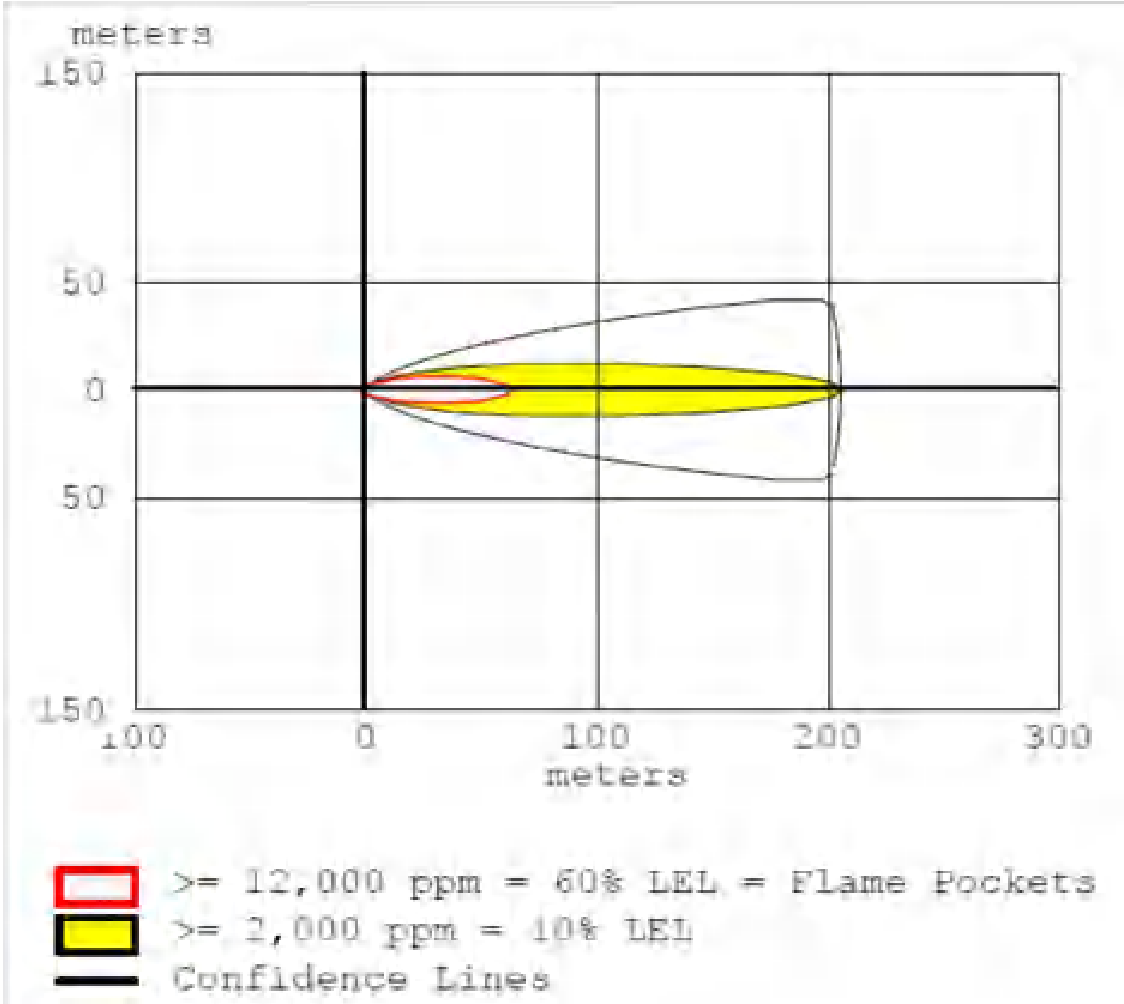
20.1.6.1 Instantaneous Release – Toxic Threat Zone (Graph)



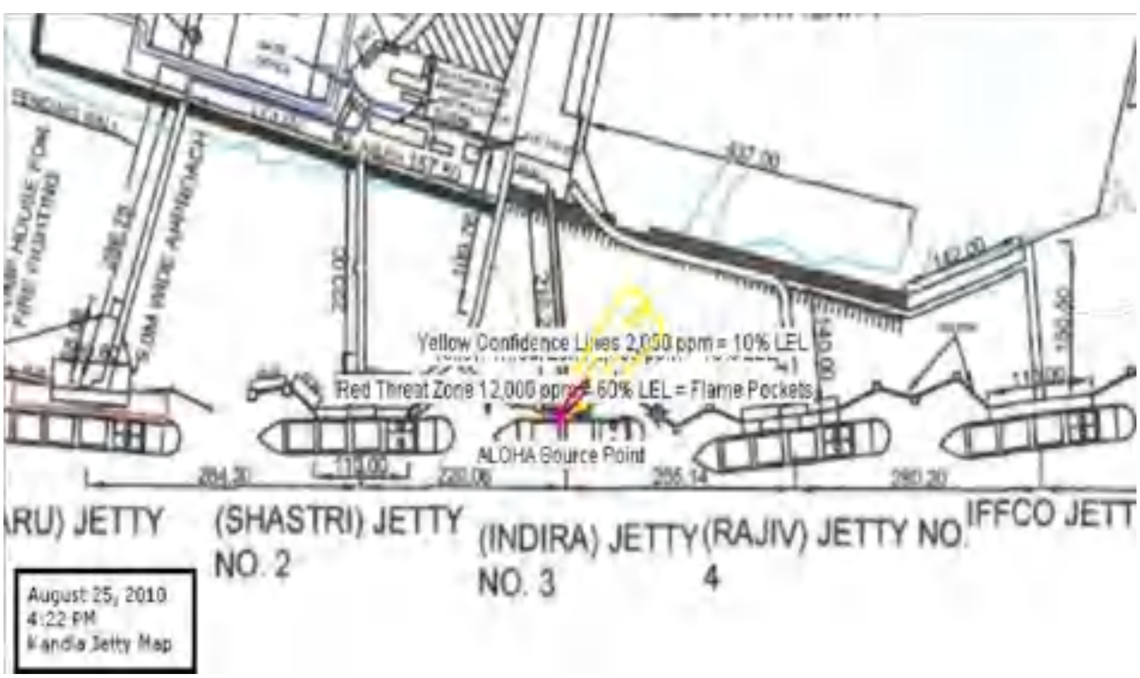
20.1.6.2 Instantaneous Release – Toxic Threat Zone (Contour)



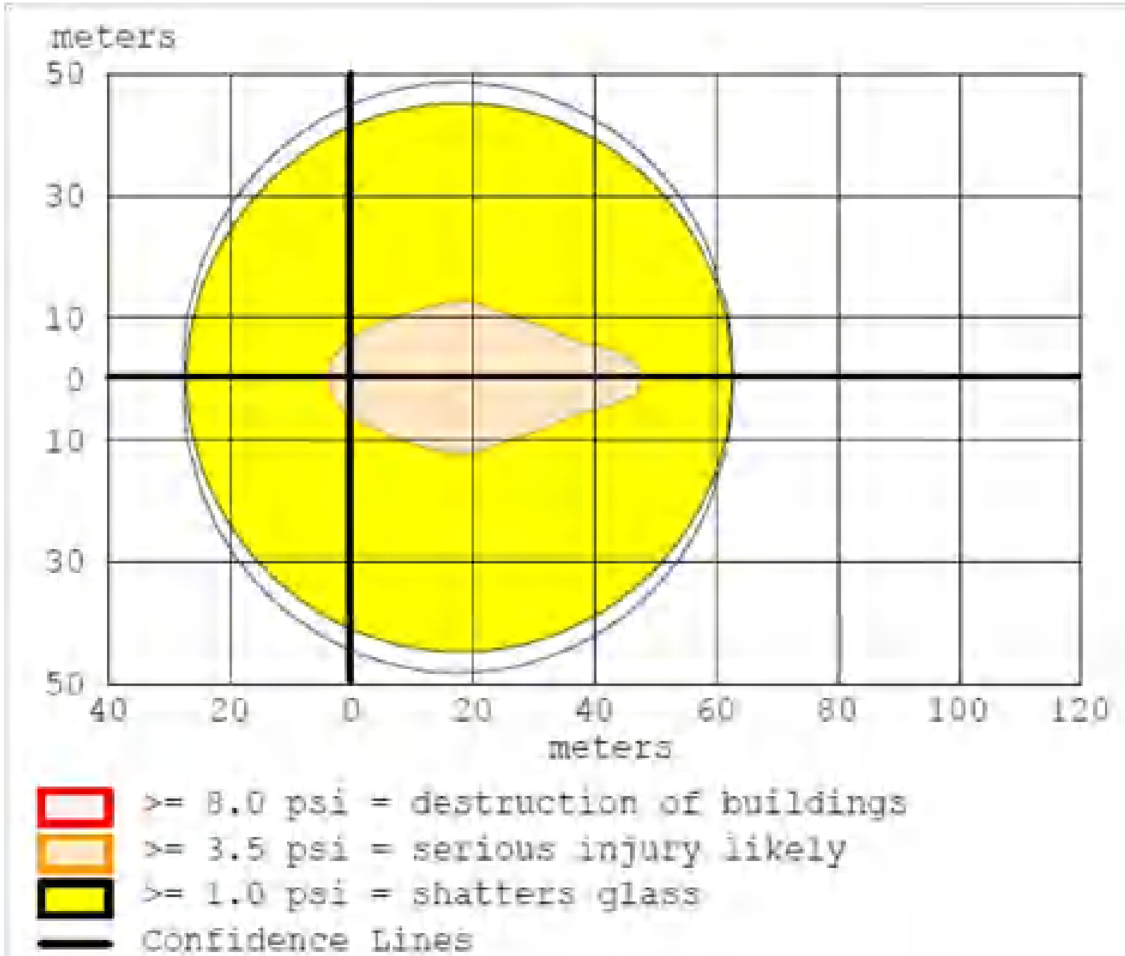
20.1.6.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



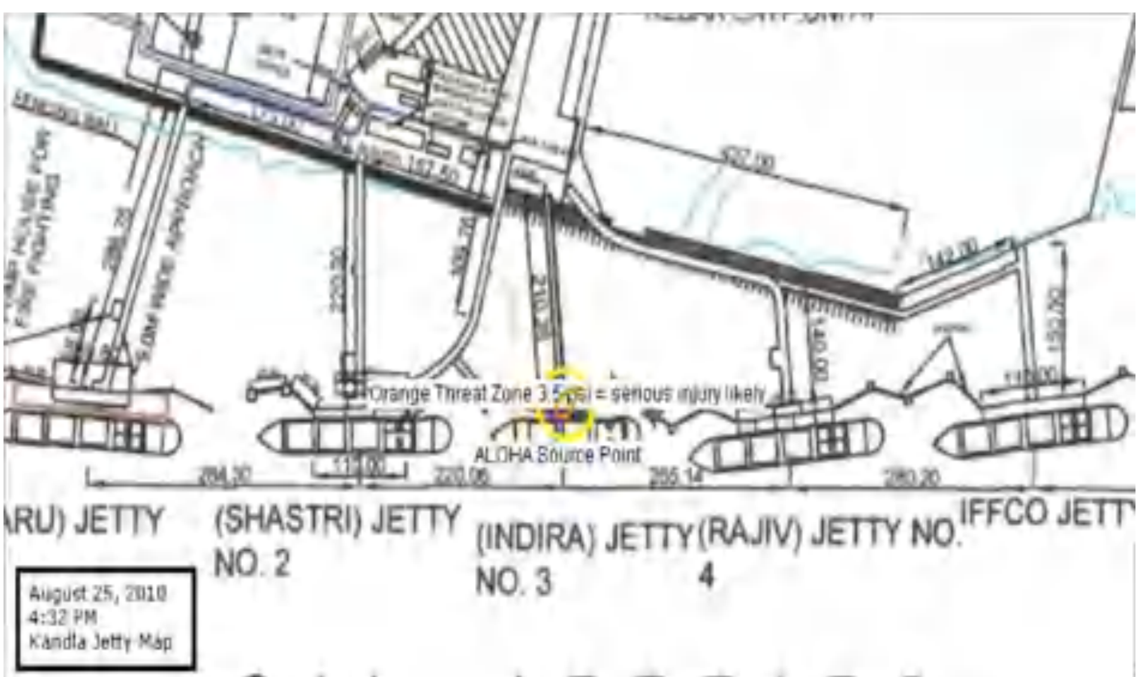
20.1.6.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



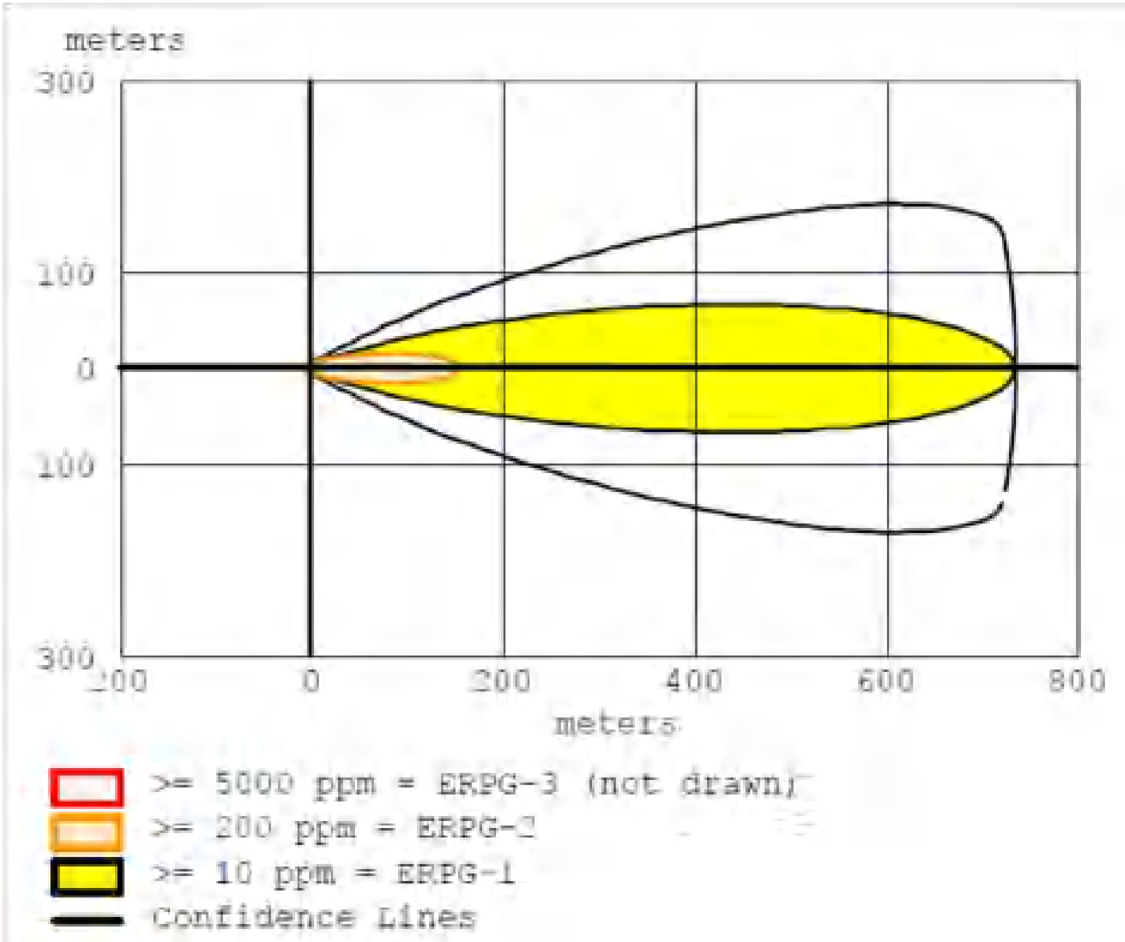
20.1.6.5 Instantaneous Release – Overpressure (Graph)



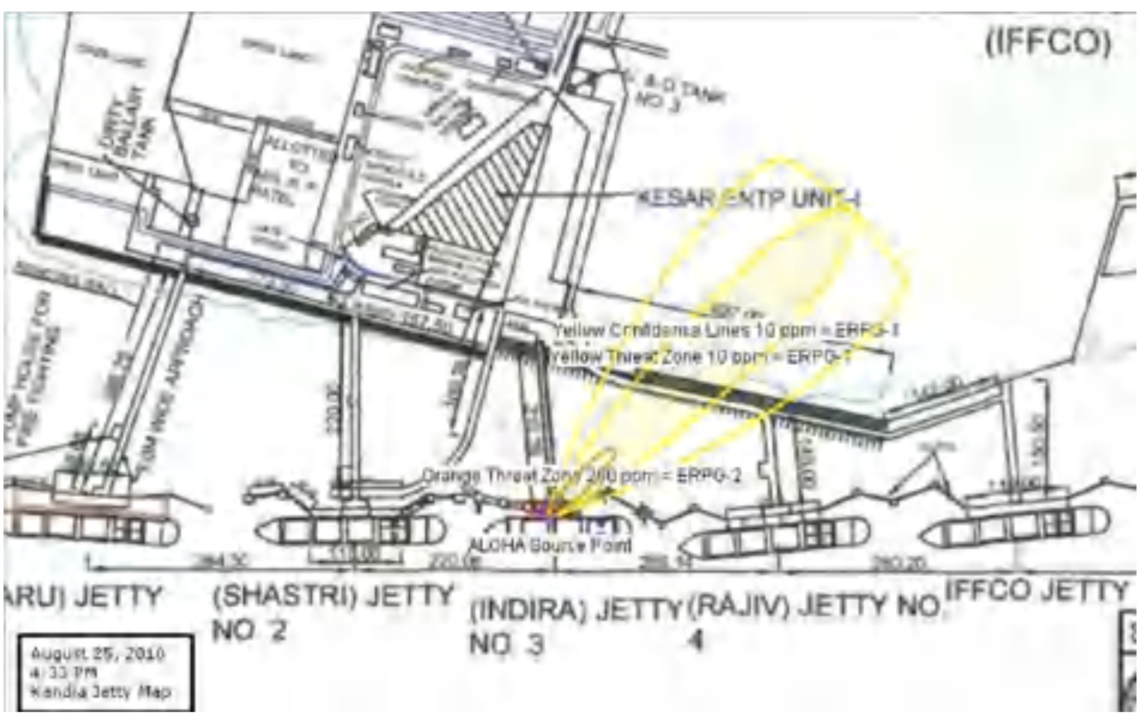
20.1.6.6 Instantaneous Release – Overpressure (Contour)



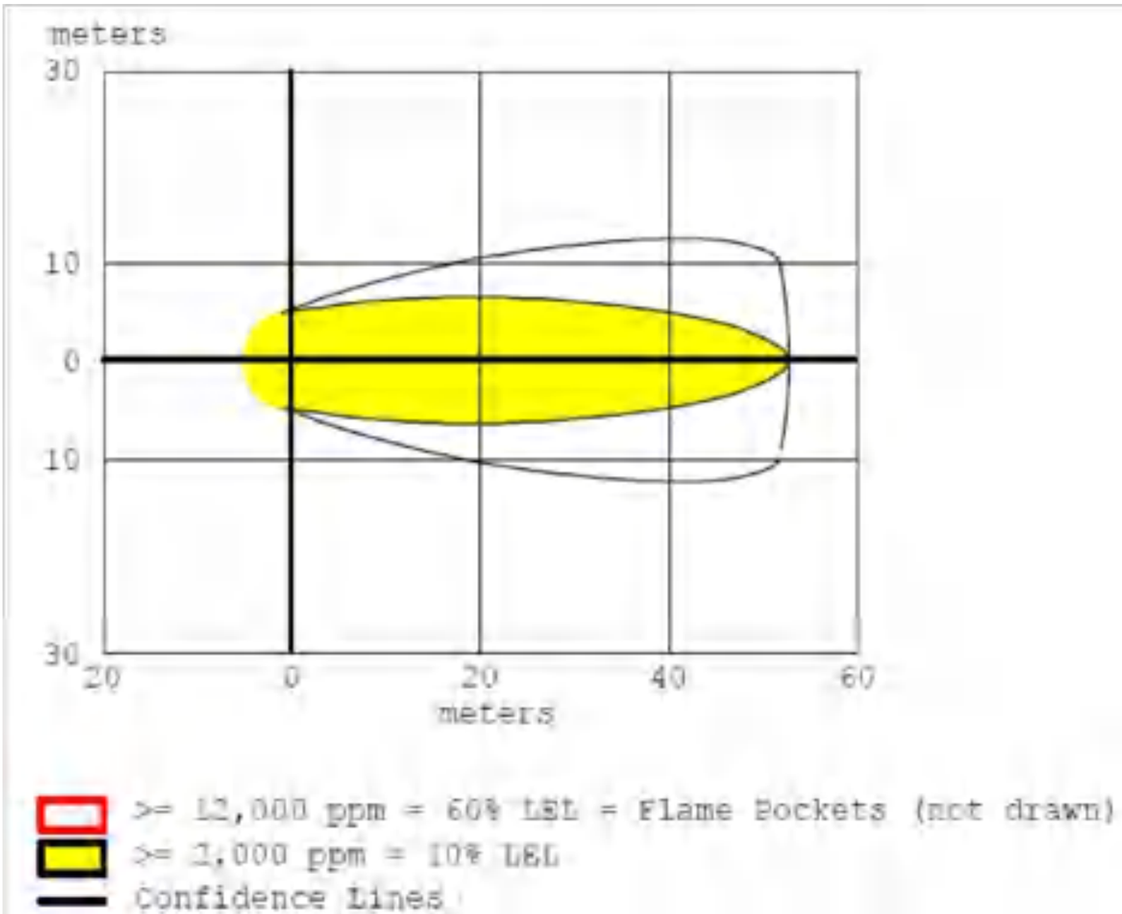
20.1.6.7 Evaporating Puddle – Toxic Threat Zone (Graph)



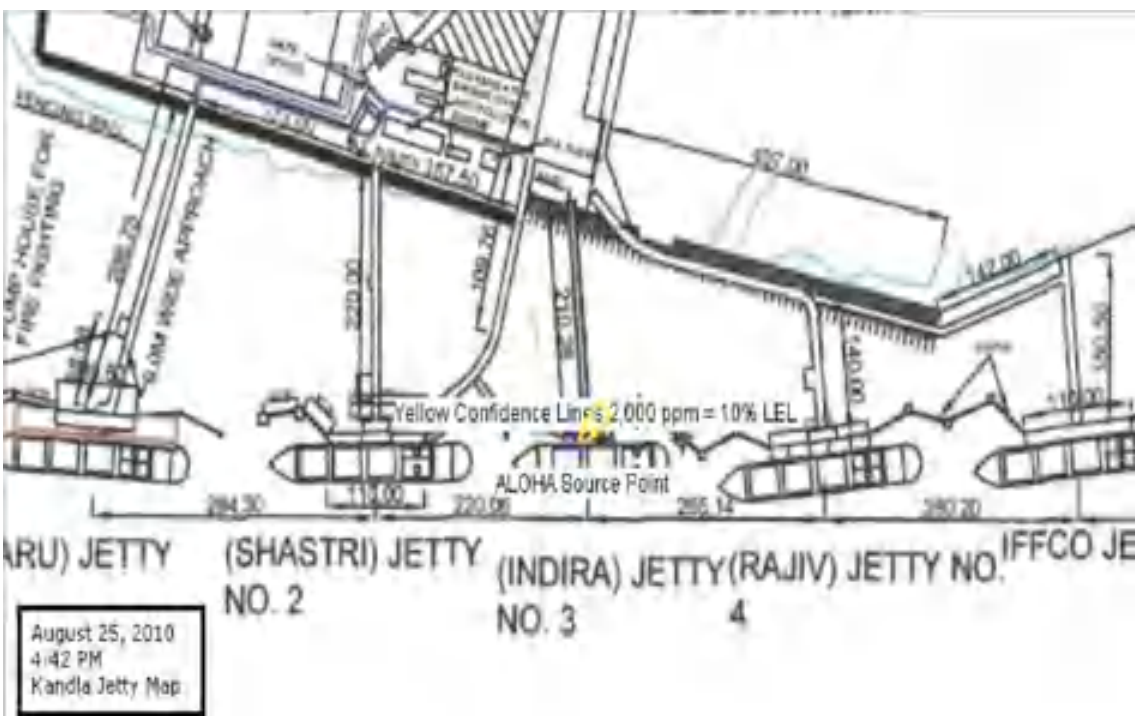
20.1.6.8 Evaporating Puddle – Toxic Threat Zone (Contour)



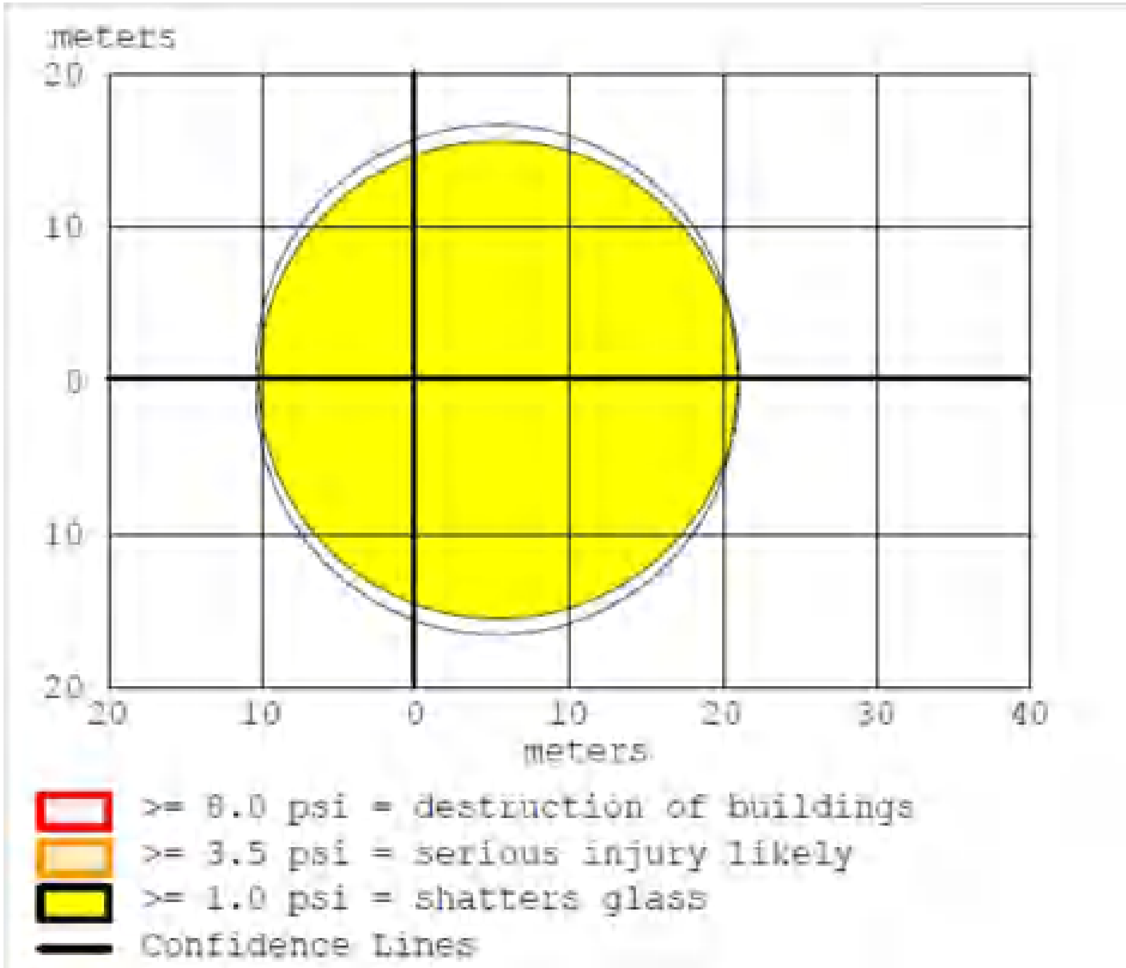
20.1.6.9 Evaporating Puddle – Flammable Area of Vapor Cloud (Graph)



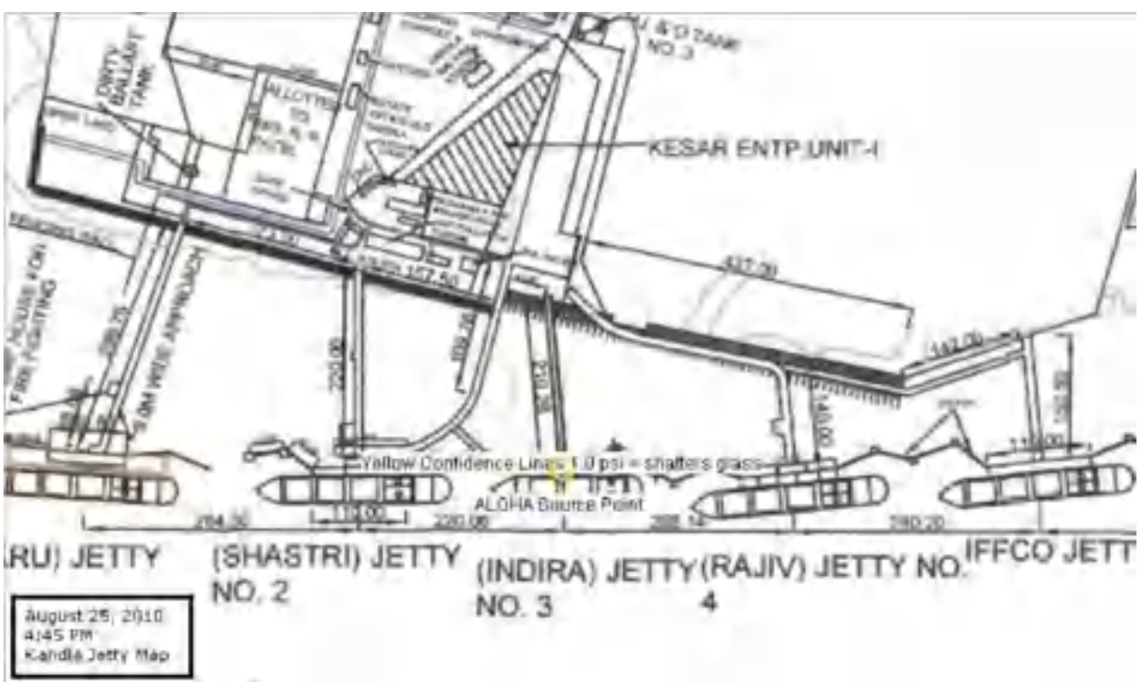
20.1.6.10 Evaporating Puddle – Flammable Area of Vapor Cloud (Contour)



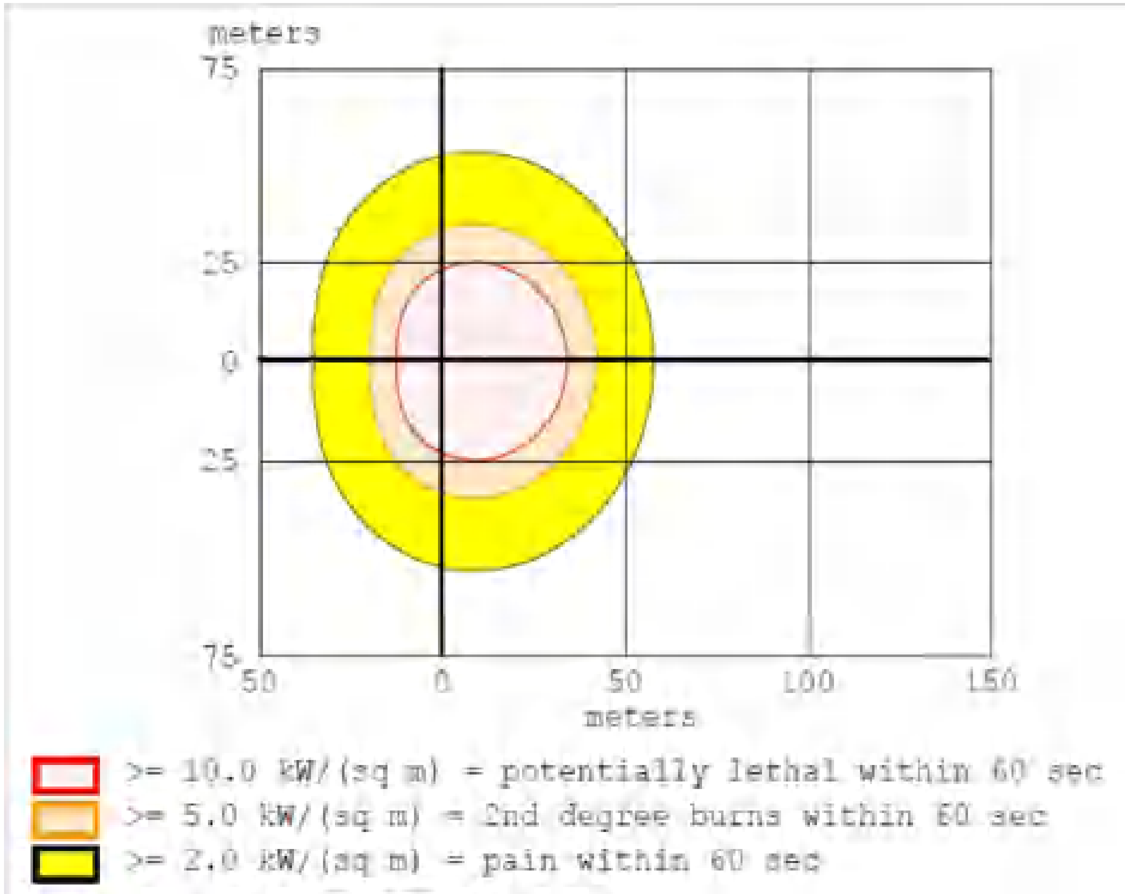
20.1.6.11 Evaporating Puddle – Overpressure (Graph)



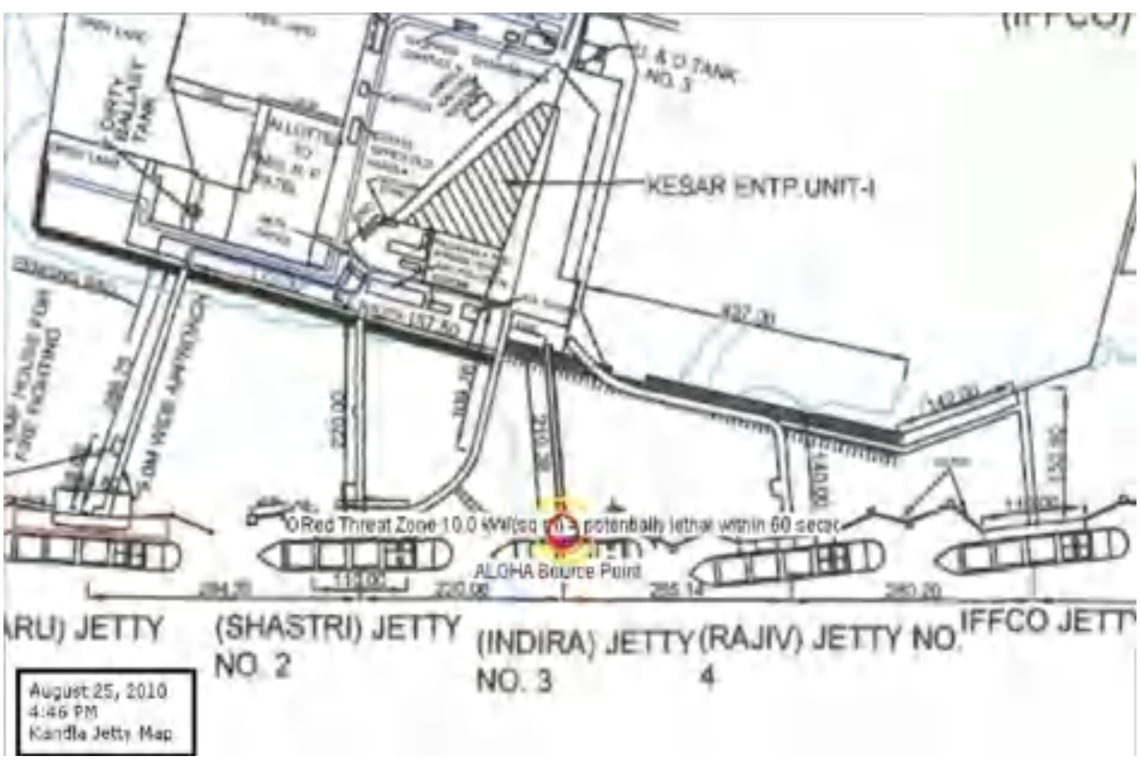
20.1.6.12 Evaporating Puddle – Overpressure (Contour)



20.1.6.13 Burning Puddle – Thermal Radiation (Graph)

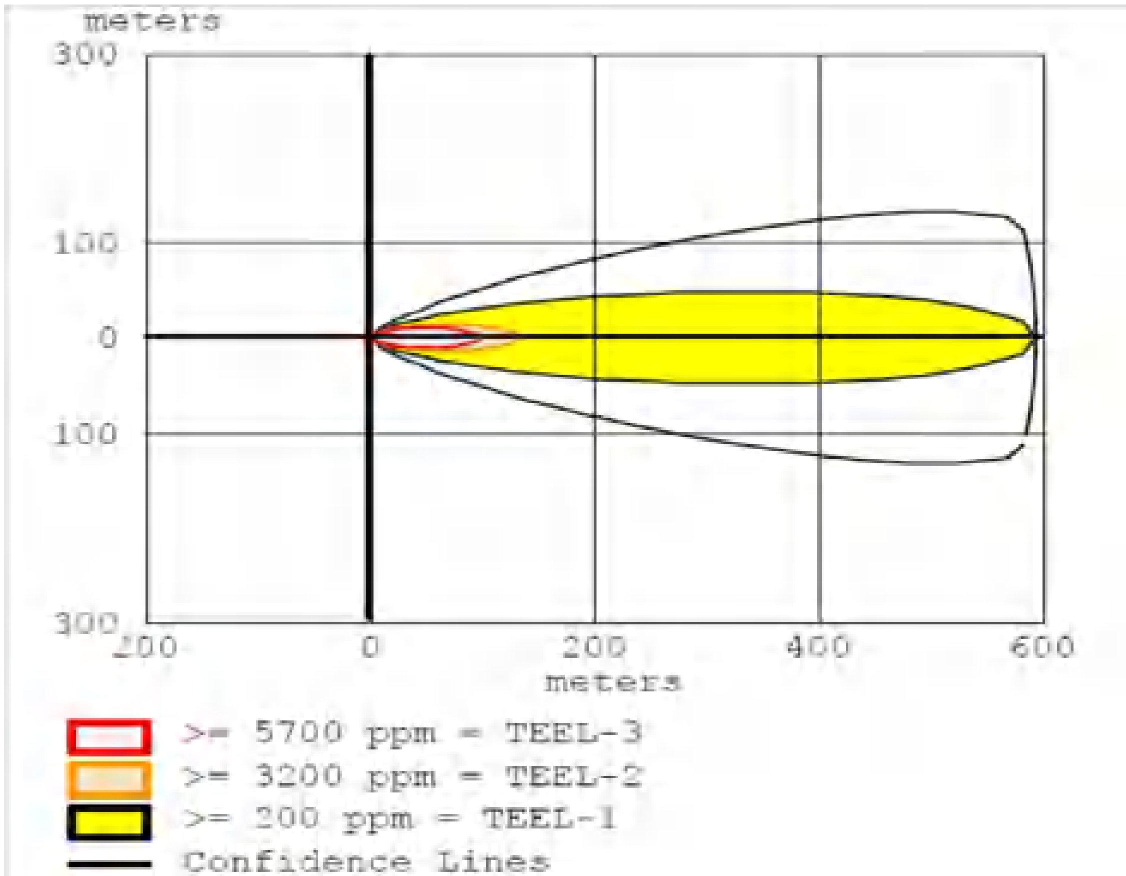


20.1.6.14 Burning Puddle – Thermal Radiation (Contour)

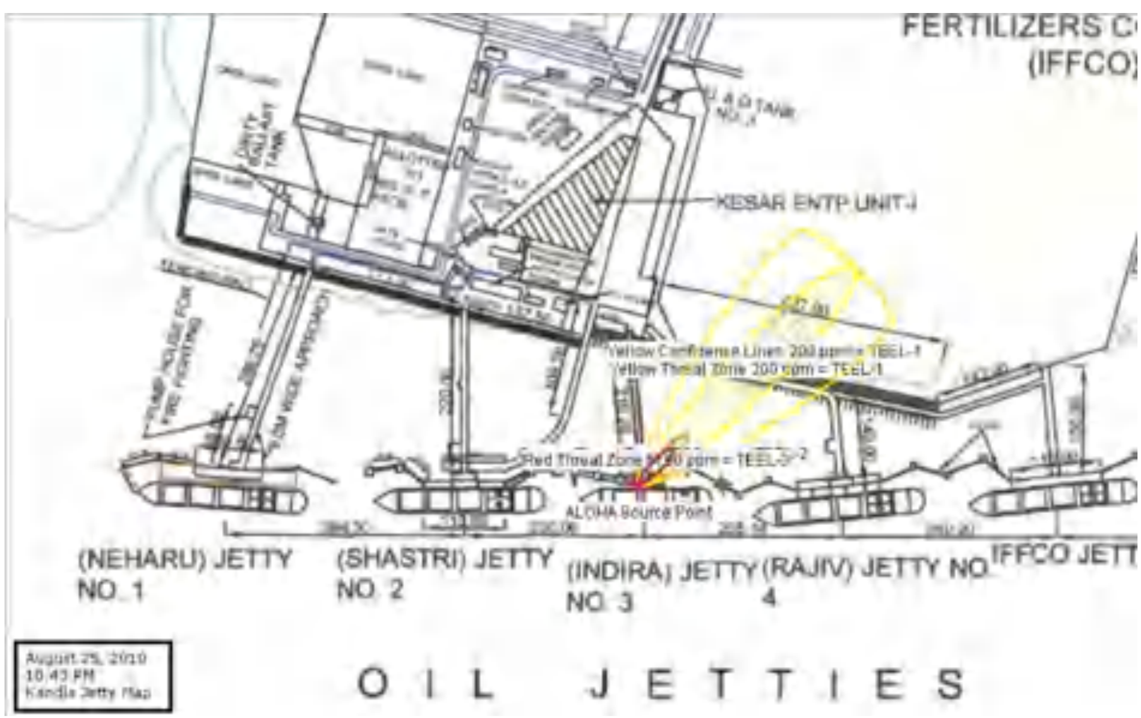


20.1.7 Jetty Three – Acetone

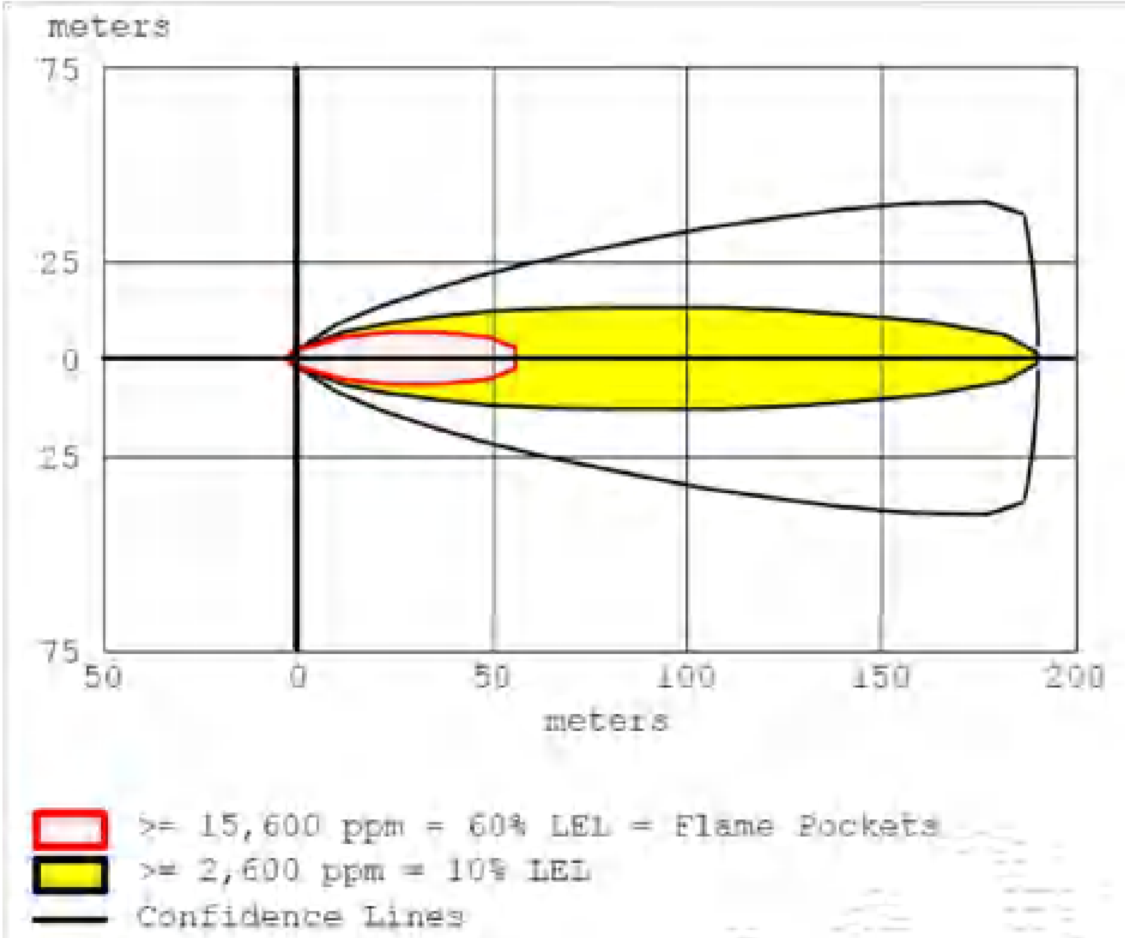
20.1.7.1 Instantaneous Release – Toxic Threat Zone (Graph)



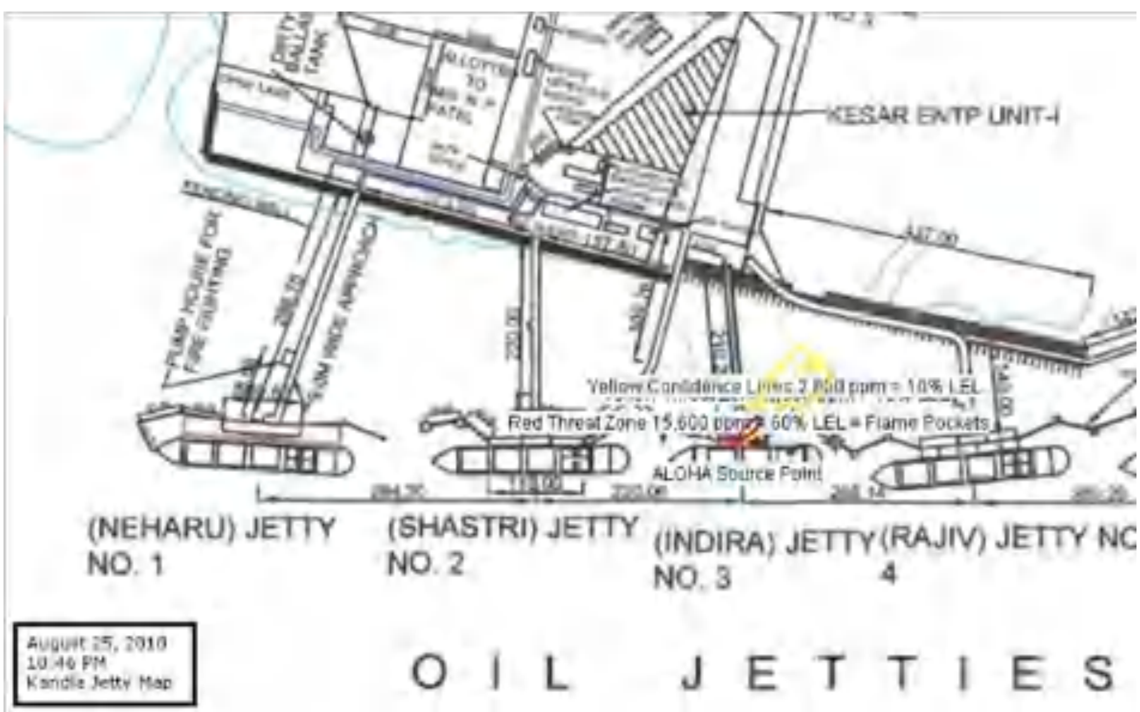
20.1.7.2 Instantaneous Release – Toxic Threat Zone (Contour)



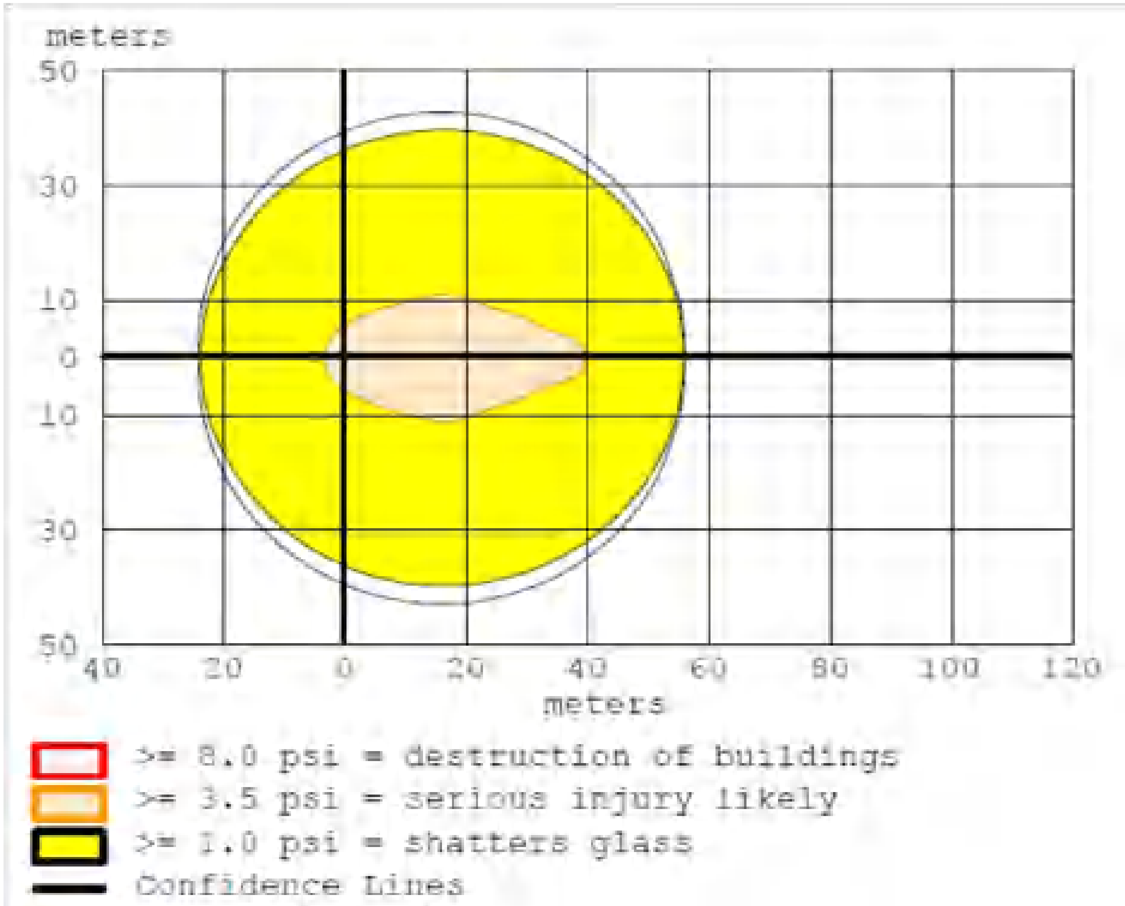
20.1.7.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



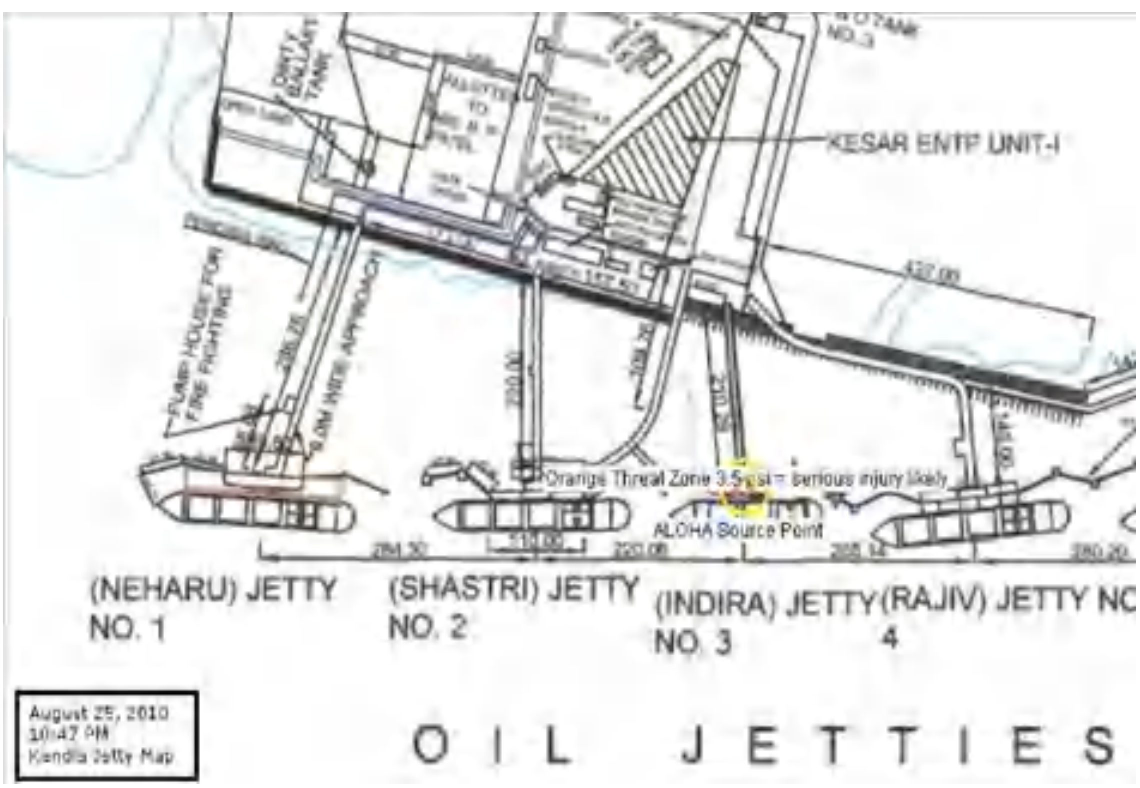
20.1.7.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



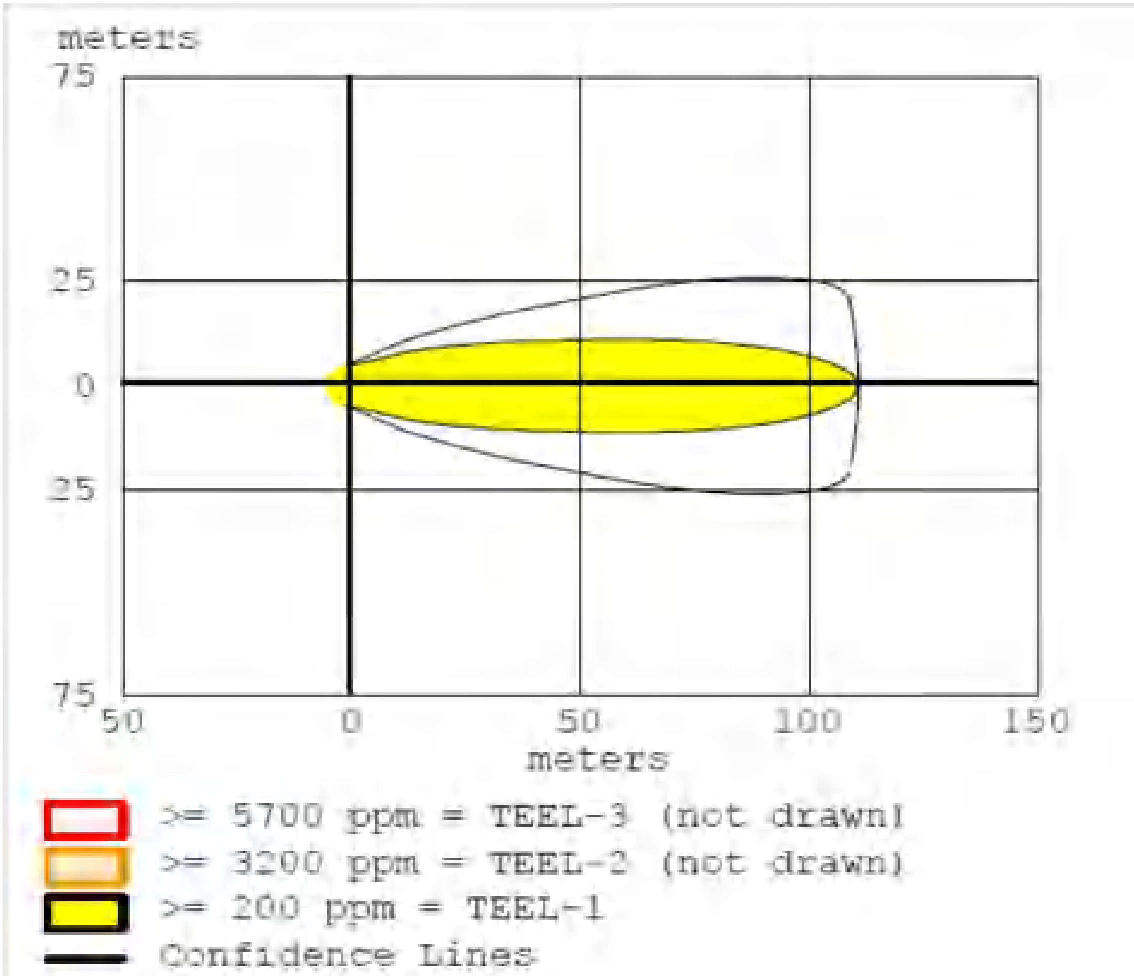
20.1.7.5 Instantaneous Release – Overpressure (Graph)



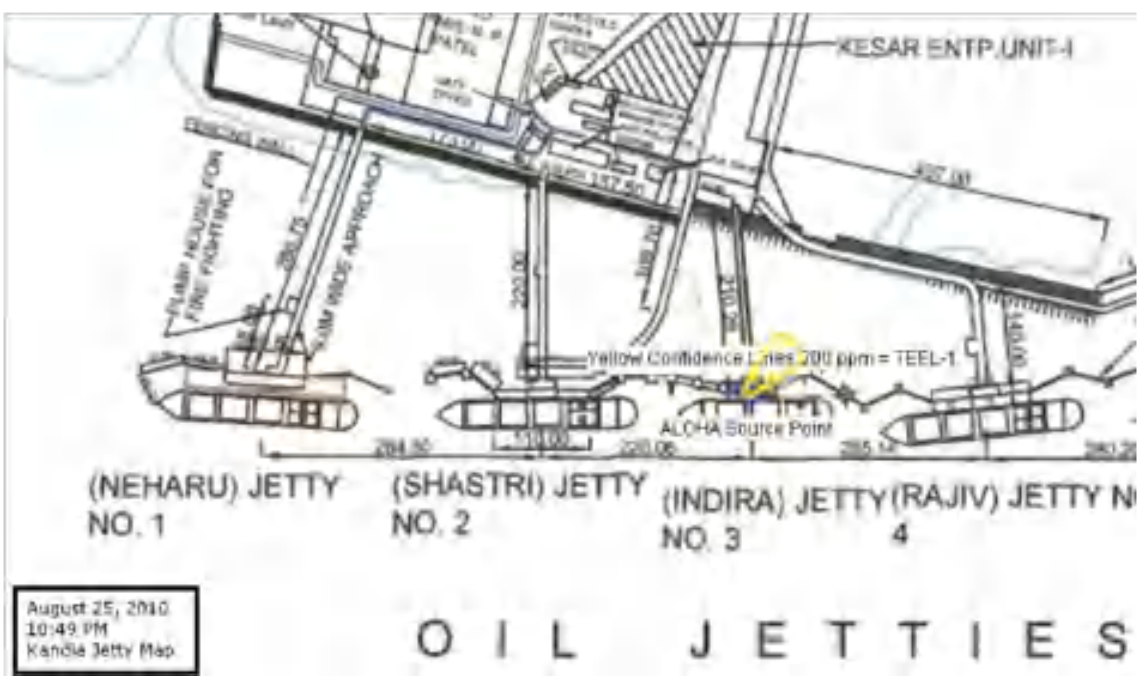
20.1.7.6 Instantaneous Release – Overpressure (Contour)



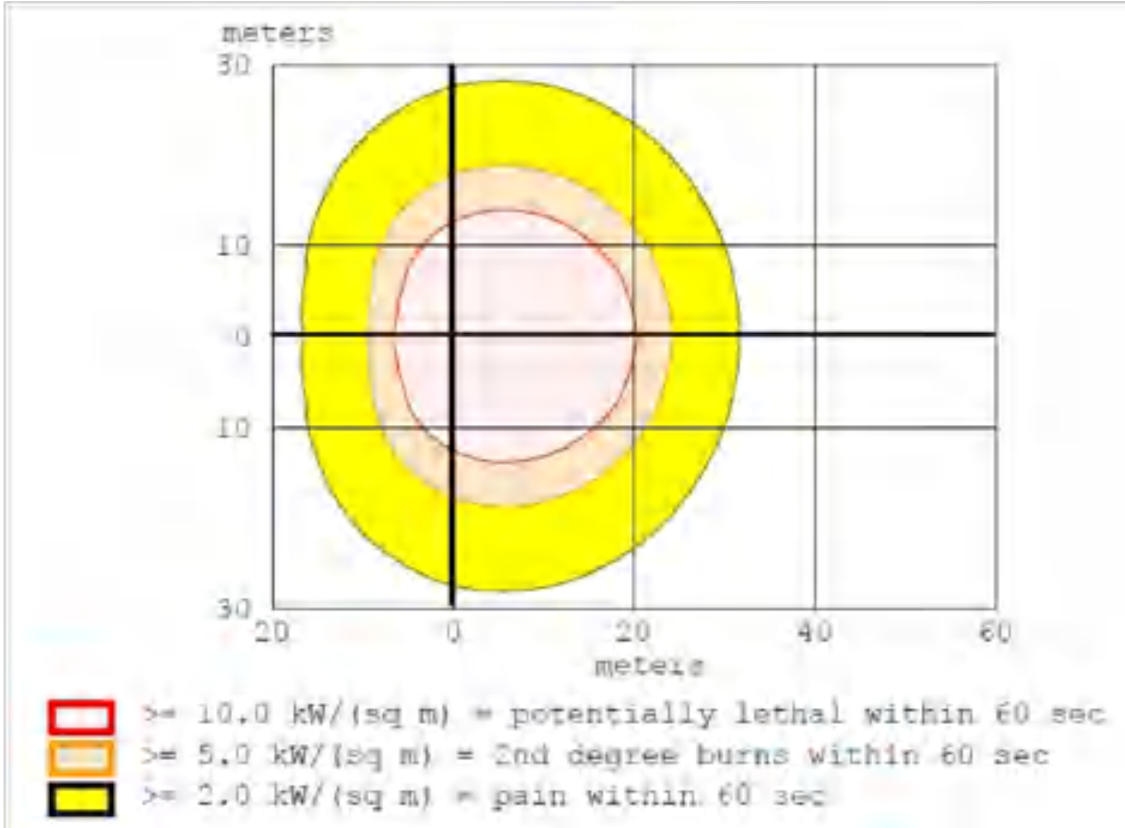
20.1.7.7 Evaporating Puddle – Toxic Threat Zone (Graph)



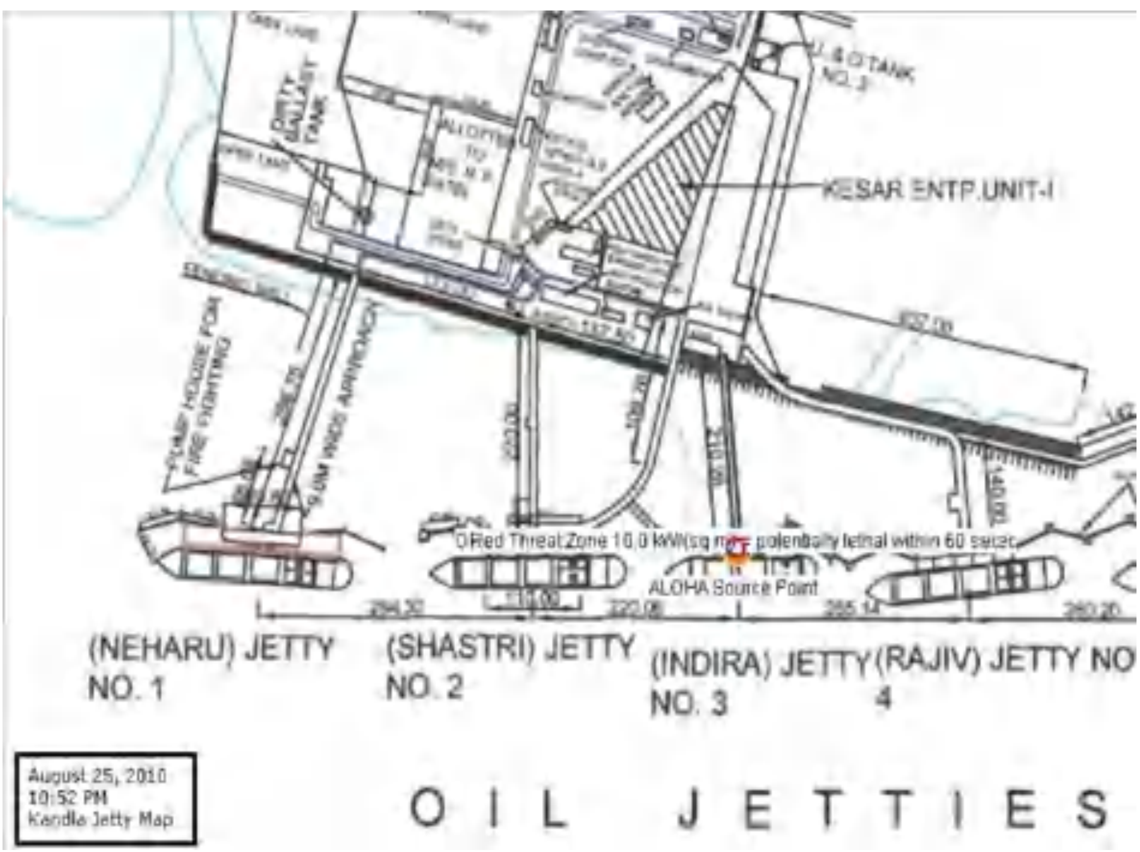
20.1.7.8 Evaporating Puddle – Toxic Threat Zone (Contour)



20.1.7.9 Burning Puddle – Thermal Radiation (Graph)

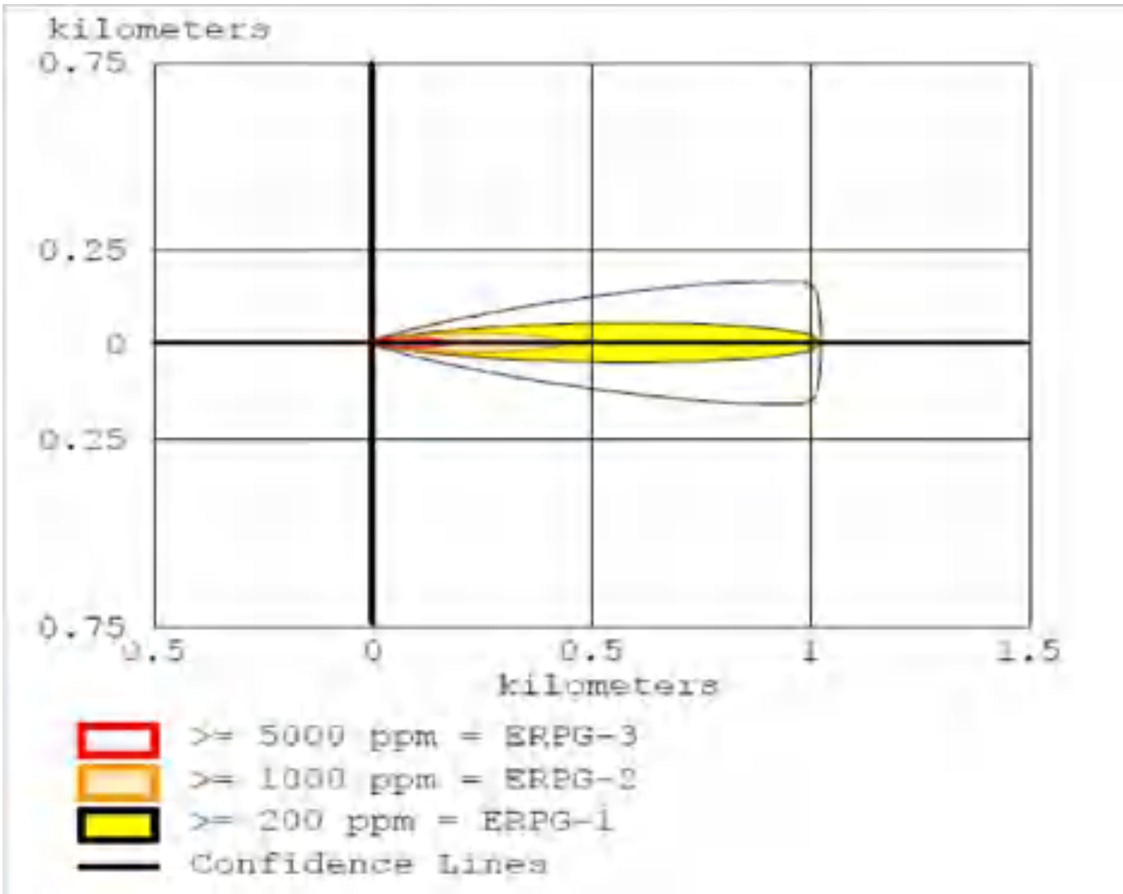


20.1.7.10 Burning Puddle – Thermal Radiation (Contour)

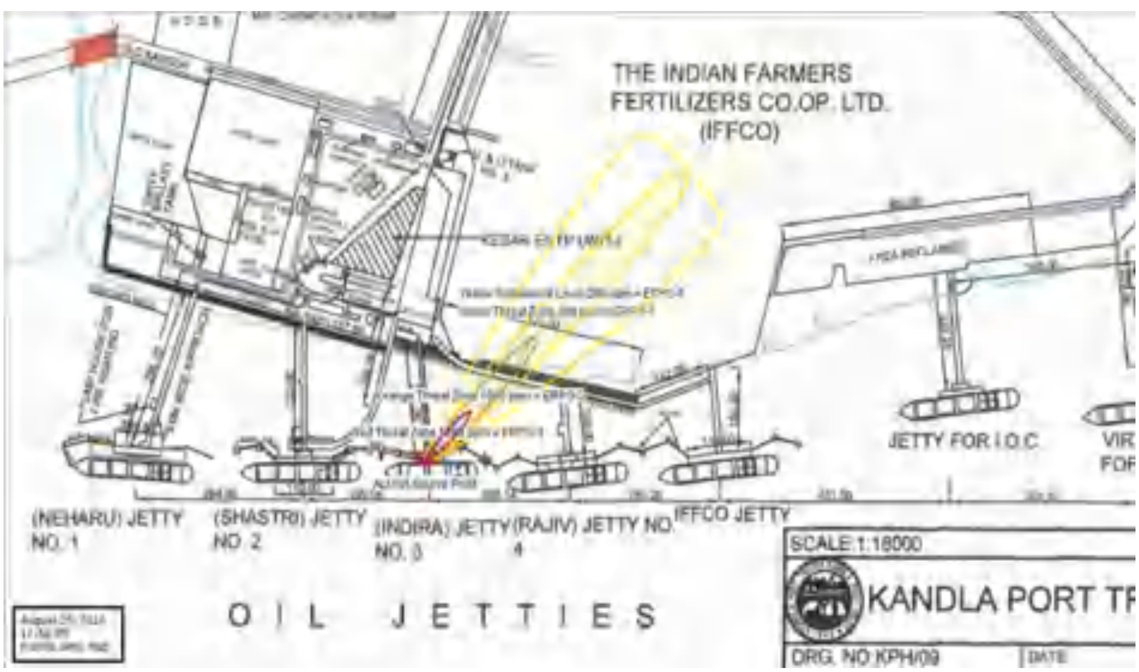


20.1.8 Jetty Three – Methanol

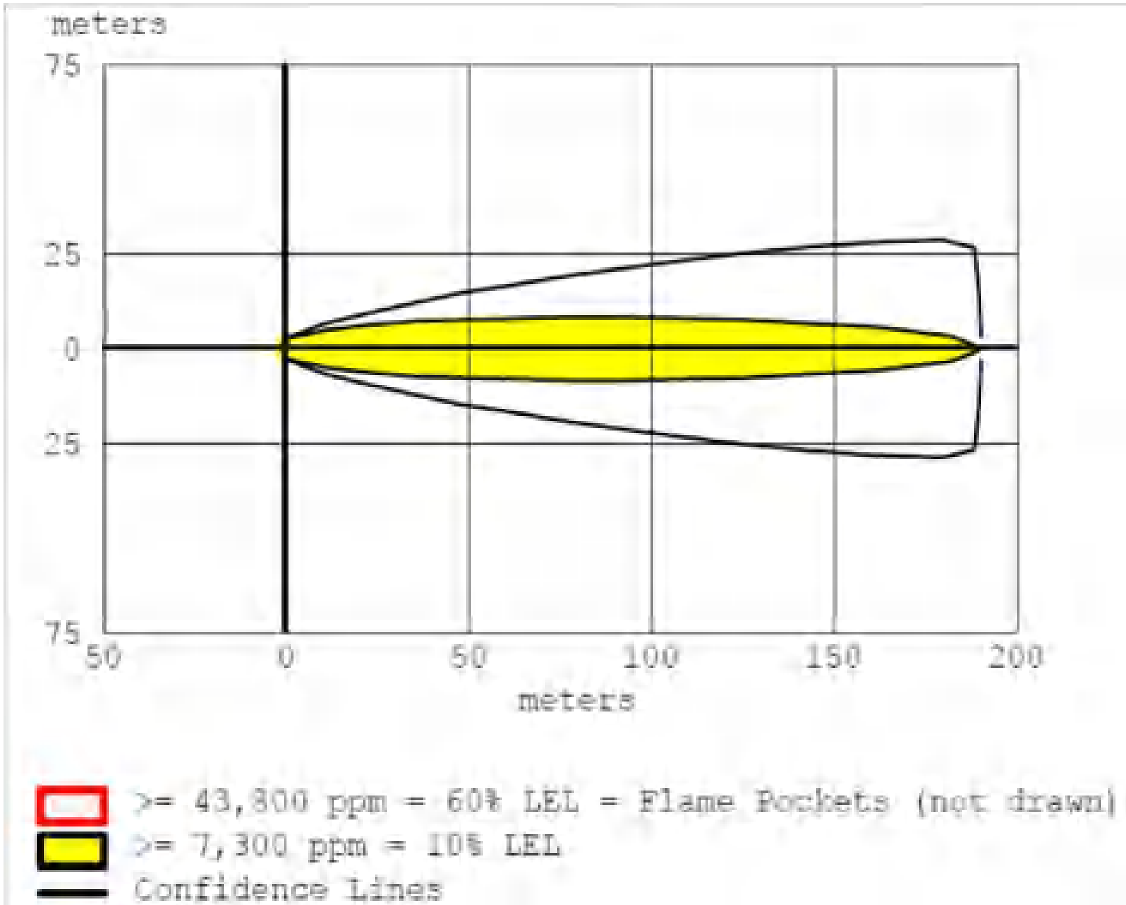
20.1.8.1 Instantaneous Release – Toxic Threat Zone (Graph)



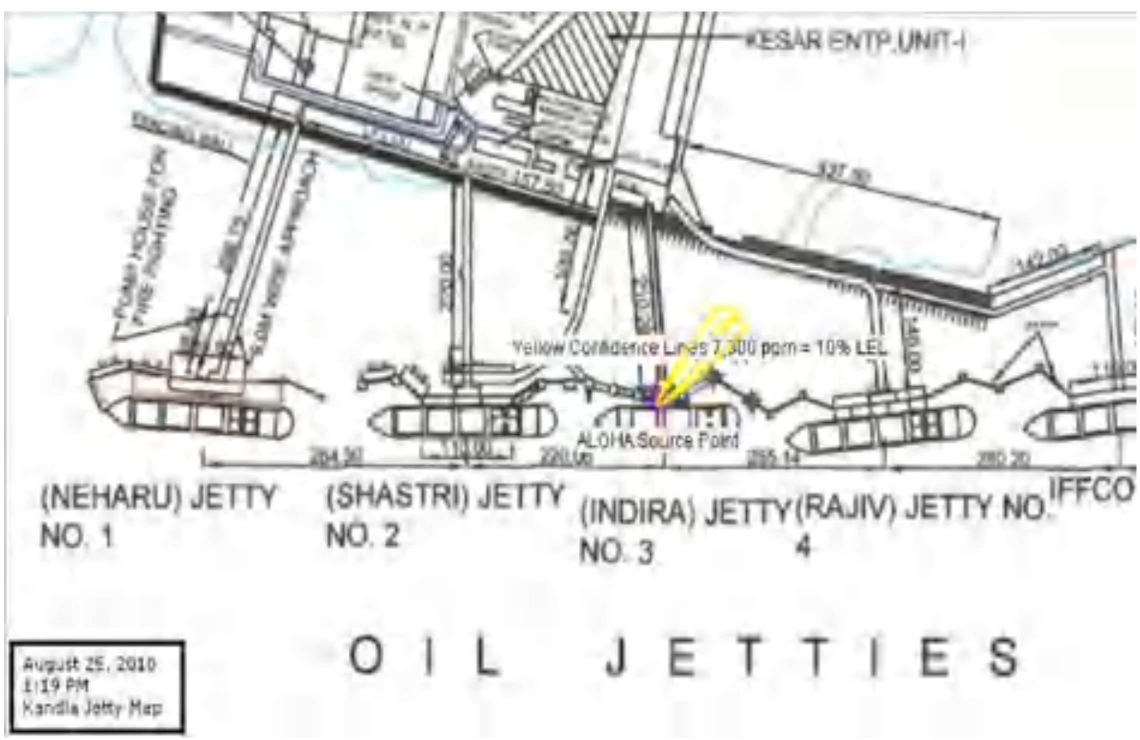
20.1.8.2 Instantaneous Release – Toxic Threat Zone (Contour)



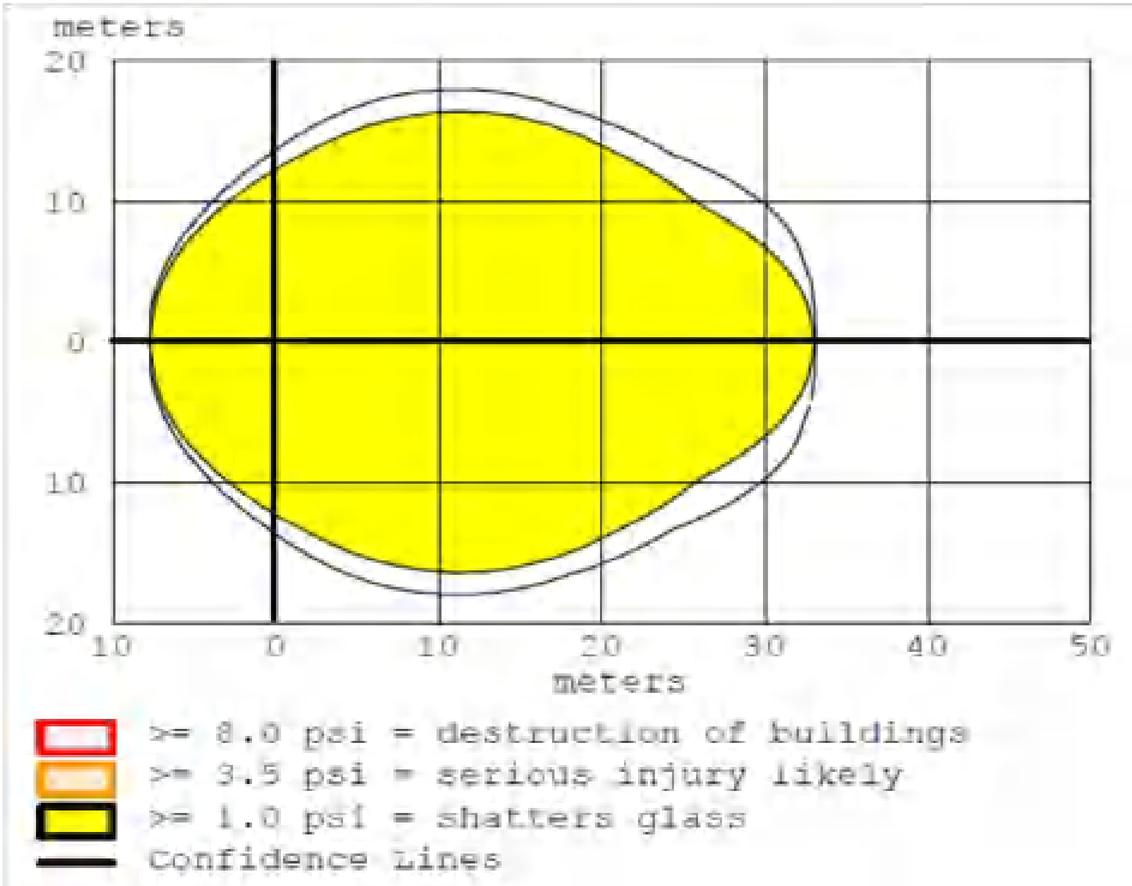
20.1.8.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



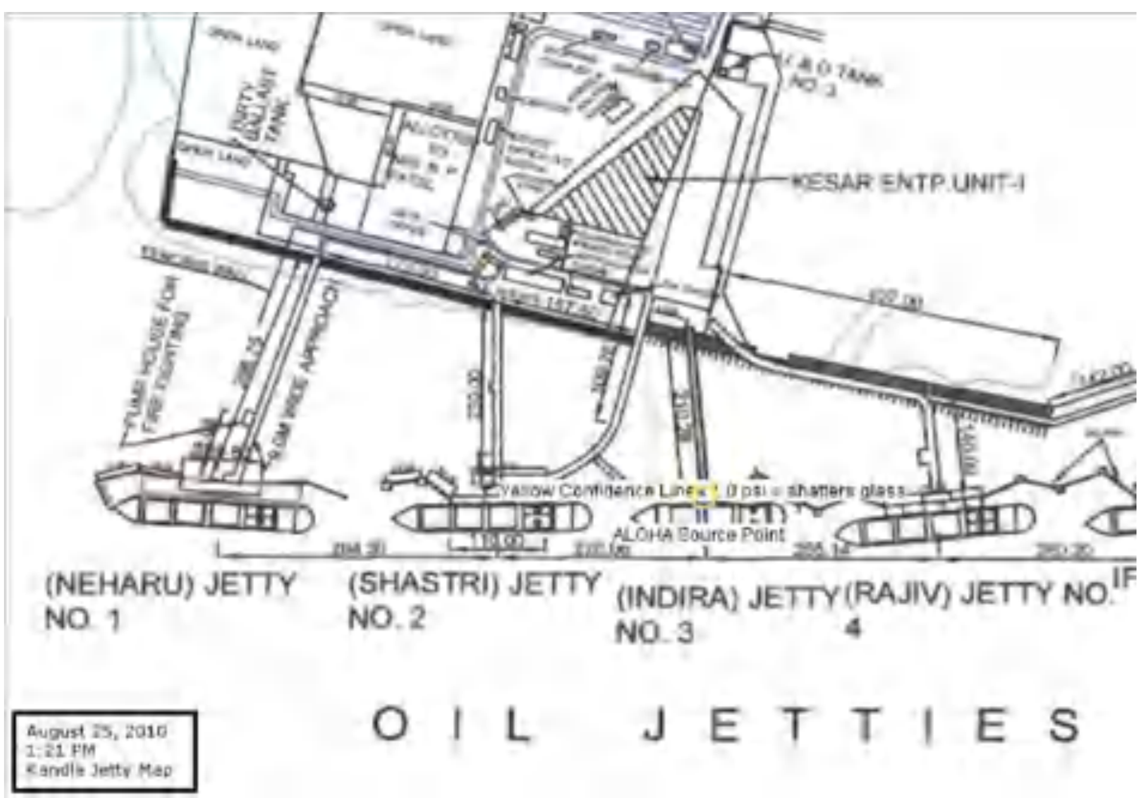
20.1.8.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



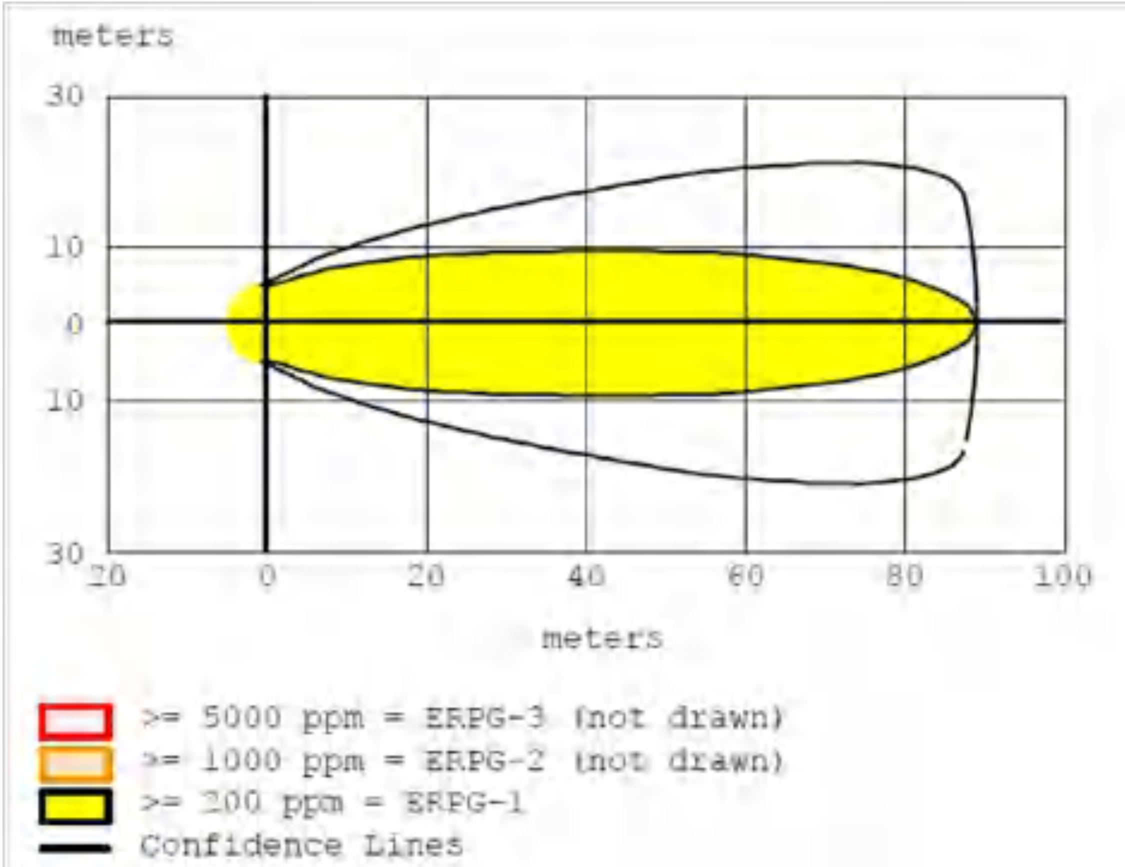
20.1.8.5 Instantaneous Release – Overpressure (Graph)



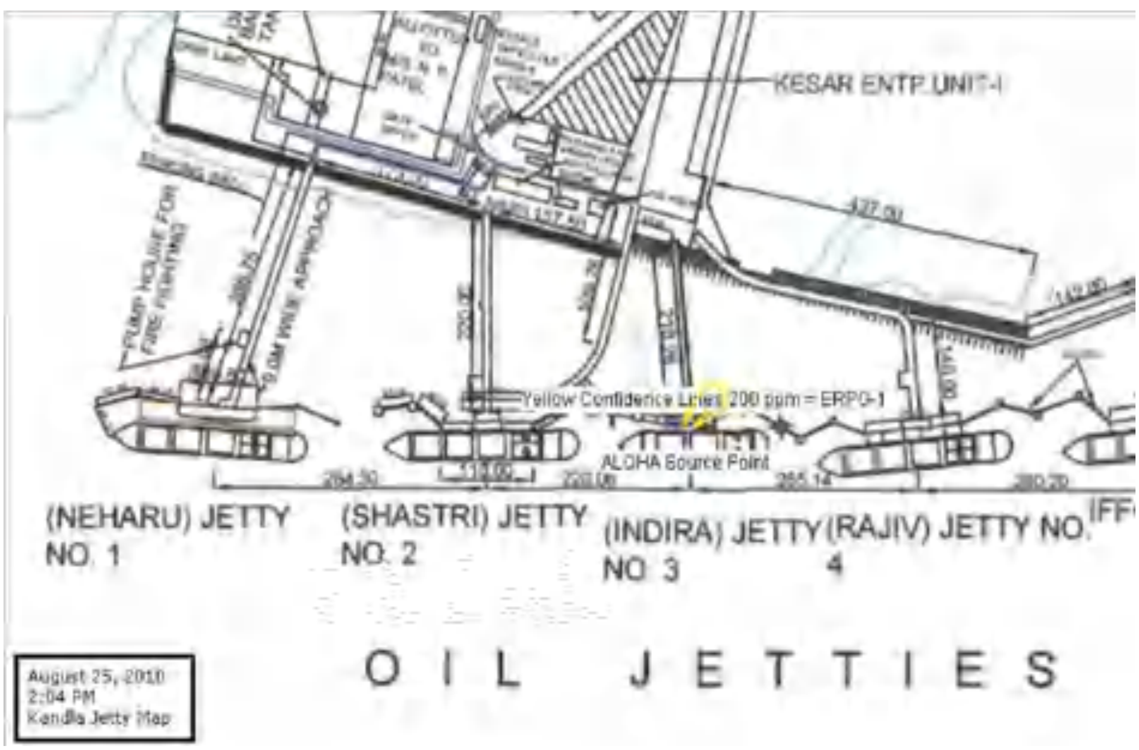
20.1.8.6 Instantaneous Release – Overpressure (Contour)



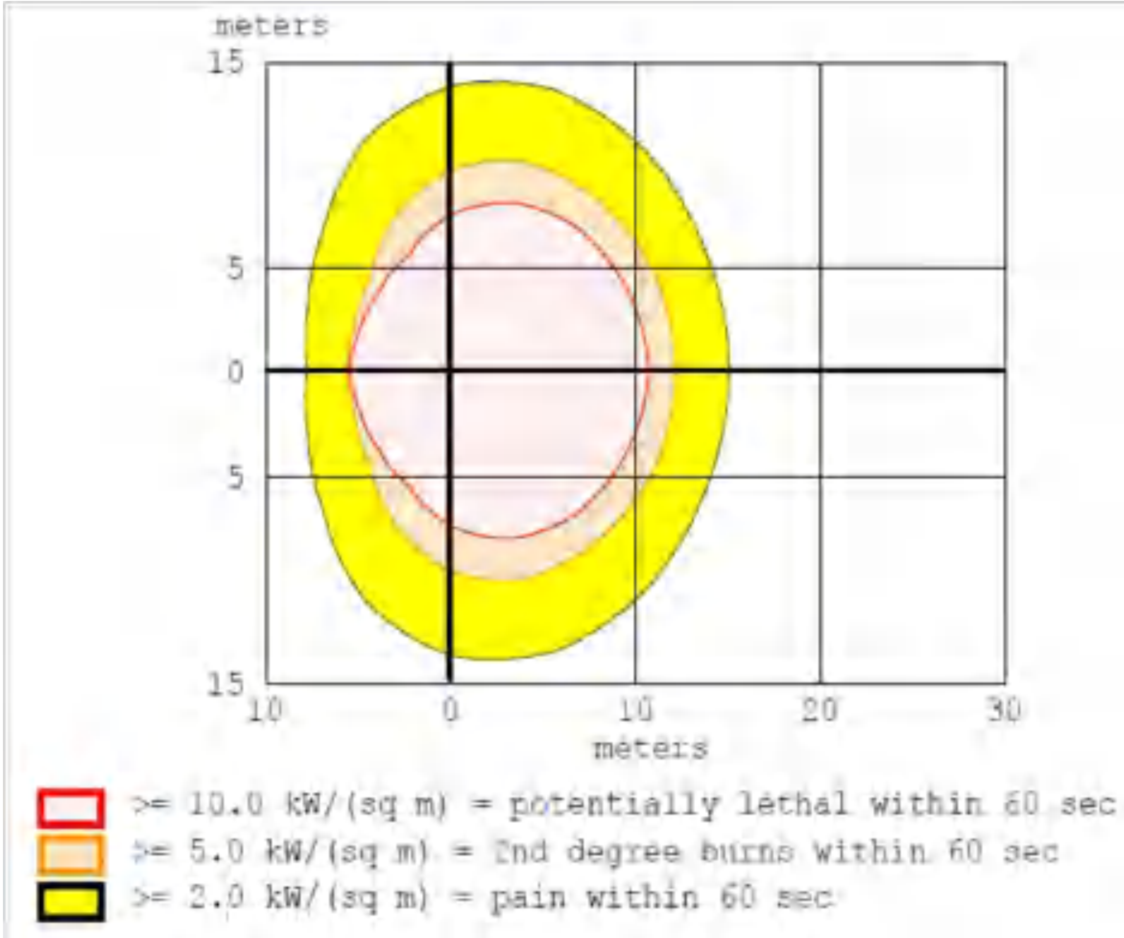
20.1.8.7 Evaporating Puddle – Toxic Threat Zone (Graph)



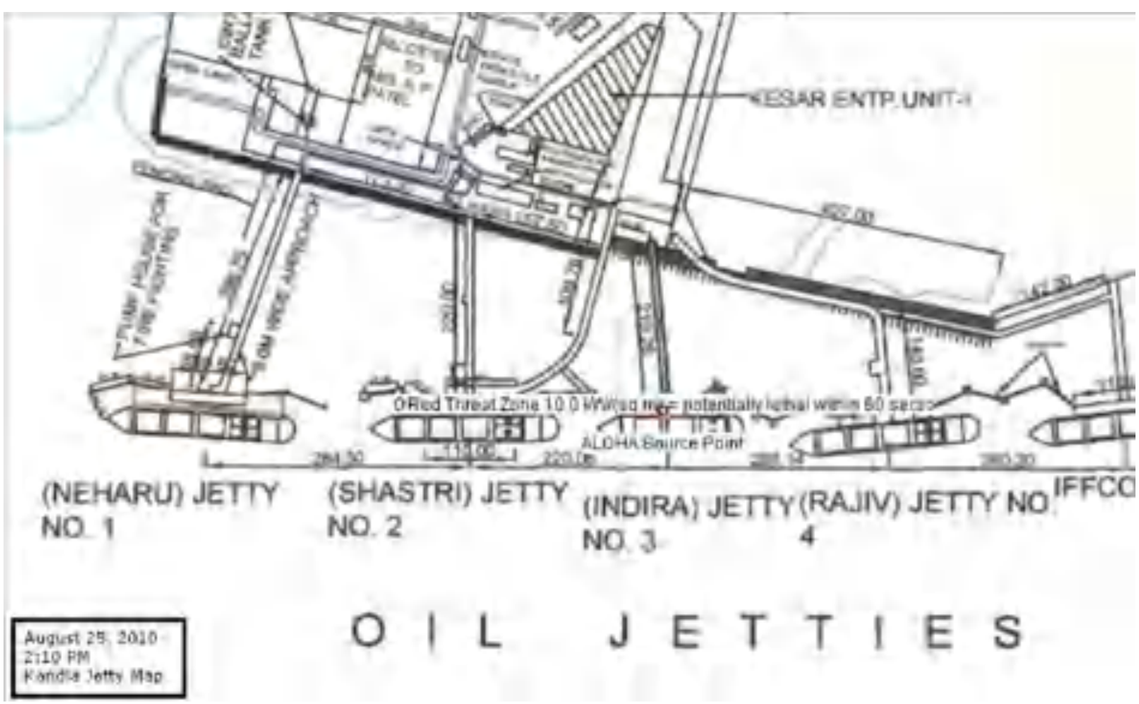
20.1.8.8 Evaporating Puddle – Toxic Threat Zone (Contour)



20.1.8.9 Burning Puddle – Thermal Radiation (Graph)

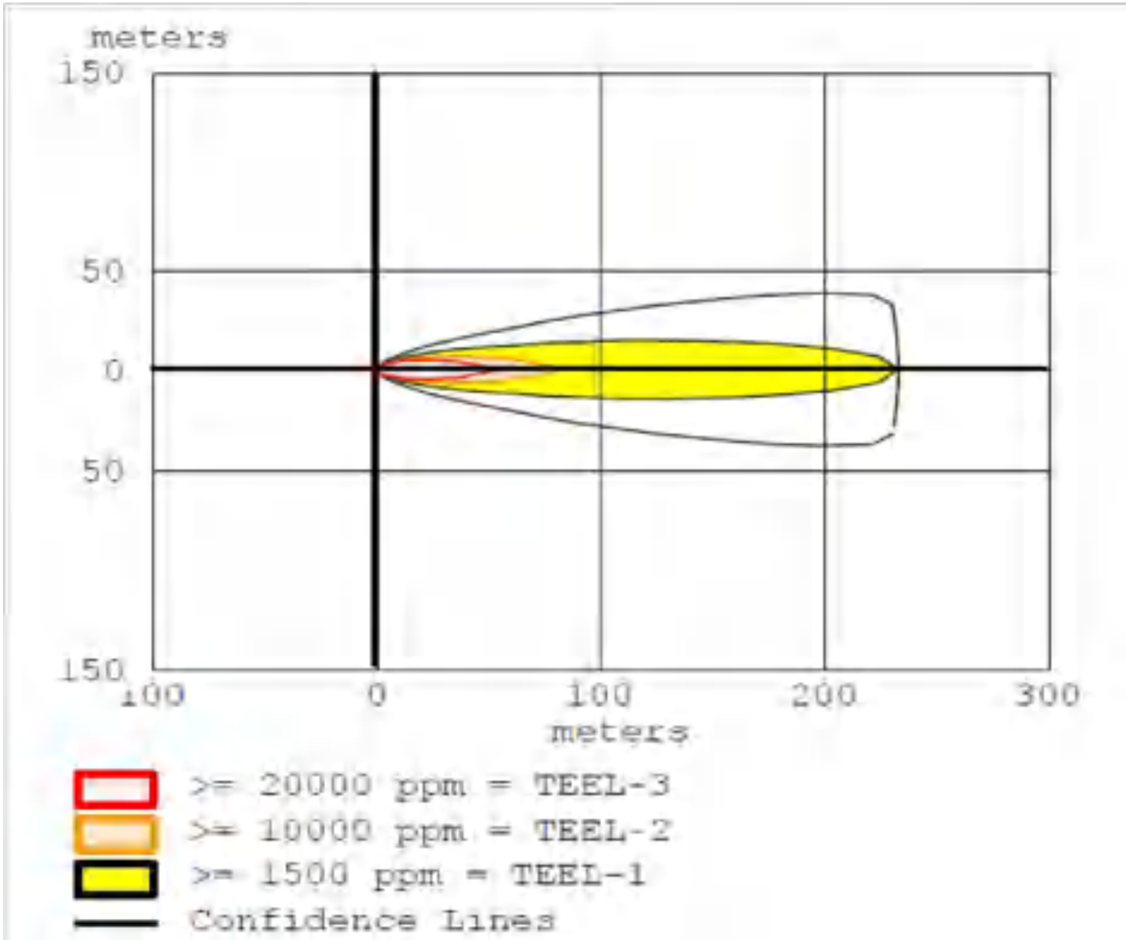


20.1.8.10 Burning Puddle – Thermal Radiation (Contour)

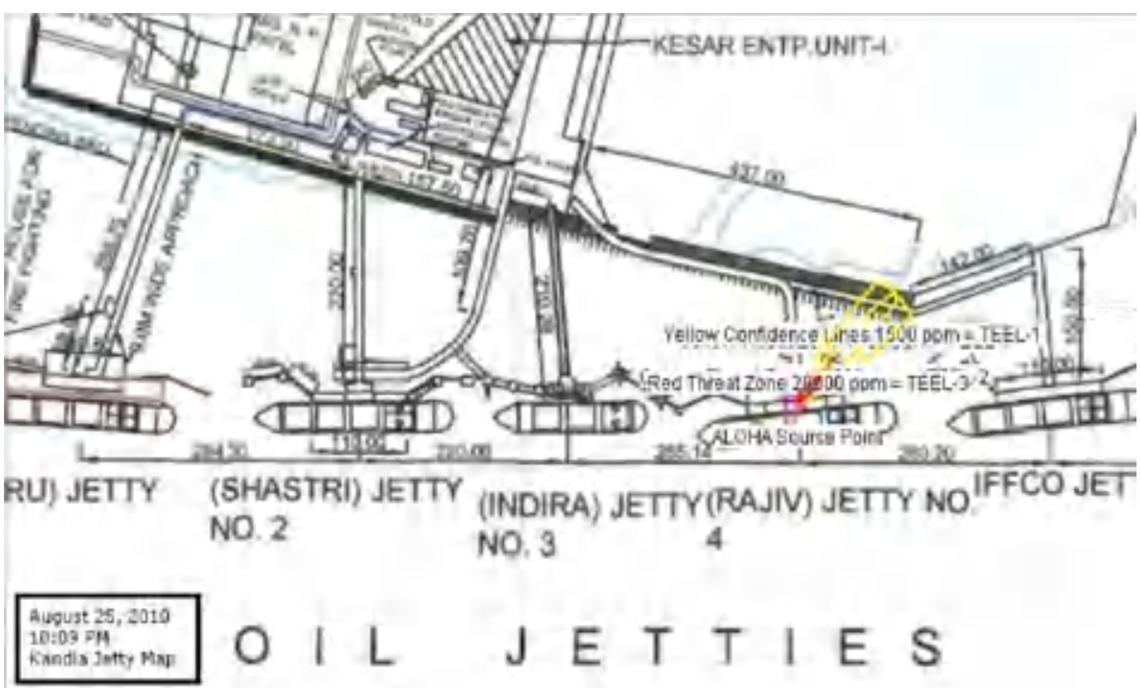


20.1.9 Jetty Four – Propylene

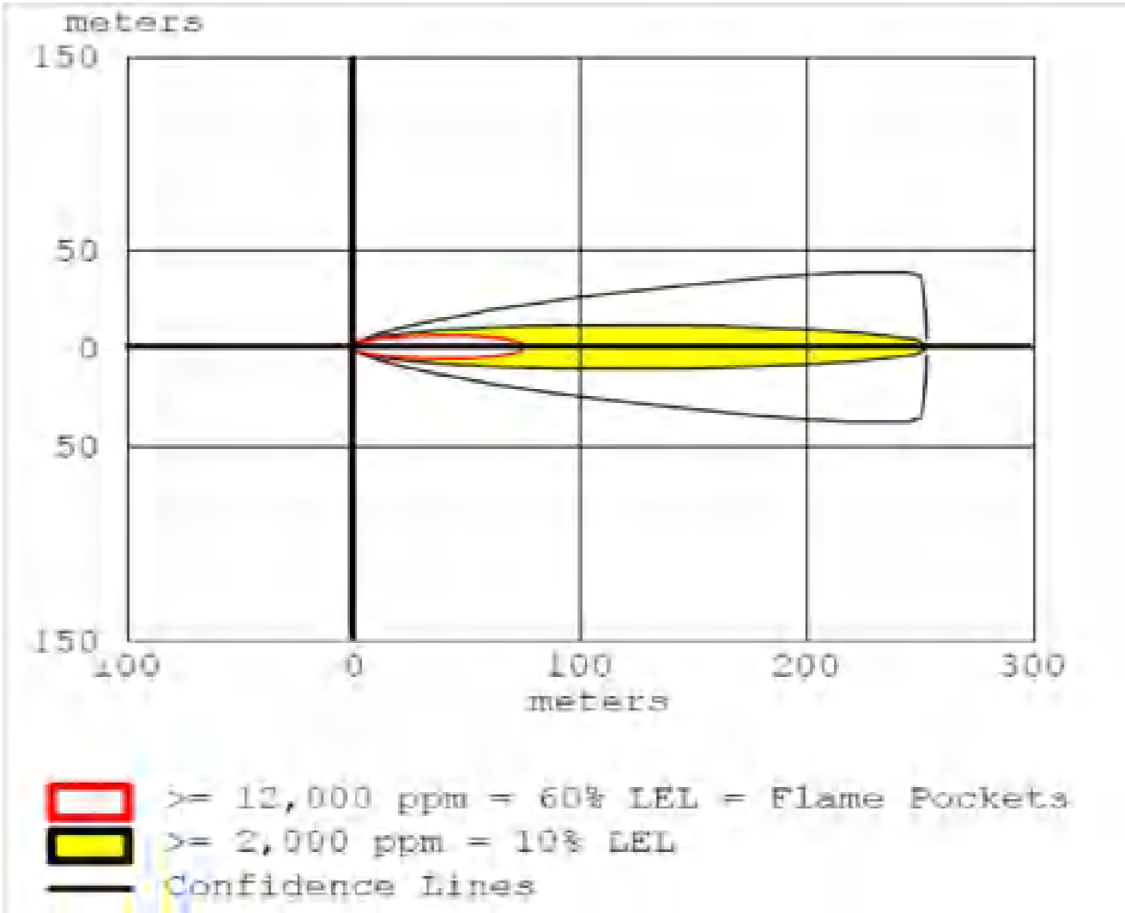
20.1.9.1 Instantaneous Release – Toxic Threat Zone (Graph)



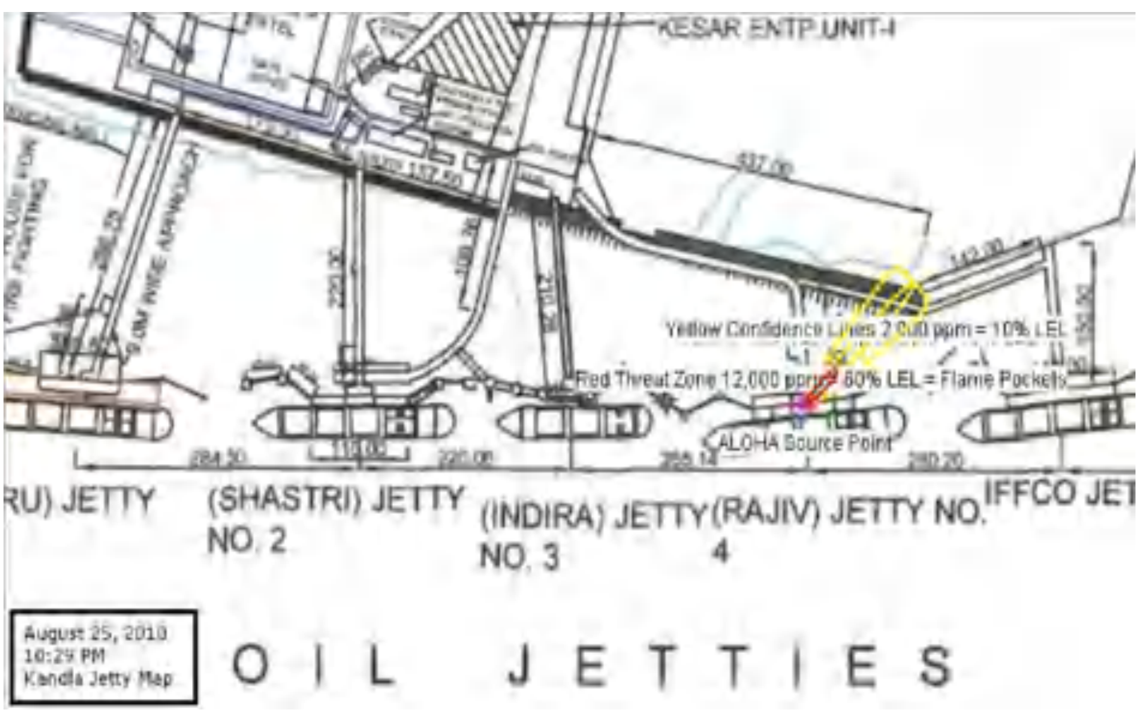
20.1.9.2 Instantaneous Release – Toxic Threat Zone (Contour)



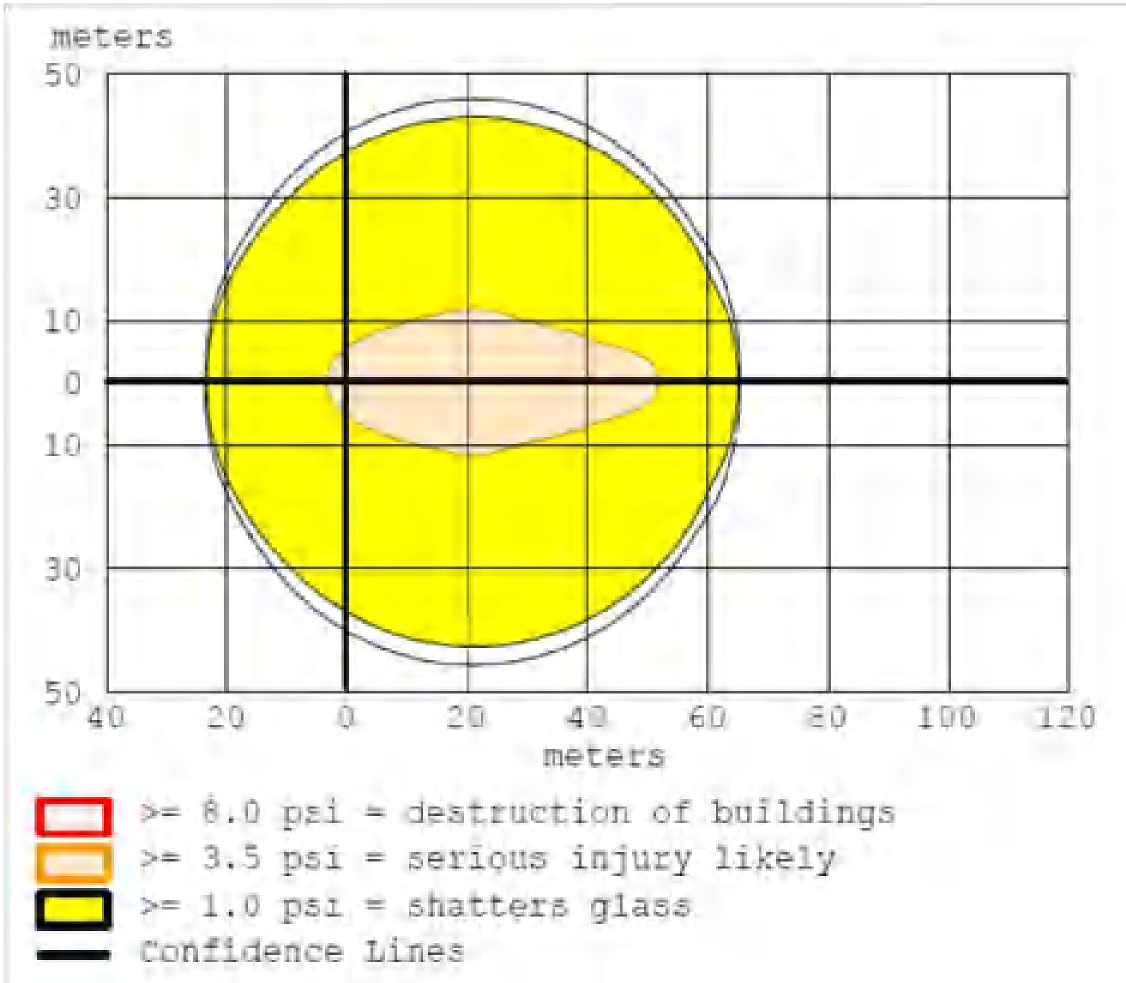
20.1.9.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



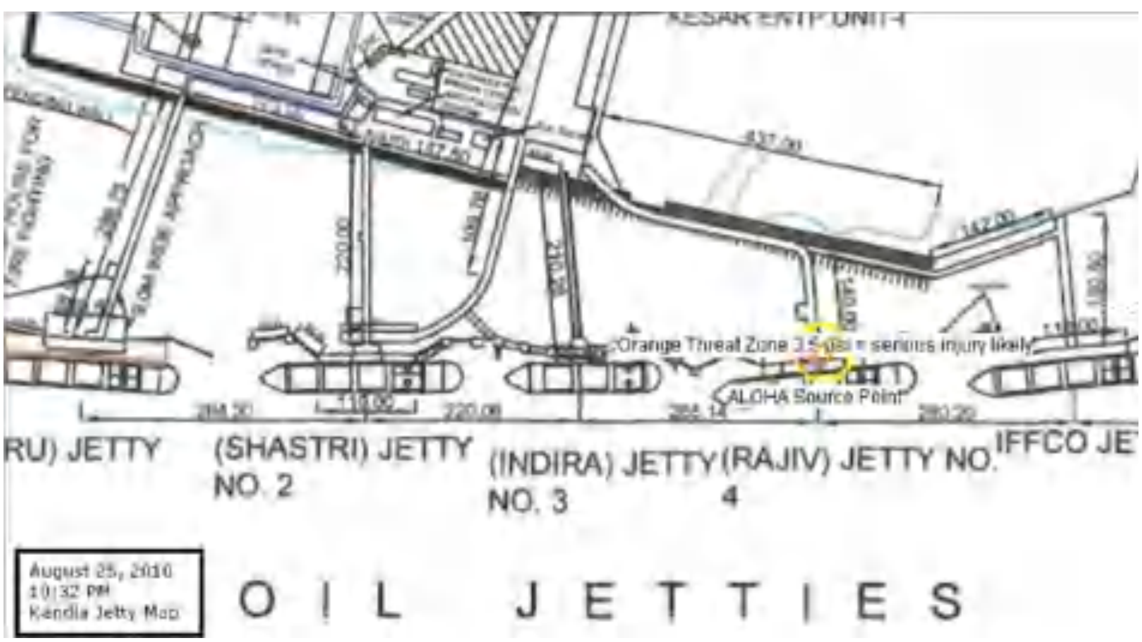
20.1.9.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



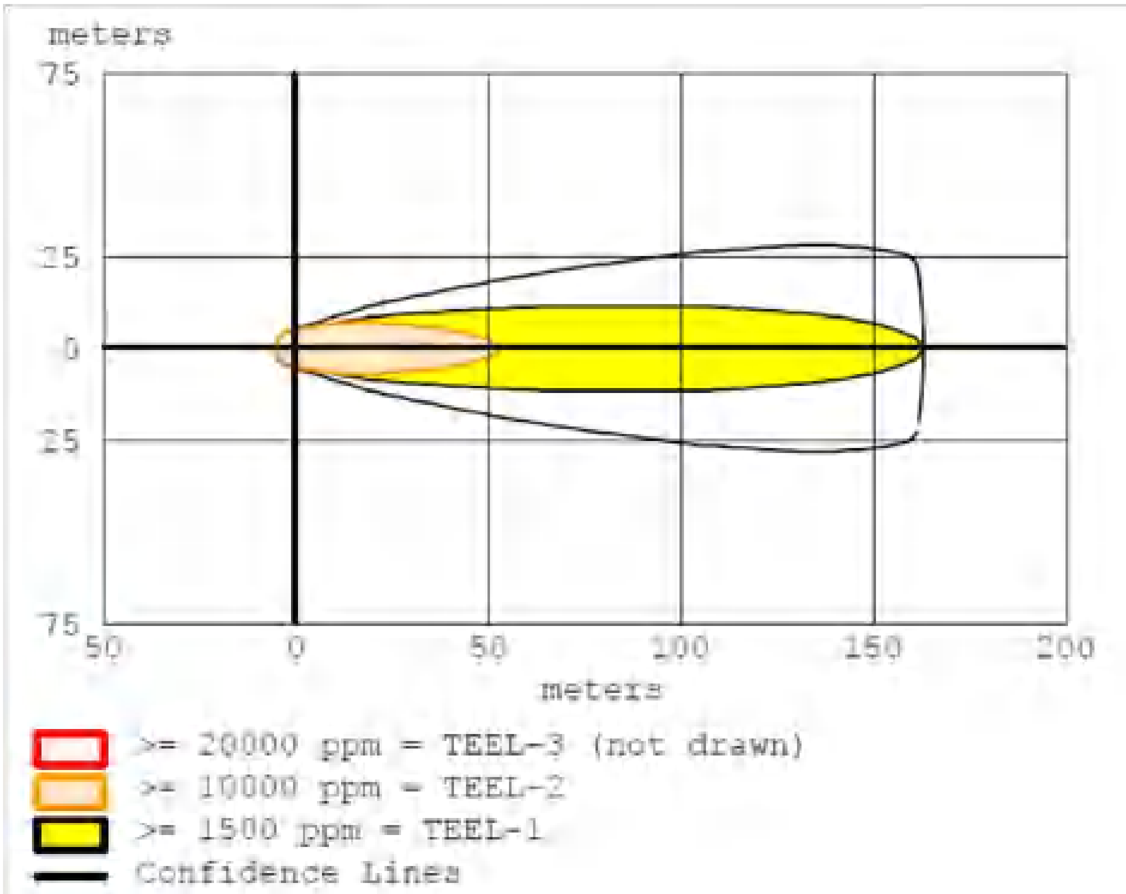
20.1.9.5 Instantaneous Release – Overpressure (Graph)



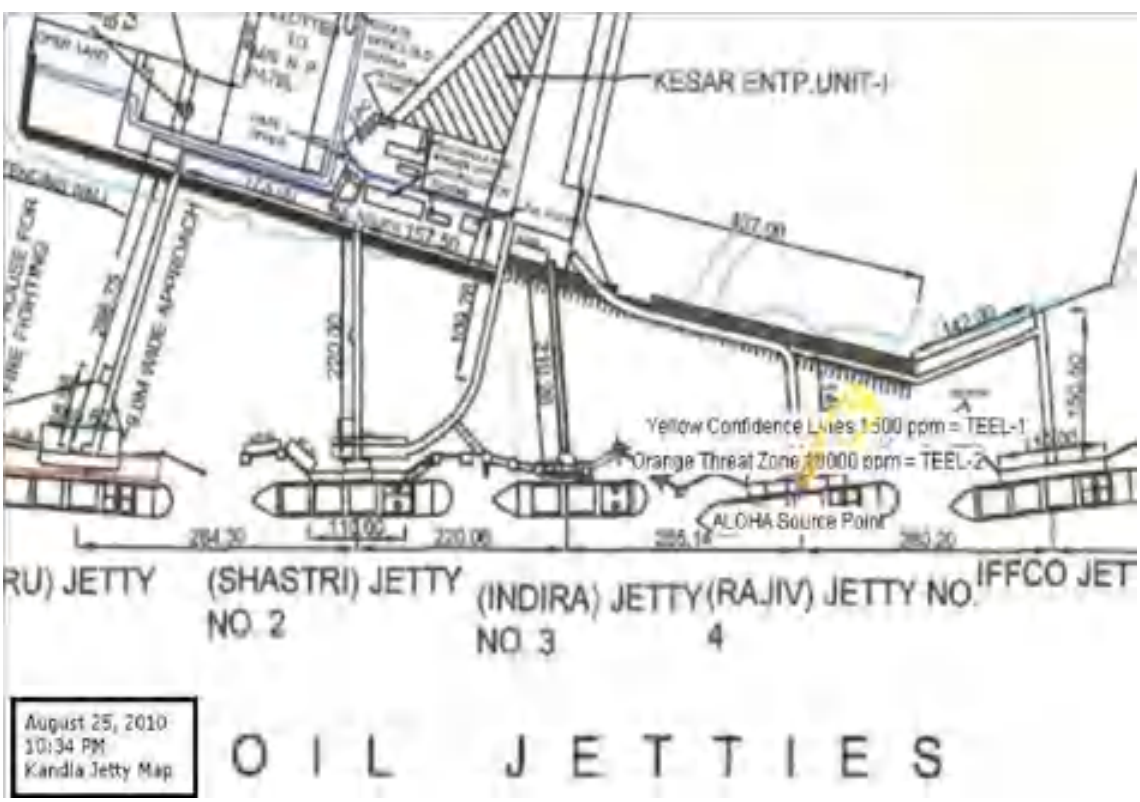
20.1.9.6 Instantaneous Release – Overpressure (Contour)



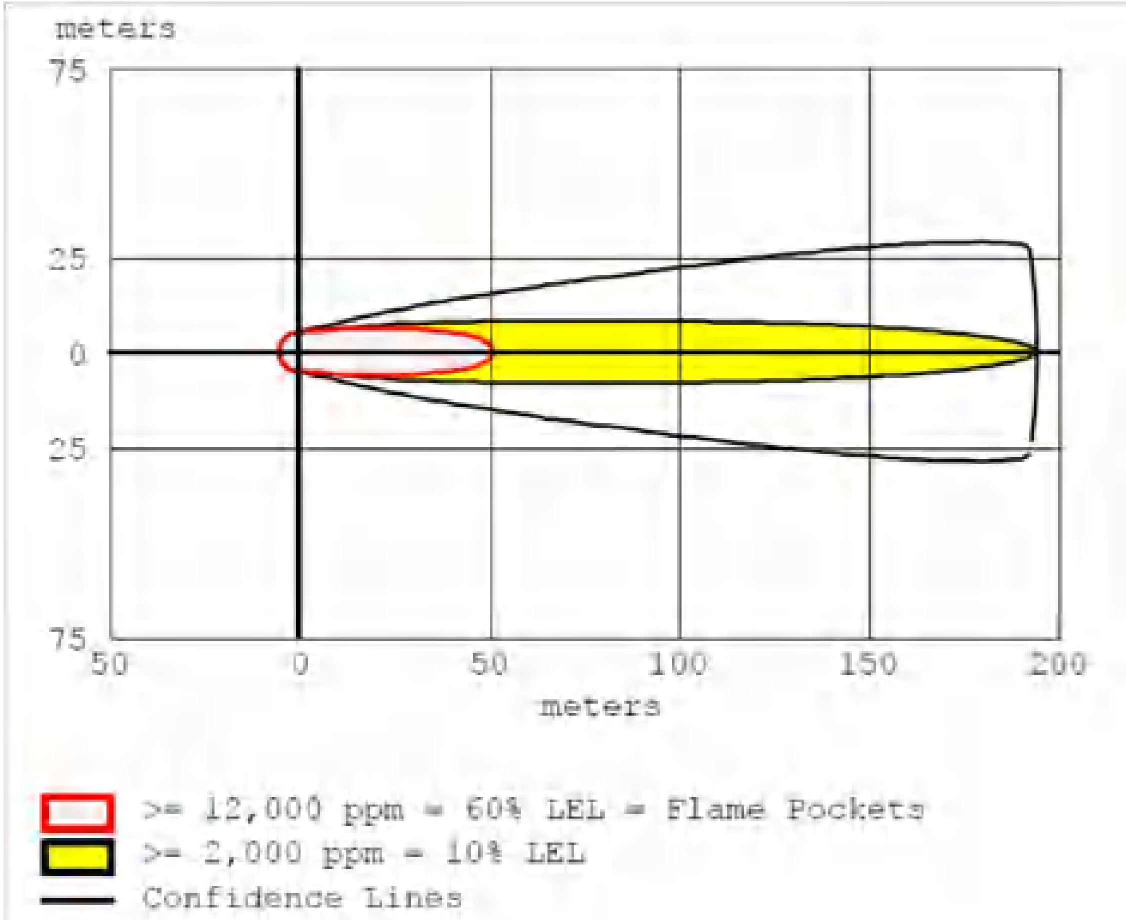
20.1.9.7 Evaporating Puddle – Toxic Threat Zone (Graph)



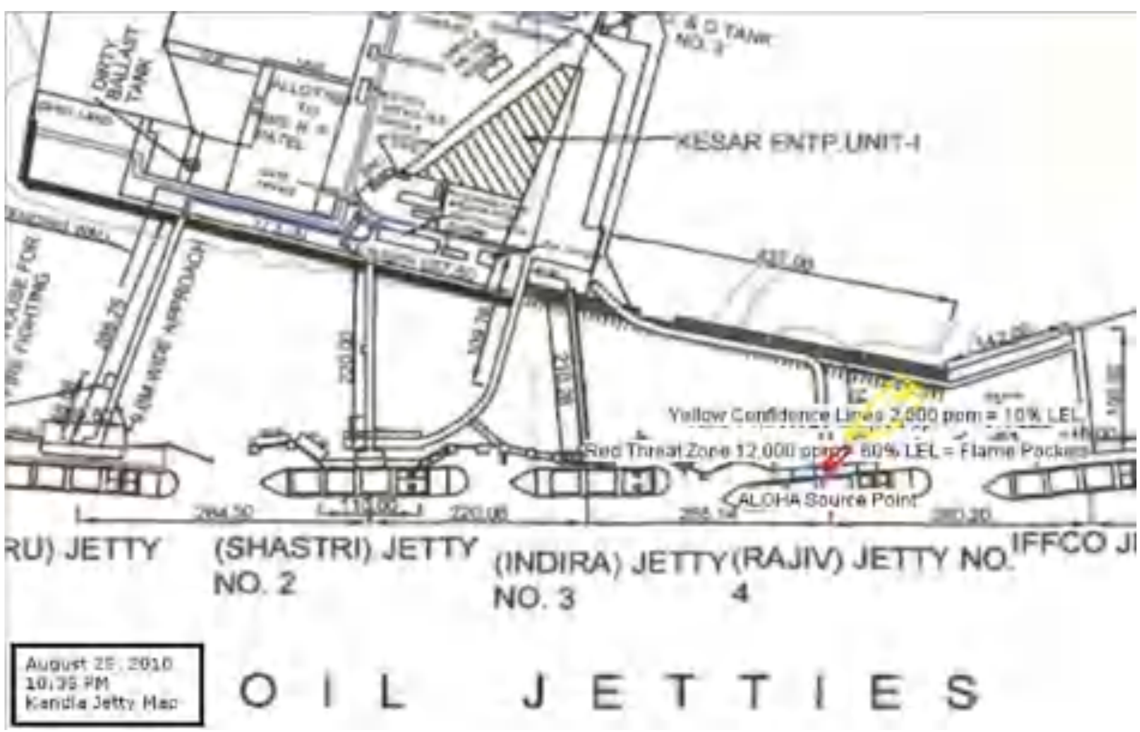
20.1.9.8 Evaporating Puddle – Toxic Threat Zone (Contour)



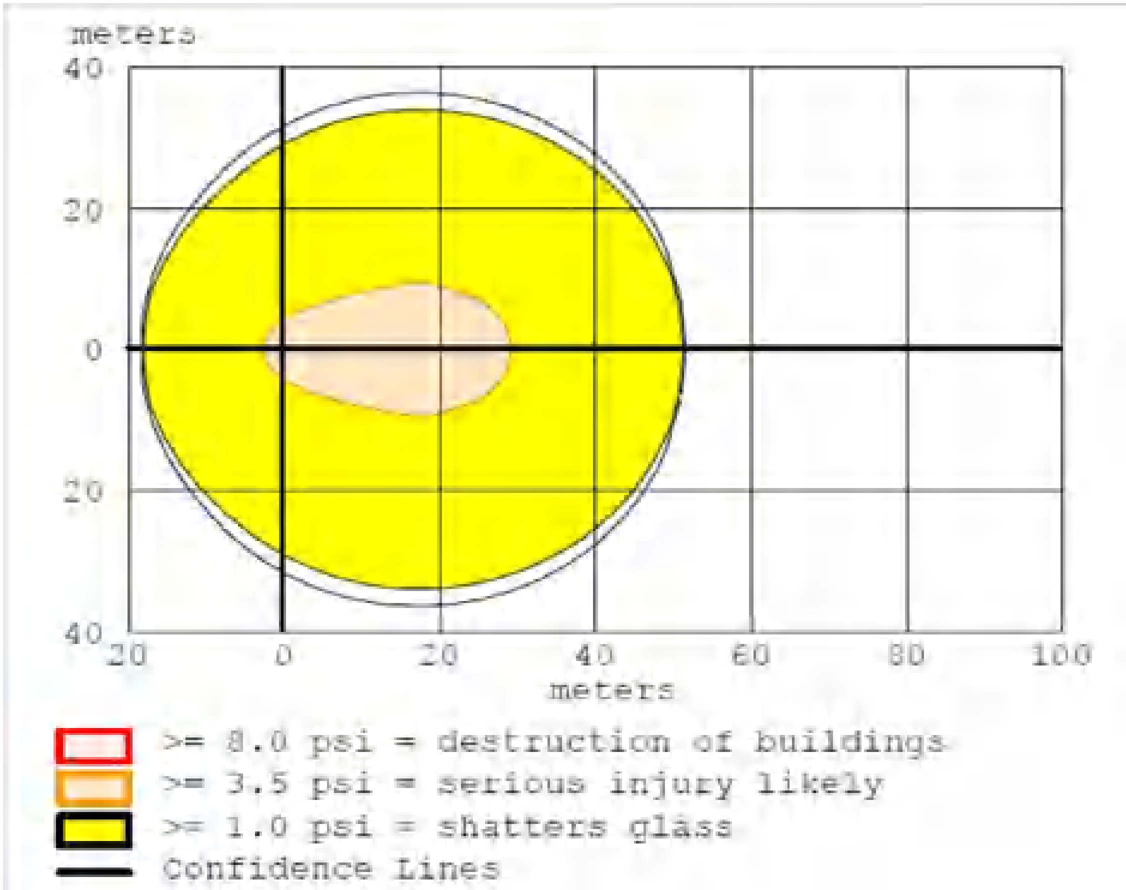
20.1.9.9 Evaporating Puddle – Flammable Area of Vapor Cloud (Graph)



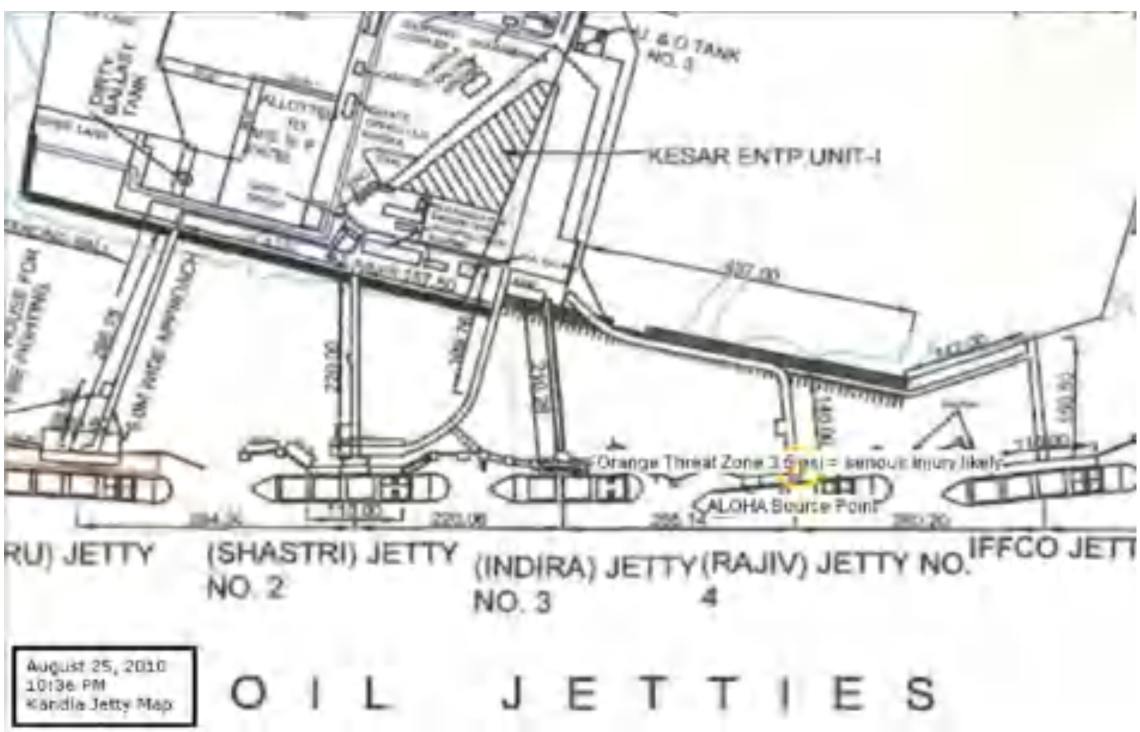
20.1.9.10 Evaporating Puddle – Flammable Area of Vapor Cloud (Contour)



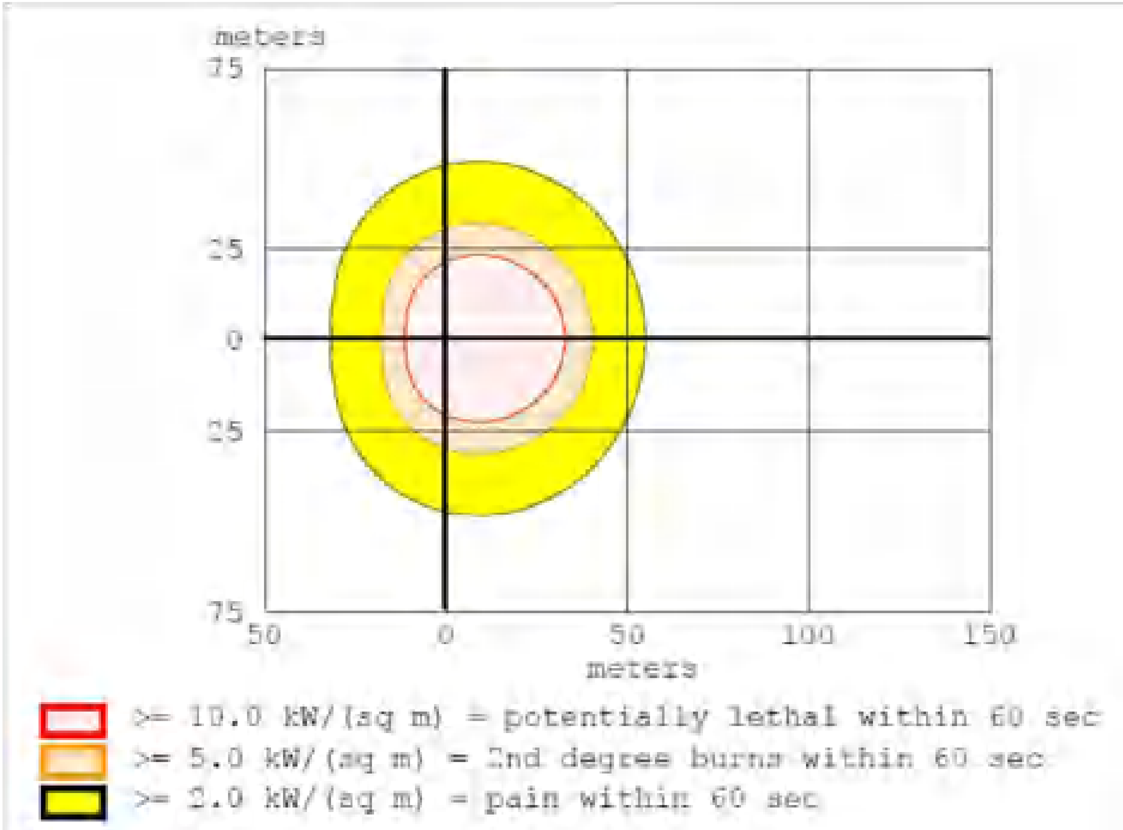
20.1.9.11 Evaporating Puddle – Overpressure (Graph)



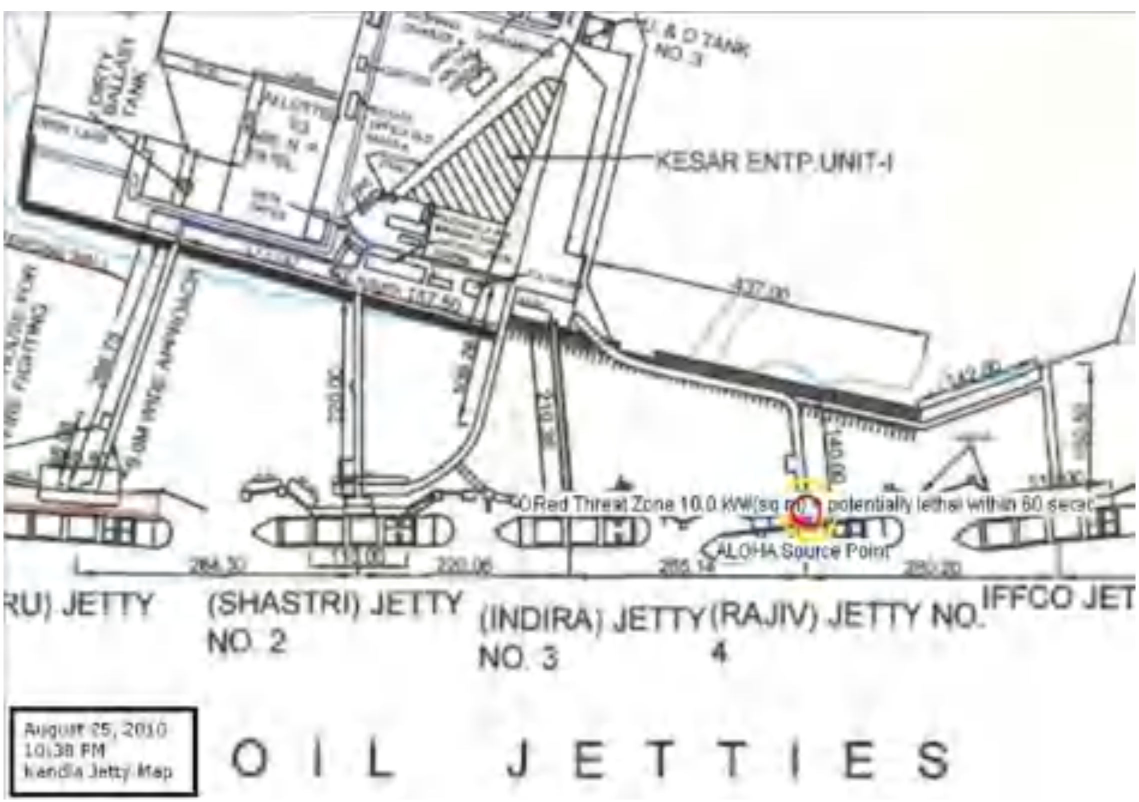
20.1.9.12 Evaporating Puddle – Overpressure (Contour)



20.1.9.13 Burning Puddle – Thermal Radiation (Graph)

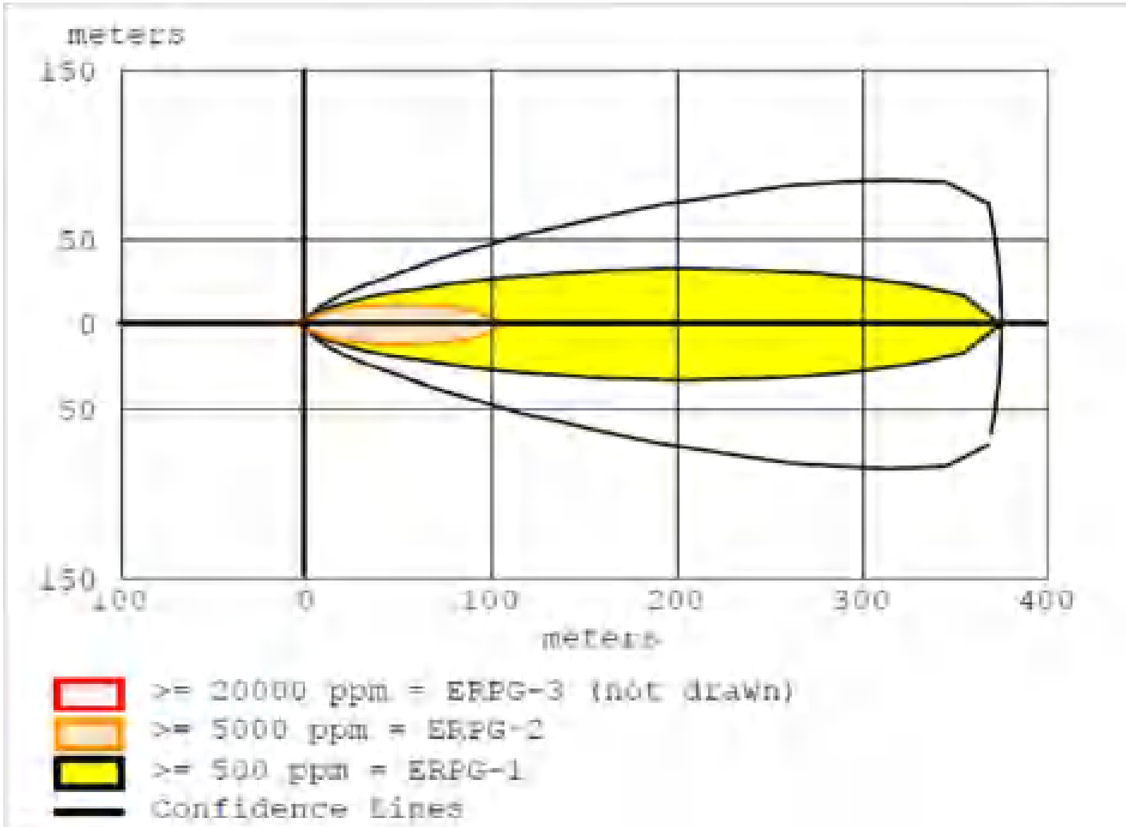


20.1.9.14 Burning Puddle – Thermal Radiation (Contour)

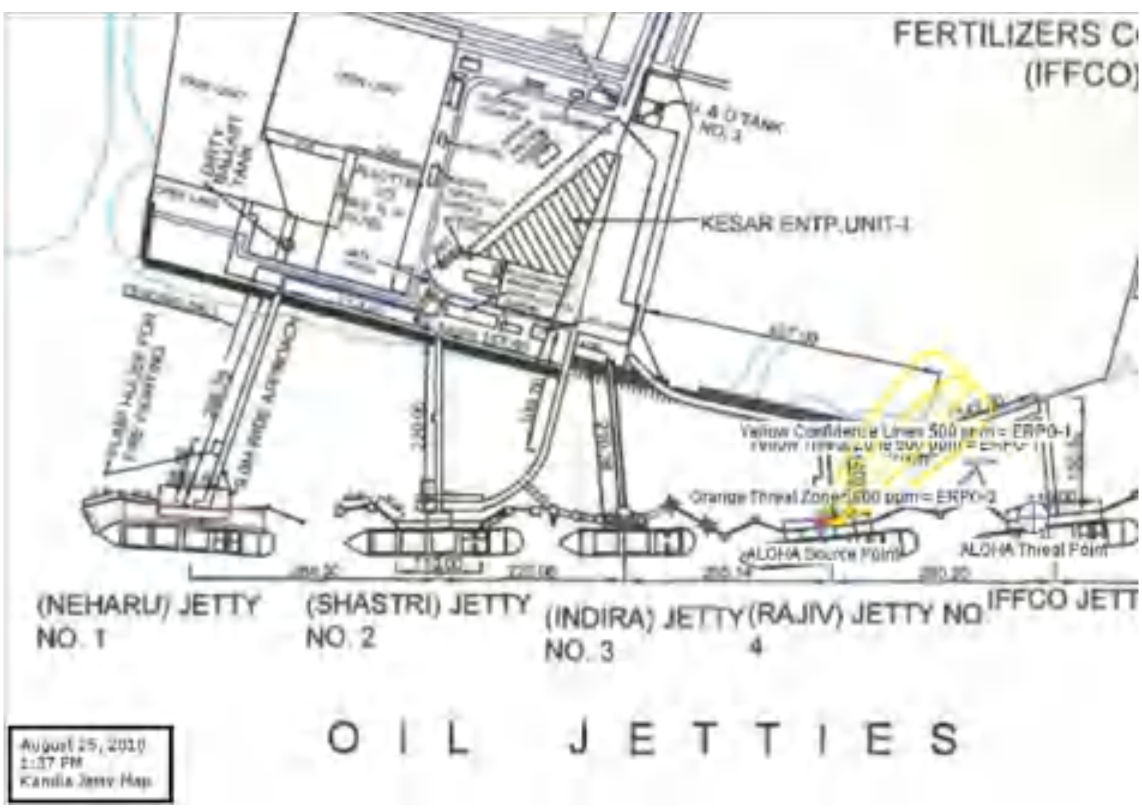


20.1.10 Jetty Four – Vinyl Chloride

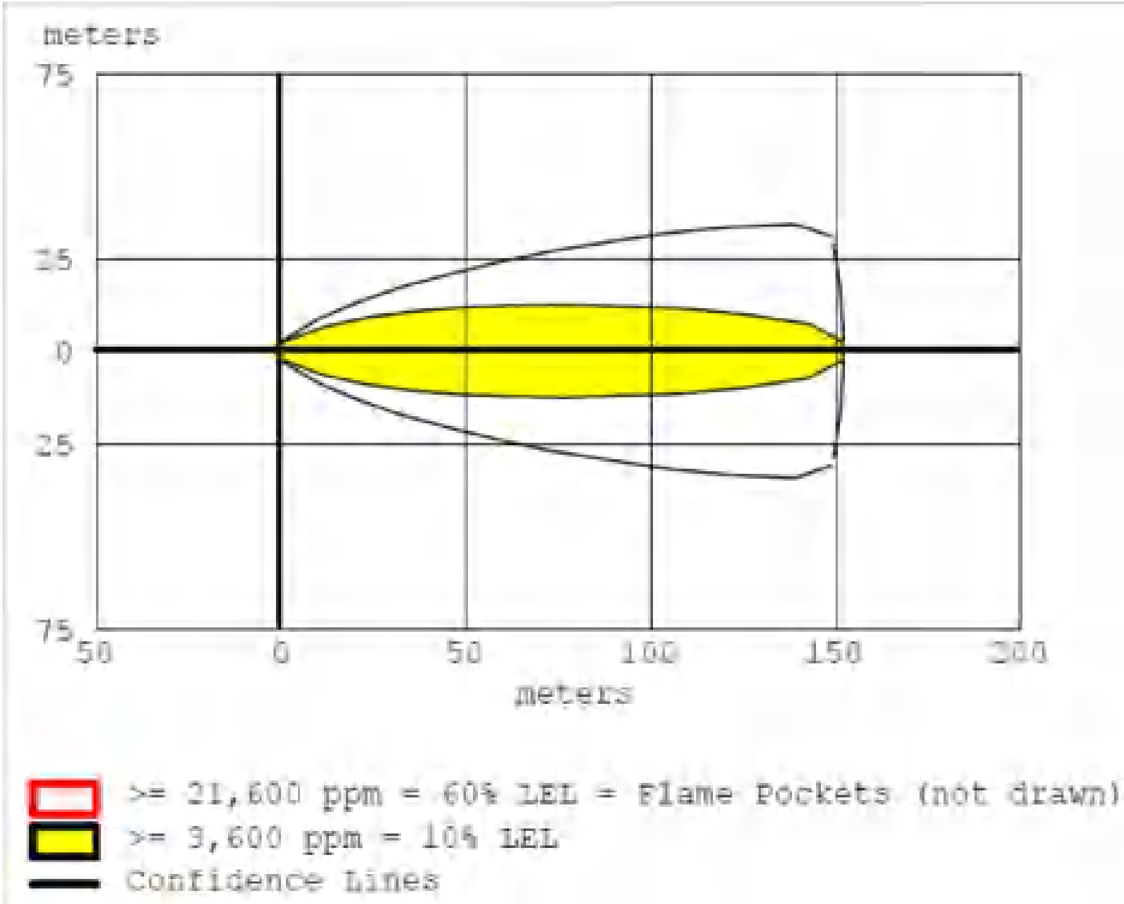
20.1.10.1 Instantaneous Release – Toxic Threat Zone (Graph)



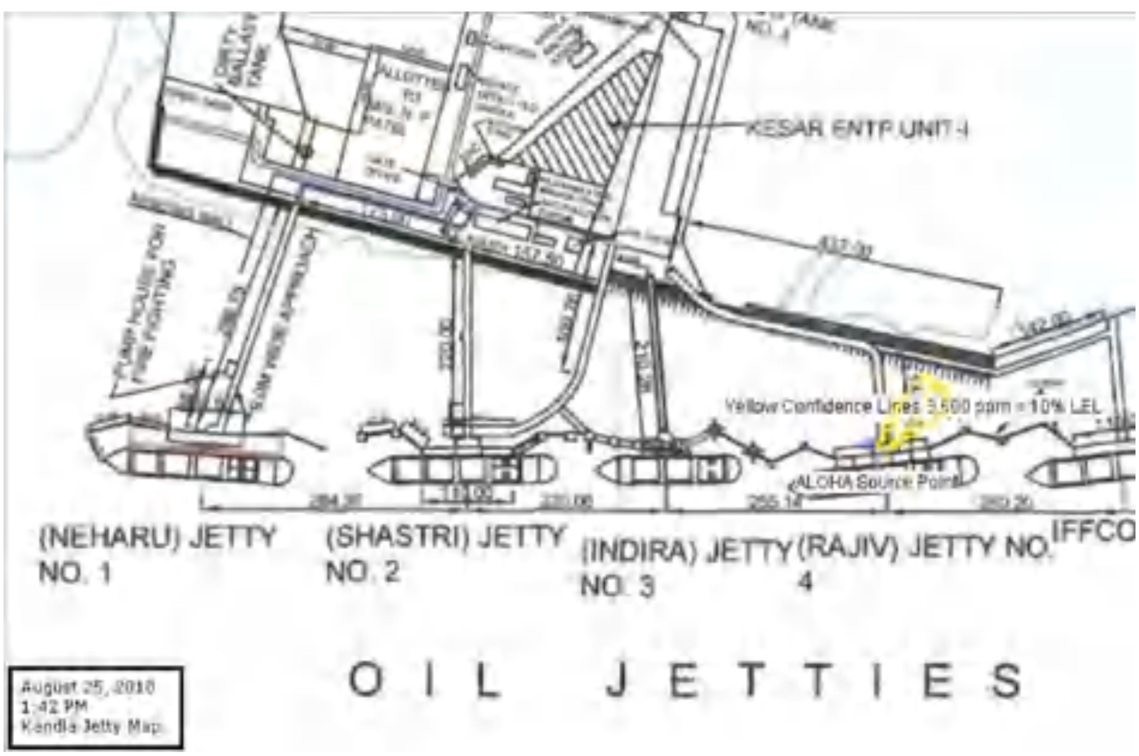
20.1.10.2 Instantaneous Release – Toxic Threat Zone (Contour)



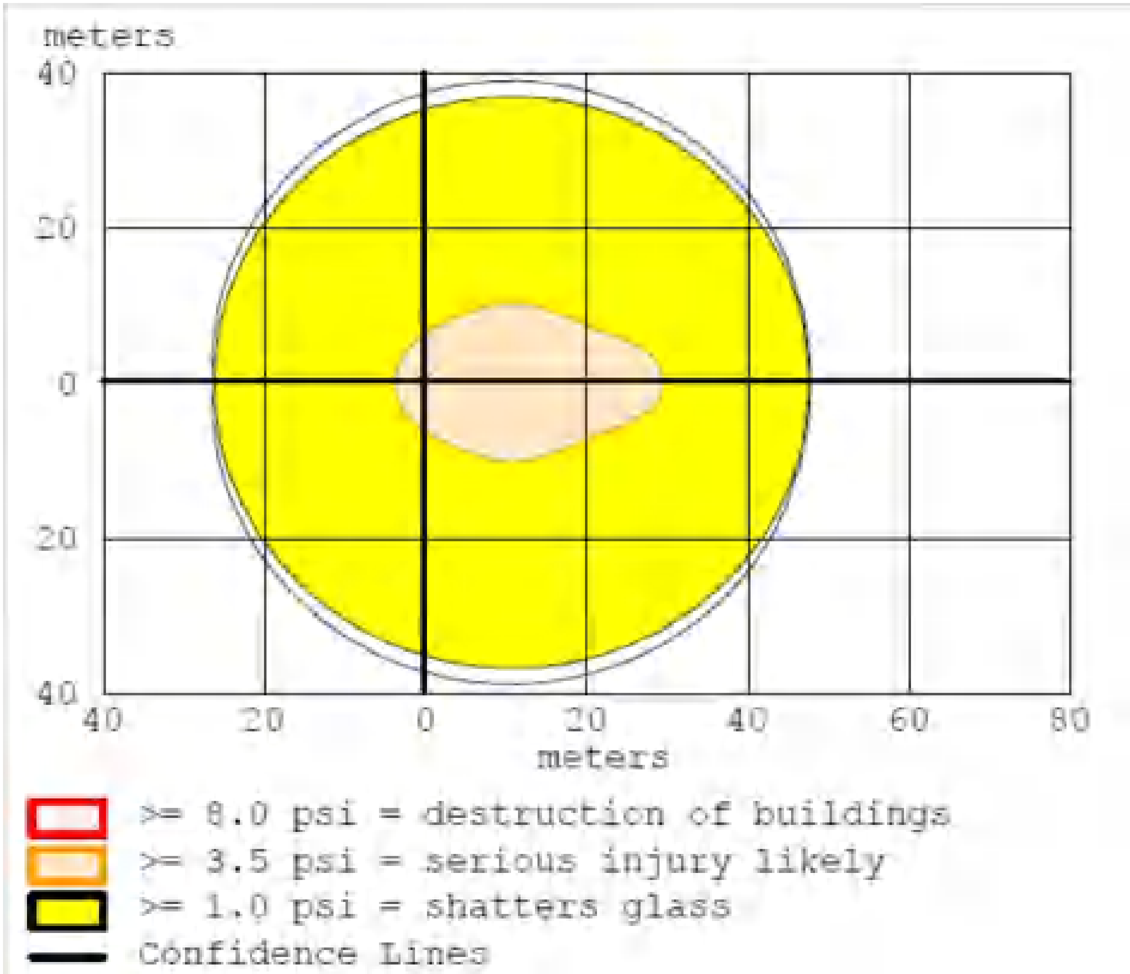
20.1.10.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



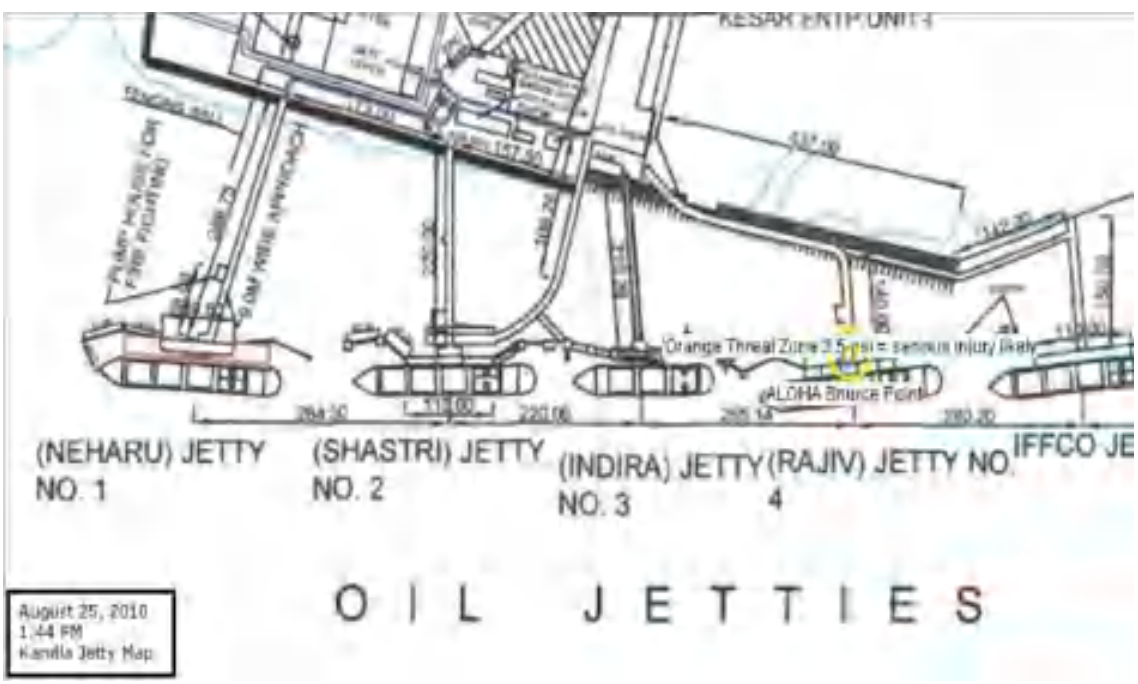
20.1.10.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



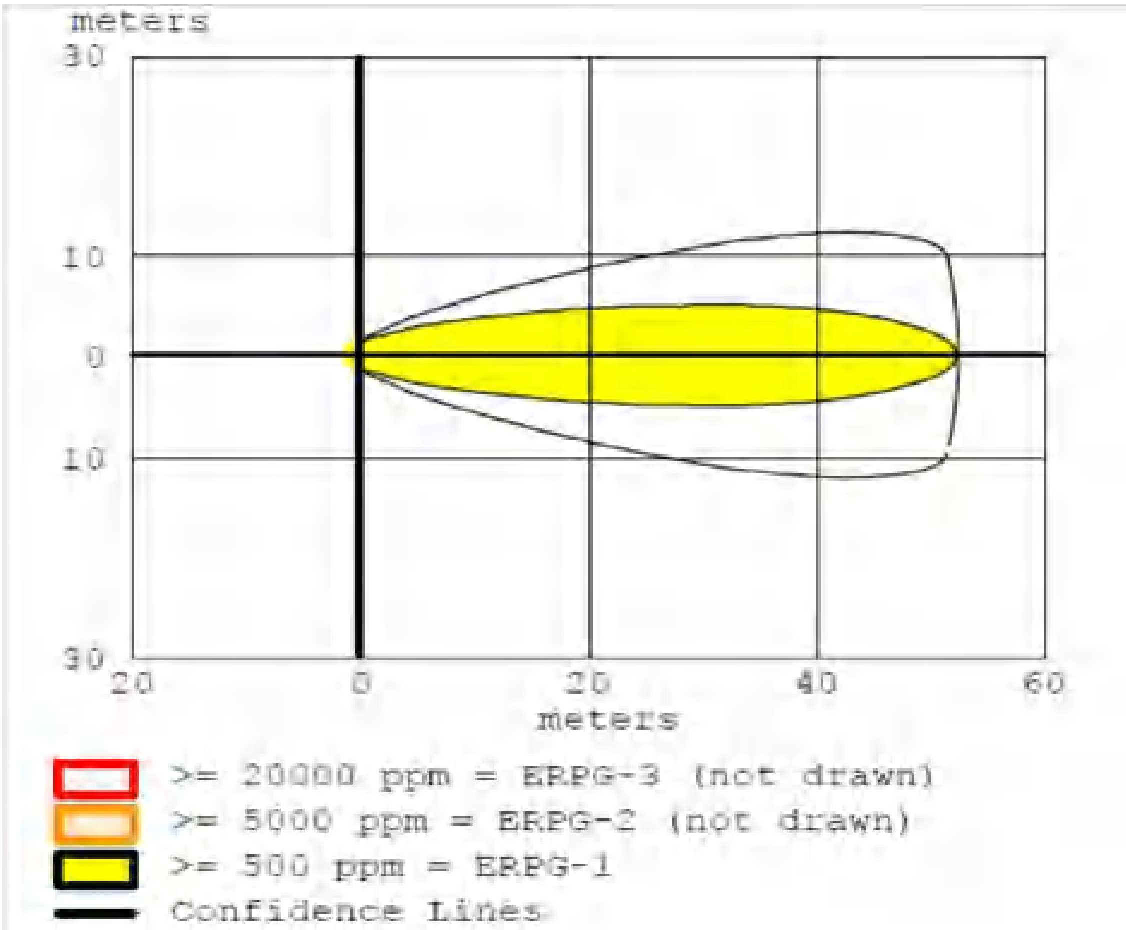
20.1.10.5 Instantaneous Release – Overpressure (Graph)



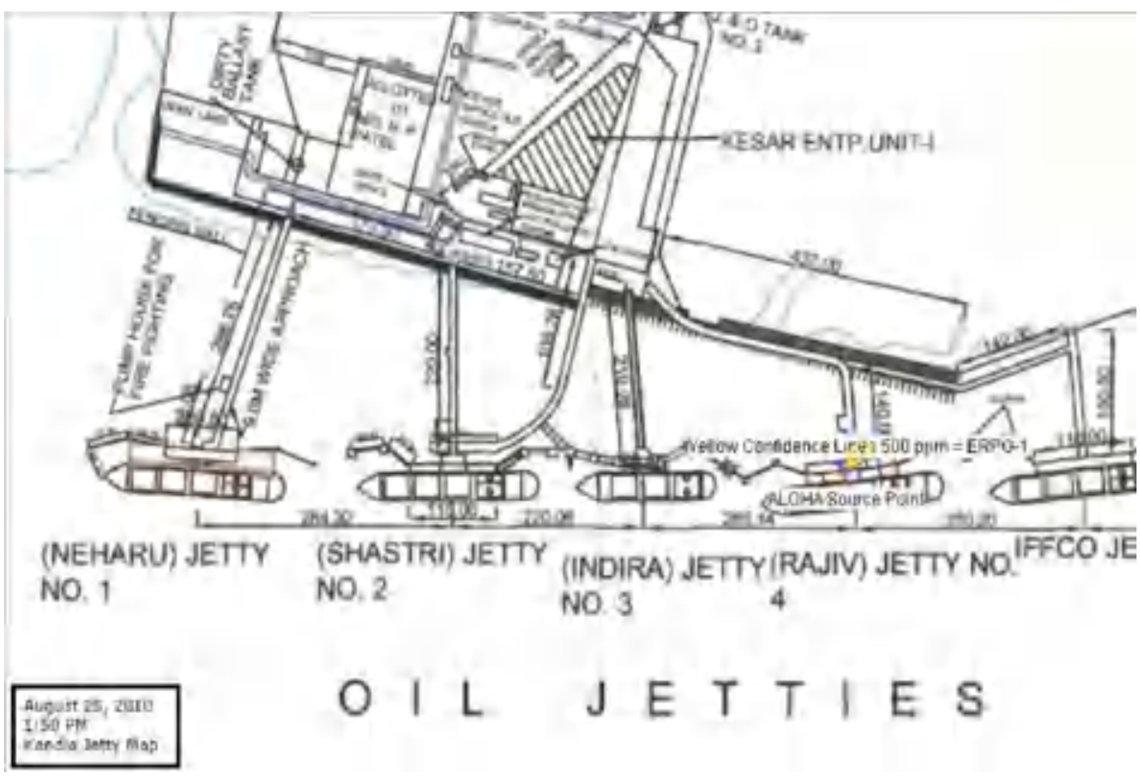
20.1.10.6 Instantaneous Release – Overpressure (Contour)



20.1.10.7 Evaporating Puddle – Toxic Threat Zone (Graph)

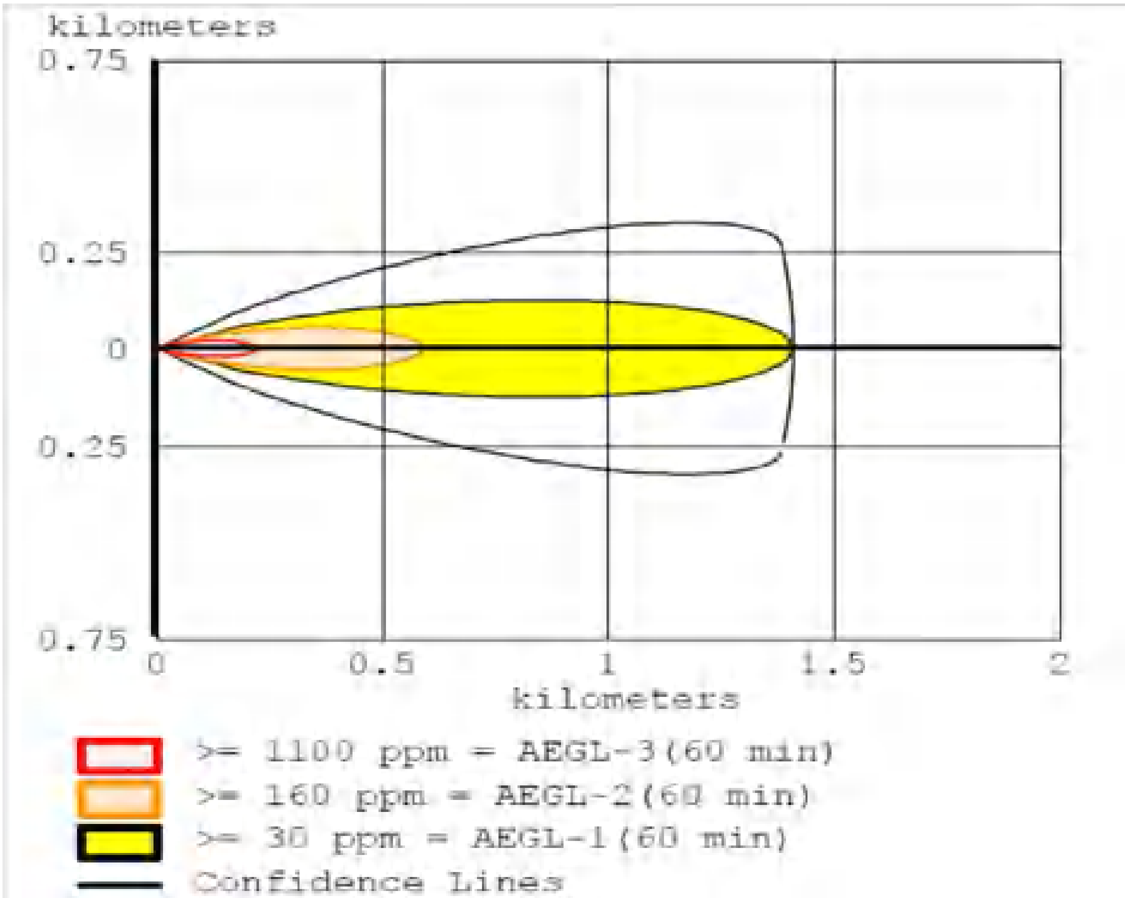


20.1.10.8 Evaporating Puddle – Toxic Threat Zone (Contour)

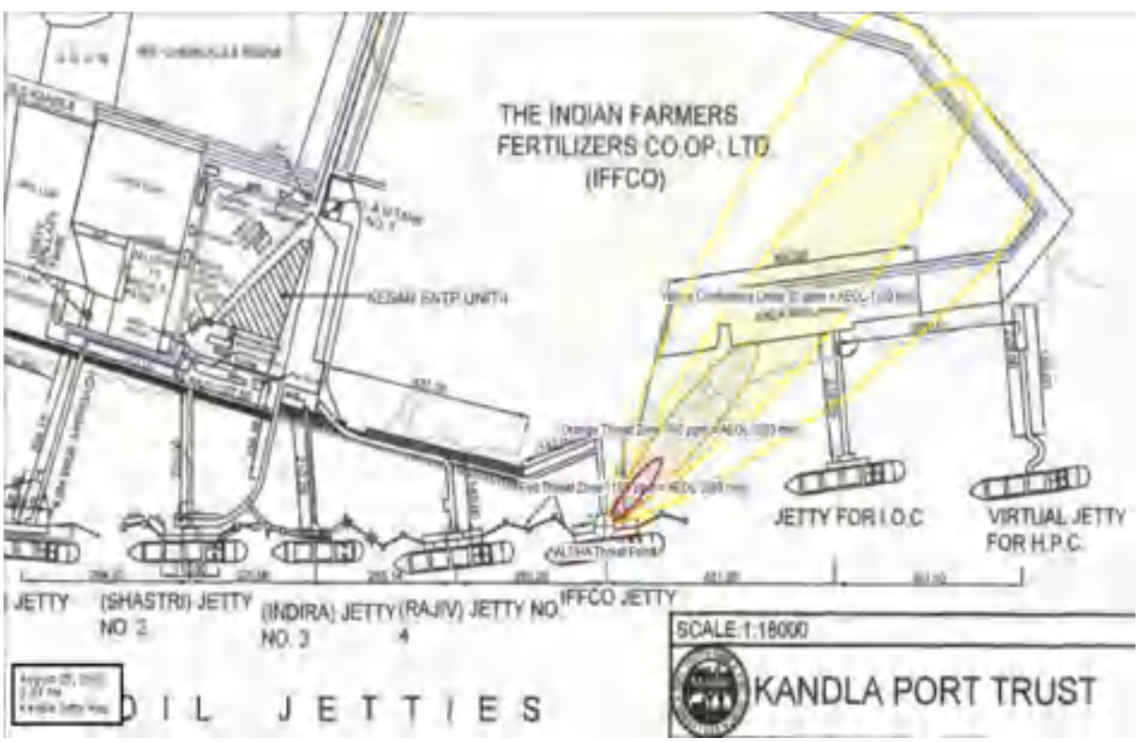


20.1.11 Jetty Five – Ammonia

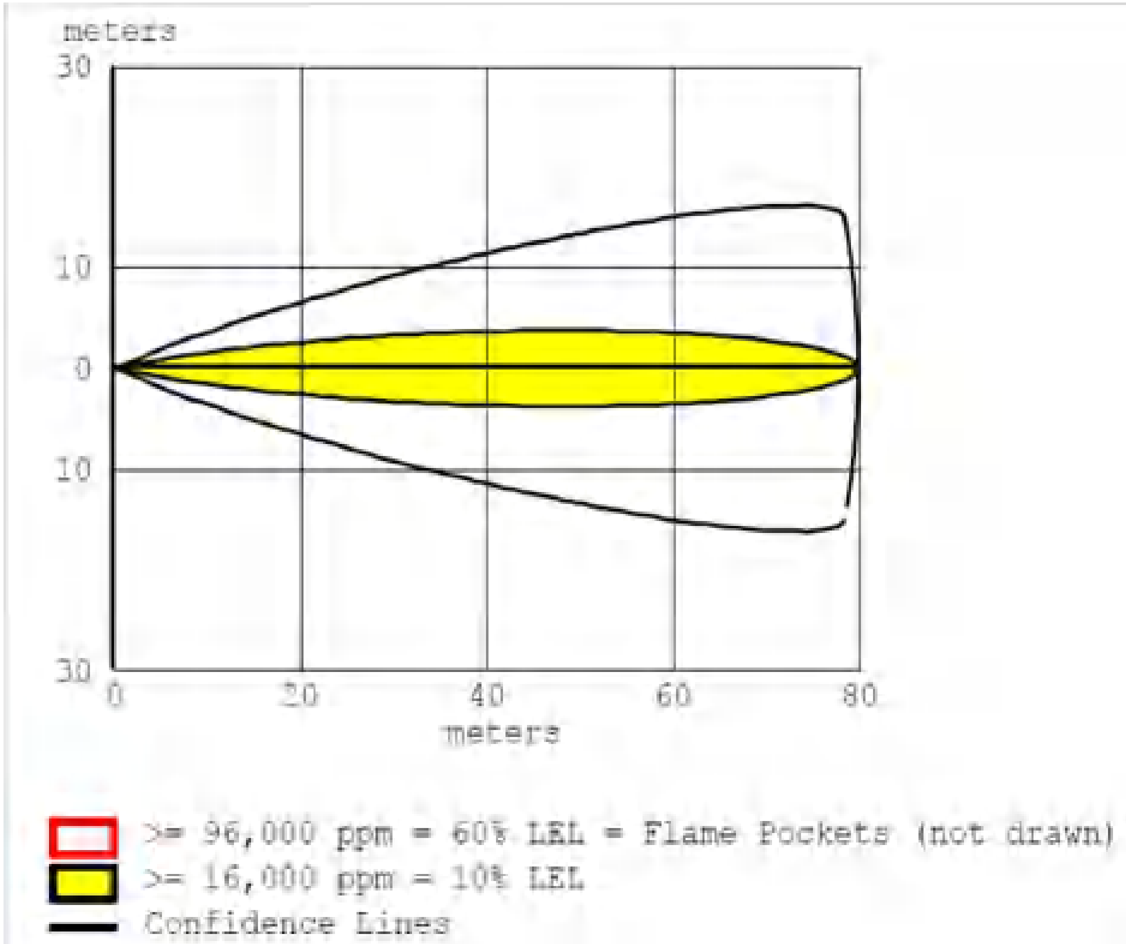
20.1.11.1 Instantaneous Release – Toxic Threat Zone (Graph)



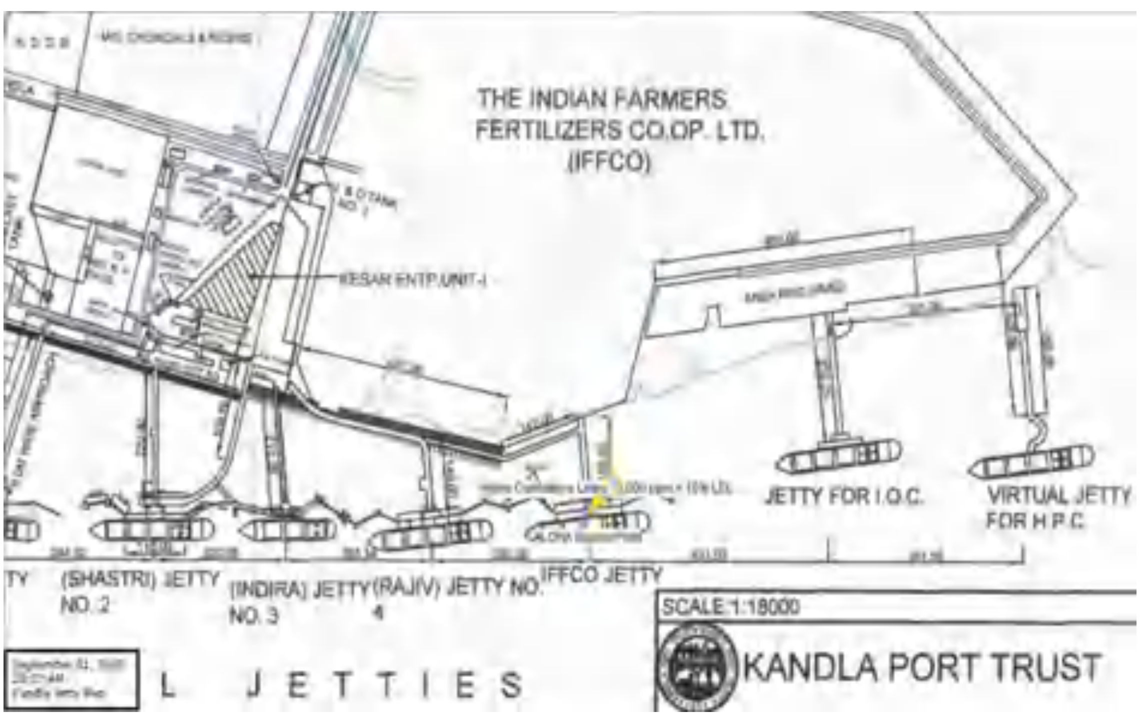
20.1.11.2 Instantaneous Release – Toxic Threat Zone (Contour)



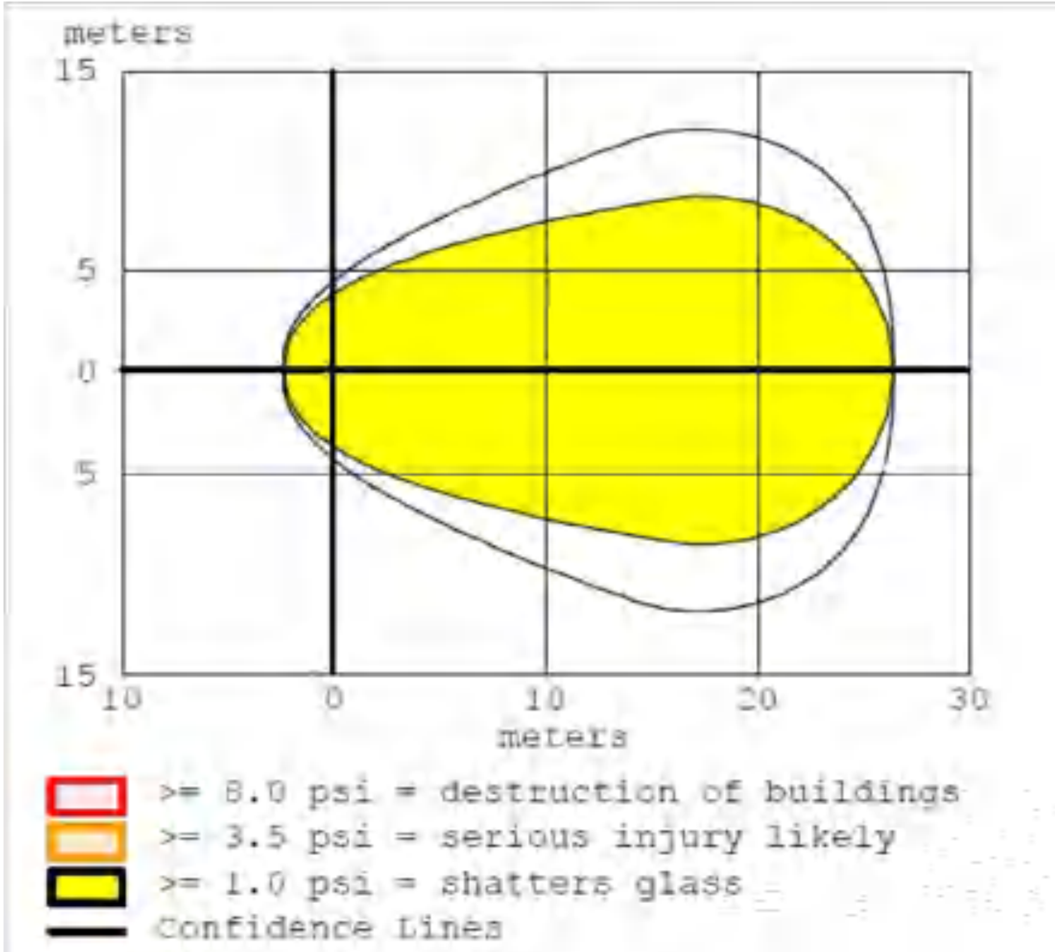
20.1.11.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



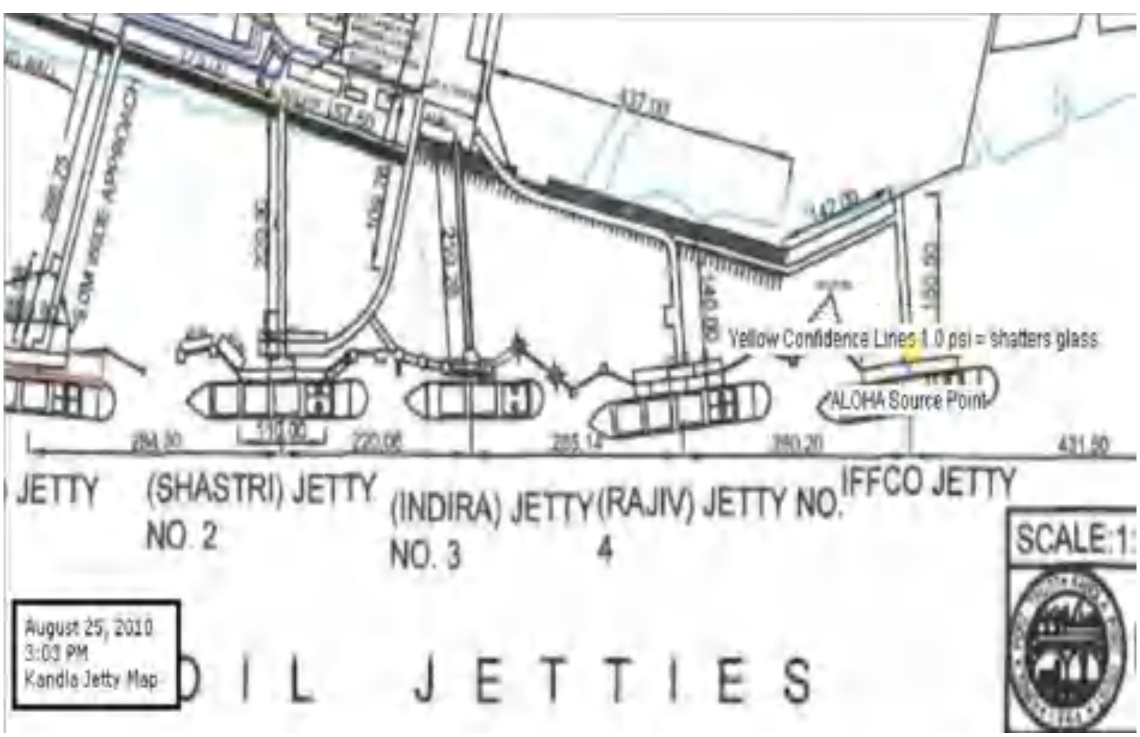
20.1.11.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



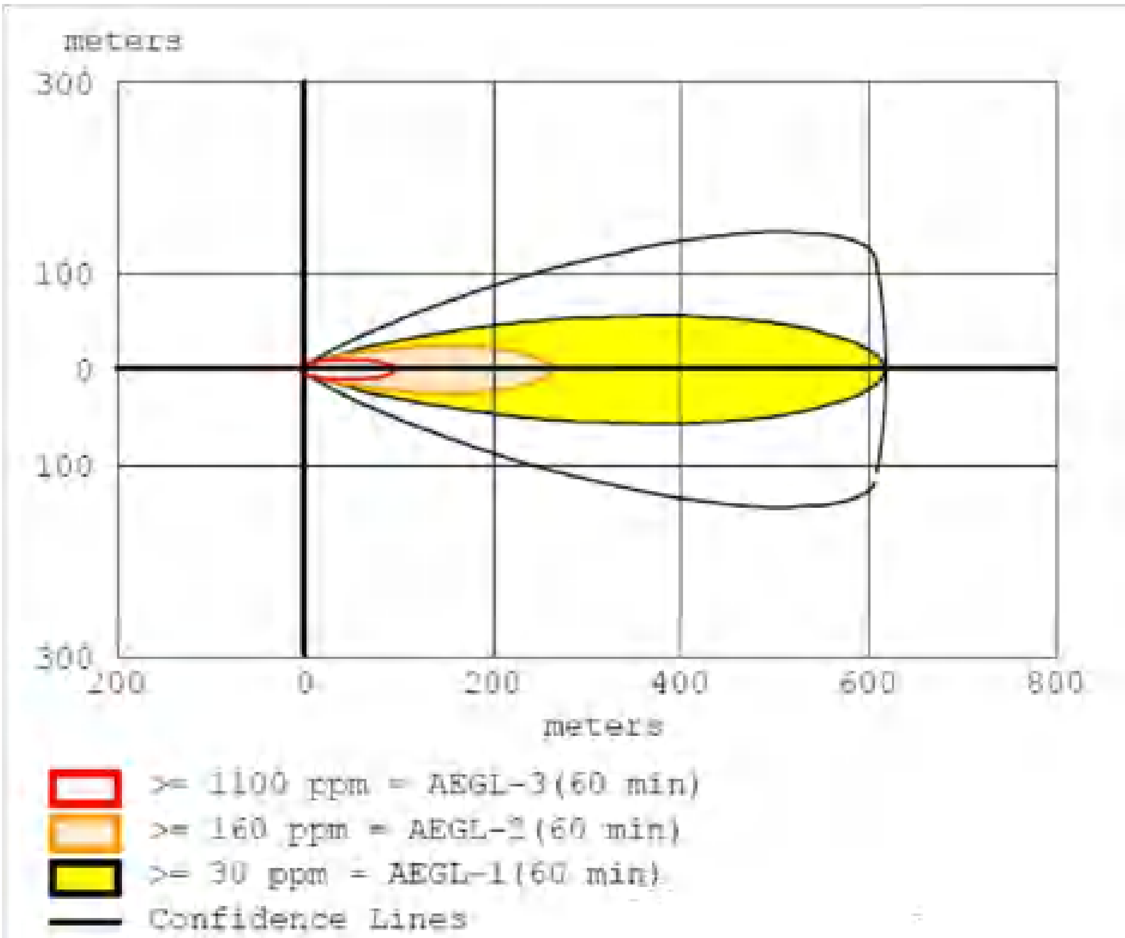
20.1.11.5 Instantaneous Release – Overpressure (Graph)



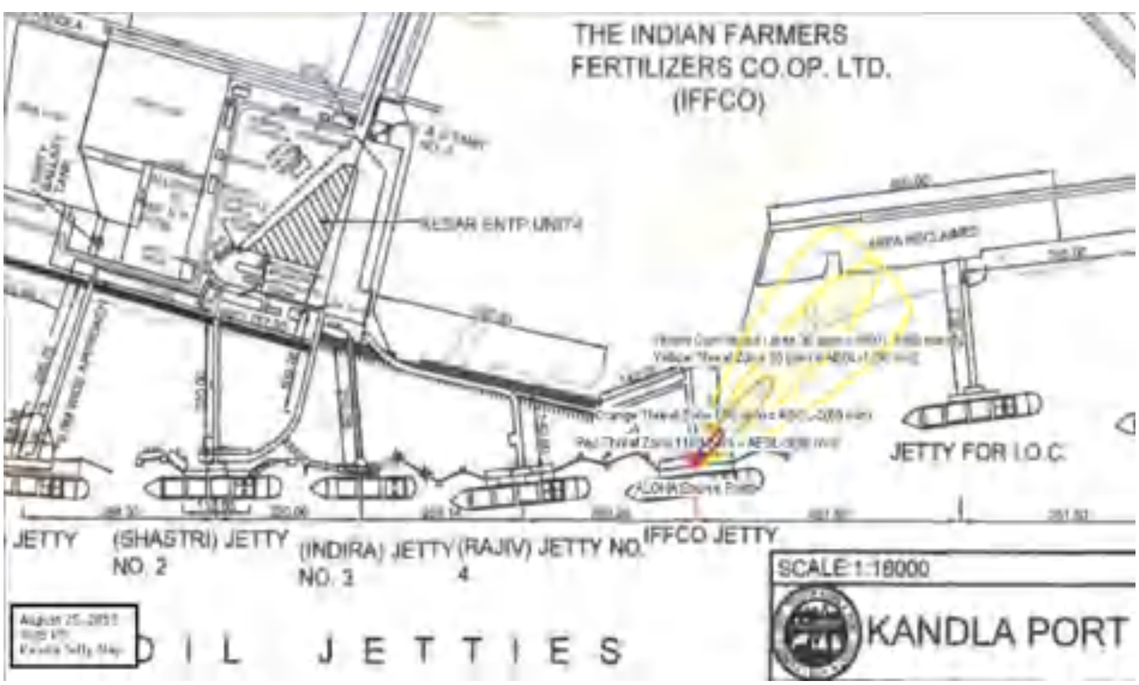
20.1.11.6 Instantaneous Release – Overpressure (Contour)



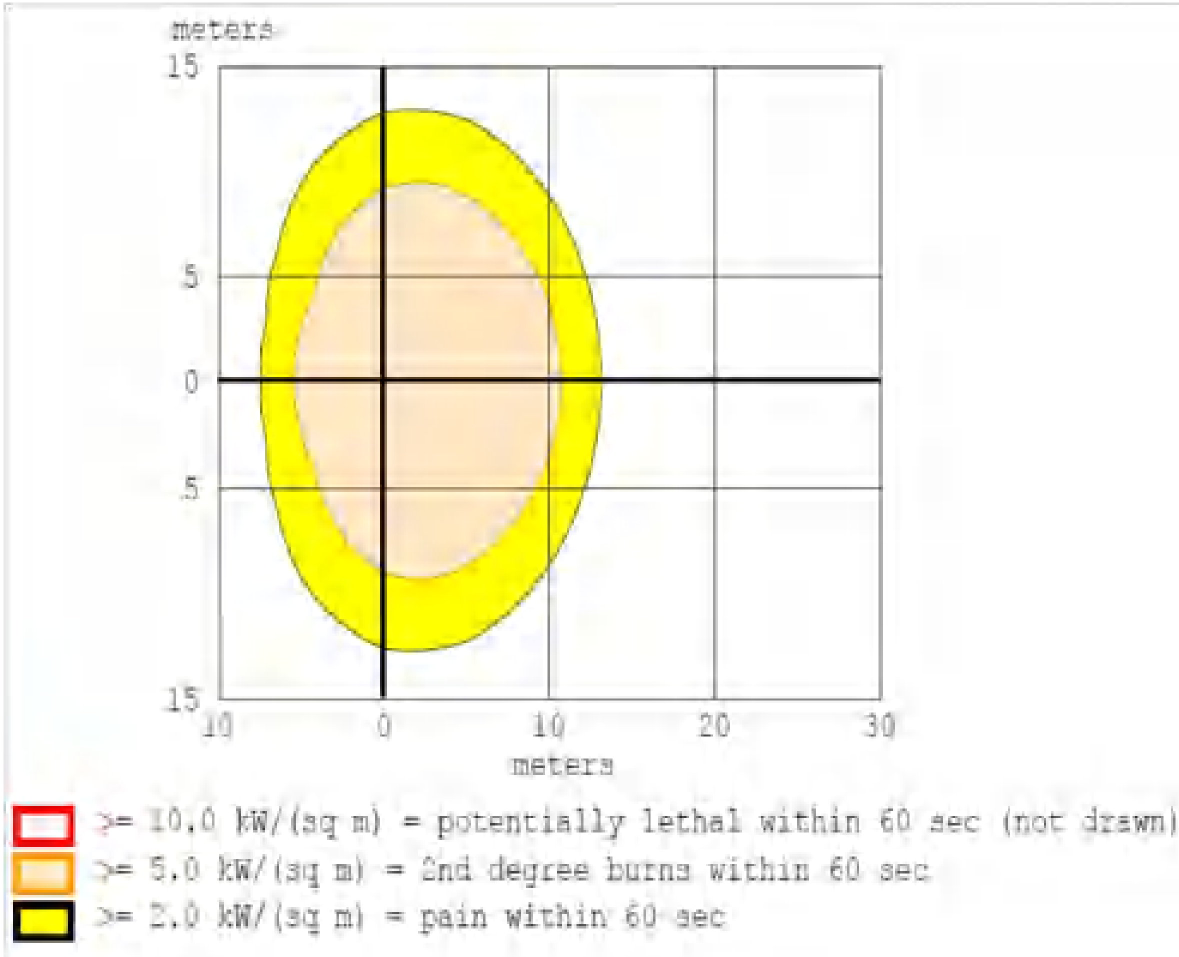
20.1.11.7 Evaporating Puddle – Toxic Threat Zone (Graph)



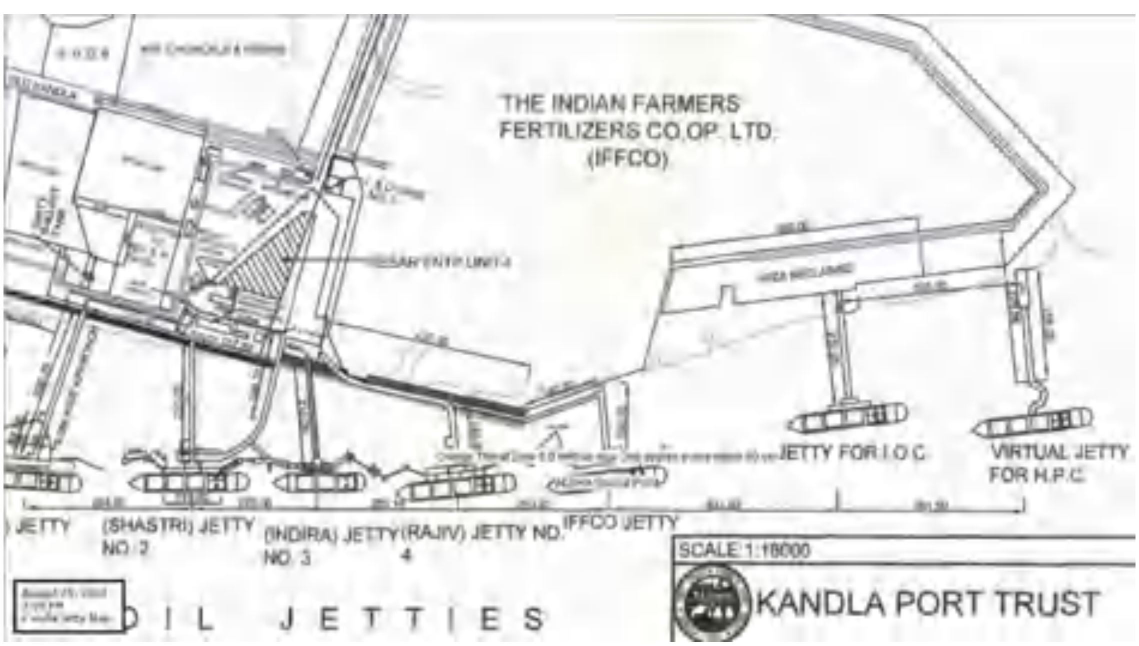
20.1.11.8 Evaporating Puddle – Toxic Threat Zone (Contour)



20.1.11.9 Burning Puddle – Thermal Radiation (Graph)

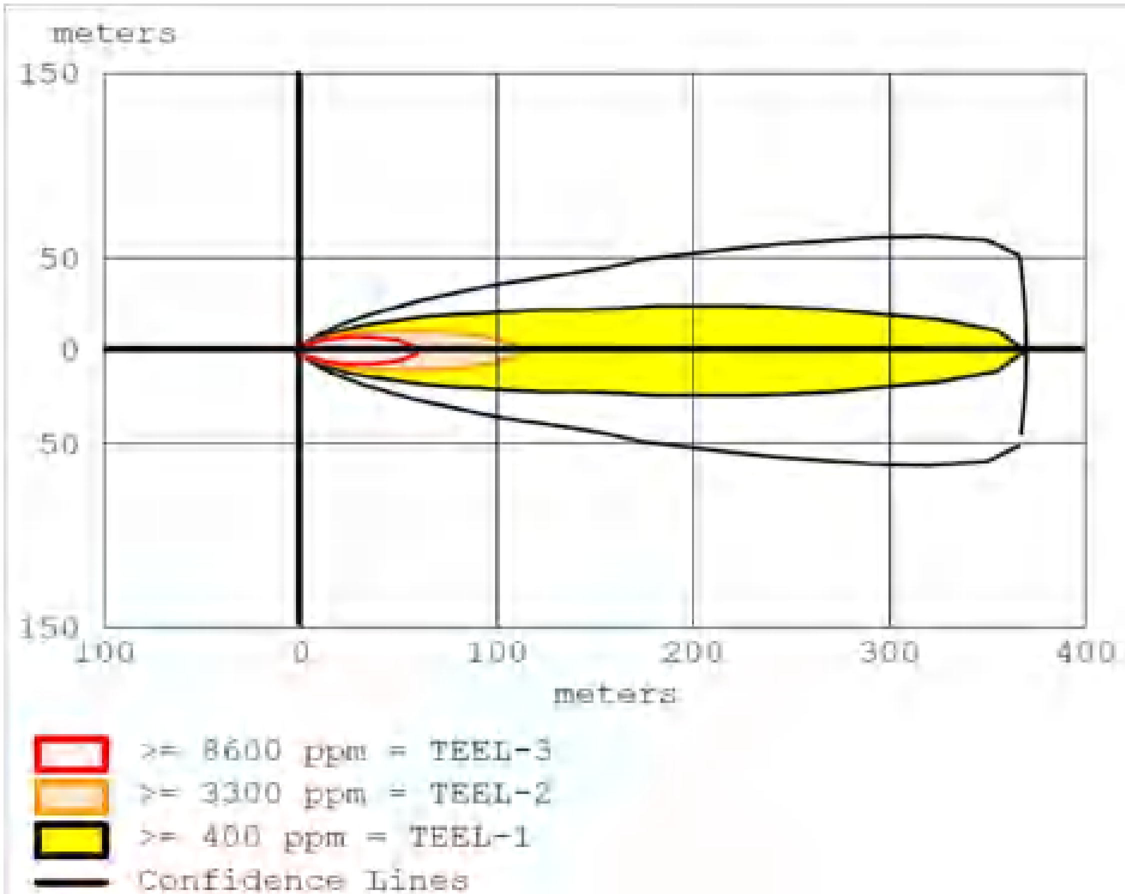


20.1.11.10 Burning Puddle – Thermal Radiation (Contour)

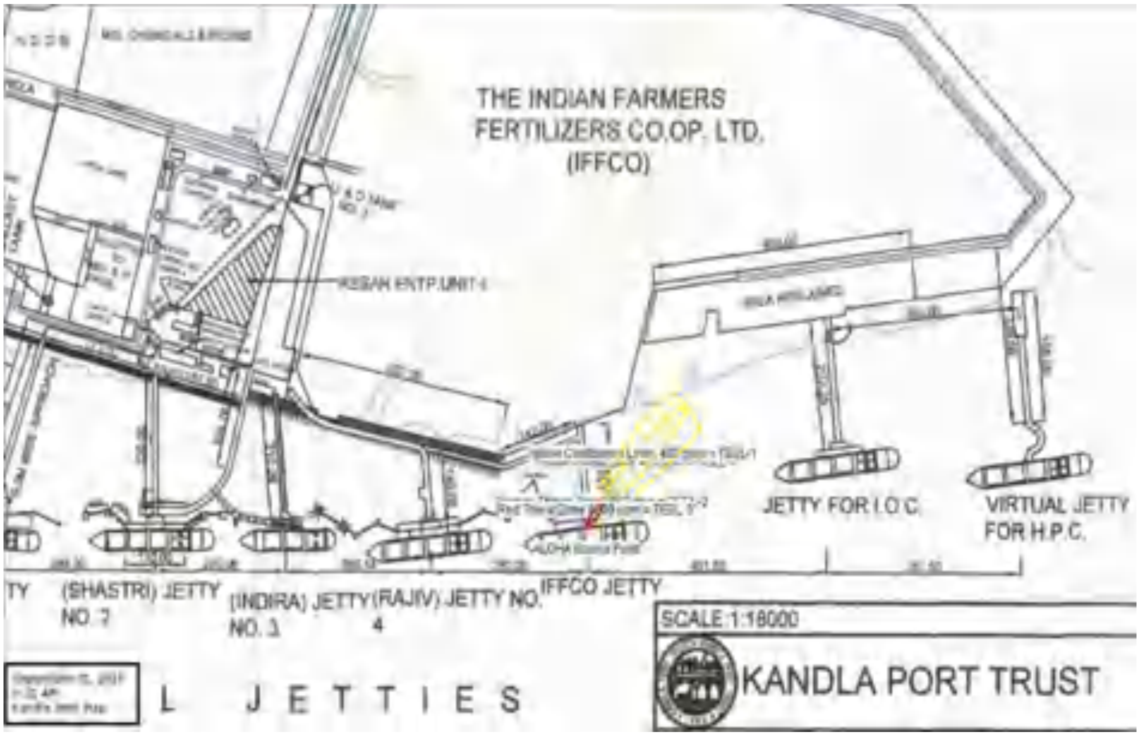


20.1.12 Jetty Five – HSD

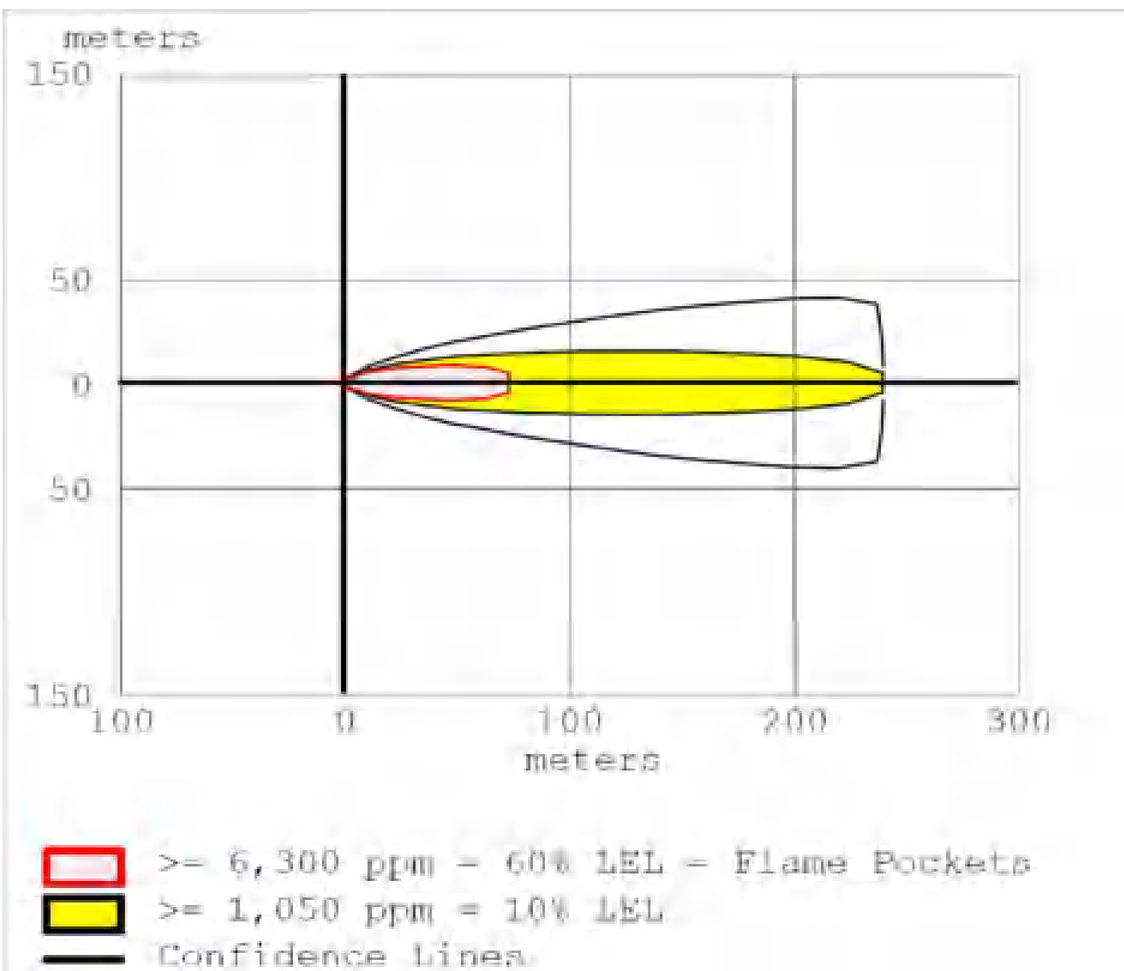
20.1.12.1 Instantaneous Release – Toxic Threat Zone (Graph)



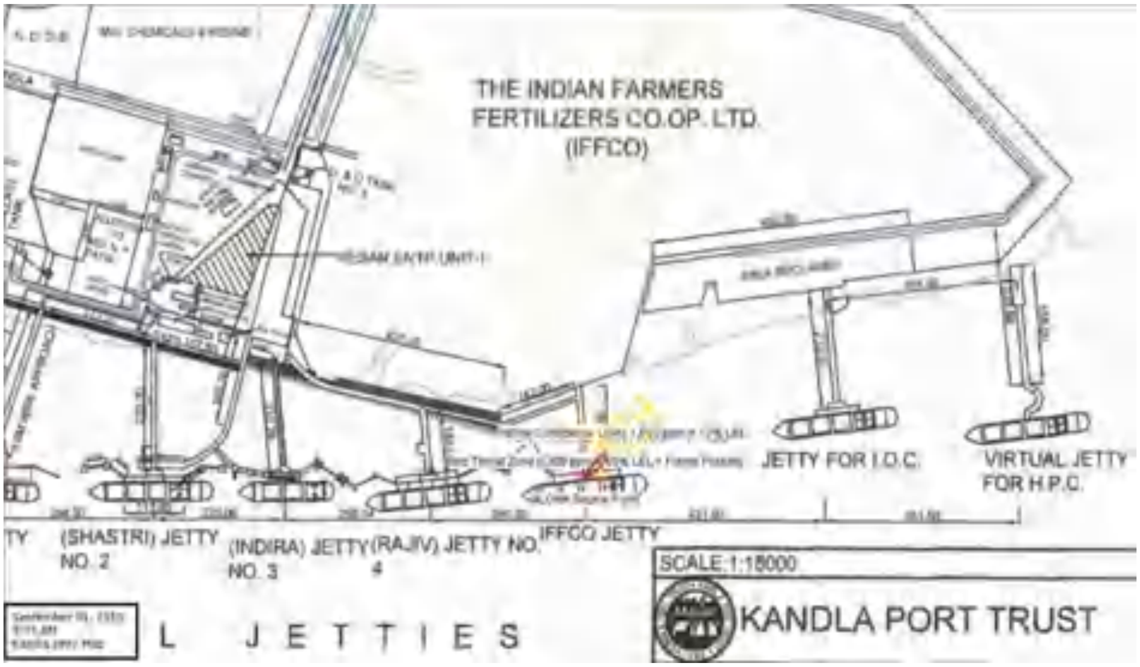
20.1.12.2 Instantaneous Release – Toxic Threat Zone (Contour)



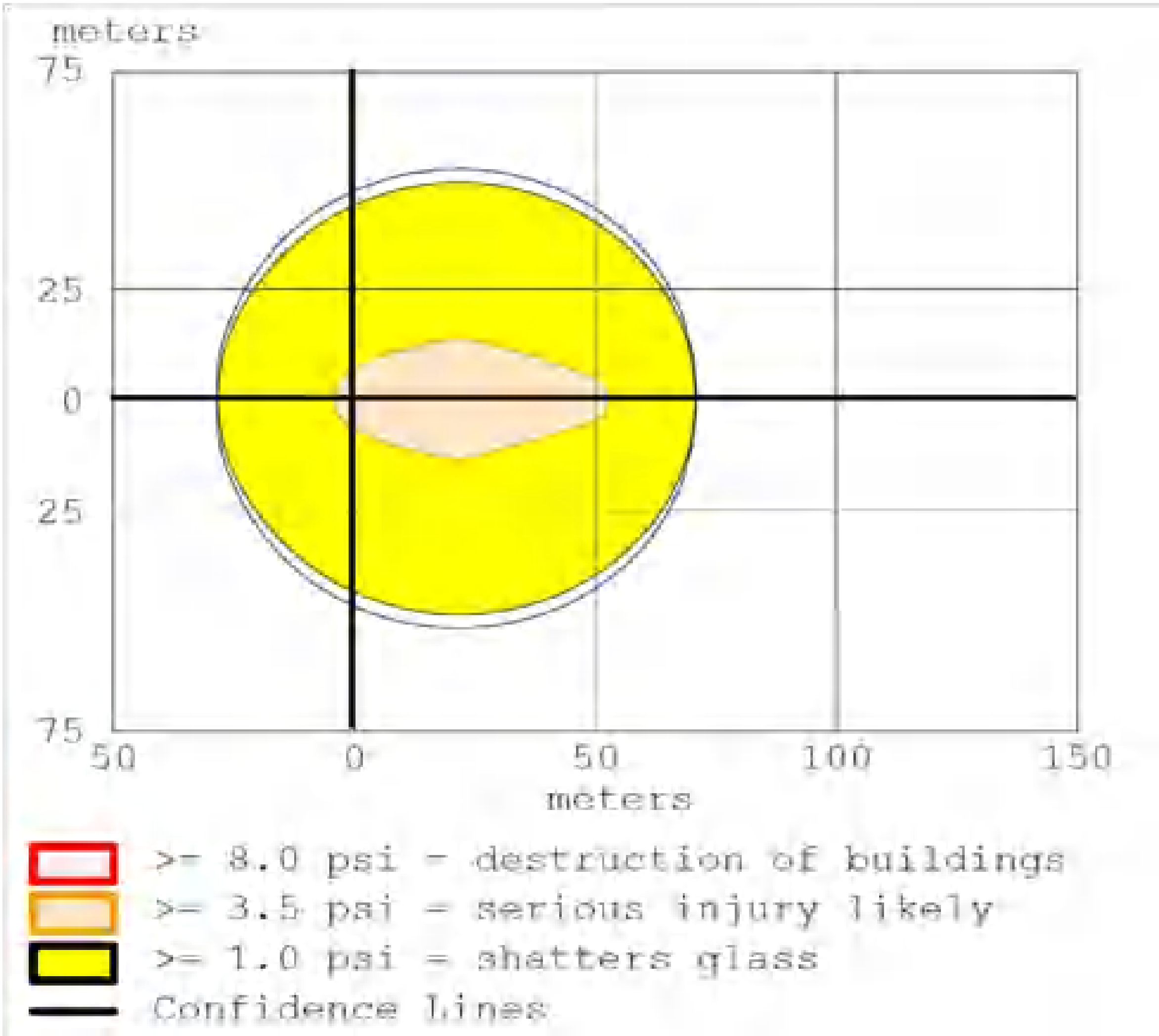
20.1.12.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



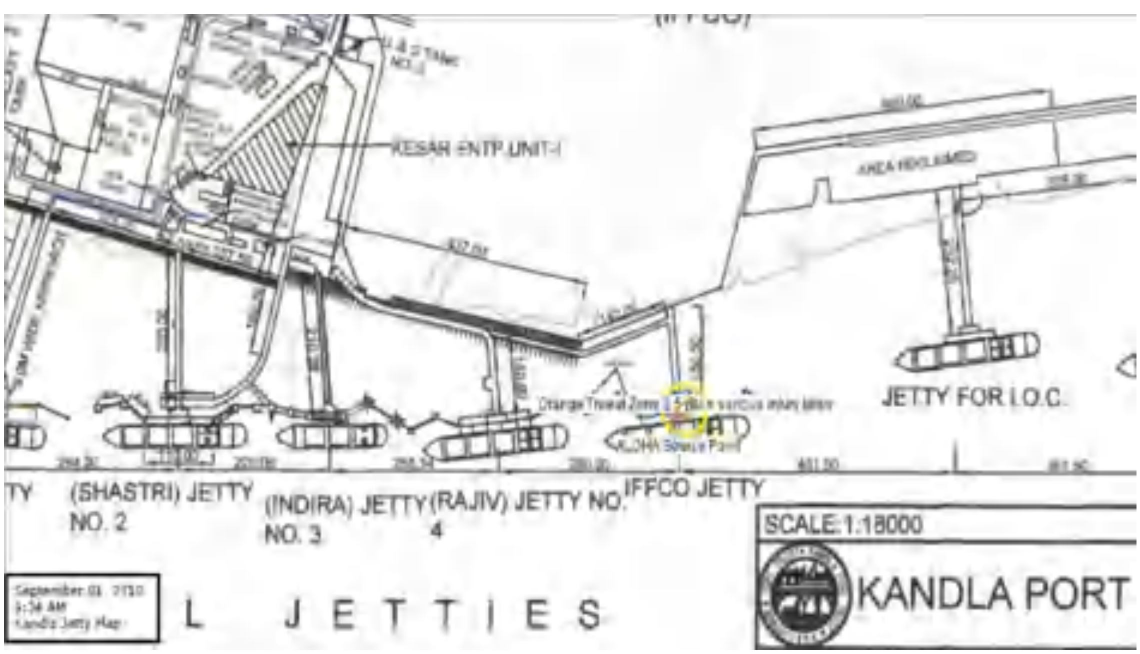
20.1.12.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



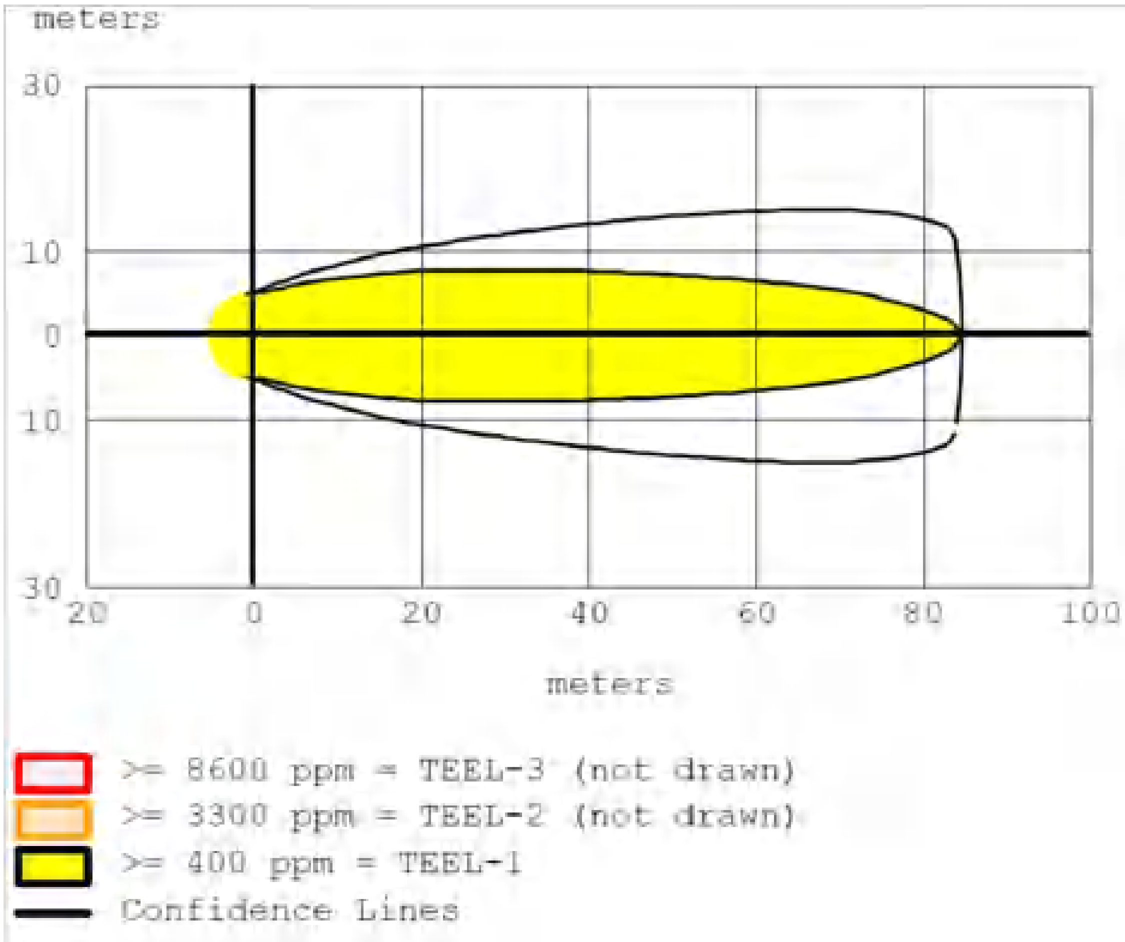
20.1.12.5 Instantaneous Release – Overpressure (Graph)



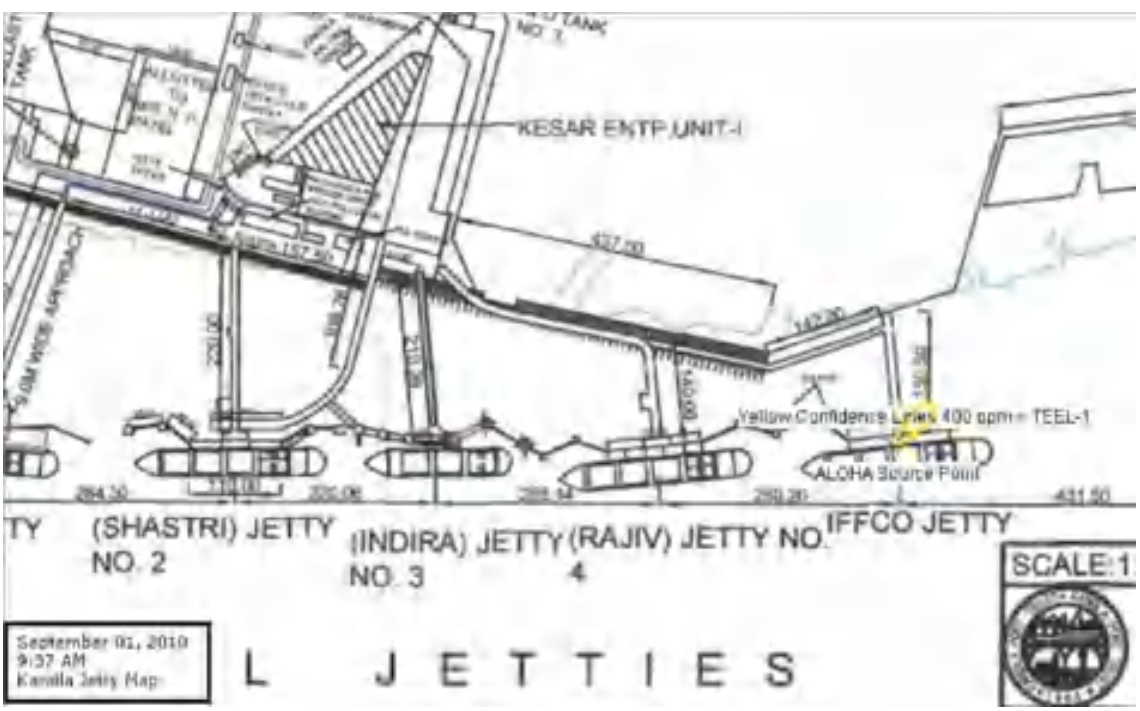
20.1.12.6 Instantaneous Release – Overpressure (Contour)



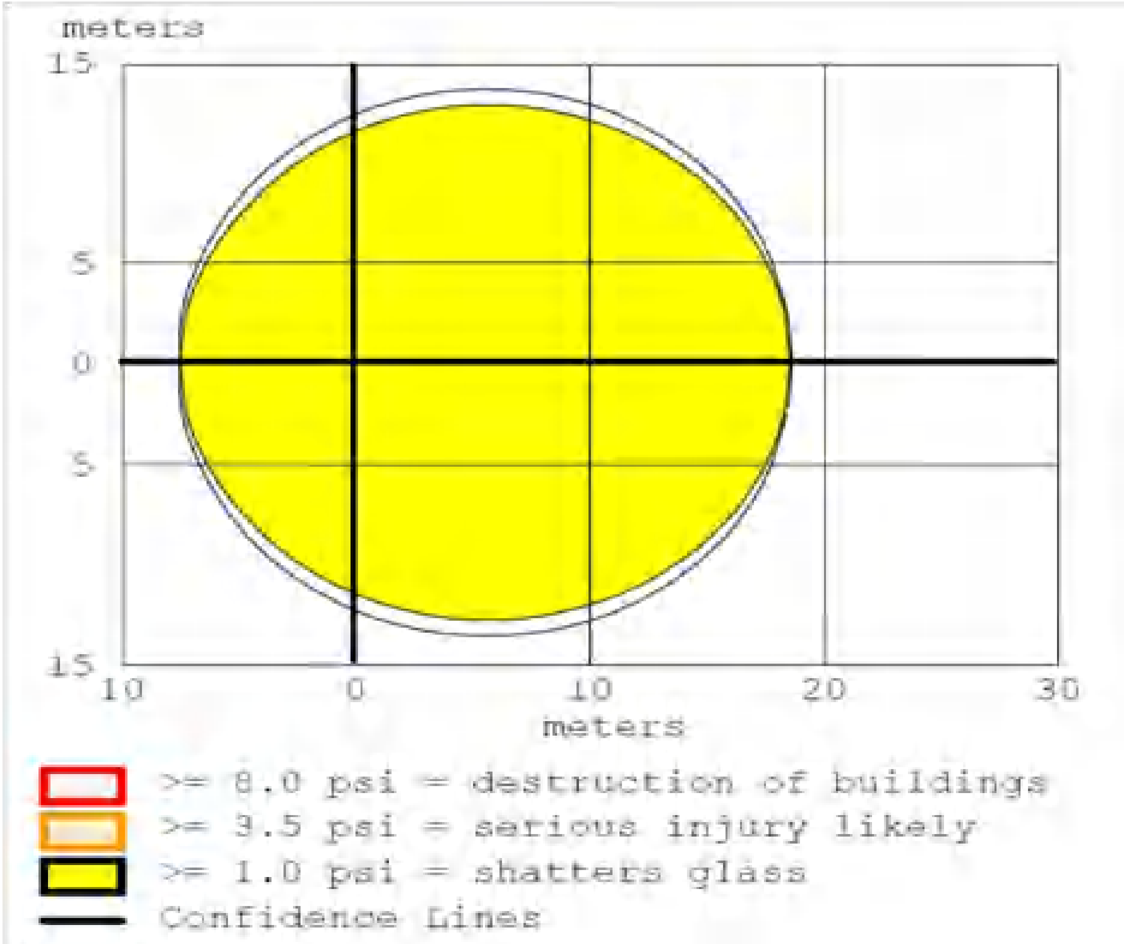
20.1.12.7 Evaporating Puddle – Toxic Threat Zone (Graph)



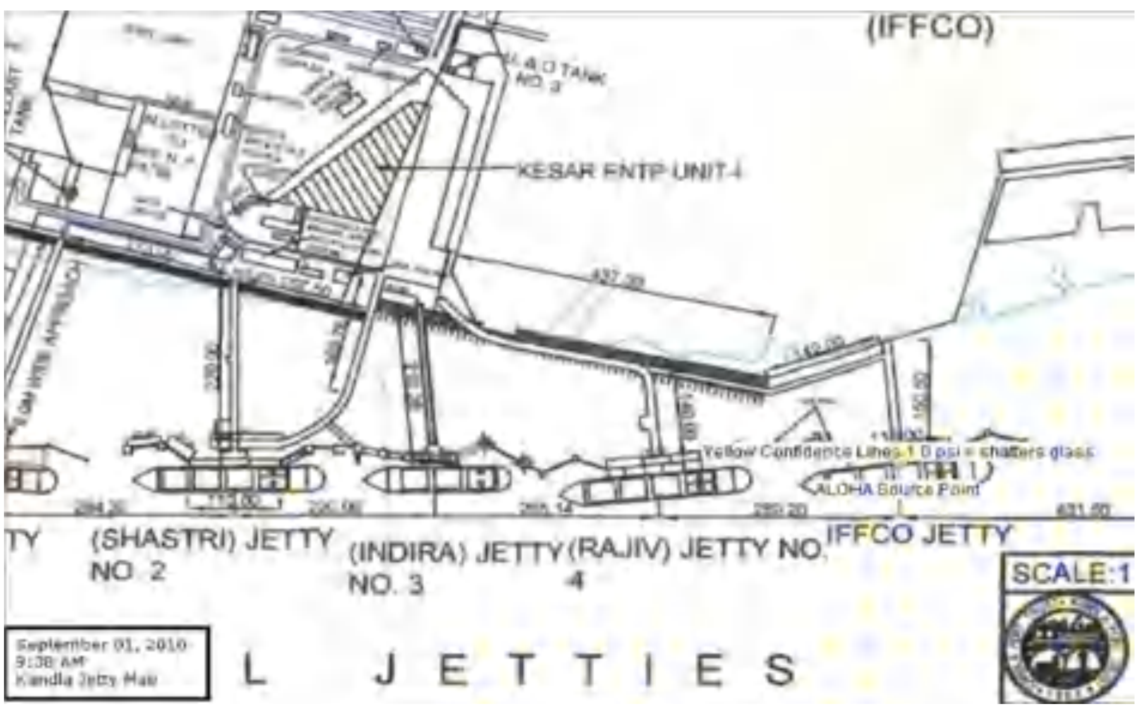
20.1.12.8 Evaporating Puddle – Toxic Threat Zone (Contour)



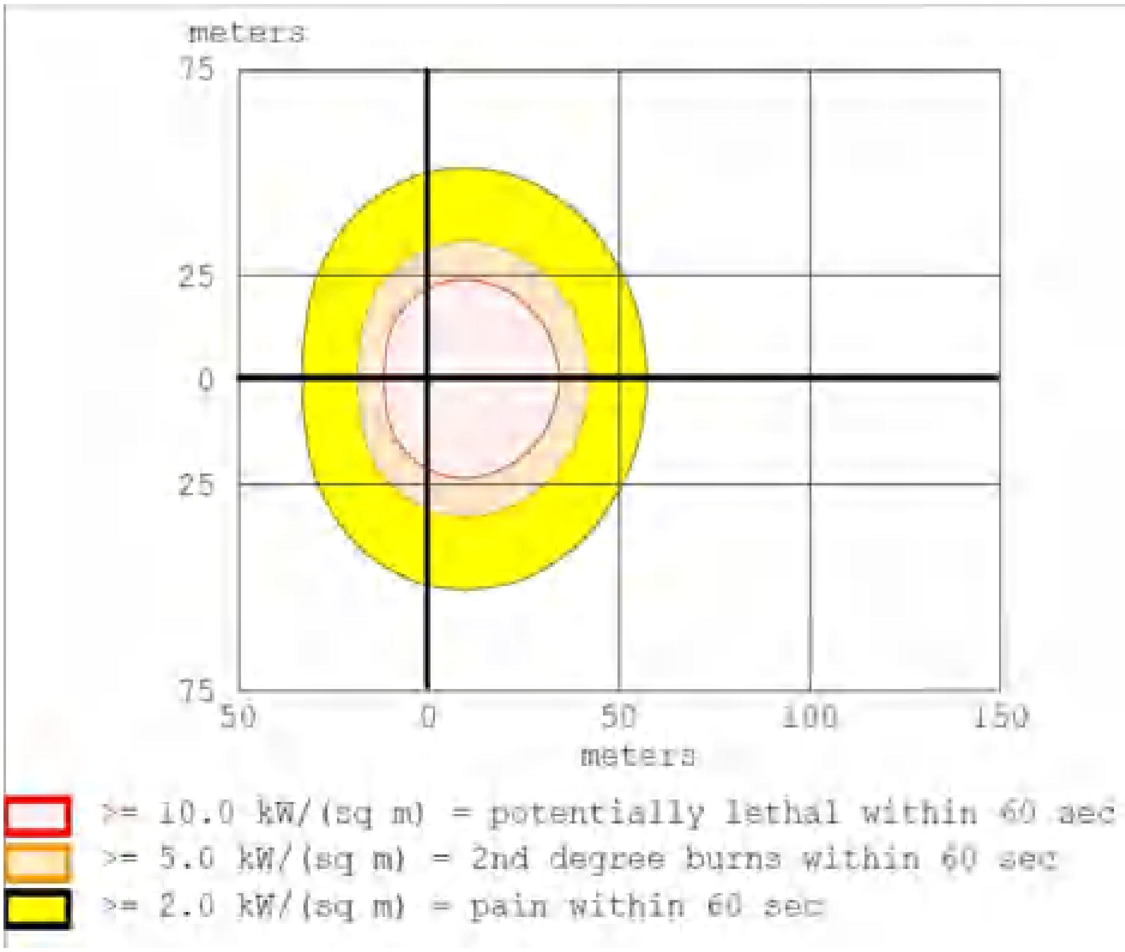
20.1.12.9 Evaporating Puddle – Overpressure (Graph)



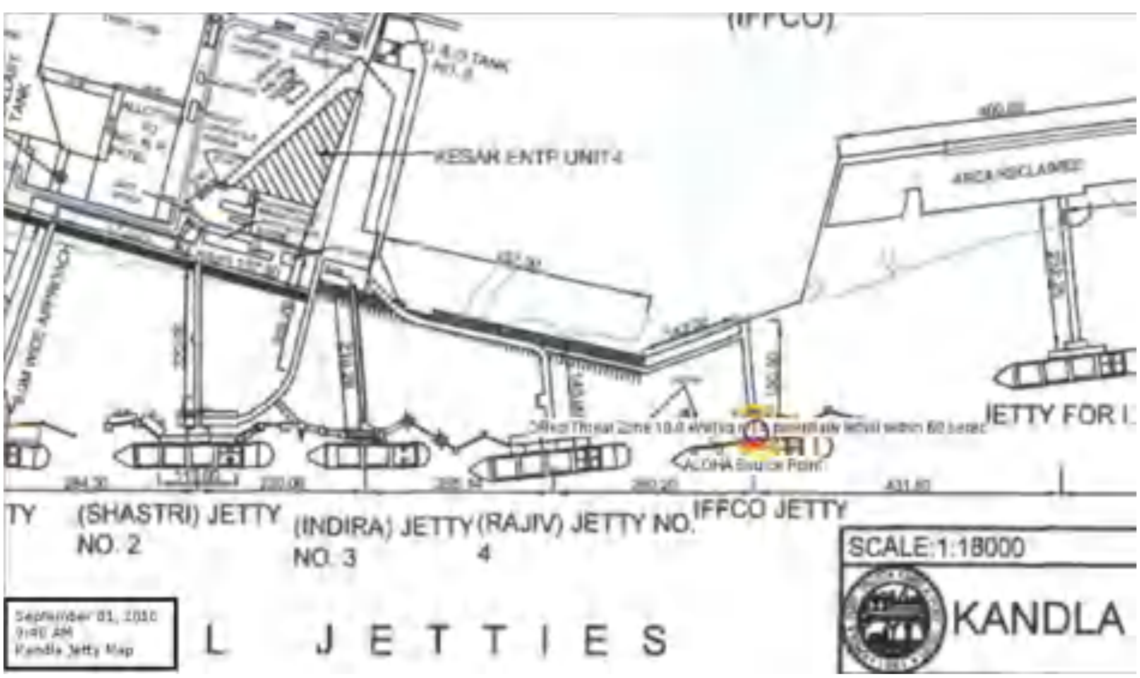
20.1.12.10 Evaporating Puddle – Overpressure (Contour)



20.1.12.11 Burning Puddle – Thermal Radiation (Graph)

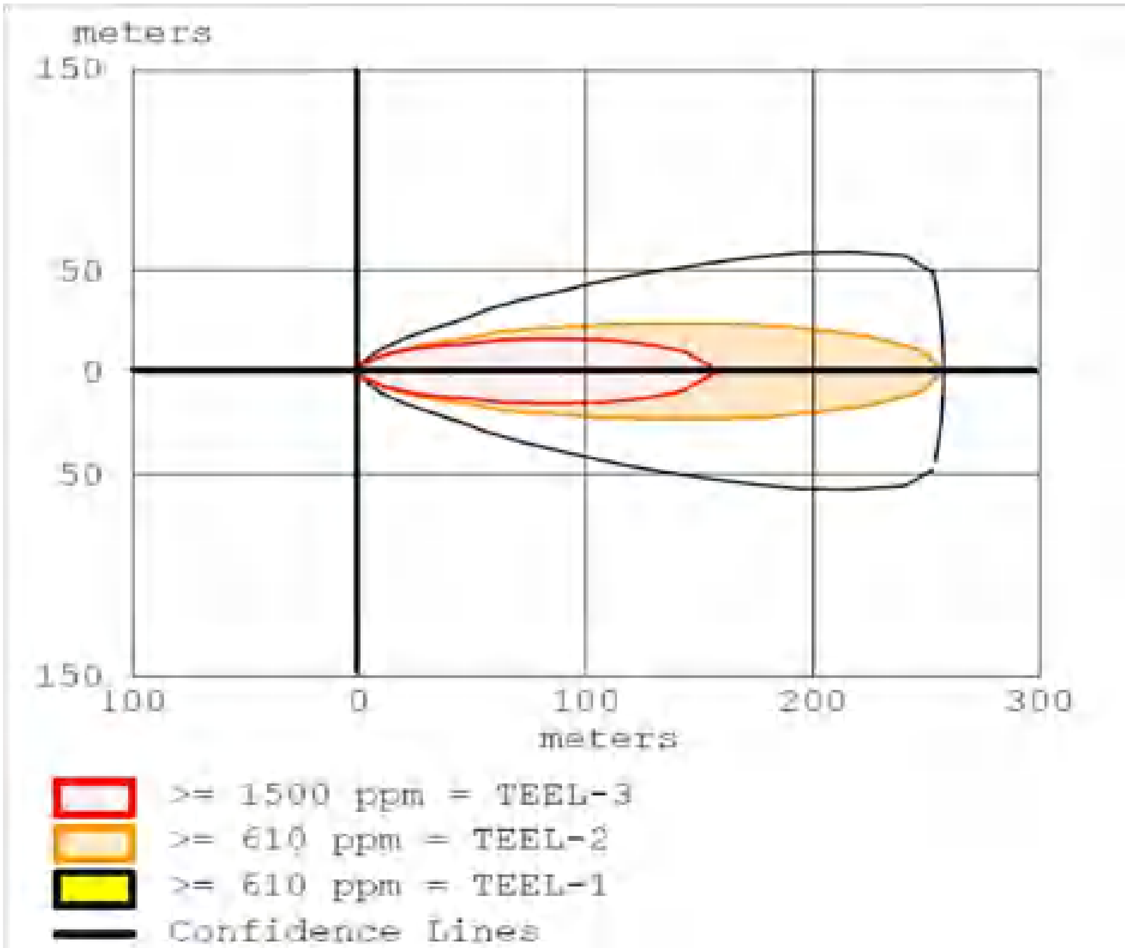


20.1.12.12 Burning Puddle – Thermal Radiation (Contour)

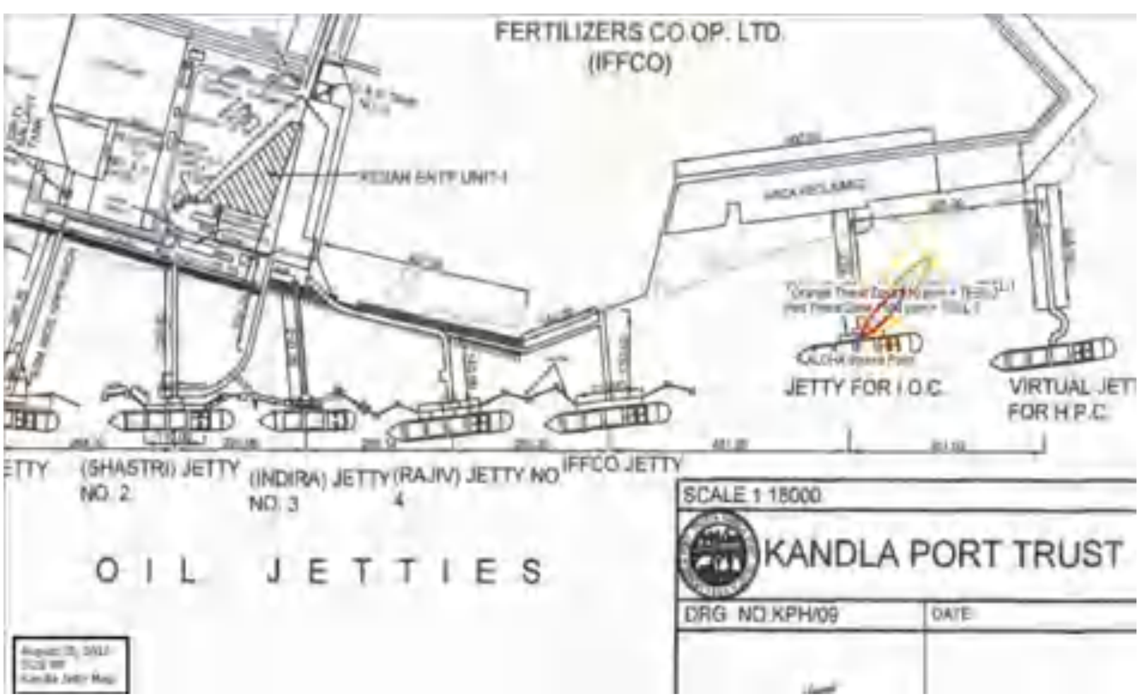


20.1.13 Jetty Six – Motor Spirit

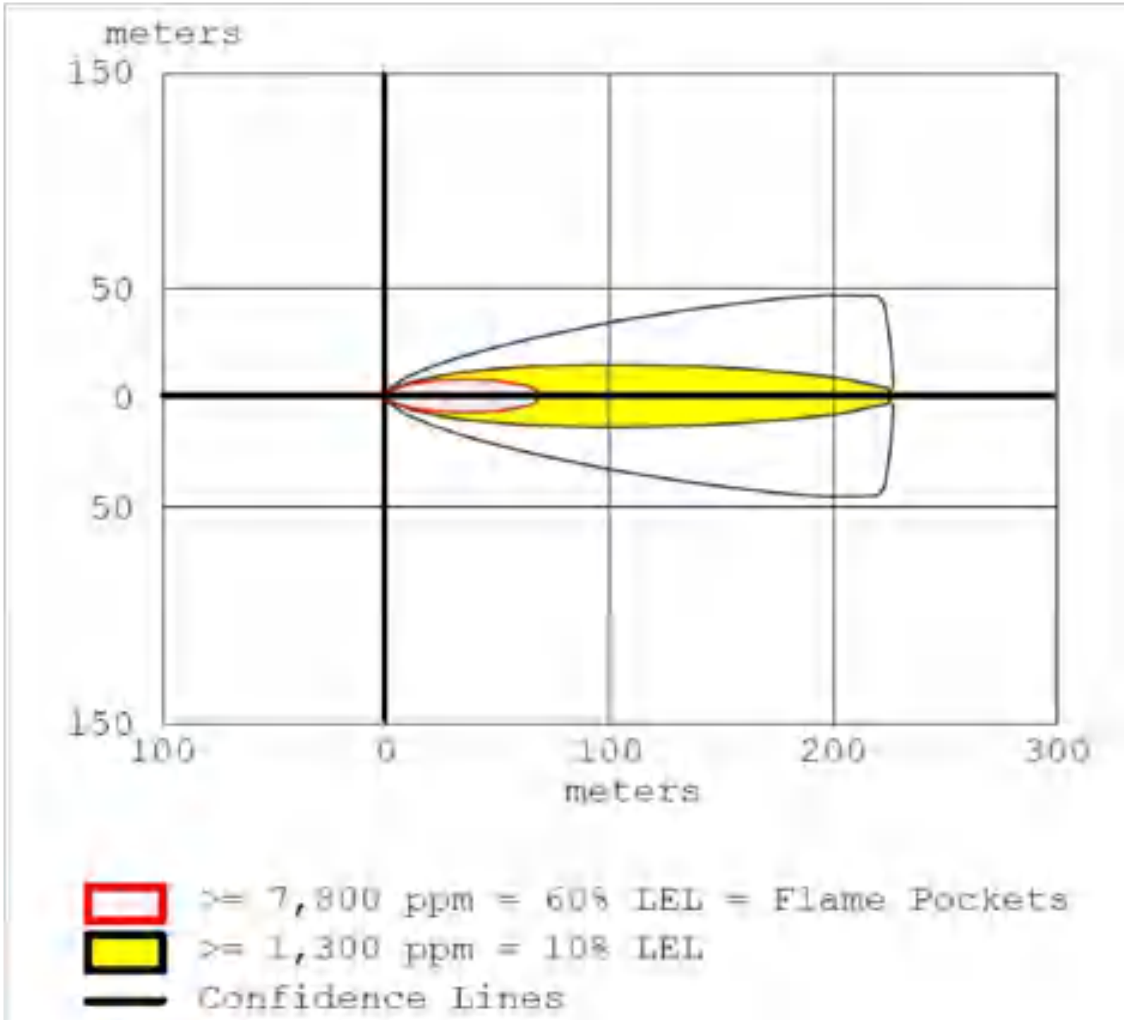
20.1.13.1 Instantaneous Release – Toxic Threat Zone (Graph)



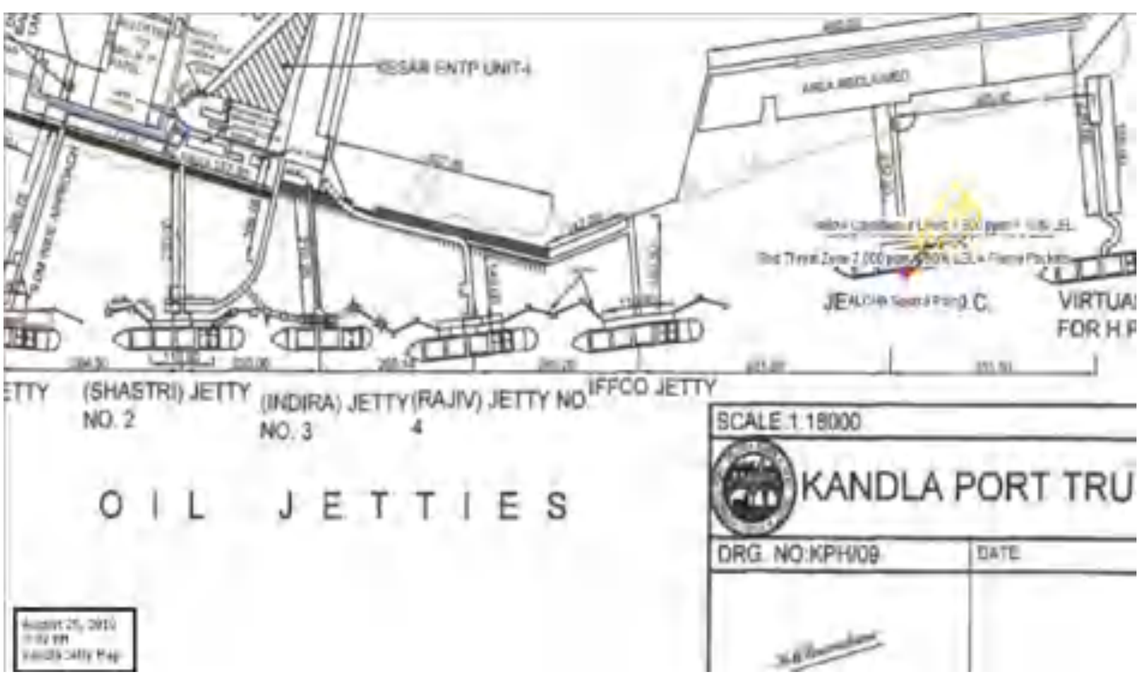
20.1.13.2 Instantaneous Release – Toxic Threat Zone (Contour)



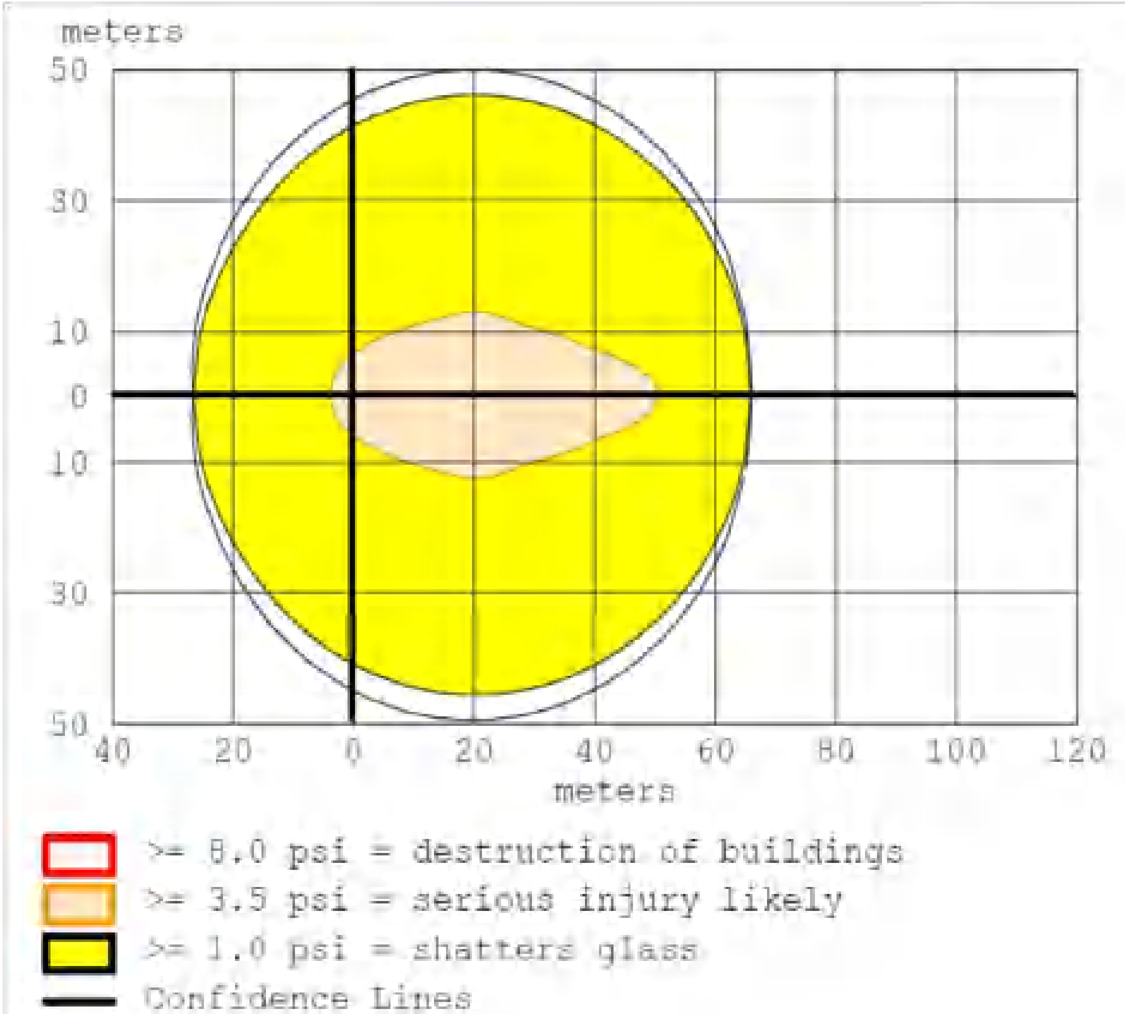
20.1.13.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



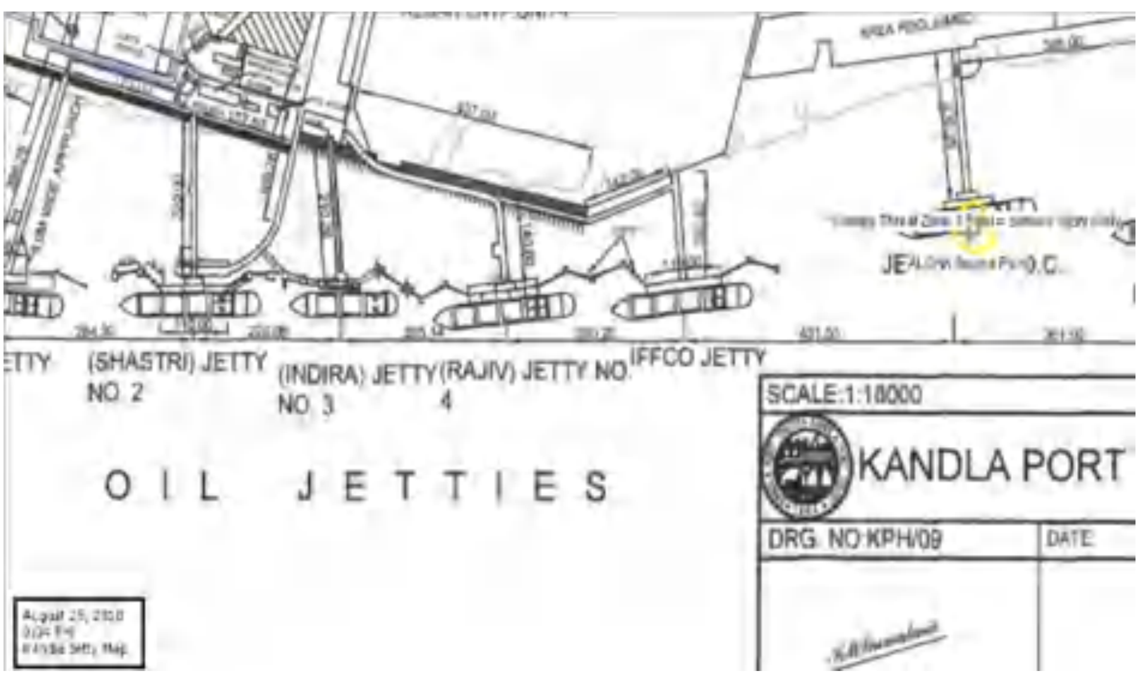
20.1.13.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



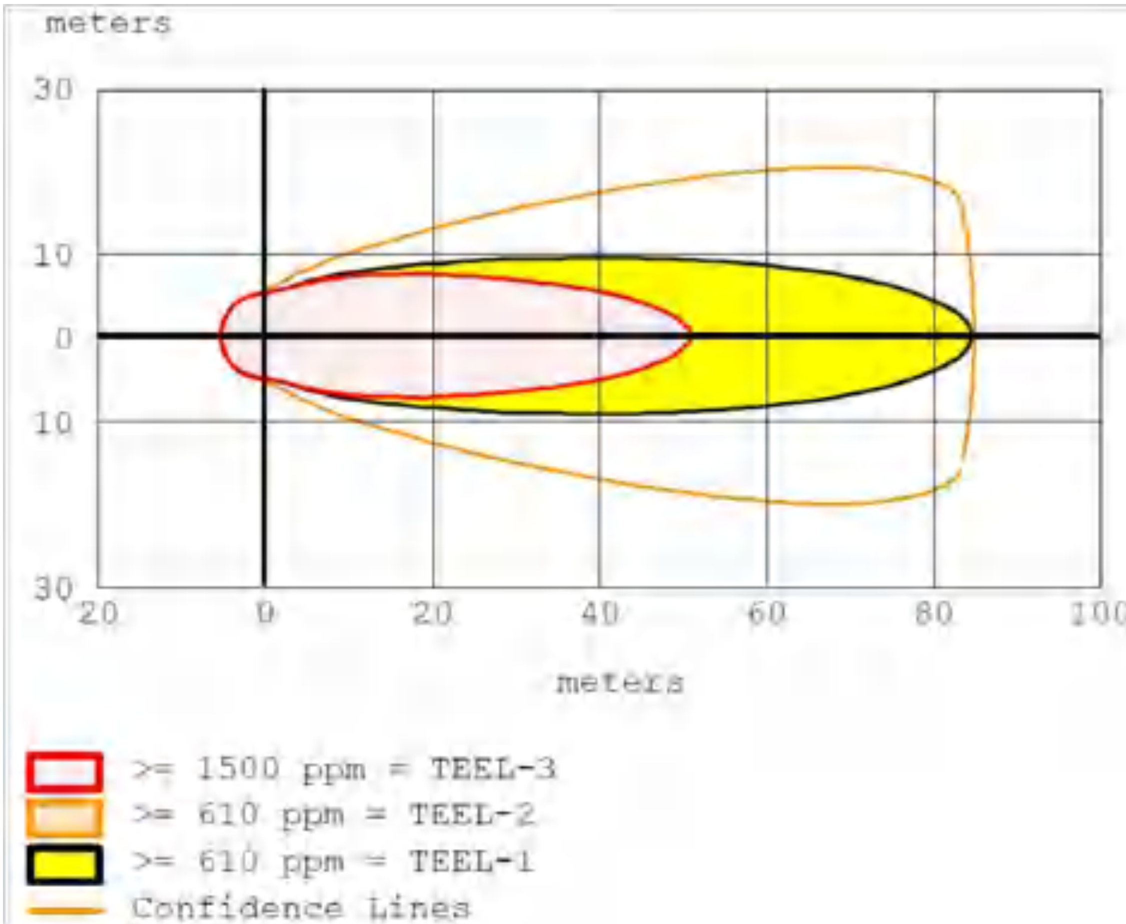
20.1.13.5 Instantaneous Release – Overpressure (Graph)



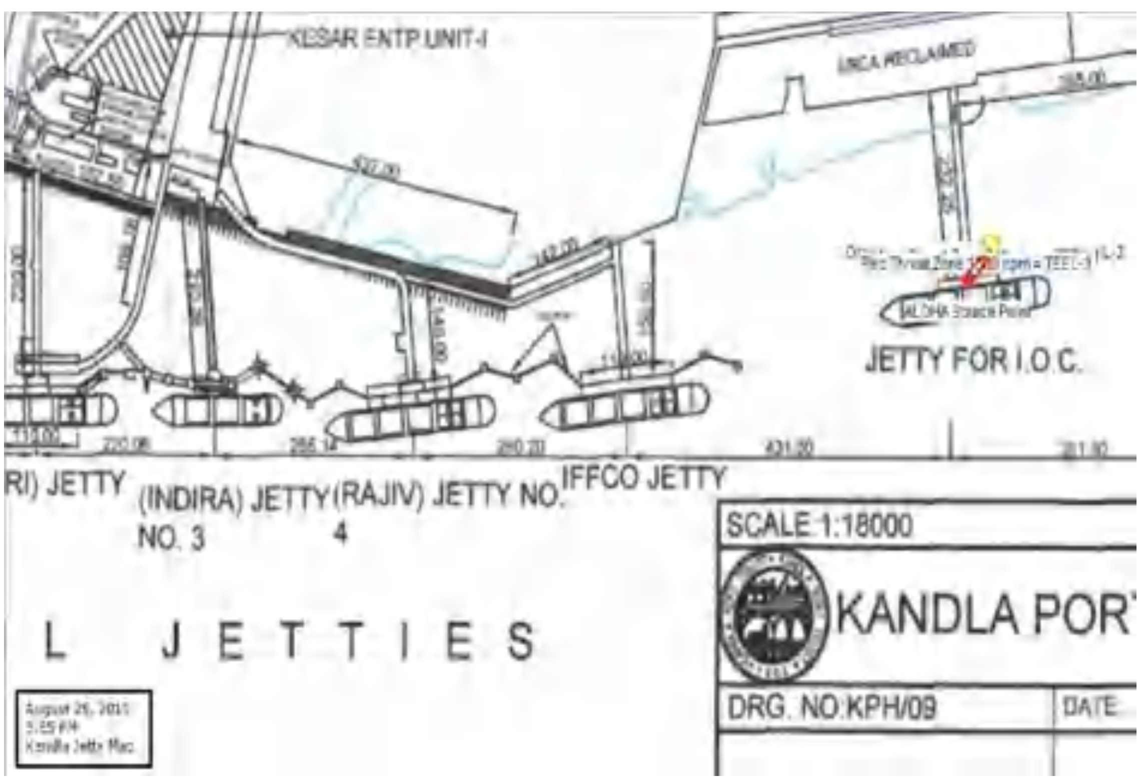
20.1.13.6 Instantaneous Release – Overpressure (Contour)



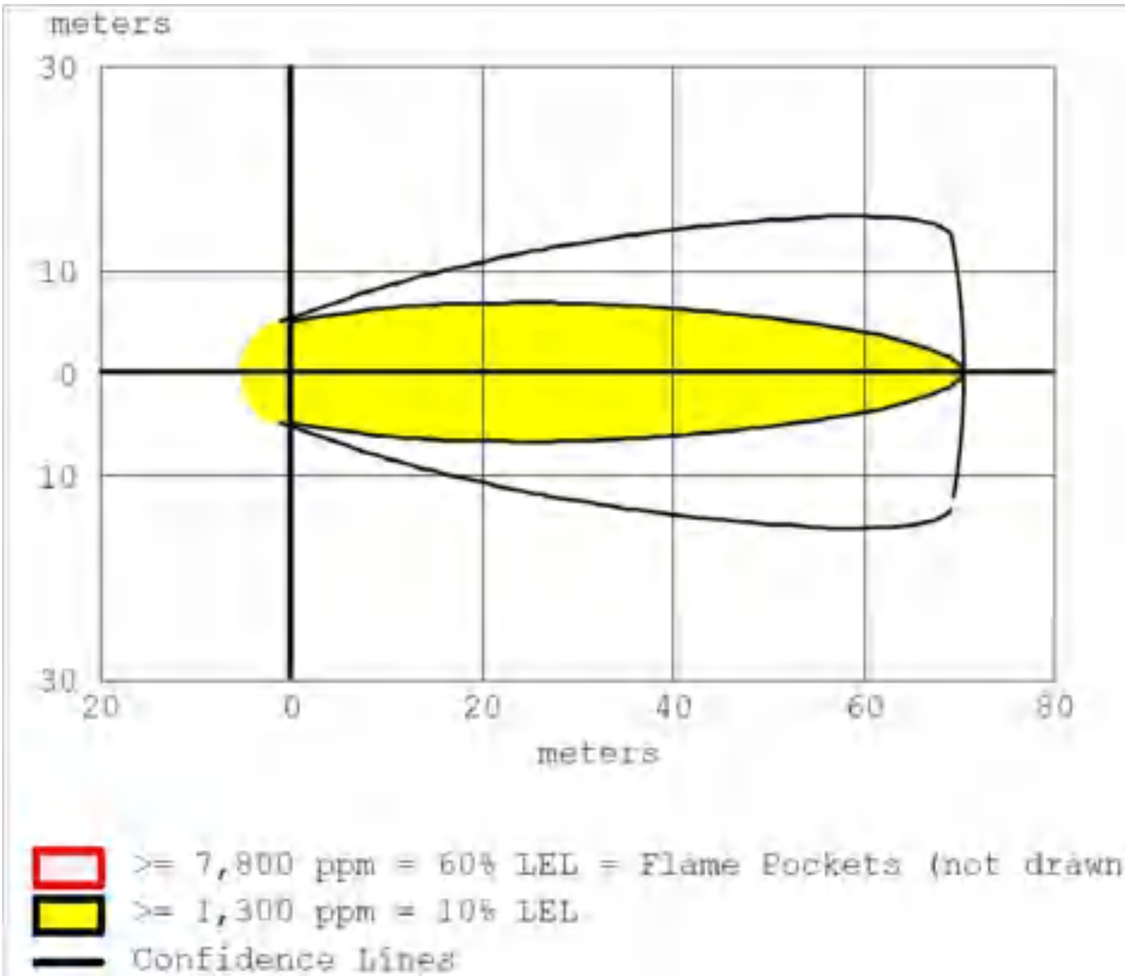
20.1.13.7 Evaporating Puddle – Toxic Threat Zone (Graph)



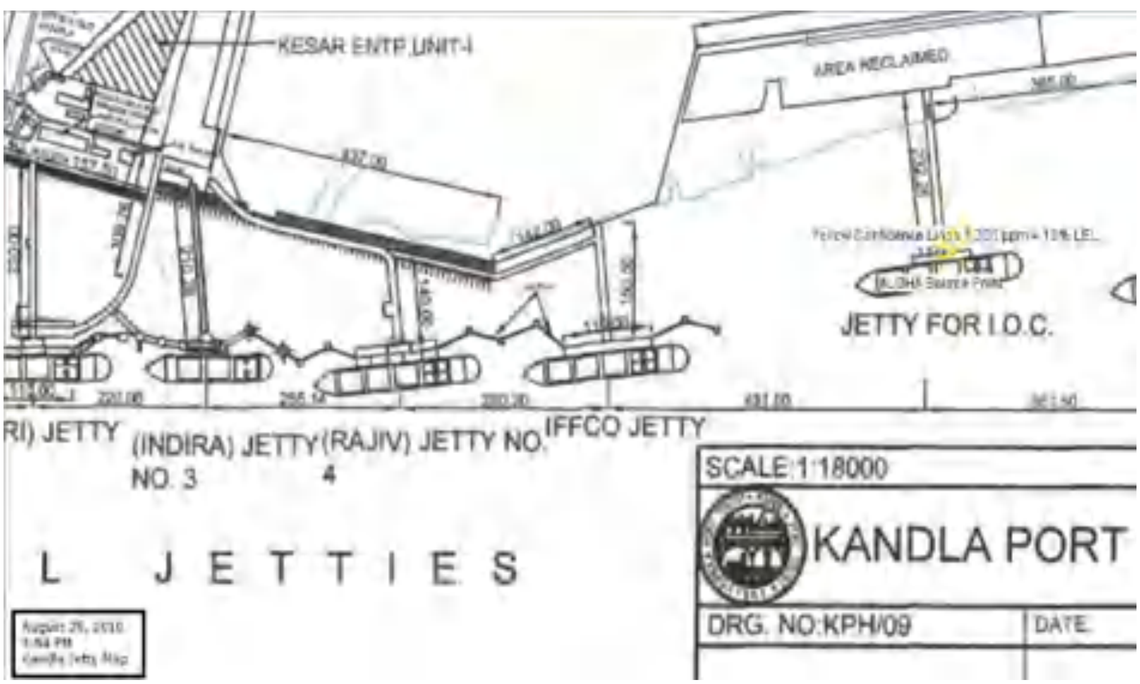
20.1.13.8 Evaporating Puddle – Toxic Threat Zone (Contour)



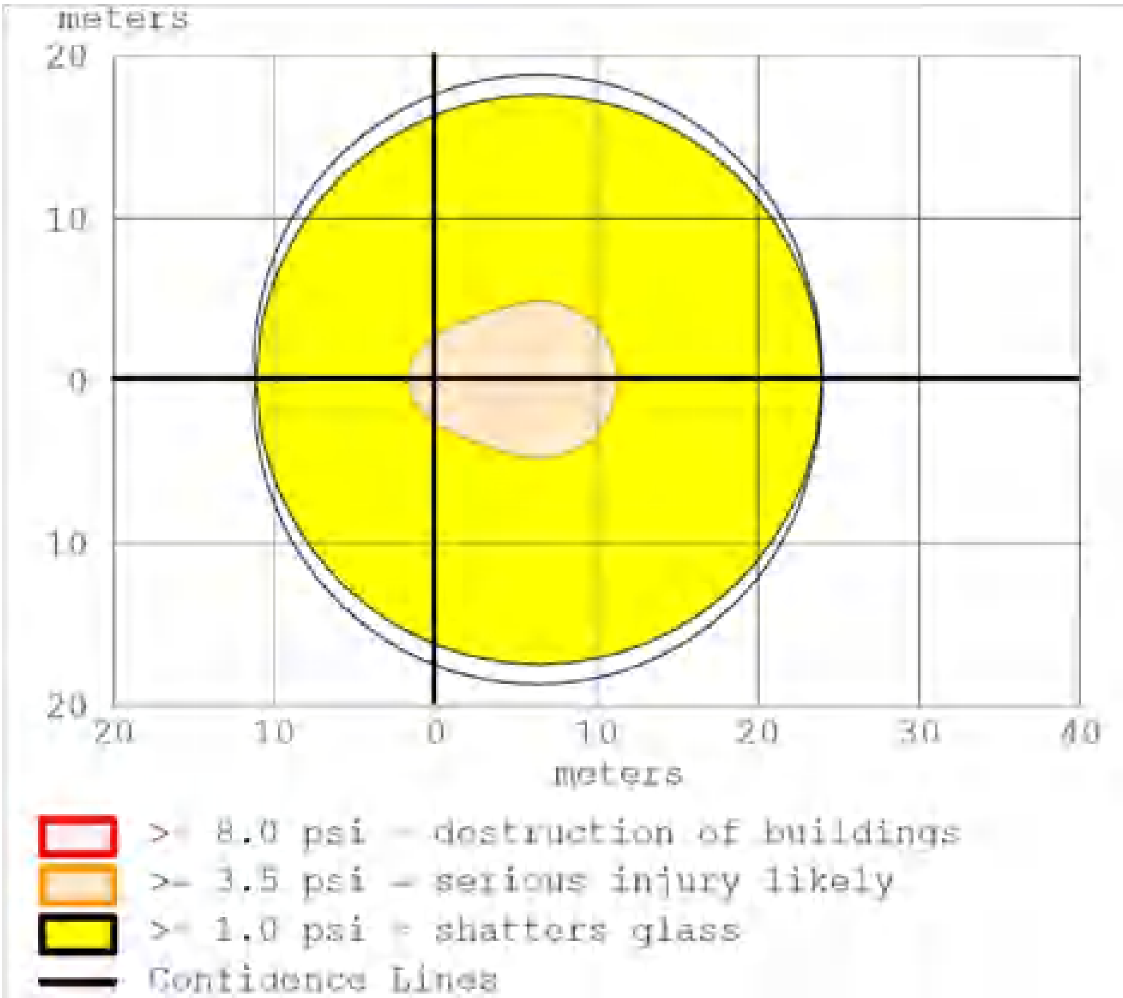
20.1.13.9 Evaporating Puddle – Flammable Area of Vapor Cloud (Graph)



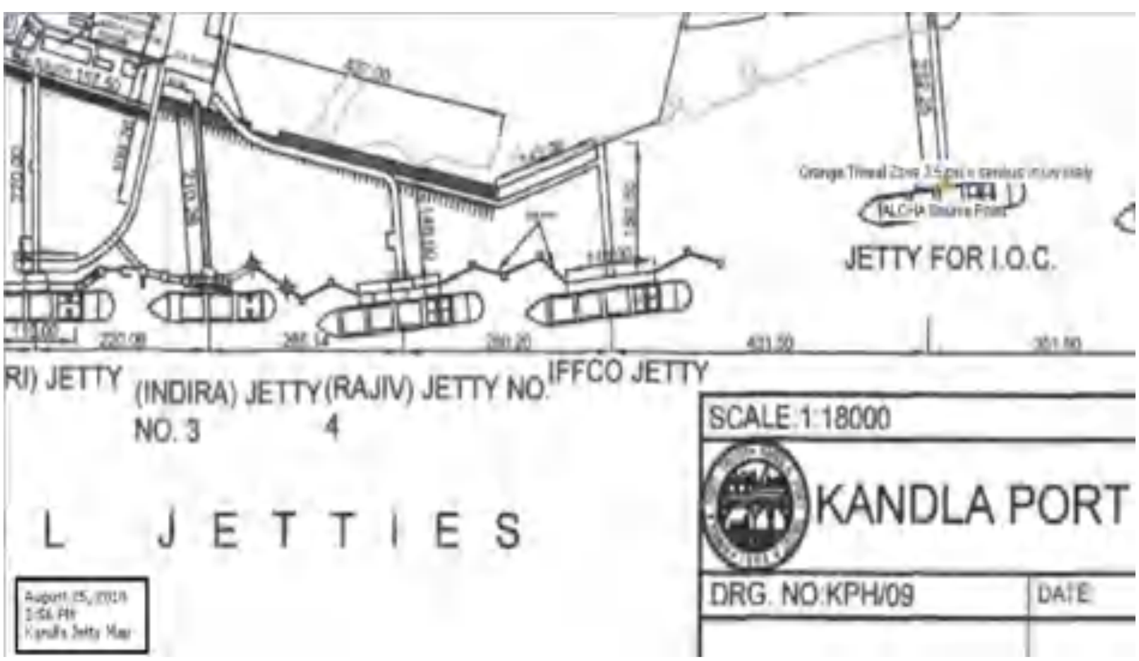
20.1.13.10 Evaporating Puddle – Flammable Area of Vapor Cloud (Contour)



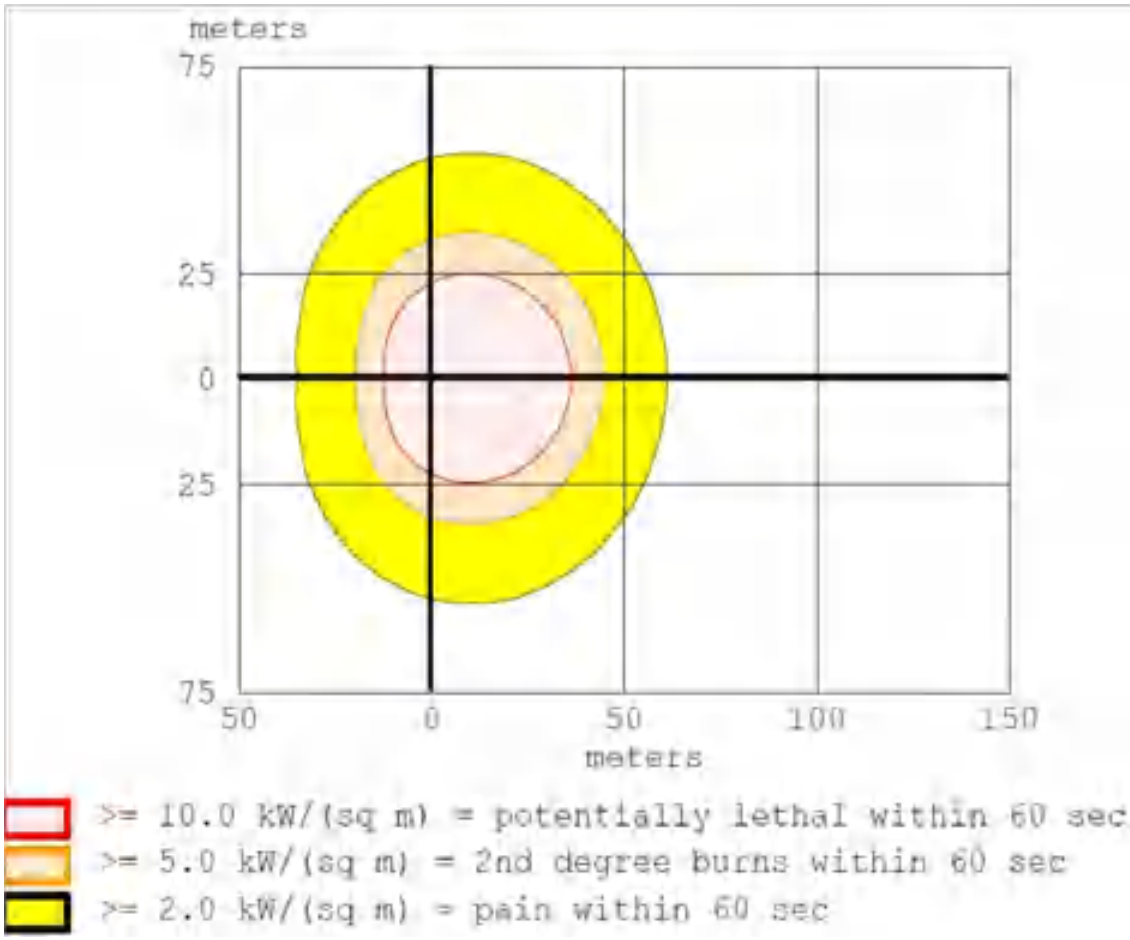
20.1.13.11 Evaporating Puddle – Overpressure (Graph)



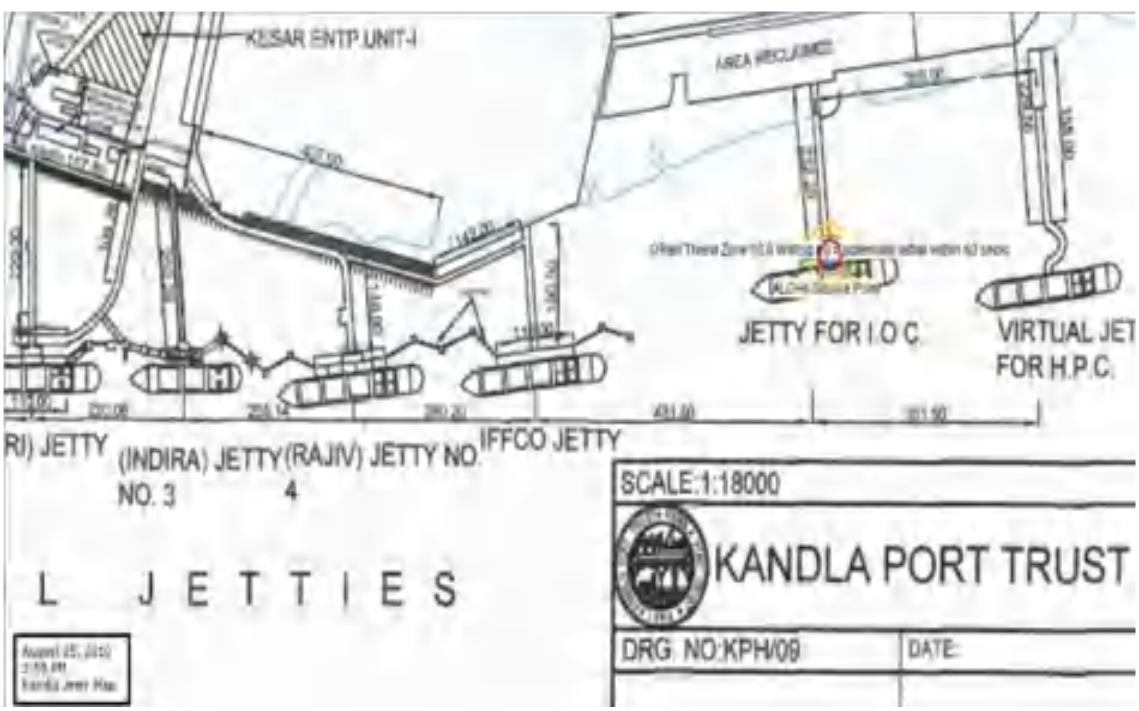
20.1.13.12 Evaporating Puddle – Overpressure (Contour)



20.1.13.13 Burning Puddle – Thermal Radiation (Graph)

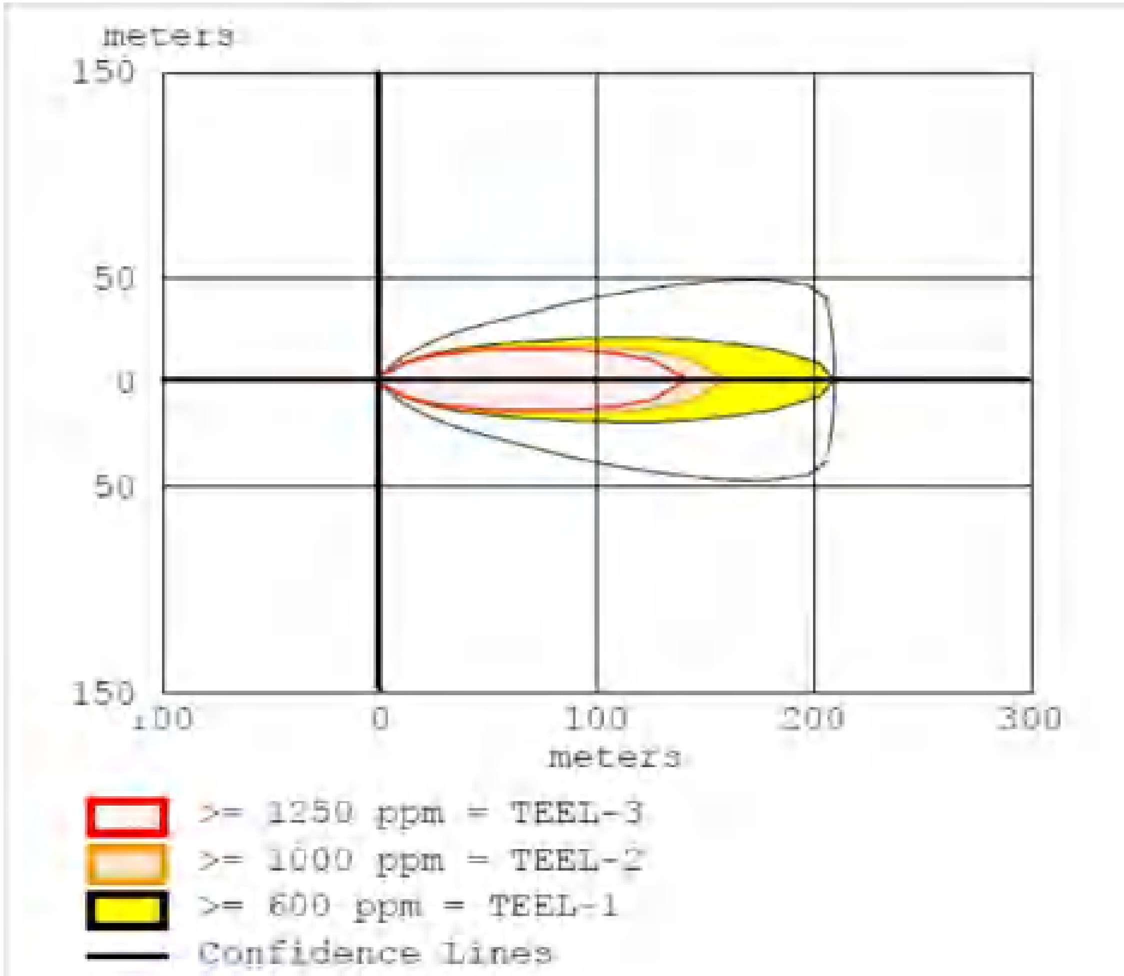


20.1.13.14 Burning Puddle – Thermal Radiation (Contour)

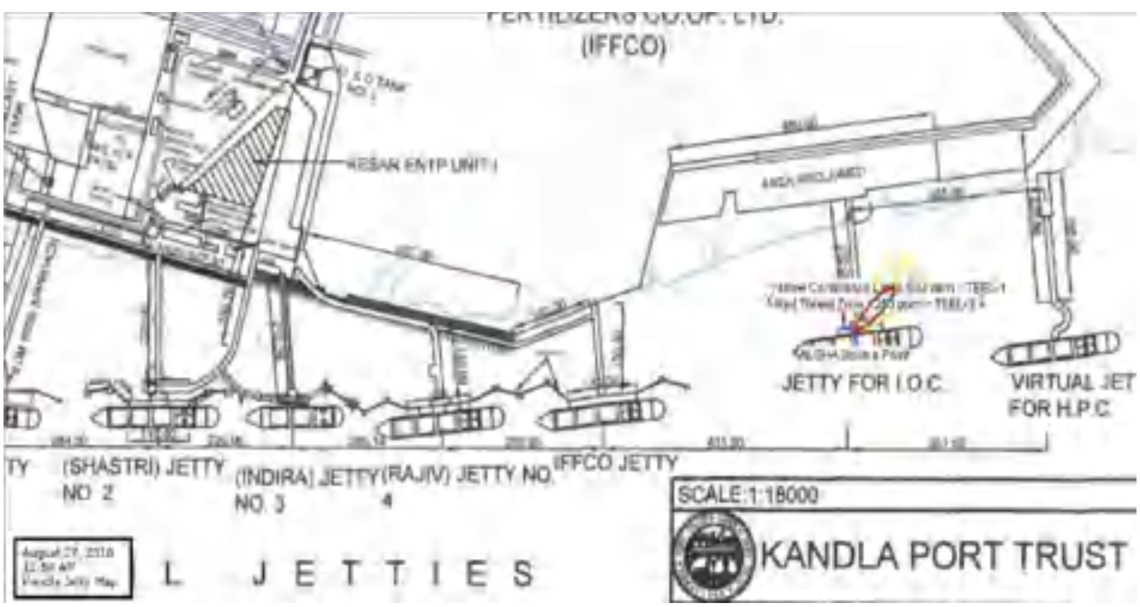


20.1.14 Jetty Six – Motor Spirit

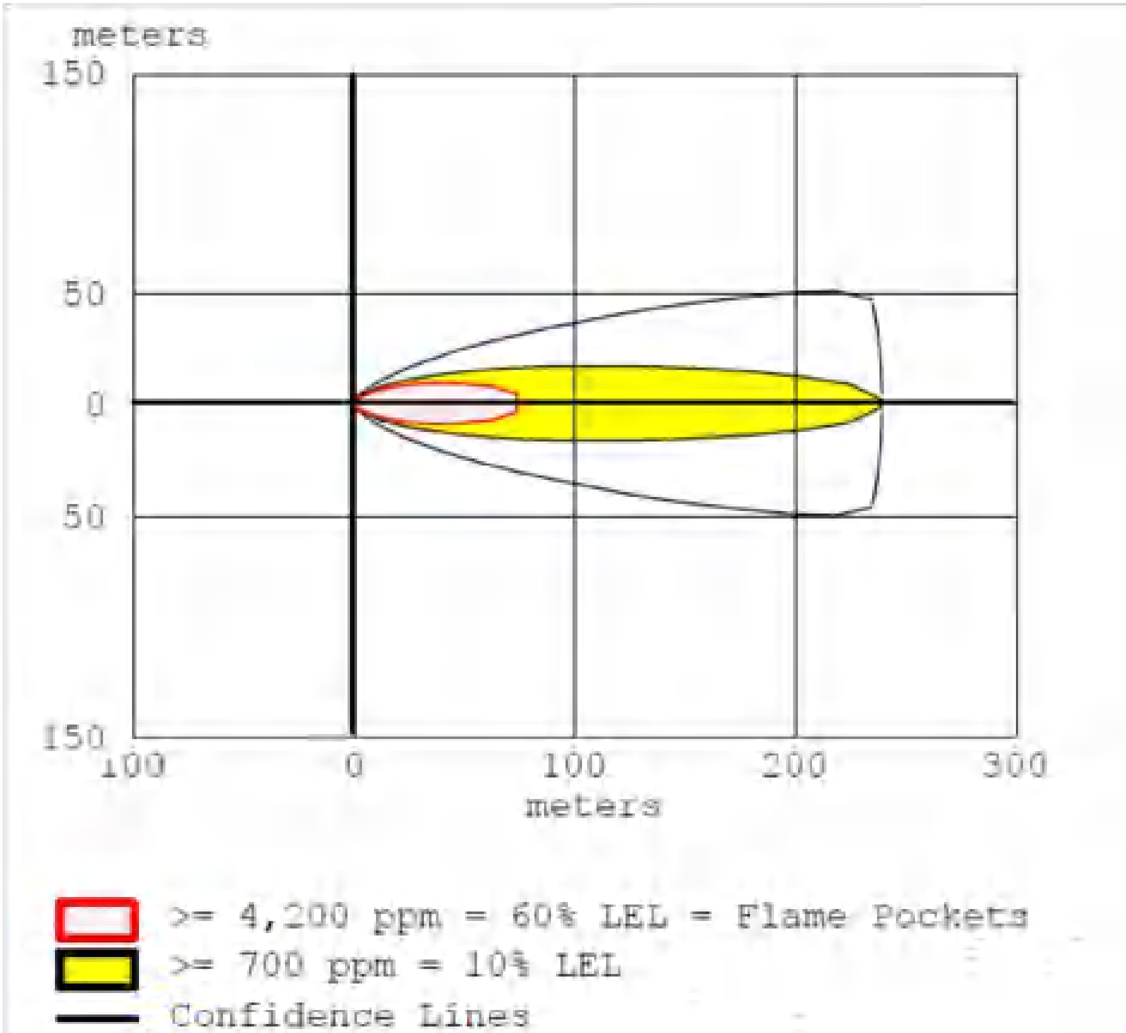
20.1.14.1 Instantaneous Release – Toxic Threat Zone (Graph)



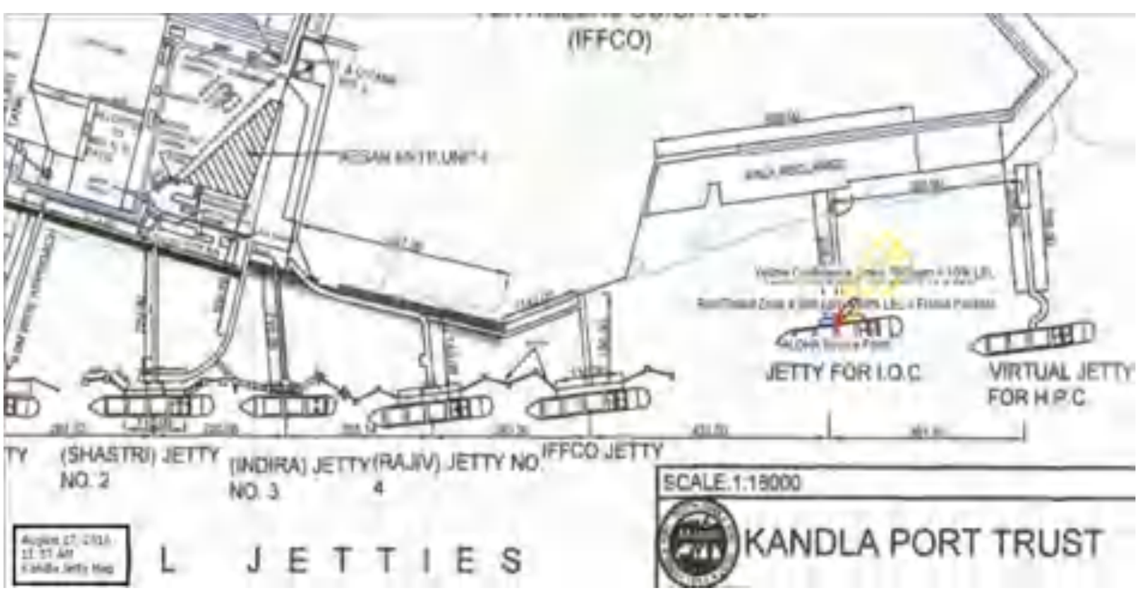
20.1.14.2 Instantaneous Release – Toxic Threat Zone (Contour)



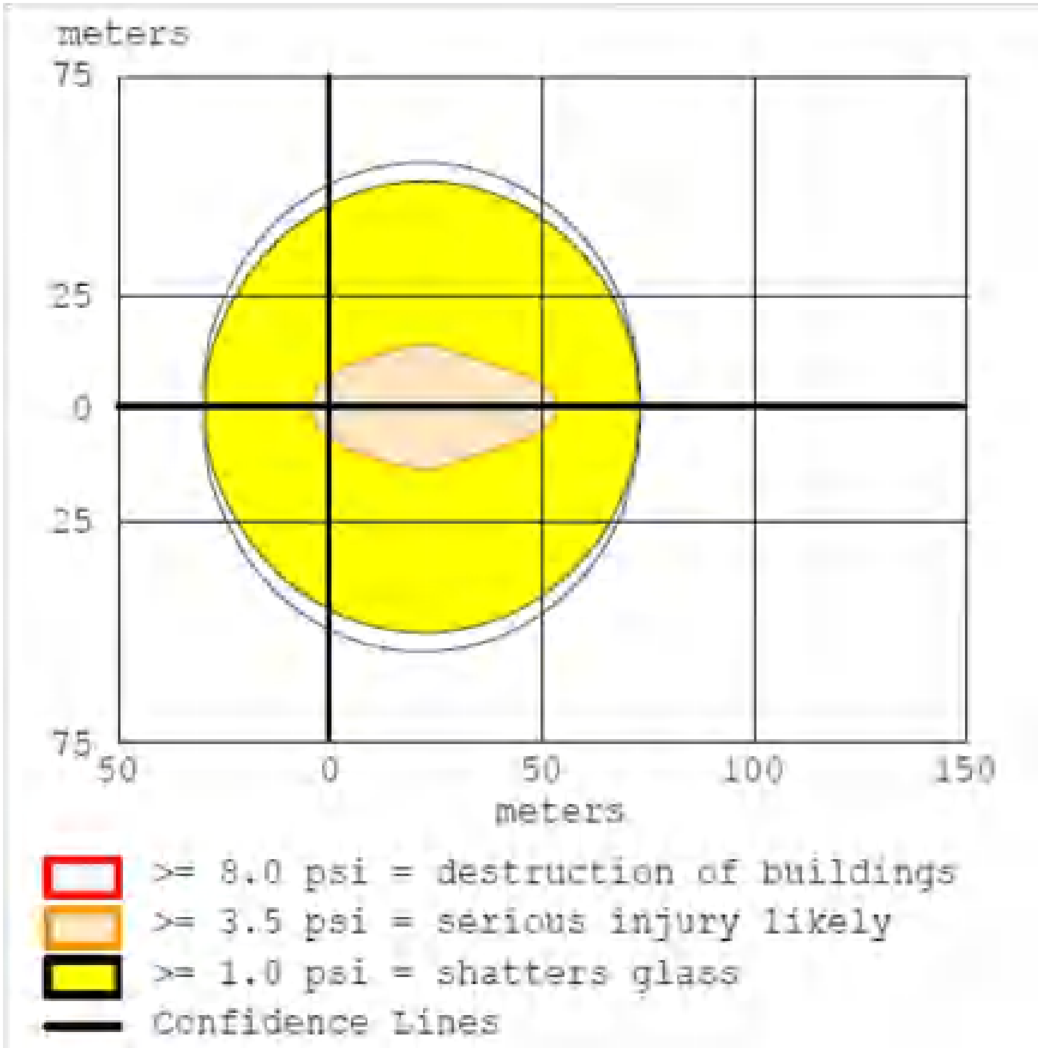
20.1.14.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



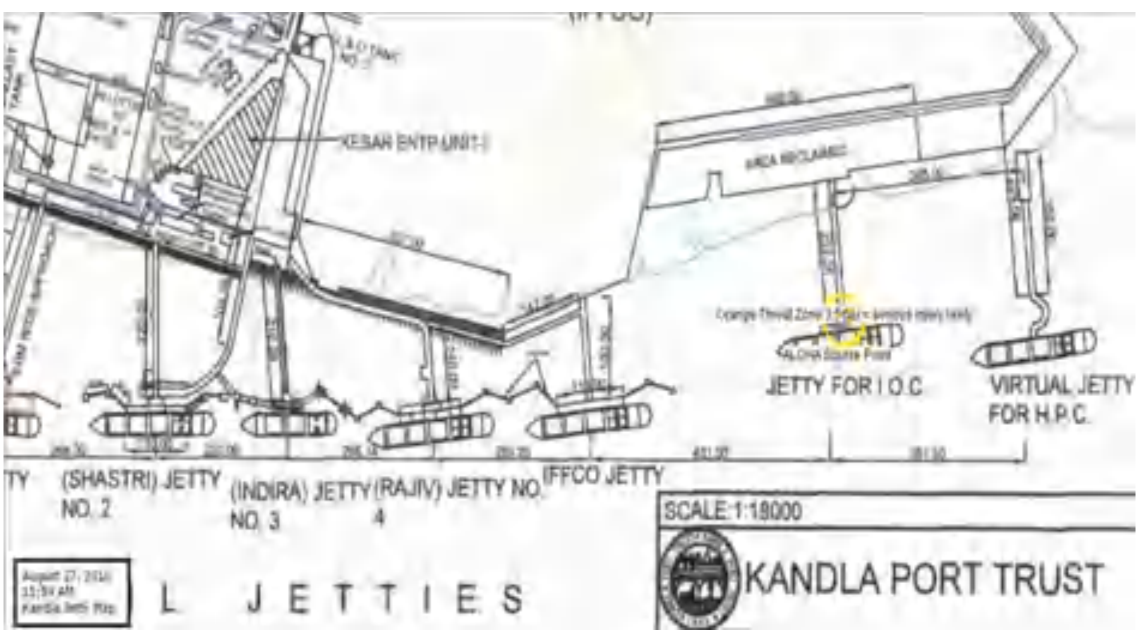
20.1.14.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



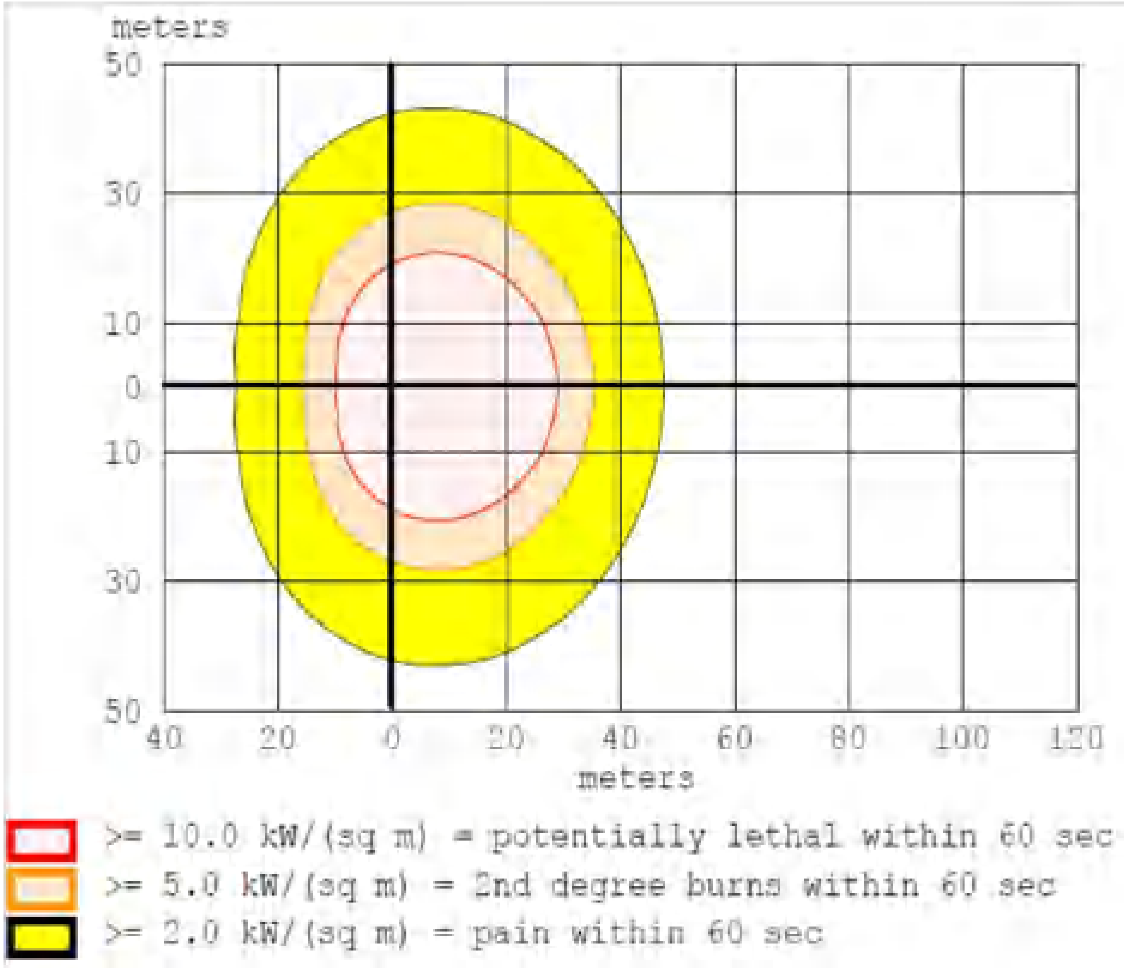
20.1.14.5 Instantaneous Release – Overpressure (Graph)



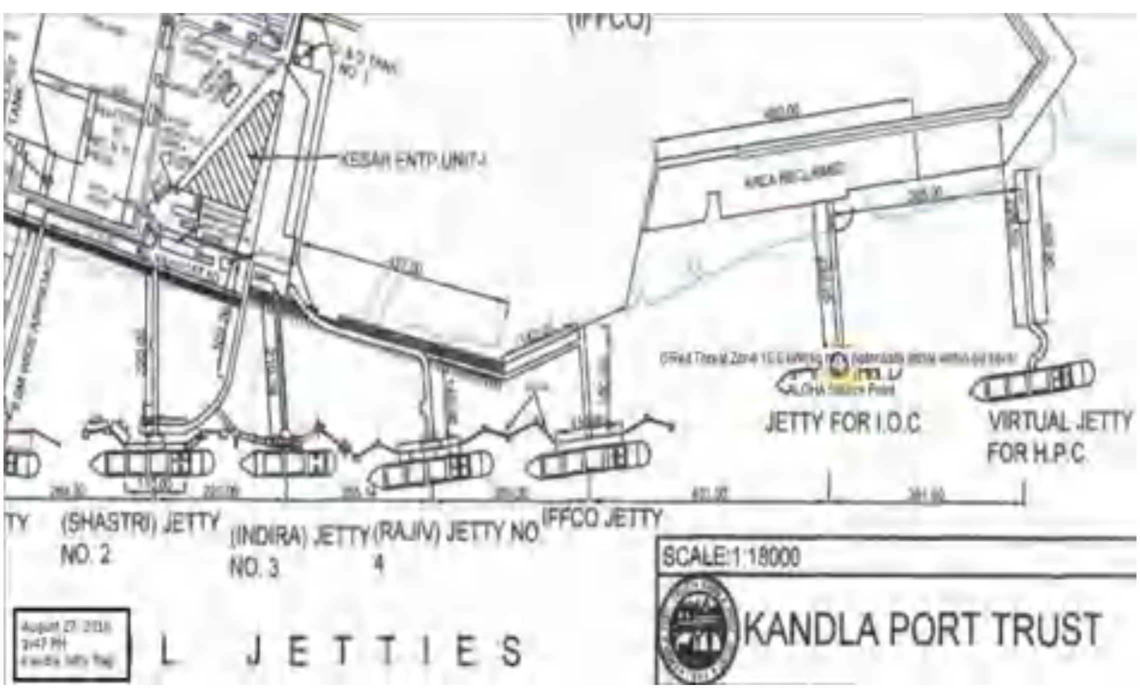
20.1.14.6 Instantaneous Release – Overpressure (Contour)



20.1.14.7 Burning Puddle – Thermal Radiation (Graph)



20.1.14.8 Burning Puddle – Thermal Radiation (Contour)



CBRN: Chemical Biological Radio Activity Nuclear related contingencies Dos & Donts

20 ANNEXURE Very useful telephone numbers

NDMA CONTACT DETAILS

NDMA Bhawan,
A-1, Safdarjung Enclave,
New Delhi - 110029
Telephones:
+91-11-26701700
Control Room: +91-11-26701728
Fax: +91-11-26701729
E-mail: controlroom@ndma.gov.in

NDMA CONTROL ROOM

Name	Office	Fax	Mob.	E.mail id
Control Room	011-26701728 011-1078	011-26701729	9868891801 9868101885	controlroom@ndma.gov.in, ndmacontrolroom@gmail.com,

GSDMA

- **Block No.11 , 5thFloor, Udyog Bhavan , Sectoг-11 , Gandhinagar, Gujarat.**
- ***Email***

  info@gsdma.org
- ***PHONE +91-79-23259283***

21.1 Telephone Nos of Gujarat State District Collectors

No.	District	Collector Name	Phone	Fax
1	Ahmedabad (079)	Dr. Vikrant Pandey	(O)079-27551681	7927552144
2	Amreli (02792)	Shri Oak Aayush Sanjeev	(O)02792-222307	2792222710
3	Anand (02692)	Shri Dilip Kumar Rana	(O)02692-261575	2692261575
4	Arvalli (02774)	Shri Nagarajan M.	(O)02774-250200	2774250202
5	Banaskantha (02742)	Shri Sagale Sandip J.	(O)02742-257171	2742252740
6	Bharuch (02642)	Shri Ravi Kumar Arora	(O)02642-240600	2642240602
7	Bhavnagar (0278)	Shri Harshadkumar Ratilal Patel	(O)02782428822	2782427941
8	Botad (02849)	Shri Sujeet Kumar	(O)02849271301	2849271304
9	Chhotaudepur (02669)	Shri Sujal Jayantibhai Mayatra	(O)02669-233003	2669233002
10	Dahod (02673)	Shri Vijaykumar Lalubhai Kharadi	(O)02673-239001	2673239005
11	Dangs-Ahwa (02631)	Shri N.K. Damor	(O)02631220201	2631220294

12	Devbhumi Dwarka-Khambhaliya	Dr. Narander Kumar Meena	(O)02833232804	2833232102
13	Gandhinagar (079)	Shri S. K. Langa	(O)079-23220630	7923259040
14	Gir-Somnath-Veraval (02876)	Shri Ajay Prakash	(O)02876240001	2876243300
15	Jamnagar (0288)	Shri Ravi Shanakar	(O)02882555869	2882555899
16	Junagadh (0285)	Dr. Pardhi Sourabh Zamsingh	(O)0285-2630100	2852635599
17	Kachchh (02832)	Ms. Remya Mohan Moothadath	(O)02832250020	2832250430
18	Kheda (0268)	Shri S.B. Patel	(O)0268-2553334	2682553358
19	Mahisagar-Lunavada (02674)	Shri R.B. Barad	(O)02674-250664	2674250655
20	Mehsana (02762)	Shri H K Patel	(O)02762222211	2762222202
21	Morbi (02822)	Shri R. J. Makadia	(O)02822-240701	2822240701

22	Narmada-Rajpipla (02640)	Shri I.K. Patel	(O)02640222161	2640222171
23	Navsari (02637)	Dr. M. D. Modia	(O)02637-244999	2637281540
24	Panchmahal (02672)	Shri Udit Agrwal	(O)02672-242800	2672242899
25	Patan (02766)	Shri Anand Babulal Patel	(O)02766233301	2766233055
26	Porabandar (0286)	Shri M. A. Pandya	(O)0286-2221800	2862222527
27	Rajkot (0281)	Dr. Rahul Babubhai Gupta	(O)0281-2473900	2812453621
28	Sabarkantha (02772)	Ms Praveena D.K.	(O)02772-241001	2772241611
29	Surat (0261)	Dr. Dhaval Kumar Patel	(O)0261-2652525	2612655757
30	Surendranagar (02752)	Shri Kankipati Rajesh	(O)02752-282200	2752283862
31	Tapi-Vyara (02626)	Shri R.S. Ninama	(O)02626224460	2626221281
32	Vadodara (0265)	Ms. Shalini Agarwal	(O)0265-2433000	2652431093
33	Valsad (02632)	Shri C.R. Kharsan	(O)02632253613	2632243417

21.2 District Level Authorities

District Collector Office
Near Circuit House, Mandvi Road,
Nr. Mota Bandh,
Bhuj,
Gujarat - 370001

- +91 2832 250650
- +91 2832 250430
- collector-kut@gujarat.gov.in

Emergencies

District Helpline
Call : +91 2832 1077
District EOCs Helpline No.
Call : +91 2832 250650

Commissioner of Rescue & Relief
Call : 1070

Shri R. M. Thakkar Dy. Mamlatdar Disaster +91 2832 250923

MP Bhuj		252595	251177
Dy. Collector, Anjar Mob. 9825228049		243345	243363
Shri N. C. Rajgor Mamlatdar, Anjar +91 2836 242588 mam-anjar@gujarat.gov.in		242588	243362
Shri J. S. Sindhi (I/C) Mamlatdar, Gandhidham +91 2836 250270 mam-gandhidham@gujarat.gov.in		250475 250270	222875 250475

Collector, Jamnagar		2555869	2554059
Collector's Control Room, Bhuj. **Mehul Padharia Kutch District Project Officer Officer 02832- 252347 09557920767 02832- 224150 mehul.nitb04@gmail.com District Project Officer Disaster Risk Management Program, District Emergency Operation Center(DEOC) , Emergency Operation Branch, Collector Office, Kutch**		2252347 2231733 02832- 252347 09557920767 02832- 224150	-
Doordarshan, Bhuj		2251107	
Dy. Mamlatdar, Gandhidham		250475 250270	
Civil Defense, Gandhidham		220221	
PGVCL, Gandhidham		221728 222809	
GW&SB, Gandhidham		220975	
GSRTC, Gandhidham		220198	
Duty Officer, All India Radio, Bhuj		222503	
State Information Dept. (Shri Antani)		224859 250954	253034 252855
Air Force Duty Officer, Bhuj		252501 252502	
Air Force, Bhuj		223450	
Air Port, Bhuj		254550	
Aerodrome Officer, Kandla		238370	223247
Indian Navy, Jamnagar		550263 to 5	550825
Air force, Jamnagar		550245 to 7	550247

21.3 List of Telephone Numbers of Gujarat Maritime Board

Sr. No.	Name, Designation and place of Office	Tele. No. (Office)	Tele. No. (Residence)	Fax No.
1	Chairman, G'nagar	23250508 23250506		079-23250589
2	VC&CEO,Gandhinagar	23238363	23262280	23234703
3	Chief Nautical Officer, Gandhinagar	23238346-47		-do-
4	Chief Engineer(C), Gandhinagar	23238346		-do-
5	Officer on Special Duty, Gandhinagar	23238346	079-2323232	-do-
6	Exe. Asst. to VC&CEO,	3238363	7451465	-
	Gandhinagar			
7	Head Office, G'nagar	3238346 to 8	-	34703/04
8	Port Officer, Magdalla	0261-2470533	-	2475645
9	Port Officer, Bharuch	02642-241772	229082	220377
10	Port Officer, Bhavnagar	0278-2519221	2568580	2211026
11	Port Officer, Jafrabad	02794-245165		245152
12	Port Officer, Porbandar	0286-2242408	2242412	2244013
13	Port Officer, Veraval	02876-220001	242956	243138
14	Port Officer, Okha	02892-	262010	262002

		262001		
15	Port Officer, Jamnagar	0288- 2755106	2557163	2756909
16	Port Officer, Navlakhi Main Gate	02822- 220435		232470
17	Port Officer, Mandvi	02834- 220033	220040	230033
18	Traffic Inspector, Mundra	02838- 222136	222136	-
19	Executive Engineer(C), Jakhau	02831- 287261	222996	-
20	Gujarat Pipavav Port Ltd., Chief Operating Officer, Duty Office	02794286314 86001/92	286070	-
21	Gujarat Adani Port Ltd., Mundra.	02838- 288201 to 8	287241	-

21.4 For supply of Food Packets etc. following agencies to be contacted.

Sr. No.	Name of Agency	Contact Person	Telephone No.
1	Arya Samaj Mandal	Mr.Vachanidhi	231223 Mob. 9824221332
2	Agrawal Samaj	Mr.Dinanath	231638
3	RSS	Mr. Sunil Kothari	222560 / 232909
4	Lions Club, Gandhidham	Mr. Naresh Bulchandani	220212 Mb: 982428470

5	Rotary Club, Gandhidham	Mr. Rajabhai / P.K. Mukherjee	228213 / 232035
6	Red Cross Society	Dr. Bhavesh Acharya	234854, 232736
7	Lohana Mahajan, Gandhidham	Mr. Premji Bhai Thakker	220925
8	Rajasthan Yuva Mandal	Mr. Sunil Bajaj (President) Mr. Dilip Jain	221459 / 230902 234525 / 9825168170
9	Swaminarain Mandir	Mr.Lavjibhai Thackker	231555, 233666
10	Sindhi Youth Circle	Mr.Vijay Khubchandani & Mr.Kundabhai	220490
11	Satwara Samaj	Mr.Agavjibhai	235659
12	Sitaram Parivar	Mr.Mohanbhai Dharsi	222373, 234603
13	Gurudwara, Gandhidham		220643
14	Swaminarayan Gurukul	Swamimukta Prasadji	228098, 226555

21.5 Apart from the above, if required, the following hotels may be contacted for the supply of food packets:-

Sr. No.	Name of Hotel	Contact Person	Telephone No.
1	Shiv	Mr. Nagendra Singh / Mr. Bharat Singh	237712-13-14-15, 221297
2	Sharma Resorts	Mr. Madan Mohta / Mr. J. Gonasaives	31824/231823/231825/ 224885-86-87-88-89

3	Satkar	Mr. Babu Bhai Agrawal	234100/222597 234101 (R)
4	Natraj	Mr. Maulinbhai Acharya	221749/221956/221955 221954/238002
5	President	Mr. Rameshbhai	220053/229364/238002
6	K.K.Caterers	Kaniyalal Rajwani	(O) 227419, (R) 224995, (Mob) 9825226998
7	Bhawani Caterers	Mr. Hukamsinh Purohit	230366(PP)
8	Hotel Mid-Town, Adipur	Mr. Nagendra Singh	9825226568 260237/260080
9	Hotel Sea-Rock, New Kandla	Mr. Vithal Shetty	270490

21.6 List of Labour contractors operating at Kandla Port

Sr. No.	Name of the Company	Contact person	Address	Contact Nos
1	Neelkant Handling A/c Shree Radhey Shipping	Haresh Bupendra	Tenament B Plot 290,Ward 10/A, G'dham	237040 9825001743
2	Ratnakar Handling A/c Aditya Marine	Radhakishan Parida	83-84, GIDC G'dham	9879123371
3	Tirupati Handling Co.	Dayalal B. Rabari	6-8, Goyal Chamber, GIM	235504 9825056599

4	Al Pirani Al Sailani	Akbar Yakub	CS-10, Port Colony, Kandla	22053,232174 9979331100 9825787808
5	Shree Ravechi Handling A/c Trinity Shipping	Mahadeva Agaria	11,2nd Floor, Plot.343, Ward 12- B, GIM	250286 9825361347
6	Shree Ramdev Handling	Nimbaram Gulabji	377, Sector-7 GIM	9825348935 9979898564
7	AVB & Co	Mukesh Gujjar	15, GF, Gokul Park, GIM	232967
8	Ashapura Labour Supply	Khimji Jallabhai Rathod	48, GIDC, Near Ambika Weigh Bridge, GIM	9979053378 9898128069
9	Shree Krishna Handling	Harinder Yadav	E – 108, GHB ,Sec-5,GIM	9879549803
10	Naasmin & Co	Umar Osman Chamadia	Plot – 14, Sector-7, GIM	9898333397
11	M.S. Logistics	Asgar Haji Mungrani	Shop No. 5, Opp.CISF Gate,Kandla	9825241065 9913620407
12	Shree Majeesa Handling	Jugal Kishor Joshi	Block 24, MIG, Kidana, GIM	9879373992 9979898564
13	Shree Kailash Handling Co.	Mohanbhai Heera	Plot No. 7, Sector-8, GIM	9825228555 9879288875
14	Javed Abu Saicha	Javed Abu Saicha Gani Patel	Shop – 13, Port Colony,	9825092748 9825563094
			Kandla	

15	Shree Ganesh Handling	Dayabhai Rabari	6-8, Goyal Chamber, GIM	9825056599
16	Bhupendra & Co	Mayur M Ahir	Plot 253, Ward 12/C, GIM	9727762191 9825225239

21.7 List of Doctors in Gandhidham Complex

Sr No	Name of Doctor	Telephone	Telephone	Mobile No
Consulting Physician (MD Medcine				
1	Dr. Babita	261802	322111	
2	Dr. Gandhi C. K.	234561	230111	
3	Dr. Gonsair R. M.	230333	239944	
4	Dr. Johnson Samuel	222344	232244	
5	Dr. Morkahia V. L.	222008	232161	
6	Dr. Raiyani V. R.	230022	234214	9824241220
7	Dr. Sakaria S. B.	230114	230947	
8	Dr. Siju	230160	223852	
Dentist				
1	Dr. Asha Y. Parekh	234295	234451	
2	Dr. Ajay Bhimjiani	233347	260256	982544118
3	Dr. Chadotra M.	220142	237909	
4	Dr. Hitesh Sheth	226763	220965	
5	Dr. Kela B.V.	222094	231181	
6	Dr. Sanghvi V.K.	234979	223343	
7	Dr. Sharma R.	229211	227627	
8	Dr. Singh N.	230769	261343	

9	Dr. Soneta S.	236319	229172	
Dermatologist				
1	Dr.Jhala J.J.	223568	235567	
2	Dr. Deepak Sorathia	242882		9426909822
E.N.T. Surgeon				
1	Dr. Dave A.B.	221931 260394	260461	
2	Dr. Harani D.D.	222096	239121	9825227322
3	Dr. Khatri R.S.	222701	235959	9879195798
4	Dr. Maheswari S.K.	231874	250940	
M.B.B.S				
1	Dr.Acharya B.F.	220715	232736	9825210157
2	Dr. Acharya C.M.	220263		
3	Dr. (Mrs.) Acharya S.C	232606		
4	Dr. Agarwal B.B.	227767	570212	9825225599
5	Dr.Asher G.K.	239139	233765	
6	Dr. Bhadra D.M.		230259	
7	Dr. (Mrs.) Bhatia K.	260255		
8	Dr. C. Jonwal	220263	263987	
9	Dr. (Mrs.) Chellani	220099	270441	
10	Dr. Chudasama V.K.		240952	
11	Dr.Dasani M.G.	260001	261495	
12	Dr. Goswami S.K.	261399		
13	Dr. Guptabhaya D.N.	221305	231777	
14	Dr. Gurdasani V.S.	260674		
15	Dr. Harani H.C.	235369	239327	

16	Dr. (Mrs.) HitemathU.S.	261844	260097	
17	Dr.Joshi N.L.	260666	261661	
18	Dr. Kela H.V.	232069	232071	
19	Dr. Khushlani A.	260562	260738	
20	Dr. Leon A.	261802	262188	
21	Dr. Makwana	220263	263406	
22	Dr. Minocha Ravi	236306	232127	
23	Dr.Mehta H.K.	231590	235021	
24	Dr. Mehta J.R.	220164	220834	
25	Dr. Morbia V.M.	230011		
26	Dr. Parekh S.K.	260608	261123	
27	Dr. Puri R.P.	223355		
28	Dr.Rawal S.	235119		
29	Dr. Singh D.P.	221990		9825359928
30	Dr. Thakkar A. D.	220582	222829	
31	Dr. Thakkar H. M.	223506	222350	
32	Dr. Thakkar M. C.	260577		
33	Dr. Thakkar S. B.	221046 228267 221177	238467	
34	Dr. Vaccharajani N. D.	220088		
35	Dr. Vasudev Jethani	260577	261650	
36	Dr. Vora C. B.	223084		
37	Dr. Vadhwani Vjay	262076	262843	
38	Dr. Zola Mithubhai	260608		
39	Dr. (Mrs.) Raiyani P.V.	230022	234214	

40	Dr. (Mrs.) Singh R. D.	221990		
General Surgeon				
1	Dr. Ahir J. K.	237744		
2	Dr. Dasani D. G.	229231 227505	223346	
3	Dr. Gandhi R. G.	236700	229156	
4	Dr. Girdhani R. C.	233300	231219	
5	Dr. Jiladiya A.	220263	244844	
6	Dr. Joshi Y. V.	221557 230013	233324	
7	Dr. Naik S. K.	234333	231332	
8	Dr. Patel J .K.	230007		
9	Dr. Vora Chetan	224787	229369	9825225942
Obstetrician & Gynecologist				
1	Dr. (Mrs.) Acharya N.B.	220715	232736	9825226700
2	Dr. Alpa D. Mehta	262599	265266	
3	Dr. Chandrakant Thacker	224488	225588	
4	Dr. Darshak Mehta	220263	265266	9824211534
5	Dr. (Mrs.) Gor A. A.	235135	239635	
6	Dr. Khanchandani	260833	260839	
7	Dr. (Mrs.) Kaur J. P.	229655	220673	
8	Dr. (Mrs.) Naik P. S.	234333	231332	
9	Dr. (Mrs.) Patel M. H.	230202	230353	
Ophthalmic Surgeon				
1	Dr. Gor A.	235135	239635	
2	Dr. Masand S. N.	220139	234187	9825196989

3	Dr. Parikh Y. B.	234295	234451	
Orthopedic Surgeon				
1	Dr. Hotchandani	220039	261530	
2	Dr. Patel H. A.	230202	230353	
3	Dr. Sailesh Ramawat	230160		
4	Dr. Vachhani P. S.	230400	222400	
Pediatrician				
1	Dr. Dubal J. A.	232591	233777	
2	Dr. Jeswani R. M.	255689		9825229249
3	Dr. Majithiya M. S.	222413 222406	227134	
4	Dr. Rupesh Seth	260836	222397	
5	Dr. Naveen Thacker	230195	230894	
6	Dr. Nitin Thacker	221046	220615	
Pathologist				
1	Dr. Sukla K. L.	221611	234062	
2	Dr. (Mrs.) Pawde S. V.	230370	231352	
3	Dr. (Mrs.) Verma G. H.	229168	238386	
		Psychiatrist		
1	Dr. Barot S.	221041	234885	
		Radiologist		
1	Dr. Shah R. M.	222878 234215	222868 235868	
2	Dr. Bhupendra Shah	572824	227724	

21.8 List of Essential Services

HOSPITALS	OFFICE	RESIDENT

1	General Hospital, Bhuj Civil Surgeon, Bhuj	222850	250554
2	Referal Hospital, Anjar	232455	
3	Rambaugh Hospita Gandhidham	220263	
4	Divine Life, Adipur	261802	
5	Railway Hospita Gandhidham	231874	
6	Government Dispensary dipur	260608	
	TELECOMMUNICATION		
1	General Manager, BSNL, Bhuj	253000	252322
2	Dy. Manager, Bhuj	252505	251505
3	Area Manager, Gandhidham	238000	235000
4	SDO, Gandhidham	236250	236251
	ELECTRICITY		
1	S.E., PGVCL, Bhuj	222550	250189
2	Jr. S.E., Anjar	243008	242656
3	XEN, Anjar	242845	242446
4	Dy. Engineer, Gandhidham	222809	--
5	Line Office, Gandhidham	221728	
	WATER SUPPLY		
1	S.E., GWS&SB, Bhuj	221806	250601
2	XEN, Bhuj	250685	253016
3	SE, Anjar	242416	242421
4	XEN, Gandhidham	220717	223273
5	Control Room, Gandhidham	221252	

6	Water Tank, Sunderpuri	231313	
7	Water Tank, NU-4	654564	
8	Gandhidham Municipality	231610	
9	Chief Officer, Gandhidham Municipality	234967	

21.9 List of Vehicle Suppliers

Sl. No	Name of Institution	Contact Person	Parking Place Phone No.	Name and Phone No. of Driver	Availability of Vehicle.
(A) Vehicle Hire Contractors					
2	M/s Rohit Enterprise /RISHABH ENTERPRISE	Mr. Rohit Shah 228550/237538 237547 (O) 234140 (R) Mob.9825225121			
3	M/s Jai Somnath Travels (GIM)	Mr. Mishra Mob.9825386739			
(B) Ambulance Pool					
01	St. Joseph Hospital, Gandhidham	Administrator 230160/229336	Hospital Premises	Driver available round the clock	First come first serve

02	IFFCO-Kandla on contract, Dispensary No. 20164 Dr. Mehta (R) 220832 Plant. Dispt. 270832	Mr. Mukesh Agrawal Hotel Gokul 221311			First come first serve
03	Kandla Salt Mfg. Ass. Neelkanth Bldg.	Mr. Shamji Ahir 231485 (R) 222765/220421 (O)	Zanda Chowk	Driver available round the clock	First come first serve
04	Zhulelal Mandir Trust	Mr. Kundan Guwalani 221760 (R) 229800 (O) Kundan Stores 221533/227800 229580	Mandir Premises	255580	
05	Red Cross Society	Dr. B F Acharya 225636/230345	Red Cross	Driver available round the clock	
06	Western Railway, Gandhidham	Medical Supdt. 231874 (R)	Hospital		
07	Rambaugh Government Hospital	220263	Hospital Premises	Driver available round the	
				clock	

08	Gautam Frei Pvt Ltd.	Mr. Ramesh Proprietor 232605/220163, 230345 (O)	GIDC Work shop Sector10C, Plot No. 24.		First Come First Serve
09	Sindhu Sewa Samiti Trust, Adipur	Mr. Jotwar (R) 260836, 260698 TBX-45, Adipur	Hospital Premises	Driver round the clock residence in hospital (Break duty at present)	
10	Tolani Eye Hospital	1. Supdt (O) 260497 (R) 260773 2. Vic Chairman (C 260373 Mr. N Chandnani (R) 260456, Prabhu Chaya, Behind Prabhu Darshan	Hospital Premises	One driver in absence of compounder residing in hospital	First Come first Serve
11	Divine Life r Society, Adi	261802	Hospital Premises	Round the clock	
12	Atmaram Severam Charitable Trust	237759 Mob 9825225294	Gandhidham	Round the clock	
13	Dev Smru Trust	222096/231073			

14	Mobile Morgue	229430/239965	Lions Club		
15	Shav Vahini/Mobile Mrogue	239965			

21.10 List of Clearing & Forwarding Agents at Kandla

A V Joshi & Co Tel. 232605, 232227, 230345	C. Jivram Joshi & Sons (Gujarat) Tel. 220621 Fax. 231141

Fax. 233924 Mr. Harshandu Mr. Vaidya (Mob.) 9825226013	Mr. Sunil Chowdhari (Mob) 9825225400
ACT Shipping Ltd Tel. 270111/12/13, 270530, 220407 Fax. 270579, 232175	Cargo Movers Tel. 220453, 230883, 270563 Fax.231687
A. Jaswantrai & Co. Tel. 222630, 222717, 222145, 221943 Fax. 232308, 270385	Cargo Clearing Agency (Gujarat) Tel. 221721, 221674, 220655, 270542 Fax. 233034
Asia Shipping Services Tel. 230954. Fax. 231285	Chinubhai Kalidas & Brothers Tel. 232284 Fax. 231881
Airol Shipping Services Tel. 230080, 220180. Fax. 236131	CAP Shipping Pvt Ltd Tel. 221460, 232081 Fax. 233734
Aarpee Clearing Agency Tel. 222614. Fax. 255252	Centrans Shipping Agency (I) Pvt Ltd Tel. 256854 Fax. 234074
Ashirwad Clearing Agencies Tel. 232426, 233245 Fax. 234107	Cargo Shipping Tel. 270802, 270803 Fax. 270802
Ambalika Enterprises Tel. 255382. Fax. 255577	C. Joshi & Sons Tel. 221094

Ashmka Shipping (Tel. 222481)	Dilip A Goplani Tel. 224082, 255423 Fax. 224082
Ashis Enterprise (Tel. 234722)	D.B.C. & sons Gujarat Pvt Ltd Tel. 270263, 270348, 270503 Fax. 270631
Anchor Shipping Tel. 235781 Fax. 235781	Damjidhiroo & Sons Tel. 222329, 221328 Fax. 230139
B N Thakkar & Co., Tel. 222293, 222285, 270239 Fax. 230556	Dvji Premji Punara & Sons Tel. 222057, 221338 Fax. 230139
B. Devchand & Sons Pvt Ltd Tel. 232220 Fax. 234014	Express Transport Pvt Ltd Tel. 220193, 220179, 270591, 222565 Fax: 220193
Benits Forwarders Pvt Ltd Tel. 221707, 222086 Fax. 223151	Friends & Friends Shipping Pvt Ltd Tel. 232227, 231588 Fax. 233924
Blue Sea Shipping Agencies Tel. 235317 Fax. 255221	Fast & Fair Company Tel. 255254, 238175 Fax. 255254
Bhanu Clearing Agency Tel. 256861 Fax. 256861	Flamingo Shipping & Forwarding Pvt Ltd Tel. 256755, 257756 Fax. 256755
Global Marine Agencies Tel. 222928, 223196, 223252 Fax.255418	Liladhar Passoo Forwarders Pvt Ltd Tel. 252288, 252297, 252402, 252617 Fax. 252383
Gayatri Shippers Tel. 230692, 223292 Fax. 230818	Lalbahi Trading Company Tel. 222139

Hiral Enterprise Te. 255644	Leap Forwarders Pvt Ltd Tel. 255530, 255509 Fax. 252383
Hindustan Shipping services Tel. 255644, 222821 Fax. 256618	Link International Tel. 255206/07 Fax. 255530

Hardip Shipping Logistics Pvt Ltd Tel. 232909, 222560 Fax. 232909	Lexicon Shipping Agencies Pvt Ltd Tel. 229951-53 Fax. 229949/50
Hansraj Pragji & Sons Tel. 221650, 255228 Fax. 255228	Logistics Enterprise Pvt Ltd Tel. 255157, 255458 Fax. 255520
H K Dave Pvt Ltd Tel. 221504, 2333632 Fax. 230411	Mathuradas Narndas & Sons Forwards Pvt Ltd, Tel. 252224, 252350, 252115 Fax.252221
Intralink Clearing & Forwarding Tel. 255188 Fax. 23148	Magal Singh & Company Tel. 224030, 255253, 234688
J M Baxi & Co. Tel. 270630/35, 270148/50, 270525 Fax. 270616	Meridian Shipping Services Tel. 233981, 255362 Fax. 230701
Jesia Mistry Agencies Pvt Ltd Tel. 222317, 223317	Megha Shipping Agency Tel. 222671, 255304 Fax. 230937
Jaisu Shipping Company Pvt Ltd Tel. 270428, 270128/538 Fax.270556	Mayur Forwarders Pvt Ltd Tel. 222671, 255304 Fax. 230937
Jivanlal Laloobhai Tel. 220308, 230530 Fax. 231640, 233803	Maritime service Pvt Ltd Tel. 222671, 255304 Fax. 255304
Krishna Clearing Agency Tel. 223813, 230501 Fax. 233135	Marathon Shipping Combine Tel. 222202, 230106 Fax. 255220
Kiran Roadlines Tel. 232297, 231984, 234108 Fax.231422	Shiv Shipping Service Tel. 255568 Fax. 22256
Kandla Clearing Agency Pvt L td Tel. 232337, 223211, 223210 Fax.230402	Narendra Forwarders Pvt Ltd Tel. 232504, 231795 Fax. 256678
Kamat & Co. Tel. 223471, 232730, 232729 Fax. 255243, 270779	Natwar Parikh Industries Ltd Tel. 232628 Fax. 232628

K S Chaya & Co Tel. 256604 Fax. 230693	New Dholera Shipping & Trading Company Limited. Tel. 222637 Fax. 255329
Kashyap Shipping Ltd Tel. 220816 Fax. 230030	National Shipping Tel. 232319 Fax. 232319
Kanak Shipping & Transport Tel. 231314, 230543, 222059 Fax.221702	Navjeevan Enterprise Tel. 252611, 252360 Fax. 252515
IEE & Muirhead Pvt Ltd Tel. 231535/36 Fax. 231018.	N. G. Bhanushali & Company Tel. 233648, 256791 Fax. 256879
OTA Kandla Pvt Limited Tel. 220145, 223241, 270450 Fax.223241	Shivji Kanji & Company Tel. 230127, 223728, 223729 Fax.220308
Pravin Bhatt & Sons Tel. 224032, 230079 Fax. 230079	South India Corp. (Agencies) Limited Tel. 234646, 231494, 221276, 255209 Fax.234416
Prime Forwarders Tel. 234047, 232505 Fax. 231345	S J Thacker & Company Tel.255678,221745 Fax.230659
Purshotam Ramjee & Company Tel. 220354, 222287 Fax. 231754	Star Shipping Services Tel.255424,255425,235326(F)255426
Patel Handling Agency Tel. 221718, 224024, 231004, 270017 Fax. 231143	Shivani Shipping, Tel. & Fax.256836
P S Bedi & Company Tel. 223201, 222841 Fax. 255494	Sea Trans Shipping Agency Tel. 255564 Fax. 233228, 233517
Purshotam Chtrabhuj Thacker Tel. 222720	Seaster Shipping Services Tel. 255349 Fax. 232719
Prashant Shipping Tel. 255306, 223927 Fax. 223927	Seaway Shipping Services Tel. 234272 Fax. 232719

Pramukh Forwarders Tel. 255400 Fax. 232602	Star Clearing Agencies Tel. 230273, 255529, 222983 Fax.232719
P M Agency Pvt Ltd Tel. 232553, 233973, 236414 Fax.255413	S S Shipping Agencies Tel. 236605, 238283 Fax. 236605
Raj Shipping Service Tel. 233948, 232402 Fax. 231395	SPN Shipping Services Tel. 222453, 270733 Fax. 236605
Rajesh Shipping Service Tel. 255444, 255450/52, Fax.255151	Sierra Shipping Pvt Limited Tel. 255395 Fax. 232771
Rudra Shipping Service Tel. 220429, 255317 Fax.255317	Sonal Enterprises Tel. 252666, 252053
Rishi Shipping Tel. 220813, 229830, 2555661/2/3 Fax. 238943, 255522 Mr. B K Mansukhani (M)9825225170	S R Clearing Agency Tel. 232974, 255494 Fax. 255494
Rudraksh Shipping Service Tel. 235937 Fax. 255582	St. John Freight System Limited Tel. 235414, 236444 Fax.235414
Sanghvi Freight Forwarders Pvt Ltd Tel. 234993, 234995, 222401 Fax.230508	Siddi Shipping Services Tel. 232356, 230268 Fax.256712
Sri R K Shipping Pvt Ltd Tel. 232028, 231940, 231936 Fax. 232740	Spalsh Shipping Pvt Limited Tel. 255562, Fax. 220710
Shakti Enterprises Tel. 223531, 221591 Fax. 233898	Thakarshi Madhavji & Sons Tel. 255457, 255458 Fax. 221770
Shree Ambica Commercial Company	Trinity Shipping & Allied Services Pvt
Tel. 220213, 221253	Ltd Tel. 223703, 230911 Fax. 232060

Shri Maruti Shipping Services. Tel. 270760, 256853, 233245 Fax.220308	Tokto Shipping Services Tel. 234040
Unity Shipping Tel. 255271	Vinson Tel. 220466 Fax. 231948
Umiya Shipping Agency Tel. 255640 Fax. 233625	Vaz Forwarders Ltd Tel. 235317 Fax. 255221
Unique Forwarders Tel. 230080, 255417 Fax. 236131	Varsh Shipping & Travels Tel. 222386, 255300 Fax. 255300
V. Arjoon Tel. 221049, 221335, 222058, 223307 Fax. 234167	Venus Clearing Agency Tel. 233960 Fax. 233362
Velji Dosabhai & Sons Tel. 270220, 270025, 221818, 231423 Fax. 270164, 232363	Vishal Shipping & Handling Tel. 223960 Fax. 233362
Vishvajyoti Enterprises Tel. 252381, 252318 Fax. 253091	Worldwide Cargo Care Pvt Ltd Tel. 221290, 221479, 220307, 230217 Fax. 231913
Velji P & Sons Tel. 255327, 231545, 231546, 270976 Fax. 255328	Zenith Trade Link Tel. 223193 Fax. 255522
Vailash Transport Co. Tel. 233579, 223580	

21.11 Surveyors at Kandla

Adnuralty Marine Services Tel. 235412, 256813 Fax. 256813	Marine Consultants & Surveyors Pvt Ltd Tel. 255293 Fax. 234416
Capt. S. Kochar & co. Tel. 222247, 221084 Fax. 231357	Murray Fenton (India) Surveyors Limited Tel. 235960, 236238 Fax. 233335

Dr. Amin Superintendents & Surveyors Pvt Limited, Tel. 221520, 235636 Fax. 226527	M. M. Cargo Gear & Marine Surveyors Tel. 231385 Fax. 235255
Det Norske Veritas (DNV) Tel. 232712	M.BS. Surveyors Tel. 256782
Geo-Chem Laboratories Pvt Limited Tel. 221841, 222179 Fax. 233743	Navark & Mareng Surveyors & Consultants Tel. 232123, 233270
G. P. Dave & Sons Tel. 234288 Fax. 234382	S.G.S. India Limited Tel. 221857, 238047, 231869 Fax.232883
Gupta & Associates Tel. 222542 Fax. 222542	S. K. S. Surveyors Assessors Tel. 220555
Inspectorate (India) Consulting	Seascan Surveyors Pvt Limited
Engineering Pvt Limited Tel. 221520, 235636 Fax. 255217	Tel. 221833, 233639, 221627 Fax. 233639
Indian Register of Shipping & Indian Register Quality System Tel. 238623, 233695 Fax. 233695	Sterling Surveyors Tel. 230216 Fax. 230216
Iteng Engineering Tel. 221520, 255429 Fax. 255247	Technomar Surveyors Pvt Limited Tel. 221966
J B Boda Surveyors Pvt Limited Tel. 231801, 231946 Fax. 231693	TCRC Surveyors Tel. 220862, 230050 Fax. 230050
Lloyds Register of Shipping Tel. 234068	Uni Lab (India) Surveyors and Superintendents Tel. 255503
Mitra S K Pvt Limited Tel. 222648	Universal Cargo Inspection Agencies Tel. 222542

Metcalfe Hodgkinsons Pvt Limited Tel. 220940, 221740, 233707, 221845 Fax. 231629	U Marine (India) surveyors Tel. 220070 Fax. 233228

ANNEXURE-I

PARTICULARS OF THE ACTION PLAN COMMITTEE MEMBERS

Sr. No	Name	Desgn.	Telephone Nos.			
			Office	Resi.	Fax	Mobile
1	Mr SANJAY MEHTA, IFS	Chairman	233001 234601	233002	235982	
2	Mr.	Deputy Chairman	234121	234218	236323	
3	Capt. T. Srivnivas	Dy. Conservator	233585	232806	233585	98252 32982
4	Mr. A. Krishnan	Dy. FA & CAO	220214	223854	-	98252 27036
5	Mr. R. V. Rajwani	Dy. FA & CAO	221648	226112	-	98793 70975
6	Mr. AJAY GUPTA	Sr. DD (EDP)	239623	234116	-	98252 27095
7	Mr. Bimal Kumar Jha	Secretary	220167	231939	233172	81410 84794
8	Mr.	Sr. Dy. Secy	220033	234730	-	98252 27480
9	Mr. Suresh Balan	Dy. Secretary	221375	236086	-	98252 27044
10	Mr.	Sr. Astt. Secy	221679	-	-	82380 37207
11	Mr.	SE(H) and OSD(Estate)	270429	235683		98252 25963
12	Mr. Y. K Singh	Personnel Officer	223828	228584		98252 27079
13	Mr.	Traffic Manager				
14	Mr. S. Krupanand Swamy	Sr. Dy.TM	270270	235100		98252 27049
15	Mr. Shankar Jivaji	Deputy TM	270324	234918		94264 51554
16	Mr. D. N. Sondhi	FA & CAO	233174	-	233174	98252 14726
17	Capt. S. K. Pathak	Harbour Master	270201	231310		98258 03499
18						
19	Mr. Sunil Kumar	Flotilla Supdt.	270280	226121		78746 27756
20	Mr. K. Varughese	FCSO	270176/ 78	227512	270176	98252 27041

21	Mr. SSP PATIL	Chief Engineer	233192	228777	220050	98252 27243
22	Mr	C.M.E.	270632	231043		
23	Mr.	Dy. CME	270426	226067	270184	98252 35196
24	Mr. N M Parmar	DY CHIEF ENGINEER	270787	252624		98252 27046
25	Dr. Kalindi Gandhi	Chief Medical Officer	225767 220072	225555	232288	98256 11208
26	Dr. Mahesh Bapat	Sr. MO	234598	228167		96876 07528
27	Shri CHAUDHRI	Sr. Commandant CISF	271037	229140	271037	98252 27282

ANNEXURE – II

THE TELEPHONE NUMBERS OF SOME OF THE VIPS

Sr. No.	Name and Designation	Fax / Mobile	Telephone (Office)	Telephone (Resi)
1	District Collector, Bhuj	02832-250430	250020	250350
2	Resident Add. Collector, Bhuj	250430 9978405099	250650	
3	Superintends of Police, Bhuj,	99784 05073	250444 250250	250850
4	Asstt. Supdt. Of Police, Bhuj		253405	250850
5	Dy. Collector, Anjar	99784 05079	243345	243345
6	Mamlatdar, Anjar		242588	243362
7	Mamlatdar, Gandhidham.	75670 03975	250475 250270	222875 250475
8	Traffic Manager, IOC	234396	231871	236442
9	Air Force Commander, Jamnagar		2550245	-
10	Collector, Jamnagar		2555869	2554059
11	Commandant, BSF, Gandhidham		223845	
12	Mrs. Vinod Chawda, MP, Kachchh	02832 - 225466 9825905467		
13	Mr. Vasan Ahir, MLA, Anjar	9825025148		
14	Dr. Nimaben Acharya, MLA, Bhuj	9825226700	220715	
15	Mr. Rameshbhai Maheshwari,Gandhidham	9909910619		
16	Mr. Tarachand Chedda, MLA, Mandvi	9825225394		
17	Mr. Pankaj Mehta, MLA,Rapar	9825227883		
18	Mr. Shaktisinh Gohil,	95865 58120		

	MLA, Abdasa,			
19	Kum. Tulsi P. Anandani, SRC	260401	260404 260811	260631
20	Civil Surgeon, GK Gen. Hospital,Bhuj		222850	

ANNEXURE –III

IMPORTANT TELEPHONE NUMBERS OF
INDIAN METEOROLOGICAL DEPARTMENT

Designation	Address	Office	Resi.	Fax
Director General	Mausam Bhavan, Lodi Road, New Delhi.	011-24611842	011-24633692	011-24611792
		011-		011-24619167

D.D.G.M. (C.W)	-do -	24611068		
D.D.G.M. (WF)	Met Office, Simla Office, Pune	020-25535886	020-25884104	020-24623210 25893330 25535201
D.D.G.M.	RC Colaba, Mumbai	022-22150517	22150417	
Director (ACWC)	-do-	022-22150405	022-22150452	
Director (I/c)	Met Center Ahmedabad	079-22865012 22867206		079-22865449
Met I/C	MET Centre, Ahmedabad	22861413		
Dr. Jayanta Sarkar,	Director I/C.	22865165, 22867657		

Websites

www.imd.emet.in

www.imdmumbai.gov.in

DISASTER MANAGEMENT CELL

Chief Executive Officer,

9978407002(M), 079-3259276(O)

079-23254900(R)

079-3259248(FAX)

ANNEXURE-IV

TELEPHONE NOS. OF STATE MINISTERS

Sr. No.	Name and Designation	Telephone Numbers		
		Office	Residence	Mobile / Fax
1	**Mrs. Anandiben Patel,** Hon'ble Chief Minister, Block No.1, 5th Floor, Sachivalaya, Gandhinagar	O) 079 – 23232611- 19	(R) 079 - 23222020	(F) 079 - 23222101
2	**Mr Babubhai B. Bokhiriya**, Minister for Agri., Animal husbandary. Fisheries	079 - 23238109		079 - 23250133
3	**Shri Sankarbhai Chaudhry** Min. for Health & Family Welfare and Transport	079 – 23250193		079 – 23250145
4	**Shri Ramanlal Vora** Min. for Social Justice and Empower	079 - 23238078		079 - 23257973

	Department			
5	**Shri <u>Mangubhai C. Patel</u>** Forest and Environment, Tribal Development.	079 – 23250113		079 - 23250306
6	**Shri Bhupendrasinh Manubha Chudasma**, Education, Food and Civil Supplied.	079 - 23243389		079 - 23250120
7	**Mr Saurabhai Patel,** (Finance, Energy and Petrochemicals, Salt Industries, Tourism)	079 - 23238152	23250625	079- 23250215

OFFICIALS

Sr. No.	**Designation**	**office**		**Fax**
01	Chief Secretary, GAD	23220372		23250305
02	Principal Secretary, GAD	23250016		23222101
03	Addl. Chief Secretary, Port & Road Transport	23250506		23252132
04	Principal Secretary (Industries & Mines)	23250701		23250844
05	Principal Secretary (Labour & Employment)	23250871		
06	Addl. Chief Secretary (Home)	23250701		23250844
07	Principal Secretary (Energy & Petro-chemicals)	23250771		23250797
08	Principal Secretary (Finance)	23220286		
09	Principal Secretary (Revenue)	23251603		23251325

10	Principal Secretary (Education)	23251301		23251325
11	Chairman, GMB	23238346	23249356	

ANNEXURE – V

TELEPHONE NOS. OF GUJARAT STATE DISTRICT COLLECTORS

Sr. No.	District	Office	Residence
1	Ahmedabad	27551681	22863595
2	Amreli	222307	222301
3	Anand	242871	261000
4	Banaskantha	257171	257007
5	Bharuch	240600	223701
6	Bhavnagar	2428822	2568866
7	Dahod	221999	221888
8	Dang	220201	220202
9	Gandhinagar	23220330	23254884
10	Jamnagar	2555869	2554059
11	Junagadh	2651202	2650203
12	Kachchh	250020	250350
13	Kheda	2550856	2556700
14	Mehsana	222200	253565
15	Narmada	222162	222161
16	Navsari	244999	246000
17	Panchmahal	242800	242900
18	Patan	233301	233300

19	Porbandhar	2243800	2243801
20	Rajkot	2463900	2172900
21	Sabarkantha	241001	223001
22	Surat	2471121	2471416
23	Surendranagar	282200	282201
24	Vadodara	2433000	2313131
25	Valsad	253613	253060
26	Vapi	224400	220221

Control Room (Earthquake, Gandhinagar):

3251914 / 3251910 / 3240339 / 3240303 (Fax)

ANNEXURE – VI

GUJARAT STATE DISASTER MANAGEMENT AUTHORITY

TEL. NOS OF SENIOR OFFICIALS

Sr. No.	Name and Designation	Office	Residence	Mobile
1	Dr.Ranjit Banerjee, IAS, Chief Executive Officer, GSDMA	079-3259276 Fax.0793259248		9978407002
2	Mr V.Thirupuzzah,IAS, Addl. CEO, GSDMA	079-3259502 Fax.0793259275	079-6309273	9825095148
3.	Mr. H.N. Gamit,IAS, Director(Admn.)	079-3259278		9978407005

ANNEXURE –VII

DISTRICT LEVEL AUTHORITIES (EAST)

Name and Designation of Officer	Fax	Telephone Nos. (Office)	Telephone Nos. (Residence)
District Collector, Bhuj. 9978406212	250430	(02832) 250020	02832-250350
Resident Add. Collector, Bhuj Mob.9978405099	250430	250650	
Mr. Deepakkumar Menghani (IPS) S. P.-(Purab),9978405690		280233	
Mr. C.R. Kotad, GPS Dy. SP (Anjar)9825304239	243254		
Mr. D.R. Agrawat(GPS) Dy. SP(HQ)9825225071			
Mr. Chirag Patel,(GPS) Dy. SP.9824543004	0837-224040		
Control Room(DC-5)Purab	280287		
Mr. Vinod Chawda, M.P.,Kachchh		(m)	
Dy.Collector, Anjar Mob. 9825228049		243345	243363
Mamlatdar, Anjar Mob. 9879278174		242588	243362
Mamlatdar, Gandhidham 7567003975		250475 250270	222875 250475
Collector, Jamnagar		2555869	2554059
Collector's Control Room, Bhuj.		2252347 2231733	-
Dy. Mamlatdar, Gandhidham		250475 250270	9427719800
Civil Defence, Gandhidham		220221	

PGVCL, Gandhidham		221728 222809	
GW&SB, Gandhidham		220975	
GSRTC, Gandhidham		220198	
Duty Officer, All India Radio, Bhuj		221412	
State Information Dept. (Shri Sony) (m) 9879012714		224859 250954	253034 252855
Air Force,Duty Officer, Bhuj		252501 252502	
Air Force, Bhuj		223450	
Air Port, Bhuj		254550	
Aerodrame Officer, Kandla		238370	223247
Indian Navy, Jamnagar		550263 to 5	550825
Airforce, Jamnagar		550245 to 7	550247

ANNEXURE – VIII

List of Telephone Numbers of Gujarat Maritime Board

Sr. No.	Name, Designation and place of Office	Tele. No. (Office)	Tele. No. (Residence)	Fax No.
1	Mr. Rajgopal, Chairman, Gandhinagar.	23250508 23250506		079-23250589

2	Mr. A. K. Rakesh VC & CEO,Gandhinagar	23238363	23262280	23234703
3	Chief Nautical Officer, Gandhinagar	23238346-47		-do-
4	Chief EngineerI, Gandhinagar	23238347		-do-
5	Officer on Special Duty, Gandhinagar	23238346	079-2323232	-do-
6	Exe. Asst. to VC&CEO, Gandhinagar	3238363	7451465	-
7	Head Office, Gandhinagar	3238346 to 48	-	34703/04
8	Port Officer, Magdalla	0261-2470533	-	2475645
9	Port Officer, Bharuch	02642-241772	229082	220377
10	Port Officer, Bhavnagar	0278-2519221	2568580	2211026
11	Port Officer, Jafrabad	02794-245165		245152
12	Port Officer, Porbandar	0286-2242408	2242412	2244013
13	Port Officer, Veraval	02876-220001	242956	243138
14	Port Officer, Okha	02892-262001	262010	262002
15	Port Officer, Jamnagar	0288-2755106	2557163	2756909
16	Port Officer, Navlakhi Main Gate	02822-220435		232470
17	Port Officer, Mandvi	02834-220033	220040	230033
18	Traffic Inspector, Mundra	02838-222136	222136	-
19	Executive EngineerI, Jakhau	02831-287261	222996	-
20	Gujarat Pipavav Port Ltd., Chief Operating Officer, Duty Office	02794-286314 86001/92	286070	-
21	Gujarat Adani Port Ltd.,	02838-	287241	-

	Mundra.	288201 to 208		

ANNEXURE – IX

POLICE AUTHORITIES

Name and Designation of Officer	Telephone Nos. (Office)	Telephone Nos. (Residence)
PARIXITA RATHORE S. P. (Purab), 99784 05690	280233	
Dy. SP (Anjar)9825304239	243254	
Dy. SP(HQ)9825225071	243254	
Dy. SP.9824543004	224040	
Police Control Room,DC-5,Poorab, Gandhidham	280287	
Police Control Room, Bhuj	253593 / 250960	Fax – 250427

Dy. Supdt. Of Police, Anjar	02836-243254	242596
Dy. Supdt. Of Police – Bhachau	02837-224040	224020
Bhachau Police Station	02837-224036	
Anjar Police Station	02836 – 242517	242517
Gandhidham Police Station	A. 100/232500/ 229513 B. 233752	
Kandla Police Station	270527	
Adipur Police Station	260615	
Air Commander, Jamnagar	0288-2720003 -009	
Commandant, BSF, GIM	223845	
Air Force Commander, Bhuj	(02832)244005-10	
Army, Bhuj, C.O 128 AD Regmt	229239,229942	

ANNEXURE – X

For the supply of food packets etc., the following Agencies will be contacted:

Sr. No.	Name of Agency	Contact Person	Telephone No.
1	Arya Samaj Mandal	Mr.Vachanidhi	231223 / 9824221332
2	Agrawal Samaj	Mr. Sunil Sharma	234977
3	RSS	Mr. Sunil Kothari	222560
4	Rotary Club, Gandhidham	Mr. Samir shah	9825093732
5	Red Cross Society	Dr. Bhavesh Acharya	234854 / 232736
6	Lohana Mahajan, Gandhidham	Mr. J.P. Thakkar	9879109826
7	Marvaari Yuva Manch	Mr.Sunil Bajaj (President) Mr. Prashant Agarwal	9879015408
8	Swaminarain Mandir	Mr.Lavjibhai Thackker	231555, 233666
9	Gandhidham Sindhi Youth Circle	Mr.Vijay Khubchandani & Mr.Kundabhai	220490
10	Satwara Samaj	Mr.agavjibhai	235659
11	Sitaram Parivar	Mr.Mohanbhai Dharsi	222373, 234603
12	Gurudwara, Gandhidham		220643
13	Swaminarayan Gurukul	Swamimukta Prasadji	228098, 226555

Apart from the above, if required, the following hotels may be contacted for the supply of food packets:-

Sr. No.	**Name of Hotel**	**Contact Person**	**Telephone No.**
1	Grand Shiv	Mr Nagendra Singh	221297, 9825226568
2	Sharma Resorts	Mr Madan Mohta	31824/231823/231825/ 224885-86-87-88-89
3	Satkar	Mr Babu Bhai Agrawal	234100/222597
4	Natraj	Mr. Acharya	221749/221956/221955 221954/238002
5	President	Mr. Romesh	220053
6	K.K.Caterers	Mr. Kaniyalal Rajwani	(M) 98252 26998 (M) 98983 74896
7	Hotel Mid-Town, Adipur	Mr. Nagendra Singh	98252 26568 260237/260080
8	Hotel Sea-Rock, New Kandla	Mr. Devidas Shetty	270490

ANNEXURE – XI

LIST OF LABOUR CONTRACTORS OPERATING AT KANDLA PORT

Sr. No.	Name of the Company	Contact person	Address	Contact Nos
1	Neelkant Handling A/c Shree Radhey Shipping	Haresh Bupendra	Tenament B Plot 290,Ward 10/A, G'dham	237040 98250 01743
2	Ratnakar Handling A/c Aditya Marine	Radhakishan Parida	83-84, GIDC G'dham	98791 23371
3	Ganesh Handling Co.	Dayalal B. Rabari	6-8, Goyal Chamber, GIM	235504
4	Al Pirani Al Sailani	Akbar Yakub	CS-10, Port Colony, Kandla	22053 / 232174 99793 31100 98257 87808
5	Shree Ravechi Handling A/c Trinity Shipping	Mahadeva Agaria	11, Second Floor, Plot.343, Ward 12- B, GIM	250286 9825361347
6	Shree Ramdev Handling	Nimbaram Gulabji	377, Sector-7 GIM	9825348935 9979898564
7	AVB & Co	Mukesh Gujjar	15, GF, Gokul Park, GIM	232967
8	Ashapura Labour Supply	Khimji Jallabhai Rathod	48, GIDC, Near Ambika Weigh Bridge, GIM	9979053378 9898128069
9	Shree Krishna Handling	Harinder Yadav	Plot E – 108, Guj Housing Soceity,Sec-5,GIM	9879549803
10	Naasmin & Co	Umar Osman Chamadia	Plot – 14, Sector- 7, GIM	9898333397
11	M.S. Logistics	Asgar Haji Mungrani	Shop No. 5, Opp. CISF Gate,	9825241065 9913620407

			Kandla	
12	Shree Majeesa Handling	Jugal Kishor Joshi	Block 24, MIG, Kidana, GIM	9879373992 9979898564
13	Shree Kailash Handling Co.	Mohanbhai Heera	Plot No. 7, Sector- 8, GIM	9825228555 9879288875
14	Javed Abu Saicha	Javed Abu Saicha Gani Patel	Shop – 13, Port Colony, Kandla	9825092748 9825563094
15	Shree Ganesh Handling	Dayabhai Rabari	6-8, Goyal Chamber, GIM	9825056599
16	Bhupendra & Co	Mayur M Ahir	Plot 253, Ward 12/C, GIM	9727762191 9825225239

ANNEXURE – XII

LIST OF CIVIL ELECTRICAL AND MECHANICAL CONTRACTORS

Sr. No.	Name & Address of Contractor	Office	Resi	Mobile
1	Mr. Dilip Bhandbe, M/s Mukund Ltd.	223412		
2	M/s. Maheshwari Const. Co., SDX-N-5, Gandhidham-Kutch Mr Rameshbhai	232134		
3	M/s. Apex Engineers, Bajaj Chambers, 12/B, Gandhidham – Kutch (Mr. Vishal)	222002 222223		9898226666
4	M/s. Gadhvi Constructions, Plot No.524, Sector – 5, Gandhidham – Kutch	235772		9426215258
5	M/s. Advance Builders & Contractors, B-23, Apnanagar, Gandhidham – Kutch.		232864 234242	9825255934
6	M/s. Mohan Construction Co., 415, 2/B, Adipur (Mr.Mohan)		264140	9825174351
7	M/s. Star Decorators, 17, Plot No.5, 12/A, National Highway, Gandhidham – Kutch (Mr. Vinod Bajaj)	221450		
8	M/s. Kamal P. Chellani, DBZ-S-81-A, Gandhidham-Kutch (Mr.Kamal)			9825221542
9	M/s. K.K.Construction, E-71, Gujarat Housing Society,			230064

	Devi Krupa, Sector –5, Gandhidham (Mr Milanbhai)			
10	M/s. Mepabhai Madan, Plot No. 21/22, Sector-9, Opp. KPT Office, Gandhidham Mr Rajubhai	222209 222210		233627
11	M/s. S. B. Singh, B-110, Sapna Nagar, Gandhidham – Kutch	239351		
12	M/s. Dipesh Construction Co., 11, Apurva Chambers, Ganga Gate, Anjar – Kutch. (Mr. Parth) (Mr. Sukhdevbhai)	242997	243319	9824294260 9825179040
13	M/s. Raj Construction Co., Deepak Complex, Plot No.315, Ward 12/B, Gandhidham-Kutch Mr Rajesh Makhijani	220911		
14	M/s. M. V. Rajani,444, 2/B, Matruchhaya,Rambaugh Road, Adipur – Kutch (Mr. Narayan)	260800 262920		9825225690
15	M/s. Bhimji Velji Sorathia, 21, Nilesh Park, Plot No.80, Sector – 8, Near New Court Building, Gandhidham – Kutch (Mr. Bhimji Velji)	231383		9825225948
16	M/s. Sollone & Parco Engg. Co., CCX-165, Adipur – Kutch (Mr Ravi Solanki)	261298 263248		9825222919
17	M/s. Mahesh Construction,			

	Plot No. 415, 2/B, Adipur- Kutch (Mr. Mahesh)		264140	9825091599
18	M/s. Patel Construction Co. Zanda Chowk, Gandhidham (Mr. Tejabhai Kangad)	220421		9825227199
19	M/s. M. G. Bhavnani, Plot No.102, Sector 1/A, Gandhidham – Kutch			9825191636
20	M/s. Patel Engineering Works, Gandhidham	231832		
21	M/s. H.M.G. Gandhidham	235710 234609		
22	M/s. Mukund Limited Mumbai	022- 25347373		
23	M/s. Bajaj Electric Mumbai	022- 23724192		
24	M/s. Mishra Brothers Gandhidham	221172		
25	M/s. Sonu Electricals 18, K.P.Shopping Centre, Near Jivan Bharati School, Karelibaug, Vadodara-390018 Shri Jayendrasingh.B. Thakker	0265- 2464108	2647886	
26	M/s. Ravi Electonics, "Prashant", 20, New Jagnath Rajkot – 360 001 Mr. G.K.Patel	465256 460 253		
27	M/s Megha Technicals, CCX – 165, Adipur – Kutch (Mr. Ravi Solanki)	261298 263248		9375320232

28	M/s Maruti Construction, Gandhidham – Kutch			9824893851
29	M/s Ramesh Meghji Sorathia, Anjar – Kutch			9825225948
30	M/s Mohit Construction, B-168, Shaktinagar, Gandhidham – Kutch			9825227072

ANNEXURE – XIII

LIST OF SALT LAND LESSEES

Sr. No.	Name of Salt Works	Contact Person	Tel. No. Office	Tel. No. Residence
1	Asstt. Salt Commissioner, Gandhidham	Mr. Jagdish Tripathi	233670	263690
2	M/s. Kanoria Chemicals and Ind. Ltd., Plot No.220,	Mr. B. N. Singh, Mr. J. Singh	229470 0237-74433	283325 9825225841

	Sector –4, Gandhidham	Factory -		
3	Shree Krishna Salt Industries, Central Bank Compound, Gandhidham	Mr. Kantibhai Thakkar Mr. Vikash Patel Mb: 9825206214	234727 233990	235315 234089
4	M/s. Chirai Salt Works, DBZ-S-46, Jawahar Chock, Gandhidham.	Mr.Sureshbhai Mr.Parasbhai Mb: 9825225181 Mr.Mayajar	221109 221267 9826214709	234386 233081
5	M/s. Bhuveneshwari Salt Works, TCX-S-62, Gandhidham	Mr.Sreechandji Jain Mob: 9825222269	237114 235203	233605 236860
6	M/s. Dungershee Salt Works, Shop No. D-93, P.B.No.9, Gandhidham	Mr.Hiralal Parekh Mb: 9825019661 Mr. R.B.Agrawal Mb: 9825019662 Mr. Bhikhabhai (Salt Area)	222765 223440 9825225667	232767
7	M/s. Shree Laxmi Salt Allied Ind., "Shree Sadan", 207 / 12-B, Gandhidham	Mr. Rajubhai Rathi Mr. Rameshbhai Rathi Mob.: 9824214901	232167	232167 235482
8	M/s. Jyoti Salt Industries, "Sukh Sadan", Opp. Hotel President, Gandhidham	Mr.Acharya Sukhdevbhai Mr. Sukhdevbhai Acharya Mb: 9825226075	223776 221082 221089 223094	221876
9	M/s. New Kandla Salt and Chemical Co., "Maitri Bhavan", Plot No.18, Sector 8,	Mr. Ashokbhai Sanghvi Mr. Babulalji Sanghvi	232227 231588 234087	234325 231814 232122

	Gandhidham	Mb: 9825226091 Mr. Sukhrajbhai Mb: 98252 26011		
10	M/s. Kutch Salt Works, New Kandla	Mr. Mitenbhai Mb: 9825225990 Mr. S.P.Giria, Works Manager, Mb: 9825228085	234659 022-22040561 22041598 270371	238633

11	M/s. Vijay Salt Works and Allied Industries, "Friends House", P.No. 50, Sector –1A, P.B.No.106, Gandhidham	Mr. Harishbhai Chaturani Mb: 9825064241 Mr. Babulal Nahata Mr. Lalchandji Nahata	231119 252247 223743	234856 9825228398
12	M/s. Rajesh Salt Works, "Chandan Chambers" National Highway, Plot No.18, 12/A, Gandhidham.	Mr. Kishorbhai Thakkar Mob: 9825177081 Mr. Rameshbhai Mb: 9825226026	220586 221048 222301	234387
13	M/s. Western Chemical, DBZ-S-151, Gandhidham	Mr. Naranbhai Mb: 9825226092	233185 230913	230141
14	M/s. Urvakunj Nicotine Ltd., Central Bank Compound, Plot No.31, Sector No.9, Gandhidham	Mr. Mahendrabhai Patel – 9825206214 Mr. Vikash Patel Mb: 9825226214	234727	234480
15	M/. Friends Salt Works, "Maitri Bhavan", Plot No.18, Sector No.8, Gandhidham	Mr. Babulalji Mb: 9825226015 Mr. Ashokbhai Mb: 9825226091 Mr. Sukhrajbhai Mb: 9825226011	232227 231588 234087	231646 231814
16	Smt. Savitri H.Pandya, DBZ-N-21/A, Gandhidham	Mr. Jagdihbhai	220212 238112	255612

17	Smt. Vimlaben.H. Pandya, DBZ-N-21/A, Gandhidham	Mr. Jadishbhai Mr.Amritlal Pandya Mb: 9825225212	220212/ 238112/ 238212/ 255612 Fax: 222930	
18	M/s. Rajendra Salt Works, D-125, Jawahar Chowk, Gandhidham	Mr. Tarachand	-	-
19	Mr Natwarlal Agrawal, TCX-S-75, Gandhidham	Mr. Natwarlal Mb: 9825393555	222672	231564
20	Mr Indrumal Khubchand, C/o Gulab Salt Works, D-125, Jawahar Chowk, Gandhidham	Mr. Tarachand	233041 234388	234937
21	Mr Virji Khimji C/o Ajit Salt works, D-75, Gandhidham	Mr. Kirtibhai	220310	-
22	Mr Girdharilal.S. Agrawal, Plot No.126, Ward – 12/B, Gandhidham	Mr. Girdharilal	232862	234755
23	Mr Vijay Kumar.D. Palan & Mri Jagdish Kumar.D.	Mr. Navrotambhai Palan	220310	-
24	M/s. Satya Salt Works, DBZ-S-183, Gandhidham	Mr. Candubhai Mb: 9825225911	224055 221445	234739 234469
25	Shri Premji Gangji Soni,	Mr. Mahesh Soni	221263	-

	DBZ-S-183, Gandhidham			
26	Smt. Geetadevi P. Chaturani Plot No.13, Sector 1, Gandhidham	Mr. Romesh / Ashwin Mr. Dayalbhai Chaturani, Mb:9825064245	221048 256713 220586 256706 Fax: 222930	-
27	Shri Rashmin A.Pandya DBZ-N-21/A, Gandhidham	Mr. Jagdish Pandya	220212 238112 238212 Fax: 222930	-
28	M/s. Neelkanth Enterprise, DBZ-S-60, Gandhidham	Mr. Shamjibhai Mb: 9825 25711	220421 220103 Fax: 223560	231485
29	Dayalal G.Chaturani Shop No.1 to 4, "Chandan Chamber" Plot No.18, Ward No.12, Gandhidham	Mr.Dayal	221048 220588	-
30	Shri Chaganlal Punamchand, DBZ-N-197, Gandhidham	Mr. Chaganlal	220545	-

Annexure – XIV

LIST OF STEVEDORES AT THE PORT

Sr. No.	Name	Address	Fax No.	Telephone Nos.	
				Office	Resi.
1	M/s. Cargo Movers	"Cargo House" BBZS-32A, Gandhidham	231687	220453 231365	261280
2	M/s. DBC & Sons (P) Ltd.	Seva Sadan-II, Room No. 303 / 304, New Kandla	270631	270503 270263 270348	-
3	M/s. A.V.Joshi & Co.	Plot No. 18, Sector-8, Maitry Bhavan, Nr. Post Office, Gandhidham –Kutch	233924	231070 232227 231588	234909

4	M/s. Agarwal Handling Agencies	DBZ-N-47, Gandhidham – Kutch	232749	220282 233187	232749
5	M/s. ACT Shipping P. Ltd	Seva Sadan-II, Room No. 206/207, New Kandla	232175	270111 270112 270015 229967 231734	261308 231416
6	M/s. Cargo Carriers	214/215, Rishab Corner, Plot 93, Sector- 8, GIM	230030	220816 231649 230030	231694
7	M/s. Cargo Clearing Agency (Gujarat)	Plot No. 271, Ward 12-B, Gandhidham	233034	221721 220655	231452
8	M/s. Chotalal Premji Stevedores Pvt. Ltd	C-8, Shaktinagar, GIM	231509	270009	-
9	M/s. Hiralal Maganlal & Co.	C-11, GIDC Area, Gandhidham – Kutch	223914	223914 231832	223878 232430
10	M/s. New Dholera Shipping Company	Goyal Commerce Centre Building – 1, Plot No.259, Ward 12B, Gandhidham – Kutch	-	222637 232267	237284
11	M/s. J.M. Baxi & Co.	Seva Sadan – II, Room No. 301 / 306, New Kandla	270646	270630 270550 270448	260427
12	M/s. Pestonjee	Seva Sadan-II, Room	270650	270257	262914

	Bhicajee (Kutch)	No.203, New Kandla	270556	270367 270221	
13	M/s. OTA Kandla Pvt. Ltd.	BBZ-N-324, Gandhidham	223241	220145 270560	223241
14	M/s. Purshotamdas Jeramdas & Co.	5, Vaswani Chamber, Plot 16, Sector-8, GIM	222850	238242 222598	220598
15	M/s. R. Tulsidas & Co.	Ahit Building , Plot No.323, Gandhidham – Kutch	232308	222717 221943	-
16	M/s. Robinsons	101 / 102, Maritime House, Plot No.45, Sector – 9A, Gandhidham – Kutch	234394	221578 223836	231767
17	Rishi Shipping	Plot 50, Sector 1/A GIM	238943	229830 229831	
18	M/s. Vinsons	BBZ-S-25, Gandhidham – Kutch	231948	220466	222395 239460
19.	Sical Logistics Ltd	403, 4th Floor, Madhuban Compex, OSLO, GIM	234416	234646 234194	
20	Parekh Marine Agency	C-8, Shaktinagar GIM	231509	229297 221158 230587	
21	Krishna Shipping and	Transport Nagar, NH	233135	230501	

	Allied Services	GIM		223814 229085	
22	Kevar Carrier Handling & Transport	Shop 24, Tolani Chamber, Sector –8 GIM	228298	228298	
23	Trinity Shipping & Allied Industries	Trinity House, Plot 46 Sec 1/A, GIM	232060	230911 230910	
24	Velji P & Sons(P) Ltd	2nd Floor, Deepak Compex, 315, 12/B GIM	236168	231545 231546 225466	
25	Asean Marine Services	Ashit Bldg, Plot 33 Sector 1/A, GIM	232308	222717 221943 222145	
26	Rishikiran Roadlines	Kiran House, Plot 8 Sector 8, GIM	231422	231894 234108	
27	Universal Shipping Services	Hotel Sea Bird, Plot 173, Sector 1/A GIM	235251	230663 226050 226037	
28	R.T.Bhojwani &Sons	DBZ –S- 146, GIM	232423	222211 221831	
29	Logistic Enterprises(P) Ltd	C-8, Shaktinagar, GIM	231509	235341 230587	

30	Seaways Shipping (P) Ltd	2nd Floor, Plot 351 Ward 12/B, GIM		226183 237147	
31	Seacrest Shipping Services Pvt. Ltd	216, 2nd Floor Om Corner, Plot 336 Ward 12/B, GIM	227028	233325	
32	Shree Maruti Shipping Services	18/21, Swaminarayan Bldg, Sector 9, GIM	234107 250690	233245 237247 250690	
33	Liladhar Pasoo Forwarders P.Ltd	Plot 4, Sector –1 KASEZ, GIM	252383 253506	252286 252297 252612	
34	Shree Radhey Shipping Company	14-16/C, GF Green Park, GIM	232967	222919 228919 238883	
35	Pearl Shipping	220, Rishab Corner, Plot 93, Sector 8 GIM	235570	225283 225284	
36	Patel Shipping Agency	Patel Avenue, Floor 2, Plot 170, Sector 1/A GIM	231143	224024	
37	Ashirvad Shipping	18-21, Swaminarayan Bldg, Sector- 9, GIM	250690	233245 237247 222822	
38.	M/s. Swaminarayan	1st Floor, H-6, Op. Tejas Society,	079-	231981,	

	Vijay Trade Carriar	Ghatlodia, Ahmedabad	231983	231982	

Annexure – XV

LIST OF TANK FARM OWNERS

Sr. No.	Tank Farm Owners	Persons to be contacted in case of emergency		
		Name and Position	**Telephone No.**	**Mobile No.**
1	**Kesar Enterprises Ltd.,** Near Oil Jetty, Old Kandla (Kutch)-370210	Mr. R.K. Gupta Gen. Manager	270435 (O) 295676 I	9375349181
2	**Kessar Enterprises Ltd,** Terminal II, Plot No. 5 &6 Old Kandla	Mr. R.K. Gupta G.M	270435 (O) 270177 (O)	9375349181
2	**Chemical & Resins Pvt.Ltd** Terminal –I, Near Oil Jetty, Old Kandla, Kutch Terminal – II, Near West Gate, New Kandla – Kutch	Mr. Manoj Kumar Gupta, Terminal Manager	270505(O) 270916 (O)	99240 44424
3	**Indo-Nippon Co. Ltd.,** Plot No.2, K.K.Road, Old Kandla,	Mr. R.N. Pathak Asst. Terminal Manager	270795(O) 235818I 270295 (O)	9879571295
4	**J. R. Enterprise,** Plot No.3, Old Kandla,	Mr. Devendra Dadhich, Terminal In-charge	653528 (O) 257152 ®	9898238380
5	**Friends Oil & Chemical Terminals Pvt. Ltd.,** Near Booster Pump Station, Old Kandla, Kutch	Mr.S.Ramakrishnan Terminal Manager	270987 (O) 257249 ®	9879572107
6	**Indian Oil Corporation Ltd.,** Main Terminal, GIM	Mr. AK. Khanna Sr. Term. Manager	233274 (O) 229002 I	9427216637

	Foreshore Terminal, Kandla KBPL LPG Import Plant	Mr. KS Rao, Sr.TM Mr. PS Negi Plant Manager	270394 (O) 270628 (O) 270477 (O) 233359 ® 270978 (O) 236944 ®	9426416108 9426725342
7	**United Storage & Tank Ltd** Near IOC Foreshore Terminals, New Kandla Gas Terminal, Plot No. 4 Old Kandla	 Mr. Manoj Gor Terminal Manager Mr. G. Chudasama	270609 (O) 653525 (O) 651238 ® 653529 (O)	989850029 9904366855
8	**IFFCO Kandla Unit,** Kandla, Kutch	Mr. M.R. Patel. Execut. Director, Mr. N.C. Patel, Sr. Manager	270711 270352(O) 270381 (O)	9687666888 9979026415
9	**BPCL,** **KK Road, GIM**	Mr.Vineet Bhudhai Sr. Manager Operations	234313 (O) 257808 ®	9409305433
10	**HPCL** **KK Road, GIM**	Mr. Murthy Manager (Installation)	230936 (O) 220084 (O) 233078 Ext 109(R)	
11	**INEOS ABS (I) Ltd** Plot No. 8 Old Kandla	Mr. Vineeth Nair Dy. Manager	270087 (O) 234409 I	9825237029
12	L**iberty Investments Pvt. Ltd.,** Plot No. 1 & 2, Block 'H', New Kandla	Mr. Jitendra Vaidya Terminal Manager	270151 (O) 270464 (O) 270468 I	9825025645

13	**Avean International Pvt. Ltd.,** Liquid Storage Tank Terminal, Plot No. B-1, New Kandla	Mr. Bharat Rathod Terminal Manager	270537 (O)	9375310260
14	**Rishi Kiran Logistics Pvt Limited,** Plot No. 7, Link Road Old Kandla	Mr. RH. Pandya GM (Terminal)	270223 (O) 270443 (O)	 9879104556
15	**N.P.P. Pvt. Ltd.,** Old Kandla	Mr. Jud Sequeira, GM(Terminal)	270347 (O) 257807 (R)	9099944900
16	**Friends Salt Works and Allied Industries,** KK Road, Old Kandla	Mr. NJ.Zinduwadia Sr. Manager Mr. HA. Mehta Sr. Manager	270814 (O) 262698 I 271260 (O) 235072 I	9825506361 9825506360
17	**IMC Ltd,** Cargo Jetty New Kandla	Mr. Anil Brahmbhat	270369(O) 653524 (O) 657963	9898126243
18	**Agencies & Cargo Care Ltd.,** Plot No.3,New Kandla	Mr.Shivkumar Menon, Term. Mgr.	270714 (O)	9825226765
19	**Dipak Estate Agency** Plot No. 5-6, Block –A Behind Petrol Pump New Kandla	Mr. Narendra Thacker	270375 (O)	9879611243
20	**Parker Agrochem Exports Ltd,** Plot No. 3 –4,Block- H New Kandla	Mr. Bharat Thacker	270486 (O) 270528 (O) 231876 I	9825238260
21	**Tejmalbhai & Co** Plot 10, Block- A New Kandla	Mr. Ankitbhai Chandan	271330 (O) 230090 I	9825225101 9825222101
22	**Parker Agrochem**	Mr. P.Raja Babu	270528 (O)	9979158543

	Product P Ltd, Plot 7-9, Block-A,New Kandla	Dy Manager	231876 I	
23	**Mother Dairy Fruit & Vegetable Pvt. Ltd,** Near Oil Jetty, Old Kandla	Mr. Saju Therattu	270654 (O) 270655 (O) 230979(R)	9974022681
24	**Mother Dairy Fruit & Vegetable Pvt. Ltd.,** Nr. Oil Jetty, **Old Kandla**	Mr. Saju Therattu	270654(O) 270655(O) 230979(R)	9974022681

ANNEXURE – XVI

LIST OF SCHOOLS IN GANDHIDHAM – KANDLA COMPLEX

Sr. No.	Name of School	Contact Person	Telephone No.
1	Dr. C. G. High School	Principal	220271
2	SVP Gujarat Vidhyalaya	Principal	220242
3	M.P. Patel Kanya Vidhyalaya	Principal	220705
4	Adarsh Maha Vidhyalaya	Principal	234172
5	Adarsh Kanya Vidhyalaya	Principal	220175
6	Bhartiya Vidhya Mandir, Kandla Bhartiya Vidhya Mandir, Gopalpuri	Head Master Head Master	271049 233684
7	Central School, (IFFCO)	Principal	221288
8	Central School (Railway)	Principal	220657

9	Modern School	Principal	220284
10	Mount Carmel School	Principal	234262
11	Aum Vidhyalaya, IFFCO	Principal	221104
12	Saint Xavier's School, Adipur	Principal	260265
13	Maitri Maha Vidhyala, Adipur	Principal	260445
14	Maitri Kanya Vidhyalaya, Adipur	Principal	260612
15	Model Excelsior High School, Adipur	Principal	260707
16	Gujarat Vidhyalaya, Adipur	Principal	261312
17	Nagarpalika High School, Anjar	Principal	242510
18	Adarsh Nivasi School, Gandhidham	Principal	223246
19	P.N.Amersey School	Principal	223646
20	Shree Gurunanak English School	Principal	238421
21	Swaminarayan Gurukul	Principal	228098
22	Kairali English School	Principal	221050
23	Sarvodaya Pradhamic Shala Near Oslo Cinema, Gandhidham		227958
24	Ganeshnagar Pr.Shala, G'nagar		
25	Jagjivan Pra. Shala, Sapnanagar, Gandhidham		
26	Cargo Pra. Shala, Sapnanagar, Gandhidham		
27	Old & New Sunderpuri Schools	Head Master	224867
28	G'dham Pr. Shala, Near Shivaji Park, Gandhidham	Head Master	229255
29	Adipur Prathmic Shala, Adipur	Head Master	264525 264181
30	Kandla Pr. Shala, Shirva Camp & Thermal Colony & United Salt Works	Head Master	253198

ANNEXURE – XVII

LIST OF DOCTORS IN GANDHIDHAM COMPLEX

Sl. No.	Name of Doctor	Telephone Numbers	
		Office	Residential
ANAESTHETIST			
1	Dr. (Mrs.) Dubal	232591	233555
2	Dr. (Mrs.) S.R.Gandhi	236700	229156
3	Dr. P. P. Kour	229655	220673
PHYSICIAN			
1	Dr. (Mrs) Gandhi	234561	230111
2	Dr. Johnson	222344	232244
3	Dr. Morakhiya	222008	232161
4	Dr. Sakaria	230114	230947
5	Dr. Siju Jacob (St. Joseph Hospital)	230160	223852
6	Dr. Acharya	220715	232736
7	Dr. D. P. Singh	221990	221990
SURGEONS			
1	Dr. D.G.Dasani	229231	223346
2	Dr. Girdhani	233300	231219
3	Dr. Y.V.Joshi	221557	233324

4	Dr. Hotchandani	230039	261530
5	Dr. Hemang Patel	230202	230353
6	Dr. Vachani	230400	222400
7	Dr. J.K.Ahir	237744	--
8	Dr. Harani	222096	222096

GYNAECOLOGISTS			
1	Dr. (Mrs.) N.B.Acharya	220715	232736
2	Dr. Chandrakant Thakker	224488	225588
3	Dr. (Mrs.) Rekha Singh	221990	221990
4	Dr. (Mrs.) Naik P.S.	234333	231332

PAEDIATRICIANS			
1	Dr. J. A. Dubal	232591	233777
2	Dr. Navin Thakker	230195	230894
3	Dr. Nitin Thakker	221046	220615

PATHOLOGISTS			
1	Dr. K. L. Shukla	221611	234062
2	Dr. (Mrs.) Seema Pavde	230370	231352
3	Dr. (Mrs.) Verma G.H.	229168	238386

ANNEXURE – XVIII

LIST OF ESSENTIAL SERVICES

HOSPITALS	OFFICE	RESIDENT

1	General Hospital, Bhuj Civil Surgeon, Bhuj	222850	250554
2	Referal Hospital, Anjar	232455	
3	Rambaugh Hospital, Gandhidham	220263	
4	Divine Life, Adipur	261802	
5	Railway Hospital, Gandhidham	231874	
6	Government Dispensary, Adipur	260608	

TELECOMMUNICATION			
1	General Manager, BSNL, Bhuj	253000	252322
2	Dy. Manager, Bhuj	252505	251505
3	Area Manager, Gandhidham	238000	235000
4	SDO, Gandhidham	236250	236251

ELECTRICITY			
1	S.E., PGVCL, Bhuj	222550	250189
2	Jr. S.E., Anjar	243008	242656
3	XEN, Anjar	242845	242446
4	Dy. Engineer, Gandhidham	222809	--
5	Line Office, Gandhidham	221728	

WATER SUPPLY			
1	S.E., GWS&SB, Bhuj	221806	250601
2	XEN, Bhuj	250685	253016

3	SE, Anjar	242416	242421
4	XEN, Gandhidham	220717	223273
5	Control Room, Gandhidham	221252	
6	Water Tank, Sunderpuri	231313	
7	Water Tank, NU-4	654564	
8	Gandhidham Municipality	231610	
9	Chief Officer, Gandhidham Municipality	234967	

ANNEXURE – XIX

LIST OF VEHICLES SUPPLIER

Sl. No	Name of Institution	Contact Person	Parking Place Phone No.	Name and Phone No. of Driver	Availability of Vehicle.
(A) Vehicle Hire Contractors					
1	M/s Rohit Enterprise	Mr Rohit Shah 228550/237538 237547 (O) 234140 I Mob.9825225121			
(B) Ambulance Pool					
01	St.Joseph Hospital, Gandhidham	Administrator 230160/229336	Hospital Premises	Driver available round the clock	First come first serve
02	Red Cross Society, Gandhidham.	230269	Red Cross	Driver available round the	

				clock	
03	Western Railway, Gandhidham	238891, 231874	Hospital		
04	Rambaugh Government Hospital, Adipur	261625	Hospital Premises	Driver available round the clock	
05	Gautam Freight Pvt Ltd.	Mr Ramesh, Proprietor 232605/220163, 230345 (O)	GIDC Work shop Sector-10C, Plot No. 24.		First Come First Serve
06	Tolani Eye Hospital	Supdt.(O)260497 - 260773	Hospital Premises	One driver in absence of compounder residing in hospital	First Come first Serve
07	Sterling Divine Life Hospital, Adipur	260577, 7698166555	Hospital Premises	Round the clock	
08	Dev Smruti Trust Dr. Harani	222096, 9825227322			
09	Mobile Morgue	229430/239965	Lions Club		
10	Shav Vahini/Mobile Mrogue	239965			
11	Varsha Cheritable Trust C/o Hareshkumar Tulsidas	9909829555			
12	Hari Om Trust Mr. K. Parmar	260833			

ANNEXURE-XX

PLACEMENT OF PORT CRAFTS ON CYCLONE WARNING.

(A)	SHIPPING TUGS	Heera Mehul	Bunder
		Kalinga	Maintenance Jetty (West side)
(B)	PILOT LAUNCHES AND SURVEY LAUNCHES	M. L. BHARINI, M.L. NIHARIKA M. T. SWATI	Floating Crafts Jetty
		ML Karishma	Bunder Basin
		ML Nirishak	Inside Bunder Area North Side.
I	G.S. LAUNCHES AND MOORING LAUNCHES	M. L. Mrinal	Inside Bunder Area North Side on Pilot Launches
		M. L. Unnati M.L. Vaishali	Inner Side of Floating Craft Jetty
		M. L. Vijay M. L. Priyadashani PL Rakshak	Inside Bunder Area North on G. S. and Pilot Launches.

ANNEXURE –XXI

LIST OF LICENSE HOLDERS TO KEEP THEIR CRAFTS INSIDE THE PORT AREA.

Sl. No.	Name of Party	Name of Nodal Officer	Tele. (Office)	Tele. (Resi)
01	M/s Jaisu Shipping Co. P Ltd., Kewalramani House, Dinshaw, Bldg. Road, New Kandla	Mr.Preetam, Director, Mob. 9825226114	270538 270128 270428	260235 260224
02	M/s Gautam Freight Pvt Ltd., Plot No. 24, Sector, 10/C, GIDC Area, Gandhidham	Mr. Ramesh Singhvi, CMD	231386 232605 230345 220163	234176 230328
03	M/s Bapu's Shipping, Plot No. 32, Sec – 9 GIM	Mr. Vishalsinh Jadeja	222002	
04	M/s Blue Ocean Sea Transport, Manali Chamber, Plot No.306, Sec 1/A GIM	Mr. Hukumat T. Bhojwani & Mr. Dushyant Patel	239143 222518 230488 239058	
05	M/s Rishi Shipping, Rishi House, Sec 1/A, Plot No. 50 Gandhidham	Mr. Manoj Mansukhani Proprietor	220843 229830 229831 223913 229517 Fax. No. 238943	
06	M/s Velji P & Sons, Deepak Complex, 2nd Floor, Plot No. 315,	Mr. Sureshchandra	231545 231546	232247

	Ward 12/B, GIM			
07	M/s A.S. Moloobhoy & Sons, Anchor House Shivkripa Bldg, Plot No. 135, Sec 1/A, GIM	Mr. Adil Sheth M- 9375312077	326543 225060 225061 225060	
08	M/s Gudani International Pvt. Ltd, C/o Chemoil Adani Mithakali Circle, Ahmedabad.		079- 25555765 25555266	

Annexure-XXII

LIST OF TRAVEL AGENCIES

Sr. No.	Name of Agency	Phone No.	Mobile
01	M/s. Rathod Tours and Travels, Gandhidham	222444	222959
02	M/s. Rishabh Enterprises, M/s. Rishabh Tours and Travels, 30-31, Tolani Chamber, Plot no. 2, Sector No. 8, Nr. B.M. Petrol Pump, Gandhidham	228550 237538 237547	234140 9825225121
03	M/s. Jai Somnath Travels, Mr. Mishra		9727304414
04	M/s. Agrawal Tourists, Gandhidham	221311 220068	
05	M/s. Krishna Travels, Gandhidham	220683 234838	
06	M/s. Shiv Tourists, Gandhidham	221454	
07	M/s. Thakker Travels, Gandhidham	225097	9825271072

ANNEXURE-XXIII

LIST OF MAJOR HEAVY LIFT OPERATORS AT K P T

NAME OF PARTY	NAME OF CONTACT PERSON	Phone Number
Swastik Heavy Lifters	Mr. Jigneshbhai Mr. Aslambhai	9825758151 9825228421
Kutch Carrier Transport Co	Mr. C. R. Thackar	9825225591
Agarwal Handling Agency	Mr. Rakesh Thackar	9426928728
Active Cargo Movers	Mr. Narendra	9825220411
Raghuvirsingh & Sons	Mr. Harcharan	9879104853
Thacker Brothers	Mr. Kamleshbhai	9825296107
Kiran Roadlines	Mr. Pankaj Gadvi	9879104552
Regal Shipping	Mr. Ashok Dudi	9825326328
Rathore Freight Carriers		220759/ 220380

ADDITIONAL LIST OF FIRMS FOR PAY-LOADERS/CRANES

M/s Mahalaxmi Transport Co., Plot No. 35, Sector No. 8, Behind Hotel Fun & Food, Gandhidham	Mr H K Rathod	(O)222387 I233500
M/s Kandla Earth Mover, DBZ-S-151, Gandhidham	Mr Sanjay Goyal	(O)221759 I222338 (M) 9825020550
Mr Lalji Bhavanji Sathwara, Laljibhai Sathwara, Plot No. 27, Shop No.5, Sector-9/A, Gandhidham		(O)234118 I232566 (M) 9825225957

ANNEXURE-XXIV

LINER AND STEAMER AGENTS AT KANDLA

Sl. No.	Name	Fax No.	Tele. No.	Mobile
01	M/s ACT Shipping Ltd Mr. Harshad Gandhi	232175/ 270597	270111 270115-6 229967 231734	9825226141
02	M/s Admiral Shipping Ltd	233596	230552 232823	
03	M/s Areadia Shipping Ltd	232542	234254 223486	
04	M/s Ambica Maritime Ltd Mr. Amit Vyas	252447	252479 252349	9825225210
05	M/s APL (India) Pvt Ltd., Mr. Murli Krishnan	236361	224601/2 236357 236355	9825225753
06	M/s Arebee Star Maritime Agencies Pvt Ltd. Mr. anil Talwar	235831	220465 235832	9824229109
07	M/s Ashit Shipping Ser. Pvt Ltd. Mr. Sanjay Thakkar	232308	221943 222717 222145	9825225698
08	M/s Atlantic Shipping Pvt Ltd	223372	230552	
09	M/a Asia Shipping Services. Mr. Mohan Karia239326	231285	234526 230954	
10	M/s Bayland Freight Systems Pvt Ltd., Mr. Danendran Gopalan	239326	225522/23	9825230880
11	M/s B D Vithlani Shipping Services Pvt Ltd.	234104	232220 221081	
12	M/s Cargo Conveyors Mr. Shekhar Ayachi Mob. 9825226102	233034	221460 220655	
13	M/s CCA Shipping Services Mr. K C Varghese	233034	221721 220655	9825225217
14	M/s Chowgule Brothers	229227	278521	9825361782

	Mr. C R Soman		225051 232365	
15	M/s Coastline Services (India) Pvt Ltd.	221137	232095 222853	
16	M/s Container Marine Agency Pvt Ltd	234541	230026 220416	
17	M/s Confreight Shipping Agency (India) Pvt Ltd. Mr. K T R Nair	-	233615 236157	
18	M/s Cresent Shipping Agency (India) Pvt Ltd Mr. Sanjay Salve.	224506	221290 221957	9825227311
19	M/s DBC Freight International	230832	230832 230639	
20	M/s DBC Sons (Gujarat) Pvt Ltd. Mr. R C Vazirani	270631	270263 270503	
21	M/s Depe Global Shipping Agency Pvt Ltd. Mr. Jaydeep Roy	232079	231528 233608 234582	9825228121
22	M/s Evershine Shipping Services. Mr. Kishan Motwani	234083	221588 237408	
23	M/s Forbes Gokak Ltd	231464	222634 235004	
24	M/s Freight Connection (India) Pvt Ltd	231357 270726	222247 222545 270727	
25	M/s GAC Shipping (India) Pvt Ltd. Mr. V C Rao	231429	231427 237244	9825225136
26	M/s Ganges Liners Pvt Ltd	233437	231608 233436	
27	M/s German Exp. Shipping Agency Pvt Ltd	236040	223269 236040	
28	M/s Goodrich Maritime Pvt Ltd	222875	222882 222883	
29	M/s G P Dave & Sons (Shipping)	234382	234288 234382	
30	M/s Greenways Shipping Agencies Pvt Ltd	232079	233608 234585	
31	M/s K. Shipping Services Pvt Ltd	233632	231933	

32	M/s Halar Ship & Freight Forwarders. Mr. Tejas Shrma	270224	270192 270568	9825212646
33	M/s Hind Shipping Agencies. Mr. Mahesh Vyas	234795	232710 235375	
34	M/s Hindustan Shipping Services. Mr. M D Sorathiya	239110	239110 222821	9824214994
35	M/s Interocean Shipping India Pvt Ltd. Mr. Suresh Tripathy	232579	235201 230589	9825225583
36	M/s Intra Trade Pvt Ltd. Mr. B P Vasavda	233295	233313 231255	9825226129
37	M/s Trades Shipping Pvt Ltd	231463	235572 233606	
38	M/s James Mackintosh Marine (A) Pvt Ltd. Mr. Satish Nair	270793	270792 270846	9825226077
39	M/s. J.M. Baxi & Co.	270646	270630 270635 270525	9825225107
40	M/s Kutch Shipping Agency Pvt Ltd.	233339	221148 250226/ 7/8	
41	M/s Liladhar Passop Forwarders Pvt Ltd. Mr. S. Chakraborthy	252383	252297 252402 252288	9825020523
42	M/s Maersk (India) Ltd. Mr. Dinesh Joshi	231388	231387 236192 233963	9825270419
43	M/s Maheshwari Handling Agency Pvt Ltd. MR. Chaggan Maheshwary	230575 234633	223228 230393	9825227111
44	M/s Maltrans Shipping Agencies India Pv Ltd.	230606	220147 230336 235022	
45	M/s Mathurdas N. & Sons	252221	252224	

	Forwarders Ltd.		252350	
46	M/s Meridian Shipping Agency Pvt Ltd	230212	220305 230220	
47	M/s Mitsutor Shipping Agency Pvt Ltd	230411	220110	
48	M/s M M Shipping Services	235255	231385 238385	
49	M/s Modest Shipping Agency Pvt Ltd	-	230576	
50	M/s NLS Agency India Pvt Ltd. Mr. Sanjay Salve	232413	231318 220305	9825237311
51	M/s Orient Express Lines Ltd	230359	232186 232805	
52	M/s Orient Ship Agency Pvt Ltd. Mr. H G Digrani	233518	223430 223487	9824214801
53	M/s Oscar Shipping Agencies.	231812	226959/60 232123	
54	M/s Parekh Marine Agencies Pvt Ltd. Mr. Mitesh Dharamshi	231509	221409 235341	9825226557
55	M/s Patel Handling Agency (Capt. Kalra)- 9825062912	231143	224024 231004 221718	
56	M/s Patvolk (Mr. Shreekumar Nair)	231464	222624 235004	
57	M/s Pearl Shipping Agency. Capt. Kalra	231143	224024 221718	9825062912
58	M/s Penguin Shipping Agencies Pvt Ltd.	230606	230336 220147	
59	M/s Pestonjee Bhieajee (Kutch)	270650 270556	270221 270257 270367	9825226962
60	M/s Prudential Shipping Agencies Pvt Ltd. Mr. Siddharth Mishra	232911	230479 233982	9825226477
61	M/s P&R Nedlloyed India Pvt Ltd	232207	224906/7 232128	

62	M/s R T Bhojwani & Sons Mr. Gopichand Bhijwani	232423	223831 220839	9825225639
63	M/s Sahasu Shipping Services Pvt Ltd	236358	225224 237854	
64	M/s Sai Shipping Co. (P) Ltd Mr. S T Hingorani	231972	221369 231739	9825228681
65	M/s Samrat Shipping Co Pvt Ltd	232890	231983 222939	
66	M/s Samsara Shipping Pvt Ltd. Mr. Pranesh Rathod	233165	228602	9825225755
67	M/s Scorpio Shipping Agency	-	223085	
68	M/s SDS Shipping Pvt Ltd	231542	221326 221087	
69	M/s Seanay Shipping Pvt Ltd	270026	270788	
70	M/s Seabridge Maritime Agencies Pvt Ltd	231509	221409 221158	
71	M/s Seafreight Pvt Ltd	222850	233530 222393	
72	M/s Sealand Agencies India Pvt Ltd	230584	231179 230584	
73	M/s Scamar Shipping India	255563	-	
74	M/s Scatrade Shipping	234171	233810	
75	M/s Sentrans Maritime Pvt Ltd	236129	230002 220702	
76	M/s South India Corporation (Agencies) Ltd Mr. Antony	234416	221276 234646 231494	9825226256
77	M/s Spoonbill Maritime Agencies Pvt Ltd	234167	221049 222058 234454	
78	M/s Star International	231395	233948 232402	

79	M/s Taipan Shipping Pvt Ltd	236040	223269 227010	
80	M/s Taurus Shipping Services. Mr. Sukhveersingh	231266	221334 223074	9825227325
81	M/s Oceanic Shipping Agency Pvt Ltd	270631	270263 270503	
82	M/s TICC Container Line (Kandla) Pvt Ltd	237854	237854	
83	M/s Total Transport Systems Pvt Ltd	231463	222634	
84	M/s Transocean Shipping Agency Pvt Ltd	-	230832	
85	M/s Transworld Shipping Services India Pvt Ltd Mr. Sandeep Rajvanshi	231913	229824 221290	9825225733
86	M/s Trinity Shipping & All. Services Pvt Ltd Mr. Soly	222060	230911 223703	9825225245
87	M/s Unimarine Agencies (Gujarat). Mr. Jaikumar Ramdasani	224633	224631/ 32 223113	9825225216
88	M/s Unique Shipping Services Pvt Ltd	-	232729 232730	
89	M/s United Liner Agencies of India Pvt Ltd, Capt Rakesj Kumar	236040	227779 223269	9825225741
90	M/s Universal Freight Systems	252383	252288 252297	
91	M/s Universal Shipping Services Mr. Anil Pillai	235251	230663 231708	9824215168
92	M/s Velhi P. Sons (Agencies) Pvt Ltd	255328	255327 231545	
93	M/s Vibhuti Shipping Pvt Ltd Mr. Vinod	236219	236719 230035 232424	9825226536

ANNEXURE-XXV

LIST OF CLEARING & FORWARDING AGENTS AT KANDLA

A V Joshi & Co Tel. 232605, 232227, 230345 Fax. 233924 Mr. Harshandu Mr. Vaidya (Mob.) 9825226013	C. Jivram Joshi & Sons (Gujarat) Tel. 220621 Fax. 231141 Mr. Sunil Chowdhari (Mob) 9825225400
ACT Shipping Ltd Tel. 270111/12/13, 270530, 220407 Fax. 270579, 232175	Cargo Movers Tel. 220453, 230883, 270563 Fax.231687
Jaswantrai & Co. Tel. 222630, 222717, 222145, 221943 Fax. 232308, 270385	Cargo Clearing Agency (Gujarat) Tel. 221721, 221674, 220655, 270542 Fax. 233034
Asia Shipping Services Tel. 230954. Fax. 231285	Chinubhai Kalidas & Brothers Tel. 232284 Fax. 231881
Airol Shipping Services Tel. 230080, 220180. Fax. 236131	CAP Shipping Pvt Ltd Tel. 221460, 232081 Fax. 233734
Aarpee Clearing Agency Tel. 222614. Fax. 255252	Centrans Shipping Agency (I) Pvt Ltd Tel. 256854 Fax. 234074
Ashirwad Clearing Agencies Tel. 232426, 233245 Fax. 234107	Cargo Shipping Tel. 270802, 270803 Fax. 270802
Ambalika Enterprises Tel. 255382. Fax. 255577	C. Joshi & Sons Tel. 221094
Ashmka Shipping (Tel. 222481)	Dilip A Goplani Tel. 224082, 255423 Fax. 224082
Ashis Enterprise (Tel. 234722)	D.B.C. & sons Gujarat Pvt Ltd Tel. 270263, 270348, 270503 Fax. 270631
Anchor Shipping Tel. 235781 Fax. 235781	Damjidhiroo & Sons Tel. 222329, 221328 Fax. 230139
B N Thakkar & Co., Tel. 222293, 222285, 270239	Dvji Premji Punara & Sons Tel. 222057, 221338 Fax. 230139

Fax. 230556	
B. Devchand & Sons Pvt Ltd Tel. 232220 Fax. 234014	Express Transport Pvt Ltd Tel. 220193, 220179, 270591, 222565, Fax. 220193
Benits Forwarders Pvt Ltd Tel. 221707, 222086 Fax. 223151	Friends & Friends Shipping Pvt Ltd Tel. 232227, 231588 Fax. 233924
Blue Sea Shipping Agencies Tel. 235317 Fax. 255221	Fast & Fair Company Tel. 255254, 238175 Fax. 255254
Bhanu Clearing Agency Tel. 256861 Fax. 256861	Flamingo Shipping & Forwarding Pvt Ltd Tel. 256755, 257756 Fax. 256755
Global Marine Agencies Tel. 222928, 223196, 223252 Fax.255418	Liladhar Passoo Forwarders Pvt Ltd Tel. 252288, 252297, 252402, 252617 Fax. 252383
Gayatri Shippers Tel. 230692, 223292 Fax. 230818	Lalbahi Trading Company Tel. 222139
Hiral Enterprise Te. 255644	Leap Forwarders Pvt Ltd Tel. 255530, 255509 Fax. 252383
Hindustan Shipping services Tel. 255644, 222821 Fax. 256618	Link International Tel. 255206/07 Fax. 255530
Hardip Shipping Logistics Pvt Ltd Tel. 232909, 222560 Fax. 232909	Lexicon Shipping Agencies Pvt Ltd Tel. 229951-53 Fax. 229949/50
Hansraj Pragji & Sons Tel. 221650, 255228 Fax. 255228	Logistics Enterprise Pvt Ltd Tel. 255157, 255458 Fax. 255520
H K Dave Pvt Ltd Tel. 221504, 2333632 Fax. 230411	Mathuradas Narndas & Sons Forwards Pvt Ltd, Tel. 252224, 252350, 252115 Fax.252221
Intralink Clearing & Forwarding Tel. 255188 Fax. 23148	Magal Singh & Company Tel. 224030, 255253, 234688
J M Baxi & Co. Tel. 270630/35, 270148/50, 270525 Fax. 270616	Meridian Shipping Services Tel. 233981, 255362 Fax. 230701

Jesia Mistry Agencies Pvt Ltd Tel. 222317, 223317	Megha Shipping Agency Tel. 222671, 255304 Fax. 230937
Jaisu Shipping Company Pvt Ltd Tel. 270428, 270128/538 Fax.270556	Mayur Forwarders Pvt Ltd Tel. 222671, 255304 Fax. 230937
Jivanlal Laloobhai Tel. 220308, 230530 Fax. 231640, 233803	Maritime service Pvt Ltd Tel. 222671, 255304 Fax. 255304
Krishna Clearing Agency Tel. 223813, 230501 Fax. 233135	Marathon Shipping Combine Tel. 222202, 230106 Fax. 255220
Kiran Roadlines Tel. 232297, 231984, 234108 Fax.231422	Shiv Shipping Service Tel. 255568 Fax. 22256
Kandla Clearing Agency Pvt Ltd Tel. 232337, 223211, 223210 Fax.230402	Narendra Forwarders Pvt Ltd Tel. 232504, 231795 Fax. 256678
Kamat & Co. Tel. 223471, 232730, 232729 Fax. 255243, 270779	Natwar Parikh Industries Ltd Tel. 232628 Fax. 232628
K S Chaya & Co Tel. 256604 Fax. 230693	New Dholera Shipping & Trading Company Limited. Tel. 222637 Fax. 255329
Kashyap Shipping Ltd Tel. 220816 Fax. 230030	National Shipping Tel. 232319 Fax. 232319
Kanak Shipping & Transport Tel. 231314, 230543, 222059 Fax.221702	Navjeevan Enterprise Tel. 252611, 252360 Fax. 252515
IEE & Muirhead Pvt Ltd Tel. 231535/36 Fax. 231018.	N. G. Bhanushali & Company Tel. 233648, 256791 Fax. 256879
OTA Kandla Pvt Limited Tel. 220145, 223241, 270450 Fax.223241	Shivji Kanji & Company Tel. 230127, 223728, 223729 Fax.220308
Pravin Bhatt & Sons Tel. 224032, 230079 Fax. 230079	South India Corp. (Agencies) Limited Tel. 234646, 231494, 221276, 255209 Fax.234416
Prime Forwarders	S J Thacker & Company

Tel. 234047, 232505 Fax. 231345	Tel.255678,221745 Fax.230659
Purshotam Ramjee & Compnay Tel. 220354, 222287 Fax. 231754	Star Shipping Services Tel.255424,255425,235326(F)255426
Patel Handling Agency Tel. 221718, 224024, 231004, 270017 Fax. 231143	Shivani Shipping, Tel. & Fax.256836
P S Bedi & Company Tel. 223201, 222841 Fax. 255494	Sea Trans Shipping Agency Tel. 255564 Fax. 233228, 233517
Purshotam Chtrabhuj Thacker Tel. 222720	Seaster Shipping Services Tel. 255349 Fax. 232719
Prashant Shipping Tel. 255306, 223927 Fax. 223927	Seaway Shipping Services Tel. 234272 Fax. 232719
Pramukh Forwarders Tel. 255400 Fax. 232602	Star Clearing Agencies Tel. 230273, 255529, 222983 Fax.232719
P M Agency Pvt Ltd Tel. 232553, 233973, 236414 Fax.255413	S S Shipping Agencies Tel. 236605, 238283 Fax. 236605
Raj Shipping Servie Tel. 233948, 232402 Fax. 231395	SPN Shipping Services Tel. 222453, 270733 Fax. 236605
Rajesh Shipping Service Tel. 255444, 255450/52, Fax.255151	Sierra Shipping Pvt Limited Tel. 255395 Fax. 232771
Rudra Shipping Service Tel. 220429, 255317 Fax.255317	Sonal Enterprises Tel. 252666, 252053
Rishi Shipping Tel. 220813, 229830, 2555661/2/3 Fax. 238943, 255522 Mr. B K Mansukhani (M)9825225170	S R Clearing Agency Tel. 232974, 255494 Fax. 255494
Rudraksh Shipping Servie Tel. 235937 Fax. 255582	St. John Freight System Limited Tel. 235414, 236444 Fax.235414
Sanghvi Freight Forwarders Pvt Ltd	Siddi Shipping Services

Tel. 234993, 234995, 222401 Fax.230508	Tel. 232356, 230268 Fax.256712
Sri R K Shipping Pvt Ltd Tel. 232028, 231940, 231936 Fax. 232740	Spalsh Shipping Pvt Limited Tel. 255562, Fax. 220710
Shakti Enterprises Tel. 223531, 221591 Fax. 233898	Thakarshi Madhavji & Sons Tel. 255457, 255458 Fax. 221770
Shree Ambica Commercial Company Tel. 220213, 221253	Trinity Shipping & Allied Services Pvt Ltd Tel. 223703, 230911 Fax. 232060
Shri Maruti Shipping Services. Tel. 270760, 256853, 233245 Fax.220308	Tokto Shipping Services Tel. 234040
Unity Shipping Tel. 255271	Vinson Tel. 220466 Fax. 231948
Umiya Shipping Agency Tel. 255640 Fax. 233625	Vaz Forwarders Ltd Tel. 235317 Fax. 255221
Unique Forwarders Tel. 230080, 255417 Fax. 236131	Varsh Shipping & Travels Tel. 222386, 255300 Fax. 255300
V. Arjoon Tel. 221049, 221335, 222058, 223307 Fax. 234167	Venus Clearing Agency Tel. 233960 Fax. 233362
Velji Dosabhai & Sons Tel. 270220, 270025, 221818, 231423 Fax. 270164, 232363	Vishal Shipping & Handling Tel. 223960 Fax. 233362
Vishvajyoti Enterprises Tel. 252381, 252318 Fax. 253091	Worldwide Cargo Care Pvt Ltd Tel. 221290, 221479, 220307, 230217 Fax. 231913
Velji P & Sons Tel. 255327, 231545, 231546, 270976 Fax. 255328	Zenith Trade Link Tel. 223193 Fax. 255522
Vailash Transport Co. Tel. 233579, 223580	

ANNEXURE-XXVI

SURVEYORS AT KANDLA

Adnuralty Marine Services Tel. 235412, 256813 Fax. 256813	Marine Consultants & Surveyors Pvt Ltd Tel. 255293 Fax. 234416
Capt. S. Kochar & co. Tel. 222247, 221084 Fax. 231357	Murray Fenton (India) Surveyors Limited Tel. 235960, 236238 Fax. 233335
Dr. Amin Superintendents & Surveyors Pvt Limited, Tel. 221520, 235636 Fax. 226527	M. M. Cargo Gear & Marine Surveyors Tel. 231385 Fax. 235255
Det Norske Veritas (DNV) Tel. 232712	M.BS. Surveyors Tel. 256782
Geo-Chem Laboratories Pvt Limited Tel. 221841, 222179 Fax. 233743	Navark & Mareng Surveyors & Consultants Tel. 232123, 233270
G. P. Dave & Sons Tel. 234288 Fax. 234382	S.G.S. India Limited Tel. 221857, 238047, 231869 Fax.232883
Gupta & Associates Tel. 222542 Fax. 222542	S. K. S. Surveyors Assessors Tel. 220555
Inspectorate (India) Consulting Engineering Pvt Limited Tel. 221520, 235636 Fax. 255217	Seascan Surveyors Pvt Limited Tel. 221833, 233639, 221627 Fax. 233639
Indian Register of Shipping & Indian Register Quality System Tel. 238623, 233695 Fax. 233695	Sterling Surveyors Tel. 230216 Fax. 230216
Iteng Engineering Tel. 221520, 255429 Fax. 255247	Technomar Surveyors Pvt Limited Tel. 221966
J B Boda Surveyors Pvt Limited Tel. 231801, 231946 Fax. 231693	TCRC Surveyors Tel. 220862, 230050 Fax. 230050
Metealfe Hodgkinsons Pvt Limited Tel. 220940, 221740, 233707, 221845 Fax. 231629	U. . Marine (India) surveyors

	Tel. 220070 Fax. 233228

ANNEXURE – XXVII

LIST OF JOURNALISTS

PRINT MEDIA

Sr. No.	Name of Newspaper	Correspondent & Address	Tel. No.	Fax
1	Kutchmitra Neewspaper	Mr. Adwait Anjaria Bureau Chief Gandhidham	222930	222930
2.	Kutch Uday,	Mr. Gangaram Bhanushali Editor, Plot.No.287, Sector-1/A, Nr.Gayatri Mandir, Gandhidham	235851 231213 9825226987	231267 239887
3	Pandya News Agency	Mr. Jagdish Pandya, Main Bazaar, Gandhidham	220212 238112 238212	221412
4.	AAjkal	Mr. Nidhiresh Raval Bureau Chief Gandhidham	9825517030	229834
5.	Chanchal	Mr. Satish Upadhyay Bureau Chief, Shardha Appartment, Hinglaj Vadi,Bhuj	02832-252942	02832- 252945
6.	Sandesh	Ms. Kulsumben Yusuf,	02832-229200	255601

	Bhuj	Editor, Bhuj		228797
7.	Sandesh - Gandhidham	Mr. Jaydeep Purohit Bureau Chief Office No.: 108, Golden Point, Plot No. 31, Sector – 8, Gandhidham	222411	233211
	Sandesh Ahmedabad	Sandesh Sandesh Bhavan, Lad Society Road, Behind Vastrapur Gam, Ahmedabad-380015	079- 6762952, 6765480, 6765481, 6765482,	
8.	Gujarat Samachar Gandhidham	Mr. Awesh Malviya, B-ureau Chief, Gandhidham	9825425978	228222
	Gujarat Samachar Ahmedabad	Lok Prakashan ltd. Gujarat Samachar Bhavan, Khanpur, AHMEDABAD	30410000	
9.	Jansatta – Loksatta	Ms Jayshreeben Mehta, Bureau Chief,Gim	9825225453 228797	---
10.	Indian Express Rajkot	216, Dhan Rajni Complex, Dr. Yagnik Road,Rakot	0281- 22481156	0281- 2481158
11.	The Times of India	Sterling Apartments,	9879324200	---

	Rajkot	1st floor, Jawahar Road, Rajkot – 360001	0281- 2226995 2227490	
	The Times of India Ahmedabad	SAKAR-1, 2nd Floor, Opp. Gandhigram Rly. Station, AHMEDABAD–380 009	079- 26554430, 26554431	079- 26587741 26554458
9.	DNA	Mr. D. V. Maheshwari Bureau Chief, Bhuj	02832-251689	
10.	Mumbai Samachar, Chaupal	Mr. Tridev Vaidya Bureau Chief , Bhuj	02832-231200	
11.	UNI	Mr. Mahesh Gadhvi Bureau Chief , Bhuj	9428294194	
12.	Exim Newsletter	Mr. P. G,.Nair, Bureau Chief Gandhidham	234194 9898573833	
13.	Daily Shipping Times	Mr. Haresh Manji Bureau Chief Gandhidham	222665 9925744679	
14.	Divya Bhaskar	Mr. Jayesh Shah Bureau Chief Gandhidham	9909944054	
15.	ETV	Mr. Rakesh Kotwal Bureau Chief Gandhidham	9909944080	
16.	Bhandarkar Shipping	Mr. Mehul Raval Bureau Chief Gandhidham	231455 / 9724307499	
17.	Hindustan Times, Ahmedabad	50, 5th Floor, Srikrishna Centre,	079- 6560049	079- 6560037

		Mithakali, Ahmedabad	6560061	

PRINT MEDIA

18.	Mr. Kishore Ahir	Dy. Director	9427974892
19.	Shri Soni	Assistant Director	9879012714
20.	Mr. Shailesh Vyas	Chief News, All India Radio	9426802510

ANNEXURE-XXVIII

LIST OF FLEET OWNERS

Sl. No.	Name of Company	Contact Person	Tel. Office	Tel. Resi.	Mobile
01	M/s A V Joshi & Company	Mr. Ramesh Singhvi Mr. Thacker MR. Harshandhu	231386 232605 233147	234176 221451 234325	98251 91325 98252 26105 98252 26013
02	M/s Rishi Shipping	Mr. B. K. Manshukhani Mr. Manoj Manshukhani	220843 229830 238943	234889 235587	98252 25170
03	M/s Maheshwari Handling Agency	Mr. C. P. Maheshwari Mr. Chandan Maheshwari	223228 230393	222339	98252 27111
04	M/s ABC	Mr. Latif Mr. Mithu Mr. Kasam	220483 221390 270190	234163 231477 251684	98252 26707
05	M/s Ganesh Transport	Mr. Hira Rabari Mr. Visa Rabari	223638 223915	260425	
06	M/s Kewar Carrier		220483 227553	234163	
07	M/s Krishna Transport Service	Mr. K. M. Thakker Mr. Pankaj Thacker	223814 224938	220998 234988	98250 19699 98252 25228
08	M/s Gautam Freight Ltd	Mr. Ramesh Singhvi	220163 230345	230328 234176	98251 91325

VTS GOK OFFICERS OF MASTER CONTROL CENTER (MCC) KANDLA

Sr. No.	Name	Designation	Mobile number
01	Shir B. Mishra	Deputy Director	7383576832
02	Shri Hansraj	Deputy Director	9428863924
03	Shri Mukesh Parmar	Asstt. Executive Engineer	9016106566
04	Shri M. Nimare	Asstt. Executive Engineer	9408553192

RADIO ACTIVE DISASTERS Dos AND DONTs

NUCLEAR EMERGENCIES - HOW TO RESPOND:

Nuclear facilities in India adopt internationally accepted guidelines for ensuring their safe operations and safety to the public and the environment. An independent regulatory authority oversees their safe operations. While the limits for radiation release/exposure have been set at a fraction of what can cause any significant harm, emergency procedures get implemented even when these very low limits are exceeded. As a result, it is extremely unlikely that the public near a nuclear facility will be exposed to any radiation beyond the permissible limits. However, to reassure the public, contingency plans are put in place even to handle such unlikely scenarios.

Keeping these facts in mind, if you still feel concerned on hearing any news or rumour about an incident at a nearby nuclear facility, follow these simple guidelines. These guidelines could also be followed in the event of any other nuclear emergency in your area, which does not even involve any nuclear facility.

- **DO THE FOLLOWING:**

1. Go indoors. Stay inside.

2. Switch on Radio/TV and look out for public announcements from your local authority.
3. Close doors/windows.
4. Cover all food, water and consume only such covered items.
5. If in the open, cover your face and body with a wet handkerchief, towel, dhoti or saree. Return home, change/remove clothes. Have a complete wash and use fresh clothing.
6. Extend full co-operation to local authorities and obey their instructions completely - be it for taking medication, evacuation, etc.

- **DO NOT DO THE FOLLOWING:**

1. Do not panic.
2. Do not believe in rumours passed on by word of mouth from one person to another.
3. Do not stay outside or go outside.
4. As far as possible, AVOID - water from open wells/ponds, exposed crops and vegetables, food, water or milk from outside.
5. Do not disobey any instruction of the District or Civil Defence Authorities who would be doing their best to ensure the safety of yourself, your family and your property.

AN OVERVIEW OF THE EMERGENCY RESPONSE PLANS IN THE DEPARTMENT OF ATOMIC ENERGY:

1. The Department of Atomic Energy **(DAE)** has been identified as the nodal agency in the country in respect of man made radiological emergencies in the public domain.
2. For this purpose, a Crisis Management Group **(CMG)** has been functioning since 1987 in DAE. In the event of any radiological or nuclear emergency in the public domain, the CMG is immediately activated and will co-ordinate between the local authority in the affected area and the National Crisis Management Committee **(NCMC)**. The CMG comprises of senior officials drawn from various units of DAE like the Nuclear Power Corporation of India Ltd **(NPCIL)**, Bhabha Atomic Research Centre **(BARC)**, Heavy Water Board **(HWB)** and the Directorate of Purchase and Stores **(DP&S).** It also includes a senior official from the regulatory authority, the Atomic Energy Regulatory Board **(AERB)**. Each member is backed by an alternate member, so that the CMG can be activated at a very short notice. Several Resource Agencies from BARC also backup the CMG. They can provide advice and assistance in the areas of radiation measurement and protection and medical assistance to radiation affected personnel.
3. As regards major nuclear facilities of DAE like the nuclear power stations, they have an Exclusion Zone of 1.6 km surrounding the power station in which no habitation is permitted. The entire area is fenced or walled off and defines the boundary of the site. Beyond this is the public domain and an area of 16 km radius around the plant site is called the Off Site Emergency Planning Zone (EPZ).
4. As a general practice, elaborate and comprehensive safety systems are in place for the operation of any nuclear facility. These are in turn overseen by the AERB who have powers to license and even shutdown any facility which violates their guidelines. However, as a matter of abundant caution, even some "beyond design basis" accidents are postulated for the nuclear power stations. It is only under such highly unlikely scenarios, that there is a possibility of a radiological emergency in the public domain. Therefore, in addition to the other types of emergency response plans in place within the facility to handle local emergencies, response plans have also been drawn up for handling such emergencies in the public domain, which are called as "Off Site Emergencies". These plans - drawn up separately in detail for each site - which are under the jurisdiction of the local District Administration, cover an area of about 16 km radius around the plant or the Off Site Emergency Planning Zone.
5. The first three types of Emergencies which are foreseen and for which detailed plant specific emergency response plans have been drawn up are Emergency Standby, Personnel Emergency and Plant Emergency. In all these, the consequences of the accident are expected to be limited to the plant facility only. The next type of Emergency which is foreseen is the Site Emergency, wherein the consequences of an accident are not expected to cross the site boundary, that is, the Exclusion Zone - which means that even under this condition, there is no radiological emergency in the public domain. The last type of Emergency which assumes the highly unlikely possibility of radiological releases in the public domain is the "Off Site Emergency" and detailed response plans have been drawn up even for this hypothetical scenario at each site. **The local District Administration, the Crisis Management**

Group, DAE and the National Crisis Management Committee (NCMC) get involved in this last type of Emergency.

6. It is mandatory for NPCIL to have comprehensive and well laid out plans to deal with all the above types of Emergencies. Barring the last one, all the others fall within the domain of responsibility of NPCIL, and the AERB as the Regulatory Authority approves these plans. It is also mandatory for the NPCIL to periodically test out these plans by way of Exercises and Drills and take corrective measures as stipulated by the Safety Committees and AERB. As the first stage of the trigger mechanism, the Crisis Management Group, DAE and its resource agencies are automatically alerted even when a Plant or Site Emergency/Exercise takes place.

7. In accordance with statutory requirements, it is the local District Administration which is responsible for drawing up and testing the Off Site Emergency Plans. NPCIL has co-ordinated with all concerned District Administration to enable them to draw up comprehensive Off Site Emergency Plans for each power station. It may be mentioned that the AERB does not permit any nuclear power station to be commissioned unless and until, such plans for all types of Emergencies are in place well before the commissioning date.

8. The Off Site Emergency Plans are also periodically tested and all power stations have ensured that this is being done atleast once in about two years. During these exercises, all the Members and Alternate Members of the Crisis Management Group, DAE, the Resource Agencies and Key Officials in Mumbai and Delhi are alerted. In these Exercises, the district administration is fully involved and the reports of the independent observers (from AERB, NPCIL and CMG) are used as a feedback to further improve the Emergency Response System.

9. Recognising the importance of communications in the handling of any Emergency, **Emergency Control Rooms (ECRs) are maintained at Mumbai at two different locations. These manned and operated on a round-the-clock and on all days of the year and maintain continuous contact with all the critical facilities of DAE.** The ECRs are equipped with Wireless, Telephone, Facsimile, VSAT and Electronic Mail facilities. These are tested practically on a daily basis to ensure their continuous availability. Further, each major site also carries out fortnightly or monthly communication exercises to test all the links in the entire communication chain.

10. In addition to about 165 communication exercises, about 110 emergency exercises are carried out every year. During the period from 1987 to 2000, 34 Off Site Emergency exercises have been conducted by the respective district administrations at various locations in the country. These involve direct participation by local district officials like police, health, transport, etc. At the end of each of these exercises, the District Collector/Magistrate chairs a "critique or feedback" session at which the deficiencies are recorded for taking corrective actions.

11. As regards transport of nuclear material, mandatory design specifications for the packaging, systems and procedures for handling and transport are in place to ensure that there is no release of radioactivity in the public domain in the unlikely event of such an accident. However, even if such an event were to occur, the procedures are such that the Emergency Control Room at the DAE Secretariat gets an alert which in turn would immediately activate the Crisis Management Group, DAE.

12. In the event of any other type of nuclear emergency in the public domain arising from the unauthorized presence or suspected presence of nuclear materials, a booklet giving the essential guidelines to be followed has been circulated to State Governments and Union Territories. Among other steps, the guidelines require that the nearest listed DAE facility as well as the DAE Emergency Control Room be also contacted immediately, who would then advise on the further necessary steps to be taken to attend to the emergency.

This short write up is primarily meant to educate the public and instill confidence about the Emergency Response System of DAE to handle radiation emergencies. As regards nuclear facilities of DAE, the regulatory and safety systems ensure that equipment are designed to operate safely and even in the unlikely event of any failure or accident, mechanisms like plant and site emergency response plans are in place to ensure that the public is not affected in any manner. In addition, detailed plans which involve the local public authorities, are also in place to respond if the consequences were to spill into the public domain. The System is also in a position to respond to any other radiation emergency in the public domain that may occur at locations which do not even have any DAE facility.

Annexure -VI

ENVIRONMENT MONITORING REPORT
OF
DEENDAYAL PORT TRUST

(Annual Report)
(March 2020 to February 2021)

(Report No - DCPL/DPT(19-22)/AMR/20-21/01)

Submitted to

Deendayal Port Trust

Prepared by

Detox Corporation Pvt. Ltd.
Detox House, Udhna Darwaja, Ring Road
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1. Introduction

The environmental Monitoring plan is the key document in the environmental management system and sets out the detailed targets, objectives and procedures that will be adopted in order to achieve the goals set out in the environmental policy. EMP document is a collation of background information relevant to the Kandla Port Environmental Management and Monitoring Plan (EMMP).

1.1. The Environment (Protection) Act, 1986

The EPA 1986 came into force in all of India in November of 1986, under an official notification. The Act contains 26 sections divided into 4 chapters. The Act has its genesis in Indian Constitution's Article 48(A) and Article 51(A)g. The Act is a part of Article 253 of the Indian Constitution.

The rules of Environment protection came into force on 19th November 1986 and these rules provide for the following:

- The standards of quality of air, soil and water for various areas and purposes of environment.
- The standard set up to know about the limits of the environmental pollutants.
- Rules include the procedure and safeguards needed to handle the hazardous substance.
- Restrictions and some prohibitions on handling the hazardous substances in different areas and premise
- The procedures and safeguards required for the prevention of accidents which may cause environmental pollution and also the remedies for it.
- The prohibition and restrictions possessed on the location of industries in different areas.

1.2. EIA and CRZ Notification

The Ministry of Environment, Forests & Climate Change (MoEF & CC), Government of India, exercising the powers conferred upon it under the provisions of the Environment (Protection) Act, 1986, issued the Environment Impact Assessment Notification, 2006 and its subsequent amendments.

1.2.1. EIA Notification

The basic objective of the Environment Impact Assessment is to identify, predict, mitigate and communicate the possible impacts due the proposed project to the Government authority and people likely to be affected and incorporate the conditions for construction, operation, maintenance and waste disposal phases of the project to mitigate the negative (adverse) impacts and enhance the positive impacts for the sustainable development of the region.

Environmental Impact Notification S.O.1533 (E), dtd.14th September 2006 as amended 2009, issued under Environment (Protection) Act 1986, has made it mandatory to obtain prior environmental clearance (EC) for scheduled development projects. The notification has classified projects under two categories A & B. Category A projects (including expansion and modernization of existing projects) require clearance from The Ministry of Environment, Forests & Climate Change (MoEF & CC), Govt. of India (GoI) and for category B from State Environmental Impact Assessment Authority (SEIAA), constituted by Govt. of India.

Some important features of the said Notification are:

I. Prior Environmental Clearance (EC) is required by all new projects or activities listed in the Schedule of the EIA Notification 2006 and subsequent amendments thereafter. EC is required before

commencement of any construction work or preparation of land by the project management.

II. Prior EC is also required by the existing projects or activities if its capacity is likely to exceed the threshold limit mentioned in the said Schedule.

III. All category B projects where general condition does not apply, the project proponents are required to apply to the SEAC who will hear the case according to the procedure laid down in the EIA notification and based on whose recommendation, EC may be granted or rejected by the SEIAA.

IV. For all category A projects and also category B projects where general condition applies, the project proponents are required to apply directly to The Ministry of Environment, Forests & Climate Change (MoEFCC), Government of India, who would consider the project for grant or rejection of the EC based on the recommendation of the Expert Appraisal Committee at the central level.

V. If projects attract CRZ clearance, then clearance under CRZ rules is also required.

1.2.2. Coastal Regulation Zone (CRZ)

The Union Cabinet approved the Coastal Regulation Zone (CRZ) Notification, 2018 which were last reviewed and issued in 2011. The notification was released after a series of representations received by the Ministry of Environment, Forest & Climate Change (MoEF&CC) from various Coastal States/UTs for a comprehensive review of the provisions of the CRZ Notification, 2011.

1.2.2.1. Classification of CRZ

For the purpose of conserving and protecting the coastal areas and marine waters, the CRZ area shall be classified as follows, namely: -

CRZ-I A

CRZ-I A shall constitute the ecologically sensitive areas (ESAs) and the geomorphological features which play a role in maintaining the integrity of the coast viz.: Mangroves, corals, biologically active mudflats, Marine national parks, turtle nesting grounds etc.

CRZ-I B

The intertidal zone i.e. the area between Low Tide Line and High Tide Line shall constitute the CRZ-I B.

CRZ-II

CRZ-II shall constitute the developed land areas up to or close to the shoreline, within the existing municipal limits or in other existing legally designated urban areas, which are substantially built-up with a ratio of built-up plots to that of total plots being more than 50 per cent and have been provided with drainage and approach roads and other infrastructural facilities, such as water supply, sewerage mains, etc.

CRZ-III

Land areas that are relatively undisturbed (viz. rural areas, etc.) and those which do not fall under CRZ-II, shall constitute CRZ-III, and CRZ-III shall be further classified into following categories: -

CRZ-III A

Such densely populated CRZ-III areas, where the population density is more than 2161 per square kilometer as per 2011 census base, shall be designated as CRZ-III A and in CRZ-III A, area up to 50 meters from the HTL on the landward side shall be earmarked as the 'No Development Zone (NDZ)', provided the CZMP as per this notification, framed with due consultative process, have been approved, failing which, a NDZ of 200 meters shall continue to apply.

CRZ-III B

All other CRZ-III areas with population density of less than 2161 per square kilometer, as per 2011 census base, shall be designated as CRZ-III B and in CRZ-III B, the area up to 200 meters from the HTL on the landward side shall be earmarked as the 'No Development Zone (NDZ)'.

Land area up to 50 meters from the HTL, or width of the creek whichever is less, along the tidal influenced water bodies in the CRZ III, shall also be earmarked as the NDZ in CRZ III.

CRZ- IV

The CRZ- IV shall constitute the water area and shall be further classified as under:

- **CRZ- IVA**

The water area and the sea bed area between the Low Tide Line up to twelve nautical miles on the seaward side shall constitute CRZ-IV A.

- **CRZ- IVB**

CRZ-IV B areas shall include the water area and the bed area between LTL at the bank of the tidal influenced water body to the LTL on the opposite side of the bank, extending from the mouth of the water body at the sea up to the influence of tide, i.e., salinity of five parts per thousand (ppt) during the driest season of the year.

1.2.3. EMMP Plan

As per the guidelines of Ministry of Environment Forests and Climate Change and also as per the environment management plans submitted by various agencies during their EIA studies, DPT has appointed M/s. Detox Corporation Pvt. Ltd. for the work of "Preparing and Monitoring of Environmental Management Plan for Deendayal Port Trust at Kandla vide Work Order No. EG/WK/EMC/11023/2011/IV/213 Dated-07/12/2019.

As part of this assignment, M/s. Detox Corporation Pvt. Ltd. prepared an Environmental Management and Monitoring Plan (EMMP) and submitted this EMMP prior to commencement of the Environment Monitoring of Deendayal Port in February 2020. The EMMP summarized the background information as a resource to develop Environment Monitoring Plan, based on the results of the EIA studies carried out at Deendayal Port by several agencies.

This environmental Management and Monitoring Plan (EMMP) plan submitted in February 2020 was the key document in the environmental management system and set out the detailed targets, objectives and procedures that are adopted in order to achieve the goals to efficiently manage the environmental policy of Deendayal Port Trust.

2. DEENDAYAL PORT TRUST

Deendayal Port is one of the most important ports of India. This port is situated at Latitude 23º 01′ N and Longitude 70º 13′ E on the shores of the Kandla Creek. The Deendayal Port came into existence in the year 1931 with a single Pier construction. Later on with the loss of Karachi port to Pakistan during partition, after independence the Government of India chose Kandla as an ideal sea outlet. Thus the Deendayal Port was developed and since then Deendayal Port has played a pivotal role in enhancing country`s maritime trade.

The Port of Kandla was declared a major port in 1955. The Deendayal Port Trust was created by law in 1963 to manage the new port. In 1978, The Deendayal Port had commissioned the off-shore Oil Terminal facilities at Vadinar jointly with Indian Oil Corporation, by providing Single Buoy Mooring (SBM) system, having a capacity of 54 MMTPA, which was first of its kind in India. Further, significant quantum of infrastructure up-gradation has been effected, excellent maritime infrastructure has been created having capacity of 32 MMTPA by M/s Essar Oil Refinery in Jamnagar district.

The port governed by Deendayal Port Trust (DPT) is a gateway port to the hinterland in western and northern states of Jammu & Kashmir, Delhi, Punjab, Himachal Pradesh, Haryana, Rajasthan, Gujarat and parts of Madhya Pradesh, Uttaranchal and Uttar Pradesh. It is in the district of Kutch and is located on the west bank of Kandla creek which runs into the Gulf of Kutch at a distance of 90 nautical miles from the Arabian Sea. The Port is well connected by the network of rail and road and is a gateway port for export and import of goods for northern states (Map 1). The width

of the channel varies from 200 meters to 1,000 meters. The contour depth along the shipping channel is around 10 meters. The total length of the Deendayal Port approach Channel is around 23 kms. Presently, the Port has sixteen cargo berths for handling dry cargo traffic, six oil jetties for handling Petroleum Oil products and other liquid cargo traffic at Kandla Creek and 3 Single Buoy Mooring (SBM) at Vadinar for handling crude oil and two product jetties for handling petroleum products.

2.1. The Physical Environment

Deendayal Port (23^0 02′ 29.92″ N, 70^0 13′ 08.99″ E) is located at the tail end of Gulf of Kachchh (GoK), an east west oriented Gulf system in the western part of Gujarat. It is about 90 nautical miles from the open waters of Arabian Sea. Kandla creek harboring the Deendayal Port is one of the major creeks of the inner Gulf of Kachchh. Gulf of Kachchh (GoK) is 75 km wide at its mouth and after running about 170 km away from the Arabian sea towards east, narrows down into a constriction at 70^0 20′ E at *Sat Saida* Bet and then bifurcates into many creek systems (Map 1). The Little Rann at the tail end of GoK has a network of many small and large creeks, intermingling with marshy tidal flats rich in fine clays. Kandla creek is one of the major tributaries of this creek system, which empties into the inner GoK. All these creeks bring water from the Little Rann into Kandla creek, which has a fairly good depth and stable banks.

Coastal and inland environmental setting of Kandla, similar to other parts of Kachchh, has marked climatological peculiarities like aridity, geomorphology and coastal and terrestrial ecosystems. Annual rainfall in Kachchh district was 458 mm during 2001- 10 whereas it was 443 mm at Gandhidham taluka during the same period which is often irregular. Rain during monsoon is confined to only 15-20 days and occurs as an instant downpour. The mean rainfall in year 2019 was 194 mm.

On the terrestrial side there are no major rivers or rivulets or freshwater streams. Winter and summer temperatures range from 7°- 47°C with a yearly average humidity of 60% which increases to 80% during southwest monsoon and decreases to 50% during November-December. Average wind speed is 4.65 m/s with a maximum of 10.61 m/s during June. Drought is a common phenomenon in Kachchh with 2 drought year in a cycle of 5 years. Annual temperature fluctuation in the district is extreme, ranging from 4°C to 47.5°C.

2.2. Biophysical Environment

a. Creek system

The creek system consists of 3 main creeks the Nakti, the Kandla and the Hansthal, and the Little Gulf of Kutch interconnecting through many other big and small creeks, all along the coast. Very few rivers drain into the Gulf and they carry only a small quantity of freshwater, except during the brief monsoon. They are broad-valleyed and their river bed is mostly composed of coarse sand and gravel. The Gulf is uniquely characterized by numerous hydrographic features like pinnacles, as much as 10 m high. The southern shore has numerous islands and inlets covered with mangroves and surrounded by coral reefs. The northern shore is predominantly sandy or muddy confronted by numerous shoals.

The Marine water of Gulf of Kutch and its creeks like Kandla creek, Nakti creek and Khori creek are providing the suitable habitat for marine vegetation. The Gulf abounds in marine wealth and is considered as one of the biologically rich marine habitat along the west coast of India. The marine vegetation is highly varied, which includes sand dune vegetation, mangroves, sea grasses, macrophytes and phytoplankton. The dominant species of sand dune flora are *Euphorbia caudicifolia, E. nerifolia, Aloevera sp, Ephedra foliata, Urochodra setulosa, Sporobolus maderaspatenus,*

Eragrostis unioloides, Calotropis procera, Fimbristylis sp, *Indigofera* sp and *Ipomoea pescaprae*. The common sea grasses found growing on the mud flats are *Halophila ovata* and *H.beccarii*.

b. Mangroves

Deendayal Port Trust (DPT) is one of the largest ports of India in terms of volume of cargo handled. Among Indian ports, this port also has the largest coastal habitats such as mangroves (193.1 km2) and mudflats (312.9 km2). DPT has implemented mangrove plantation in 1300 ha during 2005 - 2017 through various implementing agencies at Sat Saida Bet, Nakti creek and Kantiyajal. The Deendayal Port Trust has entrusted the task of evaluating 1300 ha of mangrove plantation in these three locations to Gujarat Institute of Desert Ecology (GUIDE), Bhuj.

Coastal belt in and around Kandla region is characterized by a network of creek systems and mudflats which are covered by sparse halophytic vegetation like scrubby to dense mangroves, creek water and salt encrusted land mass which forms the major land component. The surrounding environment in a radius of 10 km from the Port is mostly built up areas consisting salt works, human habitations and Port related structures on west and north, creek system, mangrove formations and mudflats in the east and south. Deendayal Port and its surroundings have mangroves, mudflats and creek systems as major ecological entities.

Mangrove plantation activity by DPT was initiated in 2005 as mandated by the Ministry of Environment, Forests & Climate Change (MoEF&CC). Subsequently, 1300 ha of mangrove plantation has been completed till the end of 2017 in different years in order to meet the legal mandate of Ministry of Environment, Forests and Climate Change (MoEF & CC). The mangrove plantation activities were carried out at Sat Saida Bet, Nakti creek and Kantiyajal of Bharuch district in South Gujarat. At Sat Saida Bet,

plantation activities were carried out in phased out manner i.e. 20 ha during 2005-2006, 200 ha during 2011-2012, 300 ha during 2012-2013, and 330 ha during 2013-2014 (Plate1). At Nakti creek plantation was carried out during 2008-2009 and 2010-2011 in 50 ha and 100 ha, respectively (GUIDE, 2018).

A. marina was the preferred species for plantation activities in all the three locations due to prevailing high salinity and high success rate of this species. At Nakti creek *Rhizophora mucronata* and *Ceriops tagal* were also planted in small numbers along with *A. marina*. Likewise, at Kantiyajal attempts were made for planting *R. mucronata* along with *A. marina*.

c. Marine Fauna

In the marine environment of Deendayal Port, there are eleven species of mollusca, seven species of shrimps (Prawn) and seven species of annelids. Besides these, there are twelve groups of phytoplankton, 7 groups of zooplanktons. The density of meio-fauna ranged from 382 to 670 nos/10 cm^2. The density of benthic macro fauna ranged from 952 to 1092 no/m^2. The dominant macro-faunal group was porifera (Mantec, 2014).

d. Terrestrial Biodiversity

Sensitive ecological habitats like forest, grassland, agricultural land, wetlands are absent within and in the proximity of the Deendayal Port due to its highly built-up nature. The species richness and abundance of aquatic birds and terrestrial fauna (reptiles, mammals) in the port environ and its surrounding was low with least conservation significance.

There are 11 species of herpetofauna (reptiles and amphibians), 53 species of terrestrial birds, 49 species of aquatic birds in the Port Environs. Due to absence of forest habitat in the immediate vicinity of Deendayal Port, only nine species of mammals were recorded with very low abundance.

Map 1: Deendayal Port and its Physical Environs

3. Environment Management Plan

Port activities can often affect the quality of air, noise and marine water in the surrounding areas due to the wide range of port operation activities. For the determination of environment quality, need for identification of sources, control and disposal of waste from various point and non-point sources and for prediction of various parameters of sound environmental quality, regular monitoring and assessment are required.

The Environment management plan is the key document in the environmental management system and sets out the detailed targets, objectives and procedures that will be adopted in order to achieve the goals set out in the environmental policy.

It is extremely essential that port and harbour projects should have an environmental management plan (EMP), which also incorporates monitoring of air, noise, soil and marine water quality along with the collection of meteorological data.

Deendayal Port Trust targets the achievement of high environmental standards and strives to ensure that activities within the Port are environmentally and ecologically sustainable and have minimal impact on the natural environment.

Several developmental projects have been initiated and EIAs have been carried out for the said projects. These EIA studies have also submitted the suggestions on the environmental management of the project area and Deendayal Port in general. These suggestions and mitigation measures have also been considered in framing the current environment management plan.

The present Environment Management Plan summarizes the suggestions of the ECs received from the Ministry of Environment, Forests & Climate Change (MoEF & CC), and consents granted by Gujarat Pollution Control Board (GPCB).

The projects for which ECs were granted and which formed the framework of the present EMP are as below;

- EC and CRZ Clearance for Construction of 13th to 16th Cargo berth at Kandla in year 2008
- EC & CRZ clearance for development of plots for construction of liquid storage tank farms at Kandla , district Kutch in year 2009
- Environmental and CRZ Clearance to DPT for development of plots for construction of warehouses/Godowns (stage II) in year 2012.
- Environmental and CRZ clearance for Single Point Mooring (SPM) and Allied facilities off Veera in the Gulf of Kachchh for handling Crude Oil on BOT basis in year 2013.
- Developing seven integrated facilities within the Existing Kandla port at Kandla, Gujarat –December 2016
- Proposed Smart Industrial Port City (SIPC) at green Field Site 1 (Adipur side –Northeast of Antarjaal, South of Tagore Road, 580 Acres), Gandhidham, Kutch -Gujarat" - October 2017
- Proposed Smart Industrial Port City (SIPC) at Green Field Site 2 (DPT Complex, 849.96 Acres), Gandhidham, Kutch –Gujarat. – October 2017.

Based on the suggestions of the above referred EIAs, following environmental parameters have been suggested to be monitored.

3.1. Air Quality

Air quality in a port area can be affected by dust and particulates from traffic (re-suspension of road dust), site clearing, loading and un-loading of cargo, construction activity and emissions from vehicles bringing materials to the site and from ships and construction equipments. The

photochemical reactions (complex chain reactions between sunlight and gaseous pollutants), emissions from burning waste materials and escaping dust (due to handling of fine-particulate materials such as fertilizers and minerals) are also major sources of air pollution in port areas. Air quality can also be affected by secondary developments such as modernization and increased vehicular traffic.

Besides day to day port activities, ship emissions are the main source of SO in harbour areas. Emissions from port activities account for about 4.5% of total shipping emissions.

In Deendayal Port, major source of air pollution are large volumes of dry cargo especially coal handled at berths and their loading and unloading during transportation.

i. During Construction Phase

- Generation of dust due to handling and transport in uncovered trucks on dusty roads. Fugitive dust, emissions and dust generation due to concrete mixing, cement handling, welding operation of construction machinery.
- Combustion emissions from ships propulsion and auxiliary engines and boilers, followed by combustion source emissions from vehicles and land-based engines and boilers. Storage and handling of dry bulk cargo and vehicle traffic on unpaved roads, may also contribute to particulate matter emissions.

Measures to be taken

i. During Construction Phase

- Water sprinklers shall be used; Improperly functioning vehicles & equipment shall be removed; Vehicle engines shall not be left running when not in use; Prudent and good construction practices shall be used to minimize the spread of sediments;
- Vehicle trips to be minimized to the extent possible
- Any dry, dusty materials should be stored in sealed containers or

prevented from blowing

- Stack emissions from DG sets to be monitored
- Ambient air quality within the premises of the proposed project to be monitored.
- Exhaust from vehicles to be minimized by use of fuel-efficient vehicles and well maintained vehicles having PUC certificate.
- Compaction of soil during various construction activities
- Ambient air quality within the premises of the proposed project to be monitored.
- The ambient air quality will conform to the standards for PM_{10}, $PM_{2.5}$, SO_2 and NOx.

ii. During Operation Phase

- Emissions of NOx and Sox shall be maintain within the limits established by international regulations (MARPOL)
- Low-sulfur fuels shall be used in port
- Encouraging storage planning to avoid or minimize re storage and reshuffling of cargo
- Transfer equipment (e.g. cranes, forklifts, and trucks) shall be kept in good working condition
- Dust suppression mechanisms (e.g. water spray or covered storage areas) shall be used

3.1.1. Air Quality Management

The air quality at most of the locations in port areas and in residential areas should be within the norms as specified by the National Ambient Air Quality Standards barring particulate matter. However, day to day operations in the dry cargo berth areas produce more particulate matter.

The following measures are being undertaken to control fugitive dust:

- To control dust from operations at the existing dry cargo berths, especially where dusty cargo is handled, water should be sprinkled on the berths to suppress fugitive dust. Treated sewage should be utilized for dust suppression operations.
- Protection wall with wind screen should be set up to prevent spread

of fugitive dust from coal wagon loading yard.

- To reduce fugitive dust generation from transport roads, the roads from the berths to the national road network should be always kept in good repair. This would also reduce emissions from trucks' engines due to lower fuel consumption.
- Swiping of dust on routine basis should be carried out on these roads.
- Wherever possible dry bulk cargo should be transported by trucks covered with tarpaulin sheets.
- Coal dispatched in wagons should also be properly covered with tarpaulin sheets.
- Gaseous pollutants in the exhaust fumes generated by diesel powered machinery should be minimized by ensuring vigorous maintenance adhering to stringent overhaul schedules.
- Green belt should be developed along the side of the roads, railway lines and stack-yards to screen fugitive dust generated from the roads.

3.2. Noise Quality

Ports contain several noise sources in various sectors with different characteristics. Sources include, ships, trade operations, loading and unloading of the cargo, transportation and movement of heavy vehicles. Such activities strongly impact the environment of the surrounding area and, as a consequence, port workers.

i. During Construction Phase

- Vehicular noise, use of excavation equipment; Use of construction equipment and power tools; Use of pile drivers, boring equipment, power tools, drill bits, etc.

ii. During Operation Phase

- Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships.

- Generation of vehicular noise

Measures to be taken

i. During Construction Phase

- During night time transportation activities shall not be allowed
- Adequate silencers must be attached with all vehicles to reduce the noise
- Machineries/equipment causing high noise level shall not be operated during the night time
- Construction machinery shall be in good working condition and engines turned off when not in use.
- Suitable mufflers on engine exhausts and compressor components shall be installed
- Acoustic enclosures for equipment casing radiating noise shall be installed
- Vibration isolation for mechanical equipment shall be installed
- Personal Protective Equipments shall be provided for eardrum protection of the workers as well as visitors
- Periodical maintenance of all equipments and transport vehicles shall be done.
- Implement good working practices (equipment selection and siting) to minimize noise and reduce its impacts on human health (ear muffs, safe distances, and enclosures).
- Noise to be monitored in ambient air within the project premises.
- All equipment operated within specified design parameters.
- Vehicle trips to be minimized to the extent possible

ii. During Operation Phase

- Suitable mufflers on engine exhausts and compressor components shall be installed
- Acoustic enclosures for equipment casing radiating noise shall be installed
- Vibration isolation for mechanical equipment shall be installed
- noise sources shall be relocated to less sensitive areas to take advantage of distance and shielding
- Periodical maintenance of all equipments and transport vehicles shall be done.

3.2.1. Noise Quality Management

At the port, noise is generated due to operation of high capacity liquid cargo pumps, diesel powered trucks, cranes and other material handling equipment, diesel powered railway locomotives, railway wagons, and ships' horns (occasionally). The following measures shall be implemented to control noise:

- High capacity liquid cargo pumps, diesel powered mobile cargo handling equipment, should be properly maintained as per maintenance schedule to reduce noise. Attention should be paid towards rigorous maintenance of the silencers of diesel engines.
- Operators should be issued earmuffs. Wearing personal protective equipment should be compulsory and the Safety Officer / Supervisor should carry out regular inspections to this effect. Duty hours of operators of noisy machinery may be regulated to keep their noise exposure levels within limits.
- The dust barriers comprising of high-walls also act as a noise barrier.
- Dispatch of materials by trucks should be regulated such that, the traffic is evenly distributed. This will avoid congestion and consequent excessive noise and vehicular emissions.

3.3. Water Quality

Deendayal Port is one of the largest port of the country and thus, is engaged in wide variety of activities such as movement of large vessels, oil tankers and its allied small and medium vessels and handling of dry cargo several such activities whose waste if spills in water, can cause harmful effects to marine water quality. Regardless of their size, the environmental impact of seaports largely depends on these commercial activities. In port areas or in their vicinity, several activities, such as fisheries, industrial installations, storage of hazardous materials, may cause further environmental impacts.

i. During Construction Phase

- Turbidity level may increase in the water body due to dredging and other construction activity which may lead to the considerable impacts on marine resources. Increase turbidity may affect the rate of the photosynthetic activity of the aquatic life.

ii. During Operation Phase

- Water effluents associated with port activities may include storm water and sewage from port operations, as well as sewage, ballast water, bilge water, and vessel cleaning wastewater from ships.

Measures to be taken

i. During Construction Phase

- Excavation and dredging methods will be selected to minimize suspension of sediments
- Care should be taken that no construction material shall fall in the water
- Plastics sheet or tarpaulin shall be provide in order to avoid any chance of dumping of construction materials into the water
- Storage area of the construction material shall be at adequate distance from the coastal area.
- No untreated discharge to be made to surface water, groundwater or soil.
- The discharge point should be selected properly and sampling and analysis should be undertaken prior to discharge
- Take care in disposal of wastewater generated such that soil and groundwater resources are protected.
- Ensure drainage system and specific design measures are working effectively.

ii. During Operation Phase

- No untreated discharge to be made to surface water, groundwater or soil.
- Take care in disposal of wastewater generated such that soil and groundwater resources are protected
- Installation of storm drainage catch basins to avoid discharge directly into surface waters

- Oil /water separators and trapping catch basins shall be provided
- The capacity of oily waste collection shall be established based on applicable MARPOL provisions
- Wastewater with noxious chemicals from bulk tank cleaning shall be collected through appropriate on-site or off-site treatment prior to discharge.
- Drinking water parameter will be monitored as per requirement of GPCB/MoEF & CC

3.4. Impact on Marine Fauna (Planktons & Benthos)

i. During Construction Phase

- Pilling & dredging may lead to increased turbidity, less penetration of light and hence less photosynthesis and resulting less primary productivity. Due to this fishes and other fauna may migrate.

ii. During Operation Phase

- Spillage of Oil & wastes from Ships may impact on the creek biota, especially mangroves and fishes.

Measures to be taken

i. During Construction Phase

- Pilling and dredging shall be done by such methods so as to reduce the impact.

- Silt curtain shall be used to reduce the impact of turbidity and thus reducing the loss of primary productivity and subsequent impact on food chain

ii. During Operation Phase

- No discharge from ships shall be allowed, MARPOL norms shall be complied.
- Due care shall be taken from spillage of the oil and other chemicals during loading or unloading.

3.5. Hazardous Waste / Oil Spills

- Spills may occur due to accidents (e.g. collisions, groundings, fires), equipment failure (e.g. Pipelines, hoses, flanges), or improper

operating procedures during cargo transfer or fueling.

Measures to be taken

- Oil and chemical-handling facilities shall be located with consideration of natural drainage systems and environmentally-sensitive areas
- Hazardous materials storage and handling facilities shall be constructed away from active traffic
- DPT shall follow the spill prevention, control, and countermeasure plan consistent with the IMO Manual on Oil Pollution Section II-Contingency Planning.
- Implement waste management plan that identifies and characterizes every waste arising associated with proposed activities and which identifies the procedures for collection, handling and disposal of each waste arising.

3.6. Hazardous Waste Management

Hazardous waste means any waste which by reason of characteristics such as physical, chemical, biological, reactive, toxic, flammable or corrosive, causes danger to health or environment. It comprises the waste generated during the manufacturing processes of the commercial products such as industries involved in petroleum refining, production of pharmaceuticals, petroleum, paint, aluminum, electronic products, etc. Management of hazardous waste mainly includes two components viz. i) Collection, Waste handling and Segregation 7 ii)Treatment, Storage and Disposal.

Disposal of solid waste generated by ships calling at DPT has been outsourced and the collection & disposal are undertaken by the Licensed Agencies. The removal of hazardous and non-hazardous wastes such as garbage, food waste, plastic, metal, batteries, etc., are done in accordance with the provisions of the Hazardous Waste (Management & Handling

Rules) and in compliance of the guidelines of Pollution Control Boards, MARPOL 73/78 and other Statutory Authorities.

The Companies authorized by the Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB) have been awarded the work of collection, transportation and disposal of hazardous Wastes by the Deendayal Port Trust. The same is handed over to authorize parties for further Treatment & disposal.

3.6.1. Policy and Management

Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs) together form the regulatory and administrative core of the waste management sector in India. At the state level, the management of solid waste is the responsibility of Urban Local bodies. Industries generating hazardous wastes must seek permission from the respective SPCB. A key issue is that municipal authorities do not possess the budgets to adequately cover the costs associated with developing effective waste management systems. The lack of strategic plans, as well as systems for governance (particularly waste collection/segregation) and regulation are major barriers to achieving effective Solid Waste Management (SWM) in India.

3.6.2. Deendayal Port Trusts' Policy on Waste Management

Deendayal Port Trust should appoint recognized consultancy firm in the field of Environmental Planning & advisory services (NABET–accredited agency in sector Ports, harbours, jetties, terminals, break water and dredging), for–preparation of waste management plan of–entire DPT–area considering various rules/regulations in force with following objectives;

- Identification & categorization of various Wastes, into hazardous & non-hazardous Biodegradable wastes , Solid wastes including C & D Wastes, Biomedical Waste ,plastic waste, E- waste etc. with assessment of quantity & disposal.

- Separate identification of Ship waste into hazardous, non-hazardous & Biodegradable waste as per the MARPOL 73/78 (as amended) and other conventions of IMO as applicable for Port and Harbour.
- Preparation of Training Module for Port officers & Employees.
- The consultant shall have to coordinate with all concerned departments of DPT for collection of required details/information/data.
- The selected consultant shall have to provide comprehensive reception and safe disposal facilities plan with subsequent monitoring plan including provision for engagement external agencies/private operators.
- The selected consultant is required to list out requirement & procedure for obtaining necessary clearance/license from statutory authorities under respective category of waste management rules.
- Review Procedure with respect to Audits/Inspection reports of licensed contractors.
- Consultant shall have to assist DPT in implementation of waste management plan during the contract period.
- Considering above all, the consultant shall have to prepare & submit detailed waste management plan covering all wastes and also shall have to prepare & submit waste management plan of each waste, separately, as under:

  ✓ Solid waste management plan including C & D wastes as per Municipal solid wastes (management & handling) rules, 2000 & C & D wastes management rules 2016 (GSR 317 E dated 29/3/2016).

  ✓ Plastic waste Management Plan as per plastic waste management Rules 2016 (GSR 320 (E) dated 18/3/2016).

  ✓ E wastes management plan as per e waste management rules 2016 (GSR 337 E dated 23/3/2016).

  ✓ Biomedical waste management plan as per Bio medical wastes management rules 2016 & its subsequent amendment in 2019.

  ✓ Hazardous & other wastes (Management & trans-boundary

movement) Rules, 2016 & subsequent amendment in 2019.

3.6.2.1. Measures taken by Deendayal Port Trust

- DPT obtained authorization from the GPCB vide Consent (Consolidated Consent & Authorization) Order no. AWH -72820 date of Issue: 31/08/2015, valid up to 21/7/2020.
- Deendayal Port Trust is maintaining the records for collection and disposal of Wastes generated from Port area etc.
- Deendayal Port Trust is regularly submitting the Hazardous Waste Statement in From – IV every financial year to the Gujarat Pollution Control Board, Gandhinagar.
- A report on collection and disposal of the wastes from ships is submitted by the licensees to Deendayal Port and GPCB.
- The DPT officials inspect each vessel calling at the Port with reference to the Garbage Record Book in accordance with the MARPOL 1973/78.

3.6.3. Bio-medical Waste Management

To protect the environment and human health from infectious bio-medical waste, Ministry of Environment, Forest and Climate Change, vide Notification G.S.R. 234(E) dated March 16, 2018 made amendments to Bio-Medical Waste Management Rules (1998), to improve compliance and strengthen the implementation of environmentally sound management of biomedical waste in India.

Salient features of Bio-Medical Waste Management (Amendment) Rules, 2018 are as follows:

1) Bio-medical waste generators including hospitals, nursing homes, clinics, dispensaries, veterinary institutions, animal houses, pathological laboratories, blood banks, health care facilities, and clinical establishments will have to phase out chlorinated plastic bags (excluding blood bags) and gloves by March 27, 2019.

2) All healthcare facilities shall make available the annual report on its website within a period of two years from the date of publication of the Bio-Medical Waste Management (Amendment) Rules, 2018.
3) Operators of common bio-medical waste treatment and disposal facilities shall establish bar coding and global positioning system for handling of bio-medical waste in accordance with guidelines issued by the Central Pollution Control Board by March 27, 2019.
4) The State Pollution Control Boards/ Pollution Control Committees have to compile, review and analyze the information received and send tis information to the Central Pollution Control Board in a new Form (Form IV A), which seeks detailed information regarding district-wise bio-medical waste generation, information on Health Care Facilities having captive treatment facilities, information on common bio-medical waste treatment and disposal facilities.
5) Every occupier, i.e. a person having administrative control over the institution and the premises generating biomedical waste shall pre-treat the laboratory waste, microbiological waste, blood samples, and blood bags through disinfection or sterilization on-site in the manner as prescribed by the World Health Organization (WHO) or guidelines on safe management of wastes from health care activities and WHO Blue Book 2014 and then sent to the Common bio-medical waste treatment facility for final disposal.

3.6.4. Plastic Waste Management

The Government has notified the Plastic Waste Management Rules, 2016, in suppression of the earlier Plastic Waste (Management and Handling) Rules, 2011.The draft rules, namely the Plastic Waste Management Rules, 2015 were published by the Government of India vide G.S.R. 423(E), dated the 25th May, 2015 in the Gazette of India, inviting public objections and suggestions. The Plastic Waste Management Rules, 2016 aim to:

- Increase minimum thickness of plastic carry bags from 40 to 50 microns and stipulate minimum thickness of 50 micron for plastic sheets also to facilitate collection and recycle of plastic waste,

- Expand the jurisdiction of applicability from the municipal area to rural areas, because plastic has reached rural areas also;
- To bring in the responsibilities of producers and generators, both in plastic waste management system and to introduce collect back system of plastic waste by the producers/brand owners, as per extended producers responsibility;
- To introduce collection of plastic waste management fee through pre-registration of the producers, importers of plastic carry bags/multilayered packaging and vendors selling the same for establishing the waste management system;
- To promote use of plastic waste for road construction as per Indian Road Congress guidelines or energy recovery, or waste to oil etc. for gainful utilization of waste and also address the waste disposal issue; to entrust more responsibility on waste generators, namely payment of user charge as prescribed by local authority, collection and handing over of waste by the institutional generator, event organizers.

3.6.5. E-Waste Management

Ministry for Environment, Forest and Climate Change, has amended the E-waste (Management) Rules vide notification G.S.R. 261(E), dated March 22, 2018 in supersession of the e-waste (Management & Handling) Rules, 2011. The amendment was done to facilitate and effectively implement the environmentally sound management of e-waste in India with the objective of channelizing the E-waste generated in the country towards authorized dismantlers and recyclers in order to formalize the e-waste recycling sector.

Some of the salient features of the E-waste (Management) Amendment Rules, 2018 are as follows:

1) The e-waste collection targets under Extended Producer Responsibility (EPR) have been revised and will be applicable from 1 October 2017. The phase-wise collection targets for e-waste in weight shall be 10% of the quantity of waste generation as indicated in the EPR Plan during 2017-18, with a 10% increase every year until 2023. After 2023 onwards,

the target has been made 70% of the quantity of waste generation as indicated in the EPR Plan.

2) Separate e-waste collection targets have been drafted for new producers, i.e. those producers whose number of years of sales operation is less than the average lives of their products. The average lives of the products will be as per the guidelines issued by CPCB from time to time.

3) Producer Responsibility Organizations (PROs) shall apply to the Central Pollution Control board (CPCB) for registration to undertake activities prescribed in the Rules.

4) Under the Reduction of Hazardous Substances (RoHS) provisions, cost for sampling and testing shall be borne by the government for conducting the RoHS test. If the product does not comply with RoHS provisions, then the cost of the test will be borne by the Producers.

3.6.6. E-waste Management at Deendayal Port Trust

"E-Waste (Management & Handling) Rules, 2011 were notified in 2011 and had come into force since 1st May, 2012. In order to ensure effective implementation of E-Waste Rules and to clearly delineated the role of producers in EPR, MoEF&CC, Government of India in supersession of E-Waste (Management and Handling) Rules, 2011 has notified the E-Waste (Management) Rules, 2016 vide G.S.R. 338(E) dated 23.03.2016 which will be effective from 01-10-2016.

Over a period of 20 years several IT items and consumables got accumulated and during *Swachh Bharat Abhiyan* conducted by the Port during 2017, the E-waste (viz. CPU, Monitor, Keyboards, Printers, Mouse, UPS, Stabilizer, etc.) were accumulated and were disposed off and stored at one location in the Port for E-waste disposal as per regulations.

3.7. Dredging Management

The present guidelines for dredging management has been suggested by the Ministry of Shipping in the report titled "Guidelines on undertaking dredging at major Ports" released in November, 2015.

When the major ports plan to take up a capital dredging project irrespective of the size of the project, the following actions have to be taken up by the ports simultaneously so that proposal can be taken to approval stage at the earliest possible time.

I. Engaging Marine survey, Geo technical/Geo physical survey agencies to carry out bathymetric surveys, geo technical investigations etc., if the same is not available with the port

II. Preparation of Detailed Project Report/Feasibility Report/other port specific investigation required if any by consultants or by Port themselves.

III. Engaging Agencies wherever required as per the provision, for preparation of Environment Impact Assessment

3.7.1. Deendayal Port Trusts' Policy on Dredging Management

The Ministry of Environment, Forest and Climate Change (MoEF & CC), had asked DPT to carry out the *"Study on Dredged Material for presence of contaminants"* as accorded by the MoEF & CC, GoI dated 19/12/2016.

Based on the above condition, DPT should assign the task of carrying out the study "*Studies on Dredged materials for the presence of contaminants and suggesting suitable disposal options*" to Gujarat Institute of Desert Ecology (GUIDE), Bhuj for the period of Nov 2018 to October 2021, with following objectives;

- To monitor the locations where dredged materials are dumped will be conducted.
- Dredged materials in the area will be analyzed for the presence of contaminants in two different locations.
- Detailed assessment of the dredged materials for physical, chemical and biological characteristics will be studied.
- Suggesting suitable disposal options for the dredged material will be made.

Further, the study will envisage the evaluation of physico-chemical constituents in the dredged materials in the dumped locations in the study area.

3.7.2. Managing Dredging Impacts

(As suggested by GUIDE vide their report on "*Studies on Dredged materials for the presence of contaminants and suggesting suitable disposal options*")

Some measures to be taken to prevent the reach of dredged materials reach to nearby sensitive environment are listed below:

- In order to ameliorate the likely impacts due to sediment load through changes in operational procedure such as appropriately timing the operation in tune with tides and tidal current direction) may be considered.
- Efforts may be attempted in disposing the trapped sediments only in pre-designated sites.
- Turbidity curtains, nowadays, are increasingly used during dredging operations as suggested by Researchers (Sawaragi, 1995; Elander and Hammar, 1998; Otoyo, 2003; Dreyer, 2006; Guo *et a!.,* 2009; Ishizaki and Rikitake, 2010; Ueno, 2010, Trang and Keat, 2010) which could also be attempted based on its operational convenience. Moreover various other factors such as current speed, water depth and wave heights to be considered as these also play role in the efficiency of Turbidity curtains. Turbidity curtains allow suspended sediments to settle out of the water column in the dredging spot thus minimizing sediment transport towards the shore. Constructed with thermoplastic material, they serve as a primary method to control turbidity in dredging sites. There are various types of curtains like floating, hanging, solid diversion baffles and permeable and impermeable screens. However, they have proved to be an effective method to contain sediment load in ecologically sensitive areas such as mangroves and corals during dredging operations.
- Many management measures such as enhancing the biodiversity of the intertidal/sub tidal areas by means of artificial reef structures and controlling water column turbidity by deploying mechanisms to trap silts arising out of dredging activity may be better options which can be implemented by the port authorities.

3.8. Other Important International Treaties and Indian acts supporting EMP

Shipping is an international activity and hence national specifications and regulations relating to loading and safety at sea are largely based on international agreements and conventions. International regulations relevant to port and harbors are given herein. India is a signatory to these International agreements/conventions.

3.8.1. Shipping

i. International Maritime Dangerous Goods Code (IMDG-code)

The IMDG code relates to methods of safe transport of dangerous cargoes and related activities. It sets out procedures for documentation, storage, segregation, packing, marking and labelling of dangerous goods (http://hazmat.dot.gov.imdg.html).

ii. International Convention for the Prevention of Pollution from ships (MARPOL)

The main objectives of this convention are to prevent the pollution of the marine environment by the operational discharges of oil and other harmful substances and the minimization of the accidental discharges of such substances. Further details are available at www.imo.org/imo/ convent/pollute.html.

iii. United Nations Convention on the Law of the Sea (UNCLOS), 1982

The main objective is the obligation to prevent pollution damage by addressing particular sources of pollution, including those from land based activities, seabed activities, dumping, vessels and from or through the atmosphere. (www.tufts.edu/departments/fletcher/ multi/texts/BH825.txt).

3.8.2. Other International Conventions

i. Ramsar Convention on Wetlands

The Convention on Wetlands, called the Ramsar Convention, is an inter-governmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources (http://www.ramsar.org).

ii. Convention in International Trade in Endangered Species (CITES)

CITES is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival (http://www.cites.org).

3.8.3. Indian Acts

- The Indian Ports Act, 1908 and amendments thereon
- The Wildlife (Protection) Act, 1972 and amendments thereon
- The Water (Prevention & Control of Pollution) Act, 1974 and amendments thereon
- The Water (Prevention & Control of Pollution) Cess Act, 1977 and amendments thereon
- The Forest (Conservation) Act, 1980 and amendments thereon
- The Air (Prevention & Control of Pollution) Act, 1981 and amendments thereon
- The Environmental (Protection) Act, 1986 and amendments thereon
- The Public Liability Insurance Act, 1991 and amendments thereon
- The Biological Diversity Act, 2002 and amendments thereon (http://envfor.nic.in)
- The Indian Explosives Act, 1884 and amendments thereon (http://explosives.nic.in)

3.9. General Considerations for Environment Management of Deendayal Port

During the developments of key projects for Kandla Port, as the guidelines of the Ministry of Environment, Forests & Climate Change (MoEFCC), (Govt. of India), Central Pollution Control Board and Gujarat Pollution Control Board, DPT with reputed EIA consultants carried out comprehensive EIA and reports were submitted to respective departments. Based on these EIA studies, several key considerations for the management of Environment were suggested which are listed as below as per the category.

3.9.1. Construction and Operation Phase

- Heavy vehicles shall be covered with tarpaulin sheets to minimize fugitive dust from moorum during transportation
- There shall be regular emission checks on vehicles
- Wherever required, culverts, road crossings may be provided for uninterrupted flow of creek waters
- Storage areas shall be lined to prevent any leaching. The yards shall be covered to prevent any dust emission from the stored cargo
- Solid wastes generated shall be collected and disposed appropriately
- Movement of construction barges, ships, machinery etc should be restricted to the pre-decided operational area, to avoid disturbance to larger marine area
- There shall be bunding around the proposed construction site to prevent leaching of material from the site into the coastal waters
- It shall be ensured that construction debris is cleared by the contractor after completion of work

3.9.2. Control of Discharge

- All liquids containing oil shall pass into the sea only via oil separation systems (MARPOL Regulation 9 & 12).

- Sludge shall not be discharged. The sludge and the separated oil residues are either to be incinerated on board in special furnaces or discharged in port to the oil collection facilities.
- Adequate facilities for discharging oily residues shall be provided and effective supervision and monitoring of adherence to the regulations shall be done.
- The servicing yards shall be provided with appropriate facilities for receiving oily residues and other solid wastes such as batteries etc.
- Channels of minimum 1m widths and frequent intervals shall be provided around the plots to provide drainage in the event of tidal ingress in the creek.
- Proper drainage shall be designed and provided for flushing out tidal inflows

3.9.3. Control of Exhaust Emissions from Vessels

- Exhausts shall be frequently cleaned
- Correct adjustment and maintenance of engines and boilers shall be ensured.
- Mechanical precautions (like safety valves) shall be included to ensure the containment of the gases which escape during loading and discharge operations
- There shall be a reporting structure and responsibility for handling spills; Emergency numbers for contact during emergencies shall be readily available at the harbour.
- Fuel storage tanks shall be frequently monitored for leakages
- Fuel lines shall be adequately protected from being tampered

3.9.4. Compensatory Afforestation

- DPT shall be responsible for compensatory afforestation for mangroves lost due to proposed developmental activities. This shall be carried out in consultation with organizations like Gujarat

Department of Forest Department / various agencies and with mangrove experts.

4. Environment Management Policy of Deendayal Port Trust

In 2013, the DPT achieved certification of its Environmental Management System to ISO 14001. In 2019, DPT obtained ISO 14001:2015 certifications. One of the key requirements of the ISO 14001 series is that the systems, plans and controls are under the operational control of the entity committed to managing the activity. The DPT also manages environmental risk to land and marine areas under its control arising from third party industrial activities. While these parties and the associated risks are covered in the risk register, the controls are managed by standalone EMP's of the third party in accordance with the DPT development Approval Process and /or through direct state or central Government requirements as part of an:

- Environmental Clearance, CRZ Clearance, in the case of a new project; and
- Consent to Establish /NOC for an establishment, and Consent to Operate/NOC for operation of the projects.

4.1. The Key Objectives of Deendayal Port Trust

- To provide our Clientele, efficient and economical Port services. To render value for money and value added services to our Customers to their utmost satisfaction.
- To create facilities of international standards, and facilitate quicker turnaround of vessels. To maintain peaceful industrial relations by recognizing our work force as an asset and develop them to adopt to the changing Port scenario.
- To participate in social development by contributing our mite to the society at large.
- To be Environment friendly.

4.2. QHSE Policy of Deendayal Port

Quality, Occupational health, Safety and Environmental Policy (QHSE) of Deendayal Port Trust is the statement of its intentions, principles & commitment in relation to its overall QHSE performance, which provides a frame work for the action and for the setting of QHSE objectives & targets. QHSE policy has been developed through initial status review of quality, Occupational health, Safety and Environment Management comprising of following key areas namely;

- Legislative, regulatory and other requirements
- Identification of equipment and services supporting quality of final services.
- Identification of significant OH&S risks and Environmental aspects.
- Examination of all existing environmental & Occupational health and safety management practices and procedures.
- Evaluation and feedback from the investigation of previous incidents and accidents.

The QHSE policy of Deendayal Port Trust has been communicated at all levels through display in all the relevant places. The policy has also been communicated to external parties by way of displaying it at the main gate of Deendayal Port Trust in Hindi/ English / local (vernacular) language.

Management representative of Deendayal Port Trust has established, implemented and maintaining the QHSE management system and continually improves its effectiveness by regular monitoring in accordance with the requirements of this international standard. MR has identified the various processes needed for the QHSE management system and their application throughout the organization.

The sequence and interrelation of these processes are determined to control the effectiveness of these processes & operations. The criteria &

methods are determined necessary resources & information/details are made available at the point of use so that operations & processes can be monitored. (Ref: Department Operational Manual and their Process Flow Chart).

Measurement of these processes are timely analyzed and the relevant actions are implemented to achieve planned results & for continual improvement.

QHSE Policy

Kandla Port Trust

QHSE Policy

We At Kandla Port Trust are commited to providing maritime service timely, of best quality with cost effectiveness & matching the expectation of customers with professionalism with commitment to managing environmental matters as an integral part of our business. In particular, it is our policy to assure the environmental integrity of our processes and facilities at all times and at all places. We will do so by adhering to the following principles :

Compliance

Comply with applicable laws and regulations and will implement programs and procedures to assure compliance. Compliance with environmental standards will be a key ingredient in the training, Performance reviews and motivations of all employees.

Risk Reduction, Prevention and Resource Management

Seek opportunities, beyond compliance requirement, for reducing risk to the environment, establish and meet our own quality standards where appropriate. employ management systems and procedures specifically designed to prevent activities and/or conditions that pose a threat to the environment. Look for ways to minimize risk and protect our employees and the communities in which we operate by employing clean technology, including safe technologies and operating Procedures, as well as being prepared for emergencies.

Strive to minimize release to the air, land or water through use of cleaner technologies and the safer Handling, Minimize the amount and toxicity of waste scarce resource such as water, energy, land and forests in an environmentally sensitive manner.

Communications

Communicate our commitment to our employees, vendors and customers. Solicit their input in meeting our EMS goals.

Continuously Improvement

Continuously measure our progress. We will review our progress at least on an annual basis. Continuously seek opportunities to improve our adherence to these principles and will periodically report progress to our stakeholders. Comply the requirement of International Standard for continual improvement.

5. Environment Monitoring Plan

Environment Monitoring Plan is very important for monitoring the environmental status of the port for sustainable development. The EMP mainly consists of monitoring of the Air quality, Marine water quality, Ecological and Biological quality and Noise quality of the Deendayal Port area. The monitoring programme is also required to suggest suitable mitigation measures for the deviation found in the results of the monitoring, so as to keep the pollution level within control.

The list of main elements for which Environmental monitoring is carried out is mentioned below.

- Air Quality Monitoring
- Drinking Water Monitoring
- Noise Monitoring
- Marine Water Monitoring
- Soil Monitoring
- Sewage Treatment Plant Monitoring
- Meteorological Monitoring

M/s Detox Corporation Pvt. Ltd. appointed by Deendayal Port Trust will carry out monitoring of the various environmental aspects of the port with following objectives;

- To review the locations of ambient air and marine water quality monitoring stations within the impacted region in and around DPT establishment, in view of the developmental projects.
- To assess the ambient air quality and marine water quality at selected stations in terms of gases and particulate matter, physical, chemical and biological parameters for the assignment period.
- To assess the marine water quality in terms of aquatic flora and fauna and sediment quality in terms of benthic flora and fauna.
- To assess the trends of air and water quality by comparing the data

collected over a specified time period.

- To assess the trends of water quality in terms of marine ecology by comparing the data collected over a specified time period.
- To review the results and to check compliance with environmental quality standards.
- To suggest mitigation measures, if necessary, based on the findings of this study.
- To recommend future action plans on air and marine water quality monitoring programme based on the findings of this study.
- Drinking Water samples at twenty stations will also be monitored for various physical, chemical and biological parameters viz., color, odor, turbidity, conductivity, pH, total dissolved solids, chlorides, hardness, total iron, sulfate, NH4, +-N, PO4, and bacterial count on a monthly basis.
- Every week a sample (inlet and outlet) of the Sewage Treatment Plant (STP) shall be analyzed to see the water quality being discharged by DPT. However, the results will be submitted every month. If in a particular month any deviation is observed, the same shall be submitted immediately to the Employer.
- Noise monitoring will be carried out twice a day at the representative stations for a period of 24 hours. A report of the same will be submitted to DPT.
- Meteorological parameters are very important from air pollution point of view and precise and continuous data collection is of utmost importance. The data collected is analyzed as per the standards. Meteorological data on wind speed, wind direction, temperature, relative humidity, solar radiation and rainfall will be collected from one permanent station at DPT and one permanent station at Vadinar.
- All Locations & Monitoring parameters are tentative and subject to change as per GPCB/CPCB/MoEF&CC Guideline.

5.1. Selection of Sampling Locations

Sampling locations have been selected by Deendayal Port Trust considering various activities of Deendayal Port Trust and its environs and various Environment Impact Assessment Studies carried out in Deendayal Port. The sampling locations of various air, water and marine water surveys will be reviewed periodically and may be altered if required as per the suggestions/discussions with the Deendayal Port Authority and Environmental consultants engaged by the Deendayal Port Trust.

The major components of the monitoring are:

5.1.1. Air Quality Monitoring

Air Monitoring is done at eight fixed locations in port area. The description of stations is depicted in Table 1. The monitoring cycle at all eight monitoring stations is twice in a week.

Method of Monitoring

Sampling and analysis will be carried out as per CPCB guidelines for Ambient Air Quality monitoring. The monitoring is carried-out for air quality parameters mentioned in the National Ambient Air Quality Standards (NAAQS), CPCB Notification published in 2009. Sampling for Particulate Matter (PM_{10}) and Total Suspended Particulate Matter (TSPM) is done for a twenty four hour period.

Frequency of AAQ Monitoring

The monitoring cycle at all eight monitoring Stations is twice in a week. Sampling for Particulate matter (PM_{10}, $PM_{2.5}$) and total suspended particulate matter is done for a twenty four hour period. Sampling for gaseous samples like SO_x, NOx will be done for a twenty four hour period with sample collection at every eight hour. Table 1 gives description of Ambient Air Monitoring Stations.

Table 1: Ambient Air Monitoring Stations

Sr. No.	Location	Station Description	Location Codes
1	6 Stations at Kandla	Marine Bhavan	AL- 1
2		Oil Jetty	AL -2
3		Kandla Port Colony	AL-3
4		Gopalpuri Hospital	AL -4
5		Coal Storage Area	AL- 5
6		Tuna Port	AL-6
7	2 Stations at Vadinar	Signal Building	AL-7
8		Vadinar Colony	AL- 8

Map 2: Ambient Air Monitoring stations at Deendayal Port

5.1.2. Monitoring of Drinking Water Quality

Method of Monitoring

The sampling and analysis will be done as per standard methods and CPCB/GPCB Guidelines. The water samples will be analysed for various parameters viz; Color, Odor, Turbidity, Conductivity, pH, Chlorides, TDS, Total hardness, Iron, Sulphate, Salinity, Biological Oxygen Demand (BOD), Chlorides, Sodium(Na), Potassium(as K+), Calcium (as Ca), Magnesium (Mg), Fluorides (F), Nitrate (NO_3), Nitrite (NO_2), Manganese (Mn), Iron (Fe), Chromium (Cr_6+), Copper(as Cu), Cadmium (Cd) , Arsenic (As),Mercury (Hg), Lead (Pb), Zinc (Zn), CFU, & bacterial count. The method will be manual at all monitoring stations.

Frequency of Drinking Water Monitoring:

The monitoring at all twenty drinking water stations will be done once a month.

Drinking Water Monitoring Stations

A list of locations for collecting the drinking water samples is depicted in Table 2.

Table 2: Monitoring locations for Drinking Water

Sr. No	Monitoring Locations	Location Code
Location at Kandla		
1	Nirman Building 1	DW -1
2	P & C Building	DW -2
3	Main Gate (North)	DW -3
4	Canteen	DW -4
5	West gate I	DW -5
6	Wharf area	DW -6
7	Sewasadan-3	DW -7
8	Workshop	DW -8
9	Custom building	DW -9
10	Port Colony Kandla	DW -10

Sr. No	Monitoring Locations	Location Code
11	Hospital Kandla	DW -11
12	A.O. Building	DW -12
13	School Gopalpuri	DW -13
14	Guest House	DW -14
15	E- Type quarter	DW -15
16	F-type quarter	DW -16
17	Hospital Gopalpuri	DW -17
18	Tuna Port	DW -18
Locations at Vadinar		
19	Nr. Vadinar Jetty	DW -19
20	Port colony	DW -20

5.1.3. Monitoring of Marine Water Quality and Biological Parameters

Methodology for Physico-chemical Monitoring

Water samples will be collected for analyzing physico-chemical and biochemical parameters viz. pH, Temperature, Colour, Odour, Salinity, Turbidity, SS, TDS, TS, DO, COD, BOD, Silicate, PO_4, SO_4, NO_3, NO_2, Ca, Mg, Na, K, Iron (as Fe), Chromium (as Cr), Copper (As Cu), Arsenic (as As), Cadmium (as Cd), Mercury (Hg), Lead (as Pb), Zinc (as Zn), petroleum hydrocarbons, trace metals total coliform & fecal coliform.

Methodology for Biological Monitoring

Sampling will be conducted from sub surface layer in high tide period and low tide period of the tide from all sampling stations during consecutive spring tide and neap tide.

Net sampling for qualitative evaluation of mixed plankton will be conducted only once during between maximum high water and slack water and maximum low water and Slack water.

Sediment sampling for qualitative and quantitative evaluation of benthic organisms will be conducted only once during one tidal cycle during maximum low water and slack water.

The collected samples will be first collected in a clean bucket to reduce the heterogeneity. From the collected water sample 1 liter of water sample will be taken in an opaque plastic bottle for chlorophyll estimation. Quantitative plankton samples will be collected by filtering rest of the water sample using plankton net of 20µm mesh size.

Methodology adopted for Plankton sampling

Mixed plankton sample for qualitative evaluation will be obtained from the sub surface layer, at each sampling locations by towing the net horizontally with the weight during highest high tide and slack period and lowest low

tide and slack period .After the tow of about 15-20 minutes at speed of 1-1.5 m/s. For quantitative evaluation 50 L sample will be collected from the sub surface during high tide and low tide period will be filtered through 20μm mesh size net assembly.

Methodology adopted for benthic fauna sampling

Van veen sampler (0.1 m^2) will be used for sampling bottom sediments during lowest low tide. The fixation of benthic fauna will be normally done by bulk fixation of the sediment sample. The bulk fixation will be done by using 10% formalin (buffered with borate) with Rose Bengal as stain. The organisms will be preserved with seawater as diluting agent.

Frequency

Phytoplankton (Qualitative & Quantitative) Zooplankton (Qualitative & Quantitative) & Benthos (Qualitative & Quantitative) samples will be collected during high tide and low tide during each spring and neap tides of the month.

Sampling Stations

The monitoring of marine environment for the study of biological and ecological parameters will be carried out in harbour regions of DPT (Table 3) during Spring tide period of full moon phase of Lunar Cycle.

Table 3: Sampling Locations for Marine Monitoring

Sr. No	Monitoring locations	Location Code
Locations at Kandla		
1	Near passenger Jetty One	ML -1
2	Near Berth No. 8 & 9	ML -2
3	Kandla Creek Near KPT colony	ML -3
4	Near 13th & 14th Berth	ML -4
5	Nakti Creek Near Tuna Port	ML -5
6	Nakti Creek Near NH-8A Bridge	ML -6
Locations at Vadinar		
7	Nr. SBM 2	ML -7
8	Nr. Vadinar Jetty	ML -8

Map 1.3 Marine Sampling Locations at Deendayal Port

Map 1.4 Marine Sampling Locations at Vadinar Port

5.1.4. Noise Monitoring

Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading of cargo to/from ships. Noise Monitoring will be done at 13 stations at Kandla, and three locations in Vadinar.

Method and Frequency of monitoring

Sampling will be done at all stations for 24 hour period once in month. Data will be recorded using automated sound level meter. The intensity of sound will be measured in sound pressure level (SPL) and common unit of measurement is decibel (Db).

Sampling Stations

The sampling locations for noise monitoring as listed in table 4.

Table 4: Locations for Noise Monitoring

Sr. No	Name of locations	Location Code	Sr. No	Name of locations	Location Code
Locations at Kandla			8	Nirman Building 1	NL - 8
1	West Gate no 1	NL -1	NL -	Tuna Port	NL - 9
2	Main gate (North)	NL -2	NL -	Port & customs office	NL - 10
3	Wharf area/Jetty Area	NL -3	**Location at Vadinar**		
4	Main road/ Central Road	NL -4	11	Nr. Port Gate - Vadinar	NL - 11
5	Canteen Area	NL -5	12	Nr. Vadinar Jetty	NL - 12
6	ATM building	NL -6	13	Port colony Vadinar	NL - 13
7	Marine Bhavan	NL -7			

5.1.5. Soil Quality Monitoring

Soil quality monitoring is important for evaluating the effects of environment management practices of a region/area.

Method of Monitoring

The soil samples will be collected from four locations in Kandla and two locations in Vadinar Port. The soil samples will be filled in polythene bags,

labeled in the field with number and site name and taken to the laboratory for analysis (as per IS 2720). Physical and chemical properties of soil at selected locations will be studied.

Frequency of monitoring

Sampling will be done at all stations in Kandla and Vadinar once in a month.

Soil quality Monitoring Stations

List of the locations for collecting the soil samples are as per Table 5:

Table 5: List of sampling locations for Soil Quality Monitoring

Sr. No	Name of locations	Location Code
Locations at Kandla		
1	Tuna Port	SL -1
2	IFFCO Plant	SL -2
3	Khori Creek	SL -3
4	Nakti creek bridge at NH-8A	SL -4
Location at Vadinar		
5	Nr. Vadinar Port Office	SL -5
6	Nr. Vadinar Colony	SL -6

Map 1.5A Soil Sampling Locations in Deendayal Port

Map 1.5B Soil Sampling Locations in Vadinar Port

5.1.6. Monitoring of performance of the Sewage Treatment Plant (STP) at Gopalpuri Township, Deendayal Port & Vadinar

The principal objective of wastewater treatment is generally to allow human and industrial effluents to be disposed off without danger to human health or unacceptable damage to the natural environment.

Method of Monitoring

The parameters monitored will be pH, BOD, COD, residual chlorine, MLSS, MLVSS and TSS. The data collected will be analyzed as per the standards. The performance of the Sewage Treatment plant will be studied by collecting samples of the influent, aeration tank and effluent tank.

Frequency of monitoring

Sampling will be done at all stations from inlet, aeration tank and outlet of an STP once in week.

Monitoring Stations:

Lists of the location for collecting the STP samples are as per table 6.

Table 6: List of sampling locations for STP

Sr. No	Sampling location
1	STP at Kandla
2	STP at Gopalpuri
3	STP At Vadinar

6. Monitoring Results

Based on the EMMP submitted, M/s Detox Corporation Pvt. Ltd. carried out monitoring of the following environmental aspects of the port for the period of March 2020 to February 2021. However, due to nationwide lockdown imposed by Government of India from 23rd March to 14th April and subsequent lockdown imposed by state government *(Circular No. 13/NCV/102020/SFS-1/G)* till 17th May 2020, the sample collection was not possible.

1 Ambient Air

The monitoring was carried out twice a week. The results obtained from the sampling and analysis is submitted to Deendayal Port authority on monthly basis. The monthly averaged and annual results for the ambient air monitoring are given in the sections followed.

I. Total Suspended Particulate Matter (TSPM)

The frequency of sampling was twice a week for every sampling station.

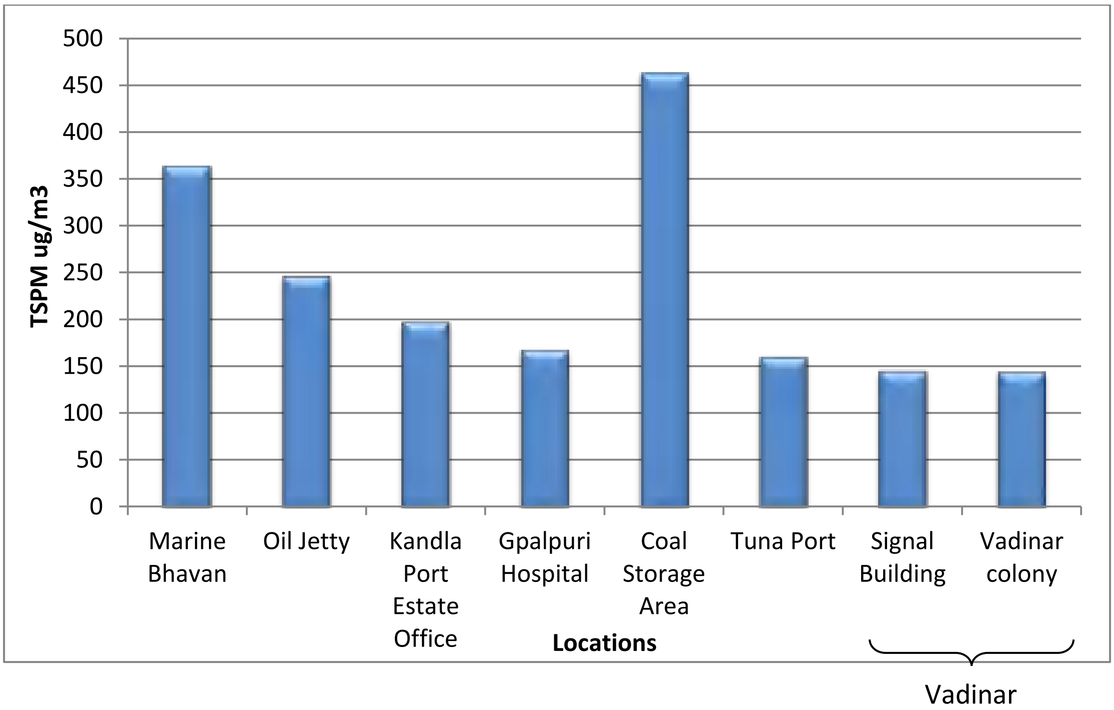
Table 6.1 TSPM (in μg/m^3) values at monitoring locations in Kandla and Vadinar Port

Months	Marine Bhavan	Oil Jetty	Kandla Estate Office	Gopalpuri Hospital	Coal Storage Area	Tuna Port	Signal Building	Vadinar colony
Mar-20	325.9	171.1	155.9	151.4	347.4	173.4	129.1	132.9
Apr-20	**COVID-19 Lockdown**							
May-20	**COVID-19 Lockdown**							
Jun-20	207.2	180	164	153	319	169	148	157
Jul-20	233	197	188	164	276	171	152	147
Aug-20	349	260	162	133	506	93	133	152
Sep-20	405	257	130	155	459	204	151.4	145
Oct-20	313	204	152	122	436	70	124.6	122.9
Nov-20	364	287	245	182	505	167	151	149.9
Dec-20	635	323	321	208	621	179.4	156.6	174
Jan-21	387	261	165	165	438	236	157	154
Feb-21	422	329	296	247	723	140	148	163
Annual Mean	**364.1**	**246.9**	**197.9**	**168.1**	**463.0**	**160.3**	**145.1**	**154.5**

The mean TSPM values were highest at Coal Storage location and Marine Bhavan, followed by Oil Jetty. TSPM values were least at both the locations of Vadinar Port. The major cause of TSPM values at Coal Storage and Marine Bhavan is large amount of coal is handled at Berth No. 6, 7, 8 and use of grabs for unloading of coal directly in the truck cause coal to spread in air as well as coal dust to fall on ground. This settled coal dust again mixes with the air during trucks movement through it.

Also, the coal laden trucks are not always covered with tarpaulin sheets and these results in spillage of coal from trucks/dumpers during its transit from vessel to yard or storage site.

Fig 6.1 Observed values (annual mean) of TSPM at all eight monitoring stations



Interpretation of Results

- Maximum TSPM of 723.0 µg/m^3 was recorded in the month of February' 21 at Coal storage site and the minimum value was recorded in the month of October '20 at Tuna Port 70.1 µg/m^3.

- At Vadinar, maximum TSPM of 157 µg/m^3 was recorded in the month of January at Vadinar signal building site and the minimum value was recorded in the month of October'20 at Vadinar Port colony (122 µg/m^3).

II. Particulate Matter (PM_{10})

PM_{10} is particulate matters which are 10 micrometers or less in diameter. The frequency of sampling was twice a week for every sampling station.

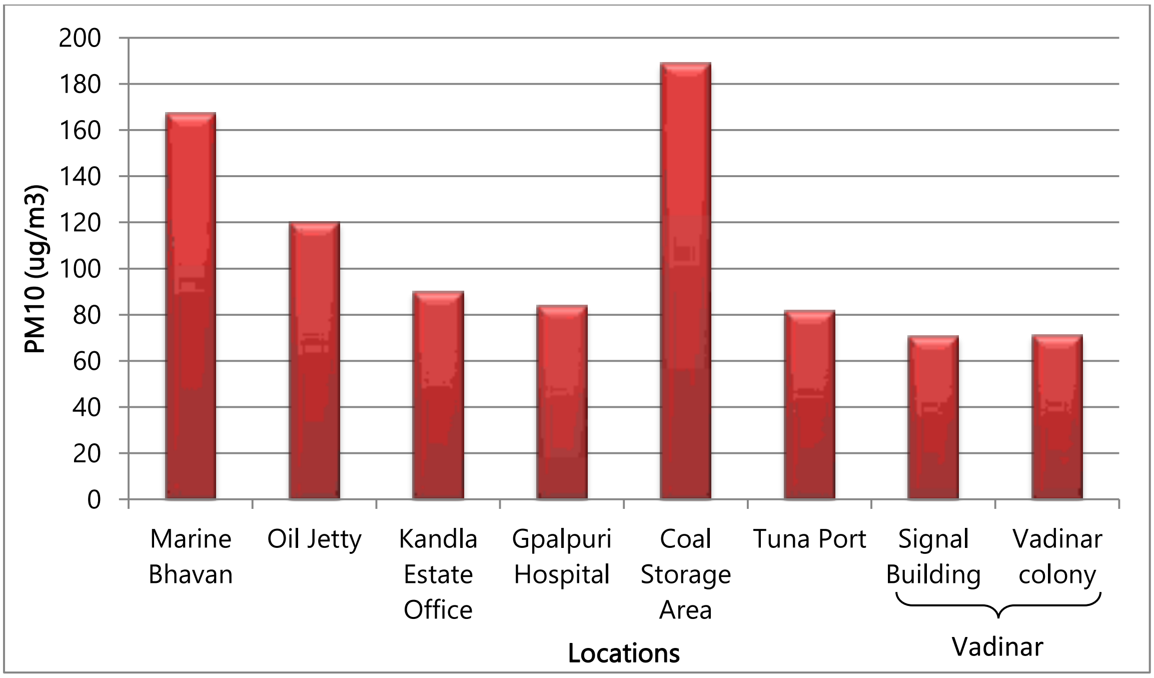
Table 6.2 PM_{10} (in µg/m^3) values at monitoring locations in Kandla and Vadinar Port

Months	Marine Bhavan	Oil Jetty	Kandla Estate Office	Gopalpuri Hospital	Coal Storage Area	Tuna Port	Signal Building	Vadinar colony
Mar-20	175.9	116.3	87	74.9	162.6	88	74.4	54.6
Apr-20	COVID-19 Lockdown							
May-20								
Jun-20	81.9	81.6	79.8	87	108.8	72	59.8	52.9
Jul-20	89.1	85.6	81.6	81.6	110.6	73	77.6	72.6
Aug-20	191.7	99.7	86.6	93	184.6	54	75	72.6
Sep-20	254	154	79	91	266	86	82.5	81
Oct-20	96.4	91.1	73	63.6	112.4	49	63.5	67.8
Nov-20	103	87.8	81.3	78.4	242.3	97.4	56.5	67.3
Dec-20	297	167	144	104	233	92.4	51.5	79
Jan-21	232	153	91	91	261	134	85	83
Feb-21	153	166	96	73	208	71	81	79
Annual Mean	**167.4**	**120.2**	**89.9**	**83.8**	**188.9**	**81.7**	**70.7**	**71.0**

The mean PM_{10} Values were highest at Coal Storage location and Marine Bhavan, followed by Oil Jetty. PM_{10} values were least at both the locations of Vadinar Port. Higher PM_{10} values at Coal Storage and Marine Bhavan is a result of large amount of coal handling and its inappropriate transportation methods.

Coal laden trucks are seldom covered with tarpaulin sheets and these results in spillage of coal from trucks/dumpers resulting into higher PM_{10} values.

Fig 6.2 Observed values (annual mean) of PM_{10} at all eight monitoring stations



Interpretation of Results

- Maximum value of PM_{10} of 297 µg/m^3 was recorded in the month of December'20 at Coal storage site and the minimum value was recorded in the month of October at Tuna Port 49.0 µg/m^3.

- In Vadinar, maximum value of PM_{10} of 85 µg/m3 was recorded in the month of March at Port admin building site and the minimum value was recorded in the month of December at Vadinar Port signal building (51.5 µg/m^3).

III. Particulate Matter ($PM_{2.5}$)

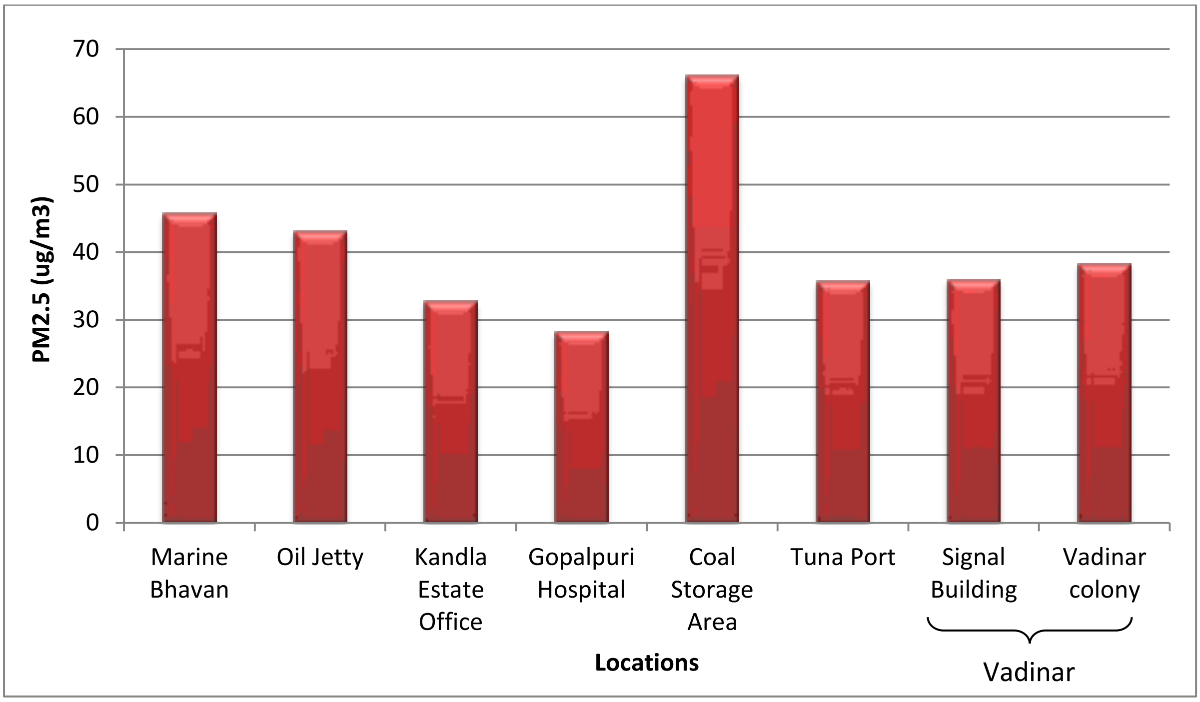
$PM_{2.5}$ particles are air pollutants with a diameter of 2.5 micrometers or less, small enough to invade even the smallest airways. $PM_{2.5}$ was also monitored twice a week for every sampling station.

Table 6.3 $PM_{2.5}$ (in μg/m^3) values at monitoring locations in Kandla and Vadinar Port

Months	Marine Bhavan	Oil Jetty	Kandla Estate Office	Gopalpuri Hospital	Coal Storage Area	Tuna Port	Signal Building	Vadinar colony
Mar-20	32.9	46.6	45.1	38.3	75.1	37.5	32.4	30.8
Apr-20	**COVID-19 Lockdown**							
May-20								
Jun-20	32.8	22	25	23	62.5	22	38.8	38.3
Jul-20	27	28.6	36.3	25	42	26	40	41
Aug-20	25	27	19	19	68.4	22	32	41
Sep-20	55	49	37	47	53	46	37.3	39
Oct-20	39	21	28	14	63.1	17	35.6	36.3
Nov-20	57.3	43.9	31.4	27	90.5	49.6	28.6	32.3
Dec-20	55	71	24	23	67	52.6	30.6	41
Jan-21	51	49	41	41	55	50	44	42
Feb-21	82	73	40	25	84	34	40	41
Annual Mean	**45.7**	**43.1**	**32.7**	**28.2**	**66.1**	**35.7**	**35.9**	**38.3**

Average $PM_{2.5}$ values were highest at Coal Storage location (mean = 66.1 μg/m^3) followed by Marine Bhavan (mean = 45.7 μg/m^3) and Oil Jetty (mean = 43.1 μg/m^3). $PM_{2.5}$ values At Vadinar Port the $PM_{2.5}$ values were significantly lower.

Fig 6.3 Observed values (annual mean) of $PM_{2.5}$ at all eight monitoring stations



Interpretation of Results

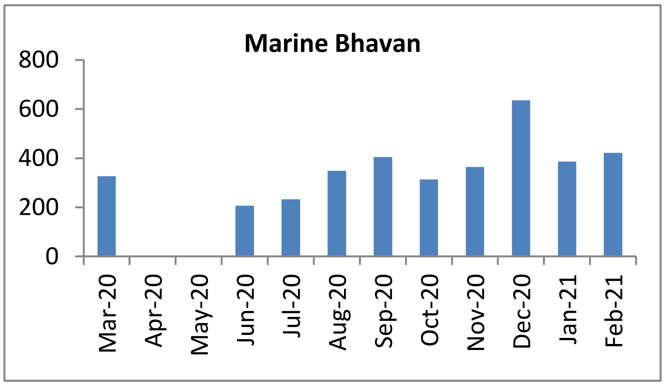
- Maximum value of $PM_{2.5}$ (90.5 µg/m^3) was recorded in the month of November at Coal storage site and the minimum value was recorded in the month of August at Gopalpuri Hospital (14.0 µg/m^3).

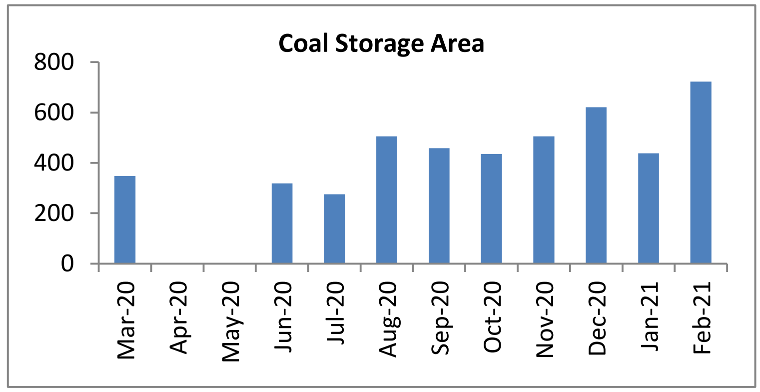
- Annual mean values of $PM_{2.5}$ was highest at Coal Storage Area (66.1 µg/m^3).

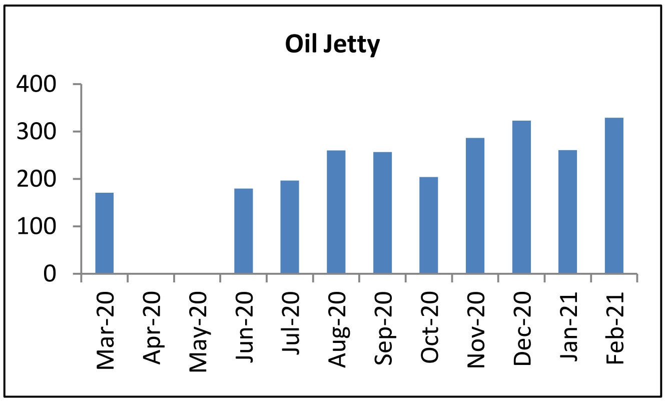
- In Vadinar, maximum value of $PM_{2.5}$ of 44.0 µg/m^3 was recorded in the month of January' 21 at Signal building site and the minimum value was recorded in the month of November at Vadinar Port colony (28.6 µg/m^3).

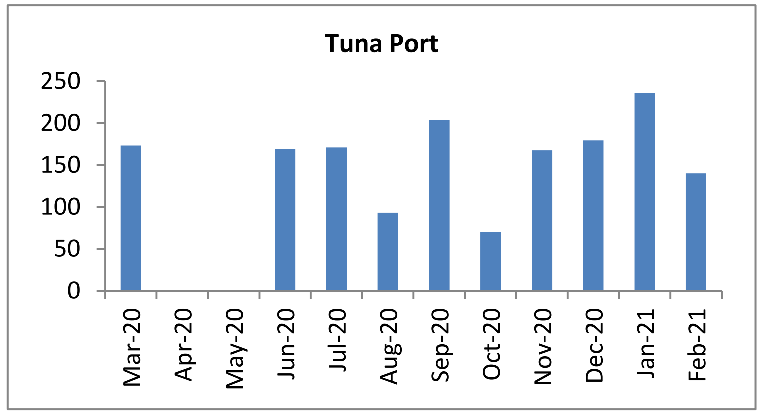
Location wise graphs depicting trends in TSPM, PM_{10} and $PM_{2.5}$ in all locations of Kandla and Vadinar Port are depicted in Fig 5.1 to 5.6.

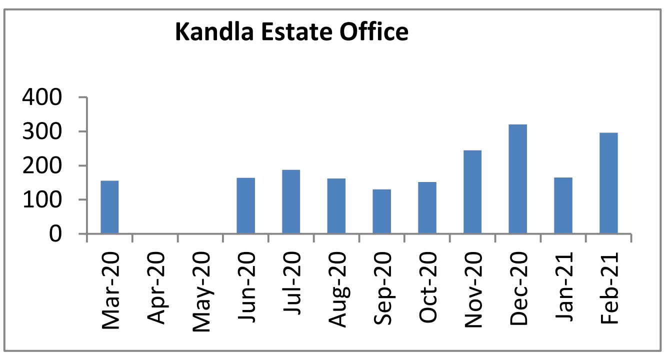
Trend in TSPM values of various AAQ Monitoring Locations

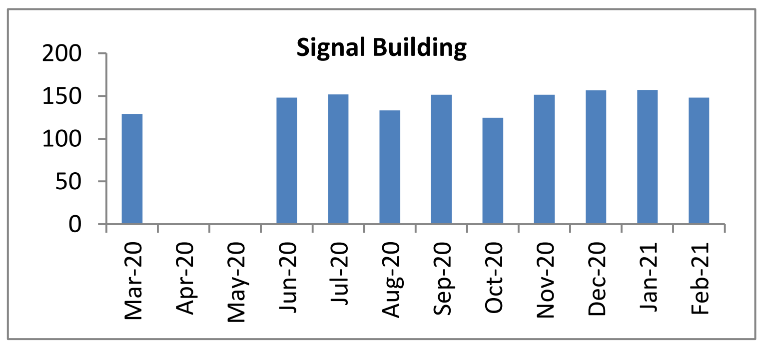


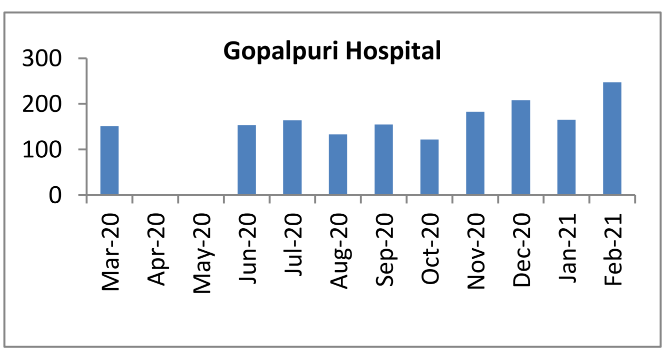


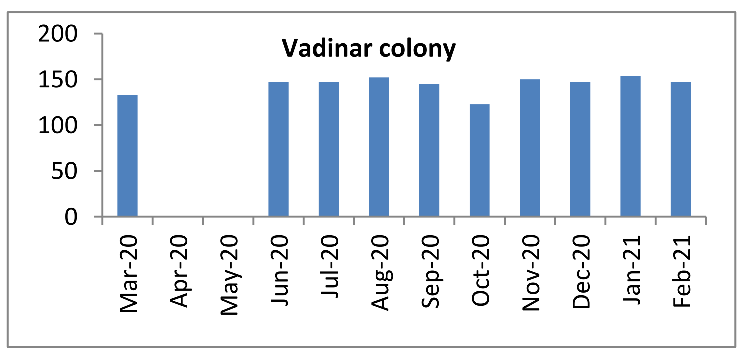




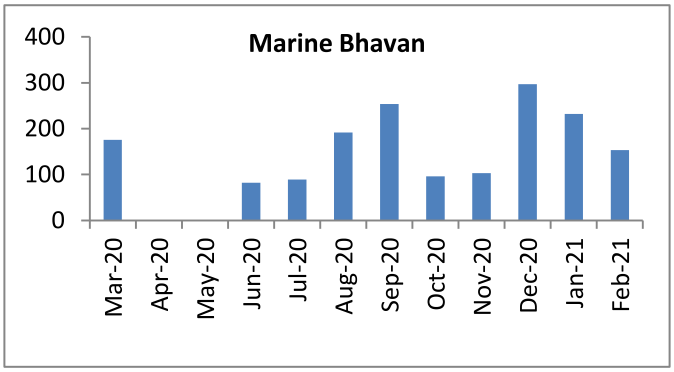


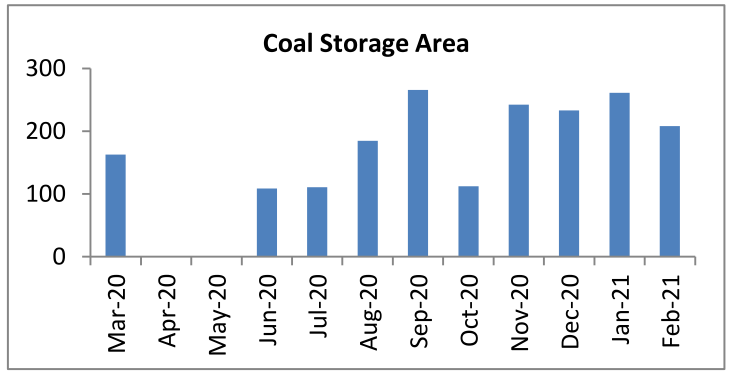


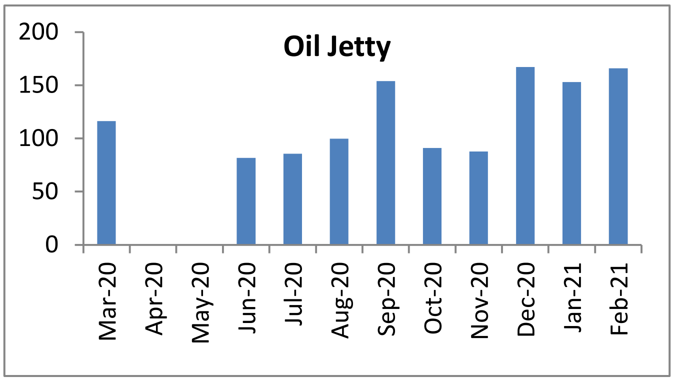


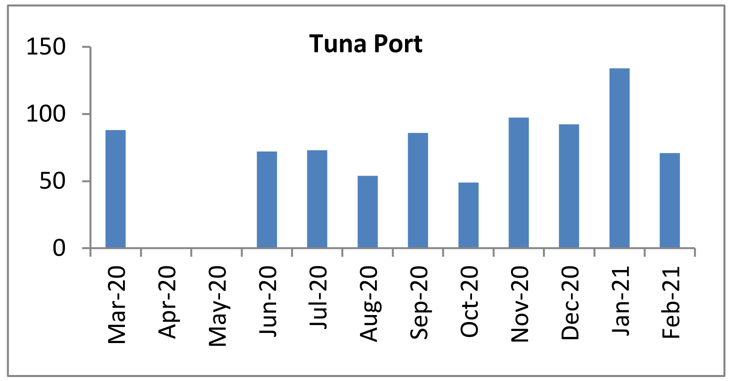


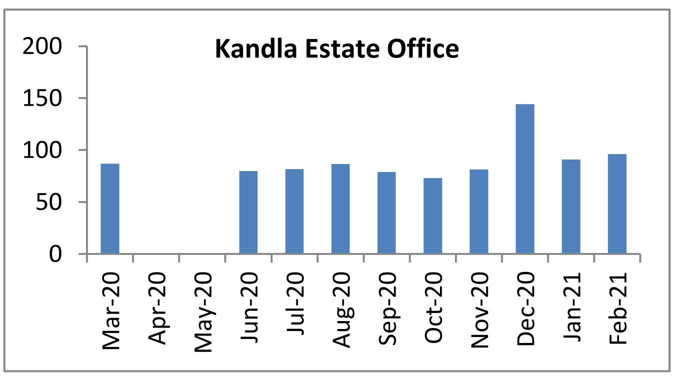
Trend in PM_{10} values of various AAQ Monitoring Locations

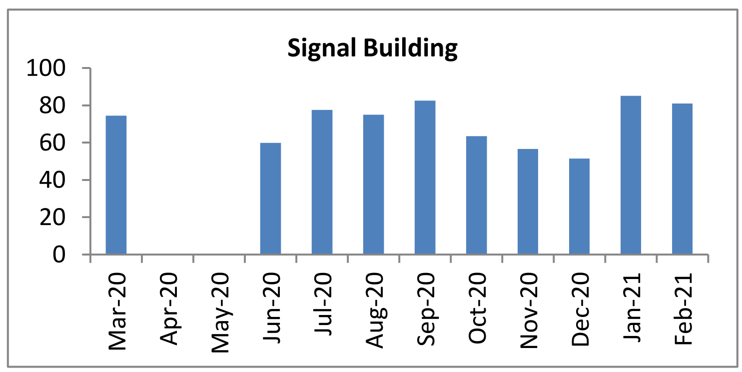


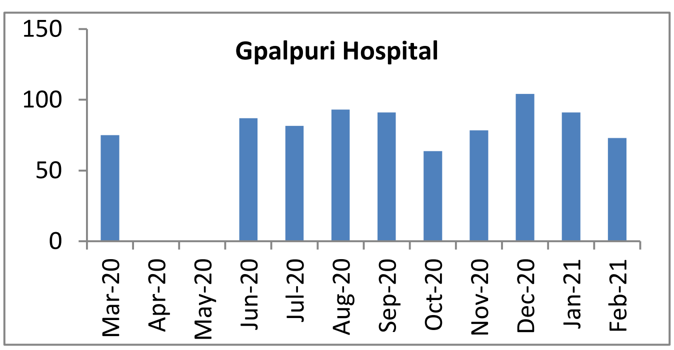


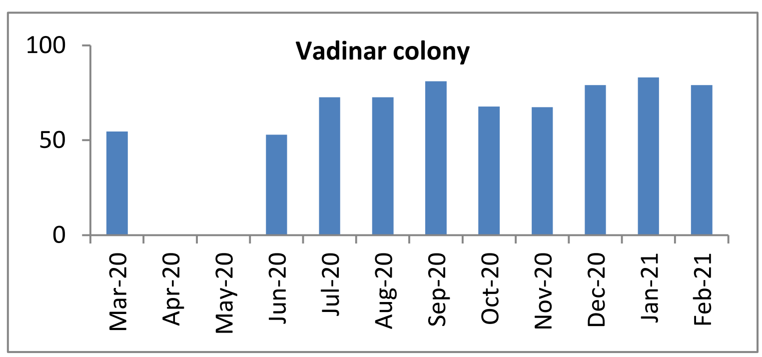




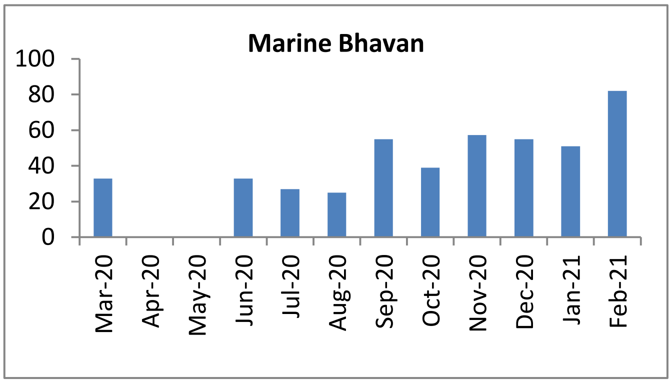


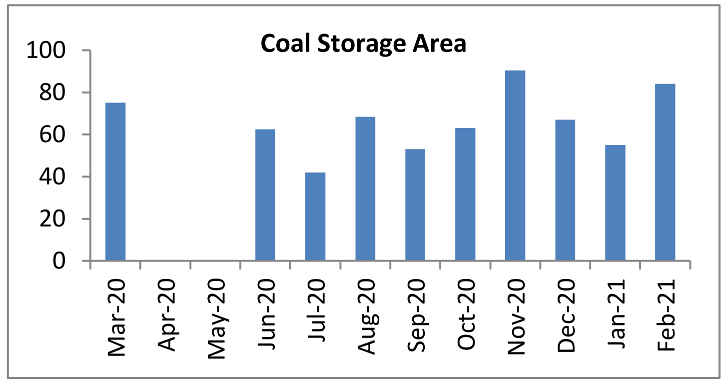


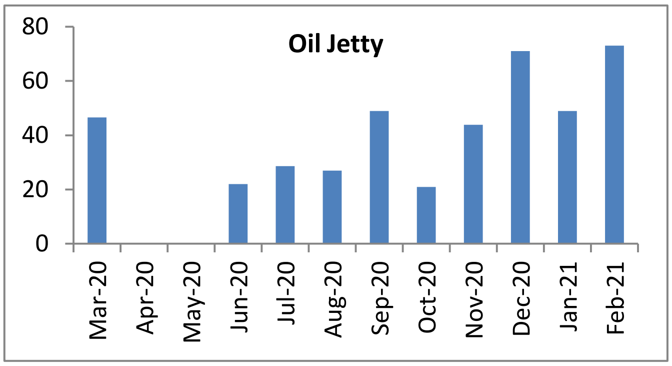


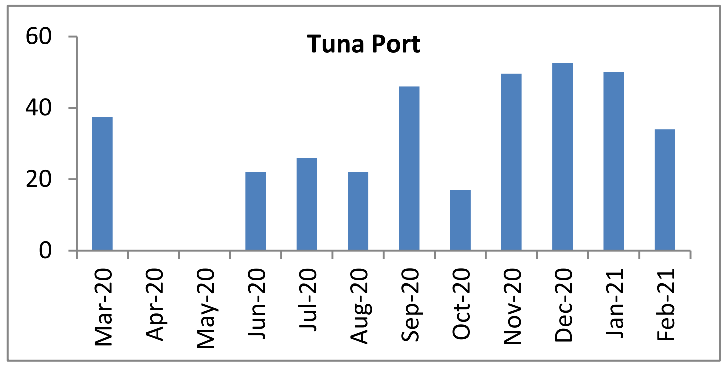


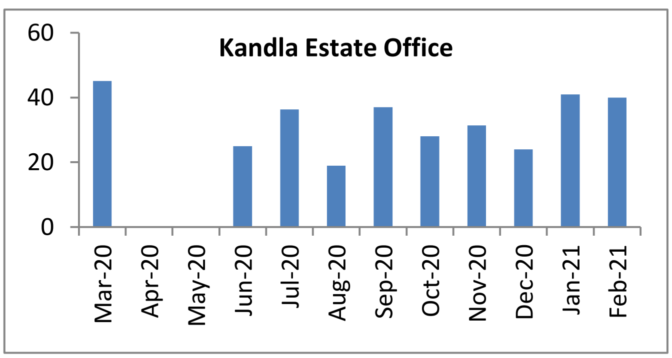
Trend in $PM_{2.5}$ values of various AAQ Monitoring Locations

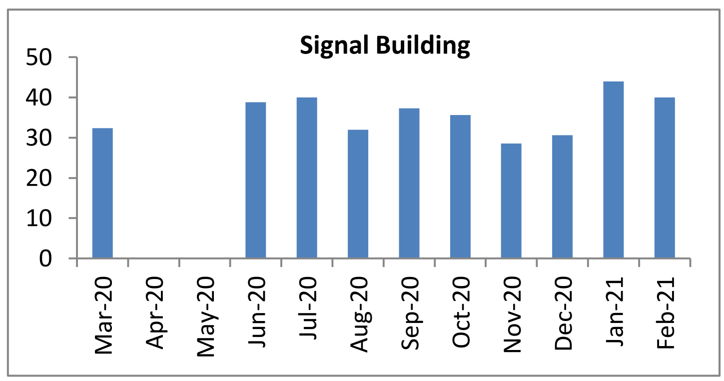


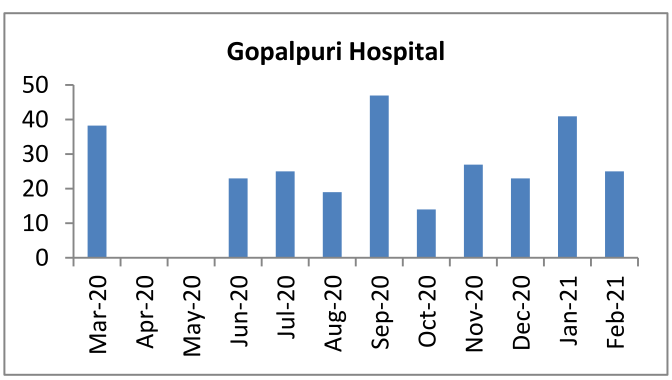


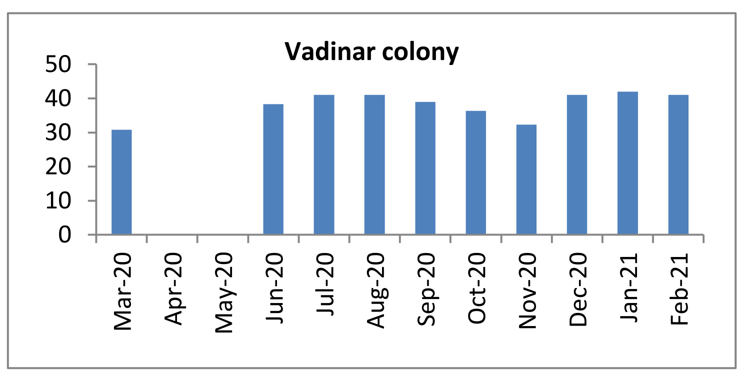












2. Drinking Water Quality Monitoring

Drinking Water Quality Monitoring was carried out at twenty stations at Kandla, Vadinar & Township Area of Deendayal Port.

Drinking water samples are collected from 20 locations (18 locations in Kandla and 2 locations in Vadinar). Samples for physico-chemical analysis are collected and analysed in laboratory for various parameters, viz. Color, Odor, Turbidity, Conductivity, pH, Chlorides, TDS, Total Hardness, Iron, Sulphate, Salinity, DO, BOD, Na, K, Ca, Mg, F, NO3, NO2, Mn, Cu, Cd, As, Hg, Pb, Zn, Bacterial Count (CFU).

Monitoring Results

Mean values of drinking water of Deendayal Port Locations are given in table 5.1. The values shown are the annual average of all the locations of Deendayal Port Colony, Port and Harbor area as well as Deendayal Port Trust office buildings.

Table 6.4: Annual average values of Drinking water at Deendayal Port Trust

Sr. No.	Parameter	Unit	1st quarter Mean	2nd quarter Mean	3rd quarter Mean	Value (Annual Avg.)	Acceptable Limits	Permissible Limits
1	pH	pH Unit	7.9	7.5	7.4	7.5	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/L	669.4	386.7	1117.0	794.6	500	2000
3	Turbidity	NTU	83.1	55.3	0.4	43.6	1	5
4	Odor	-	Odorless	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	Colorless	5	15
6	Conductivity	µs/cm	1248.0	809.9	2278.7	1630.5	NS*	NS*
7	Bio.Oxygen Demand	mg/L	<2	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/L	234.8	417.7	631.5	504.0	250	1000
9	Ca as Ca	mg/L	103.0	98.4	66.9	80.5	75	200
10	Mg as Mg	mg/L	23.2	50.0	54.5	51.0	30	100
11	Total Hardness	mg/L	248.6	308.2	391.0	354.4	200	600
12	Iron as Fe	mg/L	0.1	0.1	<0.01	0.1	0.3	1
13	Fluorides as F	mg/L	0.5	0.8	0.5	0.6	1	1.5

Sr. No.	Parameter	Unit	1st quarter Mean	2nd quarter Mean	3rd quarter Mean	Value (Annual Avg.)	Acceptable Limits	Permissible Limits
14	Sulphate as SO_4	mg/L	143.0	94.8	178.3	168.4	200	400
15	Nitrite as NO2	mg/L	209.4	209.4	<0.1	209.4	NS*	NS*
16	Nitrate as NO3	mg/L	11.8	7.2	10.4	8.8	45	100
17	Salinity	%	1.7	1.6	1.1	1.3	NS*	NS*
18	Sodium as Na	mg/L	90.8	230.8	265.3	234.0	NS*	NS*
19	Potassium as K	mg/L	52.9	37.3	3.1	18.7	NS*	NS*
20	Manganese	mg/L	<0.04	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/L	<0.03	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/L	<0.05	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/L	<0.002	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/L	<0.01	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/L	<0.001	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/L	<0.01	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/L	<0.1	<0.1	<0.1	<0.1	5	15
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent	Absent

NS = Not specified, ND= Not detected

Discussion

The colour of all drinking water samples was < 5 Hazen unit and odour of the samples was also agreeable. The values of turbidity, Iron as Fe and Ammonia as NH_3-N were observed to be below detection limits of measurement i.e. <0.1 NT, <0.03 mg/L and <0.1 mg/L respectively. Apparently these parameters were not at alarming levels. Some important parameters for drinking water are discussed below in detail;

pH

pH value in the studied area varied from 7.3 to 8.2 pH unit during the first year of monitoring. The limit of pH value for drinking water is specified as 6.5 to 8.5. All the sampling points showed pH values within the prescribed limit by Indian Standards.

Total Dissolved Solids (TDS)

TDS values in the studied area varied between 140-1647 mg/L. The mean TDS value was 776.7 mg/L. None of the sampling points showed higher TDS values than the prescribed limit by Indian standards which are 500-2000 mg/L.

Conductivity

Conductivity is used to measure the concentration of dissolved solids which have been ionized in a polar solution such as water. The conductivity in the samples collected during the month of June ranged from 796-2841 µs/cm. Electrical conductivity standards do not appear in BIS standards for drinking water.

Chlorides

Chloride values in drinking water for the present year varied between 215-895 mg/L. Excessive chloride concentration increase rates of corrosion of metals in the distribution system. This can lead to increased concentration of metals in the supply.

Calcium

Calcium value in drinking water for the present year the studied area varied between 25.7 – 124.1 mg/L. The mean Ca was observed to be 83.7 mg/L. If calcium is present beyond the maximum acceptable limit, it causes incrustation of pipes.

Magnesium

Magnesium value in the studied area for the present year varied from 10.6 mg/L to 69.7 mg/L. All the locations had Magnesium within the prescribed limits of 30-100 mg/L.

Total Hardness

Total Hardness value in the studied area for the present year varied between 188-510 mg/L. The prescribed limit by Indian Standards is 200-600 mg/L.

Fluoride

Fluoride value in the studied area varied between 0.3 – 1.4 mg/L. The permissible limit as per Indian Standards is 1.0-1.5 mg/L. Moderate amount of fluoride in water lead to dental effects, but long-term ingestion of large amounts can lead to potentially severe skeletal problems.

Sulphates

Sulphate value in the studied area varied between 32 –315 mg/L. All the sampling points showed 67ulphates values within the prescribed limits by Indian Standards (200-400 mg/L). Sulphate occurs naturally in water as a result of leaching from gypsum and other common minerals. Sulphate content in drinking water exceeding the 400 mg/L imparts bitter taste.

Nitrites (NO_2)

Nitrite values in all the water samples were observed to be <0.1 mg/L. There are no specified standard values for Nitrites in drinking water. Groundwater contains nitrate due to leaching of nitrate with the percolating water and by sewage and other wastes rich in nitrates.

Salinity

Salinity in drinking water in the present samples collected ranged from 0.4 to 1.1 %. There are no prescribed Indian standards for salinity in Drinking water.

Heavy Metals in Drinking Water

In the present study period drinking water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals were well below/ the permissible limits of the Indian Standards for drinking water.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that total Coliform values is observed to be 0.1 to cfu/100 ml. total Coliform and E-Coli values showed that all the drinking water samples were safe from any bacteriological contamination.

Conclusion

The results are compared with acceptable limits as prescribed in IS 10500:2012 – Drinking Water Specification. It was observed from the data analysis that during the first year (March '20 to February '21) the drinking water was safe for human consumption at all drinking water monitoring stations.

Fig 6.7 Annual average values of TDS at all the drinking water monitoring stations

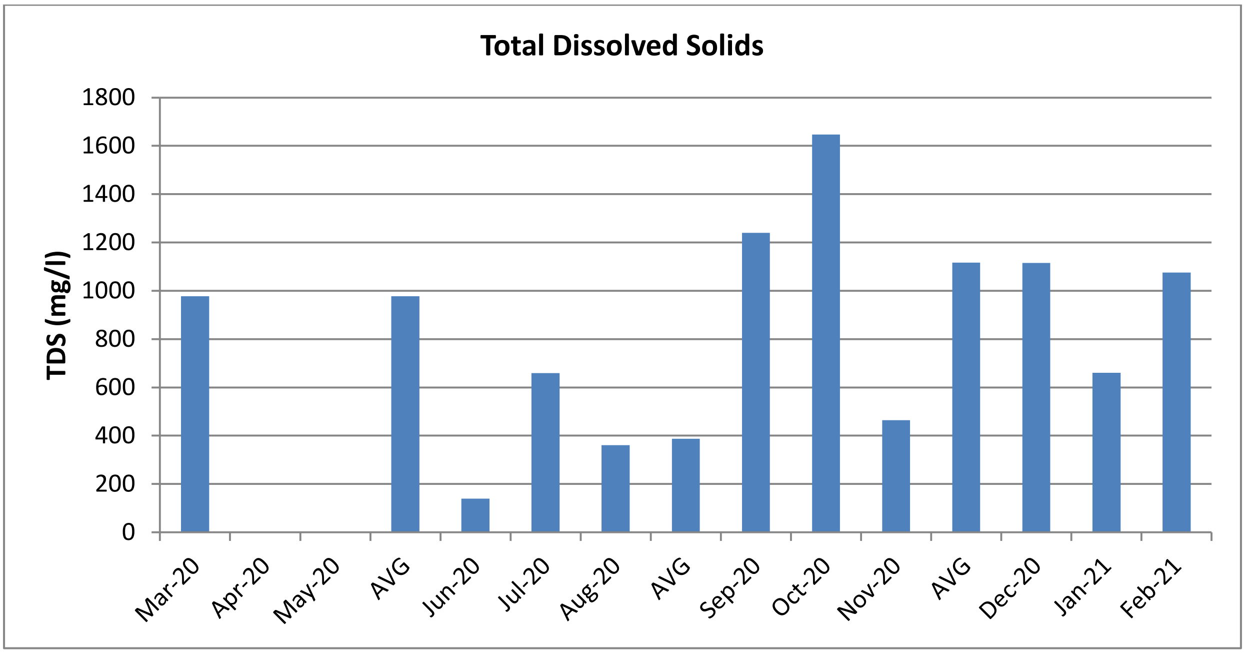


Fig 6.8 Yearly trends in mean annual average values of TDS at all the drinking water monitoring stations

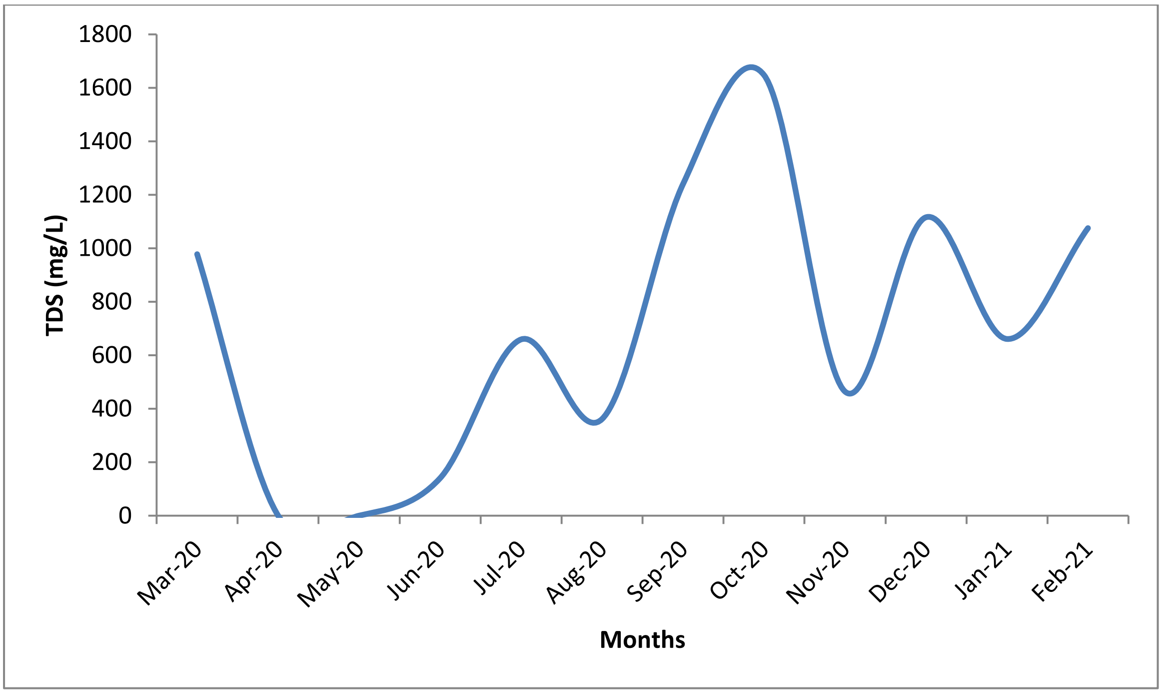


Fig 6.9 Annual average values of Total Hardness at all the drinking water monitoring stations

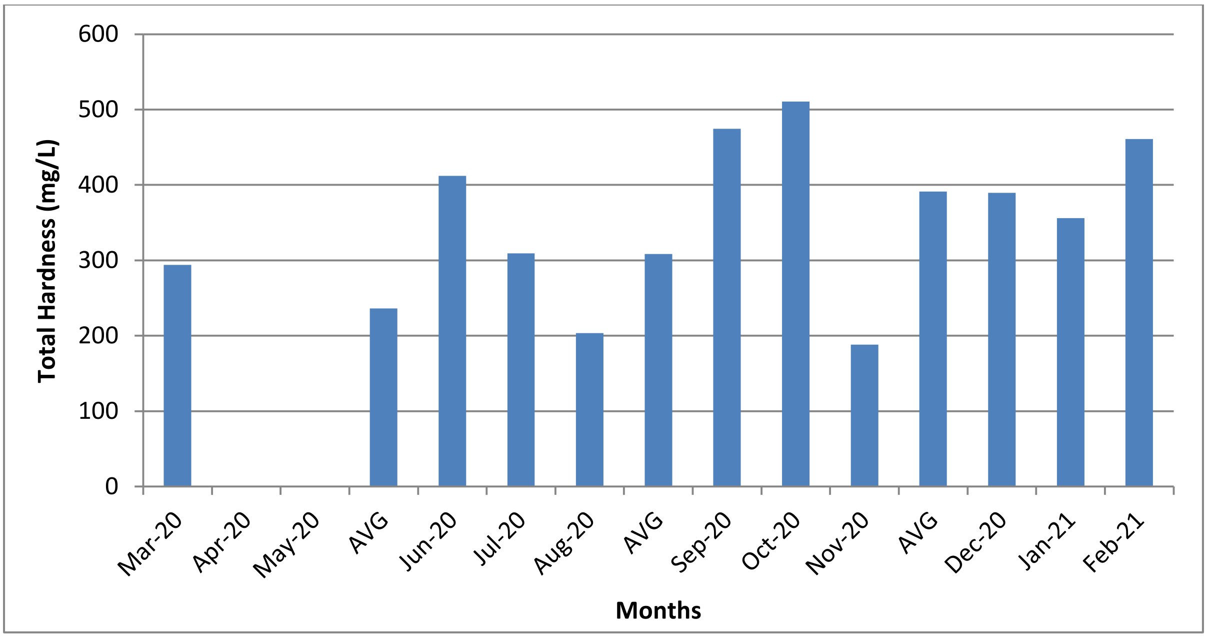
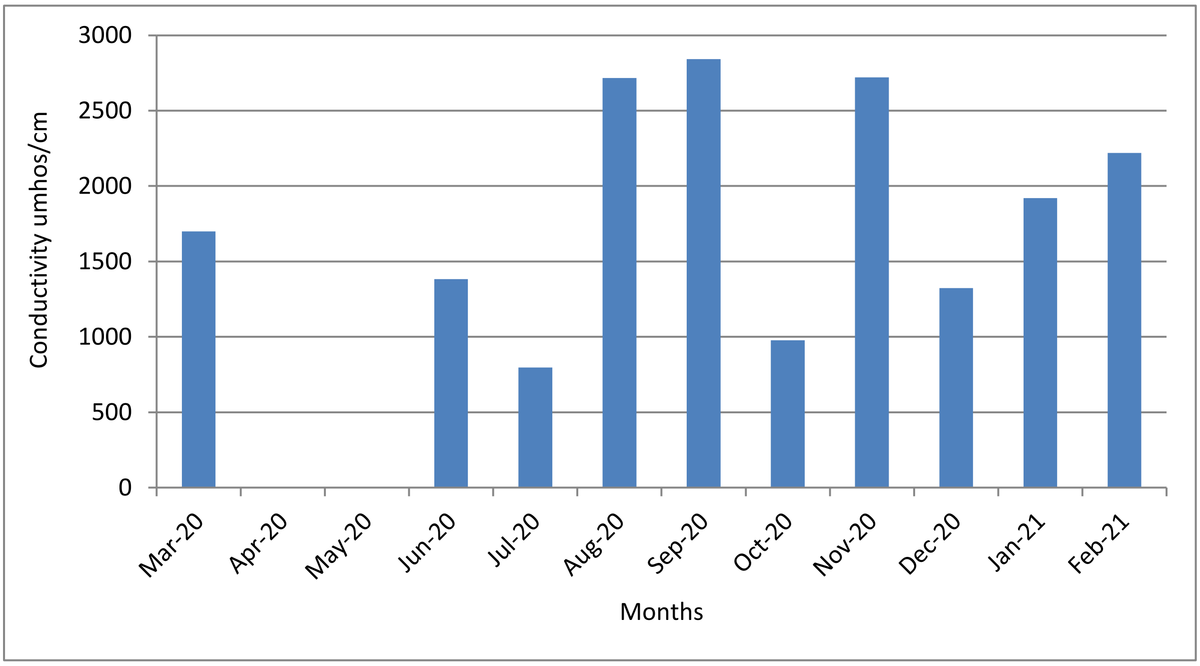


Fig 6.10 Annual average values of Conductivity at all the drinking water monitoring stations



3. Marine Water Monitoring

Marine Water Monitoring was carried out at six stations at Deendayal Port and two locations at Vadinar Port.

Water samples were analyzed for physico-chemical and Biochemical parameters. Besides these, Phytoplankton (Qualitative & Quantitative) Zooplankton (Qualitative & Quantitative) & Benthos (Qualitative & Quantitative) samples were collected during spring tide and neap tide from all the eight fixed monitoring stations.

Results

The annual average values of monitored parameters for marine waters of DPT are given as per table 6.3.

Table 6.3 Annual average values of various physico-chemical parameters at Deendayal Port during neap tide

Sr. No.	Parameters	Unit	1st quarter Mean	2nd quarter Mean	3rd quarter Mean	4th Quarter Mean
1	pH	pH unit	7.9	7.6	7.6	7.5
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	odorless	odorless	odorless	odorless
4	Salinity	ppt	33.3	33.1	33.1	33.4
5	Turbidity	NTU	66.6	70.2	60.6	68.2
6	Total Dissolved Solids	mg/L	36790.0	35760.1	34897.8	35509.6
7	Total Suspended Solids	mg/L	114.5	100.0	95.9	98.9
8	Total Solids	mg/L	36904.6	35860.1	34993.7	35608.5
9	DO	mg/L	5.7	5.6	5.9	5.4
10	COD	mg/L	99.1	91.3	89.6	85.6
11	BOD	mg/L	<2	<2	<2	<2
12	Silica	mg/L	1.4	1.4	1.5	1.2
13	Phosphate	mg/L	0.6	0.5	0.1	0.2
14	Sulphate	mg/L	3206.6	3469.2	2394.7	3459.0
15	Nitrate	mg/L	3.4	4.0	4.6	6.1
16	Nitrite	mg/L	<0.1	<0.1	<0.1	<0.1
17	Calcium	mg/L	661.1	642.4	445.5	505.0
18	Magnesium	mg/L	1709.6	1841.3	1225.7	1656.0

Sr. No.	Parameters	Unit	1st quarter Mean	2nd quarter Mean	3rd quarter Mean	4th Quarter Mean
19	Sodium	mg/L	10982.2	11125.1	9724.8	12467.6
20	Potassium	mg/L	391.0	442.2	327.0	400.9
21	Iron	mg/L	1.6	1.8	1.7	2.4
22	Chromium	mg/L	0.2	0.2	0.1	0.2
23	Copper	mg/L	0.1	0.1	0.1	0.1
24	Arsenic	mg/L	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/L	<0.001	<0.001	<0.001	<0.001
26	Mercury	mg/L	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/L	0.2	0.2	0.2	0.2
28	Zinc	mg/L	0.1	0.1	0.1	0.1

Discussion

Coastal ecosystems are characterized by daily fluctuations, driven by tidal amplitude, wind direction and also on the anthropogenic activities carried out on the coasts. Marine water parameters at Kandla Harbor and creek waters also showed an high array of fluctuations in several of its parameters such as TDS, TSS, salinity and salts.

Some of the important parameters are explained below;

pH

The pH of all marine water samples collected from Deendayal Port varied from 7.5 to 7.9 pH Unit. The mean pH of all samples was 7.64 pH unit.

Salinity

Salinity in the DPT marine water ranged from 32.9 ppt to 33.5 ppt. The mean salinity at was recorded to be 33.2 ppt.

Turbidity

Turbidity in the DPT marine water ranged from 60.2 – 73.1 NTU. The mean turbidity of all the locations of Deendayal Port was 66.4 NTU. Turbidity at Vadinar port was <1.0 NTU.

Total Dissolved Solids (TDS)

TDS values varied from 34411 to 37022 mg/L at all locations of Deendayal Port. Mean TDS values at Deendayal Port was 35739 mg/L.

Dissolved Oxygen (DO)

DO value in the studied area varied between 5.4 – 6.0 mg/L. The mean DO values of Kandla Marine waters were 5.7 mg/L.

Nitrates (NO3)

The mean Nitrate values in all the marine water samples were of Deendayal Port was 4.5 mg/L at DPT waters. Nitrite was rarely detected from marine waters of Vadinar.

Sodium (Na)

Sodium value in the Deendayal Port marine waters varied between 9675-12913 mg/L. The mean Na recorded at DPT waters was 11074.9 mg/L.

Trace Metals

In the present study period water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals reported below trace levels.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that total Coliform values is observed to be 0.1 to cfu/100 ml.

3.1 Productivity Study

Chlorophyll-A

Water Samples for the chlorophyll estimation collected from sub surface layer during high tide and low tide period of the tidal cycle for each sampling locations and analysed for Chlorophyll -a and after acidification for Pheophytin –a.

In the sub surface water chlorophyll-a was varying from 0.25 to 1.26 mg/m^3 in harbour region of DPT during sampling done in from March 2020 to February 2021. In the nearby creeks chlorophyll-a was varying from 0.31-1.93 mg/m^3.

In the sub surface water chlorophyll-a was varying from 0.807 – 4.718 mg/m3 at Vadinar jetty and 0.731 mg/m3 to 3.210 mg/m3near SPM during sampling done spring tide period and during Neap tide.

Algal Biomass

Chlorophyll- a value was used as algal biomass indicator (APHA 1998). Algal biomass was estimated by converting Chlorophyll value.

In the sub surface water algal biomass was varying from 16.5 to 84.6 mg/m^3 in harbour region of DPT during sampling done in from March 2020 to February 2021. In the nearby creeks Algal Biomass was varying from 20.5 to 102.7 mg/m^3.

Fig 6.11 Annual average values of Chlorophyll-a in harbor waters of DPT

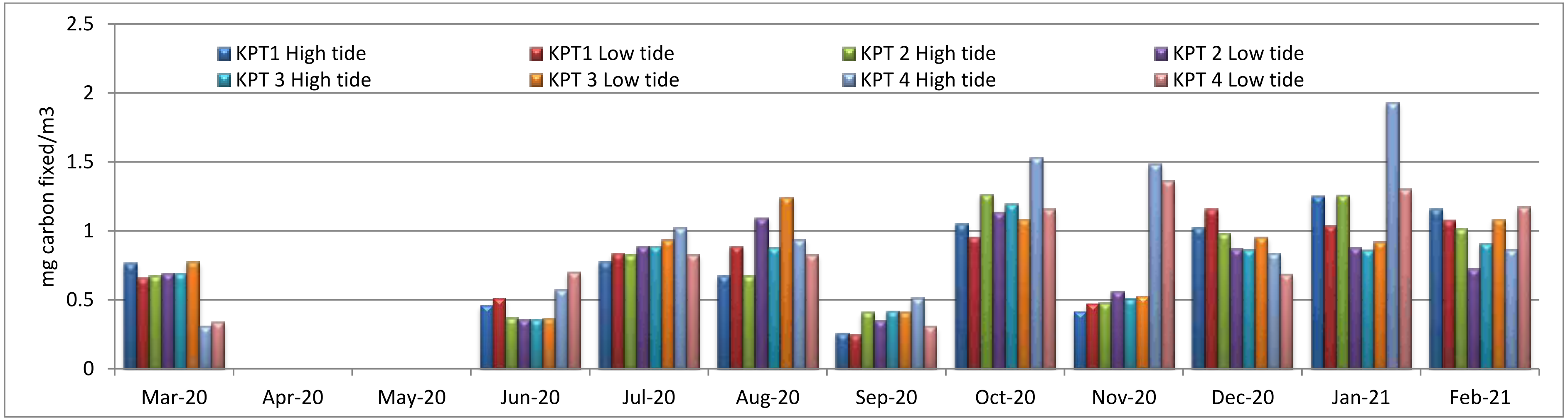
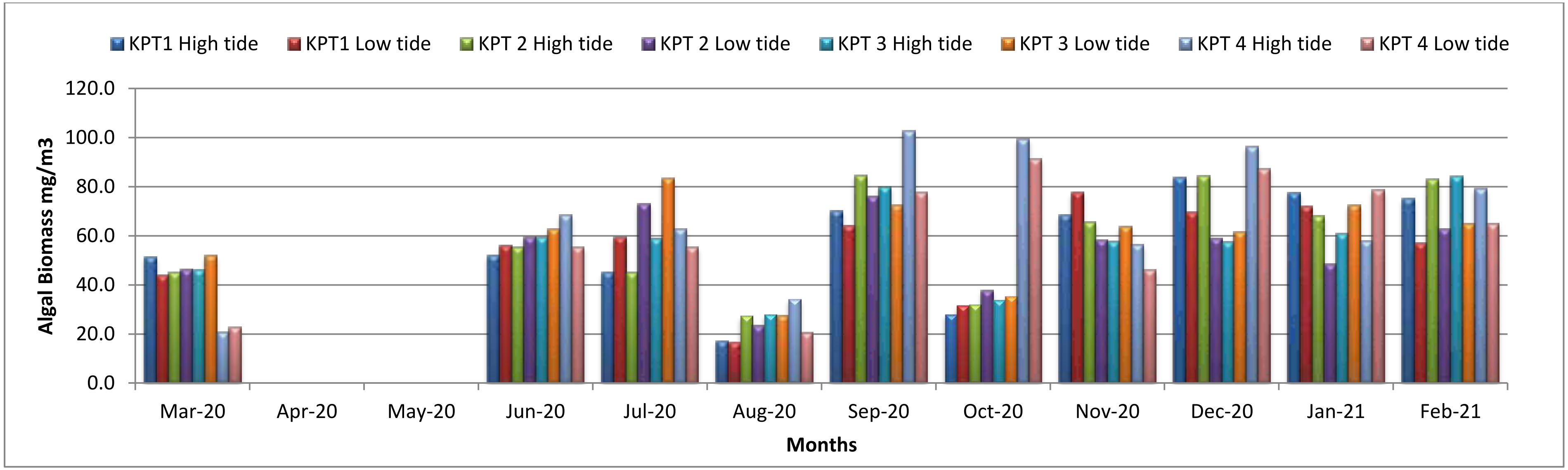


Fig 6.12 Annual average values of Algal Biomass in harbor waters of DPT



3.2 Phytoplankton and Zooplankton

The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by Blue green algae and diatoms during spring tide period and neap tide period. Diatoms were represented by 13 genera belonging to 3 classes, 9 orders and 12 families.

The Zooplankton community of the sub surface water in the harbour and nearby creeks is comparatively low and represented by mainly four groups Tintinids, Copepods, Foramiferans, and larval forms of Crustaceans.

However, Vadinar waters were observed to be rich in terms of diversity and abundance of phytoplankton and zooplanktons.

4. Noise Monitoring

Noise monitoring is carried out as per 'Noise Pollution (Regulation and Control) Rules, 2000. The results of noise monitoring results are annual mean of each location of Kandla and Vadinar Port (Table 5.3).

Table 5.3 Annual avg. of noise level at locations of Kandla (10 locations) and Vadinar (3 locations) Port

Sr. No.	Locations	Day Time Average Noise Level(SPL) in dB(A)	Night Time Average Noise Level(SPL) in dB(A)
	Time	**6 am. And 10 pm.**	**10 pm. To 6 am**
1	Marine Bhavan	67.8	59.8
2	Nirman Building 1	67.2	62.5
3	Tuna Port	53.0	48.7
4	Main Gate North	64.6	60.4
5	West Gate I	70.0	66.1
6	Canteen Area	68.8	58.7
7	Main Road	66.9	59.4
8	ATM Building	61.3	62.3
9	Wharf /Jetty Area	66.2	63.6
10	Port & Custom Office	58.9	52.2
	Vadinar Port		
11	Nr. Vadinar Port Gate	51.8	49.7
12	Port Colony Vadinar	51.5	50.6
13	Nr. Vadinar Jetty	54.1	47.5

Observations:

- The Day Time Average Noise Level in all ten locations at Deendayal Port ranged from 53.0 dB to 70.0 dB
- The noise levels were within the day time limits (75 dB (A)) of industrial area.
- The Night Time Average Noise Level in all ten locations of Deendayal Port ranged from 48.7 dB to 66.1 dB and it was within the permissible limits of 70 dBA for the industrial area for the night time.

- The mean day time noise levels at Vadinar were 52.5 dB and the mean noise levels at night hours was 49.3 dB.

5. Soil Monitoring

Sampling and analysis of soil samples was undertaken at six locations within the study area (Deendayal Port and Vadinar Port). The soil monitoring locations are coastal soils and exhibits saline soil characteristics, typical of a muddy shore.

The texture of soil of all locations was Sandy Loam. The soil at all the locations is saline in nature. The mean pH of the soil at all the locations of Kandla was 8.08 pH unit suggesting it to be slightly to medium alkaline.

Electrical conductivity of the soil was high with low moisture and organic carbon indicating less productivity of the soil and its unsuitability for any agriculture activities.

Other metals like copper, nickel and lead were detected in traces or within permissible limits. The overall surrounding soils were found to be less in essential nutrients, hence less suitable for plant growth.

6. Sewage Treatment Monitoring

This involve safe collection of waste water (spent/used water) from wash areas, bathroom, cargo operational units, etc., waste from toilets of various buildings and its conveyance to the treatment plant and final disposal in conformity with the requirement and guide lines of State Pollution Control Board and other statutory bodies.

The waste water is let into sewer network (network of pipes and manholes) and let by gravity and intermittent pumping stations to the main Sewage Treatment Plant (STP).

The Sewage Treatment Monitoring is carried out at Deendayal Port Colony

(Gopalpuri), Vadinar Port and Deendayal Port.

STP at Gopalpuri Port Colony

Gopalpuri STP is working properly and overall performance of the existing STP was found satisfactory. The removal efficiency of BOD, TSS was in order. The individual units were also performing well and their removal efficiencies are satisfactory. Thus with the sample tested in laboratory the plant is working satisfactory and the individual units are also working well.

STP at Kandla Port

STP with improved capacity of 1.5 MLD at Deendayal Port is operational. The newly installed sewage treatment plant has 1500 cum/day fluidized media reactor based STP to treat domestic waste water generated from the campus and treated water will be utilized for gardening and plantation purpose.

7. Conclusion

i. Ambient Air

Ambient Air Quality monitoring results for the first year shows TSPM, PM_{10} and $PM_{2.5}$ concentrations of the ambient air were within the permissible limits as per the National Ambient Air Quality Standards (NAAQS 2009). The concentration of PM_{10} was above the permissible limit at Coal Storage Area, Marine Bhavan and occasionally at Oil Jetty Area and Tuna Port area at some occasions.

Deendayal Port has handled 305.480 Lakh tonne of dry cargo and in 2017-18, DPT handled 310.038 Lakh tonne dry cargo. This huge volume of dry cargo handled at DPT along with high winds in coastal areas causes slight rise in the Ambient Air Quality near coal berth.

Very high volume of dry cargo is being handled (especially coal) at berth no. 7, 8 and 9. Besides handling of coal, thousands of vehicles laded with coal and other dry cargo criss-cross the port/harbour roads causing the rise in suspended particles in the air.

ii. Drinking Water Quality

The results of the current year monitoring suggest that, the drinking water parameters of all the locations (18 at Kandla and 2 at Vadinar Port) were found within the permissible limits as per the BIS 10500 (2012) drinking water specification.

iii. Noise Quality

The day and night time noise quality was found within the permissible limits of the Noise Pollution (regulation and control) rules, 2000. The Day Time and Night Time Average Noise Level (SPL) in all ten locations at Deendayal

Port were within the permissible limits of 75 dBA (for day time) and 70 dBA (for the night time) for an industrial area.

iv. Marine Water Quality

The marine water samples were collected from the harbour area and the creek area and were monitored for 28 different parameters. The mean DO levels of DPT waters ranged from 4.9 mg/L to 6.0 mg/L (mean = 5.6 mg/L), which is normal for marine waters of ports and harbors.

Evaluation of the Phytoplankton and Zooplankton population in DPT harbour area and within the immediate surroundings of the port suggests that the Kandla waters harbours low to moderate diversity and abundance of phytoplankton and zooplanktons.

v. Sewage Treatment Plant

Gopalpuri STP is working properly and overall performance of the existing STP was found satisfactory.

A new STP with improved capacity of 1.5 MLD at Deendayal Port is operational which is working as per the standards of CPCB/GPCB.

At Vadinar Port, sewage water released into septic tank for treatment and then released. Immediate actions should be taken to commission a full fledge STP plant at Vadinar.

7.1. Steps taken by Deendayal Port to improve Environment

- 'Safety Week' is being celebrated in Kandla Port by demonstrating mock drill, firefighting, emergency preparedness, health checkup program etc.
- Regular Safety training and mockdrill are being carried out and awareness is being created by lectures among the workers of the Port.
- Personal Protective Equipments (PPE) like ear plugs, helmets, safety suits, etc are being used during Port Operational work.
- Sewage generated at Port Area as well as in Port colonies is being properly treated through Sewage Treatment Plants at outside Port area at Kandla and Port colony at Gopalpuri. However, DPT is planning to construct a new STP with the latest technology as the existing one is very old.
- Deendayal Port Trust have planted about one lakhs trees in road side dividers, colony areas at Kandla and Gopalpuri, in green belt area of Gandhidham & Adipur Township, Sewage Treatment Plants at Gopalpuri & Kandla and some green belt development plans initiated at different locations in Town ship areas.
- Deendayal Port Trust also carries out Environmental Auditing every year through recognized environmental auditor (Schedule I) of Gujarat Pollution Control Board from the year 2010 .Three Audit Reports for the year 2010, 2011 and 2012 were already submitted to GPCB as per the norms.
- DPT planted Mangroves in an area of 1350 hectares from 2005 to 2019:

  Mangrove Plantation Plan carried out in following phases;
  1) Year 2005-06 – 20 hectares
  2) Year 2008-09 - 50 hectares
  3) Year 2010-11 – 100 hectares
  4) Year 2011-12 – 200 hectares
  5) Year 2012-13 – 300 hectares
  6) Year 2013-14- 330 hectares
  7) Year 2015-17 - 300 hectares
  8) Year 2018-19 - 50 hectares

  Total - 1350 hectares

- Water sprinkling on coal is regularly done to prevent coal dust pollution in the port area.
- To control the dust from bulk cargo like fertilizer, coal, sulphur, etc, the Port-users are encouraged to use hopper during discharge from vessels.
- Annual maintenance contracts have been awarded for garbage collection, cleaning of buildings and roads.
- Deendayal Port Trust is maintaining the records for collection and disposal of Solid Wastes generated from Port area, Residential area and Office Buildings.
- Deendayal Port Trust is regularly submitting the Hazardous Waste Statement in From – IV and Form V in environment sheet every financial year to the Gujarat Pollution Control Board, Gandhinagar.
- A report on collection and disposal of the wastes from ships is submitted by the licensees to Deendayal Port and GPCB. A monthly report is given to the DG (Shipping) also.
- All trucks before leaving the storage yards are covered with tarpaulin and not over loaded as well as there is no spillage during transportation.
- Sewage generated at Port area and Port colonies is being properly treated through Sewage Treatment Plants outside Port area at Kandla and Port Colony at Gopalpuri.
- Deendayal Port has engaged CPCB/GPCB authorized agencies for the disposal of Hazardous waste (spent / used oil from ships) as per the Hazardous Wastes (Management and Handling) Rules.
- Pollution under Control (PUC) Certificate is mandatory for vehicles and equipments operating in the Port.
- Deendayal Port has awarded several projects to M/s Gujarat Institute of Desert Ecology (GUIDE), Bhuj relating to monitoring of Marine environment viz;
    - Regular Monitoring of Marine Ecology of Kandla Port Area since 2017-18
    - Creek Bathymetry
    - Analysis of dredging contaminants

- Strategic Regional Impact Assessment Studies
- Assessment and Monitoring of Mangrove Plantation in 1300 Ha area.
- Biodiversity Action Plan for DPT and its surrounding areas

7.1.1. ISO 14001:2015 - Environmental Management System of Deendayal Port Trust

Deendayal port has appointed QMS India Ltd. as for Continual Improvement of ISO 14001:2015 - Environmental Management System with following scope;

- Review of environmental aspect-impacts,
- Review and monitoring of legal requirement
- Review and monitoring of emergency preparedness
- Management review by every six months
- Training of internal auditors and EMC members
- Active participation during external audit.

7.1.2. Green Ports Initiative

Deendayal Port is committed to sustainable development and adequate measures are being taken to maintain the Environmental well-being of the Port and its surrounding environs. Weighing in the environmental perspective for sustained growth, the Ministry of Shipping had started 'Project Green Ports' which will help in making the Major Ports across India cleaner and greener. 'Project Green Ports' will have two verticals - one is 'Green Ports Initiatives' related to environmental issues and second is 'Swachh Bharat Abhiyaan'.

The Green Port Initiatives include twelve initiatives such as preparation and monitoring plan, acquiring equipments required for monitoring environmental pollution, acquiring dust suppression system, setting up of sewage/waste water treatment plants/ garbage disposal plant, setting up Green Cover area, projects for energy generation from renewable energy

sources, completion of shortfalls of Oil Spill Response (OSR) facilities (Tier-I), prohibition of disposal of almost all kind of garbage at sea, improving the quality of harbour wastes etc.

Deendayal port has also appointed GEMI as an Advisor for "Making Deendayal Port a Green Port - Intended Sustainable Development under the Green Port Initiatives.

- Deendayal Port has also signed MoU with Gujarat Forest Department in August 2019 for Green Belt Development in an area of 31.942 Ha of land owned by Deendayal Port Trust. The plantation is being carried out by the Social Forestry division of Kachchh.

8. Suggestions

8.1. Ambient Air Quality

PM_{10} values at Coal storage area, Marine Bhavan, Oil Jetty and Tuna Port were occasionally found above the permissible standards and $PM_{2.5}$ was occasionally found above permissible limits at Coal storage area. (100 $\mu g/m^3$ for PM_{10} & 60 $\mu g/m^3$ for $PM_{2.5}$). The principle reason for higher PM_{10} values at Coal Storage and Marine Bhavan are bulk handling of coal, other dry cargo and heavy traffic of transport vehicles.

8.1.1. Sprinkling

- Heavy duty Water sprinklers should be used inside port where large scale dry cargo is handled.
- Mobile air Sprinklers should also be procured, which suppresses the fine dust from blowing during handling of dry cargo.

8.1.2. Enclosed conveyors

- Port users should be motivated to use enclosed conveyors which prevents secondary dust emissions due to wind in the port area.

8.1.3. Mechanized handling systems

- This involves using screw type unloaders which results in much less spillage and loss of material as compared to bucket unloaders. Mechanized systems can also use pre-packed containers for ease and pollution free loading unloading. Diligent use of various systems can keep the pollution due to ports at minimum level.

Besides these prevention measures, Gujarat Pollution Control Board (GPCB) has also issued guidelines for handling of Coal. Guidelines for Coal Transport, Storage and Handling given below should be strictly followed; (*https://gpcb.gujarat.gov.in/uploads/coal-handling-guidelines1.pdf)*

8.2. GPCB Guidelines for Coal handling units:

(A) Location criteria

- In case of coal handling activities at the ports and jetties or extension thereof, the distance and land use criteria may be relaxed and compensated by advanced/sophisticated pollution control measures and mechanization & thick plantation, however all such ports and jetties, where coal handling is carried out, shall provide closed conveyor belt and mechanization for handling of coal

(B) Storage and handling criteria

- Coal handling unit/Agency shall store coal in such a way that coal heap should not be higher than 5 meter and clear distance between two adjoining heaps at G.L. should be 5 meters, so that in case of fire, approach is available.

- There should be mechanized loading/unloading system from the loading /unloading area to the stacking yards and in to the vehicles.

- Coal handling unit/Agency shall take all corrective steps to resolve the issue of air pollution at permitted coal storage/handling area where coal is being stored.

(C) Transport criteria

- Coal handling unit/Agency shall ensure that all trucks before leaving the storage yard shall be showered with water with adequate system, Shall be covered with tarpaulin or any other effective measure/device completely and also that trucks are not over loaded as well as there is no spillage during transportation.

- The vehicle carrying the coal should not be overloaded by raising the height of carriage. Weigh scale shall be provided within the loading area only and port / coal park authority shall ensure that no overloading is done.

- The top of the vehicle should be covered with fixed cover to avoid spillage or dusting of coal.

(D) Pollution prevention criteria

- Coal handling unit/Agency shall provide paved approach with adequate traffic carrying capacity

- Coal handling unit/Agency shall construct compound wall all along periphery of the premises with minimum 9 meters height

- Continuous water sprinkling shall be carried out on the top of the heap at regular intervals to prevent dusting, fire & smoke. To prevent fugitive emission during loading/unloading, fixed pipe network with sufficient water storage and pump shall be installed. Water sprinkling shall be carried out at each and every stage of handling to avoid generation of coal dust or other dust within premises

- Coal handling unit/Agency shall ensure regular sweeping of coal dust from internal and main road and also ensure that there is adequate space for free movement of vehicles.

- The following adequate Air Pollution Control Measures shall be installed and to be operated efficiently.

- Dust containment cum suppression system for the coal stack, loading and unloading.

- Construction of effective wind breaking wall suitable to local condition to prevent the suspension of particles from the heaps.

- Construction of metal road & RCC Pucca flooring in the plot area/godown etc.

- System for regular cleaning and wetting of the floor area within the premises.

- Entire coal storage area/godown should be covered with permanent weather shed roofing and side walls i.e., in closed shed, in case of crushing/sieving/grading activity is carried out (i.e. G. I. Sheet) along with adequate additional APCM should be installed.

- Coal handling unit/Agency shall carryout three rows plantation with tall growing tress all along the periphery of the coal handling premises, inside & outside of the premises along with road.

- Proper drainage system shall be provided in all coal storage area so that water drained from sprinkling & runoff is collected at a common tank and can be reused after screening through the coal slit or any other effective treatment system.

- All the engineering control measures and state of art technology including covered conveyer belts, mechanized loading and unloading, provision of silo etc. shall be provided in addition to the measures recommended in the environmental guidelines for curbing the pollution.

(E) Safety requirement

- Coal handling unit/Agency shall provide adequate fire-fighting measure to avoid any fire or related hazards including adequate water storage facility, and the premises shall be exclusively used for storage of the coal.

- An onsite emergency plan shall be prepared and implemented by coal handling unit.

(F) Legal criteria

- Necessary permission from all the applicable regulatory authorities and adequate steps under the provisions of applicable environmental acts/ rules shall be taken.

- Coal handling unit/Agency shall prepare EMP (Environment Management Plan) and implement the same in true spirit and thus maintain overall environment of that area.

- Coal handling unit/Agency shall not carry out the operation of loading/unloading of coal/coal dust at any place, till adequate air pollution control equipment for dust control/suppression are installed and efficiently operated and the consent under the provisions of Air (Prevention & Control of Pollution) Act, 1981 is obtained by the coal

yard owners/ Coal handling unit/Agency / coal importers.

- Coal handling unit/Agency shall operate continuous Ambient Air Quality Monitoring Stations as per CPCB guideline.
- In case of port which provides the facility to individual developers an agreement/MoU shall be made between port authority and developer for curtailment of pollution. Port authority shall be responsible for supervising and controlling the pollution control related activities and implementation of the environmental guidelines.

8.3. Sewage Treatment Plant at Vadinar

- At Vadinar, the sewage waste water from the colony is drained into septic tank and later, is released for plantation/gardening. Till the new STP is commissioned; operation of the existing unit should be maintained.

ANNEXURE- I-A

Ambient Air Quality Standards (NAAQS)

Pollutants	Time weighted average	Concentration in Ambient air µg/m³		
		Industrial Areas	Resi. rural & other areas	Sensitive Areas
Suspended Particulate Matter (SPM)	Annual Average*	360	140	70
	24 hours**	500	200	100
Respirable Particulate Matter (size >10 mm) (RPM)	Annual Average*	120	60	50
	24 hours**	150	100	75
Carbon Monoxide (CO)	8 hours**	5.0	2.0 mg/ m^3	1.0 mg/
	1 hour	10.0 mg/ m^3	4.0 mg/ m^3	2.0 mg/ m^3

- Annual arithmetic mean of minimum of 104 measurements in a year taken twice a week. 24 hourly at uniform interval
- 24 hourly / 8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days

Note:

- National Ambient Air Quality Standard: The levels of air quality with an adequate margin of safety, to protect the public health, vegetation and property.
- Wherever and whenever two consecutive values exceeds the limit specified above for the respective category, it would be considered adequate reason to institute regular/continuous monitoring and further investigations.
- The State Government / State Board shall notify the sensitive and other

areas in the respective states within a period of six months from the date of Notification of National Ambient Air Quality Standards.

[{S.O. 384 (E), Air (Prevention & Cont. of Pollution) Act, 1981 dated April 11, 1994]

ANNEXURE- I-B

Drinking Water Standards (BIS)

Sr. No.	Parameter	Unit	Acceptable Limits	Permissible Limits
1	pH	pH Unit	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	500	2000
3	Turbidity	NTU	1.0	5.0
4	Odor	-	Agreeable	Agreeable
5	Color	Hazen Units	5.0	15.0
6	Conductivity	µs/cm	NS*	NS*
7	Dissolved Oxygen	mg/l	NS*	NS*
8	Biochemical Oxygen Demand	mg/l	NS*	NS*
9	Chloride as Cl	mg/l	250.0	1000.0
10	Ca as Ca	mg/l	75.0	200.0
11	Mg as Mg	mg/l	30.0	100.0
12	Total Hardness	mg/l	200.0	600.0
13	Iron as Fe	mg/l	0.3	1.0
14	Fluorides as F	mg/l	1.0	1.5
15	Sulphate as SO4	mg/l	200.0	400
16	Nitrite as NO2	mg/l	NS*	NS*
17	Nitrate as NO3	mg/l	45.0	100
18	Salinity	%o	NS*	NS*
19	Sodium as Na	mg/l	NS*	NS*
20	Potassium as K	mg/l	NS*	NS*
21	Manganese	mg/l	0.1	0.3
22	Hexavalent Chromium	mg/l	NS*	NS*
23	Copper	mg/l	0.05	1.5
24	Cadmium	mg/l	0.003	0.003
25	Arsenic	mg/l	0.01	0.05
26	Mercury	mg/l	0.001	0.001
27	Lead	mg/l	0.01	0.01
28	Zinc	mg/l	5.0	15.0
29	Bacterial Count	CFU/100ml	Absent	Absent

(BIS specifications (IS 10500-1991)

Bacteriological Standards (for Drinking water)

	Organisms	Requirements
All water intended for drinking		
	(a) E. coli or thermo-tolerant Coliform bacteria	Shall not be detectable in any 100 ml sample
Treated water entering the distribution system		
	a) E. coli or thermo-tolerant Coliform bacteria	Shall not be detectable in any 100 ml sample
	b) Total Coliform bacteria	Shall not be detectable in any 100 ml sample
Treated water in the distribution system		
	a) E. coli or thermo-tolerant Coliform bacteria	Shall not be detectable in any 100 ml sample
	b) Total Coliform bacteria	Shall not be detectable in any 100 ml sample

(BIS specifications (IS 10500-1991)

ANNEXURE- I-C

Noise Quality Standards

Area Code	Category of Area	Limits in dB(A) Leq	
		Day Time	Night Time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

- Day Time is recorded in between 6 a.m. and 9 p.m.
- Night time is recorded in between 9 p.m. to 6 a.m.
- Silence zone is defined as areas up to 100 meters around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by the Competent Authority.
- Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.
- Mixed categories of areas should be declared as one of the four above mentioned categories by the Competent Authority and the corresponding standards shall apply.

[Source: EPA Notification [G.S.R. 1063 (E) dt. 26.12.1989 published in the Gazette No. 643 dt. 26.12.1989.]

ENVIRONMENTAL MONITORING REPORT
FOR
DEENDAYAL PORT TRUST

REPORT NO.	:	**DCPL/DPT/20-21/11**
Month	:	**March 2021**
Issue No	:	**01**
Revision No	:	**00**
Prepared by	:	**DETOX CORPORATION PVT. LTD., SURAT**

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Introduction

Monitoring of various environmental aspects of the Deendayal Port is being carried out by Detox Corporation Pvt. Ltd. through collection of samples, analysis of the same, comparing results with respect to the national standards and any other relevant standards by GBCB/CPCB/MoEF&CC to identify non conformities in the Environment of the Deendayal Port. The results shall address the identified impacts and suggest measures to minimize the environmental impact due to various operations at Deendayal Port.

The environmental monitoring is carried out as per the Environment Management and Monitoring Plan submitted by Detox Corporation Pvt. Ltd.

1. Ambient Air Quality Monitoring

As per the Environmental Monitoring Plan of Deendayal Port Trust, Air monitoring was carried out at six identified locations at Deendayal Port and two locations at Vadinar Port.

1.1. Air Quality Monitoring Methodology

Air quality is measured in all the stations, for 24 hour for Total Suspended Particulate Matter (TSPM), PM_{10}, $PM_{2.5}$, SO_2, NO_X, NH_3, Benzene, CO & CO_2. The Air samplers are operated for a period of 24 hours and after a continuous operation of 8 hours of the sampler, the reagents were replaced to obtain 3 samples per day for each parameter namely; SO_2, NO_X and NH_3. The EPM 2000 filter paper and PTFE Membrane bound filter paper are used for a period of 24 hours to obtain one sample each of TSPM, PM_{10} & $PM_{2.5}$.

The AAQ samples are collected twice a week from all the eight locations as per the EMP.

1.2. Results

The Ambient Air Quality (AAQ) monitoring data for six stations, viz. Marine Bhavan, Oil Jetty, Deendayal Port Colony, Gopalpuri Hospital, Tuna Port and Nr. Coal Storage Area for the month of March 2021 are given in Tables 1A to 6B. The AAQ monitoring data for two stations at Vadinar (Vadinar Port Colony & Signal Building) are given in Tables 7A to 8B.

Location 1: Marine Bhavan (AL1)

Table 1A : Results of Air Pollutant Concentration at Marine Bhavan

	Date	TSPM [µg/m^3]	PM10 [µg/m^3]	PM2.5 [µg/m^3]	SO2 [µg/m^3]		NOx [µg/m^3]		NH3 [µg/m^3]	
Sampling Period		24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit		500 µg/m^3	100 µg/m^3	60 µg/m^3		80 µg/m^3		80 µg/m^3		400 µg/m^3
AL1 – 1	03.03.2021	284	188	95	5.71	4.10	6.35	8.89	8.93	8.85
					3.52		9.53		9.96	
					3.08		10.80		7.66	
AL1 – 2	05.03.2021	414	162	60	9.23	9.52	19.05	16.94	9.45	10.98
					10.99		22.23		9.96	
					8.35		9.53		13.53	
AL1 – 3	10.03.2021	667	84	28	12.75	9.38	22.23	20.33	8.93	9.96
					9.67		26.04		9.96	
					5.71		12.70		10.98	
AL1 – 4	12.03.2021	803	166	31	15.39	12.60	17.78	18.42	14.04	13.44
					12.31		17.78		14.55	
					10.11		19.69		11.74	
AL1 – 5	17.03.2021	694	107	13	8.35	9.08	9.53	11.64	9.45	10.98
					10.98		12.07		9.70	
					7.91		13.34		13.79	
AL1 - 6	19.03.2021	424	95	71	8.35	9.08	8.89	14.61	9.45	11.74
					10.98		15.88		9.70	
					7.91		19.05		16.08	
AL1 - 7	24.03.2021	430	125	81	7.91	7.03	19.69	23.50	4.85	4.42
					5.71		24.77		3.83	
					7.47		26.04		4.60	
AL1 – 8	26.03.2021	520	109	66	7.47	7.03	1.91	13.55	6.89	7.40
					5.28		25.41		7.91	
					8.35		13.34		7.40	
Monthly Average		**530**	**130**	**56**		**8.48**		**15.98**		**9.72**
Standard Deviation		**175**	**38**	**29**		**2.48**		**4.77**		**2.81**

* NMHC- Non- Methane Hydrocarbons BDL- Below Detection Limit (Detection Limit – NMHC: 1ppm)

Table 1B : Results of Air Pollutant Concentration at Marine Bhavan					
	Date	**C_6H_6 [µg/m^3]**	**HC**	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**		**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**		**4.0 mg/m^3**	**-**
AL1 – 1	03.03.2021	1.02	BDL	1.65	351
AL1 – 2	05.03.2021	1.18	BDL	1.76	346
AL1 – 3	10.03.2021	1.1	BDL	1.81	371
AL1 – 4	12.03.2021	1.06	BDL	1.64	354
AL1 – 5	17.03.2021	1.09	BDL	1.75	385
AL1 - 6	19.03.2021	1.25	BDL	1.8	380
AL1 - 7	24.03.2021	1.2	BDL	1.1	326
AL1 - 8	26.03.2021	1.1	BDL	1.3	298
Monthly Average		**1.13**	**NA**	**1.60**	**351**
Standard Deviation		**0.08**		**0.26**	**29**

Location 2: Oil Jetty (AL2)

Table 2A : Results of Air Pollutant Concentration at Oil Jetty

	Date	TSPM [µg/m^3]	PM_{10} [µg/m^3]	$PM_{2.5}$ [µg/m^3]	SO_2 [µg/m^3]		NOx [µg/m^3]		NH3 [µg/m^3]	
Sampling No.		**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit		**500 µg/m^3**	**100 µg/m^3**	**60 µg/m^3**		**80 µg/m^3**		**80 µg/m^3**		**400 µg/m^3**
AL2 -1	03.03.2021	162	72	37	3.52	5.71	6.99	8.26	9.96	7.74
					4.84		15.88		4.34	
					8.79		1.91		8.93	
AL2 -2	05.03.2021	505	94	36	5.28	5.28	9.53	7.83	5.36	9.19
					6.59		6.99		10.72	
					3.96		6.99		11.49	
AL2 -3	10.03.2021	505	94	36	10.99	9.38	24.77	22.23	7.40	8.59
					13.19		17.15		9.45	
					3.96		24.77		8.93	
AL2 -4	12.03.2021	517	81	17	10.99	9.52	13.34	16.30	14.55	16.42
					8.79		18.42		16.08	
					8.79		17.15		18.64	
AL2 – 5	17.03.2021	492	108	84	4.83	5.42	10.80	10.16	9.45	13.44
					5.27		11.43		16.08	
					6.15		8.26		14.81	
AL2 – 6	19.03.2021	461	139	74	7.91	8.06	15.88	10.37	21.19	16.51
					8.35		6.99		15.57	
					7.91		8.26		12.76	
AL2 – 7	24.03.2021	593	93	46	8.83	7.04	18.42	19.48	9.45	7.74
					5.71		16.51		10.47	
					6.59		23.50		3.32	
AL2 -8	26.03.2021	337	144	73	8.35	8.64	5.72	5.93	10.72	6.81
					8.79		4.45		3.32	
					8.79		7.62		6.38	
Monthly Average		**447**	**103**	**50**		**7.38**		**12.57**		**10.81**
Standard Deviation		**135**	**26**	**24**		**1.77**		**5.99**		**4.02**

Table 2B : Results of Air Pollutant Concentration at Oil Jetty					
	Date	**C_6H_6 [µg/m^3]**	**HC**	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**		**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**		**4.0 mg/m^3**	**-**
AL2 -1	03.03.2021	1.04	BDL	1.8	364
AL2 -2	05.03.2021	1.1	BDL	1.74	375
AL2 -3	10.03.2021	1.29	BDL	1.7	362
AL2 -4	12.03.2021	1.19	BDL	1.69	359
AL2 – 5	17.03.2021	1.01	BDL	1.84	358
AL2 – 6	19.03.2021	1.16	BDL	1.87	376
AL2 -7	24.03.2021	1.2	BDL	1.5	301
AL2 – 8	26.03.2021	1.1	BDL	1.72	322
Monthly Average		**1.14**		**1.73**	**352**
Standard Deviation		**0.09**		**0.11**	**27**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 1ppm)

Location 3: Deendayal Colony – Estate Office (AL-3)

Table 3A : Results of Air Pollutant Concentration at Estate Office										
	Date	TSPM [µg/m^3]	PM_{10} [µg/m^3]	$PM_{2.5}$ [µg/m^3]	SO_2 [µg/m^3]		NOx [µg/m^3]		NH3 [µg/m^3]	
Sampling No.		24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit		500 µg/m^3	100 µg/m^3	60 µg/m^3		80 µg/m^3		80 µg/m^3		400 µg/m^3
AL3 – 1	03.03.2021	119	55	30	3.96	3.08	6.35	11.22	6.38	6.13
					1.32		9.53		6.89	
					3.96		17.78		5.11	
AL3 – 2	05.03.2021	291	96	48	4.84	4.84	24.14	14.40	11.49	11.49
					4.84		8.26		15.32	
					4.84		10.80		7.66	
AL3 – 3	10.03.2021	555	101	36	10.11	6.59	13.34	20.54	1.28	5.36
					5.28		19.69		9.45	
					4.40		28.58		5.36	
AL3 – 4	12.03.2021	467	64	27	9.23	9.67	6.99	8.68	20.68	12.17
					15.39		8.26		2.81	
					4.40		10.80		13.02	
AL3 – 5	17.03.2021	416	76	25	5.71	4.83	19.05	11.86	6.89	6.64
					4.83		6.99		7.15	
					3.96		9.53		5.87	
AL3 – 6	19.03.2021	378	57	28	6.15	6.74	9.53	8.89	6.38	8.76
					8.35		11.43		10.47	
					5.71		5.72		9.45	
AL3 – 7	24.03.2021	172	101	49	5.71	6.01	15.88	16.94	5.36	6.55
					3.96		17.15		6.38	
					8.35		17.78		7.91	
AL3 – 8	26.03.2021	225	173	29	6.15	6.74	18.42	20.75	9.45	7.66
					8.35		31.76		6.13	
					5.71		12.07		7.40	
Monthly Average		328	90	34		6.06		14.16		8.09
Standard Deviation		152	38	10		1.93		4.83		2.52

Table 3B : Results of Air Pollutant Concentration at Deendayal Port Colony					
	Date	C_6H_6 [µg/m^3]	HC	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		**8 hr**		**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**		**4.0 mg/m^3**	**-**
AL3 -1	03.03.2021	1.03	BDL	1.86	360
AL3 -2	05.03.2021	1.2	BDL	1.74	382
AL3 -3	10.03.2021	1.1	BDL	1.81	342
AL3 -4	12.03.2021	1.02	BDL	1.76	345
AL3 – 5	17.03.2021	1.12	BDL	1.66	377
AL3 – 6	19.03.2021	1.23	BDL	1.58	365
AL3 – 7	24.03.2021	1.2	BDL	1.74	352
AL3 – 8	26.03.2021	1.24	BDL	1.62	333
Monthly Average		**1.14**		**1.72**	**357**
Standard Deviation		**0.09**		**0.10**	**17**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 1ppm)

Location 4: Gopalpuri Hospital (AL-4)

Table 4A : Results of Air Pollutant Concentration at Gopalpuri Hospital

	Date	TSPM [µg/m³]	PM_{10} [µg/m³]	$PM_{2.5}$ [µg/m³]	SO_2 [µg/m³]		NOx [µg/m³]		NH3 [µg/m³]	
Sampling No.		24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit		500 µg/m³	100 µg/m³	60 µg/m³		80 µg/m³		80 µg/m³		400 µg/m³
AL4 -1	03.03.2021	193	44	16	0.88	4.69	6.99	7.20	0.77	2.30
					9.23		7.62		2.81	
					3.96		6.99		3.32	
AL4 -2	05.03.2021	399	94	38	1.32	1.47	13.34	6.78	7.66	5.79
					0.88		5.08		8.93	
					2.20		1.91		0.77	
AL4 -3	10.03.2021	479	98	26	4.84	3.52	6.99	5.08	5.36	3.23
					3.96		4.45		2.30	
					1.76		3.81		2.04	
AL4 -4	12.03.2021	277	130	39	2.20	3.37	6.99	6.56	4.34	3.83
					3.52		7.62		4.60	
					4.40		5.08		2.55	
AL4 – 5	17.03.2021	173	79	26	5.28	5.71	1.91	5.29	4.34	3.23
					5.71		5.72		3.32	
					6.15		8.26		2.04	
AL4 – 6	19.03.2021	159	105	26	4.84	3.96	15.88	14.19	7.91	7.06
					1.32		19.69		6.38	
					5.71		6.99		6.89	
AL4 – 7	24.03.2021	210	125	37	4.84	5.42	15.88	10.37	2.04	2.55
					5.71		9.53		2.55	
					5.71		5.72		3.06	
AL4 – 8	26.03.2021	234	110	26	9.67	8.64	5.72	7.62	4.34	4.42
					8.35		7.62		5.87	
					7.91		9.53		3.06	
Monthly Average		**266**	**98**	**29**		**4.60**		**7.89**		**4.05**
Standard Deviation		**115**	**27**	**8**		**2.11**		**3.02**		**1.64**

Table 4B : Results of Air Pollutant Concentration at Gopalpuri Hospital					
	Date	C_6H_6 [µg/m^3]	HC	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr		Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3		4.0 mg/m^3	-
AL4 -1	03.03.2021	1.22	BDL	1.84	386
AL4 -2	05.03.2021	1.06	BDL	1.66	377
AL4 -3	10.03.2021	1.32	BDL	1.72	366
AL4 -4	12.03.2021	1.18	BDL	1.67	367
AL4 – 5	17.03.2021	1.22	BDL	1.7	384
AL4 – 6	19.03.2021	1.02	BDL	1.58	359
AL4 – 7	24.03.2021	1.18	BDL	1.6	333
AL4 – 8	26.03.2021	1.2	BDL	1.55	301
Monthly Average		**1.18**	**NA**	**1.67**	**359**
Standard Deviation		**0.09**		**0.09**	**29**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC : 1ppm)

Location 5: Coal Storage Area (AL-5)

Table 5A : Results of Air Pollutant Concentration at Coal Storage Area										
	Date	TSPM [µg/m^3]	PM_{10} [µg/m^3]	$PM_{2.5}$ [µg/m^3]	SO_2 [µg/m^3]		NOx [µg/m^3]		NH3 [µg/m^3]	
Sampling No.		24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit		500 µg/m^3	100 µg/m^3	60 µg/m^3		80 µg/m^3		80 µg/m^3		400 µg/m^3
AL6 – 1	03.03.2021	337	105	40	10.99	5.13	14.61	13.13	13.53	12.59
					0.88		6.99		11.49	
					3.52		17.78		12.76	
AL6 – 2	05.03.2021	377	197	98	3.96	7.33	19.69	19.27	17.10	13.61
					9.23		17.15		13.53	
					8.79		20.96		10.21	
AL6 – 3	10.03.2021	582	138	44	5.71	6.45	12.07	16.09	6.89	9.45
					6.15		15.88		11.49	
					7.47		20.33		9.96	
AL6 – 4	12.03.2021	162	98	51	12.31	9.82	28.58	27.95	9.45	8.93
					13.19		26.68		9.96	
					3.96		28.58		7.40	
AL6 – 5	17.03.2021	557	180	47	8.35	9.67	18.42	17.36	13.02	16.34
					12.75		22.87		14.30	
					7.91		10.80		21.70	
AL6 – 6	19.03.2021	256	121	87	5.28	5.71	16.51	14.19	13.53	14.38
					5.71		10.16		16.59	
					6.15		15.88		13.02	
AL6 – 7	24.03.2021	593	243	73	9.23	7.47	27.31	27.52	5.36	9.62
					5.71		31.76		9.45	
					7.47		23.50		14.04	
AL6 – 8	26.03.2021	617	225	94	7.03	6.74	5.72	11.22	7.40	10.21
					8.35		12.07		9.45	
					4.84		15.88		13.79	
Monthly Average		435	163	67		7.29		18.34		11.89
Standard Deviation		175	56	24		1.70		6.31		2.73

Table 5B : Results of Air Pollutant Concentration at Coal Storage Area					
	Date	**C_6H_6 [µg/m^3]**	**HC**	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**		**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**		**4.0 mg/m^3**	**-**
AL6 – 1	03.03.2021	1.02	BDL	1.61	377
AL6 – 2	05.03.2021	1.36	BDL	1.74	386
AL6 – 3	10.03.2021	1.22	BDL	1.82	371
AL6 – 4	12.03.2021	1.12	BDL	1.77	396
AL6 – 5	17.03.2021	1.06	BDL	1.86	366
AL6 – 6	19.03.2021	1.32	BDL	1.59	358
AL6 – 7	24.03.2021	1.22	BDL	1.62	346
AL6 – 8	26.03.2021	1.20	BDL	1.58	322
Monthly Average		**1.19**	**NA**	**1.70**	**365**
Standard Deviation		**0.12**		**0.11**	**23**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 1ppm)

Location 6: Tuna Port (AL-6)

Table 6A : Results of Air Pollutant Concentration at Tuna Port										
	Date	TSPM [µg/m^3]	PM_{10} [µg/m^3]	$PM_{2.5}$ [µg/m^3]	SO_2 [µg/m^3]		NOx [µg/m^3]		NH3 [µg/m^3]	
Sampling No.		24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit		500 µg/m^3	100 µg/m^3	60 µg/m^3		80 µg/m^3		80 µg/m^3		400 µg/m^3
AL5 -1	03.03.2021	84	30	15	11.87	5.13	12.07	13.13	4.86	12.59
					1.32		8.26		7.66	
					4.84		10.80		5.36	
AL5 – 2	05.03.2021	220	87	40	3.96	7.33	12.07	19.27	4.85	13.61
					1.32		8.26		7.40	
					2.20		17.15		7.91	
AL5 – 3	10.03.2021	272	74	45	1.32	6.45	6.99	16.09	5.62	9.45
					3.96		7.61		8.17	
					3.52		8.26		7.91	
AL5 – 4	12.03.2021	137	87	20	5.28	9.82	15.88	27.95	5.62	8.93
					4.40		17.78		5.87	
					3.96		13.34		6.13	
AL5 – 5	17.03.2021	134	104	17	3.08	9.67	8.26	17.36	5.62	16.34
					3.96		8.89		5.87	
					2.64		8.26		10.21	
AL5 – 6	19.03.2021	194	44	13	4.84	5.71	12.07	14.19	16.59	14.38
					3.96		11.42		10.72	
					3.52		10.80		16.59	
AL5 – 7	24.03.2021	162	52	28	2.20	7.47	7.62	27.52	4.85	9.62
					3.96		8.26		4.60	
					1.32		6.99		4.36	
AL5 – 8	26.03.2021	120	64	15	5.71	6.74	6.99	11.22	5.62	10.21
					3.08		12.07		11.49	
					3.96		9.53		7.15	
Monthly Average		**165**	**68**	**24**		**7.29**		**18.34**		**11.89**
Standard Deviation		**61**	**25**	**12**		**1.70**		**6.31**		**2.73**

Table 6B : Results of Air Pollutant Concentration at Tuna Port					
	Date	C_6H_6 [µg/m^3]	HC	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr		Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3		4.0 mg/m^3	-
AL5 -1	03.03.2021	1.34	BDL	1.45	331
AL5 – 2	05.03.2021	1.48	BDL	1.37	364
AL5 – 3	10.03.2021	1.54	BDL	1.63	333
AL5 – 4	12.03.2021	1.32	BDL	1.75	355
AL5 – 5	17.03.2021	1.47	BDL	1.31	371
AL5 – 6	19.03.2021	1.46	BDL	1.27	315
AL5 – 7	24.03.2021	1.52	BDL	1.36	375
AL5 – 8	26.03.2021	1.22	BDL	1.48	329
Monthly Average		**1.42**	**NA**	**1.45**	**347**
Standard Deviation		**0.11**		**0.16**	**22**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 1ppm)

Location 7: Vadinar Colony (Vadinar) (AL-7)

Table 7A : Results of Air Pollutant Concentration at Vadinar Colony										
	Date	TSPM [µg/m^3]	PM_{10} [µg/m^3]	$PM_{2.5}$ [µg/m^3]	SO_2 [µg/m^3]		NOx [µg/m^3]		NH3 [µg/m^3]	
Sampling No.		**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit		**500 µg/m^3**	**100 µg/m^3**	**60 µg/m^3**		**80 µg/m^3**		**80 µg/m^3**		**400 µg/m^3**
AL8 -1	03.03.2021	143	57	27	10.84	12.15	17.03	14.91	11.65	13.78
					14.34		15.12		9.61	
					11.27		12.58		20.08	
AL8 -2	05.03.2021	185	67	37	6.88	11.71	11.94	16.19	11.91	19.90
					14.34		15.76		24.16	
					13.91		20.87		23.63	
AL8 -3	10.03.2021	197	57	41	9.07	10.10	24.64	18.29	11.65	16.67
					9.95		13.85		20.08	
					11.27		16.39		18.29	
AL8 -4	12.03.2021	210	61	44	9.51	11.10	15.12	15.33	11.4	11.06
					13.85		16.39		9.87	
					9.95		14.48		11.91	
AL8 -5	17.03.2021	211	51	38	9.52	8.64	17.03	14.91	18.29	16.93
					9.52		15.12		20.08	
					6.88		12.58		12.42	
AL8 -6	19.03.2021	219	65	49	9.95	10.39	15.75	15.75	36.16	22.54
					12.15		15.12		13.18	
					9.07		16.39		18.29	
AL8 -7	24.03.2021	210	70	36	6.88	8.49	14.48	15.97	12.42	11.23
					9.07		18.30		11.65	
					9.51		15.12		9.61	
AL8 -8	26.03.2021	191	57	35	12.15	10.54	17.05	14.92	11.91	13.22
					9.51		17.03		14.16	
					9.95		10.67		13.6	
Monthly Average		**147**	**79**	**41**		**10.39**		**15.78**		**15.67**
Standard Deviation		**13**	**8**	**7**		**1.32**		**1.13**		**4.11**

Table 7B : Results of Air Pollutant Concentration at Vadinar Colony					
	Date	C_6H_6 [µg/m^3]	HC	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr		Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3		4.0 mg/m^3	-
AL1 -1	03.03.2021	1.36	BDL	1.77	364
AL1-2	05.03.2021	1.22	BDL	1.84	388
AL1 -3	10.03.2021	1.06	BDL	1.67	374
AL1-4	12.03.2021	1.14	BDL	1.58	366
AL1 -5	17.03.2021	1.28	BDL	1.48	358
AL1-6	19.03.2021	1.2	BDL	1.67	345
AL1-7	24.03.2021	1.33	BDL	1.77	355
AL1-8	26.03.2021	1.06	BDL	1.65	346
Monthly Average		**1.21**	**NA**	**1.68**	**362.00**
Standard Deviation		**0.11**	**0.00**	**0.12**	**14.39**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 1ppm)

Location 8: Signal Building (Vadinar) (AL-8)

Table 8A : Results of Air Pollutant Concentration at Signal Building										
	Date	TSPM [µg/m^3]	PM_{10} [µg/m^3]	$PM_{2.5}$ [µg/m^3]	SO_2 [µg/m^3]		NOx [µg/m^3]		NH3 [µg/m^3]	
Sampling No.		24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit		500 µg/m^3	100 µg/m^3	60 µg/m^3		80 µg/m^3		80 µg/m^3		400 µg/m^3
AL7 -1	03.03.2021	123	83	39	11.22	10.34	21.53	23.23	14.89	15.74
					8.58		27.89		19.99	
					11.21		20.27		12.33	
AL7 -2	05.03.2021	158	65	32	11.22	10.48	13.28	16.67	12.33	17.61
					9.89		11.37		19.48	
					10.33		25.35		21.02	
AL7 -3	10.03.2021	177	62	41	11.65	10.48	24.07	14.76	18.46	16.50
					8.58		8.83		18.46	
					11.22		11.37		12.59	
AL7 -4	12.03.2021	156	75	36	8.14	9.89	24.07	24.92	19.99	14.80
					11.21		20.90		12.59	
					10.33		29.79		11.82	
AL7 -5	17.03.2021	126	51	31	8.58	10.19	17.09	17.94	11.82	14.20
					11.65		25.35		12.33	
					10.33		11.37		18.46	
AL7 -6	19.03.2021	125	73	43	11.65	10.34	20.27	14.55	18.46	13.01
					8.14		9.47		8.76	
					11.22		13.91		11.82	
AL7 -7	24.03.2021	143	83	41	11.65	11.36	13.28	15.82	19.99	16.93
					11.21		13.28		12.33	
					11.21		20.90		18.46	
AL7 -8	26.03.2021	169	81	31	11.65	11.51	21.53	22.38	11.82	14.20
					14.29		25.35		12.33	
					8.58		20.27		18.46	
Monthly Average		**157**	**73**	**21**		**10.6**		**18.8**		**15.4**
Standard Deviation		**18**	**6**	**5**		**1.5**		**6.1**		**3.7**

Table 8B : Results of Air Pollutant Concentration at Signal Building					
	Date	C_6H_6 [µg/m^3]	HC	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr		Grab Sampling	Grab Sampling
NAAQMS limit	500 µg/m^3	5.0 µg/m^3		4.0 mg/m^3	-
AL1 -1	03.03.2021	1.18	BDL	1.78	333
AL1-2	05.03.2021	1.06	BDL	1.68	345
AL1 -3	10.03.2021	1.16	BDL	1.77	362
AL1-4	12.03.2021	1.28	BDL	1.87	377
AL1 -5	17.03.2021	1.36	BDL	1.85	359
AL1-6	19.03.2021	1.22	BDL	1.74	374
AL1-7	24.03.2021	1.07	BDL	1.62	366
AL1-8	26.03.2021	1.11	BDL	1.44	347
Monthly Average		**1.2**	**NA**	**1.7**	**357.9**
Standard Deviation		**0.1**	**0.0**	**0.1**	**15.2**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 1ppm)

1.4 Observations and Conclusion

During the monitoring period, the overall Ambient Air Quality of the port area was found to be well within the desired levels for various pollutants. However, Near Coal storage area, Marine Bhavan, Oil Jetty PM_{10} values and at Coal storage location, $PM_{2.5}$ were above the permissible standards of CPCB. All other pollutants were recorded well below the prescribed limits.

2. Drinking Water Quality Monitoring

Drinking Water Quality Monitoring was carried out at twenty stations at Kandla, Vadinar & Township Area of Deendayal Port.

Drinking Water Monitoring Methodology

Drinking water samples were collected from 20 locations as prescribed in the tender document. Samples for physico-chemical analysis were collected in 1 liter carboys and samples for Biological parameters were collected in BOD bottles. These samples were then analyzed in laboratory for various drinking water parameters at Kandla Lab/Surat.

The Sampling and Analysis was done as per standard methods and CPCB/GPCB Guidelines. The water samples were analyzed for various parameters, viz. Color , Odor, Turbidity , Conductivity , pH , Chlorides , TDS, Total Hardness, Iron , Sulphate , Salinity, BOD, Na, K, Ca, Mg, F, NO_3, NO_2, Mn, Cr-6, Cu, Cd, As, Hg, Pb, Zn, Bacterial Count (CFU) .

2.1. Results

The Drinking Water Quality monitoring data for 20 stations are given in below from table No. 9 to Table No. 15

Table 9: Drinking Water Quality Monitoring Parameters for Nirman Building 1, P & C building & Main Gate (North) at Kandla

Sr. No.	Parameter	Unit	Nirman Building 1	P & C building	Main Gate North	Acceptable Limits	Permissible Limits
1	pH	pH Unit	7.15	7.25	7.26	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1180	1090	1170	500	2000
3	Turbidity	NTU	0	0	0	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	1940	1945	1950	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/l	467.95	417.84	498.01	250.0	1000.0
9	Ca as Ca	mg/l	100.20	92.18	84.17	75.0	200.0
10	Mg as Mg	mg/l	68.04	63.18	82.62	30.0	100.0
11	Total Hardness	mg/l	530	490	550	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	1.0
13	Fluorides as F	mg/l	0.66	0.61	0.31	1.0	1.5
14	Sulphate as SO4	mg/l	212.4	316.8	301.2	200.0	400
15	Nitrite as NO2	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate as NO3	mg/l	1.97	3.59	1.76	45.0	100
17	Salinity	%o	0.14	1.22	1.17	NS*	NS*
18	Sodium as Na	mg/l	325	289	258	NS*	NS*
19	Potassium as K	mg/l	3.82	4.21	5.01	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 10: Drinking Water Quality Monitoring Parameters for Canteen, West Gate -I & Wharf Area at Kandla

Sr. No.	Parameter	Unit	Canteen	West Gate I	Wharf Area	Acceptable Limits	Permissible Limits
1	pH	pH Unit	7.65	7.17	7.29	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1050	1130	1010	500	2000
3	Turbidity	NTU	0	0	1	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	1940	1900	1904	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	501	<2	NS*	NS*
8	Chloride	mg/l	377.75	447.90	477.97	250.0	1000.0
9	Ca as Ca	mg/l	80.16	100.20	100.20	75.0	200.0
10	Mg as Mg	mg/l	72.90	68.04	58.32	30.0	100.0
11	Total Hardness	mg/l	500	530	490	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	1.0
13	Fluorides	mg/l	0.64	0.66	0.54	1.0	1.5
14	Sulphate	mg/l	318	274.8	382.8	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	4.15	2.60	2.04	45.0	100
17	Salinity	%	1.23	1.17	1.25	NS*	NS*
18	Sodium as Na	mg/l	413	395	354	NS*	NS*
19	Potassium as K	mg/l	3.01	4.11	5.85	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100 ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 11: Drinking Water Quality Monitoring Parameters for Sewa sadan – 3, Workshop I & Custom Building at Kandla

Sr. No.	Parameter	Unit	Sewa Sadan – 3	Workshop	Custom Building	Acceptable Limits	Permissible Limits
1	pH	pH Unit	7.55	7.17	7.19	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1040	1170	1190	500	2000
3	Turbidity	NTU	1	0	1	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorles s	5.0	15.0
6	Conductivity	µs/cm	1940	1904	2770	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	422.85	472.96	382.76	250.0	1000.0
9	Ca as Ca	mg/l	92.18	80.16	76.15	75.0	200.0
10	Mg as Mg	mg/l	58.32	60.75	70.47	30.0	100.0
11	Total Hardness	mg/l	470	450	480	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	1.0
13	Fluorides	mg/l	0.38	0.63	0.23	1.0	1.5
14	Sulphate	mg/l	354	282	390	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	1.97	1.48	2.39	45.0	100
17	Salinity	%0	1.31	1.22	1.13	NS*	NS*
18	Sodium as Na	mg/l	435	410	503	NS*	NS*
19	Potassium as K	mg/l	3.89	4.21	4.82	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100 ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 12: Drinking Water Quality Monitoring Parameters for Port Colony Kandla, Hospital Kandla & A.O. Building at Gandhidham

Sr. No.	Parameter	Unit	Port Colony Kandla	Hospital Kandla	A.O. Building	Acceptable Limits	Permissible Limits
1	pH	pH Unit	7.56	7.51	7.47	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1190	1110	1080	500	2000
3	Turbidity	NTU	0	0	1	1.0	5.0
4	Odor	-	Odorless	Odorles s	Odorles s	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorles s	Colorles s	5.0	15.0
6	Conductivity	µs/cm	2220	2160	1839	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	477.97	447.90	442.89	250.0	1000.0
9	Ca as Ca	mg/l	84.17	96.19	76.15	75.0	200.0
10	Mg as Mg	mg/l	70.47	58.32	65.61	30.0	100.0
11	Total Hardness	mg/l	500	480	460	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	1.0
13	Fluorides	mg/l	0.32	0.64	0.48	1.0	1.5
14	Sulphate	mg/l	397.2	393.6	309.6	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	2.89	3.31	3.31	45.0	100
17	Salinity	%0	1.13	1.25	1.26	NS*	NS*
18	Sodium as Na	mg/l	521	333	580	NS*	NS*
19	Potassium as K	mg/l	4.36	3.89	3.83	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100 ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 13: Drinking Water Quality Monitoring Parameters for School Gopalpuri, Guest House & E - Type Quarter at Gopalpuri, Gandhidham

Sr. No.	Parameter	Unit	School Gopalpuri	Guest House	E - Type Quarter	Acceptable Limits	Permissible Limits
1	pH	pH Unit	7.68	7.25	7.62	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	950	950	970	500	2000
3	Turbidity	NTU	2	2	1	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	1660	1840	1630	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	498.01	543.11	498.01	250.0	1000.0
9	Ca as Ca	mg/l	80.16	92.18	80.16	75.0	200.0
10	Mg as Mg	mg/l	63.18	63.18	68.04	30.0	100.0
11	Total Hardness	mg/l	460	490	480	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	1.0
13	Fluorides	mg/l	0.41	0.25	0.48	1.0	1.5
14	Sulphate	mg/l	397.2	393.6	385.2	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	3.87	4.51	3.66	45.0	100
17	Salinity	%0	1.22	1.13	1.16	NS*	NS*
18	Sodium as Na	mg/l	299	342	416	NS*	NS*
19	Potassium as K	mg/l	3.64	4.78	4.29	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 14: Drinking Water Quality Monitoring Parameters for F - Type Quarter, Hospital Gopalpuri & Tuna Port

Sr. No.	Parameter	Unit	F - Type Quarter	Hospital Gopalpuri	Tuna Port	Acceptable Limits	Permissible Limits
1	pH	pH Unit	7.21	7.63	7.38	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1050	1090	680.00	500	2000
3	Turbidity	NTU	0	0	0.00	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Unit	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	1640	1638	1211.00	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	482.98	508.04	365.81	250.0	1000.0
9	Ca as Ca	mg/l	88.18	80.16	76.15	75.0	200.0
10	Mg as Mg	mg/l	65.61	63.18	29.16	30.0	100.0
11	Total Hardness	mg/l	490	460	310.00	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	<0.01	0.3	1.0
13	Fluorides	mg/l	0.41	0.65	0.57	1.0	1.5
14	Sulphate	mg/l	297.6	385.2	58.80	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.1	NS*	NS*
16	Nitrate	mg/l	4.15	4.44	17.46	45.0	100
17	Salinity	%	1.13	1.18	0.66	NS*	NS*
18	Sodium as Na	mg/l	281	302	249.00	NS*	NS*
19	Potassium as K	mg/l	4.51	4.04	4.80	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 15: Drinking Water Quality Monitoring Parameters for Vadinar Jetty & Port Colony at Vadinar

Sr. No.	Parameter	Unit	Vadinar Jetty	Port Colony Vadinar	Acceptable Limits	Permissible Limits
1	pH	pH Unit	7.77	7.58	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	160	189	500	2000
3	Turbidity	NTU	ND	ND	1.0	5.0
4	Odor	-	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	321	377	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	NS*	NS*
8	Chloride	mg/l	120.00	128.00	250.0	1000.0
9	Ca as Ca	mg/l	40.08	48.10	75.0	200.0
10	Mg as Mg	mg/l	27.20	28.62	30.0	100.0
11	Total Hardness	mg/l	220.0	232.0	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	0.3	1.0
13	Fluorides	mg/l	0.20	0.32	1.0	1.5
14	Sulphate	mg/l	66.42	76.22	200.0	400
15	Nitrite	mg/l	<0.1	<0.1	NS*	NS*
16	Nitrate	mg/l	2.42	2.78	45.0	100
17	Salinity	%	0.22	0.23	NS*	NS*
18	Sodium as Na	mg/l	78.0	82.0	NS*	NS*
19	Potassium as K	mg/l	2.2	2.3	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent

*NS: Not Specified

2.2. Results & Discussion

The colour of all drinking water samples was < 5 Hazen unit and odour of the samples was also agreeable. The values of turbidity, Iron as Fe and Ammonia as NH3-N were observed to be below detection limits of measurement i.e. <0.1 NT, <0.03 mg/L and <0.1 mg/L respectively. Apparently these parameters are not at alarming levels.

Heavy Metals in Drinking Water

In the present study period drinking water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals were well below the permissible limits prescribed by the Indian Standards.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that total Coliform values is observed to be 0.1 to cfu/100 ml. total Coliform and E-Coli values showed that all the drinking water samples were safe from any bacteriological contamination.

2.3. Conclusions

These results are compared with acceptable limits as prescribed in IS 10500:2012 – Drinking Water Specification. It is seen from the analysis data that during the study period the water was safe for human consumption at all drinking water monitoring stations in and around the port.

3. Noise Level Monitoring

Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships. Noise Monitoring was done at 13 stations at Kandla, Vadinar and Township area.

3.1. Method of Monitoring

Sampling was done at all stations for 24 hour period. Data was recorded using automated sound level meter. The intensity of sound was measured in sound pressure level (SPL) and common unit of measurement is decibel (Db).

3.2. Results

Table 16: Noise Monitoring data for ten locations of Deendayal Port and two locations of Vadinar Port

Sr. No.	Location	Day Time Average Noise Level (SPL) in dB(A)	Night Time Average Noise Level (SPL) in dB(A)
	Sampling Time	**6:00 am to 10:00 PM**	**10:00PM to 6:00 AM**
1	Marine Bhavan	63.54	57.07
2	Nirman Building 1	64.22	61.72
3	Tuna Port	54.79	49.93
4	Main Gate North	60.69	58.8
5	West Gate I	66.84	67.7
6	Canteen Area	66.98	61.96
7	Main Road	64.27	57.57
8	ATM Building	67.29	60.98
9	Wharf Area /Jetty Area	68.35	64.16
10	Port & Custom Office	60.71	50.81
	Vadinar Port		
11	Entrance Gate of Vadinar Port	50.56	52.72
12	Nr. Port Colony, Vadinar	53.69	53.84
13	Nr. Vadinar Jetty	53.82	54.02

3.3. Conclusions

Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships.

The Day Time Average Noise Level (SPL) in all ten locations at Deendayal Port ranged from 54.8 dB to 68.3 dB and it was within the permissible limits of 75 dBA for the industrial area for the daytime. The Night Time Average Noise Level (SPL) in all ten locations of Deendayal Port ranged from 49.9 dB to 67.7 dB and it was within the permissible limits of 70 dBA for the industrial area for the night time. The mean day time noise levels at Deendayal Port was 63.8 dB whereas the mean day time noise levels at Vadinar were 52.7 dB.

4. Soil Monitoring

Sampling and analysis of soil samples were undertaken at six locations within the study area (Deendayal Port and Vadinar Port) as a part of EMP. The soil sampling locations are initially decided based on the locations as provided in the tender document of the Deendayal Port.

4.1. Methodology

The soil samples were collected in the month of March 2021. The samples collected from the all locations are homogeneous representative of each location. At random locations were identified at each location and soil was dug from 30 cm below the surface. It was uniformly mixed before homogenizing the soil samples. The samples were filled in polythene bags, labeled in the field with number and site name and sent to laboratory for analysis.

4.2. Results

Table-17: Chemical Characteristics of soil in the study area

Parameter	Unit	Station Name					
		SL1	SL2	SL3	SL4	SL5	SL6
		Tuna Port	IFFCO Plant	Khori Creek	Nakti Creek	KPT Admin Site	KPT Colony
		Near main gate of Port	10 m away from main gate	Sand from creek at low tide		Vadinar	
Texture		Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
pH	-	8.71	7.98	8.75	8.39	8.46	8.82
Electrical Conductivity	µs/cm	10,600.0	28,900.0	8,500.0	13,340.0	585.0	875.0
Moisture	%	21.72	23.97	19.04	22.65	7.16	9.67
Total Organic Carbon	%	1.62	6.29	1.46	1.61	2.53	2.42
Alkalinity	mg/kg	40.04	40.04	60.06	40.04	60.06	60.06
Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloride	mg/kg	1,244.0	2,487.0	1,144.0	1,386.0	280.0	290.0
Sulphate	mg/kg	102.0	204.0	120.0	214.0	330.0	210.0
Phosphorus	mg/kg	31.44	21.25	17.74	35.87	2.83	3.36
Potassium	mg/kg	1,178.0	1,715.0	903.0	743.0	131.0	103.0
Calcium	mg/kg	4,843.0	4,710.0	4,235.0	3,453.0	56.0	94.0
Sodium	mg/kg	501.00	601.00	200.00	501.00	1,303.00	501.00
Copper as Cu	mg/kg	52.2	60.8	40.6	21.2	16.6	17.4
Lead as Pb	mg/kg	5	1	4.2	6.8	ND	ND
Nickel as Ni	mg/kg	33.30	27.52	31.62	22.02	26.42	22.10
Zinc as Zn	mg/kg	56.20	43.20	46	62.00	40.00	36.00
Cadmium as Cd	mg/kg	ND	ND	ND	ND	ND	ND

4.3. Discussion

The soil monitoring locations are coastal soils and exhibits saline soil characteristics, typical of a muddy shore. The soil monitoring of all the locations is of Deendayal and Vadinar Port are all saline in nature. The texture of soil of all locations was Sandy Loam. The mean pH of the soil at all the locations of Kandla was 8.46 pH unit suggesting it to be slightly to medium alkaline.

Heavy Metals in the Soil

Traces of Copper, Lead, Nickel, Zinc and Cadmium were observed in the soil samples collected from all the four locations of Deendayal Port and two locations of Vadinar Port. However, the concentration of these heavy metals was observed to be very less

4.4. Conclusion

The soils of Deendayal Port and Vadinar Port appears to be neutral to basic with varying levels of Chloride, Sulphate, NPK and Calcium. As the nature of soil at different locations are different with respect to its proximity to the sea, the samples showed high degree of variations in their chemical properties.

5. Sewage Treatment Plant Monitoring

This involves safe collection of waste water (spent/used water) from wash areas, bathroom, industrial units, etc., waste from toilets of various buildings and its conveyance to the treatment plant and final disposal in conformity with the requirement and guide lines of State Pollution Control Board and other statutory bodies.

5.1. Methodology for STP Monitoring

To monitor the working efficiency of Sewage Treatment Plant (STP), STP Inlet and Outlet Samples were collected once a week. Locations selected are namely Gopalpuri Township, Deendayal Port and Vadinar. Samples were collected in 1 liter carboys and were analyzed in laboratory for various parameters.

5.2. Results

5.2.1. Deendayal Port STP

Table 18: Sewage Water Monitoring at Kandla STP (1st Week)

	Date of Sampling		5.03.21	
Sr. No.	**Parameter**	**Unit**	**KPT Inlet**	**KPT Outlet**
1	pH	pH Unit	7.61	7.21
2	Total Suspended Solids	mg/l	199.1	23
3	Residual Chlorine	mg/l	<1.0	<0.5
4	Chemical Oxygen Demand	mg/l	272.7	50.5
5	Biochemical Oxygen Demand	mg/l	85.0	11.0
Aeration Tank				
6	MLSS	mg/l	15.0	
7	MLVSS	mg/l	84.0	

Table 19: Sewage Water Monitoring at Kandla STP (2nd Week)

	Date of Sampling		12.03.21	
Sr. No.	**Parameter**	**Unit**	**KPT Inlet**	**KPT Outlet**
1	pH	pH Unit	7.62	7.09
2	Total Suspended Solids	mg/l	123.3	25
3	Residual Chlorine	mg/l	<1.0	<0.5
4	Chemical Oxygen Demand	mg/l	303	91.5
5	Biochemical Oxygen Demand	mg/l	110.0	19.0
Aeration Tank				
6	MLSS	mg/l	26.0	
7	MLVSS	mg/l	60.0	

Table 20: Sewage Water Monitoring at Kandla STP (3rd Week)

	Date of Sampling		19.03.21	
Sr. No.	**Parameter**	**Unit**	**KPT Inlet**	**KPT Outlet**
1	pH	pH Unit	7.51	7.11
2	Total Suspended Solids	mg/l	170.1	27.3
3	Residual Chlorine	mg/l	<1.0	<0.5
4	Chemical Oxygen Demand	mg/l	404.0	45.0
5	Biochemical Oxygen Demand	mg/l	124.0	14.0
Aeration Tank				
6	MLSS	mg/l	22.0	
7	MLVSS	mg/l	86.0	

Table 21: Sewage Water Monitoring at Kandla STP (4th Week)

	Date of Sampling		26.03.21	
Sr. No.	**Parameter**	**Unit**	**KPT Inlet**	**KPT Outlet**
1	pH	pH Unit	7.39	7.09
2	Total Suspended Solids	mg/l	176	28.2
3	Residual Chlorine	mg/l	<1.0	<0.5
4	Chemical Oxygen Demand	mg/l	253	51
5	Biochemical Oxygen Demand	mg/l	86.0	17.0
Aeration Tank				
6	MLSS	mg/l	37.0	
7	MLVSS	mg/l	86.0	

5.2.2. Gopalpuri Colony STP

Table 22: Sewage Water Monitoring at Gopalpuri STP (1st Week)

Date of Sampling			05.03.21	
Sr. No.	**Parameter**	**Unit**	**Gopalpuri Township Inlet**	**Gopalpuri Township Outlet**
1	pH	pH Unit	7.56	7.1
2	Total Suspended Solids	mg/l	245.8	68.9
3	Residual Chlorine	mg/l	<1.0	<1.0
4	Chemical Oxygen Demand	mg/l	101	80.8
5	Biochemical Oxygen Demand	mg/l	28.0	17.0
Aeration Tank				
6	MLSS	mg/l	11.0	
7	MLVSS	mg/l	96.0	

Table 23: Sewage Water Monitoring at Gopalpuri STP (2nd Week)

Date of Sampling			12.03.21	
Sr. No.	Parameter	Unit	Gopalpuri Township Inlet	Gopalpuri Township Outlet
1	pH	pH Unit	7.26	7.1
2	Total Suspended Solids	mg/l	67.1	21.5
3	Residual Chlorine	mg/l	<1.0	<1.0
4	Chemical Oxygen Demand	mg/l	404	151.5
5	Biochemical Oxygen Demand	mg/l	120.0	32.0
Aeration Tank				
6	MLSS	mg/l	18.0	
7	MLVSS	mg/l	82.0	

Table 24: Sewage Water Monitoring at Gopalpuri STP (3rd Week)

Date of Sampling			19.03.21	
Sr. No.	Parameter	Unit	Gopalpuri Township Inlet	Gopalpuri Township Outlet
1	pH	pH Unit	7.62	7.15
2	Total Suspended Solids	mg/l	440	45.2
3	Residual Chlorine	mg/l	<1.0	<1.0
4	Chemical Oxygen Demand	mg/l	404.0	71
5	Biochemical Oxygen Demand	mg/l	126.0	18.0
Aeration Tank				
6	MLSS	mg/l	32.0	
7	MLVSS	mg/l	90.0	

Table 25: Sewage Water Monitoring at Gopalpuri STP (4th Week)

Date of Sampling			26.03.21	
Sr. No.	Parameter	Unit	Gopalpuri Township Inlet	Gopalpuri Township Outlet
1	pH	pH Unit	7.66	7.16
2	Total Suspended Solids	mg/l	126	48.9
3	Residual Chlorine	mg/l	<1.0	<1.0
4	Chemical Oxygen Demand	mg/l	455	111
5	Biochemical Oxygen Demand	mg/l	142.0	36.0
Aeration Tank				
6	MLSS	mg/l	22.0	
7	MLVSS	mg/l	90.0	

5.2.3. Vadinar STP

Table 26: Sewage Water Monitoring at Vadinar STP (1st Week)

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar STP O/L
1	pH	pH unit	7.22	Not Working
2	Total Suspended Solids	mg/l	100	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	70.0	
5	BOD @ 27 °C	mg/l	18.0	

Table 27: Sewage Water Monitoring at Vadinar STP (2ndWeek)

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar STP O/L
1	pH	pH unit	7.58	Not Working
2	Total Suspended Solids	mg/l	80.0	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	58.0	
5	BOD @ 27 °C	mg/l	14.0	

Table 28: Sewage Water Monitoring at Vadinar STP (3rdWeek)

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar STP O/L
1	pH	pH unit	7.16	Not Working
2	Total Suspended Solids	mg/l	96.0	
3	Residual Chlorine	mg/l	<0.1	
4	COD	mg/l	101	
5	BOD @ 27 °C	mg/l	30.0	

Table 29: Sewage Water Monitoring at Vadinar STP (4th Week)

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar STP O/L
1	pH	pH unit	7.32	Not Working
2	Total Suspended Solids	mg/l	62	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	68.0	
5	BOD @ 27 °C	mg/l	20.0	

5.3 Conclusion

The GPCB standards of BOD, TSS and Residual Chlorine are 20 mg/lit, 30 mg/lit & 0.5 mg/lit respectively. The STP at Gopalpuri is working within set standards of GPCB/CPCB. The STP at Vadinar is non-functional and thus, steps should be taken to commission the STP at Vadinar Port.

6. Marine Water Monitoring

The Forty Second Amendment to the Constitution in 1976 underscored the importance of 'green thinking'. Article 48A enjoins the state to protect and improve the environment and safeguard the forests and wildlife in the country. Further, Article 51A(g) states that the "fundamental duty of every citizen is to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures".

Policy Statement for Abatement of Pollution (1992) has suggested developing relevant legislation and regulation, fiscal incentives, voluntary agreements and educational programs and information campaigns. It emphasizes the need for integration by incorporating environmental considerations into decision making at all levels by adopting frameworks namely, pollution prevention at source, application of best practicable solution, ensure polluter pays for control of pollution, focus on heavily polluted areas and river stretches and involve public in decision-making. The National Conservation Strategy and Policy Statement on Environment and Development, (1992) aimed at "Integrating environmental concerns with developmental imperatives to meet the challenges by redirecting the thrust of our developmental process so that the basic needs of our people could be fulfilled by making judicious and sustainable use of natural resources." The priorities mentioned in this policy document include the sustainable use of land and water resources, prevention and control of pollution and preservation of biodiversity.

The National Water Policy, (2002) contains provisions for developing, conserving, sustainable utilizing and managing this important water resources and need to be governed by national perspectives.

6.1. Marine Environment

On national and state levels, we have several policies and regulation like Water (Prevention and Control of Pollution) Act, 1974, to regulate pollution discharges and restore water quality of our aquatic resources including the prescription of monitoring activities. One of the important provisions of the Water Act, 1974, is to maintain and restore the 'wholesomeness' of our aquatic resources. Water quality monitoring is one of the first steps required in the rational development and management of water resources. In the field of water quality management, there has been a steady evolution in procedures for designing system to obtain information on the changes of water quality. The monitoring comprises all activities to obtain 'information' with respect to the water system.

6.2. Sampling Stations

The monitoring of marine environment for the study of biological and ecological Parameters was carried out on 12th March, 2021 in in harbour region of KPT, 13th March, 2021 in creeks near by the port and on 15th March 2021 at Vadinar region during Spring tide period of lunar cycle.

The monitoring of marine environment for the study of biological and ecological parameters was repeated again on 19th and 20th March 2021 in harbour regions of KPT and nearby creeks respectively and on 22th March 2021 near Vadinar jetty during Neap tide period corresponding to Last Quarter of lunar cycle.

Plankton samples from sub surface layer was collected both during high tide period and low tide period from four water quality monitoring stations of DPT harbour area and one stations in Nakti creek and one station in Khori creek. Sampling at second sampling station of Nakti creek was possible only during high tide period. The same sampling schedule was repeated during consecutive spring tide and neap tide in same month. Plankton samples from sub surface layer were collected during high tide period and low tide period from monitoring station near Vadinar jetty during spring tide period and neap tide. Collected water samples were processed for estimation of Chlorophyll- a, Pheophytin- a, qualitative &quantitative evaluation of phytoplankton, qualitative &quantitative evaluation zooplanktons (density and their population).

Table 28: Sampling Locations

Offshore monitoring requirement	Number of locations
Offshore Installations	4 in Kandla creek 1 in Nakti creek 1 in Khori creek 1 near Vadinar Jetty 1 near 1st SBM
Total Number of locations	**8**

6.3. Marine Water Quality

Marine water quality of marine waters of Deendayal Port Harbor waters, Khori and Nakti Creeks and two locations of Vadinar are monitored for various physico-chemical parameters during spring and neap tide of each month.

The results of marine water quality and Marine sediments are as below;

Table 29: Marine Water Quality Monitoring Parameters for location near KPT colony

Parameters	Unit	Kandla Creek Near KPT colony (1) 23°0'58"N 70°13'22."E			
		Spring Tide		Neap Tide	
Tide →		**High Tide**	**Low Tide**	**High Tide**	**Low Tide**
pH	pH unit	7.73	7.51	7.15	7.26
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	32.2	32.6	32.8	32.2
Turbidity	NTU	36.0	31.0	26.0	28.0
Total Dissolved Solids	mg/l	34635.0	39060.0	43469.0	45346.0
Total Suspended Solids	mg/l	523.0	495.0	602.0	479.0
Total Solids	mg/l	35158.0	39555.0	44071.0	45825.0
DO	mg/l	4.9	4.0	5.9	4.3
COD	mg/l	68.0	69.0	72.0	76.0
BOD	mg/l	<2	<2	<2	<2
Silica	mg/l	0.48	0.38	0.43	0.44
Phosphate	mg/l	0.15	0.16	0.27	0.24
Sulphate	mg/l	2352.0	2076.0	2352.0	2196.0
Nitrate	mg/l	8.66	2.60	9.29	3.66
Nitrite	mg/l	<0.1	<0.1	<0.1	<0.1
Calcium	mg/l	721	683	601	521
Magnesium	mg/l	1409	559	1531	1482
Sodium	mg/l	11120.0	11521.0	12820.0	13425.0
Potassium	mg/l	289.0	277.0	320.0	333.0
Iron	mg/l	1.85	1.95	1.77	1.79
Chromium	mg/l	0.11	0.11	0.13	0.12
Copper	mg/l	0.07	0.06	0.07	0.07
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.05	0.06	0.03	0.02
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.17	0.17	0.14	0.16
Zinc	mg/l	0.05	0.06	0.05	0.05

Table 30: Marine Water Quality Monitoring Parameters for location near passenger Jetty One at Kandla

Parameters	**Unit**	**Near passenger Jetty One (2)**			
		23° 0'18 "N 70°13'31"E			
		Spring Tide		**Neap Tide**	
Tide →		**High Tide**	**Low Tide**	**High Tide**	**Low Tide**
pH	pH unit	7.18	7.35	7.13	7.28
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	32.2	32.8	32.7	33.1
Turbidity	NTU	20.0	30.0	27.0	27.0
Total Dissolved Solids	mg/l	39310.0	42110.0	42189.0	18464.0
Total Suspended Solids	mg/l	608.0	600.0	676.0	685.0
Total Solids	mg/l	39918.0	42710.0	42865.0	19149.0
DO	mg/l	4.6	3.3	5.3	5.4
COD	mg/l	72.0	78.0	62.0	58.0
BOD	mg/l	<2	<2	<2	<2
Silica	mg/l	0.36	0.23	0.45	0.53
Phosphate	mg/l	0.23	0.24	0.24	0.17
Sulphate	mg/l	2652.0	2556.0	2460.0	3156.0
Nitrate	mg/l	4.71	8.52	8.10	4.43
Nitrite	mg/l	<0.1	<0.1	<0.1	<0.1
Calcium	mg/l	403	721	682	561
Magnesium	mg/l	1041	1312	1555	1409
Sodium	mg/l	12111.0	11892.0	12444.0	13058.0
Potassium	mg/l	278.0	268.0	348.0	358.0
Iron	mg/l	1.88	1.91	1.79	1.78
Chromium	mg/l	0.14	0.15	0.10	0.11
Copper	mg/l	0.08	0.09	0.08	0.06
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.05	0.04	0.03	0.03
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.15	0.16	0.15	0.17
Zinc	mg/l	0.06	0.05	0.07	0.05

Table 31: Marine Water Quality Monitoring Parameters for location Near Coal Berth

Parameters	**Unit**	**Near Coal Berth** 22°59'12"N 70°13'40"E			
		Spring Tide		**Neap Tide**	
Tide →		**High Tide**	**Low Tide**	**High Tide**	**Low Tide**
pH	pH unit	7.43	7.19	7.13	7.25
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	31.2	31.6	32.4	31.8
Turbidity	NTU	37.0	40.0	31.0	35.0
Total Dissolved Solids	mg/l	41570.0	37700.0	38554.0	31024.0
Total Suspended Solids	mg/l	605.0	554.0	347.0	315.0
Total Solids	mg/l	42175.0	38254.0	38901.0	31339.0
DO	mg/l	3.9	3.5	5.2	5.3
COD	mg/l	82.0	80.0	82.0	72.0
BOD	mg/l	<2	<2	<2	<2
Silica	mg/l	0.27	0.31	0.38	0.33
Phosphate	mg/l	0.16	0.17	0.16	0.27
Sulphate	mg/l	2616.0	2628.0	2532.0	2220.0
Nitrate	mg/l	10.21	6.68	2.88	4.50
Nitrite	mg/l	<0.1	<0.1	<0.1	<0.1
Calcium	mg/l	681	761	481	601
Magnesium	mg/l	1409	1215	1531	1628
Sodium	mg/l	10585.0	10824.0	11524.0	11442.0
Potassium	mg/l	196.0	188.0	352.0	286.0
Iron	mg/l	1.93	1.95	1.78	2.12
Chromium	mg/l	0.17	0.17	0.12	0.13
Copper	mg/l	0.08	0.08	0.09	0.07
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.05	0.04	0.05	0.05
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.15	0.14	0.15	0.17
Zinc	mg/l	0.08	0.10	0.09	0.07

Table 32: Marine Water Quality Monitoring Parameters for location Khori creek at Kandla

Parameters	Unit	KPT 4			
		Near 15/16 Berth			
		Spring Tide		Neap Tide	
Tide →		High Tide	Low Tide	High Tide	Low Tide
pH	pH unit	7.25	7.13	7.18	7.18
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	32.2	32.4	32.6	33.0
Turbidity	NTU	25.0	21.0	30.0	3.0
Total Dissolved Solids	mg/l	37910.0	42270.0	44781.0	4215.0
Total Suspended Solids	mg/l	446.0	443.0	681.0	600.0
Total Solids	mg/l	38356.0	42713.0	45462.0	4815.0
DO	mg/l	3.4	3.3	5.2	5.0
COD	mg/l	79.0	96.0	59.0	62.0
BOD	mg/l	<2	<2	<2	<2
Silica	mg/l	0.42	0.51	0.35	0.51
Phosphate	mg/l	0.20	0.24	0.38	0.28
Sulphate	mg/l	2556.0	2736.0	2844.0	3156.0
Nitrate	mg/l	10.42	11.12	2.46	9.08
Nitrite	mg/l	<0.1	<0.1	<0.1	<0.1
Calcium	mg/l	882	761	641	521
Magnesium	mg/l	1045	1191	1482	1458
Sodium	mg/l	10528.0	10052.0	10152.0	10782.0
Potassium	mg/l	196.0	199.0	248.0	253.0
Iron	mg/l	2.28	2.20	2.34	2.22
Chromium	mg/l	0.18	0.14	0.17	0.16
Copper	mg/l	0.07	0.07	0.08	0.10
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.07	0.05	0.06	0.06
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.17	0.18	0.19	0.19
Zinc	mg/l	0.12	0.07	0.07	0.07

Table 33: Marine Water Quality Monitoring Parameters for location Nakti Creek near Tuna Port

Parameters	**Unit**	**Nakti Creek Near Tuna Port**			
		22°57'49."N 70° 7'0.67"E			
		Spring Tide		**Neap Tide**	
Tide →		**High Tide**	**Low Tide**	**High Tide**	**Low Tide**
pH	pH unit	7.54	8.11	7.25	7.10
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	31.8	33.0	32.8	33.1
Turbidity	NTU	29.0	27.0	37.0	30.0
Total Dissolved Solids	mg/l	37820.0	41420.0	40683.0	40589.0
Total Suspended Solids	mg/l	571.0	618.0	685.0	566.0
Total Solids	mg/l	38391.0	42038.0	41368.0	41155.0
DO	mg/l	4.1	3.3	5.7	6.0
COD	mg/l	88.0	106.0	72.0	78.0
BOD	mg/l	<2	<2	<2	<2
Silica	mg/l	0.44	0.42	0.42	0.49
Phosphate	mg/l	0.23	0.24	0.23	0.15
Sulphate	mg/l	2088.0	2316.0	2556.0	2628.0
Nitrate	mg/l	10.84	10.06	4.07	8.16
Nitrite	mg/l	<0.1	<0.1	<0.1	<0.1
Calcium	mg/l	1082	922	481	561
Magnesium	mg/l	778	1482	1531	1555
Sodium	mg/l	11852.0	12125.0	14452.0	14625.0
Potassium	mg/l	296.0	325.0	382.0	368.0
Iron	mg/l	2.25	2.24	2.26	2.26
Chromium	mg/l	0.21	0.21	0.15	0.18
Copper	mg/l	0.09	0.10	0.11	0.11
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.06	0.06	0.05	0.06
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.17	0.21	0.21	0.18
Zinc	mg/l	0.07	0.08	0.09	0.07

Table 34: Marine Water Quality Monitoring Parameters for location Nakti Creek Near NH-8A at Kandla

Parameters	Unit	Nakti Creek Near NH-8A 23° 02'01"N 70° 09'31"E			
		Spring Tide		Neap Tide	
Tide →		High Tide	Low Tide	High Tide	Low Tide
pH	pH unit	7.57	Sampling not possible during Low Tide	7.11	Sampling not possible during Low Tide
Color	-	Colorless		Colorless	
Odor	-	Odorless		Odorless	
Salinity	ppt	33.5		32.8	
Turbidity	NTU	38.0		19.0	
Total Dissolved Solids	mg/l	42002.0		27530.0	
Total Suspended Solids	mg/l	1330.0		362.0	
Total Solids	mg/l	43332.0		27892.0	
DO	mg/l	4.0		5.8	
COD	mg/l	108.0		80.0	
BOD	mg/l	<2		<2	
Silica	mg/l	0.38		0.49	
Phosphate	mg/l	0.28		0.23	
Sulphate	mg/l	2208.0		2724.0	
Nitrate	mg/l	11.75		8.02	
Nitrite	mg/l	<0.1		<0.1	
Calcium	mg/l	681		601	
Magnesium	mg/l	1312		1361	
Sodium	mg/l	13252.0		14852.0	
Potassium	mg/l	352.0		377.0	
Iron	mg/l	2.26		2.27	
Chromium	mg/l	0.23		0.20	
Copper	mg/l	0.10		0.10	
Arsenic	mg/l	<0.01		<0.01	
Cadmium	mg/l	0.07		0.05	
Mercury	mg/l	<0.001		<0.001	
Lead	mg/l	0.22		0.22	
Zinc	mg/l	0.11		0.11	

Table 35: Marine Water Quality Monitoring Parameters for locations Nr. Vadinar Jetty

Parameters	Unit	Nr. Vadinar Jetty 22°26'25.26"N 69°40'20.41"E			
		Spring Tide		Neap Tide	
Tide →		**High Tide**	**Low Tide**	**High Tide**	**Low Tide**
pH	pH unit	7.58	7.38	7.26	7.21
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	32.8	30.6	33.2	33.0
Turbidity	NTU	36.0	22.0	23.0	27.0
Total Dissolved Solids	mg/l	39310.0	83696.0	41820.0	32961.0
Total Suspended Solids	mg/l	580.0	50.0	352.0	35.0
Total Solids	mg/l	39890.0	83746.0	42172.0	32996
DO	mg/l	5.4	6.2	5.6	6.1
COD	mg/l	78.0	42.0	62.0	43.0
BOD	mg/l	<2	<2	<2	<2
Silica	mg/l	0.42	1.86	0.58	0.75
Phosphate	mg/l	0.23	0.05	0.23	0.15
Sulphate	mg/l	2610.0	2304.0	3621.0	2436.0
Nitrate	mg/l	4.71	2.46	4.82	1.76
Nitrite	mg/l	<0.1	<0.1	<0.1	<0.1
Calcium	mg/l	683	401	561	441
Magnesium	mg/l	1386	1531	1409	1312
Sodium	mg/l	13111.0	14975.0	13452.0	15750.0
Potassium	mg/l	292.0	628.0	362.0	702.0
Iron	mg/l	2.25	1.76	2.22	1.44
Chromium	mg/l	0.18	0.11	0.15	0.14
Copper	mg/l	0.10	0.06	0.11	0.08
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.07	<0.001	0.06	<0.001
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.12	0.07	0.18	0.10
Zinc	mg/l	0.08	0.09	0.08	0.05

Trace Metals

In the present study period water samples contained traces of Cr (mean=0.14 mg/L), Cu (mean=0.14 mg/L), Pb (mean = 0.21 mg/L), Cd, As, Hg, and Zn (mean = 0.07 mg/L). All these heavy metals reported were below trace levels.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that total Coliform values is observed to be 0.1 to cfu/100 ml.

6.4. Marine Sediments

Sediment samples were collected with Van Veen Grab from the six locations in Deendayal Port Waters and two locations in Vadinar Port. Samples were collected and preserved in silver foil in ice box to prevent the contamination/decaying of the samples.

The Sediment Quality results are given in below from table no. 35A & table no. 35B

Table 35A: Results of analysis of sediment of Kandla & Vadinar Port (Neap Tide)

Sr. No.	Parameters	Unit	KPT -1 (HT)	KPT -1 (LT)	KPT - 2 (HT)	KPT 2 LT	KPT -3 (LT)	KPT4 (LT)	Natki - 1 (LT)	Jetty (HT)
1	Texture		Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	%	0.74	0.64	1.88	0.89	1.20	0.96	0.65	1.02
3	Organic Carbon	%	0.37	0.40	0.63	0.90	1.26	1.06	0.86	1.12
4	Inorganic Phosphate	mg/kg	126.0	120.0	111.0	126.0	128.0	189.0	166.0	126.0
5	Moisture	%	16.22	16.50	17.62	16.42	19.20	14.52	17.48	20.32
6	Aluminum	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	32.0	26.0	26.2	22.0	28.0	38.0	39.5	32.0
8	Phosphate	mg/kg	6.66	7.25	3.52	8.62	7.26	6.52	7.06	9.20
9	Sulphate	mg/kg	138.0	136.0	158.0	162.0	111.0	162.0	112.0	136.0
10	Nitrite	mg/kg	0.1	0.11	0.11	0.12	0.1	0.11	0.12	0.11
11	Nitrate	mg/kg	6.62	9.26	7.66	8.68	9.02	10.02	10.33	6.52
12	Calcium	mg/kg	356.0	348.0	296.0	301.0	312.0	396.0	389.0	401.0
13	Magnesium	mg/kg	166.0	156.0	122.0	142.0	178.0	122.0	215.0	252.0
14	Sodium	mg/kg	6365.0	6665.0	7156.0	7242.0	8925.0	8778.0	9678.0	9789.0
15	Potassium	mg/kg	1282.0	1268.0	488.0	495.0	589.0	788.0	898.0	760.0
16	Chromium	mg/kg	8.54	9.54	12.35	10.06	9.55	10.51	9.55	12.65
17	Nickel	mg/kg	10.04	11.56	12.55	11.63	10.51	12.4	15.64	16.24
18	Copper	mg/kg	11.26	10.67	12.6	14.27	15.39	16.26	14.56	15.36
19	Zinc	mg/kg	28.64	30.21	35.06	30.00	34.64	38.46	37.05	40.21
20	Cadmium	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND
21	Lead	mg/kg	19.27	20.35	19.33	25.23	24.28	26.78	27.28	28.67
22	Mercury	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND

Table 35B: Results of Analysis of Sediment of Kandla & Vadinar Port (Spring Tide)

Sr. No.	Parameters	Unit	KPT - 1 (HT)	KPT - 1 (LT)	KPT - 2 (HT)	KPT - 2 (LT)	KPT - 3 (HT)	KPT - 3 (LT)	KPT - 4 (HT)	KPT - 4 (LT)	Natki - 1 (HT)	Natki - 1 (LT)
1	Texture		Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	%	0.66	0.53	0.66	1.08	0.96	1.26	0.96	0.82	0.62	0.62
3	Organic Carbon	%	0.36	0.42	0.52	0.69	0.85	1.06	0.88	0.72	0.52	0.50
4	Inorganic Phosphate	mg/kg	152.0	142.0	126.0	130.0	136.0	133.0	196.0	188.0	126.0	162.0
5	Moisture	%	12.82	14.62	16.22	18.52	19.62	20.25	20.12	20.25	18.62	22.22
6	Aluminum	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	12.82	16.32	14.36	16.28	20.2	12.5	18.2	16.3	22.80	26.20
8	Phosphate	mg/kg	16.2	15.55	17.6	16.2	16.50	19.04	18.62	17.02	16.88	16.62
9	Sulphate	mg/kg	288.0	296.0	302.0	289.0	312.0	311.0	325.0	320.0	379.0	406.0
10	Nitrite	mg/kg	0.11	0.10	0.11	0.12	0.1	0.11	0.12	0.13	0.11	0.14
11	Nitrate	mg/kg	11.2	11.02	10.6	10.42	9.45	10.02	11.26	11.06	12.68	12.7
12	Calcium	mg/kg	306.0	312.0	289.0	299.0	262.0	272.0	320.0	310.0	345.0	340.0
13	Magnesium	mg/kg	113.0	120.0	101.0	100.0	126.0	120.0	115.0	106.0	132.0	128.0
14	Sodium	mg/kg	11282.0	11352.0	12452.0	12600.0	11025.0	11068.0	10282.0	10189.0	9282.0	9665.0
15	Potassium	mg/kg	400.0	428.0	389.0	388.0	325.0	289.0	378.0	486.0	485.0	385.0
16	Chromium	mg/kg	14.21	10.06	9.54	15.22	19.21	8.15	9.56	10.85	17.68	15.63
17	Nickel	mg/kg	11.36	12.34	9.58	10.89	11.35	12.39	14.67	15.69	16.64	15.66
18	Copper	mg/kg	15.24	16.25	13.36	10.89	16.25	18.24	10.02	11.35	19.31	18.74
19	Zinc	mg/kg	35.64	34.68	38.52	30.63	28.63	45.56	42.64	52.51	43.58	45.62
20	Cadmium	mg/kg	ND	ND	ND	ND	1.71	1.39	ND	ND	1.22	1.35
21	Lead	mg/kg	17.34	18.66	16.24	23.54	18.3	17.33	15.02	14	16.31	14.06
22	Mercury	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

6.5. Sampling Methodology (Biological Monitoring of Marine Waters)

A marine sampling is an estimation of the body of information in the population. The theory of the sampling design depends upon the underlying frequency distribution of the population of interest. Water sampling is carried out to collect a representative sample of suitable volume from the specified depth and retain it free from contamination during retrieval.

Sampling was conducted from sub surface layer in high tide period and low tide period of the tide from all sampling stations during consecutive spring tide and neap tide.

Net sampling for qualitative evaluation of mixed plankton was conducted only once during between Maximum High water and Slack water and Maximum low water and Slack water).

Sediment sampling for qualitative and quantitative evaluation of benthic organisms was conducted only once during one tidal cycle during Maximum low water and Slack water.

The collected samples were first collected in a clean bucket to reduce the heterogeneity. From the collected water sample 1 liter of water sample were taken in an opaque plastic bottle for chlorophyll estimation. Quantitative Plankton samples were collected by filtering rest of the water sample using plankton net of 20µm mesh size.

Methodology adopted for Plankton sampling

Mixed plankton sample for qualitative evaluation were obtained from the sub surface layer, at each sampling locations by towing the net horizontally with the weight during highest high tide and slack period. And lowest low tide and slack period .After the tow of about 15-20 minutes at speed of 1-1.5 m/s, plankton net was pulled up and washed down to the tail and collected the plankton adhered to plankton net in the collection bucket at the bottom by springing outer and inner surface of the net with sea water, while the net was hanging with the mouth upward. As already mentioned for quantitative evaluation 50 L sample each was collected from the sub surface during high tide and low tide period were filtered through 20µm mesh size net assembly.

Methodology adopted for Benthic fauna sampling

Van veen sampler (0.1 m^2) was used for sampling bottom sediments during lowest low tide. Two sets of sediments were sampled from each location, the macro fauna in the sediments were sieved on board to separate out the organisms. The fixation of benthic fauna is normally done by bulk fixation of the sediment sample. The bulk fixation is done by using 10% formalin (Buffered with borate) with Rose Bengal as stain. The organisms were preserved with seawater as diluting agent.

Samples Processing for Chlorophyll Estimation

Samples for the chlorophyll estimation were preserved in ice box on board in darkness to avoid degradation in opaque container covered with aluminum foil. Immediately after reaching the shore after sampling, 1 litter of collected water sample was filtered through GF/F filters (pore size 0.45 µm) by using vacuum filtration assembly. After vacuum filtration the glass micro fiber filter paper was grunted in tissue grinder, macerating of glass fiber filter paper along with the filtrate was done in 90% aqueous Acetone in the glass tissue grinder with glass grinding tube. Glass fiber filter paper will assist breaking the cell during grinding and chlorophyll content was extracted with 10 ml of 90% Acetone, under cold dark conditions along with saturated magnesium carbonate solution in glass screw cap tubes. After an extraction period of 24 hours, the samples were transferred to calibrated centrifuge tubes and adjusted the volume to original volume with 90% aqueous acetone solution to make up the evaporation loss. The extract was clarified by using centrifuge in closed tubes. The clarified extracts were then decanted in clean cuvette and optical density was observed at wavelength 630, 664, 665 nm. By using corrected optical density, Chlorophyll-a value was calculated as given in (APHA, 1998). The extract of pigments was then measured by spectrophotometer at wavelength of 750 nm and 664 nm before acidification and at 665 nm after acidification by 0.1ml of 0.1N HCl.

Samples Processing for Plankton

The entire area open water in the sea is the pelagic realm. Pelagic organisms live in the open sea. In contrast to the pelagic realm, the benthic realm comprises organisms and zone of the bottom of the sea. Vertically the pelagic realm can be dividing into two zones based on light penetration; upper photic or euphotic zone and lower dark water mass, aphotic zone below the photic zone.

The term plankton is general term for organisms have such limited powers of locomotion that they are at the mercy of the prevailing water movement. Plankton is subdivided to phytoplankton and zooplankton. Phytoplankton is free floating organisms that are capable of photosynthesis and zooplankton is the various free floating animals.

Phytoplankton

The phytoplankton includes a wide range of photosynthetic and phototrophic organisms. Marine phytoplankton is mostly microscopic and unicellular floating flora, which are the primary producers that support the pelagic food-chain. The two most prominent groups of phytoplankton are diatoms (Bacillariophyceae) and dinoflagellates (Dinophyceae).

Zooplankton

Zooplankton can be subdivided into holoplankton, i.e., permanent members of the plankton (e.g., Calanoid copepods), and meroplankton, i.e., temporary members in the plankton e.g., larvae of fish, shrimp, and crab). The meroplankton group consists of larval and young stages of animals that will adopt a different lifestyle once they mature. In contrast to phytoplankton which consist of a relatively smaller variety of organisms, Zooplankton are extremely divers, consist of a host of larval and adult forms representing many animal phylum.

Among the zooplankton two group always dominate than others; they are the members of sub class copepods (Phylum Athropoda), and Tintinids(Phylum Protozoa) among the net planktons. These small animals are of vital importance in marine ecosystem as one of the primary herbivores animals in the sea, and it is they provide vital link between primary producer (autotrophs) and numerous small and large marine consumers.

Preservation and storage

Both filtered plankton and those collected from the plankton net were preserved with 5% buffered formalin and stored in 1L plastic container for further processing in the laboratory.

Sample concentration

The collected plankton samples were concentrated by using centrifuge and made up to 50 ml with 5% formalin -Glycerin mixture.

Taxonomic evaluation

Before processing, the sample was mixed carefully and a subsample was taken with a calibrated Stempel-pipette. 1 ml of the concentrated plankton samples were transferred on a glass slide with automatic pipette. The plankton sample on the glass slides were stained by using Lugol's iodine and added glycerin to avoid drying while observation. The plankton samples were identified by using Labex triangular Research microscope with photographic attachment. Microphotographs of the plankton samples were taken for record as well as for confirming the identification. The bigger sized zooplankton was observed through dissecting stereomicroscope with magnification of 20-30 x. Plankton organisms in the whole slide were identified to the lowest taxon possible. A thorough literature search was conducted for the identification of the different groups of zooplankton that were encountered.

Cell counts by drop count method

The common glass slide mounted with a 1ml of concentrated phytoplankton/ zooplankton sample in glycerol and covered with cover slip 22x 60mm was placed under the compound microscope provided with a mechanical stage. The plankton was then counted from the microscopic field of the left top corner of the slide. Then slide is moved horizontally along the right side and plankton in each microscopic field was thus counted. When first microscopic field row was finished the next consecutive row was adjusted using the mechanical device of the stage. In this way all the plankton present in entire microscopic field are counted.

From this total number in 1ml of the concentrated plankton, total number of plankton in the original volume of sample filtered was calculated as units/L

Samples Processing for Benthic Organisms

Benthos is those organisms that are associated with the sea bed or benthic habitats. Epibenthic organisms live attached to a hard substratum or rooted to a shallow depth below the surface. In fauna organisms live below the sediment–water interface. Interstitial organisms live and move in pore water among sedimentary grains.

Because the benthic organisms are often collected and separated on sieves, a classification based on the overall size is used. Macro benthos include organisms whose shortest dimension is greater than or equal to 0.5 mm. Meio benthos are smaller than 0.5mm but larger than 42µ in size.

The terms such as macro fauna and Meio fauna generally have little relevance with taxonomic classification. The terms Meio fauna and macro fauna depend on the size. Meio fauna were considered as good bioassay of community health and rather sensitive indicators of environmental changes

Sample sieving

Sediments samples were sieved to extract the organisms. Sieving was performed carefully as possible to avoid any damage to the animals. The large portion of the sediment was split in to smaller portions and mixed with sea water in a bucket. The cohesive lumps were broken down by continuous stirring. The disaggregated sediments were then passed through the sieves.

Sample staining

Sorting of the Meio fauna from the sieve is difficult task especially in the preserved material, because organisms are not easily detectable. To facilitate the animal detection the entire sample retained on the sieve after sieving operation were stained by immersing the sieve in a flat bottom tub with 1% Rose Bangal stain; a protein stain. A staining period of 10-30 minutes is sufficient for sample detection.

6.6. Results

Chlorophyll-A & Pheophytin-A

Water Samples for the chlorophyll estimation were collected from sub surface layer during high tide and low tide period of the tidal cycle for each sampling locations and analysed for Chlorophyll -a and after acidification for Pheophytin –a. Chlorophyll- a value was used as algal biomass indicator (APHA 1998) Algal biomass was estimated by converting Chlorophyll value.

In the sub surface water chlorophyll-a was varying from 0.512-834 mg/m3.in harbour region of KPT during sampling done in Neap tide period of March,2021. In the nearby creeks chlorophyll-a was varying from 0.850 1.071 mg/m3.While chlorophyll-a was varying 0.426-0.938 mg/m3.in harbour region of KPT during sampling done in spring period of March, 2021 and in the sampling stations creeks chlorophyll-a was varying from 0.613-1.189 mg/m3.Pheophytin –a level was below detectable limit in the all the sampling stations during spring tide and neap tide.

In the sub surface water chlorophyll-a was varying from 0.732-0.629 mg/m3 between high tide and low tide at Vadinar jetty during sampling done during Neap tide period. While chlorophyll was detected at the jetty region during spring tide period was 0.967 -0.835 mg/m3 during low tide and high tide respectively 0.629 mg/m3 chlorophyll-a was detected in the sampling dine during the high tide period at SBM during Neap tide period 0.732 mg/m^3 chlorophyll-a was detected in the sampling dine during the high tide period at SBM during Spring tide period

Table 36: variations in productivity from sampling stations in KPT harbour area near by creeks and Vadinar area during Neap tide

Sr. No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin-a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
KPTHARBOUR AREA					
1	KPT1	High tide	0.629	BDL	42.14
		Low tide	0.526	BDL	35.24
2	KPT 2	High tide	0.512	BDL	34.30
		Low tide	0.527	BDL	35.31
3	KPT 3	High tide	0.834	BDL	55.88
		Low tide	0.732	BDL	49.04

	KPT-4	High tide	1.071	BDL	71.75
		Low tide	0.937	BDL	62.78
CREEKS					
5	KPT-5 Nakti-I	High tide	0.850	BDL	56.95
		Low tide	0.834	BDL	55.88
6	KPT-6 Naktii -II	High tide	ND	ND	ND
VADINAR					
7	VADINAR-I jetty	High tide	0.732	BDL	49.04
		Low tide	0.629	BDL	42.14

Table 37 Variations In Productivity from Sampling Stations In Kpt Harbour Area Near By Creeks And Vadinar Area During Spring Tide In In March , 2021

Sr. No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
KPT HARBOUR AREA					
1	KPT1	High tide	0.716	0.716	BDL
		Low tide	0.495	0.495	BDL
2	KPT 2	High tide	0.938	0.938	BDL
		Low tide	0.527	0.527	BDL
3	KPT 3	High tide	0.817	0.817	BDL
		Low tide	0.426	0.426	BDL
4	KPT-4	High tide	0.850	BDL	56.95
		Low tide	0.613	BDL	41.07
CREEKS					
5	KPT-5 Nakti-I	High tide	1.189	BDL	79.66
		Low tide	0.833	BDL	55.81
6	KPT-6 Nakti-II	High tide	ND	ND	ND
7	VADINAR-I jetty	High tide	0.835	BDL	55.94
		Low tide	0.967	BDL	64.79

Productivity Estimation (Oxygen Method)

Productivity is defined as the rate at which inorganic carbon is converted to an organic form. Chlorophyll-bearing organisms (phytoplankton, periphytons,) serve as primary producers in the aquatic food chains. Photosynthesis ultimately results in the formation in a wide range in organic compounds, release in oxygen and reduction in Carbon dioxide (CO2) in the surrounding waters. Primary Productivity can be determined by measuring the changes in the Oxygen and CO_2 concentration. There are two methods in measuring the rate in carbon uptake and net photosynthesis in situ, Oxygen method and the Carbon 14 method. In both methods, clear(light) and darkened(Dark) bottles are filled with water samples and suspended at particular depth for an incubation period in several hours or samples are incubated under controlled conditions in chambers in the laboratory.

The chief advantages in the Oxygen method are that it provides estimates in gross and net productivity and respiration and those analyses can be performed with inexpensive laboratory equipment and common reagents. The dissolved oxygen (DO) concentration is determined at the beginning and end in the incubation period. Productivity is calculated on the assumption that one atom in carbon is assimilated for each molecule in oxygen released.

Table 38 Variations in Productivity from Sampling Stations in DPT Harbour Area Near by Creeks and Vadinar Area during neap Tide

Sr. No.	Station	Tide	Net Productivity mg carbon fixed/m^3
KPT HARBOUR AREA			
1	KPT1	High tide	112.5
		Low tide	75
2	KPT 2	High tide	112.5
		Low tide	150
3	KPT 3	High tide	150
		Low tide	150
4	KPT-4	High tide	150
		Low tide	150
CREEKS			
5	KPT-5 (Nakti–I)	High tide	112.5
		Low tide	150
6	KPT-6 (Nakti–II)	High tide	150
VADINAR			
7	VADINAR-I jetty	High tide	75
		Low tide	150

Table 39: Variations in productivity from sampling stations in DPT harbour area near by creeks and Vadinar area during spring tide

Sr. No	Station	Tide	Net Productivity mg carbon fixed/m^3
KPT HARBOUR AREA			
1	KPT1	High tide	75
		Low tide	112.5
2	KPT 2	High tide	112.5
		Low tide	75
3	KPT 3	High tide	112.5
		Low tide	150
4	KPT-4	High tide	150
		Low tide	112.5
CREEK			
5	KPT-5 (Nakti-I)	High tide	150
		Low tide	150
6	KPT-6 (Nakti–II)	High tide	75
VADINAR1			
7	VADINAR-I jetty	High tide	75
		Low tide	150

Table 40: Variations in productivity from sampling stations in KPT harbour area near by creeks and Vadinar area during Neap tide

Sr. No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin-a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
KPTHARBOUR AREA					
1	KPT1	High tide	0.748	BDL	42.08
		Low tide	0.613	BDL	34.30
2	KPT 2	High tide	0.716	BDL	43.21
		Low tide	0.527	BDL	34.17
3	KPT 3	High tide	0.936	BDL	42.01
		Low tide	0.834	BDL	35.24
4	KPT-4	High tide	0.850	BDL	55.95
		Low tide	0.937	BDL	48.98
		CREEKS			
5	KPT-5 Nakti-I	High tide	0.732	BDL	62.64
		Low tide	0.817	BDL	49.04
6	KPT-6 Naktii -II	High tide	ND	ND	-
VADINAR					
7	VADINAR-I jetty	High tide	0.645	BDL	35.31
		Low tide	0.527	BDL	36.38

Table 41 Variations in Productivity from Sampling Stations in KPT Harbour Area near by Creeks and Vadinar area during Spring Tide

Sr. No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
KPT HARBOUR AREA					
1	KPT1	High tide	0.747	BDL	50.05
		Low tide	0.645	BDL	43.21
2	KPT 2	High tide	0.763	BDL	51.12
		Low tide	0.537	BDL	35.98
3	KPT 3	High tide	0.630	BDL	42.21
		Low tide	0.527	BDL	35.31
4	KPT-4	High tide	0.510	BDL	34.17
		Low tide	0.613	BDL	41.07
	CREEKS				
5	KPT-5 Nakti-I	High tide	0.730	BDL	48.91
		Low tide	0.834	BDL	55.88
6	KPT-6 Nakti-II	High tide	ND	ND	-
7	VADINAR-I jetty	High tide	0.953	BDL	63.85
		Low tide	1.038	BDL	69.55

Productivity Estimation, Oxygen Method

Productivity is defined as the rate at which inorganic carbon is converted to an organic form. Chlorophyll bearing organisms (phytoplankton, periphytons,) serves as primary producers in the aquatic food chains. Photosynthesis ultimately results in the formation of a wide range of organic compounds, release of oxygen and reduction of Carbon dioxide (CO_2) in the surrounding waters. Primary Productivity can be determined by measuring the changes in the Oxygen and CO_2 concentration. There are two methods of measuring the rate of carbon uptake and net photosynthesis in situ, Oxygen method and the Carbon 14 method. In methods, clear (light) and darkened (Dark) bottles are filled with water samples and suspended at particular depth for an incubation period of several hours or samples are incubated under controlled conditions in chambers in the laboratory.

The chief advantages of the Oxygen method are that it provides estimates of gross and net productivity and respiration and those analyses can be performed with inexpensive laboratory equipment and common reagents. The dissolved oxygen (DO) concentration is determined at the beginning and end of the incubation period. Productivity is calculated on the assumption that one atom of carbon is assimilated for each molecule of oxygen released.

Table 42 Variations in Productivity from sampling stations in KPT Harbour Area nearby creeks and Vadinar area during neap Tide

Sr. No.	Station	Tide	Net Productivity mg carbon fixed/m^3
KPT HARBOUR AREA			
1	KPT1	High tide	112.5
		Low tide	75
2	KPT 2	High tide	112.5
		Low tide	75
3	KPT 3	High tide	75
		Low tide	112.5
4	KPT-4 (Khori–I)	High tide	75
		Low tide	112.5
	CREEKS		
5	KPT-5 (Nakti–I)	High tide	225
		Low tide	112.5
6	KPT-6 (Nakti–II)	High tide	75
VADINAR			
7	VADINAR-I jetty	High tide	112.5
		Low tide	75

Table 43 Variations in productivity from sampling stations in KPT harbour area near by creeks and Vadinar area during spring tide

Sr. No	Station	Tide	Net Productivity mg carbon fixed/m^3
KPT HARBOUR AREA			
1	KPT1	High tide	75
		Low tide	112.5
2	KPT 2	High tide	75
		Low tide	150
3	KPT 3	High tide	112.5
		Low tide	112.5
4	KPT-4 (Khori–I)	High tide	75
		Low tide	112.5
	CREEK		
5	KPT-5 (Nakti-I)	High tide	112.5
		Low tide	187.5
6	KPT-6 (Nakti–II)	High tide	112.5
VADINAR1			
7	VADINAR-I jetty	High tide	150
		Low tide	112.5

Phytoplankton Population

For the evaluation of the Phytoplankton population in KPT harbour area and within the immediate surroundings of the port, sampling was conducted from 6 sampling locations (3 in harbour area and two in Nakti creek and one in Khori creek) during high tide period and low tide period of consecutive spring tide and neap tide. The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by Blue green algae, Diatoms during spring tide and Neap tide period. Diatoms were represented by 14 genera. Dinoflagellates were totally absent during the sampling conducted in March 2021 during this sampling run, while Blue green algae were represented by very few strands of *Stigonema* sp. that also near Nakti creek during spring tide sampling. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 8-62 units/ L during high tide period and 49-56 units/ L during low tide of Neap tide. While Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 22-94 units/ L during high tide and 97-114 units/L during low tide of Spring tide period.

For the evaluation of the Phytoplankton population in Vadinar Jetty area and within the immediate surroundings, sampling was conducted only from one sampling location near Jetty area. Sampling was conducted during high tide period and low tide of spring tide and Neap tide at jetty location. The phytoplankton community of the sub surface water in the jetty area was represented by three groups, Diatoms, Blue green algae and Dinoflagellates. Diatoms were represented by 20 genera. Blue green algae were represented by. *Oscillatoria sp. Stigonema sp*. Dinoflagellates were represented by very few population of *Protoperidinium SP., Ceratium furca*. Phytoplankton of the sampling stations at sub surface layer in the Jetty area 86 units/L and 89 units/L, respectively during low tide and high tide period of Neap tide and 249 units/L and 240 units/L respectively during low tide and high tide period of Spring tide.

Zooplankton Population

For the evaluation of the Zooplankton population in KPT harbour area and within the immediate surroundings of the port sampling was conducted from 6 sampling locations (4 in harbour area and one in Nakti creek and one in Khori creek) during high tide period and low tide period of consecutive Neap tide and spring tide. The Zooplankton community of the sub surface water in the harbour and nearby creeks during March, 2021 was represented by mainly three groups, Tintinids, Copepods, and larval forms of Crustacea. Zooplankton of the sampling stations at sub surface layer in the KPT harbour area, varying from 14 -58 N/L during high tide and 59-77 N/L during low tide of Neap Tide period. While Zooplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 21-86 N/ L during high tide and 84-96 N/ L during low tide of Spring tide period.

For the evaluation of the Zooplankton population in Vadinar Jetty area and within the immediate surroundings, sampling was conducted from one sampling location in Jetty area Sampling was conducted during high tide period and low tide period of neap tide and spring tide at jetty location. The Zooplankton community of the sub surface water in the jetty was represented by six groups, Tintinids, Copepods, Decapods and larval forms Crustaceans, and Polychaetes. Zooplankton of the sampling stations at sub surface layer in the Jetty area was 64 N/ L, 67 N/ L during low tide and high tide respectively of Neap tide period and 1115-121 N/L during low tide and high tide respectively of Spring tide period.

Table 40: Systematic account of Phytoplankton in the sampling locations in of KPT harbour area and nearby creeks during spring tide and Spring tide period

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#
BLUE GREEN ALGAE	**Cynophyta**	**Cyanophyceae**	Stigonematales	Stigonemataceae	*Stigonema* sp	*B1*
DIATOMS	**Bacillariophyta**	**Coscinodiscophyceae**	Thalassiosirales	Thalassiosiraceae	*Planktoniella SP.*	*D1*
				Skeletonemataceae	Skeletonema sp	*D2*
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	*D3*
			Triceratiales	Triceratiaceae	Triceratium sp	*D4*
					Odontella sp.	*D5*
			Biddulphiales	Biddulphiaceae	*Biddulphia sp.*	*D6*
			Hemiaulales	Bellerocheaceae	Bellerochea sp	*D7*
			Lithodesmiales	Lithodesmiaceae	Ditylum sp	*D8*
			Rhizosoleniales	Rhizosoleniales	Rhizosolenia sp	*D9*
			Chaetocerotales	Chaetocerotaceae	Chaetoceros sp	*D10*
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma sp.*	*D11*
		Fragilariophyceae	Fragilariales	Fragilariaceae	Synedra sp	*D12*
			Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	*D13*
					Thalassionema sp	*D14*

Table 41: Systematic account of Phytoplankton in the sampling locations in of Vadinar during Spring tide & Neap tide period

GROUP	PHYLUM Division	CLASS	ORDER	FAMILY	GENUS/SPECIES	#
BLUE GREEN ALGAE	**Cynophyta**	**Cyanophyceae**	Pleurocapsales	Oscillatriaceae	*Oscillatoria* sp.	*B1*
			Stigonematales	Stigonemataceae	*Stigonema* sp	*B2*
Diatoms	**Bacillariophyta**	**Coscinodiscophyceae**	Thalassiosirales	Thalassiosiraceae	*Planktoniella sp.*	*D1*
					Thalassiosira sp	*D2*
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp*	*D3*
			Melosirales	Melosiraceae	Melosira sp	*D4*
			Biddulphiales	Biddulphiaceae	*Biddulphia sp*	*D5*
			Hemiaulales	Hemiaulaceae	Eucampia sp	*D6*
				Bellerocheaceae	Bellerochea sp	*D7*
			Rhizosoleniales	Rhizosoleniaceae	Rhizosolenia sp	*D8*
					Guinardia sp	*D9*
			Triceratiales	Triceratiaceae	*.Odontella SP.*	*D10*
					Triceratium sp	*D11*
			Lithodesmiales	Lithodesmiaceae	*Ditylum sp.*	*D12*
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros SP.*	*D13*
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma sp.*	*D14*
			Bacillariales	Bacillariaceae	*Bacillariasp*	*D15*
					Nitzschia sp.	*D16*
		Fragilariophyceae	Fragilariales	Fragilariaceae	*Synedra sp*	*D17*
			Licmophorales	Licmophoraceae	Licmosphenia sp	*D18*
			Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	*D19*
					Thalassionema sp	*D20*
DINOFLAGELLATES	**Dinophyta**	**Desmophyceae**	Peridiniales	Protoperidiniaceae:	*Protoperidinium SP.*	*F1*
			Gonyaulacales	Ceratiaceae	*Ceratium furca*	*F2*

Table 42: Quantitative Evaluation of Marine Phytoplankton in sub-surface samples from sampling locations of KPT harbour area creeks during spring tide

GENUS/ SPECIES		ABUNDANCE IN UNITS/CELLS / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING HIGH TIDE PERIOD						ABUNDANCE IN UNITS/CELLS / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING LOW TIDE PERIOD				
		KPT HARBOUR			CREEKS			KPT HARBOUR			CREEKS	
		KPT -1	KPT-2	KPT-3	KPT-4	KPT-5	KPT-6	KPT-1	KPT-2	KPT-3	KPT-4	KPT-5
DIATOMS												
D1	*Planktoniella SP.*	4	2	2	6	4	0	7	4	4	5	2
D2	Skeletonema sp	0	0	0	0	0	0	0	0	0	0	0
D3	*Coscinodiscus sp.*	17	12	14	10	14	0	10	18	12	10	17
D4	Triceratium sp	0	0	0	0	0	0	0	0	0	0	0
D5	*Odontella sp.*	0	0	0	0	0	0	0	0	0	0	0
D6	*Biddulphia sp.*	9	10	7	10	9	2	9	6	10	9	14
D7	Bellerochea sp	0	0	0	4	6	0	0	2	0	4	6
D8	Ditylum sp	0	0	0	0	0	0	0	0	0	0	0
D9	Rhizosolenia sp	6	4	7	5	2	0	6	5	8	4	4
D10	Chaetoceros sp	0	4	2	2	5	0	4	2	5	4	0
D11	*Pleurosigma sp.*	2	0	2	0	2	0	0	0	2	4	6
D12	Synedra sp	4	2	6	4	4	2	8	6	4	2	3
D13	*Thalassiothrix sp.*	2	4	8	6	10	4	9	8	12	7	4
D14	Thalassionema sp	0	2	4	8	6	0	0	0	0	0	0
DIATOMS Total units/L												
BLUE GREEN ALGAE												
B1	*Stigonema* sp	0	0	0	0	0	0	0	0	0	0	0
Blue green algae Total units/L		0	0	0	0	0	0	0	0	0	0	0
TOTAL PHYTOPLANKTON UNITS/L		44	40	52	55	62	8	53	51	57	49	56

Table 43: Quantitative Evaluation of Marine Phytoplankton in sub-surface samples from sampling locations of KPT harbour area Creeks during neap tide

GENUS/ SPECIES		ABUNDANCE IN UNITS/CELLS / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING HIGH TIDE PERIOD						ABUNDANCE IN UNITS/CELLS / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING LOW TIDE PERIOD				
		KPT HARBOUR			CREEKS			KPT HARBOUR			CREEKS	
		KPT -1	KPT-2	KPT-3	KPT-4	KPT-5	KPT-6	KPT-1	KPT -2	KPT-3	KPT-4	KPT-5
DIATOMS												
D1	*Planktoniella SP.*	6	8	4	9	10	0	9	12	14	10	12
D2	Skeletonema sp	8	4	6	4	4	0	10	12	9	6	10
D3	*Coscinodiscus sp.*	18	12	16	14	10	6	20	18	12	16	19
D4	Triceratium sp	0	0	2	6	4	0	0	0	4	6	8
D5	*Odontella sp.*	5	6	6	7	4	2	8	10	6	4	7
D6	*Biddulphia sp.*	8	9	10	7	9	4	7	4	8	9	6
D7	Bellerochea sp	4	6	2	7	6	0	6	4	8	6	4
D8	Ditylum sp	4	2	6	6	9	0	4	7	3	5	4
D9	Rhizosolenia sp	4	2	0	4	2	0	5	4	2	3	4
D10	Chaetoceros sp	0	0	0	0	0	0	0	0	0	0	0
D11	*Pleurosigma sp.*	4	0	2	0	2	0	0	0	0	4	6
D12	Synedra sp	4	2	6	4	4	2	8	6	4	2	3
D13	*Thalassiothrix sp.*	12	15	16	10	9	6	14	18	20	15	16
D14	Thalassionema sp	9	4	6	8	7	2	8	9	10	7	6
DIATOMS Total units/L		86	70	82	86	80	22	99	104	100	93	105
BLUE GREEN ALGAE												
B1	*Stigonema* sp	0	0	0	8	12	0	0	0	0	4	9
Blue green algae Total units/L		0	0	0	8	12	0	0	0	0	4	9
TOTAL PHYTOPLANKTON UNITS/L		86	70	82	94	92	22	99	104	100	97	114

Table 44: Quantitative Evaluation of Marine Phytoplankton in sub-surface samples from sampling locations of Vadinar area during spring tide

GENUS/ SPECIES		ABUNDANCE IN UNITS/CELLS / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING LOW TIDE PERIOD	ABUNDANCE IN UNITS/CELLS / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING HIGH TIDE PERIOD
		Vadinar Jetty	**Vadinar Jetty**
		VAD-1	**VAD-1**
	BLUE GREEN ALGAE		
B1	*Oscillatoria* sp.	6	10
B2	*Stigonema* sp	0	0
BLUE GREEN ALGAE Units/L		6	10
DIATOMS			
D1	*Planktoniella sp.*	0	0
D2	Thalassiosira sp	0	0
D3	*Coscinodiscus sp*	8	10
D4	Melosira sp	0	0
D5	*Biddulphia sp*	8	12
D6	Eucampia sp	9	7
D7	Bellerochea sp	6	4
D8	Rhizosolenia sp	24	20
D9	Guinardia sp	0	0
D10	*.Odontella SP.*	0	0
D11	Triceratium sp	0	0
D12	*Ditylum sp.*	0	0
D13	*Chaetoceros SP.*	0	0
D14	*Pleurosigma sp.*	0	0
D15	*Bacillariasp*	0	0
D16	*Nitzschia sp.*	0	0
D17	*Synedra sp*	12	10
D18	Licmosphenia sp	0	0
D19	*Thalassiothrix sp.*	9	14
D20	Thalassionema sp	0	0
DIATOMS TOTAL UNITS/L		76	77
DINOFLAGELLATES			
F1	*Protoperidinium SP.*	0	0
F2	*Ceratium furca*	4	2
DINOFLAGELLATES unit/L		4	2
TOTAL PHYTOPLANKTON UNITS/L		**86**	**89**

Table 45: Quantitative Evaluation of Marine Phytoplankton in sub-surface samples from sampling locations of Vadinar area during neap tide

GENUS/ SPECIES		ABUNDANCE IN UNITS/CELLS / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING LOW TIDE PERIOD	ABUNDANCE IN UNITS/CELLS / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING HIGH TIDE PERIOD
		Vadinar Jetty	**Vadinar Jetty**
		VAD-1	VAD-1
	BLUE GREEN ALGAE		
B1	*Oscillatoria* sp.	22	14
B2	*Stigonema* sp	14	20
BLUE GREEN ALGAE Units/L		36	34
DIATOMS			
D1	*Planktoniella sp.*	16	12
D2	Thalassiosira sp	20	18
D3	*Coscinodiscus sp*	12	10
D4	Melosira sp	4	8
D5	*Biddulphia sp*	32	24
D6	Eucampia sp	4	2
D7	Bellerochea sp	6	4
D8	Rhizosolenia sp	18	14
D9	Guinardia sp	4	8
D10	*.Odontella SP.*	7	9
D11	Triceratium sp	4	2
D12	*Ditylum sp.*	18	26
D13	*Chaetoceros SP.*	6	4
D14	*Pleurosigma sp.*	8	7
D15	*Bacillariasp*	4	6
D16	*Nitzschia sp.*	4	8
D17	*Synedra sp*	8	6
D18	Licmosphenia sp	4	5
D19	*Thalassiothrix sp.*	14	12
D20	Thalassionema sp	9	10
DIATOMS TOTAL UNITS/L		202	195
DINOFLAGELLATES			
F1	*Protoperidinium SP.*	6	8
F2	*Ceratium furca*	5	3
DINOFLAGELLATES unit/L		11	11
TOTAL PHYTOPLANKTON UNITS/L		249	240

Table 46: Systematic account of Zooplankton from the sampling locations in KPT harbour area, and nearby creeks during Spring tide and Neap tide

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#
TINTINIDS	PROTOZOA (CILIOPHORA)	SPIROTRICHEA	TINTINNIDA	Tintinnidiidae	*Leprotintinnus sp.*	*T1*
				codonellidae	*Tintinnopsisgracilis*	*T2*
					Tintinopsis radix	*T3*
					Tintinnopsis dadayi	*T4*
					Tintinnopsis failakkaensis	*T5*
COPEPODS	ARTHROPODA CRUSTACEA	SUB CLASS COPEPODA	CALANOIDA	Paracalanidae	*Acrocalanus sp*	*C1*
			CYCLOPOIDA	Oithonidae	*Oithona* sp.	*C2*
			HARPACTICOIDA	Ectinosomatidae	*Microstella sp.*	*C3*
				Euterpinidae	*Euterpina* sp.	*C4*
CRUSTACEAN LARVAE	ARTHROPODA CRUSTACEA				Nauplius larvae of Copepods	*C5*

Table 47: Systematic account of Zooplankton from the sampling locations in Vadinar area during spring tide & neap tide

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#
TINTINIDS	PROTOZOA (CILIOPHORA)	SPIROTRICHEA	TINTINNIDA	Tintinnidiidae	*Leprotintinnus sp.*	*T1*
				codonellidae	*Tintinnopsisgracilis*	*T2*
					Tintinopsis radix	*T3*
					Tintinnopsis failakkaensis	*T4*
COPEPODS	ARTHROPODA CRUSTACEA	SUB CLASS COPEPODA	Calanoida	Paracalanidae	*Acrocalanus sp*	*C1*
			Cyclopoida	Oithonidae	*Oithona* sp.	*C2*
			Harpacticoida	Euterpinidae	*Euterpina sp.*	*C3*
				Ectinosomatidae	*Microsetella* sp.	*C4*
DECAPODS	ARTHROPODA CRUSTACEA	Malacostraca	Decapoda	Penaeidae	*Penaeus sp.*	*D1*
CRUSTACEAN LARVAE					Nauplius larvae of Copepods	*L1*
Barnacles LARVAE	Arthropoda Crustacea	Maxillopoda Infra Class Cirripedia			Nauplius and Cyprids of Barnacles	*L2*
ZOE LARVAE					Zoea Larvae	*L3*
Polychaetes					Trachophore larvae	*L4*

Table 48: Quantitative evaluation of Marine Zooplankton in sub surface samples from sampling locations of KPT Harbour area creeks during spring tide

GENUS/ SPECIES		ABUNDANCE IN N / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING HIGH TIDE PERIOD						ABUNDANCE IN N / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING LOW TIDE PERIOD				
		KPT HARBOUR			CREEKS			KPT HARBOUR			CREEKS	
		KPT-1	KPT-2	KPT-3	KPT-4	KPT-5	KPT-6	KPT-1	KPT-2	KPT-3	KPT-4	KPT-5
TINTINIDS												
T1	*Leprotintinnus sp.*	4	2	2	4	2	0	8	4	6	5	4
T2	*Tintinnopsisgracilis*	6	8	10	4	7	2	14	9	10	8	6
T3	*Tintinopsis radix*	4	6	4	8	2	2	12	10	9	8	6
T4	*Tintinnopsis dadayi*	15	10	8	12	9	0	9	10	8	6	4
T5	*Tintinnopsis failakkaensis*	0	0	2	2	5	0	2	0	0	4	2
TINTINIDS TOTAL N/L		30	26	26	30	25	4	45	33	33	31	22
COPEPODS												
C1	*Acrocalanus sp*	0	0	0	0	0	0	0	0	0	0	0
C2	*Oithona* sp.	0	0	0	0	0	0	0	0	0	0	0
C3	*Microstella sp.*	8	10	9	8	7	2	14	9	12	10	16
C4	*Euterpina* sp.	0	0	0	0	0	0	0	0	0	0	0
COPEPODS TOTALN/L		8	10	9	8	7	2	14	9	12	10	16
LARVAL FORMS												
L1	Nauplius larvae of Copepods	18	22	10	20	16	8	18	24	16	20	21
Larval forms TOTAL N/L		18	22	10	20	16	8	18	24	16	20	21
TOTAL ZOOPLANKTON N /L		56	58	45	58	48	14	77	66	61	61	59

Table 49 Quantitative evaluation of marine zooplankton in sub surface samples from sampling locations of DPT harbour area and nearby creeks during neap tide

GENUS/ SPECIES		ABUNDANCE IN N / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING HIGH TIDE PERIOD						ABUNDANCE IN N / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING LOW TIDE PERIOD				
		KPT HARBOUR			CREEKS			KPT HARBOUR			CREEKS	
		KPT-1	KPT-2	KPT-3	KPT-4	KPT-5	KPT-6	KPT-1	KPT-2	KPT-3	KPT-4	KPT-5
TINTINIDS												
T1	*Leprotintinnus sp.*	8	4	6	2	4	0	8	9	5	4	4
T2	*Tintinnopsisgracilis*	4	8	7	4	7	2	5	7	6	8	4
T3	*Tintinopsis radix*	6	4	4	5	6	2	8	10	9	14	10
T4	*Tintinnopsis dadayi*	8	6	7	9	8	0	9	8	6	4	9
T5	*Tintinnopsis failakkaensis*	6	4	4	8	2	5	8	10	9	12	7
TINTINIDS TOTAL N/L		34	26	28	28	27	9	38	44	35	42	34
COPEPODS												
C1	*Acrocalanus sp*	8	6	7	9	10	0	8	9	7	6	9
C2	*Oithona* sp.	4	2	6	4	4	2	9	4	8	2	5
C3	*Microstella sp.*	12	17	16	10	12	2	16	9	12	10	14
C4	*Euterpina* sp.	4	2	4	2	6	0	6	2	2	4	5
COPEPODS TOTALN/L		28	27	33	25	32	4	39	24	29	22	33
LARVAL FORMS												
L1	Nauplius larvae of Copepods	24	32	12	20	16	8	19	24	26	20	18
Larval forms TOTAL N/L		24	32	12	20	16	8	19	24	26	20	18
TOTAL ZOOPLANKTON N/L		86	85	73	73	75	21	96	92	90	84	85

Table 50 Quantitative evaluation of marine zooplankton in sub surface samples from sampling locations of Vadinar area during spring tide

GENUS/ SPECIES		**ABUNDANCE IN N / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING LO0W TIDE PERIOD**	**ABUNDANCE IN N/ L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING HIGH TIDE PERIOD**
		Vadinar jetty	**Vadinar jetty**
		VAD-1	**VAD-1**
TINTINIDS			
T1	*Leprotintinnus sp.*	14	12
T2	*Tintinnopsisgracilis*	0	0
T3	*Tintinopsis radix*	8	9
T4	*Tintinnopsis failakkaensis*	0	0
Titinids N/L		22	21
COPEPODS			
C1	*Acrocalanus sp*	0	0
C2	*Oithona* sp.	0	0
C3	*Euterpina sp.*	0	0
C5	*Microsetella* sp.	12	10
COPEPODS TOTAL N/L		12	10
DECAPODS			
D1	*Penaeus sp.*	2	4
Total Deacapods N/L		2	4
LARVAL FORMS			
L1	Nauplius larvae of Copepods	*14*	12
L2	Nauplius and Cyprids of Barnacles	*8*	10
L3	Zoea Larvae	4	6
L4	Trachophore larvae	2	4
TOTAL LARVAL Forms N/L		28	32
TOTAL ZOOPLANKTON N/L		64	67

Table 51: Quantitative evaluation of marine zooplankton in sub surface samples from sampling locations of Vadinar area and nearby creeks during neap tide

GENUS/ SPECIES		ABUNDANCE IN N / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING LO0W TIDE PERIOD	ABUNDANCE IN N/ L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS DURING HIGH TIDE PERIOD
		Vadinar jetty	**Vadinar jetty**
		VAD-1	**VAD-1**
TINTINIDS			
T1	*Leprotintinnus sp.*	14	8
T2	*Tintinnopsisgracilis*	12	10
T3	*Tintinopsis radix*	10	14
T4	*Tintinnopsis failakkaensis*	7	9
Titinids N/L		43	41
COPEPODS			
C1	*Acrocalanus sp*	12	8
C2	*Oithona* sp.	6	9
C3	*Euterpina sp.*	4	6
C5	*Microsetella* sp.	6	7
COPEPODS TOTAL N/L		28	30
DECAPODS			
D1	*Penaeus sp.*	6	4
Total Deacapods N/L		6	4
LARVAL FORMS			
L1	Nauplius larvae of Copepods	*24*	32
L2	Nauplius and Cyprids of Barnacles	*10*	12
L3	Zoea Larvae	4	2
L4	Trachophore larvae	6	4
TOTAL LARVAL Forms N/L		44	50
TOTAL ZOOPLANKTON N/L		115	121

Benthic Organisms

No Benthic organism was observed in the collected sediments by using the Van-veen grabs during the sampling conducted during spring tide period and Neap tide period from KPT harbour region and nearby creek. Vadinar jetty region during spring tide and neap tide no benthic organisms observed collected sediments.

7. Meteorological Data

Automatic Weather station have been installed in Seva Sadan -3 at the Kandla Port 3 which records the data on Temperature (°C), Humidity (%),Wind (mph), Dew Point (°C), Wind Direction (°), Pressure, Solar radiation, heat Index and UVI.

Temperature

The mean day time temperature for Kandla Port was 28.4 °C. The day-time maximum temperature was 36.2 °C. The mean night time temperature was 25.9 °C. The minimum mean night time temperature recorded was 18.0 °C.

Air Pressure

The mean absolute air pressure for the month of March was 1013.2 hpa, whereas the mean relative pressure was 1017.27 hpa. The maximum absolute air pressure recorded for the month of March was 1023.02 hpa.

Heat Index

The mean day-time heat index for the month of March was 28.98 ^{o}C. The maximum heat index recorded was 43^{o}C.

Solar Radiation

The mean Solar Radiation in March was 166.74 w/m^2. The maximum solar radiation recorded in the month of March was 292.3 w/m^2.

Humidity

The mean day-time humidity was 24.7 % for the month of March and mean night time humidity was 33.3%. Maximum humidity recorded during day-time was 92.0 % and maximum humidity recorded during night-time was 93.0%.

Wind Velocity and Wind Direction

The mean wind velocity for the entire month of March was 6.8 km/hour (i.e. 1.89 mtr/sec). Maximum wind velocity recorded was 38.2 Km/hr (10.6 mtr/sec). The wind direction was mostly N to NW.

Conclusive Summary and Remedial measures Suggested

- The AAQ monitoring at six locations of Deendayal Port indicates that the mean PM_{10} values at four locations viz. Coal storage area, Marine Bhavan and Oil Jetty area were found above the permissible standards (100 µg/m^3)and $PM_{2.5}$ was above permissible limits at Coal storage location(Limit 60 µg/m^3).

- Drinking water at all the twenty locations was found potable and was within permissible limits of BIS standards (IS 10500).

- Noise quality was also within the set permissible standards of an Industrial Area. The noise level observed during day time was >75 dB (A) and at night time was >70 dB (A) during the entire monitoring period.

- The sewage treated water of Deendayal Port Colony (Gopalpuri) was in line with the standards set by the Gujarat Pollution Control Board. The STP at Deendayal Port is not fully operational and STP at Vadinar Port was found non-operational.

Reasons for higher Values of PM_{10}

- Large amount of coal is handled at Berth No. 6, 7, 8 and 9. The unloading of coal directly in the truck, using grabs cause coal to spread in air as well as coal dust to fall on ground. This settled coal dust again mixes with the air while trucks travel through it.

- Also, the coal laden trucks are not always covered with tarpaulin sheets, and these results in spillage of coal from trucks/dumpers during its transit from vessel to yard or storage site. This also increased PM values around marine Bhavan.

- Coal handling at Tuna/Coal Jetty also contributes to higher PM_{10} values at Tuna Port as fine coal dust generated at Tuna Coal Jetty is carried by the wind for longer distance.

Remedial Measures

The values of PM_{10} during the month of March, 2021 were observed beyond the permissible limit at four locations mentioned above. Given below are the remedial measures suggest to minimize the Air pollution at Deendayal Port.

- Guidelines for Coal Handling by GPCB should be strictly followed. (http://gpcb.gov.in/pdf/coal-handling-guidelines.pdf)

- Sewage Treatment Plan at Vadinar Port is not working. Hence, it is recommended to commission the sewage treatment plant at Vadinar immediately.

- Except for the higher values of PM_{10} at Coal storage site, Oil Jetty, Tuna Port and Marine Bhavan locations, the monitoring results for the present month suggest that the overall Environment Quality of Deendayal Port for is satisfactory.

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ENVIRONMENTAL MONITORING REPORT
FOR
DEENDAYAL PORT TRUST

REPORT NO.	:	DCPL/DPT/20-21/13
Month	:	MAY 2021
Issue No	:	01
Revision No	:	00
Prepared by	:	DETOX CORPORATION PVT. LTD., SURAT

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Introduction

Monitoring of various environmental aspects of the Deendayal port by M/s Detox Corporation Pvt. Ltd. has been carried out through collection of samples, analysis of the same, comparing results with respect to the national standards and any other relevant standards by GBCB/CPCB/MoEF to identify non conformities in the Environment of the Deendayal Port. The results shall address the identified impacts and suggest measures to minimize the environmental impact due to various operations at Deendayal Port.

The environmental monitoring is carried out as per the Environment Management and Monitoring Plan submitted by Detox Corporation Pvt. Ltd.

1. Ambient Air Quality Monitoring

As per the Environmental Monitoring Plan of Deendayal Port Trust, Air monitoring was carried out at six identified locations at Deendayal Port and two locations at Vadinar Port.

1.1 Air Quality Monitoring Methodology

Air quality is measured in all the stations, for 24 hour for Total Suspended Particulate Matter (TSPM), PM_{10}, $PM_{2.5}$, SO_2, NO_X, NH_3 & Benzene, and Grab-sampling for CO & CO_2 measurements. The Air samplers are operated for a period of 24 hours and after a continuous operation of 8 hours of the sampler, the reagents were replaced to obtain 3 samples per day for each parameter namely, SO_2, NO_X. The EPM 2000 filter paper and PTFE Membrane bound filter paper are used for a period of 24 hours to obtain one sample each of TSPM, PM_{10} & $PM_{2.5}$.

The AAQ samples are collected twice a week from all the eight locations as per the EMP.

1.2 Results

The ambient air quality monitoring data for six stations, viz. Marine Bhavan, Oil Jetty, Port Colony,Gopalpuri Hospital,Tuna Port and Nr. Coal Storage Area for the month of May 2021 are given in Tables 1A to 6B. The ambient air quality monitoring data for two stations at Vadinar (Nr. Admin Building &Nr. Signal Building) are given in Tables 7A to 8B.

Location 1: Marine Bhavan (AL1)

Table 1 : Results of Air Pollutant Concentration at Marine Bhavan

	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period		24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit		NS	100 µg/m3	60 µg/m3		80 µg/m3		80 µg/m3		400 µg/m3
AL1 – 1	05.05.2021	407	395	27	10.55	14.65	22.87	27.52	5.62	5.28
					15.83		26.04		5.36	
					17.58		33.66		4.85	
AL1 – 2	07.05.2021	843	200	20	9.67	9.08	17.78	18.00	9.70	9.28
					9.23		22.23		7.91	
					8.35		13.97		10.21	
AL1 – 3	12.05.2021	795	653	74	2.20	5.28	37.47	22.02	13.02	12.51
					5.71		11.43		10.72	
					7.91		17.15		13.79	
AL1 – 4	14.05.2021	1164	927	46	5.71	8.50	20.33	21.38	31.91	41.70
					7.47		18.42		39.57	
					12.31		25.41		53.61	
AL1 – 5	19.05.2021	2190	1791	35	10.11	9.52	18.42	22.02	12.00	17.10
					5.71		26.04		22.72	
					12.75		21.60		16.59	
AL1 - 6	21.05.2021	770	229	12	8.79	7.91	20.33	21.60	16.59	23.66
					5.71		26.04		27.57	
					9.23		18.42		26.80	
AL1 - 7	26.05.2021	877	426	43	9.23	11.72	22.23	23.92	5.62	5.36
					13.19		31.12		5.87	
					12.75		18.42		4.60	
AL1 – 8	28.05.2021	682	234	70	8.35	7.03	12.70	13.97	35.74	29.27
					7.91		8.26		29.36	
					4.84		20.96		22.72	
Monthly Average		966	607	41		9.21		21.30		18.02
Standard Deviation		537	539	22		2.89		3.99		12.81

NS: Not Specified

Table 1B : Results of Air Pollutant Concentration at Marine Bhavan					
Parameter	Date	C_6H_6 [µg/m³]	HC* ppm	CO [mg/m³]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m³	NS	4.0 mg/m³	NS
AL1 – 1	05.05.2021`	1.23	BDL	1.36	518
AL1 – 2	07.05.2021	1.13	BDL	1.57	520
AL1 – 3	12.05.2021	1.04	BDL	1.56	503
AL1 – 4	14.05.2021	1.14	BDL	1.81	465
AL1 – 5	19.05.2021	1.12	BDL	1.51	480
AL1 - 6	21.05.2021	1.05	BDL	1.58	485
AL1 – 7	26.05.2021	1.04	BDL	1.68	527
AL1 – 8	28.05.2021	1.1	BDL	1.59	490
Monthly Average		**1.11**	-	**1.58**	**499**
Standard Deviation		**0.06**	-	**0.13**	**22**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC: 0.5ppm)
NS -Not Specified

At Marine Bhavan, the overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_X and NH_3 is attributed mainly by motor vehicle emission produced from various types of automobiles (both diesel and petrol driven). Moreover, the loading and unloading of Food Grains and Timber at Jetty no. 1 and 2 also contributes to the high levels of TSPM and PM_{10}. The mean TSPM value at Marine Bhavan was 966 µg/m³, The mean PM_{10} values were 607.0 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were below the permissible limit (mean = 41 µg/m³). The average values of SO_2, NO_x and NH_3 were within the permissible limit. The average values of SO_2, NO_x and NH3 were 9.21 µg/ m³, 21.30 µg/ m³ & 18.02 µg/ m³ respectively.These were within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Marine Bhavan. The mean Benzene concentration was 1.11 µg/m³,well below the

permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.58 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 2: Oil Jetty (AL2)

Table 2 : Results of Air Pollutant Concentration at Oil Jetty

	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period		24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit		NS	100 µg/m3	60 µg/m3		80 µg/m3		80 µg/m3		400 µg/m3
AL2 -1	05.05.2021	342	303	31	19.34	14.80	28.58	28.58	6.38	7.83
					13.19		22.87		7.40	
					11.87		34.30		9.70	
AL2 -2	07.05.2021	840	806	13	10.99	13.48	20.33	21.38	8.17	14.38
					12.75		25.41		16.59	
					16.70		18.42		18.38	
AL2 -3	12.05.2021	793	638	18	1.75	5.28	15.88	29.01	7.40	12.93
					5.71		32.39		11.49	
					8.35		38.74		19.91	
AL2 -4	14.05.2021	678	611	37	8.79	9.23	36.84	35.15	101.60	92.58
					8.35		25.41		57.69	
					10.55		43.19		118.45	
AL2 – 5	19.05.2021	1113	597	17	10.55	10.40	25.41	22.87	20.93	21.44
					8.79		19.69		26.80	
					11.87		23.50		16.59	
AL2 – 6	21.05.2021	634	561	23	8.35	8.50	25.41	23.50	22.72	39.74
					9.23		19.05		32.93	
					7.91		26.04		63.56	
AL2 – 7	26.05.2021	961	740	116	7.03	9.52	20.96	22.44	21.95	26.72
					11.43		20.33		17.36	
					10.11		26.04		40.84	
AL2 -8	28.05.2021	654	628	40	5.28	10.55	21.60	25.62	33.70	40.50
					12.75		38.11		41.36	
					13.63		17.15		46.46	
Monthly Average		752	611	37		10.22		26.07		32.02
Standard Deviation		233	148	33		2.94		4.62		27.25

NS: Not Specified

Table 2B : Results of Air Pollutant Concentration at Oil Jetty					
Parameter	Date	C_6H_6 [µg/m^3]	HC* ppm	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3	NS	4.0 mg/m^3	NS
AL2 -1	05.05.2021	1.1	BDL	1.81	518
AL2 -2	07.05.2021	1.11	BDL	1.68	503
AL2 -3	12.05.2021	1.11	BDL	1.76	498
AL2 -4	14.05.2021	1.28	BDL	1.9	474
AL2 – 5	19.05.2021	1.09	BDL	1.9	491
AL2 – 6	21.05.2021	1.12	BDL	1.4	510
AL2 -7	26.05.2021	1.19	BDL	1.76	515
AL2 – 8	28.05.2021	1.08	BDL	1.65	498
Monthly Average		**1.14**	**-**	**1.73**	**501**
Standard Deviation		**0.07**	**-**	**0.16**	**14**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 0.5ppm)

NS- Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Oil Jetty area was mainly by motor vehicle emission produced from various types of vehicles Oil Jetty Area. The mean TSPM values at Oil Jetty were 752 µg/m^3± 48 (SD), The mean PM_{10} values were 611 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 37 µg/m^3).The average values of SO_2, NO_x and NH_3 were within the permissible limit; The mean concentration of SO_2, NO_x and NH3 were 10.22 µg/m^3, 26.07 µg/m^3 and 32.02 µg/m^3 respectively.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Oil Jetty. The mean Benzene concentration was 1.14 µg/m^3, HC's were below the detectable limit of 5.0 µg/m^3. and Carbon Monoxide concentration was 1.73 µg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 3: Kandla Colony – Estate Office (AL-3)

Table 3 : Results of Air Pollutant Concentration at Estate Office										
	Date	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**	
Sampling Period		**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit		**NS**	**100 µg/m3**	**60 µg/m3**		**80 µg/m3**		**80 µg/m3**		**400 µg/m3**
AL3 – 1	05.05.2021	151	134	23	15.39	13.48	24.77	22.02	7.40	5.79
					12.31		19.69		5.36	
					12.75		21.60		4.60	
AL3 – 2	07.05.2021	511	352	14	12.75	9.96	22.23	19.69	11.23	9.10
					9.23		19.05		7.40	
					7.91		17.78		8.68	
AL3 – 3	12.05.2021	710	471	21	3.96	3.66	14.61	9.74	16.59	10.13
					3.08		6.99		8.17	
					3.96		7.62		5.62	
AL3 – 4	14.05.2021	557	782	78	5.71	8.79	18.42	24.77	88.33	55.14
					12.75		24.77		25.02	
					7.91		31.12		52.08	
AL3 – 5	19.05.2021	484	744	17	5.71	7.03	15.88	18.00	28.59	30.89
					9.23		18.42		22.72	
					6.15		19.69		41.36	
AL3 – 6	21.05.2021	979	971	106	4.84	5.71	41.29	29.64	28.34	42.29
					6.59		28.58		51.31	
					5.71		19.05		47.23	
AL3 – 7	26.05.2021	801	767	31	8.35	9.23	25.41	19.69	22.98	23.32
					10.99		20.33		15.83	
					8.35		13.34		31.14	
AL3 – 8	28.05.2021	370	252	31	9.23	9.52	15.88	20.33	25.02	28.51
					8.35		19.69		30.12	
					10.99		25.41		30.38	
Monthly Average		570	559	40		8.43		20.48		25.64
Standard Deviation		258	298	33		2.97		5.70		17.31

NS: Not Specified

Table 3B : Results of Air Pollutant Concentration at Kandla Port Colony					
Parameter	Date	C_6H_6 [µg/m^3]	HC*	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3	NS	4.0 mg/m^3	NS
AL3 -1	05.05.2021	1.06	BDL	1.69	503
AL3 -2	07.05.2021	1.03	BDL	1.76	528
AL3 -3	12.05.2021	1.13	BDL	1.64	527
AL3 -4	14.05.2021	1.01	BDL	1.59	502
AL3 – 5	19.05.2021	1.14	BDL	1.68	462
AL3 – 6	21.05.2021	1.14	BDL	1.65	480
AL3 – 7	26.05.2021	1.32	BDL	1.51	490
AL3 – 8	28.05.2021	1.16	BDL	1.53	488
Monthly Average		**1.12**	**-**	**1.63**	**498**
Standard Deviation		**0.10**	**-**	**0.08**	**23**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)
NS- Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Kandla Port Colony was attributed by vehicle emission produced from trucks and heavy duty vehicles that pass through the road outside Kandla Port Colony. The mean TSPMvalues at Oil Jetty were 570 µg/m^3, The mean PM_{10} values were 559µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 40 µg/m^3). The average values of SO_2, NO_x and NH3 were 8.43 µg/m^3, 20.48 µg/m^3 and 25.64 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Kandla Port Colony. The mean Benzene concentration was 1.12 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.63 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 4: Gopalpuri Hospital (AL-4)

Table 4 : Results of Air Pollutant Concentration at Gopalpuri Hospital										
	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period		24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit		NS	100 µg/m3	60 µg/m3		80 µg/m3		80 µg/m3		400 µg/m3
AL4 -1	05.05.2021	126	125	21	20.66	15.68	30.49	24.77	4.60	5.53
					12.31		24.77		7.40	
					14.07		19.05		4.60	
AL4 -2	07.05.2021	289	241	15	7.91	9.52	15.88	18.21	10.72	11.49
					12.75		18.42		13.27	
					7.91		20.33		10.47	
AL4 -3	12.05.2021	425	265	16	5.28	5.28	16.51	20.11	14.30	13.44
					7.47		13.97		14.04	
					3.08		29.85		12.00	
AL4 -4	14.05.2021	281	195	30	9.67	9.08	20.33	20.96	16.59	16.85
					5.28		17.78		18.38	
					12.31		24.77		15.57	
AL4 – 5	19.05.2021	360	148	43	7.47	7.18	19.69	19.05	11.49	12.00
					8.35		18.42		14.04	
					5.71		19.05		10.47	
AL4 – 6	21.05.2021	478	139	29	9.67	8.65	22.23	18.84	14.04	17.87
					7.91		15.88		18.38	
					8.35		18.42		21.19	
AL4 – 7	26.05.2021	526	126	36	10.55	10.70	15.24	18.00	5.11	5.96
					13.19		18.42		7.91	
					8.35		20.33		4.85	
AL4 – 8	28.05.2021	334	168	25	10.99	9.82	20.33	16.94	11.49	15.91
					8.35		12.07		15.83	
					10.11		18.42		20.42	
Monthly Average		352	176	27		9.49		19.61		12.38
Standard Deviation		126	53	10		3.02		2.43		4.67

NS: Not Specified

Table 4B : Results of Air Pollutant Concentration at Gopalpuri Hospital					
Parameter	Date	C_6H_6 [µg/m^3]	HC*	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3	NS	4.0 mg/m^3	NS
AL4 -1	05.05.2021	1.19	BDL	1.53	491
AL4 -2	07.05.2021	1.14	BDL	1.46	498
AL4 -3	12.05.2021	1.37	BDL	1.36	491
AL4 -4	14.05.2021	1.16	BDL	1.68	520
AL4 – 5	19.05.2021	1.32	BDL	1.57	511
AL4 – 6	21.05.2021	1.23	BDL	1.85	465
AL4 – 7	26.05.2021	1.04	BDL	1.46	481
AL4 – 8	28.05.2021	1.19	BDL	1.35	488
Monthly Average		**1.21**	**-**	**1.53**	**493**
Standard Deviation		**0.10**	**-**	**0.17**	**17**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)
NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Gopalpuri Hospital was attributed by vehicle emission produced from light motor vehicles of the colony residents. The mean TSPMvalues at Oil Jetty were 352 µg/m^3, The mean PM_{10} values were 176 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean= 27 µg/m^3). The average values of SO_2, NO_x and NH_3 were 9.49 µg/m^3, 19.61 µg/m^3 and 12.38 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Gopalpuri Hospital. The mean Benzene concentration was 1.21 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.53 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 5: Coal Storage Area (AL-5)

Table 6 : Results of Air Pollutant Concentration at Coal Storage Area											
	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]		
Sampling Period		24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	
NAAQMS limit		NS	100 µg/m3	60 µg/m3		80 µg/m3		80 µg/m3		400 µg/m3	
AL6 – 1	05.05.2021	829	705	33	14.07	14.65	27.95	25.19	7.15	5.36	
					18.90		20.96		4.60		
					10.99		26.68		4.34		
AL6 – 2	07.05.2021	814	654	47	12.31	9.23	24.77	19.27	7.40	10.55	
					7.91		17.15		8.93		
					7.47		15.88		15.32		
AL6 – 3	12.05.2021	745	667	73	4.40	8.79	8.89	19.90	26.29	21.53	
					12.31		24.77		16.59		
					9.67		26.04		21.70		
AL6 – 4	14.05.2021	1040	730	100	12.31	9.82	19.69	21.38	98.54	94.11	
					8.79		25.41		57.44		
					8.35		19.05		126.36		
AL6 – 5	19.05.2021	2563	2516	95	7.47	10.84	25.41	25.19	21.95	18.29	
					12.75		24.77		10.21		
					12.31		25.41		22.72		
AL6 – 6	21.05.2021	1726	1383	189	12.75	8.65	26.04	22.44	26.55	26.63	
					5.71		22.87		27.06		
					7.47		18.42		26.29		
AL6 – 7	26.05.2021	1696	1350	146	12.31	12.16	31.12	23.92	10.72	11.32	
					10.55		17.15		15.06		
					13.63		23.50		8.17		
AL6 – 8	28.05.2021	1311	1187	135	11.43	11.87	29.85	26.04	25.02	37.87	
					9.23		24.77		42.12		
					14.95		23.50		46.46		
Monthly Average		1341	1149	102		10.75		22.92		28.21	
Standard Deviation		627	634	52		2.07		2.57		28.54	

NS: Not Specified

Table 5B : Results of Air Pollutant Concentration at Coal Storage Area					
Parameter	Date	C_6H_6 [µg/m³]	HC*	CO [mg/m³]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m³	NS	4.0 mg/m³	NS
AL5 – 1	05.05.2021	1.38	BDL	1.9	522
AL5 – 2	07.05.2021	1.29	BDL	1.59	494
AL5 – 3	12.05.2021	1.14	BDL	1.68	462
AL5 – 4	14.05.2021	1	BDL	1.50	470
AL5 – 5	19.05.2021	1.14	BDL	1.68	462
AL5 – 6	21.05.2021	1.3	BDL	1.6	491
AL5 – 7	26.05.2021	1.17	BDL	1.98	500
AL5 – 8	28.05.2021	1.06	BDL	1.55	490
Monthly Average		**1.19**	**-**	**1.69**	**486**
Standard Deviation		**0.13**	**-**	**0.17**	**21**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)

NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Coal Storage Area was comparatively highest among all the locations of Air Quality monitoring in Kandla Port. High values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_X at this location was due to lifting of coal with grab and other coal handling processes near Berth no. 6 & 7. Moreover, the traffic was also heavy around this place for transport of coal thus emissions produced from heavy vehicles. The mean TSPMvalues at Coal storage were 1341 µg/m³. The mean PM_{10} values were 1149 µg/m³, which is well above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 102 µg/m³). The average values of SO_2, NO_x and NH_3 were 10.75 µg/m³, 22.92 µg/m³ and 28.21 µg/m³ respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Coal Storage Area. The mean Benzene concentration was 1.19 µg/m³, well below the

permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.69 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 6: Tuna Port (AL-6)

Table 5 : Results of Air Pollutant Concentration at Tuna Port

	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period		24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit		NS	100 µg/m3	60 µg/m3		80 µg/m3		80 µg/m3		400 µg/m3
AL5 -1	05.05.2021	83	76	24	4.84	8.65	8.89	10.80	1.79	1.62
					8.35		12.07		2.04	
					12.75		11.43		1.02	
AL5 – 2	07.05.2021	148	121	5	3.08	2.78	11.43	10.59	4.60	5.70
					3.52		12.07		7.40	
					1.76		8.26		5.11	
AL5 – 3	12.05.2021	302	279	10	3.96	3.22	11.43	10.37	13.02	11.49
					3.52		7.62		14.04	
					2.20		12.07		7.40	
AL5 – 4	14.05.2021	208	154	27	3.08	2.93	18.42	14.19	3.06	5.87
					3.96		11.43		7.15	
					1.76		12.70		7.40	
AL5 – 5	19.05.2021	192	145	40	3.08	2.78	7.62	7.62	3.06	5.45
					3.96		8.26		7.40	
					1.32		6.99		5.87	
AL5 – 6	21.05.2021	391	150	25	1.32	2.49	11.43	12.07	6.38	9.62
					2.20		17.15		12.25	
					3.96		7.62		10.21	
AL5 – 7	26.05.2021	628	177	27	3.08	1.47	11.43	9.95	4.08	4.94
					0.44		6.35		7.40	
					0.88		12.07		3.32	
AL5 – 8	28.05.2021	230	178	23	4.84	3.52	11.43	9.95	5.62	6.98
					3.52		7.62		9.96	
					2.20		10.80		5.36	
Monthly Average		273	160	23		3.48		10.69		6.46
Standard Deviation		171	58	11		2.17		1.88		3.01

NS: Not Specified

Table 6B : Results of Air Pollutant Concentration at Tuna Port					
Parameter	Date	C_6H_6 [µg/m³]	HC*	CO [mg/m³]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m³	NS	4.0 mg/m³	NS
AL6 -1	05.05.2021	1.27	BDL	1.67	511
AL6 – 2	07.05.2021	1.01	BDL	1.56	527
AL6 – 3	12.05.2021	1.09	BDL	1.65	496
AL6 – 4	14.05.2021	1.21	BDL	1.57	456
AL6 – 5	19.05.2021	1.02	BDL	1.6	470
AL6 – 6	21.05.2021	1.1	BDL	1.81	462
AL6 – 7	26.05.2021	1.21	BDL	1.5	492
AL6 – 8	28.05.2021	1.26	BDL	1.66	486
Monthly Average		**1.15**	**-**	**1.63**	**488**
Standard Deviation		**0.10**	**-**	**0.09**	**24**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)
NS- Not Specified

The mean TSPM values at Tuna Port were 273 µg/m³, The mean PM_{10} values were 160 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were within the permissible limit (mean = 23 µg/m³ µg/m³). The average values of SO_2, NO_x and NH_3 were 3.48µg/m³, 10.69µg/m³ and 6.46µg/m³ respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Tuna Port. The mean Benzene concentration was 1.15µg/m³, well below the permissible limit of 5.0µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.63 mg/m³, well below the permissible limit of 4.0 mg/m³.

Location 7: Signal Building (Vadinar) (AL-7)

Table 7 : Results of Air Pollutant Concentration at Signal Building										
	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period		24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit			100 µg/m3	60 µg/m3		80 µg/m3		80 µg/m3		400 µg/m3
AL8 -1	05.05.2021	107	81	25	3.077	2.051	19.69	17.78	6.89	9.28
					1.758		13.97		9.96	
					1.319		19.69		10.98	
AL8 -2	07.05.2021	111	48	33	1.758	2.198	14.61	12.91	10.47	11.40
					1.319		12.70		12.76	
					3.517		11.43		10.98	
AL8 -3	12.05.2021	125	75	22	3.956	2.051	15.88	19.69	10.72	11.57
					0.879		24.14		9.45	
					1.319		19.05		14.55	
AL8 -4	14.05.2021	126	41	50	4.396	4.689	15.88	20.96	13.53	15.06
					3.956		19.69		15.32	
					5.715		27.31		16.34	
AL8 -5	19.05.2021	145	61	56	4.396	2.491	23.50	30.49	16.08	14.89
					0.879		34.30		13.53	
					2.198		33.66		15.06	
AL8 -6	21.05.2021	145	95	28	3.956	4.689	18.42	26.47	10.98	15.91
					5.715		36.20		16.08	
					4.396		24.77		20.68	
AL8 -7	26.05.2021	158	91	19	2.198	2.051	10.79776	20.11	13.52972	13.36
					2.638		24.13618		13.01917	
					1.319		25.4065		13.52972	
AL8 -8	28.05.2021	154	90	30	1.758	1.758	23.50102	15.24	11.23222	11.57
					1.319		9.527439		13.01917	
					2.198		12.70325		10.46639	
Monthly Average		134	73	33		2.747		20		13
Standard Deviation		19	21	13		1.215		6		2

NS: Not Specified

Table 7B : Results of Air Pollutant Concentration at Signal Building					
Parameter	Date	C_6H_6 [µg/m³]	HC*	CO [mg/m³]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m³	NS	4.0 mg/m³	NS
AL7 -1	05.05.2021	1.16	BDL	1.72	488
AL7 – 2	07.05.2021	1.11	BDL	1.66	492
AL7 – 3	12.05.2021	1.02	BDL	1.56	468
AL7 – 4	14.05.2021	1.13	BDL	1.62	477
AL7 – 5	19.05.2021	1.1	BDL	1.72	460
AL7 – 6	21.05.2021	1.22	BDL	1.46	498
AL7 – 7	26.05.2021	1.1	BDL	1.68	462
AL7 – 8	28.05.2021	1.25	BDL	1.5	465
Monthly Average		**1.14**	**-**	**1.62**	**476**
Standard Deviation		**0.07**	**-**	**0.10**	**15**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)
NS_ Not Specified

The mean TSPM values at Vadinar Port were 134 µg/m³. The mean PM_{10} values were 73 µg/m³, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 33 µg/m³ µg/m³). The average values of SO_2, NO_x and NH_3 were 2.74 µg/m³, 20 µg/m³ and 13 µg/m³ respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Vadinar Port. The mean Benzene concentration was 1.14 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.62mg/m³, well below the permissible limit of 4.0 mg/m³.

Location 8: Admin Building (Vadinar) (AL-8)

Table 8 : Results of Air Pollutant Concentration at Admin Building											
	Date	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**		
Sampling Period		**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	
NAAQMS limit			**100 µg/m3**	**60 µg/m3**		**80 µg/m3**		**80 µg/m3**		**400 µg/m3**	
AL7 -1	05.05.2021	201	89	25	1.319	2.784	5.716	4.234	5.361	6.297	
					3.077		5.081		7.658		
					3.956		1.905		5.871		
AL7 -2	07.05.2021	231	77	40	0.440	1.758	5.716	6.775	12.509	11.658	
					1.758		8.257		11.232		
					3.077		6.352		11.232		
AL7 -3	12.05.2021	105	88	35	3.956	4.103	8.257	8.892	13.785	15.997	
					4.835		8.892		16.083		
					3.517		9.527		18.125		
AL7 -4	14.05.2021	109	126	39	3.077	2.198	7.622	7.834	13.785	13.955	
					1.319		8.892		13.019		
					2.198		6.987		15.061		
AL7 -5	19.05.2021	201	124	32	2.638	3.077	17.785	16.938	16.083	12.253	
					3.956		15.879		9.956		
					2.638		17.149		10.722		
AL7 -6	21.05.2021	181	85	55	3.956	3.810	18.420	20.749	9.956	15.061	
					4.396		19.690		14.551		
					3.077		24.136		20.678		
AL1 -5	26.05.2021	143	123	34	1.758	2.198	13.338	13.338	3.574	5.191	
					3.077		9.527		7.148		
					1.758		17.149		4.850		
AL1-6	28.05.2021	119	76	24	2.198	2.344	22.231	15.456	5.361	6.807	
					2.198		10.798		7.658		
					2.638		13.338		7.403		
Monthly Average		161	99	36		2.7840		11.777		10.90	
Standard Deviation		48	22	10		0.8289		5.718		4.24	

NS: Not Specified

Table 8B : Results of Air Pollutant Concentration at Admin Building					
Parameter	Date	C_6H_6 [µg/m³]	HC*	CO [mg/m³]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m³	NS	4.0 mg/m³	NS
AL8 -1	05.05.2021	1.13	BDL	1.88	478
AL8-2	07.05.2021	1.12	BDL	1.72	486
AL8 -3	12.05.2021	1.06	BDL	1.68	492
AL8-4	14.05.2021	1.15	BDL	1.55	482
AL8 -5	19.05.2021	1.02	BDL	1.69	466
AL8-6	21.05.2021	1.1	BDL	1.68	511
AL8-7	28.05.2021	1.08	BDL	1.98	474
AL8-8	30.05.2021	1.13	BDL	1.62	459
Monthly Average		**1.10**	**-**	**1.73**	**481**
Standard Deviation		**0.04**	**-**	**0.14**	**16**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)

NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Admin Building Vadinar was comparatively low among all the locations of Air Quality monitoring in Kandla Port and Vadinar Port. The mean TSPM values at Vadinar Port were 161 µg/m³. The mean PM_{10} values were 99 µg/m³, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 36.0 µg/m³). The average values of SO_2, NO_x and NH_3 were 2.78 µg/m³, 11.77 µg/m³ and 10.90 µg/m³ respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Admin Building, Vadinar Port. The mean Benzene concentration was 1.10 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.73 mg/m³, well below the permissible limit of 4.0 mg/m³.

1.4 Observations and Conclusion

During the monitoring period, the overall Ambient Air Quality of the port area was found to be well within the desired levels for various pollutants. However, Near Coal storage area, Marine Bhavan and Oil Jetty area, PM_{10} values was above the permissible standards. All other pollutants were recorded well below the prescribed limits.

2. Drinking Water Quality Monitoring

Drinking Water Quality Monitoring was carried out at twenty stations at Kandla, Vadinar & Township Area of Deendayal Port.

2.1 Drinking Water Monitoring Methodology

Drinking water samples were collected from 20 locations as prescribed in the tender document. Samples for physico-chemical analysis were collected in 1 liter carboys and samples for microbiological parameters were collected in sterilized bottles. These samples were then analyzed in laboratory for various drinking water parameters at Kandla Lab/Surat.

The Sampling and Analysis was done as per standard methods and CPCB/GPCB Guidelines and Standard Methods -APHA. The water samples were analyzed for various parameters, viz. Color , Odor, Turbidity , Conductivity , pH , Chlorides , TDS, Total Hardness, Iron , Sulphate , Salinity , DO, BOD, Na, K, Ca, Mg, F, NO_3, NO_2, Mn, Cr-6, Cu, Cd, As, Hg, Pb, Zn, Bacterial Count (cfu) .

2.2 Results

The Drinking Water Quality monitoring data for 20 stations are given in below from table No. 9 to Table No. 15

Table 9: Drinking Water Quality Monitoring Parameters for Nirman Building 1, P & C building & Main Gate (North) at Kandla

Sr. No.	Parameter	Unit	Nirman Building 1	P & C building	Main Gate North	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.15	7.26	7.21	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1150	1170	1160	500	2000
3	Turbidity	NTU	3	1	1	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	2475	2314	2614	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2.0	NS*	NS*
8	Chloride as Cl	mg/l	836.86	912.03	861.92	250.0	1000.0
9	Ca as Ca	mg/l	72.14	64.13	80.16	75.0	200.0
10	Mg as Mg	mg/l	72.90	70.47	70.47	30.0	100.0
11	Total Hardness	mg/l	480	450	490	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides as F	mg/l	0.09	0.08	0.12	1.0	1.5
14	Sulphate as SO4	mg/l	130.8	86.4	128.4	200.0	400
15	Nitrite as NO2	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate as NO3	mg/l	4.3648	5.3504	1.6896	45.0	No Relaxation
17	Salinity	‰	1.51	1.65	1.56	NS*	NS*
18	Sodium as Na	mg/l	316	332	558	NS*	NS*
19	Potassium as K	mg/l	6.21	7.08	5.32	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified, BDL : Below Detection Limit

Table 10: Drinking Water Quality Monitoring Parameters for Canteen, West Gate -I&Wharf Area at Kandla

Sr. No.	Parameter	Unit	Canteen	West Gate I	Wharf Area	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.36	7.22	7.84	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1180	1200	1180	500	2000
3	Turbidity	NTU	3	2	BDL	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	2458	2569	2413	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2.0	NS*	NS*
8	Chloride as Cl	mg/l	927.06	856.90	846.88	250.0	1000.0
9	Ca as Ca	mg/l	64.13	68.14	64.13	75.0	200.0
10	Mg as Mg	mg/l	75.33	70.47	70.47	30.0	100.0
11	Total Hardness	mg/l	470	460	450	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides as F	mg/l	0.31	0.59	0.46	1.0	1.5
14	Sulphate as SO4	mg/l	126	112.8	116.4	200.0	400
15	Nitrite as NO2	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate as NO3	mg/l	3.6608	4.7872	3.0976	45.0	No Relaxation
17	Salinity	‰	1.67	1.55	1.53	NS*	NS*
18	Sodium as Na	mg/l	452	306	292	NS*	NS*
19	Potassium as K	mg/l	5.2	6.08	4.30	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified, BDL: Below Detection Limit

Table 11: Drinking Water Quality Monitoring Parameters for Sewa sadan – 3, Workshop I&Custom Building at Kandla

Sr. No.	Parameter	Unit	SewaSadan – 3	Workshop	Custom Building	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.14	7.36	7.14	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1160	1150	1250	500	2000
3	Turbidity	NTU	2	2	BDL	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	2321	2412	2685	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2.0	NS*	NS*
8	Chloride	mg/l	891.98	796.77	891.98	250.0	1000.0
9	Ca as Ca	mg/l	76.15	60.12	64.13	75.0	200.0
10	Mg as Mg	mg/l	72.90	63.18	68.04	30.0	100.0
11	Total Hardness	mg/l	490	410	440	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.18	0.37	0.46	1.0	1.5
14	Sulphate	mg/l	141.6	267.6	278.4	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	5.91	7.32	13.79	45.0	No Relaxation
17	Salinity	‰	1.61	1.44	1.61	NS*	NS*
18	Sodium as Na	mg/l	303	323	299	NS*	NS*
19	Potassium as K	mg/l	4.8	5.4	5.20	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified,BDL: Below Detection Limit

Table 12: Drinking Water Quality Monitoring Parameters for Port Colony Kandla, Hospital Kandla & A.O. Building at Gandhidham

Sr. No.	Parameter	Unit	Port Colony Kandla	Hospital Kandla	A.O. Building	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.55	7.57	7.62	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1170	1170	1330	500	2000
3	Turbidity	NTU	BDL	BDL	1	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	2614	2328	2965	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2.0	NS*	NS*
8	Chloride	mg/l	977.17	746.66	937.08	250.0	1000.0
9	Ca as Ca	mg/l	68.14	72.14	72.14	75.0	200.0
10	Mg as Mg	mg/l	65.61	68.04	72.90	30.0	100.0
11	Total Hardness	mg/l	440	460	480	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.37	0.24	0.53	1.0	1.5
14	Sulphate	mg/l	96	240	250.8	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	2.63	2.33	1.38	45.0	No Relaxation
17	Salinity	‰	1.77	1.35	1.69	NS*	NS*
18	Sodium as Na	mg/l	330	363	441	NS*	NS*
19	Potassium as K	mg/l	4.4	5.30	6.2	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified, BDL: Below Detection Limit

Table 13: Drinking Water Quality Monitoring Parameters for School Gopalpuri, Guest House & E - Type Quarter at Gopalpuri, Gandhidham

Sr. No.	Parameter	Unit	School Gopalpuri	Guest House	E - Type Quarter	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.36	7.21	7.22	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1120	1260	1300	500	2000
3	Turbidity	NTU	1	1	1	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	2588	2463	2881	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2.0	NS*	NS*
8	Chloride	mg/l	896.99	957.13	731.63	250.0	1000.0
9	Ca as Ca	mg/l	68.14	72.14	68.14	75.0	200.0
10	Mg as Mg	mg/l	72.90	72.90	70.47	30.0	100.0
11	Total Hardness	mg/l	470	480	460	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.18	0.59	0.35	1.0	1.5
14	Sulphate	mg/l	238.8	78	67.2	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	12.32	2.112	2.44992	45.0	No Relaxation
17	Salinity	‰	1.62	1.73	1.32	NS*	NS*
18	Sodium as Na	mg/l	413	451	394	NS*	NS*
19	Potassium as K	mg/l	5.4	5.2	4.3	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 14: Drinking Water Quality Monitoring Parameters for F - Type Quarter, Hospital Gopalpuri & Tuna Port

Sr. No.	Parameter	Unit	F - Type Quarter	Hospital Gopalpuri	Tuna Port	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.12	7.28	7.40	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1240	1230	1020.0	500	2000
3	Turbidity	NTU	0	0	0	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Unit	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	2699	2414	1700.0	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	726.62	691.54	682.22	250.0	1000.0
9	Ca as Ca	mg/l	64.13	72.14	72.15	75.0	200.0
10	Mg as Mg	mg/l	80.19	70.47	32.16	30.0	100.0
11	Total Hardness	mg/l	490	470	322.0	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.44	0.57	0.48	1.0	1.5
14	Sulphate	mg/l	180	40.8	103.8	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	19.28	3.38	1.36	45.0	No Relaxation
17	Salinity	‰	1.31	1.25	1.23	NS*	NS*
18	Sodium as Na	mg/l	413	344	356	NS*	NS*
19	Potassium as K	mg/l	3.86	3.93	3.8	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 15: Drinking Water Quality Monitoring Parameters for Vadinar Jetty & Port Colony at Vadinar

Sr. No.	Parameter	Unit	Vadinar Jetty	Port Colony Vadinar	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.41	7.23	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	980	950	500	2000
3	Turbidity	NTU	BDL	BDL	1.0	5.0
4	Odor	-	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	2101	2039	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	NS*	NS*
8	Chloride	mg/l	636.41	596.33	250.0	1000.0
9	Ca as Ca	mg/l	60.12	48.10	75.0	200.0
10	Mg as Mg	mg/l	58.32	60.75	30.0	100.0
11	Total Hardness	mg/l	390.0	370.0	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.39	0.20	1.0	1.5
14	Sulphate	mg/l	30.12	27.72	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	2.89	0.92	45.0	No Relaxation
17	Salinity	‰	1.15	1.08	NS*	NS*
18	Sodium as Na	mg/l	314	299	NS*	NS*
19	Potassium as K	mg/l	6.3	5.9	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent

*NS: Not Specified, BDL: Below Detection Limit

2.3 Results & Discussion

The colour of all drinking water samples was < 5 Hazen unit and odour of the samples was also agreeable. All parameters are found to be within the specified limit of the Drinking water Standard.

pH

The limit of pH value for drinking water is specified as 6.5 to 8.5. pH value in the studied area varied from 7.12 to 7.84 pH unit. All the sampling points showed pH values within the prescribed limit by Indian Standards.

Total Dissolved Solids (TDS)

TDS values in the studied area varied between 1020 -1300 mg/l. None of the sampling points showed higher TDS values than the prescribed limit by Indian standards .

Conductivity

Electrical Conductivity is the ability of a solution to transfer (conduct) electric current. Conductivity is used to measure the concentration of dissolved solids which have been ionized in a polar solution such as water. The conductivity in the samples collected during the month of May ranged from 1700-3000 µs/cm. Electrical conductivity standards do not appear in BIS standards for drinking water.

BOD

BOD value in the studied area was less than 2.0 mg/L. Indian standards does not show any permissible limit for BOD in drinking water.

Chlorides

Excessive chloride concentration increase rates of corrosion of metals in the distribution system. This can lead to increased concentration of metals in the supply. Chloride value in the studied area varied between 680-980 mg/l and is found to be within the Permissible limit of the Drinking Water Standard.

Calcium

Calcium value in the studied area varied between 60 - 90 mg/l and is found to be within the Permissible limit of the Drinking Water Standard. If calcium is present beyond the maximum acceptable limit, it causes incrustation of pipes.

Magnesium

Magnesium value in the studied area varied between 60 – 81 mg/l. All the locations had Magnesium within the prescribed limits of 30-100 mg/L.

Total Hardness

Hardness value in the studied area varied between 322-490 mg/l and is found to be within the Permissible limit of the Drinking Water Standard.The prescribed limit by Indian Standards is 200-600 mg/L.

Iron

Iron value in the studied area was below 0.01mg/L and hence well below the permissible limit as per Indian Standards is 0.3 mg/L. The excess amount of iron causes slight toxicity; gives stringent taste to water.

Fluoride

Fluoride value in the studied area varied between 0.08 – 1.0 mg/l and hence well below the permissible limit as per Indian Standards is 1.0-1.5 mg/L. Moderate amounts lead to dental effects, but long-term ingestion of large amounts can lead to potentially severe skeletal problems.

Sulphates

Sulphate value in the studied area varied between 40 – 280 mg/l. All the sampling points showed sulphate values within the prescribed limits by Indian Standards (200-400 mg/L). Sulphate content in drinking water exceeding the 400 mg/L imparts bitter taste.

Nitrites (NO_2) and Nitrates (NO_3)

Nitrite values in all the water samples were <0.1. There are no specified standard values for Nitrites in Drinking water. The mean Nitrate values in drinking water of KPT was 4.10 mg/l which is well within the permissible limit of the Drinking water Standard.

Salinity

Salinity in drinking water in the present samples collected ranged from 1.2 to 1.8 ‰ . There are no prescribed Indian standards for salinity in Drinking water.

Sodium and Potassium Salts

Sodium values in the samples collected ranged from 290 - 560 mg/l and Potassium salts ranged from 3.8 to 7.1 mg/l. There are no prescribed limits of Sodium and Potassium in Indian standards for Drinking water.

Heavy Metals in Drinking Water

In the present study period drinking water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals were well below the permissible limits prescribed by the Indian Standards.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that Bacteria is not present and hence Bacterial count is in line with the permissible limit of drinking water. This shows that all the drinking water samples were safe from any bacteriological contamination.

2.4 Conclusions

These results are compared with acceptable limits as prescribed in IS 10500:2012 – Drinking Water Specification. It is seen from the analysis data that during the study period the water was safe for human consumption at all drinking water monitoring stations.

3. Noise Level Monitoring

Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships. Noise Monitoring was done at 13 stations at Kandla, Vadinar and Township area.

3.1 Method of Monitoring

Sampling was done at all stations for 24 hour period. Data was recorded using automated sound level meter. The intensity of sound was measured in sound pressure level (SPL) and common unit of measurement is decibel (Db).

3.2 Results

Table 16: Noise Monitoring data for ten locations of Deendayal Port and two locations of Vadinar Port

Sr. No.	Location	Day Time Average Noise Level (SPL) in dB(A)	Night Time Average Noise Level (SPL) in dB(A)
	Sampling Time	**6:00 am to 10:00 PM**	**10:00PM to 6:00 AM**
1	Marine Bhavan	61.45	57.15
2	Nirman Building 1	58.63	52.13
3	Tuna Port	52.15	46.13
4	Main Gate North	62.73	54.59
5	West Gate I	61.62	53.66
6	Canteen Area	58.43	47.39
7	Main Road	63.42	58.60
8	ATM Building	63.76	56.02
9	Wharf Area /Jetty Area	65.09	59.70
10	Port & Custom Office	57.12	50.16
	Vadinar Port		
11	Entrance Gate of Vadinar Port	49.64	48.4
12	Nr. Port Colony, Vadinar	53.12	52.52
13	Nr. Vadinar Jetty	54.4	54.6

3.3 Conclusions- Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships. The Day Time Average Noise Level (SPL)in all ten locations at Deendayal Port ranged from 56.25 dB(A) to 69.51 dB(A) and it was within the permissible limits of 75 dB(A) for the industrial area for the daytime. The Night Time Average Noise Level (SPL) in all ten locations of Deendayal Port ranged from 48.28 dB to 62.33 dB(A) and it was within the permissible limits of 70 dB(A) for the industrial area for the night time.

4. Soil Monitoring

Sampling and analysis of soil samples were undertaken at six locations within the study area (Deendayal Port and Vadinar Port) as a part of EMP. The soil sampling locations are initially decided based on the locations as provided in the tender document of the Deendayal Port.

4.1 Methodology

The soil samples were collected in the month of May 2021. The samples collected from the all locations are homogeneous representative of each location. At random locations were identified at each location and soil was dug from 30 cm below the surface. It was uniformly mixed before homogenizing the soil samples. The samples were filled in polythene bags, labeled in the field with number and site name and sent to laboratory for analysis.

4.2 Results

Table-17: Chemical Characteristics of Soil in the Study Area

Parameter	Unit	Station Name					
		SL1	SL2	SL3	SL4	SL5	SL6
		Tuna Port	IFFCO Plant	Khori Creek	Nakti Creek	KPT Admin Site	KPT Colony
		Near main gate of Port	10 m away from main gate	Sand from creek at low tide		Vadinar	
Texture		Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
pH	-	8.38	8.25	8.13	7.91	8.76	8.85
Electrical Conductivity	µs/cm	29,500.0	44,400.0	39,900.0	38,200.0	260.0	513.0
Moisture	%	14.0	20.91	28.10	26.2	7.26	6.35
Total Organic Carbon	%	0.94	1.52	1.70	1.58	1.16	1.71
Alkalinity	mg/kg	80.08	60.06	70.05	70.05	60.06	70.05
Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloride	mg/kg	7896.2	6866.3	7160.6	9416.7	29.43	40.09
Sulphate	mg/kg	2502.08	804.5	356.6	3966.5	23.2	4.02
Phosphorus	mg/kg	0.76	2.45	7.79	1.66	8.50	7.35
Potassium	mg/kg	1128.0	762.0	578.4	755.8	302.8	152.0
Calcium	mg/kg	320.64	661.32	460.92	821.64	1703.4	1463.0
Sodium	mg/kg	11092.4	5832.2	6336.6	6355.8	246.0	166.0
Copper as Cu	mg/kg	10.20	26.20	29.40	33.70	80.50	71.60
Lead as Pb	mg/kg	5.40	8.50	31.0	15.30	ND	ND
Nickel as Ni	mg/kg	16.70	2020	9.00	25.40	35.30	31.80
Zinc as Zn	mg/kg	22.60	89.10	95.80	87.30	33.20	33.50
Cadmium as Cd	mg/kg	ND	ND	ND	ND	ND	ND

4.3 Discussion

- The data shows that value of pH ranges from 7.91at Nakti Creek to 8.38 at Tuna Creek indicating that all soil sample sare neutral to basic. Iffco plant sampleshowed maximum conductivity of 44,400µmhos/cm, while Tuna port location showed minimum conductivity of 29000µmhos/cm. Conductivity at Vadinar Port was 260 and 513 µmhos/cm at Admin site and Vadinar Port colony respectively.

- Total organic Carbon ranged from 0.94 % to 1.7 at Deendayal Port. At Vadinar Port, organic carbon content ranged from 1.16 % and 1.71 %.

- The concentration of Phosphorus and Potassium in the soil samples varies from 0.76 to 8.0mg/kg and 150.0 to 1130 mg/kg respectively at Deendayal Port. The mean concentration of Phosphorous at Vadinar site was 7.93 mg/kg and mean concentration of Potassium at Vadinar site was 228.0 mg/kg.

These differences in NPK in soil at different locations are due to the dissimilar nature of soil at each of the locations. Samples SL3 & SL4 (Khori Creek & Nakti Creek) are of saline nature as they are coastal soil; where as other locations are inland locations and have different chemical properties.

Heavy Metals in the Soil

Traces of Copper, Lead, Nickel, Zinc were observed in the soil samples collected from all the four locations of Deendayal Port and two locations of Vadinar Port. Cadmium metal was not detected in the Soil.

4.4 Conclusion

The soils of Deendayal Port and Vadinar Port appears to be neutral to basic with varying levels of Chloride, Sulphate, NPK and Calcium. As the nature of soil at different locations are different with respect to its proximity to the sea, the samples showed high degree of variations in their chemical properties.

5. Sewage Treatment Plant Monitoring

This involves safe collection of waste water (spent/used water) from wash areas, bathroom, industrial units, etc., waste from toilets of various buildings and its conveyance to the treatment plant and final disposal in conformity with the requirement and guide lines of State Pollution Control Board and other statutory bodies.

5.1 Methodology for STP Monitoring

To monitor the working efficiency of Sewage Treatment Plant (STP), STP Inlet and Outlet Samples were collected once a week. Locations selected are namely Gopalpuri Township, Deendayal Port and Vadinar. Samples were collected in 1 lit. carboys and were analyzed in laboratory for various parameters.

5.2 Results

Kandla STP

Table 18: Sewage Water Monitoring at Kandla STP (1st Week)

	Date of Sampling		**05.05.21**	
Sr. No.	**Parameters**	**Unit**	**Results**	
			KPT STP I/L	**KPT STP O/L**
1	pH	pH unit	7.53	7.07
2	Total Suspended Solids	mg/l	453.9	95.6
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	373.5	50.5
5	BOD @ 27 °C	mg/l	118.0	14.0
Aeration Tank				
6	MLSS	mg/l	36.0	
7	MLVSS	%	88.0	

Table 19: Sewage Water Monitoring at Kandla STP (2nd Week)

Sr. No.	Parameters	Unit	Results	
	Date of Sampling		15.05.21	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.29	7.13
2	Total Suspended Solids	mg/l	229.5	50.1
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	434.3	30.3
5	BOD @ 27 °C	mg/l	138.0	8.0
Aeration Tank				
6	MLSS	mg/l	76.0	
7	MLVSS	%	64.0	

Table 20: Sewage Water Monitoring at Kandla STP (3rd Week)

Sr. No.	Parameters	Unit	Results	
	Date of Sampling		20.05.21	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.53	7.19
2	Total Suspended Solids	mg/l	162.2	84
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	393.9	70.7
5	BOD @ 27 °C	mg/l	122.0	18.0
Aeration Tank				
6	MLSS	mg/l	24.0	
7	MLVSS	%	98.0	

Table 21: Sewage Water Monitoring at Kandla STP (4th Week)

Sr. No.	Parameters	Unit	Results	
	Date of Sampling		24.05.21	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.64	7.2
2	Total Suspended Solids	mg/l	205.3	50.2
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	272.7	70.7
5	BOD @ 27 °C	mg/l	86.0	19.0
Aeration Tank				
6	MLSS	mg/l	60.0	
7	MLVSS	%	98.0	

Gopalpuri Colony STP

Table 22: Sewage Water Monitoring at Gopalpuri STP (1st Week)

Sr. No.	Parameters	Unit	Results	
	Date of Sampling		05.05.21	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.61	7.25
2	Total Suspended Solids	mg/l	204.7	23.9
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	343.4	70.7
5	BOD @ 27 °C	mg/l	102.0	20.0
Aeration Tank				
6	MLSS	mg/l	20.0	
7	MLVSS	%	88.0	

Table 23: Sewage Water Monitoring at Gopalpuri STP (2nd Week)

Sr. No.	Parameters	Unit	Results	
	Date of Sampling		15.05.21	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.73	7.21
2	Total Suspended Solids	mg/l	125.8	30.8
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	343.4	50.5
5	BOD @ 27 °C	mg/l	96.0	12.0
Aeration Tank				
6	MLSS	mg/l	13.0	
7	MLVSS	%	99.0	

Table 24: Sewage Water Monitoring at Gopalpuri STP (3rd Week)

Sr. No.	Parameters	Unit	Results	
	Date of Sampling		20.05.21	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.8	7.2
2	Total Suspended Solids	mg/l	114.3	28.9
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	353.5	50.5
5	BOD @ 27 °C	mg/l	106.0	14.0
Aeration Tank				
6	MLSS	mg/l	2.0	
7	MLVSS	%	99.0	

Table 25: Sewage Water Monitoring at Gopalpuri STP (4th Week)

Sr. No.	Parameters	Unit	Gopalpuri STP I/L	Gopalpuri STP O/L
	Date of Sampling		**24.05.21**	
			Results	
1	pH	pH unit	7.85	7.31
2	Total Suspended Solids	mg/l	401	38.7
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	292.9	111.1
5	BOD @ 27 °C	mg/l	94.0	
	Aeration Tank			
6	MLSS	mg/l	40.0	
7	MLVSS	%	99.0	

Vadinar STP

Table 26: Sewage Water Monitoring at Vadinar STP (1st Week)

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	**Vadinar O/L**
1	pH	pH unit	7.23	NOT WORKING
2	Total Suspended Solids	mg/l	160	
3	Residual Chlorine	mg/l	-	
4	COD	mg/l	70.7	
5	BOD @ 27 °C	mg/l	16.0	

Table 27: Sewage Water Monitoring at Vadinar STP (2nd Week)

Sample Collection Date:- 15.05.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.31	NOT WORKING
2	Total Suspended Solids	mg/l	152.9	
3	Residual Chlorine	mg/l	-	
4	COD	mg/l	50.5	
5	BOD @ 27 °C	mg/l	14.0	

Table 28: Sewage Water Monitoring at Vadinar STP (3rd Week)

Date of Sampling			20.05.21	
Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.55	NOT WORKING
2	Total Suspended Solids	mg/l	325.4	
3	Residual Chlorine	mg/l	-	
4	COD	mg/l	56.56	
5	BOD @ 27 °C	mg/l	12.0	

Table 29: Sewage Water Monitoring at Vadinar STP (4th Week)

Date of Sampling			24.05.21	
Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/l
1	pH	pH unit	7.63	Not working
2	Total Suspended Solids	mg/l	102.6	
3	Residual Chlorine	mg/l	-	
4	COD	mg/l	136.4	
5	BOD @ 27 °C	mg/l	38.0	

5.3 Conclusions:

The GPCB standards of BOD, TSS and Residual Chlorine for STP outlet are 20 mg/lit, 30 mg/lit & 0.5 mg/lit respectively. It is suggested to do treatment on regular basis to avoid flow of contaminated/polluted water into the sea. Also, the STP at Vadinar is also non-functional and thus, steps should be taken to commission the STP at Vadinar Port. Hence, currently only inlet samples are collected and analysed.

6. Marine Water Monitoring

The Forty Second Amendment to the Constitution in 1976 underscored the importance of ‘green thinking’. Article 48A enjoins the state to protect and improve the environment and safeguard the forests and wildlife in the country. Further, Article 51A(g) states that the “fundamental duty of every citizen is to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures”.

Policy Statement for Abatement of Pollution (1992) has suggested developing relevant legislation and regulation, fiscal incentives, voluntary agreements and educational programs and information campaigns. It emphasizes the need for integration by incorporating environmental considerations into decision making at all levels by adopting frameworks namely, pollution prevention at source, application of best practicable solution, ensure polluter pays for control of pollution, focus on heavily polluted areas and river stretches and involve public in decision-making. The National Conservation Strategy and Policy Statement on Environment and Development, (1992) aimed at “integrating environmental concerns with developmental imperatives to meet the challenges by redirecting the thrust of our developmental process so that the basic needs of our people could be fulfilled by making judicious and sustainable use of natural resources.” The priorities mentioned in this policy document include the sustainable use of land and water resources, prevention and control of pollution and preservation of biodiversity.

The National Water Policy, (2002) contains provisions for developing, conserving, sustainable utilizing and managing this important water resources and need to be governed by national perspectives.

Marine Environment

On national and state levels, we have several policies and regulation like Water (Prevention and Control of Pollution) Act, 1974, to regulate pollution discharges and restore water quality of our aquatic resources including the prescription of monitoring activities. One of the important provisions of the Water Act, 1974, is to maintain and restore the 'wholesomeness' of our aquatic resources. Water quality monitoring is one of the first steps required in the rational development and management of water resources. In the field of water quality management, there has been a steady evolution in procedures for designing system to obtain information on the changes of water quality. The monitoring comprises all activities to obtain 'information' with respect to the water system.

Sampling Stations

The monitoring of marine environment for the study of biological and ecological parameters was carried out on 10^{th}& 11^{th} May -2021 in harbor regions of KPT and on 10^{th} May-2021 at Vadinar during spring tide period of New moon phase of Lunar Cycle. The monitoring of marine environment for the study of biological and ecological parameters was repeated again on 21^{st}& 22^{nd} May 2021 in harbor regions of KPT. 21^{st} May -2021 in Vadinar during Neap tide period first quarter of Lunar Cycle.

Plankton samples from sub surface layer was collected both during high tide period and low tide period from 3 water quality monitoring stations of KPT harbour area and two stations in Nakti creek and one station in Khori creek. The same sampling schedule was repeated during consecutive spring tide and neap tide in same month. Plankton samples from sub surface layer was collected both during high tide period and low tide period from 1 water quality monitoring stations near Vadinar jetty area during spring tide and neap tide in this month .Collected water samples were processed for estimation of Chlorophyll- a, Pheophytin- a, qualitative &quantitative evaluation of phytoplankton, qualitative &quantitative evaluation zooplanktons (density and their population).

Sampling Locations

Offshore monitoring requirement	Number of locations
Offshore Installations	3 in Kandla creek 2 in Nakti creek 1 in Khori creek 1 near Vadinar Jetty 1 near 1st SBM
Total Number of locations	**8**

6.1 Marine Water Quality

Marine water quality of marine waters of Deendayal Port Harbor waters, Khori and Nakti Creeks and two locations of Vadinar are monitored for various physico-chemical parameters during spring and neap tide of each month.

The results of marine water quality and Marine sediments are as below;

Table 30: Marine Water Quality Monitoring Parameters for location near KPT colony

Parameters	Unit	Kandla Creek Near KPT colony (1) 23°0'58"N 70°13'22."E			
		Spring Tide		Neap Tide	
Tide →		High Tide	Low Tide	High Tide	Low Tide
pH	pH unit	7.15	7.32	7.9	7.25
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	32.6	32.8	33.8	34.7
Turbidity	NTU	28	26	31	23
Total Dissolved Solids	mg/l	36116	39501	43116	46501
Total Suspended Solids	mg/l	189.59	168.55	440.9	423.2
Total Solids	mg/l	45554	42876	55500	63798
DO	mg/l	4.3	4.5	4.7	4.8
COD	mg/l	78.0	80.0	92.0	96.0
BOD	mg/l	<2.0	<2.0	<2.0	<2.0
Silica	mg/l	0.96	0.57	0.54	4.96
Phosphate	mg/l	0.23	0.16	0.21	0.36
Sulphate	mg/l	2532	2712	2532	2712
Nitrate	mg/l	10.63	7.04	1.58	8.02
Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01
Calcium	mg/l	440.88	521.04	521.04	440.88
Magnesium	mg/l	1652.4	1749.6	1846.8	1798.2
Sodium	mg/l	10250	12680	13300	12103
Potassium	mg/l	330	290	378	223
Iron	mg/l	1.76	1.56	1.68	1.83
Chromium	mg/l	0.12	0.10	0.13	0.16
Copper	mg/l	0.06	0.05	0.07	0.08
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.05	0.07	0.06	0.05
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.18	0.16	0.18	0.19
Zinc	mg/l	0.06	0.05	0.07	0.05

Table 31: Marine Water Quality Monitoring Parameters for location near passenger Jetty One at Kandla

Parameters	Unit	Near passenger Jetty One (2) 23° 0'18 "N 70°13'31"E			
		Spring Tide		Neap Tide	
Tide →		**High Tide**	**Low Tide**	**High Tide**	**Low Tide**
pH	pH unit	7.17	7.62	7.6	7.23
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	32.0	32.1	33.2	33.4
Turbidity	NTU	29.0	35.0	38.0	24.0
Total Dissolved Solids	mg/l	38894.0	39271.0	48894.0	49271.0
Total Suspended Solids	mg/l	220.25	268.89	399.6	660.8
Total Solids	mg/l	44586.0	46906.0	53718.0	56698.0
DO	mg/l	4.2	4.4	4.3	5.3
COD	mg/l	78.	80	92	90
BOD	mg/l	<2.0	<2.0	<2.0	<2.0
Silica	mg/l	0.55	0.50	0.76	1.47
Phosphate	mg/l	0.26	0.30	0.33	0.36
Sulphate	mg/l	2532	2412	2532	3420
Nitrate	mg/l	12.74	2.95	6.33	4.48
Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01
Calcium	mg/l	480.96	440.88	601.2	521.04
Magnesium	mg/l	1846.8	1652.4	1846.8	1773.9
Sodium	mg/l	11860.0	11210.0	11761.0	11197.0
Potassium	mg/l	370.0	362.0	355.2	345.0
Iron	mg/l	1.89	1.96	1.68	1.73
Chromium	mg/l	0.11	0.12	0.10	0.11
Copper	mg/l	0.05	0.06	0.05	0.07
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.06	0.05	0.07	0.05
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.17	0.14	0.15	0.18
Zinc	mg/l	0.05	0.05	0.07	0.06

Table 32: Marine Water Quality Monitoring Parameters for location NearCoalBerth

Parameters	Unit	Near Coal Berth			
		22°59'12"N 70°13'40"E			
		Spring Tide		Neap Tide	
Tide →		High Tide	Low Tide	High Tide	Low Tide
pH	pH unit	7.18	7.35	7.28	7.41
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	32.8	33.1	32.6	33.2
Turbidity	NTU	37.0	38.0	33.0	39.0
Total Dissolved Solids	mg/l	36926.0	36563.0	46926.0	46563.0
Total Suspended Solids	mg/l	391.19	163.3	636.7	719.8
Total Solids	mg/l	43904.0	43300.0	57984.0	53288.0
DO	mg/l	4.3	4.7	4	4.5
COD	mg/l	77.0	68.0	82.0	84.0
BOD	mg/l	<2.0	<2.0	<2.0	<2.0
Silica	mg/l	0.32	0.33	1.45	0.83
Phosphate	mg/l	0.23	0.21	0.36	0.42
Sulphate	mg/l	2136.0	3768.0	2136.0	3768.0
Nitrate	mg/l	8.51	10.91	3.37	2.71
Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01
Calcium	mg/l	561.12	521.04	480.96	561.12
Magnesium	mg/l	1822.5	1749.6	1749.6	1773.9
Sodium	mg/l	11143.0	11052.0	11114.0	10840.0
Potassium	mg/l	343.0	355.0	332.0	371.0
Iron	mg/l	1.56	1.36	1.62	1.53
Chromium	mg/l	0.10	0.11	0.12	0.14
Copper	mg/l	0.05	0.07	0.06	0.08
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.06	0.07	0.05	0.06
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.17	0.15	0.17	0.16
Zinc	mg/l	0.05	0.06	0.06	0.07

Table 33: Marine Water Quality Monitoring Parameters for location Khoricreek at Kandla

Parameters	Unit	KPT 4			
		Near 15/16 Berth			
		Spring Tide		Neap Tide	
Tide →		High Tide	Low Tide	High Tide	Low Tide
pH	pH unit	7.41	7.5	7.32	7.85
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	32.8	32.02	33.8	32.9
Turbidity	NTU	26.0	24.0	31.0	30.0
Total Dissolved Solids	mg/l	36050.0	35633.0	46050.0	45633.0
Total Suspended Solids	mg/l	245.7	360.56	335.5	637.9
Total Solids	mg/l	46180.0	43700.0	53124.0	50184.0
DO	mg/l	4.3	4.2	4.1	4.4
COD	mg/l	82.0	72.0	90.0	88.0
BOD	mg/l	<2.0	<2.0	<2.0	<2.0
Silica	mg/l	0.86	0.92	0.65	0.77
Phosphate	mg/l	0.46	0.33	0.30	0.38
Sulphate	mg/l	3876.0	3816.0	3876.0	3816.0
Nitrate	mg/l	7.04	9.29	2.31	0.11
Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01
Calcium	mg/l	480.96	561.12	521.04	521.04
Magnesium	mg/l	1822.5	1579.5	1822.5	1846.8
Sodium	mg/l	11000.0	10862.0	10386.0	10909.0
Potassium	mg/l	344.0	352.0	343.0	377.0
Iron	mg/l	1.69	1.36	1.46	1.63
Chromium	mg/l	0.10	0.11	0.13	0.11
Copper	mg/l	0.06	0.07	0.06	0.05
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.07	0.06	0.08	0.06
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.19	0.17	0.18	0.15
Zinc	mg/l	0.07	0.05	0.06	0.08

Table 34: Marine Water Quality Monitoring Parameters for location Nakti Creek near Tuna Port

Parameters	Unit	NaktiCreek NearTuna Port 22°57'49."N 70° 7'0.67"E			
		Spring Tide		Neap Tide	
Tide →		High Tide	Low Tide	High Tide	Low Tide
pH	pH unit	7.29	7.31	7.24	7.65
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	32.0	31.6	33.0	32.6
Turbidity	NTU	28.0	25.0	28.0	26.0
Total Dissolved Solids	mg/l	35493.0	35643.0	45493.0	45643.0
Total Suspended Solids	mg/l	335.59	274.11	513.3	377.0
Total Solids	mg/l	47840.0	47120.0	53992.0	54132.0
DO	mg/l	4.5	4.3	4.7	4.8
COD	mg/l	96.0	90.0	106.0	110.0
BOD	mg/l	<2.0	<2.0	<2.0	<2.0
Silica	mg/l	0.27	0.22	0.61	0.68
Phosphate	mg/l	0.36	0.38	0.46	0.40
Sulphate	mg/l	3348	3492	3348	3492
Nitrate	mg/l	9.5744	3.4496	2.14016	1.0208
Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01
Calcium	mg/l	440.88	521.04	561.12	521.04
Magnesium	mg/l	1798.2	1773.9	1749.6	1871.1
Sodium	mg/l	11062	11110.0	10931.0	10678.0
Potassium	mg/l	352.0	372.0	361.0	358.0
Iron	mg/l	1.71	1.56	1.49	1.53
Chromium	mg/l	0.12	0.13	0.11	0.14
Copper	mg/l	0.08	0.07	0.06	0.07
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.06	0.06	.07	0.05
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.14	0.16	0.15	0.13
Zinc	mg/l	0.06	0.07	0.05	0.05

Table 35: Marine Water Quality Monitoring Parameters for location Nakti Creek Near NH-8A at Kandla

Parameters	Unit	NaktiCreek NearNH-8A 23° 02'01"N 70° 09'31"E			
		Spring Tide		Neap Tide	
Tide →		High Tide	Low Tide	High Tide	Low Tide
pH	pH unit	7.83	Sampling not possible during Low Tide	7.55	Sampling not possible during Low Tide
Color	-	Colorless		Colorless	
Odor	-	Odorless		Odorless	
Salinity	ppt	32.2		33.6	
Turbidity	NTU	48.0		27.0	
Total Dissolved Solids	mg/l	40293.0		55593.0	
Total Suspended Solids	mg/l	733.38		510.6	
Total Solids	mg/l	47052.0		67651.0	
DO	mg/l	3.5		4.5	
COD	mg/l	106.0		100.0	
BOD	mg/l	<2.0		<2.0	
Silica	mg/l	0.95		1.67	
Phosphate	mg/l	0.68		0.72	
Sulphate	mg/l	2184		4584	
Nitrate	mg/l	15.2768		8.096	
Nitrite	mg/l	0.00425		0.009833	
Calcium	mg/l	521.04		480.96	
Magnesium	mg/l	1798.2		2016.9	
Sodium	mg/l	11412.0		11503.0	
Potassium	mg/l	386.0		395.0	
Iron	mg/l	1.62		1.59	
Chromium	mg/l	0.11		0.13	
Copper	mg/l	0.07		0.08	
Arsenic	mg/l	<0.01		<0.01	
Cadmium	mg/l	0.04		0.06	
Mercury	mg/l	<0.001		<0.001	
Lead	mg/l	0.18		0.17	
Zinc	mg/l	0.06		0.07	

Table 36: Marine Water Quality Monitoring Parameters for locations Nr. Vadinar Jetty

Parameters	Unit	Nr.VadinarJetty 22°26'25.26"N 69°40'20.41"E			
		Spring Tide		Neap Tide	
Tide →		High Tide	Low Tide	High Tide	Low Tide
pH	pH unit	7.21	7.51	7.25	7.32
Color	-	Colorless	Colorless	Colorless	Colorless
Odor	-	Odorless	Odorless	Odorless	Odorless
Salinity	ppt	32.2	31.8	32.4	32.6
Turbidity	NTU	3.0	8.0	26.0	23.0
Total Dissolved Solids	mg/l	30832.0	30960.0	40832.0	40960.0
Total Suspended Solids	mg/l	287.58	177.64	117.9	267.6
Total Solids	mg/l	48284.0	49576.0	49960.0	50155.0
DO	mg/l	5.2	5.0	5.1	5.2
COD	mg/l	82.0	78.0	86.0	82.0
BOD	mg/l	<2.0	<2.0	<2.0	<2.0
Silica	mg/l	0.15	0.17	0.22	0.22
Phosphate	mg/l	0.26	0.18	0.36	0.22
Sulphate	mg/l	3012.0	2772.0	2652.0	2460.0
Nitrate	mg/l	6.688	6.336	5.984	6.688
Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01
Calcium	mg/l	480.96	521.04	480.96	440.88
Magnesium	mg/l	1530.9	1603.8	1676.7	1749.6
Sodium	mg/l	11820.0	12060.0	11862.0	11960.0
Potassium	mg/l	338.0	346.0	356.0	333.0
Iron	mg/l	1.65	1.52	1.46	1.72
Chromium	mg/l	0.11	0.10	0.13	0.14
Copper	mg/l	0.06	0.05	0.07	0.05
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	0.04	0.06	0.05	0.07
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
Lead	mg/l	0.14	0.17	0.15	0.16
Zinc	mg/l	0.06	0.07	0.05	0.06

Trace Metals

In the present study period water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals reported at trace levels.

6.1.1 Marine Sediments

Sediment samples were collected with Van Veen Grab from the six locations in Kandla Port Waters and two locations in Vadinar Port. Samples were collected and preserved in silver foil in ice box to prevent the contamination/decaying of the samples.

6.2 Results

The Sediment Quality results are given in below from table no. 33Table 34A: Results of Analysis of Sediment of Kandla & Vadinar Port (Spring Tide)

Sr. No.	Parameters	Unit	KPT - 1	KPT - 2	KPT - 3	Nakti Creek Near Tuna Port	Nakti - 1 (Near NH-8A)	Jetty
1	Texture		Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	mg/kg	0.86	1.88	1.20	1.96	1.78	1.36
3	Organic Carbon	mg/kg	0.86	0.96	0.87	0.65	0.83	0.68
4	Inorganic Phosphate	mg/kg	126.0	136.0	186.0	177.0	162.0	165.0
5	Moisture	%	16.60	17.36	18.20	20.2	17.52	24.62
6	Aluminium	mg/kg	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	33.0	26.0	44.0	56.0	42.6	43.6
8	Phosphate	mg/kg	11.52	10.52	11.02	9.56	10.62	18.00
9	Sulphate	mg/kg	258.0	272.0	168.0	186.0	162.0	152.0
10	Nitrite	mg/kg	0.1	0.15	0.13	0.12	0.11	0.12
11	Nitrate	mg/kg	11.20	8.42	11.82	9.04	16.02	8.52
12	Calcium	mg/kg	358.0	275.0	425.0	349.0	356.0	402.0
13	Magnesium	mg/kg	186.0	145.0	178.0	152.0	186.0	202.0
14	Sodium	mg/kg	8625.0	7952.0	9583.0	7789.0	9645.0	9785.0
15	Potassium	mg/kg	387.0	389.0	489.0	687.0	888.0	782.0
16	Chromium	mg/kg	135.03	186	142.2	135.6	87.6	175
17	Nickel	mg/kg	22.2	28.6	24.6	27	31	36
18	Copper	mg/kg	56	32.6	20.52	28.2	36.2	24.5
19	Zinc	mg/kg	36.25	42.00	34.50	42.00	35.00	38.00
20	Cadmium	mg/kg	ND	ND	ND	ND	ND	ND
21	Lead	mg/kg	3.06	2.6	7.2	6.2	7.2	6.2
22	Mercury	mg/kg	ND	ND	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND	ND	ND

*Grab samples could not be collected due high current at Vadinar SBM

Table 34B: Results of Analysis of Sediment of Kandla & Vadinar Port (Neap Tide)

Sr. No.	Parameters	Unit	KPT - 1	KPT - 2	KPT - 3	Nakti Creek Near Tuna Port	Nakti - 1 (Near NH-8A)	Jetty
1	Texture		Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
2	Organic Matter	mg/kg	1.03	1.78	1.07	1.78	0.77	1.08
3	Organic Carbon	mg/kg	0.59	1.03	0.62	1.03	0.44	0.86
4	Inorganic Phosphate	mg/kg	163.0	133.0	126.0	186.0	204.0	210.0
5	Moisture	%	14.94	13.40	14.26	18.84	18.45	19.62
6	Aluminum	mg/kg	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	20.62	23.33	30.6	31.52	33.50	33.61
8	Phosphate	mg/kg	11.2	16.64	9.39	12.30	17.70	16.22
9	Sulphate	mg/kg	359.8	281.0	252.0	248.0	266.0	325.0
10	Nitrite	mg/kg	0.10	0.11	0.1	0.12	0.14	0.15
11	Nitrate	mg/kg	11.3	8.9	10.02	11.52	12.62	11.66
12	Calcium	mg/kg	341.0	200.0	301.0	241.0	341.0	322.0
13	Magnesium	mg/kg	207.0	231.0	158.0	231.0	219.0	186.0
14	Sodium	mg/kg	11210.0	11524.0	11452.0	9312.0	9236.0	11120.0
15	Potassium	mg/kg	480.0	486.0	355.0	865.0	878.0	362.0
16	Chromium	mg/kg	165.5	179	134.4	88.7	61.22	210.4
17	Nickel	mg/kg	21.8	30.5	23.6	22	22.62	23.9
18	Copper	mg/kg	74.3	19.4	13.7	17.1	12.62	84.7
19	Zinc	mg/kg	24.00	39.40	34.50	33.50	49.29	84.70
20	Cadmium	mg/kg	ND	ND	1.39	1.22	1.35	ND
21	Lead	mg/kg	ND	4.2	4.4	4.4	6.66	ND
22	Mercury	mg/kg	ND	ND	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND	ND	ND

*Grab samples could not be collected due high current at KPT 2, Vadinar Jetty and Vadinar SBM

INTRODUCTION:

The Forty Second Amendment to the Constitution in 1976 underscored the importance of 'green thinking'. Article 48A enjoins the state to protect and improve the environment and safeguard the forests and wildlife in the country. Further, Article 51A(g) states that the "fundamental duty of every citizen is to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures".

Policy Statement for Abatement of Pollution (1992) has suggested developing relevant legislation and regulation, fiscal incentives, voluntary agreements and educational programs and information campaigns. It emphasizes the need for integration by incorporating environmental considerations into decision making at all levels by adopting frameworks namely, pollution prevention at source, application of best practicable solution, ensure polluter pays for control of pollution, focus on heavily polluted areas and river stretches and involve public in decision-making. The National Conservation Strategy and Policy Statement on Environment and Development, (1992)aimed at "integrating environmental concerns with developmental imperatives to meet the challenges by redirecting the thrust of our developmental process so that the basic needs of our people could be fulfilled by making judicious and sustainable use of natural resources." The priorities mentioned in this policy document include the sustainable use of land and water resources, prevention and control of pollution and preservation of biodiversity.

The National Water Policy, (2002) contains provisions for developing, conserving, sustainable utilizing and managing this important water resources and need to be governed by national perspectives.

MARINE ENVIRONMENT:

On national and state levels, we have several policies and regulation like Water (Prevention and Control of Pollution) Act, 1974, to regulate pollution discharges and restore water quality of our aquatic resources including the prescription of monitoring activities. One of the important provisions of the Water Act, 1974, is to maintain and restore the 'wholesomeness' of our aquatic resources. Water quality monitoring is one of the first steps required in the rational development and management of water resources. In the field of water quality management, there has been a steady evolution in procedures for designing system to obtain information on the changes of water quality. The monitoring comprises all activities to obtain 'information' with respect to the water system.

Sampling Stations:

The monitoring of marine environment for the study of biological and ecological Parameters was carried out on11th May, 2021 in in harbour region of DPT, 12th May,2020in creeks near by the port during spring tide .The monitoring of marine environment for the study of biological and ecological parameters was repeated again on 21st May ,2020 in harbour region of DPT, 22nd May ,2021 in creeks near by the port .

Plankton samples from sub surface layer was collected both during high tide period and low tide period from 3 water quality monitoring stations of DPT harbour area andone stations in Nakti creek and one station in Khori creek. Sampling at second sampling station of Nakti creek was possible only during high tide period. Collected water samples were processed for estimation of Chlorophyll- a, Pheophytin- a, qualitative &quantitative evaluation of phytoplankton, qualitative &quantitative evaluation zooplanktons(density and their population).

TABLE #1 SAMPLING LOCATIONS

monitoring requirement	**Number of locations**
Kandla creek Nakti creek Khori Creek	3 in Kandla creek 2 in Nakti creek 1 in Khori creek
Total Number of locations	**6**

Sampling methodology adopted:

A marine sampling is an estimation of the body of information in the population. The theory of the sampling design is depending upon the underlying frequency distribution of the population of interest. The requirement for useful water sampling is to collect a representative sample of suitable volume from the specified depth and retain it free from contamination during retrieval.

Pump sampler was used to sample sea water from the sub surface. 500 litters of the water sample were collected from Sub surface by using pump sampler. The collected samples were first collected in a clean bucket to reduce the heterogeneity. From the collected water sample 1 litter of water sample were taken in an opaque plastic bottle for chlorophyll estimation, thereafter plankton samples were collected by using filtration assembly with nilyobolt cloth of 20µm mesh size.

Samples Processing for chlorophyll estimation:

Samples for the chlorophyll estimation were preserved in ice box on board in darkness to avoid degradation in opaque container covered with aluminium foil. Immediately after reaching the shore after sampling, 1 litter of collected water sample was filtered through GF/F filters (pore size 0.45 µm) by using vacuum filtration assembly. After vacuum filtration the glass micro fiber filter paper was grunted in tissue grinder, macerating of glass fiber filter paper along with the filtrate was done in 90% aqueous Acetone in the glass tissue grinder with glass grinding tube. Glass fiber filter paper will assist breaking the cell during grinding and chlorophyll content was extracted with 10 ml of 90% Acetone, under cold dark conditions along with saturated magnesium carbonate solution in glass screw cap tubes. After an extraction period of 24 hours, the samples were transferred to calibrated centrifuge tubes and adjusted the volume to original volume with 90% aqueous acetone solution to make up the evaporation loss. The extract was clarified by using centrifuge in closed tubes. The clarified extracts were then decanted in clean cuvette and optical density was observed at wavelength 664, 665 nm. By using corrected optical density, Chlorophyll-a value was calculated as given in (APHA, 1998).

PLANKTON:

The entire area open water in the sea is the pelagic realm. Pelagic organisms live in the open sea. In contrast to the pelagic realm, the benthic realm comprises organisms and zone of the bottom of the sea. Vertically the pelagic realm can be dividing into two zones based on light penetration; upper photic or euphotic zone and lower dark water mass, aphotic zone below the photic zone.

The term plankton is general term for organisms have such limited powers of locomotion that they are at the mercy of the prevailing water movement. Plankton is subdivided to phytoplankton and zooplankton. Phytoplankton is free floating organisms that are capable of photosynthesis and zooplankton is the various free floating animals.

Pelagic zone, represents the entire ocean water column from the surface to the deepest depths, is home to a diverse community of organisms. Differences in their locomotive ability categorize the organisms in the pelagic realm into two, ***plankton*** and ***nekton*** (Lalli and Parsons, 1997). ***Plankton*** consists of all organisms drifting in the water and is unable to swim against water currents, whereas ***Nekton*** includes organisms having strong locomotive power. Ecological studies on the plankton community, which form the base of the aquatic food chain, help in the better understanding of the dynamics and functioning of the marine ecosystem. The term 'Plankton' first coined by Victor Hensen (1887), Plankton, (Greek word: *planktos*meaning "passively drifting or wandering") is defined as drifting or free-floating organisms that inhabit the pelagic zone of water. Based on their mode of nutrition planktonic organisms are categorised into phytoplankton (organisms having an autotrophic mode of nutrition) and zooplankton (organisms having a heterotrophic mode of nutrition).

Phytoplankton in the marine environment:

Phytoplankton is free floating unicellular, filamentous and colonial eutrophic organisms that grow in aquatic environments whose movement is more or less dependent upon water currents. These micro flora acts as primary producers as well as the basis of food chain, source of protein, bio purifier and bio indicators of the aquatic ecosystems of which diverse array of the life depends .They are considered as an important component of aquatic flora, play a key role in maintaining equilibrium between abiotic and biotic components of aquatic ecosystem.

The phytoplankton includes a wide range of photosynthetic and phototrophic organisms. Marine phytoplankton is mostly microscopic and unicellular floating flora, which are the primary producers that support the pelagic food-chain. The two most prominent groups of phytoplankton are diatoms (Bacillariophyceae) and dinoflagellates (Dinophyceae).The phytoplankton those normally captured in the net from the Gulf of Kutch is normally dominated by these two major groups; diatoms and dinoflagellates. Phytoplankton also include numerous and diverse collection of extremely small, motile algae which are termed micro flagellates (naked flagellates) as well as and Cyanophytes (blue-green algae).

Algae are an ecologically important group in most aquatic ecosystems and have been an important component of biological monitoring programs. Algae are ideally suited for water quality assessment because they have rapid reproduction rates and very short life cycles, making them valuable indicators of short-term impacts.

Aquatic populations are impacted by anthropogenic stress, resulting in a variety of alterations in the biological integrity of aquatic systems. Algae can serve as an indicator of the degree of deterioration of water quality, and many algal indicators have been used to assess environmental status.

Zooplankton in the marine environment:

Zooplankton includes a taxonomically and morphologically diverse community of heterotrophic organisms that drift in the waters of the world's oceans. Qualitative and quantitative studies on zooplankton community is a prerequisite to delineate the ecological processes active in the marine ecosystem. Zooplankton community plays a pivotal role in the pelagic food web as the primary consumers of phytoplankton and act as the food source for organisms in the higher trophic levels, particularly the economically essential groups such as fish larvae and fishes. They also function in the cycling of elements in the marine ecosystem. The dynamics of the zooplankton community, their reproduction, growth and survival rate are all significant factors determining the recruitment and abundance of fish stocks as they form an essential food for larval, juvenile and adult fishes (Beaugrand et al., 2004). Zooplankton grazing in the marine environment controls the primaryProduction and helps in determining the pelagic ecosystem (Banse, 1995). Through grazing in surface waters and following the production of sinking faecal matters and also by the active transportation of dissolved and particulate matter to deeper waters via vertical migration, they help in the transport of organic carbon to deep ocean layers and thus act as key drivers of biological pump' in the marine ecosystem. Zooplankton grazing and metabolism also, transform particulate organic matter into dissolved forms, promoting primary producer community, microbial demineralization, and particle export to the ocean's interior.

The categorisation of zooplankton into various ecological groups is based on several factors such as duration of planktonic life, size, food preferences and habitat. As they vary significantly in size from microscopic to metazoic forms, the classification of zooplankton based on size has paramount importance in the field of quantitative plankton research.

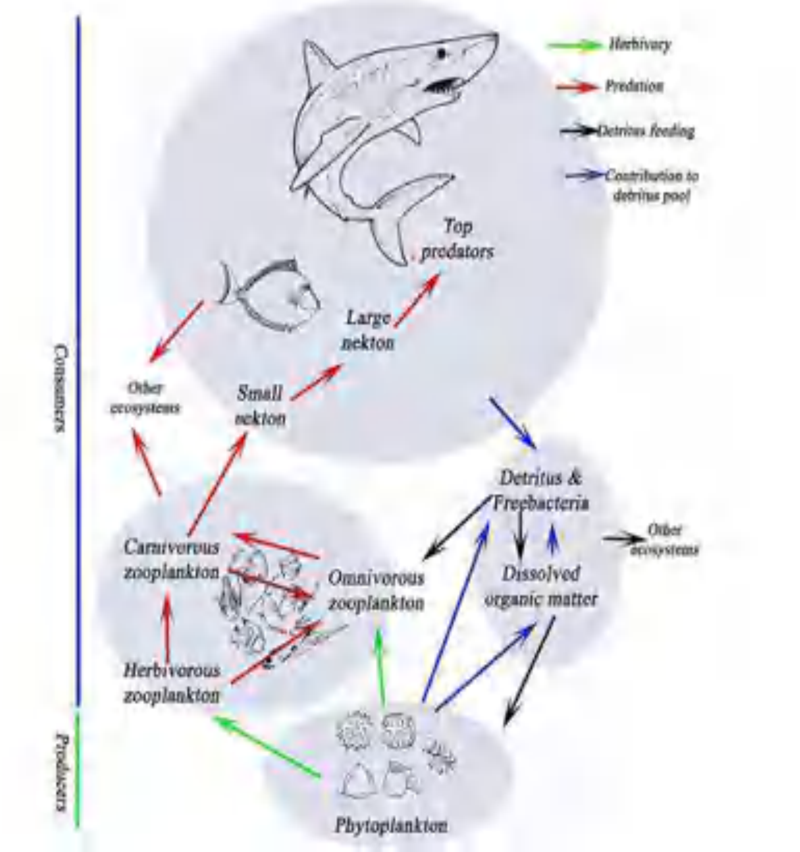
Based on the duration of planktonic life, zooplankton are categorised into Holoplankton (organisms which complete their entire lifecycle as plankton) and Meroplankton (organisms which are planktonic during the early part of their lives such as the larval stages of benthic and nektonic organisms). Tychoplankton are organisms which live a brief planktonic life, such as the benthic crustaceans (cumaceans, mysids, isopods) which ascend to the water column at night for feeding and certain ectoparasitic copepods, they leave the host and spend their life as plankton during their breeding cycle.

Zooplankton can be subdivided into holoplankton, i.e., permanent members of the plankton (e.g., Calanoid copepods), and meroplankton, i.e., temporary members in the plankton e.g., larvae of fish, shrimp, and crab). The meroplankton group consists of larval and young stages of animals that will adopt a different lifestyle once they mature. In contrast to phytoplankton which consist of a relatively smaller variety of organisms, Zooplankton are extremely divers, consist of a host of larval and adult forms representing many animal phylum.

Among the zooplankton one group always dominate than others; members of sub class copepods (Phylum Athropoda), and Tintinids (Phylum Protozoa) among the net planktons. These small animals are of vital importance in marine ecosystem as one of the primary herbivores animals in the sea, and it is they provide vital link between primary producer (autotrophs) and numerous small and large marine consumers.

As their community structure and function are highly susceptible to changes in the environmental conditions regular monitoring of their distribution as well as their interactions with various physicochemical parameters is inevitable for the sustainable management of the ecosystem (Kusum et al., 2014). Of all the marine zooplankton groups, copepods mainly calanoid copepods are the dominant groups in marine subtropical and tropical waters and exhibit considerable diversity in morphology and habitats they occupy (Madhupratap, 1991;)

It has been well established that potential of pelagic fishes viz. finfishes, crustaceans, molluscs and marine mammals either directly or indirectly depend on zooplankton. The herbivorous zooplankton is efficient grazers of the phytoplankton and is referred to as living machines transforming plant material into animal tissue. Hence they play an essential role as the intermediaries for nutrients/energy transfer between primary and tertiary trophic levels. Due to their large density, shorter lifespan, drifting nature, high group/species diversity and different tolerance to the stress, they used as the indicator organisms for the physical, chemical and biological processes in the aquatic ecosystem (Ghajbhiye, 2002).



Simplified marine food web

Spatial distribution of Plankton:

A characteristic of plankton population is that they tend to occur in patches, which are varying spatially on a scale of few meters to far as few kilometres in distance. They also vary in time scale, season as well as vertically in the water column. It is this patchiness and its constant changes in time and spot, that has made it so difficult for plankton biologist to learn about the ecology of plankton. The biological factors that causes this patchiness is due to the ability of zooplankton to migrate vertically and graze out the phytoplankton at a rapid rate that can create patchiness. Similarly the active swimming ability by certain zooplankton organisms can cause to aggregate in dense group.

At its most extreme, because the water in which plankton is suspended is constantly moving, each sample taken by the plankton biologists remain a different volume of water, so each sample is unique and replicate does not exist.

Plankton may also exhibit vertical patchiness. Physical factors contribute to this type of patchiness include light intensity, nutrients and density gradients in the water column. Phytoplankton in particular tends to be unequally distributed vertically, which leads to the existence of different concentration of a chlorophyll value between photic zone and below the photic zone.

Methodology adopted for Plankton sampling:

Mixed plankton sample were obtained from the sub surface layer at each sampling locations by towing the net horizontally with the weight .After the tow of about 15-30minutes, plankton net was pulled up and washed down to the tail and collected the plankton adhered to plankton net in the collection bucket at the bottom by springing outer and inner surface of the net with sea water, while the net was hanging with the mouth upward. For quantitative evaluation 100 L water samples were collected from subsurface layer and filtered through 20µm mesh size net by using pump and filtration assembly.

Preservation and storage:

Both filtered plankton and those collected from the plankton net were preserved with 5% buffered formalin and stored in 1L plastic container for further processing in the laboratory.

Sample concentration:

The collected plankton samples were concentrated by using centrifuge and made up to 50 ml with 5% formalin -Glycerine mixture.

Taxonomic evaluation:

Before processing, the sample was mixed carefully and a subsample was taken with a calibrated Stempel-pipette. 1 ml of the concentrated plankton samples were transferred on a glass slide with automatic pipette. The plankton sample on the glass slides were stained by using Lugol's iodine and added glycerine to avoid drying while observation. The plankton samples were identified by using Labex triangular Research microscope with photographic attachment. Microphotographs of the plankton samples were taken for record as well as for confirming the identification. The bigger sized zooplankton was observed through dissecting stereomicroscope with magnification of 20-30 x. Plankton organisms in the whole slide were identified to the lowest axon possible. A thorough literature search was conducted for the identification of the different groups of zooplankton that were encountered

Cell counts by drop count method:

The common glass slide mounted with a 1ml of concentrated phytoplankton/zooplankton sample in glycerol and covered with cover slip 22x 60mm was placed under the compound microscope provided with a mechanical stage. The plankton was then counted from the microscopic field of the left top corner of the slide. Then slide is moved horizontally along the right side and plankton in each microscopic field was thus counted. When first microscopic field row was finished the next consecutive row was adjusted using the mechanical device of the stage. In this way all the plankton present in entire microscopic field are counted. From this total number in 1ml of the concentrated plankton, total number of plankton in the original volume of sample filtered was calculated as units/L.

BENTHIC ORGANISMS:

Benthos is those organisms that are associated with the sea bed or benthic habitats. Epi-benthic organisms live attached to a hard substratum or rooted to a shallow depth below the surface. In fauna organisms live below the sediment–water interface. Interstitial organisms live and move in pore water among sedimentary grains.

Because the benthic organisms are often collected and separated on sieves, a classification based on the overall size is used. Macro benthos include organisms whose shortest dimension is greater than or equal to 0.5 mm. Meio benthos are smaller than 0.5mm but larger than 42µ in size.

The terms such as macro fauna and Meio fauna generally have little relevance with taxonomic classification. The terms Meio fauna and macro fauna depend on the size. Meio fauna were considered as good bioassay of community health and rather sensitive indicators of environmental changes

SAMPLING METHODOLOGY ADOPTED FOR SUB TIDAL REGION:

Van veen sampler ($0.0929m^2$) was used for sampling bottom sediments. Two sets of sediments were sampled from each location, one for macro fauna and other for Meio fauna. The macro fauna in the sediments were sieved on board to separate out the organisms. The fixation of Meio fauna is normally done by bulk fixation of the sediment sample. The bulk fixation is done by using 10% formalin (Buffered with borate). The organisms were preserved with seawater as diluting agent.

Sample sieving:

Sediments samples were sieved to extract the organisms. Sieving was performed carefully as possible to avoid any damage to the animals. The large portion of the sediment was split in to smaller portions and mixed with sea water in a bucket. The cohesive lumps were broken down by continuous stirring. The disaggregated sediments were then passed through the sieves.

Sample staining:

Sorting of the Meio fauna from the sieve is difficult task especially in the preserved material, because organisms are not easily detectable. To facilitate the animal detection the entire sample retained on the sieve after sieving operation were stained by immersing the sieve in a flat bottom tub with 1% Rose Bangal stain; a protein stain. A staining period of 10-30 minutes is sufficient for sample detection.

DIVERSITY INDICES:

On the whole, diversity indices provide more information about community composition than simply species richness (number of species present); they also, take the relative abundances of different species into account. Based on this fact, diversity indices therefore depend not only on species richness but on the evenness, or equitability, with which individuals are distributed among the different species (Magurram, A. E. (1988)

A diversity index is a measure of species diversity within a community that consists of co-occurring populations of several (two or more) different species. It includes two components: richness and evenness. Richness is the measure of the number of different species within a sample showing that more the types of species in a community, the higher is the diversity or greater is the richness. Evenness is the measure of relative abundance of the different species with in a community.

The basic idea of diversity index is to obtain a quantitative estimate of biological variability that can be used to compare biological entities composed of discrete components in space and time (Carol H.R. *etal*. 1998). Biodiversity is commonly expressed through indices based on species richness and species abundances (Whittaker 1972, Lande 1996, Purvis and Hector 2000). Biodiversity indices are a non-parametric tool used to describe the relationship between species number and abundance. The most widely used bio diversity indices are Shannon Weiner index and Simpson's index.

A diversity Index is a single statistic that incorporates in formation on richness and evenness. The diversity measures that incorporate the two concepts may be termed heterogeneity measures (Magurran, 2004).

Any study intended to interpret causes and effect of adverse impact on Biodiversity of communities require suitable measures to evaluate specie richness and Diversity. The former is number of species in community, while latter is a function of relative frequency of different species. Species richness is the iconic measure of biological diversity (Magurran, 2004). Several indices have been created to measure the diversity of species; however, the most widely used in the last decades are the Shannon (1948) and Simpson (1949) (Buzas and Hayek 1996; Gorelick 2006), with the components of diversity: richness (*S)* and evenness (*J)*

Simpson's diversity index

Simpson's index (**D**) is a measure of diversity, which takes into account both species richness, and evenness of abundance among the species present.. The Simson index is one of the meaningful and robust biodiversity measures available.(Magurran ,2004).

The formula for calculating D is presented as:

$$D = \frac{\sum n_i(n_i - 1)}{N(N-1)}$$

Where n_i = the total number of organisms of each individual species

N = the total number of organisms of all species

The value of D ranges from 0 to 1. With this index, 0 represents infinite diversity and, 1, no diversity. When D increases diversity decreases. Simpson's index is therefore usually expressed as 1-D or 1/D. (Magurran, 2004)

Low species diversity suggests:

- relatively few successful species in the habitat
- the environment is quite stressful with relatively few ecological niches and only a few organisms are really well adapted to that environment
- food webs which are relatively simple
- change in the environment would probably have quite serious effects

High species diversity suggests:

- a greater number of successful species and a more stable ecosystem
- more ecological niches are available and the environment is less likely to be hostile complex food webs
- environmental change is less likely to be damaging to the ecosystem as a whole

Species richness indices

The species richness***(S)*** is simply the number of species present in an ecosystem. Species richness Indices of species richness are widely used to quantify or monitor the effects of anthropogenic disturbance. A decline in species richness may be concomitant with severe or chronic human-induced perturbation (Fair Fair weather 1990,) Species richness measures have traditionally been the mainstay in assessing the effects of environmental degradation on the biodiversity of natural assemblages of organisms (Clarke &Warwick, 2001)

Species richness is the iconic measure of biological diversity (Magurran, 2004). The species richness***(S)*** is simply the number of species present in an ecosystem. This index makes no use of relative abundances. The term species richness was coined by

McIntosh (1967) and oldest and most intuitive measure of biological diversity (Magurran, 2004).

Margalef's diversity index is a species richness index. Margalef’s Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, were derived.

The value of a diversity index increases both when the number of types increases and when evenness increases. For a given number of types, the value of diversity index is maximised when all types are equally abundant (Rosenzweig, M. L. (1995).

Shannon-Wiener’s index:

An index of diversity commonly used in plankton community analyses is the Shannon-Wiener’s index **(H),** which emphasizes not only the number of species (richness or variety), but also the apportionment of the numbers of individuals among the species (Odum 1971 and Reish 1984). Shannon-Wiener’s index **(H**) reproduce community parameters to a single numberby using an equation.

$$H' = -\sum_{j=1}^{s} \frac{n_j}{N} \ln\left(\frac{n_j}{N}\right)$$

Shannon and Weiner index represents entropy. It is a diversity index taking into account the number of individuals as well as the number of taxa. It varies from 0 for communities with only single taxa to high values for community with many taxa each with few individuals. This index can also determine the pollution status of a water body. Normal values range from 0 to 4. This index is a combination of species present and the evenness of the species. Examining the diversity in the range of polluted and unpolluted ecosystems, Wilham and Dorris (1968) concluded that the values of the index greater than 3 indicate clean water, values in the range of 1 to 3 are characterized by moderate pollution and values less than 1 are characterized as heavily polluted

RESULTS:

CHLOROPHYLL-a:

Water Samples for the chlorophyll estimation were collected from sub surface layer during high tide and low tide period of the tidal cycle for each sampling locations and analysed for Chlorophyll -a and after acidification for Pheophytin –a. Chlorophyll- a value was used as algal biomass indicator (APHA,1998) Algal biomass was estimated by converting Chlorophyll value.

In the sub surface water chlorophyll-a was varying from 0.291 -0.630mg/m^3.in harbour region of DPT during sampling done in spring tide period of May,2021. In the nearby creeks chlorophyll-a was varying from 0.476 -0.872 mg/m^3.Pheophytin –a level was below detectable limit- the all the sampling stations during spring in the harbour region of DPT.

In the sub surface water chlorophyll-a was varying from 0.526 -0.818 mg/m^3.in harbour region of DPT during sampling done in neap tide period of May ,2021. In the nearby creeks chlorophyll-a was varying from 0.399-0.743 mg/m^3.·Pheophytin –a level was below detectable limit- the all the sampling stations during spring in the harbour region of DPT

TABLE #2 VARIATIONS IN CHLOROPHYLL –A PHEOPHYTIN- A AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN MAY,2021

Sr.No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREA					
1	KPT1	High tide	0.3158	BDL	21.16
		Low tide	0.3069	BDL	20.56
2	KPT 2	High tide	0.3922	BDL	26.27
		Low tide	0.3061	BDL	20.51
3	KPT 3	High tide	0.2907	BDL	19.48
		Low tide	0.6300	BDL	42.21
CREEKS					
4	KPT-4 Khori-I	High tide	0.7647	BDL	51.25
		Low tide	0.5431	BDL	36.38
5	KPT-5 Nakti-I	High tide	0.8721	BDL	58.42
		Low tide	0.6292	BDL	42.14
6	KPT-5 Nakti-II	High tide	0.4762	BDL	31.89

BDL: Below Detectable Limit.

TABLE #3 VARIATIONS IN CHLOROPHYLL –A PHEOPHYTIN- A AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN MAY,2021

Sr.No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREA					
1	KPT1	High tide	0.7570	BDL	50.72
		Low tide	0.6541	BDL	43.81
2	KPT 2	High tide	0.8184	BDL	54.81
		Low tide	0.5261	BDL	35.24
3	KPT 3	High tide	0.6133	BDL	41.07
		Low tide	0.5559	BDL	37.18
CREEKS					
4	KPT-4 Khori-I	High tide	0.5587	BDL	37.39
		Low tide	0.7435	BDL	49.78
5	KPT-5 Nakti-I	High tide	0.4762	BDL	31.89
		Low tide	0.5451	BDL	36.52
6	KPT-5 Nakti-II	High tide	0.3999	BDL	26.73

BDL: Below Detectable Limit.

PHYTOPLANKTON POPULATION:

For the evaluation of the Phytoplankton population in DPT harbour area and within the immediate surroundings of the port, sampling was conducted from 5 sampling locations (3 in harbour area and two in Nakti creek) during high tide period and low tide period of spring tide. The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by,Diatoms and dinoflagellates during spring tide period.Diatoms were represented by 13 genera. Dinoflagellates wererepresented by two genera .during the sampling conducted in spring tide in May,2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 72-190 units/ L during high tide period and 73-204 units/ L during low tide of Spring Tide.

The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by blue green algae , Diatoms and dinoflagellates during spring tide period.Diatoms were represented by 13 genera. Dinoflagellateswere represented 2 genera and Blue green algae were represented by one genera eachduring the sampling conducted in Neap tide in May, 2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 75-173 units/ L during high tide period and 88-191 units/ L during low tide of Neap Tide.

Species Richness Indices and Diversity Indices :

Margalef's diversity index (Species Richness)S

At the organismal level, the most widely used biodiversity measures are those based on the number of species present, perhaps adjusted for the number of individuals sampled, Here Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, are derived.

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was varying from 2.295-2.806 with an average of 2.516 during the sampling conducted in High tide period of spring tide While .Margalef's diversity index (Species Richness) S of phytoplankton communities in the Kandla Harbour region and nearby creeks was varying from. 1.773-2.645 with an average of 2.063 during the consecutive in low tide period .

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was varying from 1.853-2.771 with an average of 2.472 during the sampling conducted in High tide period of Neaptide While .Margalef's diversity index (Species Richness) S of phytoplankton communities in the Kandla Harbour region and nearby creeks was varying from. 2.094-2.457 with an average of 2.303 during the consecutive in low tide period .

Shannon-Wiener's index:

Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.828-0.991 (H'(log10)) between selected sampling stations with an average value of 0.907. during high tide period of spring tide .Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.645-0.897 (H'(log10)) between selected sampling stations with an average value of 0.775 during consecutive lowtide. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.814-0.959 (H'(log10)) between selected sampling stations with an average value of 0.904. during high tide period of neap tide . Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.822-0.894 (H'(log10)) between selected sampling stations with an average value of 0.868. during consecutive low tide. Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon-Wiener's index increases as both the richness and the evenness of the community increase. This result indicates that diversity of phytoplankton of Kandla Harbour region and nearby creeks is less but with abundant population of few, with relatively few ecological niches and only very few opportunist organisms are really well adapted to this environment and thrive better than other species.

Simpson's diversity index:

Simpson's index (D) is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. The Simson index is one of the meaningful and robust biodiversity measures available. (Magurran,2004).

Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in the Kandla Harbour region and nearby creeks, which was varying from 0.794- 0.8884 between selected sampling stations with an average of 0.842 during high tide period of spring tide . Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in the Kandla Harbour region and nearby creeks, which was varying from 0.707- 0.828 between selected sampling stations with an average of 0.780 during consecutive low tide . Low species diversity suggests a relatively few successful species in this habitat. The environment is quite stressful with relatively few ecological niches and only a few organisms are really well adapted to that environment. Any change in the environment would probably have quite serious effects.

Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in Kandla Harbour region and nearby creeks, during high tide period and low tide period during neap tide also, which was varying from 0.818-0.871 with an average value of 0.850 between selected sampling stations during high tide period and varying from 0.814-0.858 with an average value of 0.843 between selected sampling stations during consecutive low tide period Low species diversity suggests a relatively few successful species in this habitat.

Table # 4PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN MAY,2021

Tide	Sampling Station	Abundance In units/L	No of Species observed /total species	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	96	13/15	86.66	2.629	0.9387	0.8566
	2	102	12/15	80	2.378	0.8284	0.7936
	3	78	11/15	73.33	2.295	0.8771	0.8458
	4	177	14/15	93.33	2.512	0.9139	0.8378
	5	190	14/15	93.33	2.478	0.8926	0.8343
	6	72	13/15	86.66	2.806	0.9916	0.8846
LOW TIDE	1	91	9/15	60	1.773	0.6453	0.707
	2	73	10/15	66.66	2.098	0.773	0.7896
	3	109	10/15	66.66	1.918	0.7463	0.7586
	4	199	15/15	100	2.645	0.8973	0.8287
	5	204	11/15	73.33	1.88	0.8151	0.8194

Table # 5 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN MAY,2021

Tide	Sampling Station	Abundance In units/L	No of Species observed /total species	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	151	13/16	81.25	2.392	0.8834	0.818
	2	106	13/16	81.25	2.573	0.915	0.8571
	3	109	14/16	87.50	2.771	0.9452	0.8685
	4	171	15/16	93.75	2.723	0.959	0.8713
	5	173	14/16	87.50	2.523	0.9066	0.8567
	6	75	9/16	56.25	1.853	0.8139	0.8292
LOW TIDE	1	88	12/16	75	2.457	0.8941	0.8524
	2	91	11/16	68.75	2.217	0.8913	0.8579
	3	135	13/16	81.25	2.446	0.8225	0.8142
	4	191	12/16	75	2.094	0.8769	0.8528
	5	185	13/16	81.25	2.299	0.8554	0.8378

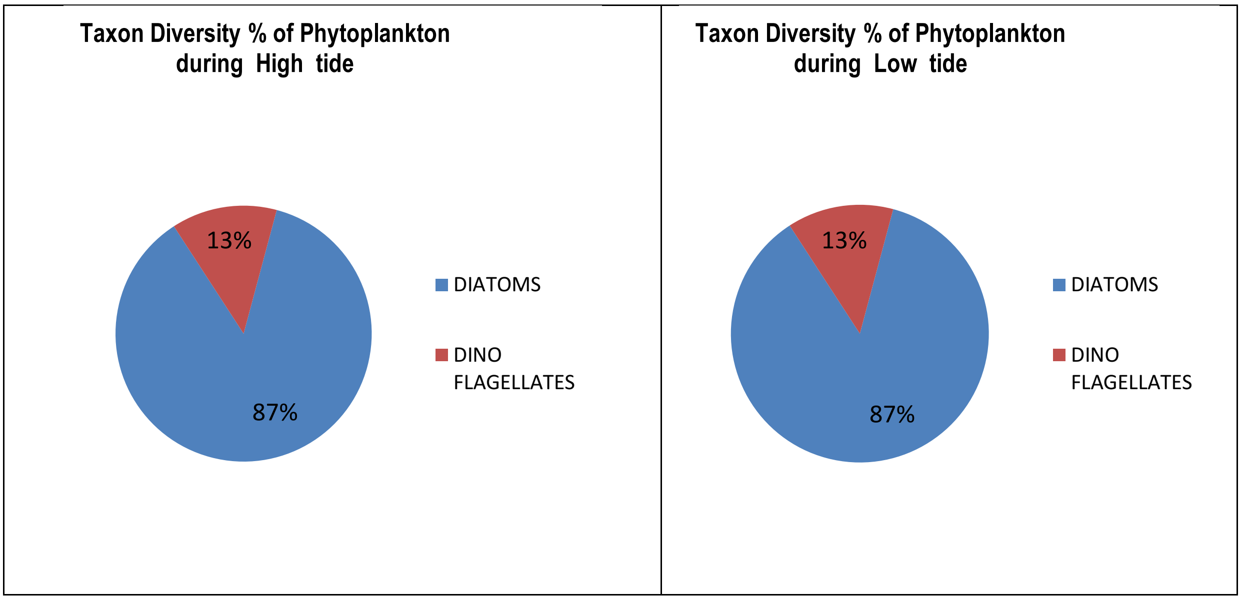
Table # 6 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING SPRING TIDE IN MAY,2021

Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	71-184	13/15	86.67
			DINO FLAGELLATES	0-6	2/15	13.33
			TOTAL PHYTO PLANKTON	72-190	15	-
LOW TIDE	Sub surface	5	DIATOMS	73-202	13/15	86.67
			DINO FLAGELLATES	0-3	2/15	13.33
			TOTAL PHYTO PLANKTON	73-204	15	-

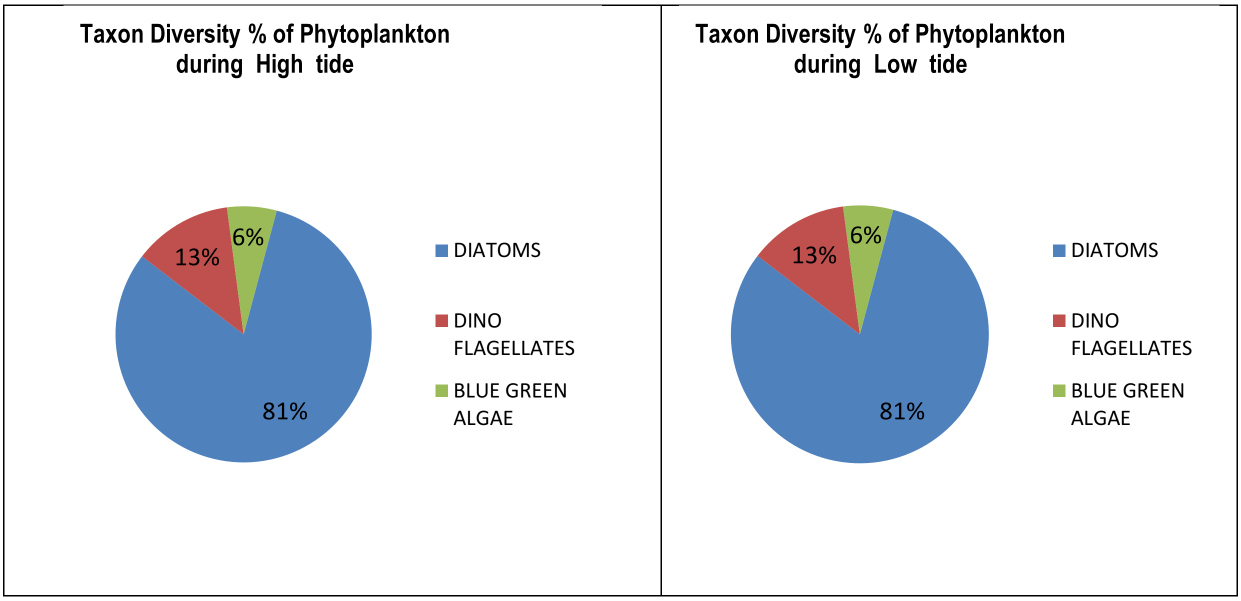
Table # 7 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING NEAP TIDE IN MAY,2021

Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	67-149	13/16	81.25
			DINO FLAGELLATES	0-2	2/16	12.5
			BLUE GREEN ALGAE	7-23	1/16	6.25
			TOTAL PHYTO PLANKTON	75-173	16	
LOW TIDE	Sub surface	5	DIATOMS	74-172	13/16	81.25
			DINO FLAGELLATES	3-4	2/16	12.5
			BLUE GREEN ALGAE	10-18	1/16	6.25
			TOTAL PHYTO PLANKTON	88-191	16	

Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide



Taxon Diversity % of Phytoplankton during High tide and Low tide period during Neap tide



ZOOPLANKTON POPULATION:

For the evaluation of the Zooplankton population in DPT harbour area and within the immediate surroundings of the port sampling was conducted from 6 sampling locations (3 in harbour area and two in Nakti creek and one in Khori creek) during high tide period and low tide period of spring tide and Neap tide in May 2021 . The Zooplankton community of the sub surface water in the harbour and nearby creeks during spring tide was represented by mainly three groups, Tintinids, Copepods, and larval forms of Crustacea, Polychates, Cyprids larvae of Barnacles and Cyphonautes larvae of Phylum Bryozoa. The Zooplankton community of the sub surface water in the harbour and nearby creeks during neap tide was represented by mainly three groups, Tintinids, Copepods, and larval forms of Crustacea, Polychates, Cyprids larvae of Barnacles and Cyphonautes larvae of Phylum Bryozoa.

Zooplankton of the sampling stations at sub surface layer in the DPT harbour area and nearby creek was varying from 30-125 x10^3 N/ m^3 during high tide and 35-135 N/ L during low tide of Spring Tide period. Zooplankton of the sampling stations at sub surface layer in the DPT harbour area and nearby creek was varying from 38-135x10^3 N/ m^3 during high tide and 60-120 N/ L during low tide of Neap Tide period.

Species Richness Indices and Diversity Indices:

Margalef's diversity index (Species Richness)S

At the organismal level, the most widely used biodiversity measures are those based on the number of species present, perhaps adjusted for the number of individuals sampled, Here Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, are derived.

Margalef's diversity index (Species Richness) S of Zooplankton communities in the stations Kandla Harbour region and nearby creeks was varying from 1.764-2.278 with an average of 1.950 during the sampling conducted in High tide period.varying from. 1.406-2.242 with an average of 1.884 during the sampling conducted in low tide period. during Spring tide.

Margalef's diversity index (Species Richness) S of Zooplankton communities in the Kandla Harbour region and nearby creeks sampling stations was varying from. 1.649 - 3.087 with an average of 2.717 during the sampling conducted in high tide and varying from. 2.298-3.162 with an average of 2.645 during the sampling conducted in low tide during Neap tide period .**Shannon-Wiener's index:**

Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.633-0.903 (H'(log10)) between selected sampling stations with an average value of 0.779 (H'(log10)) during high tide period of spring tide .Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of

0.660-0.921 (H'(log10)) between selected sampling stations with an average value of 0.803 (H'(log10)) during consecutive low tide period .

Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.730-1.046 (H'(log10)) between selected sampling stations with an average value of 0.961 (H'(log10)) during high tide period of Neap tide . Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.879-1.041(H'(log10)) between selected sampling stations with an average value of 0.960 (H'(log10)) during consecutive low tide period .Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon-Wiener's index increases as both the richness and the evenness of the community increase. This result indicates that diversity of Zooplankton of Kandla Harbour region and nearby creeks stations is slightly high with very minimum diverse population but very few opportunist organisms are really well adapted to this environment and thrive better than other species.

Simpson's diversity index:

Simpson's index (D) is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. The Simson index is one of the meaningful and robust biodiversity measures available. (Magurran, 2004).

Simpson diversity index (1-D) of Zooplankton communities was below 0.9 at all sampling stations in the Kandla Harbour region and nearby creeksduring high tide and low tide of spring tide period, which was varying from 0.708-0.848 between selected sampling stations with an average of 0.794 during high tide period and was varying from 0.743-0.864 with an average value of 0.811 between selected sampling stations during low tide

Simpson diversity index (1-D) of Zooplankton communities was below 0.9 at all sampling stationsin the Kandla Harbour region and nearby creeks during high tide and except one during low tide of Neap tide, which was varying from 0.808-0.891 between selected sampling stations with an average of 0.872 during high tide period and was varying from 0.843- 0.906 with an average value of 0.875 between selected sampling stations during consecutive low tide

This low species diversity suggests a relatively low number of successful species in this habitat. Environment is quite stressful with relatively few ecological niches and only few organisms are really well adapted to that environment. Any change in the environment would probably have quite serious effects.

Table # 8 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN MAY,2021

Tide	Sampling Station	Abundance In No / m^3	No of Species/ groups observed /total species/group	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	47 $x10^3$	8/12	66.66	1.818	0.7544	0.8002
	2	50 $x10^3$	8/12	66.66	1.789	0.705	0.751
	3	57 $x10^3$	9/12	75	1.979	0.7907	0.812
	4	125 $x10^3$	12/12	100	2.278	0.9033	0.8486
	5	124 $x10^3$	11/12	91.66	2.075	0.8878	0.844
	6	30 $x10^3$	7/12	58.33	1.764	0.6331	0.708
LOW TIDE	1	35 $x10^3$	6/12	50	1.406	0.6609	0.7681
	2	54 $x10^3$	9/12	75	2.006	0.7286	0.7435
	3	69 $x10^3$	8/12	66.66	1.653	0.7883	0.824
	4	114 $x10^3$	11/12	91.66	2.111	0.917	0.8638
	5	135 $x10^3$	12/12	100	2.242	0.921	0.8593

Table # 9 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN MAY ,2021

Tide	Sampling Station	Abundance In No / m^3	No of Species/ groups observed /total species/group	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	62 $x10^3$	13/16	81.25	2.908	0.9868	0.881
	2	56 $x10^3$	13/16	81.25	2.981	0.9832	0.8857
	3	70 $x10^3$	13/16	81.25	2.825	0.9837	0.8787
	4	129 $x10^3$	16/16	100	3.087	1.046	0.8895
	5	135 $x10^3$	15/16	93.75	2.854	1.038	0.8913
	6	38 $x10^3$	7/16	43.75	1.649	0.7306	0.808
LOW TIDE	1	60 $x10^3$	11/16	68.75	2.442	0.9379	0.8785
	2	61 $x10^3$	14/16	87.50	3.162	1.041	0.906
	3	107 $x10^3$	12/16	75	2.354	0.9455	0.869
	4	112 $x10^3$	15/16	93.75	2.967	0.9985	0.8832
	5	120 $x10^3$	12/16	75	2.298	0.8795	0.8431

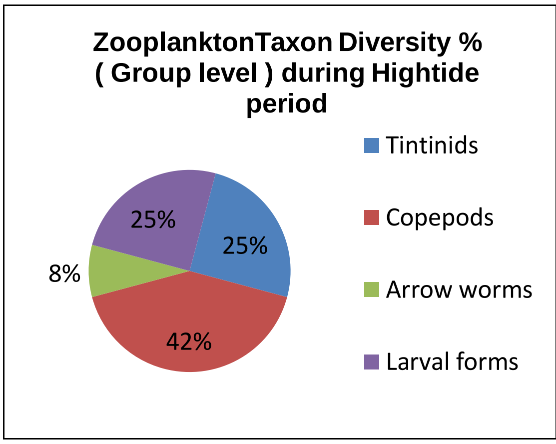
Table # 10 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN MAY,2021

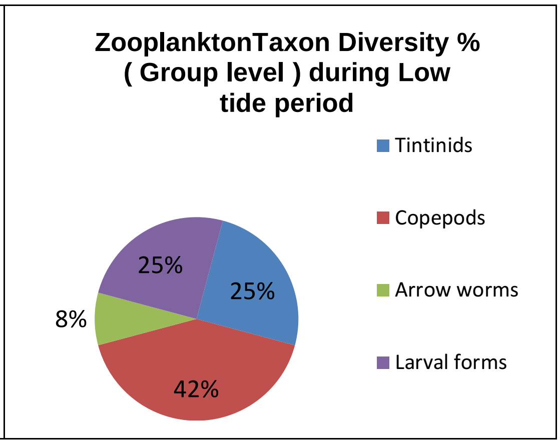
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton $x10^3$ Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	2-21	3/12	25
			Copepods	11-66	5/12	41.67
			Arrow worms	0-4	1/12	8.33
			Larval forms	17-45	3/12	25
			TOTAL ZOOPLANKTON NO/L	**30-122**	**12**	**-**
LOW TIDE	Sub surface	5	Tintinids	0-22	3/12	25
			Copepods	18-72	5/12	41.67
			Arrow worms	0-2	1/12	8.33
			Larval forms	16-41	3/12	25
			TOTAL ZOOPLANKTON NO/L	**34-133**	**12**	**-**

Table # 11 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA , NEAR BY CREEKS DURING NEAP TIDE IN MAY,2021

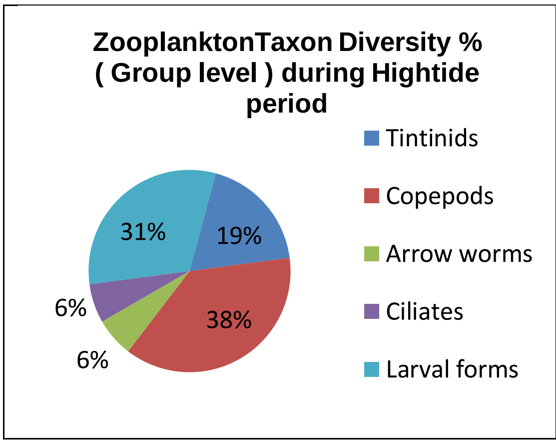
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton $x10^3$ Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	4-22	3/16	18.75
			Copepods	20-51	6/16	37.5
			Arrow worms	0-2	1/16	6.25
			Ciliates	2-12	1/16	6.25
			Larval forms	13-54	5/16	31.25
			TOTAL ZOOPLANKTON NO/L		**16**	
LOW TIDE	Sub surface	5	Tintinids	5-17	3/16	18.75
			Copepods	22-63	6/16	37.5
			Arrow worms	0-2	1/16	6.25
			Ciliates	0-4	1/16	6.25
			Larval forms	24-45	5/16	31.25
			TOTAL ZOOPLANKTON NO/L		**16**	

Taxon Diversity % of Zooplankton during High tide and Low tide period of Spring tide





Taxon Diversity % of Zooplankton during High tide and Low tide period of Neap tide



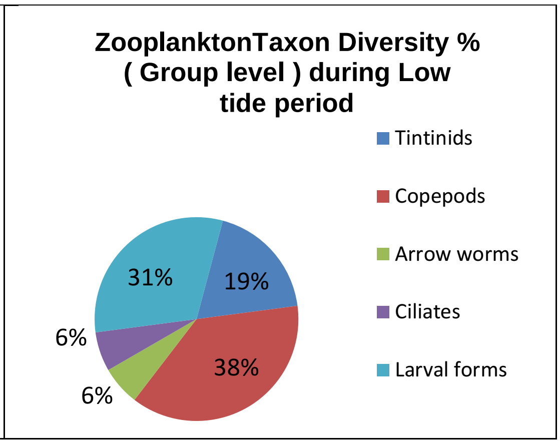


TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURINGSPRING TIDE OF MAY,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniellasp*	D1	Rare
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D2	Dominant
			Triceratiales	Triceratiaceae	*Odontellasp*	D3	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphiasp*	D4	Abundant
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D5	Frequent
			Chaetocerotales	Chaetocerotaceae	*Chaetocerossp*	D6	Occasional
			Lithodesmiales	Lithodesmiaceae	*Ditylumsp*	D7	Frequent
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigmasp*	D8	Rare
			Bacillariales	Bacillariaceae	*Bacillariasp.*	D9	Occasional
			Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D10	Frequent
					Thalassionema sp.	D11	Occasional
		Fragilariophyceae	Fragilariales	Fragilariaceae	*Fragilariasp*	D12	Rare
					Synedrasp	D13	Occasional

DINO FLAGELLATE S	Dinoflagellata / Dinozoa	Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium sp.*	DF1	Rare
			Gonyaulacales	Ceratiaceae	*Ceratiumfusus*	DF2	Rare

TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURING AND NEAP TIDE OF MAY,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALGAE	Cyanophyta	Cyanophyceae	Nostocales	Oscillatoriaceae	*Trichodesmium*sp.	B1	Occasional
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniellasp*	D1	Rare
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D2	Frequent
			Triceratiales	Triceratiaceae	*Triceratiumsp*	D3	Rare
					Odontellasp	D4	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphiasp*	D5	Frequent
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D6	Occasional
			Chaetocerotales	Chaetocerotaceae	*Chaetocerossp*	D7	Occasional
			Lithodesmiales	Lithodesmiaceae	*Ditylumsp*	D8	Abundant
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigmasp*	D9	Rare
			Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D10	Dominant
					Thalassionema sp.	D11	Rare

		Fragilariophyceae	Fragilariales	Fragilariaceae	*Fragilaria*sp	D12	Rare
					*Synedra*sp	D13	Rare
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Gonyaulacales	Ceratiaceae	*Ceratiumfusus*	DF1	Rare
					Ceratiummacroceros	DF2	Rare

TABLE #13 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS IN DPT HARBOUR AREA, AND NEAR BY CREEKS DURING SPRING TIDE OF MAY,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Codonellidae	*Tintinnopsisfailakkaensis*	T1	Rare
					Tintinnopsisgracilis	T2	Occasional
				Xystonellidae	*Favella* sp.	T3	Rare
COPEPODS	ATHROPODA	Crustacea Sub class copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Frequent
				Temoridae	*Temora sp.*	C2	Rare
			Cyclopoida	Oithonidae	*Oithona sp.*	C3	Abundant
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C4	Occasional
				Euterpinidae	*Euterpina sp.*	C5	Frequent
ARROW WORMS	CHAETOGNATHA	Sagittoideae	Aphragmophora	Sagittidae	*Sagitta sp.*	A1	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant

BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L2	Occasional
CYPHONAUTES LARVAE	BRYOZOA				Cyphonautes larvae	L3	Rare

TABLE # 13 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS IN DPT HARBOUR AREA, AND NEAR BY CREEKS DURING NEAP TIDE OF MAY,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Rare
				Codonellidae	*Tintinnopsisfailakkaensis*	T2	Occasional
				Codonellopsidae	*Codonellopsis* sp.	T3	Rare
COPEPODS	ATHROPODA	Crustacea Sub class copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Occasional
				Acartiidae	*Acartia sp.*	C2	Rare
			Cyclopoida	Oithonidae	*Oithona sp.*	C3	Dominant
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C4	Frequent

				Euterpinidae	*Euterpina sp.*	C5	Rare
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C6	Rare
ARROW WORMS	CHAETOGNATHA	Sagittoideae	Aphragmophora	Sagittidae	*Sagitta sp.*	A1	Rare
CILIATES	CILIOPHORA	Oligohymenophorea	Sessilida	Zoothamniidae	*Zoothamniumsp.*	CI1	Occasional
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Abundant
POLYCHAETE LARVA	ANNELIDA	Polychaeta			Trochophore larvae	L2	Rare
BARNACLE LARVAE	ATHROPODA CRUSTACEA	Maxillopoda Thecostraca			Cirripede larvae	L3	Occasional
					Zoea larvae	L4	Occasional
CYPHONAUTES LARVAE	BRYOZOA				Cyphonautes larvae	L5	Rare

BENTHIC ORGANISMS:

No Benthic organism was observed in the collected sediments by using the Van-veen grabs during the sampling conducted during spring tide period and Neap tide from DPT harbour region and nearby creek.

7. Meteorological Data

Automatic Weather station have been installed in SevaSadan -3 at the Deendayal Port which records the data on Temperature (°C), Humidity (%),Wind (mph), Dew Point (°C), Wind Direction (°), Pressure, Solar radiation, heat Index and UVI.

Temperature

The mean day time temperature for Deendayal Port was 32.65 °C. The day-time maximum temperature was 37.3 °C. The mean night time temperature was 28.6 °C. The minimum mean night time temperature recorded was 27.5 °C.

Air Pressure

The mean absolute air pressure for the month of May was 1005.28 hpa, whereas the mean relative pressure was 1005.38 hpa. The maximum absolute air pressure recorded for the month of May was 1010.6 hpa.

Heat Index

The mean day-time heat index for the month of May was 38.09 ^{o}C. The maximum heat index recorded was 47^{o}C.

Solar Radiation

The mean Solar Radiation in May was 157.73 w/m^2. The maximum solar radiation recorded in the month of May was 383.3 w/m^2.

Humidity

The mean day-time humidity was 60.22 % for the month of May and mean night time humidity was 74.93%. Maximum humidity recorded during day-time was 82.0 % and maximum humidity recorded during night-time was 89.0%.

Wind Velocity and Wind Direction

The mean wind velocity for the entire month of May was 7.05 km/hour (i.e. 1.95 mtr/sec). Maximum wind velocity recorded was 29.2 Km/hr (8.11 mtr/sec). The wind direction was mostly S to SE.

Conclusive Summary and Remedial measures Suggested

- The AAQ monitoring at six locations of Deendayal Port indicates that the mean PM_{10} values at four locations viz. Coal storage area, Marine Bhavan and Oil Jetty area were found above the permissible standards (100 µg/m^3)and$PM_{2.5}$was above permissible limits at Coal storage location(Limit 60 µg/m^3).

- Drinking water at all the twenty locations was found potable and was within permissible limits of BIS standards (IS 10500).

- Noise quality was also within the set permissible standards of an Industrial Area. The noise level observed during day time was >75 dB (A) and at night time was >70 dB (A) during the entire monitoring period.

- The sewage treated water of Deendayal Port Colony (Gopalpuri) was in line with the standards set by the Gujarat Pollution Control Board. The STP at Deendayal Port is not fully operational and STP at Vadinar Port was found non-operational.

Reasons for higher Values of PM_{10}

- Large amount of coal is handled at Berth No. 6, 7, 8 and 9. The unloading of coal directly in the truck, using grabs cause coal to spread in air as well as coal dust to fall on ground. This settled coal dust again mixes with the air while trucks travel through it.

- Also, the coal laden trucks are not always covered with tarpaulin sheets, and these results in spillage of coal from trucks/dumpers during its transit from vessel to yard or storage site. This also increased PM values around marine Bhavan & Coal storage area.

Remedial Measures

AIR:

The values of PM_{10} during the month of May, 2021 were observed beyond the permissible limit at four locations mentioned above. Given below are the remedial measures suggest to minimize the Air pollution at Deendayal Port.

- Guidelines for Coal Handling by GPCB should be strictly followed. (http://gpcb.gov.in/pdf/coal-handling-guidelines.pdf)
- Except for the higher values of PM_{10} at Coal storage site, Oil Jetty, Tuna Port and Marine Bhavan locations, the monitoring results for the present month suggest that the overall Environment Quality of Deendayal Port is satisfactory.

SEWAGE WATER:

- Sewage Treatment Plan at Vadinar Port is not working. Hence, it is recommended to commission the sewage treatment plant at Vadinar immediately.

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ENVIRONMENTAL MONITORING REPORT FOR DEENDAYAL PORT TRUST

REPORT NO.	:	DCPL/DPT/20-21/14
Month	:	June 2021
Issue No	:	01
Revision No	:	00
Prepared by	:	DETOX CORPORATION PVT. LTD., SURAT

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Introduction

Monitoring of various environmental aspects of the Deendayal port by M/s Detox Corporation Pvt. Ltd. has been carried out through collection of samples, analysis of the same, comparing results with respect to the national standards and any other relevant standards by GBCB/CPCB/MoEF to identify non conformities in the Environment of the Deendayal Port. The results shall address the identified impacts and suggest measures to minimize the environmental impact due to various operations at Deendayal Port.

The environmental monitoring is carried out as per the Environment Management and Monitoring Plan submitted by Detox Corporation Pvt. Ltd.

1. Ambient Air Quality Monitoring

As per the Environmental Monitoring Plan of Deendayal Port Trust, Air monitoring was carried out at six identified locations at Deendayal Port and two locations at Vadinar Port.

1.1 Air Quality Monitoring Methodology

Air quality is measured in all the stations, for 24 hour for Total Suspended Particulate Matter (TSPM), PM_{10}, $PM_{2.5}$, SO_2, NO_X, NH_3 & Benzene, and Grab-sampling for CO & CO_2 measurements. The Air samplers are operated for a period of 24 hours and after a continuous operation of 8 hours of the sampler, the reagents were replaced to obtain 3 samples per day for each parameter namely, SO_2, NO_X. The EPM 2000 filter paper and PTFE Membrane bound filter paper are used for a period of 24 hours to obtain one sample each of TSPM, PM_{10} & $PM_{2.5}$.

The AAQ samples are collected twice a week from all the eight locations as per the EMP.

1.2 Results

The ambient air quality monitoring data for six stations, viz. Marine Bhavan, Oil Jetty, Port Colony,Gopalpuri Hospital,Tuna Port and Nr. Coal Storage Area for the month of June 2021 are given in Tables 1A to 6B. The ambient air quality monitoring data for two stations at Vadinar (Nr. Admin Building &Nr. Signal Building) are given in Tables 7A to 8B.

Location 1: Marine Bhavan (AL1)

Table 1 : Results of Air Pollutant Concentration at Marine Bhavan

Parameter	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**		**80 µg/m3**		**80 µg/m3**		**400 µg/m3**
AL1 – 1	02-06-2021	447	107	53	14.07	9.23	23.50	24.14	12.51	11.83
					9.23		20.33		10.72	
					4.40		28.58		12.25	
AL1 – 2	04-06-2021	399	135	46	12.75	11.28	20.33	22.87	12.51	11.74
					11.87		24.77		12.00	
					9.23		23.50		10.72	
AL1 – 3	09-06-2021	423	204	172	13.63	14.95	24.77	19.27	7.40	7.06
					18.46		17.15		7.91	
					12.75		15.88		5.87	
AL1 – 4	11-06-2021	223	58	149	5.71	6.59	16.51	13.76	9.19	9.62
					5.71		14.61		8.93	
					8.35		10.16		10.72	
AL1 – 5	16-06-2021	476	103	203	17.14	16.56	18.42	16.51	7.15	6.81
					14.07		16.51		6.89	
					18.46		14.61		6.38	
AL1 - 6	18-06-2021	268	111	116	9.23	10.55	26.68	25.41	12.00	12.42
					9.67		27.95		12.51	
					12.75		21.60		12.76	
AL1 - 7	23-06-2021	415	179	65	5.71	6.74	26.68	26.68	6.89	7.83
					6.15		28.58		5.87	
					8.35		24.77		10.72	
AL1 – 8	25-06-2021	341	141	57	11.87	13.48	17.15	23.29	10.98	10.98
					17.14		20.33		12.00	
					11.43		32.39		9.96	
Monthly Average		374	130	108		11.17		21.49		9.79
Standard Deviation		89	46	61		3.65		4.53		2.28

NS: Not Specified

Table 1B : Results of Air Pollutant Concentration at Marine Bhavan					
Parameter	Date	C_6H_6 [µg/m^3]	HC* ppm	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL1 – 1	02/06/2021	1.2	BDL	1.46	510
AL1 – 2	04/06/2021	1.23	BDL	1.3	519
AL1 – 3	09/06/2021	1.07	BDL	1.86	495
AL1 – 4	11/06/2021	1.06	BDL	1.84	476
AL1 – 5	16/06/2021	1.06	BDL	1.75	490
AL1 - 6	18/06/2021	1.11	BDL	1.62	489
AL1 – 7	23/06/2021	1	BDL	1.8	480
AL1 – 8	25/06/2021	1.07	BDL	1.71	476
Monthly Average		**1.10**	-	**1.67**	**492**
Standard Deviation		**0.08**	-	**0.20**	**16**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5ppm)

NS -Not Specified

At Marine Bhavan, the overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_X and NH_3 is attributed mainly by motor vehicle emission produced from various types of automobiles (both diesel and petrol driven). Moreover, the loading and unloading of Food Grains and Timber at Jetty no. 1 and 2 also contributes to the high levels of TSPM and PM_{10}. The mean TSPM value at Marine Bhavan was 374 µg/m^3, The mean PM_{10} values were 130.0 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 108 µg/m^3). The average values of SO_2, NO_x and NH_3 were within the permissible limit. The average values of SO_2, NO_x and NH3 were 11.17 µg/ m^3, 21.49 µg/ m^3 & 9.79 µg/ m^3 respectively.These were within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Marine Bhavan. The mean Benzene concentration was 1.10 µg/m^3,well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and CarbonMonoxide concentration was 1.67 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 2: Oil Jetty (AL2)

Table 2 : Results of Air Pollutant Concentration at Oil Jetty										
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**	
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**	-	**80 µg/m3**	-	**80 µg/m3**	-	**400 µg/m3**
AL2 - 1	02-06-2021	283	68	120	9.23	11.72	20.33	23.08	13.27	10.47
					13.19		25.41		10.72	
					12.75		23.50		7.40	
AL2 - 2	04-06-2021	353	108	210	9.23	11.14	18.42	17.15	10.72	10.89
					14.07		14.61		11.23	
					10.11		18.42		10.72	
AL2 - 3	09-06-2021	275	42	137	17.58	13.19	17.15	20.54	9.96	8.25
					12.74		24.14		7.91	
					9.23		20.33		6.89	
AL2 - 4	11-06-2021	257	37	145	5.27	5.42	23.50	19.27	3.32	5.87
					5.71		18.42		4.85	
					5.27		15.88		9.45	
AL2 - 5	16-06-2021	532	84	117	12.75	12.02	17.15	18.21	7.15	6.98
					9.23		20.33		7.40	
					14.07		17.15		6.38	
AL2 - 6	18-06-2021	192	111	65	11.87	7.91	26.68	28.58	10.72	11.40
					8.35		27.95		12.51	
					3.52		31.12		10.98	
AL2 - 7	23-06-2021	346	79	80	5.71	6.30	15.88	16.73	9.45	8.85
					7.91		17.15		9.70	
					5.28		17.15		7.40	
AL2 - 8	25-06-2021	256	125	31	11.87	15.09	18.42	18.84	3.83	7.83
					13.63		18.42		8.93	
					19.78		19.69		10.72	
Monthly Average		312	82	113		10.35		20.30		8.82
Standard Deviation		103	32	55		3.43		3.90		1.97

NS: Not Specified

Table 2B : Results of Air Pollutant Concentration at Oil Jetty					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC* ppm**	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL2 -1	02/06/2021	1.11	BDL	1.78	482
AL2 -2	04/06/2021	1.06	BDL	1.77	496
AL2 -3	09/06/2021	1.22	BDL	1.8	480
AL2 -4	11/06/2021	1.05	BDL	1.75	484
AL2 – 5	16/06/2021	1.02	BDL	1.81	515
AL2 – 6	18/06/2021	1.07	BDL	1.78	496
AL2 -7	23/06/2021	1.09	BDL	1.88	491
AL2 – 8	25/06/2021	1.06	BDL	1.64	470
Monthly Average		**1.09**	**-**	**1.78**	**489**
Standard Deviation		**0.06**	**-**	**0.07**	**14**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC : 0.5ppm)

NS- Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Oil Jetty area was mainly by motor vehicle emission produced from various types of vehicles Oil Jetty Area. The mean TSPM values at Oil Jetty were 312 µg/m^3 The mean PM_{10} values were 82 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 113 µg/m^3).The average values of SO_2, NO_x and NH_3 were within the permissible limit; The mean concentration of SO_2, NO_x and NH3 were 10.35 µg/m^3, 20.30 µg/m^3 and 8.82 µg/m^3 respectively.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Oil Jetty. The mean Benzene concentration was 1.09 µg/m^3 .Well below the permissible limit of 5.0 µg/m^3. , HC's were below the detectable limit and Carbon Monoxide concentration was 1.78 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 3: Kandla Colony – Estate Office (AL-3)

Table 3 : Results of Air Pollutant Concentration at Estate Office

Parameters	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period	-	24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit	-	NS	100 µg/m3	60 µg/m3	-	80 µg/m3	-	80 µg/m3	-	400 µg/m3
AL3 – 1	02-06-2021	151	18	41	3.96	6.01	18.42	16.51	4.85	8.42
					5.28		17.15		6.89	
					8.79		13.97		13.53	
AL3 – 2	04-06-2021	232	63	12	10.11	11.58	17.15	18.00	6.89	9.19
					12.75		19.69		8.17	
					11.87		17.15		12.51	
AL3 – 3	09-06-2021	290	98	55	12.75	10.84	20.33	20.11	10.98	10.47
					9.67		24.77		12.25	
					10.11		15.24		8.17	
AL3 – 4	11-06-2021	235	61	128	1.76	2.34	20.33	20.54	6.89	6.13
					2.20		23.50		5.87	
					3.08		17.78		5.62	
AL3 – 5	16-06-2021	231	66	139	5.71	10.84	26.68	22.02	13.53	9.28
					12.75		20.96		7.40	
					14.07		18.42		6.89	
AL3 – 6	18-06-2021	463	76	37	10.11	11.43	20.33	22.23	7.91	8.00
					13.63		22.87		9.96	
					10.55		23.50		6.13	
AL3 – 7	23-06-2021	382	70	35	11.87	13.33	8.26	13.97	9.96	8.68
					14.07		15.24		10.72	
					14.07		18.42		5.36	
AL3 – 8	25-06-2021	148	99	42	12.75	12.16	19.69	19.69	7.15	7.91
					12.31		22.23		9.19	
					11.43		17.15		7.40	
Monthly Average		267	69	61		9.82		19.13		8.51
Standard Deviation		109	25	46		3.70		2.83		1.27

NS: Not Specified

Table 3B : Results of Air Pollutant Concentration at Kandla Port Colony					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC***	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL3 -1	02/06/2021	1.07	BDL	1.72	489
AL3 -2	04/06/2021	1.1	BDL	1.82	502
AL3 -3	09/06/2021	1.07	BDL	1.74	482
AL3 -4	11/06/2021	1.16	BDL	1.61	480
AL3 – 5	16/06/2021	1.17	BDL	1.69	475
AL3 – 6	18/06/2021	1.1	BDL	1.7	489
AL3 – 7	23/06/2021	1.04	BDL	1.96	486
AL3 – 8	25/06/2021	1.04	BDL	1.59	464
Monthly Average		**1.09**		**1.73**	**483**
Standard Deviation		**0.05**		**0.12**	**11**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)
NS- Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Kandla Port Colony was attributed by vehicle emission produced from trucks and heavy duty vehicles that pass through the road outside Kandla Port Colony. The mean TSPMvalues at Oil Jetty were 267 µg/m^3, The mean PM_{10} values were 69µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were slightly above the permissible limit (mean = 61 µg/m^3). The average values of SO_2, NO_x and NH3 were 9.82 µg/m^3, 19.13 µg/m^3 and 8.51 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Kandla Port Colony. The mean Benzene concentration was 1.09 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.73 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 4: Gopalpuri Hospital (AL-4)

Table 4 : Results of Air Pollutant Concentration at Gopalpuri Hospital										
Parameter	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**	
Sampling Period	**-**	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	**-**	**NS**	**100 µg/m3**	**60 µg/m3**	**-**	**80 µg/m3**	**-**	**80 µg/m3**	**-**	**400 µg/m3**
AL4 -1	02-06-2021	115	40	15	3.96	2.64	13.34	15.46	5.11	5.28
					3.08		14.61		4.85	
					0.88		18.42		5.87	
AL4 -2	04-06-2021	144	43	13	8.79	7.33	14.61	17.57	6.89	7.49
					5.71		19.69		7.40	
					7.47		18.42		8.17	
AL4 -3	09-06-2021	157	49	34	2.64	3.37	14.61	20.96	6.89	7.40
					3.52		29.85		7.40	
					3.96		18.42		7.91	
AL4 -4	11-06-2021	122	29	46	9.23	7.47	5.08	6.99	3.06	4.60
					9.23		7.62		4.85	
					3.96		8.26		5.87	
AL4 – 5	16-06-2021	156	35	21	3.96	3.96	10.80	12.49	10.72	11.40
					3.52		12.07		10.98	
					4.40		14.61		12.51	
AL4 – 6	18-06-2021	207	72	108	9.23	8.65	13.34	18.42	7.40	7.57
					8.79		24.77		9.96	
					7.91		17.15		5.36	
AL4 – 7	23-06-2021	263	36	13	0.88	3.08	11.43	13.97	10.98	10.30
					3.96		13.34		12.00	
					4.40		17.15		7.91	
AL4 – 8	25-06-2021	216	111	14	3.52	4.54	12.70	11.86	7.40	7.06
					4.84		12.07		7.15	
					5.28		10.80		6.64	
Monthly Average		173	52	33		5.13		14.71		7.64
Standard Deviation		51	27	33		2.33		4.39		2.28

NS: Not Specified

Table 4B : Results of Air Pollutant Concentration at Gopalpuri Hospital					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC***	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL4 -1	02/06/2021	1.07	BDL	1.68	482
AL4 -2	04/06/2021	1.06	BDL	1.7	488
AL4 -3	09/06/2021	1.11	BDL	1.9	478
AL4 -4	11/06/2021	1.1	BDL	1.54	470
AL4 – 5	16/06/2021	1.21	BDL	1.58	455
AL4 – 6	18/06/2021	1.2	BDL	1.78	460
AL4 – 7	23/06/2021	1.19	BDL	1.94	481
AL4 – 8	25/06/2021	1.13	BDL	1.91	475
Monthly Average		**1.13**		**1.75**	**474**
Standard Deviation		**0.06**		**0.15**	**11**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)

NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Gopalpuri Hospital was attributed by vehicle emission produced from light motor vehicles of the colony residents. The mean TSPMvalues at Oil Jetty were 173 µg/m^3, The mean PM_{10} values were 52 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean= 33 µg/m^3). The average values of SO_2, NO_x and NH_3 were 5.13 µg/m^3, 14.71 µg/m^3 and 7.64 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Gopalpuri Hospital. The mean Benzene concentration was 1.13 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.75 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 5: Coal Storage Area (AL-5)

Table 5 : Results of Air Pollutant Concentration at Coal Storage Area

Parameters	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period	-	24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit	-	NS	100 µg/m3	60 µg/m3	-	80 µg/m3	-	80 µg/m3	-	400 µg/m3
AL5 – 1	02-06-2021	829	78	60	9.23	9.23	26.04	26.47	13.27	13.96
					12.75		28.58		15.32	
					5.71		24.77		13.27	
AL5 – 2	04-06-2021	332	104	97	5.71	7.77	20.33	21.60	12.51	12.00
					8.79		24.77		12.51	
					8.79		19.69		10.98	
AL5 – 3	09-06-2021	289	185	154	10.11	13.48	18.42	18.84	10.72	11.83
					12.75		17.78		12.51	
					17.58		20.33		12.25	
AL5 – 4	11-06-2021	280	70	162	9.23	13.19	12.07	13.55	10.98	10.64
					13.19		13.34		10.72	
					17.14		15.24		10.21	
AL5 – 5	16-06-2021	944	148	150	3.96	10.99	14.61	18.84	2.30	5.45
					19.78		10.80		6.89	
					9.23		31.12		7.15	
AL5 – 6	18-06-2021	603	145	234	10.11	9.23	26.68	24.56	13.53	13.96
					7.47		22.87		13.27	
					10.11		24.14		15.06	
AL5 – 7	23-06-2021	766	181	152	11.87	12.75	12.70	21.17	12.51	10.47
					14.07		17.15		10.72	
					12.31		33.66		8.17	
AL5 – 8	25-06-2021	728	208	94	13.63	11.72	18.42	15.03	12.51	9.53
					10.55		17.78		9.19	
					10.99		8.89		6.89	
Monthly Average		596	140	138		11.04		20.01		10.98
Standard Deviation		263	51	54		2.11		4.40		2.74

NS: Not Specified

Table 5B : Results of Air Pollutant Concentration at Coal Storage Area					
Parameter	Date	C_6H_6 [µg/m^3]	HC*	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3	NS	4.0 mg/m^3	NS
AL5 – 1	02/06/2021	1.08	BDL	1.78	482
AL5 – 2	04/06/2021	1.1	BDL	1.68	490
AL5 – 3	09/06/2021	1.24	BDL	1.64	462
AL5 – 4	11/06/2021	1.28	BDL	1.66	464
AL5 – 5	16/06/2021	1.31	BDL	1.66	460
AL5 – 6	18/06/2021	1.2	BDL	1.7	490
AL5 – 7	23/06/2021	1.33	BDL	1.74	464
AL5 – 8	25/06/2021	1.11	BDL	1.91	484
Monthly Average		**1.21**	**-**	**1.72**	**475**
Standard Deviation		**0.10**	**-**	**0.09**	**13**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)
NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Coal Storage Area was comparatively highest among all the locations of Air Quality monitoring in Kandla Port. High values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_X at this location was due to lifting of coal with grab and other coal handling processes near Berth no. 6 & 7. Moreover, the traffic was also heavy around this place for transport of coal thus emissions produced from heavy vehicles. The mean TSPMvalues at Coal storage were 596 µg/m^3. The mean PM_{10} values were 140 µg/m^3, which is well above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 138 µg/m^3). The average values of SO_2, NO_x and NH_3 were 11.04 µg/m^3, 20.01 µg/m^3 and 10.98 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Coal Storage Area. The mean Benzene concentration was 1.21 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.72 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 6: Tuna Port (AL-6)

Table 6 : Results of Air Pollutant Concentration at Tuna Port

Parameters	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period	-	24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit	-	NS	100 µg/m3	60 µg/m3	-	80 µg/m3	-	80 µg/m3	-	400 µg/m3
AL6 -1	02-06-2021	72	72	37	0.44	1.76	17.15	16.73	4.60	6.72
					1.32		13.34		8.17	
					3.52		19.69		7.40	
AL6 – 2	04-06-2021	80	42	39	4.84	6.01	24.77	18.84	7.40	8.76
					3.96		13.34		9.45	
					9.23		18.42		9.45	
AL6 – 3	09-06-2021	122	38	31	9.23	12.45	17.78	16.94	7.40	8.76
					18.90		14.61		8.17	
					9.23		18.42		10.72	
AL6 – 4	11-06-2021	72	25	44	3.52	2.93	10.80	14.61	3.32	4.25
					1.32		14.61		4.85	
					3.96		18.42		4.60	
AL6 – 5	16-06-2021	86	78	12	8.79	11.72	15.24	19.69	9.45	9.19
					13.63		20.33		9.96	
					12.75		23.50		8.17	
AL6 – 6	18-06-2021	187	32	66	11.87	6.74	19.69	18.00	5.62	6.30
					3.96		17.78		6.13	
					4.40		16.51		7.15	
AL6 – 7	23-06-2021	261	73	8	11.87	12.75	20.33	18.42	8.17	9.87
					12.75		26.68		10.72	
					13.63		8.26		10.72	
AL6 – 8	25-06-2021	123	109	26	8.35	10.26	11.43	10.16	9.96	8.25
					9.23		6.99		9.45	
					13.19		12.07		5.36	
Monthly Average		125	59	33		8.08		16.67		7.76
Standard Deviation		67	29	18		4.33		3.06		1.86

NS: Not Specified

Table 6B : Results of Air Pollutant Concentration at Tuna Port					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC***	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL6 -1	02/06/2021	1.2	BDL	1.72	489
AL6 – 2	04/06/2021	1.12	BDL	1.65	479
AL6 – 3	09/06/2021	1.03	BDL	1.71	466
AL6 – 4	11/06/2021	1.14	BDL	1.74	469
AL6 – 5	16/06/2021	1.05	BDL	1.71	490
AL6 – 6	18/06/2021	1.12	BDL	1.72	472
AL6 – 7	23/06/2021	1.29	BDL	1.7	470
AL6 – 8	25/06/2021	1.27	BDL	1.88	480
Monthly Average		**1.15**	**-**	**1.73**	**477**
Standard Deviation		**0.09**	**-**	**0.07**	**9**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)

NS- Not Specified

The mean TSPM values at Tuna Port were 125 µg/m^3, The mean PM_{10} values were 59 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were within the permissible limit (mean = 33 µg/m^3 µg/m^3). The average values of SO_2, NO_x and NH_3 were 8.08 µg/m^3, 16.67 µg/m^3 and 7.76 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Tuna Port. The mean Benzene concentration was 1.15 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.73 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 7: Signal Building (Vadinar) (AL-7)

Table 7 : Results of Air Pollutant Concentration at Signal Building										
Parameters	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period	-	24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit	-	NS	100 µg/m3	60 µg/m3	-	80 µg/m3	-	80 µg/m3	-	400 µg/m3
AL7 -1	02-06-2021	56	27	27	3.517	4.396	10.98	9.96	17.15	17.57
					5.715		10.47		19.69	
					3.956		8.42		15.88	
AL7 -2	04-06-2021	59	16	29	3.517	2.051	7.91	10.13	10.80	12.70
					1.319		10.98		12.07	
					1.319		11.49		15.24	
AL7 -3	09-06-2021	51	41	26	2.198	1.905	6.13	6.30	10.80	14.19
					1.319		3.32		12.70	
					2.198		9.45		19.05	
AL7 -4	11-06-2021	49	38	63	3.956	3.077	7.15	9.53	9.53	10.80
					3.077		9.96		10.80	
					2.198		11.49		12.07	
AL7 -5	16-06-2021	62	51	24	1.758	3.810	10.98	9.10	10.80	11.43
					2.198		11.49		11.43	
					7.473		4.85		12.07	
AL7 -6	18-06-2021	68	29	58	11.869	6.447	6.89	13.96	15.88	16.94
					3.956		21.44		17.78	
					3.517		13.53		17.15	
AL7 -7	23-06-2021	63	41	24	10.110	10.843	3.318611	9.28	8.892276	10.37
					10.990		11.4875		10.79776	
					11.429		13.01917		11.43293	
AL7 -8	25-06-2021	66	23	55	0.879	1.612	6.8925	7.23	24.77134	22.44
					1.758		7.913611		23.50102	
					2.198		6.8925		19.05488	
Monthly Average		59	33	38		4.268		9		15
Standard Deviation		7	11	17		3.098		2		4

NS: Not Specified

Table 7B : Results of Air Pollutant Concentration at Signal Building					
Parameter	Date	C_6H_6 [µg/m^3]	HC*	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3	NS	4.0 mg/m^3	NS
AL7 -1	02/06/2021	1.06	BDL	1.68	472
AL7 – 2	04/06/2021	1.11	BDL	1.72	468
AL7 – 3	09/06/2021	1.23	BDL	1.55	482
AL7 – 4	11/06/2021	1.07	BDL	1.69	492
AL7 – 5	16/06/2021	1.23	BDL	1.78	466
AL7 – 6	18/06/2021	1.21	BDL	1.92	478
AL7 – 7	23/06/2021	1.18	BDL	1.88	485
AL7 – 8	25/06/2021	1.14	BDL	1.68	488
Monthly Average		**1.15**	**-**	**1.74**	**479**
Standard Deviation		**0.07**	**-**	**0.12**	**10**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)
NS_ Not Specified

The mean TSPM values at Vadinar Port were 59 µg/m^3. The mean PM_{10} values were 33 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 38 µg/m^3 µg/m^3). The average values of SO_2, NO_x and NH_3 were 4.26 µg/m^3, 9 µg/m^3 and 15 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Vadinar Port. The mean Benzene concentration was 1.15 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.74 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 8: Admin Building (Vadinar) (AL-8)

Table 8 : Results of Air Pollutant Concentration at Admin Building											
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**		
Sampling Period	**-**	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	**-**	**NS**	**100 µg/m3**	**60 µg/m3**	**-**	**80 µg/m3**	**-**	**80 µg/m3**	**-**	**400 µg/m3**
AL8 -1	02-06-2021	54	16	27	0.879	1.905	8.257	8.469	6.893	6.637
					1.758		8.257		7.148	
					3.077		8.892		5.871	
AL8 -2	04-06-2021	58	19	23	0.879	1.172	19.690	16.514	5.361	4.850
					1.758		17.149		4.850	
					0.879		12.703		4.340	
AL8 -3	09-06-2021	70	63	23	2.198	1.612	14.609	12.915	1.276	1.106
					1.319		8.257		1.021	
					1.319		15.879		1.021	
AL8 -4	11-06-2021	53	47	28	1.758	2.198	17.149	17.996	2.298	4.340
					2.198		13.338		6.382	
					2.638		23.501		4.340	
AL8 -5	16-06-2021	57	12	14	2.198	2.638	17.149	12.915	3.319	3.234
					2.638		12.703		3.063	
					3.077		8.892		3.319	
AL8 -6	18-06-2021	59	28	19	1.319	1.758	9.527	9.527	4.850	4.340
					1.758		8.257		4.340	
					2.198		10.798		3.829	
AL8 -5	23-06-2021	56	29	15	0.879	1.758	6.352	8.892	3.829	5.191
					1.319		9.527		4.340	
					3.077		10.798		7.403	
AL8-6	25-06-2021	73	51	28	0.440	0.733	13.974	15.667	7.914	8.084
					0.879		15.244		10.466	
					0.879		17.785		5.871	
Monthly Average		60	33	22		1.7217		12.862		4.72
Standard Deviation		7	18	6		0.5848		3.660		2.10

NS: Not Specified

Table 8B : Results of Air Pollutant Concentration at Admin Building					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC***	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL8 -1	02/06/2021	1.21	BDL	1.78	496
AL8-2	04/06/2021	1.18	BDL	1.92	477
AL8 -3	09/06/2021	1.23	BDL	1.68	468
AL8-4	11/06/2021	1.16	BDL	1.77	484
AL8 -5	16/06/2021	1.25	BDL	1.84	477
AL8-6	18/06/2021	1.22	BDL	1.68	485
AL8-7	23/06/2021	1.16	BDL	1.62	476
AL8-8	25/06/2021	1.12	BDL	1.77	466
Monthly Average		**1.19**	**-**	**1.76**	**479**
Standard Deviation		**0.04**	**-**	**0.10**	**10**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)

NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Admin Building Vadinar was comparatively low among all the locations of Air Quality monitoring in Kandla Port and Vadinar Port. The mean TSPMvalues at Vadinar Port were 60 µg/m^3. The mean PM_{10} values were 33 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 22.0 µg/m^3). The average values of SO_2, NO_x and NH_3 were 1.72 µg/m^3, 12.86 µg/m^3 and 4.72 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Admin Building, Vadinar Port. The mean Benzene concentration was 1.19 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.76 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

1.4 Observations and Conclusion

During the monitoring period, the overall Ambient Air Quality of the port area was found to be well within the desired levels for various pollutants. However, Near Coal storage area, Marine Bhavan and Oil Jetty area, PM_{10} values was above the permissible standards. All other pollutants were recorded well below the prescribed limits.

2. Drinking Water Quality Monitoring

Drinking Water Quality Monitoring was carried out at twenty stations at Kandla, Vadinar & Township Area of Deendayal Port.

2.1 Drinking Water Monitoring Methodology

Drinking water samples were collected from 20 locations as prescribed in the tender document. Samples for physico-chemical analysis were collected in 1 liter carboys and samples for microbiological parameters were collected in sterilized bottles. These samples were then analyzed in laboratory for various drinking water parameters at Kandla Lab/Surat.

The Sampling and Analysis was done as per standard methods - CPCB/GPCB Guidelines and Standard Methods -APHA. The water samples were analyzed for various parameters, viz. Color , Odor, Turbidity , Conductivity , pH , Chlorides , TDS, Total Hardness, Iron , Sulphate , Salinity , DO, BOD, Na, K, Ca, Mg, F, NO_3, NO_2, Mn, Cr-6, Cu, Cd, As, Hg, Pb, Zn, Bacterial Count (cfu) .

2.2 Results

The Drinking Water Quality monitoring data for 20 stations are given in below from table No. 9 to Table No. 15

Table 9: Drinking Water Quality Monitoring Parameters for Nirman Building 1, P & C building & Main Gate (North) at Kandla

Sr. No.	Parameter	Unit	Nirman Building 1	P & C building	Main Gate North	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.1	7.3	7.8	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	570	590	610	500	2000
3	Turbidity	NTU	1	1	0	1.0	5.0
4	Odor	-	Odourless	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	1243.0	1150.0	1190.0	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2.0	NS*	NS*
8	Chloride as Cl	mg/l	513.19	457.02	561.25	250.0	1000.0
9	Ca as Ca	mg/l	48.10	44.09	48.10	75.0	200.0
10	Mg as Mg	mg/l	82.62	87.48	89.91	30.0	100.0
11	Total Hardness	mg/l	460.0	470.0	490.0	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides as F	mg/l	0.30	0.47	0.24	1.0	1.5
14	Sulphate as SO4	mg/l	232.8	180	258	200.0	400
15	Nitrite as NO2	mg/l	0.04	0.05	0.05	NS*	NS*
16	Nitrate as NO3	mg/l	0.77	9.15	28.16	45.0	No Relaxation
17	Salinity	%	0.93	0.83	1.01	NS*	NS*
18	Sodium as Na	mg/l	322.0	315.0	342.0	NS*	NS*
19	Potassium as K	mg/l	3.44	3.21	4.08	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 10: Drinking Water Quality Monitoring Parameters for Canteen, West Gate – I & Wharf Area at Kandla

Sr. No.	Parameter	Unit	Canteen	West Gate - I	Wharf Area	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.0	7.6	7.4	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	910.0	960.0	870.0	500	2000
3	Turbidity	NTU	0	1	0	1.0	5.0
4	Odor	-	Odourless	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	1703.0	1753.0	1630.0	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2.0	NS*	NS*
8	Chloride as Cl	mg/l	613.86	620.88	658.46	250.0	1000.0
9	Ca as Ca	mg/l	52.10	52.10	44.09	75.0	200.0
10	Mg as Mg	mg/l	72.90	80.19	77.76	30.0	100.0
11	Total Hardness	mg/l	430.0	460.0	430.0	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<.0.01	0.3	No Relaxation
13	Fluorides as F	mg/l	0.47	0.32	0.42	1.0	1.5
14	Sulphate as SO4	mg/l	156.0	300.0	366.0	200.0	400
15	Nitrite as NO2	mg/l	0.03	<0.01	0.03	NS*	NS*
16	Nitrate as NO3	mg/l	24.64	10.56	12.67	45.0	No Relaxation
17	Salinity	%	1.11	1.12	1.19	NS*	NS*
18	Sodium as Na	mg/l	333.0	362.0	412.0	NS*	NS*
19	Potassium as K	mg/l	3.78	3.99	4.11	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 11: Drinking Water Quality Monitoring Parameters for Sewa sadan – 3, Workshop I & Custom Building at Kandla

Sr. No.	Parameter	Unit	SewaSadan – 3	Workshop	Custom Building	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.3	7.4	7.8	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1090.0	830.0	935.0	500	2000
3	Turbidity	NTU	1	0	1	1.0	5.0
4	Odor	-	Odourless	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	1910.0	1600.0	1820.0	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2.0	NS*	NS*
8	Chloride	mg/l	743.65	571.77	550.72	250.0	1000.0
9	Ca as Ca	mg/l	52.10	56.11	48.10	75.0	200.0
10	Mg as Mg	mg/l	82.62	85.05	80.19	30.0	100.0
11	Total Hardness	mg/l	470.0	490.0	450.0	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.32	0.93	0.30	1.0	1.5
14	Sulphate	mg/l	190.8	172.8	195.6	200.0	400
15	Nitrite	mg/l	0.01	0.03	0.05	NS*	NS*
16	Nitrate	mg/l	13.37	6.33	12.67	45.0	No Relaxation
17	Salinity	%	1.34	1.03	0.99	NS*	NS*
18	Sodium as Na	mg/l	333.0	342.	392.0	NS*	NS*
19	Potassium as K	mg/l	3.88	3.71	4.12	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 12: Drinking Water Quality Monitoring Parameters for Port Colony Kandla, Hospital Kandla & A.O. Building at Gandhidham

Sr. No.	Parameter	Unit	Port Colony Kandla	Hospital Kandla	A.O. Building	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.2	7	7.2	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1200.0	1400.0	1090.0	500	2000
3	Turbidity	NTU	0	0	1	1.0	5.0
4	Odor	-	Odourless	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	2512.0	2830.0	1920.0	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2.0	NS*	NS*
8	Chloride	mg/l	763.70	794.77	838.86	250.0	1000.0
9	Ca as Ca	mg/l	56.11	48.10	60.12	75.0	200.0
10	Mg as Mg	mg/l	77.76	80.19	77.76	30.0	100.0
11	Total Hardness	mg/l	460.0	450.0	470.0	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.77	0.12	0.21	1.0	1.5
14	Sulphate	mg/l	202.8	261.6	372	200.0	400
15	Nitrite	mg/l	0.05	0.05	0.06	NS*	NS*
16	Nitrate	mg/l	5.63	12.67	16.89	45.0	No Relaxation
17	Salinity	%	1.38	1.44	1.52	NS*	NS*
18	Sodium as Na	mg/l	322.0	373.0	432.0	NS*	NS*
19	Potassium as K	mg/l	3.61	3.81	4.45	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 13: Drinking Water Quality Monitoring Parameters for School Gopalpuri, Guest House & E - Type Quarter at Gopalpuri, Gandhidham

Sr. No.	Parameter	Unit	School Gopalpuri	Guest House	E - Type Quarter	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.1	7.3	7.4	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	970.0	1010.0	1135.0	500	2000
3	Turbidity	NTU	0	1	0	1.0	5.0
4	Odor	-	Odourless	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	1850.0	1920.0	2210.0	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2.0	NS*	NS*
8	Chloride	mg/l	708.58	615.87	845.88	250.0	1000.0
9	Ca as Ca	mg/l	56.11	52.10	56.11	75.0	200.0
10	Mg as Mg	mg/l	82.62	85.05	85.05	30.0	100.0
11	Total Hardness	mg/l	480.0	480.0	490.0	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	1.37	0.89	0.33	1.0	1.5
14	Sulphate	mg/l	369.6	384	376.8	200.0	400
15	Nitrite	mg/l	0.04	0.06	0.04	NS*	NS*
16	Nitrate	mg/l	7.74	6.33	12.67	45.0	No Relaxation
17	Salinity	%	1.28	1.11	1.53	NS*	NS*
18	Sodium as Na	mg/l	392.0	320.0	332.0	NS*	NS*
19	Potassium as K	mg/l	4.11	3.11	3.29	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 14: Drinking Water Quality Monitoring Parameters for F - Type Quarter, Hospital Gopalpuri & Tuna Port

Sr. No.	Parameter	Unit	F - Type Quarter	Hospital Gopalpuri	Tuna Port	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7	7.3	7.38	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	890.0	950.0	1030.0	500	2000
3	Turbidity	NTU	1	0	0	1.0	5.0
4	Odor	-	Odourless	Odourless	Odorless	Agreeable	Agreeable
5	Color	Hazen Unit	Colourless	Colourless	Colorless	5.0	15.0
6	Conductivity	µs/cm	1700.0	2030.0	1920.0	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	<2	NS*	NS*
8	Chloride	mg/l	706.57	545.21	692.0	250.0	1000.0
9	Ca as Ca	mg/l	52.10	56.11	69.74	75.0	200.0
10	Mg as Mg	mg/l	85.05	85.05	38.39	30.0	100.0
11	Total Hardness	mg/l	480	490	332.0	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.65	1.00	0.39	1.0	1.5
14	Sulphate	mg/l	358.8	378	112.8	200.0	400
15	Nitrite	mg/l	0.06	0.04	<0.01	NS*	NS*
16	Nitrate	mg/l	9.856	11.264	1.42	45.0	No Relaxation
17	Salinity	%	1.28	0.98	1.23	NS*	NS*
18	Sodium as Na	mg/l	373.0	351.0	344	NS*	NS*
19	Potassium as K	mg/l	4.07	3.87	3.4	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 15: Drinking Water Quality Monitoring Parameters for Vadinar Jetty & Port Colony at Vadinar

Sr. No.	Parameter	Unit	Vadinar Jetty	Port Colony Vadinar	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.5	7.3	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	990.0	1010.0	500	2000
3	Turbidity	NTU	0.00	1.00	1.0	5.0
4	Odor	-	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	1830.0	1990.0	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2.0	<2.0	NS*	NS*
8	Chloride	mg/l	445.99	496.10	250.0	1000.0
9	Ca as Ca	mg/l	52.104	56.11	75.0	200.0
10	Mg as Mg	mg/l	80.19	80.19	30.0	100.0
11	Total Hardness	mg/l	460.0	470.0	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.82	0.94	1.0	1.5
14	Sulphate	mg/l	30.00	34.80	200.0	400
15	Nitrite	mg/l	0.04	0.04	NS*	NS*
16	Nitrate	mg/l	4.93	4.79	45.0	No Relaxation
17	Salinity	%	0.81	0.90	NS*	NS*
18	Sodium as Na	mg/l	311.0	306.0	NS*	NS*
19	Potassium as K	mg/l	4.3	4.9	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent

*NS: Not Specified

2.3 Results & Discussion

The colour of all drinking water samples was < 5 Hazen unit and odour of the samples was also agreeable. All parameters are found to be within the specified limit of the Drinking water Standard.

pH

The limit of pH value for drinking water is specified as 6.5 to 8.5. pH value in the studied area varied from 6.9 to 7.8 pH unit. All the sampling points showed pH values within the prescribed limit by Indian Standards.

Total Dissolved Solids (TDS)

TDS values in the studied area varied between 600 -1800 mg/l. None of the sampling points showed higher TDS values than the prescribed limit by Indian standards .

Conductivity

Electrical Conductivity is the ability of a solution to transfer (conduct) electric current. Conductivity is used to measure the concentration of dissolved solids which have been ionized in a polar solution such as water. The conductivity in the samples collected during the month of June ranged from 2000-3800 µs/cm. Electrical conductivity standards do not appear in BIS standards for drinking water.

BOD

BOD value in the studied area was less than 2.0 mg/L. Indian standards does not show any standard values for BOD in drinking water.

Chlorides

Excessive chloride concentration increase rates of corrosion of metals in the distribution system. This can lead to increased concentration of metals in the supply. Chloride value in the studied area varied between 380-960 mg/l and is found to be within the Permissible limit of the Drinking Water Standard.

Calcium

Calcium value in the studied area varied between 60 - 90 mg/l and is found to be within the Permissible limit of the Drinking Water Standard. If calcium is present beyond the maximum acceptable limit, it causes incrustation of pipes.

Magnesium

Magnesium value in the studied area varied between 25 – 90 mg/l. All the locations had Magnesium within the prescribed limits of 30-100 mg/L.

Total Hardness

Hardness value in the studied area varied between 312-520 mg/l and is found to be within the Permissible limit of the Drinking Water Standard.The prescribed limit by Indian Standards is 200-600 mg/L.

Iron

Iron value in the studied area was below 0.01mg/L and hence well below the permissible limit as per Indian Standards is 0.3 mg/L. The excess amount of iron causes slight toxicity; gives stringent taste to water.

Fluoride

Fluoride value in the studied area varied between 0.1 – 1.0 mg/l and hence well below the permissible limit as per Indian Standards is 1.0-1.5 mg/L. Moderate amounts lead to dental effects, but long-term ingestion of large amounts can lead to potentially severe skeletal problems.

Sulphates

Sulphate value in the studied area varied between 100 – 330 mg/l. All the sampling points showed sulphate values within the prescribed limits by Indian Standards (200-400 mg/L). Sulphate content in drinking water exceeding the 400 mg/L imparts bitter taste.

Nitrites (NO_2) and Nitrates (NO_3)

Nitrite values in all the water samples were <0.1. There are no specified standard values for Nitrites in Drinking water. The mean Nitrate values in drinking water of KPT was 4.10 mg/l which is well within the permissible limit of the Drinking water Standard.

Salinity

Salinity in drinking water in the present samples collected ranged from 0.6 to 1.8 % . There are no prescribed Indian standards for salinity in Drinking water.

Sodium and Potassium Salts

Sodium values in the samples collected ranged from 80 - 460 mg/l and Potassium salts ranged from 2.8 to 4.6 mg/l. There are no prescribed limits of Sodium and Potassium in Indian standards for Drinking water**.**

Heavy Metals in Drinking Water

In the present study period drinking water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals were well below the permissible limits prescribed by the Indian Standards.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that Bacteria is not present and hence Bacterial count is in line with the permissible limit of drinking water. This shows that all the drinking water samples were safe from any bacteriological contamination.

2.4 Conclusions

These results are compared with acceptable limits as prescribed in IS 10500:2012 – Drinking Water Specification. It is seen from the analysis data that during the study period the water was safe for human consumption at all drinking water monitoring stations.

3. Noise Level Monitoring

Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships. Noise Monitoring was done at 13 stations at Kandla, Vadinar and Township area.

3.1 Method of Monitoring

Sampling was done at all stations for 24 hour period. Data was recorded using automated sound level meter. The intensity of sound was measured in sound pressure level (SPL) and common unit of measurement is decibel (Db).

3.2 Results

Table 16: Noise Monitoring data for ten locations of Deendayal Port and two locations of Vadinar Port

Sr. No.	Location	Day Time Average Noise Level (SPL) in dB(A)	Night Time Average Noise Level (SPL) in dB(A)
	Sampling Time	**6:00 am to 10:00 PM**	**10:00PM to 6:00 AM**
1	Marine Bhavan	63.40	57.1
2	Nirman Building 1	57.8	53.9
3	Tuna Port	55.8	47.1
4	Main Gate North	57.1	52.8
5	West Gate I	62.1	54.6
6	Canteen Area	57.1	49.6
7	Main Road	60.0	57.8
8	ATM Building	63.5	56.2
9	Wharf Area /Jetty Area	67.1	57.8
10	Port & Custom Office	55.5	52.7
	Vadinar Port		
11	Entrance Gate of Vadinar Port	57.1	54.6
12	Nr. Port Colony, Vadinar	56.2	56.2
13	Nr. Vadinar Jetty	59.6	55.8

3.3 Conclusions- Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships. The Day Time Average Noise Level (SPL)in all ten locations at Deendayal Port ranged from 56.25 dB(A) to 69.51 dB(A) and it was within the permissible limits of 75 dB(A) for the industrial area for the daytime. The Night Time Average Noise Level (SPL) in all ten locations of Deendayal Port ranged from 48.28 dB to 62.33 dB(A) and it was within the permissible limits of 70 dB(A) for the industrial area for the night time.

4. Soil Monitoring

Sampling and analysis of soil samples were undertaken at six locations within the study area (Deendayal Port and Vadinar Port) as a part of EMP. The soil sampling locations are initially decided based on the locations as provided in the tender document of the Deendayal Port.

4.1 Methodology

The soil samples were collected in the month of June 2021. The samples collected from the all locations are homogeneous representative of each location. At random locations were identified at each location and soil was dug from 30 cm below the surface. It was uniformly mixed before homogenizing the soil samples. The samples were filled in polythene bags, labeled in the field with number and site name and sent to laboratory for analysis.

4.2 Results

Table-17: Chemical Characteristics of Soil in the Study Area

Sr. No.	Parameter	Unit	Station Name					
			SL1	SL2	SL3	SL4	SL5	SL6
			Tuna Port	IFFCO Plant	Khori Creek	Nakti Creek	KPT Admin Site	KPT Colony
			Near main gate of Port	10 m away from main gate	Sand from creek at low tide		Vadinar	
1	Texture		Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	pH	-	7.30	8.16	8.36	8.26	7.27	7.82
3	Electrical Conductivity	µs/cm	33400.0	48500.0	21800.0	37200.0	511.0	464.0
4	Moisture	%	21.45	13.94	18.82	14.26	6.28	4.56
5	Total Organic Carbon	%	0.31	0.19	0.26	0.24	0.15	0.11
6	Alkalinity	mg/kg	100.1	140.14	80.08	140.14	60.06	100.1
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
8	Chloride	mg/kg	6228.7	6032.5	2550.3	7160.6	68.66	78.47
9	Sulphate	mg/kg	2056.4	75.86	292.0	87.84	14.37	13.58
10	Phosphorus	mg/kg	0.97	1.41	0.79	1.59	0.97	0.97
11	Potassium	mg/kg	1161.0	592.2	700.2	765.0	626.4	876.4
12	Calcium	mg/kg	641.3	561.12	701.4	661.32	124.2	172.3
13	Sodium	mg/kg	10821.6	2992.8	3164.4	3736.8	2116.8	2565.0
14	Copper as Cu	mg/kg	11.21	27.22	28.20	31.78	82.66	72.42
15	Lead as Pb	mg/kg	3.10	6.20	23.0	11.4	ND	ND
16	Nickel as Ni	mg/kg	20.71	1823	7.80	15.10	25.46	27.73
17	Zinc as Zn	mg/kg	32.26	72.62	65.90	77.21	23.46	43.20
18	Cadmium as Cd	mg/kg	ND	ND	ND	ND	ND	ND

4.3 Discussion

- The data shows that value of pH ranges from 8.68at Nakti Creek to 9.02 at Tuna Creek indicating that all soil sample sare neutral to basic. Iffco plant samples howed maximum conductivity of 36,200µmhos/cm, while Nakti Creek location showed minimum conductivity of 4790µmhos/cm. Conductivity at Vadinar Port was 439 and 634 µmhos/cm at Admin site and Vadinar Port colony respectively.
- Total organic Carbon ranged from 0.7 % to 2.3 at Deendayal Port. At Vadinar Port, organic carbon content ranged from 0.8 % to 1.04 %.
- The concentration of Phosphorus and Potassium in the soil samples varies from 34.0 to 53.0mg/kg and 700.0 to 1100 mg/kg respectively at Deendayal Port. The mean concentration of Phosphorous at Vadinar site was 6.82 mg/kg and mean concentration of Potassium at Vadinar site was 176.5 mg/kg.

These differences in NPK in soil at different locations are due to the dissimilar nature of soil at each of the locations. Samples SL3 & SL4 (Khori Creek & Nakti Creek) are of saline nature as they are coastal soil; where as other locations are inland locations and have different chemical properties.

Heavy Metals in the Soil

Traces of Copper, Lead, Nickel, Zinc were observed in the soil samples collected from all the four locations of Deendayal Port and two locations of Vadinar Port. Cadmium metal was not detected in the Soil.

4.4 Conclusion

The soils of Deendayal Port and Vadinar Port appears to be neutral to basic with varying levels of Chloride, Sulphate, NPK and Calcium. As the nature of soil at different locations are different with respect to its proximity to the sea, the samples showed high degree of variations in their chemical properties.

5. Sewage Treatment Plant Monitoring

This involves safe collection of waste water (spent/used water) from wash areas, bathroom, industrial units, etc., waste from toilets of various buildings and its conveyance to the treatment plant and final disposal in conformity with the requirement and guide lines of State Pollution Control Board and other statutory bodies.

5.1 Methodology for STP Monitoring

To monitor the working efficiency of Sewage Treatment Plant (STP), STP Inlet and Outlet Samples were collected once a week. Locations selected are namely Gopalpuri Township, Deendayal Port and Vadinar. Samples were collected in 1 lit. carboys and were analyzed in laboratory for various parameters.

5.2 Results

- **Kandla STP**

Table 18: Sewage Water Monitoring at Kandla STP (1st Week)

Date of Sampling	05.06.21

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.62	7.23
2	Total Suspended Solids	mg/l	450	38.2
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	494.9	40.4
5	BOD @ 27 °C	mg/l	152.0	12.0
Aeration Tank				
6	MLSS	mg/l	40.0	
7	MLVSS	%	82.0	

Table 19: Sewage Water Monitoring at Kandla STP (2nd Week)

Date of Sampling	10.06.21

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.93	7.13
2	Total Suspended Solids	mg/l	268.3	58.3
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	289.87	63.63
5	BOD @ 27 °C	mg/l	94.0	16.0
Aeration Tank				
6	MLSS	mg/l	36.0	
7	MLVSS	%	74.0	

Table 20: Sewage Water Monitoring at Kandla STP (3rd Week)

Date of Sampling	15.06.21

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.43	7.23
2	Total Suspended Solids	mg/l	210.5	99
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	259.57	31.31
5	BOD @ 27 °C	mg/l	72.0	8.0
Aeration Tank				
6	MLSS	mg/l	36.0	
7	MLVSS	%	78.0	

Table 21: Sewage Water Monitoring at Kandla STP (4th Week)

Date of Sampling	21.06.21

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.71	7.02
2	Total Suspended Solids	mg/l	226.1	18.3
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	303.0	96.0
5	BOD @ 27 °C	mg/l	110.0	18.0
Aeration Tank				
6	MLSS	mg/l	20.0	
7	MLVSS	%	96.0	

- **Gopalpuri Colony STP**

Table 22: Sewage Water Monitoring at Gopalpuri STP (1st Week)

Date of Sampling	05.06.21

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.21	7.09
2	Total Suspended Solids	mg/l	166.7	54.9
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	383.8	84.4
5	BOD @ 27 °C	mg/l	124.0	16.0
Aeration Tank				
6	MLSS	mg/l	28.0	
7	MLVSS	%	86.0	

Table 23: Sewage Water Monitoring at Gopalpuri STP (2nd Week)

Date of Sampling	10.06.21

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.7	7.26
2	Total Suspended Solids	mg/l	95.21	41.9
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	431.27	109.8
5	BOD @ 27 °C	mg/l	138.0	19.0
Aeration Tank				
6	MLSS	mg/l	18.0	
7	MLVSS	%	96.0	

Table 24: Sewage Water Monitoring at Gopalpuri STP (3rd Week)

Date of Sampling	15.06.21

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.53	7.29
2	Total Suspended Solids	mg/l	52.9	20.1
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	230.28	57.57
5	BOD @ 27 °C	mg/l	76.0	15.0
Aeration Tank				
6	MLSS	mg/l	12.0	
7	MLVSS	%	92.0	

Table 25: Sewage Water Monitoring at Gopalpuri STP (4th Week)

Date of Sampling	21.06.21

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.25	7.12
2	Total Suspended Solids	mg/l	183.8	89
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	202	20.2
5	BOD @ 27 °C	mg/l	68.0	6.0
Aeration Tank				
6	MLSS	mg/l	38.0	
7	MLVSS	%	98.0	

- **Vadinar STP**

Table 26: Sewage Water Monitoring at Vadinar STP (1st Week)

Date of Sampling	05.06.21

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.26	NOT WORKING
2	Total Suspended Solids	mg/l	139.5	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	222.2	
5	BOD @ 27 °C	mg/l	86.0	

Table 27: Sewage Water Monitoring at Vadinar STP (2nd Week)

Date of Sampling	05.06.21

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.36	NOT WORKING
2	Total Suspended Solids	mg/l	108.8	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	353.5	
5	BOD @ 27 °C	mg/l	108.0	

Table 28: Sewage Water Monitoring at Vadinar STP (3rd Week)

Date of Sampling	15.06.21

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.14	NOT WORKING
2	Total Suspended Solids	mg/l	166.7	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	171.7	
5	BOD @ 27 °C	mg/l	52.0	

Table 29: Sewage Water Monitoring at Vadinar STP (4th Week)

Date of Sampling	21.06.21

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/l
1	pH	pH unit	7.26	Not working
2	Total Suspended Solids	mg/l	203.5	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	90.9	
5	BOD @ 27 °C	mg/l	28.0	

5.3 Conclusions:

The GPCB standards of BOD, TSS and Residual Chlorine for STP outlet are 20 mg/lit, 30 mg/lit & 0.5 mg/lit respectively. It is suggested to do treatment on regular basis to avoid flow of contaminated/polluted water into the sea. Also, the STP at Vadinar is also non-functional and thus, steps should be taken to commission the STP at Vadinar Port. Hence, currently only inlet samples are collected and analysed.

6. Marine Water Monitoring

The Forty Second Amendment to the Constitution in 1976 underscored the importance of 'green thinking'. Article 48A enjoins the state to protect and improve the environment and safeguard the forests and wildlife in the country. Further, Article 51A(g) states that the "fundamental duty of every citizen is to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures".

Policy Statement for Abatement of Pollution (1992) has suggested developing relevant legislation and regulation, fiscal incentives, voluntary agreements and educational programs and information campaigns. It emphasizes the need for integration by incorporating environmental considerations into decision making at all levels by adopting frameworks namely, pollution prevention at source, application of best practicable solution, ensure polluter pays for control of pollution, focus on heavily polluted areas and river stretches and involve public in decision-making. The National Conservation Strategy and Policy Statement on Environment and Development, (1992) aimed at "integrating environmental concerns with developmental imperatives to meet the challenges by redirecting the thrust of our developmental process so that the basic needs of our people could be fulfilled by making judicious and sustainable use of natural resources." The priorities mentioned in this policy document include the sustainable use of land and water resources, prevention and control of pollution and preservation of biodiversity.

The National Water Policy, (2002) contains provisions for developing, conserving, sustainable utilizing and managing this important water resources and need to be governed by national perspectives.

Marine Environment

On national and state levels, we have several policies and regulation like Water (Prevention and Control of Pollution) Act, 1974, to regulate pollution discharges and restore water quality of our aquatic resources including the prescription of monitoring activities. One of the important provisions of the Water Act, 1974, is to maintain and restore the 'wholesomeness' of our aquatic resources. Water quality monitoring is one of the first steps required in the rational development and management of water resources. In the field of water quality management, there has been a steady evolution in procedures for designing system to obtain information on the changes of water quality. The monitoring comprises all activities to obtain 'information' with respect to the water system.

Sampling Stations

The monitoring of marine environment for the study of biological and ecological parameters was carried out on 10th& 11th June -2021 in harbor regions of KPT and on 10th June-2021 at Vadinar during spring tide period of New moon phase of Lunar Cycle. The monitoring of marine environment for the study of biological and ecological parameters was repeated again on 18th& 19th June 2021 in harbor regions of KPT. 18th June -2021 in Vadinar during Neap tide period first quarter of Lunar Cycle..

Plankton samples from sub surface layer was collected both during high tide period and low tide period from 3 water quality monitoring stations of KPT harbour area and two stations in Nakti creek and one station in Khori creek. The same sampling schedule was repeated during consecutive spring tide and neap tide in same month. Plankton samples from sub surface layer was collected both during high tide period and low tide period from 1 water quality monitoring stations near Vadinar jetty area during spring tide and neap tide in this month .Collected water samples were processed for estimation of Chlorophyll- a, Pheophytin- a, qualitative &quantitative evaluation of phytoplankton, qualitative &quantitative evaluation zooplanktons (density and their population).

Sampling Locations

Offshore monitoring requirement	Number of locations
Offshore Installations	3 in Kandla creek 2 in Nakti creek 1 in Khori creek 1 near Vadinar Jetty 1 near 1st SBM
Total Number of locations	**8**

6.1 Marine Water Quality

Marine water quality of marine waters of Deendayal Port Harbor waters, Khori and Nakti Creeks and two locations of Vadinar are monitored for various physico-chemical parameters during spring and neap tide of each month.

The results of marine water quality and Marine sediments are as below;

Table 30: Marine Water Quality Monitoring Parameters for location near KPT colony

Sr. No.	Parameters	Unit	Kandla Creek Near KPT colony (1) 23°0'58"N 70°13'22."E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.21	7.35	7.18	7.14
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.7	32.1	32.8	
5	Turbidity	NTU	29	28	28	24
6	Total Dissolved Solids	mg/l	31107.0	35947.0	37797.0	33665.0
7	Total Suspended Solids	mg/l	377.4	359.9	714.2	412.4
8	Total Solids	mg/l	31560.0	36800.0	38860.0	34260.0
9	DO	mg/l	4.9	4.6	3.5	3.3
10	COD	mg/l	78.0	82.0	72.0	76.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.23	0.25	0.56	0.38
13	Phosphate	mg/l	0.35	0.36	0.27	0.24
14	Sulphate	mg/l	3360	3156	2628	3216
15	Nitrate	mg/l	1.97	2.35	2.14	2.78
16	Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01
17	Calcium	mg/l	561.12	641.28	641.28	521.04
18	Magnesium	mg/l	1676.7	1676.7	1555.2	1725.3
19	Sodium	mg/l	11220.0	12080.0	8194.0	7418.0
20	Potassium	mg/l	380.0	390.0	372.0	414.0
21	Iron	mg/l	1.48	1.66	1.76	1.92
22	Chromium	mg/l	0.11	0.13	0.12	0.13
23	Copper	mg/l	0.05	0.06	0.06	0.07
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.06	0.08	0.05	0.06
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.15	0.17	0.16	0.18
28	Zinc	mg/l	0.06	0.07	0.05	0.06

Table 31: Marine Water Quality Monitoring Parameters for location near passenger Jetty One at Kandla

Sr. No.	Parameters	Unit	Near passenger Jetty One (2) 23° 0'18 "N 70°13'31"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.5	7.5	7.28	7.15
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.0	32.1	32.6	32.1
5	Turbidity	NTU	29	31	39	29
6	Total Dissolved Solids	mg/l	39865.0	39935.0	41765.0	36900.0
7	Total Suspended Solids	mg/l	366.8	414.5	404.0	477.9
8	Total Solids	mg/l	40212.0	40500.0	46018.0	37338.0
9	DO	mg/l	5.1	5.0	3.5	3.5
10	COD	mg/l	82.0	92.0	78.0	80.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.25	0.27	0.81	0.32
13	Phosphate	mg/l	0.35	0.32	0.20	0.33
14	Sulphate	mg/l	3120.0	3708.0	3336.0	2880.0
15	Nitrate	mg/l	6.0	2.54	1.35	4.33
16	Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01
17	Calcium	mg/l	721.44	601.2	681.36	561.12
18	Magnesium	mg/l	1701.0	1603.8	1676.7	1725.3
19	Sodium	mg/l	11460.0	13211.0	9929.0	10111.0
20	Potassium	mg/l	390.0	382.0	471.0	381.0
21	Iron	mg/l	1.76	1.56	1.72	1.80
22	Chromium	mg/l	0.13	0.11	0.14	0.12
23	Copper	mg/l	0.06	0.07	0.08	0.07
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.05	0.06	0.06	0.07
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.18	0.16	0.17	0.16
28	Zinc	mg/l	0.06	0.06	0.07	0.07

Table 32: Marine Water Quality Monitoring Parameters for location Near Coal Berth

Sr. No.	Parameters	Unit	Near Coal Berth			
			22°59'12"N 70°13'40"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.3	7.21	7.2	7.5
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.0	32.2	32.0	32.3
5	Turbidity	NTU	33.0	31.0	31.8	32.0
6	Total Dissolved Solids	mg/l	34545.0	37030.0	35312.0	35363.0
7	Total Suspended Solids	mg/l	275.3	344.5	563.5	603.2
8	Total Solids	mg/l	35266.0	38080.0	36540	36100.0
9	DO	mg/l	4.8	4.6	4.2	4.3
10	COD	mg/l	86.0	92.0	101.0	100.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.27	0.20	0.38	0.22
13	Phosphate	mg/l	0.28	0.30	0.22	0.21
14	Sulphate	mg/l	1344	1500	2436	3240
15	Nitrate	mg/l	5.56	5.70	2.45	2.27
16	Nitrite	mg/l	0.028	0.02	0.04	0.02
17	Calcium	mg/l	641.28	681.36	601.2	641.28
18	Magnesium	mg/l	1555.2	1676.7	1652.4	1725.3
19	Sodium	mg/l	12015.0	11852.0	9320.0	9481.0
20	Potassium	mg/l	343.0	355.0	491.0	512.0
21	Iron	mg/l	1.44	1.23	1.64	1.34
22	Chromium	mg/l	0.12	0.10	0.12	0.13
23	Copper	mg/l	0.06	0.05	0.06	0.06
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.05	0.06	0.06	0.07
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.18	0.12	0.16	0.14
28	Zinc	mg/l	0.06	0.06	0.05	0.06

Table 33: Marine Water Quality Monitoring Parameters for location Khori creek at Kandla

Sr. No.	Parameters	Unit	KPT 4			
			Near 15/16 Berth			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.43	7.59	7.21	7.39
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.2	33.1	31.8	31.6
5	Turbidity	NTU	37	35	25	47
6	Total Dissolved Solids	mg/l	40837.0	45070.0	33588.0	33133.0
7	Total Suspended Solids	mg/l	299.2	315.5	407.3	438.9
8	Total Solids	mg/l	42994.0	46208.0	34336.0	34040.0
9	DO	mg/l	4.7	4.5	4.4	3.6
10	COD	mg/l	86.0	92.0	78.0	80.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.24	2.34	0.63	0.41
13	Phosphate	mg/l	0.28	0.32	0.26	0.28
14	Sulphate	mg/l	2628	2124	2988	2148
15	Nitrate	mg/l	7.25	2.64	4.67	7.08
16	Nitrite	mg/l	0.02	0.02	0.02	0.02
17	Calcium	mg/l	641.28	601.2	641.28	601.2
18	Magnesium	mg/l	1628.1	1749.6	1676.7	1652.4
19	Sodium	mg/l	10920.0	10962.0	9381.0	9252.0
20	Potassium	mg/l	344.0	352.0	366.0	488.0
21	Iron	mg/l	1.72	1.49	1.56	1.66
22	Chromium	mg/l	0.12	0.11	0.12	0.10
23	Copper	mg/l	0.05	0.05	0.06	0.05
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.06	0.07	0.08	0.07
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.18	0.16	0.15	0.14
28	Zinc	mg/l	0.06	0.05	0.05	0.06

Table 34: Marine Water Quality Monitoring Parameters for location Nakti Creek near Tuna Port

Sr. No.	Parameters	Unit	Nakti Creek Near Tuna Port			
			22°57'49."N 70° 7'0.67"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.39	7.21	7.73	7.7
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.2	31.8	32.4	31.6
5	Turbidity	NTU	34	60	39	49
6	Total Dissolved Solids	mg/l	48922.0	26656.0	39244.0	26963.0
7	Total Suspended Solids	mg/l	287.3	243.68	326.4	214.2
8	Total Solids	mg/l	49728.0	27300.0	40996.0	27294.0
9	DO	mg/l	4.6	4.9	4.2	3.5
10	COD	mg/l	96.0	98.0	88.0	82.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.28	0.29	0.61	0.74
13	Phosphate	mg/l	0.35	0.37	0.18	0.18
14	Sulphate	mg/l	3480	2868	2316	3480
15	Nitrate	mg/l	5.28	2.80	4.50	4.58
16	Nitrite	mg/l	0.02	<0.01	<0.01	0.03
17	Calcium	mg/l	601.2	721.44	521.04	601.2
18	Magnesium	mg/l	1749.6	1628.1	1773.9	1773.9
19	Sodium	mg/l	12126.0	12102.0	10821.0	10728.0
20	Potassium	mg/l	352.0	372.0	521.0	510.0
21	Iron	mg/l	1.52	1.42	1.56	1.59
22	Chromium	mg/l	0.16	0.14	0.13	0.15
23	Copper	mg/l	0.07	0.08	0.07	0.07
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.08	0.07	0.07	0.07
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.14	0.12	0.12	0.13
28	Zinc	mg/l	0.05	0.06	0.06	0.07

Table 35: Marine Water Quality Monitoring Parameters for location Nakti Creek Near NH-8A at Kandla

Sr. No.	Parameters	Unit	Nakti Creek Near NH-8A			
			23° 02'01"N 70° 09'31"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.3	Sampling not possible during Low Tide	7.51	Sampling not possible during Low Tide
2	Color	-	Colorless		Colorless	
3	Odor	-	Odorless		Odorless	
4	Salinity	ppt	32.2		32.8	
5	Turbidity	NTU	37		38	
6	Total Dissolved Solids	mg/l	34970		35210.0	
7	Total Suspended Solids	mg/l	736.8		318.3	
8	Total Solids	mg/l	36048.0		36110.0	
9	DO	mg/l	5.1		3.9	
10	COD	mg/l	98.0		110.0	
11	BOD	mg/l	<2.0		<2.0	
12	Silica	mg/l	0.31		0.98	
13	Phosphate	mg/l	0.28		0.29	
14	Sulphate	mg/l	3720		2220	
15	Nitrate	mg/l	5.45		3.62	
16	Nitrite	mg/l	0.03		0.04	
17	Calcium	mg/l	721.44		681.36	
18	Magnesium	mg/l	1506.6		1749.6	
19	Sodium	mg/l	11622.0		10303.0	
20	Potassium	mg/l	486.0		495.0	
21	Iron	mg/l	1.49		1.62	
22	Chromium	mg/l	0.13		0.14	
23	Copper	mg/l	0.08		0.08	
24	Arsenic	mg/l	<0.01		<0.01	
25	Cadmium	mg/l	0.05		0.07	
26	Mercury	mg/l	<0.001		<0.001	
27	Lead	mg/l	0.19		0.14	
28	Zinc	mg/l	0.07		0.06	

Table 36: Marine Water Quality Monitoring Parameters for locations Nr. Vadinar Jetty

Sr. No.	Parameters	Unit	Nr.Vadinar Jetty 22°26'25.26"N 69°40'20.41"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.25	7.36	7.26	7.21
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.8	32.2	31.2	32.0
5	Turbidity	NTU	5	9	21	15
6	Total Dissolved Solids	mg/l	34444	31931	37088	41030
7	Total Suspended Solids	mg/l	258	482	405.5	399.5
8	Total Solids	mg/l	34948.0	32054.0	37892.0	41410.0
9	DO	mg/l	3.8	4.2	1.9	2.8
10	COD	mg/l	86.0	88.0	72.0	68.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.21	0.30	0.45	0.39
13	Phosphate	mg/l	0.28	0.30	0.16	0.14
14	Sulphate	mg/l	3012	3192	2388	1980
15	Nitrate	mg/l	5.7376	4.32256	0.07744	3.4496
16	Nitrite	mg/l	0.02	0.02	0.02	<0.01
17	Calcium	mg/l	561.12	521.04	561.12	521.04
18	Magnesium	mg/l	1409.4	1603.8	1579.5	1676.7
19	Sodium	mg/l	11720.0	12118.0	10062.0	10080.0
20	Potassium	mg/l	458.0	456.0	406.0	412.0
21	Iron	mg/l	1.77	1.56	1.66	1.62
22	Chromium	mg/l	0.13	0.12	0.16	0.15
23	Copper	mg/l	0.07	0.06	0.05	0.06
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.04	0.04	0.05	0.05
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.18	0.19	0.17	0.16
28	Zinc	mg/l	0.08	0.08	0.06	0.07

6.1.1 Marine Sediments

Sediment samples were collected with Van Veen Grab from the six locations in Kandla Port Waters and two locations in Vadinar Port. Samples were collected and preserved in silver foil in ice box to prevent the contamination/decaying of the samples.

6.2 Results

The Sediment Quality results are given in below from table no. 33

Table 34A: Results of Analysis of Sediment of Kandla & Vadinar Port (Spring Tide)

Sr. No.	Parameters	Unit	KPT - 1	KPT - 2	KPT - 3	Khori - 1	Nakti Creek Near Tuna Port	Nakti - 1 (Near NH-8A)	Jetty
1	Texture		Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	mg/kg	1.20	1.88	1.20	1.30	1.76	1.88	1.56
3	Organic Carbon	mg/kg	0.80	0.96	0.87	0.87	0.69	0.78	0.78
4	Inorganic Phosphate	mg/kg	132.0	126.0	156.0	177.0	167.0	182.0	175.0
5	Moisture	%	24.96	26.86	21.33	16.64	26.33	22.78	23.01
6	Aluminium	mg/kg	ND	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	23.0	22.0	26.0	28.0	32.0	36.0	40.0
8	Phosphate	mg/kg	10.80	11.50	11.77	12.71	9.24	9.88	10.20
9	Sulphate	mg/kg	218.0	252.0	138.0	225.2	239.0	280.0	252.0
10	Nitrite	mg/kg	0.1	0.12	0.13	0.12	0.13	0.12	0.13
11	Nitrate	mg/kg	9.20	7.22	10.42	8.88	8.02	7.89	6.88
12	Calcium	mg/kg	861.0	1102.0	801.0	862.0	922.0	1082.0	802.0
13	Magnesium	mg/kg	437.0	851.0	693.0	765.0	449.0	522.0	422.0
14	Sodium	mg/kg	2083.0	2387.0	1937.0	1859.0	2857.0	2034.0	2185.0
15	Potassium	mg/kg	707.0	918.0	954.0	774.0	1058.0	779.0	792.0
16	Chromium	mg/kg	123.0	180.0	140.0	138.2	146.0	92.0	145.0
17	Nickel	mg/kg	26.0	23.2	28.9	26.2	32.6	33.6	37.7
18	Copper	mg/kg	46	42.7	21.20	36.0	37.2	29.6	26.8
19	Zinc	mg/kg	32.35	38.30	36.70	40.	41.00	39.00	40.00
20	Cadmium	mg/kg	ND	ND	ND	ND	ND	ND	ND
21	Lead	mg/kg	2.86	2.8	5.2	5.0	4.2	5.6	7.2
22	Mercury	mg/kg	ND	ND	ND	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND	ND	ND	ND

*Grab samples could not be collected due high current at Vadinar SBM

Table 34B: Results of Analysis of Sediment of Kandla & Vadinar Port (Neap Tide)

Sr. No.	Parameters	Unit	KPT - 1	KPT - 3	Khori - 1	Nakti Creek Near Tuna Port	Nakti – 1 (Near NH-8A)	Jetty
1	Texture		Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
2	Organic Matter	mg/kg	1.46	1.22	1.66	1.55	1.46	1.35
3	Organic Carbon	mg/kg	0.84	0.69	0.48	0.90	0.96	0.78
4	Inorganic Phosphate	mg/kg	155.0	148.0	162.0	149.0	164.0	166.0
5	Moisture	%	24.9	22.05	28.4	30.08	28.62	20.30
6	Aluminium	mg/kg	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	23.8	22.5	21.82	33.6	32.8	26.0
8	Phosphate	mg/kg	8.53	7.97	9.80	8.62	9.88	11.06
9	Sulphate	mg/kg	196.6	163.89	184.45	140.0	152.0	171.88
10	Nitrite	mg/kg	0.11	0.13	0.14	0.12	0.14	0.12
11	Nitrate	mg/kg	6.42	7.77	6.88	6.89	7.02	8.88
12	Calcium	mg/kg	288.6	212.0	232.4	284.0	296.0	224.0
13	Magnesium	mg/kg	177.4	177.0	170.76	197.2	188.0	535.0
14	Sodium	mg/kg	2662.0	1216.0	990.0	828.0	910.0	1150.0
15	Potassium	mg/kg	200.0	106.0	50.2	79.0	89.0	110.0
16	Chromium	mg/kg	145.0	133.0	146.0	126.0	101.0	166.0
17	Nickel	mg/kg	31.2	26.6	20.3	28.2	27.8	20.9
18	Copper	mg/kg	54.2	26.5	16.2	12.10	11.02	42.0
19	Zinc	mg/kg	23.0	31.0	24.62	29.42	33.36	42.52
20	Cadmium	mg/kg	ND	ND	ND	ND	ND	ND
21	Lead	mg/kg	ND	4.2	4.0	4.2	4.2	3.8
22	Mercury	mg/kg	ND	ND	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND	ND	ND

*Grab samples could not be collected due high current at KPT 2, Vadinar Jetty and Vadinar SBM

REPORT

ON

ECOLOGICAL MONITORING

OF MARINE ENVIRONMENT

IN

DPT HARBOURAREA, NEAR BY CREEKS

For

DEENDAYAL PORT TRUST

JUNE, 2021

***INTRODUCTION*:**

The Forty Second Amendment to the Constitution in 1976 underscored the importance of 'green thinking'. Article 48A enjoins the state to protect and improve the environment and safeguard the forests and wildlife in the country. Further, Article 51A(g) states that the "fundamental duty of every citizen is to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures".

Policy Statement for Abatement of Pollution (1992) has suggested developing relevant legislation and regulation, fiscal incentives, voluntary agreements and educational programs and information campaigns. It emphasizes the need for integration by incorporating environmental considerations into decision making at all levels by adopting frameworks namely, pollution prevention at source, application of best practicable solution, ensure polluter pays for control of pollution, focus on heavily polluted areas and river stretches and involve public in decision-making. The National Conservation Strategy and Policy Statement on Environment and Development, (1992)aimed at "integrating environmental concerns with developmental imperatives to meet the challenges by redirecting the thrust of our developmental process so that the basic needs of our people could be fulfilled by making judicious and sustainable use of natural resources." The priorities mentioned in this policy document include the sustainable use of land and water resources, prevention and control of pollution and preservation of biodiversity.

The National Water Policy, (2002) contains provisions for developing, conserving, sustainable utilizing and managing this important water resources and need to be governed by national perspectives.

MARINE ENVIRONMENT:

On national and state levels, we have several policies and regulation like Water (Prevention and Control of Pollution) Act, 1974, to regulate pollution discharges and restore water quality of our aquatic resources including the prescription of monitoring activities. One of the important provisions of the Water Act, 1974, is to maintain and restore the 'wholesomeness' of our aquatic resources. Water quality monitoring is one of the first steps required in the rational development and management of water resources. In the field of water quality management, there has been a steady evolution in procedures for designing system to obtain information on the changes of water quality. The monitoring comprises all activities to obtain 'information' with respect to the water system.

Sampling Stations:

The monitoring of marine environment for the study of biological and ecological Parameters was carried out on 10th June, 2021 in in harbour region of DPT, and on 11thJune, 2021 in creeks near by the port during spring tide .The monitoring of marine environment for the study of biological and ecological parameters was repeated again on 18th June, 2021 in harbour region of DPT and on19thJune, 2021 in creeks near by the port during neap tidal condition .

Plankton samples from sub surface layer was collected both during high tide period and low tide period from 3 water quality monitoring stations of DPT harbour area andone stations in Nakti creek and one station in Khori creek. Sampling at second sampling station of Nakti creek was possible only during high tide period. Collected water samples were processed for estimation of Chlorophyll- a, Pheophytin- a, qualitative &quantitative evaluation of phytoplankton, qualitative &quantitative evaluation zooplanktons (density and their population).

TABLE #1 SAMPLING LOCATIONS

monitoring requirement	**Number of locations**
Kandla creek Nakti creek Khori Creek	3 in Kandla creek 2 in Nakti creek 1 in Khori creek
Total Number of locations	**6**

Sampling methodology adopted:

A marine sampling is an estimation of the body of information in the population. The theory of the sampling design is depending upon the underlying frequency distribution of the population of interest. The requirement for useful water sampling is to collect a representative sample of suitable volume from the specified depth and retain it free from contamination during retrieval.

50 litters of the water sample were collected from Sub surface by using bucket. From the collected water sample 1 litter of water sample were taken in an opaque plastic bottle for chlorophyll estimation, thereafter plankton samples were collected by using filtration assembly with nilyobolt cloth of 20µm mesh size.

Samples Processing for chlorophyll estimation:

Samples for the chlorophyll estimation were preserved in ice box on board in darkness to avoid degradation in opaque container covered with aluminium foil. Immediately after reaching the shore after sampling, 1 litter of collected water sample was filtered through GF/F filters (pore size 0.45 µm) by using vacuum filtration assembly. After vacuum filtration the glass micro fiber filter paper was grunted in tissue grinder, macerating of glass fiber filter paper along with the filtrate was done in 90% aqueous Acetone in the glass tissue grinder with glass grinding tube. Glass fiber filter paper will assist breaking the cell during grinding and chlorophyll content was extracted with 10 ml of 90% Acetone, under cold dark conditions along with saturated magnesium carbonate solution in glass screw cap tubes. After an extraction period of 24 hours, the samples were transferred to calibrated centrifuge tubes and adjusted the volume to original volume with 90% aqueous acetone solution to make up the evaporation loss. The extract was clarified by using centrifuge in closed tubes. The clarified extracts were then decanted in clean cuvette and optical density was observed at wavelength 664, 665 nm. By using corrected optical density, Chlorophyll-a value was calculated as given in (APHA, 1998).

PLANKTON:

The entire area open water in the sea is the pelagic realm. Pelagic organisms live in the open sea. In contrast to the pelagic realm, the benthic realm comprises organisms and zone of the bottom of the sea. Vertically the pelagic realm can be dividing into two zones based on light penetration; upper photic or euphotic zone and lower dark water mass, aphotic zone below the photic zone.

The term plankton is general term for organisms have such limited powers of locomotion that they are at the mercy of the prevailing water movement. Plankton is subdivided to phytoplankton and zooplankton. Phytoplankton is free floating organisms that are capable of photosynthesis and zooplankton is the various free floating animals.

Pelagic zone, represents the entire ocean water column from the surface to the deepest depths, is home to a diverse community of organisms. Differences in their locomotive ability categorize the organisms in the pelagic realm into two, ***plankton*** and ***nekton*** (Lalli and Parsons, 1997). ***Plankton*** consists of all organisms drifting in the water and is unable to swim against water currents, whereas ***Nekton*** includes organisms having strong locomotive power. Ecological studies on the plankton community, which form the base of the aquatic food chain, help in the better understanding of the dynamics and functioning of the marine ecosystem. The term 'Plankton' first coined by Victor Hensen (1887), Plankton, (Greek word: *planktos*meaning "passively drifting or wandering") is defined as drifting or free-floating organisms that inhabit the pelagic zone of water. Based on their mode of nutrition planktonic organisms are categorised into phytoplankton (organisms having an autotrophic mode of nutrition) and zooplankton (organisms having a heterotrophic mode of nutrition).

Phytoplankton in the marine environment:

Phytoplankton is free floating unicellular, filamentous and colonial eutrophic organisms that grow in aquatic environments whose movement is more or less dependent upon water currents. These micro flora acts as primary producers as well as the basis of food chain, source of protein, bio purifier and bio indicators of the aquatic ecosystems of which diverse array of the life depends .They are considered as an important component of aquatic flora, play a key role in maintaining equilibrium between abiotic and biotic components of aquatic ecosystem.

The phytoplankton includes a wide range of photosynthetic and phototrophic organisms. Marine phytoplankton is mostly microscopic and unicellular floating flora, which are the primary producers that support the pelagic food-chain. The two most prominent groups of phytoplankton are diatoms (Bacillariophyceae) and dinoflagellates (Dinophyceae).The phytoplankton those normally captured in the net from the Gulf of Kutch is normally dominated by these two major groups; diatoms and dinoflagellates. Phytoplankton also include numerous and diverse collection of extremely small, motile algae which are termed micro flagellates (naked flagellates) as well as and Cyanophytes (blue-green algae).

Algae are an ecologically important group in most aquatic ecosystems and have been an important component of biological monitoring programs. Algae are ideally suited for water quality assessment because they have rapid reproduction rates and very short life cycles, making them valuable indicators of short-term impacts.

Aquatic populations are impacted by anthropogenic stress, resulting in a variety of alterations in the biological integrity of aquatic systems. Algae can serve as an indicator of the degree of deterioration of water quality, and many algal indicators have been used to assess environmental status.

Zooplankton in the marine environment:

Zooplankton includes a taxonomically and morphologically diverse community of heterotrophic organisms that drift in the waters of the world's oceans. Qualitative and quantitative studies on zooplankton community is a prerequisite to delineate the ecological processes active in the marine ecosystem. Zooplankton community plays a pivotal role in the pelagic food web as the primary consumers of phytoplankton and act as the food source for organisms in the higher trophic levels, particularly the economically essential groups such as fish larvae and fishes. They also function in the cycling of elements in the marine ecosystem. The dynamics of the zooplankton community, their reproduction, growth and survival rate are all significant factors determining the recruitment and abundance of fish stocks as they form an essential food for larval, juvenile and adult fishes (Beaugrand et al., 2004). Zooplankton grazing in the marine environment controls the primaryProduction and helps in determining the pelagic ecosystem (Banse, 1995). Through grazing in surface waters and following the production of sinking faecal matters and also by the active transportation of dissolved and particulate matter to deeper waters via vertical migration, they help in the transport of organic carbon to deep ocean layers and thus act as key drivers of biological pump' in the marine ecosystem. Zooplankton grazing and metabolism also, transform particulate organic matter into dissolved forms, promoting primary producer community, microbial demineralization, and particle export to the ocean's interior.

The categorisation of zooplankton into various ecological groups is based on several factors such as duration of planktonic life, size, food preferences and habitat. As they vary significantly in size from microscopic to metazoic forms, the classification of zooplankton based on size has paramount importance in the field of quantitative plankton research.

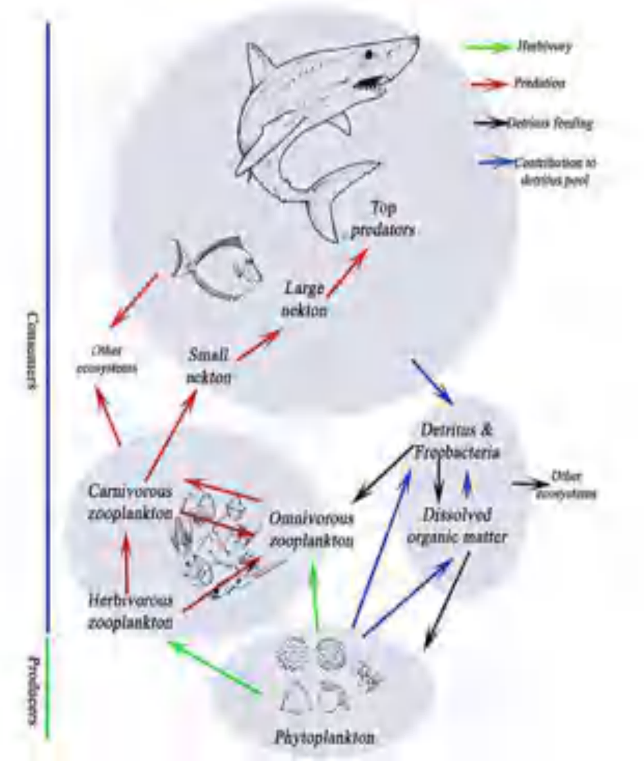
Based on the duration of planktonic life, zooplankton are categorised into Holoplankton (organisms which complete their entire lifecycle as plankton) and Meroplankton (organisms which are planktonic during the early part of their lives such as the larval stages of benthic and nektonic organisms). Tychoplankton are organisms which live a brief planktonic life, such as the benthic crustaceans (cumaceans, mysids, isopods) which ascend to the water column at night for feeding and certain ectoparasitic copepods, they leave the host and spend their life as plankton during their breeding cycle.

Zooplankton can be subdivided into holoplankton, i.e., permanent members of the plankton (e.g., Calanoid copepods), and meroplankton, i.e., temporary members in the plankton e.g., larvae of fish, shrimp, and crab). The meroplankton group consists of larval and young stages of animals that will adopt a different lifestyle once they mature. In contrast to phytoplankton which consist of a relatively smaller variety of organisms, Zooplankton are extremely divers, consist of a host of larval and adult forms representing many animal phylum.

Among the zooplankton one group always dominate than others; members of sub class copepods (Phylum Athropoda), and Tintinids (Phylum Protozoa) among the net planktons. These small animals are of vital importance in marine ecosystem as one of the primary herbivores animals in the sea, and it is they provide vital link between primary producer (autotrophs) and numerous small and large marine consumers.

As their community structure and function are highly susceptible to changes in the environmental conditions regular monitoring of their distribution as well as their interactions with various physicochemical parameters is inevitable for the sustainable management of the ecosystem (Kusum et al., 2014). Of all the marine zooplankton groups, copepods mainly calanoid copepods are the dominant groups in marine subtropical and tropical waters and exhibit considerable diversity in morphology and habitats they occupy (Madhupratap, 1991;)

It has been well established that potential of pelagic fishes viz. finfishes, crustaceans, molluscs and marine mammals either directly or indirectly depend on zooplankton. The herbivorous zooplankton is efficient grazers of the phytoplankton and is referred to as living machines transforming plant material into animal tissue. Hence they play an essential role as the intermediaries for nutrients/energy transfer between primary and tertiary trophic levels. Due to their large density, shorter lifespan, drifting nature, high group/species diversity and different tolerance to the stress, they used as the indicator organisms for the physical, chemical and biological processes in the aquatic ecosystem (Ghajbhiye, 2002).



Simplified marine food web

Spatial distribution of Plankton:

A characteristic of plankton population is that they tend to occur in patches, which are varying spatially on a scale of few meters to far as few kilometres in distance. They also vary in time scale, season as well as vertically in the water column. It is this patchiness and its constant changes in time and spot, that has made it so difficult for plankton biologist to learn about the ecology of plankton. The biological factors that causes this patchiness is due to the ability of zooplankton to migrate vertically and graze out the phytoplankton at a rapid rate that can create patchiness. Similarly the active swimming ability by certain zooplankton organisms can cause to aggregate in dense group.

At its most extreme, because the water in which plankton is suspended is constantly moving, each sample taken by the plankton biologists remain a different volume of water, so each sample is unique and replicate does not exist.

Plankton June also exhibit vertical patchiness. Physical factors contribute to this type of patchiness include light intensity, nutrients and density gradients in the water column.

Phytoplankton in particular tends to be unequally distributed vertically, which leads to the existence of different concentration of a chlorophyll value between photic zone and below the photic zone.

Methodology adopted for Plankton sampling:

Mixed plankton sample were obtained from the sub surface layer at each sampling locations by towing the net horizontally with the weight .After the tow of about 15-30minutes, plankton net was pulled up and washed down to the tail and collected the plankton adhered to plankton net in the collection bucket at the bottom by springing outer and inner surface of the net with sea water, while the net was hanging with the mouth upward. For quantitative evaluation 50 L water samples were collected from subsurface layer and filtered through 20µm mesh size net by using bucket and filtration assembly.

Preservation and storage:

Both filtered plankton and those collected from the plankton net were preserved with 5% buffered formalin and stored in 1L plastic container for further processing in the laboratory.

Sample concentration:

The collected plankton samples were concentrated by using centrifuge and made up to 50 ml with 5% formalin -Glycerine mixture.

Taxonomic evaluation:

Before processing, the sample was mixed carefully and a subsample was taken with a calibrated Stempel-pipette. 1 ml of the concentrated plankton samples were transferred on a glass slide with automatic pipette. The plankton sample on the glass slides were stained by using Lugol's iodine and added glycerine to avoid drying while observation. The plankton samples were identified by using Labex triangular Research microscope with photographic attachment. Microphotographs of the plankton samples were taken for record as well as for confirming the identification. The bigger sized zooplankton was observed through dissecting stereomicroscope with magnification of 20-30 x. Plankton organisms in the whole slide were identified to the lowest axon possible. A thorough literature search was conducted for the identification of the different groups of zooplankton that were encountered

Cell counts by drop count method:

The common glass slide mounted with a 1ml of concentrated phytoplankton/zooplankton sample in glycerol and covered with cover slip 22x 60mm was placed under the compound microscope provided with a mechanical stage. The plankton was then counted from the microscopic field of the left top corner of the slide. Then slide is moved horizontally along the right side and plankton in each microscopic field was thus counted. When first microscopic field row was finished the next consecutive row was adjusted using the mechanical device of the stage. In this way all the plankton present in entire microscopic field are counted. From this total number in 1ml of the concentrated plankton, total number of plankton in the original volume of sample filtered was calculated as units/L.

BENTHIC ORGANISMS:

Benthos is those organisms that are associated with the sea bed or benthic habitats. Epi- benthic organisms live attached to a hard substratum or rooted to a shallow depth below the surface. In fauna organisms live below the sediment–water interface. Interstitial organisms live and move in pore water among sedimentary grains.

Because the benthic organisms are often collected and separated on sieves, a classification based on the overall size is used. Macro benthos include organisms whose shortest dimension is greater than or equal to 0.5 mm. Meio benthos are smaller than 0.5mm but larger than 42µ in size.

The terms such as macro fauna and Meio fauna generally have little relevance with taxonomic classification. The terms Meio fauna and macro fauna depend on the size. Meio fauna were considered as good bioassay of community health and rather sensitive indicators of environmental changes

SAMPLING METHODOLOGY ADOPTED FOR SUB TIDAL REGION:

Van veen sampler ($0.09m^2$) was used for sampling bottom sediments. Two sets of sediments were sampled from each location, one for macro fauna and other for Meio fauna. The macro fauna in the sediments were sieved on board to separate out the organisms. The fixation of Meio fauna is normally done by bulk fixation of the sediment sample. The bulk fixation is done by using 10% formalin (Buffered with borate). The organisms were preserved with seawater as diluting agent.

Sample sieving:

Sediments samples were sieved to extract the organisms. Sieving was performed carefully as possible to avoid any damage to the animals. The large portion of the sediment was split in to smaller portions and mixed with sea water in a bucket. The cohesive lumps were broken down by continuous stirring. The disaggregated sediments were then passed through the sieves.

Sample staining:

Sorting of the Meio fauna from the sieve is difficult task especially in the preserved material, because organisms are not easily detectable. To facilitate the animal detection the entire sample retained on the sieve after sieving operation were stained by immersing the sieve in a flat bottom

tub with 1% Rose Bangal stain; a protein stain. A staining period of 10-30 minutes is sufficient for sample detection.

DIVERSITY INDICES:

On the whole, diversity indices provide more information about community composition than simply species richness (number of species present); they also, take the relative abundances of different species into account. Based on this fact, diversity indices therefore depend not only on species richness but on the evenness, or equitability, with which individuals are distributed among the different species (Magurram, A. E. (1988)

A diversity index is a measure of species diversity within a community that consists of co-occurring populations of several (two or more) different species. It includes two components: richness and evenness. Richness is the measure of the number of different species within a sample showing that more the types of species in a community, the higher is the diversity or greater is the richness. Evenness is the measure of relative abundance of the different species with in a community.

The basic idea of diversity index is to obtain a quantitative estimate of biological variability that can be used to compare biological entities composed of discrete components in space and time (Carol H.R. *etal*. 1998). Biodiversity is commonly expressed through indices based on species richness and species abundances (Whittaker 1972, Lande 1996, Purvis and Hector 2000). Biodiversity indices are a non-parametric tool used to describe the relationship between species number and abundance. The most widely used bio diversity indices are Shannon Weiner index and Simpson's index.

A diversity Index is a single statistic that incorporates in formation on richness and evenness. The diversity measures that incorporate the two concepts may be termed heterogeneity measures (Magurran, 2004).

Any study intended to interpret causes and effect of adverse impact on Biodiversity of communities require suitable measures to evaluate specie richness and Diversity. The former is number of species in community, while latter is a function of relative frequency of different species. Species richness is the iconic measure of biological diversity (Magurran, 2004). Several indices have been created to measure the diversity of species; however, the most widely used in the last decades are the Shannon (1948) and Simpson (1949) (Buzas and Hayek 1996; Gorelick 2006), with the components of diversity: richness (*S)* and evenness (*J)*

Simpson's diversity index

Simpson's index (**D**) is a measure of diversity, which takes into account both species richness, and evenness of abundance among the species present.. The Simson index is one of the meaningful and robust biodiversity measures available.(Magurran ,2004).

The formula for calculating D is presented as:

$$D = \frac{\sum n_i(n_i - 1)}{N(N-1)}$$

Where n_i = the total number of organisms of each individual species

N = the total number of organisms of all species

The value of D ranges from 0 to 1. With this index, 0 represents infinite diversity and, 1, no diversity. When D increases diversity decreases. Simpson's index is therefore usually expressed as 1-D or 1/D. (Magurran, 2004)

Low species diversity suggests:

- relatively few successful species in the habitat
- the environment is quite stressful with relatively few ecological niches and only a few organisms are really well adapted to that environment
- food webs which are relatively simple
- change in the environment would probably have quite serious effects

High species diversity suggests:

- a greater number of successful species and a more stable ecosystem
- more ecological niches are available and the environment is less likely to be hostile complex food webs
- environmental change is less likely to be damaging to the ecosystem as a whole

Species richness indices

The species richness***(S)*** is simply the number of species present in an ecosystem. Species richness Indices of species richness are widely used to quantify or monitor the effects of anthropogenic disturbance. A decline in species richness may be concomitant with severe or chronic human-induced perturbation (Fair Fair weather 1990,) Species richness measures have traditionally been the mainstay in assessing the effects of environmental degradation on the biodiversity of natural assemblages of organisms (Clarke &Warwick, 2001)

Species richness is the iconic measure of biological diversity (Magurran, 2004). The species richness***(S)*** is simply the number of species present in an ecosystem. This index makes no use of

relative abundances. The term species richness was coined by McIntosh (1967) and oldest and most intuitive measure of biological diversity (Magurran, 2004).

Margalef's diversity index is a species richness index. Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, were derived.

The value of a diversity index increases both when the number of types increases and when evenness increases. For a given number of types, the value of diversity index is maximised when all types are equally abundant (Rosenzweig, M. L. (1995).

Shannon-Wiener's index:

An index of diversity commonly used in plankton community analyses is the Shannon-Wiener's index **(H),** which emphasizes not only the number of species (richness or variety), but also the apportionment of the numbers of individuals among the species (Odum 1971 and Reish 1984). Shannon-Wiener's index (**H**) reproduce community parameters to a single numberby using an equation.

Shannon and Weiner index represents entropy. It is a diversity index taking into account the number of individuals as well as the number of taxa. It varies from 0 for communities with only single taxa to high values for community with many taxa each with few individuals. This index can also determine the pollution status of a water body. Normal values range from 0 to 4. This index is a combination of species present and the evenness of the species. Examining the diversity in the range of polluted and unpolluted ecosystems, Wilham and Dorris (1968) concluded that the values of the index greater than 3 indicate clean water, values in the range of 1 to 3 are characterized by moderate pollution and values less than 1 are characterized as heavily polluted

$$H' = -\sum_{j=1}^{s} \frac{n_j}{N} \ln\left(\frac{n_j}{N}\right)$$

RESULTS:

CHLOROPHYLL-a:

Water Samples for the chlorophyll estimation were collected from sub surface layer during high tide and low tide period of the tidal cycle for each sampling locations and analysed for Chlorophyll -a and after acidification for Pheophytin –a. Chlorophyll- a value was used as algal biomass indicator (APHA,1998) Algal biomass was estimated by converting Chlorophyll value.

In the sub surface water chlorophyll-a was varying from 0.314 -0.468mg/m^3.in harbour region of DPT during sampling done in spring tide period of June, 2021. In the nearby creeks chlorophyll-a was varying from 0.329-0.739 mg/m^3.Pheophytin –a level was below detectable limit- the all the sampling stations during spring in the harbour region of DPT.

In the sub surface water chlorophyll-a was varying from 0.527 -0.765 mg/m^3.in harbour region of DPT during sampling done in neap tide period of June, 2021 . In the nearby creeks chlorophyll-a was varying from 0.425- 0.850 mg/m^3. Pheophytin –a level was below detectable limit- the all the sampling stations during spring in the harbour region of DPT

TABLE #2 VARIATIONS IN CHLOROPHYLL –a PHEOPHYTIN- a AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN JUNE,2021

Sr.No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREA					
1	KPT1	High tide	0.381	BDL	25.53
		Low tide	0.440	BDL	29.48
2	KPT 2	High tide	0.314	BDL	21.04
		Low tide	0.417	BDL	27.94
3	KPT 3	High tide	0.468	BDL	31.36
		Low tide	0.424	BDL	28.41
CREEKS					
4	KPT-4 Khori-I	High tide	0.739	BDL	49.51
		Low tide	0.578	BDL	38.73
5	KPT-5 Nakti-I	High tide	0.637	BDL	42.68
		Low tide	0.409	BDL	27.40
6	KPT-5 Nakti-II	High tide	0.329	BDL	22.04

BDL: Below Detectable Limit.

TABLE #3 VARIATIONS IN CHLOROPHYLL –aPHEOPHYTIN- a AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN JUNE,2021

Sr.No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREA					
1	KPT1	High tide	0.631	BDL	42.28
		Low tide	0.765	BDL	51.25
2	KPT 2	High tide	0.731	BDL	48.98
		Low tide	0.614	BDL	41.14
3	KPT 3	High tide	0.527	BDL	35.31
		Low tide	0.615	BDL	41.21
CREEKS					
4	KPT-4 Khori-I	High tide	0.748	BDL	50.12
		Low tide	0.850	BDL	56.95
5	KPT-5 Nakti-I	High tide	0.715	BDL	47.90
		Low tide	0.715	BDL	47.90
6	KPT-5 Nakti-II	High tide	0.425	BDL	28.47

BDL: Below Detectable Limit.

PHYTOPLANKTON POPULATION:

For the evaluation of the Phytoplankton population in DPT harbour area and within the immediate surroundings of the port, sampling was conducted from 5 sampling locations (3 in harbour area and two in Nakti creek) during high tide period and low tide period of spring tide. The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by,Diatoms and dinoflagellates during spring tide period.Diatoms were represented by 14 genera. Dinoflagellates wererepresented by onegenera .during the sampling conducted in spring tide in June,2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 112-216 units/ L during high tide period and 147-172 units/ L during low tide of Spring Tide.

The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by Diatoms and dinoflagellates during spring tide period.Diatoms were represented by 15genera and Dinoflagellateswere represented onegenera during the sampling conducted in Neap tide in June, 2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 72-293 units/ L during high tide period and 202-375 units/ L during low tide of Neap Tide.

Species Richness Indices and Diversity Indices :

Margalef's diversity index (Species Richness)S

At the organismal level, the most widely used biodiversity measures are those based on the number of species present, perhaps adjusted for the number of individuals sampled, Here Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, are derived.

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was varying from 1.907-2.660 with an average of 2.381during the sampling conducted in High tide period of spring tide While .Margalef's diversity index (Species Richness) S of phytoplankton communities in the Kandla Harbour region and nearby creeks was varying from. 1.603-2.395 with an average of 2.140 during the consecutive in low tide period .

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was varying from 1.775-2.614 with an average of 2.212 during the sampling conducted in High tide period of Neaptide While .Margalef's diversity index (Species Richness) S of phytoplankton communities in the Kandla Harbour region and nearby creeks was varying from. 1.695-2.193 with an average of 1.966 during the consecutive in low tide period .

Shannon-Wiener's index:

Shannon-Wiener’s Index (H) of phytoplankton communities in the sampling stations was in the range of 0.794-0.908 (H'(log10)) between selected sampling stations with an average value of 0.844. during high tide period of spring tide .Shannon-Wiener’s Index (H) of phytoplankton communities in the sampling stations was in the range of 0.788-0.845 (H'(log10)) between selected sampling stations with an average value of 0.813 during consecutive lowtide. Shannon-Wiener’s Index (H) of phytoplankton communities in the sampling stations was in the range of 0.722-0.883 (H'(log10)) between selected sampling stations with an average value of 0.814. during high tide period of neap tide . Shannon-Wiener’s Index (H) of phytoplankton communities in the sampling stations was in the range of 0.723-0.883 (H'(log10)) between selected sampling stations with an average value of 0.813 during consecutive low tide. Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon-Wiener’s index increases as both the richness and the evenness of the community increase. This result indicates that diversity of phytoplankton of Kandla Harbour region and nearby creeks is less but with abundant population of few, with relatively few ecological niches and only very few opportunist organisms are really well adapted to this environment and thrive better than other species.

Simpson’s diversity index:

Simpson’s index (D) is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. The Simson index is one of the meaningful and robust biodiversity measures available. (Magurran,2004).

Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in the Kandla Harbour region and nearby creeks, which was varying from 0.796- 0.840 between selected sampling stations with an average of 0.815 during high tide period of spring tide . Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in the Kandla Harbour region and nearby creeks, which was varying from 0.790- 0.821 between selected sampling stations with an average of 0.803 during consecutive low tide . Low species diversity suggests a relatively few successful species in this habitat. The environment is quite stressful with relatively few ecological niches and only a few organisms are really well adapted to that environment. Any change in the environment would probably have quite serious effects.

Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in Kandla Harbour region and nearby creeks, during high tide period and low tide period during neap tide also, which was varying from 0.741-0.831 with an average value of 0.800

between selected sampling stations during high tide period and varying from 0.719-0.808 with an average value of 0.758 between selected sampling stations duringconsecutive low tide period Low species diversity suggests a relatively few successful species in this habitat.

Table # 4PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN JUNE,2021

Tide	Sampling Station	Abundance In units/L	No of Species observed /total species	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H ($\log_{10}$)	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	158	14/15	93.33	2.568	0.89	0.8401
	2	151	14/15	93.33	2.591	0.8397	0.8165
	3	170	12/15	80	2.142	0.7942	0.7962
	4	216	14/15	93.33	2.418	0.8223	0.8042
	5	193	15/15	100	2.66	0.9078	0.8326
	6	112	10/15	66.66	1.907	0.8103	0.8029
LOW TIDE	1	156	13/15	86.66	2.376	0.8446	0.8209
	2	147	9/15	60	1.603	0.7909	0.8148
	3	152	12/15	80	2.19	0.8051	0.791
	4	172	12/15	80	2.137	0.788	0.7904
	5	150	13/15	86.66	2.395	0.8371	0.7996

Table # 5 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN JUNE,2021

Tide	Sampling Station	Abundance In units/L	No of Species observed /total species	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H ($\log_{10}$)	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	240	15/16	93.75	2.554	0.883	0.8308
	2	248	12/16	75	1.995	0.7916	0.7925
	3	212	15/16	93.75	2.614	0.8664	0.8285
	4	293	15/16	93.75	2.465	0.8666	0.8224
	5	280	11/16	68.75	1.775	0.7227	0.7413
	6	72	9/16	56.25	1.871	0.7522	0.7891
LOW TIDE	1	278	11/16	68.75	1.777	0.7379	0.7658
	2	206	12/16	75	2.065	0.7625	0.784
	3	202	10/16	62.50	1.695	0.7941	0.8008
	4	375	14/16	87.5	2.193	0.7182	0.7189
	5	303	13/16	81.25	2.1	0.7164	0.7232

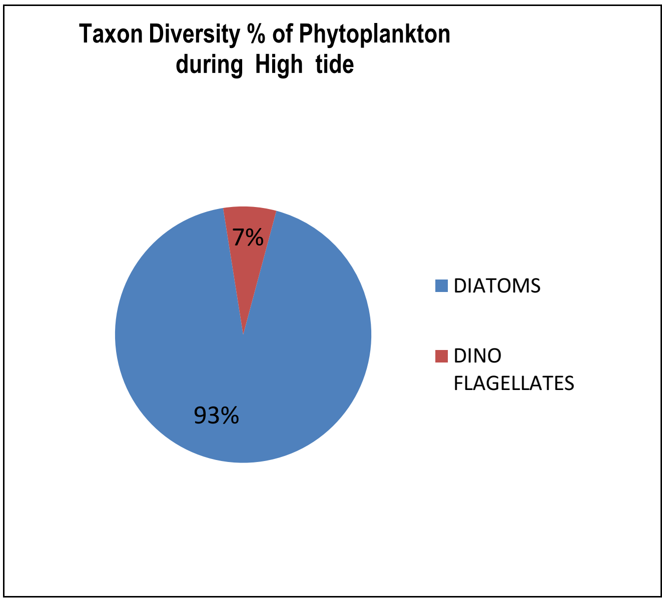
Table # 6 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING SPRING TIDE IN JUNE,2021

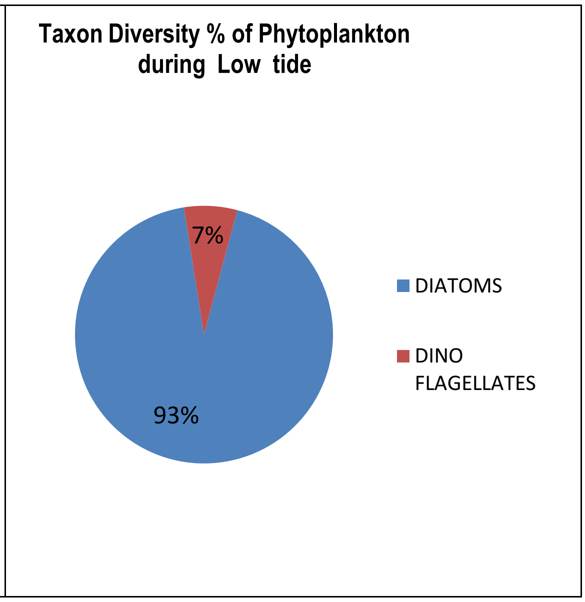
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	112-214	14/15	93.33
			DINO FLAGELLATES	0-2	1/15	6.67
			TOTAL PHYTO PLANKTON	112-216	15	-
LOW TIDE	Sub surface	5	DIATOMS	147-171	14/15	93.33
			DINO FLAGELLATES	0-2	1/15	6.67
			TOTAL PHYTO PLANKTON	147-172	15	-

Table # 7 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING NEAP TIDE IN JUNE, 2021

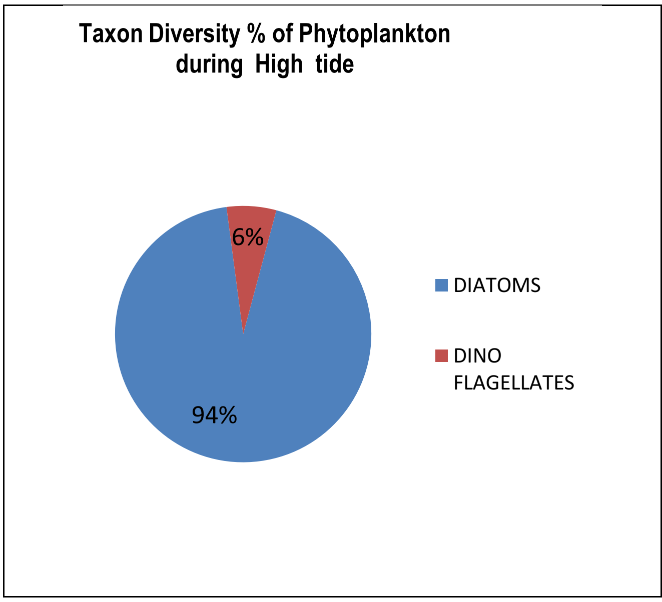
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	72-291	15/16	93.75
			DINO FLAGELLATES	0-2	1/16	6.25
			TOTAL PHYTO PLANKTON	72-293	16	-
LOW TIDE	Sub surface	5	DIATOMS	202-374	15/16	93.75
			DINO FLAGELLATES	0-1	1/16	6.25
			TOTAL PHYTO PLANKTON	202-375	16	

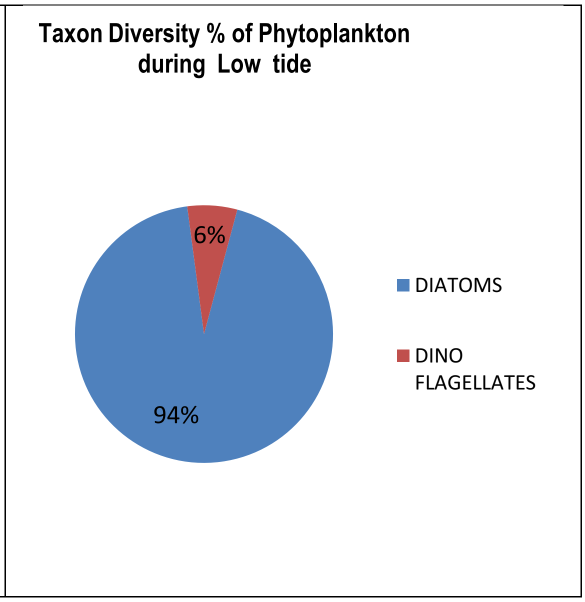
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide





Taxon Diversity % of Phytoplankton during High tide and Low tide period during Neap tide





ZOOPLANKTON POPULATION:

For the evaluation of the Zooplankton population in DPT harbour area and within the immediate surroundings of the port sampling was conducted from 6 sampling locations (3 in harbour area and two in Nakti creek and one in Khoricreek) during high tide period and low tide period of spring tide and Neap tide in June 2021 . The Zooplankton community of the sub surface water in the harbour and nearby creeks during spring tide was represented by mainly four groups, Tintinids, Copepods,Foraminiferans and larval forms of Crustacea, Molluscans. The Zooplankton community of the sub surface water in the harbour and nearby creeks during neap tide was represented by mainly five groups, Tintinids, Copepods, Arrow worms, Mysids and larval forms of Crustacea and Polychates,.

Zooplankton of the sampling stations at sub surface layer in the DPT harbour area and nearby creek was varying from 61-138x10^3 N/ m^3 during high tide and 78-112x10^3 N/ m^3during low tide of Spring Tide period. Zooplankton of the sampling stations at sub surface layer in the DPT harbour area and nearby creek was varying from 47-176 x10^3 N/ m^3 during high tide and80-157 N/ L during low tide of Neap Tide period.

Species Richness Indices and Diversity Indices:

Margalef's diversity index (Species Richness)S

At the organismal level, the most widely used biodiversity measures are those based on the number of species present, perhaps adjusted for the number of individuals sampled, Here Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, are derived.

Margalef's diversity index (Species Richness) S of Zooplankton communities in the stations Kandla Harbour region and nearby creeks was varying from 2.563-3.067 with an average of 2.804 during the sampling conducted in High tide period.Margalef's diversity index (Species Richness) S of Zooplankton communities varying from.2.136-2.875 with an average of 2.485 during the sampling conducted in low tide period during Spring tide.

Margalef's diversity index (Species Richness) S of Zooplankton communities in the Kandla Harbour region and nearby creeks sampling stations was varying from3.610-453 with an average of 4.016 during the sampling conducted in high tide and varying from. 2.755-4.747 with an average of 3.779 during the sampling conducted in low tide during Neap tide period.**Shannon-Wiener's index:**

Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.912-1.017 (H'(log10)) between selected sampling stations with an average value of 0.947 (H'(log10)) during high tide period of spring tide .Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.872-0.939 (H'(log10)) between selected sampling stations with an average value of 0.908 (H'(log10)) during consecutive low tide period .

Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.962-1.143 (H'(log10)) between selected sampling stations with an average value of 1.071 (H'(log10)) during high tide period of Neap tide . Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.952-1.168(H'(log10)) between selected sampling stations with an average value of 1.051 (H'(log10)) during consecutive low tide period .Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon-Wiener's index increases as both the richness and the evenness of the community increase. This result indicates that diversity of Zooplankton of Kandla Harbour region and nearby creeks stations is slightly high with very minimum diverse population but very few opportunist organisms are really well adapted to this environment and thrive better than other species.

Simpson's diversity index:

Simpson's index (D) is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. The Simson index is one of the meaningful and robust biodiversity measures available. (Magurran, 2004).

Simpson diversity index (1-D) of Zooplankton communities was below 0.9 at all sampling stations in the Kandla Harbour region and nearby creeksduring high tide and low tide of spring tide period except few during high tide period, which was varying from 0.838-0.904 between selected sampling stations with an average of 0.862 during high tide period and was varying from 0.838-0.865 with an average value of 0.849 between selected sampling stations during low tide

Simpson diversity index (1-D) of Zooplankton communities was below 0.9 at all sampling stationsin the Kandla Harbour region and nearby creeks during high tide and except one duringhigh tide of Neap tide, which was varying from 0.853-0.905 between selected sampling stations with an average of 0.886 during high tide period and was varying from 0.840- 0.909 with an average value of 0.881 between selected sampling stations during consecutive low tide

This low species diversity suggests a relatively low number of successful species in this habitat. Environment is quite stressful with relatively few ecological niches and only few organisms are really well adapted to that environment. Any change in the environment would probably have quite serious effects.

Table # 8 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN JUNE,2021

Tide	Sampling Station	Abundance In No / m^3	No of Species/groups observed /total species/group	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	96 $X10^3$	15/17	88.24	3.067	1.01	0.8836
	2	77 $X10^3$	13/17	76.47	2.763	0.9118	0.8506
	3	92 $X10^3$	14/17	82.35	2.875	0.9144	0.8385
	4	138 $X10^3$	14/17	82.35	2.638	0.9177	0.8445
	5	108 $X10^3$	13/17	76.47	2.563	0.9144	0.852
	6	61 $X10^3$	13/17	76.47	2.919	1.017	0.9038
LOW TIDE	1	78 $X10^3$	11/17	64.70	2.295	0.8723	0.8382
	2	92 $X10^3$	14/17	82.35	2.875	0.9395	0.8538
	3	105 $X10^3$	12/17	70.58	2.364	0.8972	0.8443
	4	112 $X10^3$	14/17	82.35	2.755	0.9159	0.8468
	5	108 $X10^3$	11/17	64.70	2.136	0.9189	0.8654

Table # 9 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN JUNE,2021

Tide	Sampling Station	Abundance In No / m^3	No of Species/groups observed /total species/group	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	111 $X10^3$	18/26	69.23	3.61	0.9985	0.8526
	2	100 $X10^3$	19/26	73.07	3.909	1.068	0.8846
	3	103 $X10^3$	22/26	84.61	4.531	1.129	0.905
	4	176 $X10^3$	24/26	92.31	4.448	1.143	0.904
	5	155 $X10^3$	21/26	80.77	3.966	1.13	0.9041
	6	47 $X10^3$	15/26	57.69	3.636	0.9622	0.8668
LOW TIDE	1	80 $X10^3$	16/26	61.54	3.423	1	0.8684
	2	103 $X10^3$	17/26	65.38	3.452	0.9526	0.8401
	3	112 $X10^3$	14/26	53.85	2.755	1.005	0.8795
	4	157 $X10^3$	25/26	96.15	4.747	1.168	0.9082
	5	130 $X10^3$	23/26	88.46	4.52	1.131	0.9095

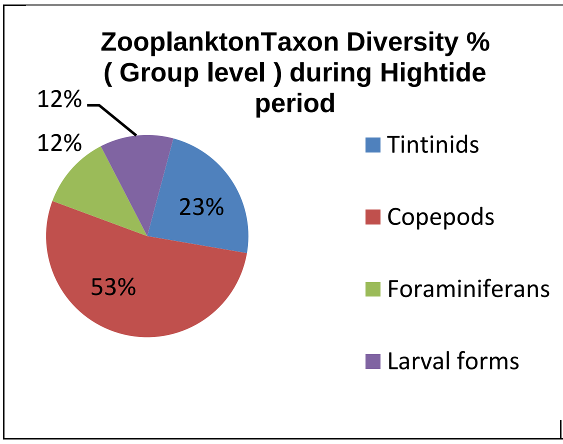
Table # 10 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN JUNE,2021

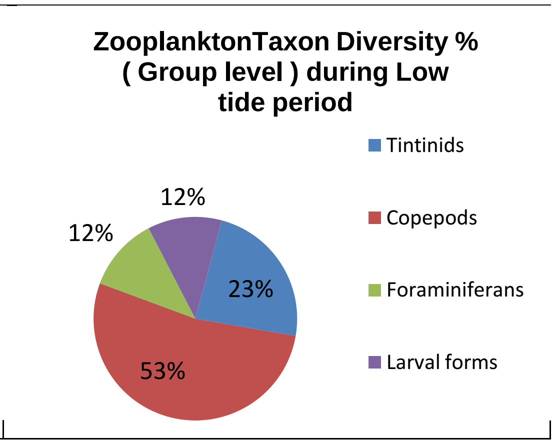
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	10-16	4/17	23.53
			Copepods	31-72	9/17	52.95
			Foraminiferans	0-4	2/17	11.76
			Larval forms	15-50	2/17	11.76
			TOTAL ZOOPLANKTON NO/L	**61-138**	**17**	**-**
LOW TIDE	Sub surface	5	Tintinids	8-15	4/17	23.53
			Copepods	45-57	9/17	52.95
			Foraminiferans	0-2	2/17	11.76
			Larval forms	25-43	2/17	11.76
			TOTAL ZOOPLANKTON NO/L	**78-112**	**17**	**-**

Table # 11 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA , NEAR BY CREEKS DURING NEAP TIDE IN JUNE,2021

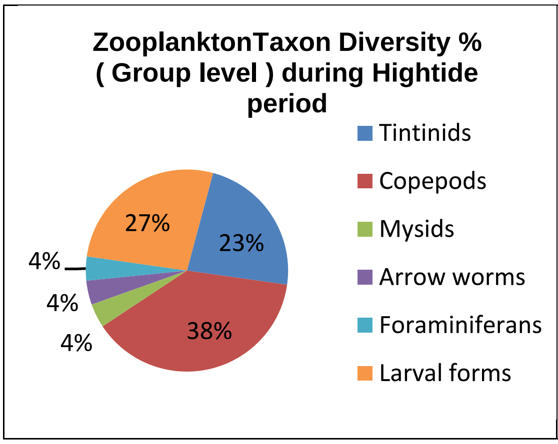
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	4-15	6/26	23.07
			Copepods	25-98	10/26	38.46
			Mysids	1-2	1/26	3.85
			Arrow worms	1-2	1/26	3.85
			Foraminiferans	0-2	1/26	3.85
			Larval forms	17-59	7/26	26.92
			TOTAL ZOOPLANKTON NO/L	**47-176**	**26**	**-**
LOW TIDE	Sub surface	5	Tintinids	4-15	6/26	23.07
			Copepods	38-85	10/26	38.46
			Mysids	0-2	1/26	3.85
			Arrow worms	0-2	1/26	3.85
			Foraminiferans	0-1	1/26	3.85
			Larval forms	37-52	7/26	26.92
			TOTAL ZOOPLANKTON NO/L	**80-157**	**26**	**-**

Taxon Diversity % of Zooplankton during High tide and Low tide period of Spring tide





Taxon Diversity % of Zooplankton during High tide and Low tide period of Neap tide



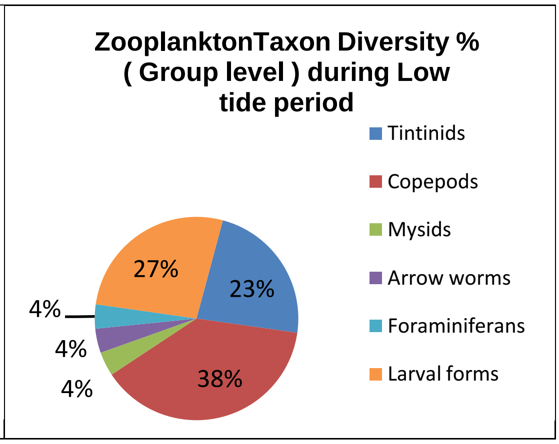


TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURINGSPRING TIDE OF JUNE,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Rare
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D2	Abundant
			Triceratiales	Triceratiaceae	*Odontella*sp	D3	Rare
					*Triceratium*sp.	D4	Occasional
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D5	Frequent
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D6	Occasional
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros*sp	D7	Occasional
			Lithodesmiales	Lithodesmiaceae	*Ditylum*sp	D8	Dominant
			Thalassiosirales	Thalassiosiraceae	*Thalassiosira*sp	D9	Rare
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*sp	D10	Rare
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D11	Frequent
					Thalassionema sp.	D12	Rare
			Fragilariales	Fragilariaceae	*Fragilaria*sp	D13	Occasional
					*Synedra*sp	D14	Frequent
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Gonyaulacales	Ceratiaceae	*Ceratiumfurca*	DF1	Rare

TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURING AND NEAP TIDE OF JUNE,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Occasional
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D2	Dominant
			Triceratiales	Triceratiaceae	*Triceratium*sp	D3	Occasional
					*Odontella*sp	D4	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D5	Abundant
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D6	Rare
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros*sp	D7	Rare
			Lithodesmiales	Lithodesmiaceae	*Ditylum*sp	D8	Abundant
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*sp	D9	Occasional
			Bacillariales	Bacillariaceae	*Bacillaria* sp.	D10	Rare
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D11	Frequent
					Thalassionema sp.	D12	Rare
			Fragilariales	Fragilariaceae	*Fragilaria*sp	D13	Rare
					*Synedra*sp	D14	Frequent
					*Asterionella*sp	D15	Occasional
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium sp.*	DF1	Rare

TABLE #13 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS IN DPT HARBOUR AREA, AND NEAR BY CREEKS DURING SPRING TIDE OF JUNE,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Occasional
				Codonellidae	*Tintinnopsisfailakkaensis*	T2	Occasional
					Tintinnopsisgracilis	T3	Occasional
					Tintinnopsis radix	T4	Rare
COPEPODS	ATHROPODA	Crustacea Sub class copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Frequent
					Bestiolina sp.	C2	Rare
					Parvocalanus sp.	C3	Occasional
				Eucalanidae	*Pareucalanus sp.*	C4	Rare
				Clausocalanidae	*Clausocalanus sp.*	C5	Occasional
				Temoridae	*Temora sp.*	C6	Rare
			Cyclopoida	Oithonidae	*Oithona sp.*	C7	Abundant
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C8	Frequent
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C9	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L2	Occasional
FORAMINIFERA	FORAMINIFERA	Globothalamea	Rotaliida	Globigerinidae	*Globigerina* sp.	F1	Rare
				Rotalliidae	*Rotalia* sp.	F2	Rare

TABLE # 13 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS IN DPT HARBOUR AREA, AND NEAR BY CREEKS DURING NEAP TIDE OF JUNE,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Rare
				Codonellidae	*Tintinnopsisaccuminata*	T2	Occasional
					Tintinnopsisfailakkaensis	T3	Occasional
					Tintinnopsisgracilis	T4	Rare
					Tintinnopsis radix	T5	Rare
				Codonellopsidae	*Codonellopsis* sp.	T6	Rare
COPEPODS	ATHROPODA	Crustacea Sub class copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Abundant
					Parvocalanus sp.	C2	Rare
				Eucalanidae	*Pareucalanus sp.*	C3	Frequent
					Subeucalanus sp.	C4	Occasional
				Temoridae	*Temora sp.*	C5	Frequent
				Acartiidae	*Acartia sp.*	C6	Occasional
			Cyclopoida	Oithonidae	*Oithona sp.*	C7	Frequent
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C8	Frequent
				Euterpinidae	*Euterpina sp.*	C9	Frequent
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C10	Rare
ARROW WORMS	CHAETOGNATHA	Sagittoideae	Aphragmophora	Sagittidae	*Sagitta sp.*	A1	Rare
MYSIDS	ATHROPODA CRUSTACEA	Malacostraca	Mysida, Decapoda	Penaeidae	*Metapenaeussp.*	M1	Rare

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
POLYCHAETE LARVA	ANNELIDA	Polychaeta			Trochophore larvae	L2	Occasional

BENTHIC ORGANISMS:

No Benthic organism was observed in the collected sediments by using the Van-veen grabs during the sampling conducted during spring tide periodfrom DPT harbour region and nearby creek except few dead shells. Benthic organisms form the sample collected during Neap tide is represented by mainly Polychates ,*Pontodra*sp. *Paronis* sp. and *Phalacophorus*sp and few Amphipods. The benthic organisms at subtidal region of harbour region and creek varies from 30-100 N/m^2

Table # 14 BENTHIC FAUNA IN THE SAMPLING LOCATIONS IN DPT HARBOUR AREA CREEKS DURING NEAP TIDE IN JUNE,2021

Benthic fauna	ABUNDANCE IN NO/M^2 DIFFERENT SAMPLING STATIONS REPRESENTATION BY GROUP						
	DPT HARBOUR			CREEKS			
POLYCHATES	KPT-1	KPT-2	KPT-3	KPT-4	KPT-5	KPT-6	
Family : Iospilidae *Pondodora sp.*	10	NS	0	20	30	NS	
Family : Syllidae *Syllis sp*.	20	NS	10	30	10	NS	
Family Glyceredae *Glycerasp.*	30	NS	0	0	0	NS	
Total Polychates N/M^2		NS				NS	
Un identified Nematode worms		NS		0		NS	
Amhipods Un identified	0	NS	0	50	0	NS	
TOTAL Benthic Fauna NUMBER/ M^2	60	NS	10	100	30	NS	

NS : No sample

7. Meteorological Data

Automatic Weather station have been installed in SevaSadan -3 at the Deendayal Port which records the data on Temperature (°C), Humidity (%),Wind (mph), Dew Point (°C), Wind Direction (°), Pressure, Solar radiation, heat Index and UVI.

Temperature

The mean day time temperature for Deendayal Port was 29.77 °C. The day-time maximum temperature was 34.1 °C. The mean night time temperature was 32.53 °C. The minimum mean night time temperature recorded was 28.2 °C.

Air Pressure

The mean absolute air pressure for the month of June was 1004.93 hpa, whereas the mean relative pressure was 1005.03 hpa. The maximum absolute air pressure recorded for the month of June was 1008.9 hpa.

Heat Index

The mean day-time heat index for the month of June was 35.20 ^{o}C. The maximum heat index recorded was 44^{o}C.

Solar Radiation

The mean Solar Radiation in June was 208.28 w/m^2. The maximum solar radiation recorded in the month of June was 654.8 w/m^2.

Humidity

The mean day-time humidity was 76.42 % for the month of June and mean night time humidity was 65.97%. Maximum humidity recorded during day-time was 84.0 % and maximum humidity recorded during night-time was 82.0%.

Wind Velocity and Wind Direction

The mean wind velocity for the entire month of June was 9.72 km/hour (i.e. 2.7 mtr/sec). Maximum wind velocity recorded was 46.8 Km/hr (13 mtr/sec). The wind direction was mostly S to SW.

Conclusive Summary and Remedial measures Suggested

- The AAQ monitoring at six locations of Deendayal Port indicates that the mean PM_{10} values at four locations viz. Coal storage area, Marine Bhavan and Oil Jetty area were found above the permissible standards (100 µg/m^3)and$PM_{2.5}$was above permissible limits at Coal storage location(Limit 60 µg/m^3).

- Drinking water at all the twenty locations was found potable and was within permissible limits of BIS standards (IS 10500).

- Noise quality was also within the set permissible standards of an Industrial Area. The noise level observed during day time was >75 dB (A) and at night time was >70 dB (A) during the entire monitoring period.

- The sewage treated water of Deendayal Port Colony (Gopalpuri) was in line with the standards set by the Gujarat Pollution Control Board. The STP at Deendayal Port is not fully operational and STP at Vadinar Port was found non-operational.

Reasons for higher Values of PM_{10}

- Large amount of coal is handled at Berth No. 6, 7, 8 and 9. The unloading of coal directly in the truck, using grabs cause coal to spread in air as well as coal dust to fall on ground. This settled coal dust again mixes with the air while trucks travel through it.

- Also, the coal laden trucks are not always covered with tarpaulin sheets, and these results in spillage of coal from trucks/dumpers during its transit from vessel to yard or storage site. This also increased PM values around marine Bhavan & Coal storage area.

Remedial Measures

The values of PM_{10} during the month of June, 2021 were observed beyond the permissible limit at four locations mentioned above. Given below are the remedial measures suggest to minimize the Air pollution at Deendayal Port.

- Guidelines for Coal Handling by GPCB should be strictly followed. (http://gpcb.gov.in/pdf/coal-handling-guidelines.pdf)

- Sewage Treatment Plan at Vadinar Port is not working. Hence, it is recommended to commission the sewage treatment plant at Vadinar immediately.

- Except for the higher values of PM_{10} at Coal storage site, Oil Jetty, Tuna Port and Marine Bhavan locations, the monitoring results for the present month suggest that the overall Environment Quality of Deendayal Port is satisfactory.

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ENVIRONMENTAL MONITORING REPORT
FOR
DEENDAYAL PORT TRUST

REPORT NO.	:	DCPL/DPT/20-21/15
Month	:	July 2021
Issue No	:	01
Revision No	:	00
Prepared by	:	DETOX CORPORATION PVT. LTD., SURAT

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Introduction

Monitoring of various environmental aspects of the Deendayal port by M/s Detox Corporation Pvt. Ltd. has been carried out through collection of samples, analysis of the same, comparing results with respect to the national standards and any other relevant standards by GBCB/CPCB/MoEF to identify non conformities in the Environment of the Deendayal Port. The results shall address the identified impacts and suggest measures to minimize the environmental impact due to various operations at Deendayal Port.

The environmental monitoring is carried out as per the Environment Management and Monitoring Plan submitted by Detox Corporation Pvt. Ltd.

1. Ambient Air Quality Monitoring

As per the Environmental Monitoring Plan of Deendayal Port Trust, Air monitoring was carried out at six identified locations at Deendayal Port and two locations at Vadinar Port.

1.1 Air Quality Monitoring Methodology

Air quality is measured in all the stations, for 24 hour for Total Suspended Particulate Matter (TSPM), PM_{10}, $PM_{2.5}$, SO_2, NO_X, NH_3 & Benzene, and Grab-sampling for CO & CO_2 measurements. The Air samplers are operated for a period of 24 hours and after a continuous operation of 8 hours of the sampler, the reagents were replaced to obtain 3 samples per day for each parameter namely, SO_2, NO_X. The EPM 2000 filter paper and PTFE Membrane bound filter paper are used for a period of 24 hours to obtain one sample each of TSPM, PM_{10} & $PM_{2.5}$.

The AAQ samples are collected twice a week from all the eight locations as per the EMP.

1.2 Results

The ambient air quality monitoring data for six stations, viz. Marine Bhavan, Oil Jetty, Port Colony,Gopalpuri Hospital,Tuna Port and Nr. Coal Storage Area for the month of July 2021 are given in Tables 1A to 6B. The ambient air quality monitoring data for two stations at Vadinar (Nr. Admin Building &Nr. Signal Building) are given in Tables 7A to 8B.

Location 1: Marine Bhavan (AL1)

Table 1 : Results of Air Pollutant Concentration at Marine Bhavan

Parameter	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period	-	24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit	-	NS	100 µg/m3	60 µg/m3		80 µg/m3		80 µg/m3		400 µg/m3
AL1 – 1	01.07.2021	417	302	96	3.08	2.78	59.07	48.70	13.53	15.32
					3.52		55.26		16.08	
					1.76		31.76		16.34	
AL1 – 2	05.07.2021	875	776	40	6.59	5.71	57.16	52.51	15.83	12.34
					5.71		47.64		10.21	
					4.84		52.72		10.98	
AL1 – 3	09.07.2021	769	693	11	8.79	7.62	33.03	34.30	13.79	13.87
					8.35		31.76		13.53	
					5.71		38.11		14.30	
AL1 – 4	14.07.2021	267	257	31	2.64	4.69	14.61	24.98	19.15	10.21
					5.28		28.58		5.11	
					6.15		31.76		6.38	
AL1 – 5	16.07.2021	234	143	8	10.55	10.11	13.34	20.11	9.19	12.34
					13.19		22.87		14.04	
					6.59		24.14		13.79	
AL1 - 6	21.07.2021	314	257	202	4.84	2.93	13.34	13.76	7.66	12.17
					1.32		15.24		12.25	
					2.64		12.70		16.59	
AL1 - 7	23.07.2021	387	256	163	1.76	3.08	38.11	28.16	16.34	61.10
					3.52		27.31		13.79	
					3.96		19.05		153.17	
AL1 – 8	27.07.2021	471	299	163	6.15	6.01	12.70	16.09	137.85	53.78
					6.59		18.42		10.98	
					5.28		17.15		12.51	
Monthly Average		467	373	89		5.37		29.83		23.89
Standard Deviation		234	230	78		2.58		14.43		20.85

NS: Not Specified

Table 1B : Results of Air Pollutant Concentration at Marine Bhavan					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC* ppm**	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL1 – 1	01.07.2021	1.13	BDL	1.46	508
AL1 – 2	05.07.2021	1.1	BDL	1.52	489
AL1 – 3	09.07.2021	1.04	BDL	1.36	512
AL1 – 4	14.07.2021	1.14	BDL	1.48	562
AL1 – 5	16.07.2021	1.12	BDL	1.52	496
AL1 - 6	21.07.2021	1.05	BDL	1.48	485
AL1 – 7	23.07.2021	1.04	BDL	1.78	508
AL1 – 8	27.07.2021	1.1	BDL	1.69	495
Monthly Average		**1.09**	**-**	**1.54**	**507**
Standard Deviation		**0.04**	**-**	**0.13**	**24**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5ppm)

NS -Not Specified

At Marine Bhavan, the overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_X and NH_3 is attributed mainly by motor vehicle emission produced from various types of automobiles (both diesel and petrol driven). Moreover, the loading and unloading of Food Grains and Timber at Jetty no. 1 and 2 also contributes to the high levels of TSPM and PM_{10}. The mean TSPM value at Marine Bhavan was 467 µg/m^3, The mean PM_{10} values were 373.0 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 89 µg/m^3). The average values of SO_2, NO_x and NH_3 were within the permissible limit. The average values of SO_2, NO_x and NH3 were 5.37 µg/ m^3, 29.83 µg/ m^3 & 23.89 µg/ m^3 respectively. These were within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Marine Bhavan. The mean Benzene concentration was 1.09 µg/m^3,well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.54 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 2: Oil Jetty (AL2)

Table 2 : Results of Air Pollutant Concentration at Oil Jetty										
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**	
Sampling Period	**-**	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	**-**	**NS**	**100 µg/m3**	**60 µg/m3**	**-**	**80 µg/m3**	**-**	**80 µg/m3**	**-**	**400 µg/m3**
AL2 – 1	01.07.2021	265	392	127	2.20	1.47	55.26	45.94	7.66	9.96
					0.88		52.72		10.98	
					1.32		29.85		11.23	
AL2 – 2	05.07.2021	812	737	42	0.88	2.93	44.46	47.64	13.53	13.96
					2.64		47.64		13.53	
					5.28		50.81		14.81	
AL2 – 3	09.07.2021	807	707	35	5.28	8.35	17.15	24.56	7.91	10.98
					10.11		24.77		12.76	
					9.67		31.76		12.25	
AL2 – 4	14.07.2021	602	280	5	3.08	3.37	19.05	20.33	15.32	16.59
					2.64		17.15		16.08	
					4.40		24.77		18.38	
AL2 – 5	16.07.2021	578	539	6	4.40	4.10	16.51	17.15	6.13	6.98
					3.52		17.15		5.11	
					4.40		17.78		9.70	
AL2 – 6	21.07.2021	867	772	10	4.84	5.13	29.22	28.16	10.98	13.36
					4.40		32.39		12.76	
					6.15		22.87		16.34	
AL2 – 7	23.07.2021	244	194	76	2.20	2.20	23.50	26.25	13.79	15.40
					1.76		26.68		15.83	
					2.64		28.58		16.59	
AL2 – 8	27.07.2021	448	350	76	6.15	6.45	23.50	18.84	12.00	12.59
					7.03		14.61		13.02	
					6.15		18.42		12.76	
Monthly Average		578	496	47		4.25		28.61		12.48
Standard Deviation		244	224	43		2.30		11.83		3.10

NS: Not Specified

Table 2B : Results of Air Pollutant Concentration at Oil Jetty					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC* ppm**	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL2 -1	01.07.2021	1.12	BDL	1.76	512
AL2 -2	05.07.2021	1.16	BDL	1.85	498
AL2 -3	09.07.2021	1.06	BDL	1.77	506
AL2 -4	14.07.2021	1.15	BDL	1.54	489
AL2 – 5	16.07.2021	1.14	BDL	1.78	490
AL2 – 6	21.07.2021	1.19	BDL	1.62	506
AL2 -7	23.07.2021	1.72	BDL	1.82	515
AL2 – 8	27.07.2021	1.58	BDL	1.78	510
Monthly Average		**1.27**	**-**	**1.74**	**503**
Standard Deviation		**0.24**	**-**	**0.11**	**10**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 0.5ppm)

NS- Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Oil Jetty area was mainly by motor vehicle emission produced from various types of vehicles Oil Jetty Area. The mean TSPM values at Oil Jetty were 578 µg/m^3 The mean PM_{10} values were 496 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were below the permissible limit (mean = 47 µg/m^3).The average values of SO_2, NO_x and NH_3 were within the permissible limit; The mean concentration of SO_2, NO_x and NH3 were 4.25 µg/m^3, 28.61 µg/m^3 and 12.48 µg/m^3 respectively.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Oil Jetty. The mean Benzene concentration was 1.27 µg/m^3 .Well below the permissible limit of 5.0 µg/m^3. , HC's were below the detectable limit and Carbon Monoxide concentration was 1.74 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 3: Kandla Colony – Estate Office (AL-3)

Table 3 : Results of Air Pollutant Concentration at Estate Office											
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**		
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**	-	**80 µg/m3**	-	**80 µg/m3**	-	**400 µg/m3**	
AL3 – 1	01.07.2021	168	153	55	3.52	3.81	20.96	21.38	14.30	10.21	
					5.28		27.31		9.45		
					2.64		15.88		6.89		
AL3 – 2	05.07.2021	467	373	21	3.52	2.49	21.60	23.50	14.04	15.91	
					1.32		18.42		15.83		
					2.64		30.49		17.87		
AL3 – 3	09.07.2021	297	139	37	3.08	4.98	23.50	24.77	9.19	7.66	
					6.15		29.85		6.38		
					5.71		20.96		7.40		
AL3 – 4	14.07.2021	292	121	80	4.84	5.86	21.60	19.27	14.55	72.33	
					5.71		18.42		186.35		
					7.03		17.78		16.08		
AL3 – 5	16.07.2021	629	566	96	17.58	10.11	17.15	14.82	13.53	12.00	
					7.91		15.24		9.70		
					4.84		12.07		12.76		
AL3 – 6	21.07.2021	721	668	57	3.96	2.49	6.99	14.82	20.42	18.98	
					1.32		15.88		21.44		
					2.20		21.60		15.06		
AL3 – 7	23.07.2021	490	406	51	2.64	2.49	22.87	23.29	11.23	11.91	
					3.08		19.69		9.70		
					1.76		27.31		14.81		
AL3 – 8	27.07.2021	640	500	51	1.76	3.66	20.96	18.00	11.23	10.04	
					4.40		17.15		8.17		
					4.84		15.88		10.72		
Monthly Average		463	366	56		4.49		19.98		19.88	
Standard Deviation		196	210	23		2.59		3.89		21.49	

NS: Not Specified

Table 3B : Results of Air Pollutant Concentration at Kandla Port Colony					
Parameter	Date	C_6H_6 [µg/m^3]	HC*	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3	NS	4.0 mg/m^3	NS
AL3 -1	01.07.2021	1.12	BDL	1.78	510
AL3 -2	05.07.2021	1.22	BDL	1.84	526
AL3 -3	09.07.2021	1.16	BDL	1.96	520
AL3 -4	14.07.2021	1.26	BDL	1.88	542
AL3 – 5	16.07.2021	1.18	BDL	1.78	533
AL3 – 6	21.07.2021	1.26	BDL	1.6	525
AL3 – 7	23.07.2021	1.21	BDL	1.58	542
AL3 – 8	27.07.2021	1.11	BDL	1.78	502
Monthly Average		**1.19**	**-**	**1.78**	**525**
Standard Deviation		**0.06**	**-**	**0.13**	**14**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)

NS- Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Kandla Port Colony was attributed by vehicle emission produced from trucks and heavy duty vehicles that pass through the road outside Kandla Port Colony. The mean TSPM values at Oil Jetty were 463 µg/m^3, The mean PM_{10} values were 366 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were slightly above the permissible limit (mean = 56 µg/m^3). The average values of SO_2, NO_x and NH3 were 4.49 µg/m^3, 19.98 µg/m^3 and 19.88 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Kandla Port Colony. The mean Benzene concentration was 1.19 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.78 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 4: Gopalpuri Hospital (AL-4)

Table 4 : Results of Air Pollutant Concentration at Gopalpuri Hospital

Parameter	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period	-	24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit	-	NS	100 µg/m3	60 µg/m3	-	80 µg/m3	-	80 µg/m3	-	400 µg/m3
AL4 -1	01.07.2021	148	138	21	1.32	2.20	12.70	13.34	3.57	5.36
					2.20		13.34		7.40	
					3.08		13.97		5.11	
AL4 -2	05.07.2021	313	277	115	3.52	1.76	24.14	19.48	5.36	6.72
					1.32		13.34		8.42	
					0.44		20.96		6.38	
AL4 -3	09.07.2021	287	152	40	1.32	2.49	12.70	30.06	5.87	5.79
					2.64		22.23		5.11	
					3.52		55.26		6.38	
AL4 -4	14.07.2021	143	77	8	1.32	0.88	13.34	11.64	11.74	9.19
					0.88		11.43		8.17	
					0.44		10.16		7.66	
AL4 – 5	16.07.2021	196	119	83	1.32	2.93	20.33	15.24	5.62	7.49
					3.52		13.34		9.45	
					3.96		12.07		7.40	
AL4 – 6	21.07.2021	228	128	100	2.64	1.90	22.87	17.57	7.15	6.89
					1.32		13.34		7.40	
					1.76		16.51		6.13	
AL4 – 7	23.07.2021	338	200	109	0.88	1.32	19.05	26.25	7.15	9.36
					1.32		28.58		9.70	
					1.76		31.12		11.23	
AL4 – 8	27.07.2021	806	746	27	1.76	2.49	19.05	16.94	6.89	6.47
					2.20		14.61		6.38	
					3.52		17.15		6.13	
Monthly Average		307	230	63		2.00		18.82		7.16
Standard Deviation		214	217	43		0.67		6.34		1.46

NS: Not Specified

Table 4B : Results of Air Pollutant Concentration at Gopalpuri Hospital					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC***	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL4 -1	01.07.2021	1.22	BDL	1.62	502
AL4 -2	05.07.2021	1.16	BDL	1.48	499
AL4 -3	09.07.2021	1.32	BDL	1.62	501
AL4 -4	14.07.2021	1.28	BDL	1.78	489
AL4 – 5	16.07.2021	1.25	BDL	1.46	496
AL4 – 6	21.07.2021	1.18	BDL	1.62	510
AL4 – 7	23.07.2021	1.14	BDL	1.78	502
AL4 – 8	27.07.2021	1.23	BDL	1.48	496
Monthly Average		**1.22**	**-**	**1.61**	**499**
Standard Deviation		**0.06**	**-**	**0.13**	**6**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)

NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Gopalpuri Hospital was attributed by vehicle emission produced from light motor vehicles of the colony residents. The mean TSPMvalues at Oil Jetty were 307 µg/m^3, The mean PM_{10} values were 230 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were slight above the permissible limit (mean= 63 µg/m^3). The average values of SO_2, NO_x and NH_3 were 2.00 µg/m^3, 18.82 µg/m^3 and 7.16 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Gopalpuri Hospital. The mean Benzene concentration was 1.22 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.61 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 5: Coal Storage Area (AL-5)

Table 5 : Results of Air Pollutant Concentration at Coal Storage Area										
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**	
Sampling Period	**-**	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	**-**	**NS**	**100 µg/m3**	**60 µg/m3**	**-**	**80 µg/m3**	**-**	**80 µg/m3**	**-**	**400 µg/m3**
AL5 – 1	01.07.2021	428	158	47	3.08	3.37	42.56	48.70	15.83	14.04
					4.84		50.81		12.76	
					2.20		52.72		13.53	
AL5 – 2	05.07.2021	496	150	44	9.67	6.01	57.16	54.84	10.21	14.98
					4.84		49.54		13.53	
					3.52		57.80		21.19	
AL5 – 3	09.07.2021	222	135	76	9.67	7.62	60.98	50.60	16.85	17.44
					3.52		57.16		18.89	
					9.67		33.66		16.59	
AL5 – 4	14.07.2021	349	309	21	17.58	9.23	22.87	31.97	9.45	15.32
					4.84		32.39		21.70	
					5.28		40.65		14.81	
AL5 – 5	16.07.2021	264	123	12	9.67	11.87	16.51	21.38	12.00	14.21
					13.19		22.23		14.04	
					12.75		25.41		16.59	
AL5 – 6	21.07.2021	358	303	33	4.40	5.28	22.87	19.69	16.85	18.47
					6.15		19.05		16.34	
					5.28		17.15		22.21	
AL5 – 7	23.07.2021	268	194	45	4.40	5.28	27.95	23.71	12.76	16.76
					5.28		20.96		16.59	
					6.15		22.23		20.93	
AL5 – 8	27.07.2021	446	273	45	6.15	6.89	14.61	17.15	10.21	13.19
					7.03		22.23		14.04	
					7.47		14.61		15.32	
Monthly Average		354	206	40		6.94		33.50		15.55
Standard Deviation		98	77	19		2.65		15.50		1.84

NS: Not Specified

Table 5B : Results of Air Pollutant Concentration at Coal Storage Area					
Parameter	**Date**	**C_6H_6 [µg/m³]**	**HC***	**CO [mg/m³]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m³**	**NS**	**4.0 mg/m³**	**NS**
AL5 – 1	01.07.2021	1.28	BDL	1.82	526
AL5 – 2	05.07.2021	1.11	BDL	1.78	522
AL5 – 3	09.07.2021	1.16	BDL	1.88	520
AL5 – 4	14.07.2021	1.32	BDL	1.78	530
AL5 – 5	16.07.2021	1.28	BDL	1.82	536
AL5 – 6	21.07.2021	1.22	BDL	1.77	522
AL5 – 7	23.07.2021	1.18	BDL	1.86	526
AL5 – 8	27.07.2021	1.26	BDL	1.9	530
Monthly Average		**1.23**	**-**	**1.83**	**527**
Standard Deviation		**0.07**	**-**	**0.05**	**5**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)

NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Coal Storage Area was comparatively highest among all the locations of Air Quality monitoring in Kandla Port. High values of TSPM, PM10, $PM_{2.5}$, SO_2, NO_X at this location was due to lifting of coal with grab and other coal handling processes near Berth no. 6 & 7. Moreover, the traffic was also heavy around this place for transport of coal thus emissions produced from heavy vehicles. The mean TSPM values at Coal storage were 354 µg/m³. The mean PM_{10} values were 206 µg/m³, which is well above the permissible limit. $PM_{2.5}$ values were below the permissible limit (mean = 40 µg/m³). The average values of SO_2, NO_x and NH_3 were 6.94 µg/m³, 33.50 µg/m³ and 15.55 µg/m³ respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Coal Storage Area. The mean Benzene concentration was 1.23 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.83 mg/m³, well below the permissible limit of 4.0 mg/m³.

Location 6: Tuna Port (AL-6)

Table 6 : Results of Air Pollutant Concentration at Tuna Port											
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**		
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**	-	**80 µg/m3**	-	**80 µg/m3**	-	**400 µg/m3**	
AL6 -1	01.07.2021	149	97	39	0.88	2.20	16.51	15.24	5.87	7.32	
					2.20		17.15		7.91		
					3.52		12.07		8.17		
AL6 – 2	05.07.2021	270	169	97	2.20	2.20	13.97	17.36	12.76	12.00	
					1.32		14.61		11.74		
					3.08		23.50		11.49		
AL6 – 3	09.07.2021	513	198	86	5.71	4.98	21.60	20.96	6.89	7.06	
					6.15		17.15		6.64		
					3.08		24.14		7.66		
AL6 – 4	14.07.2021	230	97	98	2.20	3.08	8.26	9.53	7.40	8.76	
					2.64		9.53		8.93		
					4.40		10.80		9.96		
AL6 – 5	16.07.2021	554	484	18	1.76	2.20	14.61	12.07	10.72	10.89	
					3.52		12.07		10.98		
					1.32		9.53		10.98		
AL6 – 6	21.07.2021	405	302	98	2.20	2.64	6.35	9.95	16.34	14.89	
					1.76		10.80		15.57		
					3.96		12.70		12.76		
AL6 – 7	23.07.2021	211	128	12	1.32	2.05	21.60	19.05	10.98	11.83	
					2.20		13.34		13.27		
					2.64		22.23		11.23		
AL6 – 8	27.07.2021	645	524	12	0.88	2.05	14.61	18.84	10.21	9.36	
					2.64		17.15		8.68		
					2.64		24.77		9.19		
Monthly Average		372	250	58		2.67		15.38		10.26	
Standard Deviation		183	171	41		1.00		4.40		2.65	

NS: Not Specified

Table 6B : Results of Air Pollutant Concentration at Tuna Port					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC***	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL6 -1	01.07.2021	1.2	BDL	1.79	510
AL6 – 2	05.07.2021	1.11	BDL	1.84	502
AL6 – 3	09.07.2021	1.19	BDL	1.72	511
AL6 – 4	14.07.2021	1.15	BDL	1.69	496
AL6 – 5	16.07.2021	1.06	BDL	1.88	499
AL6 – 6	21.07.2021	1.11	BDL	1.87	502
AL6 – 7	23.07.2021	1.06	BDL	1.74	506
AL6 – 8	27.07.2021	1.15	BDL	1.7	512
Monthly Average		**1.13**	**-**	**1.78**	**505**
Standard Deviation		**0.05**	**-**	**0.08**	**6**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)

NS- Not Specified

The mean TSPM values at Tuna Port were 372 µg/m^3, The mean PM_{10} values were 250 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were within the permissible limit (mean = 58 µg/m^3 µg/m^3). The average values of SO_2, NO_x and NH_3 were 2.63 µg/m^3, 15.38 µg/m^3 and 10.26 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Tuna Port. The mean Benzene concentration was 1.13 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.78 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 7: Signal Building (Vadinar) (AL-7)

Table 7 : Results of Air Pollutant Concentration at Signal Building											
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**		
Sampling Period	**-**	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	
NAAQMS limit	**-**	**NS**	**100 µg/m3**	**60 µg/m3**	**-**	**80 µg/m3**	**-**	**80 µg/m3**	**-**	**400 µg/m3**	
AL7 -1	01.07.2021	119	72	37	3.20	3.08	8.05	8.26	4.41	4.34	
					2.97		8.49		4.42		
					3.06		8.24		4.19		
AL7 -2	05.07.2021	104	81	30	3.40	3.52	13.07	12.70	5.45	5.36	
					3.18		12.38		5.29		
					3.99		12.65		5.35		
AL7 -3	09.07.2021	62	73	42	4.28	3.96	6.35	6.35	6.09	5.87	
					3.60		6.50		5.82		
					4.01		6.20		5.69		
AL7 -4	14.07.2021	104	74	110	4.18	3.96	6.24	6.35	18.21	17.88	
					3.87		6.47		17.45		
					3.84		6.34		17.97		
AL7 -5	16.07.2021	96	63	40	2.82	2.64	20.65	20.33	9.23	8.93	
					2.65		19.80		8.86		
					2.45		20.54		8.69		
AL7 -6	21.07.2021	102	68	12	8.02	7.47	5.73	5.72	2.71	2.81	
					7.18		6.03		2.59		
					7.22		5.40		3.13		
AL7 -7	23.07.2021	143	95	35	5.17	4.84	33.65	33.57	3.29	3.57	
					5.10		33.82		3.8		
					4.26		33.23		3.62		
AL7 -8	27.07.2021	107	74	18	7.26	7.46	31.49	31.46	4.5	4.45	
					7.49		31.78		4.75		
					7.62		31.12		4.1		
Monthly Average		105	75	40		5		16		7	
Standard Deviation		23	10	30		2		12		5	

NS: Not Specified

Table 7B : Results of Air Pollutant Concentration at Signal Building					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC***	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL7 -1	01.07.2021	1.1	BDL	1.56	489
AL7 – 2	05.07.2021	1.06	BDL	1.66	488
AL7 – 3	09.07.2021	1.02	BDL	1.72	479
AL7 – 4	14.07.2021	1.1	BDL	1.62	496
AL7 – 5	16.07.2021	1.11	BDL	1.68	488
AL7 – 6	21.07.2021	1.16	BDL	1.58	490
AL7 – 7	23.07.2021	1.12	BDL	1.66	481
AL7 – 8	27.07.2021	1.1	BDL	1.6	475
Monthly Average		**1.10**	**-**	**1.64**	**486**
Standard Deviation		**0.04**	**-**	**0.05**	**7**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)
NS_ Not Specified

The mean TSPM values at Vadinar Port were 105 µg/m^3. The mean PM_{10} values were 75 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 40 µg/m^3 µg/m^3). The average values of SO_2, NO_x and NH_3 were 5.0 µg/m^3, 16.0 µg/m^3 and 7.0 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Vadinar Port. The mean Benzene concentration was 1.10 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.64 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 8: Admin Building (Vadinar) (AL-8)

Table 8 : Results of Air Pollutant Concentration at Admin Building										
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**	
Sampling Period	**-**	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	**-**	**NS**	**100 µg/m3**	**60 µg/m3**	**-**	**80 µg/m3**	**-**	**80 µg/m3**	**-**	**400 µg/m3**
AL8 -1	01.07.2021	172	96	25	2.71	2.64	10.75	10.80	3.42	3.57
					2.64		10.55		3.71	
					2.58		11.09		3.58	
AL8 -2	05.07.2021	121	100	16	4.05	3.96	8.89	8.89	4.51	4.85
					3.95		8.81		5.18	
					3.88		8.96		4.86	
AL8 -3	09.07.2021	108	88	14	5.02	4.84	5.80	5.72	9.48	9.19
					4.79		5.70		8.94	
					4.72		5.67		9.15	
AL8 -4	14.07.2021	169	68	84	6.74	6.59	5.76	5.72	22.65	22.61
					6.16		5.52		23.06	
					6.88		5.89		22.12	
AL8 -5	16.07.2021	136	85	37	1.40	1.32	18.40	18.42	23.67	22.98
					1.23		18.53		22.46	
					1.32		18.33		22.81	
AL8 -6	21.07.2021	140	65	87	9.58	9.67	9.04	8.89	6.65	6.63
					9.80		8.86		6.72	
					9.62		8.76		6.52	
AL8 -5	23.07.2021	168	96	47	6.10	6.15	44.85	44.46	9.23	8.93
					6.24		44.21		8.46	
					6.10		44.32		9.1	
AL8-6	27.07.2021	153	53	40	3.46	3.52	45.00	44.46	3.95	4.08
					3.72		44.05		4.09	
					3.38		44.32		4.2	
Monthly Average		146	81	44		5		18		10
Standard Deviation		24	17	28		3		17		8

NS: Not Specified

Table 8B : Results of Air Pollutant Concentration at Admin Building					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC***	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL8 -1	01.07.2021	1.1	BDL	1.56	489
AL8-2	05.07.2021	1.06	BDL	1.66	488
AL8 -3	09.07.2021	1.02	BDL	1.72	479
AL8-4	14.07.2021	1.1	BDL	1.62	496
AL8 -5	16.07.2021	1.11	BDL	1.68	488
AL8-6	21.07.2021	1.16	BDL	1.58	490
AL8-7	23.07.2021	1.12	BDL	1.66	481
AL8-8	27.07.2021	1.1	BDL	1.6	475
Monthly Average		**1.10**	**-**	**1.64**	**486**
Standard Deviation		**0.04**	**-**	**0.05**	**7**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)

NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Admin Building Vadinar was comparatively low among all the locations of Air Quality monitoring in Kandla Port and Vadinar Port. The mean TSPM values at Vadinar Port were 146 µg/m^3. The mean PM_{10} values were 81 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 44.0 µg/m^3). The average values of SO_2, NO_x and NH_3 were 5.0µg/m^3, 18.0 µg/m^3 and 10.0 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Admin Building, Vadinar Port. The mean Benzene concentration was 1.10 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.64 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

1.4 Observations and Conclusion

During the monitoring period, the overall Ambient Air Quality of the port area was found to be well within the desired levels for various pollutants. However, Near Coal storage area, Marine Bhavan and Oil Jetty area, PM_{10} values was above the permissible standards. All other pollutants were recorded well below the prescribed limits.

2. Drinking Water Quality Monitoring

Drinking Water Quality Monitoring was carried out at twenty stations at Kandla, Vadinar & Township Area of Deendayal Port.

2.1 Drinking Water Monitoring Methodology

Drinking water samples were collected from 20 locations as prescribed in the tender document. Samples for physico-chemical analysis were collected in 1 liter carboys and samples for microbiological parameters were collected in sterilized bottles. These samples were then analyzed in laboratory for various drinking water parameters at Kandla Lab/Surat.

The Sampling and Analysis was done as per standard methods - IS 10500:2012. The water samples were analyzed for various parameters, viz. Color , Odor, Turbidity , Conductivity , pH , Chlorides , TDS, Total Hardness, Iron , Sulphate , Salinity , DO, BOD, Na, K, Ca, Mg, F, NO_3, NO_2, Mn, Cr-6, Cu, Cd, As, Hg, Pb, Zn, Bacterial Count (cfu) .

2.2 Results

The Drinking Water Quality monitoring data for 20 stations are given in below from table No. 9 to Table No. 15

Table 9: Drinking Water Quality Monitoring Parameters for Nirman Building 1, P & C building & Main Gate (North) at Kandla

Sr. No.	Parameter	Unit	Nirman Building 1	P & C building	Main Gate North	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.7	7.4	7.6	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1290	1530	1180	500	2000
3	Turbidity	NTU	0	1	0	1.0	5.0
4	Odor	-	Odourless	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	2500	3010	2200	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/l	416	436	451	250.0	1000.0
9	Ca as Ca	mg/l	72.14	52.10	64.13	75.0	200.0
10	Mg as Mg	mg/l	51.03	68.04	65.61	30.0	100.0
11	Total Hardness	mg/l	390	410	430	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides as F	mg/l	0.26	0.47	0.21	1.0	1.5
14	Sulphate as SO4	mg/l	140.52	166.8	156	200.0	400
15	Nitrite as NO2	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate as NO3	mg/l	10.21	8.45	7.74	45.0	No Relaxation
17	Salinity	%	0.75	0.79	0.81	NS*	NS*
18	Sodium as Na	mg/l	170	168	148	NS*	NS*
19	Potassium as K	mg/l	2.2	2.3	2.8	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 10: Drinking Water Quality Monitoring Parameters for Canteen, West Gate – I & Wharf Area at Kandla

Sr. No.	Parameter	Unit	Canteen	West Gate - I	Wharf Area	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.5	7.3	7.6	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1590	1190	1670	500	2000
3	Turbidity	NTU	0	0	1	1.0	5.0
4	Odor	-	Odourless	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	3110	2330	3300	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/l	411	416	426	250.0	1000.0
9	Ca as Ca	mg/l	56.11	64.13	52.10	75.0	200.0
10	Mg as Mg	mg/l	60.75	48.60	63.18	30.0	100.0
11	Total Hardness	mg/l	390	360	390	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides as F	mg/l	0.18	0.53	1.05	1.0	1.5
14	Sulphate as SO4	mg/l	166.8	165.6	226.8	200.0	400
15	Nitrite as NO2	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate as NO3	mg/l	10.56	11.97	7.53	45.0	No Relaxation
17	Salinity	%	0.74	0.75	0.77	NS*	NS*
18	Sodium as Na	mg/l	133	168	156	NS*	NS*
19	Potassium as K	mg/l	3	2.2	2.4	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 11: Drinking Water Quality Monitoring Parameters for Sewa sadan – 3, Workshop I & Custom Building at Kandla

Sr. No.	Parameter	Unit	SewaSadan – 3	Workshop	Custom Building	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.7	7.9	7.3	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1490	1090	1330	500	2000
3	Turbidity	NTU	1	0	0	1.0	5.0
4	Odor	-	Odourless	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	2990	2090	2680	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	451	456	461	250.0	1000.0
9	Ca as Ca	mg/l	60.12	56.11	64.13	75.0	200.0
10	Mg as Mg	mg/l	60.75	63.18	53.46	30.0	100.0
11	Total Hardness	mg/l	400	400	380	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.93	0.70	1.45	1.0	1.5
14	Sulphate	mg/l	156	171.6	195.6	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	14.78	16.83	9.50	45.0	No Relaxation
17	Salinity	%	0.81	0.82	0.83	NS*	NS*
18	Sodium as Na	mg/l	162	152	162	NS*	NS*
19	Potassium as K	mg/l	2.3	2.4	2.8	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 12: Drinking Water Quality Monitoring Parameters for Port Colony Kandla, Hospital Kandla & A.O. Building at Gandhidham

Sr. No.	Parameter	Unit	Port Colony Kandla	Hospital Kandla	A.O. Building	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.8	7.7	7.0	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1210	1450	1010	500	2000
3	Turbidity	NTU	1	2	2	1.0	5.0
4	Odor	-	Odourless	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	2370	2880	2030	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	526	541	491	250.0	1000.0
9	Ca as Ca	mg/l	52.10	52.10	48.10	75.0	200.0
10	Mg as Mg	mg/l	58.32	68.04	75.33	30.0	100.0
11	Total Hardness	mg/l	370	410	430	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	1.05	1.16	0.93	1.0	1.5
14	Sulphate	mg/l	204	214.8	147.6	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	9.01	9.72	9.15	45.0	No Relaxation
17	Salinity	%	0.95	0.98	0.89	NS*	NS*
18	Sodium as Na	mg/l	178	160	180	NS*	NS*
19	Potassium as K	mg/l	2.7	2.3	2.8	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 13: Drinking Water Quality Monitoring Parameters for School Gopalpuri, Guest House & E - Type Quarter at Gopalpuri, Gandhidham

Sr. No.	Parameter	Unit	School Gopalpuri	Guest House	E - Type Quarter	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.1	7.3	7.2	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	990	1410	1330	500	2000
3	Turbidity	NTU	1	0	1	1.0	5.0
4	Odor	-	Odourless	Odourless	Odourless	Agreeable	Agreeable
5	Color	Hazen Units	Colourless	Colourless	Colourless	5.0	15.0
6	Conductivity	µs/cm	1900	2900	2660	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	526	476	516	250.0	1000.0
9	Ca as Ca	mg/l	60.12	56.11	68.14	75.0	200.0
10	Mg as Mg	mg/l	55.89	53.46	53.46	30.0	100.0
11	Total Hardness	mg/l	380	360	390	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	1.08	0.82	1.14	1.0	1.5
14	Sulphate	mg/l	183.6	157.2	150	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	10.35	11.48	10.35	45.0	No Relaxation
17	Salinity	%	0.95	0.86	0.93	NS*	NS*
18	Sodium as Na	mg/l	196	203	200	NS*	NS*
19	Potassium as K	mg/l	2.4	2.3	2.6	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 14: Drinking Water Quality Monitoring Parameters for F - Type Quarter, Hospital Gopalpuri & Tuna Port

Sr. No.	Parameter	Unit	F - Type Quarter	Hospital Gopalpuri	Tuna Port	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.5	7.2	7.3	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1100	1020	1050	500	2000
3	Turbidity	NTU	1	1	0	1.0	5.0
4	Odor	-	Odourless	Odourless	Odorless	Agreeable	Agreeable
5	Color	Hazen Unit	Colourless	Colourless	Colorless	5.0	15.0
6	Conductivity	µs/cm	2200	2050	1940	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	506	546	592	250.0	1000.0
9	Ca as Ca	mg/l	64.13	72.14	72.14	75.0	200.0
10	Mg as Mg	mg/l	65.61	43.74	36.45	30.0	100.0
11	Total Hardness	mg/l	430	360	330	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.94	1.02	0.46	1.0	1.5
14	Sulphate	mg/l	165.6	159.6	120	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	10.63	9.36	1.33	45.0	No Relaxation
17	Salinity	%	0.91	0.99	0.92	NS*	NS*
18	Sodium as Na	mg/l	180	180	188	NS*	NS*
19	Potassium as K	mg/l	2.5	2.4	2.6	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 15: Drinking Water Quality Monitoring Parameters for Vadinar Jetty & Port Colony at Vadinar

Sr. No.	Parameter	Unit	Vadinar Jetty	Port Colony Vadinar	Acceptable Limits as per IS 10500 : 2012	Permissible Limits as per IS 10500 : 2012
1	pH	pH Unit	7.9	7.6	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	950.0	620.0	500	2000
3	Turbidity	NTU	ND	ND	1.0	5.0
4	Odor	-	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	1580.0	1030.0	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	NS*	NS*
8	Chloride	mg/l	445.99	466.04	250.0	1000.0
9	Ca as Ca	mg/l	60.12	52.10	75.0	200.0
10	Mg as Mg	mg/l	63.18	60.75	30.0	100.0
11	Total Hardness	mg/l	410	380	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.99	0.94	1.0	1.5
14	Sulphate	mg/l	16.80	17.64	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	11.48	9.50	45.0	No Relaxation
17	Salinity	%	0.81	0.84	NS*	NS*
18	Sodium as Na	mg/l	142.0	156.0	NS*	NS*
19	Potassium as K	mg/l	2.3	2.4	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent

*NS: Not Specified

2.3 Results & Discussion

The colour of all drinking water samples was < 5 Hazen unit and odour of the samples was also agreeable. All parameters are found to be within the specified limit of the Drinking water Standard.

pH

The limit of pH value for drinking water is specified as 6.5 to 8.5. pH value in the studied area varied from 7.0 to 7.9 pH unit. All the sampling points showed pH values within the prescribed limit by Indian Standards.

Total Dissolved Solids (TDS)

TDS values in the studied area varied between 600 -1800 mg/l. None of the sampling points showed higher TDS values than the prescribed limit by Indian standards .

Conductivity

Electrical Conductivity is the ability of a solution to transfer (conduct) electric current. Conductivity is used to measure the concentration of dissolved solids which have been ionized in a polar solution such as water. The conductivity in the samples collected during the month of July ranged from 1000-3300 µs/cm. Electrical conductivity standards do not appear in BIS standards for drinking water.

BOD

BOD value in the studied area was less than 2.0 mg/L. Indian standards does not show any standard values for BOD in drinking water.

Chlorides

Excessive chloride concentration increase rates of corrosion of metals in the distribution system. This can lead to increased concentration of metals in the supply. Chloride value in the studied area varied between 400-600 mg/l and is found to be within the Permissible limit of the Drinking Water Standard.

Calcium

Calcium value in the studied area varied between 45 - 80 mg/l and is found to be within the Permissible limit of the Drinking Water Standard. If calcium is present beyond the maximum acceptable limit, it causes incrustation of pipes.

Magnesium

Magnesium value in the studied area varied between 30 – 80 mg/l. All the locations had Magnesium within the prescribed limits of 30-100 mg/L.

Total Hardness

Hardness value in the studied area varied between 330-430 mg/l and is found to be within the Permissible limit of the Drinking Water Standard.The prescribed limit by Indian Standards is 200-600 mg/L.

Iron

Iron value in the studied area was below 0.01mg/L and hence well below the permissible limit as per Indian Standards is 0.3 mg/L. The excess amount of iron causes slight toxicity; gives stringent taste to water.

Fluoride

Fluoride value in the studied area varied between 0.1 – 1.4 mg/l and hence well below the permissible limit as per Indian Standards is 1.0-1.5 mg/L. Moderate amounts lead to dental effects, but long-term ingestion of large amounts can lead to potentially severe skeletal problems.

Sulphates

Sulphate value in the studied area varied between 100 – 330 mg/l. All the sampling points showed sulphate values within the prescribed limits by Indian Standards (200-400 mg/L). Sulphate content in drinking water exceeding the 400 mg/L imparts bitter taste.

Nitrites (NO_2) and Nitrates (NO_3)

Nitrite values in all the water samples were <0.1. There are no specified standard values for Nitrites in Drinking water. The mean Nitrate values in drinking water of KPT was 4.10 mg/l which is well within the permissible limit of the Drinking water Standard.

Salinity

Salinity in drinking water in the present samples collected ranged from 0.6 to 0.9 %. There are no prescribed Indian standards for salinity in Drinking water**.**

Sodium and Potassium Salts

Sodium values in the samples collected ranged from 100 - 2000 mg/l and Potassium salts ranged from 2.2 to 3.0 mg/l. There are no prescribed limits of Sodium and Potassium in Indian standards for Drinking water**.**

Heavy Metals in Drinking Water

In the present study period drinking water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals were well below the permissible limits prescribed by the Indian Standards.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that Bacteria is not present and hence Bacterial count is in line with the permissible limit of drinking water. This shows that all the drinking water samples were safe from any bacteriological contamination.

2.4 Conclusions

These results are compared with acceptable limits as prescribed in IS 10500:2012 – Drinking Water Specification. It is seen from the analysis data that during the study period the water was safe for human consumption at all drinking water monitoring stations.

3. Noise Level Monitoring

Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships. Noise Monitoring was done at 13 stations at Kandla, Vadinar and Township area.

3.1 Method of Monitoring

Sampling was done at all stations for 24 hour period. Data was recorded using automated sound level meter. The intensity of sound was measured in sound pressure level (SPL) and common unit of measurement is decibel (Db).

3.2 Results

Table 16: Noise Monitoring data for ten locations of Deendayal Port and two locations of Vadinar Port

Sr. No.	Location	Day Time Average Noise Level (SPL) in dB(A)	Night Time Average Noise Level (SPL) in dB(A)
	Sampling Time	**6:00 am to 10:00 PM**	**10:00PM to 6:00 AM**
1	Marine Bhavan	60.71	55.49
2	Nirman Building 1	58.02	52.12
3	Tuna Port	53.16	46.37
4	Main Gate North	56.47	53.21
5	West Gate I	61.41	53.6
6	Canteen Area	56.78	48.45
7	Main Road	59.41	56.44
8	ATM Building	63.81	55.02
9	Wharf Area /Jetty Area	65.66	56.59
10	Port & Custom Office	53.59	49.22
	Vadinar Port		
11	Entrance Gate of Vadinar Port	56.32	54.2
12	Nr. Port Colony, Vadinar	55.5	54.8
13	Nr. Vadinar Jetty	58.76	55.4

3.3 Conclusions- Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships. The Day Time Average Noise Level (SPL)in all ten locations at Deendayal Port ranged from 56.25 dB(A) to 69.51 dB(A) and it was within the permissible limits of 75 dB(A) for the industrial area for the daytime. The Night Time Average Noise Level (SPL) in all ten locations of Deendayal Port ranged from 48.28 dB to 62.33 dB(A) and it was within the permissible limits of 70 dB(A) for the industrial area for the night time.

4. Soil Monitoring

Sampling and analysis of soil samples were undertaken at six locations within the study area (Deendayal Port and Vadinar Port) as a part of EMP. The soil sampling locations are initially decided based on the locations as provided in the tender document of the Deendayal Port.

4.1 Methodology

The soil samples were collected in the month of July 2021. The samples collected from the all locations are homogeneous representative of each location. At random locations were identified at each location and soil was dug from 30 cm below the surface. It was uniformly mixed before homogenizing the soil samples. The samples were filled in polythene bags, labeled in the field with number and site name and sent to laboratory for analysis.

4.2 Results

Table-17: Chemical Characteristics of Soil in the Study Area

Sr. No.	Parameter	Unit	Station Name					
			SL1	SL2	SL3	SL4	SL5	SL6
			Tuna Port	IFFCO Plant	Khori Creek	Nakti Creek	KPT Admin Site	KPT Colony
			Near main gate of Port	10 m away from main gate	Sand from creek at low tide		Vadinar	
1	Texture		Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	pH	-	8.56	8.11	8.38	8.33	8.12	8.42
3	Electrical Conductivity	µs/cm	26,800.0	23,800.0	23,700.0	16,260.0	509.0	419.0
4	Moisture	%	23.66	22.09	24.41	23.65	9.44	7.59
5	Total Organic Carbon	%	0.16	0.24	0.32	0.10	0.20	0.12
6	Alkalinity	mg/kg	140.14	140.14	100.10	80.08	100.10	60.06
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
8	Chloride	mg/kg	3,908.6	4,309.5	6,114.0	3,959.0	39.3	68.7
9	Sulphate	mg/kg	203.0	177.9	113.8	93.8	13.4	15.5
10	Phosphorus	mg/kg	0.97	0.80	1.24	1.77	0.80	0.97
11	Potassium	mg/kg	779.4	644.4	1,135.8	766.8	129.6	180.0
12	Sodium	mg/kg	2,241.0	3,556.8	3,981.6	3,038.4	1,220.0	1,445.4
13	Calcium	mg/kg	144.29	128.22	168.30	224.40	104.20	56.11
14	Copper as Cu	mg/kg	42.6	61.2	38.2	22.6	16.2	23
15	Lead as Pb	mg/kg	4.2	3.2	3.6	3.8	ND	ND
16	Nickel as Ni	mg/kg	36.2	31.6	39.4	22.6	18.3	21.2
17	Zinc as Zn	mg/kg	58.60	39.25	52.4	46.60	46.80	38.20
18	Cadmium as Cd	mg/kg	ND	ND	ND	ND	ND	ND

4.3 Discussion

- The data shows that value of pH ranges from 8.11 at Nakti Creek to 8.56 at Tuna Creek indicating that all soil samples are neutral to slight basic. Tuna port samples howed maximum conductivity of 26,800µmhos/cm, while Nakti Creek location showed minimum conductivity of 16,260 µmhos/cm. Conductivity at Vadinar Port was 509 and 419 µmhos/cm at Admin site and Vadinar Port colony respectively.
- Total organic Carbon ranged from 0.1 % to 0.3 at Deendayal Port. At Vadinar Port, organic carbon content ranged from 0.1 % to 0.2 %.
- The concentration of Phosphorus and Potassium in the soil samples varies from 0.8 to 1.77 mg/kg and 600.0 to 1150 mg/kg respectively at Deendayal Port. The mean concentration of Phosphorous at Vadinar site was 0.89 mg/kg and mean concentration of Potassium at Vadinar site was 154.8 mg/kg.

These differences in NPK in soil at different locations are due to the dissimilar nature of soil at each of the locations. Samples SL3 & SL4 (Khori Creek & Nakti Creek) are of saline nature as they are coastal soil; where as other locations are inland locations and have different chemical properties.

Heavy Metals in the Soil

Traces of Copper, Lead, Nickel and Zinc were observed in the soil samples collected from all the four locations of Deendayal Port and two locations of Vadinar Port. Cadmium metal was not detected in the Soil.

4.4 Conclusion

The soils of Deendayal Port and Vadinar Port appears to be neutral to basic with varying levels of Chloride, Sulphate, NPK and Calcium. As the nature of soil at different locations are different with respect to its proximity to the sea, the samples showed high degree of variations in their chemical properties.

5. Sewage Treatment Plant Monitoring

This involves safe collection of waste water (spent/used water) from wash areas, bathroom, industrial units, etc., waste from toilets of various buildings and its conveyance to the treatment plant and final disposal in conformity with the requirement and guide lines of State Pollution Control Board and other statutory bodies.

5.1 Methodology for STP Monitoring

To monitor the working efficiency of Sewage Treatment Plant (STP), STP Inlet and Outlet Samples were collected once a week. Locations selected are namely Gopalpuri Township, Deendayal Port and Vadinar. Samples were collected in 1 lit. Carboys and were analyzed in laboratory for various parameters.

5.2 Results

- **Kandla STP**

Table 18: Sewage Water Monitoring at Kandla STP (1st Week)

Date of Sampling	05.07.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.5	7.8
2	Total Suspended Solids	mg/l	125.4	64.3
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	333.3	102
5	BOD @ 27 °C	mg/l	110.0	26.0
Aeration Tank				
6	MLSS	mg/l	18.0	
7	MLVSS	%	88.0	

Table 19: Sewage Water Monitoring at Kandla STP (2nd Week)

Date of Sampling	15.07.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.6	7.68
2	Total Suspended Solids	mg/l	350	46
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	585	98
5	BOD @ 27 °C	mg/l	196.0	26.0
Aeration Tank				
6	MLSS	mg/l	24.0	
7	MLVSS	%	82.0	

Table 20: Sewage Water Monitoring at Kandla STP (3rd Week)

Date of Sampling	20.07.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.73	7.61
2	Total Suspended Solids	mg/l	192.6	62
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	222	20
5	BOD @ 27 °C	mg/l	68.0	8.0
Aeration Tank				
6	MLSS	mg/l	16.0	
7	MLVSS	%	86.0	

Table 21: Sewage Water Monitoring at Kandla STP (4th Week)

Date of Sampling	26.07.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	Plant was not working	
2	Total Suspended Solids	mg/l		
3	Residual Chlorine	mg/l		
4	COD	mg/l		
5	BOD @ 27 °C	mg/l		
Aeration Tank				
6	MLSS	mg/l	-	
7	MLVSS	%	-	

- **Gopalpuri Colony STP**

Table 22: Sewage Water Monitoring at Gopalpuri STP (1st Week)

Date of Sampling	05.07.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.7	7.63
2	Total Suspended Solids	mg/l	408.3	38.3
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	262.6	102
5	BOD @ 27 °C	mg/l	82.0	28.0
Aeration Tank				
6	MLSS	mg/l	12.0	
7	MLVSS	%	92.0	

Table 23: Sewage Water Monitoring at Gopalpuri STP (2nd Week)

Date of Sampling	15.07.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.3	7.43
2	Total Suspended Solids	mg/l	333	69
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	444.4	103
5	BOD @ 27 °C	mg/l	142.0	28.0
Aeration Tank				
6	MLSS	mg/l	16.0	
7	MLVSS	%	89.0	

Table 24: Sewage Water Monitoring at Gopalpuri STP (3rd Week)

Date of Sampling	20.07.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.39	7.43
2	Total Suspended Solids	mg/l	166.6	36.7
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	230	58
5	BOD @ 27 °C	mg/l	70.0	19.0
Aeration Tank				
6	MLSS	mg/l	12.0	
7	MLVSS	%	92.0	

Table 25: Sewage Water Monitoring at Gopalpuri STP (4th Week)

Date of Sampling	26.07.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.28	7.4
2	Total Suspended Solids	mg/l	160	38
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	210	62
5	BOD @ 27 °C	mg/l	62.0	19.0
Aeration Tank				
6	MLSS	mg/l	11.0	
7	MLVSS	%	96.0	

- **Vadinar STP**

Table 26: Sewage Water Monitoring at Vadinar STP (1st Week)

Date of Sampling	05.07.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.23	NOT WORKING
2	Total Suspended Solids	mg/l	8	
3	Residual Chlorine	mg/l	70.0	
4	COD	mg/l	86.0	
5	BOD @ 27 °C	mg/l	27.0	

Table 27: Sewage Water Monitoring at Vadinar STP (2nd Week)

Date of Sampling	15.07.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.22	NOT WORKING
2	Total Suspended Solids	mg/l	62	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	82.0	
5	BOD @ 27 °C	mg/l	27.0	

Table 28: Sewage Water Monitoring at Vadinar STP (3rd Week)

Date of Sampling	20.07.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.22	NOT WORKING
2	Total Suspended Solids	mg/l	62	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	82.0	
5	BOD @ 27 °C	mg/l	27.0	

Table 29: Sewage Water Monitoring at Vadinar STP (4th Week)

Date of Sampling	26.07.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.18	NOT WORKING
2	Total Suspended Solids	mg/l	72	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	80.0	
5	BOD @ 27 °C	mg/l	26.0	

5.3 Conclusions:

The GPCB standards of BOD, TSS and Residual Chlorine for STP outlet are 20 mg/lit, 30 mg/lit & 0.5 mg/lit respectively. It is suggested to do treatment on regular basis to avoid flow of contaminated/polluted water into the sea. Also, the STP at Vadinar is also non-functional and thus, steps should be taken to commission the STP at Vadinar Port. Hence, currently only inlet samples are collected and analysed. And the sample of kandla stp was not collected in the last week of July 2021 as plant was not working.

6. Marine Water Monitoring

The Forty Second Amendment to the Constitution in 1976 underscored the importance of 'green thinking'. Article 48A enjoins the state to protect and improve the environment and safeguard the forests and wildlife in the country. Further, Article 51A(g) states that the "fundamental duty of every citizen is to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures".

Policy Statement for Abatement of Pollution (1992) has suggested developing relevant legislation and regulation, fiscal incentives, voluntary agreements and educational programs and information campaigns. It emphasizes the need for integration by incorporating environmental considerations into decision making at all levels by adopting frameworks namely, pollution prevention at source, application of best practicable solution, ensure polluter pays for control of pollution, focus on heavily polluted areas and river stretches and involve public in decision-making. The National Conservation Strategy and Policy Statement on Environment and Development, (1992) aimed at "integrating environmental concerns with developmental imperatives to meet the challenges by redirecting the thrust of our developmental process so that the basic needs of our people could be fulfilled by making judicious and sustainable use of natural resources." The priorities mentioned in this policy document include the sustainable use of land and water resources, prevention and control of pollution and preservation of biodiversity.

The National Water Policy, (2002) contains provisions for developing, conserving, sustainable utilizing and managing this important water resources and need to be governed by national perspectives.

Marine Environment

On national and state levels, we have several policies and regulation like Water (Prevention and Control of Pollution) Act, 1974, to regulate pollution discharges and restore water quality of our aquatic resources including the prescription of monitoring activities. One of the important provisions of the Water Act, 1974, is to maintain and restore the 'wholesomeness' of our aquatic resources. Water quality monitoring is one of the first steps required in the rational development and management of water resources. In the field of water quality management, there has been a steady evolution in procedures for designing system to obtain information on the changes of water quality. The monitoring comprises all activities to obtain 'information' with respect to the water system.

Sampling Stations

The monitoring of marine environment for the study of biological and ecological parameters was carried out on 10^{th}& 12^{th} July -2021 in harbor regions of KPT and on 10^{th} July-2021 at Vadinar during spring tide period of New moon phase of Lunar Cycle. The monitoring of marine environment for the study of biological and ecological parameters was repeated again on 17^{th}& 19^{th} July 2021 in harbor regions of KPT. 17^{th} July -2021 in Vadinar during Neap tide period first quarter of Lunar Cycle..

Plankton samples from sub surface layer was collected both during high tide period and low tide period from 3 water quality monitoring stations of KPT harbour area and two stations in Nakti creek and one station in Khori creek. The same sampling schedule was repeated during consecutive spring tide and neap tide in same month. Plankton samples from sub surface layer was collected both during high tide period and low tide period from 1 water quality monitoring stations near Vadinar jetty area during spring tide and neap tide in this month .Collected water samples were processed for estimation of Chlorophyll- a, Pheophytin- a, qualitative &quantitative evaluation of phytoplankton, qualitative &quantitative evaluation zooplanktons (density and their population).

Sampling Locations

Offshore monitoring requirement	Number of locations
Offshore Installations	3 in Kandla creek 2 in Nakti creek 1 in Khori creek 1 near Vadinar Jetty 1 near 1^{st} SBM
Total Number of locations	**8**

6.1 Marine Water Quality

Marine water quality of marine waters of Deendayal Port Harbor waters, Khori and Nakti Creeks and two locations of Vadinar are monitored for various physico-chemical parameters during spring and neap tide of each month.

The results of marine water quality and Marine sediments are as below;

Table 30: Marine Water Quality Monitoring Parameters for location near KPT colony

Sr. No.	Parameters	Unit	Kandla Creek Near KPT colony (1)			
			23°0'58"N 70°13'22."E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.29	7.25	7.13	7.15
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.0	31.8	32.1	32.6
5	Turbidity	NTU	30	28	35	27
6	Total Dissolved Solids	mg/l	37802.0	23743	43720.0	43881.0
7	Total Suspended Solids	mg/l	624	412	409	261
8	Total Solids	mg/l	38426.2	24155.4	44129.0	44142.0
9	DO	mg/l	4.5	5	4.9	5.3
10	COD	mg/l	72.0	68.0	74.0	76.0
11	BOD	mg/l	<2	<2	<2	<2
12	Silica	mg/l	0.23	0.38	0.30	0.48
13	Phosphate	mg/l	0.31	0.28	0.19	0.35
14	Sulphate	mg/l	2856	2556	2076	2160
15	Nitrate	mg/l	2.10	2.04	2.40	2.04
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	521.04	561.12	521.04	440.88
18	Magnesium	mg/l	1798.2	1798.2	1773.9	1871.1
19	Sodium	mg/l	14122.0	14820.0	10110.0	10872.0
20	Potassium	mg/l	325.0	289.0	321.0	289.0
21	Iron	mg/l	1.12	1.42	1.52	1.45
22	Chromium	mg/l	0.12	0.13	0.12	0.11
23	Copper	mg/l	0.12	0.19	0.06	0.08
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.07	0.06	0.05	0.06
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.20	0.19	0.11	0.12
28	Zinc	mg/l	0.05	0.06	0.06	0.07

Table 31: Marine Water Quality Monitoring Parameters for location near passenger Jetty One at Kandla

Sr. No.	Parameters	Unit	Near passenger Jetty One (2)			
			23° 0'18 "N 70°13'31"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	5.3	4.7	7.3	7.27
2	Color	-	80.0	76.0	Colorless	Colorless
3	Odor	-	<2	<2	Odorless	Odorless
4	Salinity	ppt	0.32	0.68	33.0	32.6
5	Turbidity	NTU	0.32	0.26	22	28
6	Total Dissolved Solids	mg/l	2976	2748	46102.0	47052.0
7	Total Suspended Solids	mg/l	2.25	2.03	211	312
8	Total Solids	mg/l	<0.05	<0.05	46313.0	47364.0
9	DO	mg/l	521.04	521.04	4.6	4.9
10	COD	mg/l	1846.8	1773.9	86.0	79.0
11	BOD	mg/l	11052.0	13425.0	<2	<2
12	Silica	mg/l	325.0	306.0	0.39	0.72
13	Phosphate	mg/l	1.55	1.62	0.34	0.30
14	Sulphate	mg/l	0.12	0.14	1956	2520
15	Nitrate	mg/l	0.18	0.16	1.74	2.52
16	Nitrite	mg/l	<0.01	<0.01	<0.05	<0.05
17	Calcium	mg/l	0.07	0.05	480.96	480.96
18	Magnesium	mg/l	<0.001	<0.001	1822.5	1822.5
19	Sodium	mg/l	0.28	0.16	11011.0	10452.0
20	Potassium	mg/l	0.05	0.06	333.0	315.0
21	Iron	mg/l	5.3	4.7	1.56	1.89
22	Chromium	mg/l	80.0	76.0	0.16	0.14
23	Copper	mg/l	<2	<2	0.09	0.08
24	Arsenic	mg/l	0.32	0.68	<0.01	<0.01
25	Cadmium	mg/l	0.32	0.26	0.06	0.07
26	Mercury	mg/l	2976	2748	<0.001	<0.001
27	Lead	mg/l	2.25	2.03	0.16	0.19
28	Zinc	mg/l	<0.05	<0.05	0.06	0.08

Table 32: Marine Water Quality Monitoring Parameters for location Near Coal Berth

Sr. No.	Parameters	Unit	Near Coal Berth			
			22°59'12"N 70°13'40"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.51	7.30	7.29	7.5
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.6	32.8	32.4	33.1
5	Turbidity	NTU	35	47	35	47
6	Total Dissolved Solids	mg/l	40788	35363	41086.0	42830.0
7	Total Suspended Solids	mg/l	563	601	215	161
8	Total Solids	mg/l	41351.3	35964.2	41301.0	42991.0
9	DO	mg/l	4.8	5	4.8	5
10	COD	mg/l	88.0	70.0	90.0	79.0
11	BOD	mg/l	<2	<2	<2	<2
12	Silica	mg/l	0.30	0.34	0.42	0.36
13	Phosphate	mg/l	0.28	0.32	0.35	0.38
14	Sulphate	mg/l	2580	3444	3156	3240
15	Nitrate	mg/l	1.93	2.10	2.56	2.46
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	561.12	480.96	561.12	601.2
18	Magnesium	mg/l	1725.3	1798.2	1725.3	1725.3
19	Sodium	mg/l	15555.0	13252.0	11052.0	11412.0
20	Potassium	mg/l	389.0	296.0	315.0	296.0
21	Iron	mg/l	1.47	2.02	2.10	2.02
22	Chromium	mg/l	0.19	0.15	0.12	0.20
23	Copper	mg/l	0.14	0.12	0.06	0.10
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.04	0.06	0.08	0.07
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.20	0.18	0.10	0.12
28	Zinc	mg/l	0.08	0.06	0.07	0.06

Table 33: Marine Water Quality Monitoring Parameters for location Khori creek at Kandla

Sr. No.	Parameters	Unit	KPT 4			
			Near 15/16 Berth			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.25	7.20	7.39	7.45
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.4	32.8	32.4	32.2
5	Turbidity	NTU	50	29	51	55
6	Total Dissolved Solids	mg/l	35588	33113	43563.0	44059.0
7	Total Suspended Solids	mg/l	407	420	213	265
8	Total Solids	mg/l	35995.3	33533.4	43776.0	44324.0
9	DO	mg/l	5.2	4.8	5.3	4.7
10	COD	mg/l	68.0	79.0	76.0	86.0
11	BOD	mg/l	<2	<2	<2	<2
12	Silica	mg/l	0.81	0.29	0.79	0.37
13	Phosphate	mg/l	0.26	0.34	0.43	0.42
14	Sulphate	mg/l	2388	2652	2280	2376
15	Nitrate	mg/l	1.74	1.96	2.10	2.57
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	601.20	561.12	601.2	561.12
18	Magnesium	mg/l	1749.6	1822.5	1725.3	1798.2
19	Sodium	mg/l	10026.0	11252.0	10512.0	9899.0
20	Potassium	mg/l	302.0	378.0	266.0	275.0
21	Iron	mg/l	1.66	1.48	1.45	1.60
22	Chromium	mg/l	0.16	0.16	0.18	0.16
23	Copper	mg/l	0.15	0.10	0.12	0.10
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.07	0.06	0.06	0.05
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.16	0.2	0.08	0.10
28	Zinc	mg/l	0.07	0.08	0.05	0.05

Table 34: Marine Water Quality Monitoring Parameters for location Nakti Creek near Tuna Port

Sr. No.	Parameters	Unit	Nakti Creek Near Tuna Port			
			22°57'49."N 70° 7'0.67"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.29	7.35	7.2	7.28
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.6	33.2	33.6	33.0
5	Turbidity	NTU	35	29	29	29
6	Total Dissolved Solids	mg/l	38200	18212	46852.0	47695.0
7	Total Suspended Solids	mg/l	324	214	200	196
8	Total Solids	mg/l	38524.4	18426.2	47052.0	47891.0
9	DO	mg/l	5.1	5.1	4.9	5
10	COD	mg/l	80.0	68.0	89.0	78.0
11	BOD	mg/l	<2	<2	<2	<2
12	Silica	mg/l	0.26	0.29	0.62	0.30
13	Phosphate	mg/l	0.28	0.26	0.31	0.38
14	Sulphate	mg/l	2964	3408	3240	3156
15	Nitrate	mg/l	1.95	2.18	2.56	2.49
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	561.12	521.04	601.2	440.88
18	Magnesium	mg/l	1822.5	1749.6	1798.2	1822.5
19	Sodium	mg/l	11256.0	12625.0	11021.0	11425.0
20	Potassium	mg/l	302.0	366.0	396.0	378.0
21	Iron	mg/l	1.83	1.76	2.02	2.11
22	Chromium	mg/l	0.15	0.18	0.20	0.18
23	Copper	mg/l	0.12	0.11	0.16	0.10
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.04	0.06	0.07	0.08
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.18	0.19	0.12	0.16
28	Zinc	mg/l	0.06	0.05	0.06	0.07

Table 35: Marine Water Quality Monitoring Parameters for location Nakti Creek Near NH-8A at Kandla

Sr. No.	Parameters	Unit	Nakti Creek Near NH-8A			
			23° 02'01"N 70° 09'31"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.37	Sampling not possible during Low Tide	7.37	Sampling not possible during Low Tide
2	Color	-	Colorless		Colorless	
3	Odor	-	Odorless		Odorless	
4	Salinity	ppt	33.4		32.4	
5	Turbidity	NTU	27		33	
6	Total Dissolved Solids	mg/l	35166		42125.0	
7	Total Suspended Solids	mg/l	180		164.3	
8	Total Solids	mg/l	35346.3		42289.3	
9	DO	mg/l	5		5.5	
10	COD	mg/l	72.0		79.0	
11	BOD	mg/l	<2		<2	
12	Silica	mg/l	0.61		0.62	
13	Phosphate	mg/l	0.30		0.39	
14	Sulphate	mg/l	2988		3036	
15	Nitrate	mg/l	2.43		2.72	
16	Nitrite	mg/l	<0.05		<0.05	
17	Calcium	mg/l	601.20		521.04	
18	Magnesium	mg/l	1749.6		1749.6	
19	Sodium	mg/l	14485.0		11528.0	
20	Potassium	mg/l	396.0		311.0	
21	Iron	mg/l	1.52		2.06	
22	Chromium	mg/l	0.16		0.19	
23	Copper	mg/l	0.16		0.11	
24	Arsenic	mg/l	<0.01		<0.01	
25	Cadmium	mg/l	0.04		0.06	
26	Mercury	mg/l	<0.001		<0.001	
27	Lead	mg/l	0.17		0.10	
28	Zinc	mg/l	0.06		0.07	

Table 36: Marine Water Quality Monitoring Parameters for locations Nr. Vadinar Jetty

Sr. No.	Parameters	Unit	Nr.Vadinar Jetty 22°26'25.26"N 69°40'20.41"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.60	7.45	7.5	7.8
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	33.2	32.6	33.0	33.1
5	Turbidity	NTU	32	28	35	25
6	Total Dissolved Solids	mg/l	37530	35780	43940.0	46623.0
7	Total Suspended Solids	mg/l	327	417	405.5	399.5
8	Total Solids	mg/l	37856.5	36197.4	44345.5	47022.5
9	DO	mg/l	5.2	5.1	5.2	5.1
10	COD	mg/l	68.0	72.0	78.0	79.0
11	BOD	mg/l	<2	<2	<2	<2
12	Silica	mg/l	0.32	0.31	0.42	0.62
13	Phosphate	mg/l	0.26	0.26	0.35	0.33
14	Sulphate	mg/l	2136	2352	2220	2304
15	Nitrate	mg/l	2.72	2.80	2.09	2.44
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	480.96	561.12	561.12	521.04
18	Magnesium	mg/l	1749.6	1749.6	1579.5	1555.2
19	Sodium	mg/l	16458.0	15555.0	11425.0	12021.0
20	Potassium	mg/l	345.0	388.0	316.0	296.0
21	Iron	mg/l	2.06	2.10	2.45	2.3
22	Chromium	mg/l	0.16	0.20	0.15	0.16
23	Copper	mg/l	0.17	0.18	0.09	0.08
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.05	0.06	0.05	0.06
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.14	0.13	0.10	0.10
28	Zinc	mg/l	0.08	0.09	0.05	0.06

6.1.1 Marine Sediments

Sediment samples were collected with Van Veen Grab from the six locations in Kandla Port Waters and two locations in Vadinar Port. Samples were collected and preserved in silver foil in ice box to prevent the contamination/decaying of the samples.

6.2 Results

The Sediment Quality results are given in below from table no. 34 A & B.

Table 34A: Results of Analysis of Sediment of Kandla & Vadinar Port (Spring Tide)

Sr. No.	Parameters	Unit	KPT - 1	KPT - 2	Khori - 1	Nakti - 1 (Near NH-8A)	Jetty
1	Texture	-	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	mg/kg	0.64	1.12	0.39	1.03	1.06
3	Organic Carbon	mg/kg	0.37	0.65	0.22	0.60	0.52
4	Inorganic Phosphate	mg/kg	126.0	125.0	136.0	146.0	152.0
5	Moisture	%	11.70	18.10	6.60	26.1	23.50
6	Aluminium	mg/kg	ND	ND	ND	ND	ND
7	Silica	mg/kg	26.0	24.0	42.0	49.0	41.2
8	Phosphate	mg/kg	9.88	7.82	8.80	9.70	18.00
9	Sulphate	mg/kg	170.0	192.0	259.0	259.0	362.0
10	Nitrite	mg/kg	0.12	0.13	0.11	0.11	0.11
11	Nitrate	mg/kg	9.23	7.82	9.25	9.25	7.52
12	Calcium	mg/kg	144.3	148.0	132.0	124.0	169.0
13	Magnesium	mg/kg	165.2	214.0	122.0	136.0	162.0
14	Sodium	mg/kg	2221.0	1686.0	1882.0	1775.0	3785.0
15	Potassium	mg/kg	641.0	542.0	738.0	562.0	658.0
16	Chromium	mg/kg	123	145	126	130	162
17	Nickel	mg/kg	24.8	22.5	18.9	26.02	38
18	Copper	mg/kg	48	42	20.6	27.5	23.6
19	Zinc	mg/kg	32.60	36.00	30.40	36.00	32.00
20	Cadmium	mg/kg	ND	ND	ND	ND	ND
21	Lead	mg/kg	2.8	1.8	1.2	4.5	5.8
22	Mercury	mg/kg	ND	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND	ND

*Grab samples could not be collected due high current at KPT 3, Natki Creek Near Tuna port & Vadinar SBM

Table 34B: Results of Analysis of Sediment of Kandla & Vadinar Port (Neap Tide)

Sr. No.	Parameters	Unit	KPT - 1	KPT - 2	Jetty
1	Texture	-	Sandy loam	Sandy loam	Sandy loam
2	Organic Matter	mg/kg	0.74	1.10	1.10
3	Organic Carbon	mg/kg	0.52	0.62	0.63
4	Inorganic Phosphate	mg/kg	162.0	142.0	162.0
5	Moisture	%	15.62	14.20	21.52
6	Aluminium	mg/kg	ND	ND	ND
7	Silica	mg/kg	16.60	20.30	39.2
8	Phosphate	mg/kg	9.8	7.26	16.66
9	Sulphate	mg/kg	342.0	280.0	289.0
10	Nitrite	mg/kg	0.10	0.11	0.1
11	Nitrate	mg/kg	10.6	9.8	8.02
12	Calcium	mg/kg	141.0	152.0	178.0
13	Magnesium	mg/kg	156.0	214.0	206.0
14	Sodium	mg/kg	2210.0	1786.0	3682.0
15	Potassium	mg/kg	590.0	562.0	666.0
16	Chromium	mg/kg	136	149	158
17	Nickel	mg/kg	26.2	23.5	32
18	Copper	mg/kg	52	46	18.2
19	Zinc	mg/kg	33.20	34.00	22.00
20	Cadmium	mg/kg	ND	ND	ND
21	Lead	mg/kg	2.4	2.2	4.6
22	Mercury	mg/kg	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND

*Grab samples could not be collected due high current at KPT 3,Khori, Natki Creek Near Tuna Port, Vadinar Jetty and Vadinar SBM

REPORT

ON

ECOLOGICAL MONITORING

OF MARINE ENVIRONMENT

IN

DPT HARBOUR AREA, NEAR BY CREEKS

For

DEENDAYAL PORT TRUST

JULY, 2021

DCPL/DPT/20-21/15 -JULY - 2021

INTRODUCTION:

The Forty Second Amendment to the Constitution in 1976 underscored the importance of 'green thinking'. Article 48A enjoins the state to protect and improve the environment and safeguard the forests and wildlife in the country. Further, Article 51A(g) states that the "fundamental duty of every citizen is to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures".

Policy Statement for Abatement of Pollution (1992) has suggested developing relevant legislation and regulation, fiscal incentives, voluntary agreements and educational programs and information campaigns. It emphasizes the need for integration by incorporating environmental considerations into decision making at all levels by adopting frameworks namely, pollution prevention at source, application of best practicable solution, ensure polluter pays for control of pollution, focus on heavily polluted areas and river stretches and involve public in decision-making. The National Conservation Strategy and Policy Statement on Environment and Development, (1992)aimed at "integrating environmental concerns with developmental imperatives to meet the challenges by redirecting the thrust of our developmental process so that the basic needs of our people could be fulfilled by making judicious and sustainable use of natural resources." The priorities mentioned in this policy document include the sustainable use of land and water resources, prevention and control of pollution and preservation of biodiversity.

The National Water Policy, (2002) contains provisions for developing, conserving, sustainable utilizing and managing this important water resources and need to be governed by national perspectives.

MARINE ENVIRONMENT:

On national and state levels, we have several policies and regulation like Water (Prevention and Control of Pollution) Act, 1974, to regulate pollution discharges and restore water quality of our aquatic resources including the prescription of monitoring activities. One of the important provisions of the Water Act, 1974, is to maintain and restore the 'wholesomeness' of our aquatic resources. Water quality monitoring is one of the first steps required in the rational development and management of water resources. In the field of water quality management, there has been a steady evolution in procedures for designing system to obtain information on the changes of water quality. The monitoring comprises all activities to obtain 'information' with respect to the water system.

Sampling Stations:

The monitoring of marine environment for the study of biological and ecological Parameters was carried out on 10th July, 2021 in in harbour region of DPT, and on 12thJuly, 2021 in creeks near by the port during spring tide .The monitoring of marine environment for the study of biological and ecological parameters was repeated again on 17th July, 2021 in harbour region of DPT and on 19thJuly, 2021 in creeks near by the port during neap tidal condition.

Plankton samples from sub surface layer was collected both during high tide period and low tide period from 3 water quality monitoring stations of DPT harbour area andone stations in Nakti creek and one station in Khori creek. Sampling at second sampling station of Nakti creek was possible only during high tide period. Collected water samples were processed for estimation of Chlorophyll- a, Pheophytin- a, qualitative &quantitative evaluation of phytoplankton, qualitative &quantitative evaluation zooplanktons(density and their population).

TABLE #1 SAMPLING LOCATIONS

monitoring requirement	**Number of locations**
Kandla creek Nakti creek Khori Creek	3 in Kandla creek 2 in Nakti creek 1 in Khori creek
Total Number of locations	**6**

Sampling methodology adopted:

A marine sampling is an estimation of the body of information in the population. The theory of the sampling design is depending upon the underlying frequency distribution of the population of interest. The requirement for useful water sampling is to collect a representative sample of suitable volume from the specified depth and retain it free from contamination during retrieval.

50 litters of the water sample were collected from Sub surface by using bucket. From the collected water sample 1 litter of water sample were taken in an opaque plastic bottle for chlorophyll estimation, thereafter plankton samples were collected by using filtration assembly with nilyobolt cloth of 20µm mesh size.

Samples Processing for chlorophyll estimation:

Samples for the chlorophyll estimation were preserved in ice box on board in darkness to avoid degradation in opaque container covered with aluminium foil. Immediately after reaching the shore after sampling, 1 litter of collected water sample was filtered through GF/F filters (pore size 0.45 µm) by using vacuum filtration assembly. After vacuum filtration the glass micro fiber filter paper was grunted in tissue grinder, macerating of glass fiber filter paper along with the filtrate was done in 90% aqueous Acetone in the glass tissue grinder with glass grinding tube. Glass fiber filter paper will assist breaking the cell during grinding and chlorophyll content was extracted with 10 ml of 90% Acetone, under cold dark conditions along with saturated magnesium carbonate solution in glass screw cap tubes. After an extraction period of 24 hours, the samples were transferred to calibrated centrifuge tubes and adjusted the volume to original volume with 90% aqueous acetone solution to make up the evaporation loss. The extract was clarified by using centrifuge in closed tubes. The clarified extracts were then decanted in clean cuvette and optical density was observed at wavelength 664, 665 nm. By using corrected optical density, Chlorophyll-a value was calculated as given in (APHA, 1998).

PLANKTON:

The entire area open water in the sea is the pelagic realm. Pelagic organisms live in the open sea. In contrast to the pelagic realm, the benthic realm comprises organisms and zone of the bottom of the sea. Vertically the pelagic realm can be dividing into two zones based on light penetration; upper photic or euphotic zone and lower dark water mass, aphotic zone below the photic zone.

The term plankton is general term for organisms have such limited powers of locomotion that they are at the mercy of the prevailing water movement. Plankton is subdivided to phytoplankton and zooplankton. Phytoplankton is free floating organisms that are capable of photosynthesis and zooplankton is the various free floating animals.

Pelagic zone, represents the entire ocean water column from the surface to the deepest depths, is home to a diverse community of organisms. Differences in their locomotive ability categorize the organisms in the pelagic realm into two, ***plankton*** and ***nekton*** (Lalli and Parsons, 1997). ***Plankton*** consists of all organisms drifting in the water and is unable to swim against water currents, whereas ***Nekton*** includes organisms having strong locomotive power. Ecological studies on the plankton community, which form the base of the aquatic food chain, help in the better understanding of the dynamics and functioning of the marine ecosystem. The term 'Plankton' first coined by Victor Hensen (1887), Plankton, (Greek word: *planktos*meaning "passively drifting or wandering") is defined as drifting or free-floating organisms that inhabit the pelagic zone of water. Based on their mode of nutrition planktonic organisms are categorised into phytoplankton (organisms having an autotrophic mode of nutrition) and zooplankton (organisms having a heterotrophic mode of nutrition).

Phytoplankton in the marine environment:

Phytoplankton is free floating unicellular, filamentous and colonial eutrophic organisms that grow in aquatic environments whose movement is more or less dependent upon water currents. These micro flora acts as primary producers as well as the basis of food chain, source of protein, bio purifier and bio indicators of the aquatic ecosystems of which diverse array of the life depends .They are considered as an important component of aquatic flora, play a key role in maintaining equilibrium between abiotic and biotic components of aquatic ecosystem.

The phytoplankton includes a wide range of photosynthetic and phototrophic organisms. Marine phytoplankton is mostly microscopic and unicellular floating flora, which are the primary producers that support the pelagic food-chain. The two most prominent groups of phytoplankton are diatoms (Bacillariophyceae) and dinoflagellates (Dinophyceae).The phytoplankton those normally captured in the net from the Gulf of Kutch is normally dominated by these two major groups; diatoms and dinoflagellates. Phytoplankton also include numerous and diverse collection of extremely small, motile algae which are termed micro flagellates (naked flagellates) as well as and Cyanophytes (blue-green algae).

Algae are an ecologically important group in most aquatic ecosystems and have been an important component of biological monitoring programs. Algae are ideally suited for water quality assessment because they have rapid reproduction rates and very short life cycles, making them valuable indicators of short-term impacts.

Aquatic populations are impacted by anthropogenic stress, resulting in a variety of alterations in the biological integrity of aquatic systems. Algae can serve as an indicator of the degree of deterioration of water quality, and many algal indicators have been used to assess environmental status.

Zooplankton in the marine environment:

Zooplankton includes a taxonomically and morphologically diverse community of heterotrophic organisms that drift in the waters of the world's oceans. Qualitative and quantitative studies on zooplankton community is a prerequisite to delineate the ecological processes active in the marine ecosystem. Zooplankton community plays a pivotal role in the pelagic food web as the primary consumers of phytoplankton and act as the food source for organisms in the higher trophic levels, particularly the economically essential groups such as fish larvae and fishes. They also function in the cycling of elements in the marine ecosystem. The dynamics of the zooplankton community, their reproduction, growth and survival rate are all significant factors determining the recruitment and abundance of fish stocks as they form an essential food for larval, juvenile and adult fishes (Beaugrand et al., 2004). Zooplankton grazing in the marine environment controls the primaryProduction and helps in determining the pelagic ecosystem (Banse, 1995). Through grazing in surface waters and following the production of sinking faecal matters and also by the active transportation of dissolved and particulate matter to deeper waters via vertical migration, they help in the transport of organic carbon to deep ocean layers and thus act as key drivers of biological pump' in the marine ecosystem. Zooplankton grazing and metabolism also, transform particulate organic matter into dissolved forms, promoting primary producer community, microbial demineralization, and particle export to the ocean's interior.

The categorisation of zooplankton into various ecological groups is based on several factors such as duration of planktonic life, size, food preferences and habitat. As they vary significantly in size from microscopic to metazoic forms, the classification of zooplankton based on size has paramount importance in the field of quantitative plankton research.

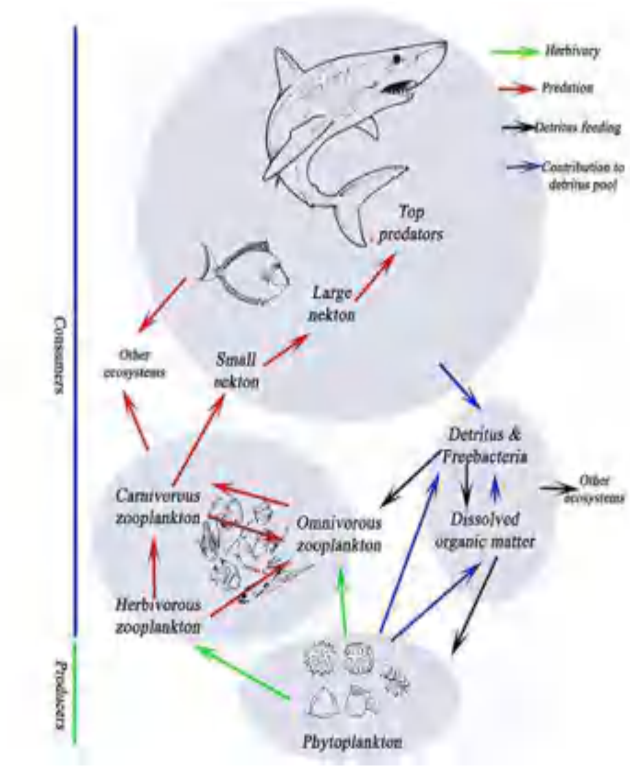
Based on the duration of planktonic life, zooplankton are categorised into Holoplankton (organisms which complete their entire lifecycle as plankton) and Meroplankton (organisms which are planktonic during the early part of their lives such as the larval stages of benthic and nektonic organisms). Tychoplankton are organisms which live a brief planktonic life, such as the benthic crustaceans (cumaceans, mysids, isopods) which ascend to the water column at night for feeding and certain ectoparasitic copepods, they leave the host and spend their life as plankton during their breeding cycle.

Zooplankton can be subdivided into holoplankton, i.e., permanent members of the plankton (e.g., Calanoid copepods), and meroplankton, i.e., temporary members in the plankton e.g., larvae of fish, shrimp, and crab). The meroplankton group consists of larval and young stages of animals that will adopt a different lifestyle once they mature. In contrast to phytoplankton which consist of a relatively smaller variety of organisms, Zooplankton are extremely divers, consist of a host of larval and adult forms representing many animal phylum.

Among the zooplankton one group always dominate than others; members of sub class copepods (Phylum Athropoda), and Tintinids (Phylum Protozoa) among the net planktons. These small animals are of vital importance in marine ecosystem as one of the primary herbivores animals in the sea, and it is they provide vital link between primary producer (autotrophs) and numerous small and large marine consumers.

As their community structure and function are highly susceptible to changes in the environmental conditions regular monitoring of their distribution as well as their interactions with various physicochemical parameters is inevitable for the sustainable management of the ecosystem (Kusum et al., 2014). Of all the marine zooplankton groups, copepods mainly calanoid copepods are the dominant groups in marine subtropical and tropical waters and exhibit considerable diversity in morphology and habitats they occupy (Madhupratap, 1991;)

It has been well established that potential of pelagic fishes viz. finfishes, crustaceans, molluscs and marine mammals either directly or indirectly depend on zooplankton. The herbivorous zooplankton is efficient grazers of the phytoplankton and is referred to as living machines transforming plant material into animal tissue. Hence they play an essential role as the intermediaries for nutrients/energy transfer between primary and tertiary trophic levels. Due to their large density, shorter lifespan, drifting nature, high group/species diversity and different tolerance to the stress, they used as the indicator organisms for the physical, chemical and biological processes in the aquatic ecosystem (Ghajbhiye, 2002).



Simplified marine food web

Spatial distribution of Plankton:

A characteristic of plankton population is that they tend to occur in patches, which are varying spatially on a scale of few meters to far as few kilometres in distance. They also vary in time scale, season as well as vertically in the water column. It is this patchiness and its constant changes in time and spot, that has made it so difficult for plankton biologist to learn about the ecology of plankton. The biological factors that causes this patchiness is due to the ability of zooplankton to migrate vertically and graze out the phytoplankton at a rapid rate that can create patchiness. Similarly the active swimming ability by certain zooplankton organisms can cause to aggregate in dense group.

At its most extreme, because the water in which plankton is suspended is constantly moving, each sample taken by the plankton biologists remain a different volume of water, so each sample is unique and replicate does not exist.

Plankton may also exhibit vertical patchiness. Physical factors contribute to this type of patchiness include light intensity, nutrients and density gradients in the water column.

Phytoplankton in particular tends to be unequally distributed vertically, which leads to the existence of different concentration of a chlorophyll value between photic zone and below the photic zone.

Methodology adopted for Plankton sampling:

Mixed plankton sample were obtained from the sub surface layer at each sampling locations by towing the net horizontally with the weight .After the tow of about 15-30minutes, plankton net was pulled up and washed down to the tail and collected the plankton adhered to plankton net in the collection bucket at the bottom by springing outer and inner surface of the net with sea water, while the net was hanging with the mouth upward. For quantitative evaluation 50 L water samples were collected from subsurface layer and filtered through 20µm mesh size net by using bucket and filtration assembly.

Preservation and storage:

Both filtered plankton and those collected from the plankton net were preserved with 5% buffered formalin and stored in 1L plastic container for further processing in the laboratory.

Sample concentration:

The collected plankton samples were concentrated by using centrifuge and made up to 50 ml with 5% formalin -Glycerine mixture.

Taxonomic evaluation:

Before processing, the sample was mixed carefully and a subsample was taken with a calibrated Stempel-pipette. 1 ml of the concentrated plankton samples were transferred on a glass slide with automatic pipette. The plankton sample on the glass slides were stained by using Lugol's iodine and added glycerine to avoid drying while observation. The plankton samples were identified by using Labex triangular Research microscope with photographic attachment. Microphotographs of the plankton samples were taken for record as well as for confirming the identification. The bigger sized zooplankton was observed through dissecting stereomicroscope with magnification of 20-30 x. Plankton organisms in the whole slide were identified to the lowest axon possible. A thorough literature search was conducted for the identification of the different groups of zooplankton that were encountered

Cell counts by drop count method:

The common glass slide mounted with a 1ml of concentrated phytoplankton/zooplankton sample in glycerol and covered with cover slip 22x 60mm was placed under the compound microscope provided with a mechanical stage. The plankton was then counted from the microscopic field of the left top corner of the slide. Then slide is moved horizontally along the right side and plankton in each microscopic field was thus counted. When first microscopic field row was finished the next consecutive row was adjusted using the mechanical device of the stage. In this way all the plankton present in entire microscopic field are counted. From this total number in 1ml of the concentrated plankton, total number of plankton in the original volume of sample filtered was calculated as units/L.

BENTHIC ORGANISMS:

Benthos is those organisms that are associated with the sea bed or benthic habitats. Epi- benthic organisms live attached to a hard substratum or rooted to a shallow depth below the surface. In fauna organisms live below the sediment–water interface. Interstitial organisms live and move in pore water among sedimentary grains.

Because the benthic organisms are often collected and separated on sieves, a classification based on the overall size is used. Macro benthos include organisms whose shortest dimension is greater than or equal to 0.5 mm. Meio benthos are smaller than 0.5mm but larger than 42µ in size.

The terms such as macro fauna and Meio fauna generally have little relevance with taxonomic classification. The terms Meio fauna and macro fauna depend on the size. Meio fauna were considered as good bioassay of community health and rather sensitive indicators of environmental changes

SAMPLING METHODOLOGY ADOPTED FOR SUB TIDAL REGION:

Van veen sampler ($0.09m^2$) was used for sampling bottom sediments. Two sets of sediments were sampled from each location, one for macro fauna and other for Meio fauna. The macro fauna in the sediments were sieved on board to separate out the organisms. The fixation of Meio fauna is normally done by bulk fixation of the sediment sample. The bulk fixation is done by using 10% formalin (Buffered with borate). The organisms were preserved with seawater as diluting agent.

Sample sieving:

Sediments samples were sieved to extract the organisms. Sieving was performed carefully as possible to avoid any damage to the animals. The large portion of the sediment was split in to smaller portions and mixed with sea water in a bucket. The cohesive lumps were broken down by continuous stirring. The disaggregated sediments were then passed through the sieves.

Sample staining:

Sorting of the Meio fauna from the sieve is difficult task especially in the preserved material, because organisms are not easily detectable. To facilitate the animal detection the entire sample retained on the sieve after sieving operation were stained by immersing the sieve in a flat bottom

tub with 1% Rose Bangal stain; a protein stain. A staining period of 10-30 minutes is sufficient for sample detection.

DIVERSITY INDICES:

On the whole, diversity indices provide more information about community composition than simply species richness (number of species present); they also, take the relative abundances of different species into account. Based on this fact, diversity indices therefore depend not only on species richness but on the evenness, or equitability, with which individuals are distributed among the different species (Magurram, A. E. (1988)

A diversity index is a measure of species diversity within a community that consists of co-occurring populations of several (two or more) different species. It includes two components: richness and evenness. Richness is the measure of the number of different species within a sample showing that more the types of species in a community, the higher is the diversity or greater is the richness. Evenness is the measure of relative abundance of the different species with in a community.

The basic idea of diversity index is to obtain a quantitative estimate of biological variability that can be used to compare biological entities composed of discrete components in space and time (Carol H.R. *etal*. 1998). Biodiversity is commonly expressed through indices based on species richness and species abundances (Whittaker 1972, Lande 1996, Purvis and Hector 2000). Biodiversity indices are a non-parametric tool used to describe the relationship between species number and abundance. The most widely used bio diversity indices are Shannon Weiner index and Simpson's index.

A diversity Index is a single statistic that incorporates in formation on richness and evenness. The diversity measures that incorporate the two concepts may be termed heterogeneity measures (Magurran, 2004).

Any study intended to interpret causes and effect of adverse impact on Biodiversity of communities require suitable measures to evaluate specie richness and Diversity. The former is number of species in community, while latter is a function of relative frequency of different species. Species richness is the iconic measure of biological diversity (Magurran, 2004). Several indices have been created to measure the diversity of species; however, the most widely used in the last decades are the Shannon (1948) and Simpson (1949) (Buzas and Hayek 1996; Gorelick 2006), with the components of diversity: richness (*S)* and evenness (*J)*

Simpson's diversity index

Simpson's index (**D**) is a measure of diversity, which takes into account both species richness, and evenness of abundance among the species present.. The Simson index is one of the meaningful and robust biodiversity measures available.(Magurran ,2004).

The formula for calculating D is presented as:

$$D = \frac{\sum n_i(n_i - 1)}{N(N-1)}$$

Where n_i = the total number of organisms of each individual species

N = the total number of organisms of all species

The value of D ranges from 0 to 1. With this index, 0 represents infinite diversity and, 1, no diversity. When D increases diversity decreases. Simpson's index is therefore usually expressed as 1-D or 1/D. (Magurran, 2004)

Low species diversity suggests:

- relatively few successful species in the habitat
- the environment is quite stressful with relatively few ecological niches and only a few organisms are really well adapted to that environment
- food webs which are relatively simple
- change in the environment would probably have quite serious effects

High species diversity suggests:

- a greater number of successful species and a more stable ecosystem
- more ecological niches are available and the environment is less likely to be hostile complex food webs
- environmental change is less likely to be damaging to the ecosystem as a whole

Species richness indices

The species richness***(S)*** is simply the number of species present in an ecosystem. Species richness Indices of species richness are widely used to quantify or monitor the effects of anthropogenic disturbance. A decline in species richness may be concomitant with severe or chronic human-induced perturbation (Fair Fair weather 1990,) Species richness measures have traditionally been the mainstay in assessing the effects of environmental degradation on the biodiversity of natural assemblages of organisms (Clarke &Warwick, 2001)

Species richness is the iconic measure of biological diversity (Magurran, 2004). The species richness***(S)*** is simply the number of species present in an ecosystem. This index makes no use of

relative abundances. The term species richness was coined by McIntosh (1967) and oldest and most intuitive measure of biological diversity (Magurran, 2004).

Margalef's diversity index is a species richness index. Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, were derived.

The value of a diversity index increases both when the number of types increases and when evenness increases. For a given number of types, the value of diversity index is maximised when all types are equally abundant (Rosenzweig, M. L. (1995).

Shannon-Wiener's index:

An index of diversity commonly used in plankton community analyses is the Shannon-Wiener's index **(H),** which emphasizes not only the number of species (richness or variety), but also the apportionment of the numbers of individuals among the species (Odum 1971 and Reish 1984). Shannon-Wiener's index **(H**) reproduce community parameters to a single numberby using an equation.

Shannon and Weiner index represents entropy. It is a diversity index taking into account the number of individuals as well as the number of taxa. It varies from 0 for communities with only single taxa to high values for community with many taxa each with few individuals. This index can also determine the pollution status of a water body. Normal values range from 0 to 4. This index is a combination of species present and the evenness of the species. Examining the diversity in the range of polluted and unpolluted ecosystems, Wilham and Dorris (1968) concluded that the values of the index greater than 3 indicate clean water, values in the range of 1 to 3 are characterized by moderate pollution and values less than 1 are characterized as heavily polluted

$$H' = -\sum_{j=1}^{s} \frac{n_j}{N} \ln\left(\frac{n_j}{N}\right)$$

RESULTS:

CHLOROPHYLL-a:

Water Samples for the chlorophyll estimation were collected from sub surface layer during high tide and low tide period of the tidal cycle for each sampling locations and analysed for Chlorophyll -a and after acidification for Pheophytin –a. Chlorophyll- a value was used as algal biomass indicator (APHA,1998) Algal biomass was estimated by converting Chlorophyll value.

In the sub surface water chlorophyll-a was varying from 0.511 -0.921mg/m^3.in harbour region of DPT during sampling done in spring tide period of July, 2021. In the nearby creeks chlorophyll-a was varying from 0.173-0.980 mg/m^3.Pheophytin –a level was below detectable limit- the all the sampling stations during spring in the harbour region of DPT.

In the sub surface water chlorophyll-a was varying from 0.391 -0.835mg/m^3.in harbour region of DPT during sampling done in neap tide period of July, 2021 . In the nearby creeks chlorophyll-a was varying from 0.308-0.991 mg/m^3.·Pheophytin –a level was below detectable limit- the all the sampling stations during spring in the harbour region ofDPT

TABLE #2 VARIATIONS IN CHLOROPHYLL –a PHEOPHYTIN- a AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN JULY,2021

Sr.No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREA					
1	KPT1	High tide	0.629	BDL	42.14
		Low tide	0.921	BDL	61.71
2	KPT 2	High tide	0.745	BDL	49.92
		Low tide	0.558	BDL	37.39
3	KPT 3	High tide	0.511	BDL	34.24
		Low tide	0.598	BDL	40.06
CREEKS					
4	KPT-4 Khori-I	High tide	0.425	BDL	28.48
		Low tide	0.473	BDL	31.69
5	KPT-5 Nakti-I	High tide	0.714	BDL	47.84
		Low tide	0.980	BDL	65.66
6	KPT-5 Nakti-II	High tide	0.173	BDL	11.59

BDL: Below Detectable Limit.

TABLE #3 VARIATIONS IN CHLOROPHYLL –aPHEOPHYTIN- a AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN JULY,2021

Sr.No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREA					
1	KPT1	High tide	0.730	BDL	48.91
		Low tide	0.835	BDL	55.94
2	KPT 2	High tide	0.391	BDL	26.20
		Low tide	0.484	BDL	32.43
3	KPT 3	High tide	0.612	BDL	41.00
		Low tide	0.513	BDL	34.37
CREEKS					
4	KPT-4 Khori-I	High tide	0.385	BDL	25.80
		Low tide	0.497	BDL	33.30
5	KPT-5 Nakti-I	High tide	0.991	BDL	66.39
		Low tide	0.692	BDL	46.36
6	KPT-5 Nakti-II	High tide	0.308	BDL	20.64

BDL: Below Detectable Limit.

PHYTOPLANKTON POPULATION:

For the evaluation of the Phytoplankton population in DPT harbour area and within the immediate surroundings of the port, sampling was conducted from 5 sampling locations (3 in harbour area and two in Nakti creek) during high tide period and low tide period of spring tide. The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by,Diatoms andblue green algae during spring tide period.Diatoms were represented by 14 genera. Blue green wererepresented by onegenera .during the sampling conducted in spring tide in July,2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 68 -196 units/ L during high tide period and 171-212 units/ L during low tide of Spring Tide.

The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by Diatoms andBlue green algae during spring tide period.Diatoms were represented by 14genera and Blue green algae were represented two genera during the sampling conducted in Neap tide in July , 2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 86-224 units/ L during high tide period and 222-254 units/ L during low tide of Neap Tide.

Species Richness Indices and Diversity Indices :

Margalef's diversity index (Species Richness)S

At the organismal level, the most widely used biodiversity measures are those based on the number of species present, perhaps adjusted for the number of individuals sampled, Here Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, are derived.

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was varying from 1.896 -2.495 with an average of 2.315during the sampling conducted in High tide period of spring tide.While Margalef's diversity index (Species Richness) S of phytoplankton communities in the Kandla Harbour region and nearby creeks was varying from. 2.054-2.334 with an average of 2.170 during the consecutive in low tide period .

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was varying from 2.245-2.630 with an average of 2.495 during the sampling conducted in High tide period of Neaptide While .Margalef's diversity index (Species Richness) S ofphytoplankton communities in the Kandla Harbour region and nearby creeks was varying from. 2.003-2.709 with an average of 2.232 during the consecutive in low tide period .

Shannon-Wiener's index:

Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.878-0.959 (H'(log10)) between selected sampling stations with an average value of 0.905 during high tide period of spring tide .Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.863-0.904 (H'(log10)) between selected sampling stations with an average value of 0.892 during consecutive lowtide. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.960-1.025 (H'(log10)) between selected sampling stations with an average value of 0.990. during high tide period of neap tide . Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.969-1.008 (H'(log10)) between selected sampling stations with an average value of 0.990 during consecutive low tide. Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon-Wiener's index increases as both the richness and the evenness of the community increase. This result indicates that diversity of phytoplankton of Kandla Harbour region and nearby creeks is less but with abundant population of few, with relatively few ecological niches and only very few opportunist organisms are really well adapted to this environment and thrive better than other species.

Simpson's diversity index:

Simpson's index (D) is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. The Simson index is one of the meaningful and robust biodiversity measures available. (Magurran,2004).

Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in the Kandla Harbour region and nearby creeks, which was varying from 0.837- 0.878 between selected sampling stations with an average of 0.855 during high tide period of spring tide . Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in the Kandla Harbour region and nearby creeks, which was varying from 0.840- 0.856 between selected sampling stations with an average of 0.849 during consecutive low tide . Low species diversity suggests a relatively few successful species in this habitat. The environment is quite stressful with relatively few ecological niches and only a few organisms are really well adapted to that environment. Any change in the environment would probably have quite serious effects.

Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in Kandla Harbour region and nearby creeks, during high tide period and low tideperiod during neap tide also, which was varying from 0.872-0.891 with an average value of 0.881 between selected sampling stations during high tide period and varying from 0.882-0.889 with an average value of 0.885 between selected sampling stations during consecutive low tide period Low species diversity suggests a relatively few successful species in this habitat.

Table # 4PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN JULY,2021

Tide	Sampling Station	Abundance In units/L	No of Species observed /total species	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	183	14/15	93.33	2.495	0.906	0.8502
	2	154	13/15	86.66	2.382	0.8957	0.8537
	3	159	13/15	86.66	2.367	0.8948	0.8424
	4	188	13/15	86.66	2.292	0.8783	0.8372
	5	196	14/15	93.33	2.463	0.9587	0.8667
	6	68	9/15	60	1.896	0.899	0.8784
LOW TIDE	1	171	13/15	86.66	2.334	0.9041	0.8535
	2	212	12/15	80	2.054	0.8992	0.8565
	3	197	13/15	86.66	2.271	0.89	0.8406
	4	203	12/15	80	2.07	0.8634	0.8401
	5	179	12/15	80	2.121	0.9037	0.856

Table # 5 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN JULY2021

Tide	Sampling Station	Abundance In units/L	No of Species observed /total species	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	205	15/16	93.75	2.63	1.002	0.8735
	2	184	14/16	87.5	2.493	0.9603	0.872
	3	221	14/16	87.5	2.408	0.9762	0.8773
	4	213	15/16	93.75	2.611	1.025	0.8905
	5	224	15/16	93.75	2.587	1.011	0.8859
	6	86	11/16	68.75	2.245	0.9685	0.8914
LOW TIDE	1	243	12/16	75	2.003	0.9696	0.8823
	2	222	12/16	75	2.036	0.9893	0.8893
	3	222	13/16	81.25	2.221	1.001	0.8872
	4	254	16/16	100	2.709	1.008	0.883
	5	239	13/16	81.25	2.191	0.985	0.8864

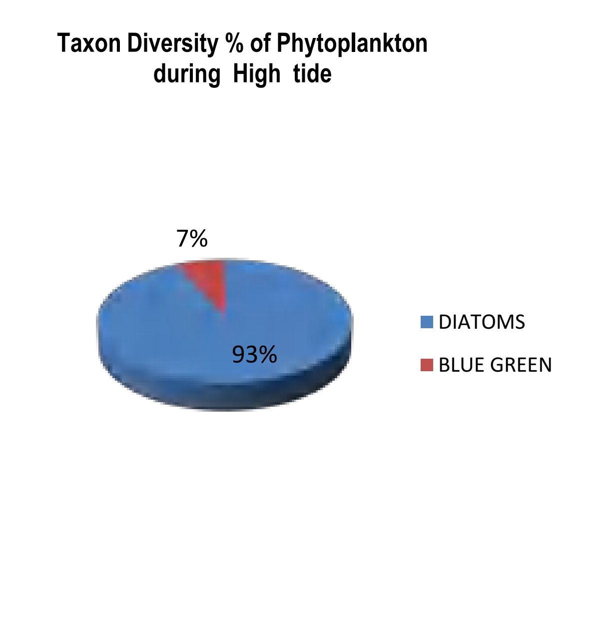
Table # 6 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING SPRING TIDE IN JULY,2021

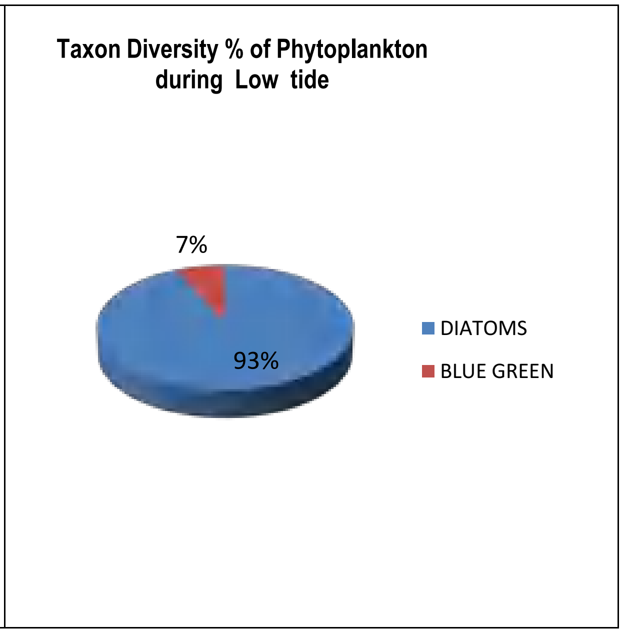
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	68-194	14/15	93.33
			BLUE GREEN	0-2	1/15	6.67
			TOTAL PHYTO PLANKTON	68-196	15	-
LOW TIDE	Sub surface	5	DIATOMS	170-211	14/15	93.33
			BLUE GREEN	0-1	1/15	6.67
			TOTAL PHYTO PLANKTON	171-212	15	-

Table # 7 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING NEAP TIDE IN JULY,2021

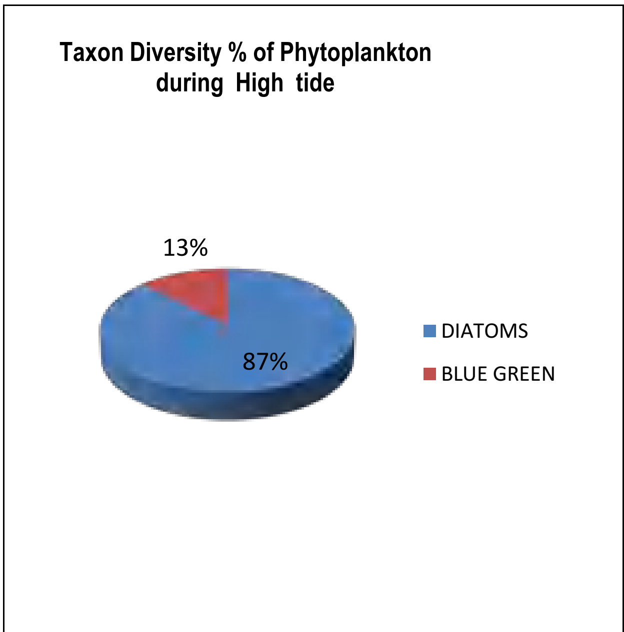
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	74-202	14/16	87.5
			BLUE GREEN	12-26	2/16	12.5
			TOTAL PHYTO PLANKTON	86-224	16	-
LOW TIDE	Sub surface	5	DIATOMS	201-236	14/16	87.5
			BLUE GREEN	16-21	2/16	12.5
			TOTAL PHYTO PLANKTON	222-254	16	-

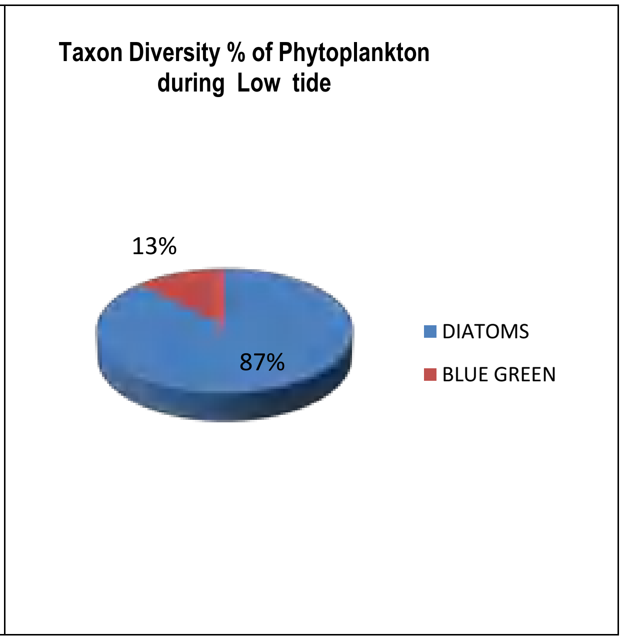
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide





Taxon Diversity % of Phytoplankton during High tide and Low tide period during Neap tide





ZOOPLANKTON POPULATION:

For the evaluation of the Zooplankton population in DPT harbour area and within the immediate surroundings of the port sampling was conducted from 6 sampling locations (3 in harbour area and two in Nakti creek and one in Khoricreek) during high tide period and low tide period of spring tide and Neap tide in July 2021 . The Zooplankton community of the sub surface water in the harbour and nearby creeks during spring tide was represented by mainly four groups, Tintinids, Copepods,Foraminiferans and larval forms of Crustacea, Molluscans and Polychates. The Zooplankton community of the sub surface water in the harbour and nearby creeks during neap tide was represented by mainly five groups, Tintinids, Copepods, Arrow worms, Mysids and larval forms of Crustaceans , Mollusacansand Polychates,.

Zooplankton of the sampling stations at sub surface layer in the DPT harbour area and nearby creek was varying from 59-142x10^3 N/ m^3 during high tide and 123 -147x10^3 N/ m^3during low tide of Spring Tide period. Zooplankton of the sampling stations at sub surface layer in the DPT harbour area and nearby creek was varying from 59-147x10^3 N/ m^3 during high tide and 141-164 N/ L during low tide of Neap Tide period.

Species Richness Indices and Diversity Indices:

Margalef's diversity index (Species Richness)S

At the organismal level, the most widely used biodiversity measures are those based on the number of species present, perhaps adjusted for the number of individuals sampled, Here Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, are derived.

Margalef's diversity index (Species Richness) S of Zooplankton communities in the stations Kandla Harbour region and nearby creeks was varying from 2.850 -3.366 with an average of 3.040 during the sampling conducted in High tide period.Margalef's diversity index (Species Richness) S of Zooplankton communities varying from.2.263-2.701 with an average of 2.562 during the sampling conducted in low tide period during Spring tide.

Margalef's diversity index (Species Richness) S of Zooplankton communities in the Kandla Harbour region and nearby creeks sampling stations was varying from3.188-4. 133 with an average of 3.754 during the sampling conducted in high tide and varying from.2.802 -4.314 with an average of 3.548 during the sampling conducted in low tide during Neap tide period**Shannon-Wiener's index:**

Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 1.011-1.080 (H'(log10)) between selected sampling stations with an average value of 1.050 (H'(log10)) during high tide period of spring tide .Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.953 -1.011 (H'(log10)) between selected sampling stations with an average value of 0.988 (H'(log10)) during consecutive low tide period .

Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.884-1.145 (H'(log10)) between selected sampling stations with an average value of 1.075 (H'(log10)) during high tide period of Neap tide. Shannon-Wiener's Index (H) of Zooplankton communities in the samplingstations in Kandla Harbour region and nearby creeks was in the range of 1.004- 1.177 (H'(log10)) between selected sampling stations with an average value of 1.056 (H'(log10)) during consecutive low tide period .Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon-Wiener's index increases as both the richness and the evenness of the community increase. This result indicates that diversity of Zooplankton of Kandla Harbour region and nearby creeks stations is slightly high with very minimum diverse population but very few opportunist organisms are really well adapted to this environment and thrive better than other species.

Simpson's diversity index:

Simpson's index (D) is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. The Simson index is one of the meaningful and robust biodiversity measures available. (Magurran, 2004).

Simpson diversity index (1-D) of Zooplankton communities was below 0.9 most of sampling stations except few in the Kandla Harbour region and nearby creeksduring high tide and low tide of spring tide period, which was varying from 0.882-0.911between selected sampling stations with an average of 0.899 during high tide period and was varying from 0.875- 0.888 with an average value of 0.882 between selected sampling stations during low tide

Simpson diversity index (1-D) of Zooplankton communities was below 0.9 at all sampling stationsin the Kandla Harbour region and nearby creeks during high tide and low tide period except few, which was varying from 0.829-0.907 between selected sampling stations with an average of 0.887 during high tide period and was varying from 0.872- 0.913 with an average value of 0.886 between selected sampling stations during consecutive low tide

This low species diversity suggests a relatively low number of successful species in this habitat. Environment is quite stressful with relatively few ecological niches and only few organisms are really well adapted to that environment. Any change in the environment would probably have quite serious effects.

Table # 8 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN JULY,2021

Tide	Sampling Station	Abundance In No / m^3	No of Species/groups observed /total species/group	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	125 X10^3	15/19	78.95	2.9	1.02	0.8906
	2	116 X10^3	16/19	84.21	3.156	1.08	0.9076
	3	116 X10^3	17/19	89.47	3.366	1.076	0.8961
	4	142 X10^3	16/19	84.21	3.027	1.011	0.8821
	5	136 X10^3	15/19	78.95	2.85	1.077	0.9077
	6	59 X10^3	13/19	68.42	2.943	1.037	0.9112
LOW TIDE	1	129 X10^3	12/19	63.16	2.263	0.9534	0.8751
	2	123 X10^3	14/19	73.68	2.701	0.9887	0.8835
	3	145 X10^3	14/19	73.68	2.612	1.011	0.8879
	4	147 X10^3	14/19	73.68	2.605	0.9919	0.8823
	5	140 X10^3	14/19	73.68	2.631	0.9951	0.8808

Table # 9 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN JULY,2021

Tide	Sampling Station	Abundance In No / m^3	No of Species/groups observed /total species/group	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	162 X10^3	19/23	82.61	3.538	1.094	0.895
	2	152 X10	20/23	86.96	3.782	1.088	0.8906
	3	146 X10	20/23	86.96	3.812	1.106	0.9011
	4	174 X10	22/23	95.65	4.071	1.134	0.9015
	5	161 X10	22/23	95.65	4.133	1.145	0.9069
	6	59 X10	14/23	60.86	3.188	0.8842	0.8299
LOW TIDE	1	141 X10	17/23	73.91	3.233	1.004	0.8719
	2	142 X10	18/23	78.26	3.43	1.022	0.8797
	3	148 X10	15/23	65.22	2.802	1.034	0.8911
	4	164 X10	23/23	100	4.314	1.177	0.9134
	5	156 X10	21/23	91.30	3.961	1.046	0.8781

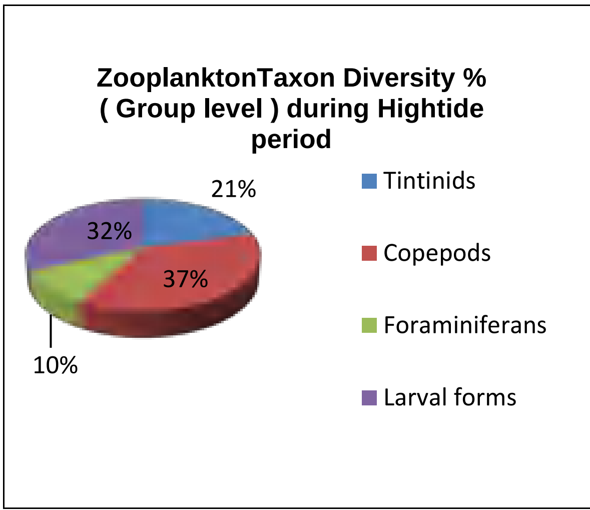
Table # 10 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN JULY2021

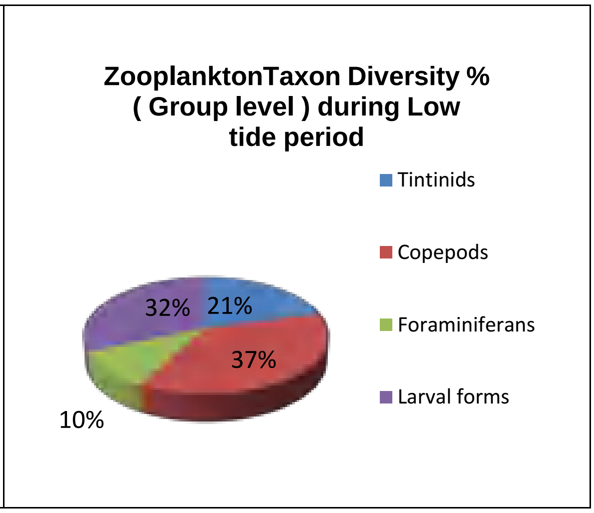
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	3-10	4/19	21.05
			Copepods	34-77	7/19	36.84
			Foraminiferans	2-6	2/19	10.53
			Larval forms	20-57	6/19	31.58
			TOTAL ZOOPLANKTON NO/L	**59-142**	**19**	**-**
LOW TIDE	Sub surface	5	Tintinids	3-8	4/19	21.05
			Copepods	76-80	7/19	36.84
			Foraminiferans	0-2	2/19	10.53
			Larval forms	40-63	6/19	31.58
			TOTAL ZOOPLANKTON NO/L	**123-147**	**19**	**-**

Table # 11 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA , NEAR BY CREEKS DURING NEAPTIDE IN JULY,2021

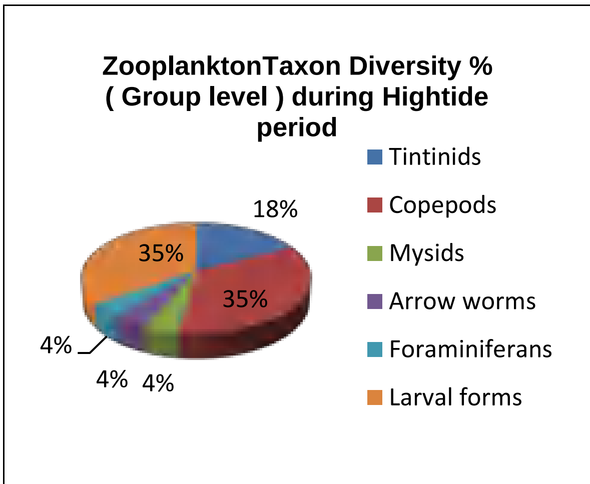
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	4-13	4/23	17.39
			Copepods	37-83	8/23	34.78
			Mysids	0-2	1/23	4.35
			Arrow worms	1-2	1/23	4.35
			Foraminiferans	0-4	1/23	4.35
			Larval forms	17-74	8/23	34.78
			TOTAL ZOOPLANKTON NO/L	**59-173**	**23**	**-**
LOW TIDE	Sub surface	5	Tintinids	3-13	4/23	17.39
			Copepods	70-84	8/23	34.78
			Mysids	0-2	1/23	4.35
			Arrow worms	0-2	1/23	4.35
			Foraminiferans	0-2	1/23	4.35
			Larval forms	60-70	8/23	34.78
			TOTAL ZOOPLANKTON NO/L	**140-164**	**23**	

Taxon Diversity % of Zooplankton during High tide and Low tide period of Spring tide





Taxon Diversity % of Zooplankton during High tide and Low tide period of Neap tide



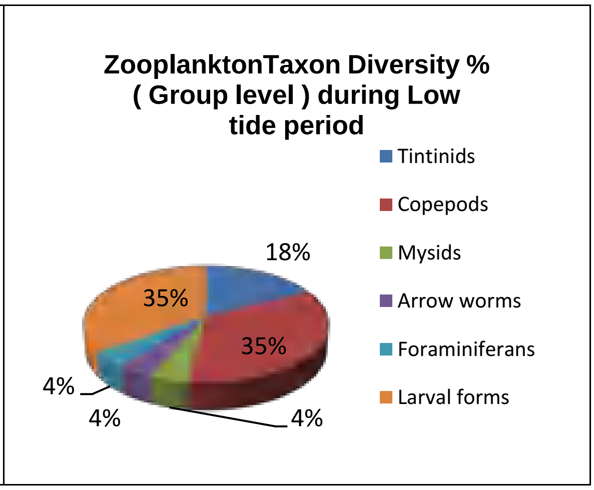


TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURINGSPRING TIDE OF JUlY,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALAGE	Cynophyta	Cynophyceae	Stigonematales	Stigonemataceae	*Stigonema*sp	**B1**	Rare
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Rare
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D2	Abundant
					*Palmeria*sp	D3	Occasional
			Triceratiales	Triceratiaceae	*Odontellasp*	D4	Frequent
					*Triceratium*sp.	D5	Frequent
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D6	Abundant
			Hemiaulales	Bellerocheaceae	Bellerocheasp	D7	Occasional
				Hemiaulaceae	*Eucampia*sp	D8	Rare
			Lithodesmiales	Lithodesmiaceae	*Ditylumsp*	D9	Frequent
			Thalassiosirales	Thalassiosiraceae	*Thalassiosira*sp	D10	Rare
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*sp	D11	Rare
			Bacillariales	Bacillariaceae	*Nitzschia*sp	D12	Rare
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D13	Dominant
			Fragilariales	Fragilariaceae	*Synedra*sp	D14	Occasional

TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURING AND NEAP TIDE OF JULY,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALAGE	Cynophyta	Cynophyceae	Chlorococcales	Chroococcaceae	*Microcystis* sp.	B1	Occasional
			Stigonematales	Stigonemataceae	*Stigonema*sp	B2	Frequent
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Rare
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D2	Abundant
					Palmeriasp	D3	Occasional
			Triceratiales	Triceratiaceae	*Odontella*sp	D4	Frequent
					*Triceratium*sp.	D5	Abundant
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D6	Dominant
			Hemiaulales	Bellerocheaceae	Bellerocheasp	D7	Occasional
				Hemiaulaceae	*Eucampia*sp	D8	Rare
			Lithodesmiales	Lithodesmiaceae	*Ditylum*sp	D9	Abundant
			Thalassiosirales	Thalassiosiraceae	*Thalassiosira*sp	D10	Frequent
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*sp	D11	Rare
			Bacillariales	Bacillariaceae	*Nitzschia*sp	D12	Rare
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp*.	D13	Frequent
			Fragilariales	Fragilariaceae	*Synedra*sp	D14	Frequent

TABLE #13 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS IN DPT HARBOUR AREA, AND NEAR BY CREEKS DURING SPRING TIDE OF JULY,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Rare
				Codonellidae	*Tintinnopsisfailakkaensis*	T2	Rare
					Tintinnopsisgracilis	T3	Rare
					Tintinnopsis radix	T4	Rare
COPEPODS	ATHROPODA	Crustacea Sub class copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Abundant
					Bestiolina sp.	C2	Rare
					Parvocalanus sp.	C3	Occasional
				Temoridae	*Temora sp.*	C4	Frequent
			Cyclopoida	Oithonidae	*Oithona sp.*	C5	Frequent
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C6	Abundant
				Euterpinidae	*Euterpina*	C7	Occasional
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
(Brachyuraian LARVAE	ARTHROPODA CRUSTACEA	DECAPODA (BRACHYURA)			Zoea larvae	L2	Rare
CYPHONAUTES LARVAE	BRYOZOA				Cyphonautes larvae	L3	Occasional
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L4	Rare
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L5	Rare
POLYCHAETE LARVAE	ANNELIDA				Trochophore larvae	L6	Frequent
FORAMINIFERA	FORAMINIFERA	Globothalamea	Rotaliida	Globigerinidae	*Globigerina* sp.	F1	Rare
				Rotalliidae	*Rotalia* sp.	F2	Rare

TABLE # 13 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS IN DPT HARBOUR AREA, AND NEAR BY CREEKS DURING NEAP TIDE OF JULY,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Rare
				Codonellidae	*Tintinnopsisfailakkaensis*	T2	Occasional
					Tintinnopsisgracilis	T3	Occasional
					Tintinnopsis radix	T4	Rare
COPEPODS	ATHROPODA	Crustacea Sub class copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Abundant
					Parvocalanus sp.	C2	Rare
				Eucalanidae	*Subeucalanus sp.*	C3	Frequent
				Temoridae	*Temora sp.*	C5	Frequent
				Acartiidae	*Acartia sp.*	C6	Occasional
			Cyclopoida	Oithonidae	*Oithona sp.*	C7	Frequent
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C8	Abundant
				Euterpinidae	*Euterpina sp.*	C9	Frequent
ARROW WORMS	CHAETOGNATHA	Sagittoideae	Aphragmophora	Sagittidae	*Sagitta sp.*	A1	Rare
MYSIDS	ATHROPODA CRUSTACEA	Malacostraca	Mysida, Decapoda	Penaeidae	*Metapenaeus sp.*	M1	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
POLYCHAETE LARVA	ANNELIDA	Polychaeta			Trochophore larvae	L2	Occasional
BARNACLE LARVAE	ATHROPODA CRUSTACEA	Maxillopoda Thecostraca			Cirripede larvae	L3	Rare
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L4	Occasional

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L5	Rare
BRACHYURAIAN LARVAE	ARTHROPODA CRUSTACEA	DECAPODA (BRACHYURA)			Zoea larvae	L6	Occasional
CYPHONAUTES LARVAE	BRYOZOA				Cyphonautes larvae	L7	Occasional
ECHINODERMATA larvae	ECHINODERMATA	Ophiuroidea			Ophiopluetus larvae	L8	Occasional
FORAMINIFERA	FORAMINIFERA	Globothalamea	Rotaliida	Rotalliidae	*Rotalia* sp.	F1	Rare

BENTHIC ORGANISMS:

No Benthic organisms were observed in the collected sediments by using the Van-veen grabs during the sampling conducted IN spring tide period as well as Neap tide period from DPT harbour region and nearby creek except few dead shells.

7. Meteorological Data

Automatic Weather station have been installed in SevaSadan -3 at the Deendayal Port which records the data on Temperature (°C), Humidity (%),Wind (mph), Dew Point (°C), Wind Direction (°), Pressure, Solar radiation, heat Index and UVI.

Temperature

The mean day time temperature for Deendayal Port was 28.5 °C. The day-time maximum temperature was 32.1 °C. The mean night time temperature was 30.3 °C. The minimum mean night time temperature recorded was 27.8 °C.

Air Pressure

The mean absolute air pressure for the month of July was 1002.4 hpa, whereas the mean relative pressure was 1000.2 hpa. The maximum absolute air pressure recorded for the month of July was 1004.1 hpa.

Heat Index

The mean day-time heat index for the month of July was 36.1 ^{o}C. The maximum heat index recorded was 43^{o}C.

Solar Radiation

The mean Solar Radiation in July was 158.4 w/m^2. The maximum solar radiation recorded in the month of July was 751.7 w/m^2.

Humidity

The mean day-time humidity was 80.3 % for the month of July and mean night time humidity was 71.2%. Maximum humidity recorded during day-time was 89.0 % and maximum humidity recorded during night-time was 85.0%.

Wind Velocity and Wind Direction

The mean wind velocity for the entire month of July was 11.72 km/hour (i.e. 2.7 mtr/sec). Maximum wind velocity recorded was 47.2 Km/hr (13 mtr/sec). The wind direction was mostly S to SW.

Rainfall

The mean Rainfall in July was 58.1 mm. The maximum Rainfall recorded in the month of July was 132.7 mm.

Conclusive Summary and Remedial measures Suggested

- The AAQ monitoring at six locations of Deendayal Port indicates that the mean PM_{10} values at four locations viz. Coal storage area, Marine Bhavan and Oil Jetty area were found above the permissible standards (100 µg/m^3)and$PM_{2.5}$was above permissible limits at Coal storage location(Limit 60 µg/m^3).

- Drinking water at all the twenty locations was found potable and was within permissible limits of BIS standards (IS 10500).

- Noise quality was also within the set permissible standards of an Industrial Area. The noise level observed during day time was >75 dB (A) and at night time was >70 dB (A) during the entire monitoring period.

- The sewage treated water of Deendayal Port Colony (Gopalpuri) was in line with the standards set by the Gujarat Pollution Control Board. The STP at Deendayal Port is not fully operational and STP at Vadinar Port was found non-operational.

Reasons for higher Values of PM_{10}

- Large amount of coal is handled at Berth No. 6, 7, 8 and 9. The unloading of coal directly in the truck, using grabs cause coal to spread in air as well as coal dust to fall on ground. This settled coal dust again mixes with the air while trucks travel through it.

- Also, the coal laden trucks are not always covered with tarpaulin sheets and these results in spillage of coal from trucks/dumpers during its transit from vessel to yard or storage site. This also increased PM values around marine Bhavan & Coal storage area.

Remedial Measures

The values of PM_{10} during the month of July, 2021 were observed beyond the permissible limit at four locations mentioned above. Given below are the remedial measures suggest to minimize the Air pollution at Deendayal Port.

- Guidelines for Coal Handling by GPCB should be strictly followed. (http://gpcb.gov.in/pdf/coal-handling-guidelines.pdf)

- Sewage Treatment Plan at Vadinar Port is not working. Hence, it is recommended to commission the sewage treatment plant at Vadinar immediately.

- Except for the higher values of PM_{10} at Coal storage site, Oil Jetty, Tuna Port and Marine Bhavan locations, the monitoring results for the present month suggest that the overall Environment Quality of Deendayal Port is satisfactory.

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ENVIRONMENTAL MONITORING REPORT
FOR
DEENDAYAL PORT TRUST

REPORT NO.	:	DCPL/DPT/20-21/16
Month	:	Aug 2021
Issue No	:	01
Revision No	:	00
Prepared by	:	DETOX CORPORATION PVT. LTD., SURAT

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Introduction

Monitoring of various environmental aspects of the Deendayal port by M/s Detox Corporation Pvt. Ltd. has been carried out through collection of samples, analysis of the same, comparing results with respect to the national standards and any other relevant standards by GBCB/CPCB/MoEF to identify non conformity in the Environment of the Deendayal Port. The results shall address the identified impacts and suggest measures to minimize the environmental impact due to various operations at Deendayal Port.

The environmental monitoring is carried out as per the Environment Management and Monitoring Plan submitted by Detox Corporation Pvt. Ltd.

1. Ambient Air Quality Monitoring

As per the Environmental Monitoring Plan of Deendayal Port Trust, Air monitoring was carried out at six identified locations at Deendayal Port and two locations at Vadinar Port.

1.1 Air Quality Monitoring Methodology

Air quality is measured in all the stations, for 24 hour for Total Suspended Particulate Matter (TSPM), PM_{10}, $PM_{2.5}$, SO_2, NO_X, NH_3 & Benzene, and Grab-sampling for CO & CO_2 measurements. The Air samplers are operated for a period of 24 hours and after a continuous operation of 8 hours of the sampler, the reagents were replaced to obtain 3 samples per day for each parameter namely, SO_2, NO_X. The EPM 2000 filter paper and PTFE Membrane bound filter paper are used for a period of 24 hours to obtain one sample each of TSPM, PM_{10} & $PM_{2.5}$.

The AAQ samples are collected twice a week from all the eight locations as per the EMP.

1.2 Results

The ambient air quality monitoring data for six stations, viz. Marine Bhavan, Oil Jetty, Port Colony,Gopalpuri Hospital,Tuna Port and Nr. Coal Storage Area for the month of August 2021 are given in Tables 1A to 6B. The ambient air quality monitoring data for two stations at Vadinar (Nr. Admin Building &Nr. Signal Building) are given in Tables 7A to 8B.

Location 1: Marine Bhavan (AL1)

Table 1 : Results of Air Pollutant Concentration at Marine Bhavan

Parameter	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**		**80 µg/m3**		**80 µg/m3**		**400 µg/m3**
AL1 – 1	04.08.2021	328	179	68	2.64	2.40	20.33	21.17	9.45	9.87
					0.62		19.05		9.70	
					3.96		24.14		10.47	
AL1 – 2	06.08.2021	659	211	75	7.03	6.15	14.61	20.11	13.79	13.70
					5.71		15.88		13.53	
					5.71		29.85		13.79	
AL1 – 3	11.08.2021	813	247	70	8.35	7.03	29.85	27.10	12.00	11.49
					7.91		31.76		13.02	
					4.84		19.69		9.45	
AL1 – 4	13.08.2021	549	272	89	2.20	2.05	18.42	17.15	14.55	15.68
					1.76		15.88		17.69	
					2.20		17.15		14.81	
AL1 – 5	18.08.2021	442	300	45	3.96	3.66	19.69	21.38	5.36	9.62
					4.40		20.33		12.00	
					2.64		24.14		11.49	
AL1 - 6	20.08.2021	360	299	88	3.08	3.22	17.78	16.51	10.47	6.13
					4.40		21.60		5.36	
					2.20		10.16		2.55	
AL1 - 7	25.08.2021	340	290	72	2.64	2.64	13.34	18.00	14.81	11.57
					3.52		22.23		10.47	
					1.76		18.42		9.45	
AL1 – 8	27.08.2021	471	299	63	3.08	2.93	27.31	26.25	10.98	7.83
					1.76		30.49		5.62	
					3.96		20.96		6.89	
Monthly Average		495	262	71		3.76		20.96		10.74
Standard Deviation		171	46	14		1.83		3.96		3.08

NS: Not Specified

Table 1B : Results of Air Pollutant Concentration at Marine Bhavan					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC* ppm**	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL1 – 1	04.08.2021	1.06	BDL	1.86	488
AL1 – 2	06.08.2021	1.22	BDL	1.74	496
AL1 – 3	11.08.2021	1.28	BDL	1.7	499
AL1 – 4	13.08.2021	1.2	BDL	1.68	501
AL1 – 5	18.08.2021	1.21	BDL	1.72	490
AL1 - 6	20.08.2021	1.06	BDL	1.62	497
AL1 – 7	25.08.2021	1.12	BDL	1.52	488
AL1 – 8	27.08.2021	1.06	BDL	1.72	496
Monthly Average		**1.15**	**-**	**1.70**	**494**
Standard Deviation		**0.09**	**-**	**0.10**	**5**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC: 0.5ppm)
NS -Not Specified

At Marine Bhavan, the overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_X and NH_3 is attributed mainly by motor vehicle emission produced from various types of automobiles (both diesel and petrol driven). Moreover, the loading and unloading of Food Grains and Timber at Jetty no. 1 and 2 also contributes to the high levels of TSPM and PM_{10}. The mean TSPM value at Marine Bhavan was 495 µg/m^3, The mean PM_{10} values were 262.0 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were slightly above the permissible limit (mean = 71 µg/m^3). The average values of SO_2, NO_x and NH_3 were within the permissible limit. The average values of SO_2, NO_x and NH3 were 3.76 µg/ m^3, 20.96 µg/ m^3 & 10.74 µg/ m^3 respectively. These were within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Marine Bhavan. The mean Benzene concentration was 1.15 µg/m^3,well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.70 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 2: Oil Jetty (AL2)

Table 2 : Results of Air Pollutant Concentration at Oil Jetty

Parameters	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period	-	24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit	-	NS	100 µg/m3	60 µg/m3	-	80 µg/m3	-	80 µg/m3	-	400 µg/m3
AL2 – 1	04.08.2021	299	222	55	3.52	3.81	18.42	16.30	13.53	14.81
					4.84		12.70		14.81	
					3.08		17.78		16.08	
AL2 – 2	06.08.2021	837	394	89	1.32	3.08	12.07	12.28	7.40	10.47
					3.08		10.80		11.74	
					4.84		13.97		12.25	
AL2 – 3	11.08.2021	403	350	49	8.35	9.38	33.66	25.62	4.08	6.89
					8.79		19.05		6.89	
					10.99		24.14		9.70	
AL2 – 4	13.08.2021	511	327	82	3.08	2.05	17.78	16.30	7.15	9.10
					1.76		15.88		10.72	
					1.32		15.24		9.45	
AL2 – 5	18.08.2021	567	281	75	3.08	2.20	17.15	18.63	9.70	7.83
					1.32		26.04		5.36	
					2.20		12.70		8.42	
AL2 – 6	20.08.2021	728	490	90	6.15	5.86	22.87	15.88	5.36	8.00
					7.91		8.89		8.42	
					3.52		15.88		10.21	
AL2 – 7	25.08.2021	344	237	67	0.88	1.17	24.14	20.75	9.96	10.38
					0.88		15.88		12.76	
					1.76		22.23		8.42	
AL2 – 8	27.08.2021	475	278	76	1.32	2.20	15.88	17.78	5.87	8.51
					1.76		24.14		9.19	
					3.52		13.34		10.47	
Monthly Average		520	322	73		3.72		17.94		9.50
Standard Deviation		186	88	15		2.70		3.95		2.47

NS: Not Specified

Table 2B : Results of Air Pollutant Concentration at Oil Jetty					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC* ppm**	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL2 -1	04.08.2021	1.22	BDL	1.86	492
AL2 -2	06.08.2021	1.06	BDL	1.72	496
AL2 -3	11.08.2021	1.26	BDL	1.76	489
AL2 -4	13.08.2021	1.23	BDL	1.66	500
AL2 – 5	18.08.2021	1.2	BDL	1.84	496
AL2 – 6	20.08.2021	1.16	BDL	1.74	489
AL2 -7	25.08.2021	1.18	BDL	1.76	476
AL2 – 8	27.08.2021	1.23	BDL	1.7	490
Monthly Average		**1.19**	**-**	**1.76**	**491**
Standard Deviation		**0.06**	**-**	**0.07**	**7**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 0.5ppm)

NS- Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Oil Jetty area was mainly by motor vehicle emission produced from various types of vehicles Oil Jetty Area. The mean TSPM values at Oil Jetty were 520 µg/m^3 .The mean PM_{10} values were 322 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were slightly above the permissible limit (mean = 73 µg/m^3).The average values of SO_2, NO_x and NH_3 were within the permissible limit; The mean concentration of SO_2, NO_x and NH3 were 3.72 µg/m^3, 17.94 µg/m^3 and 9.50 µg/m^3 respectively.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Oil Jetty. The mean Benzene concentration was 1.19 µg/m^3 .Well below the permissible limit of 5.0 µg/m^3. , HC’s were below the detectable limit and Carbon Monoxide concentration was 1.76 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 3: Kandla Colony – Estate Office (AL-3)

Table 3 : Results of Air Pollutant Concentration at Estate Office											
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**		
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**	-	**80 µg/m3**	-	**80 µg/m3**	-	**400 µg/m3**	
AL3 – 1	04.08.2021	159	97	35	1.32	2.05	25.41	23.92	14.04	16.68	
					2.20		33.66		17.36		
					2.64		12.70		18.64		
AL3 – 2	06.08.2021	473	176	60	3.96	9.96	12.70	13.13	8.68	7.40	
					21.98		10.80		7.15		
					3.96		15.88		6.38		
AL3 – 3	11.08.2021	379	253	74	3.96	4.25	15.24	20.75	8.42	6.47	
					5.28		20.96		7.15		
					3.52		26.04		3.83		
AL3 – 4	13.08.2021	652	331	67	4.84	2.49	9.53	9.32	12.76	9.62	
					1.76		9.53		9.70		
					0.88		8.89		6.38		
AL3 – 5	18.08.2021	643	457	92	4.84	3.52	24.14	24.77	9.70	38.21	
					3.52		34.30		10.47		
					2.20		15.88		94.45		
AL3 – 6	20.08.2021	721	389	75	4.84	4.25	20.96	20.96	10.21	8.25	
					2.20		15.88		9.45		
					5.71		26.04		5.11		
AL3 – 7	25.08.2021	298	208	68	4.40	3.22	22.23	19.05	12.00	11.66	
					3.52		17.78		12.00		
					1.76		17.15		10.98		
AL3 – 8	27.08.2021	574	300	96	2.64	2.93	16.51	17.57	11.49	8.76	
					4.40		17.15		9.45		
					1.76		19.05		5.36		
Monthly Average		488	276	71		4.08		18.68		13.38	
Standard Deviation		196	117	19		2.50		5.26		10.53	

NS: Not Specified

Table 3B : Results of Air Pollutant Concentration at Kandla Port Colony					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC***	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL3 -1	04.08.2021	1.12	BDL	1.84	480
AL3 -2	06.08.2021	1.16	BDL	1.76	488
AL3 -3	11.08.2021	1.22	BDL	1.8	496
AL3 -4	13.08.2021	1.26	BDL	1.74	490
AL3 – 5	18.08.2021	1.2	BDL	1.79	496
AL3 – 6	20.08.2021	1.06	BDL	1.82	499
AL3 – 7	25.08.2021	1.11	BDL	1.8	500
AL3 – 8	27.08.2021	1.07	BDL	1.76	490
Monthly Average		**1.15**	**-**	**1.79**	**492**
Standard Deviation		**0.07**	**-**	**0.03**	**7**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)

NS- Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Kandla Port Colony was attributed by vehicle emission produced from trucks and heavy duty vehicles that pass through the road outside Kandla Port Colony. The mean TSPM values at Oil Jetty were 488 µg/m^3, The mean PM_{10} values were 276 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were slightly above the permissible limit (mean = 71 µg/m^3). The average values of SO_2, NO_x and NH3 were 4.08 µg/m^3, 18.68 µg/m^3 and 13.38 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Kandla Port Colony. The mean Benzene concentration was 1.15 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.79 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 4: Gopalpuri Hospital (AL-4)

Table 4 : Results of Air Pollutant Concentration at Gopalpuri Hospital										
Parameter	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**	
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**	-	**80 µg/m3**	-	**80 µg/m3**	-	**400 µg/m3**
AL4 -1	04.08.2021	128	77	28	3.08	3.08	7.62	12.70	9.70	8.76
					2.64		17.15		10.21	
					3.52		13.34		6.38	
AL4 -2	06.08.2021	180	115	38	3.52	2.05	6.35	10.16	5.36	5.02
					0.88		11.43		5.11	
					1.76		12.70		4.60	
AL4 -3	11.08.2021	228	110	48	1.76	3.08	11.43	9.95	4.34	4.85
					3.96		6.35		5.36	
					3.52		12.07		4.85	
AL4 -4	13.08.2021	327	260	60	3.08	3.08	11.43	9.74	7.15	5.62
					3.52		10.80		4.08	
					2.64		6.99		5.62	
AL4 – 5	18.08.2021	269	156	70	2.20	3.08	15.88	14.61	5.36	6.89
					3.96		8.89		8.93	
					3.08		19.05		6.38	
AL4 – 6	20.08.2021	228	113	86	3.52	2.34	13.97	12.91	5.36	9.02
					2.20		8.89		9.70	
					1.32		15.88		12.00	
AL4 – 7	25.08.2021	222	116	49	2.20	2.78	19.05	17.15	6.89	6.72
					3.52		14.61		8.42	
					2.64		17.78		4.85	
AL4 – 8	27.08.2021	249	119	30	2.64	3.08	12.07	12.07	7.91	8.93
					3.08		12.70		9.19	
					3.52		11.43		9.70	
Monthly Average		229	133	51		2.82		12.41		6.98
Standard Deviation		59	56	20		0.41		2.56		1.75

NS: Not Specified

Table 4B : Results of Air Pollutant Concentration at Gopalpuri Hospital					
Parameter	Date	C_6H_6 [µg/m^3]	HC*	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3	NS	4.0 mg/m^3	NS
AL4 -1	04.08.2021	1.12	BDL	1.88	490
AL4 -2	06.08.2021	1.18	BDL	1.76	488
AL4 -3	11.08.2021	1.26	BDL	1.72	496
AL4 -4	13.08.2021	1.21	BDL	1.8	500
AL4 – 5	18.08.2021	1.28	BDL	1.79	482
AL4 – 6	20.08.2021	1.2	BDL	1.84	493
AL4 – 7	25.08.2021	1.18	BDL	1.86	498
AL4 – 8	27.08.2021	1.16	BDL	1.8	490
Monthly Average		**1.20**	**-**	**1.81**	**492**
Standard Deviation		**0.05**	**-**	**0.05**	**6**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)

NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Gopalpuri Hospital was attributed by vehicle emission produced from light motor vehicles of the colony residents. The mean TSPMvalues at Oil Jetty were 229 µg/m^3, The mean PM_{10} values were 133 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were slightly above the permissible limit (mean= 51 µg/m^3). The average values of SO_2, NO_x and NH_3 were 2.82 µg/m^3, 12.41 µg/m^3 and 6.98 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Gopalpuri Hospital. The mean Benzene concentration was 1.20 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.81 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 5: Coal Storage Area (AL-5)

Table 5 : Results of Air Pollutant Concentration at Coal Storage Area

Parameters	Date	TSPM [µg/m3]	PM10 [µg/m3]	PM2.5 [µg/m3]	SO2 [µg/m3]		NOx [µg/m3]		NH3 [µg/m3]	
Sampling Period	-	24hr	24hr	24hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit	-	NS	100 µg/m3	60 µg/m3	-	80 µg/m3	-	80 µg/m3	-	400 µg/m3
AL5 – 1	04.08.2021	312	167	69	3.08	3.66	22.23	22.23	9.45	9.53
					3.52		23.50		7.15	
					4.40		20.96		12.00	
AL5 – 2	06.08.2021	530	333	77	9.23	6.15	20.96	20.11	16.59	17.02
					5.71		24.77		17.87	
					3.52		14.61		16.59	
AL5 – 3	11.08.2021	759	394	92	10.99	9.23	24.14	27.74	8.42	7.74
					7.47		25.41		7.15	
					9.23		33.66		7.66	
AL5 – 4	13.08.2021	813	435	94	1.76	1.61	17.78	18.84	13.02	10.30
					1.32		19.05		8.93	
					1.76		19.69		8.93	
AL5 – 5	18.08.2021	700	471	79	4.40	3.96	21.60	22.02	12.00	11.66
					4.40		19.05		10.47	
					3.08		25.41		12.51	
AL5 – 6	20.08.2021	566	427	80	3.08	3.96	16.51	18.00	16.85	15.66
					3.52		15.24		16.34	
					5.28		22.23		13.79	
AL5 – 7	25.08.2021	456	224	76	3.96	4.10	13.97	17.15	10.47	7.04
					4.40		19.69		9.70	
					3.96		17.78		0.94	
AL5 – 8	27.08.2021	249	164	70	4.40	3.66	23.50	27.52	11.49	13.44
					3.52		28.58		14.04	
					3.08		30.49		14.81	
Monthly Average		548	327	80		4.54		21.70		11.55
Standard Deviation		204	125	9		2.26		4.07		3.60

NS: Not Specified

Table 5B : Results of Air Pollutant Concentration at Coal Storage Area					
Parameter	Date	C_6H_6 [µg/m^3]	HC*	CO [mg/m^3]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m^3	NS	4.0 mg/m^3	NS
AL5 – 1	04.08.2021	1.06	BDL	1.96	460
AL5 – 2	06.08.2021	1.11	BDL	1.88	458
AL5 – 3	11.08.2021	1.26	BDL	1.9	456
AL5 – 4	13.08.2021	1.3	BDL	1.82	460
AL5 – 5	18.08.2021	1.26	BDL	1.96	456
AL5 – 6	20.08.2021	1.22	BDL	1.93	474
AL5 – 7	25.08.2021	1.38	BDL	1.89	470
AL5 – 8	27.08.2021	1.30	BDL	1.9	468
Monthly Average		**1.24**	**-**	**1.91**	**463**
Standard Deviation		**0.11**	**-**	**0.05**	**7**

* NMHC- Non- Methane Hydrocarbons

BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)

NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Coal Storage Area was comparatively highest among all the locations of Air Quality monitoring in Kandla Port. High values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_X at this location was due to lifting of coal with grab and other coal handling processes near Berth no. 6 & 7. Moreover, the traffic was also heavy around this place for transport of coal thus emissions produced from heavy vehicles. The mean TSPM values at Coal storage were 548 µg/m^3. The mean PM_{10} values were 327 µg/m^3, which is well above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 80 µg/m^3). The average values of SO_2, NO_x and NH_3 were 4.54 µg/m^3, 21.70 µg/m^3 and 11.55 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Coal Storage Area. The mean Benzene concentration was 1.24 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.91 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 6: Tuna Port (AL-6)

Table 6 : Results of Air Pollutant Concentration at Tuna Port											
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**		
Sampling Period	**-**	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	
NAAQMS limit	**-**	**NS**	**100 µg/m3**	**60 µg/m3**	**-**	**80 µg/m3**	**-**	**80 µg/m3**	**-**	**400 µg/m3**	
AL6 -1	04.08.2021	133	75	26	3.96	2.93	22.23	15.46	15.06	12.17	
					2.64		13.34		12.25		
					2.20		10.80		9.19		
AL6 – 2	06.08.2021	203	149	67	2.20	2.05	8.26	9.10	5.87	6.81	
					2.20		10.16		6.38		
					1.76		8.89		8.17		
AL6 – 3	11.08.2021	316	166	44	5.28	4.40	17.78	18.63	6.89	6.47	
					4.84		22.23		4.60		
					3.08		15.88		7.91		
AL6 – 4	13.08.2021	530	342	83	3.08	2.05	5.72	7.83	5.36	6.55	
					1.32		9.53		7.91		
					1.76		8.26		6.38		
AL6 – 5	18.08.2021	468	291	84	0.88	2.05	20.96	17.15	12.76	12.08	
					1.76		12.70		12.25		
					3.52		17.78		11.23		
AL6 – 6	20.08.2021	319	181	63	4.40	3.08	33.03	28.58	10.47	12.93	
					1.32		22.87		15.57		
					3.52		29.85		12.76		
AL6 – 7	25.08.2021	256	156	58	3.08	3.22	15.88	17.15	9.96	10.21	
					2.64		17.78		9.45		
					3.96		17.78		11.23		
AL6 – 8	27.08.2021	554	375	80	2.64	3.08	17.15	16.30	10.47	9.96	
					3.08		12.07		8.42		
					3.52		19.69		10.98		
Monthly Average		347	217	63		2.86		16.28		9.65	
Standard Deviation		155	106	20		0.81		6.35		2.71	

NS: Not Specified

Table 6B : Results of Air Pollutant Concentration at Tuna Port					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC***	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL6 -1	04.08.2021	1.11	BDL	1.74	460
AL6 – 2	06.08.2021	1.26	BDL	1.89	470
AL6 – 3	11.08.2021	1.2	BDL	1.88	472
AL6 – 4	13.08.2021	1.16	BDL	1.9	466
AL6 – 5	18.08.2021	1.07	BDL	1.97	460
AL6 – 6	20.08.2021	1.11	BDL	1.89	451
AL6 – 7	25.08.2021	1.2	BDL	1.8	460
AL6 – 8	27.08.2021	1.21	BDL	1.82	470
Monthly Average		**1.17**	**-**	**1.86**	**464**
Standard Deviation		**0.06**	**-**	**0.07**	**7**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)
NS- Not Specified

The mean TSPM values at Tuna Port were 347 µg/m^3, The mean PM_{10} values were 217 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were slightly the permissible limit (mean = 63 µg/m^3). The average values of SO_2, NO_x and NH_3 were 2.86 µg/m^3, 16.28 µg/m^3 and 9.65 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Tuna Port. The mean Benzene concentration was 1.17 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.86 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 7: Signal Building (Vadinar) (AL-7)

Table 7 : Results of Air Pollutant Concentration at Signal Building											
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**		
Sampling Period	-	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	
NAAQMS limit	-	**NS**	**100 µg/m3**	**60 µg/m3**	-	**80 µg/m3**	-	**80 µg/m3**	-	**400 µg/m3**	
AL7 -1	04.08.2021	144	97	30	3.08	3.08	7.62	11.86	7.66	5.53	
					2.64		14.61		5.36		
					3.52		13.34		3.57		
AL7 -2	06.08.2021	180	120	38	3.96	4.98	28.58	17.78	4.60	6.55	
					4.84		14.61		10.47		
					6.15		10.16		4.60		
AL7 -3	11.08.2021	148	85	29	2.20	2.34	8.89	16.51	5.36	8.68	
					3.08		26.04		11.49		
					1.76		14.61		9.19		
AL7 -4	13.08.2021	165	115	32	2.64	2.07	20.33	14.19	9.19	6.47	
					0.48		13.34		3.57		
					3.08		8.89		6.64		
AL7 -5	18.08.2021	151	99	35	4.84	3.96	14.61	16.30	8.93	7.49	
					3.08		21.60		6.38		
					3.96		12.70		7.15		
AL7 -6	20.08.2021	173	104	64	3.96	3.81	9.53	11.22	4.85	4.68	
					3.08		8.89		3.57		
					4.40		15.24		5.62		
AL7 -7	25.08.2021	168	114	44	3.96	1.67	13.34	13.55	16.85	10.89	
					0.44		6.99		12.00		
					0.62		20.33		3.83		
AL7 -8	27.08.2021	113	54	37	6.15	2.78	7.62	12.70	9.70	8.76	
					1.76		17.15		9.45		
					0.44		13.34		7.15		
Monthly Average		155	98	39		3.1		14.3		7.4	
Standard Deviation		21	21	11		1.1		2.4		2.0	

NS: Not Specified

Table 7B : Results of Air Pollutant Concentration at Signal Building					
Parameter	**Date**	**C_6H_6 [µg/m^3]**	**HC***	**CO [mg/m^3]**	**CO_2 [ppm]**
Sampling Period		**8 hr**	**Grab Sampling**	**Grab Sampling**	**Grab Sampling**
NAAQMS limit		**5.0 µg/m^3**	**NS**	**4.0 mg/m^3**	**NS**
AL7 -1	04.08.2021	1.11	BDL	1.9	460
AL7 – 2	06.08.2021	1.2	BDL	1.86	472
AL7 – 3	11.08.2021	1.18	BDL	1.79	460
AL7 – 4	13.08.2021	1.08	BDL	1.86	461
AL7 – 5	18.08.2021	1.12	BDL	1.96	456
AL7 – 6	20.08.2021	1.2	BDL	1.9	460
AL7 – 7	25.08.2021	1.18	BDL	1.88	470
AL7 – 8	27.08.2021	1.1	BDL	1.82	465
Monthly Average		**1.15**	**-**	**1.87**	**463**
Standard Deviation		**0.05**	**-**	**0.05**	**6**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC : 0.5 ppm)
NS_ Not Specified

The mean TSPM values at Vadinar Port were 155 µg/m^3. The mean PM_{10} values were 98 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 39 µg/m^3). The average values of SO_2, NO_x and NH_3 were 3.1 µg/m^3, 14.3 µg/m^3 and 7.4 µg/m^3 respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Vadinar Port. The mean Benzene concentration was 1.15 µg/m^3, well below the permissible limit of 5.0 µg/m^3. HC's were below the detectable limit and Carbon Monoxide concentration was 1.87 mg/m^3, well below the permissible limit of 4.0 mg/m^3.

Location 8: Admin Building (Vadinar) (AL-8)

Table 8 : Results of Air Pollutant Concentration at Admin Building										
Parameters	**Date**	**TSPM [µg/m3]**	**PM10 [µg/m3]**	**PM2.5 [µg/m3]**	**SO2 [µg/m3]**		**NOx [µg/m3]**		**NH3 [µg/m3]**	
Sampling Period	**-**	**24hr**	**24hr**	**24hr**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**	**8 hr**	**24hr (Avg.)**
NAAQMS limit	**-**	**NS**	**100 µg/m3**	**60 µg/m3**	**-**	**80 µg/m3**	**-**	**80 µg/m3**	**-**	**400 µg/m3**
AL8 -1	04.08.2021	119	55	28	4.84	3.52	19.05	18.42	7.15	6.30
					2.64		22.87		6.64	
					3.08		13.34		5.11	
AL8 -2	06.08.2021	111	56	47	17.58	6.30	17.78	16.73	7.91	8.00
					0.44		19.05		5.62	
					0.88		13.34		10.47	
AL8 -3	11.08.2021	180	100	56	1.76	2.78	15.24	15.24	4.34	5.19
					3.52		22.87		4.85	
					3.08		7.62		6.38	
AL8 -4	13.08.2021	130	77	42	3.96	4.54	13.97	11.86	8.17	7.15
					6.15		10.16		10.47	
					3.52		11.43		2.81	
AL8 -5	18.08.2021	100	68	29	3.96	2.64	7.62	8.89	7.40	7.40
					0.88		8.89		9.45	
					3.08		10.16		5.36	
AL8 -6	20.08.2021	160	97	58	3.52	4.98	12.70	12.70	8.93	8.42
					5.28		10.80		9.19	
					6.15		14.61		7.15	
AL8 -5	25.08.2021	143	65	49	3.52	3.96	6.99	12.49	12.00	8.42
					3.96		17.15		4.34	
					4.40		13.34		8.93	
AL8-6	27.08.2021	160	100	53	2.20	2.93	7.62	11.43	8.17	6.30
					3.08		19.05		4.60	
					3.52		7.62		6.13	
Monthly Average		138	77	45		4.0		13.5		7.1
Standard Deviation		28	19	12		1.3		3.1		1.2

NS: Not Specified

Table 8B : Results of Air Pollutant Concentration at Admin Building					
Parameter	Date	C_6H_6 [µg/m³]	HC*	CO [mg/m³]	CO_2 [ppm]
Sampling Period		8 hr	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS limit		5.0 µg/m³	NS	4.0 mg/m³	NS
AL8 -1	04.08.2021	1.12	BDL	1.96	460
AL8-2	06.08.2021	1.06	BDL	1.86	456
AL8 -3	11.08.2021	1.11	BDL	1.88	466
AL8-4	13.08.2021	1.18	BDL	1.9	470
AL8 -5	18.08.2021	1.26	BDL	1.92	466
AL8-6	20.08.2021	1.16	BDL	1.96	460
AL8-7	25.08.2021	1.2	BDL	1.86	456
AL8-8	27.08.2021	1.26	BDL	1.8	462
Monthly Average		**1.17**	**-**	**1.89**	**462**
Standard Deviation		**0.07**	**-**	**0.05**	**5**

* NMHC- Non- Methane Hydrocarbons
BDL- Below Detection Limit (Detection Limit – NMHC: 0.5 ppm)
NS-Not Specified

The overall values of TSPM, PM_{10}, $PM_{2.5}$, SO_2, NO_x and NH_3 at Admin Building Vadinar was comparatively low among all the locations of Air Quality monitoring in Kandla Port and Vadinar Port. The mean TSPM values at Vadinar Port were 138 µg/m³. The mean PM_{10} values were 77 µg/m³, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 45.0 µg/m³). The average values of SO_2, NO_x and NH_3 were 4.0µg/m³, 13.5 µg/m³ and 7.1 µg/m³ respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Admin Building, Vadinar Port. The mean Benzene concentration was 1.17 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.89 mg/m³, well below the permissible limit of 4.0 mg/m³.

1.4 Observations and Conclusion

During the monitoring period, the overall Ambient Air Quality of the port area was found to be well within the desired levels for various gaseous pollutants. However, Particulate matter as PM_{10} and $PM_{2.5}$ was found to exceed the limits at locations like Near Coal storage area, Marine Bhavan, Estate Office , Tuna Port and Oil Jetty area.

2. Drinking Water Quality Monitoring

Drinking Water Quality Monitoring was carried out at twenty stations at Kandla, Vadinar & Township Area of Deendayal Port.

2.1 Drinking Water Monitoring Methodology

Drinking water samples were collected from 20 locations as prescribed in the tender document. Samples for physico-chemical analysis were collected in 1 liter carboys and samples for microbiological parameters were collected in sterilized bottles. These samples were then analyzed in laboratory for various drinking water parameters at Kandla Lab/Surat.

The Sampling and Analysis was done as per standard methods - IS 10500:2012. The water samples were analyzed for various parameters, viz. Color , Odor, Turbidity , Conductivity , pH , Chlorides , TDS, Total Hardness, Iron , Sulphate , Salinity , DO, BOD, Na, K, Ca, Mg, F, NO_3, NO_2, Mn, Cr-6, Cu, Cd, As, Hg, Pb, Zn, Bacterial Count (cfu) .

2.2 Results

The Drinking Water Quality monitoring data for 20 stations are given in below from table No. 9 to Table No. 15

Table 9: Drinking Water Quality Monitoring Parameters for Nirman Building 1, P & C building & Main Gate (North) at Kandla

Sr. No.	Parameter	Unit	Nirman Building 1	P & C building	Main Gate North	Acceptable Limits as per IS 10500 : 2012	Permissible Limits in the absence of Alternate Source as per IS 10500 : 2012
1	pH	pH Unit	7.4	7.3	7.2	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	930	1250	890	500	2000
3	Turbidity	NTU	0	1	0	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	1850	2460	1700	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/l	626	656	541	250.0	1000.0
9	Ca as Ca	mg/l	68.14	60.12	76.15	75.0	200.0
10	Mg as Mg	mg/l	58.32	72.90	68.04	30.0	100.0
11	Total Hardness	mg/l	390	410	430	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides as F	mg/l	0.34	0.41	0.13	1.0	1.5
14	Sulphate as SO4	mg/l	290.4	175.2	200.4	200.0	400
15	Nitrite as NO2	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate as NO3	mg/l	6.27	8.10	13.38	45.0	No Relaxation
17	Salinity	%	1.13	1.19	0.98	NS*	NS*
18	Sodium as Na	mg/l	160	178	150	NS*	NS*
19	Potassium as K	mg/l	2.2	2.3	2.8	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 10: Drinking Water Quality Monitoring Parameters for Canteen, West Gate – I &Wharf Area at Kandla

Sr. No.	Parameter	Unit	Canteen	West Gate – I	Wharf Area	Acceptable Limits as per IS 10500 : 2012	Permissible Limits in the absence of Alternate Source as per IS 10500 : 2012
1	pH	pH Unit	7.6	7.3	7.2	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1320	990	1030	500	2000
3	Turbidity	NTU	0	0	1	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	2590	1890	2010	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/l	717	596	616	250.0	1000.0
9	Ca as Ca	mg/l	64.13	60.12	56.11	75.0	200.0
10	Mg as Mg	mg/l	72.90	70.47	68.04	30.0	100.0
11	Total Hardness	mg/l	390	360	390	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides as F	mg/l	0.44	0.49	0.51	1.0	1.5
14	Sulphate as SO4	mg/l	190.8	198	289.2	200.0	400
15	Nitrite as NO2	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate as NO3	mg/l	8.80	10.42	9.50	45.0	No Relaxation
17	Salinity	%	1.29	1.08	1.11	NS*	NS*
18	Sodium as Na	mg/l	130	168	158	NS*	NS*
19	Potassium as K	mg/l	3	2.2	2.4	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 11: Drinking Water Quality Monitoring Parameters for Sewa sadan – 3, Workshop I &Custom Building at Kandla

Sr. No.	Parameter	Unit	SewaSadan – 3	Workshop	Custom Building	Acceptable Limits as per IS 10500 : 2012	Permissible Limits in the absence of Alternate Source as per IS 10500 : 2012
1	pH	pH Unit	7.3	7.8	7.4	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	950	1050	1100	500	2000
3	Turbidity	NTU	1	1	0	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	1890	2080	2150	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	742	692	576	250.0	1000.0
9	Ca as Ca	mg/l	76.15	60.12	52.10	75.0	200.0
10	Mg as Mg	mg/l	58.32	68.04	68.04	30.0	100.0
11	Total Hardness	mg/l	400	400	380	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.88	0.59	0.59	1.0	1.5
14	Sulphate	mg/l	219.6	207.6	174	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	13.73	10.21	12.88	45.0	No Relaxation
17	Salinity	%	1.34	1.25	1.04	NS*	NS*
18	Sodium as Na	mg/l	148	150	166	NS*	NS*
19	Potassium as K	mg/l	2.3	2.4	2.8	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 12: Drinking Water Quality Monitoring Parameters for Port Colony Kandla, Hospital Kandla & A.O. Building at Gandhidham

Sr. No.	Parameter	Unit	Port Colony Kandla	Hospital Kandla	A.O. Building	Acceptable Limits as per IS 10500 : 2012	Permissible Limits in the absence of Alternate Source as per IS 10500 : 2012
1	pH	pH Unit	7.5	7.4	7.1	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1080	1350	950	500	2000
3	Turbidity	NTU	0	0	1	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	2100	2670	1890	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	767	712	641	250.0	1000.0
9	Ca as Ca	mg/l	60.12	64.13	56.11	75.0	200.0
10	Mg as Mg	mg/l	70.47	72.90	82.62	30.0	100.0
11	Total Hardness	mg/l	370	410	430	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.85	0.65	0.93	1.0	1.5
14	Sulphate	mg/l	178.8	202.8	207.6	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	9.50	10.21	11.62	45.0	No Relaxation
17	Salinity	%	1.39	1.29	1.16	NS*	NS*
18	Sodium as Na	mg/l	170	164	178	NS*	NS*
19	Potassium as K	mg/l	2.7	2.3	2.8	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 13: Drinking Water Quality Monitoring Parameters for School Gopalpuri, Guest House & E - Type Quarter at Gopalpuri, Gandhidham

Sr. No.	Parameter	Unit	School Gopalpuri	Guest House	E - Type Quarter	Acceptable Limits as per IS 10500 : 2012	Permissible Limits in the absence of Alternate Source as per IS 10500 : 2012
1	pH	pH Unit	7.5	7.5	7.4	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1010	1350	1080	500	2000
3	Turbidity	NTU	1	0	1	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	1990	2670	2120	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	697	496	586	250.0	1000.0
9	Ca as Ca	mg/l	56.11	64.13	72.14	75.0	200.0
10	Mg as Mg	mg/l	70.47	53.46	58.32	30.0	100.0
11	Total Hardness	mg/l	380	360	390	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.58	0.80	1.05	1.0	1.5
14	Sulphate	mg/l	175.2	170.4	165.6	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	9.50	10.70	9.50	45.0	No Relaxation
17	Salinity	%	1.26	0.90	1.06	NS*	NS*
18	Sodium as Na	mg/l	190	186	189	NS*	NS*
19	Potassium as K	mg/l	2.4	2.3	2.6	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 14: Drinking Water Quality Monitoring Parameters for F - Type Quarter, Hospital Gopalpuri & Tuna Port

Sr. No.	Parameter	Unit	F - Type Quarter	Hospital Gopalpuri	Tuna Port	Acceptable Limits as per IS 10500 : 2012	Permissible Limits in the absence of Alternate Source as per IS 10500 : 2012
1	pH	pH Unit	7.7	7.5	7.32	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1050	1080	1020	500	2000
3	Turbidity	NTU	0	1	0	1.0	5.0
4	Odor	-	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Unit	Colorless	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	1990	2150	2000	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	626	641	604	250.0	1000.0
9	Ca as Ca	mg/l	76.15	80.16	80.16	75.0	200.0
10	Mg as Mg	mg/l	51.03	60.75	60.75	30.0	100.0
11	Total Hardness	mg/l	430	360	330	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	1.05	0.92	0.46	1.0	1.5
14	Sulphate	mg/l	138	190.8	180	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	10.00	7.96	8.2	45.0	No Relaxation
17	Salinity	%	1.13	1.16	1.09	NS*	NS*
18	Sodium as Na	mg/l	190	186	188	NS*	NS*
19	Potassium as K	mg/l	2.5	2.4	2.6	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

Table 15: Drinking Water Quality Monitoring Parameters for Vadinar Jetty & Port Colony at Vadinar

Sr. No.	Parameter	Unit	Vadinar Jetty	Port Colony Vadinar	Acceptable Limits as per IS 10500 : 2012	Permissible Limits in the absence of Alternate Source as per IS 10500 : 2012
1	pH	pH Unit	7.6	7.4	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1010	990	500	2000
3	Turbidity	NTU	ND	ND	1.0	5.0
4	Odor	-	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	5.0	15.0
6	Conductivity	µs/cm	210.0	990.0	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	NS*	NS*
8	Chloride	mg/l	476	491	250.0	1000.0
9	Ca as Ca	mg/l	64.13	56.11	75.0	200.0
10	Mg as Mg	mg/l	75.33	68.04	30.0	100.0
11	Total Hardness	mg/l	470	420	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.99	0.94	1.0	1.5
14	Sulphate	mg/l	16.80	17.64	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	11.48	9.50	45.0	No Relaxation
17	Salinity	%	0.86	0.89	NS*	NS*
18	Sodium as Na	mg/l	140.0	146.0	NS*	NS*
19	Potassium as K	mg/l	2.2	2.3	NS*	NS*
20	Manganese	mg/l	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/l	<0.03	<0.03	NS*	NS*
22	Copper	mg/l	<0.05	<0.05	0.05	1.5
23	Cadmium	mg/l	<0.002	<0.002	0.003	0.003
24	Arsenic	mg/l	<0.01	<0.01	0.01	0.05
25	Mercury	mg/l	<0.001	<0.001	0.001	0.001
26	Lead	mg/l	<0.01	<0.01	0.01	0.01
27	Zinc	mg/l	<0.1	<0.1	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent

*NS: Not Specified

2.3 Results & Discussion

The colour of all drinking water samples was < 5 Hazen unit and odour of the samples was also agreeable. All parameters are found to be within the specified limit of the Drinking water Standard.

pH

The limit of pH value for drinking water is specified as 6.5 to 8.5. pH value in the studied area varied from 7.0 to 8.0 pH unit. All the sampling points showed pH values within the prescribed limit by Indian Standards.

Total Dissolved Solids (TDS)

TDS values in the studied area varied between 600 -1800 mg/l. None of the sampling points showed higher TDS values than the prescribed limit by Indian standards .

Conductivity

Electrical Conductivity is the ability of a solution to transfer (conduct) electric current. Conductivity is used to measure the concentration of dissolved solids which have been ionized in a polar solution such as water. The conductivity in the samples collected during the month of August ranged from 1000-3300 µs/cm. Electrical conductivity standards do not appear in BIS standards for drinking water.

BOD

BOD value in the studied area was less than 2.0 mg/L. Indian standards does not show any standard values for BOD in drinking water.

Chlorides

Excessive chloride concentration increase rates of corrosion of metals in the distribution system. This can lead to increased concentration of metals in the supply. Chloride value in the studied area varied between 400-800 mg/l and is found to be within the Permissible limit of the Drinking Water Standard.

Calcium

Calcium value in the studied area varied between 45 - 80 mg/l and is found to be within the Permissible limit of the Drinking Water Standard. If calcium is present beyond the maximum acceptable limit, it causes incrustation of pipes.

Magnesium

Magnesium value in the studied area varied between 30 – 85 mg/l. All the locations had Magnesium within the prescribed limits of 30-100 mg/L.

Total Hardness

Hardness value in the studied area varied between 330-470 mg/l and is found to be within the Permissible limit of the Drinking Water Standard. The prescribed limit by Indian Standards is 200-600 mg/L.

Iron

Iron value in the studied area was below 0.01mg/L and hence well below the permissible limit as per Indian Standards is 0.3 mg/L. The excess amount of iron causes slight toxicity; gives stringent taste to water.

Fluoride

Fluoride value in the studied area varied between 0.1 – 1.0 mg/l and hence well below the permissible limit as per Indian Standards is 1.0-1.5 mg/L. Moderate amounts lead to dental effects, but long-term ingestion of large amounts can lead to potentially severe skeletal problems.

Sulphates

Sulphate value in the studied area varied between 10 – 300 mg/l. All the sampling points showed sulphate values within the prescribed limits by Indian Standards (200-400 mg/L). Sulphate content in drinking water exceeding the 400 mg/L imparts bitter taste.

Nitrites (NO_2) and Nitrates (NO_3)

Nitrite values in all the water samples were <0.1. There are no specified standard values for Nitrites in Drinking water. The mean Nitrate values in drinking water of KPT was 6.27 mg/l which is well within the permissible limit of the Drinking water Standard.

Salinity

Salinity in drinking water in the present samples collected ranged from 0.8 to 1.3 %. There are no prescribed Indian standards for salinity in Drinking water.

Sodium and Potassium Salts

Sodium values in the samples collected ranged from 100 - 2000 mg/l and Potassium salts ranged from 2.2 to 3.0 mg/l. There are no prescribed limits of Sodium and Potassium in Indian standards for Drinking water**.**

Heavy Metals in Drinking Water

In the present study period drinking water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals were well below the permissible limits prescribed by the Indian Standards.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that Bacteria is not present and hence Bacterial count is in line with the permissible limit of drinking water. This shows that all the drinking water samples were safe from any bacteriological contamination.

2.4 Conclusions

These results are compared with acceptable limits as prescribed in IS 10500:2012 – Drinking Water Specification. It is seen from the analysis data that during the study period the water was safe for human consumption at all drinking water monitoring stations.

3. Noise Level Monitoring

Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships. Noise Monitoring was done at 13 stations at Kandla, Vadinar and Township area.

3.1 Method of Monitoring

Sampling was done at all stations for 24 hour period. Data was recorded using automated sound level meter. The intensity of sound was measured in sound pressure level (SPL) and common unit of measurement is decibel (Db).

3.2 Results

Table 16: Noise Monitoring data for ten locations of Deendayal Port and two locations of Vadinar Port

Sr. No.	Location	Day Time Average Noise Level (SPL) in dB(A)	Night Time Average Noise Level (SPL) in dB(A)
	Sampling Time	**6:00 am to 10:00 PM**	**10:00PM to 6:00 AM**
1	Marine Bhavan	52.0	48.9
2	Nirman Building 1	52.7	46.9
3	Tuna Port	56.2	49.8
4	Main Gate North	66.8	60.7
5	West Gate I	70.4	63.0
6	Canteen Area	54.8	44.7
7	Main Road	65.9	51.1
8	ATM Building	66.4	56.6
9	Wharf Area /Jetty Area	72.2	67.7
10	Port & Custom Office	51.5	46.3
	Vadinar Port		
11	Entrance Gate of Vadinar Port	66.8	53.7
12	Nr. Port Colony, Vadinar	60.4	52.8
13	Nr. Vadinar Jetty	72.5	63.7

3.3 Conclusions- Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships. The Day Time Average Noise Level (SPL)in all ten locations at Deendayal Port ranged from 52.0 dB(A) to 72.2 dB(A) and it was within the permissible limits of 75 dB(A) for the industrial area for the daytime. The Night Time Average Noise Level (SPL) in all ten locations of Deendayal Port ranged from 44.7 dB to 67.7 dB(A) and it was within the permissible limits of 70 dB(A) for the industrial area for the night time.

4. Soil Monitoring

Sampling and analysis of soil samples were undertaken at six locations within the study area (Deendayal Port and Vadinar Port) as a part of EMP. The soil sampling locations are initially decided based on the locations as provided in the tender document of the Deendayal Port.

4.1 Methodology

The soil samples were collected in the month of August 2021. The samples collected from the all locations are homogeneous representative of each location. At random locations were identified at each location and soil was dug from 30 cm below the surface. It was uniformly mixed before homogenizing the soil samples. The samples were filled in polythene bags, labeled in the field with number and site name and sent to laboratory for analysis.

4.2 Results

Table-17: Chemical Characteristics of Soil in the Study Area

Sr. No.	Parameter	Unit	Station Name					
			SL1	SL2	SL3	SL4	SL5	SL6
			Tuna Port	IFFCO Plant	Khori Creek	Nakti Creek	KPT Admin Site	KPT Colony
			Near main gate of Port	10 m away from main gate	Sand from creek at low tide		Vadinar	
1	Texture		Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	pH	-	8.60	8.10	8.42	8.30	8.09	8.32
3	Electrical Conductivity	µs/cm	23,400.0	20,420.0	23,700.0	17,200.0	510.0	400.0
4	Moisture	%	20.42	21.16	23.22	20.12	9.04	8.22
5	Total Organic Carbon	%	0.18	0.18	0.25	0.11	0.21	0.16
6	Alkalinity	mg/kg	60.06	140.04	140.04	60.06	100.10	80.04
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
8	Chloride	mg/kg	4,010.0	4,324.0	5,982.0	4,001.0	42.2	67.8
9	Sulphate	mg/kg	188.0	179.2	110.0	100.0	14.0	16.2
10	Phosphorus	mg/kg	0.90	0.86	1.04	1.62	0.78	0.88
11	Potassium	mg/kg	786.0	656.0	1,162.0	780.0	130.0	182.0
12	Sodium	mg/kg	2,341.0	3,618.0	4,220.0	3,122.0	1,224.0	1,400.0
13	Calcium	mg/kg	160.00	130.00	170.00	220.00	110.00	68.00
14	Copper as Cu	mg/kg	32.2	58.2	42.2	23.4	17.4	23
15	Lead as Pb	mg/kg	3.8	3.8	3.6	4.1	BQL	BQL
16	Nickel as Ni	mg/kg	37.2	32.4	41.2	24.5	19.3	20.4
17	Zinc as Zn	mg/kg	59.36	38.32	53.4	48.50	49.20	40.40
18	Cadmium as Cd	mg/kg	ND	ND	ND	ND	ND	ND

4.3 Discussion

- The data shows that value of pH ranges from 8.42 at Nakti Creek to 8.60 at Tuna Creek indicating that all soil samples are neutral to slight basic. Tuna port samples showed maximum conductivity of 23,400µmhos/cm, while Nakti Creek location showed minimum conductivity of 17,200 µmhos/cm. Conductivity at Vadinar Port was 510 and 400 µmhos/cm at Admin site and Vadinar Port colony respectively.
- Total organic Carbon ranged from 0.1 % to 0.3 at Deendayal Port. At Vadinar Port, organic carbon content ranged from 0.1 % to 0.2 %.
- The concentration of Phosphorus and Potassium in the soil samples varies from 0.8 to 1.62 mg/kg and 600.0 to 1170 mg/kg respectively at Deendayal Port. The mean concentration of Phosphorous at Vadinar site was 0.80 mg/kg and mean concentration of Potassium at Vadinar site was 156 mg/kg.

These differences in NPK in soil at different locations are due to the dissimilar nature of soil at each of the locations. Samples SL3 & SL4 (Khori Creek & Nakti Creek) are of saline nature as they are coastal soil; where as other locations are inland locations and have different chemical properties.

Heavy Metals in the Soil

Traces of Copper, Lead, Nickel and Zinc were observed in the soil samples collected from all the four locations of Deendayal Port and two locations of Vadinar Port. Cadmium metal was not detected in the Soil.

4.4 Conclusion

The soils of Deendayal Port and Vadinar Port appears to be neutral to basic with varying levels of Chloride, Sulphate, NPK and Calcium. As the nature of soil at different locations are different with respect to its proximity to the sea, the samples showed high degree of variations in their chemical properties.

5. Sewage Treatment Plant Monitoring

This involves safe collection of waste water (spent/used water) from wash areas, bathroom, industrial units, etc., waste from toilets of various buildings and its conveyance to the treatment plant and final disposal in conformity with the requirement and guide lines of State Pollution Control Board and other statutory bodies.

5.1 Methodology for STP Monitoring

To monitor the working efficiency of Sewage Treatment Plant (STP), STP Inlet and Outlet Samples were collected once a week. Locations selected are namely Gopalpuri Township, Deendayal Port and Vadinar. Samples were collected in 1 lit. Carboys and were analyzed in laboratory for various parameters.

5.2 Results

- **Kandla STP**

Table 18: Sewage Water Monitoring at Kandla STP (1st Week)

Date of Sampling	05.08.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.9	7.5
2	Total Suspended Solids	mg/l	107	101
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	334	108
5	BOD @ 27 °C	mg/l	118.0	27.0
Aeration Tank				
6	MLSS	mg/l	12.0	
7	MLVSS	%	88.0	

Table 19: Sewage Water Monitoring at Kandla STP (2nd Week)

Date of Sampling	12.08.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.6	7.68
2	Total Suspended Solids	mg/l	193	101
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	414	104
5	BOD @ 27 °C	mg/l	136.0	27.0
Aeration Tank				
6	MLSS	mg/l	9.0	
7	MLVSS	%	97.0	

Table 20: Sewage Water Monitoring at Kandla STP (3rd Week)

Date of Sampling	19.08.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.86	7.48
2	Total Suspended Solids	mg/l	204	104
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	261	70
5	BOD @ 27 °C	mg/l	87.0	20.0
Aeration Tank				
6	MLSS	mg/l	10.0	
7	MLVSS	%	90.0	

Table 21: Sewage Water Monitoring at Kandla STP (4th Week)

Date of Sampling	23.08.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.43	7.16
2	Total Suspended Solids	mg/l	403.3	150.4
3	Residual Chlorine	mg/l	<1.0	<1.0
4	COD	mg/l	313.1	151.5
5	BOD @ 27 °C	mg/l	106.0	52.0
6.	Fecal Coliform	MPN Index / 100 ml	-	>1600
Aeration Tank				
7.	MLSS	mg/l	33.0	
8	MLVSS	%	81.0	

- **Gopalpuri Colony STP**

Table 22: Sewage Water Monitoring at Gopalpuri STP (1st Week)

Date of Sampling	05.08.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.76	7.34
2	Total Suspended Solids	mg/l	98.1	62.4
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	324	102
5	BOD @ 27 °C	mg/l	110.0	28.0
Aeration Tank				
6	MLSS	mg/l	12.0	
7	MLVSS	%	92.0	

Table 23: Sewage Water Monitoring at Gopalpuri STP (2nd Week)

Date of Sampling	12.08.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.72	7.37
2	Total Suspended Solids	mg/l	406	107
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	320	103
5	BOD @ 27 °C	mg/l	110.0	26.0
Aeration Tank				
6	MLSS	mg/l	14.0	
7	MLVSS	%	90.0	

Table 24: Sewage Water Monitoring at Gopalpuri STP (3rd Week)

Date of Sampling	19.08.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.71	7.34
2	Total Suspended Solids	mg/l	404	107
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	351	101
5	BOD @ 27 °C	mg/l	115.0	23.0
Aeration Tank				
6	MLSS	mg/l	16.0	
7	MLVSS	%	88.0	

Table 25: Sewage Water Monitoring at Gopalpuri STP (4th Week)

Date of Sampling	23.08.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.7	7.35
2	Total Suspended Solids	mg/l	405	107
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	242	101
5	BOD @ 27 °C	mg/l	80.0	23.0
6.	Fecal Coliform	MPN Index / 100 ml	-	>1600
Aeration Tank				
7.	MLSS	mg/l	18.0	
8.	MLVSS	%	88.0	

- **Vadinar STP**

Table 26: Sewage Water Monitoring at Vadinar STP (1st Week)

Date of Sampling	05.08.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.23	NOT WORKING
2	Total Suspended Solids	mg/l	18	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	89.0	
5	BOD @ 27 °C	mg/l	28.0	

Table 27: Sewage Water Monitoring at Vadinar STP (2nd Week)

Date of Sampling	12.08.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.28	NOT WORKING
2	Total Suspended Solids	mg/l	60	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	78.0	
5	BOD @ 27 °C	mg/l	28.0	

Table 28: Sewage Water Monitoring at Vadinar STP (3rd Week)

Date of Sampling	19.08.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.32	NOT WORKING
2	Total Suspended Solids	mg/l	60	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	80.0	
5	BOD @ 27 °C	mg/l	26.0	

Table 29: Sewage Water Monitoring at Vadinar STP (4th Week)

Date of Sampling	23.08.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.18	NOT WORKING
2	Total Suspended Solids	mg/l	72	
3	Residual Chlorine	mg/l	<1.0	
4	COD	mg/l	80.0	
5	BOD @ 27 °C	mg/l	26.0	

5.3 Conclusions:

The GPCB standards of BOD, TSS and Residual Chlorine for STP outlet are 20 mg/lit, 30 mg/lit & 0.5 mg/lit respectively. It is suggested to do treatment on regular basis to avoid flow of contaminated/polluted water into the sea. Also, the STP at Vadinar is also non-functional and thus, steps should be taken to commission the STP at Vadinar Port. Hence, currently only inlet samples are collected and analysed.

6. Marine Water Monitoring

The Forty Second Amendment to the Constitution in 1976 underscored the importance of ‘green thinking’. Article 48A enjoins the state to protect and improve the environment and safeguard the forests and wildlife in the country. Further, Article 51A(g) states that the “fundamental duty of every citizen is to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures”.

Policy Statement for Abatement of Pollution (1992) has suggested developing relevant legislation and regulation, fiscal incentives, voluntary agreements and educational programs and information campaigns. It emphasizes the need for integration by incorporating environmental considerations into decision making at all levels by adopting frameworks namely, pollution prevention at source, application of best practicable solution, ensure polluter pays for control of pollution, focus on heavily polluted areas and river stretches and involve public in decision-making. The National Conservation Strategy and Policy Statement on Environment and Development, (1992) aimed at “integrating environmental concerns with developmental imperatives to meet the challenges by redirecting the thrust of our developmental process so that the basic needs of our people could be fulfilled by making judicious and sustainable use of natural resources.” The priorities mentioned in this policy document include the sustainable use of land and water resources, prevention and control of pollution and preservation of biodiversity.

The National Water Policy, (2002) contains provisions for developing, conserving, sustainable utilizing and managing this important water resources and need to be governed by national perspectives.

Marine Environment

On national and state levels, we have several policies and regulation like Water (Prevention and Control of Pollution) Act, 1974, to regulate pollution discharges and restore water quality of our aquatic resources including the prescription of monitoring activities. One of the important provisions of the Water Act, 1974, is to maintain and restore the ‘wholesomeness’ of our aquatic resources. Water quality monitoring is one of the first steps required in the rational development and management of water resources. In the field of water quality management, there has been a steady evolution in procedures for designing system to obtain information on the changes of water quality. The monitoring comprises all activities to obtain ‘information’ with respect to the water system.

Sampling Stations

The monitoring of marine environment for the study of biological and ecological parameters was carried out on 9^{th}& 10^{th} August-2021 in harbor regions of KPT and on 9^{th} August-2021 at Vadinar during spring tide period of New moon phase of Lunar Cycle. The monitoring of marine environment for the study of biological and ecological parameters was repeated again on 16^{th}& 17^{th} August 2021 in harbor regions of KPT. 16^{th} August -2021 in Vadinar during Neap tide period first quarter of Lunar Cycle..

Plankton samples from sub surface layer was collected both during high tide period and low tide period from 3 water quality monitoring stations of KPT harbour area and two stations in Nakti creek and one station in Khori creek. The same sampling schedule was repeated during consecutive spring tide and neap tide in same month. Plankton samples from sub surface layer was collected both during high tide period and low tide period from 1 water quality monitoring stations near Vadinar jetty area during spring tide and neap tide in this month .Collected water samples were processed for estimation of Chlorophyll- a, Pheophytin- a, qualitative &quantitative evaluation of phytoplankton, qualitative &quantitative evaluation zooplanktons (density and their population).

Sampling Locations

Offshore monitoring requirement	Number of locations
Offshore Installations	3 in Kandla creek 2 in Nakti creek 1 in Khori creek 1 near Vadinar Jetty 1 near 1^{st} SBM
Total Number of locations	**8**

6.1 Marine Water Quality

Marine water quality of marine waters of Deendayal Port Harbor waters, Khori and Nakti Creeks and two locations of Vadinar are monitored for various physico-chemical parameters during spring and neap tide of each month.

The results of marine water quality and Marine sediments are as below;

Table 30: Marine Water Quality Monitoring Parameters for location near KPT colony

Sr. No.	Parameters	Unit	Kandla Creek Near KPT colony (1) 23°0'58"N 70°13'22."E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.16	7.14	7.3	7.26
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.2	32.0	32.0	31.8
5	Turbidity	NTU	39	28	32	29
6	Total Dissolved Solids	mg/l	42660	41056	37802.0	43665.0
7	Total Suspended Solids	mg/l	675	979	614.2	372.4
8	Total Solids	mg/l	46346	44350	46346.0	44369.4
9	DO	mg/l	4.5	3.9	4.6	5.1
10	COD	mg/l	80.0	78.0	78.0	80.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	7.82	6.09	0.49	0.73
13	Phosphate	mg/l	0.57	0.14	0.16	0.17
14	Sulphate	mg/l	2628	1656	2352	2076
15	Nitrate	mg/l	2.22	2.03	2.53	3.77
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	1322.64	1242.48	601.2	480.96
18	Magnesium	mg/l	1239.3	1336.5	1749.6	1773.9
19	Sodium	mg/l	11012.0	10828.0	11022.0	10202.0
20	Potassium	mg/l	340.0	300.0	320.0	302.0
21	Iron	mg/l	1.32	1.40	1.20	1.30
22	Chromium	mg/l	0.16	0.14	0.12	0.11
23	Copper	mg/l	0.06	0.07	0.14	0.18
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.05	0.06	0.07	0.06
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.11	0.12	0.18	0.19
28	Zinc	mg/l	0.08	0.06	0.07	0.06

Table 31: Marine Water Quality Monitoring Parameters for location near passenger Jetty One at Kandla

Sr. No.	Parameters	Unit	Near passenger Jetty One (2)			
			23° 0'18 "N 70°13'31"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.28	7.25	7.39	7.42
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.7	32.6	32.0	32.2
5	Turbidity	NTU	37	27	42	47
6	Total Dissolved Solids	mg/l	41612	45181	41735.0	36900.0
7	Total Suspended Solids	mg/l	717	808	414	432.9
8	Total Solids	mg/l	47224	44028	37224.0	44028.0
9	DO	mg/l	4.4	4.1	5.4	4.8
10	COD	mg/l	90.0	86.0	86.0	82.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	9.44	7.84	0.53	0.64
13	Phosphate	mg/l	0.06	0.11	0.18	0.19
14	Sulphate	mg/l	2760	1572	2652	2616
15	Nitrate	mg/l	2.36	2.25	3.45	4.29
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	1202.40	1122.24	561.12	480.96
18	Magnesium	mg/l	1336.5	1385.1	1798.2	1749.6
19	Sodium	mg/l	11752.0	10652.0	11120.0	12120.0
20	Potassium	mg/l	306.0	290.0	289.0	322.0
21	Iron	mg/l	1.56	1.66	1.50	1.40
22	Chromium	mg/l	0.13	0.12	0.10	0.12
23	Copper	mg/l	0.08	0.09	0.15	0.16
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.06	0.07	0.07	0.08
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.10	0.09	0.18	0.17
28	Zinc	mg/l	0.07	0.06	0.08	0.06

Table 32: Marine Water Quality Monitoring Parameters for location Near Coal Berth

Sr. No.	Parameters	Unit	Near Coal Berth			
			22°59'12"N 70°13'40"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.30	7.51	7.53	7.32
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.0	32.5	32.0	31.8
5	Turbidity	NTU	33	25	37	45
6	Total Dissolved Solids	mg/l	48590	39430	45812.0	35363.0
7	Total Suspended Solids	mg/l	555	809	587.3	591.2
8	Total Solids	mg/l	45108	41100	41720.0	40200.0
9	DO	mg/l	3.8	4	4.9	5.1
10	COD	mg/l	88.0	90.0	90.0	82.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	5.98	3.98	0.42	0.85
13	Phosphate	mg/l	0.10	0.08	0.15	0.19
14	Sulphate	mg/l	2856	2988	2736	2208
15	Nitrate	mg/l	2.73	2.33	4.75	3.79
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	1362.72	1322.64	480.96	601.2
18	Magnesium	mg/l	1190.7	1239.3	1822.5	1846.8
19	Sodium	mg/l	11452.0	10890.0	11125.0	10890.0
20	Potassium	mg/l	311.0	269.0	345.0	400.0
21	Iron	mg/l	1.80	1.92	1.30	2.01
22	Chromium	mg/l	0.11	0.12	0.18	0.19
23	Copper	mg/l	0.07	0.06	0.18	0.16
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.05	0.06	0.06	0.07
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.10	0.11	0.20	0.19
28	Zinc	mg/l	0.08	0.06	0.07	0.06

Table 33: Marine Water Quality Monitoring Parameters for location Khori creek at Kandla

Sr. No.	Parameters	Unit	KPT 4			
			Near 15/16 Berth			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.37	7.42	7.26	7.22
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.6	31.6	31.8	31.6
5	Turbidity	NTU	45	37	52	28
6	Total Dissolved Solids	mg/l	42420	38440	33550.0	33133.0
7	Total Suspended Solids	mg/l	654	624	701.5	490.4
8	Total Solids	mg/l	44940	40080	44940.0	40080.0
9	DO	mg/l	4.4	4.3	5.3	5.9
10	COD	mg/l	92.0	88.0	88.0	92.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	2.45	7.45	0.69	0.51
13	Phosphate	mg/l	0.10	0.02	0.24	0.16
14	Sulphate	mg/l	1668	2268	2616	2580
15	Nitrate	mg/l	1.96	1.53	3.34	4.86
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	1242.48	1282.56	521.04	480.96
18	Magnesium	mg/l	1287.9	1336.5	1725.3	1725.3
19	Sodium	mg/l	12152.0	13020.0	12162.0	11782.0
20	Potassium	mg/l	288.0	316.0	389.0	380.0
21	Iron	mg/l	1.60	1.55	1.48	1.38
22	Chromium	mg/l	0.15	0.16	0.20	0.18
23	Copper	mg/l	0.08	0.10	0.15	0.11
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.08	0.06	0.08	0.07
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.09	0.11	0.18	0.17
28	Zinc	mg/l	0.07	0.05	0.08	0.06

Table 34: Marine Water Quality Monitoring Parameters for location Nakti Creek near Tuna Port

Sr. No.	Parameters	Unit	Nakti Creek Near Tuna Port 22°57'49."N 70° 7'0.67"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.18	7.30	7.3	7.37
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.6	33.0	31.8	31.6
5	Turbidity	NTU	36	48	36	28
6	Total Dissolved Solids	mg/l	47540	37880	38200.0	37205.0
7	Total Suspended Solids	mg/l	885	852	332.5	474
8	Total Solids	mg/l	46280	38780	38280.0	49040.0
9	DO	mg/l	4.2	4.3	5.3	5.2
10	COD	mg/l	76.0	78.0	90.0	92.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	4.33	2.45	0.91	0.73
13	Phosphate	mg/l	0.08	0.10	0.18	0.18
14	Sulphate	mg/l	2052	4500	2628	2268
15	Nitrate	mg/l	2.17	2.47	5.14	5.70
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	1362.72	1282.56	561.12	561.12
18	Magnesium	mg/l	1215	1239.3	1773.9	1773.9
19	Sodium	mg/l	11582.0	11262.0	10589.0	10110.0
20	Potassium	mg/l	326.0	366.0	347.0	311.0
21	Iron	mg/l	2.02	2.00	1.60	1.58
22	Chromium	mg/l	0.20	0.19	0.16	0.15
23	Copper	mg/l	0.10	0.08	0.12	0.10
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.06	0.07	0.08	0.06
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.11	0.12	0.32	0.62
28	Zinc	mg/l	0.06	0.07	0.07	0.06

Table 35: Marine Water Quality Monitoring Parameters for location Nakti Creek Near NH-8A at Kandla

Sr. No.	Parameters	Unit	Nakti Creek Near NH-8A			
			23° 02'01"N 70° 09'31"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.39	Sampling not possible during Low Tide	7.39	Sampling not possible during Low Tide
2	Color	-	Colorless		Colorless	
3	Odor	-	Odorless		Odorless	
4	Salinity	ppt	32.9		31.8	
5	Turbidity	NTU	36		35	
6	Total Dissolved Solids	mg/l	36020		35465.0	
7	Total Suspended Solids	mg/l	666		380.3	
8	Total Solids	mg/l	44660		46002.0	
9	DO	mg/l	4.7		5.5	
10	COD	mg/l	80.0		88.0	
11	BOD	mg/l	<2.0		<2.0	
12	Silica	mg/l	7.73		0.45	
13	Phosphate	mg/l	0.08		0.17	
14	Sulphate	mg/l	3660		2280	
15	Nitrate	mg/l	2.74		4.15	
16	Nitrite	mg/l	<0.05		<0.05	
17	Calcium	mg/l	1402.80		561.12	
18	Magnesium	mg/l	1190.7		1773.9	
19	Sodium	mg/l	13030.0		11120.0	
20	Potassium	mg/l	348.0		320.0	
21	Iron	mg/l	1.89		1.50	
22	Chromium	mg/l	0.17		0.17	
23	Copper	mg/l	0.09		0.11	
24	Arsenic	mg/l	<0.01		<0.01	
25	Cadmium	mg/l	0.08		0.07	
26	Mercury	mg/l	<0.001		<0.001	
27	Lead	mg/l	0.09		0.2	
28	Zinc	mg/l	0.08		0.08	

Table 36: Marine Water Quality Monitoring Parameters for locations Nr. Vadinar Jetty

Sr. No.	Parameters	Unit	Nr.Vadinar Jetty 22°26'25.26"N 69°40'20.41"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.60	7.90	7.38	7.25
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	33.0	32.5	32.0	32.0
5	Turbidity	NTU	48	37	47	40
6	Total Dissolved Solids	mg/l	38810	36220	37902.0	35080.0
7	Total Suspended Solids	mg/l	405	380	456.9	395.5
8	Total Solids	mg/l	42180	42020	38990.0	38620.0
9	DO	mg/l	4.3	4.7	4.5	4.9
10	COD	mg/l	90.0	88.0	82.0	78.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	6.00	7.65	0.76	0.93
13	Phosphate	mg/l	0.56	0.68	0.20	0.17
14	Sulphate	mg/l	2628	2268	2520	2376
15	Nitrate	mg/l	2.05	2.15	3.03	3.04
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	1242.48	1362.72	641.28	521.04
18	Magnesium	mg/l	1239.3	1239.3	1798.2	1798.2
19	Sodium	mg/l	14025.0	13879.0	11012.0	11212.0
20	Potassium	mg/l	326.0	300.0	342.0	333.0
21	Iron	mg/l	1.88	1.79	1.60	1.30
22	Chromium	mg/l	0.18	0.18	0.18	0.12
23	Copper	mg/l	0.08	0.08	0.18	0.20
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.06	0.07	0.06	0.07
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.10	0.09	0.16	0.2
28	Zinc	mg/l	0.06	0.06	0.06	0.07

6.1.1 Marine Sediments

Sediment samples were collected with Van Veen Grab from the six locations in Kandla Port Waters and two locations in Vadinar Port. Samples were collected and preserved in silver foil in ice box to prevent the contamination/decaying of the samples.

6.2 Results

The Sediment Quality results are given in below from table no. 34 A & B.

Table 34A: Results of Analysis of Sediment of Kandla & Vadinar Port (Spring Tide)

Sr. No.	Parameters	Unit	KPT - 1	KPT - 2	KPT – 3	KPT - 5	Jetty
1	Texture	-	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	mg/kg	1.20	1.08	1.20	1.86	1.46
3	Organic Carbon	mg/kg	0.70	0.96	0.87	0.65	0.68
4	Inorganic Phosphate	mg/kg	120.0	132.0	142.0	162.0	160.0
5	Moisture	%	20.20	23.10	21.88	21.2	23.80
6	Aluminium	mg/kg	ND	ND	ND	ND	ND
7	Silica	mg/kg	28.0	21.0	24.0	36.0	23.0
8	Phosphate	mg/kg	10.50	11.20	9.80	9.60	10.20
9	Sulphate	mg/kg	210.0	242.0	160.0	170.0	140.0
10	Nitrite	mg/kg	0.11	0.12	0.1	0.11	0.12
11	Nitrate	mg/kg	9.80	7.44	10.80	9.20	8.40
12	Calcium	mg/kg	342.0	270.0	325.0	309.0	322.0
13	Magnesium	mg/kg	186.0	145.0	178.0	152.0	202.0
14	Sodium	mg/kg	8824.0	7242.0	9452.0	7122.0	8777.0
15	Potassium	mg/kg	396.0	388.0	460.0	680.0	780.0
16	Chromium	mg/kg	88	60	72.2	68.8	70.2
17	Nickel	mg/kg	20.4	30.4	19.5	21.3	30
18	Copper	mg/kg	60	34	21.5	18.2	23.4
19	Zinc	mg/kg	30.20	32.50	33.20	40.00	28.00
20	Cadmium	mg/kg	ND	ND	ND	ND	ND
21	Lead	mg/kg	2.8	2.4	3.9	5.2	3.8
22	Mercury	mg/kg	ND	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND	ND

*Grab samples could not be collected due high current at KPT 3, Natki Creek Near Tuna port & Vadinar SBM

Table 34B: Results of Analysis of Sediment of Kandla & Vadinar Port (Neap Tide)

Sr. No.	Parameters	Unit	KPT - 1	KPT - 2	KPT - 3	KPT - 4	KPT - 5	Jetty
1	Texture	-	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
2	Organic Matter	mg/kg	1.20	1.12	1.20	1.80	1.62	1.10
3	Organic Carbon	mg/kg	0.69	0.65	0.69	1.04	0.94	0.64
4	Inorganic Phosphate	mg/kg	120.0	142.0	116.0	136.0	142.0	152.0
5	Moisture	%	20.08	21.52	23.05	24.55	28.88	22.02
6	Aluminium	mg/kg	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	21.20	18.88	21.0	18.8	16.20	13.60
8	Phosphate	mg/kg	8.8	8.9	7.70	8.20	8.40	6.2
9	Sulphate	mg/kg	180.0	196.0	142.0	166.0	120.0	210.0
10	Nitrite	mg/kg	0.1	0.11	0.1	0.12	0.11	0.13
11	Nitrate	mg/kg	9.80	6.89	8.99	8.80	7.93	10
12	Calcium	mg/kg	322.0	266.0	320.0	296.0	300.0	288.0
13	Magnesium	mg/kg	180.0	145.0	180.0	142.0	212.0	196.0
14	Sodium	mg/kg	8242.0	7002.0	8942.0	6641.0	8041.0	9424.0
15	Potassium	mg/kg	380.0	396.0	422.0	644.0	621.0	386.0
16	Chromium	mg/kg	79	54	74.2	64.7	58.4	66
17	Nickel	mg/kg	18.2	28.2	20.6	19.4	28.4	18.8
18	Copper	mg/kg	54	20	22.5	16.8	18.6	74.2
19	Zinc	mg/kg	28.20	18.80	28.40	34.50	18.60	75.00
20	Cadmium	mg/kg	ND	ND	ND	ND	ND	ND
21	Lead	mg/kg	2	2.1	2.8	3.8	2.4	ND
22	Mercury	mg/kg	ND	ND	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND	ND	ND

REPORT

ON

ECOLOGICAL MONITORING

OF MARINE ENVIRONMENT

IN

DPTHARBOURAREA, NEAR BY CREEKS

For

DEENDAYAL PORT TRUST

AUGUST,2021

Sampling Stations:

The monitoring of marine environment for the study of biological and ecological Parameters was carried out on9th August, 2021 in harbour region of DPT, and on 10thAugust,2021 in creeks near by the port during spring tide. The monitoring of marine environment for the study of biological and ecological parameters was repeated again on 15thAugust, 2021 in harbour region of DPT and on 16thAugust, 2021 in creeks near by the port during neap tidal condition.

Plankton samples from sub surface layer was collected both during high tide period and low tide period from 3 water quality monitoring stations of DPT harbour area andone stations in Nakti creek and one station in Khori creek. Sampling at second sampling station of Nakti creek was possible only during high tide period. Collected water samples were processed for estimation of Chlorophyll- a, Pheophytin- a, qualitative &quantitative evaluation of phytoplankton, qualitative &quantitative evaluation zooplanktons(density and their population).

TABLE #1 SAMPLING LOCATIONS

monitoring requirement	Number of locations
Kandla creek Nakti creek Khori Creek	3 in Kandla creek 2 in Nakti creek 1 in Khori creek
Total Number of locations	**6**

Sampling methodology adopted:

A marine sampling is an estimation of the body of information in the population. The theory of the sampling design is depending upon the underlying frequency distribution of the population of interest. The requirement for useful water sampling is to collect a representative sample of suitable volume from the specified depth and retain it free from contamination during retrieval.

50 litres of the water sample were collected from Sub surface by using bucket. From the collected water sample 1 litres of water sample were taken in an opaque plastic bottle for chlorophyll estimation, thereafter plankton samples were collected by using filtration assembly with nilyobolt cloth of 20µm mesh size.

Samples Processing for chlorophyll estimation:

Samples for the chlorophyll estimation were preserved in ice box on board in darkness to avoid degradation in opaque container covered with aluminium foil. Immediately after reaching the shore after sampling, 1 litres of collected water sample was filtered through GF/F filters (pore size 0.45 µm) by using vacuum filtration assembly. After vacuum filtration the glass micro fiber filter paper was grunted in tissue grinder, macerating of glass fiber filter paper along with the filtrate was done in 90% aqueous Acetone in the glass tissue grinder with glass grinding tube. Glass fiber filter paper will assist breaking the cell during grinding and chlorophyll content was extracted with 10 ml of 90% Acetone, under cold dark conditions along with saturated magnesium carbonate solution in glass screw cap tubes. After an extraction period of 24 hours, the samples were transferred to calibrated centrifuge tubes and adjusted the volume to original volume with 90% aqueous acetone solution to make up the evaporation loss. The extract was clarified by using centrifuge in closed tubes. The clarified extracts were then decanted in clean cuvette and optical density was observed at wavelength 664, 665 nm. By using corrected optical density, Chlorophyll-a value was calculated as given in (APHA, 1998).

PLANKTON:

The entire area open water in the sea is the pelagic realm. Pelagic organisms live in the open sea. In contrast to the pelagic realm, the benthic realm comprises organisms and zone of the bottom of the sea. Vertically the pelagic realm can be dividing into two zones based on light penetration; upper photic or euphotic zone and lower dark water mass, aphotic zone below the photic zone.

The term plankton is general term for organisms have such limited powers of locomotion that they are at the mercy of the prevailing water movement. Plankton is subdivided to phytoplankton and zooplankton. Phytoplankton is free floating organisms that are capable of photosynthesis and zooplankton is the various free floating animals.

Pelagic zone, represents the entire ocean water column from the surface to the deepest depths, is home to a diverse community of organisms. Differences in their locomotive ability categorize the organisms in the pelagic realm into two, ***plankton*** and ***nekton*** (Lalli and Parsons, 1997). ***Plankton*** consists of all organisms drifting in the water and is unable to swim against water currents, whereas ***Nekton*** includes organisms having strong locomotive power. Ecological studies on the plankton community, which form the base of the aquatic food chain, help in the better understanding of the dynamics and functioning of the marine ecosystem. The term 'Plankton' first coined by Victor Hensen (1887), Plankton, (Greek word: *planktos*meaning "passively drifting or wandering") is defined as drifting or free-floating organisms that inhabit the pelagic zone of water. Based on their mode of nutrition planktonic organisms are categorised into phytoplankton (organisms having an autotrophic mode of nutrition) and zooplankton (organisms having a heterotrophic mode of nutrition).

Phytoplankton in the marine environment:

Phytoplankton is free floating unicellular, filamentous and colonial eutrophic organisms that grow in aquatic environments whose movement is more or less dependent upon water currents. These micro flora acts as primary producers as well as the basis of food chain, source of protein, bio purifier and bio indicators of the aquatic ecosystems of which diverse array of the life depends .They are considered as an important component of aquatic flora, play a key role in maintaining equilibrium between abiotic and biotic components of aquatic ecosystem.

The phytoplankton includes a wide range of photosynthetic and phototrophic organisms. Marine phytoplankton is mostly microscopic and unicellular floating flora, which are the primary producers that support the pelagic food-chain. The two most prominent groups of phytoplankton are diatoms (Bacillariophyceae) and dinoflagellates (Dinophyceae).The phytoplankton those normally captured in the net from the Gulf of Kutch is normally dominated by these two major groups; diatoms and dinoflagellates. Phytoplankton also include numerous and diverse collection of extremely small, motile algae which are termed micro flagellates (naked flagellates) as well as and Cyanophytes (blue-green algae).

Algae are an ecologically important group in most aquatic ecosystems and have been an important component of biological monitoring programs. Algae are ideally suited for water quality assessment because they have rapid reproduction rates and very short life cycles, making them valuable indicators of short-term impacts.

Aquatic populations are impacted by anthropogenic stress, resulting in a variety of alterations in the biological integrity of aquatic systems. Algae can serve as an indicator of the degree of deterioration of water quality, and many algal indicators have been used to assess environmental status.

Zooplankton in the marine environment:

Zooplankton includes a taxonomically and morphologically diverse community of heterotrophic organisms that drift in the waters of the world's oceans. Qualitative and quantitative studies on zooplankton community are a prerequisite to delineate the ecological processes active in the marine ecosystem. Zooplankton community plays a pivotal role in the pelagic food web as the primary consumers of phytoplankton and act as the food source for organisms in the higher trophic levels, particularly the economically essential groups such as fish larvae and fishes. They also function in the cycling of elements in the marine ecosystem. The dynamics of the zooplankton community, their reproduction, growth and survival rate are all significant factors determining the recruitment and abundance of fish stocks as they form an essential food for larval, juvenile and adult fishes (Beaugrand et al., 2004). Zooplankton grazing in the marine environment controls the primaryProduction and helps in determining the pelagic ecosystem (Banse, 1995). Through grazing in surface waters and following the production of sinking faecal matters and also by the active transportation of dissolved and particulate matter to deeper waters via vertical migration, they help in the transport of organic carbon to deep ocean layers and thus act as key drivers of biological pump’ in the marine ecosystem. Zooplankton grazing and metabolism also, transform particulate organic matter into dissolved forms, promoting primary producer community, microbial demineralization, and particle export to the ocean’s interior.

The categorisation of zooplankton into various ecological groups is based on several factors such as duration of planktonic life, size, food preferences and habitat. As they vary significantly in size from microscopic to metazoic forms, the classification of zooplankton based on size has paramount importance in the field of quantitative plankton research.

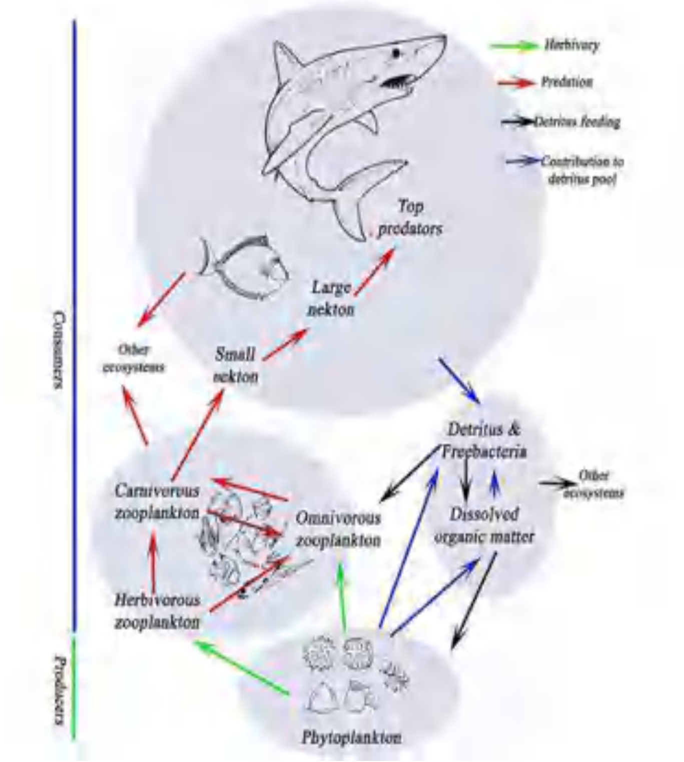
Based on the duration of planktonic life, zooplankton are categorised into Holoplankton (organisms which complete their entire lifecycle as plankton) and Meroplankton (organisms which are planktonic during the early part of their lives such as the larval stages of benthic and nektonic organisms). Tychoplankton are organisms which live a brief planktonic life, such as the benthic crustaceans (cumaceans, mysids, isopods) which ascend to the water column at night for feeding and certain ectoparasitic copepods, they leave the host and spend their life as plankton during their breeding cycle.

Zooplankton can be subdivided into holoplankton, i.e., permanent members of the plankton (e.g., Calanoid copepods), and meroplankton, i.e., temporary members in the plankton e.g., larvae of fish, shrimp, and crab). The meroplankton group consists of larval and young stages of animals that will adopt a different lifestyle once they mature. In contrast to phytoplankton which consist of a relatively smaller variety of organisms, Zooplankton are extremely divers, consist of a host of larval and adult forms representing many animal phylum.

Among the zooplankton one group always dominate than others; members of sub class copepods (Phylum Athropoda), and Tintinids (Phylum Protozoa) among the net planktons. These small animals are of vital importance in marine ecosystem as one of the primary herbivores animals in the sea, and it is they provide vital link between primary producer (autotrophs) and numerous small and large marine consumers.

As their community structure and function are highly susceptible to changes in the environmental conditions regular monitoring of their distribution as well as their interactions with various physicochemical parameters is inevitable for the sustainable management of the ecosystem (Kusum et al., 2014). Of all the marine zooplankton groups, copepods mainly calanoid copepods are the dominant groups in marine subtropical and tropical waters and exhibit considerable diversity in morphology and habitats they occupy (Madhupratap, 1991;)

It has been well established that potential of pelagic fishes viz. finfishes, crustaceans, molluscs and marine mammals either directly or indirectly depend on zooplankton. The herbivorous zooplankton is efficient grazers of the phytoplankton and is referred to as living machines transforming plant material into animal tissue. Hence they play an essential role as the intermediaries for nutrients/energy transfer between primary and tertiary trophic levels. Due to their large density, shorter lifespan, drifting nature, high group/species diversity and different tolerance to the stress, they used as the indicator organisms for the physical, chemical and biological processes in the aquatic ecosystem (Ghajbhiye, 2002).



Simplified marine food web

Spatial distribution of Plankton:

A characteristic of plankton population is that they tend to occur in patches, which are varying spatially on a scale of few meters to far as few kilometres in distance. They also vary in time scale, season as well as vertically in the water column. It is this patchiness and its constant changes in time and spot, that has made it so difficult for plankton biologist to learn about the ecology of plankton. The biological factors that causes this patchiness is due to the ability of zooplankton to migrate vertically and graze out the phytoplankton at a rapid rate that can create patchiness. Similarly the active swimming ability by certain zooplankton organisms can cause to aggregate in dense group.

At its most extreme, because the water in which plankton is suspended is constantly moving, each sample taken by the plankton biologists remain a different volume of water, so each sample is unique and replicate does not exist.

Plankton may also exhibit vertical patchiness. Physical factors contribute to this type of patchiness include light intensity, nutrients and density gradients in the water column.

Phytoplankton in particular tends to be unequally distributed vertically, which leads to the existence of different concentration of a chlorophyll value between photic zone and below the photic zone.

Methodology adopted for Plankton sampling:

Mixed plankton sample were obtained from the sub surface layer at each sampling locations by towing the net horizontally with the weight .After the tow of about 15-30minutes, plankton net was pulled up and washed down to the tail and collected the plankton adhered to plankton net in the collection bucket at the bottom by springing outer and inner surface of the net with sea water, while the net was hanging with the mouth upward. For quantitative evaluation 50 L water samples were collected from subsurface layer and filtered through 20µm mesh size net by using bucket and filtration assembly.

Preservation and storage:

Both filtered plankton and those collected from the plankton net were preserved with 5% buffered formalin and stored in 1L plastic container for further processing in the laboratory.

Sample concentration:

The collected plankton samples were concentrated by using centrifuge and made up to 50 ml with 5% formalin -Glycerine mixture.

Taxonomic evaluation:

Before processing, the sample was mixed carefully and a subsample was taken with a calibrated Stempel-pipette. 1 ml of the concentrated plankton samples were transferred on a glass slide with automatic pipette. The plankton sample on the glass slides were stained by using Lugol's iodine and added glycerine to avoid drying while observation. The plankton samples were identified by using Labex triangular Research microscope with photographic attachment. Microphotographs of the plankton samples were taken for record as well as for confirming the identification. The bigger sized zooplankton was observed through dissecting stereomicroscope with magnification of 20-30 x. Plankton organisms in the whole slide were identified to the lowest axon possible. A thorough literature search was conducted for the identification of the different groups of zooplankton that were encountered

Cell counts by drop count method:

The common glass slide mounted with a 1ml of concentrated phytoplankton/zooplankton sample in glycerol and covered with cover slip 22x 60mm was placed under the compound microscope provided with a mechanical stage. The plankton was then counted from the microscopic field of the left top corner of the slide. Then slide is moved horizontally along the right side and plankton in each microscopic field was thus counted. When first microscopic field row was finished the next consecutive row was adjusted using the mechanical device of the stage. In this way all the plankton present in entire microscopic field are counted. From this total number in 1ml of the concentrated plankton, total number of plankton in the original volume of sample filtered was calculated as units/L.

BENTHIC ORGANISMS:

Benthos is those organisms that are associated with the sea bed or benthic habitats. Epi- benthic organisms live attached to a hard substratum or rooted to a shallow depth below the surface. In fauna organisms live below the sediment–water interface. Interstitial organisms live and move in pore water among sedimentary grains.

Because the benthic organisms are often collected and separated on sieves, a classification based on the overall size is used. Macro benthos include organisms whose shortest dimension is greater than or equal to 0.5 mm. Meio benthos are smaller than 0.5mm but larger than 42µ in size.

The terms such as macro fauna and Meio fauna generally have little relevance with taxonomic classification. The terms Meio fauna and macro fauna depend on the size. Meio fauna were considered as good bioassay of community health and rather sensitive indicators of environmental changes

SAMPLING METHODOLOGY ADOPTED FOR SUB TIDAL REGION:

Van veen sampler ($0.09m^2$) was used for sampling bottom sediments. Two sets of sediments were sampled from each location, one for macro fauna and other for Meio fauna. The macro fauna in the sediments were sieved on board to separate out the organisms. The fixation of Meio fauna is normally done by bulk fixation of the sediment sample. The bulk fixation is done by using 10% formalin (Buffered with borate). The organisms were preserved with seawater as diluting agent.

Sample sieving:

Sediments samples were sieved to extract the organisms. Sieving was performed carefully as possible to avoid any damage to the animals. The large portion of the sediment was split in to smaller portions and mixed with sea water in a bucket. The cohesive lumps were broken down by continuous stirring. The disaggregated sediments were then passed through the sieves.

Sample staining:

Sorting of the Meio fauna from the sieve is difficult task especially in the preserved material, because organisms are not easily detectable. To facilitate the animal detection the entire sample retained on the sieve after sieving operation were stained by immersing the sieve in a flat bottom tub with 1% Rose Bangal stain; a protein stain. A staining period of 10-30 minutes is sufficient for sample detection.

DIVERSITY INDICES:

On the whole, diversity indices provide more information about community composition than simply species richness (number of species present); they also, take the relative abundances of different species into account. Based on this fact, diversity indices therefore depend not only on species richness but on the evenness, or equitability, with which individuals are distributed among the different species (Magurram, A. E. (1988)

A diversity index is a measure of species diversity within a community that consists of co-occurring populations of several (two or more) different species. It includes two components: richness and evenness. Richness is the measure of the number of different species within a sample showing that more the types of species in a community, the higher is the diversity or greater is the richness. Evenness is the measure of relative abundance of the different species with in a community.

The basic idea of diversity index is to obtain a quantitative estimate of biological variability that can be used to compare biological entities composed of discrete components in space and time (Carol H.R. *etal*. 1998). Biodiversity is commonly expressed through indices based on species richness and species abundances (Whittaker 1972, Lande 1996, Purvis and Hector 2000). Biodiversity indices are a non-parametric tool used to describe the relationship between species number and abundance. The most widely used bio diversity indices are Shannon Weiner index and Simpson's index.

A diversity Index is a single statistic that incorporates in formation on richness and evenness. The diversity measures that incorporate the two concepts may be termed heterogeneity measures (Magurran, 2004).

Any study intended to interpret causes and effect of adverse impact on Biodiversity of communities require suitable measures to evaluate specie richness and Diversity. The former is number of species in community, while latter is a function of relative frequency of different species. Species richness is the iconic measure of biological diversity (Magurran, 2004). Several indices have been created to measure the diversity of species; however, the most widely used in the last decades are the Shannon (1948) and Simpson (1949) (Buzas and Hayek 1996; Gorelick 2006), with the components of diversity: richness (*S)* and evenness (*J)*

Simpson's diversity index

Simpson's index (**D**) is a measure of diversity, which takes into account both species richness, and evenness of abundance among the species present.. The Simson index is one of the meaningful and robust biodiversity measures available.(Magurran ,2004).

The formula for calculating D is presented as:

$$D = \frac{\sum n_i(n_i - 1)}{N(N-1)}$$

Where n_i = the total number of organisms of each individual species

N = the total number of organisms of all species

The value of D ranges from 0 to 1. With this index, 0 represents infinite diversity and, 1, no diversity. When D increases diversity decreases. Simpson's index is therefore usually expressed as 1-D or 1/D. (Magurran, 2004)

Low species diversity suggests:

- relatively few successful species in the habitat
- the environment is quite stressful with relatively few ecological niches and only a few organisms are really well adapted to that environment
- food webs which are relatively simple
- change in the environment would probably have quite serious effects

High species diversity suggests:

- a greater number of successful species and a more stable ecosystem
- more ecological niches are available and the environment is less likely to be hostile complex food webs
- environmental change is less likely to be damaging to the ecosystem as a whole

Species richness indices

The species richness***(S)*** is simply the number of species present in an ecosystem. Species richness Indices of species richness are widely used to quantify or monitor the effects of anthropogenic disturbance. A decline in species richness may be concomitant with severe or chronic human-induced perturbation (Fair Fair weather 1990,) Species richness measures have traditionally been the mainstay in assessing the effects of environmental degradation on the biodiversity of natural assemblages of organisms (Clarke &Warwick, 2001)

Species richness is the iconic measure of biological diversity (Magurran, 2004). The species richness***(S)*** is simply the number of species present in an ecosystem. This index makes no use of relative abundances. The term species richness was coined by McIntosh (1967) and oldest and most intuitive measure of biological diversity (Magurran, 2004).

Margalef's diversity index is a species richness index. Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, were derived.

The value of a diversity index increases both when the number of types increases and when evenness increases. For a given number of types, the value of diversity index is maximised when all types are equally abundant (Rosenzweig, M. L. (1995).

Shannon-Wiener's index:

An index of diversity commonly used in plankton community analyses is the Shannon-Wiener's index **(H),** which emphasizes not only the number of species (richness or variety), but also the apportionment of the numbers of individuals among the species (Odum 1971 and Reish 1984). Shannon-Wiener's index **(H**) reproduce community parameters to a single numberby using an equation.

Shannon and Weiner index represents entropy. It is a diversity index taking into account the number of individuals as well as the number of taxa. It varies from 0 for communities with only single taxa to high values for community with many taxa each with few individuals. This index can also determine the pollution status of a water body. Normal values range from 0 to 4. This index is a combination of species present and the evenness of the species. Examining the diversity in the range of polluted and unpolluted ecosystems, Wilham and Dorris (1968) concluded that the values of the index greater than 3 indicate clean water, values in the range of 1 to 3 are characterized by moderate pollution and values less than 1 are characterized as heavily polluted

$$H' = -\sum_{j=1}^{s} \frac{n_j}{N} \ln\left(\frac{n_j}{N}\right)$$

RESULTS:

CHLOROPHYLL-a:

Water Samples for the chlorophyll estimation were collected from sub surface layer during high tide and low tide period of the tidal cycle for each sampling locations and analysed for Chlorophyll -a and after acidification for Pheophytin –a. Chlorophyll- a value was used as algal biomass indicator (APHA,1998) Algal biomass was estimated by converting Chlorophyll value.

In the sub surface water chlorophyll-a was varying from 0.305 -0.543mg/m^3.in harbour region of DPT during sampling done in spring tide period of August, 2021. In the nearby creeks chlorophyll-a was varying from 0.290-0.732 mg/m^3.Pheophytin –a level was below detectable limit- the all the sampling stations during springtide in the harbour region of DPT.

In the sub surface water chlorophyll-a was varying from 0.220 -0.748mg/m^3.in harbour region of DPT during sampling done in neap tide period of August, 2021 . In the nearby creeks chlorophyll-a was varying from BDL-0.862 mg/m^3.·Pheophytin –a level was below detectable limit- the all the sampling stations during neap tide in the harbour region of DPT.

TABLE #2 VARIATIONS IN CHLOROPHYLL –a PHEOPHYTIN- a AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN AUGUST,2021

Sr. No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREA					
1	KPT1	High tide	0.425	BDL	28.48
		Low tide	0.307	BDL	20.57
2	KPT 2	High tide	0.305	BDL	20.43
		Low tide	0.543	BDL	36.38
3	KPT 3	High tide	0.527	BDL	35.31
		Low tide	0.425	BDL	28.47
CREEKS					
4	KPT-4 Khori-I	High tide	0.543	BDL	36.38
		Low tide	0.527	BDL	35.31
5	KPT-5 Nakti-I	High tide	0.409	BDL	27.40
		Low tide	0.732	BDL	49.04
6	KPT-5 Nakti-II	High tide	0.290	BDL	19.43

BDL: Below Detectable Limit.

TABLE #3 VARIATIONS IN CHLOROPHYLL –a PHEOPHYTIN- a AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN AUGUST,2021

Sr. No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREA					
1	KPT1	High tide	0.220	BDL	14.74
		Low tide	0.308	BDL	20.64
2	KPT 2	High tide	0.748	BDL	50.11
		Low tide	0.731	BDL	48.98
3	KPT 3	High tide	0.307	BDL	20.56
		Low tide	0.221	BDL	14.81
CREEKS					
4	KPT-4 Khori-I	High tide	0.543	BDL	36.38
		Low tide	0.221	BDL	14.81
5	KPT-5 Nakti-I	High tide	0.862	BDL	57.75
		Low tide	0.216	BDL	14.47
6	KPT-5 Nakti-II	High tide	BDL	BDL	-

BDL: Below Detectable Limit.

PHYTOPLANKTON POPULATION:

For the evaluation of the Phytoplankton population in DPT harbour area and within the immediate surroundings of the port, sampling was conducted from 5 sampling locations (3 in harbour area and two in Nakti creek) during high tide period and low tide period of spring tide and neap tide.

The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by,Diatoms blue green algae and dinoflagellates during spring tide period.Diatoms were represented by 14genera. Blue green were represented by threegenera and two genera of Dinoflagellates during the sampling conducted in spring tide in August,2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 98-226 units/ L during high tide period and 191-259 units/ L during low tide of Spring Tide.

The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by Diatoms ,Blue green algae and Dinoflagellates duringNeap tide period.Diatoms were represented by 15genera and Blue green algae were represented two genera and Dinoflagellates were represented by three genera during the sampling conducted in Neap tide in August, 2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from65-307units/ L during high tide period and 238-281 units/ L during low tide of Neap Tide.

Species Richness Indices and Diversity Indices:

Margalef’s diversity index (Species Richness)S

At the organismal level, the most widely used biodiversity measures are those based on the number of species present, perhaps adjusted for the number of individuals sampled, Here Margalef’s Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, are derived.

Margalef’s diversity index (Species Richness) S of phytoplankton communities in the stations was varying from 1.527-3.091 with an average of 2.420during the sampling conducted in High tide period of spring tide.While Margalef’s diversity index (Species Richness) S of phytoplankton communities in the Kandla Harbour region and nearby creeks was varying from 1.679-2.621 with an average of 2.225 during the consecutive low tide period.

Margalef’s diversity index (Species Richness) S of phytoplankton communities in the stations was varying from 2.344 -3.188 with an average of 2.887 during the sampling conducted in High tide period of Neaptide While .Margalef’s diversity index (Species Richness) S of phytoplankton communities in the Kandla Harbour region and nearby creeks was varying from. 2.526-3. 246with an average of 2.887 during the consecutive low tide period.

Shannon-Wiener's index:

Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.728 -0.860 (H'(log10)) between selected sampling stations with an average value of 0.807 during high tide period of spring tide .Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.726-0.836 (H'(log10)) between selected sampling stations with an average value of 0.773 during consecutive lowtide. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.880-0.959 (H'(log10)) between selected sampling stations with an average value of 0.909 during high tide period of neap tide. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.819-0.911 (H'(log10)) between selected sampling stations with an average value of 0.887 during consecutive low tide. Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon-Wiener's index increases as both the richness and the evenness of the community increase. This result indicates that diversity of phytoplankton of Kandla Harbour region and nearby creeks is less but with abundant population of few, with relatively few ecological niches and only very few opportunist organisms are really well adapted to this environment and thrive better than other species.

Simpson's diversity index:

Simpson's index (D) is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. The Simson index is one of the meaningful and robust biodiversity measures available. (Magurran,2004).

Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in the Kandla Harbour region and nearby creeks, which was varying from 0.785- 0.823 between selected sampling stations with an average of 0.801 during high tide period of spring tide . Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in the Kandla Harbour region and nearby creeks, which was varying from 0.770- 0.820 between selected sampling stations with an average of 0.787 during consecutive low tide . Low species diversity suggests a relatively few successful species in this habitat. The environment is quite stressful with relatively few ecological niches and only a few organisms are really well adapted to that environment. Any change in the environment would probably have quite serious effects.

Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in Kandla Harbour region and nearby creeks, during high tide period and low tide period during neap tide also, which was varying from 0.811-0.886 with an average value of 0.836 between selected sampling stations during high tide period and varying from 0.774-0.826 with an average value of 0.813 between selected sampling stations during consecutive low tide period Low species diversity suggests a relatively few successful species in this habitat.

Table # 4PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN AUGUST,2021

Tide	Sampling Station	Abundance In units/L	No of Species observed /total species	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	210	14/19	73.68	2.431	0.7923	0.7938
	2	177	17/19	89.47	3.091	0.8603	0.8182
	3	226	12/19	63.16	2.029	0.7883	0.7853
	4	221	17/19	89.47	2.964	0.8243	0.7993
	5	190	14/19	73.68	2.478	0.8531	0.8227
	6	98	8/19	42.11	1.527	0.7279	0.7886
LOW TIDE	1	191	13/19	68.42	2.285	0.7812	0.7901
	2	233	13/19	68.42	2.201	0.7658	0.7795
	3	209	15/19	78.94	2.621	0.8367	0.8208
	4	213	10/19	52.63	1.679	0.7264	0.7732
	5	259	14/19	73.68	2.339	0.7547	0.7702

Table # 5 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN AUGUST,2021

Tide	Sampling Station	Abundance In units/L	No of Species observed /total species	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	221	18/20	90	3.149	0.9462	0.8522
	2	283	19/20	95	3.188	0.8844	0.811
	3	268	17/20	85	2.862	0.899	0.8255
	4	256	14/20	70	2.344	0.8803	0.8328
	5	307	19/20	95	3.143	0.8857	0.8113
	6	65	12/20	60	2.635	0.9594	0.8861
LOW TIDE	1	238	15/20	75	2.558	0.8192	0.7738
	2	281	19/20	95	3.192	0.9106	0.8188
	3	256	19/20	95	3.246	0.9023	0.8241
	4	242	17/20	85	2.915	0.9102	0.8263
	5	255	15/20	75	2.526	0.8939	0.824

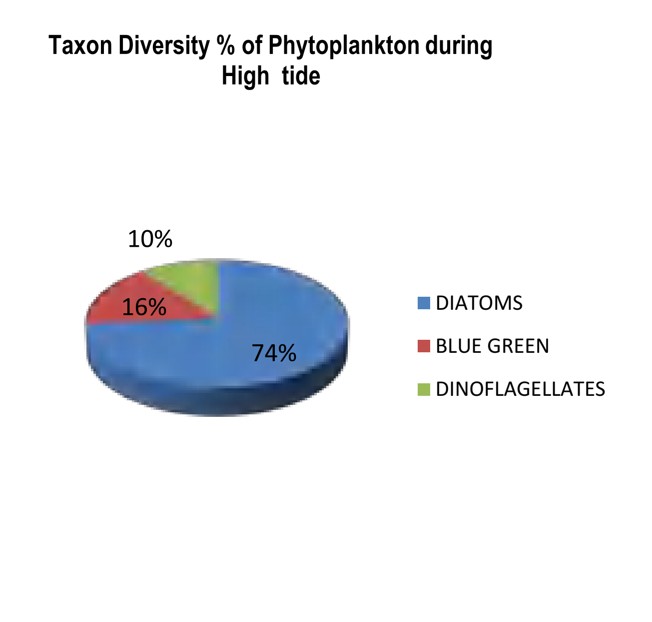
Table # 6 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING SPRING TIDEIN AUGUST, 2021

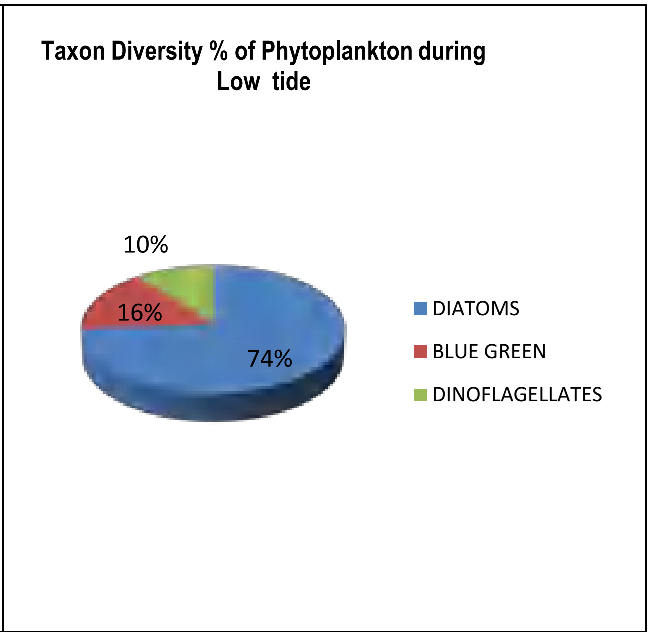
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	94-215	14/19	73.68
			BLUE GREEN	4-13	3/19	15.79
			DINOFLAGELLATES	0-1	2/19	10.53
			TOTAL PHYTO PLANKTON	98-226	19	-
LOW TIDE	Sub surface	5	DIATOMS	182-250	14/19	73.68
			BLUE GREEN	8-12	3/19	15.79
			DINOFLAGELLATES	0-1	2/19	10.53
			TOTAL PHYTO PLANKTON	191-259	19	-

Table # 7 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING NEAP TIDE IN AUGUST,2021

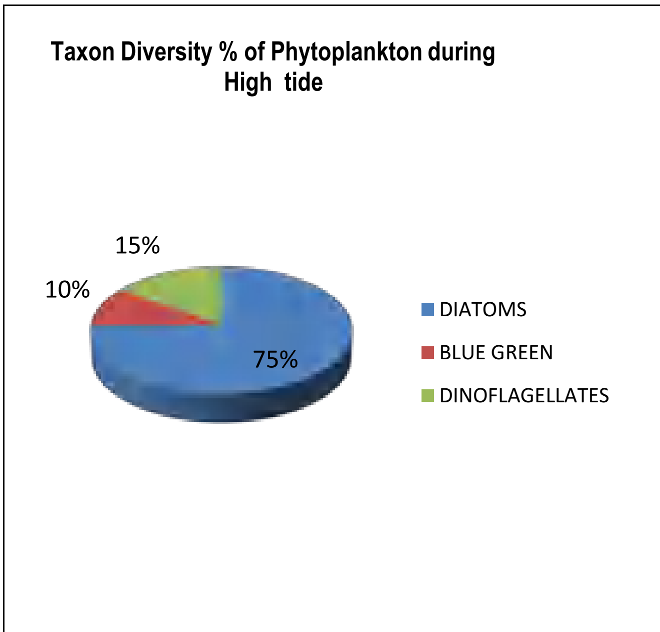
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	64-298	15/20	75
			BLUE GREEN	0-6	2/20	10
			DINOFLAGELLATES	0-5	3/20	15
			TOTAL PHYTO PLANKTON	65-307	20	-
LOW TIDE	Sub surface	5	DIATOMS	236-274	15/20	75
			BLUE GREEN	1-5	2/20	10
			DINOFLAGELLATES	0-4	3/20	15
			TOTAL PHYTO PLANKTON	238-281	20	-

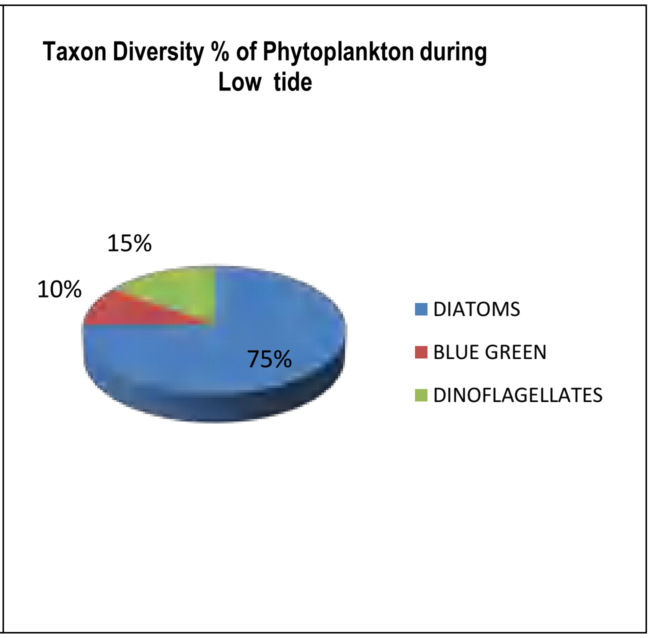
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide





Taxon Diversity % of Phytoplankton during High tide and Low tide period during Neap tide





ZOOPLANKTON POPULATION:

For the evaluation of the Zooplankton population in DPT harbour area and within the immediate surroundings of the port sampling was conducted from 6 sampling locations (3 in harbour area and two in Nakti creek and one in Khoricreek) during high tide period and low tide period of spring tide and Neap tide in August,2021. The Zooplankton community of the sub surface water in the harbour and nearby creeks during spring tide was represented by mainly five groups, Tintinids, Copepods, Ciliates Foraminiferans and larval forms of Crustacea, Molluscans and Polychaetes. The Zooplankton community of the sub surface water in the harbour and nearby creeks during neap tide was represented by mainly four groups, Tintinids, Copepods, Mysids and larval forms of Crustaceans , Molluscansand Polychaetes,.

Zooplankton of the sampling stations at sub surface layer in the DPT harbour area and nearby creek was varying from 34-109x10^3 N/ m^3 during high tide and 109-123 x10^3 N/ m^3during low tide of Spring Tide period. Zooplankton of the sampling stations at sub surface layer in the DPT harbour area and nearby creek was varying from 23-109 x10^3 N/ m^3 during high tide and86-103x10^3 N/ m^3during low tide of Neap Tide period.

Species Richness Indices and Diversity Indices:

Margalef's diversity index (Species Richness)S

At the organismal level, the most widely used biodiversity measures are those based on the number of species present, perhaps adjusted for the number of individuals sampled, Here Margalef's Species richness index (d), or indices that describe the evenness of the distribution of the numbers of individuals among species, are derived.

Margalef's diversity index (Species Richness) S of Zooplankton communities in the stations Kandla Harbour region and nearby creeks was varying from 2.269-3.505 with an average of 3.009 during the sampling conducted in High tide period.Margalef's diversity index (Species Richness) S of Zooplankton communities varying from.2.701-3.354 with an average of 3.033 during the sampling conducted in low tide period during Spring tide.

Margalef's diversity index (Species Richness) S of Zooplankton communities in the Kandla Harbour region and nearby creeks sampling stations was varying from1.914- 3.962 with an average of 2.754 during the sampling conducted in high tide and varying from. 1.972-3.236 with an average of 2.640 during the sampling conducted in low tide during Neap tide period**Shannon-Wiener's index:**

Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.813-1.052 (H'(log10)) between selected sampling stations with an average value of 0.995 (H'(log10)) during high tide period of spring tide . Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.991-1.067(H'(log10)) between selected sampling stations with an average value of 1.035 (H'(log10)) during consecutive low tide period .

Shannon-Wiener's Index (H) of Zooplankton communities in the sampling stations in Kandla Harbour region and nearby creeks was in the range of 0.696-1.007 (H'(log10)) between selected sampling stations with an average value of 0.897 (H'(log10)) during high tide period of Neap tide. Shannon-

Wiener's Index (H) of Zooplankton communities in the samplingstations in Kandla Harbour region and nearby creeks was in the range of 0.785-0.983 (H'(log10)) between selected sampling stations with an average value of 0.883 (H'(log10)) during consecutive low tide period .Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon-Wiener's index increases as both the richness and the evenness of the community increase. This result indicates that diversity of Zooplankton of Kandla Harbour region and nearby creeks stations is slightly high with very minimum diverse population but very few opportunist organisms are really well adapted to this environment and thrive better than other species.

Simpson's diversity index:

Simpson's index (D) is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. The Simson index is one of the meaningful and robust biodiversity measures available. (Magurran, 2004).

Simpson diversity index (1-D) of Zooplankton communities was below 0.9 most of sampling stations in the Kandla Harbour region and nearby creeksduring high tide and low tide of spring tide period, which was varying from 0.839-0.899between selected sampling stations with an average of 0.884 during high tide period and was varying from 0.887- 0.908 with an average value of 0.897 between selected sampling stations during low tide

Simpson diversity index (1-D) of Zooplankton communities was below 0.9 at all sampling stationsin the Kandla Harbour region and nearby creeks during high tide and low tide period except few, which was varying from 0.771-0.869 between selected sampling stations with an average of 0.833 during high tide period and was varying from 0.787- 0.863with an average value of 0.826 between selected sampling stations during consecutive low tide

This low species diversity suggests a relatively low number of successful species in this habitat. Environment is quite stressful with relatively few ecological niches and only few organisms are really well adapted to that environment. Any change in the environment would probably have quite serious effects.

Table # 8 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN AUGUST,2021

Tide	Sampling Station	Abundance In No / m^3	No of Species/groups observed /total species/group	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	93 $X10^3$	16/19	84.21	3.309	1.052	0.8955
	2	96 $X10^3$	17/19	89.47	3.505	1.032	0.8899
	3	105 $X10^3$	15/19	78.95	3.008	1.031	0.8958
	4	109 $X10^3$	15/19	78.95	2.984	1.037	0.8991
	5	109 $X10^3$	15/19	78.95	2.984	1.008	0.8865
	6	34 $X10^3$	9/19	47.37	2.269	0.8131	0.8396
LOW TIDE	1	110 $X10^3$	15/19	78.95	2.978	1.001	0.8881
	2	118 $X10^3$	17/19	89.47	3.354	1.067	0.8984
	3	123 $X10^3$	14/19	73.68	2.701	0.9911	0.887
	4	117 $X10^3$	16/19	84.21	3.15	1.065	0.9088
	5	109 $X10^3$	15/19	78.95	2.984	1.051	0.904

Table # 9 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN AUGUST,2021

Tide	Sampling Station	Abundance In No / m^3	No of Species/groups observed /total species/group	% of diversity	Margalef's diversity index (Species Richness S)	Shannon Weiner index H (log_{10})	Diversity Index (Simpson's Index) 1-D
HIGH TIDE	1	99 $X10^3$	14/20	70	2.829	0.9755	0.8695
	2	94 $X10^3$	19/20	95	3.962	1.007	0.8646
	3	91 $X10^3$	13/20	65	2.66	0.9544	0.8698
	4	101 $X10^3$	14/20	70	2.817	0.8993	0.8176
	5	109 $X10^3$	12/20	60	2.345	0.8501	0.8089
	6	23 $X10^3$	7/20	35	1.914	0.6965	0.7708
LOW TIDE	1	89 $X10^3$	11/20	55	2.228	0.8172	0.7878
	2	103 $X10^3$	16/20	80	3.236	0.9831	0.8633
	3	96 $X10^3$	14/20	70	2.848	0.92	0.8412
	4	86 $X10^3$	14/20	70	2.918	0.9071	0.8375
	5	96 $X10^3$	10/20	50	1.972	0.7875	0.7987

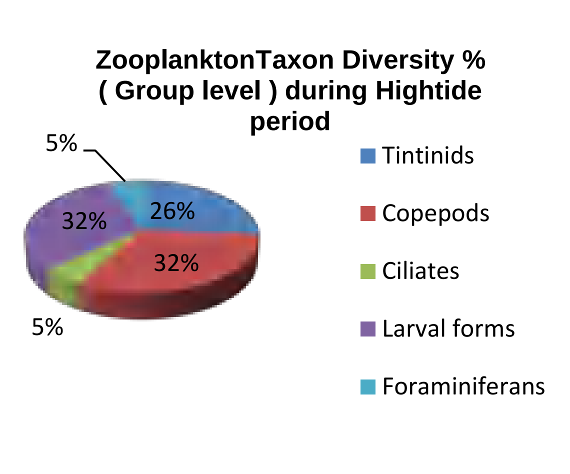
Table # 10 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN AUGUST,2021

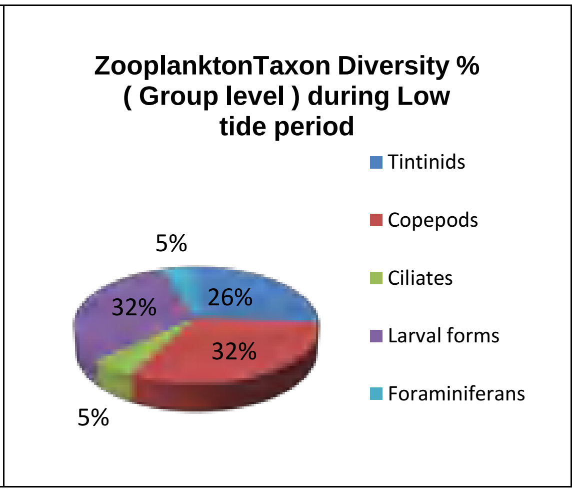
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	1-28	5/19	26.32
			Copepods	17-49	6/19	31.58
			Ciliates	1-6	1/19	5.26
			Larval forms	9-46	6/19	31.58
			Foraminiferans	0-2	1/19	5.26
			TOTAL ZOOPLANKTON NO/L	**34-109**	**19**	
LOW TIDE	Sub surface	5	Tintinids	20-27	5/19	26.32
			Copepods	39-55	6/19	31.58
			Ciliates	1-7	1/19	5.26
			Larval forms	40-46	6/19	31.58
			Foraminiferans	0-1	1/19	5.26
			TOTAL ZOOPLANKTON NO/L	**109-123**	**19**	

Table # 11 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA , NEAR BY CREEKS DURING NEAPTIDE IN AUGUST,2021

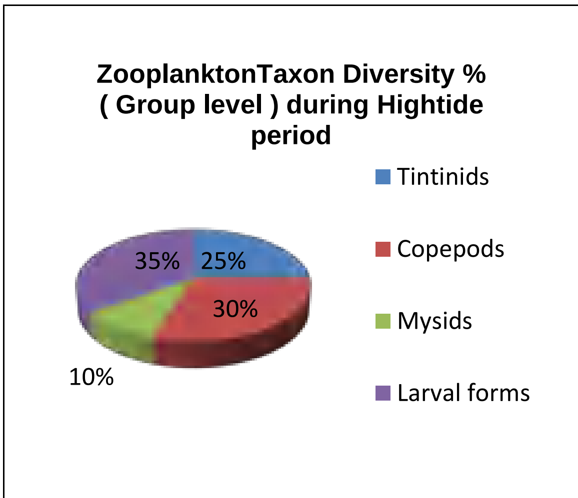
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	1-11	5/20	25
			Copepods	7-26	6/20	30
			Mysids	0-6	2/20	10
			Larval forms	15-84	7/20	35
			TOTAL ZOOPLANKTON NO/L	**23-109**	**20**	-
LOW TIDE	Sub surface	5	Tintinids	6-12	5/20	25
			Copepods	5-23	6/20	30
			Mysids	1-4	2/20	10
			Larval forms	57-74	7/20	35
			TOTAL ZOOPLANKTON NO/L	**86-103**	**20**	-

Taxon Diversity % of Zooplankton during High tide and Low tide period of Spring tide





Taxon Diversity % of Zooplankton during High tide and Low tide period of Neap tide



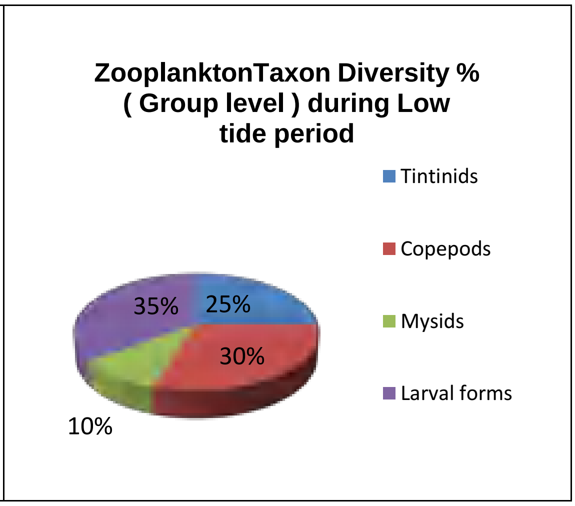


TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURINGSPRING TIDE OF AUGUST, 2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALGAE	Cyanophyta	Cyanophyceae	Nostocales	Oscillatoriaceae	*Arthospira*sp.	B1	Rare
					Lyngbya sp.	B2	Rare
			Stigonematales	Stigonemataceae	*Stigonema sp.*	B3	Occasional
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Rare
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D2	Abundant
			Triceratiales	Triceratiaceae	*Odontella*sp	D3	Occasional
					*Triceratium*sp.	D4	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D5	Dominant
			Hemiaulales	Bellerocheaceae	*Bellerochea*sp	D6	Rare
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros*sp	D7	Occasional
			Lithodesmiales	Lithodesmiaceae	*Ditylum*sp	D8	Abundant
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*sp	D9	Rare
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D10	Abundant
					Thalassionema sp.	D11	Rare
			Fragilariales	Fragilariaceae	*Asterionelopsis sp..*	D12	Rare
					*Fragilaria*sp	D13	Occasional
					*Synedra*sp	D14	Rare
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium sp.*	DF1	Rare
			Gonyaulacales	Ceratiaceae	*Ceratiumfurca*	DF2	Rare

TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURING AND NEAP TIDE OF AUGUST,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALGAE	Cyanophyta	Cyanophyceae	Nostocales	Oscillatoriaceae	*Oscillatoria* sp.	B1	Rare
			Stigonematales	Stigonemataceae	*Stigonema sp.*	B2	Rare
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D1	Dominant
			Triceratiales	Triceratiaceae	*Odontellasp*	D2	Occasional
					Triceratiumsp.	D3	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphiasp*	D4	Abundant
			Hemiaulales	Bellerocheaceae	*Bellerocheasp*	D5	Rare
			Chaetocerotales	Chaetocerotaceae	*Chaetocerossp*	D6	Occasional
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D7	Occasional
			Lithodesmiales	Lithodesmiaceae	*Ditylumsp*	D8	Abundant
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*sp	D9	Occasional
				Pinnulariaceae	*Pinnulariasp*	D10	Rare
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D11	Dominant
					Thalassionema sp.	D12	Rare
			Fragilariales	Fragilariaceae	*Asterionella sp.*	D13	Occasional
					Fragilariasp	D14	Frequent
					Synedrasp	D15	Rare
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium sp.*	DF1	Rare
			Gonyaulacales	Ceratiaceae	*Ceratiumfurca*	DF2	Rare
					Ceratiumtripos	DF3	Rare

TABLE #13 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS IN DPT HARBOUR AREA, AND NEAR BY CREEKS DURING SPRING TIDE OF AUGUST,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Frequent
				Codonellidae	*Tintinnopsisaccuminata*	T2	Rare
					Tintinnopsisfailakkaensis	T3	Rare
					Tintinnopsisgracilis	T4	Occasional
					Tintinnopsis radix	T5	Rare
COPEPODS	ATHROPODA	Crustacea Sub class copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Frequent
				Temoridae	*Temora sp.*	C2	Rare
			Cyclopoida	Oithonidae	*Oithona sp.*	C3	Frequent
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C4	Abundant
				Euterpinidae	*Euterpina sp.*	C5	Rare
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C6	Rare
CILIATES	CILIOPHORA	Oligohymenophorea	Sessilida	Zoothamniidae	*Zoothamniumsp.*	CI1	Occasional
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L2	Occasional
POLYCHAETE LARVA	ANNELIDA	Polychaeta			Trochophore larvae	L3	Occasional
BARNACLE LARVAE	ATHROPODA CRUSTACEA	Maxillopoda Thecostraca			Cirripede larvae	L4	Rare
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L5	Occasional
BRYOZOA					Cyphonautes larvae	L6	Occasional
FORAMINIFERA	FORAMINIFERA	Globothalamea	Rotaliida	Rotalliidae	*Rotalia* sp.	F1	Rare

TABLE # 13 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS IN DPT HARBOUR AREA, AND NEAR BY CREEKS DURING NEAP TIDE OF AUGUST,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Occasional
				Codonellidae	*Tintinnopsisaccuminata*	T2	Rare
					Tintinnopsisfailakkaensis	T3	Rare
					Tintinnopsisgracilis	T4	Occasional
					Tintinnopsis radix	T5	Rare
COPEPODS	ATHROPODA	Crustacea Sub class copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Frequent
				Temoridae	*Temora sp.*	C2	Rare
			Cyclopoida	Oithonidae	*Oithona sp.*	C3	Occasional
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C4	Occasional
				Euterpinidae	*Euterpina sp.*	C5	Rare
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C6	Rare
MYSIDS	ATHROPODA CRUSTACEA	Malacostraca	Mysida, Decapoda	Solenoceridae	*Solenocerasp.*	M1	Rare
				Penaeidae	*Metapenaeussp.*	M2	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L2	Occasional
POLYCHAETE LARVA	ANNELIDA	Polychaeta			Trochophore larvae	L3	Occasional
BARNACLE LARVAE	ATHROPODA CRUSTACEA	Maxillopoda Thecostraca			Cirripede larvae	L4	Rare
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L5	Abundant
CYPHONAUTES LARVAE	BRYOZOA				Cyphonautes larvae	L6	Occasional
ECHINODERMATA larave	ECHINODERMATA	Ophiuroidea			Ophiopluetus larvae	L7	Rare

BENTHIC ORGANISMS:

Few Benthic organisms were observed in the collected sediments by using the Van-veen grabs during the sampling conducted during spring tide period and Neap tide period from DPT harbour region and nearby creek.The benthic organisms during spring tide were represented by Polychaetes, Nematodes and Amphipods. The polychaetes were represented by *Syllis sp***.** *Polydorasp* , and*Pondodorasp,* during spring tide sampling. The benthic organisms in the collected samples were varying from 0-300 N/M ^{2} during spring tide and 10-140 NO/M ^{2} during neap tide sampling

Table # 14 BENTHIC FAUNA IN THE SAMPLING LOCATIONS IN DPT HARBOUR AREA CREEKS DURING NEAP TIDE IN AUGUST ,2021

Benthic fauna	ABUNDANCE IN NO/M ^{2} DIFFERENT SAMPLING STATIONS REPRESENTATION BY GROUP						
	DPT HARBOUR			CREEKS			
POLYCHATES	KPT-1	KPT-2	KPT-3	KPT-4	KPT-5	KPT-6	
Family : Iospilidae *Pondodora sp.*	0	70	0	0	0	NS	
Family : Spionidae *Polydora sp..*	10	10	0	20	0	NS	
Family : Syllidae *Syllis sp***.**	0	10	0	10	0	NS	
Total Polychates N/M^{2}	10	90	0	30	0	NS	
Un identified Nematode worms	40	200	0	10	30	NS	
Amhipods	0	10	0	10	0	NS	
TOTAL Benthic Fauna NUMBER/ M^{2}	50	300	0	50	30	NS	

NS : No sample

Table # 15BENTHIC FAUNA IN THE SAMPLING LOCATIONS IN DPT HARBOUR AREA CREEKS DURING NEAP TIDE IN AUGUST ,2021

Benthic fauna	ABUNDANCE IN NO/M ^{2} DIFFERENT SAMPLING STATIONS REPRESENTATION BY GROUP						
	DPT HARBOUR			CREEKS			
POLYCHATES	KPT-1	KPT-2	KPT-3	KPT-4	KPT-5	KPT-6	
Family : Spionidae *Polydora sp..*	20	10	0	40	20	NS	
Family : Syllidae *Syllis sp***.**	10	10	0	20	60	NS	
Total Polychates N/M^2	30	20	0	60	80	NS	
Un identified Nematode worms	40	30	10	40	40	NS	
Amhipods	10	10	0	10	20	NS	
TOTAL Benthic Fauna NUMBER/ M^2	80	60	10	110	140	NS	

NS : No sample

7. Meteorological Data

Automatic Weather station have been installed in SevaSadan -3 at the Deendayal Port which records the data on Temperature (°C), Humidity (%),Wind (mph), Dew Point (°C), Wind Direction (°), Pressure, Solar radiation, heat Index and UVI.

Temperature

The mean day time temperature for Deendayal Port was 30.5 °C. The day-time maximum temperature was 34.1 °C. The mean night time temperature was 27.4 °C. The minimum mean night time temperature recorded was 26.1 °C.

Air Pressure

The mean absolute air pressure for the month of August was 1004.7 hpa, whereas the mean relative pressure was 1001.2 hpa. The maximum absolute air pressure recorded for the month of August was 1008.3 hpa.

Heat Index

The mean day-time heat index for the month of August was 34.7 ^{o}C. The maximum heat index recorded was 42^{o}C.

Solar Radiation

The mean Solar Radiation in August was 232.4 w/m^2. The maximum solar radiation recorded in the month of August was 682.8 w/m^2.

Humidity

The mean day-time humidity was 73.0 % for the month of August and mean night time humidity was 83.2%. Maximum humidity recorded during day-time was 88.0 % and maximum humidity recorded during night-time was 90.0%.

Wind Velocity and Wind Direction

The mean wind velocity for the entire month of August was 10.8 km/hour. Maximum wind velocity recorded was 34.9 Km/hr . The wind direction was mostly S to SW.

Conclusive Summary and Remedial measures Suggested

- The AAQ monitoring at six locations of Deendayal Port indicates that the mean PM_{10} values at four locations viz. Coal storage area, Marine Bhavan and Oil Jetty area were found above the permissible standards (100 µg/m^3)and$PM_{2.5}$was above permissible limits at Coal storage location(Limit 60 µg/m^3).

- Drinking water at all the twenty locations was found potable and was within permissible limits of BIS standards (IS 10500).

- Noise quality was also within the set permissible standards of an Industrial Area. The noise level observed during day time was >75 dB (A) and at night time was >70 dB (A) during the entire monitoring period.

- The sewage treated water of Deendayal Port Colony (Gopalpuri) was in line with the standards set by the Gujarat Pollution Control Board. The STP at Deendayal Port is not fully operational and STP at Vadinar Port was found non-operational.

Reasons for higher Values of PM_{10}

- Large amount of coal is handled at Berth No. 6, 7, 8 and 9. The unloading of coal directly in the truck, using grabs cause coal to spread in air as well as coal dust to fall on ground. This settled coal dust again mixes with the air while trucks travel through it.

- Also, the coal laden trucks are not always covered with tarpaulin sheets and these results in spillage of coal from trucks/dumpers during its transit from vessel to yard or storage site. This also increased PM values around marine Bhavan & Coal storage area.

Remedial Measures

The values of PM_{10} during the month of August, 2021 were observed beyond the permissible limit at four locations mentioned above. Given below are the remedial measures suggest to minimize the Air pollution at Deendayal Port.

- Guidelines for Coal Handling by GPCB should be strictly followed. (http://gpcb.gov.in/pdf/coal-handling-guidelines.pdf)

- Sewage Treatment Plan at Vadinar Port is not working. Hence, it is recommended to commission the sewage treatment plant at Vadinar immediately.

- Except for the higher values of PM_{10} at Coal storage site, Oil Jetty, Tuna Port and Marine Bhavan locations, the monitoring results for the present month suggest that the overall Environment Quality of Deendayal Port is satisfactory.

SOURCE OF LITERATURE AND ADDITIONAL REFERENCE FOR ECOLOGICAL STUDY

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Annexure -VII

DEENDAYAL PORT TRUST

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Administrative Office Building
Post Box NO. 50
GANDHIDHAM (Kutch).
Gujarat: 370 201.
Fax: (02836) 220050
Ph.: (02836) 220038

www.deendayalport.gov.in

NO.EG/WK/4783/V/ 131 Dated : 05/02/2021

To,
M/s Precitech Laboratories Pvt Ltd,
1st Floor, Bhanujyot Complex,
Plot No C5/27, B/h Panchratna Complex,
Nr. GIDC Char Rasta,
VAPI-396195.

Sub: **Work order** for "STRENGTHENING OF EXISTING ENVIRONMENTAL MANAGEMENT CELL AT DEENDAYAL PORT TRUST: Appointment of environment experts for two years further extendable for one year"-**reg**.

Ref: 1) Tender dated 21.06.2019 submitted by M/s Precitech Laboratories Pvt.Ltd, Vapi.
2) Letter of Acceptance vide no-EG/WK/4783/V/100 dtd 01(04).01.2021
3) Letter from DPT no E/WK/4783/V/103 dtd 06.01.2021
4) Performance Guarantee submitted by M/s Precitech Laboratories Pvt Ltd in the form of Bank Guarantee of Rs. 3,60,000.00 vide Bank Guarantee no. 1102921BG0000016 dated 19.01.2021 issued by State Bank of India, Vapi.

Sir,

Kindly refer above cited Letter of Acceptance dtd 01(04).01.2021.

2) You shall have to provide Key Experts as per tender requirement during the entire contract period. Accordingly, you shall have to submit the qualification and experience certificates of the Key experts to be appointed at DPT, as per tender conditions for verification & approval.

3) Please submit the Agreement of contract as per tender conditions no 1.29.

4) Kindly commence the work on or before 15.02.2021.

………Cont………..

Please note that the time period for providing Consultancy services for the subject work will be initially for two years and further extendable for one year on mutual consent as per tender conditions.

Thanking you.

Yours faithfully,

Superintending Engineer (Design & EMC (I/c))
Deendayal Port Trust

ANNEXURE B

Annexure B

Monitoring the implemental Safe guards Ministry of Environment & Forests
Regional office (W), Bhopal.
Monitoring Report (For the period up to May, 2021)
Part – 1
DATA SHEET

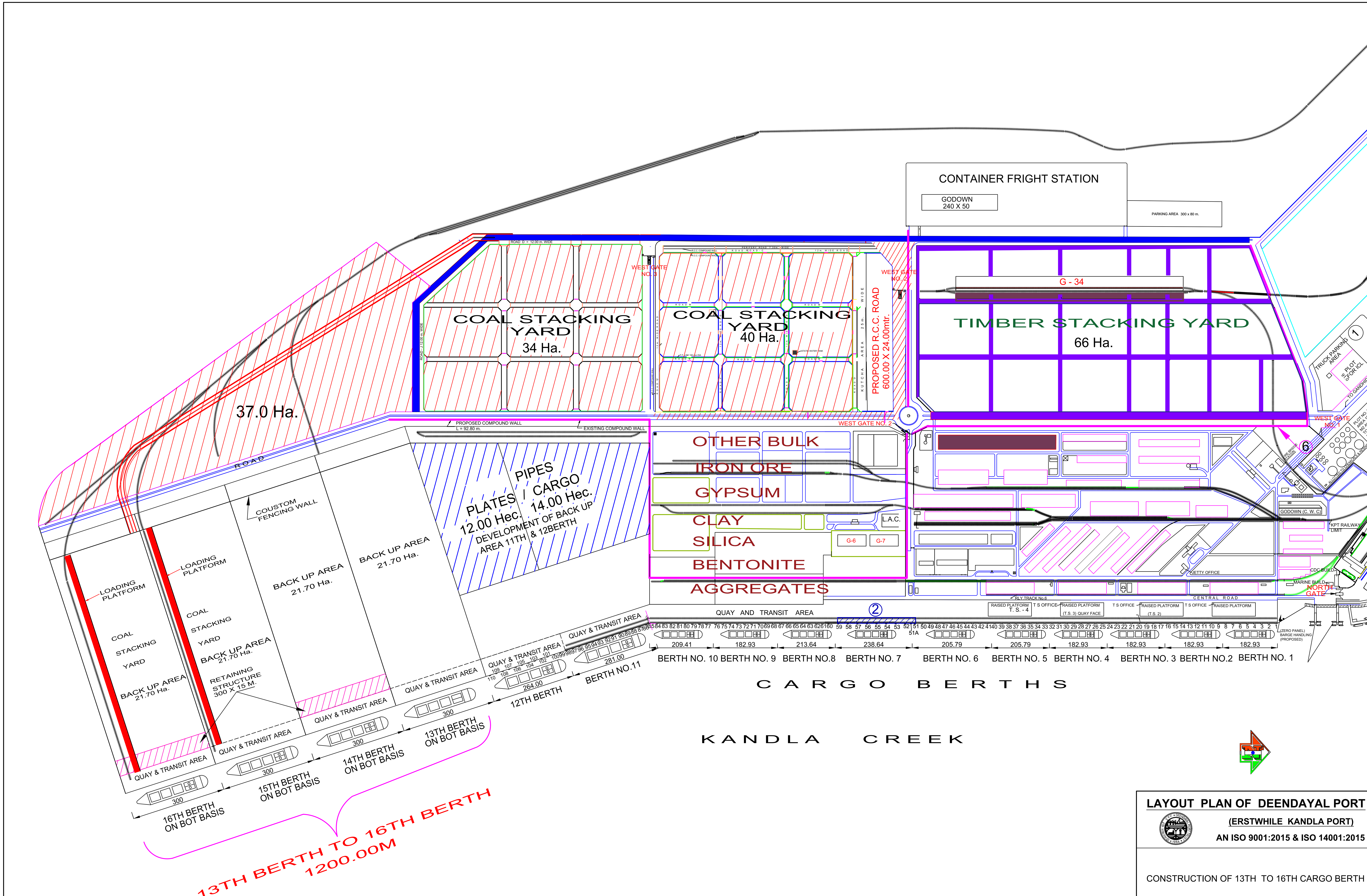
1. Project type : River valley/ Mining/Industry/ thermal/nuclear/Other (specify)	Infrastructure and Miscellaneous Projects + CRZ
2. Name of the project	Construction of 13th to 16th Cargo Berth at Kandla Port by M/s Deendayal Port Trust (Erstwhile: Kandla Port Trust) (Under Ministry of Ports, Shipping & Waterways, GoI).
3. Clearance Letter (s). OM no and date	Environment Clearance issued by Govt. of India, Ministry of Environment & Forest – New Delhi vide letter No. 11-70/2006-IA-III Dated September 08. Further, Ministry of Environment & Forest – New Delhi, Govt. of India, extended the Environmental Clearances validity for five years i.e. up to 30/09/2018, vide letter No. F.NO.11 – 70/ 2006 – IA.III dated 7thFebruary, 2014.
4. Location a) District (s) b) State (s) c) Location/latitude/longitude	 District: Kutch State : Gujarat Location: Deendayal Port Trust, 22°58'33.08"N and 70°13'16.28"E
5. Address for Correspondence a) address of Concerned Project Chief Engineer (with pin code & telephone/telex/fax numbers) b) Address of Executive project Engineer/manager/(with pin code fax numbers)	 Chief Engineer, Deendayal Port Trust, A.O. Building Post Box No.-50, Gandhidham- Kutch. Gujarat Pin – 370201 Tel : 02836-233192, Fax-02836-220050. Superintending Engineer (C-I), Office of the Superintending Engineer (C-I), Nirman Building, Room No. 110, New Kandla (Kutch) pin 370 210. Gujarat
6. Salient features of the project	All the 4 berths i.e. 13th to 16th Cargo berths are under operation. 13thCargo Berth : Under operation 15thCargo Berth : Under Operation 14th Cargo Berth : Under Operation 16th Cargo Berth : Under Operation

	1. The dimension of each berth 300m x 55m consisting of quay and transit area resting on 1200mm and 1000mm R.C.C. bored cast-in situ piles. (Total 1200m x 55m wide for 4 berths). 2. The backup area of size 21.7 Hectares/berth for 13th, 14th, 15th & 16th CB including all facilities roads, railways & other required infrastructure (Total area: 102.17 ha. + 42 Ha. (1200 m X 350 m) = 144.17 ha.) 3. The Capacity of each Berth is 4.5 MMTPA (As approved by Tariff Authority of Major Ports). 4. The drawing showing all berths viz. 13th to 16th is attached herewith as **Annexure 1.**
b) Salient features of the Environmental management plan	NIOT, Chennai had already suggested Environmental Management Plan for both construction & operation face of the project already cited in the EIA study report by NIOT, Chennai. A copy of the same has already been communicated with earlier compliance reports submitted.
7. Breakup of the project area a) Submergence area : forest & non-forest b) Others	 Nil Nil
8. Breakup of the project affected population with enumeration of those losing houses/dwelling units only agricultural land & landless labourers/artisen a) SC. ST/Adivasis b) Others (Please indicate whether these figures are based on any scientific and systematic survey carried out or only provisionalfigures, if a survey is carried out givedetails and years of survey).	 Nil Nil Nil It is based on the EIA report prepared by M/s NIOT, Chennai.
9. Financial details a) Project cost as originally planned andsubsequent revised estimates and the year of prices reference.	 Block estimated cost of Rs. 442.90 crores (Dec. 2005) Revised Block estimated cost of Rs. 755.5 crores (Apr 2009). Estimated cost revised (Year 2017) for Berth No. 14 C. B : 253 Crore & Berth No. 16 C.B : 278 Crore. All the 4 berths are operated by the Deendayal Port Trust.
b) Allocation made for environmental management plans with item wise and year wise break-up	The allocation made under the scheme of “Environmental Services & Clearance thereof other related Expenditure” during BE 2020-21 is Rs. 271 Lakhs & BE 2021- 22 is Rs. 266 Lakhs.

c) Benefit cost ratio/Internal rate of Return and the year of assessment Whether (c) includes the cost of environmental management plans so far.	FIRR EIRR 13.61% 14.62% Berth No. 14 C. B : 253 Crore FIRR EIRR 15.32% 17.42% Berth No. 16 C.B : 278 Crore FIRR EIRR 14.23% 16.17% Yes
d) Actual expenditure incurred on the project	BOT operator 13th C.B: 300.23 Crore BOT operator 15th C.B: 252.45 Crore Berth No. 14th C. B internal resources DPT: 138.28 .00 Crore (Awarded cost berth & Back up area) Berth No. 16th C.B internal resources DPT: 149.56 Crore (awarded cost berth & back up area).
e) Actual expenditure incurred on theEnvironmental management plans so far.	The expenditure made under the scheme of "Environmental Services & Clearance thereof other related Expenditure" is Rs. 4,98,43,704.70/- for the period 2020-21 upto May, 2021. .
10. Forest land requirement a) The status of approval for diversion offorest land for non-forestry use b) The status of clear felling c) The status of compensatory aforestation, if any d) Comments on the viability &	Nil Not Applicable. NIL **A) Mangrove Plantation Plan carried out:** 1) Year 2005-06 – 20 hectares 2) Year 2008-09 - 50 hectares 3) Year 2010-11 – 100 hectares 4) Year 2011-12 – 200 hectares 5) Year 2012-13 – 300 hectares 6) Year 2013 -14 – 330 hectares 7) Year 2015-17 - 300 hectares 8) Year 2018-19 - 50 hectares 9) Year 2019-20 – 50 Hectares 10) Year 2020-21 – 100 Hectares **Total - 1500 hectares** DPT awarded work of Monitoring of total 1300 Ha,

sustainability of compensatory a forestation programmed in the light of actual field experience so far	mangrove plantation carried out, to M/s GUIDE, Bhuj vide work order dated 1/9/2017 (Period 2017-2018).Final Report submitted by GUIDE, Bhuj already submitted along with last compliance report submitted during November, 2019. **Subsequently, DPT awarded the work for monitoring of mangrove plantation to M/s GUIDE, Bhuj vide work order dated 3/5/2021 (Period 2021-2022). The work in progress.**
11. The status of clear felling in non-forestareas (such as submergence area of reservoir, approach roads), if any with quantitative information.	Nil
12. Status of construction a) Date of commencement (Actual and/orplanned) b) Date of completion (Actual and/or planned)	All the 4 berths are under operation All the 4 berths are under operation.
13. Reasons for the delay if the Project isyet to start	All the 4 berths are under operation. 13thCargo Berth : Under operation. 15thCargo Berth : Under Operation. 14th Cargo Berth : Under Operation. 16th Cargo Berth : Under Operation.
Date of site visited a) The dates on which the project was monitored by the regional office on pervious occasion. if any b) The date site visit for this monitoring report	29/12/2016 ------

Annexure -I



LAYOUT PLAN OF DEENDAYAL PORT

(ERSTWHILE KANDLA PORT)

AN ISO 9001:2015 & ISO 14001:2015

CONSTRUCTION OF 13TH TO 16TH CARGO BERTH

CUTTING LINE : A 34" x 44"-W_2021_43_ FRP_ (EMC)

Annexure –C

Public Liability

Insurance

Date: 22nd July, 2021

To,
Deendayal Port Trust,
Administrative Office building,
Near Madhuban Hotel, Gandhidham,
Kutch, Gujarat. India

Insurance Intermediary: Marsh India Insurance Brokers Pvt. Ltd.

Dear Sir,

Subject: Held cover letter for Hull and Machinery Insurance of vessels owned by Deendayal Port Trust

We thankfully acknowledge the receipt of premium of **INR 3,924,592/-** (premium inclusive of brokerage and stamp duty **INR 3,325,925/-** plus 18% GST of **INR 5,98,667/-**), via online method, received by us on 22nd July, 2021 towards Hull and Machinery Insurance of vessels as per the table below:

Sr. No.	Asset Particulars	Sum Insured
A	Tugs	
1	MT Jeyshtha	520,869,308.00
2	MT Kritika	505,538,579.00
3	MT Rohini	82,304,898.00
4	MT Magh	82,304,898.00
5	MT Alok	11,309,118.00
6	MT Atri	11,309,118.00
7	ML Karishma	10,360,211.00
8	ML Swati	97,027,155.00
9	ML Nirikshak	27,995,231.00
B	Floating Dry dock/ SFDD	743,174,105.00
	GRAND TOTAL	**2,092,192,621**

We hereby hold your vessels covered for Hull and Machinery Insurance for the sum insured as per the above table to this held cover letter for the period 24th July 2021 to 23rd July 2022.

Policy documents are under preparation and will be issued shortly.

Thanking you,

The New India Assurance Insurance Company Ltd.

बृहत कॉर्पोरेट एवं ब्रोकर्स कार्यालय
Large Corporate & Brokers Office
The New India Assurance Co. Ltd.

Authorised Signatory

Annexure –D

Grant of Permission / License for removal of Dry Solid Waste (Non-Hazardous) from Vessels calling at Deendayal Port

DEENDAYAL PORT TRUST

ISO 9001:2008 PORT
ISO 14001:2004

Administrative Office Building,
Post Box No: - 50,
Gandhidham- Kachchh,
Gujarat State – India
Ph- (02836) 233585, 220235
FAX : (02836) 233585

e-mail:dyconservator@kandlaport.gov.in

No.MR/WK/1101(34)/3424 Date: - 17/10/2021
11

To,
M/s. Chitrakut Trading & Industries,
15, Brahma Samaj Building,
Plot No: 106, Sector-8,
Behind Oslo Cinema,
GANDHIDHAM - Kachchh

Sub: - Grant of Permission / License for removal of Dry Solid Waste (Non Hazardous) from Vessels calling at Deendayal Port.

Sir,

Your request for new Permission/License has been considered and permission is hereby granted for removal of **"Dry Solid Waste (Non Hazardous)"** from the Vessels calling at **Deendayal Port and Vadinar Port,** for the period of one year from the date of issue of license subject to submission of valid NOCs of PHO, Municipality and Customs immediately after expiry of its validity, recovery of wharfage charges and change in policy or guidelines of Kandla Port trust, Government of India and competent authority from time to time and issuance of instructions accordingly under the following terms & conditions;

1. The Licensee should comply with the Hazardous Waste (Management & Handling Rules) 1989 as amended from time to time.

* **The Licensee should comply with all regulations of GPCB Water (Prevention & control of pollution) Act-1974, Hazardous waste (Management & Handling & Trans boundary movement rules, 2008) under Environmental Protection Act, 1986.**

2. The Licensee shall be authorized to act as occupier and operator for the purpose of collection of Dry Waste and Garbage from ships and same can be undertaken with the permission of the Deputy Conservator free of cost subject to the Rules given at (1) above.

2A. The licensee shall be allowed to remove all type of garbage viz Expired Medicine, Food Waste, Dunnage Wood, Plastic, expired battery eye wash.

Contd.

3. The Port Trust shall not be responsible for any payment to the Licensee for collecting aforesaid Waste from the Vessels, which should be settled by Licensee with the concerned Shipping Agent or Master of the Vessel.

4. In case the port wants to deliver any Dry Waste/Garbage etc. from the Port area, the same has to be collected by the Licensee free of charge at his own cost and responsibility.

5. Permission of the Deputy Conservator or his authorized representative has to be obtained before collection of any garbage from anywhere in the Port.

6. The Licensee shall collect the waste materials as above within a reasonable time as would be determined by the Deputy Conservator. The Licensee shall also ensure that the removal of Garbage from ships will be undertaken without causing any hindrance to Port activities.

7. The Licensee shall bear the cost of the damages (without any demur, Reservation, recourse, contest and protest) if any, caused by him or by his employee to any properties of the Port or its employees.

8. The Licensee for collection of aforesaid garbage undertake the work with the permission of Port authorities, Master of the Vessel or Shipping Agent, Custom authorities, GPCB and Pollution Board of the respective State where dumping /recycling yard is located, for every act of collection.

9. The License would be valid as detailed above. However on satisfactory performance and compliance with the License conditions, the License may be renewed for a further period of one year at a time.

10. The Port reserves the right to alter the conditions of the License or even cancels the License at any point of time without assigning any reason thereof.

11. The License will automatically stand cancelled if the licensee does not meet any of the statutory /legal requirements of the work including those applicable for the protection of environment, deployment of man, machinery, vehicles, floating crafts, etc.

12. The mode of transport / road tankers being utilized by the licensee should have proper License from the respective statutory authorities, **the barges and other floating crafts** being used for undertaking the subject work must have proper validity and License from Deendayal Port authorities/ Sate /Central Government authorities as the case may be.

(Cont....)

13. The Garbage should be carried in open truck but should be carried with proper covering as per statutory regulations to approved dumping yards and to be disposed off as per statutory Regulations prevailing from time to time. Reports as required are to be made on Swach Sagar Portal & other statutory bodies as required.

14. If the Authorization is cancelled in terms Hazardous Waste(Management and Handling) Rules 1989 and amendments thereof by the Competent Authority any License granted by DPT shall automatically be lapsed till the Authorization so cancelled /suspended is restored.

15. In the event of any dispute or interpretation of the terms of and condition or any alleged breach thereof the same shall be referred to the Sole Arbitrator of the Chairman, Deendayal Port Trust or to an Authority appointed by him for the purpose. The Arbitration shall be conducted in accordance with the provisions of the Arbitration and Conciliation Act. 1996. The award of Arbitrator shall be final and binding. The Court at Gandhidham shall alone have exclusive jurisdiction to entertain and try all matter arising out of this License Agreement.

16. The Licensee shall submit a return to the Deputy Conservator during the 1st week of every Month, furnishing the details of Garbage, etc. collected from the Port area under this License and the manner in which the same has been disposed off.

17. The licensee shall intimate PHO regarding details of Garbage collection (type of Garbage, weight of garbage etc.) collected from each Vessel before sailing of Vessels.

18. The permission/License fee payable shall be as under:-

    (i) Levying License fee of **Rs. 16,000/- + GST** per annum **As per Board Resolution No. 41 of Dated 22.07.2019** from the private Licensees for removal of only dry garbage (non-hazardous) from vessels calling Kandla Port subject to production of NOC of Customs, NOC of PHO Kandla, NOC of Municipality and Monthly submission of return on collection and disposal thereof to Deputy Conservator and report on Swach Sagar Portal.

    (ii) The quantum of License fee will be extended every three years by 25%.

    (iii) Levying of Wharfage charges as specified in SOR from time to time.

Yours faithfully,

Deputy Conservator
Deendayal Port Trust

12/11/2021
O/C

Copy to: -
TM/CME/CE/HM/FCSO/CISF/COM (OOT)

DEENDAYAL PORT TRUST

ISO 9001:2008 PORT
ISO 14001:2004

Administrative Office Building,
Post Box No: - 50,
Gandhidham- Kachchh,
Gujarat State – India
Ph- (02836) 233585, 220235
FAX : (02836) 233585

e-mail:dyconservator@kandlaport.gov.in

No.MR/WK/1101(39)/814 Date: - 3/06/2021

To,
M/s. Golden Shipping Services,
Kidana Nirmal Nagar,
Survey No. 133, Plot No. 83,
Gandhidham – 370201.

Sub: - Grant of Permission / License for removal of Dry Solid Waste (Non Hazardous) from Vessels calling at Deendayal Port.

Sir,

Your request for new Permission/License has been considered and permission is hereby granted for removal of **"Dry Solid Waste (Non Hazardous)"** from the Vessels calling at **Deendayal Port** for the period of one year from the date of issue of license subject to submission of valid NOCs of PHO, Municipality and Customs immediately after expiry of its validity, recovery of wharfage charges and change in policy or guidelines of Kandla Port trust, Government of India and competent authority from time to time and issuance of instructions accordingly under the following terms & conditions;

1. The Licensee should comply with the Hazardous Waste (Management & Handling Rules) 1989 as amended from time to time.

* **The Licensee should comply with all regulations of GPCB Water (Prevention & control of pollution) Act-1974, Hazardous waste (Management & Handling & Trans boundary movement rules, 2008) under Environmental Protection Act, 1986.**

2. The Licensee shall be authorized to act as occupier and operator for the purpose of collection of Dry Waste and Garbage from ships and same can be undertaken with the permission of the Deputy Conservator free of cost subject to the Rules given at (1) above.

2A. The licensee shall be allowed to remove all type of garbage viz Expired Medicine, Food Waste, Dunnage Wood, Plastic, expired battery eye wash.

Contd.

Bhelut OK

3. The Port Trust shall not be responsible for any payment to the Licensee for collecting aforesaid Waste from the Vessels, which should be settled by Licensee with the concerned Shipping Agent or Master of the Vessel.

4. In case the port wants to deliver any Dry Waste/Garbage etc. from the Port area, the same has to be collected by the Licensee free of charge at his own cost and responsibility.

5. Permission of the Deputy Conservator or his authorized representative has to be obtained before collection of any garbage from anywhere in the Port.

6. The Licensee shall collect the waste materials as above within a reasonable time as would be determined by the Deputy Conservator. The Licensee shall also ensure that the removal of Garbage from ships will be undertaken without causing any hindrance to Port activities.

7. The Licensee shall bear the cost of the damages (without any demur, Reservation, recourse, contest and protest) if any, caused by him or by his employee to any properties of the Port or its employees.

8. The Licensee for collection of aforesaid garbage undertake the work with the permission of Port authorities, Master of the Vessel or Shipping Agent, Custom authorities, GPCB and Pollution Board of the respective State where dumping /recycling yard is located, for every act of collection.

9. The License would be valid as detailed above. However on satisfactory performance and compliance with the License conditions, the License may be renewed for a further period of one year at a time.

10. The Port reserves the right to alter the conditions of the License or even cancels the License at any point of time without assigning any reason thereof.

11. The License will automatically stand cancelled if the licensee does not meet any of the statutory /legal requirements of the work including those applicable for the protection of environment, deployment of man, machinery, vehicles, floating crafts, etc.

12. The mode of transport / road tankers being utilized by the licensee should have proper License from the respective statutory authorities, **the barges and other floating crafts** being used for undertaking the subject work must have proper validity and License from Deendayal Port authorities/ Sate /Central Government authorities as the case may be.

(Cont....)

13. The Garbage should be carried in open truck but should be carried with proper covering as per statutory regulations to approved dumping yards and to be disposed off as per statutory Regulations prevailing from time to time. Reports as required are to be made on Swach Sagar Portal & other statutory bodies as required.

14. If the Authorization is cancelled in terms Hazardous Waste(Management and Handling) Rules 1989 and amendments thereof by the Competent Authority any License granted by DPT shall automatically be lapsed till the Authorization so cancelled /suspended is restored.

15. In the event of any dispute or interpretation of the terms of and condition or any alleged breach thereof the same shall be referred to the Sole Arbitrator of the Chairman, Deendayal Port Trust or to an Authority appointed by him for the purpose. The Arbitration shall be conducted in accordance with the provisions of the Arbitration and Conciliation Act. 1996. The award of Arbitrator shall be final and binding. The Court at Gandhidham shall alone have exclusive jurisdiction to entertain and try all matter arising out of this License Agreement.

16. The Licensee shall submit a return to the Deputy Conservator during the 1st week of every Month, furnishing the details of Garbage, etc. collected from the Port area under this License and the manner in which the same has been disposed off.

17. The licensee shall intimate PHO regarding details of Garbage collection (type of Garbage, weight of garbage etc.) collected from each Vessel before sailing of Vessels.

18. The permission/License fee payable shall be as under:-

    (i) Levying License fee of **Rs. 16,000/- + GST** per annum **As per Board Resolution No. 41 of Dated 22.07.2019** from the private Licensees for removal of only dry garbage (non-hazardous) from vessels calling Kandla Port subject to production of NOC of Customs, NOC of PHO Kandla, NOC of Municipality and Monthly submission of return on collection and disposal thereof to Deputy Conservator and report on Swach Sagar Portal.

    (ii) The quantum of License fee will be extended every three years by 25%.

    (iii) Levying of Wharfage charges as specified in SOR from time to time.

Yours faithfully,

3/6

Deputy Conservator
Deendayal Port Trust

O/C
2/6/21

Copy to: -
TM/CME/CE/HM/FCSO/CISF/COM (OOT)

DEENDAYAL PORT TRUST

ISO 9001:2008 PORT
ISO 14001:2004

Administrative Office Building,
Post Box No: - 50,
Gandhidham- Kachchh,
Gujarat State – India
Ph- (02836) 233585, 220235
FAX : (02836) 233585

e-mail:dyconservator@kandlaport.gov.in

No.MR/WK/1101(1)/264

Date: - 04/02/2022

To,
M/s. Harish A. Pandya,
15, Brahm Samaj Building,
Plot No: 106, Sector-8,
Behind Oslo Cinema,
GANDHIDHAM - Kachchh

Sub: - Grant of Permission / License for removal of Dry Solid Waste (Non Hazardous) from Vessels calling at Deendayal/Vadinar/ Tuna Port.

Sir,

Your request for new Permission/License has been considered and permission is hereby granted for removal of **"Dry Solid Waste (Non Hazardous)"** from the Vessels calling at **Kandla/Tuna/Vadinar Port,** for the period of one year from the date of issue of license subject to submission of valid NOCs of PHO, Municipality and Customs immediately after expiry of its validity, recovery of wharfage charges and change in policy or guidelines of Kandla Port trust, Government of India and competent authority from time to time and issuance of instructions accordingly under the following terms & conditions;

1. The Licensee should comply with the Hazardous Waste (Management & Handling Rules) 1989 as amended from time to time.

* **The Licensee should comply with all regulations of GPCB Water (Prevention & control of pollution) Act-1974, Hazardous waste (Management & Handling & Trans boundary movement rules, 2008) under Environmental Protection Act, 1986.**

2. The Licensee shall be authorized to act as occupier and operator for the purpose of collection of Dry Waste and Garbage from ships and same can be undertaken with the permission of the Deputy Conservator free of cost subject to the Rules given at (1) above.

2A. The licensee shall be allowed to remove all type of garbage viz Expired Medicine, Food Waste, Dunnage Wood, Plastic, expired battery eye wash.

Contd.

3. The Port Trust shall not be responsible for any payment to the Licensee for collecting aforesaid Waste from the Vessels, which should be settled by Licensee with the concerned Shipping Agent or Master of the Vessel.

4. In case the port wants to deliver any Dry Waste/Garbage etc. from the Port area, the same has to be collected by the Licensee free of charge at his own cost and responsibility.

5. Permission of the Deputy Conservator or his authorized representative has to be obtained before collection of any garbage from anywhere in the Port.

6. The Licensee shall collect the waste materials as above within a reasonable time as would be determined by the Deputy Conservator. The Licensee shall also ensure that the removal of Garbage from ships will be undertaken without causing any hindrance to Port activities.

7. The Licensee shall bear the cost of the damages (without any demur, Reservation, recourse, contest and protest) if any, caused by him or by his employee to any properties of the Port or its employees.

8. The Licensee for collection of aforesaid garbage undertake the work with the permission of Port authorities, Master of the Vessel or Shipping Agent, Custom authorities, GPCB and Pollution Board of the respective State where dumping /recycling yard is located, for every act of collection.

9. The License would be valid as detailed above. However on satisfactory performance and compliance with the License conditions, the License may be renewed for a further period of one year at a time.

10. The Port reserves the right to alter the conditions of the License or even cancels the License at any point of time without assigning any reason thereof.

11. The License will automatically stand cancelled if the licensee does not meet any of the statutory /legal requirements of the work including those applicable for the protection of environment, deployment of man, machinery, vehicles, floating crafts, etc.

12. The mode of transport / road tankers being utilized by the licensee should have proper License from the respective statutory authorities, **the barges and other floating crafts** being used for undertaking the subject work must have proper validity and License from Deendayal Port authorities/ Sate /Central Government authorities as the case may be.

(Cont....)

13. The Garbage should be carried in open truck but should be carried with proper covering as per statutory regulations to approved dumping yards and to be disposed off as per statutory Regulations prevailing from time to time. Reports as required are to be made on Swach Sagar Portal & other statutory bodies as required.

14. If the Authorization is cancelled in terms Hazardous Waste(Management and Handling) Rules 1989 and amendments thereof by the Competent Authority any License granted by DPT shall automatically be lapsed till the Authorization so cancelled /suspended is restored.

15. In the event of any dispute or interpretation of the terms of and condition or any alleged breach thereof the same shall be referred to the Sole Arbitrator of the Chairman, Deendayal Port Trust or to an Authority appointed by him for the purpose. The Arbitration shall be conducted in accordance with the provisions of the Arbitration and Conciliation Act. 1996. The award of Arbitrator shall be final and binding. The Court at Gandhidham shall alone have exclusive jurisdiction to entertain and try all matter arising out of this License Agreement.

16. The Licensee shall submit a return to the Deputy Conservator during the 1st week of every Month, furnishing the details of Garbage, etc. collected from the Port area under this License and the manner in which the same has been disposed off.

17. The licensee shall intimate PHO regarding details of Garbage collection (type of Garbage, weight of garbage etc.) collected from each Vessel before sailing of Vessels.

18. The permission/License fee payable shall be as under:-

    (i) Levying License fee of **Rs. 16,000/- + GST** per annum **As per Board Resolution No. 41 of Dated 22.07.2019** from the private Licensees for removal of only dry garbage (non-hazardous) from vessels calling Kandla Port subject to production of NOC of Customs, NOC of PHO Kandla, NOC of Municipality and Monthly submission of return on collection and disposal thereof to Deputy Conservator and report on Swach Sagar Portal.

    (ii) The quantum of License fee will be extended every three years by 25%.

    (iii) Levying of Wharfage charges as specified in SOR from time to time.

Yours faithfully,

Deputy Conservator
Deendayal Port Trust

Copy to: -
TM/CME/CE/HM/FCSO/CISF/COM (OOT)

उप संरक्षक
दीनदयाल पोर्ट ट्रस्ट
Deputy Conservator
Deendayal Port Trust

DEENDAYAL PORT TRUST

ISO 9001:2008 PORT
ISO 14001:2004

Administrative Office Building,
Post Box No: - 50,
Gandhidham- Kachchh,
Gujarat State – India
Ph- (02836) 233585, 220235
FAX : (02836) 233585

e-mail:dyconservator@kandlaport.gov.in

No.MR/WK/1101(KME)/ 95 Date: - 05/05/2021

To,
M/s. K M Enterprise,
Plot No. 13, Sector – 8,
Near BM Petrol Pump, Opp. Sharma Motors,
Gandhidham – Kutch.

Sub: - Grant of Permission / License for removal of Dry Solid Waste (Non Hazardous) from Vessels calling at Deendayal Port.

Sir,

Your request for new Permission/License has been considered and permission is hereby granted for removal of **"Dry Solid Waste (Non Hazardous) Scrap"** from the Vessels calling at **Deendayal Port and Vadinar Port,** for the period of one year from the date of issue of license subject to submission of valid NOCs of PHO, Municipality and Customs immediately after expiry of its validity, recovery of wharfage charges and change in policy or guidelines of Kandla Port trust, Government of India and competent authority from time to time and issuance of instructions accordingly under the following terms & conditions;

1. The Licensee should comply with the Hazardous Waste (Management & Handling Rules) 1989 as amended from time to time.

* **The Licensee should comply with all regulations of GPCB Water (Prevention & control of pollution) Act-1974, Hazardous waste (Management & Handling & Trans boundary movement rules, 2008) under Environmental Protection Act, 1986.**

2. The Licensee shall be authorized to act as occupier and operator for the purpose of collection of Dry Waste and Garbage from ships and same can be undertaken with the permission of the Deputy Conservator free of cost subject to the Rules given at (1) above.

2A. The licensee shall be allowed to remove all type of garbage viz Expired Medicine, Food Waste, Dunnage Wood, Plastic, expired battery eye wash.

Contd.

3. The Port Trust shall not be responsible for any payment to the Licensee for collecting aforesaid Waste from the Vessels, which should be settled by Licensee with the concerned Shipping Agent or Master of the Vessel.

4. In case the port wants to deliver any Dry Waste/Garbage etc. from the Port area, the same has to be collected by the Licensee free of charge at his own cost and responsibility.

5. Permission of the Deputy Conservator or his authorized representative has to be obtained before collection of any garbage from anywhere in the Port.

6. The Licensee shall collect the waste materials as above within a reasonable time as would be determined by the Deputy Conservator. The Licensee shall also ensure that the removal of Garbage from ships will be undertaken without causing any hindrance to Port activities.

7. The Licensee shall bear the cost of the damages (without any demur, Reservation, recourse, contest and protest) if any, caused by him or by his employee to any properties of the Port or its employees.

8. The Licensee for collection of aforesaid garbage undertake the work with the permission of Port authorities, Master of the Vessel or Shipping Agent, Custom authorities, GPCB and Pollution Board of the respective State where dumping /recycling yard is located, for every act of collection.

9. The License would be valid as detailed above. However on satisfactory performance and compliance with the License conditions, the License may be renewed for a further period of one year at a time.

10. The Port reserves the right to alter the conditions of the License or even cancels the License at any point of time without assigning any reason thereof.

11. The License will automatically stand cancelled if the licensee does not meet any of the statutory /legal requirements of the work including those applicable for the protection of environment, deployment of man, machinery, vehicles, floating crafts, etc.

12. The mode of transport / road tankers being utilized by the licensee should have proper License from the respective statutory authorities, **the barges and other floating crafts** being used for undertaking the subject work must have proper validity and License from Deendayal Port authorities/ Sate /Central Government authorities as the case may be.

(Cont....)

13. The Garbage should be carried in open truck but should be carried with proper covering as per statutory regulations to approved dumping yards and to be disposed off as per statutory Regulations prevailing from time to time. Reports as required are to be made on Swach Sagar Portal & other statutory bodies as required.

14. If the Authorization is cancelled in terms Hazardous Waste(Management and Handling) Rules 1989 and amendments thereof by the Competent Authority any License granted by DPT shall automatically be lapsed till the Authorization so cancelled /suspended is restored.

15. In the event of any dispute or interpretation of the terms of and condition or any alleged breach thereof the same shall be referred to the Sole Arbitrator of the Chairman, Deendayal Port Trust or to an Authority appointed by him for the purpose. The Arbitration shall be conducted in accordance with the provisions of the Arbitration and Conciliation Act. 1996. The award of Arbitrator shall be final and binding. The Court at Gandhidham shall alone have exclusive jurisdiction to entertain and try all matter arising out of this License Agreement.

16. The Licensee shall submit a return to the Deputy Conservator during the 1st week of every Month, furnishing the details of Garbage, etc. collected from the Port area under this License and the manner in which the same has been disposed off.

17. The licensee shall intimate PHO regarding details of Garbage collection (type of Garbage, weight of garbage etc.) collected from each Vessel before sailing of Vessels.

18. The permission/License fee payable shall be as under:-

    (i) Levying License fee of **Rs. 16,000/- + GST** per annum **As per Board Resolution No. 41 of Dated 22.07.2019** from the private Licensees for removal of only dry garbage (non-hazardous) from vessels calling Kandla Port subject to production of NOC of Customs, NOC of PHO Kandla, NOC of Municipality and Monthly submission of return on collection and disposal thereof to Deputy Conservator and report on Swach Sagar Portal.

    (ii) The quantum of License fee will be extended every three years by 25%.

    (iii) Levying of Wharfage charges as specified in SOR from time to time.

Yours faithfully,

Deputy Conservator
Deendayal Port Trust

Copy to: -
TM/CME/CE/HM/FCSO/CISF/COM (OOT)

o/c
7/5/21

DEENDAYAL PORT TRUST

ISO 9001:2008 PORT
ISO 14001:2004

Administrative Office Building,
Post Box No: - 50,
Gandhidham- Kachchh,
Gujarat State – India
Ph- (02836) 233585, 220235
FAX : (02836) 233585

e-mail:dyconservator@kandlaport.gov.in

No.MR/WK/1101(23)/ 826

Date: - 5 /06/2021

To,
M/s. Naaz Shipping Services Enterprise,
Office No. 35, First Floor,
Grain Merchant Association Building,
Plot No. 297, Ward – 12/B,
Gandhidham (Kutch)

Sub: - Grant of Permission / License for removal of Dry Solid Waste (Non Hazardous) from Vessels calling at Kandla and Vadinar Port.

Sir,

Your request for new Permission/License has been considered and permission is hereby granted for removal of **"Dry Solid Waste (Non Hazardous)"** from the Vessels calling at **Deendayal Port and Vadinar Port** for the period of one year from the date of issue of license subject to submission of valid NOCs of PHO, Municipality and Customs immediately after expiry of its validity, recovery of wharfage charges and change in policy or guidelines of Kandla Port trust, Government of India and competent authority from time to time and issuance of instructions accordingly under the following terms & conditions;

1. The Licensee should comply with the Hazardous Waste (Management & Handling Rules) 1989 as amended from time to time.

* **The Licensee should comply with all regulations of GPCB Water (Prevention & control of pollution) Act-1974, Hazardous waste (Management & Handling & Trans boundary movement rules, 2008) under Environmental Protection Act, 1986.**

2. The Licensee shall be authorized to act as occupier and operator for the purpose of collection of Dry Waste and Garbage from ships and same can be undertaken with the permission of the Deputy Conservator free of cost subject to the Rules given at (1) above.

2A. The licensee shall be allowed to remove all type of garbage viz Expired Medicine, Food Waste, Dunnage Wood, Plastic, expired battery eye wash.

Contd.

3. The Port Trust shall not be responsible for any payment to the Licensee for collecting aforesaid Waste from the Vessels, which should be settled by Licensee with the concerned Shipping Agent or Master of the Vessel.

4. In case the port wants to deliver any Dry Waste/Garbage etc. from the Port area, the same has to be collected by the Licensee free of charge at his own cost and responsibility.

5. Permission of the Deputy Conservator or his authorized representative has to be obtained before collection of any garbage from anywhere in the Port.

6. The Licensee shall collect the waste materials as above within a reasonable time as would be determined by the Deputy Conservator. The Licensee shall also ensure that the removal of Garbage from ships will be undertaken without causing any hindrance to Port activities.

7. The Licensee shall bear the cost of the damages (without any demur, Reservation, recourse, contest and protest) if any, caused by him or by his employee to any properties of the Port or its employees.

8. The Licensee for collection of aforesaid garbage undertake the work with the permission of Port authorities, Master of the Vessel or Shipping Agent, Custom authorities, GPCB and Pollution Board of the respective State where dumping /recycling yard is located, for every act of collection.

9. The License would be valid as detailed above. However on satisfactory performance and compliance with the License conditions, the License may be renewed for a further period of one year at a time.

10. The Port reserves the right to alter the conditions of the License or even cancels the License at any point of time without assigning any reason thereof.

11. The License will automatically stand cancelled if the licensee does not meet any of the statutory /legal requirements of the work including those applicable for the protection of environment, deployment of man, machinery, vehicles, floating crafts, etc.

12. The mode of transport / road tankers being utilized by the licensee should have proper License from the respective statutory authorities, **the barges and other floating crafts** being used for undertaking the subject work must have proper validity and License from Deendayal Port authorities/ Sate /Central Government authorities as the case may be.

(Cont...)

13. The Garbage should be carried in open truck but should be carried with proper covering as per statutory regulations to approved dumping yards and to be disposed off as per statutory Regulations prevailing from time to time. Reports as required are to be made on Swach Sagar Portal & other statutory bodies as required.

14. If the Authorization is cancelled in terms Hazardous Waste(Management and Handling) Rules 1989 and amendments thereof by the Competent Authority any License granted by DPT shall automatically be lapsed till the Authorization so cancelled /suspended is restored.

15. In the event of any dispute or interpretation of the terms of and condition or any alleged breach thereof the same shall be referred to the Sole Arbitrator of the Chairman, Deendayal Port Trust or to an Authority appointed by him for the purpose. The Arbitration shall be conducted in accordance with the provisions of the Arbitration and Conciliation Act. 1996. The award of Arbitrator shall be final and binding. The Court at Gandhidham shall alone have exclusive jurisdiction to entertain and try all matter arising out of this License Agreement.

16. The Licensee shall submit a return to the Deputy Conservator during the 1st week of every Month, furnishing the details of Garbage, etc. collected from the Port area under this License and the manner in which the same has been disposed off.

17. The licensee shall intimate PHO regarding details of Garbage collection (type of Garbage, weight of garbage etc.) collected from each Vessel before sailing of Vessels.

18. The permission/License fee payable shall be as under:-

    (i) Levying License fee of **Rs. 16,000/- + GST** per annum **As per Board Resolution No. 41 of Dated 22.07.2019** from the private Licensees for removal of only dry garbage (non-hazardous) from vessels calling Kandla Port subject to production of NOC of Customs, NOC of PHO Kandla, NOC of Municipality and Monthly submission of return on collection and disposal thereof to Deputy Conservator and report on Swach Sagar Portal.

    (ii) The quantum of License fee will be extended every three years by 25%.

    (iii) Levying of Wharfage charges as specified in SOR from time to time.

Yours faithfully

Deputy Conservator
Deendayal Port Trust

4/6. O/C
4/6/21

Copy to: -
TM/CME/CE/HM/FCSO/CISF/COM (OOT)

DEENDAYAL PORT TRUST

ISO 9001:2008 PORT
ISO 14001:2004

Administrative Office Building,
Post Box No: - 50,
Gandhidham- Kachchh,
Gujarat State – India
Ph- (02836) 233585, 220235
FAX : (02836) 233585

e-mail:dyconservator@kandlaport.gov.in

No.MR/WK/1101(NIMW)/33

Date: - 23/02/2022

To,
M/s New India Marine Works,
Plot No. 378, Ward 11/A,
Shop No. 1, Bharatnagar,
GANDHIDHAM - Kachchh

Sub: - Grant of Permission / License for removal of Dry Solid Waste (Non Hazardous) from Vessels calling at Deendayal Port.

Sir,

Your request for new Permission/License has been considered and permission is hereby granted for removal of **"Dry Solid Waste (Non Hazardous)"** from the Vessels calling at **Kandla, Tuna and Vadinar,** for the period of one year from the date of issue of license subject to submission of valid NOCs of PHO, Municipality and Customs immediately after expiry of its validity, recovery of wharfage charges and change in policy or guidelines of Kandla Port trust, Government of India and competent authority from time to time and issuance of instructions accordingly under the following terms & conditions;

1. The Licensee should comply with the Hazardous Waste (Management & Handling Rules) 1989 as amended from time to time.

* **The Licensee should comply with all regulations of GPCB Water (Prevention & control of pollution) Act-1974, Hazardous waste (Management & Handling & Trans boundary movement rules, 2008) under Environmental Protection Act, 1986.**

2. The Licensee shall be authorized to act as occupier and operator for the purpose of collection of Dry Waste and Garbage from ships and same can be undertaken with the permission of the Deputy Conservator free of cost subject to the Rules given at (1) above.

2A. The licensee shall be allowed to remove all type of garbage viz Expired Medicine, Food Waste, Dunnage Wood, Plastic, expired battery eye wash.

Contd.

3. The Port Trust shall not be responsible for any payment to the Licensee for collecting aforesaid Waste from the Vessels, which should be settled by Licensee with the concerned Shipping Agent or Master of the Vessel.

4. In case the port wants to deliver any Dry Waste/Garbage etc. from the Port area, the same has to be collected by the Licensee free of charge at his own cost and responsibility.

5. Permission of the Deputy Conservator or his authorized representative has to be obtained before collection of any garbage from anywhere in the Port.

6. The Licensee shall collect the waste materials as above within a reasonable time as would be determined by the Deputy Conservator. The Licensee shall also ensure that the removal of Garbage from ships will be undertaken without causing any hindrance to Port activities.

7. The Licensee shall bear the cost of the damages (without any demur, Reservation, recourse, contest and protest) if any, caused by him or by his employee to any properties of the Port or its employees.

8. The Licensee for collection of aforesaid garbage undertake the work with the permission of Port authorities, Master of the Vessel or Shipping Agent, Custom authorities, GPCB and Pollution Board of the respective State where dumping /recycling yard is located, for every act of collection.

9. The License would be valid as detailed above. However on satisfactory performance and compliance with the License conditions, the License may be renewed for a further period of one year at a time.

10. The Port reserves the right to alter the conditions of the License or even cancels the License at any point of time without assigning any reason thereof.

11. The License will automatically stand cancelled if the licensee does not meet any of the statutory /legal requirements of the work including those applicable for the protection of environment, deployment of man, machinery, vehicles, floating crafts, etc.

12. The mode of transport / road tankers being utilized by the licensee should have proper License from the respective statutory authorities, **the barges and other floating crafts** being used for undertaking the subject work must have proper validity and License from Deendayal Port authorities/ Sate /Central Government authorities as the case may be.

(Cont....)

13. The Garbage should be carried in open truck but should be carried with proper covering as per statutory regulations to approved dumping yards and to be disposed off as per statutory Regulations prevailing from time to time. Reports as required are to be made on Swach Sagar Portal & other statutory bodies as required.

14. If the Authorization is cancelled in terms Hazardous Waste(Management and Handling) Rules 1989 and amendments thereof by the Competent Authority any License granted by DPT shall automatically be lapsed till the Authorization so cancelled /suspended is restored.

15. In the event of any dispute or interpretation of the terms of and condition or any alleged breach thereof the same shall be referred to the Sole Arbitrator of the Chairman, Deendayal Port Trust or to an Authority appointed by him for the purpose. The Arbitration shall be conducted in accordance with the provisions of the Arbitration and Conciliation Act. 1996. The award of Arbitrator shall be final and binding. The Court at Gandhidham shall alone have exclusive jurisdiction to entertain and try all matter arising out of this License Agreement.

16. The Licensee shall submit a return to the Deputy Conservator during the 1st week of every Month, furnishing the details of Garbage, etc. collected from the Port area under this License and the manner in which the same has been disposed off.

17. The licensee shall intimate PHO regarding details of Garbage collection (type of Garbage, weight of garbage etc.) collected from each Vessel before sailing of Vessels.

18. The permission/License fee payable shall be as under:-

(i) Levying License fee of **Rs. 16,000/- + GST** per annum **As per Board Resolution No. 41 of Dated 22.07.2019** from the private Licensees for removal of only dry garbage (non-hazardous) from vessels calling Kandla Port subject to production of NOC of Customs, NOC of PHO Kandla, NOC of Municipality and Monthly submission of return on collection and disposal thereof to Deputy Conservator and report on Swach Sagar Portal.

(ii) The quantum of License fee will be extended every three years by 25%.

(iii) Levying of Wharfage charges as specified in SOR from time to time.

Yours faithfully,

Deputy Conservator
Deendayal Port Trust

Copy to: -
TM/CME/CE/HM/FCSO/CISF/COM (OOT)

DEENDAYAL PORT TRUST

ISO 9001:2008 PORT
ISO 14001:2004

Administrative Office Building,
Post Box No: - 50,
Gandhidham- Kachchh,
Gujarat State – India
Ph- (02836) 233585, 220235
FAX : (02836) 233585

e-mail:dyconservator@kandlaport.gov.in

No.MR/WK/1101(30)/ 967 Date: - 29 /06/2021

To,
M/s. Omega marine Services,
Office No. 2, Braham Samaj Building,
Plot No. 106, Sector - 8
Gandhidham (Kutch)

Sub: - Grant of Permission / License for removal of Dry Solid Waste (Non Hazardous) from Vessels calling at Deendayal Port.

Sir,

Your request for new Permission/License has been considered and permission is hereby granted for removal of **"Dry Solid Waste (Non Hazardous)"** from the Vessels calling at **Deendayal Port** for the period of one year from the date of issue of license subject to submission of valid NOCs of PHO, Municipality and Customs immediately after expiry of its validity, recovery of wharfage charges and change in policy or guidelines of Kandla Port trust, Government of India and competent authority from time to time and issuance of instructions accordingly under the following terms & conditions;

1. The Licensee should comply with the Hazardous Waste (Management & Handling Rules) 1989 as amended from time to time.

* **The Licensee should comply with all regulations of GPCB Water (Prevention & control of pollution) Act-1974, Hazardous waste (Management & Handling & Trans boundary movement rules, 2008) under Environmental Protection Act, 1986.**

2. The Licensee shall be authorized to act as occupier and operator for the purpose of collection of Dry Waste and Garbage from ships and same can be undertaken with the permission of the Deputy Conservator free of cost subject to the Rules given at (1) above.

2A. The licensee shall be allowed to remove all type of garbage viz Expired Medicine, Food Waste, Dunnage Wood, Plastic, expired battery eye wash.

Contd.

3. The Port Trust shall not be responsible for any payment to the Licensee for collecting aforesaid Waste from the Vessels, which should be settled by Licensee with the concerned Shipping Agent or Master of the Vessel.

4. In case the port wants to deliver any Dry Waste/Garbage etc. from the Port area, the same has to be collected by the Licensee free of charge at his own cost and responsibility.

5. Permission of the Deputy Conservator or his authorized representative has to be obtained before collection of any garbage from anywhere in the Port.

6. The Licensee shall collect the waste materials as above within a reasonable time as would be determined by the Deputy Conservator. The Licensee shall also ensure that the removal of Garbage from ships will be undertaken without causing any hindrance to Port activities.

7. The Licensee shall bear the cost of the damages (without any demur, Reservation, recourse, contest and protest) if any, caused by him or by his employee to any properties of the Port or its employees.

8. The Licensee for collection of aforesaid garbage undertake the work with the permission of Port authorities, Master of the Vessel or Shipping Agent, Custom authorities, GPCB and Pollution Board of the respective State where dumping /recycling yard is located, for every act of collection.

9. The License would be valid as detailed above. However on satisfactory performance and compliance with the License conditions, the License may be renewed for a further period of one year at a time.

10. The Port reserves the right to alter the conditions of the License or even cancels the License at any point of time without assigning any reason thereof.

11. The License will automatically stand cancelled if the licensee does not meet any of the statutory /legal requirements of the work including those applicable for the protection of environment, deployment of man, machinery, vehicles, floating crafts, etc.

12. The mode of transport / road tankers being utilized by the licensee should have proper License from the respective statutory authorities, **the barges and other floating crafts** being used for undertaking the subject work must have proper validity and License from Deendayal Port authorities/ Sate /Central Government authorities as the case may be.

(Cont....)

13. The Garbage should be carried in open truck but should be carried with proper covering as per statutory regulations to approved dumping yards and to be disposed off as per statutory Regulations prevailing from time to time. Reports as required are to be made on Swach Sagar Portal & other statutory bodies as required.

14. If the Authorization is cancelled in terms Hazardous Waste(Management and Handling) Rules 1989 and amendments thereof by the Competent Authority any License granted by DPT shall automatically be lapsed till the Authorization so cancelled /suspended is restored.

15. In the event of any dispute or interpretation of the terms of and condition or any alleged breach thereof the same shall be referred to the Sole Arbitrator of the Chairman, Deendayal Port Trust or to an Authority appointed by him for the purpose. The Arbitration shall be conducted in accordance with the provisions of the Arbitration and Conciliation Act. 1996. The award of Arbitrator shall be final and binding. The Court at Gandhidham shall alone have exclusive jurisdiction to entertain and try all matter arising out of this License Agreement.

16. The Licensee shall submit a return to the Deputy Conservator during the 1st week of every Month, furnishing the details of Garbage, etc. collected from the Port area under this License and the manner in which the same has been disposed off.

17. The licensee shall intimate PHO regarding details of Garbage collection (type of Garbage, weight of garbage etc.) collected from each Vessel before sailing of Vessels.

18. The permission/License fee payable shall be as under:-

    (i) Levying License fee of **Rs. 16,000/- + GST** per annum **As per Board Resolution No. 41 of Dated 22.07.2019** from the private Licensees for removal of only dry garbage (non-hazardous) from vessels calling Kandla Port subject to production of NOC of Customs, NOC of PHO Kandla, NOC of Municipality and Monthly submission of return on collection and disposal thereof to Deputy Conservator and report on Swach Sagar Portal.

    (ii) The quantum of License fee will be extended every three years by 25%.

    (iii) Levying of Wharfage charges as specified in SOR from time to time.

Yours faithfully,

22/6

Deputy Conservator
Deendayal Port Trust

25/6. ok 25/6/21

Copy to: -
TM/CME/CE/HM/FCSO/CISF/COM (OOT)

DEENDAYAL PORT TRUST

ISO 9001:2008 PORT
ISO 14001:2004

Administrative Office Building,
Post Box No: - 50,
Gandhidham- Kachchh,
Gujarat State – India
Ph- (02836) 233585, 220235
FAX : (02836) 233585

e-mail:dyconservator@kandlaport.gov.in

No.MR/WK/1101(VKE)/953 Date: - 26/06/2021

To,
M/s. V. K. Enterprise,
Shop No. 2, Plot No. 16,
Sector 1/A, Shakti Nagar Road,
Gandhidham (Kutch)

Sub: - Grant of Permission / License for removal of Dry Solid Waste (Non Hazardous) from Vessels calling at Kandla and Tuna Port.

Sir,

Your request for new Permission/License has been considered and permission is hereby granted for removal of **"Dry Solid Waste (Non Hazardous)"** from the Vessels calling at **Deendayal Port and Tuna Port** for the period of one year from the date of issue of license subject to submission of valid NOCs of PHO, Municipality and Customs immediately after expiry of its validity, recovery of wharfage charges and change in policy or guidelines of Kandla Port trust, Government of India and competent authority from time to time and issuance of instructions accordingly under the following terms & conditions;

1. The Licensee should comply with the Hazardous Waste (Management & Handling Rules) 1989 as amended from time to time.

* **The Licensee should comply with all regulations of GPCB Water (Prevention & control of pollution) Act-1974, Hazardous waste (Management & Handling & Trans boundary movement rules, 2008) under Environmental Protection Act, 1986.**

2. The Licensee shall be authorized to act as occupier and operator for the purpose of collection of Dry Waste and Garbage from ships and same can be undertaken with the permission of the Deputy Conservator free of cost subject to the Rules given at (1) above.

2A. **The licensee shall be allowed to remove all type of garbage viz Expired Medicine, Food Waste, Dunnage Wood, Plastic, expired battery eye wash.**

Contd.

3. The Port Trust shall not be responsible for any payment to the Licensee for collecting aforesaid Waste from the Vessels, which should be settled by Licensee with the concerned Shipping Agent or Master of the Vessel.

4. In case the port wants to deliver any Dry Waste/Garbage etc. from the Port area, the same has to be collected by the Licensee free of charge at his own cost and responsibility.

5. Permission of the Deputy Conservator or his authorized representative has to be obtained before collection of any garbage from anywhere in the Port.

6. The Licensee shall collect the waste materials as above within a reasonable time as would be determined by the Deputy Conservator. The Licensee shall also ensure that the removal of Garbage from ships will be undertaken without causing any hindrance to Port activities.

7. The Licensee shall bear the cost of the damages (without any demur, Reservation, recourse, contest and protest) if any, caused by him or by his employee to any properties of the Port or its employees.

8. The Licensee for collection of aforesaid garbage undertake the work with the permission of Port authorities, Master of the Vessel or Shipping Agent, Custom authorities, GPCB and Pollution Board of the respective State where dumping /recycling yard is located, for every act of collection.

9. The License would be valid as detailed above. However on satisfactory performance and compliance with the License conditions, the License may be renewed for a further period of one year at a time.

10. The Port reserves the right to alter the conditions of the License or even cancels the License at any point of time without assigning any reason thereof.

11. The License will automatically stand cancelled if the licensee does not meet any of the statutory /legal requirements of the work including those applicable for the protection of environment, deployment of man, machinery, vehicles, floating crafts, etc.

12. The mode of transport / road tankers being utilized by the licensee should have proper License from the respective statutory authorities, **the barges and other floating crafts** being used for undertaking the subject work must have proper validity and License from Deendayal Port authorities/ Sate /Central Government authorities as the case may be.

(Cont....)

13. The Garbage should be carried in open truck but should be carried with proper covering as per statutory regulations to approved dumping yards and to be disposed off as per statutory Regulations prevailing from time to time. Reports as required are to be made on Swach Sagar Portal & other statutory bodies as required.

14. If the Authorization is cancelled in terms Hazardous Waste(Management and Handling) Rules 1989 and amendments thereof by the Competent Authority any License granted by DPT shall automatically be lapsed till the Authorization so cancelled /suspended is restored.

15. In the event of any dispute or interpretation of the terms of and condition or any alleged breach thereof the same shall be referred to the Sole Arbitrator of the Chairman, Deendayal Port Trust or to an Authority appointed by him for the purpose. The Arbitration shall be conducted in accordance with the provisions of the Arbitration and Conciliation Act. 1996. The award of Arbitrator shall be final and binding. The Court at Gandhidham shall alone have exclusive jurisdiction to entertain and try all matter arising out of this License Agreement.

16. The Licensee shall submit a return to the Deputy Conservator during the 1st week of every Month, furnishing the details of Garbage, etc. collected from the Port area under this License and the manner in which the same has been disposed off.

17. The licensee shall intimate PHO regarding details of Garbage collection (type of Garbage, weight of garbage etc.) collected from each Vessel before sailing of Vessels.

18. The permission/License fee payable shall be as under:-

    (i) Levying License fee of **Rs. 16,000/- + GST** per annum **As per Board Resolution No. 41 of Dated 22.07.2019** from the private Licensees for removal of only dry garbage (non-hazardous) from vessels calling Kandla Port subject to production of NOC of Customs, NOC of PHO Kandla, NOC of Municipality and Monthly submission of return on collection and disposal thereof to Deputy Conservator and report on Swach Sagar Portal.

    (ii) The quantum of License fee will be extended every three years by 25%.

    (iii) Levying of Wharfage charges as specified in SOR from time to time.

Yours faithfully

Deputy Conservator
Deendayal Port Trust

24/6 OK 24/6/21

Copy to: -
TM/CME/CE/HM/FCSO/CISF/COM (OOT)

DEENDAYAL PORT TRUST

ISO 9001:2008 PORT
ISO 14001:2004

Administrative Office Building,
Post Box No: - 50,
Gandhidham- Kachchh,
Gujarat State – India
Ph- (02836) 233585, 220235
FAX : (02836) 233585

e-mail:dyconservator@kandlaport.gov.in

No.MR/WK/1101(21)/3423 Date: - 17/10/2021 11

To,
M/s. Vishwa Trade-Link Inc.,
214, 2nd Floor, "Kutch Arcade" –
Platinum Building, Mithi Rohar Road, NH 8/A, ,
GANDHIDHAM - 370210

Sub: - Grant of Permission / License for removal of Dry Solid Waste (Non Hazardous) from Vessels calling at Deendayal Port.

Sir, .

Your request for new Permission/License has been considered and permission is hereby granted for removal of **"Dry Solid Waste (Non Hazardous)"** from the Vessels calling at **Deendayal Port and Vadinar Port,** for the period of one year from the date of issue of license subject to submission of valid NOCs of PHO, Municipality and Customs immediately after expiry of its validity, recovery of wharfage charges and change in policy or guidelines of Kandla Port trust, Government of India and competent authority from time to time and issuance of instructions accordingly under the following terms & conditions;

1. The Licensee should comply with the Hazardous Waste (Management & Handling Rules) 1989 as amended from time to time.

* **The Licensee should comply with all regulations of GPCB Water (Prevention & control of pollution) Act-1974, Hazardous waste (Management & Handling & Trans boundary movement rules, 2008) under Environmental Protection Act, 1986.**

2. The Licensee shall be authorized to act as occupier and operator for the purpose of collection of Dry Waste and Garbage from ships and same can be undertaken with the permission of the Deputy Conservator free of cost subject to the Rules given at (1) above.

2A. The licensee shall be allowed to remove all type of garbage viz Expired Medicine, Food Waste, Dunnage Wood, Plastic, expired battery eye wash.

Contd.

Received
17/11

3. The Port Trust shall not be responsible for any payment to the Licensee for collecting aforesaid Waste from the Vessels, which should be settled by Licensee with the concerned Shipping Agent or Master of the Vessel.

4. In case the port wants to deliver any Dry Waste/Garbage etc. from the Port area, the same has to be collected by the Licensee free of charge at his own cost and responsibility.

5. Permission of the Deputy Conservator or his authorized representative has to be obtained before collection of any garbage from anywhere in the Port.

6. The Licensee shall collect the waste materials as above within a reasonable time as would be determined by the Deputy Conservator. The Licensee shall also ensure that the removal of Garbage from ships will be undertaken without causing any hindrance to Port activities.

7. The Licensee shall bear the cost of the damages (without any demur, Reservation, recourse, contest and protest) if any, caused by him or by his employee to any properties of the Port or its employees.

8. The Licensee for collection of aforesaid garbage undertake the work with the permission of Port authorities, Master of the Vessel or Shipping Agent, Custom authorities, GPCB and Pollution Board of the respective State where dumping /recycling yard is located, for every act of collection.

9. The License would be valid as detailed above. However on satisfactory performance and compliance with the License conditions, the License may be renewed for a further period of one year at a time.

10. The Port reserves the right to alter the conditions of the License or even cancels the License at any point of time without assigning any reason thereof.

11. The License will automatically stand cancelled if the licensee does not meet any of the statutory /legal requirements of the work including those applicable for the protection of environment, deployment of man, machinery, vehicles, floating crafts, etc.

12. The mode of transport / road tankers being utilized by the licensee should have proper License from the respective statutory authorities, **the barges and other floating crafts** being used for undertaking the subject work must have proper validity and License from Deendayal Port authorities/ Sate /Central Government authorities as the case may be.

(Cont....)

13. The Garbage should be carried in open truck but should be carried with proper covering as per statutory regulations to approved dumping yards and to be disposed off as per statutory Regulations prevailing from time to time. Reports as required are to be made on Swach Sagar Portal & other statutory bodies as required.

14. If the Authorization is cancelled in terms Hazardous Waste(Management and Handling) Rules 1989 and amendments thereof by the Competent Authority any License granted by DPT shall automatically be lapsed till the Authorization so cancelled /suspended is restored.

15. In the event of any dispute or interpretation of the terms of and condition or any alleged breach thereof the same shall be referred to the Sole Arbitrator of the Chairman, Deendayal Port Trust or to an Authority appointed by him for the purpose. The Arbitration shall be conducted in accordance with the provisions of the Arbitration and Conciliation Act. 1996. The award of Arbitrator shall be final and binding. The Court at Gandhidham shall alone have exclusive jurisdiction to entertain and try all matter arising out of this License Agreement.

16. The Licensee shall submit a return to the Deputy Conservator during the 1st week of every Month, furnishing the details of Garbage, etc. collected from the Port area under this License and the manner in which the same has been disposed off.

17. The licensee shall intimate PHO regarding details of Garbage collection (type of Garbage, weight of garbage etc.) collected from each Vessel before sailing of Vessels.

18. The permission/License fee payable shall be as under:-

    (i) Levying License fee of **Rs. 16,000/- + GST** per annum **As per Board Resolution No. 41 of Dated 22.07.2019** from the private Licensees for removal of only dry garbage (non-hazardous) from vessels calling Kandla Port subject to production of NOC of Customs, NOC of PHO Kandla, NOC of Municipality and Monthly submission of return on collection and disposal thereof to Deputy Conservator and report on Swach Sagar Portal.

    (ii) The quantum of License fee will be extended every three years by 25%.

    (iii) Levying of Wharfage charges as specified in SOR from time to time.

Yours faithfully,

Deputy Conservator
Deendayal Port Trust

12/11/21 O/C

12/11/21

Copy to: -
TM/CME/CE/HM/FCSO/CISF/COM (OOT)

Annexure –E

Circular for “Controlling of Dust pollution arising out of Coal Handling”.

DEENDAYAL PORT TRUST
(AN ISO 9001:2008 & ISO 14001:2004 CERTIFIED PORT)
(आईएसओ9001:2008 एवंआईएसओ14001:2004प्रमाणितपोर्ट)

SAGARMALA

Telegram : PORT TRUST
तार : पोर्टट्रस्ट
टेलीफोन : 02836-270625
फैक्स : 02836-270475

SIPC KANDLA

यातायात प्रबंधक का कार्यालय
कंडलापोर्टट्रस्ट
गीएंडसीबिल्डिंग
नयाकंडला (कच्छ) 370210

TF/SH/Circulars/2019/1256 Date: 10/10/2019

CIRCULAR

In supersession of earlier Circulars notably No.TF/SH/2019/5362 dtd.23-24/01/2019 and No.TF/SH/Circulars/2019/1004 dtd. 18/09/2019 issued with regard to controlling the dust pollution arising out of coal handling as also ensuring safety in cargo handling so as to avoid damage to port infrastructure, in consultation with Port Users the following Standard Operating Procedures (SOPs) is formulated for due compliance :

1. During the course of discharging coal from the vessels at berth, the grab should invariably be opened at a lower height at Wharf.
2. Trucks/Dumpers are transporting coal from wharf to storage yard, storage yard to railway siding/for final delivery by road, as the case may be, should load coal below the brim/body level to avoid spillage enroute.Trucks, dumpers loaded for delivery of coal while moving from plot to weighbridge or weighbridge to plot and moving out should be covered by tarpaulin.
3. Storage of coal at yard shall not exceed above 5Mtrs height.
4. Water sprinkling on Indonesian coal heaps at plots at regular intervals to be undertaken by respective Port Users.
5. Sweeping machines should be deployed by the Port Users for their respective vessels at wharf and on roads during Coal handling operations.Spillage cargo on road/s should be cleaned immediately.
6. The residual cargo at wharf should be swept immediately on completion of dischargeof vessel to ensure the wharf is clean for next incoming vessel.
7. The internal roads at coal storage yard should be cleaned by the respective Port Users adjacent to their plots.

Further, damages are reportedly being caused to Port properties due to deployment of chain mounted heavy equipments by port users. To avoid such damages and adhering to safety norms, it has been decided not to permit deployment of such chain mounted heavy equipments / vehicles to come into direct contact with the surface on following areas:

1. Chain mounted equipments shall not be allowed to come into direct contact with the surface at wharfs neither for cargo loading nor barge unloading including Bunder area.Such equipments are permittedto be used/moved at Wharfs only on rubber mats/Steel plate and/or on cargo heaps of one meter height and above.
2. At no point of time,the Chain/ Crawler mounted equipments are allowed tocome into direct contact with Concrete/Bitumen surfaceeither whilemoving, loading, unloadingof such equipments, except on rubber mats/steel plates or directly on to cargo heaps of minimum one meter height and above.
3. While cleaning coal spillage on Railway Tracks, equipments like Pay Loaders/Escavators (Hitachis) are not to be used.

4. Dumping and/or Storage of cargo within three meters distance from Cable Ducts, Highmast Light Towers, Drainages, Railway Lines, Waterspringling system, Fire fighting installations is not permitted / allowed.

5. While handling of coal and other bulk cargoes, especially with Ship's Cranes, a temporary precautionary barrier should be made available to avoid spillage of cargo into the sea.

6. Plying of Vehicles, Equipments other than at designated places/areas is not permitted.

All Port Users/stake holders are requested to take note of the above and strictly adhere to the aforestated SOPs. CHA's are requested to inform their respective transporters of these SOP's and give wide publicity amongst them.

Any violation of above circular with regard to non adherence of precautions to be taken whilst deploying chain mounted equipment/s, a penalty of Rs. 25000/- and for any other violationsa penalty of Rs 10000/- shall be imposed for each violation of above rules. If the violation is repeated thrice, it could lead to suspension of licence/authorization for a period 10 days. Repeated and habitual violations could lead to cancellation of licence/ authorization. Road Trafffic, parking, covering of coal by Tarpauling and other safety related violations will be delt with as per Circular of life saving Rules and other Safety Rules DPT and procedure for traffic Safety Management in DPT. Any damage to port property by port user a penality of two times of assessed cost will be recorved from the port users.

This will come into effect from 10/10/2019. The same will be reviewed after three months.

The stakeholder's kind co-operation is solicited.

The Circular is issued with approval of competent authority.

Traffic Manager (I/c)
Deendayal Port Trust

To:

All Port Users/Trade Associations

Copy to :

1. **Sr.PS to Chairman – for kind information of Chairman**
2. **PS to Dy.Chairman – for kind information of Dy.Chairman**
3. **Chief Engineer**
4. **Chief Mechanical Engineer**
5. **ALL Officers of Traffic Department - for implementation**
6. **Sr.DD(EDP) - for uploading on website**

Annexure –F

Environmental Monitoring Report by M/s Detox Corporation for the year 2021-2022

ENVIRONMENT MONITORING REPORT OF DEENDAYAL PORT AUTHORITY

(Annual Report)

(March 2021 to February 2022)

(Report No-DCPL/DPA (19-22)/AMR/21-22/02)

Submitted to

Deendayal Port Authority

Prepared by

Detox Corporation Pvt. Ltd.
Detox House, Udhna Darwaja, RingRoad
Surat - 395002

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1. Introduction

The environmental Monitoring plan is the key document in the environmental management system and sets out the detailed targets, objectives and procedures that will be adopted in order to achieve the goals set out in the environmental policy. EMP document is a collation of background information relevant to the Kandla Port Environmental Management and Monitoring Plan (EMMP).

1.1 The Environment (Protection) Act, 1986

The EPA 1986 came into force in all of India in November of 1986, under an official notification. The Act contains 26 sections divided into 4 chapters. The Act has its genesis in Indian Constitution's Article 48(A) and Article 51 (A)g. The Act is a part of Article 253 of the Indian Constitution.

The rules of Environment protection came into force on 19th November1986 and these rules provide for the following:

- The standards of quality of air, soil and water for various areas and purposes of environment.
- The standard set up to know about the limits of the environmental pollutants.
- Rules include the procedure and safeguards needed to handle the hazardous substance.
- Restrictions and some prohibitions on handling the hazardous substances in different areas and premise
- The procedures and safeguards required for the prevention of accidents which may cause environmental pollution and also the remedies for it.
- The prohibition and restrictions possessed on the location of industries in different areas.

1.2 EIA and CRZ Notification

The Ministry of Environment, Forests & Climate Change (MoEF & CC), Government of India, exercising the powers conferred upon it under the provisions of the Environment (Protection) Act, 1986, issued the Environment Impact Assessment Notification, 2006 and its sub sequent amendments.

1.2.1 EIA Notification

The basic objective of the Environment Impact Assessment is to identify, predict, mitigate and communicate the possible impacts due the proposed project to the Government authority and people likely to be affected and incorporate the conditions for construction, operation, maintenance and waste disposal phases of the project to mitigate the negative (adverse) impacts and enhance the positive impacts for the sustainable development of the region.

Environmental Impact NotificationS.O.1533 (E), dtd.14th September2006as amended 2009, issued under Environment (Protection) Act 1986, has made it mandatory to obtain prior environmental clearance (EC)for scheduled development projects. The notification has classified projects under two categories A & B. Category A projects (including expansion and modernization of existing projects) require clearance from The Ministry of Environment, Forests & Climate Change (MoEF & CC), Govt. of India (GoI) and for category B from State Environmental Impact Assessment Authority(SEIAA),constituted by Govt. of India.

Some important features of the said Notification are:

I. Prior Environmental Clearance (EC) is required by all new projects or activities listed in the Schedule of the EIA Notification2006 and subsequent amendments thereafter.EC are required before Commencement of any construction work or preparation of land by the project management.

II. Prior EC is also required by the existing projects or activities if its capacity is likely to exceed the threshold limit mentioned in the said Schedule.

III. All category B projects where general condition does not apply, the project proponents are required to apply to the SEAC who will hear the case according to the procedure laid down in the EIA notification and based on whose recommendation, EC may be granted or rejected by the SEIAA.

IV. For all category A projects and also category B projects where general condition applies, the project proponents are required to apply directly to The Ministry of Environment, Forests & Climate Change (MoEF & CC), Government of India, who would consider the project for grant or rejection of the EC based on the recommendation of the Expert Appraisal Committee at the central level.

V. If projects attract CRZ clearance, then clearance under CRZ rules is also required.

1.2.2. Coastal Regulation Zone (CRZ)

The Union Cabinet approved the Coastal Regulation Zone (CRZ) Notification,2018 which were last reviewed and issued in 2011. The notification was released after a series of representations received by the Ministry of Environment, Forest & Climate Change (MoEF&CC) from various Coastal States/UTs for a comprehensive review of the provisions of the CRZ Notification, 2011.

1.2.2.1. Classification of CRZ

For the purpose of conserving and protecting the coastal areas and marine waters, the CRZ area shall be classified as follows, namely:-

CRZ-I A

CRZ-I A shall constitute the ecologically sensitive areas (ESAs) and the geomorphologic features which play a role in maintaining the integrity of the coast viz.: Mangroves, corals, biologically active mudflats, Marine national parks, turtle nesting grounds etc.

CRZ-I B

The intertidal zone i.e. the area between Low Tide Line and High Tide Line shall constitute the CRZ-IB.

CRZ-II

CRZ-II shall constitute the developed land areas up to or close to the shoreline, within the existing municipal limits or in other existing legally designated urban areas, which are substantially built-up with a ratio of built-up plots to that of total plots being more than 50 per cent and have been provided with drainage and approach roads and other infrastructural facilities, such as water supply, sewerage mains, etc.

CRZ-III

Land areas that are relatively undisturbed (viz. rural areas, etc.) and those which do not fall under CRZ-II, shall constitute CRZ-III, and CRZ-III shall be further classified into following categories:-

CRZ-III A

Such densely populated CRZ-III areas, where the population density is more than 2161 per square kilometer as per 2011 census base, shall be designated as CRZ-III A and in CRZ-III A, area up to 50 meters from the HTL on the landward side shall be earmarked as the "No Development Zone (NDZ)‟, provided the CZMP as per this notification, framed with due consultative process, have been approved, failing which, a NDZ of200meters shall continue to apply.

CRZ-III B

All other CRZ-III areas with population density of less than 2161 per square kilometer, as per 2011 census base, shall be designated as CRZ-III B and in CRZ-III B, the area up to 200 meters from the HTL on the landward side shall be earmarked as the " No Development Zone(NDZ)‟.

Land area up to 50meters from the HTL, or width of the creek whichever is less, along the tidal influenced water bodies in the CRZ III, shall also be earmarked as the NDZ in CRZ III.

CRZ-IV

The CRZ-IV shall constitute the water area and shall be further classified as under:

CRZ-IV A

The water area and the sea bed area between the Low Tide Line up to twelve nautical miles on the seaward side shall constitute CRZ-IV A.

CRZ-IV B

CRZ-IV B areas shall include the water area and the bed area between LTL at the bank of the tidal influenced water body to the LTL on the opposite side of the bank, extending from the mouth of the water body at the sea up to the influence of tide, i.e., salinity of five parts per thousand (ppt) during the driest season of the year.

1.2.3. EMMP Plan

As per the guidelines of Ministry of Environment Forests and Climate Change and also as per the environment management plans submitted by various agencies during their EIA studies, DPA has appointed M/s. Detox Corporation Pvt. Ltd. For the work of "Preparing and Monitoring of Environmental Management Plan for Deendayal Port Authority at Kandla vide Work Order No.EG/WK/EMC/11023/2011/IV/213Dated-07/12/2019.

As part of this assignment, M/s. Detox Corporation Pvt. Ltd. prepared an Environmental Management and Monitoring Plan (EMMP) and submitted this EMMP prior to commencement of the Environment Monitoring of Deendayal Port in February2020.The EMMP summarized the background information as are source to develop Environment Monitoring Plan, based on the results of the EIA studies carried out at Deendayal Port by several agencies.
This environmental Management and Monitoring Plan (EMMP) plan submitted in February2020 was the key document in the environmental management system and set out the detailed targets, objectives and procedures that are adopted in order to achieve the goals to efficiently manage the environmental policy of Deendayal Port Authority.

2. DEENDAYAL PORT Authority

Deendayal Port is one of the most important ports of India. This port is situated at Latitude23º01‟N and Longitude70º13‟E on the shores of the Kandla Creek. The Deendayal Port came into existence in the year 1931 with a single Pier construction. Later on with the loss of Karachi port to Pakistan during partition, after independence the Government of India chose Kandla as an ideal sea outlet. Thus the Deendayal Port was developed and since then Deendayal Port has played a pivotal role in enhancing country`s maritime trade.

The Port of Kandla was declared a major port in 1955. The Deendayal Port Authority was created by law in 1963 to manage the new port. In 1978, The Deendayal Port had commissioned the off-shore Oil Terminal facilities at Vadinar jointly with Indian Oil Corporation, by providing Single Buoy Mooring (SBM) system, having a capacity of 54 MMTPA, which was first of its kind in India. Further, significant quantum of infrastructure up-gradation has been effected, excellent maritime infrastructure has been created having capacity of 32 MMTPA by M/s Essar Oil Refinery in Jamnagar district.

The port governed by Deendayal Port Authority (DPA) is a gateway port to the hinterland in western and northern states of Jammu & Kashmir, Delhi, Punjab, Himachal Pradesh, Haryana, Rajasthan, Gujarat and parts of Madhya Pradesh, Uttaranchal and Uttar Pradesh. It is in the district of Kutch and is located on the west bank of Kandla creek which runs into the Gulf of Kutch at a distance of 90 nautical miles from the Arabian Sea. The Port is well connected by the network of rail and road and is a gateway port for export and import of goods for northern states (Map1). The width of the channel varies from 200 meters to 1,000 meters. The contour depth along the shipping channel is around 10 meters. The total length of the Deendayal Port approach Channel is around 23kms. Presently, the Port has sixteen cargo berths for handling dry cargo traffic, six oil jetties for handling Petroleum Oil products and other liquid cargo traffic at Kandla Creek and 3 Single Buoy Mooring (SBM) at Vadinar for handling crude oil and two product jetties for handling petroleum products.

2.1. Environment Management Policy of Deendayal Port Authority

In 2013, the DPA achieved certification of its Environmental Management System to ISO 14001. In 2019, DPA obtained ISO 14001:2015 certifications. One of the key requirements of the ISO 14001 series is that the systems, plans and controls are under the operational control of the entity committed to managing the activity. The DPA also manages environmental risk to land and marine areas under its control arising from third party industrial activities. While these parties and the associated risks are covered in the risk register, the controls are managed by standalone EMP,s of the third party in accordance with the DPA development Approval Process and /or through direct state or central Government requirements as part of an:

- Environmental Clearance, CRZ Clearance, in the case of a new project; and
- Consent to Establish /NOC for an establishment, and Consent to Operate/NOC for operation of the projects.

2.1.1 The Key Objectives of Deendayal Port Authority

- To provide our Clientele, efficient and economical Port services. To render value for money and value added services to our Customers to their utmost satisfaction.
- To create facilities of international standards, and facilitate quicker turnaround of vessels.To maintain peaceful industrial relations by recognizing our work force as an asset and develop them to adopt to the changing Port scenario.
- To participate in social development by contributing our mite to the society at large.
- To be Environment friendly.

2.2. QHSE Policy of Deendayal Port

Quality, Occupational health, Safety and Environmental Policy (QHSE) of Deendayal Port Authority is the statement of its intentions, principles & commitment in relation to its overall QHSE performance, which provides a frame work for the action and for the setting of QHSE objectives & targets. QHSE policy has been developed through initial status review of quality, Occupational health, Safety and Environment Management comprising of following key areas namely;

- Legislative, regulatory and other requirements
- Identification of equipment and services supporting quality of final services.
- Identification of significant OH&S risks and Environmental aspects.
- Examination of all existing environmental & Occupational health and safety management practices and procedures.
- Evaluation and feedback from the investigation of previous incidents and accidents.

The QHSE policy of Deendayal Port Authority has been communicated at all levels through display in all the relevant places. The policy has also been communicated to external parties by way of displaying it at the main gate of Deendayal Port Authority in Hindi/English/local (vernacular) language.

Management representative of Deendayal Port Authority has established, implemented and maintaining the QHSE management system and continually improves its effectiveness by regular monitoring in accordance with the requirements of this international standard. MR has identified the various processes needed for the QHSE management system and their application throughout the organization.

The sequence and interrelation of these processes are determined to control the effectiveness of these processes & operations. The criteria & methods are determined necessary resources & information/details are made available at the point of use so that operations & processes can be monitored. (Ref: Department Operational Manual and their Process Flow Chart).

Measurement of these processes are timely analyzed and the relevant actions are implemented to achieve planned results & for continual improvement.

2.3. The Physical Environment

Deendayal Port ($23^0$02‟29.92”N, $70^0$13‟08.99”E) is located at the tail end of Gulf of Kachchh (GoK), an east west oriented Gulf system in the western part of Gujarat. It is about 90 nautical miles from the open waters of Arabian Sea. Kandla creek harboring the Deendayal Port is one of the major creeks of the inner Gulf of Kachchh. Gulf of Kachchh (GoK) is 75 km wide at its mouth and after running about 170 km away from the Arabian sea towards east, narrows down into a constriction at 70^0 20‟ E at *Sat Saida*Bet and then bifurcates into many creek systems (Map1).The Little Ran at the tail end of GoK has a network of many small and large creeks, intermingling with marshy tidal flats rich in fine clays. Kandla creek is one of the major tributaries of this creek system, which empties into the inner GoK. All these creeks bring water from the Little Ran into Kandla creek, which has a fairly good depth and stable banks.

Coastal and inland environmental setting of Kandla, similar to other parts of Kachchh, has marked climatological peculiarities like aridity, geomorphology and coastal and terrestrial ecosystems. Annual rainfall in Kachchh district was 458 mm during 2001- 10 whereas it was 443 mm at Gandhidham taluka during the same period which is often irregular. Rain during monsoon is confined to only 15-20 days and occurs as an instant downpour. The mean rainfall in year 2019 was 194mm.

On the terrestrial side there are no major rivers or rivulets or fresh water streams. Winter and summer temperatures range from 7^o- 47^oC with a yearly average humidity of 60% which increases to 80% during southwest monsoon and decreases to 50% during November-December. Average wind speed is 4.65 m/s with a maximum of 10.61 m/s during June. Drought is a common phenomenon in Kachchh with 2 drought year in a cycle of 5years. Annual temperature fluctuation in the district is extreme, rangingfrom$4^oC$to 47.5^oC.

2.4. Biophysical Environment

a. Creek system

The creek system consists of 3 main creeks the Nakti, the Kandla and the Hansthal, and the Little Gulf of Kutch interconnecting through many other big and small creeks, all along the coast. Very few rivers drain into the Gulf and they carry only a small quantity of freshwater, except during the brief monsoon. They are broad-valleyed and their river bed is mostly composed of coarse sand and gravel. The Gulf is uniquely characterized by numerous hydrographic features like pinnacles, as much as 10 m high. The southern shore has numerous is lands and inlets covered with mangroves and surrounded by coral reefs. The northern shore is predominantly sandy or muddy confronted by numerous shoals.

The Marine water of Gulf of Kutch and its creeks like Kandla creek, Nakti creek and Khori creek are providing the suitable habitat for marine vegetation. The Gulf abounds in marine wealth and is considered as one of the biologically rich marine habitat along the west coast of India. The marine vegetation is highly varied, which includes sand dune vegetation, mangroves, sea grasses, macrophytes and phytoplankton. The dominant species of sand dune flora are *Euphorbia caudicifolia, E. nerifolia, Aloeverasp, Ephedrafoliata, Urochodrasetulosa, Sporobolus maderaspatenus, Eragrostis unioloides, Calotropis procera, Fimbristylis* sp, *Indigofera* sp and*Ipomoea pescaprae*. The common sea grasses found growing on the mud flats are *Halophila* *ovate* and *H.beccarii*.

b. Mangroves

Deendayal Port Authority (DPA) is one of the largest ports of India in terms of volume of cargo handled. Among Indian ports, this port also has the largest coastal habitats such as mangroves (193.1km2)and mudflats(312.9 km2). DPA has implemented mangrove plantation in 1500 Ha during2005 - 2017 through various implementing agencies at Sat Saida Bet, Nakti creek and Kantiyajal. The Deendayal Port Authority has enauthorityed the task of evaluating 1500 ha of mangrove plantation in these three locations to Gujarat Institute of Desert Ecology (GUIDE), Bhuj.

Coastal belt in and around Kandla region is characterized by a network of creek systems and mudflats which are covered by sparse halophytic vegetation like scrubby to dense mangroves, creek water and salt encrusted land mass which forms the major land component. The surrounding environment in a radius of 10 km from the Port is mostly built up areas consisting salt works, human habitations and Port related structures on west and north, creek system, mangrove formations and mudflats in the east and south. Deendayal Port and its surroundings have mangroves, mud flats and creek systems as major ecological entities.

Mangrove plantation activity by DPA was initiated in 2005 as mandated by the Ministry of Environment, Forests & Climate Change (MoEF&CC). Subsequently, 1300 ha of mangrove plantation has been completed till the end of 2017 in different years in order to meet the legal mandate of Ministry of Environment, Forests and Climate Change (MoEF & CC). The mangrove plantation activities were carried out at Sat Saida Bet, Nakti creek and Kantiyajal of Bharuch district in South Gujarat. At Sat Saida Bet, Plantation activities were carried out in phased out manner i.e.20 ha during2005-2006, 200 ha during 2011-2012, 300 ha during 2012-2013, and 330 ha during 2013-2014 (Plate1). At Nakti creek plantation was carried out during 2008-2009 and 2010-2011 in 50 ha and 100 ha,respectively(GUIDE,2018).In 2015-17 300 ha by GEC at Kantiyajal, Bharuch District and 2018- 20 by GEC (At Satsaida bet : 50 Ha. And 300 ha at Kantiyajal 50 Ha Taluka : Hansot, District : Bharuch). In 2020-2021 -100 ha GEC, Gandhinagar.

A. marina was the preferred species for plantation activities in all the three locations due to prevailing high salinity and high success rate of this species. At Nakti creek *Rhizophora mucronata* and *Ceriops tagal* were also planted in small numbers along with*A. marina*. Likewise, at Kantiyajal attempts were made for planting *R.mucronata*a long with *A.marina*.

c. Marine Fauna

In the marine environment of Deendayal Port, there are eleven species of mollusca, seven species of shrimps (Prawn) and seven species of annelids. Besides these, there are twelve groups of phytoplankton, 7 groups of zooplanktons. The density of meio-fauna ranged from 382 to 670 nos/10cm^2. The density of benthic macro fauna ranged from 952 to 1092 no/m^2.Thedominant macro-faunal group was porifera (Mantec, 2014).

d. Terrestrial Biodiversity

Sensitive ecological habitats like forest, grassland, agricultural land, wetlands are absent within and in the proximity of the Deendayal Port due to its highly built-up nature. The species richness and abundance of aquatic birds and terrestrial fauna (reptiles, mammals) in the port environ and its surrounding was low with least conservation significance.

There are 11 species of herpetofauna (reptiles and amphibians), 53 species of terrestrial birds, 49 species of aquatic birds in the Port Environs. Due to absence of forest habitat in the immediate vicinity of Deendayal Port, only nine species of mammals were recorded with very low abundance.

3.0 Environment Management Plan

Port activities can often affect the quality of air, noise and marine water in the surrounding areas due to the wide range of port operation activities. For the determination of environment quality, need for identification of sources, control and disposal of waste from various point and non-point sources and for prediction of various parameters of sound environmental quality, regular monitoring and assessment are required.

The Environment management plan is the key document in the environmental management system and sets out the detailed targets, objectives and procedures that will be adopted in order to achieve the goals set out in the environmental policy.

It is extremely essential that port and harbour projects should have an environmental management plan (EMP), which also incorporates monitoring of air, noise, soil and marine water quality along with the collection of meteorological data.

Deendayal Port Authority targets the achievement of high environmental standards and strives to ensure that activities within the Port are environmentally and ecologically sustainable and have minimal impact on the natural environment.

Several developmental projects have been initiated and EIAs have been carried out for the said projects. These EIA studies have also submitted the suggestions on the environmental management of the project area and Deendayal Port in general. These suggestions and mitigation measures have also been considered in framing the current environment management plan.

The present Environment Management Plan summarizes the suggestions of the ECs received from the Ministry of Environment, Forests & Climate Change (MoEF & CC), and consents granted by Gujarat Pollution Control Board(GPCB).

The projects for which ECs were granted and which formed the frame work of the present EMP are as below;

- EC and CRZ Clearance for Construction of 13th to 16th Cargo berth at Kandla in year 2008
- EC & CRZ clearance for development of plots for construction of liquid storage tank farms at Kandla, district Kutchinyear2009
- Environmental and CRZ Clearance to DPA for development of plots for construction of warehouses/Godowns (stage II) in year2012.
- Environmental and CRZ clearance for Single Point Mooring (SPM) and Allied facilities off Veera in the Gulf of Kachchh for handling Crude Oil on BOT basis in year 2013.
- Developing seven integrated facilities within the Existing Kandla port at Kandla, Gujarat–December2016
- Proposed Smart Industrial Port City (SIPC) at green Field Site 1 (Adipur side– Northeast of Antarjaal, South of Tagore Road, 580Acres),Gandhidham, Kutch-Gujarat"-October2017
- Proposed Smart Industrial Port City (SIPC) at Green Field Site 2 (DPA Complex, 849.96Acres), Gandhidham, Kutch –Gujarat.–October2017.
- Construction of Interchange cum road over bridged (SIA/GJ/NCP/19832/2017)
- Creation of water front facilities of oil jetties of 8,9,10 & 11 & development of land (1432 areas) (IA/GI/MIS/61679/2017)
- Development of plots for constructing of warehouse/ godowns ad measuring 11,50,000 m2 area at outside west gate no 1 on national highway no 8A at Kandla (SIA/GJ/MIS/122861/2019)

- Up gradation of Barge handling facility at Sunder Basin at Kandla
- Multipurpose Cargo Terminal at Tekra off Tuna on BOT basis
- Construction of Rail Over Bridge at NH-8A near Nakti Bridge (crossing of NH 8A)
- Strengthening of oil jetty no. 1
- Modification and strengthening of Cargo Berth no. 6 at Kandla Port Trust
- Container terminal Tuna Tekra (Capacity 2.19 Million TEUs)
- Railway line (NH 8A to Tuna 11 km)
- Construction of port craft jetty & SNA section
- Development of integrated facility stage II (IA/GJ/MIS/27227/2015)
- Setting up 7th oil jetty at old Kandla
- Setting up Barge jetty at Veera
- Setting up Barge jetty at JafraWadi
- One administrative building at Tuna Tekra
- Construction of 15.5 km long road from Veera Barge Jetty to Tuna Gate
- Single point Mooring and allied facilities off Veera in Gulf of Kutch for handling crude oil on BOT basis in the state of Gujarat (IA/GJ/MIS/178779/2020)

Table: 1 Yearly Monitoring schedule

Yearly Monitoring schedule				
Sr. No	**Sampling Activity Description**	**Locations**	**Monthly Monitoring**	**Yearly Monitoring**
1	Ambient Air	6 locations (Kandla)	8	96
		2 locations (Vadinar)	8	96
2	Drinking Water	18 locations (Kandla)	1	12
		2 locations (Vadinar)	1	12
3	Waste water	2 locations (Gopalpuri Township & Kandla)	4	48
		1 location (Vadinar)	4	48
4	Soil	4 locations (Kandla)	1	12
		2 locations (Vadinar)	1	12
5	Noise	10 locations (Kandla)	1	12
		2 locations (Vadinar)	1	12
6	Marine Water sampling for Physico - Chemical Parameters, Biological parameters and sediments (Twice a month)	8 Locations (6- Kandla & 2-Vadinar)	2	24

4. Environment Monitoring Plan

Environment Monitoring Plan is very important for monitoring the environmental status of the port for sustainable development. The EMP mainly consists of monitoring of the Air quality, Marine water quality, Ecological and Biological quality and Noise quality of the Deendayal Port area. The monitoring program is also required to suggest suitable mitigation measures for the deviation found in the results of the monitoring, so as to keep the pollution level with in control.

The list of main elements for which Environmental monitoring is carried out is mentioned below.

- Air Quality Monitoring
- Drinking Water Monitoring
- Noise Monitoring
- Marine Water Monitoring
- Soil Monitoring
- Sewage Treatment Plant Monitoring
- Meteorological Monitoring

M/s Detox Corporation Pvt. Ltd. appointed by Deendayal Port Authority will carry out monitoring of the various environmental aspects of the port with following objectives;

- To review the locations of ambient air and marine water quality monitoring stations within the impacted region in and around DPA establishment, in view of the developmental projects.
- To assess the ambient air quality and marine water quality at selected stations in terms of gases and particulate matter, physical, chemical and biological parameters for the assignment period.
- To assess the marine water quality in terms of aquatic flora and fauna and sediment quality in terms of benthic flora and fauna.
- To assess the trends of air and water quality by comparing the data collected over a specified time period.
- To assess the trends of water quality in terms of marine ecology by comparing the data collected over a specified time period.
- To review the results and to check compliance with environmental quality standards.
- To suggest mitigation measures, if necessary, based on the findings of this study.
- To recommend future action plans on air and marine water quality monitoring programmed based on the findings of this study.
- Drinking Water samples at twenty stations will also be monitored for various physical, chemical and biological parameters viz., color, odor, turbidity, conductivity, pH, EC, total dissolved solids, chlorides, total hardness, iron, sulfate, NH3N, PO4, Turbidity, salinity, BOD, Hardness, Calcium, Magnesium, Sodium, Potassium, metals and bacterial count on a monthly basis.
- Every week a sample (inlet and outlet) of the Sewage Treatment Plant (STP) shall be analyzed to see the water quality being discharged by DPA. However, the results will be submitted every month. If in a particular month any deviation is observed, the same shall be submitted immediately to the Employer.
- Noise monitoring will be carried out twice a day at the representative stations for a period of 24 hours. A report of the same will be submitted to DPA.
- Meteorological parameters are very important from air pollution point of view and precise and continuous

data collection is of utmost importance. The data collected is analyzed as per the standards. Meteorological data on wind speed, wind direction, temperature, relative humidity, solar radiation and rainfall will be collected from one permanent station at DPA and one permanent station at Vadinar.

- All Locations & Monitoring parameters are tentative and subject to change as per GPCB/CPCB/MoEF &CC Guideline.

4.1 Selection of Sampling Locations

Sampling locations have been selected by Deendayal Port Authority considering various activities of Deendayal Port Authority and its environs and various Environment Impact Assessment Studies carried out in Deendayal Port. The sampling locations of various air, water and marine water surveys will be reviewed periodically and may be altered if required as per the suggestions/discussions with the Deendayal Port Authority and Environmental consultants engaged by the Deendayal Port Authority.

The major components of the monitoring are:

4.1.1. Air Quality Monitoring

Air Monitoring is done at eight fixed locations in port area. The description of stations is depicted in Table1. The monitoring cycle at all eight monitoring stations is twice in a week.

Method of Monitoring

Sampling and analysis will be carried out as per CPCB guidelines for Ambient Air Quality monitoring. The monitoring is carried-out for air quality parameters mentioned in the National Ambient Air Quality Standards (NAAQS), CPCB Notification published in 2019. Sampling for Particulate Matter PM_{10}, $PM_{2.5}$ and Total Suspended Particulate Matter (TSPM) is done for a twenty four hour period.

Frequency of AAQ Monitoring

The monitoring cycle at all eight monitoring Stations is twice in a week. Sampling for Particulate matter (PM_{10}, $PM_{2.5}$) and total suspended particulate matter is done for a twenty four hour period. Sampling for gaseous samples like SO_x, NOx will be done for a twenty four hour period with sample collection at every eight hour. Table 2 gives description of Ambient Air Monitoring Stations.

Table 2: Ambient Air Monitoring Stations

Sr. No.	Location	Station Description	Location Codes
1	6 Stations at Kandla	Marine Bhavan	AL-1
2		Oil Jetty	AL-2
3		Kandla Port Colony	AL-3
4		Gopalpuri Hospital	AL-4
5		Coal Storage Area	AL-5
6		Tuna Port	AL-6
7	2 Stations at Vadinar	Signal Building	AL-7
8		Vadinar Colony	AL-8

4.1.2. Monitoring of Drinking Water Quality Method of monitoring

The sampling and analysis will be done as per standard methods IS 10500:2012. The water samples will be analyzed for various parameters via; Color, Odor, Turbidity, Conductivity, pH, Chlorides, TDS, Total hardness, Iron, Sulphate, Salinity, Biological Oxygen Demand (BOD), Chlorides, Sodium(Na), Potassium(asK+), Calcium(asCa), Magnesium(Mg), Fluorides (F), Nitrate (NO_3), Nitrite (NO_2), Manganese (Mn), Iron (Fe), Chromium(Cr_6+), Copper(asCu), Cadmium(Cd), Arsenic(As), Mercury(Hg), Lead (Pb), Zinc (Zn), CFU, & bacterial count. The method will be manual at all monitoring stations.

- **Frequency of Drinking Water Monitoring:**

  The monitoring at all twenty drinking water stations will be done monthly once.

- **Drinking Water Monitoring Stations**

  A list of locations for collecting the drinking water samples is depicted in Table 3.

Table 3: Monitoring locations for Drinking Water

Sr. No	Monitoring Locations	Location Code	Sr. No	Monitoring Locations	Location Code
Location at Kandla			11	Hospital Kandla	DW-11
1	Nirman Building1	DW-1	12	A.O. Building	DW-12
2	P& C Building	DW-2	13	School Gopalpuri	DW-13
3	Main Gate(North)	DW-3	14	Guest House	DW-14
4	Canteen	DW-4	15	E-Type quarter	DW-15
5	West gateI	DW-5	16	F-type quarter	DW-16
6	Wharf area	DW-6	17	Hospital Gopalpuri	DW-17
7	Sewasadan-3	DW-7	18	Tuna Port	DW-18
8	Workshop	DW-8	**Locations at Vadinar**		
9	Custom building	DW-9	19	Nr. Vadinar Jetty	DW-19
10	Port Colony Kandla	DW-10	20	Port colony	DW-20

4.1.3. Monitoring of Marine Water Quality and Biological Parameters Methodology for Physico-chemical Monitoring

Water samples will be collected for analyzing physico-chemical and biochemical parameters viz. pH, Temperature, Colour, Odour, Salinity, Turbidity, SS, TDS, TS, DO, COD, BOD, Silicate, PO_4, SO_4, NO_3, NO_2, Ca, Mg, Na, K, Iron (as Fe), Chromium (as Cr), Copper (As Cu), Arsenic (as As),Cadmium (as Cd), Mercury (Hg), Lead (as Pb), Zinc (as Zn), petroleum hydro carbons, trace metals total coliform & fecal coliform.

Methodology for Biological Monitoring

Sampling will be conducted from sub surface layer in high tide period and low tide period of the tide from all sampling stations during consecutive spring tide and neap tide.

Net sampling for qualitative evaluation of mixed plankton will be conducted only once during between maximum high water and slack water and maximum low water and Slack water.

Sediment sampling for qualitative and quantitative evaluation of benthic organisms will be conducted only once during one tidal cycle during maximum low water and slack water.

The collected samples will be first collected in a clean bucket to reduce the heterogeneity. From the collected water sample 1 liter of water sample will be taken in an opaque plastic bottle for chlorophyll estimation. Quantitative plankton samples will be collected by filtering rest of the water sample using plankton net of 20µm mesh size.

Methodology adopted for Plankton sampling

Mixed plankton sample for qualitative evaluation will be obtained from the sub surface layer, at each sampling locations by towing the net horizontally with the weight during highest high tide and slack period and lowest low tide and slack period. After the tow of about 15-20 minutes at speed of 1- 1.5 m/s. For quantitative evaluation 50 L sample will be collected from the sub surface during high tide and low tide period will be filtered through 20 µm mesh size net assembly.

Methodology adopted for benthic fauna sampling

Van veen sampler (0.1 m^2) will be used for sampling bottom sediments during lowest low tide. The fixation of benthic fauna will be normally done by bulk fixation of the sediment sample. The bulk fixation will be done by using 10% formalin (buffered with borate) with Rose Bengal as stain. The organisms will be preserved with sea water as diluting agent.

Frequency

Phytoplankton (Qualitative & Quantitative) Zooplankton (Qualitative & Quantitative) & Benthos (Qualitative & Quantitative) samples will be collected during high tide and low tide during each spring and neap tides of the month.

Sampling Stations

The monitoring of marine environment for the study of biological and ecological parameters will be carried out in harbour regions of DPA (Table3) during Spring tide period of full moon phase of Lunar Cycle.

Table 4: Sampling Locations for Marine Monitoring

Sr.No	Monitoring locations	Location Code
Locations at Kandla		
1	Near passenger Jetty One	ML-1
2	Near Berth No.8&9	ML-2
3	Kandla Creek Near KPT colony	ML-3
4	Near13th&14thBerth	ML-4
5	Nakti Creek Near Tuna Port	ML-5
6	Nakti Creek Near NH-8A Bridge	ML-6
Locations at Vadinar		
7	Nr.SBM 2	ML-7
8	Nr. Vadinar Jetty	ML-8

4.1.4. Noise Monitoring

Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading of cargo to/from ships. Noise Monitoring will be done at 10 stationsat Kandla, and three locations in Vadinar.

Method and Frequency of monitoring

Sampling will be done at all stations for 24 hour period once in month. Data will be recorded using automated sound level meter. The intensity of sound will be measured in sound pressure level (SPL) and common unit of measurement is decibel (dB).

Sampling Stations

The sampling locations for noise monitoring as listed in table 5.

Table 5: Locations for Noise Monitoring

Sr. No	Name of locations	Location Code		Sr. No	Name of locations	Location Code
Locations at Kandla				8	Nirman Building 1	NL-8
1	West Gate no 1	NL-1		9	Tuna Port	NL-9
2	Main gate(North)	NL-2		10	Port & customs office	NL-10
3	Wharf area/Jetty Area	NL-3		**Location at Vadinar**		
4	Main road/Central Road	NL-4		11	Nr. Port Gate-Vadinar	NL-11
5	Canteen Area	NL-5		12	Nr. Vadinar Jetty	NL-12
6	ATM building	NL-6		13	Port colony Vadinar	NL-13
7	Marine Bhavan	NL-7				

4.1.5. Soil Quality Monitoring

Soil quality monitoring is important for evaluating the effects of environment management practices of a region/area.

Method of Monitoring

The soil samples will be collected from four locations in Kandla and two locations in Vadinar Port. The soil samples will be filled in polythene bags, labeled in the field with number and site name and taken to the laboratory for analysis (as per IS 2720). Physical and chemical properties of soil at selected locations will be studied.

Frequency of monitoring

Sampling will be done at all stations in Kandla and Vadinar once in a month.

Soil Quality Monitoring Stations

List of the locations for collecting the soil samples are as per Table 6.

Table 6: List of sampling locations for Soil Quality Monitoring

Sr. No	Name of locations	Location Code
Locations at Kandla		
1	Tuna Port	SL-1
2	IFFCO Plant	SL-2
3	Khori Creek	SL-3
4	Nakti creek bridge at NH-8A	SL-4
Location at Vadinar		
5	Nr. Vadinar Port Office	SL-5
6	Nr. Vadinar Colony	SL-6

4.1.6. Monitoring of performance of the Sewage Treatment Plant (STP) at Gopalpuri Township, Deendayal Port & Vadinar

The principal objective of waste water treatment is generally to allow human and industrial effluents to be disposed off without danger to human health or unacceptable damage to the natural environment.

Method of Monitoring

The parameters monitored will be pH, BOD, COD, residual chlorine, MLSS, MLVSS and TSS. The data collected will be analyzed as per the standards. The performance of the Sewage Treatment plant will be studied by collecting samples of the aeration tank and effluent tank.

Frequency of monitoring

Sampling will be done at all stations from inlet, aeration tank and outlet of an STP once in week.

Monitoring Stations:

Lists of the location for collecting the STP samples are as per table 7.

Table 7: List of sampling locations for STP

Sr. No	Sampling location
1	STP at Kandla
2	STP at Gopalpuri
3	STP at Vadinar

5. Monitoring Results

Based on the EMMP submitted, M/s Detox Corporation Pvt. Ltd. carried out monitoring of the following environmental aspects of the port for the period of March 2021 to February 2022.

5.1 Ambient Air

The monitoring was carried out twice a week. The results obtained from the sampling and analysis is submitted to Deendayal Port authority on monthly basis. The monthly averaged and annual results for the ambient air monitoring are given in the sections followed.

I. Total Suspended Particulate Matter (TSPM)

The frequency of sampling was twice a week for every sampling station.

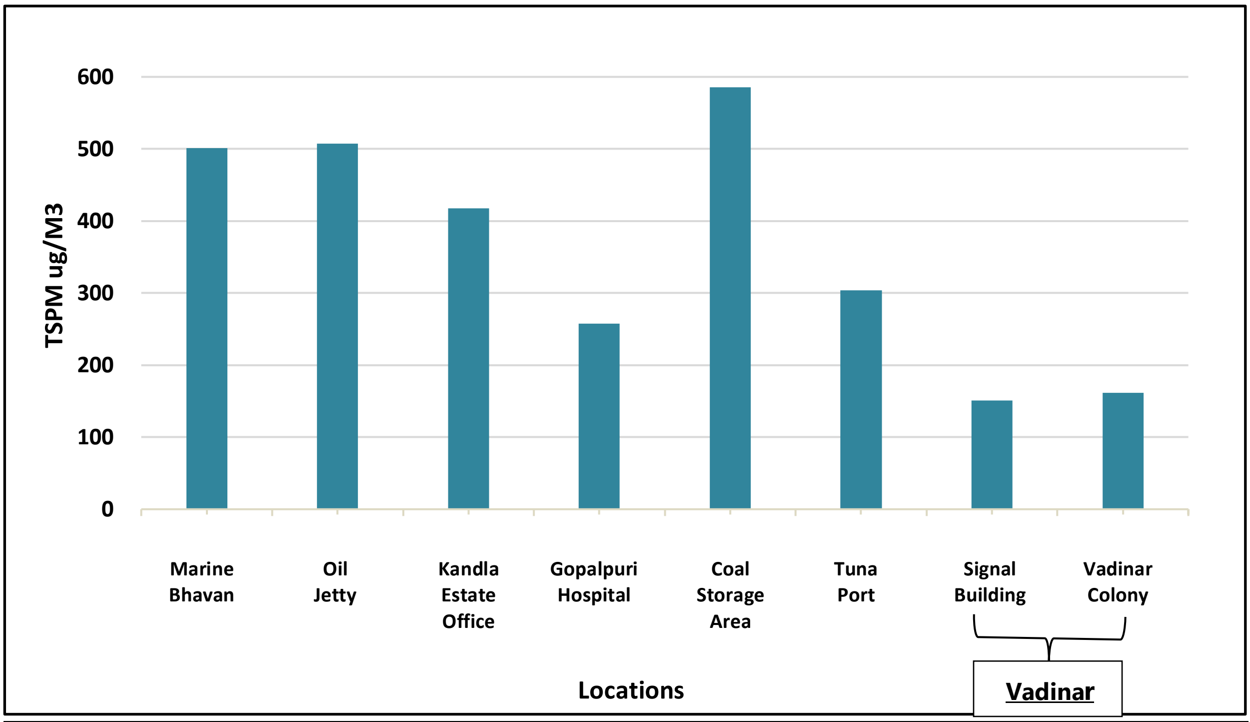
Table 8. TSPM (in µg/m^3) values at monitoring locations in Kandla and Vadinar Port

Months	Marine Bhavan	Oil Jetty	Kandla Estate Office	Gopalpuri Hospital	Coal Storage Area	Tuna Port	Signal Building	Vadinar colony
Mar-21	530	447	328	266	435	165	147	157
Apr-21	642	617	449	198	779	385	152	171
May-21	966	752	570	352	1341	273	134	161
Jun-21	374	312	267	173	596	125	59	60
Jul-21	467	578	463	307	354	372	105	146
Aug-21	495	520	488	229	548	347	155	138
Sep-21	449	554	341	194	324	238	164	169
Oct-21	364	465	402	274	527	362	157	211
Nov-21	460	489	487	357	598	387	219	205
Dec-21	442	480	427	251	518	362	176	183
Jan-22	417	480	417	251	484	348	164	164
Feb-22	412	393	371	243	523	284	171	186
Annual Mean	**502**	**507**	**418**	**258**	**586**	**304**	**150**	**163**

The mean TSPM values were highest at Coal Storage location and Marine Bhavan, followed by Oil Jetty. TSPM values were least at both the locations of Vadinar Port. The major cause of TSPM values at Coal Storage and Marine Bhavan is large amount of coal is handled at Berth No. 6, 7, 8and use of grabs for unloading of coal directly in the truck cause coal to spread in air as well as coal dust to fall on ground. This settled coal dust again mixes with the air during trucks movement through hit.

Also, the coal laden trucks are not always covered with tarpaulin sheets and these results in spillage of coal from trucks/dumpers during its transit from vessel to yard or storage site.

Fig 1. Observed values (annual mean) of TSPM at all eight monitoring stations



Interpretation of Results

- Maximum TSPM of 1341.0 µg/m^3 was recorded in the month of May‟21 at Coal storage site and the minimum value was recorded in the month of June„21at Tuna Port 125.0µg/m$^{3.}$
- At Vadinar, maximum TSPM of 219 µg/m^3 was recorded in the month of November at Vadinar Signal Building site and the minimum value was recorded in the month of June ‟21 at Vadinar Signal Building (59µg/m^3).

II. Particulate Matter (PM_{10})

PM_{10} is particulate matters which are 10 micrometers or less in diameter. The frequency of sampling was twice a week for every sampling station.

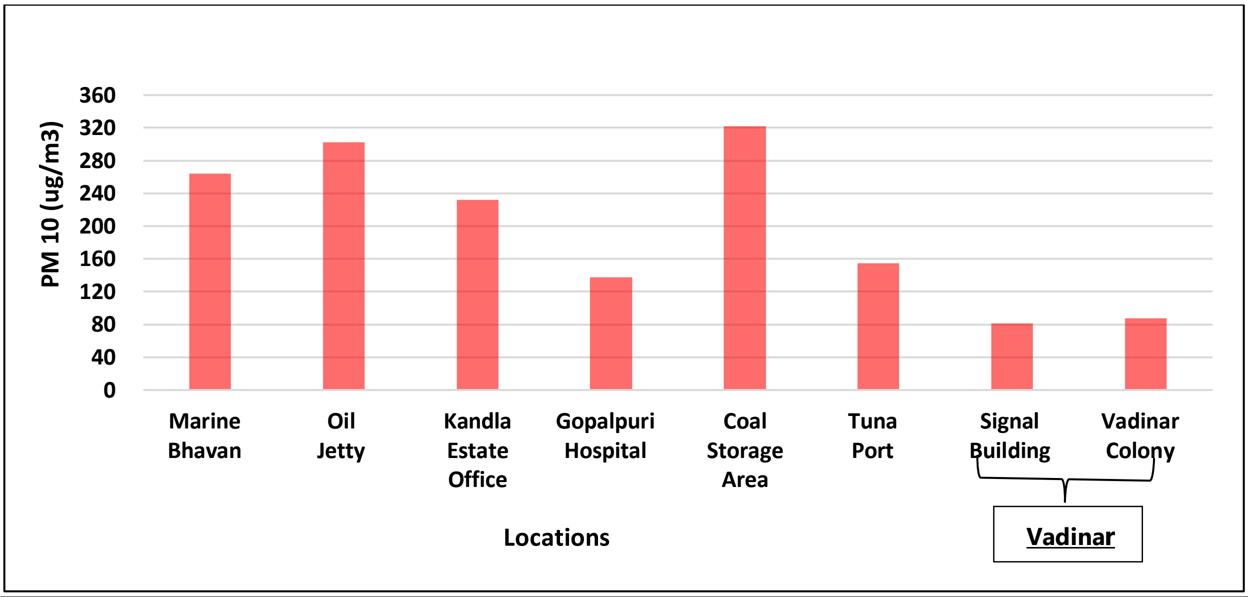
Table 9. PM_{10} (in µg/m^3) values at monitoring locations in Kandla and Vadinar Port

Months	Marine Bhavan	Oil Jetty	Kandla Estate Office	Gopalpuri Hospital	Coal Storage Area	Tuna Port	Signal Building	Vadinar colony
Mar-21	130	103	90	98	163	68	73	79
Apr-21	239	225	99	89	327	76	53	66
May-21	607	611	559	176	1149	160	73	99
Jun-21	130	82	69	52	140	59	33	33
Jul-21	373	496	366	230	206	250	75	81
Aug-21	262	322	276	133	327	217	98	77
Sep-21	333	442	211	123	200	126	97	95
Oct-21	190	246	219	140	203	163	82	116
Nov-21	193	190	217	187	292	195	115	108
Dec-21	245	263	243	142	295	194	88	98
Jan-22	227	437	217	142	264	184	93	97
Feb-22	237	213	215	139	300	161	98	104
Annual Mean	**264**	**303**	**232**	**138**	**322**	**154**	**82**	**88**

The mean PM_{10} Values were highest at Coal Storage location and Marine Bhavan, followed by Oil Jetty. PM_{10} values were least at both the locations of Vadinar Port. Higher PM_{10} values at Coal Storage and Marine Bhavan is a result of large amount of coal handling and its inappropriate transportation methods.

Coal laden trucks are seldom covered with tarpaulin sheets and these results in spillage of coal from trucks/dumpers resulting into higher PM_{10}values.

Fig 2. Observed values (annual mean) of PM_{10}at all eight monitoring stations



Interpretation of Results

- Maximum value of PM_{10} of 1149 µg/m^3 was recorded in the month ofMay‟21 at Coal storage site and the minimum value was recorded in the month of June 2021 at Tuna Port 59.0µg/m^3.

- In Vadinar, maximum value of PM_{10} of 116 µg/m3 was recorded in the month of October 2021 at Vadinar Colony and the minimum value was recorded in the month of june- 2021atVadinarColony & Signal Building (33.0 µg/m3).

III. Particulate Matter ($PM_{2.5}$)

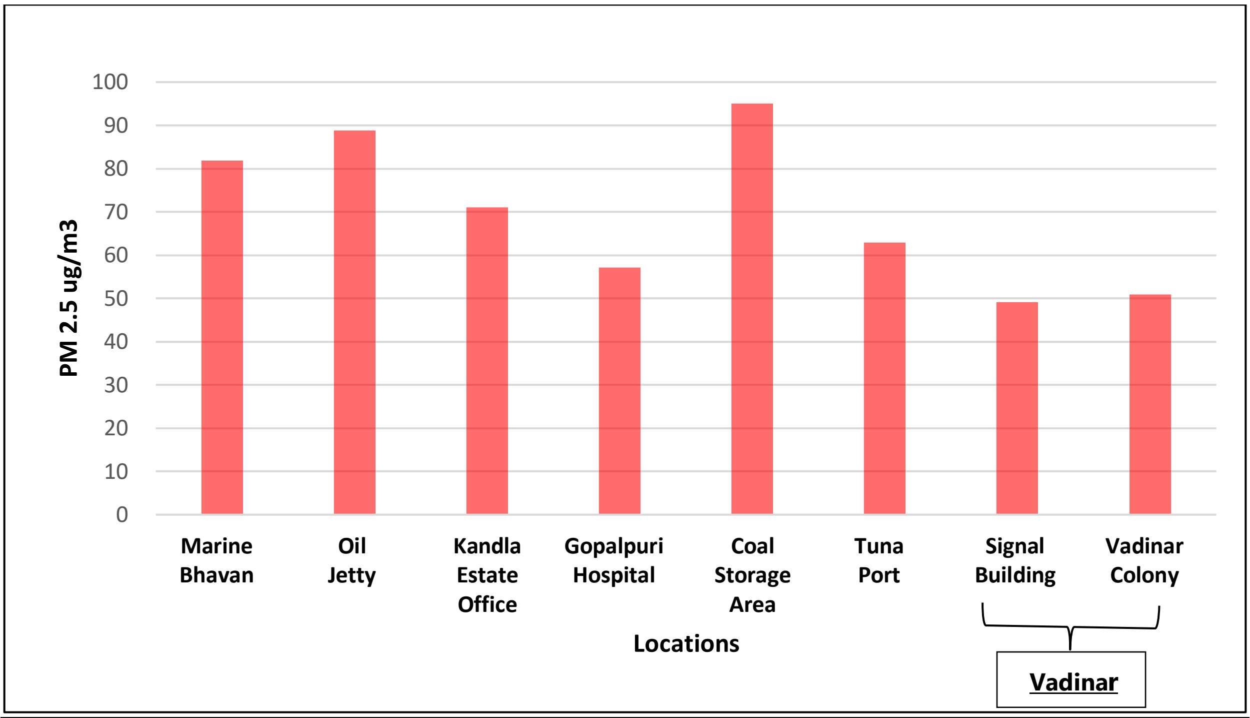
$PM_{2.5}$ particles are air pollutants with a diameter of 2.5 micrometers or less, small enough to invade even the smallest airways. $PM_{2.5}$ was also monitored twice a week for every sampling station.

Table 10. $PM_{2.5}$ (in µg/m^3) values at monitoring locations in Kandla and Vadinar Port

Months	Marine Bhavan	Oil Jetty	Kandla Estate Office	Gopalpuri Hospital	Coal Storage Area	Tuna Port	Signal Building	Vadinar colony
Mar-21	56	50	34	29	67	24	21	41
Apr-21	73	52	44	15	101	18	35	17
May-21	41	37	40	27	102	23	33	36
Jun-21	108	113	61	33	138	33	38	22
Jul-21	89	47	56	63	40	58	40	44
Aug-21	71	73	71	51	80	63	39	45
Sep-21	81	83	60	46	80	55	44	42
Oct-21	82	89	90	79	105	96	49	70
Nov-21	90	97	97	87	104	98	84	82
Dec-21	104	102	98	87	101	93	71	75
Jan-22	95	232	99	87	111	79	66	60
Feb-22	92	90	102	82	112	114	69	76
Annual Mean	**82**	**89**	**71**	**57**	**95**	**63**	**49**	**51**

Average $PM_{2.5}$ values were highest at Oil Jetty location (mean=232.0 µg/m^3) followed by Coal Storage Area (mean =138.0 µg/m^3) and Gopalpuri Hospital (mean=57.0 µg/m^3). $PM_{2.5}$ values At Vadinar Port the $PM_{2.5}$ values were significantly lower.

Fig 3. Observed values (annual mean) of $PM_{2.5}$ at all eight monitoring stations



Interpretation of Results

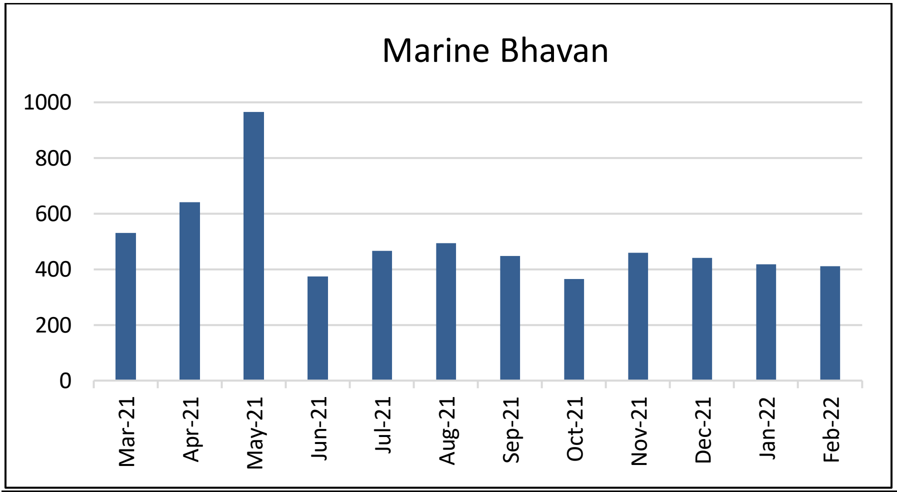
- Maximum value of $PM_{2.5}$232.0 µg/m^3) was recorded in the month of January 2022 at Oil Jetty site and the minimum value was recorded in the month of May 2021 at Gopalpuri Hospital (27.0µg/m^3).

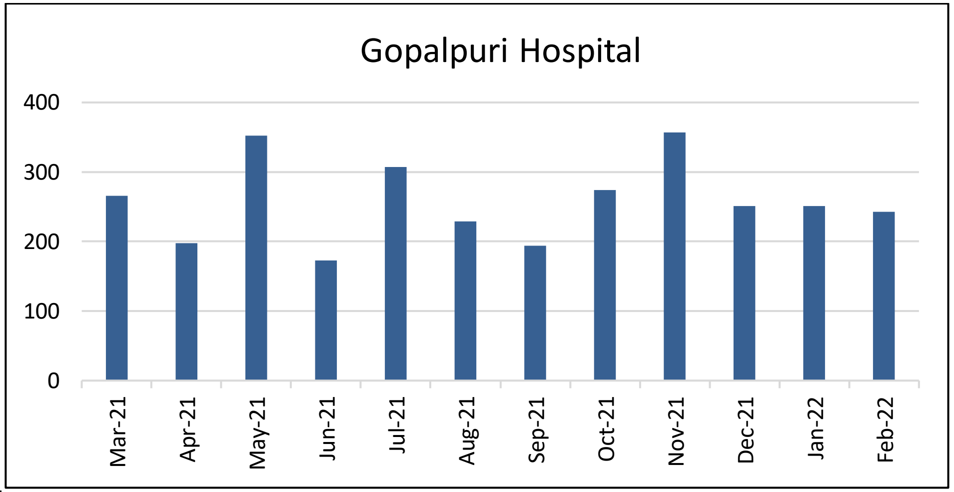
- Annual mean values of $PM_{2.5}$ were highest at Coal Storage Area (95.0µg/m^3).

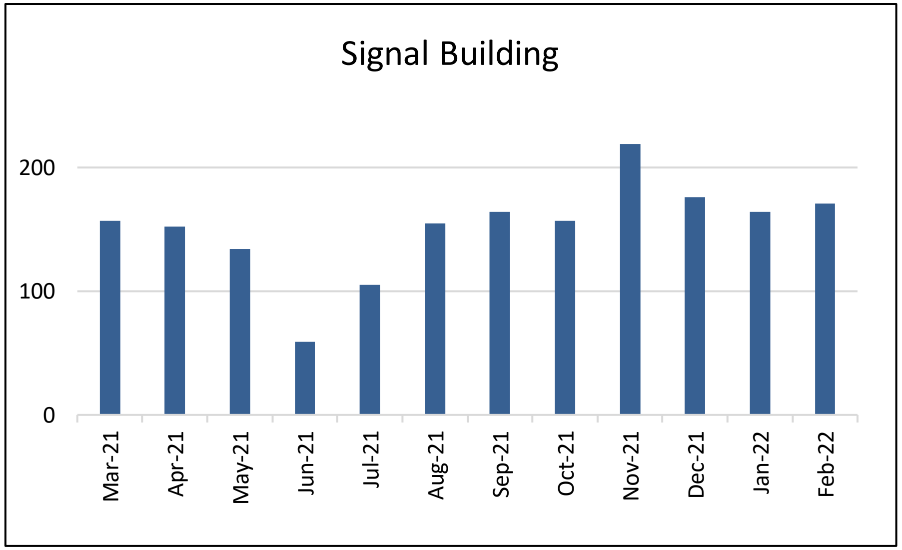
- In Vadinar, maximum value of $PM_{2.5}$ of 84.0 µg/m^3 was recorded in the month of November‟ 21 at Signal building site and the minimum value was recorded inthe month of April at Vadinar Port colony (17.0µg/m^3).

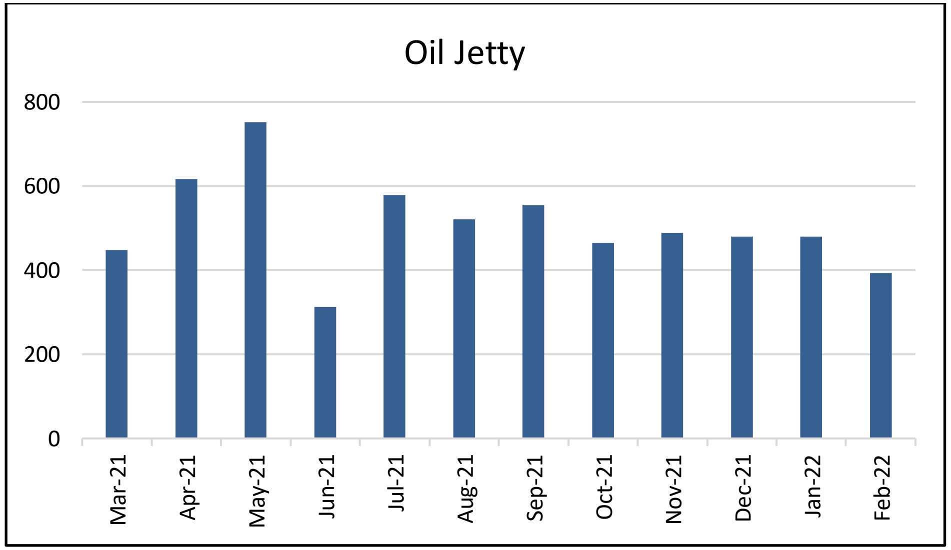
  Location wise graphs depicting trends in TSPM, PM_{10} and $PM_{2.5}$ in all locations of Kandla and Vadinar Port are depicted in 1 to 3.

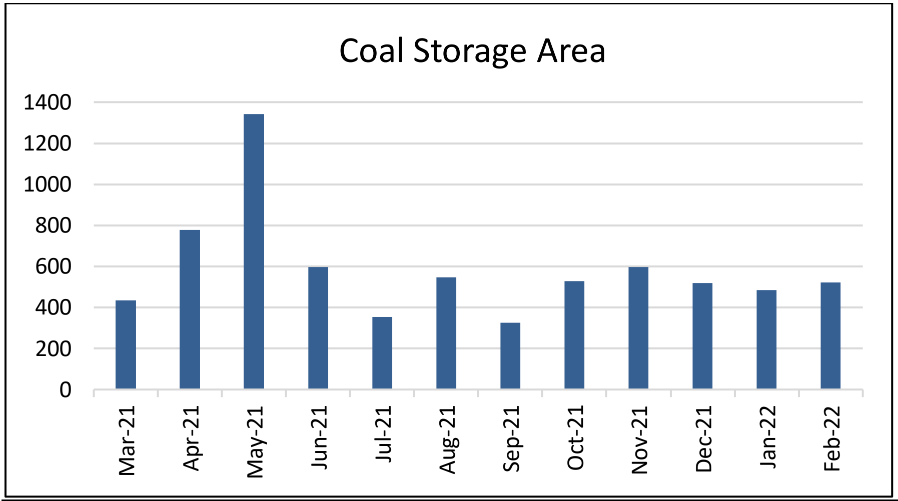
Fig 4. Trend in TSPM values of various AAQ Monitoring Locations

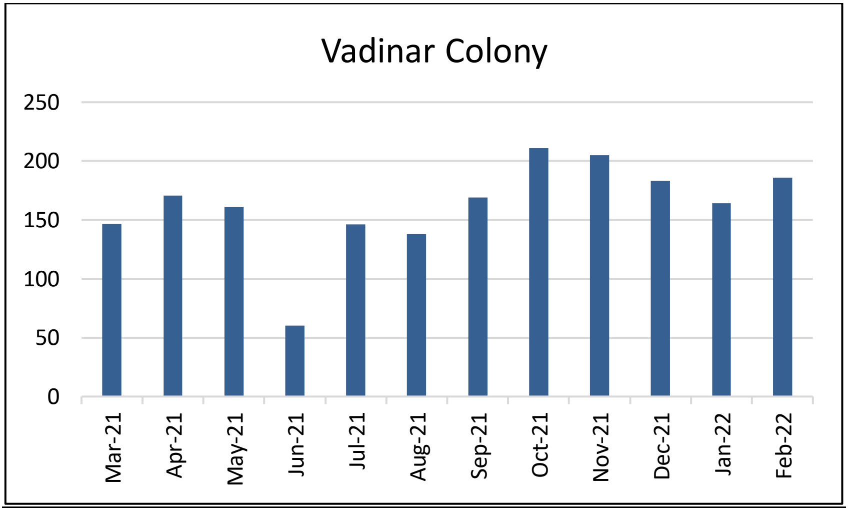


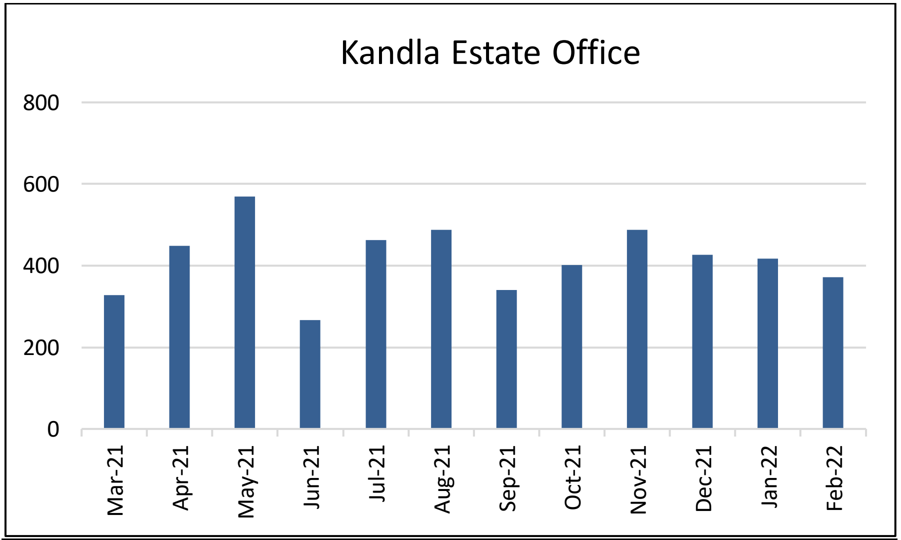







Coal Storage Area
1400
1200
1000
800
600
400
200
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22


Vadinar Colony
250
200
150
100
50
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22


Kandla Estate Office
800
600
400
200
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22

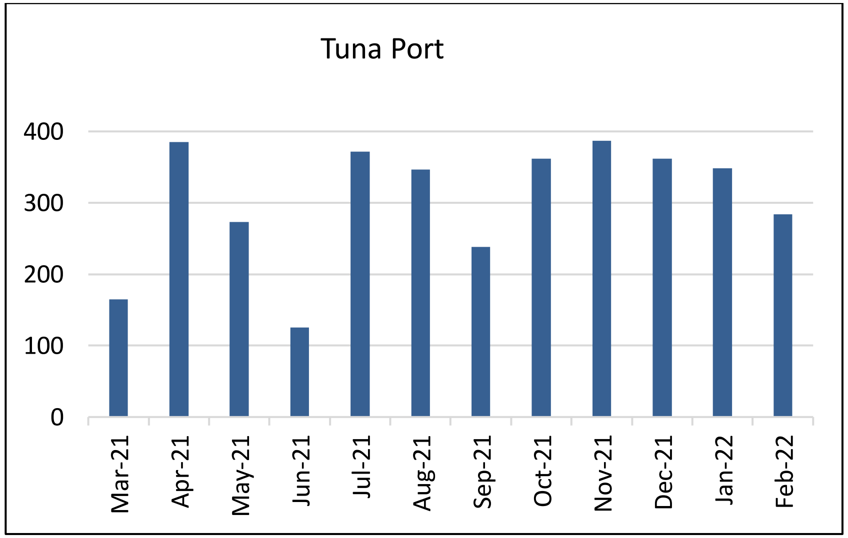
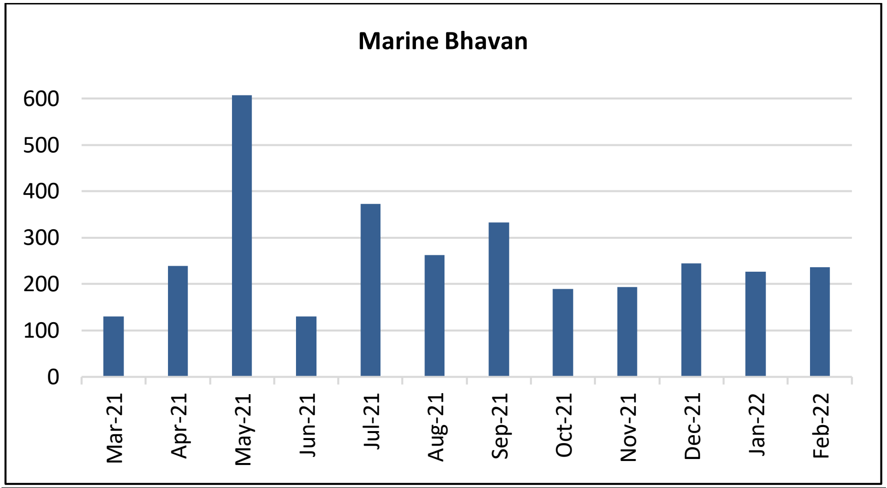
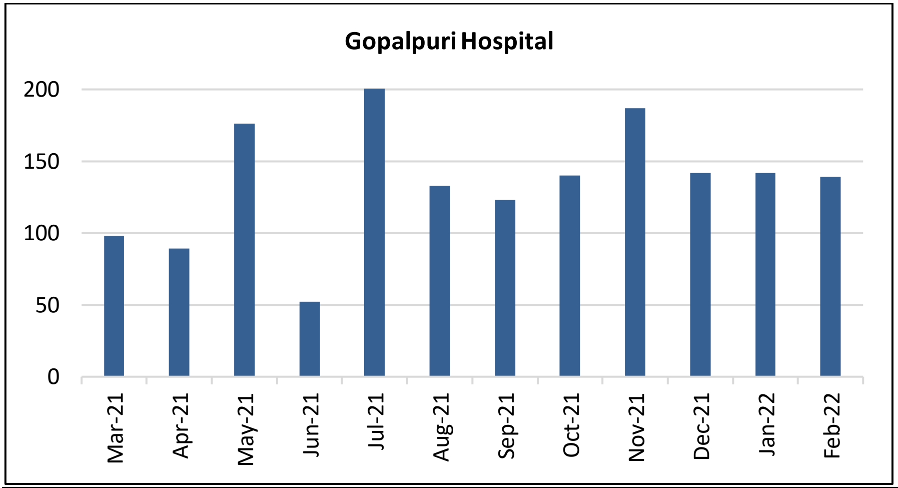
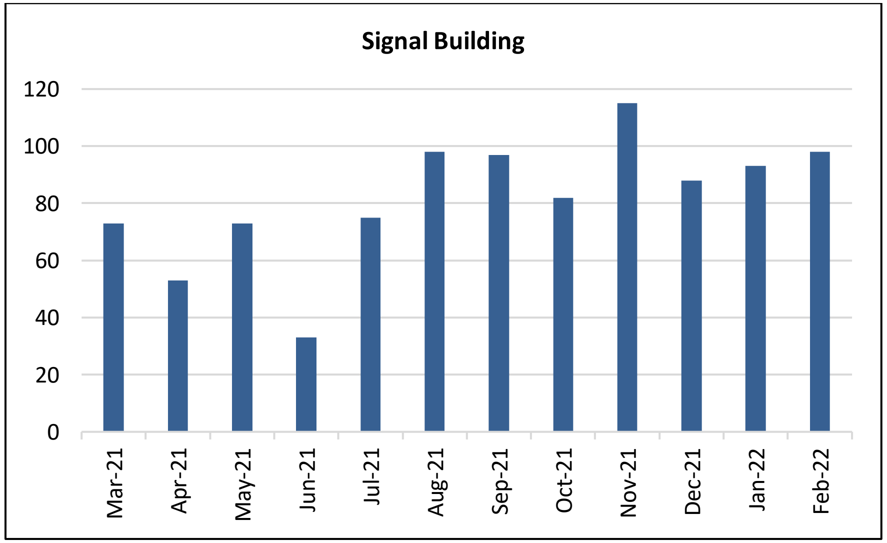
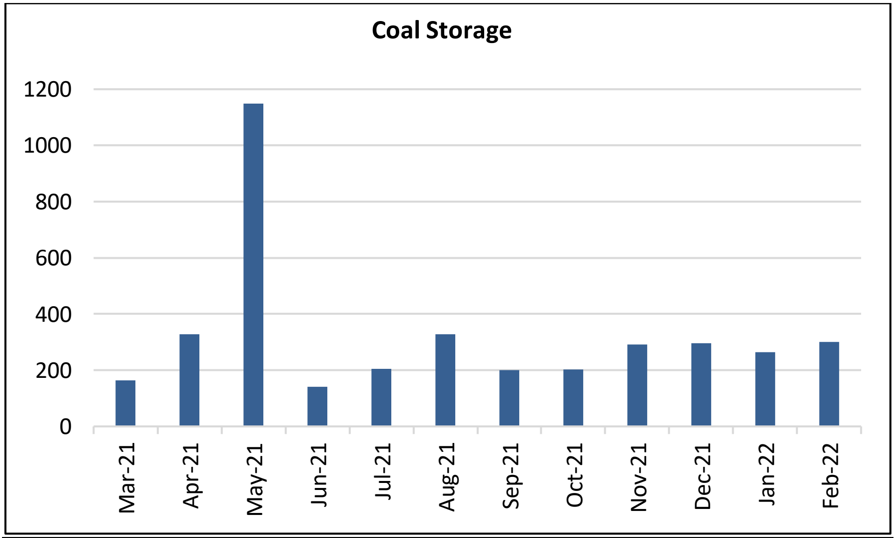

Tuna Port
400
300
200
100
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22

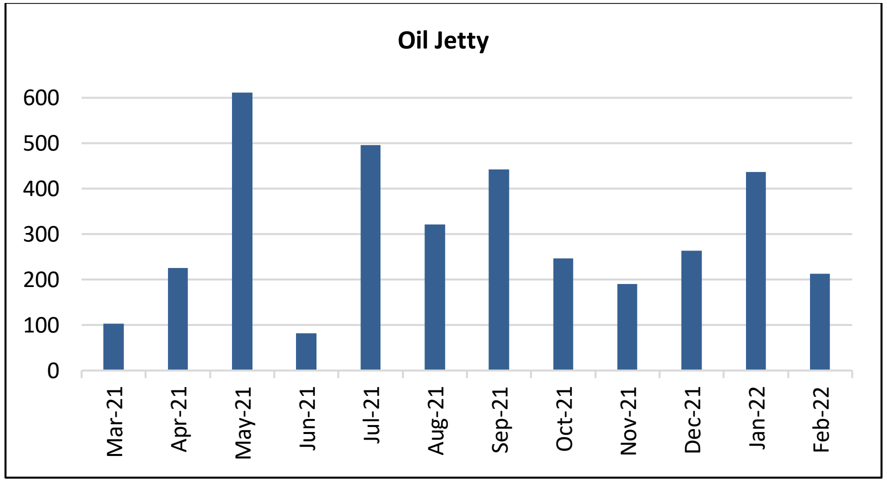
Fig 5. Trend in PM10 values of various AAQ Monitoring Locations

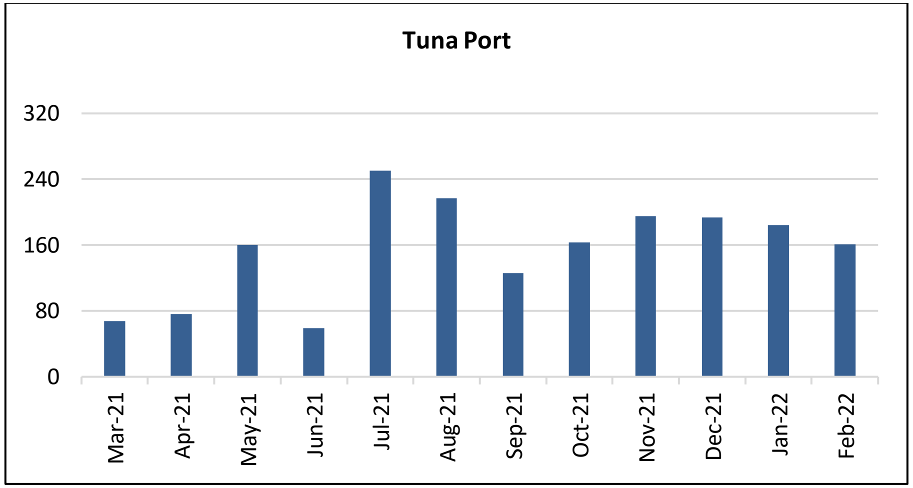


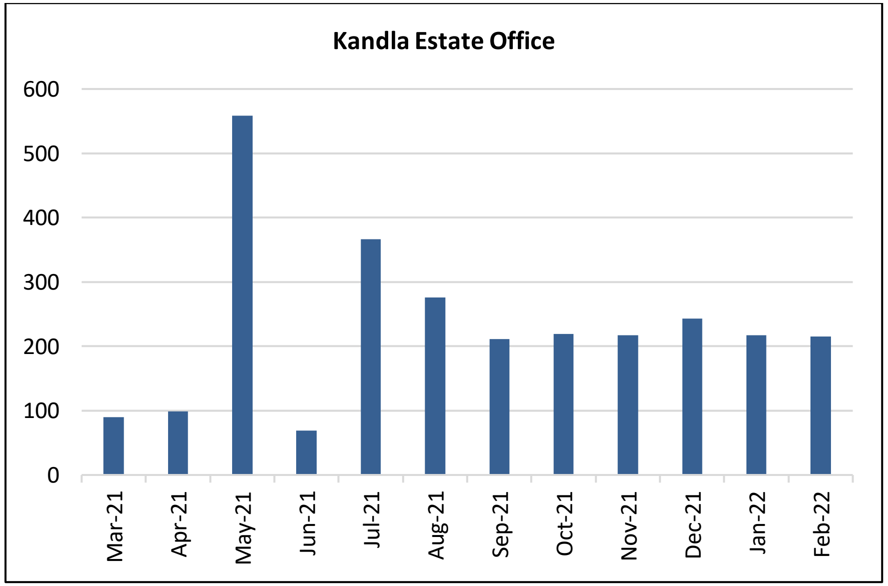







Oil Jetty
600
500
400
300
200
100
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22


Tuna Port
320
240
160
80
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22


Kandla Estate Office
600
500
400
300
200
100
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22

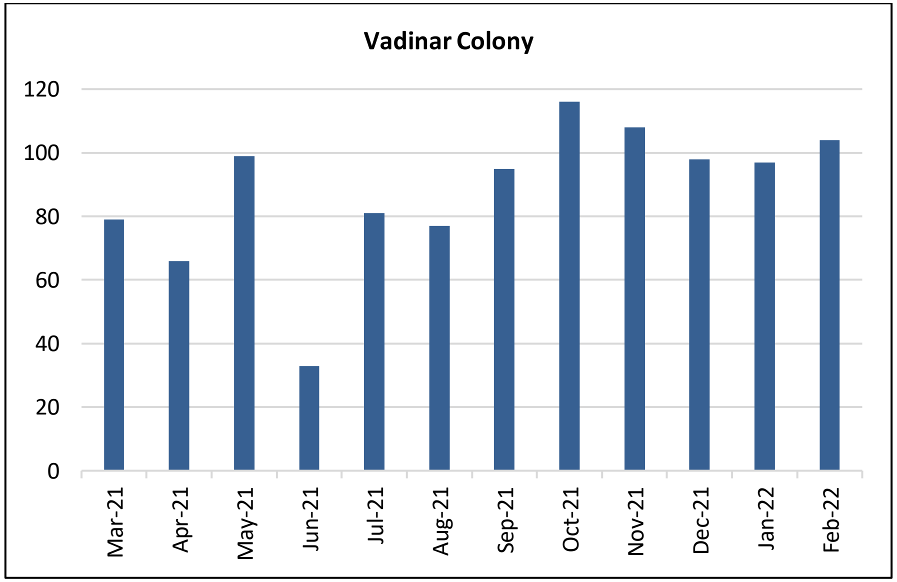
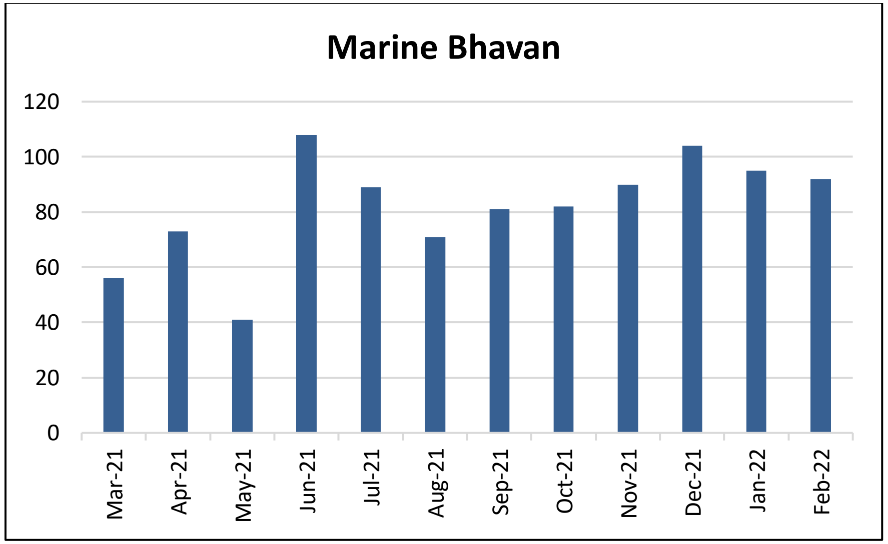
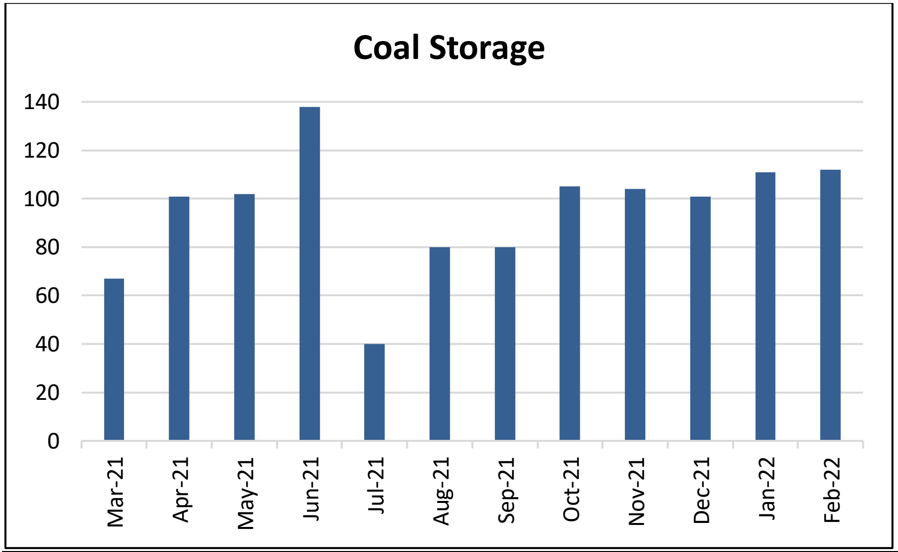
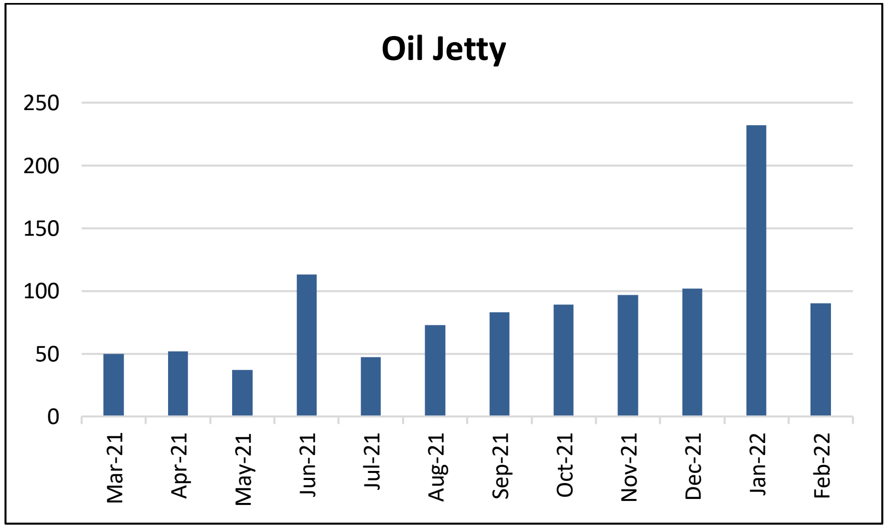
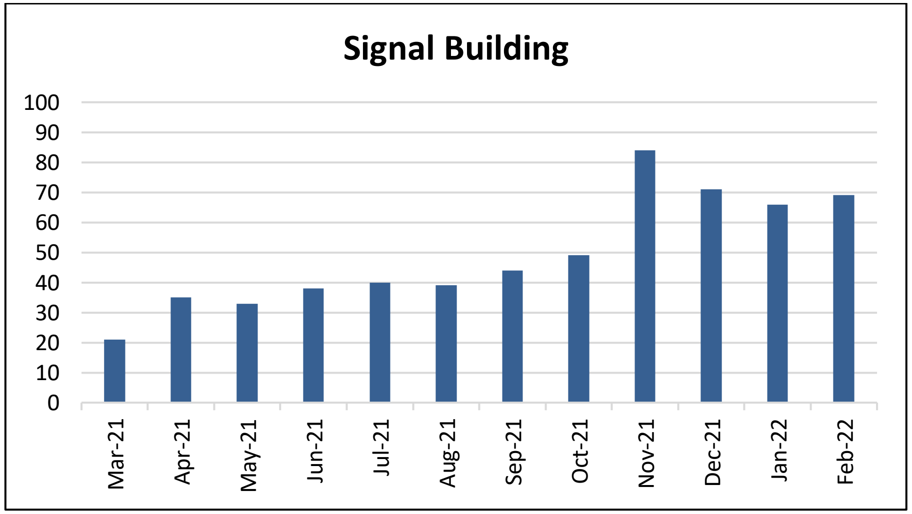

Vadinar Colony
120
100
80
60
40
20
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22

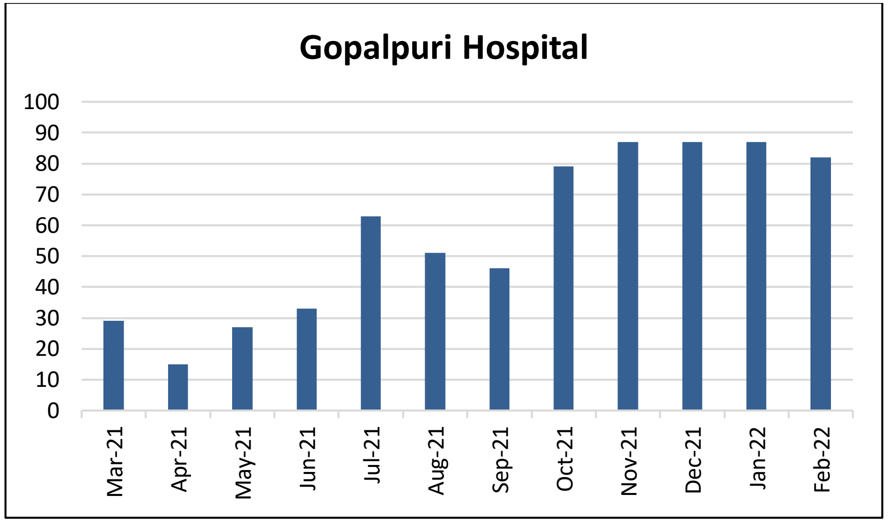
Fig 6. Trend in PM2.5 values of various AAQ Monitoring Locations

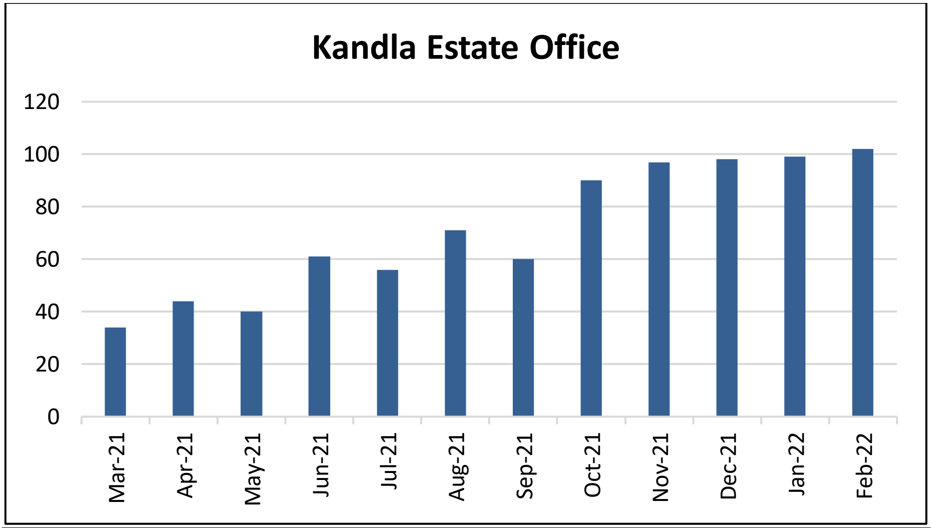


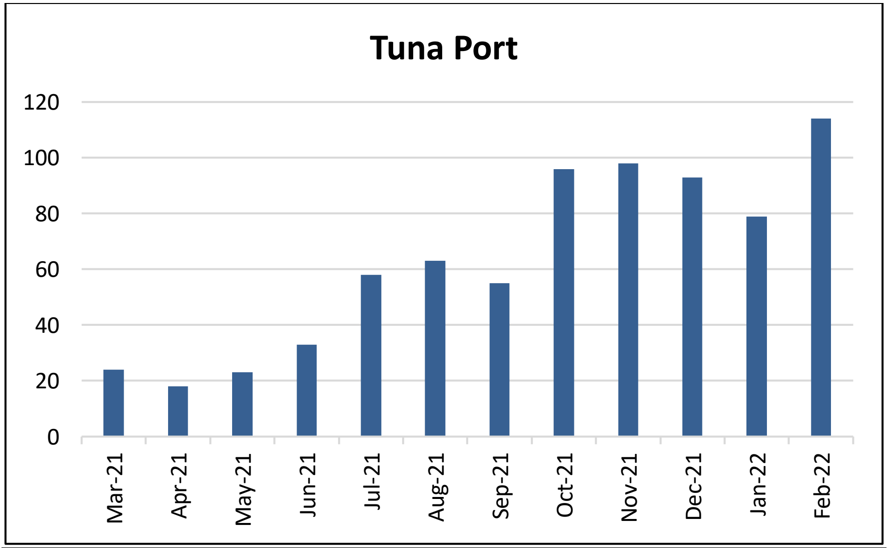


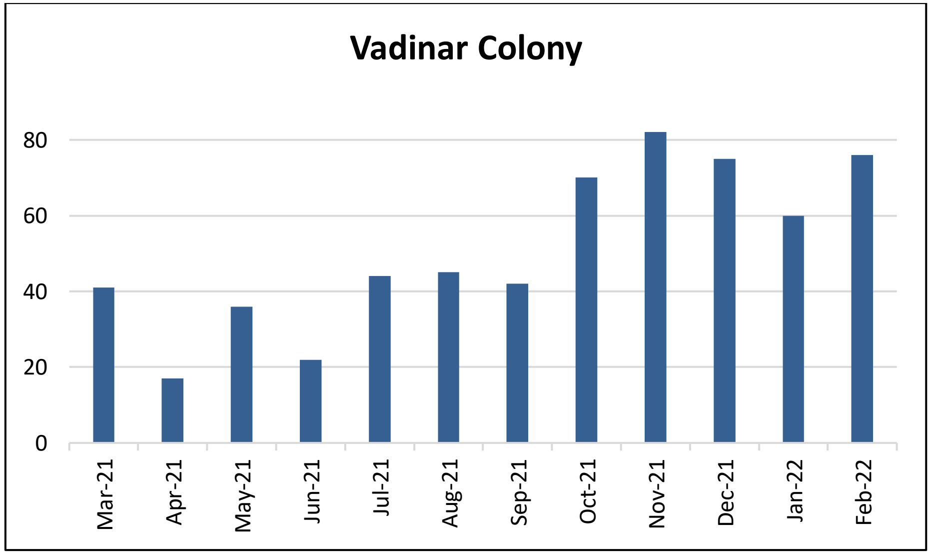





Gopalpuri Hospital
100
90
80
70
60
50
40
30
20
10
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22


Kandla Estate Office
120
100
80
60
40
20
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22


Tuna Port
120
100
80
60
40
20
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22


Vadinar Colony
80
60
40
20
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22

5.2 Drinking Water Quality Monitoring

Drinking Water Quality Monitoring was carried out at twenty stations at Kandla, Vadinar & Town ship Area of Deendayal Port.

Drinking water samples are collected from 20 locations (18 locations in Kandla and 2 locations in Vadinar). Samples for physico-chemical analysis are collected and analysed in laboratory for various parameters, viz. Color, Odor, Turbidity, Conductivity, pH, Chlorides, TDS, Total Hardness, Iron, Sulphate, Salinity, DO, BOD, Na, K, Ca, Mg, F, NO3, NO2, Mn, Cu, Cd, As, Hg, Pb, Zn, Bacterial Count (CFU).

Monitoring Results

Mean values of drinking water of Deendayal Port Locations are given in table 6.4. The values shown are the annual average of all the locations of Deendayal Port Colony, Port and Harbor area as well as Deendayal Port Authority office buildings.

Table 11 : Annual average values of Drinking water at Deendayal Port Authority

Sr. No.	Parameter	Unit	1st Quarter Mean	2nd Quarter Mean	3rd Quarter Mean	4th Quarter Mean	Value (Annual Avg.)	Acceptable Limits	Permissible Limits
1	pH	pH Unit	7.38	7.41	7.46	7.38	7.41	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/L	1114.30	1083.67	1265.93	1155.75	1154.91	500	2000
3	Turbidity	NTU	0.53	0.48	0.47	0.45	0.48	1	5
4	Odor	-	Odorless	Odorless	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	Colorless	Colorless	5	15
6	Conductivity	µs/cm	2253.97	2064.35	2448.83	2108.38	2218.88	NS*	NS*
7	Bio.Oxygen Demand	mg/L	<2	<2	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/L	651.10	579.99	484.50	539.53	563.78	250	1000
9	Ca as Ca	mg/L	74.21	59.34	62.83	61.72	64.53	75	200
10	Mg as Mg	mg/L	62.90	68.23	71.90	65.22	67.07	30	100
11	Total Hardness	mg/L	443.03	415.20	403.03	436.67	424.48	200	600
12	Iron as Fe	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	0.3	1
13	Fluorides as F	mg/L	0.45	0.69	0.55	0.64	0.58	1	1.5
14	Sulphate as SO_4	mg/L	211.96	193.41	229.75	220.67	213.95	200	400
15	Nitrite as NO2	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate as NO3	mg/L	5.29	10.23	9.92	10.04	8.87	45	100
17	Salinity	%	1.26	1.05	0.88	0.97	1.04	NS*	NS*
18	Sodium as Na	mg/L	329.18	228.77	219.20	268.63	261.45	NS*	NS*
19	Potassium as K	mg/L	4.13	2.94	3.80	4.43	3.82	NS*	NS*
20	Manganese	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	NS*	NS*
22	Copper	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	0.05	1.5
23	Cadmium	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	0.003	0.003
24	Arsenic	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	0.01	0.05
25	Mercury	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	0.001	0.001
26	Lead	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	0.01	0.01
27	Zinc	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	5	15
28	Bacterial Count	CFU/100 ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent

NS= Not specified, ND=Not detected

Discussion

The colour of all drinking water samples was colourless unit and odour of the samples was also agreeable. The values of turbidity, Iron as Fe and Ammonia as NH_3-N were observed to be below detection limits of measurement i.e. <0.1NT, <0.03mg/L and <0.1mg/L respectively. Apparently these parameters were not at alarming levels. Some important parameters for drinking water are discussed below in detail;

pH

pH value in the studied area varied from 7.37 to 7.47 pH unit during the first year of monitoring. The limit of pH value for drinking water is specified as 6.5 to 8.5. All the sampling points showed pH values within the prescribed limit by Indian Standards.

Total Dissolved Solids (TDS)

TDS values in the studied area varied between 1073.73-1201.26 mg/L. The mean TDS value was 1154.9 mg/L. None of the sampling points showed higher TDS values than the prescribed limit by Indian standards which are 500-2000mg/L.

Conductivity

Conductivity is used to measure the concentration of dissolved solids which have been ionized in a polar solution such as water. The conductivity in the samples collected during the month of June ranged from 2149.36-2320.63 µs/cm. Electrical conductivity standards do not appear in BIS standards for drinking water.

Chlorides

Chloride values in drinking water for the present year varied between 507.6 -647.63 mg/L. Excessive chloride concentration increase rates of corrosion of metals in the distribution system. This can lead to increased concentration of metals in the supply.

Calcium

Calcium value in drinking water for the present year the studied area varied between 62.32 – 68.91 mg/L. The mean Ca was observed to be 64.52 mg/L. If calcium is present beyond the maximum acceptable limit, it causes incrustation of pipes.

Magnesium

Magnesium value in the studied area for the present year varied from 65.80mg/L to 68.26 mg/L. All the locations had Magnesium within the prescribed limits of 30-100mg/L.

Total Hardness

Total Hardness value in the studied area for the present year varied between 389.03-447.43 mg/L. The prescribed limit by Indian Standards is 200-600mg/L.

Fluoride

Fluoride value in the studied area varied between 0.48 – 0.65 mg/L. The permissible limit as per Indian Standards is 1.0-1.5mg/L. Moderate amount of fluoride in water lead to dental effects, but long-term ingestion of large amounts can lead to potentially severe skeletal problems.

Sulphates

Sulphate value in the studied area varied between 195.75–225.46 mg/L. All the sampling points showed Sulphates values within the prescribed limits by Indian Standards (200-400 mg/L). Sulphate occurs naturally in water as are sult of leaching from gypsum and other common minerals. Sulphate content in drinking water exceeding the 400 mg/L imparts bitter taste.

Nitrites (NO_2)

Nitrite values in all the water samples were observed to be <0.01 mg/L. There are no specified standard values for Nitrites in drinking water. Ground water contains nitrate due to leaching of nitrate with the percolating water and by sewage and other wastes rich in nitrates.

Salinity

Salinity in drinking water in the present samples collected ranged from 0.92to 1.23 %. There are no prescribed Indian standards for salinity in Drinking water.

Heavy Metals in Drinking Water

In the present study period drinking water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals were well below/ the permissible limits of the Indian Standards for drinking water.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that total Coliform values is observed to be 0.1 to cfu/100 ml. total Coliform and E-Coli values showed that all the drinking water samples were safe from any bacteriological contamination.

Conclusion

The results are compared with acceptable limits as well as Permissible Limits as prescribed in IS10500:2012 – Drinking Water Specification. It was observed from the data analysis that during the Third year (March 2021 to February 2022) the drinking water was safe for human consumption as per tested parameters only at all drinking water monitoring stations.

5.3 Marine Water Monitoring

Marine Water Monitoring was carried out at six stations at Deendayal Port and two locations at Vadinar Port.

Water samples were analyzed for physico-chemical and Biochemical parameters. Besides these, Phytoplankton (Qualitative & Quantitative) Zooplankton (Qualitative & Quantitative) & Benthos (Qualitative & Quantitative) samples were collected during spring tide and neap tide from all the eight fixed monitoring stations.

Results

The annual average values of monitored parameters for marine waters of DPA are given as per table 12.

Table 12. Annual average values of various physico-chemical parameters at Deendayal Port during neap tide. (Marine Sampling Station at Gulf of Kutch).

Sr. No.	Parameters	Unit	1st	2nd	3rd	4th
			Quarter Mean	Quarter Mean	Quarter Mean	Quarter Mean
1	pH	-	7.30	7.35	7.36	7.39
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odourless	Odourless	Odourless	Odourless
4	Salinity	ppt	32.51	32.24	31.82	31.80
5	Turbidity	NTU	26.56	35.05	36.78	35.71
6	Total Dissolved Solids	mg/L	40307.26	39446.10	39151.25	34126.11
7	Total Suspended Solids	mg/L	468.54	393.35	503.95	630.73
8	Total Solids	mg/L	43192.33	41383.94	39672.71	34818.14
9	DO	mg/L	5.11	4.57	4.82	4.45
10	COD	mg/L	79.05	83.13	84.56	85.60
11	BOD	mg/L	0.00	0.00	0.00	0.00
12	Silica	mg/L	0.57	0.56	0.67	0.78
13	Phosphate	mg/L	0.29	0.25	0.19	0.20
14	Sulphate	mg/L	3499.62	2586.77	2451.53	2493.91
15	Nitrate	mg/L	4.15	3.23	3.80	3.97
16	Nitrite	mg/L	0.01	0.00	0.00	0.00
17	Calcium	mg/L	518.97	557.01	522.61	578.93
18	Magnesium	mg/L	1588.81	1739.01	1150.32	1680.46
19	Sodium	mg/L	9976.72	10571.44	10635.22	10265.40
20	Potassium	mg/L	314.39	367.85	324.11	343.54
21	Iron	mg/L	1.81	1.67	1.61	0.81
22	Chromium	mg/L	0.14	0.15	0.13	0.04
23	Copper	mg/L	0.07	0.10	0.04	0.00
24	Arsenic	mg/L	0.00	0.00	0.00	0.00
25	Cadmium	mg/L	0.06	0.07	0.06	0.02
26	Mercury	mg/L	0.00	0.00	0.00	0.00
27	Lead	mg/L	0.16	0.17	0.12	0.02
28	Zinc	mg/L	0.06	0.06	0.04	0.11

Discussion

Coastal ecosystems are characterized by daily fluctuations, driven by tidal amplitude, wind direction and also on the anthropogenic activities carried out on the coasts. Marine water parameters at Kandla Harbor and creek waters also showed an high array of fluctuations in several of its parameters such as TDS, TSS, salinity and salts. Some of the important parameters are explained below;

pH

The pH of all marine water samples collected from Deendayal Port variedfrom7.3to 7.39. The mean pH of all samples was 7.64pH unit.

Salinity

Salinity in the DPA marine water ranged from 31.8ppt to 32.51ppt. The mean salinity at was recorded to be 32.09 ppt.

Turbidity

Turbidity in the DPA marine water ranged from 26.56 – 36.78 NTU. The mean turbidity of all the locations of Deendayal Port was 33.52 NTU. Turbidity at Vadinar port was<1.0NTU.

Total Dissolved Solids (TDS)

TDS values varied from 34126.11 to 40307.26 mg/L at all locations of Deendayal Port. Mean TDS values at Deendayal Port was 38257.68mg/L.

Dissolved Oxygen (DO)

DO value in the studied area varied between 4.45-5.11 mg/L. The mean DO values of Kandla Marine waters were 4.7mg/L.

Nitrates (NO3)

The mean Nitrate values in all the marine water samples were of Deendayal Port was 3.78 mg/L at DPA waters. Nitrite was rarely detected from marine waters of Vadinar.

Sodium (Na)

Sodium value in the Deendayal Port marine waters varied between 9976.72-10635.22 mg/L. The mean Na recorded at DPA waters was 11448.78 mg/L.

Trace Metals

In the present study period water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals reported below trace levels.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that total Coli form values is observed to be 0.1to cfu/100ml.

5.4 Productivity Study

Chlorophyll-A

Water Samples for the chlorophyll estimation collected from sub surface layer during high tide and low tide period of the tidal cycle for each sampling locations and analysed for Chlorophyll -a and after acidification for Pheophytin –a.

In the sub surface water chlorophyll-a was varying from 0.204 to 1.923 mg/m^3 in harbour region of DPA during sampling done in from March 2021 to February 2022. In the nearby creeks chlorophyll-a was varying from 0.153.93 to 1.923mg/m^3.

In the sub surface water chlorophyll-a was varying from 0.392 – 1.356mg/m3 at Vadinar jetty and 0.392 mg/m3 to 1.365 mg/m3near SPM during sampling done spring tide period and during Neap tide.

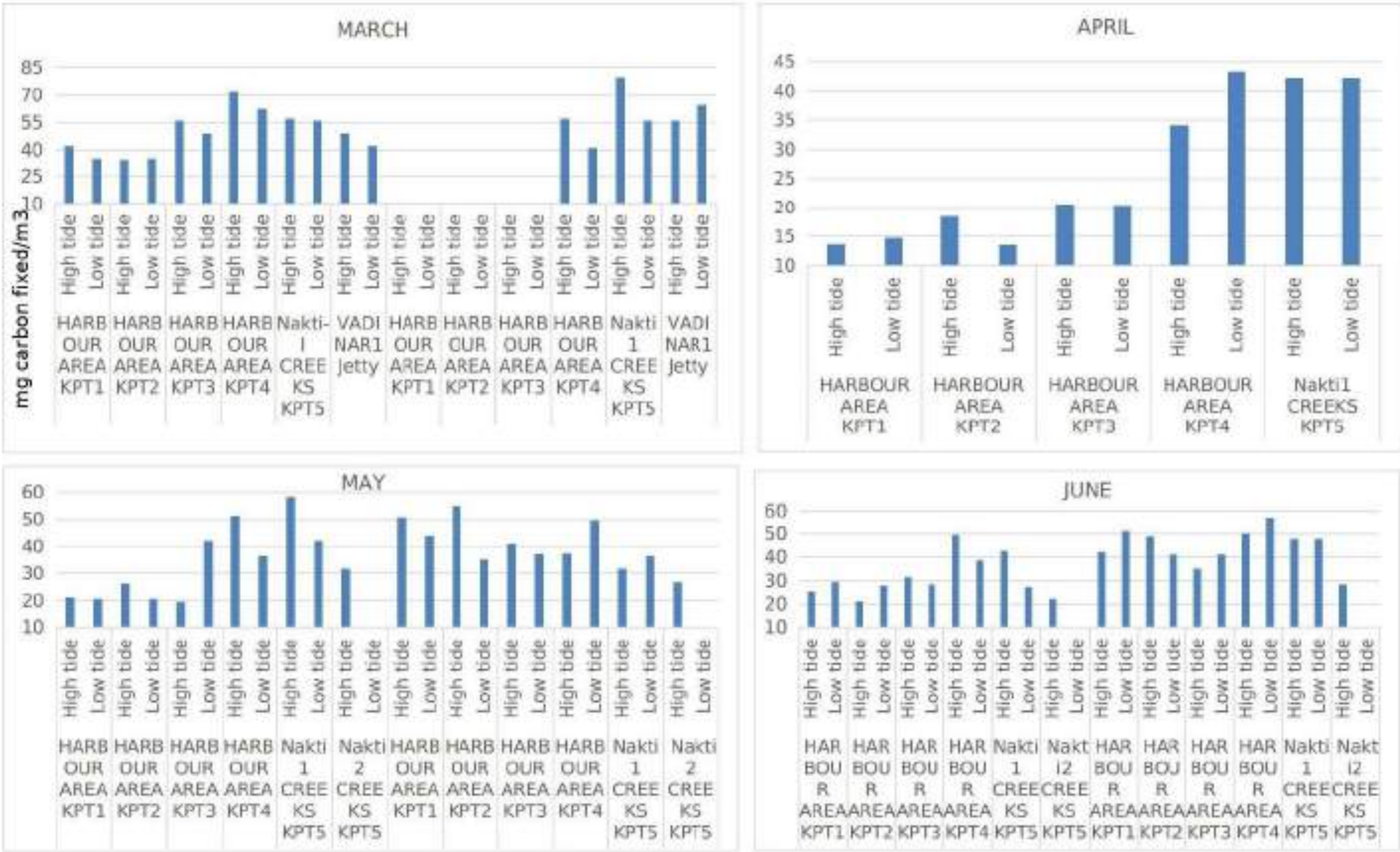
Algal Biomass

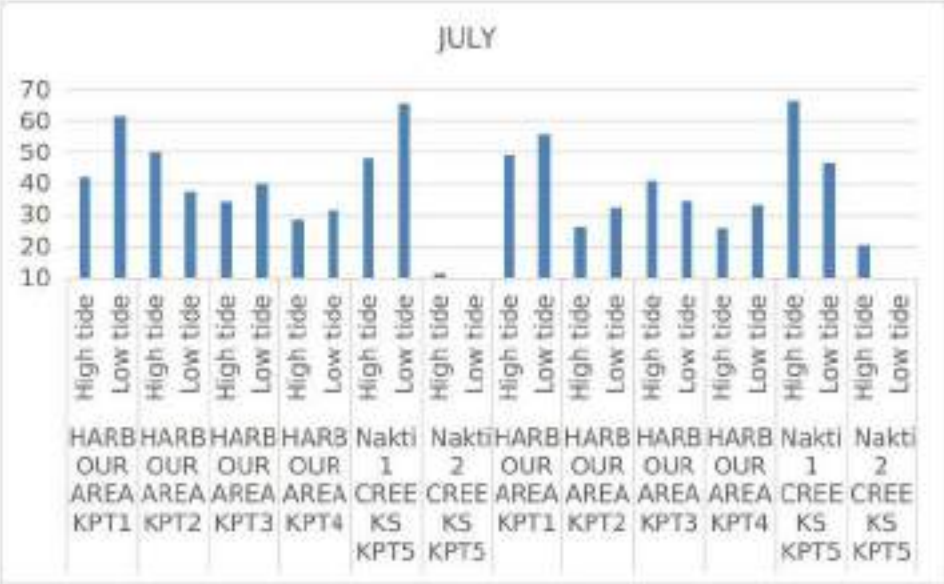
Chlorophyll-a value was used as algal biomass indicator (APHA 23rd Edition). Algal biomass was estimated by converting Chlorophyll value.

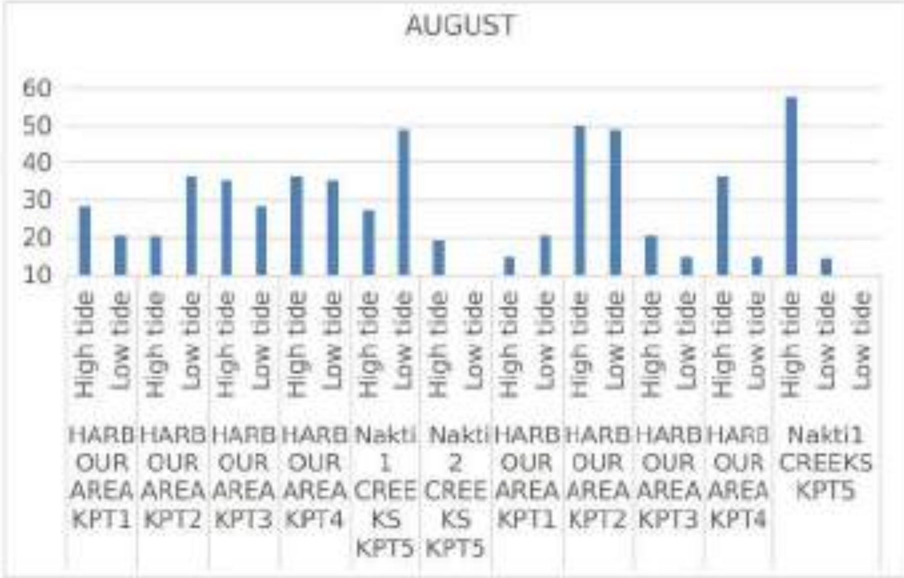
In the sub surface water algal biomass was varying from13.66to 128.84mg/m^3 in harbour region of DPA during sampling done in fromMarch2021 to February 2022. In the nearby creeks Algal Biomass was varyingfrom10.24to 128.84mg/m^3.

In the sub surface water algal biomass was varying from 26.26 – 90.85mg/m3 at Vadinar jetty and SPM during sampling done spring tide period and during Neap tide.

Fig 7. Monthly values of Algal Biomass in harbor waters of DPA




JULY
70
60
50
40
30
20
10
High tide
Low tide
HARBOUR AREA KPT1
HARBOUR AREA KPT2
HARBOUR AREA KPT3
HARBOUR AREA KPT4
Nakti 1 CREEKS KPT5
Nakti 2 CREEKS KPT5
HARBOUR AREA KPT1
HARBOUR AREA KPT2
HARBOUR AREA KPT3
HARBOUR AREA KPT4
Nakti 1 CREEKS KPT5
Nakti 2 CREEKS KPT5


AUGUST
60
50
40
30
20
10
High tide
Low tide
HARBOUR AREA KPT1
HARBOUR AREA KPT2
HARBOUR AREA KPT3
HARBOUR AREA KPT4
Nakti 1 CREEKS KPT5
Nakti 2 CREEKS KPT5
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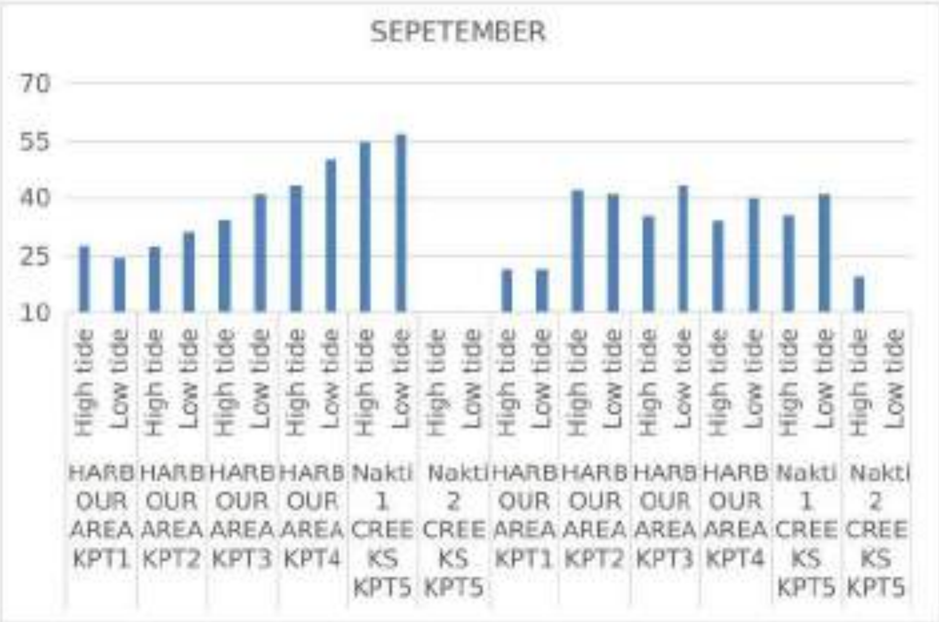
Nakti1 CREEKS KPT5


SEPETEMBER
70
55
40
25
10
High tide
Low tide
HARBOUR AREA KPT1
HARBOUR AREA KPT2
HARBOUR AREA KPT3
HARBOUR AREA KPT4
Nakti 1 CREEKS KPT5
Nakti 2 CREEKS KPT5
HARBOUR AREA KPT1
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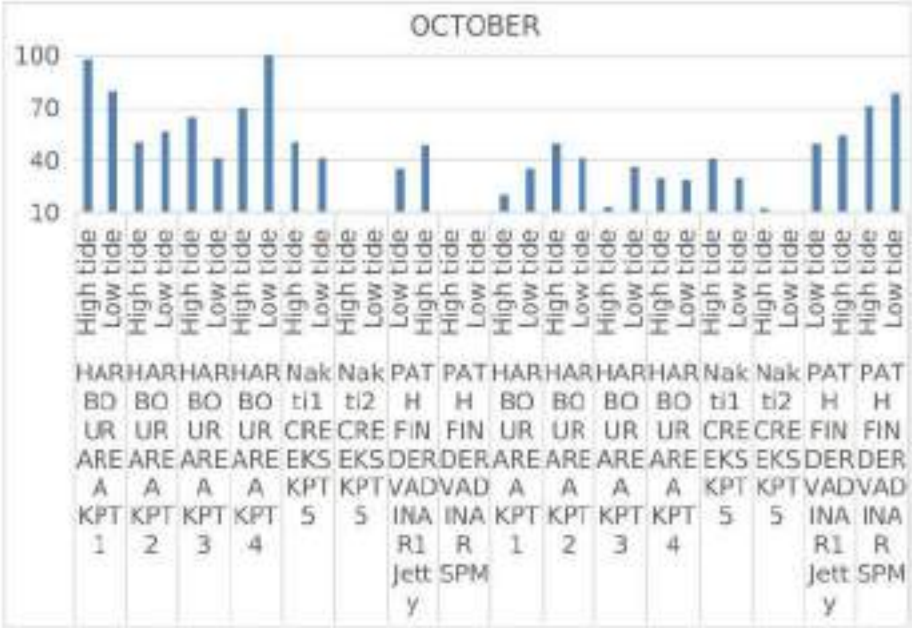
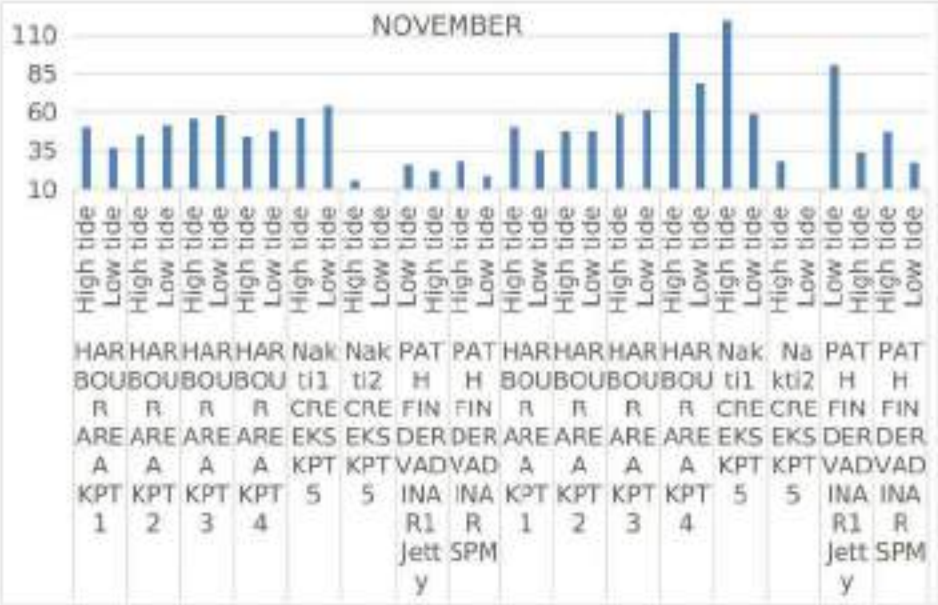
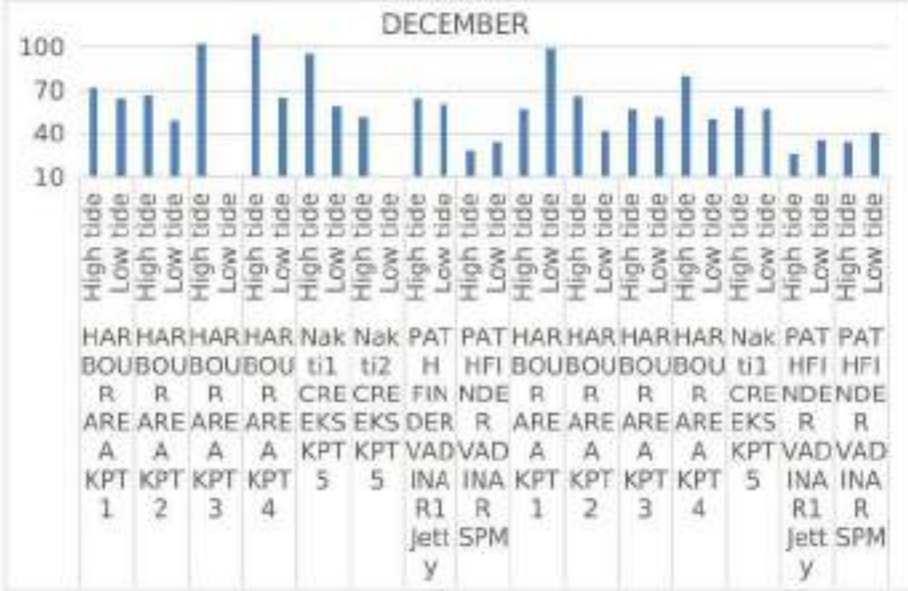
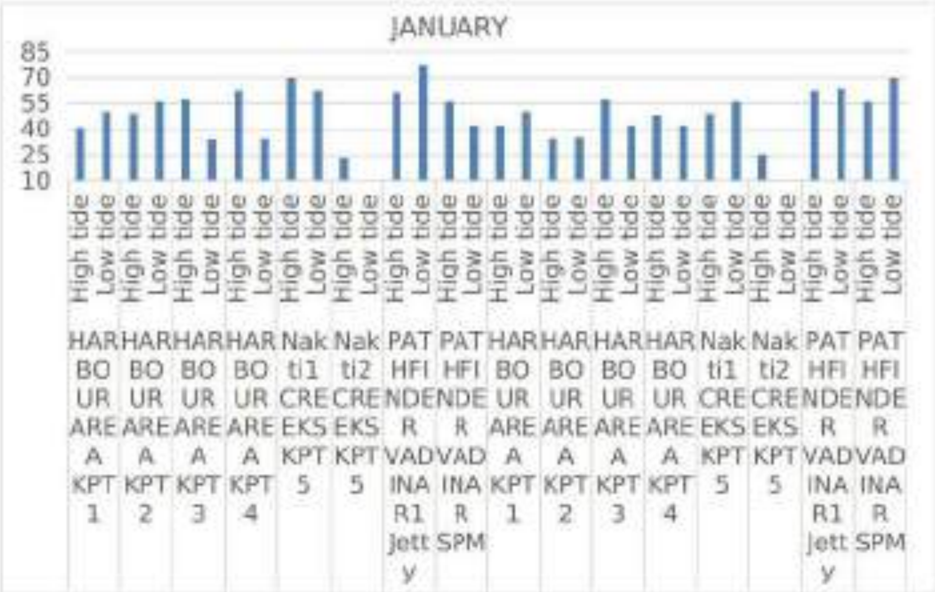
Nakti 2 CREEKS KPT5


OCTOBER
100
70
40
10
High tide
Low tide
HARBOUR AREA KPT 1
HARBOUR AREA KPT 2
HARBOUR AREA KPT 3
HARBOUR AREA KPT 4
Nakti1 CREEKS KPT 5
Nakti2 CREEKS KPT 5
PATH FINDERVADINAR1 Jetty
PATH FINDERVADINAR SPM
HARBOUR AREA KPT 1
HARBOUR AREA KPT 2
HARBOUR AREA KPT 3
HARBOUR AREA KPT 4
Nakti1 CREEKS KPT 5
Nakti2 CREEKS KPT 5
PATH FINDERVADINAR1 Jetty
PATH FINDERVADINAR SPM


NOVEMBER
110
85
60
35
10
High tide
Low tide


DECEMBER
100
70
40
10
High tide
Low tide


JANUARY
85
70
55
40
25
10
High tide
Low tide

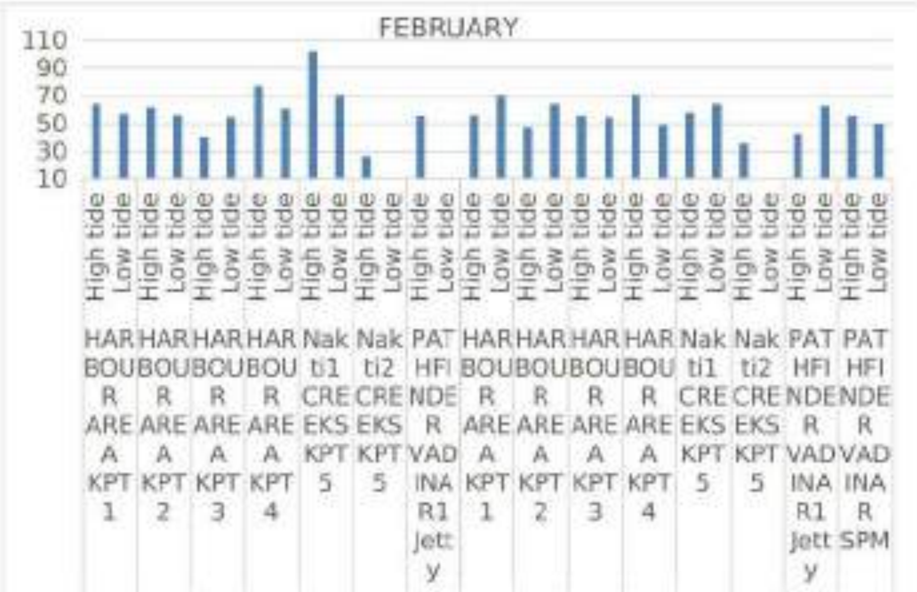
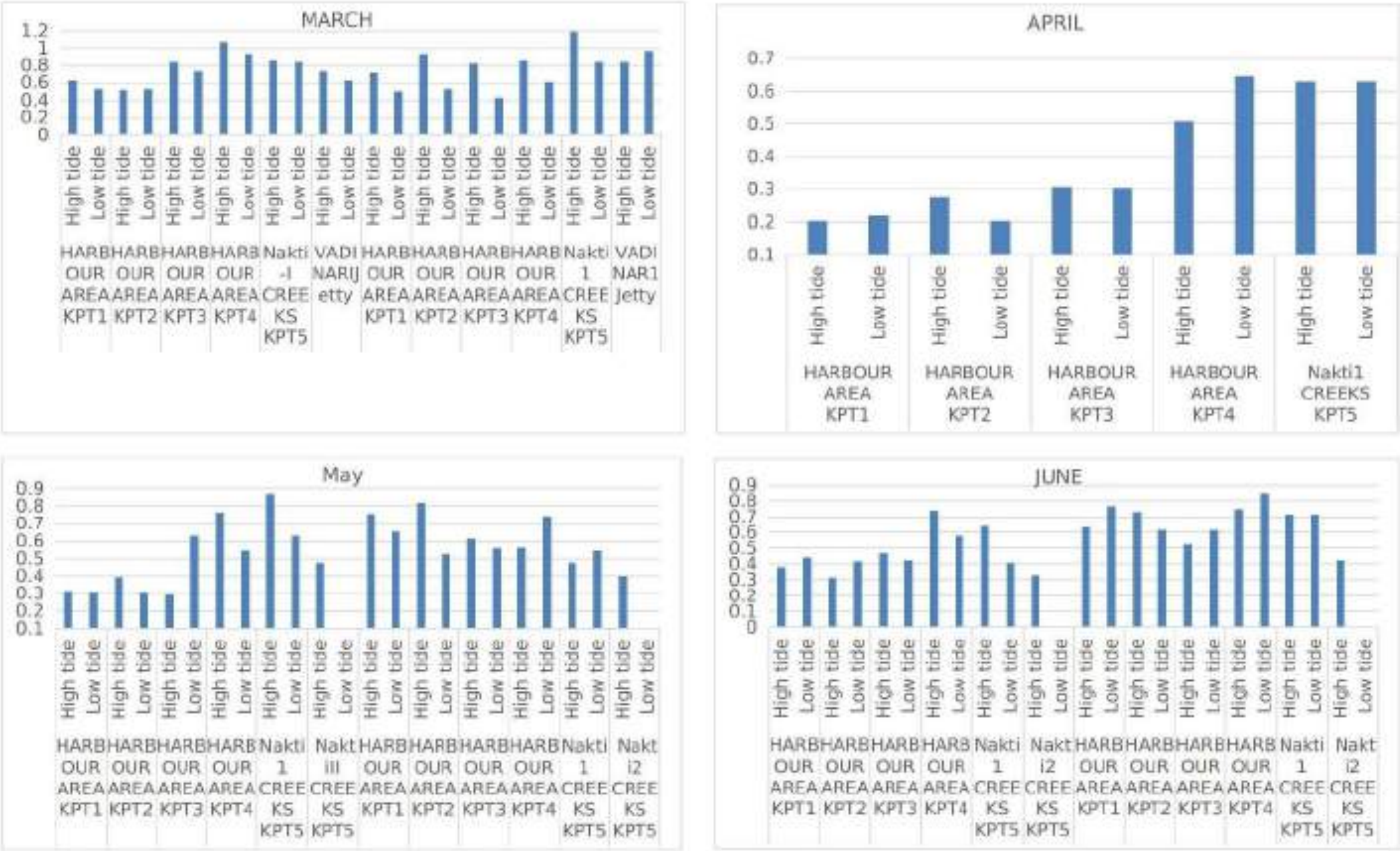
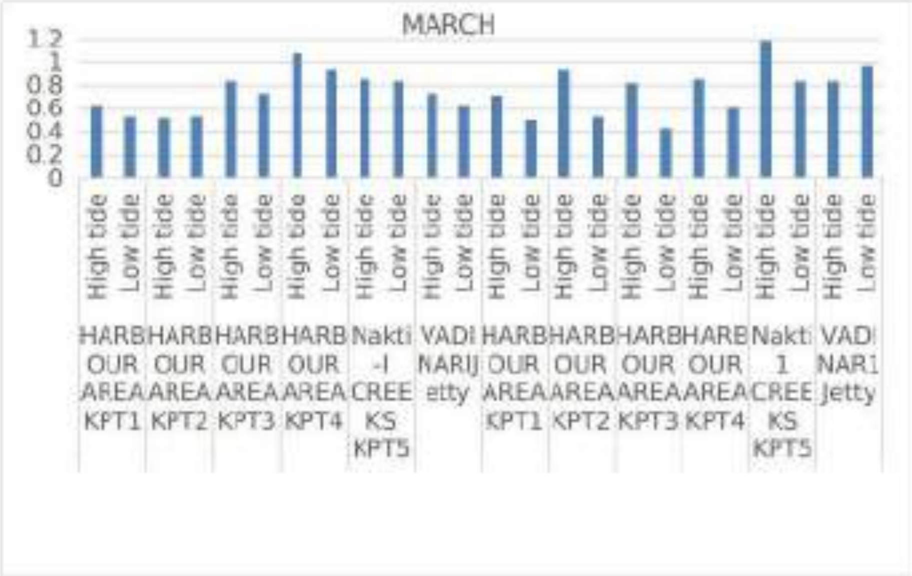
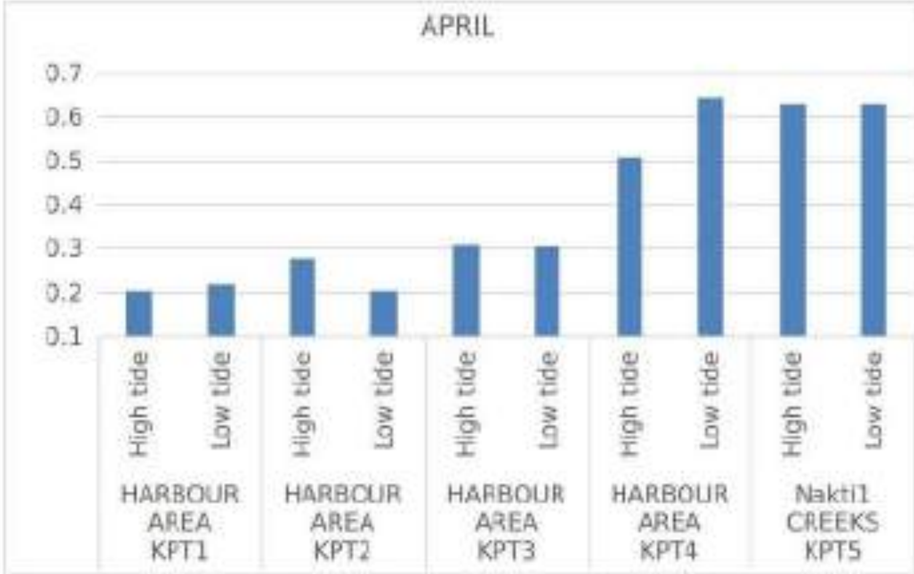

FEBRUARY
110
90
70
50
30
10
High tide
Low tide

Fig 8. Annual average values of Chlorophyll-a in harbor waters of DPA




MARCH
HARBOUR AREA KPT1
HARBOUR AREA KPT2
HARBOUR AREA KPT3
HARBOUR AREA KPT4
Nakti-I CREEKS KPT5
VADINARIJ etty
HARBOUR AREA KPT1
HARBOUR AREA KPT2
HARBOUR AREA KPT3
HARBOUR AREA KPT4
Nakti 1 CREEKS KPT5
VADINAR1 Jetty
High tide
Low tide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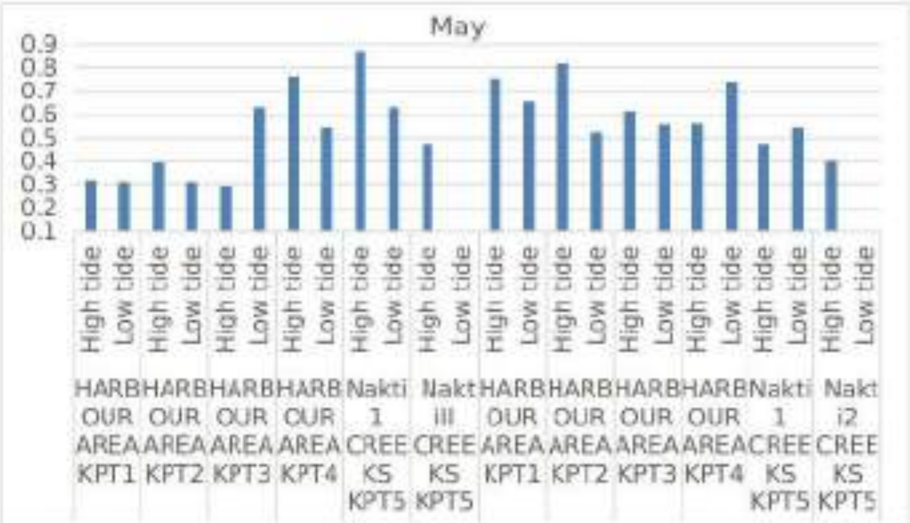
HARBOUR AREA KPT3
HARBOUR AREA KPT4
Nakti1 CREEKS KPT5
High tide
Low tide


May
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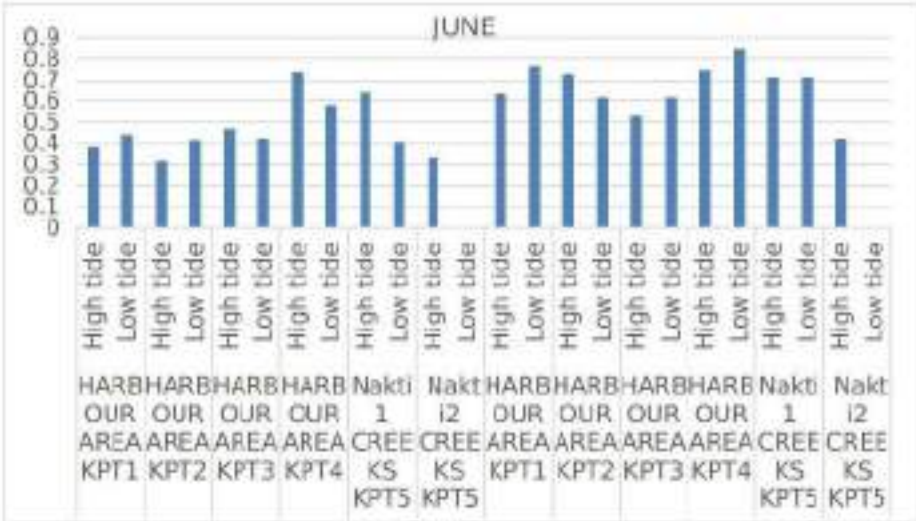
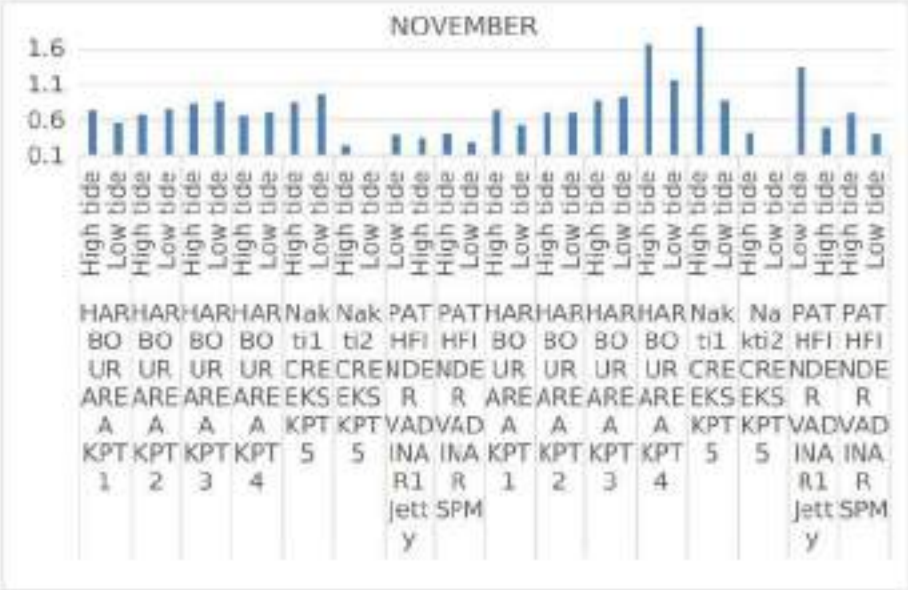
HARBOUR AREA KPT4
Nakti 1 CREEKS KPT5
Naktiii CREEKS KPT5
HARBOUR AREA KPT1
HARBOUR AREA KPT2
HARBOUR AREA KPT3
HARBOUR AREA KPT4
Nakti 1 CREEKS KPT5
Nakti2 CREEKS KPT5
High tide
Low tide


JUNE
HARBOUR AREA KPT1
HARBOUR AREA KPT2
HARBOUR AREA KPT3
HARBOUR AREA KPT4
Nakti 1 CREEKS KPT5
Nakti2 CREEKS KPT5
HARBOUR AREA KPT1
HARBOUR AREA KPT2
HARBOUR AREA KPT3
HARBOUR AREA KPT4
Nakti 1 CREEKS KPT5
Nakti2 CREEKS KPT5
High tide
Low tide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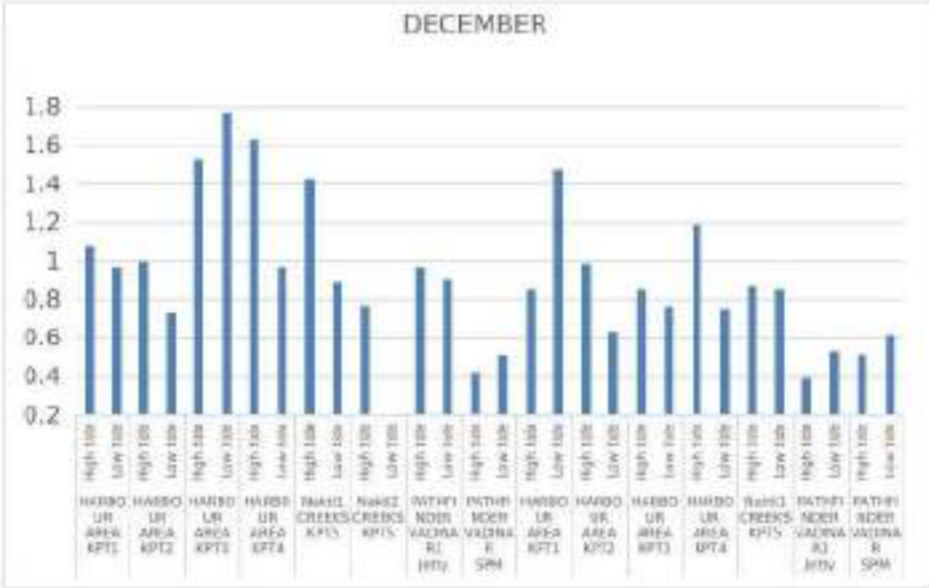
0.6
0.1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1.6
1.4
1.2
1
0.8
0.6
0.4
0.2


JANUARY
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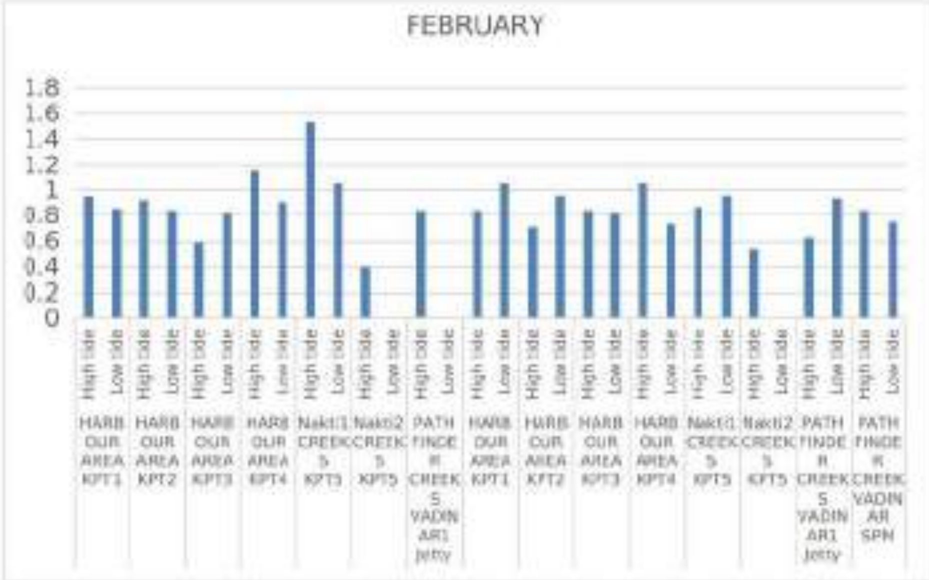
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2


FEBRUARY
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0

5.5 Phytoplankton and Zooplankton

The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by Blue green algae and diatoms during spring tide period and neap tide period. Diatoms were represented by 13 genera belonging to 3 classes, 9 orders and 12 families.

The Zooplankton community of the sub surface water in the harbour and nearby creeks is comparatively low and represented by mainly four groups Tintinids, Copepods, Foramiferans, and larval forms of Crustaceans.

However, Vadinar waters were observed to be rich in terms of diversity and abundance of phytoplankton and zooplanktons.

5.6 Noise Monitoring

Noise monitoring is carried out as per "Noise Pollution" (Regulation and Control) Rules, 2000. The results of noise monitoring results are annual mean of each location of Kandla and Vadinar Port (Table 13).

Table 13. Annual avg. of noise level at locations of Kandla (10 locations) and Vadinar (3locations) Port

Sr. No.	Locations	Day Time Average Noise Level(SPL) in dB(A)	Night Time Average Noise Level(SPL) in dB(A)
	Time	6 A.M.. And 10 P.M.	10 P.M. To 6 A.M.
1	Marine Bhavan	62.35	55.14
2	Nirman Building 1	58.41	53.72
3	Tuna Port	55.51	48.87
4	Main Gate North	62.58	57.54
5	West Gate I	66.68	60.97
6	Canteen Area	59.64	51.94
7	Main Road	65.06	56.39
8	ATM Building	67.37	58.00
9	Wharf /Jetty Area	69.50	64.12
10	Port & Custom Office	58.51	48.77
	Vadinar Port		
11	Nr. Vadinar Port Gate	59.25	52.99
12	Port Colony Vadinar	57.42	54.11
13	Nr. Vadinar Jetty	63.58	59.08

Observations:

- The Day Time Average Noise Level in all ten locations at Deendayal Port ranged from 55.51dB to 69.50dB
- The noise levels were within the day time limits (75 dB (A)) of industrial area.
- The Night Time Average Noise Level in all ten locations of Deendayal Port ranged from 48.77 dB to 64.12 dB and it was within the permissible limits of 70 dB A for the industrial area for the night time.
- The mean day time noise levels at Vadinar were 60.08dB and the mean noise levels at night hours was 55.39dB.

5.7 Soil Monitoring

Sampling and analysis of soil samples was under taken at six locations with in the study area (Deendayal Port and Vadinar Port). The soil monitoring locations are coastal soils and exhibits saline soil characteristics, typical of a muddy shore.

The texture of soil of all locations was Sandy Loam. The soil at all the locations is saline in nature. The mean pH of the soil at all the locations of Kandla was 8.08 pH unit suggesting it to be slightly to medium alkaline.

Electrical conductivity of the soil was high with low moisture and organic carbon indicating less productivity of the soil and its unsuitability for any agriculture activities.

Other metals like copper, nickel and lead were detected in traces or within permissible limits. The overall surrounding soils were found to be less in essential nutrients, hence less suitable for plant growth.

Table 14. Tuna port Soil Analysis Result

Sr.No	Month		March.21	April.21	May.21	June.21	July.21	Aug.21	Sept.21	Oct.21	Nov.21	Dec.21	Jan.22	Feb.22
	Parameter	Unit	Result											
1	Texture		Sandy Loam											
2	pH	-	8.71	9.02	8.38	7.3	8.56	8.6	8.58	8.62	8.42	8.2	8.2	8.59
3	Electrical conductivity	µs/cm	10600	8650	29500	33400	26800	23400	18400	16200	14070	10805	10805	2839
4	Moisture	%	21.72	22.9	14	21.45	23.66	20.42	21	17	18.17	6.06	6.06	22
5	Total Organic Carbon	%	1.62	2.25	0.94	0.31	0.16	0.18	0.48	0.52	0.2	0.49	0.49	0.96
6	Alkalinity	mg/kg	40.04	80.08	80.08	100.1	140.14	60.06	72.07	60.06	80.08	70.07	70.07	40.04
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	BQL	BQL	BQL	BQL
8	Chloride	mg/kg	1244	2605.8	7896.2	6228.7	3908.6	4010	1506.6	1620	1956.8	709	709	3545
9	Sulphate	mg/kg	102	107.82	2502.08	2056.4	203	188	202	230	212	778.5	778.5	3891.18
10	Phosphorus	mg/kg	31.44	39.86	0.76	0.97	0.97	0.9	0.89	0.9	2.2	9.21	9.21	50.87
11	Potassium	mg/kg	1178	1028	1128	1161	779.4	786	386	396	539	143	143	192.3
12	Calcium	mg/kg	4843	228.4	320.64	641.3	2241	2341	1585	1620	5752	1315.7	1315.7	2466.12
13	Sodium	mg/kg	501	12092.4	11092.4	10821.6	144.29	160	228.46	230.32	200.4	152.3	152.3	284.57
14	Copper as Cu	mg/kg	52.2	62.2	10.2	11.21	42.6	32.2	52.2	17.4	14.9	35.9	35.9	26.2
15	Lead as Pb	mg/kg	5	4.8	5.4	3.1	4.2	3.8	4.9	6.4	5.8	13.4	13.4	7.5
16	Nickel as Ni	mg/kg	33.3	32.86	16.7	20.71	36.2	37.2	46.2	33.5	35.3	54.5	54.5	39.1
17	Zinc as Zn	mg/kg	56.2	58.26	22.6	32.26	58.6	59.36	66.2	55.9	40.6	89.7	89.7	58.2
18	Cadmium as Cd	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL

Table15. IFFCO Plant Soil Analysis Result

Sr.No	Month		March.21	April.21	May.21	June.21	July.21	Aug.21	Sept.21	Oct.21	Nov.21	Dec.21	Jan.22	Feb.22
	Parameter	Unit	Result											
1	Texture		Sandy Loam											
2	pH	-	7.98	8.78	8.25	8.16	8.11	8.1	8.16	8.1	7.92	7.77	7.77	8.6
3	Electrical conductivity	µs/cm	28900	36200	44400	48500	23800	20420	25620	26820	16210	22960	22960	1442
4	Moisture	%	23.97	22.1	20.91	13.94	22.09	21.16	22.2	18.2	9.01	6.4	6.4	28.37
5	Total Organic Carbon	%	6.29	1.4	1.52	0.19	0.24	0.18	1.24	1.02	0.49	0.69	0.69	0.71
6	Alkalinity	mg/kg	40.04	60.06	60.06	140.14	140.14	140.04	36.04	80.44	120.12	26.03	26.03	40.04
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	BQL	BQL	BQL	BQL
8	Chloride	mg/kg	2487	4510	6866.3	6032.5	4309.5	4324	6381	5380	4112.2	4325.9	4325.9	2481.5
9	Sulphate	mg/kg	204	311.7	804.5	75.86	177.9	179.2	196	198	279	3359.5	3359.5	1650.89
10	Phosphorus	mg/kg	21.25	52.7	2.45	1.41	0.8	0.86	0.92	0.82	1.89	10.56	10.56	5.33
11	Potassium	mg/kg	1715	747	762	592.2	644.4	656	820	810	327.4	199.8	199.8	155.01
12	Calcium	mg/kg	4710	468.9	661.32	561.12	3556.8	3618	3386	3400	4061.6	1116.4	1116.4	1500.32
13	Sodium	mg/kg	601	4840.2	5832.2	2992.8	128.22	130	741.5	722.2	488.98	360.72	360.72	432.86
14	Copper as Cu	mg/kg	60.8	52.5	26.2	27.22	61.2	58.2	78.2	38.8	29.5	29.9	29.9	35.6
15	Lead as Pb	mg/kg	1	1.52	8.5	6.2	3.2	3.8	5.6	7.9	6.4	9.3	9.3	10.8
16	Nickel as Ni	mg/kg	27.52	22.62	2020	1823	31.6	32.4	28	13.9	16.6	30.8	30.8	42.9
17	Zinc as Zn	mg/kg	43.2	59.2	89.1	72.62	39.25	38.32	41.6	91.9	104.8	153.2	153.2	102.7
18	Cadmium as Cd	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL

Table 16. Khori Creek Soil Analysis Result

Sr.No	Month		March.21	April.21	May.21	June.21	July.21	Aug.21	Sept.21	Oct.21	Nov.21	Dec.21	Jan.22	Feb.22
	Parameter	Unit	Result											
1	Texture		Sandy Loam											
2	pH	-	8.75	8.82	8.13	8.36	8.38	8.42	8.46	8.75	8.44	8.53	8.53	8.68
3	Electrical conductivity	µs/cm	8500	16380	39900	21800	23700	23700	17880	16252	13680	22260	22260	1950
4	Moisture	%	19.04	21.2	28.1	18.82	24.41	23.22	24.1	19.1	21.39	9.02	9.02	21
5	Total Organic Carbon	%	1.46	2.2	1.7	0.26	0.32	0.25	0.48	0.62	0.2	0.61	0.61	0.98
6	Alkalinity	mg/kg	60.06	60.06	70.05	80.08	100.1	140.04	190.19	140.2	60.06	52.05	52.05	40.04
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	BQL	BQL	BQL	BQL
8	Chloride	mg/kg	1144	3658.1	7160.6	2550.3	6114	5982	1701	1820	1800.9	3970.4	3970.4	2836
9	Sulphate	mg/kg	120	129.05	356.6	292	113.8	110	112	120	93.3	315.3	315.3	1292.27
10	Phosphorus	mg/kg	17.74	34.55	7.79	0.79	1.24	1.04	1.05	0.96	1.41	6.92	6.92	8.87
11	Potassium	mg/kg	903	698.4	578.4	700.2	1135.8	1162	345	366	409.2	139	139	160.36
12	Calcium	mg/kg	4235	284.6	460.92	701.4	3981.6	4220	2303	2122	3954	1234.8	1234.8	1839.79
13	Sodium	mg/kg	200	7437.6	6336.6	3164.4	168.3	170	248.5	252	252	144.29	144.29	232.46
14	Copper as Cu	mg/kg	40.6	38.6	29.4	28.2	38.2	42.2	46.2	21.2	9.8	30.8	30.8	31.8
15	Lead as Pb	mg/kg	4.2	3.62	31	23	3.6	3.6	3.2	29.1	3.5	11.1	11.1	5.4
16	Nickel as Ni	mg/kg	31.62	29.62	9	7.8	39.4	41.2	33.2	34.5	23.5	44.1	44.1	42
17	Zinc as Zn	mg/kg	46	42.62	95.8	65.9	52.4	53.4	68	77.9	25.4	76.8	76.8	76.7
18	Cadmium as Cd	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL

Table 17. Nakti Creek Soil Analysis Result

Sr.No	Month		March.21	April.21	May.21	June.21	July.21	Aug.21	Sept.21	Oct.21	Nov.21	Dec.21	Jan.22	Feb.22
	Parameter	Unit	Result											
1	Texture		Sandy Loam											
2	pH	-	8.39	8.68	7.91	8.26	8.33	8.3	8.26	8.33	8.23	8.02	8.02	8.47
3	Electrical conductivity	µs/cm	13340	4790	38200	37200	16260	17200	16520	17520	9240	14090	14090	2848
4	Moisture	%	22.65	4.13	26.2	14.26	23.65	20.12	18.8	20.22	21.08	23.84	23.84	24.88
5	Total Organic Carbon	%	1.61	0.7	1.58	0.24	0.1	0.11	3.93	3.1	0.72	0.87	0.87	0.84
6	Alkalinity	mg/kg	40.04	80.08	70.05	140.14	80.08	60.06	90.09	80.44	100.1	44.04	44.04	40.04
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	BQL	BQL	BQL	BQL
8	Chloride	mg/kg	1386	4359.7	9416.7	7160.6	3959	4001	1878.9	2078	514.7	3048.7	3048.7	3190.5
9	Sulphate	mg/kg	214	299.4	3966.5	87.84	93.8	100	112	118	165.1	574.7	574.7	4950.89
10	Phosphorus	mg/kg	35.87	50.04	1.66	1.59	1.77	1.62	1.1	1.02	2.15	4.76	4.76	8.5
11	Potassium	mg/kg	743	865.8	755.8	765	766.8	780	422	460	667.6	121.9	121.9	178.48
12	Calcium	mg/kg	3453	493	821.64	661.32	3038.4	3122	1990	2012	1477	1426.3	1426.3	2450.29
13	Sodium	mg/kg	501	7165.8	6355.8	3736.8	224.4	220	468.94	470.42	470.42	192.38	192.38	492.9
14	Copper as Cu	mg/kg	21.2	19.2	33.7	31.78	22.6	23.4	33.8	35.1	27.6	25.8	25.8	25
15	Lead as Pb	mg/kg	6.8	2.8	15.3	11.4	3.8	4.1	4.8	7.6	8.2	10.5	10.5	7.6
16	Nickel as Ni	mg/kg	22.02	19.22	25.4	15.1	22.6	24.5	26.1	13.2	37.7	39.6	39.6	31.9
17	Zinc as Zn	mg/kg	62	59.8	87.3	77.21	46.6	48.5	49.55	81.9	55.2	59.1	59.1	48.1
18	Cadmium as Cd	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL

Table 18. Vadinar DPA Admin Site Soil Analysis Result

Sr.No	Month		March.21	April.21	May.21	June.21	July.21	Aug.21	Sept.21	Oct.21	Nov.21	Dec.21	Jan.22	Feb.22
	Parameter	Unit	Result											
1	Texture		Sandy Loam											
2	pH	-	8.46	8.86	8.76	7.27	8.12	8.09	8.02	8.1	7.79	8.07	8.07	7.64
3	Electrical conductivity	µs/cm	585	439	260	511	509	510	523	560	387	1994	1994	1417
4	Moisture	%	7.16	4.62	7.26	6.28	9.44	9.04	8.66	7.26	3.46	4.22	4.22	8.49
5	Total Organic Carbon	%	2.53	0.87	1.16	0.15	0.2	0.21	0.18	0.12	0.85	1.16	1.16	0.32
6	Alkalinity	mg/kg	60.06	40.04	60.06	60.06	100.1	100.1	60.06	60.06	60.06	42.04	42.04	60.06
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	BQL	BQL	BQL	BQL
8	Chloride	mg/kg	280	90.2	29.43	68.66	39.3	42.2	52	62	21.7	567.2	567.2	141.8
9	Sulphate	mg/kg	330	268	23.2	14.37	13.4	14	12	16	44.7	52.7	52.7	250.38
10	Phosphorus	mg/kg	2.83	5.85	8.5	0.97	0.8	0.78	0.78	0.8	BQL	15.06	15.06	1..88
11	Potassium	mg/kg	131	212.8	302.8	626.4	129.6	130	110	120	70.4	73	73	30.01
12	Calcium	mg/kg	56	244.5	1703.4	124.2	1220	1224	990	910	72.8	65.1	65.1	153.5
13	Sodium	mg/kg	1303	236	246	2116.8	104.2	110	118	110	436.87	460.92	460.92	837.67
14	Copper as Cu	mg/kg	16.6	14.5	80.5	82.66	16.2	17.4	18.6	16.6	88.4	54	54	18.3
15	Lead as Pb	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	3.2	4.8	BQL	BQL	BQL	BQL
16	Nickel as Ni	mg/kg	26.42	18.26	35.3	25.46	18.3	19.3	18.2	13.2	33.8	42.1	42.1	60.2
17	Zinc as Zn	mg/kg	40	38.3	33.2	23.46	46.8	49.2	24	28	66	51	51	84.6
18	Cadmium as Cd	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL

Table 19. Vadinar DPA Colony Soil Analysis Result

Sr.No	Month		March.21	April.21	May.21	June.21	July.21	Aug.21	Sept.21	Oct.21	Nov.21	Dec.21	Jan.22	Feb.22
	Parameter	Unit	Result											
1	Texture		Sandy Loam											
2	pH	-	8.82	8.49	8.85	7.82	8.42	8.32	8.56	8.22	8.43	7.84	7.84	7.11
3	Electrical conductivity	µs/cm	875	634	513	464	419	400	420	480	314	490	490	299.6
4	Moisture	%	9.67	6.51	6.35	4.56	7.59	8.22	9.02	8.22	3.95	2.86	2.86	3.96
5	Total Organic Carbon	%	2.42	1.04	1.71	0.11	0.12	0.16	0.21	0.2	0.43	1.24	1.24	0.67
6	Alkalinity	mg/kg	60.06	60.06	70.05	100.1	60.06	80.04	100.1	80.44	80.08	40.04	40.04	40.04
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	BQL	BQL	BQL	BQL
8	Chloride	mg/kg	290	120.3	40.09	78.47	68.7	67.8	67.8	77	113.4	283.6	283.6	70.9
9	Sulphate	mg/kg	210	424	4.02	13.58	15.5	16.2	18	20	27.7	14.7	14.7	BQL
10	Phosphorus	mg/kg	3.36	7.79	7.35	0.97	0.97	0.88	0.86	0.72	1.74	7.06	7.06	BQL
11	Potassium	mg/kg	103	140	152	876.4	180	182	172	160	62	17	17	28.87
12	Calcium	mg/kg	94	196.4	1463	172.3	1445.4	1400	810	888	65.9	15.9	15.9	20.32
13	Sodium	mg/kg	501	126	166	2565	56.11	68	72	82	256.51	328.66	328.66	472.94
14	Copper as Cu	mg/kg	17.4	18.2	71.6	72.42	23	23	28	17	48.4	77	77	62.3
15	Lead as Pb	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	1.1	2	4.2	6.7	6.7	BQL
16	Nickel as Ni	mg/kg	22.1	21.22	31.8	27.73	21.2	20.4	16.2	12.2	27.3	36.7	36.7	33.3
17	Zinc as Zn	mg/kg	36	35.36	33.5	43.2	38.2	40.4	38.5	36.22	30.5	98.9	98.9	44
18	Cadmium as Cd	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL

pH

The pH was found at tuna port from 7.3 to 9.02, at IFFCO plant from 7.77 to 8.78, at Khori creek from 8.13 to 8.82, at Nakti creek from 7.91 to 6.68, at Vadinar DPA admin site from 7.7 to 8.86 and 7.11 to 8.85 at Vadinar DPA colony.

Moisture

The moisture was found at tuna port 6.06 to 23.66%, at IFFCO plant 6.4 to 28.37%, at Khori creek 9.02 to 28.1%, at Nakti creek 4.13 to 26.2%, at Vadinar DPA admin site 3.46 to 9.44%, and 2.86 to 9.67% at Vadinar DPA colony.

Electrical conductivity

The Electrical Conductivity was found at tuna port 2839 to 33400 µs/cm, at IFFCO plant 1442 to 48500 µs/cm, at Khori creek 1950 to 39900 µs/cm, at Nakti creek 2848 to 38200 µs/cm, at Vadinar DPA admin site260 to 1994 µs/cm, and 299.6 to 875 µs/cm at Vadinar DPA colony.

Total Organic Carbon

The total organic Carbon was found at tuna port 0.16 to 2.25%, at IFFCO plant 0.18 to 6.29%, at Khori creek 0.2 to 2.2%, at Nakti creek 0.1 to 3.93%, at Vadinar DPA admin site 0.12 to 2.53%, and 0.11 to 2.42% at Vadinar DPA colony.

Texture

The texture was found sandy loam for all location.

Cadmium as Cd

The Cadmium was found below quantification limit for all location.

Zinc as Zn

The zink as Zn was found at tuna port 22.6 to 89.7 mg/kg , at IFFCO plant 38.32 to 153.2 mg/kg , at Khori creek25.4 to 95.8 mg/kg, at Nakti creek 46.6 to 87.3 mg/kg ,at Vadinar DPA admin site 23.46 to 84.6 mg/kg, and 30.5 to 98.9 mg/kg at Vadinar DPA colony.

5.8 Sewage Treatment Monitoring

This involve safe collection of waste water (spent/used water) from wash areas, bathroom, cargo operational units, etc., waste from toilets of various buildings and its conveyance to the treatment plant and final disposal inconformity with the requirement and guide lines of State Pollution Control Board and other statutory bodies.

The waste water is let into sewer network (network of pipes and manholes) and let by gravity and intermittent pumping stations to the main Sewage Treatment Plant (STP).

The Sewage Treatment Monitoring is carried out at Deendayal Port Colony (Gopalpuri), Vadinar Port and Deendayal Port.

STP at Gopalpuri Port Colony

Gopalpuri STP is working properly and overall performance of the existing STP was found satisfactory. The removal efficiency of BOD, TSS was in order. The individual units were also performing well and their removal efficiency is satisfactory. Thus with the sample tested in laboratory the plant is working satisfactory and the individual units are also working well.

STP at Kandla Port

STP with improved capacity of 1.5 MLD at Deendayal Port is operational. The newly installed sewage treatment plant has 1500 cum/day fluidized media reactor based STP to treat domestic waste water generated from the campus and treated water will be utilized for gardening and plantation purpose.

Table 20. Gopalpuri STP Outlet Annual Results

Sr. No.	Parameter	Unit	1st Quarter Mean	2nd Quarter Mean	3rd Quarter Mean	Value (Annual Avg.)	GPCB Prescribed Limit
1	pH	-	7.21	7.36	7.32	7.30	6.5 - 8.5
2	Total Suspended Solids	mg/l	42.94	83.3	105.41	77.22	100
3	Residual Chlorine	mg/l	<0.5	<0.5	<0.5	<0.5	No Limit
4	Chemical Oxygen Demand	mg/l	85.19	96.43	111.01	97.54	100
5	Biochemical Oxygen Demand	mg/l	19.69	25.56	32.87	26.04	30

Table 21. KPT STP Outlet Annual Results

Sr. No.	Parameter	Unit	1st Quarter Mean	2nd Quarter Mean	3rd Quarter Mean	Value (Annual Avg.)	GPCB Prescribed Limit
1	pH	-	7.15	7.37	7.40	7.31	6.5 - 8.5
2	Total Suspended Solids	mg/l	50.21	81.04	100.72	77.32	100
3	Residual Chlorine	mg/l	<0.5	<0.5	<0.5	<0.5	No Limit
4	Chemical Oxygen Demand	mg/l	62.58	90.53	110.26	87.79	100
5	Biochemical Oxygen Demand	mg/l	15.87	24.68	27.25	22.60	30

Table 22. Vadinar STP Outlet Annual Results

Sr. No.	Parameter	Unit	1st Quarter Mean	2nd Quarter Mean	3rd Quarter Mean	Value (Annual Avg.)	GPCB Prescribed Limit
1	pH	-	STP not Working	7.25	7.34	7.30	6.5 - 8.5
2	Total Suspended Solids	mg/l		46.68	55.44	51.06	100
3	Residual Chlorine	mg/l		<0.5	<0.5	<0.5	No Limit
4	Chemical Oxygen Demand	mg/l		62.56	81.72	72.14	100
5	Biochemical Oxygen Demand	mg/l		16.62	22.37	19.5	30

The GPCB specification for pH, TSS, Residual Chlorine , COD and BOD for STP outlet are 6.5 to 8.5 , 100 mg/l, 0.5 mg/l, 100 mg/l and 30 mg/l respectively. The average values for pH at all locations from 7.30 to 7.31, The average values for Total Suspended Solids at all locations from 51.06 to 77.32 mg/l , The average values for COD at all locations from 72.14 to 97.54 mg/l, The average values for BOD at all locations from 19.5 to 26.04 mg/l, Residual Chlorine were found below detectable limit. All parameters for STP outlet are within limit.

5.9 Weather

The data collected from Automatic weather station have been installed and other secondary sources to represent the metrological conditions of the project area has been reviewed and presented below for various attributes such as Temperature, Wind velocity, Relative Humidity, solar radiation, wind direction, Air pressure and Heat index.

Table 23. Weather Results

MONTH		Temperature (°C)	Solar Radiation (w/m2)	Relative Humidity (%)	Wind Velocity (m/s)	Wind Direction	Air pressure (hpa)	Heat index (°C)
March.21	MIN	28.4	166.7	24.7	1.9	North West	1013.2	29.0
	MAX	36.2	292.3	93.0	10.6		1017.3	43.0
April.21	MIN	31.5	134.4	57.0	1.9	South East	1009.0	24.2
	MAX	42.4	576.6	94.0	9.9		1014.1	48.0
May.21	MIN	32.7	157.7	60.2	2.0	South East	1005.3	38.1
	MAX	37.3	383.3	89.0	8.1		1010.6	47.0
June.21	MIN	29.8	208.3	66.0	2.7	South West	1004.9	35.2
	MAX	34.1	654.8	84.0	13.0		1008.9	44.0
July.21	MIN	28.5	158.4	71.2	2.7	South West	1002.4	36.1
	MAX	32.1	751.7	89.0	13.0		1004.1	43.0
Aug.21	MIN	34.1	232.4	73.0	3.0	South West	1001.2	34.7
	MAX	26.1	682.8	90.0	9.7		1008.3	42.0
Sept.21	MIN	26.7	136.0	83.5	1.9	South West	1002.3	33.5
	MAX	36.2	808.9	98.0	12.0		1010.1	49.0
Oct.21	MIN	26.5	252.2	60.0	1.3	South North	1009.3	33.8
	MAX	38.6	746.6	94.0	8.1		1016.5	55.0
Nov.21	MIN	26.5	252.2	60.0	1.3	South North	1009.3	33.8
	MAX	38.6	746.6	94.0	8.1		1016.5	55.0
Dec.21	MIN	10.5	109.9	39.0	1.7	North West	1018.0	27.0
	MAX	31.8	534.3	93.0	4.4		1021.2	30.0
Jan.22	MIN	12.6	115.3	47.2	1.2	North West	1015.9	27.2
	MAX	30.8	530.7	96.0	5.8		1021.9	32.0
Feb.22	MIN	12.6	119.2	45.6	1.3	North West	1006.3	27.8
	MAX	29.2	530.7	98.0	9.6		1022.0	33.0

Temperature

The min temperature for Deendayal Port was 10.5 °C on December. The maximum temperature was recorded 42.4°C on April.

Solar Radiation

The min Solar Radiation was recorded 109.9 w/m2 on December . The maximum solar radiation recorded in the September was 808.9 w/m2.

Relative Humidity

The min Relative humidity was recorded 24.7 % on March and maximum Relative humidity recorded was 98.0 % on February.

Wind Velocity and Wind Direction

The min wind velocity was recorded 1.2 m/s on January. Maximum wind velocity recorded was

13 m/s on June. The wind direction was mostly North West and south west throughout the year.

Air pressure

The min Air pressure was recorded 1001.2 hpa in August. Maximum Air pressure recorded was 1022 hpa on February.

Heat index

The min heat index was recorded 24.22 °C in April. Maximum heat index recorded was 55 °C on November.

6.0 Conclusion

A. Ambient Air

Ambient Air Quality monitoring results for the Second year shows TSPM, PM_{10} and $PM_{2.5}$ concentrations of the ambient air were above the permissible limits as per the National Ambient Air Quality Standards (NAAQS2019). The concentration of $PM_{10}$and $PM_{2.5}$was above the permissible limit at Coal Storage Area, Marine Bhavan and occasionally at Oil Jetty Area and ,Kandla Estate Office, Gopalpuri Hospital Tuna Port area at some occasions.

The concentration of PM_{10} was within the permissible limit at Vadinar locations except Signal Building in November and Vadinar Colony in October & November above the permissible limit.

Deendayal Port has handled 117.5 MMT to 127 MMT of dry cargo in 2021-22. This huge volume of dry cargo handled at DPA along with high winds in coastal areas causes slight rise in the Ambient Air Quality near coal berth.

Very high volume of dry cargo is being handled (especially coal) at berth no. 7, 8 and 9. Besides handling of coal, thousands of vehicles laded with coal and other dry cargo criss-cross the port/harbor roads causing the rise in suspended particles in the air.

B. Drinking Water Quality

The results of the current year monitoring suggest that, the drinking water parameters of all the locations (18 at Kandla and 2 at Vadinar Port) were found within the permissible limits as per the BIS 10500 (2012) drinking water specification.

C. Noise Quality

The day and night time noise quality was found within the permissible limits of the Noise Pollution (regulation and control) rules, 2000. The Day Time and Night Time Average Noise Level (SPL) in all ten locations at Deendayal

Port were within the permissible limits of 75 dB A (for day time) and 70 dB A (for the night time)for an industrial area.

D. Marine Water Quality

The marine water samples were collected from the harbour area and the creek area and were monitored for 28 different parameters. The mean DO levels of DPA waters ranged from 4.9 mg/L to 6.0 mg/L (mean = 5.6 mg/L), which is normal for marine waters of ports and harbors.

Evaluation of the Phytoplankton and Zooplankton population in DPA harbour area and within the immediate surroundings of the port suggests that the Kandla waters harbours low to moderate diversity and abundance of phytoplankton and zooplanktons.

E. Soil

The soil samples were collected from six locations. The 4 locations of Kandla (Tuna port, Khori Creek, Nakti creek, IFFCO plant) and 2 locations of Vadinar (Vadinar DPA Admin site and Vadinar DPA colony). Soil samples were collected for monitored 18 different parameter.

The pH was found at tuna port from 7.11 to 9.02 Vadinar DPT colony and Tuna Port. Cadmium was found at all soil sample is BQL. (Below quantification limit).

F. Sewage Treatment Plant

Gopalpuri STP is working properly and overall performance of the existing STP was found satisfactory.

A new STP with improved capacity of 1.5 MLD at Deendayal Port is operational which is working as per the standards of CPCB/GPCB.

At Vadinar Port, a new STP was operational which is working as per the standards of CPCB/GPCB.

6.1. Steps taken by Deendayal Port to improve Environment

- "Safety Week" is being celebrated in Kandla Port by demonstrating mock drill, fire fighting, emergency preparedness, health checkup program etc.
- Regular Safety training and mock drill are being carried out and awareness is being created by lectures among the workers of the Port.
- Personal Protective Equipments (PPE like ear plugs, helmets, safety suits, etc are being used during Port Operational work.
- Sewage generated at Port Area as well as in Port colonies is being properly treated through Sewage Treatment Plants at outside Port area at Kandla and Port colony at Gopalpuri. However, DPA is planning to construct a new STP with the latest technology as the existing one is very old.
- Deendayal Port Authority have planted about one lakhs trees in road side dividers, colony areas at Kandla and Gopalpuri, in green belt area of Gandhidham & Adipur Township, Sewage Treatment Plants at Gopalpuri & Kandla and some green belt development plans initiated at different locations in Town ship areas.
- Deendayal Port Authority also carries out Environmental Audit through recognized till 2016 from environmental auditor (Schedule) of Gujarat Pollution Control Board from the year 2010 .Three Audit Reports for the year 2010, 2011 and 2012 were already submitted to GPCB as per the norms.
- DPA planted Mangroves in an area of 1500 hectares from 2005 to 2021: Mangrove Plantation Plan carried out in following phases;

1)	Year2005-06–20 hectares
2)	Year2008-09-50 hectares
3)	Year2010-11–100 hectares
4)	Year2011-12–200 hectares
5)	Year2012-13–300 hectares
6)	Year2013-14-330 hectares
7)	Year2015-17-300 hectares
8)	Year 2018- 20 - 100 hectares
9)	Year2020- 21-100 hectares
Total	**1500hectares**

- Water sprinkling on coal is regularly done to prevent coal dust pollution in the port area.

- To control the dust from bulk cargo like fertilizer, coal, sulphur, etc, the Port-users are encouraged to use hopper during discharge from vessels.
- Annual maintenance contracts have been awarded for garbage collection, cleaning of buildings and roads.
- Deendayal Port Authority is maintaining the records for collection and disposal of Solid Wastes generated from Port area, Residential area and Office Buildings.
- Deendayal Port Authority is regularly submitting the Hazardous Waste Statement in From – IV and Form V in environment sheet every financial year to the Gujarat Pollution Control Board, Gandhinagar.
- Are port on collection and disposal of the wastes from ships is submitted it to GPCB recognized body on regular basis.
- All trucks before leaving the storage yards are covered with tarpaulin and not over loaded as well as there is no spillage during transportation.
- Sewage generated at Port area and Port colonies is being properly treated through Sewage Treatment Plants outside Port area at Kandla and Port Colony at Gopalpuri.
- Deendayal Port has engaged CPCB/GPCB authorized agencies for the disposal of Hazardous waste (spent / used oil from ships) as per the Hazardous Wastes (Management and Handling) Rules.
- Pollution under Control (PUC) Certificate is mandatory for vehicles and equipments operating in the Port.
- Deendayal Port has awarded several projects to M/s Gujarat Institute of Desert Ecology(GUIDE) ,Bhuj relating to monitoring of Marine environment viz;

o Regular Monitoring of Marine Ecology of Kandla Port Area since 2017-18
o Creek Bathymetry
o Analysis of dredging contaminants
o Strategic Regional Impact Assessment Studies
o Assessment and Monitoring of Mangrove Plantation in 1500 Ha area.
o Biodiversity Action Plan for DPA and its surrounding areas

6.1.1 ISO 14001:2015 - Environmental Management System of Deendayal Port Authority

Deendayal port has appointed QMS India Ltd. As for Continual Improvement of ISO 14001:2015 - Environmental Management System with following scope;

- Review of environmental aspect-impacts,
- Review and monitoring of legal requirement
- Review and monitoring of emergency preparedness
- Management review by every six months
- Training of internal auditors and EMC members
- Active participation during external audit.

6.1.2 Green Ports Initiative

Deendayal Port is committed to sustainable development and adequate measures are being taken to maintain the Environmental well-being of the Port and its surrounding environs. Weighing in the environmental perspective for sustained growth, the Ministry of Shipping had started “Project Green Ports” which will help in making the Major Ports across India cleaner and greener. ‘Project Green Ports‟ will have two verticals-one is “Green Ports Initiatives‟ related to environmental issues and second is **“Swachh Bharat Abhiyaan.”**

The Green Port Initiatives include twelve initiatives such as preparation and monitoring plan, acquiring equipments required for monitoring environmental pollution, acquiring dust suppression system, setting up of sewage/waste water treatment plants/ garbage disposal plant, setting up Green Cover area, projects for energy generation from renewable energy sources, completion of shortfalls of Oil Spill Response (OSR) facilities (Tier-I), prohibition of disposal of almost all kind of garbage at sea, improving the quality of harbor wastes etc.

Deendayal port has also appointed GEMI as an Advisor for "Making Deendayal Port a Green Port- Intended Sustainable Development under the Green Port Initiatives.

- Deendayal Port has also signed MoU with Gujarat Forest Department in August 2019 for Green Belt Development in an area of 31.942 Ha of land owned by Deendayal Port Authority. The plantation is being carried out by the Social Forestry division of Kachchh.

7. Suggestions

7.1 Ambient Air Quality

PM_{10} values at Coal storage area, Marine Bhavan, Oil Jetty and Tuna Port were occasionally found above the permissible standards and $PM_{2.5}$ was occasionally found above permissible limits at Coal storage area. (100µg/m^3 for PM_{10}& 60 µg/m^3 for $PM_{2.5}$). The principle reason for higher PM_{10}values at Coal Storage and Marine Bhavan are bulk handling of coal, other dry cargo and heavy traffic of transport vehicles.

7.1.1 Sprinkling

- Heavy duty Water sprinklers should be used inside port where large scale dry cargo is handled.
- Mobile air Sprinklers should also be procured, which suppresses the fine dust from blowing during handling of dry cargo.

7.1.2 Enclosed conveyors

- Port users should be motivated to use enclosed conveyors which prevents secondary dust emissions due to wind in the port area.

7.1.3 Mechanized handling systems

- This involves using screw type un loaders which results in much less spillage and loss of material as compared to bucket un loaders. Mechanized systems can also use pre-packed containers for ease and pollution free loading unloading. Diligent use of various systems can keep the pollution due to ports at minimum level.

- Besides these prevention measures, Gujarat Pollution Control Board (GPCB) has also issued guidelines for handling of Coal. Guidelines for Coal Transport, Storage and Handling given below should be strictly followed; (***https://gpcb.gujarat.gov.in/uploads/coal-handling-guidelines1.pdf)***

7.2 GPCB Guidelines for Coal handling units:

(A) Location criteria

- In case of coal handling activities at the ports and jetties or extension thereof, the distance and land use criteria may be relaxed and compensated by advanced/sophisticated pollution control measures and mechanization & thick plantation, however all such ports and jetties, where coal handling is carried out, shall provide closed conveyor belt and mechanization for handling of coal.

(B) Storage and handling criteria

- Coal handling unit/Agency shall store coal in such a way that coal heap should not be higher than 5 meter and clear distance between two adjoining heaps at G.L. should be 5 meters, so that in case of fire, approach is available.

- There should be mechanized loading/unloading system from the loading /unloading area to the stacking yards and in to the vehicles.

- Coal handling unit/Agency shall take all corrective steps to resolve the issue of air pollution at permitted coal storage/handling area where coal is being stored.

(C) Transport criteria

- Coal handling unit/Agency shall ensure that all trucks before leaving the storage yard shall be showered with water with adequate system, Shall be covered with tarpaulin or any other effective measure/device completely and also that trucks are not overloaded as well as there is no spillage during transportation.
- The vehicle carrying the coal should not be overloaded by raising the height of carriage. Weigh scale shall be provided within the loading area only and port/coal park authority shall ensure that no over loading is done.
- The top of the vehicle should be covered with fixed cover to avoid spillage or dusting of coal.

(D) Pollution prevention criteria

- Coal handling unit/Agency shall provide paved approach with adequate traffic carrying capacity

- Coal handling unit/Agency shall construct compound wall all along periphery of the premises with minimum 9 meters height

- Continuous water sprinkling shall be carried out on the top of the heap at regular intervals to prevent dusting, fire & smoke. To prevent fugitive emission during loading/unloading, fixed pipe network with sufficient water storage and pump shall be installed. Water sprinkling shall be carried out at each and every stage of handling to avoid generation of coal dust or other dust within premises

- Coal handling unit/Agency shall ensure regular sweeping of coal dust from internal and main road and also ensure that there is adequate space for free movement of vehicles.

- The following adequate Air Pollution Control Measures shall be installed and to be operated efficiently.

- Construction of effective wind breaking wall suitable to local condition to prevent the suspension of particles from the heaps.

- Construction of metal road & RCC Pucca flooring in the plot area/godown etc.

- System for regular cleaning and wetting of the floor area within the premises.

- Entire coal storage area/godown should be covered with permanent weather shed roofing and side walls i.e., in closed shed, in case of crushing/sieving/grading activity is carried out (i.e. G. I. Sheet)along with adequate additional APCM should be installed. Coal handling unit/Agency shall carryout three rows plantation with tall growing tress all along the periphery of the coal handling premises, inside & outside of the premises along with road.

- Proper drainage system shall be provided in all coal storage area so that water drained from sprinkling & runoff is collected at a common tank and can be reused after screening through the coal slit or any other effective treatment system.
- All the engineering control measures and state of art technology including covered conveyer belts, mechanized loading and unloading, provision of silo etc. shall be provided in addition to the measurers commended in the environmental guidelines for curbing the pollution.

(E) Safety requirement

- Coal handling unit/Agency shall provide adequate fire-fighting measure to avoid any fire or related hazards including adequate water storage facility, and the premises shall be exclusively used for storage of the coal.

- An onsite emergency plan shall be prepared and implemented by coal handling unit.

(F) Legal criteria

- Necessary permission from all the applicable regulatory authorities and adequate steps under the provisions of applicable environmental acts/rules shall be taken.

- Coal handling unit/Agency shall prepare EMP (Environment Management Plan) and implement the same in true spirit and thus maintain overall environment of that area.

- Coal handling unit/Agency shall not carry out the operation of loading/unloading of coal/coal dust at any place, till adequate air pollution control equipment for dust control/suppression are installed and efficiently operated and the consent under the provisions of Air (Prevention & Control of Pollution) Act, 1981 is obtained by the coal yard owners/Coal handling unit/Agency/coal importers.

- Coal handling unit/Agency shall operate continuous Ambient Air Quality Monitoring Stations as per CPCB guideline.

- In case of port which provides the facility to individual developers an agreement/MoU shall be made between port authority and developer for curtailment of pollution. Port authority shall be responsible for supervising and controlling the pollution control related activities and implementation of the environmental guidelines.

7.3 Sewage Treatment Plant at Vadinar

- At Vadinar, the sewage waste water from the colony is connected in to new STP. Is commissioned and fully operational to handle the Sewage Waste Water.

8.0 ANNEXURE I-A

Ambient Air Quality Standards (NAAQS)

Pollutants	Time weighted average	Concentration in Ambient air µg/m³		
		Industrial Areas	Residential /Rural & Other areas	Sensitive Areas
Sulphur Dioxide (SO_2	Annual	50	50	20
	24hours**	80	80	80
Respirable Particulate Matter(size>10um) (RPM) PM_{10}	Annual	60	60	60
	24hours**	100	100	100
Particulate Matter(size>2.5um) $PM_{2.5}$	Annual	40	40	40
	24hours**	60	60	60
Nitrogen Dioxide (NO_2)	Annual	40	40	30
	24hours**	80	80	80

- Annual arithmetic mean of minimum of 104 measurements in a year taken twice a week. 24 hourly at uniform interval

- 24 hourly / 8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days

Note:

- National Ambient Air Quality Standard: The levels of air quality with an adequate margin of safety, to protect the public health, vegetation and property.

- Wherever and whenever two consecutive values exceeds the limit specified above for the respective category, it would be considered adequate reason to institute regular/continuous monitoring and further investigations.
- The State Government/State Board shall notify the sensitive and other areas in the respective states within a period of six months from the date of Notification of National Ambient Air Quality Standards.

[{S.O.384 (E), Air (Prevention & Cont. of Pollution) Act,1981 dated April 11,1994]

ANNEXURE I-B

Drinking Water Standards (BIS)

Sr. No.	Parameter	Unit	Acceptable Limits	Permissible Limits
1	pH	-	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/L	500	2000
3	Turbidity	NTU	1	5
4	Odor	-	Agreeable	Agreeable
5	Color	Hazen Units	5	15
6	Conductivity	µs/cm	NS*	NS*
7	Bio.Oxygen Demand	mg/L	NS*	NS*
8	Chloride as Cl	mg/L	250	1000
9	Ca as Ca	mg/L	75	200
10	Mg as Mg	mg/L	30	100
11	Total Hardness	mg/L	200	600
12	Iron as Fe	mg/L	0.3	NS*
13	Fluorides as F	mg/L	1	1.5
14	Sulphate as SO_4	mg/L	200	400
15	Nitrite as NO2	mg/L	NS*	NS*
16	Nitrate as NO3	mg/L	45	NS*
17	Salinity	%	NS*	NS*
18	Sodium as Na	mg/L	NS*	NS*
19	Potassium as K	mg/L	NS*	NS*
20	Manganese	mg/L	0.1	0.3
21	Hexavalent Chromium	mg/L	NS*	NS*
22	Copper	mg/L	0.05	1.5
23	Cadmium	mg/L	0.003	NS*
24	Arsenic	mg/L	0.01	0.05
25	Mercury	mg/L	0.001	NS*
26	Lead	mg/L	0.01	NS*
27	Zinc	mg/L	5	15
28	Bacterial Count	CFU/100ml	Absent	Absent

*Not specified in IS10500:2012

Bacteriological Standards (for Drinking water)

	Organisms	Requirements
All water intended for drinking		
	(a)E.coliorthermo-tolerant Coli form bacteria	Shall not be detectable in any 100 ml sample
Treated water entering the distribution system		
	a)E.coliorthermo-tolerant Coliformbacteria	Shall not be detectable in any 100 ml sample
	b)Total Coli form bacteria	Shall not be detectable in any 100 ml sample
Treated water in the distribution system		
	a)E.coliorthermo-tolerant Coli form bacteria	Shall not be detectable in any 100 ml sample
	b)TotalColiformbacteria	Shall not be detectable in any 100 ml sample

(BIS specifications (IS10500-2012)

ANNEXURE -I-C

Noise Quality Standards

Area Code	Category of Area	Limits in dB(A) Leq	
		Day Time	Night Time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

- Day Time is recorded in between 6.00 A.M. and 10.00 P.M.
- Night time is recorded in between 10.00 P.M. to 6.00 A.M.
- Silence zone is defined as areas up to 100 meters around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by the Competent Authority.
- Use of vehicular horns, loud speakers and bursting of crackers shall be banned in these zones.
- Mixed categories of areas should be declared as one of the four above mentioned categories by the Competent Authority and the corresponding standards shall apply.

[Source: EPA Notification [G.S.R.1063 (E) dt.26.12.1989 published in the Gazette No.643 dt.26.12.1989.]

Annexure –G

Mangrove Plantation details with cost incurred

DEENDAYAL PORT TRUST

DETAILS OF MANGROVE PLANTATION ALREDY CARRIED OUT & Proposed To be Carried Out :

Sr. No.	Name of the Organization	Total Mangrove Plantation carried out in Hectares till date and place of plantation and agency	Cost incurred
(A) MANGROVE PLANTATION ALREDY CARRIED OUT			
1	DEENDAYAL PORT TRUST (CRZ Recommendation 13th to 16th CB issued by the GCZMA) (Total 1000 ha.)	20 Hectares – 2005-06 Satsida Bet,Kandla, by GUIDE,Bhuj 50 Hectares – 2008-09 Nakti Creek,Kandla by Patel Construction 100 Hectares – 2010-11 Nakti Creek ,Kandla by GEC. (Board 29/1/2010) 200 Hectares – 2011-12 by Forest Department, GoG at Satsaida Bet 300 Hectares – 2012-13 by Forest Department, GoG at Satsaida Bet 330 Hectares – 2013-14 by Forest Department, GoG at Satsaida Bet **TOTAL 1000 HA.**	Rs. 8.8 lakhs Rs. 27.4 lakhs Rs.24.5 lakhs Rs. 66.5 lakhs Rs. 157.5 lakhs (total 630 hectares)
2	Creation of Berthing & allied Facilities off- tekra near Tuna (Outside Kandla Creek) – EC & CRZ Clearance. (Total 500 ha. – 250Ha. by DPT & 250 ha by Adani (concessionaire) MOU signed with GEC during Vibrant Gujarat Summit 2015 for 300 Ha.	300 Hectares – 2015-17 by GEC at Kantiyajal, Bharuch District	Rs. 90.0 lakhs
3.	EC & CRZ Clearance dated 19/12/2016 for Developing 7 integrated facilities (Condition 100 Ha)	100 Ha. –2018- 20 by GEC	Rs. 45 lakhs
TOTAL MANGROVE Plantation till date by DPT 1400 Ha. – Total 419.7 lakhs			

	(B) <u>Proposed Mangrove Plantation</u>		
1.	Development of Integrated facilities (Stage-II) within the existing Deendayal Port Trust (Erstwhile Kandla Port Trust) at District Kutch, Gujarat. (1. Setting up of Oil Jetty No.7 ; 2. Setting up of Barge jetty at Jafarwadi ; 3. Setting up of Barge port at Veera; 4. Administrative office building at Tuna Tekra; 5. Road connecting from Veera barge jetty to Tuna gate by M/s Deendayal Port Trust (Erstwhile : Kandla Port Trust) - <u>Environmental & CRZ Clearance accorded by the MoEF&CC,GoI dated 19/12/2020.</u>	**<u>50 Ha. as per CRZ Recommendation issued by the GCZMA dated 29/6/2016.</u>**	Rs. 45 lakhs
2.	Development of 3 Remaining Integrated Facilities (stage I) within the existing Deendayal Port Trust (Erstwhile : Kandla Port Trust) at Gandhidham, Kutch, Gujarat - <u>Environmental & CRZ Clearance accorded by the MoEF&CC,GoI dated 18/2/2020.</u>	**<u>50 Ha. as per CRZ Recommendation issued by the GCZMA dated 29/6/2016. .</u>**	

Annexure –H

Mangrove Conservation and Management Plan by Gujarat Institute of Desert Ecology (Jan-April, 2015)

Study on present status, Conservation and Management Plan for mangroves of Kandla Port Region

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17.08.2015

Certificate

Kandla Port Trust has extensive mangrove formations within its port limits. In order to study different ecological characters of these mangroves and to draw a scientific conservation and management plan, Kandla Port Trust approached Gujarat Institute of Desert Ecology, Bhuj for undertaking an environmental assessment of the mangrove formations with regard to its ecological status, which included baseline documentation, forest structure and a detailed conservation and management plan. Thus, GUIDE undertook this study and carried out field surveys, and sampling in representative mangrove stands in order to prepare this report.

This report presents various ecological status of mangrove formations within Kandla Port area and suggest a detailed conservation and management plan to be considered by the port authorities for execution. This project report forms a baseline document indicating the baseline status and conservation plan for the mangroves which could be used to ensure long term conservation and management of Kandla Port mangroves.

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1. INTRODUCTION:

Kandla Port is located in the Gulf of Kachchh on the northwest coast of India about 430 nautical miles northwest of the Port of Mumbai (Bombay) at the Latitude of 23° 01' N and Longitude of 70° 13' E on the shoreline of the Kandla Creek. The Kandla creek runs into the Gulf of Kachchh, approximately at a distance of 90 nautical miles from the Arabian Sea. The width of the channel varied between 200 meters to 1,000 meters. It is a leading port of India by capacity of cargo handled. Kandla Port as one of India's busiest major port, is gearing to add substantial cargo handling capacity with private sector participation. It handled 72.225 million tonnes of cargo in 2008-09, over 11% more than 64.9 million tonnes handled in 2007-08.At present, Kandla Port handled 87.005 MMTPA Cargo during 2013-2014 and 92.5 MMTPA during the financial year of 2014-2015. Against this capacity, a total of 87.005 MMTPA was handled at Kandla Port resulting in berth occupancy exceeding 80% at general cargo berths in 2013-14. Consecutively, to reduce the pressure on the existing berths and increase the capacity of dry and liquid cargo handling, Kandla Port Trust has developed new Barge Jetty at Tuna, Khori Creek and a new Oil Jetty at old Kandla. Other project for strengthening and upgrading existing facilities at Kandla Port is on the anvil.

Mangroves are a conspicuous ecological entity within Kandla Port area. Similar to other forest ecosystem they discharge multiple ecological services such as production of woody trees; provision of habitat, food, and nursery/spawning grounds for fin-fish and shellfish; provision of habitat for birds and other valuable fauna; protection of coastlines and accretion of sediment to form new land. There are also many economic benefits from mangrove resources; like as a source of firewood, self-replenishing area of fishery resources, for collecting honey and for tourism.

1.1 Origin of the Study:

Due to the major port activities and accompanying development, mangroves within the premises of KPT have possible for its vegetation structure modification over the years. Consequently, conservation and management of this mangrove formation has become imperative and an environmental responsibility of the Kandla port authority. In view of the continued port expansion and development, Department of Forest and Environment, Government of Gujarat (GOG), Gandhinagar has mandated KPT to investigate the current ecological status of mangroves in the KPT premises through proper scientific assessment and formulate long term conservation and management plan. Kandla Port authorities assigned the task of investigating the mangrove ecology within the port jurisdiction to Gujarat Institute of Desert Ecology (GUIDE), Bhuj. The present study aims to come out with a sound conservation and management plan for mangroves of Kandla Port based on intensive field visits, analyzing the existing management practices of the port *vis-à-vis* mangroves and plantation and other conservation activities carried out by port authorities under different projects of the port.

1.2 Objective of the Present Study:

Suggesting management different management options with a view to conserve mangrove ecosystem within Kandla Port premises on a long term basis is the major objective of the present study. The present investigation is instituted with the following objectives.

1. This study aims to investigate thoroughly the present status of mangroves in terms of vegetation structure such as density, diversity, height, canopy dimensions and younger classes along with governing physical and chemical features of mangroves formations falling within the legal boundary of Kandla Port at Kandla, Gandhidham taluka of Kachchh.

2. Suggest a detailed plan for a holistic and long term management and conservation in order to ensure the long term wellbeing of mangroves of Kandla Port.

3. Review the mangrove plantation carried out so far by the port authorities, future mangrove plantation/rehabilitation plan, monitoring actions to be initiated in order to conserve/preserve the mangrove stands which will ward-off stand degradation in future.

4. Quantify the mangrove extent in terms of dense, sparse and other allied land cover such as mudflats, salt works, water etc by the application of GIS and RS technique.

2. STUDY AREA DESCRIPTION:

2.1 Location:

Kandla port is located in the northern coast of gulf of Kachchh (GoK) almost at its tail end (Map 2.1). Being in the arid zone, annual rainfall within the geographical range of Kandla Port is poor ranging from 250-350 mm which is often irregular. Mean rainfall (1932 to 2001) was 387 and 378 mm in the Gandhidham taluka where Kandla is located. Rain during monsoon is confined to only 15-20 days and occurs as an instant downpour. The weak monsoonal rainfall and high rate of evaporation not only make the area arid but also causes elevation in seawater salinity. Freshwater input into the near coastal waters is quite meagre and appears to have least influence on the ambient coastal water quality except during monsoon months, during which flash floods are discharged in the near coastal waters. Throughout the year, the winds are light to moderate in the Gulf except during late summer and southwest monsoon periods. Stronger winds are also encountered with the disturbances such as depressions and cyclones. Winter and summer temperatures range from 7- 48^{o}C with a yearly average humidity of 60% which increases to 80% during south-west monsoon and decreases to 50% during November-December. Average wind speed is 4.65 m/s with a maximum wind speed of 10.61 m/s during June. Tides in the port environment are mixed, predominantly semidiurnal type with Mean High Water Spring (MHWS) of 6.66 m and Mean High Water Neap (MHWN) of 5.17 m. Mangroves within the port limits are predominantly composed of *Avicennia marina*, a species known for its high tolerance of water salinity and other environmental stresses with sporadic distribution of *Ceriops tagal*.

Kandla is a seaport in Kachchh district of Gujarat state in western India which runs into the Gulf of Kachchh at a point about 90 nautical miles from the Arabian Sea. One the major ports on west coast, Kandla was constructed in the 1950 as the chief seaport serving western India. The total length of the Kandla Port approach channel is about 23 Km High tidal influences with low turnover time characterize Kandla creek. Kandla creek (22^0 55’- 23^0 5’ N and 70^0 05’- 70^0 02’ E) is one of the major creeks along the NW coast of India supplying water to the inner GoK which is an east- west oriented indentation. GoK is 75km wide at the mouth and after running about 170km away from the Arabian sea towards east, narrows down into a constriction at 70^0 20’ E at Sathsaida Bet and then bifurcates into a creek system called the Little Rann.The Little Rann has a network of so many small and large creeks, intermingled with marshy tidal flats rich in fine clays. Kandla creek is one of the major tributaries of this creek system, which empties into the inner GoK. Two large creeks , Sara and Phang creeks join the Kandla creek and act as its tributaries. Nakti creek also joins the confluence of Sara and Phang creeks. All these creeks bring water from the Little Rann into Kandla creek, which has a fairly good depth and stable banks. The width of the creek channel varies from 200 m in the upstream to 1000m at the mouth and the depth varies from 8 to 12 m, while the tidal height ranges from 0.83 to 7.2m, with tidal currents varying from 0.08 to 2 m/s (Sinha *et al*. 2006)

Kandla port is located along the western bank of Kandla creek. The protruding Indus River brings heavy sediment load into the creek lowering its primary productivity. Sampling site at Kandla is located around 100 m away from the oil jetty of the port. Ongoing expansive drive of the port and establishment of many SEZs in and around the nearby Gandhidham Township has provided renewed impetus for this coastal town to proliferate further. Various industrial- chemical manufacturing units, fertilizer- manufacturing industry (IFFCO), salt manufacturing units with salt pans rich in brines occur around the Kandla creek. There are a total of six jetties in the creek used by the KPT, Indian Oil and IFFCO for handling liquid bulks, POL, fertilizers, raw materials, industrial chemicals, iron and steel, food grains, metal and its products, mineral ore and other dry cargo, etc. The port facilitates extensive traffic of oil tankers, freighters, passenger cargo vessels, ore carriers, fishing boats and container vessels in Kandla creek.Presence of a major port with heavy vessel traffic activities are temporarly distrub the creak water quality. These activities generate different types of waste , which act as potential sources of contamination. Irrespective of their source of contribution, these contaminants from natural as well as human activities are ultimately distrub the creek water quality.

Figure 2.1: Shows the location map of the study area

2.2 Study Period:

The present field study for KPT mangrove monitoring was carried out in January 2015to April 2015.

3. VEGETATION STRUCTURE OF MANGROVES:

Mangroves are the most important salt tolerant trees of the intertidal areas (Kathiresan and Bingham, 2001). It is one of the most productive and bio-diverse wetlands on earth. Inhabiting the inter-tidal areas and estuary mouths between land and sea, mangroves provide critical habitat for a diverse marine and terrestrial flora and fauna. They normally grow poorly in stagnant waters and have luxuriant growth in the alluvial soil substrates with fine textured loose mud or silt. The diversity variability features of mangroves that occur within the inundated areas such as creeks, mudflats, salt-flats, or partially forested areas with dwarfed or sparsely distributed trees.

Vegetation structure is determined by the species diversity, relative densities of constituent species, overall density of the stand, basal area that represents the size of the plant girth and height. The vegetation structure of mangroves provides an indication of its functional capacity which has a bearing on fisheries, forestry and global climate due to its high carbon sequestration potential (Ong et al., 1993).

3.1 Methodology:

The vegetation structure of the present investigation was carried out at diverse representative sites of mangrove formations within the legal boundary of Kandla Port. Generally, KPT mangrove formations can be classified dense and sparse mangroves. Vegetation structure assessment was carried out during low tides by quadrate method by laying plots of 10 × 10m (Figure 3.1). For assessing the mangrove formations along the creeks systems, a fishing boat was used. In total, twenty one random sampling was carried out in the mangrove formations of the port premises representing different landscapes like dense mangroves and sparse mangroves in order to render the sampling truly representative. In each plot, the total numbers of mature trees along with the corresponding height (Figure 3.2), canopy dimension and tree girth-GBH (Figure 3.3) were recorded. At few places, Point Centre Quarter method was also used for the density assessment (Cottam et al. 1953).

Figure 3.1: Analysis of density by using 10 x 10 m quadrate

Figure 3.2: Measurement of tree height

Figure 3.3: Measurement of tree girth

To enumerate younger classes such as regeneration and recruitment classes, subplots of 1×1 m and 2×2 m were laid randomly in all the bigger plots of 10 × 10m. Younger plants less than 50 cm are considered as regeneration class and recruitment class represents the well established saplings which are more than 50cm but less than 1m tall. Density of mature trees, regeneration and recruitment class for each station was expressed as number per hectare (No/ha) extrapolating the data obtained for lesser units. Frequency class was analyzed in order to distinguish the location wise distribution, diversity, structure and composition of different age classes like tree height, GBH, canopy length and canopy width.

3.2 Result:

Overall vegetative structural characteristics of mangroves such as density, height, GBH and regeneration class, recruitment class and frequency classes (in order to distinguish the location wise common vegetation structure, composition of different age and growth classes) recorded in the Kandla Port premises are presented in table 3.1 and 3.2, respectively.

3.2.1 Mangrove Diversity:

During the entire study period (January to April 2015) *Avicenna marina* was the most predominant species with the sporadic occurrence of *Cereops tagal* and *Rhizophora mucronata*. In only one study site *Aegiceros corniculatum* was observed out of the study quadrate. Mangrove diversity of KPT region is comparatively higher than any other mangroves patches of Kachchh coast.

3.2.2 Mangrove Density:

The cumulative average mature tree density of 4124/ha was recorded from 21 sampling locations (Table 3.1). The occurrence of highest density of 7800tree/ha was recorded at 23°10'41.6″N; 70°35'35.4″E. as, the site is located near the water front receiving good tidal waters. Least mature tree density of 1500 trees/ha was estimated at 23° 08' 13.2″ N; 70° 18' 19.8″ E. Generally, recorded mature tree density is comparable with other healthy mangrove formations of Gulf of Kachchh (Thivakaran *et al.,* 2003).

3.2.3 Tree Height:

Mangrove stands of Kandla port showed significant variation in tree height. The overall average height of the mangroves at 21 sampled locations was 254 cm with the highest plant height of 391 cm recorded at the location 23° 02’ 24.9 N; 70° 13’ 45.4 E (Table 3.1). The overall height frequency of the mangrove stands from 21 sampling locations, revealed that the majority of the mangrove stands fall in the height class of 51-150 cm (Figure 3.4).

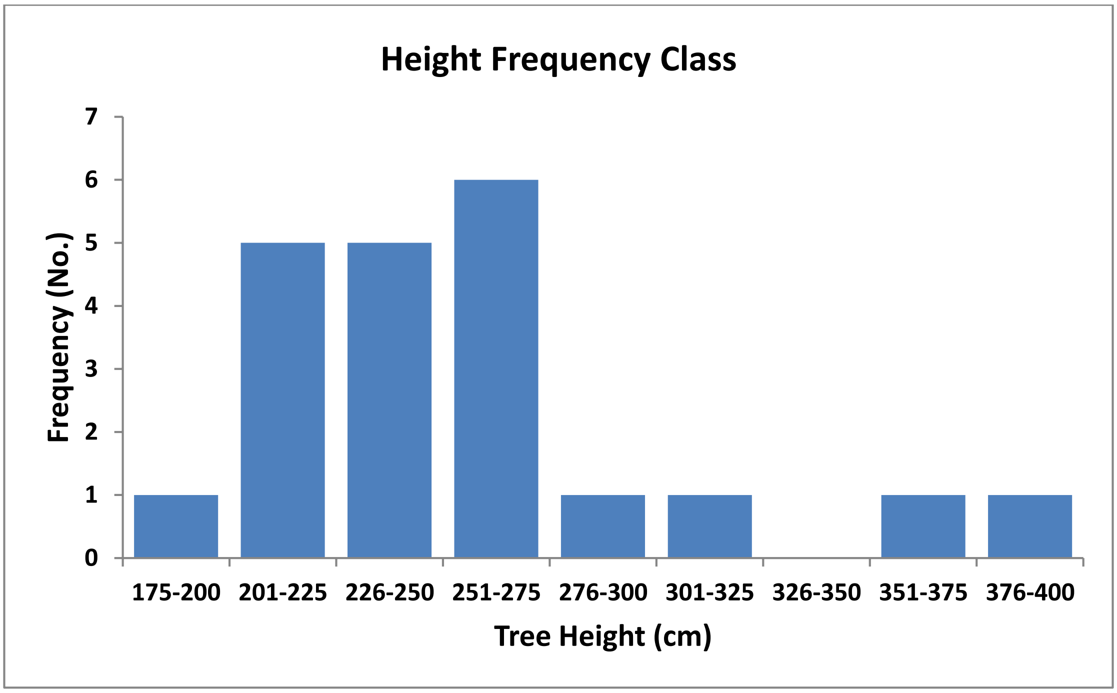

Figure 3.4: Height frequency class of sampled mangrove stands at KPT

3.2.4 Tree Girth (Girth at Breast Height-GBH):

Average tree girth (circumference) of mature trees at 21 sites ranged from 33.5 cm to 53 cm. The overall average girth based on the mean of all the 21 plots was 40.4cm (Table 3.1). During the present study very few transect showed the girth ranges of 34and 39 cm at 23° 03' 41.1″ N; 70°15'27.5″E; 23°02'48.3″N; 70°13'34.0″E, respectively. Majority of the mangrove girth were in the frequency class of 5.1 to 10cm (Figure 3.5).

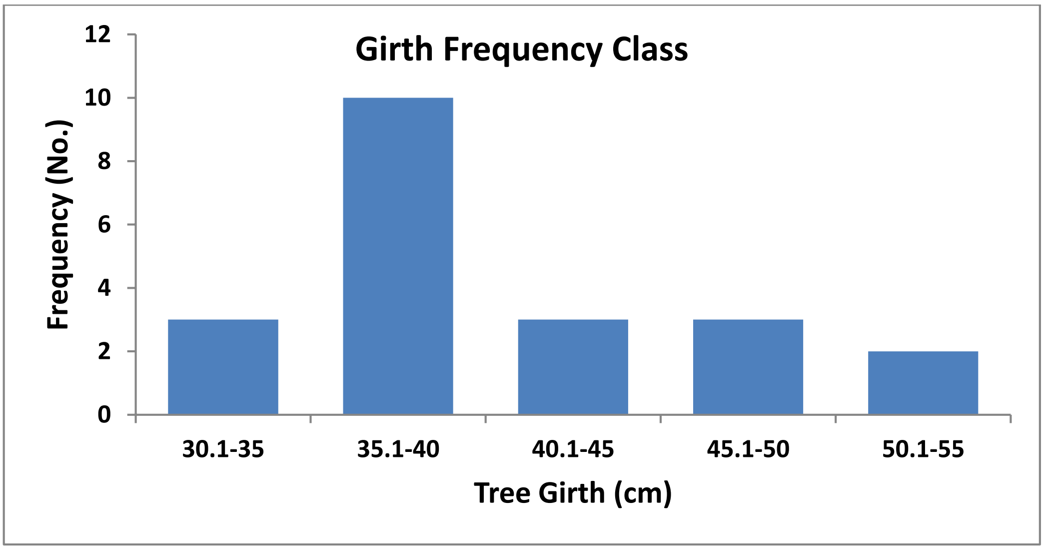

Figure 3.5: GBH freqency class ofsampled mangrove stands at KPT

3.2.5 Canopy Length (cm):

Average canopy length of mangrove was assessed at 21 sampled plots which varied from 159.5 cm to 325 cm. Cumulative average value canopy length based on the mean value of all the plots was 222.9 cm (Table 3.1). The coordinates of KPT at 23° 05'07.1N;70° 16' 25.2 E showed few trees with highest canopy length. The overall canopy length frequency class of all the mangrove formations exhibited that majority of the mangrove stands fall in the ranges of 51-100 cm (Figure 3.6).

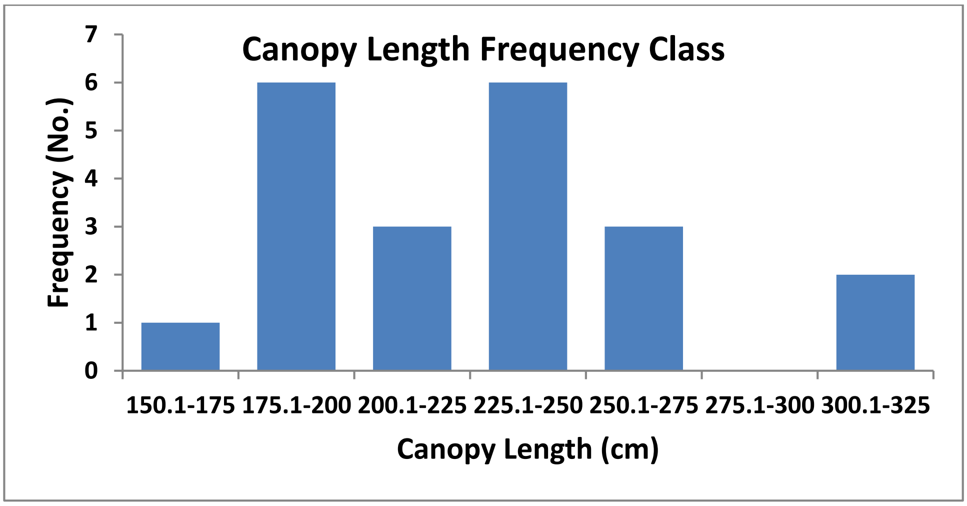

Figure 3.6: Canopy length freqency class of sampled mangrove stands at KPT

3.2.6 Canopy Width (cm):

Average canopy width of the mangrove studied at various plots ranged from 154 cm to 289.5 cm. The overall average canopy width of all the studied sampling plots was 208.4cm (Table 3.1). Mangroves at the coordinates 23° 05’ 10.4 N; 70° 16’ 25.2 E showed highest canopy width. The cumulative canopy width frequency of all the plots fall in the range of 51 to 100 cm (Figure 3.7).

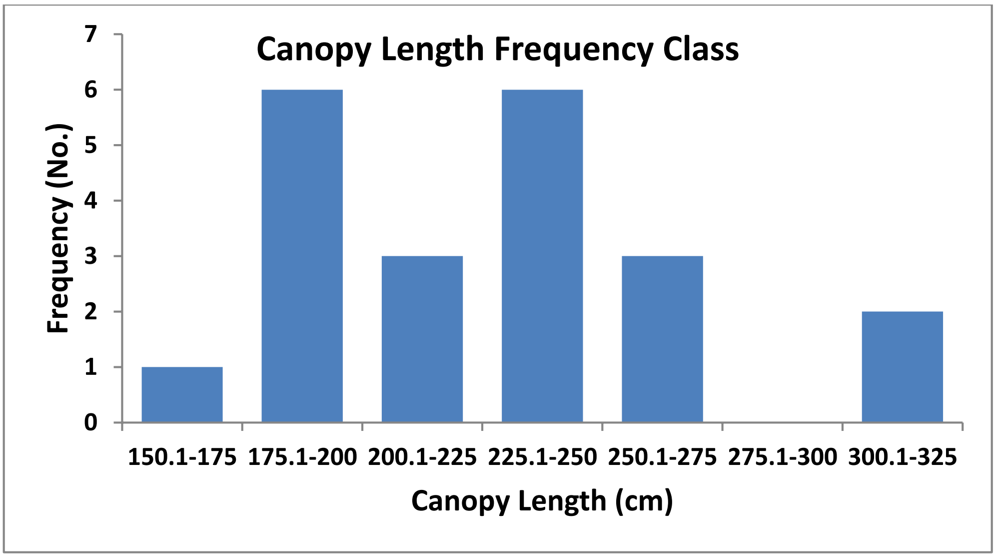

Figure 3.7: Canopy width freqency class of sampled mangrove stands at KPT

Table 3.1: Mangrove vegetation structure and classification carried out during the study

S. NO	GPS Coordinates	Density/ha	Height (cm)			Girth (cm)			Canopy Length (cm)			Canopy Width (cm)		
			Min	Max	Ave.	Min	Max	Ave.	Min	Max	Ave.	Min	Max	Ave.
1	23° 03' 41.1″ N;70° 15' 27.5″ E	3300	193	537	365	40	66	53	168	443	305.5	146	417	281.5
2	23° 02' 48.3″ N ;70° 13' 34.0″ E	2200	167	328	247.5	38	53	45.5	147	327	237	125	319	222
3	23° 02' 24.9″ N; 70° 13' 45.4″ E	3800	208	574	391	41	61	51	193	457	325	168	411	289.5
4	23° 01' 58.8″ N ;70° 15' 27.5″ E	3400	196	326	261	31.8	41.3	36.55	185	345	265	157	328	242.5
5	23° 01' 52.5″ N; 70° 15' 29.1″ E	2400	210	293	251.5	29	44	36.5	132	223	177.5	127	211	169
6	23° 02' 5.9″ N ; 70° 16' 00.7″ E	6800	157	274	215.5	30	47	38.5	98	263	180.5	89	243	166
7	23° 03' 45.3″ N; 70° 13'37.21″ E	3200	197	335	266	40	51	45.5	165	290	227.5	149	273	211
8	23° 06' 55.6″ N ;70° 16' 36.7″ E	7500	157	375	266	29	50	39.5	132	187	159.5	127	181	154
9	23° 06' 55.0″ N; 70° 16'25.5″ E	3500	154	261	207.5	28	53	40.5	130	233	181.5	119	239	179
10	23° 06' 52.5″ N; 70° 16' 25.5″ E	2100	159	335	247	28	49	38.5	138	307	222.5	126	293	209.5
11	23° 08'13.2″ N ;70° 18'19.8″ E	1500	183	302	206	31	44	37.5	156	295	225.5	143	282	212.5
12	23° 08' 20.9″ N; 70° 18' 16.6″ E	2100	165	247	213.5	28	39	33.5	139	218	178.5	127	203	165
13	23° 08' 29.7″ N ;70° 18' 17.8″ E	3500	157	270	192.5	29	40	34.5	134	242	188	122	219	170.5
14	23° 05' 03.5″ N; 70° 16' 18.0″ E	2800	155	230	272	28	40	34	136	215	175.5	124	209	166.5
15	23° 05'07.1″ N ;70° 16'23.8″ E	3400	154	390	280.5	28	48	38	128	375	251.5	111	347	229
16	23° 05' 10.4″ N; 70° 16' 25.2″ E	6800	166	395	243	28.5	65	46.75	132	383	257.5	124	369	246.5
17	23° 10' 35.9″ N ;70° 35' 28.2″ E	5900	159	330	238.5	29	50	39.5	142	327	234.5	131	314	222.5
18	23° 10' 38.6″ N; 70° 35' 31.3″ E	5700	162	324	269.5	30	48	39	145	294	219.5	128	281	204.5
19	23° 10' 30.6″ N; 70° 35' 28.3″ E	6200	163	314	254.5	30	50	40	142	311	226.5	135	303	219
20	23° 10' 36.5″ N ;70° 35' 39.0″ E	2700	165	374	229.5	33	55	44	151	257	204	139	244	191.5
21	23° 10' 41.6″ N; 70° 35' 35.4″ E	7800	160	349	214.5	28	46	37	148	332	240	129	324	226.5
Overall mean		**4124**	**171**	**341**	**254**	**31**	**49.5**	**40.4**	**144.8**	**301.1**	**222.9**	**130.7**	**286.1**	**208.4**

3.2.7 Regeneration Class:

The cumulative average density of regenerating mangroves from 21 sampled locations exhibited 24286 plants/ha (Table 3.2), which ranged from 3300 plants/ha to 100000 plants/ha. The present investigation showed that regeneration potential of mangroves in the KPT premises is good. This regeneration result indicated that the study site is healthy environment for potential mangrove growth and further succession. The co-ordinates are closure to the water front (23° 06' 55.6″ N; 70° 16' 36.7) shows maximum number of regenerating mangroves.

3.2.8. Recruitment Class:

The overall average of recruitment class in the study area was 8888 plants/ha which varied from 1000 to 56600 plants/ha (Table 3.2). The recruitment class of present study was lower than mature tree density at KPT premises due to canopy covering and the resulting low exposure to sunlight. The mature tree density and younger classes (recruitment and regeneration) at Kandla port surroundings show higher regeneration potential of the mangroves. Density Investigation of younger classes like regeneration and recruitment classes are generally indicate that future vegetation structure of the mangrove will be extended. At the coordinate 23° 06' 55.6″ N; 70° 16' 36.7 mature tree to regeneration and recruitment classes ratio is high which indicating the healthiness of the stand and its ability to perpetuate the stand characteristics in future.

In general, majority of the sampled plots shows less floral associates. Only at few plots the floral associates like *Sueda*, *Salicornea* sp. and *Salvadora* sp. are present.

Table 3.2: Regeneration and Recruitment details of the sampling points.

S. No.	GPS	Species	Regeneration/ha	Recruitment Class/ha
1	23° 03' 41.1″ N; 70° 15' 27.5″ E	*A. marina*	17000	9000
2	23° 02' 48.3″ N 70° 13' 34.0″ E	*A. marina*	11000	7500
3	23° 02' 24.9″ N 70° 13' 45.4″ E	*A. marina*	38000	13000
4	23° 01' 58.8″ N 70° 15' 27.5″ E	*A. marina*	13300	5000
5	23° 01' 52.5″ N 70° 15' 29.1″ E	*A. marina*	6600	8350
6	23° 02' 5.9″ N 70° 16' 00.7″ E	*A. marina*	40000	5000
7	23° 03' 45.3″ N 70° 13'37.21″ E	*A. marina*	86600	10000
8	23° 06' 55.6″ N 70° 16' 36.7″ E	*A. marina*	100000	8300
9	23° 06' 55.0″ N ; 70° 16'25.5″ E	*A. marina*	6600	5000
10	23° 06' 52.5″ N ;70° 16' 25.5″ E	*A. marina*	6600	1600
11	23° 08'13.2″ N ;70° 18'19.8″ E	*A. marina*	3300	1600
12	23° 08' 20.9″ N ;70° 18' 16.6″ E	*A. marina*	3300	1000
13	23° 08' 29.7″ N ;70° 18' 17.8″ E	*A. marina*	6600	1600
14	23° 05' 03.5″ N ;70° 16' 18.0″ E	*A. marina*	6600	3300
15	23° 05'07.1″ N ;70° 16'23.8″ E	*A. marina*	6600	1600
16	23° 05' 10.4″ N ;70° 16' 25.2″ E	*A. marina*	16600	3300
17	23° 10' 35.9″ N ;70° 35' 28.2″ E	*A. marina*	60000	5000
18	23° 10' 38.6″ N ;70° 35' 31.3″ E	*A. marina*	55000	6600
19	23° 10' 30.6″ N ;70° 35' 28.3″ E	*A. marina*	10000	3300
20	23° 10' 36.5″ N ;70° 35' 39.0″ E	*A. marina*	8300	30000
21	23° 10' 41.6″ N ;70° 35' 35.4″ E	*A. marina*	8000	56600
Cumulative Average			**23423.81**	**8888**

4. PHYSICO-CHEMICAL PARAMETRS*:*

4.1 Introduction:

Range of physico-chemical parameters determines the creek water quality and assessing these parameters are essential in order to understand the governing factors of mangrove environment (Reddi et al., 1993). The mangrove system plays a major role in the global cycle of carbon, nitrogen and sulphur and acts as reservoirs of waste materials (Kathiresan and Bingham 2001; Kathiresan, 2000). Many works are available on the physical and chemical characters of some Indian estuaries and mangroves (Satpathy, 1996; Govindasamy et al., 2000; Rajasekar et al., 2003 and Asha and Diwakar 2007). Salinity, redox potential, pH and sulphide concentration in pore-water parameters play key roles in the development of mangroves and their spatial distributions. To cope with the variation of these properties, mangroves have developed many adaptations that give them wide ranges of tolerance. Additionally, climate, tidal flooding, vegetation evolution, bioturbation and organic matter content are parameters that also contribute to the complexity of the geochemistry of mangrove soil. The physico-chemical parameters like pH, pore-water salinity, sediment texture and Total Organic carbon (TOC) are direct indicators for the healthiness of mangrove stands and also influence vegetation structure of mangroves. In the present attempt some vital parameters that influence the mangrove vegetation structure have been studied and presented below.

4.2 Methodology:

4.2.1 Water Analysis:

Standard protocols (APHA, 1995) were followed for the sample collection and analysis. Water samples were collected using sterile polyethylene containers. Salinity (ppt- ‰) was estimated using a pre-calibrated Refractometer (Aatago–Japan). Collected pore water was analyzed for pH and Salinity.

4.2.2 Sediment Analysis:

Sediment samples of 1 kg weight were collected from random locations; two from each transect to cover the entire study area. The sediment texture was determined by the *Sand- Silt- Clay method* which is based on the particle size distribution after sieving the soil using grading sieves. The sediment texture results are expressed in percentage.

4.2.3 Pore-Water Analysis:

The pore water samples were collected from the random locations of the study site. About 20 cm pit was dug using a spade and water was allowed to seep inside the pit. The clean water in the pit was collected using a syringe from the surface to avoid sediment deposition (Figure 4.1).

Figure 4.1: Collection of Pore-water samples in the sampled locations of KPT

pH was measured in situ using a pre-calibrated handheld pH meter (Hanna make) and the salinity was determined by a Refractometer (Fisher Scientific). The basic nutrients (Nitrate, Nitrite and Phosphate) were determined within 6 hours of sampling. For all analysis protocol given in *Standard methods for the examination of* *water and wastewater*, 17^{th} Ed. by American Public Health Association (APHA, 1995) was followed.

4.3 Result:

4.3.1 Salinity:

Seawater salinity is the most important factor that determines many life processes of mangrove ecosystem. The surface water salinity concentration of the 21 sampled mangrove stands varied from 35 to 43‰ with an overall average value of 38.95‰ (Table 4.1). The surface salinity was maximum (43 ‰) at 23° 01' 58.8″ N 70° 15' 27.5″ E. The recorded values of surface salinity are very common in the mangrove ecosystem of Kachchh.

The pore water salinity of the present investigation ranged from 47 to 62‰ with an overall average value of 53.71 ‰. Pore-water salinity is uneven in all the 21 sampled locations of KPT. The pore water salinity was found to be maximum at 23° 05' 10.4″ N 70° 16' 25.2″ E. Pore-water salinity in general is influenced by tidal pattern.

4.3.2 Hydrogen Ion Concentration:

The water pH value was varied from 7.1 to 7.8 with a cumulative average value of 7.4. The pH concentration of the present study was maximum at 23° 06' 52.5″ N 70° 16' 25.5″ E. The pore-water pH ranged from 7.9 to 8.7 with a cumulative average value of 8.21(Table 4.1). The pore-water pH concentration is always higher than surface water pH which is very common in the mangrove environment.

Table 4.1: Physico-Chemical parameters of water in the sampled locations of KPT

		Temperature-°C		Salinity		pH	
Sample No	**Sampling Co-Ordinates**	**Surface Water**	**Porewater**	**Surface Water**	**Porewater**	**Surface Water**	**Porewater**
S1	23° 03' 41.1″ N; 70° 15' 27.5″ E	29	22	38	54	7.4	8.3
S2	23° 02' 48.3″ N; 70° 13' 34.0″ E	28.5	23.8	37	52	7.2	8.1
S3	23° 02' 24.9″ N; 70° 13' 45.4″ E	31.3	23.6	42	58	7.7	8.5
S4	23° 01' 58.8″ N; 70° 15' 27.5″ E	28	25.2	40	55	7.3	8.2
S5	23° 01' 52.5″ N; 70° 15' 29.1″ E	30.8	25.5	43	60	7.6	8.5
S6	23° 02' 5.9″ N; 70° 16' 00.7″ E	29	25.3	36	51	7.2	8.0
S7	23° 03' 45.3″ N; 70° 13'37.21″ E	31.2	28.2	35	47	7.6	8.5
S8	23° 06' 55.6″ N; 70° 16' 36.7″ E	28.2	25.5	37	49	7.3	8.1
S9	23° 06' 55.0″ N; 70° 16'25.5″ E	30.8	23.8	41	54	7.5	8.2
S10	23° 06' 52.5″ N; 70° 16' 25.5″ E	29.5	25.5	40	53	7.8	8.7
S11	23° 08'13.2″ N; 70° 18'19.8″ E	27.8	25.7	40	51	7.4	8.1
S12	23° 08' 20.9″ N; 70° 18' 16.6″ E	30	25	38	48	7.1	7.9
S13	23° 08' 29.7″ N; 70° 18' 17.8″ E	29.5	23	39	54	7.5	8.3
S14	23° 05' 03.5″ N; 70° 16' 18.0″ E	28.5	23.6	36	55	7.2	8.0
S15	23° 05'07.1″ N; 70° 16'23.8″ E	28.6	23	38	54	7.4	8.1
S16	23° 05' 10.4″ N; 70° 16' 25.2″ E	28.9	25.7	42	62	7.7	8.5
S17	23° 10' 35.9″ N; 70° 35' 28.2″ E	29.8	28.9	40	57	7.3	8.1
S18	23° 10' 38.6″ N; 70° 35' 31.3″ E	30.9	26.8	41	54	7.4	8.0
S19	23° 10' 30.6″ N; 70° 35' 28.3″ E	29.2	23	38	52	7.6	8.4
S20	23° 10' 36.5″ N; 70° 35' 39.0″ E	28	23.2	39	53	7.2	7.9
S21	23° 10' 41.6″ N; 70° 35' 35.4″ E	29.5	24.3	38	55	7.1	8.0
Cumulative Average		**29.38**	**24.79**	**38.95**	**53.71**	**7.4**	**8.21**

4.3.3 Nutrient Concentration:

During the present study, nutrient concentration was determined by estimating the nitrite, nitrate and phosphate. Nitrite concentration ranged from 0.1 to 0.9 mg/L with an overall average of 0.635 mg/L. The nitrite concentration recorded maximum at 23° 05' 07.1″ N 70° 16' 25.2″ E, while the lower concentration was recorded at 23° 03' 45.3″ N 70° 13' 37.21″ E. Nitrate content of the present study varied from 0.9 to 1.9 mg/L with a cumulative average of 1.45 mg/L. The nitrate content at 23° 01' 52.5″ N 70° 15' 29.1 shows highest level (1.9 mg/L) than that of all other sampled locations. Phosphate concentration ranged from 0.1 – 1.8 mg/L with an average of 0.75 mg/L with maximum at 23° 03' 45.3″ N 70° 13' 37.21″ E and minimum at 23° 08' 29.7″ N 70° 18' 17.8″ E. The recorded nutrient contents are sufficient to support the growth and vegetation structure of the KPT mangroves (Table 4.2).

Table 4.2: Pore-water nutrient concentration of in the KPT sampled locations

Sample ID	Location Coordinates	Nitrite (mg/L)	Nitrate (mg/L)	Phosphate (mg/L)
S1	23° 03' 41.1″ N; 70° 15' 27.5″ E	0.4	1.4	0.8
S2	23° 02' 48.3″ N; 70° 13' 34.0″ E	0.2	1.5	0.6
S3	23° 02' 24.9″ N; 70° 13' 45.4″ E	0.6	1.2	1.3
S4	23° 01' 58.8″ N; 70° 15' 27.5″ E	0.3	1.0	1.1
S5	23° 01' 52.5″ N; 70° 15' 29.1″ E	0.2	0.9	0.9
S6	23° 02' 5.9″ N; 70° 16' 00.7″ E	0.2	1.4	1.1
S7	23° 03' 45.3″ N; 70° 13'37.21″ E	0.1	1.2	1.8
S8	23° 06' 55.6″ N; 70° 16' 36.7″ E	0.8	1.9	1
S9	23° 06' 55.0″ N; 70° 16'25.5″ E	0.1	1.6	0.8
S10	23° 06' 52.5″ N; 70° 16' 25.5″ E	0.6	1.2	0.6
S11	23° 08'13.2″ N; 70° 18'19.8″ E	0.8	1.0	0.4
S12	23° 08' 20.9″ N; 70° 18' 16.6″ E	0.7	1.4	0.2
S13	23° 08' 29.7″ N; 70° 18' 17.8″ E	0.7	1.4	0.1
S14	23° 05' 03.5″ N; 70° 16' 18.0″ E	0.8	1.8	0.8
S15	23° 05'07.1″ N; 70° 16'23.8″ E	0.9	1.6	1.3
S16	23° 05' 10.4″ N; 70° 16' 25.2″ E	0.2	1.2	1.5
S17	23° 10' 35.9″ N; 70° 35' 28.2″ E	0.5	1.4	0.8
S18	23° 10' 38.6″ N; 70° 35' 31.3″ E	0.4	1.5	1.1
S19	23° 10' 30.6″ N; 70° 35' 28.3″ E	0.8	1.8	1.0
S20	23° 10' 36.5″ N; 70° 35' 39.0″ E	0.8	1.3	0.8
9S21	23° 10' 41.6″ N; 70° 35' 35.4″ E	0.8	1.2	0.2
Cumulative Average		0.635	1.45	0.757

4.3.4. Sediment Quality:

4.3.4.1 Sediment Texture:

During the present investigation, sediment texture varied widely among all the 21 sampled stations. Sediment texture typically represents the percentage composition of sand, silt and clay. Percentage composition of sand was maximum 38.1% and minimum 20.5% at the coordinates of 23° 06' 55.0″ N, 70° 16'25.5″ E; 23° 01' 52.5″

N, 70° 15'29.1″ E; respectively (Table 4.3). Overall average of all the 21 study sites sand constituted 30.09%. The silt composition was maximum at the study site 23° 06' 55.6″ N, 70° 16' 36.7″ E (16.5%) followed by the site at of 23° 09' 5.9″ N, 70° 16' 00.7″ E (16.1%) and minimum at 23° 03' 41.1″ N, 70° 15'27.5″ E(7.6%) with a cumulative mean value of 11.89%. Percentage composition of clay varied from 47.3% to 64.6% with an average value of 58.02%. Higher composition of clay was recorded at23° 01' 52.5″ N, 70° 15'29.1″ E. The cumulative average of the sediment indicated that in all the 21 sampled locations clay was the dominant fraction followed by silt and sand.

4.3.4.2Total Organic Carbon:

The total organic carbon in the sediment ranged from 0.51% to 0.8% with a cumulative mean value of 0.644% (Table 4.3). The higher TOC value was recorded at the site at 23° 10' 41.6″ N, 70° 35' 35.4″ E (0.8%) followed by the site at 23° 10' 30.6″ N, 70° 35' 35.4″ E (0.75%) and it was lower at 23° 02' 5.9″ N, 70° 16' 00.7″ E (0.51%).

Table: Percentage of Sediment texture and TOC in the sampled locations of KPT

Sampling Point No.	Sampling Coordinates	Post-Monsoon Texture (%)			Total Organic Carbon (%)
		Sand	Silt	Clay	
S1	23° 03' 41.1″ N; 70° 15' 27.5″ E	31.1	7.6	61.3	0.6
S2	23° 02' 48.3″ N; 70° 13' 34.0″ E	35.5	11.6	52.9	0.525
S3	23° 02' 24.9″ N; 70° 13' 45.4″ E	33.1	10.9	56	0.6
S4	23° 01' 58.8″ N; 70° 15' 27.5″ E	29	15.8	55.2	0.712
S5	23° 01' 52.5″ N; 70° 15' 29.1″ E	20.5	15	64.5	0.675
S6	23° 02' 5.9″ N; 70° 16' 00.7″ E	26.9	16.1	57	0.51
S7	23° 03' 45.3″ N; 70° 13'37.21″ E	23.2	12.2	64.6	0.6
S8	23° 06' 55.6″ N; 70° 16' 36.7″ E	28.9	16.5	54.6	0.58
S9	23° 06' 55.0″ N; 70° 16'25.5″ E	38.1	10	51.9	0.8
S10	23° 06' 52.5″ N; 70° 16' 25.5″ E	32.3	15	52.7	0.721
S11	23° 08'13.2″ N; 70° 18'19.8″ E	37.5	15.2	47.3	0.628
S12	23° 08' 20.9″ N; 70° 18' 16.6″ E	22.6	14.1	63.3	0.538
S13	23° 08' 29.7″ N; 70° 18' 17.8″ E	30.1	8.7	61.2	0.6
S14	23° 05' 03.5″ N; 70° 16' 18.0″ E	33.2	9.8	57	0.712
S15	23° 05'07.1″ N; 70° 16'23.8″ E	29.2	9.5	61.3	0.52
S16	23° 05' 10.4″ N; 70° 16' 25.2″ E	31.0	11.2	57.8	0.6
S17	23° 10' 35.9″ N; 70° 35' 28.2″ E	26.5	11.5	62	0.728
S18	23° 10' 38.6″ N; 70° 35' 31.3″ E	29.2	9.5	61.3	0.73
S19	23° 10' 30.6″ N; 70° 35' 28.3″ E	28.6	10.6	60.8	0.75
S20	23° 10' 36.5″ N; 70° 35' 39.0″ E	32.2	9.3	58.5	0.61
S21	23° 10' 41.6″ N; 70° 35' 35.4″ E	33.1	9.5	57.4	0.8
Cumulative Average		**30.09**	**11.89**	**58.02**	**0.644**

4.3.5 Conclusion

Assessment of mangrove health through vegetation structure and its status and water and sediment quality in 21 sampling locations within the boundary of Kandla Port indicated that most of the governing physio-chemical parameters of mangrove formations are within the prescribed limits. Essential parameters like surface water and pore-water salinity of the present study are comparable with other mangrove environment are within the prescribed limits. The high level of salinity is mainly due to the arid condition of the zone and resulting high evapo-transpiration rates prevailing in Gulf of Kachchh waters.

The status of mangrove within Kandla Port premises were characterized by evaluating their vegetation structures such as stand density, diversity, Girth at Breast Height (GBH),Canopy length and canopy width cover in 21 sampled locations. During the present study, mangrove stand at 23° 10' 41.6″ N, 70° 35' 35.4″ E is structurally better than other stands. The cumulative average mature tree density of 4124 trees/ha recorded in all the 21 sampled stands indicated that this mangrove formations is structurally dense than other mangrove formations of Kachchh. Tree height in all the 21 sampled stands showed noticeable variation which ranged from 171 cm to 341 cm with an cumulative average of 254cm.Mangrove trees were considerably taller at 23° 05' 07.1″ N, 70° 16' 23.8″ E, which is higher than all other samplings stands of KPT. Mangroves had highest GBH of 26.5 at 23° 02' 24.9″ N, 70° 13' 45.4″ E. The canopy cover in mangroves of Kandla port is rather small and comparatively lesser than other formations of Kachchh. This is solely attributable to the prevailing ambience like high pore-water salinity and other natural factors. Overall average density of regeneration class from 21 sampling locations is 23423.81 plants/ha, which indicate that the regeneration potential of mangroves of Kandla Port is good. Similarly, overall average density of the next younger class namely recruitment class was equally good establishing the high regeneration potential of the mangrove formation. Density Investigation of younger classes like regeneration and recruitment classes of the present study generally indicated that vegetation structure of the mangroves has high potential to sustain its structural integrity in future.

5. MANGROVE LAND COVER STUDIES IN KPT AREA

5.1 Introduction:

Kachchh mangroves are the largest single stand in the west coast with the extent of 789sq.Km (FSI, 2009). An increase of 11 sq. km was reported from the earlier estimates (FSI, 2013). Harsh environmental settings like arid hinter land minimal rainfall (458mm/year) and extreme evapo-transpiration rate have rendered these mangrove formations to a single species stand comprising hardy *Avicennia marina,* though sporadic occurrence of other species such as *R. mucronata, C. tagal* and *A. corniculatum* has been reported in very few coastal stretches.

Gandhidham taluka of Kachchh district where Kandla port is located is estimated to have 61.97sq.kmof mangroves (GEC&BISAG, 2009). In the present study dense and sparse mangrove formations within the jurisdiction of Kandla Port have been estimated tobearound13841.4ha (13234.2 ha area located in Kandla region). In the present GIS study, land-cover estimation of within the boundary of Kandla port was carried out to understand mangrove distribution.

Kandla Port Jurisdiction includes mainly Kandla port, Tuna port, Sat Saida bet and surrounding area of the port. Kandla creek on whose bank the port is located runs into the Gulf of Kachchh at a distance of 90 nautical miles from the port. The width of the channel varies from 200 meters to 1,000 meters. The contour depth along the shipping channel is around 10 meters. The study site falls under the co-ordinates of latitude between $23^{0}12'$ 20.49"N to $23^{0}53'$ 35.64"N and Longitude between $69^{0}59'$ 35.64"E to $70^{0}37'$ 51.40"E as given in Figure 5.1 (Annexure). It encompasses an approximate area of 120206.1 ha (1202.06 sq. km). This includes terrestrial and part of Gulf systems which fall within the port boundary.

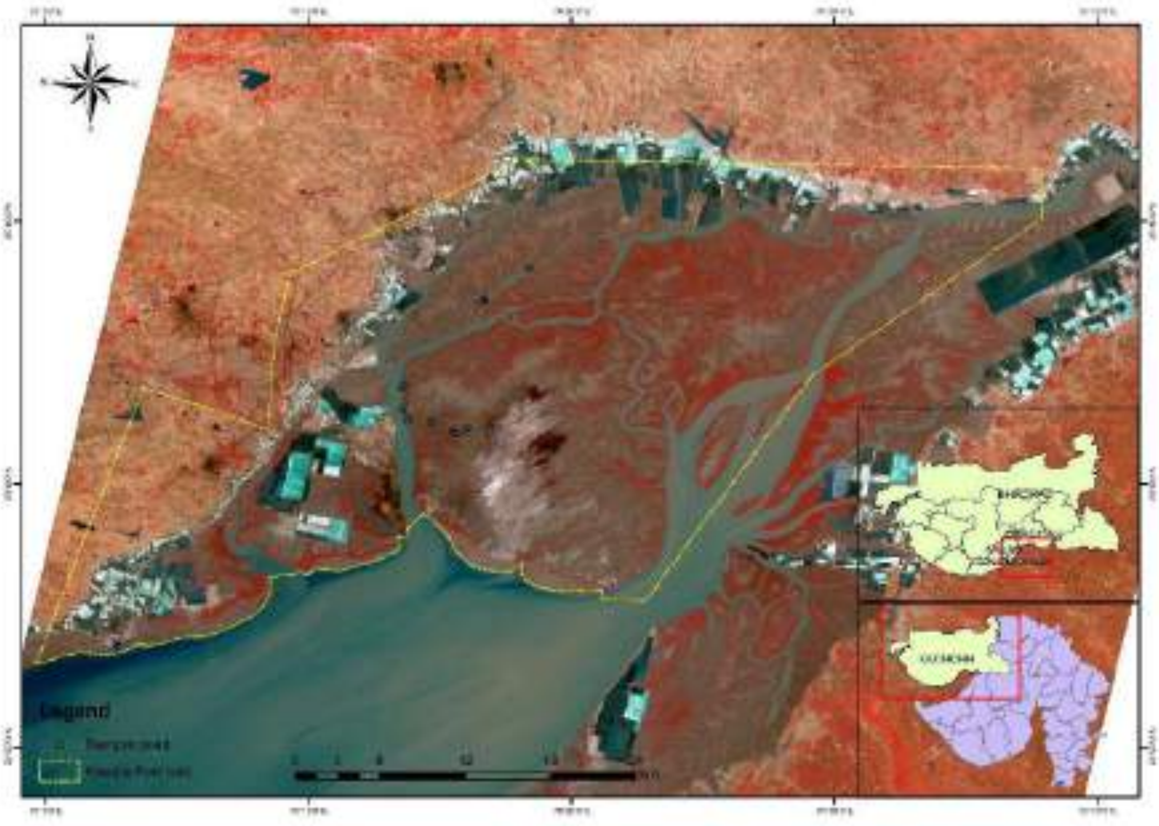

Figure 5.1: Sampling Points of Kandla Port Jurisdiction

5.2 GIS and Remote Sensing:

LISS 4 Satellite imagery of pre-monsoon season procured from NRSC, Hyderabad was used for the present study. The procured imagery has a resolution of 5.8 m with UTM projection with spheroid and datum named WGS 84 in UTM zone 42 north, which will meet the requirement of estimating the areal extent of mangroves within marked port limit area and its current status. Supervised Classification Method is applied to delineate the mangrove area and other natural areas. The details of the satellite imagery used are given below.

Satellite	Year	Month	Sensor	Bands	Pixel Resolution
IRS P6	2014	14,Dec	**LISS 4**	3	5.8 m

5.3 Pre-Processing:

Pre-processing of satellite data including geometric correction, atmospheric correction and radiometric correction and clipping of the area has been carried out. The rectification operation aims to correct distorted images to create a more faithful representation of the original scene. It typically involves the initial processing of raw image data to correct for geometric distortions.

5.3.1 Radiometric correction:

Radiometric correction addresses variations in the pixel intensities (DNs) that are not caused by the object or scene being scanned. These variations include differing sensitivities or malfunctioning of the detectors, topographic effects and atmospheric effects.

5.3.2 Geometric correction:

Geometric correction addresses errors in the relative positions of pixels. These errors are induced by sensor viewing geometry or terrain variations. Geometric correction was done based on Ground Control Points (GCPs) and the image was re-sampled using nearest neighborhood interpolation method.

5.3.3Supervised classification:

Supervised classification can be defined normally as the process of sample of known identity to classify pixels of unknown identity. Samples of known identity are those pixels located within training areas. Pixels located within these areas term the training samples used to guide the classification algorithm to assigning specific spectral values to appropriate information class.

Preliminary surveys were conducted on the ground to collect training samples for different Land cover using Garmin GPS with the help of training sample, classification map was generated based on Maximum Likelihood Supervised Classification model using ERDAS Software.

5.4 Land Cover classification for 2014:

Land Cover as observed in the imagery of December 2014 was classified in 10 classes namely Dense mangrove, sparse mangrove, Saltpan, mudflat, other vegetation, settlement, water, agriculture, fallow land and barren land. This imagery classification was supported by ground truthing through fieldwork as it is a very important to check and collect most of the ground information required for mapping.

Reconnaissance field survey was undertaken to get acquainted with the general land cover pattern of the area. Different patches of mangrove area characteristics were recorded. The variation and tonal patterns observed in the ground truthing was recorded on the existing images. Traverses along Kandla main creek and subordinates creek of Kandla, mangrove area, saline area, saltpan and other vegetation was made for ground truthing the patterns and characters recorded in the image. Various features identified in the ground truthing were correlated with the image element and GPS observations was obtained for various land cover by superimposing on the satellite image.

5.5 Result:

5.5.1 Land Cover Mapping:

The land cover map based on supervised classification of LISS IV December 2014 is given in Fig.5.2and the area analysis of land cover is given in hectares.

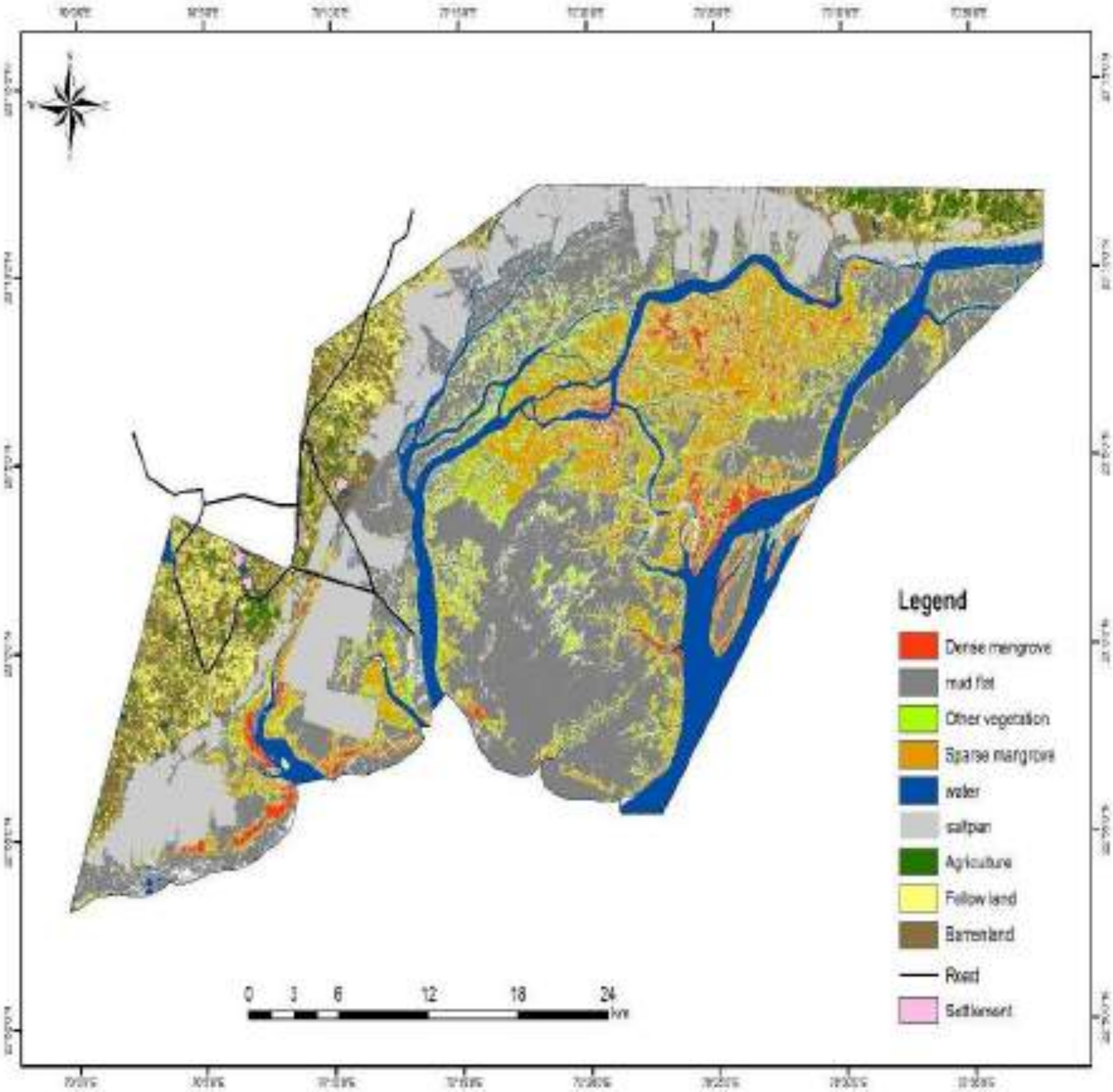

Fig.5.2: Land cover classification map of the study area -December2014

As per this classification different land cover category has been estimated in hectares (Figure 5.3). Total mangrove cover constitutes 15.3% with dense mangroves constituting 3.8% and sparse mangrove 11.5 %. Highest land cover is occupied by mudflats to the tune of 36.9% followed by water spread (11.5%) whereas cover of settlement (01%) and agriculture (1.7%) was lowest (Table 5.1).

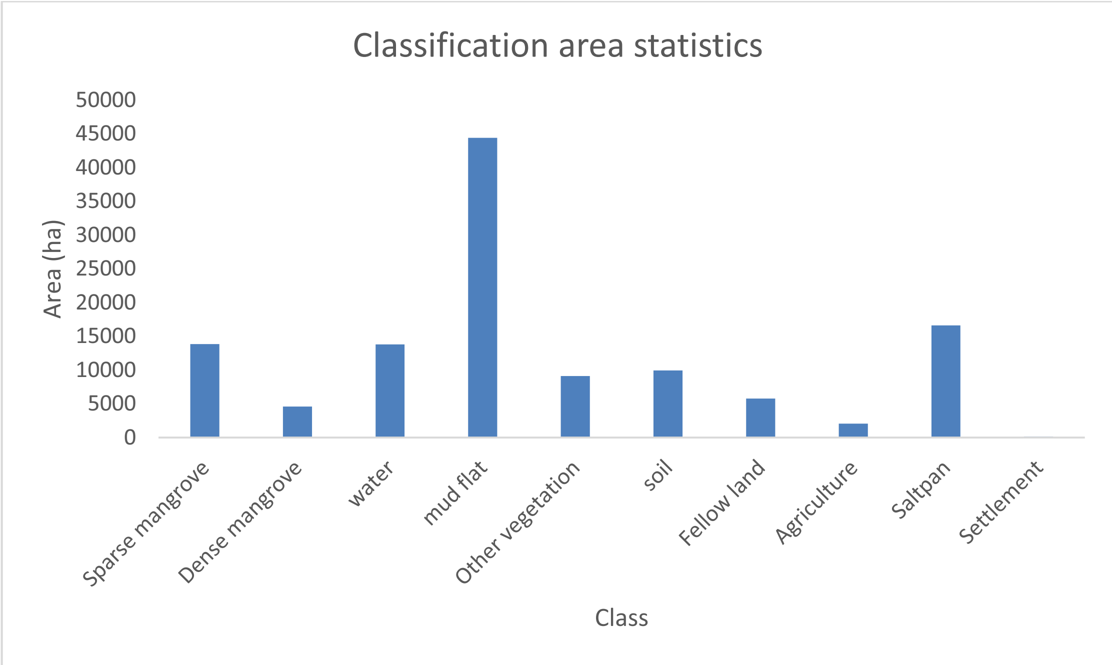

Fig. 5.3: Total Land Cover Classification Statistics in Hectares

Table 5.1: Percentage of Land Cover Classification in Kandla Port Area

Sr. No.	Class	Kandla Area (ha)	Tuna Tekra Area (ha)	Total Area (ha)	Total Area Percentage (%)
1	Sparse mangrove	13234.2	607.03	13841.2	11.5
2	Dense mangrove	4025.1	565.38	4590.4	3.8
3	Water	13117.3	671.54	13788.8	11.5
4	mud flat	41310.4	3080.69	44391.1	36.9
5	Other vegetation	8655.2	439.76	9095.0	7.6
6	Soil	5097.1	4840.60	9937.7	8.3
7	Fellow land	2582.7	3177.75	5760.4	4.8
8	Agriculture	1241.2	817.48	2058.7	1.7
9	Saltpan	12843.6	3754.50	16598.10	13.8
10	Settlement	49.7	94.96	144.7	0.1
	Total	**102156.5**	**18049.68**	**120206.18**	**100.0**

6. MANGROVE MANAGEMENT PLAN FOR KPT

6.1 Background:

The Kandla Port Trust envisages several facilities to be built at the location. The establishment of facilities over the years, buildings, etc. involves notable changes in the landscapes including natural environment as a result of intensive activities. Doubtlessly, this will alter the local ecological makeup of the area. Any long term human centered activity in any coastal belt will have serious repercussions on all its natural resources and ecosystems in the vicinity. Thus, measures should be taken to conserve and preserve KPT mangroves, thus retaining several visible and invisible ecological services of mangrove. As a first and foremost step it is imperative that no mangroves in the region are to be cleared for any activities and more mangrove plantation/ restoration work should be undertaken. Dumping of any materials such as cement, rubble, sand, steel, spilling of materials, etc. should be strictly avoided.

Regular monitoring programmes at fixed intervals are crucial to assess any change in mangrove diversity during different developmental activities. Therefore, KPT would be explored the possibility to engage an experts for monitoring the area regularly as ecological perspective. Emphasis on growth with respect to survival percentage, height, density, regeneration and recruitment classes, frequency class, etc. should be given during regular monitoring. Other phyto-sociological parameters should also be addressed during regular monitoring programme. Mangroves being a dynamic ecosystem such changes may be studied annually. Nevertheless, in areas with new mangrove growths/restoration the monitoring may be more frequent in order to arrest any adverse impact. Regular monitoring of these factors will facilitate the KPT authorities to understand the impact of the ongoing activities, if any. This would, inturn, help in mangrove conservation and management of the region. The data generated as an outcome of regular monitoring should be collected from predetermined/identified locations to avoid any sampling error. A team of expert groups should be engaged by KPT, in order to assess/evaluate the mangrove growth and vegetation structure.

The expert team may also help to conducting appropriate awareness programmes to the workers, supervisory staff and contract labours of KPT. Thus, environmental training and awareness creation should be undertaken for all jetty staff and contractors during their initial induction period. The training should involve both ecological and environmental importance of mangroves and measures to be taken in order to protect and preserve them during their activities in the areas contiguous to mangroves. Signboards and hoardings at appropriate places should be placed reflecting mangroves importance. These hoardings should be in easily understandable languages and in pictorial forms. Restricted entry/no entry boards may also be placed at appropriate places to regulate/monitor the frequency of visiting labours. This way, any illegal cutting, etc. can be immediately reported to KPT Environment Cell. This must involve a routine system of reporting such incidences. Similarly, KPT should hold an active Environment Cell to handle such problems cases. The consultancy peoples may also help in conducting awareness programs to the workers, supervisory staff and contract labours of KPT.

6.2 Other Activities:

Immense care should be taken to avoid any oil spillage from calling ships and other machineries in the vicinity of mangroves. Any unauthorized entry, cattle grazing and collection of mangrove forest products should be timely reported and entered in the register. Utmost care is required for any chemical/hydrocarbon spillage in the vicinity. Environment Division of KPT should investigate such incidences and take measures to arrest these activities. Further strengthening of this Division is essential as indicated in chapter 7.

No clearance and disturbance to soil surface in the areas close to mangrove formations should be done which would otherwise lead to increased turbidity of run-off. For such purpose it is suggested to earmark the area into buffer zone and core zone and no activity should take place in core zone including the earthmoving machineries. In some places scrub-rolling should be followed to allow resprouting/germination. No oil, loitering, rubbles, etc. should disposed off. In buffer zone, these items are to be managed, collected, transported and disposed following GPCB norms.

Kachchh being arid zone, encounters dust storms. Thus, to minimize/avoid dust spreading into these ecologically important areas sprinklers should be used to arrest air borne dust and this frequency should be increased based on wind and weather conditions.

6.3 Significant Ecological Parameter:

Pore-water properties in mangroves ecosystem play a major role in determining the health of the mangrove forest. Alteration in the pore-water chemical and physical characteristics, especially salinity is a reliable indicator of changing physical condition in the mangrove. If any alteration in pore-water salinity and conductivity beyond the limit is reported during monitoring, immediate investigation should be carried out to identify the reason and appropriate remedial measures should be taken. For such purposes, constructing canal system to ensure increased flushing, groundwater recovery bores and interceptor channels which would facilitate increased water flushing to mangroves in the event of changed tidal pattern may be included. The construction of such a canal system should be in a well planned manner using the expertise of civil engineers. Since *Avicennia marina*, takes several years to respond to any of these changes, a long term sustained monitoring as mentioned earlier is vital.

6.4 Mangrove Rehabilitation:

At the same time KPT has carried out mangrove plantation and rehabilitation in 1000 ha (excluding 200 ha of IFFCO plantation site and 250 ha by M/S AKBTPL), the efforts are restricted to the tidal flats of Sat Saida Bet and Nakti creek (Refer Table 7.1). Thus, it is recommended to extend mangrove plantation and rehabilitation activities at Sat Saida Bet region. Such activities should be carried out through mangrove experts of consultancy.

6.5 Biodiversity Monitoring Committee:

Macrofauna is an integral part of mangrove ecosystem. Macrofaunal diversity in mangrove ecosystem reflects its health. It is well known that a steady mangrove system supports rich faunal diversity/density. The faunal diversity in mangrove ecosystem is very sensitive to alterations in the habitat. Thus, monitoring faunal diversity would directly alert the KPT authorities about at any changes happened/ happening in the area. Thus, it is suggested to carry out regular monitoring of macrofauna in the mangrove area.

6.6 Mangrove Plantation and Restoration Activities:

It is known that mudflats experiencing favourable tidal amplitude are suitable for mangrove plantation. Sat Saida Bet area has widespread mudflats and suitable environmental conditions, Therefore, Sat Saida Bet area is recommended to carry out the future mangrove plantation and restoration activities. Being at the tail end of Gulf, the vicinity of Kandla port abounds with networks of creek systems, mudflats and tidal swamps with pronounced tidal amplitude of 6.66 m (Mean High Water Spring-MHWS) that inundates a vast intertidal belt rendering it suitable for plantation. It is noticed that the substrate nature is silty-clay which favours mangrove growth. The areas at Sat Saida Bet can be explored for mangrove plantation in available mudflats. However, this should be carried out in consultation with experts and should also involve long-term monitoring to ensure the growth of mangroves. Any impacts on mangrove health should be studied and measures should be taken to revive the growth. Such impact can be understood by studying faunal diversity as mentioned above.

KPT should undertake restoration activities to replenish the growth of mangroves in areas with stunted growth. This may be based on existence of creeks, removal of blockages in the natural minor creeks, and creation of new tidal regimes through fish bone canals. To undertake such activities, it is suggested to study the area characteristics and relate it with existing scientific knowledge. Thus, this should be carried out in consultation with the experts. It is envisaged that correlating long-term mangrove conservation and preservation with KPT’s foreseen expansion would improve its greener outlook and enable KPT to get environmental clearance of its future projects/activities.

Desiltation of natural canals, increased frequency of tidal flushing, should be carried out in areas with natural stunted growth areas in order to improve mangroves health, and ecological functions and services. Thus, for all such activities, and mangrove plantation and restoration activities creation of a Separate Mangrove Monitoring Cell under the Environmental Division is suggested. For any plantation activity the in site selection is foremost. Nevertheless, protocol involved during site identification as well as selection will play an important role in long term survival of mangroves areas and their well being. Thus, it is recommended to select the future plantation sites in consultation with experts. Experts ought to have a thorough knowledge and experience on ecology, faunal diversity, sediment quality assessment, pore-water quality assessment and impact of other factor on mangrove formations / growth.

It is suggested that other candidate species of mangroves *viz*., *Aegiceros corniculatum, Ceriops tagal* and *Rhizophora mucronata*, should also be attempted in natural areas. These species area likely to improve/increase the diversity of the area and thus improving mangrove health.

For any plantation activity, improved techniques as elaborated in earlier sections should be followed. Raised bed (*Otla*) method should be followed in sites experiencing high tidal currents. However, such plantation technique should be carried out in previous existing mangroves stands and new areas should be completely avoided. Also, sediment erosion monitors and in plantation areas following *Otla* method should be carried out. Kandla port premises especially Sat Saida Bet receives gentle tidal currents, therefore, open mudflats here should have nursery raised sapling or direct dibbling of seeds in a pit.

In order to ensure any negative impact on the health of mangrove ecosystem in Kandla Port region, long term planning and conservation strategies should be attempted and most vulnerable mangrove stand should be identified and exposed to conservation efforts. Thus, special efforts should be taken to conserve these stands.

7. MANGROVE PLANTATION AND REHABILITATION EFFORTS

7.1 Background:

Among Kachchh mangroves with a spread of 789 sq.km, Gandhidham taluka, where Kandla Port is located, has a mangrove formation of 61.97 sq. km. Extent of dense mangrove within this taluka is only around 2.89 sq.km whereas sparse mangroves are 59.07 sq. km (GEC & BISAC, 2009). Potential mudflat area within the taluka is estimated to be 55.47 sq.km presenting a vast scope for mangrove plantation and rehabilitation. Kandla Port Trust within its jurisdiction encompasses a total land area (excluding water) of 893.03 sq. km rendering it the largest land holder in Kachchh district. Extent of mangroves within the Jurisdiction of Kandla Port is estimated to be 18831.64ha with the inclusion of 4990.4 and 13841.2 sq.km sparse and dense mangroves, respectively; a largest patch outside the administrative jurisdiction of forest department. During early 1960s mangrove cover in Kandla-Surajbari belt was reported to be 506 sq.km which ultimately shrank to 49 sq.km during 2002 due to various human and natural factors.

Cargo handling in Kandla Port consistently recorded an increasing growth trend; the total cargo traffic handled by the port has increased from 24.5 million tons in 1993-94 to 82.5 million tons in 2011-12. Moreover, KPT handled 87.005 MMT cargo during the year of 2013-2014 and 92.5 MMT in the financial year of 2014-2015 Additionally, it is planned to construct four dry cargo berths within the Kandla creek; it is also planned to develop two Multi-Product Special Economic Zones (MPSEZ) at Kandla (3400 ha) and at Tuna Tekra (1400 ha). Out of 12 existing cargo berths, six berths have already served their lifespan of 50 years. In addition, existing vessel traffic, congestion in the main port and draft restrictions demand expansion of the port facility to adjacent creek systems.

Due to these commercial, operational and economic reasons and to meet the demands of the expanding trade, KPT has to increase its cargo handling capacity in the future while simultaneously caring for the ecological wellbeing of mangroves in its port vicinity. As expected, these developments will have their own repercussions on the surrounding port environ. Mangrove being a major ecological entity within the port premise, it is imperative that a well planned, long term conservation measure in terms of aggressive mangrove plantation and rehabilitation has to be initiated in order to bring back the mangrove cover to the pre-port era of pristine nature and also to conserve the existing mangrove formations intact in a sustained long term basis. This calls for consistent effort both for preserving and improving the mangrove formation. This chapter narrates the ongoing mangrove plantation activities by the port authorities and recommend future plan of action for long term conservation. Recommendations on the monitoring programmes to be initiated in order to keep track of the ecosystem health and to initiate course corrections and remedies, if any impacts are felt is also narrated.

7.2 KPT-Present Mangrove Plantation/Rehabilitation Efforts:

Three different terminologies namely Rehabilitation, Restoration and Plantation are interchangeably used to denote human interventions to improve mangrove condition. Field (1999) defines 'Rehabilitation' as 'return of degraded mangrove land to a fully functional mangrove ecosystem'; the term 'Restoration' is defined by him as 'returning the degraded mangrove land to something like its presumed original state'. The term, 'Plantation' could be considered as raising mangroves in a technically suitable coastal belt where mangroves were absent earlier. Going by this definition most of the activities undertaken by Kandla port or any other stake holder agencies until now is only plantation with restoration and rehabilitation activities seldom attempted.

With a vast wide mudflat area extending up to 44391 ha and numerous network of creek systems enabling a rich and conducive environment for mangrove growth, Kandla port environ is an ideal location for mangrove plantation and restoration efforts. These possible mudflats for mangrove plantation are available along the creek systems of Sat Saida Bet. Similarly, many earlier pristine mangrove stands that are now degraded within Kandla port offers equally high opportunity to restore them.

Mangrove plantation activity by Kandla Port was initiated during 2002 as mandated by the Ministry of Environment Forests and Climate Change (MoEF). The first mangrove plantation activity was during 2002 with the development of 20 ha at

Sat Saida Bet, a vast tidally flushed area along the northern bank of Kandla creek opposite to Kandla port. Subsequently, 1200 ha of mangrove plantation has been completed till the end of 2014 in order to meet the legal mandate of Ministry of Environment, Forests and Climate Change (Table 7.1).

Table 7.1: Details of implemented Mangrove Plantation by Kandla Port Trust

Sr. no.	Year of Plantation & Site	Area-ha.	Species	Survival -%	Agency
1	2005-2006 (Sat Saida Bed)	20	*A.marina*	98	M/s Gujarat Ecology Commission
2	2008–09 (Nakti Creek)	50	*A.marina*	71	M/s Gujarat Ecology Commission
3	2010–11 (Nakti Creek)	100	*A.marina, R. mucronata, C. tagal*	68	M/s Gujarat Ecology Commission
4	2011–12 (Sat Saida Bed)	200	*A.marina*	74	Forest & Environment Department, GoG
5	2012-13 (Sat Saida Bed)	300	*A.marina*	71	Forest & Environment Department, GoG
6	2013–14 (Sat Saida Bed)	330	*A.marina*	69	Forest & Environment Department, GoG
Total Mangrove Plantation carried out by KPT – 1000 ha					
7	2013-14 (Sat Saida Bed)	250	*A.marina*	70	M/s AKBTPL
8	2013-15 (Sat Saida Bed)	200	*A.marina*	74	IFFCO through GUIDE
9	2015-17	300	-	-	MoU signed with Gujarat Ecology Comission (GEC), Government of Gujarat

In all these plantations the following three different methods were followed.

1. Raised Bed Method (Otla method)
2. Transplantation of nursery raised saplings (Nursery method)
3. Direct Seed Sowing Method

7.2.1 Otla Method:

In majority of the plantation sites raised bed method (*Otla* method) was followed as it is believed to give better results than other methods. Further, this method is perceived to be less cost and labour intensive. This method is especially suitable for sites with high tidal currents. In this method, square earthen mounts of 10-15 cm height were raised and propagules numbering 50-60 were dibbled on the surface of the mount. Generally, number of raised beds per hectare is around 1000 with a spacing of less than 1 × 1 m. In case of plantation among gaps of natural mangroves, clusters of *Otlas* mostly exceeding the density of 1500/ha were made closely.

7.2.2 Direct Propagule Dibbling:

Next to raised bed method, direct propagule dibbling (locally called '*Sing'* Plantation) was attempted in many sites. This method is less labour and cost intensive, though repeated dibbling was often required in order to obtain desirable survival rate. In this method, mature propagules are dibbled in open empty mudflats or among gaps of natural stands. Spacing maintained between each dibbled propagule varied differently and in some sites it was as close as 75×50 cm, especially in plantation raised among gaps of natural mangroves. Propagules used were collected freshly from the nearby mangrove formations which are thought to give better results and no pre-dibbling seed treatments were used. Often propagules were dibbled repeatedly in order to increase survival rates and in raised (O*tla*) bed and nursery plantation sites, dibbling propagules was resorted to increase survival.

7.2.3. Nursery Methods (Polybag Method):

Transplantation of nursery raised saplings was also followed as its success rate is much higher than any other method. Unlike raised bed and direct dibbling methods, this method is labour and cost intensive and time consuming. Nursery raised saplings are transplanted as individual plants either in open intertidal mudflats or along the banks of the creek systems. Saplings in the polythene bags were allowed to attain a height of 40-50 cm before transplantation in a period of 3-4 months. This method was found to be promising and yield better survival rate wherever it was attempted. While transplanting, varying density, ranging from 3000 to 6000 saplings/ha as dictated by the site condition were followed.

7.3 Mangrove Plantation Targets Achieved:

The targeted plantation area of 1000 ha, Kandla Port Trust has been carried out plantation in two sites namely Sat Saida Bet on the banks of Kandla creek opposite to Kandla Port and along the Nakti creek till the end of 2013-14. Year-wise target achieved and other details of plantation are given in table 7.1. Sat Saida Bet opposite to the port bank of Kandla was chosen to implement the mangrove plantation at Sat Saida Bet, it is a vast mudflat area receiving adequate tidal flushing to support a healthy plantation. Numerous minor tidal creeks criss-cross the mudflat producing very conducive conditions for undertaking plantation activity. Out of the 1000 ha completed till 2013-14, 850 ha of plantation were carried out in Sat Saida Bet which yielded better results with high survival rate of more than 80%.

In all plantation years, except 2008-09, the candidate species was *Avicennia marina*. This is the dominant species occurring in the mangrove formations of Kachchh, though sporadic occurrence of other two species, *Rhizophora mucronata* and *Ceriops tagal* has been reported. *Avicennia marina* is known to survive in very high water and soil salinity due to its extreme tolerance to different environmental conditions. Kachchh coastal region experiences elevated water and soil salinity levels due to aridity and very high evaporation rate. In this prevailing ambiance of high salinity, growth of *A. marina* is fairly good comparing other mangrove species since it is due to its high tolerance to higher salinity ranges. Obviously, *A. marina* is the candidate species in the whole of Kachchh and Gujarat coast due to these reasons. Earlier attempts during 2008-09 to plant *Rhizophora mucronata* and *Ceriops tagal* at Sat Saida Bet yielded only very limited success rates in terms of survival.

7.4 Potential for Plantation and Restoration Activities in Kandla Port Area:

Scope for successful mangrove plantation and restoration activities in Kandla Port area is plenty as basic environmental requirements and conditions are quite conducive. Presence of extensive mudflats, favourable tidal amplitude and conducive substrate nature favours mangrove plantation in vast areas. The vast mudflat area is around 44391 ha located in the Kandla port premises, around 20000 ha receives good tidal flushing rates which exactly located in Sat Saida Bet region. Being at the tail end of Gulf, the vicinity of Kandla port abounds with networks of creek systems mudflats and tidal swamps with pronounced tidal amplitude of 6.66 m (Mean High Water Spring-MHWS) that inundates vast intertidal belt, rendering it suitable for plantation. Substrate nature is silty-clay which favours luxuriant mangrove growth. Despite factors like high aridity, water salinity and poor rainfall (340 mm/year), growth of mangrove species, especially *A. marina* is favoured by other positive factors. It is estimated that out of available extent of 44391.1 ha of mudflats, nearly 20000 ha has high potential for mangrove plantation. About 830 ha out 1000 ha of plantation executed so far by Kandla port has been carried out at Sat Saida Bet, since it has vast extent of mudflats and tidal swamps. Network of creek systems at Sat Saida Bet and adjacent mudflats in the creek system on its northern extent has vast potential mudflats for mangrove plantation. Other than this, creek systems like Nakti and Khori has extensive mudflats along their banks which are suitable for mangrove plantation.

Similar to plantation potential, potential for mangrove restoration activities are equally high in and around Kandla port. It is estimated that out of total mangrove extent of 18431.6 ha within the port jurisdiction, 4590.4 ha are dense and 13841.2 ha are sparse. Potential for developing the sparse mangroves into a healthy and dense mangrove habitat is plenty by undertaking restoration activities such as deepening the existing minor creek systems, creating new tidal regimes through fish bone canals and removing blockages in the natural minor creeks. Most of these sparse mangroves were once reported to be dense and healthy (ICMAM, 2004) and they were rendered sparse due to micro-level changes in the topography and geomorphology due to various natural and anthropogenic factors.

Majority of the mudflat area in the Tuna region do not support mangrove growth in spite of adequate tidal flushing solely due to lack of geomorphic and tidal factors which prevent effective mangrove seed dispersal. Potential mangrove plantation sites at Sat Saida Bet is enabling by broadcasting or by other means of most likely convert these mudflats into mangrove formations.

7.5 Recommendation for Future Mangrove Plantation:

Given the vast extent of natural mangroves within the port environ and the ecological sensitivity of mangroves, it will be in the long term commercial interest of Kandla port to ensure that a committed management plan encompassing conservation of natural stand and further areal expansion through plantation and restoration is in place with appropriate budgetary allotment. Since Kandla port is poised for further growth in the future, linking long term mangrove conservation and preservation with its entire future expansion plan will manifold enhance its greener outlook and enable easy environmental clearance of its future project activities. Sustained and planned effort with a strong will and determination will render Kandla Port a truly green port surrounded by thick, dense and luxuriant mangroves. Recommendations to this effect are presented below.

7.6 Long term Plan for Mangrove Plantation or Restoration:

Creation of a separate mangrove cell manned by scientific manpower with clearly defined timely goal could be the first step towards mangrove conservation. Kandla port may create its own cell or it could be assigned to a competent organization with adequate experience in mangrove conservation such as forest department and Gujarat Ecology Commission (GEC). With parallel planning and execution for plantation and restoration, yearly target of plantation and restoration are fixed and met with adequate fund support from port authorities. A long term plan with yearly target of plantation/restoration irrespective of ministry mandate could be drawn by this cell. This plan, to begin with, will identify and demarcate potential mangrove sites separately for plantation and restoration activities through application of GIS and RS tools. Similarly, patches that are likely to face impact due to different anthropogenic activities could be identified and appropriate mitigation measures initiated.

7.6.1 Restoration along with Plantation:

Until now, outright plantation is the sole measure of mangrove conservation while restoration of degraded stand has never been attempted. It is recommended that restoration by bio-physical amendments along with plantation could be attempted in future conservation activities; especially in identified scrubby/stunted stands facing inadequate tidal flushing this restoration effort will yield better results rather than direct plantation. Desiltation of natural canals and enhancing tidal flushing rates through canal systems and increasing number of tidal days in such natural stunted stands by physical amendments will render the scrubby formation healthy, viable and a functional mangrove ecosystem. This could be done in a cost effective manner yielding better results than direct plantation. A thorough and detailed surveillance and categorizing the sites requiring different approaches/treatments could be undertaken in future mangrove conservation efforts. Through application of GIS tools, this task could be done in a scientific manner. These restoration activities could be delinked from ministry mandated conditional plantation for different project setting/expansion and are to be carried out as per the yearly targets set out by Kandla port itself. This will be a time saving and proactive measure to meet conservation mandate that will be imposed by the ministry in future for different project implementation.

7.6.2 Improved Plantation Techniques:

As narrated in section 7.2 three basic techniques for plantation is followed namely, raised bed (Otla) method, Plantation of nursery raised saplings and direct seed dibbling. While raised (Otla) method is predominantly followed, other two methods are supplementary. Raised bed (*Otla*) method is more suitable for sites which experiences heavy tidal currents. Since raised beds control the velocity of receding tidal waters, germinating seedlings do not get dislodged. Though raised bed method initially results in high survival rate, in due course of time, sediment in the bed gets eroded in the receding tidal currents and saplings gets uprooted when their root system are exposed to the currents. In majority of the sites where raised bed method was attempted initial high survival rates is followed by heavy mortality and survival becomes poor after six months. However, this method is satisfactory if the plantation is carried out among existing mangrove stands which effectively checks and slow down the receding tidal currents. Hence, caution is to be exercised whole adapting raised bed method of plantation. It is suggested that this method could be used as a last resort and only in sites facing heavy tidal currents. For the mudflats of Kandla port region, where tidal currents are mostly gentle due to gradual intertidal gradient raised bed method may not be suitable. Either plantation of nursery raised sapling or direct dibbling of seeds in a pit will be more appropriate method.

7.6.3 Site Selection:

By far, suitable site selection in the intertidal belt is foremost criterion determining success of mangrove plantation. A list of bio-physical parameters like gradient of the chosen intertidal belt, soil nature, number of days of tidal flushing, presence/absence of natural mangroves in the vicinity and availability of adequate intertidal extent are to be carefully considered for choosing plantation site. More emphasis is to be given to tidal flushing; only sites that receive good tidal flushing for 15-20 days in a month are to be chosen for plantation activities. A suite of 12 parameters indicated in the table 7.2 are to be meticulously considered before choosing a site. In earlier plantation attempts by Kandla Port, sites among existing natural mangrove formation with good tidal flushing and regeneration potential were taken up. In other cases, plantation was raised along the banks of natural creeks or in the gaps among scrubby mangrove formations and open mudflats close to the coastal belt after ascertaining adequate tidal inundation. In short all bio-physical characters (Table 7.2) are to be carefully considered before choosing plantation sites. Based on bio-physical characteristics of sites, few areas at Sat Saida bet was suggested here for future mangrove plantation activities (Figure 7.1).

Table 7.2: Criteria Adapted by Forest Staff for site selection

Priority Order	Criteria	Preferred Conditions
1	Site Nature- Open coast/creek/Natural Mangrove formations	Creek systems and estuaries with freshwater input is preferable- In open coast sites gentle gradient preferred. In natural mangroves, adequate gaps with good tidal flushing considered.
2	Intertidal Gradient	Intertidal extent with gentle slope preferred-Steep intertidal gradient and those with convex morphology avoided to prevent water logging.
3	Tidal inundation	Only sites with gentle gradient with minimum 15 days

		tidal flushing per month mostly preferred
4	Soil Texture	Silty-clay or muddy soil preferred
5	Water Salinity	Sites close to discharge points of run-off preferred which controls salinity fluctuations -Based on this candidate species are selected.
6	Intertidal Extent/Width	Sites with minimum 150-200 m width and gentle gradient close to the waterfront preferred
7	Tidal Currents	Sites with gentle and low velocity currents preferred
8	Mangrove Presence/ Absence in the Vicinity	Presence of natural mangroves in the vicinity is a reliable indication that the site can support good mangroves.
9	Accessibility of the site	Mostly considered in site where plantation was implemented in EDC mode.
10	Labor Availability	Availability of good labour in nearby villages was considered as a major factor
11	Seed Source	Seed source was from nearby mangroves-If new species were attempted seeds/propaguleswereacclimatized to higher salinity
12	Pressure-Grazing, Cattle visit, resource gathering etc.	Avoided through constant vigil- EDC village partners were educated not to send their cattle to the natural or planted mangroves.

Figure 7.1: Suggested plantation sites at Sat Saida Bet

7.6.4 Biodiversity Enrichment:

In most of the plantation sites, *A. marina* was the natural candidate species as they are the most predominant in all natural mangrove stands indicating nature's preference to this species. Environmental plasticity of *A. marina* to tolerate extremes of salinity, temperature and light intensity and its adaptation to different soil conditions is scientifically well proven. In addition, easy seed availability, faster germination in high saline water, tolerance to prolonged drought situation and higher growth rates enables good success rates with *A. marina*. Nevertheless, other candidate species such as *R. mucronata, C. tagal* and *Aegiceras corniculatum* could be planted in small areas following their natural zonation pattern. *C. tagal* and *A. corniculatum* occur sporadically in Kandla port region. Though these species are less salinity tolerant, planting them close to the water front where they will get inundated daily will enhance diversity of true mangroves in Kandla port to ensure better ecosystem function.

7.6.5 Monitoring and Arresting Stand Degradation:

In the last five decades since inception of port activities during 1960s mangrove formation in and around Kandla port seems to have undergone degradation due to various human and natural factors. The stand with an extent of 506 sq.km at the tail end of GoK during 1960s has reduced to 49 sq.km during 2002 (ICMAM, 2004). This calls for immediate measures by port authorities to arrest further stand degradation by appropriate action oriented management measures. Following measures are suggested in this line.

Exhaustive GIS mapping with corresponding ground truthing to record and document different stand characteristics such as dense, sparse, moderate stands and identifying stands that are prone to immediate stand degradation.

Earmarking core pristine stands at Kandla and Tuna areas within port limits as reserve forests that are to be protected where further port activities are not to be taken up in future. This earmarked core mangrove formation deserves total protection and preservation against all developmental activities and disturbances.

Rapid and short mangrove monitoring programs at a spatial interval of one year is to be instituted in order to keep track of changes that may happen due to further construction and operation of jetties and other port related structures. Kandla port has already generated considerable primary data on its mangrove formation through various project reports. Consolidating this data and filling the lacunae in the data through further monitoring is suffice to generate up to date baseline data on mangrove vegetation stand of Kandla port; special attention could be paid to document segment wise data on density, tree canopy, tree diameter classes, stand dynamics, pore-water chemistry, etc. This baseline creation and further yearly monitoring will enable the port authorities on the time series changes happening in the vegetation. Table 7.3 presents different components of the monitoring program, time schedule and other details. Regular monitoring of the chosen parameters in the mangroves of port environment will enable the port authorities to gain knowledge about the impact of the ongoing activities as it is the primary step to device management options to ensure mangrove preservation and health in a holistic manner.

Table 7.3: Mangrove Monitoring Program Components and other Details

Component	**Details**	**Inference to be derived**
GIS & RS Mapping	GIS maps for Port limit procured from NRSC and mangrove distribution to be studied-Delineation of different density classes such as dense, moderately dense and sparse mangroves, potential mudflats for plantation, sparse patches for restoration could be earmarked on the map	Changes in the physical extent could be traced by overlaying the subsequent maps on the baseline maps. Changes in areal extent to be gleaned- Potential sites for plantation and restoration identified
Vegetation Structure	Mostly vegetation characters like density, Canopy cover, health in terms of regeneration potential to be established as baseline	General regeneration potential of mangrove stand inferred. This data is to be considered along with pore water parameter like salinity, pH and conductivity in subsequent monitoring to glean information on changes.
Sedimentation Process	To monitor potential changes in sedimentation rate in the mangrove proper due to port activities	To be considered in conjunction with dredging and other civil engineering activities of the port to derive possible correlation
Porewater Chemistry- Salinity, pH, conductivity	Representative samples in a gradient to be collected for better comparison with the baseline data	Produced structural and physiognomic zones to be compared for changes with the baseline data
Photographs	Photographs to be taken from a reference standard points fixed during baseline studies	Visual comparison with the earlier baseline photos establishes changes.

For gathering monitoring data, reference points fixed during baseline collection is to be strictly maintained in order to avoid ambiguous and misleading results during the monitoring activities.

For all the above mentioned parameters a threshold limit of 20% could be kept as standard margin and deviation more than this from the baseline data could be treated as the signs of degradation that calls for appropriate management plan and options to be exercised to control the impact. Some of the options are as follows.

Analyzing the causative factor(s) for the degradation such as physical, geomorphological, biological and exploring the possibility of remedial measures to mitigate the problem that cause stand degradation is the first step. Increased sedimentation due to port activity and resultant micro-level change in geomorphology is often the major cause for mangrove degradation. Other natural causative factors such as cattle grazing and mangrove resource collection is negligible in Kandla though natural coastal erosion is noticed in certain pockets.

In the event of excessive sedimentation in mangrove proper, causative factors like source of sediment load reaching mangroves is to be investigated thoroughly. Measures to ameliorate the impact like reducing the sediment load through changes in operational procedure may be considered.

Efforts to trap run-off slurry and sediment plume from the dredging area by means of silt traps may be attempted and the trapped sediments will be responsibly disposed in pre-designated sites.

Similarly, a safety exclusion zone will be required around the dredging vessel whose size will depend on the final dredging plan and will range from 150 m to 500 m in accordance with the international standards and best practices.

Altered tidal flushing due to various reasons in and around the creek system is a possibility which may affect mangroves on the creek banks leading to erosion. Tidal water flow in small intertidal canals that feed isolated mangrove stands generally get disrupted due to sedimentation with the possibility of complete filling. This could be best managed through micro-level study of the degrading patch and ensuring adequate and proper tidal flushing through measures narrated in section 7.6. Majority of the problem of stand degradation could be addressed by ensuring adequate tidal flushing, which is the single most important factor for stand degradation.

7.6.6 Erosion:

Fringes of Sat Saida Bet as well as parts Tuna are directly exposed to high tidal currents and erosion. This ongoing natural process is taking a heavy toll of many fully grown and healthy mangrove trees on the mudflat periphery. Following actions are recommended for controlling erosion and check further uprooting of mangroves.

- ♣ Initial earmarking of erosion prone sites along all the creek system.
- ♣ Since the process of erosion is highest along Sat Saida bet, it could be controlled only by physical means by constructing appropriate civil engineering structures. Erosion control structures or constructing embankment of stones or any suitable material along the erosion site is strongly recommended if the problem is too heavy. The proposed embankment should be eco-engineering design with a gentle slope of appropriate angle to the tidal action that will allow natural flushing while totally controlling erosion.
- ♣ Oceanographic factors that cause erosion in the immediate port vicinity need to be understood. Whether the erosion is caused due to ongoing port activities and other port structures or natural cause needs to be ascertained. Coastal stretch of Kandla is stated to fall either under a low or medium erosion category (National Assessment of Shoreline changes, 2011). The erosion map prepared by Ministry of Environment and Forests (MoEF, 2011) marks certain parts of Kandla region and nearby stretches as stable or high accretion coast. Contrarily, erosion of high intensity has been witnessed during this study indicating that this might be due to ongoing port activity.
- ♣ A rapid survey through the survey department of Kandla Port could be undertaken at regular time intervals to identify coastal stretches within the port limit which are prone to high erosion. These high erosion coastal stretches could be provided with gentle slopes with stone pitching and other civil

engineering works which will reduce the rate of erosion. These measures are required only if mangroves are present in vast areas in this stretch.

8 SUMMARY:

Kandla Port is one of the biggest port of India situated in the northwestern part of Gujarat. Mangrove forest is a conspicuous ecological entity within Kandla Port area. Due to the major port activities and accompanying development, mangroves within the premises of KPT have become vulnerable, susceptible and fragile over the years. Consequently, conservation and management of this mangrove formation has become imperative and an environmental responsibility of the Kandla port authority. In view of the continued port expansion and development, Department of Forest and Environment, Government of Gujarat, Gandhinagar has mandated KPT to investigate the current ecological status of mangroves in the KPT premises through proper scientific assessment and formulate long term conservation and management plan. Kandla Port authorities assigned the task of investigating the mangrove ecology within the port jurisdiction to Gujarat Institute of Desert Ecology (GUIDE), Bhuj.

In the present study conservation and management measures for the long term wellbeing of mangroves of Kandla Port is suggested based on intensive field visits, analyzing the existing management practices of the port *vis-à-vis* mangroves and plantation and other conservation activities carried out by port authorities under different projects of the port.

In order to understand the present status in terms of overall mangrove forest structure, stand health and governing physio-chemical factors a detailed field based investigation was carried out. For delineating mangrove characteristics, 21 transects were sampled covering various patches of Kandla port premises. Parameters like density, tree height, GBH, canopy length, canopy width, vegetation frequency and regeneration and recruitment potential were investigated. The mangrove vegetation structure of 21 sampled locations shows an average tree density of 4124/ha and tree height of 254cm and GBH of 40.4 cm. During the present study, mangrove tree density in all the 21 sampled locations ranged between 1500/ha and 7800/ha. Mangrove tree height ranged from 171 cm m to 431 cm with average value of 254cm. The Girth at Breast Height (GBH)of at different patches was from 31 cm to 49.5 cm with an average value of 40.4 cm. Regeneration class density ranged between 3300 to

100000/ha whereas recruitment class density were ranged from 1000 and 56600/ha. In general, mangrove vegetation structure at KPT premises demonstrated that mangrove patches are healthy with very moderate density and with good regeneration potential as evidenced by the ratio between mature trees and younger classes (recruitment and regeneration).

Water and sediment health status of KPT premises examined indicated that majority of the parameters are well within the prescribed limits and no pollution could be distinguished showing that the water and sediment at KPT premises is clean. Important parameters like salinity and pH of both surface water and pore-water are within expected level of any mangrove formation. Observed average pore-water salinity was 53.7 ppt and pHwas8.21. Nitrite concentration ranged from 0.1 to 0.9 mg/L with an overall average of 0.63 mg/L. Nitrate content of the present study varied from 0.9 to 1.9 mg/L with a cumulative average of 1.45 mg/L. Phosphate concentration ranged from 0.1 – 1.8 mg/L with an average of 0.75 mg/L. The recorded nutrient concentrations of the present investigation are good enough to support the growth and vegetation structure of the KPT mangroves.

Land cover category of KPT jurisdictions has been estimated in hectares and area contribution are expressed in percentage. Total mangrove cover constitutes 15.3% with dense mangroves constituting 3.8% and sparse mangrove 11.5 %. Highest land cover is occupied by mudflats to the tune of 36.9% followed by water spread (11.5%) whereas cover of settlement (01%) and agriculture (1.7%) was lowest.

During the present study, following impacts were recorded due to coastal modification, tidal regime and water currents.

1. Erosion of the creek banks in the immediate vicinity of water front.
2. Reduced tidal flushing and decrease in the tidal flat in and around the construction points.

Following the forecast of impacts, effective mangrove management plan for the preservation of KPT mangroves, suggestions which covers the following three important aspects.

- Creation of Baseline Information to track subsequent changes in mangrove vegetation structure due to port activities and related development activities.
- Periodic monitoring programs are to be organized whose results in comparison with baseline data will assist to formulate appropriate management options to check any stand degradation.
- Preservation measures to be undertaken in the event of signs of impact

Mangrove monitoring programs at a regular interval of one year for gathering all baseline parameters in the same GPS referenced points is suggested. Overlaying the data generated during monitoring program with those of baseline data will help the port authorities to track changes happening in KPT mangroves. Regular monitoring of the chosen parameters in KPT mangroves will highlight the impact of the ongoing activities. Management alternatives to preserve mangroves could be contemplated based on this changes detected during monitoring phases.

Suggested mangrove preservation measures include the following. These preservation measures are parallel and consequent to monitoring programs.

Incidences that are detrimental to mangroves like Oil/fuel and other hydrocarbon spillage from earthwork machineries, fire, unauthorized entry of personnel, trespassing and grazing by cattle and collecting forest produce from mangroves are to be reported which will be investigated and appropriate follow-up action taken.

Washing frontline mangrove foliage through pressure hosing if dust deposition is notices in frontline mangroves along with a thorough review of dust control measures.

Since developmental activities in the intertidal and near intertidal regions are perceived to cause impact to a large extent, various measures to preserve mangroves from port development impact are suggested. Undertaking mangrove rehabilitation activities in the KPT premises is also recommended in technically suitable sites.

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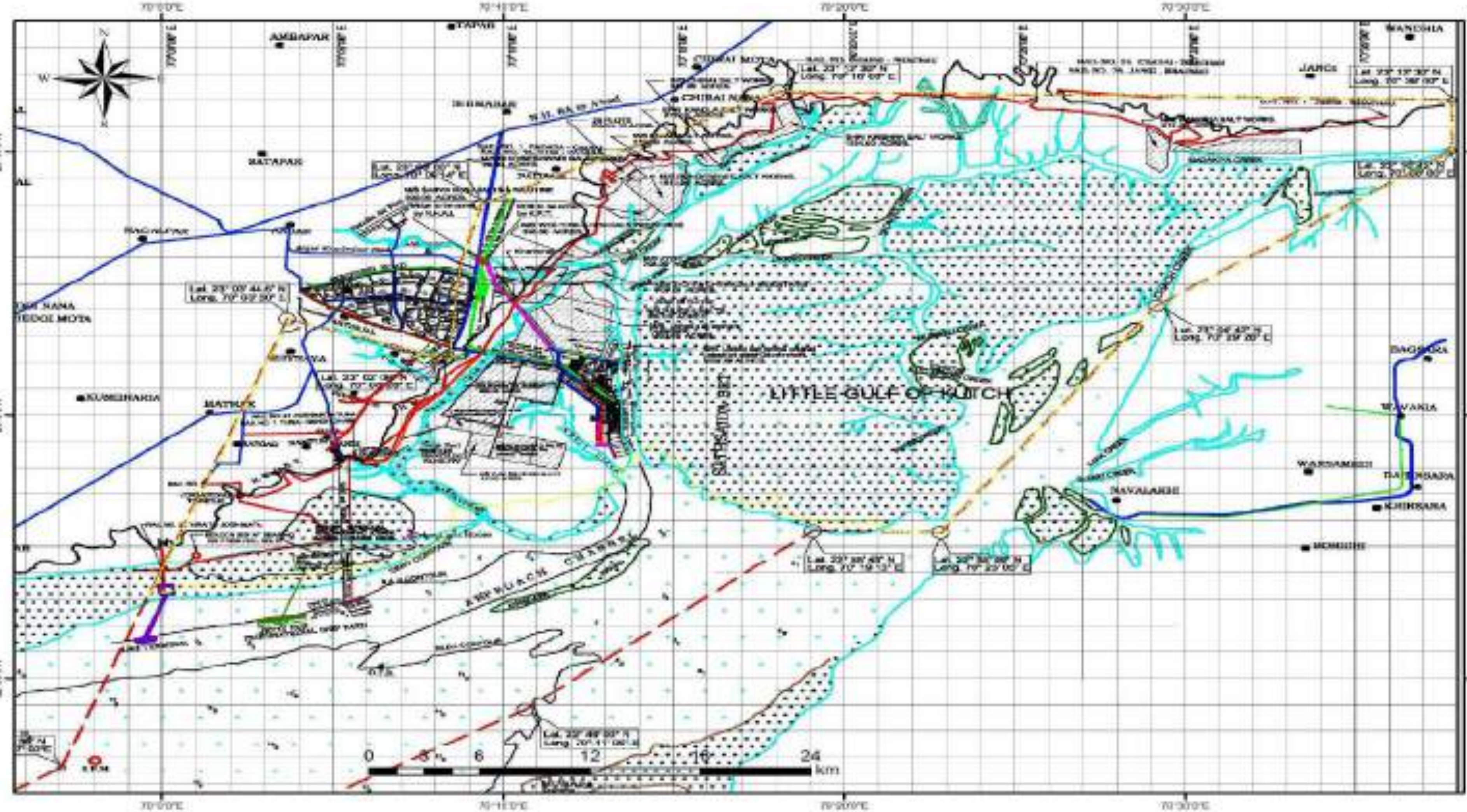
Annexure I. Location Map of the Kandla Port Premises



Annexure –I

Final report on “Regular Monitoring of Mangrove Plantation carried out by DPA” by M/s GUIDE

(2017-2018)

Assessment and Monitoring of Mangrove Plantation (1300 Ha) carried out by Deendayal Port Trust, Kandla

Final report submitted to

Deendayal Port Trust
Gandhidham

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Snapshot of the Project," Assessment and Monitoring of Mangrove Plantation (1300 Ha) carried out by Deendayal Port Trust, Kandla"

S.No	Components of the Study	Remarks
1	Deendayal Port letter sanctioning the project	NO.EG/WK/4751/CRZ II Letter dated : 01/09/2017
2	Duration of the project	One year-from 15.09.2017 to 15.09.2018
3	Period of survey carried out for various components	November 2017 – August 2018
4	Survey area within the port limit	Sat Saida Bet, Nakti creek and Kantiyajal mangrove plantation sites
5	No of locations sampled within the port limits	04 blocks in Sat Saida Bet, 02 blocks each in Nakti creek and Kantiyajal
6	Components of the report	
7a	Mangrove density	*Sat Saida Bet:* average density of *A. marina* varied from 2031 to 5387 individuals/ha with average height ranging from 39 - 113 cm *Nakti creek:* average density of *A. marina* varied from 2340 – 2370 individuals/ha with average height from 53 - 84 cm. *Kantiyajal:* average density of *A. marina* varied from 1460 - 2220 individuals/ha with average height from 32 -37 cm. Average density of *R. mucronata* at Kantiyajal was 1280 individuals/ha with an average height of 30 cm
7b	Mangrove survival	Highest survival rate (88.8%) for *A. marina* plantation in 150 ha at Kantiyajal followed by *A. marina* plantation in 20 ha at Sat Saida bet (81.6%).
7c	Carbon sequestration potential	The carbon biomass of *A. marina* plantation varied from 0.041 to 0.202 Mg/ha. The highest Carbon sequestration potential was of Nakti creek.
7d	Management Suggestions	The sparse mangrove patches need to be made dense through restoration efforts following multi-species plantation, more restoration efforts, bio-physical amendments to promote natural regeneration and long term voluntary restoration and plantation efforts.

1. INTRODUCTION

1.1. Background

Mangroves are complex ecosystems that provide coastal bioshield to habitats and societies from natural disasters. Mangrove ecosystems, making up less than 0.4% of the world's forests (Spalding *et al*., 2010), are being lost at the rate of 1% per year (FAO, 2007). In some areas the rate of mangrove loss is between 2 and 8% per year (Miththapala, 2008). By 1970's decline in mangrove ecosystem was drastic due to both natural and anthropogenic activities. Since 1980, around 20% to 35% of the world's mangrove areas were lost. The mangrove loss has been higher in most of the developing countries for want of space to accommodate various coastal and maritime development activities. Over the years the ecological role of mangroves and the services they provide have been widely realized by the global scientific fraternity. Thus, several researchers eventually targeted mangrove restoration in order to restore their ecological and economical values. The state of Gujarat is no exception to this.

India is lined with a 7516.6 km coastline distributed among nine coastal states and four Union Territories (Anon 2001). Gujarat possesses the longest coastline extending to 1650 km among all the maritime states in India. Mangrove ecosystem in Gujarat is important and is the second largest after Sundarbans in West Bengal. Though contentious, around 15 mangrove species are reported from 13 coastal districts of Gujarat. Of these, the Southern coast of Gulf of Kachchh and South Gujarat are the important districts for mangrove diversity. In Gujarat, the coastal stretch of Gulf of Kutch (GoK) has the largest mangrove extent of 986 km^2 out of 1140 km^2. Kachchh district, constituting the northern coast (northern shore) of GoK alone has 798 km^2 of mangroves constituting 70% of the whole Gujarat mangroves.

True mangroves are taxonomically diverse group, majority of which fall under four genera: *Avicennia*, *Rhizophora*, *Sonneratia* and *Bruguiera*. Though mangrove restoration activities in Gujarat are one of the best examples of habitat restoration in the world, the mangrove formation / restoration in GoK is largely single species, comprising of *Avicennia marina*. Majority of the mangrove species require fresh water inundation at certain time intervals for propagation. Given the topography of Gujarat state and in particular Kachchh region, finding continuous fresh water sources is atypical. Aridity is the most striking feature of the coastal belt of GoK which often renders plantation of mangrove species other than *A. marina* least promising. This, in turn, makes mangroves restoration / plantation work more challenging and uncertain in semi-arid regions such as Kachchh.

1.2. Rationale

Deendayal Port Trust (DPT) is one of the largest ports of India in terms of volume of cargo handled. Among Indian ports, this port also has the largest coastal habitats such as mangroves (193.1 km^2) and mudflats (312.9 km^2). Due to this vast coastal resources under its jurisdiction, the port authorities besides legal mandate, desire to conserve, protect and enhance these coastal habitats. The establishment of facilities over the years, buildings, etc. involve notable movement of materials and people in the area. Doubtlessly, this will alter the local ecological makeup of the area. Any long-term activity in the adjacent place will have serious repercussions. Thus, measures should be taken to conserve and preserve KPT mangrove area, thus retaining several unsung ecological services of mangroves. Accordingly, DPT has implemented mangrove plantation in 1300 ha during 2005 - 2017 through various implementing agencies at Sat Saida Bet, Nakti creek and Kantiyajal. The Deendayal Port Trust has entrusted the task of evaluating 1300 ha of mangrove plantation in these three locations to Gujarat Institute of Desert Ecology (GUIDE), Bhuj.

1.3. Objectives of the Study

The overall goal of this study is to assess the mangrove plantation, associated factors affecting mangrove health and suggest tools and techniques of conserving them. The specific objectives are as below:

i. To evaluate 1300 ha of mangrove plantation at Sat Saida Bet, Nakti creek and Kantiyajal in Kachchh coast carried out by Gujarat Ecology Commission (GEC), Forest & Environment Department and GUIDE.

ii. To assess the extent of plantation, health status, sapling survival, mortality rate and growth of the planted mangroves.

iii. To provide a comprehensive overview of both the composition and distribution of the planted mangroves following Phyto-sociological methods.

iv. To assess the Carbon sequestration potential of the mangrove plantation in view of Climate Change.

2. STUDY AREA

2.1. DPT Environ

Deendayal Port in Kachchh District of Gujarat State (formerly Kandla Port) operated by Deendayal Port Trust (DPT) is a gateway Port to the hinterland in western and northern states of India. It is one of the 11 major Ports of India situated at latitude 23°1' N; longitude 70° 13' E on Kandla creek at the inner end of Gulf of Kachchh. Inclusion of Karachi Port in Pakistan after India's partition and heavy traffic congestion at the then Bombay Port gave impetus for the promotion of Deendayal Port during 1950s. During 1955, Deendayal Port acquired the status of a major Port in India. Because of its proximity to the Gulf countries, large quantities of crude petroleum and other assorted cargo are imported through Deendayal Port.

An assortment of liquid and dry cargo is being handled at Deendayal Port. Dry cargo includes fertilizers, iron crap, steel, food grain, metal products, ores, cement, coal, machineries, sugar, wooden logs, salt extractions, etc. Liquid cargo includes edible oil, crude oil and other petroleum products. Total cargo handling was 105 MMTPA during 2016-2017 and 110 MMTPA during 2017-2018. The Port has presently 14 jetties and six oil terminals and several allied facilities for handling dry and liquid cargo. Regular expansion/developmental activities such as the addition of jetties, allied Special Economic Zones, industrial parks and ship bunkering facilities are underway in order to cope with the increasing cargo handling demands.

Developmental initiatives of this magnitude going on in the past six decades will have its own environmental repercussions. Being located at the inner end of Gulf of Kachchh (GoK), Deendayal Port has a fragile marine ecosystem that includes a vast expanse of mangroves, mudflats, creek systems and allied biota. Deendayal Port is a natural harbour located on the eastern bank of North-South trending Kandla creek at an aerial distance of 145 km from the Gulf's mouth. The Port location is marked by a network of major and minor mangrove lined creek systems with the vast extent of mudflats. Coastal belt in and around the Port has an irregular and dissected configuration. Due to its location, tidal amplitude is elevated, experiencing 6.66 m during Mean High Water Spring (MHWS) and 0.78 m during Mean Low Water Spring (MLWS) with an MSL of 3.88 m. Commensurate with the increasing tidal amplitude, vast intertidal expanses are present in and around the port environ. This, along with the occurrence of mudflats enables mangrove formations at the intertidal belts. Annual rainfall during 2015 was 398 mm, which is often irregular (India Meteorological Office, Ahmedabad). Mean rainfall at Gandhidham taluka where Deendayal Port is located, during 1985 to 2014 was 398 mm (Table 1). There are no perennial or seasonal rivers in Gandhidham taluka. Rain during monsoon is confined to only 15-20 days and occurs as an instant downpour. Freshwater input into the near coastal waters is quite meagre and appears to have less influence on the ambient coastal water quality except during monsoon months during which flash floods are discharged in the near coastal waters. Annual average humidity is 60%, which increases to 80% during south-west monsoon and decreases to 50% during November-December. Average wind speed is 4.65 m/s with a maximum wind speed of 10.61 m/s during June. The phenomenon of drought is common with 2 drought year in a cycle of 5 years. Annual mean maximum and minimum temperature of the area are 41.8°C and 22.9°C, respectively.

Coastal belt in and around Kandla region is characterized by a network of creek systems and mudflats which are covered by sparse halophytic vegetation like scrubby to dense mangroves, creek water and salt encrusted land mass which forms the major land component. The surrounding environment in a radius of 10 km from the Port is mostly built up areas consisting salt works, human habitations and Port related structures on west and north, creek system, mangrove formations and mudflats in the east and south. Deendayal Port and its surroundings have mangroves, mudflats and creek systems as major ecological entities.

Table 1. Environmental setting of the Deendayal Port region.

Sl. No.	Particulars	Details
1	Deendayal Port Co-ordinates	23° 1' N, 70° 13' E
2	Elevation above Mean Sea level	~20 ft
3	Climatic Conditions	As per Meteorological Station, Deendayal Port Annual Mean Max Temp: 41.8°C Annual Mean Min Temp: 22.9°C Rainfall: 398 mm (2015)
4	Land Use of nearby areas	Comparatively flat marshy land with stunted and dense mangrove formation, mudflats, creek systems, coastal halophytes, saltpans and salt swamps
5	Nearest Highway	National Highway 8A
6	Nearest Railway Station	Gandhidham RS
7	Nearest major airport	Bhuj (~60 km, NW)
8	Nearest Village habitation	Tuna (~12 km, North)
9	Nearest Major Town	Gandhidham (12 km, Northwest)
10	Reserved Forest	Nil
11	Historically Important Places	Nil
12	Rivers/streams around the project environs	Nil
13	Major Dams and barrages	Nil
14	Survey of India Topo sheet covering the proposed site and surroundings	F42K1
15	Seismic Zone	Zone -V

2.2. Mangrove Plantation Activities undertaken by DPT

Mangrove plantation activity by DPT was initiated during the monsoon months of 2005 as mandated by the Ministry of Environment Forests (MoEF). Subsequently, 1300 ha of mangrove plantation has been completed till the end of 2017 in different years in order to meet the legal mandate of Ministry of Environment, Forests and Climate Change (MoEF & CC). The mangrove plantation activities by DPT were carried out at Sat Saida Bet, Nakti creek and Kantiyajal of Bharuch district in South Gujarat. At Sat Saida Bet, plantation activities were carried out in phased out manner i.e. 20 ha during 2005-2006, 200 ha during 2011-2012, 300 ha during 2012-2013, and 330 ha during 2013-2014 (Plate1). At Nakti creek plantation was carried out during 2008-2009 and 2010-2011 in 50 ha and 100 ha, respectively. At Kantiyajal, mangrove plantation activities were carried out in two phases i.e. 150 ha during 2015-2016 and 150 ha during 2016-2017. The details of implemented mangrove plantation by DPT are given in Table 2. *A. marina* was the preferred species for plantation activities in all the three locations due to prevailing high salinity and high success rate of this species. At Nakti creek *Rhizophora mucronata* and *Ceriops tagal* were also planted in small numbers along with *A. marina*. Likewise, at Kantiyajal attempts were made for planting *R. mucronata* along with *A. marina*. All these mangrove plantations in different years since 2005 were carried out to meet MoEF & CC imposed conditions for different port expansion projects and construction of jetties.

Table 2. Details of implemented mangrove plantation activities by DPT

Location	Year of Plantation	Area (ha)	Species planted	Implementing Agency
Sat Saida Bet, Kachchh district	2005-2006	20	*A. marina*	M/s Gujarat Institute of Desert Ecology, Bhuj
	2011-2012	200	*A. marina*	Forest & Environment Department, GoG
	2012-2013	300	*A. marina*	Forest & Environment Department, GoG
	2013-2014	330	*A. marina*	Forest & Environment Department, GoG
Nakti Creek, Kachchh district	2008-2009	50	*A. marina*	M/s Patel Construction Co, Gandhidham
	2010-2011	100	*A. marina* *R. mucronata* *C. tagal*	M/s Gujarat Ecology Commission
Kantiyajal, Bharuch District	2015-2016	150	*A. marina*	M/s Gujarat Ecology Commission
	2016-2017	150	*A. marina* *R. mucronata*	M/s Gujarat Ecology Commission

2.3. Plantation Techniques

For mangrove plantation the following three methods were chosen i) Raised bed method (*Otla* method), ii) Direct propagule dibbling (Seed sowing method), and iii) Transplantation of nursery raised saplings (Polybag method). However, raised bed and propagules dibbling methods were predominately followed in the majority of the plantation efforts while transplantation of nursery raised saplings were followed in few instances.

2.3.1. Raised Bed Method (*Olta* Methods)

In majority of the plantation sites raised bed method (*Otla* method) was followed, as it is believed to give better results than other methods. Further, this method is perceived to be less costly and labour intensive. This method is especially suitable for sites with high tidal currents since the raised beds resist uprooting of sown seeds in the receding tidal current. In this method, circular earthen mounts of 10-15 cm height and 1 m radius were raised and around 20 seeds/propagules were dibbled on the surface of each bed. Generally, number of raised beds of *A. marina* per ha at Sat Saida bet and Nakti creek was around 3300 with a spacing of 1 x 1 m. *A. marina* survival percentage was calculated based on 6600 saplings/ha for *A. marina* i.e. assuming each *Otla* to has a minimum of two surviving seeds/saplings (3300 *Otla*/ha x 2 surviving saplings = 6600 saplings/ha). In case of plantation where already natural mangroves existed, clusters of *Otlas* mostly exceeding the density of 1500/ha were made closely. In the case of Kantiyajal mangroves 2500 saplings/ha of *A. marina* were considered for calculating survival percentage as per GEC (2015-2017).

2.3.2. Direct Propagule Dibbling (Seed Sowing Method)

Next to raised bed method, direct propagule dibbling (locally called *'Sing'* plantation) was attempted in many sites. This method is less labour and cost intensive, though repeated dibbling is often required in order to obtain desirable survival rate. In this method, mature propagules were dibbled in open empty mudflats or among gaps of natural mangrove stands. Spacing maintained between each dibbled propagule varied and at some sites it was as close as 0.75 × 0.5 m, especially in plantation raised among gaps of natural mangroves. Propagules used were collected freshly from the nearby mangrove formations, which are thought to give better results, and no pre-dibbling seed treatments were used. Often propagules were dibbled repeatedly in order to increase survival rates and in raised (*Otla*) bed and nursery plantation sites, dibbling propagules was resorted to increase survival.

2.3.3. Translation of Nursery Raised Saplings (Polybag Method)

Transplantation of nursery raised saplings was also followed as its success rate is higher than other methods. Unlike raised bed and direct dibbling methods, this method is labour and cost intensive, and time consuming. Nursery raised saplings were transplanted as individual plants in the open intertidal mudflats. Saplings in the polythene bags were allowed to attain a height of 40-50 cm before transplantation over a period of 4-5 months. Based on site specific conditions, the number of saplings transplanted varied from 3000 to 6000 per ha. In certain instances, nursery raised saplings were used to gap filling in the seed dibbled plantation in order to raise the survival rate.

2.3.4. Mangrove Plantation at Sat Saida Bet

Sat Saida on the eastern bank of Kandla creek is a unique Island of 253.8 km^2 opposite to Deendayal port. As one of the major Islands of Gulf of Kachchh, the Island has sparse mangroves (32.8 km^2) dense mangroves (7.74 km^2) and mudflats (144.73 km^2) and halophytic vegetation other than mangroves (49.6 km^2). Surrounded by Kandla creek and its branches in the west, Navlakhi creek and its branches on the east and Sara and Pang creek on its north, Sat Saida bet is a highly potential site for mangrove plantation with its vast mudflat. Many major, medium and minor creek systems of Kandla and Navlakhi creeks ramify into this Island in varying length and dimension, supplying tidal water to the interior regions. Southern border of the Island represents the innermost end of Gulf of Kachchh with very few minor creek systems. It is known that mudflats experiencing favourable tidal amplitude are suitable for mangrove plantation. Therefore, Sat Saida Bet area was chosen by DPT to carry out the mangrove plantation and restoration activities. The plantation work in this Island was done in four phases i.e. 2005-2006, 2011-2012, 2012-2013, and 2013-2014, details of which are given in subsequent sections.

2.3.4.1. 2005-2006 Plantation in 20 ha

During 2005-2006, the mangrove plantation work at Sat Saida Bet was carried out at Dharkadia creek banks in 20 ha. Two sites on both the banks of Dharkadia creek were planted with *A. marina* by M/s. Gujarat Institute of Desert Ecology. Transplanting nursery grown seedlings and direct seed sowing for gap filling were followed during mangrove plantation work. Nevertheless, majority of mangrove plantation was through direct seed dibbing.

2.3.4.2. *2011-2012 Plantation in 200 ha*

Mangrove plantation in 200 ha was initiated by Forest Department, Kachchh circle during 2011-2012 on DPT's request. Forest Department (Anjar circle) initiated the plantation activities at Sat Saida Bet during the rainy season of June 2011. The plantation site is opposite to Deendayal port oil jetty and is ~2 km from the bank of Sat Saida bet. A buffer zone of nearly 2 km was allowed between waterfront from the banks of Sat Saida bet and the plantation site. The seeds of *A. marina* were used for plantation activities due to prevailing high salinity in the area. Raised bed method (*Otla*) was followed as the plantation technique and *A. marina* seeds were mostly collected from Kandla mangroves for plantation work.

2.3.4.3. *2012-2013 Plantation in 300 ha*

The mangrove plantation carried out during 2012-2013 in 300 ha was covered by Range office of Forest Department at Anjar. *A. marina* was the candidate species for plantation activities at this site. Initially, raised bed method was followed for mangrove plantation but was eventually replaced by direct seed sowing.

2.3.4.4. *2013-2014 Plantation in 330 ha*

In continuation of previous year activities, mangrove plantation in 330 ha was carried out by Range Forest Office at Anjar of Kachchh Circle. The plantation site is located at Sat Saida bet northeast of Kandla port where the main Kandla creek bifurcates east and further north. The plantation site is around 5 km from the bank of Sat Saida bet. Akin to other sites, *A. marina* was the preferred species for plantation activities. Raised bed method was largely followed as the plantation technique at this site. In few spaces, direct seed dibbling was also done.

2.3.5. Mangrove Plantation at Nakti Creek

2.3.5.1. *2008-2009 Plantation in 50 ha*

The 50 ha mangrove plantation was carried out at Nakti creek in one block by M/s. Patel Construction Co, Gandhidham. Nursery raised saplings, *Otla* bed, and direct dibbling methods were followed for planting *A. marina*.

2.3.5.2. *2010-2011 Plantation in 100 ha*

This mangrove plantation work was executed by M/s. Gujarat Ecology Commission at different blocks at Nakti creek following raised bed method (*Otla*), direct dibbling, and transplantation of nursery raised saplings. The first block was along the Nakti creek and *A. marina* was the candidate species for plantation. In the second block (other side of Nakti creek) *Ceriops tagal* were also sown. In the third block, located on the eastern side of the second block, seeds of *A. marina* were sown. The fourth block plantation was along the minor creek system along the bund and road where propagules of *Rhizophora mucronata* and *C. tagal* were planted. In this 100 ha, *R. mucronata* and *C. tagal* were sown in 5 ha each, and remaining area was planted with *A. marina*. Around 6 lakh seeds involving three species of true mangroves are estimated to be planted in four different blocks. One lakh saplings each of *R mucronata* and *C tagal* were planted in Nakti creek. Accordingly, 20,000 saplings per hectare were transplanted.

2.3.6. Mangrove Plantation at Kantiyajal

Unlike other plantation sites, which are located in and around Deendayal port, this 300 ha, plantation was carried out at Katpor village of Bharuch district near Kantiyajal in South Gujarat by Gujarat Ecology Commission, Gandhinagar. The plantation was done in two blocks each with 150 ha during 2015-16 and 2016-17 at the coastal stretch of Katpor, Hansot taluka, Bharuch District. *Koteshwar Paryavaran Vikas Vyavasthapan Samiti*, a Community based Organization was entrusted with the task of executing this plantation. Table 3 gives details about the methods followed, candidate species and the target achieved in each method. The seeds of both *A. marina* and *R. mucronata* were collected from the nearby natural mangrove areas. Village level CBO in association with GEC maintain the plantation by gap-filling activities and protection through social fencing. Saplings of *A. marina* were transplanted at the distance of 2.5 x 2.5 m i.e. 2500 saplings/ha. A total of 4,62,500 plants were transplanted in all plantation years. Further, due to large intertidal region as compared to other costal districts of South Gujarat, human habitations are far off from the mangrove habitats.

In total, 70000 propagules of *R. mucronata* were planted to cover 35 ha of area at intertidal belt. The *R. mucronata* propagules were imported from Sindhudurg district of Maharashtra State and each propagule was planted at the distance of 2.5 x 2 m at the banks of small and medium creeks.

Table 3. Mangrove plantation details of Katpor, South Gujarat

Sl. No.	Year of Plantation	Method	Species	Area (ha)
1	2015-2016	Nursery Method	*A. marina*	70
2	2015-2016	Raised Beds	*A. marina*	80
3	2016-2017	Nursery Method	*A. marina*	115
4	2016-2017	Direct dibbling	*R. mucronata*	35
Total				300

2.3.6.1. ***2015-2016 Plantation in 150 ha***

This site has naturally growing *A. marina* extending from lower littoral to the mid-littoral. The plantation site is near to this luxuriantly growing mangrove patch. The site is behind the naturally growing plants away from the waterline; however, every day flushing keeps this site quite healthy. The 150 ha mangrove plantation during 2015-2016 at Kantiyajal was carried out in two blocks. Of this 150 ha, 70 ha plantation activities were carried out following nursery method and remaining area following *Otla* bed. The *Otla* beds of 1 x 1 x 1 m were prepared to improve mangrove density. *A. marina* saplings were transplanted at a distance of 2.5 x 2 m. Around 32,000 such beds were prepared in 80 ha. All plantation activities were taken care by M/s. Gujarat Ecology Commission. *A. marina* was the preferred species for plantation in both the blocks.

2.3.6.2. ***2016-2017 Plantation in 150 ha***

The plantation site is locally called as "Lalavi area of Alia Bet". The site is little far away from the approach road and is close to water front. The plantation site is near the aquaculture ponds and a small creek passes through the plantation site. The 150 ha mangrove plantation during 2016-2017 at Kantiyajal was carried out in two blocks. Of this 150 ha, 115 ha plantation activities were carried out following nursery method and in the remaining area direct dibbling method was followed. All plantation activities were taken care by M/s. Gujarat Ecology Commission. *A. marina* was transplanted in 115 ha and *R. mucronata* was planted in 35 ha.

3. METHODOLOGY

3.1. Evaluation of mangrove plantation

The field surveys were undertaken during November 2017 to August 2018 to assess the overall plantation success in these eight blocks. To evaluate the *A. marina* plantation success at Sat Saida bet and Nakti creek i.e. survival percentage and growth rate, initial plantation density of 6600 saplings/ha as a baseline density was considered. Since in most of the plantation method a density 1x1.5 m was used this was considered as initial density at Sat Saida bet and Nakti creek. This contention of implementing agencies that 6600 saplings/ha as equivalent to 1 ha of physical extent, irrespective of the area covered was ascertained through estimating density of the *Otla* beds or saplings per unit area which was then extrapolated to 1 ha in order to ensure notional or physical coverage. Often, raised beds or planted saplings were closely made and compacted at different densities in order to use the available suitable sites.

To assess the survival percentage of the mangrove plantation, the area was divided into uniform grids. Sampling grids were randomly chosen and all surviving saplings in that grid were counted to evaluate the survival status, density of transplanted saplings. The assessment was carried out during low tides by quadrate method by laying plots of 10 × 10 m. In each quadrate, number of planted saplings and their corresponding height were recorded. For assessing the mangrove formations along the creeks systems, a fishing boat was used.

Sat Saida bet, where there are four plantation sites, were taken up first for assessment followed by Nakti creek where two plantation sites exist. Later Kantiyajal mangrove plantation sites were assessed. Based on the GIS co-ordinates all plantation sites were plotted on google map (for the details of satellite imageries procurement, please refer to Annexure 1). Detailed discussion was held with the officials of implementing agencies, i.e. Kachchh forest division and the field supervisor and all relevant information and documents such as plantation registers, local maps, address and personnel involved was gathered. The implementing agencies were requested to intimate the respective range forest office to extend assistance to the study team.

At Sat Saida bet a total of 72 quadrates were laid, which include, 15 quadrates in 20 ha, 17 quadrates in 200 ha, 16 quadrates in 300 ha, and 24 quadrates in 330 ha. At Nakti creek, 10 quadrates each at 50 and 100 ha plantation sites were laid. At Kantiyajal, 20 quadrates at first block and 10 quadrates in second block were laid. Thus, in total 122 quadrates were laid covering Sat Saida bet, Nakti creek, and Kantiyajal plantation sites.

Of the eight plantation sites, four are located in Sat Saida and Nakti sites where approach and labour mobilization has proved extremely difficult. Though a massive plantation effort has been made which was physically inspected and assessed in the present survey, physical, ecological and environmental changes arising out of the created resources will be visible only after ten years when the raised forest matures into a functional ecosystem discharging all its ecological services.

3.2. Carbon Sequestration Potential of Planted Mangroves

The annual per capita emission of CO_2 from India is 1.67 metric ton and the population of India in 2016 was ~1324 million. According to Kaladharan et al. (2009), the total annual CO_2 emission from India is ~ 2211 million tons. Thus, any intervention proposed must aim at balancing this emission. Mangroves are the first defender during any natural disasters and also a sink of ‘Blue carbon’ (Donato et al. 2011; Alongi et al. 2016). But unlike other terrestrial ecosystems, mangrove carbon is stored mostly below-ground (Alongi *et al.* 2016). Past researches indicate that mangroves are among the most carbon-rich forests in the tropics, containing an average of 1,023Mg carbon per hectare (Donato *et al.* 2011). In view of above specific, the present study attempted to assess the carbon sequestration potential of planted mangroves at all the sites.

3.2.1. Sampling of Soil and Plant Biomass

Sampling sites for soil/sediment and mangroves were identified through reconnaissance survey. The survey and sampling involved (i) identification of sites for sampling in and around the study area, (ii) collection of soil/sediment and mangrove in and around the study area, and (iii) processing the samples for TOC (%), bulk density and plant biomass. Selection of sampling sites was based on different age/height classes of mangroves.

Based on the above criteria one time sampling was carried out following random sampling protocol for all the samples. At Sat Saida Bet and Nakti creek three pits of 100 cm in each block were made. At Kantiyajal, 2 such pits at each block were made. Samples were collected across the layers i.e. 0-30 cm and 30- 100 cm from each pedon/pit using a plastic scoop. The sampling involved packing of soil samples in pre-cleaned airtight plastic bags, labeling with appropriate code numbers, and subsequent transfer to the laboratory for further processing and analysis (Plate 2). The field collected soil samples were air-dried at normal room temperature (Jackson, 1958), homogenized using an agate mortar and pestle, and sieved through a standard sieve of 2-mm mesh (Tandon, 2005). The particles with size less than 2mm were retained in pre-cleaned plastic bottles for bulk density and Total Organic Carbon (%).

Against each pit/pedon, two mangrove plants were collected. Mangrove samples were collected by complete uprooting of the individual at each site. Individual plants were then packed and labeled. The plant samples were washed thoroughly under tap water several times followed by rinsing with deionized water, drained, and then chopped and separated into root and shoot using a plant cutter. Fresh weight of the samples was taken and subsequently oven dried till constant weight. Mangrove biomass and associated carbon stock calculations were done as follows:

3.2.2. Carbon content in Mangrove Biomass

The mangrove girth is generally measured at 1.3 m height for achieving tree diameter. However, since the present stands were young the whole plant was uprooted for assessing biomass. Total biomass was directly estimated by summing the dry weight of above ground and below ground biomass.

3.2.2.1. Carbon biomass

The biomass was then converted into carbon biomass by multiplying by a factor of 0.42, i.e. *Carbon biomass* = Total biomass× 0.42

3.2.2.2. Carbon biomass per hectare

Carbon biomass was calculated per hectare by multiplying the carbon biomass with tree density per hectare, i.e.

Carbon biomass (kg/ha) = carbon biomass x density of plants per hectare.

Carbon biomass (Mg/ha) = (carbon biomass x density of plants per hectare) / 1000

3.2.2.3. Calculation of CO2 equivalent

Carbon biomass value is converted into carbon dioxide equivalent by multiplying carbon biomass with 3.67 i.e. CO_2 *equivalent (%)* = carbon biomass × 3.67

3.2.3. Analysis of soil bulk density, particle density, and air space

Volume of known amount (20 g) of dry soil sample was noted and to this a known volume of water (50 ml) was added. At least 5 ml of water above the soil surface was kept in an undisturbed condition for 30 min. The final volume of soil plus water was noted and bulk density was calculated as follows:

Bulk density = weight of soil (g) / Volume of soil (g/ml)

3.2.4. Total organic carbon in mangrove soil (El Wakeel and Riley, 1956)

TOC (%) was estimated following the chromic acid digestion and phenonthroline indicator method (El Wakeel and Riley, 1956), wherein the organic matter was oxidized with a mixture of potassium dichromate and concentrated sulphuric acid, utilizing the heat of dilution of the acid to speed up the process. The unspent potassium dichromate was back titrated against ferrous sulphate solution. The total carbon calculation was as follows:

Ferrous ammonium sulphate (ml) (T) = Titre for Blank – Titre for sample

Total organic carbon (TOC) in sediment soil (mgC/g) (X) = 1.14 x 0.6 x T

Total organic carbon (TOC) in sediment soil (%) = X / 10

Total carbon in sediment soil (%) = TOC ÷ 2

3.2.5. Calculation of carbon stock in sediment soil

Carbon stock in sediment soli upto 100 cm was calculated as follows:

Carbon stock in sediment (%) = Bulk density ($g.cm^{-3}$) × Total carbon (%) × Soil depth interval (cm)

3.2.6. Calculation of CO_2 equivalent

CO_2 equivalent was calculated as follows:

CO_2 equivalent (%) = carbon stock × 3.67

4. RESULTS

Evaluated mangrove survival percentage at Sat Saida bet, Nakti creek and Kantiyajal are detailed in Table 4 to Table 11. In total, four blocks at Sat Saida bet, two blocks at Nakti creek and two blocks at Kantiyajal were visited and assessed. The findings based on site visits and subsequent data analyses are given below:

4.1. Mangrove Plantation Evaluation at Sat Saida bet

4.1.1. 2005-2006 *A. marina* Plantation in 20 ha

This was the first plantation carried out by DPT and executed by Gujarat Institute of Desert Ecology, Bhuj. In total 15 quadrates were laid at this site to assess the *A. marina* status and survival percentage. An average density of 5387 individuals/ha was recorded against the planted 6600 individuals/ha. Thus, a total survival percentage of *A. marina* in this block was 81.6%, which was categorized as successful. Average height of *A. marina* plantation at this site was 113 cm (Table 4, Plate 3 – Plate 7). Minimum and maximum GBH recorded for A. marina plantation was 5 cm and 7.5 cm with an average value of 5.7 cm. The minimum and maximum canopy in this plantation stand ranged between 0.49 and 1.19 m2 with a mean value of 0.92 m2. Generally, canopy cover was more for plants near the waterline. Average density of regeneration class in the quadrates was 1400 plants/ha with a range of 800 to 2100 plants/ha. Generally, density of recruitment class is expected to increase in the future as the phonological cycle of the plant has started in the last 4 years. Density of recruitment class ranged from 300 to 450 plants/ha with an average density of 375 plants/ha.

Around 17 species of associated mangrove fauna were recorded during the survey. Based on current high survival percentage, it is evident that nursery bed and direct seed sowing methods are better suited than raised bed (*Otla*) method. Plantation raised through *Otla* method eventually undergoes high mortality rate even when initial survival rates are high.

Table 4. *A. marina* plantation (2005-2006) in 20 ha at Sat Saida bet

Sl. No.	Sampling Location		Density (Ha)	Height (cm)	St. Dev
Q1	23˚ 04" 43.38N	70˚ 16"47.88E	4400	109	28.34
Q2	23˚ 04" 48.18N	70˚ 16"48.18E	4900	115	24.7
Q3	23˚ 04" 43.77N	70˚ 16"48.41E	5600	110	26.2
Q4	23˚ 04" 44.38N	70˚ 16"47.99E	5700	110	27.7
Q5	23˚ 04" 44.10N	70˚ 16"48.18E	5100	124	29.2
Q6	23˚ 04" 48.17N	70˚ 16"48.17E	4900	135	30.7
Q7	23˚ 04" 44.37N	70˚ 16"48.99E	5300	103	32.2
Q8	23˚ 04" 43.49N	70˚ 16"48.69E	5300	100	34.44
Q9	23˚ 04" 44.14N	70˚ 16"48.93E	6100	121	35.2
Q10	23˚ 04" 44.99N	70˚ 16"47.63E	5200	104	36.7
Q11	23˚ 04" 43.07N	70˚ 16"49.06E	4900	136	29.2
Q12	23˚ 04" 43.85N	70˚ 16"49.88E	5200	105	28.22
Q13	23˚ 04" 44.61N	70˚ 16"48.75E	6100	102	32.15
Q14	23˚ 04" 43.53N	70˚ 16"49.25E	6300	110	33.22
Q15	23˚ 04" 44.04N	70˚ 16"50.02E	5800	110	31.2
Average			**5387**	**113**	**--**

4.1.2. 2011-2012 *A. marina* Plantation in 200 ha

At this site, 17 quadrates were laid to evaluate survival percentage. Average density recorded was 2647 individuals/ha against the planted density of 6600 individuals/ha, which projects poor survival i.e. 40.1%. The average height of plantation was 45 cm only (Table 5, Plate 8 - Plate 12). Minimum and maximum girth of the planted saplings at this site was 4.5 cm and 6.5 cm, respectively with an average value of 5.1 cm. The minimum and maximum canopy Index in *A. marina* plantation stands ranged between 0.67 and 1.1 m^2 with a mean value of 0.72 m^2. Only regeneration class (<50 cm) was recorded whereas the recruitment (>50 cm but <100 cm) class was absent. Average density of regeneration class was less to the tune of 400 plants/ha.

Survival of planted mangroves is dependent on several factors, amongst which inundation is a major one. Most of the blocks at Sat Saida bet are inundated only during spring and neap tide i.e. for 6-7 days. Given the scenario, it was apparent that saplings growth and height at Sat Saida bet would be less. Additionally, Kachchh being an arid zone, rainfall is scanty (340 mm) which adversely affects the growth rate and height of mangroves.

Table 5. *A. marina* plantation (2011-2012) in 200 ha at Sat Saida bet

Sl. No.	Sampling Location		Density (Ha)	Height (cm)	St. Dev
Q1	23˚ 00" 48.4N	70˚ 15"49.5E	3000	33.6	9.6
Q2	23˚ 00" 50.5˚ N	70˚ 15" 50.0 E	0	0	0
Q3	23˚ 00 "53.1˚ N	70˚15" 49.2 E	2700	55.9	9.5
Q4	23˚ 00 "50.9˚ N	70˚ 15" 47.2 E	3300	31.8	14.9
Q5	23˚ 00 "50.1˚ N	70˚15" 45.4 E	3500	43.7	14
Q6	23˚ 00 "49˚ N	70˚15" 43.5 E	3500	53.5	16.6
Q7	23˚ 00" 49.3˚ N	70˚15" 41.3 E	3500	58.8	26.5
Q8	23˚ 00" 51.4˚ N	70˚15" 42E	1700	47.9	18.7
Q9	23˚ 00" 76.9˚ N	70˚13".50 E	4000	52.7	18.9
Q10	23˚ 00 "52.2˚ N	70˚15" 37.9E	4600	53.6	24
Q11	23˚ 00" 51.7˚ N	70˚15" 35.6E	2100	69.9	22.1
Q12	23˚ 00 "52.4N	70˚15" 34.4E	2600	52.7	19.6
Q13	23˚ 00 "53.2˚ N	70˚15" 33.3E	3500	63.4	19.2
Q14	23˚ 00" 55.1˚ N	70˚15" 32.4 E	4000	57.6	18.9
Q15	23˚ 00" 57.2˚ N	70˚15" 33.4 E	2500	40.8	15.7
Q16	23˚ 00 "57.9˚ N	70˚15 "35.6 E	0	0	0
Q17	23˚ 00" 3.6˚ N	70˚15" 35.6 E	500	46.6	14.9
Average			**2647**	**45**	**--**

4.1.3. 2012-2013 *A. marina* Plantation in 300 ha

To assess the plantation success, 16 quadrates were laid at this site. Average density of 2031 individuals/ha and average height of 39 cm were recorded (Table 6, Plate 13 - Plate 17) at the site during the survey. Thus, survival percentage of *A. marina* in this block was poor and was to a tune of only 30.8%. Sapling stem girth measured at this plantation ranged from 4.1 to 8 cm with an average of 5.1 cm. Plants with maximum girth of 8 cm were few and recorded sporadically. The canopy Index in this block ranged between 0.69 and 1.28 m^2 with a mean value of 0.82 m^2. Canopy cover varied widely among the quadrates in accordance with the growth of the plant. In very few plants, canopy cover was exceptionally high whereas in others it was poor. Similar to earlier stands density of younger classes in this 300 ha plantation was low since this plantation carried out during 2012-13 has yet to attain its full phonological cycle. Average density of regeneration class was less to the tune of 550 plants/ha whereas the recruitment class plants were almost absent. Average height of the saplings in this block was 89 cm with a GBH value of <4 cm showing that these plants are still very young and the phonological cycle is yet to start in the whole plantation. The minimum and maximum canopy Index in this 330 ha mangrove plantation stands planted during 2013-14 was low and ranged between 0.32 and 0.93 m^2 with a mean value of 0.42 m^2. Plants are still in recruitment and regeneration stage recording a poor growth rate explaining the low canopy cover recorded presently.

Growth of planted and natural mangroves in this region was slow which could be attributed to higher soil and water salinity. Further, given the low survival percentage of planted *A. marina* in this block, it is quintessential to check the grazing by camels and other livestock. Low survival of planted mangroves could also be due to wrong selection of plantation site, plantation technique i.e. *Otla* bed method which would have affected survival percentage when compared to direct seed sowing. Thus, it is suggested to follow the direct seed sowing or nursery bed techniques for plantation of this species.

Scientifically poor survival in the mangrove plantation could be attributed to inadequate tidal inundation and wrong plantation method. When a planted mangrove fail to get adequate tidal water either it fails to germinate or its growth becomes stunted. Hence, selection of site plays a crucial role in the mangrove plantation success.

Table 6. *A. marina* plantation (2012-2013) in 300 ha at Sat Saida bet

Sl. No.	Sampling Location		Density (Ha)	Height (cm)	St. Dev
Q1	23˚02.06604 N	70˚ 13.25285 E	3600	68.1	25.9
Q2	23˚01.93788 N	70˚13.244884 E	3700	46.1	19.7
Q3	23˚ 1.507972 N	70˚13 23.2248E	1500	40.9	10.8
Q4	23˚ 14.5986N	70˚15.2648E	1100	35.5	15.6
Q5	23˚15.948N	70˚15.28626 E	0	0	0
Q6	23˚17.128 N	70˚15. 30816 E	0	0	0

Q7	23˚19.636 N	70˚15. 29886 E	0	0	0
Q8	23˚18.814N	70˚15. 27636 E	1000	31.4	13.4
Q9	23˚18.838N	70˚15.27648 E	4200	44.5	20.5
Q10	23˚19.768N	70˚15. 26198 E	1400	31.6	13.8
Q11	23˚11.3704N	70˚15.231 E	2800	59	20.3
Q12	23˚1 1.3644N	70˚15. 231 E	3600	56	22.1
Q13	23˚11.7004N	70˚15.2334 E	2500	70.2	23.5
Q14	23˚16.61N	70˚15.25192 E	2900	59.4	21
Q15	23˚1 1.4514 N	70˚15.27484 E	500	22.2	6.4
Q16	23˚1 1.4418 N	70˚15.27336 E	3700	57.2	22.7
Average			**2031**	**39**	**--**

4.1.4. 2013-2014 *A. marina* Plantation in 330 ha

This plantation site is located northwest of the Deendayal Port and in the northern extent of Sat Saida Bet. The plantation site is tidally fed by branches of Pang creek, which is the northern bifurcation of main Kandla creek. We laid 24 quadrates at this site to assess the *A. marina* survival percentage. An average density of 4133 individuals/ha was recorded against the planted 6600 individuals/ha. The average height of *A. marina* plantation at this site was 89 cm with a survival percentage of 62.6% (Table 7, Plate 18 – Plate 22). Both raised bed method and direct seed dibbling were followed at this site. Since poor tidal flushing was identified as a major issue, care was exercised during plantation to choose sites with good tidal flushing to target good survival percentage.

Table 7. *A. marina* plantation (2013-2014) in 330 ha at Sat Saida bet

S. No.	Sampling Locations		Density (Ha)	Height (cm)	St. Dev
Q1	23°04'48.34" N	70° 17' 10.05" E	4400	109	28.34
Q2	23°04'46.55" N	70° 17' 13.94" E	4900	115	24.7
Q3	23°04'45.14" N	70° 17' 18.65" E	4100	110	26.2
Q4	23°04'41.97" N	70° 17' 16.66" E	5600	110	27.7
Q5	23°04'50.58" N	70° 17' 16.68" E	2900	124	29.2
Q6	23°04'44.43" N	70° 17' 16.54" E	4900	135	30.7
Q7	23°04'49.39" N	70° 17' 15.54" E	2800	103	32.2
Q8	23°04'45.35" N	70° 17' 06.79" E	5300	100	34.44
Q9	23°04'42.94" N	70° 17' 09.32" E	5200	121	35.2
Q10	23°04'40.49" N	70° 17' 13.53" E	2900	86	36.7
Q11	23°04'46.46" N	70° 17' 12.37" E	4900	73	29.2

Q12	23°04'44.26" N	70° 17' 15.86" E	5200	105	28.22
Q13	23°04'48.25" N	70° 17' 12.93" E	6100	102	32.15
Q14	23°04'44.174" N	70° 17' 16.32" E	6300	70	33.22
Q15	23°04'38.25" N	70° 17' 10.33" E	5800	110	31.2
Q16	23°04'40.41" N	70° 17' 12.07" E	3500	62	16.1
Q17	23°04'40.76" N	70° 17' 12.89" E	2600	51	14.7
Q18	23°04'38.16" N	70° 17' 20.60" E	3600	43	12.2
Q19	23°04'38.76" N	70° 17' 10.60" E	3300	45	11.1
Q20	23°04'40.69" N	70° 17' 06.48" E	2300	66	23.7
Q21	23°04'49.68" N	70° 17' 14.62" E	3600	72	9.3
Q22	23°04'47.10" N	70° 17' 03.65" E	3100	78	17.6
Q23	23°04'49.42" N	70° 17' 07.81" E	3300	85	19.2
Q24	23°04'49.87" N	70° 17' 10.23" E	2600	64	17.2
Average			**4133**	**89**	**--**

4.2. Mangrove Plantation Evaluation at Nakti creek

Two mangrove plantation sites of 50 ha and 100 ha were developed at the north-eastern bank of Nakti creek, a major creek system west of Kandla creek. The main creek and its branches are getting inundated by 3-4 m of tidal water during high tide. Two mangrove plantation sites developed in this site are adjacent to each other with good tidal flooding.

4.2.1. 2008-2009 *A. marina* Plantation in 50 ha

At this block, 10 quadrates were laid to evaluate the *A. marina* survival. The results revealed that *A. marina* survival in this block was poor with only 35.5% i.e. average density of 2340 individuals/ha. The average height of this plantation was 53 cm (Table 8, Plate 23 - Plate 27). Stem girth of the saplings in this 50 ha stand at Nakti creek ranged from 3.5 cm to 6 cm with an average value of 4.4 cm. Minimum and maximum canopy cover in this stand ranged between 0.42 and 1.1 m^2 with a mean value of 0.71 m^2. Average density of regeneration class was 2900 plants/ha with a minimum and maximum range of 4900 to 8000 plants/ha showing good regeneration potential of the site. Similarly, recruitment class density ranged from 900 to 1800 plants/ha with an average density of 1100 plants/ha. It is known that direct dibbling and nursery raised transplantation are superior to *Otla* bed technique. Poor survival of planted *A. marina* could be ascribed to mixed plantation techniques as more than two species, namely *Rhizophora mucronata* and *Ceriops tagal* were planted at this site.

Table 8. *A. marina* plantation (2008-2009) in 50 ha at Nakti creek

Sl. No.	Sampling Location		Density (Ha)	Height (cm)	St. Dev
Q1	22° 57' 12. 9N	70° 09' 04.9 E	3000	53.8	19.6
Q2	22°57' 11.6 N	70° 09'04.5 E	3000	64.8	18.4
Q3	22°57'10.9 N	70°09' 04.7 E	2400	70.5	24.0
Q4	22°57'10.3 N	70°09' 05.4 E	2800	65.8	19.2
Q5	22°57'09.6 N	70°09'06.2 E	2500	63.0	15.9
Q6	22°57'09.1 N	70°09'07.2 E	2700	60.2	15.2
Q7	22°57'09.1 N	70°09'08.2 E	2500	40.9	15.6
Q8	22°57'09.2 N	70°09'08.4 E	0	0.0	0.0
Q9	22°57'08.1 N	70°09'10.0 E	2700	54.1	15.6
Q10	22°57'07.7 N	70°09'10.3 E	1800	60.9	24.6
Average			**2340**	**53**	**--**

4.2.2. 2010-2011 *A. marina* Plantation in 100 ha

4.2.2.1. *A. marina* Plantation in 90 ha

In total, 10 quadrates were laid at this site to assess the A. marina survival percentage. Akin to A. marina plantation in 50 ha of Nakti creek block, this site also showed poor survival of only 35.9%. The average density of 2370 individuals/ha in this block with average height of 84 cm was recorded (Table 9, Plate 28 – Plate 32). Even though the plantation activities were carried out near the creek system, poor survival of planted mangroves could be due to mixed plantation techniques. The GBH in this plantation varied from 2.8 - 5.2 cm with an average value of 3.7 cm. The minimum and maximum canopy Index in this plantation stand ranged from 0.82 to 1.28 m^2 with a mean value of 0.96 m^2. Younger classes were recorded in low density in this block. While regeneration recorded an average density of 2700 plants/ha, the recruitment classes showed a poor density of only 400 plants/ha.

Table 9. *A. marina* plantation (2010-2011) in 100 ha at Nakti creek

S. No.	Sampling Location		Density (Ha)	Height (cm)	St. Dev
Q1	22˚ 57 50.0 N	70˚ 09 40.8 E	1200	55.3	14.7

Q2	22 ˚57 47.8 N	70˚ 09 42.4 E	2000	67.1	21.04
Q3	22 ˚57 46.1N	70 ˚09 42.8E	1200	70.1	29.3
Q4	22˚ 57 42.4N	70 ˚09 44.3E	2000	80.1	41.4
Q5	22˚ 57 41.6N	70˚ 09 46.2E	3200	90.9	28.3
Q6	22˚57 31.1N	70˚ 09 49.6E	2700	90.9	23.4
Q7	22˚57 39.8 N	70˚ 09 48.8E	3400	82.8	19.9
Q8	22˚57 38.6 N	70 ˚09 51.2E	3500	88.9	20.6
Q9	22˚57 38.2N	70 09 54.5 E	2500	115.9	28.2
Q10	22˚57 37.5 N	70 09 52.9 E	2000	99.5	17.8
Average			**2370**	**84**	**--**

4.2.2.2. *R. mucronata* Plantation in 5 ha

During the surveys, we did not record any individual inside the quadrates laid. Nevertheless, *R. mucronata* saplings were recorded outside the quadrates with height varying from 50-60 cm. Around 10 individuals were seen during the entire survey. Thus, it was apparent that plantation of *R. mucronata* in 5 ha was a failure. Unlike *A. marina*, *R. mucronata* needs 20 - 25 days of tidal flushing in a month and can tolerate only moderate salinity. During the field surveys, it was recorded that the saplings were invaded by the alga *Enteromorpha* sp. and regular tidal flushing was lacking. All these factors could be attributed to plantation failure.

4.2.2.3. *C. tagal* Plantation in 5 ha

Similar to *R. mucronata* plantation in 5 ha at Nakti creek, no individuals of *C. tagal* could be recorded inside the laid quadrates. Nevertheless, around 20 individuals *C. tagal* with 40-45 cm height were noticed outside the quadrates. Since, nearly 1 lakh propagules of *C. tagal* were planted in 5 ha, presence of only 20 individuals indicates plantation failure. Similar to *R. mucronata*, plantation site of *C. tagal* was also invaded by algae and lacked regular flushing. *C. tagal* and *R. mucronata* are frontline mangroves and thus regular tidal flushing is essential. Algal infestation on mangroves needs regular monitoring and manual removal to help the plant survive. Physical protection and regular monitoring of mangrove plantation stand are the best conservation efforts that will yield positive results.

4.3. Mangrove Plantation Evaluation at Kantiyajal

4.3.1. 2015-2016 *A. marina* and *R. mucronata* Plantation in 150 ha

The 300 ha plantation was carried out at the coastal stretch of Katpor village near Kantiyajal at Bharuch district. This plantation was carried out in two blocks of 150 ha each during 2015-16 and 2016-17. Gujarat Ecology Commission (GEC), Gandhinagar executed this plantation with the community participation of a formed *Samiti* at the Katpor village.

A total of 30 quadrates were laid in this block for assessing mangrove survival success. As per earlier report by GEC (2015-2017), at this site only *A. marina* individuals were planted. However, our field surveys revealed that this block had *R. mucronata* saplings in addition to *A. marina*. An average density of 1460 individuals/ha was recorded for *A. marina* against 2500 saplings/ha. Similarly, average density of *R. mucronata* was 1280 individuals/ha (Table 10, Plate 33 - Plate 34) against the targeted 2000 individuals/ha. The survival percentage of *A. marina* and *R. mucronata* were 58.4% and 64.0%, respectively. The average height of *A. marina* was 32 cm and that of *R. mucronata* was 30 cm at this block. *R. mucronata* being a frontline mangrove, its plantation was carried out towards the lower intertidal region. Continuous tidal flushing and following appropriate zonation pattern during plantation could be attributed to higher survival percentage of *R. mucronata*.

Table 10. Mangrove plantation (2015-2016) in 150 ha at Kantiyajal

A. marina					
Sl. No.	**Sampling Location**		**Density (Ha)**	**Height (cm)**	**St. Dev**
Q1	21˚ 28’5.2″ N	72˚ 38’57.0" E	2000	29.8	9.0
Q2	21˚ 28’ 22.19" N	72˚38` 12. 43"	2200	42.4	10.9
Q3	21 ˚28’14.73"N	72˚38`52. 97"	1900	41.1	13.9
Q4	21˚28’05.00"N	72˚ 38`58. 66"	1000	38.1	7.1
Q5	21˚28’56.68"N	72˚ 38`50.88"	0	0.0	0.0
Q6	21˚28’59. 18" N	72˚38`28.70"	1600	40.9	11.6
Q7	21˚28’15.05"N	72˚38`32.30"	1900	36.0	11.3
Q8	21˚28’17.86"N	72˚38`39. 86"	0	0.0	0.0
Q9	21˚28’18.73"N	72˚38`50.30"	2200	44.2	12.0

Q10	21˚28’00.43"N	72˚38` 08.02"	1800	45.8	9.7
Average			**1460**	**32**	**--**
R. mucronata					
Sl. No.	**Sampling Location**		**Density (Ha)**	**Height (cm)**	**St. Dev**
Q1	21˚ 28’ 20.93″ N	72˚ 38’ 22.20″E	1700	32.5	7.4
Q2	21˚ 28’16.56″ N	72˚ 38’27.88″E	1400	41.4	4.5
Q3	21˚ 28’19.69″ N	72˚ 38’11.96″E	0	0.0	0.0
Q4	21˚ 28’9.32″ N	72˚ 38’7.73″ E	700	39.4	7.4
Q5	21˚ 28’19.73″ N	72˚ 38’57.43″E	0	0.0	0.0
Q6	21˚ 28’11.18" N	72˚ 38’5.68″E	400	36.0	2.0
Q7	21˚ 28’5.26″ N	72˚ 38’4.07″E	300	26.0	1.8
Q8	21˚ 28’8.12″ N	72˚ 38’57.79″E	0	0.0	0.0
Q9	21˚ 28’23.34″ N	72˚ 38’48.32″E	800	45.6	8.6
Q10	21˚ 28’17.6″ N	72˚ 38’40.84″E	800	48.4	13.0
Q11	21°31'7.25"N	72°38'44.82"E	2800	40.6	11.5
Q12	21°31'6.76"N	72°38'52.51"E	2300	43.4	10.4
Q13	21°31'3.83"N	72°38'49.30"E	0	0.0	0.0
Q14	21°31'0.54"N	72°38'45.11"E	2200	35.9	6.8
Q15	21°31'0.58"N	72°38'39.17"E	2600	42.4	8.7
Q16	21°31'1.28"N	72°38'33.98"E	0	0.0	0.0
Q17	21°31'5.42"N	72°38'33.96"E	2300	44.9	9.8
Q18	21°31'7.28"N	72°38'38.40"E	2800	39.4	11.5
Q19	21°31'7.10"N	72°38'42.80"E	2400	42.7	12.7
Q20	21°31'3.75"N	72°38'44.30"E	2100	44.8	12.9
Average			**1280.0**	**30**	**--**

4.3.2. 2016-2017 *A. marina* Plantation in 150 ha at Kantiyajal

At this block, 10 quadrates were laid (Table 11, Plate 35 – Plate 36) for evaluating mangrove plantation success. During field surveys, we did not record *R. mucronata* plantation in this block as mentioned by GEC (2015-2017). Thus, from field data it was evident that single species plantation i.e. *A. marina* was only carried out at this block. Average density of *A. marina* at this site was 2220 individual/ha against 2500 individual/ha which contributes to 88.8% plantation success. Proper site selection, regular inundation and monitoring, etc. are few factors, which affect survival percentage. It was apparent from the field data that this site is good for *A. marina* plantation.

For both the blocks at Kantiyajal, the girth plantation varied from 3.5 - 5 cm with an average of 3.9 cm. Similarly, the canopy cover for both the blocks ranged between 0.42 and 81m^2 with a mean value of 0.67 m^2. In both the blocks of this plantation, younger classes such as regeneration and recruitment were absent as the planted saplings have not yet started their flowering and fruiting cycles.

Table 11. *A. marina* (2016-2017) in 150 ha at Kantiyajal

Sl. No.	Sampling Location		Density (Ha)	Height (cm)	St. Dev
Q1	21˚ 30 58.13″ N	72˚ 38 59.38″ E	2600	44.4	13.9
Q2	21˚ 31 0.49″ N	72˚ 38 48.24″ E	2200	41.9	12.7
Q3	21˚ 31 11.8″ N	72˚ 38 41.61″ E	2300	42.9	14.7
Q4	21˚ 31 15.00″ N	72˚ 38 49.07″ E	3000	44.0	9.2
Q5	21˚ 31 26.22″ N	72˚ 38 46.59″ E	2800	37.3	11.8
Q6	21˚ 31 25.92″ N	72˚ 38 53.85″ E	0	0.0	0.0
Q7	21˚ 31 35.09″ N	72˚ 38 5.04″ E	2100	42.1	12.2
Q8	21˚ 3113.63″ N	72˚ 38 58.43″ E	2400	40.5	12.0
Q9	21˚ 31 5.94″ N	72˚38 53.41″ E	2500	41.2	10.4
Q10	21˚ 31 41.71″ N	72˚ 38 34.34″ E	2300	40.0	10.9
Average			**2220.0**	**37**	**--**

4.4. Carbon sequestration potential at Sat Saida Bet

The carbon biomass (Mg/ha) of *A. marina* plantation at Sat Saida bet was 0.076 Mg/ha for plantation with less than 20 cm m height and 0.087 Mg/ha for 60 cm height. The average CO_2 equivalent (dry weight and soil) of *A. marina* plantation at Sat Saida bet was 1.56%.

4.5. Carbon sequestration potential at Nakti creek

At Nakti creek the carbon biomass of *A. marina* plantation varied from 0.041 to 0.202 Mg/ha. Irrespective of the height, the Carbon sequestration potential was more in 100 ha plantation when compared with 50 ha plantation at Nakti creek. The CO_2 equivalent (dry weight and soil) of *A. marina* plantation at Nakti creek was 2.17%. Among the three locations, i.e. Sat Saida bet, Nakti creek and Kantiyajal, the highest Carbon sequestration potential was recorded for Nakti creek.

4.6. Carbon sequestration potential at Kantiyajal

At Kantiyajal carbon biomass of *A. marina* plantation was only carried out which ranged from 0.095 to 0.132 Mg/ha. The CO_2 equivalent (dry weight and soil) for *A. marina* plantation at this site was 1.18%.

5. SUGGESTIONS AND RECOMMENDATIONS

Deendayal port with an area of 999.19 km^2 including 193.19 km^2 of mangroves and 312.9 km^2 of tidal mudflats presents enormous scope for mangrove plantation, restoration and rehabilitation. Based on the present and earlier field surveys and data analysis the following recommendations are suggested for current and future plantation activities.

5.1. Site Selection

By far, site selection within the broader landscape for plantation is the foremost criterion that determines the plantation success. For successful plantation, it is essential that the existing bio-physical conditions of the coastal landscape in a broader and general manner are to be thoroughly understood. Consideration of a set of criteria as given in the Table 12 will enable the planter to conclude the site suitability reliably.

A list of bio-physical parameters such as gradient of the intertidal belt, soil nature, number of days of tidal flushing, presence/absence of natural mangroves in the vicinity and availability of adequate intertidal extent are to be considered and grades should be assigned in a scale of 1 to 10. One major parameter that deserves careful consideration is number of days of tidal flushing which in turn is influenced by the gradient of the intertidal extent; only sites with gentle gradient receiving good tidal flushing for >15 days in a month are to be chosen for plantation activities. The suite of criteria indicated in Table 12 is applicable even for plantation among gaps of natural mangroves, along creek banks and mudflats. Involving local people and fishermen living nearby will render the site selection easier since they are well versed with the local conditions, especially tidal flushing rate. In addition, short term and small-scale feasibility trials could be conducted in order to ascertain the suitability of the site. Several plantation attempts in Kachchh coast and elsewhere have failed due to unsuitable site selection. Hence, it is important that great care be exercised while choosing the plantation site.

Table 12. Criteria for Technically suitable site for Mangrove Plantation

Priority Order	Criteria	Preferred Conditions
1	Site Nature - Open coast/creek/Natural Mangrove formations	Creek systems and river mouths with freshwater input is preferable- In open coast sites gentle gradient is preferred. In enrichment plantation among natural mangroves, adequate gaps with good tidal flushing are to be considered.
2	Intertidal Gradient	Intertidal extent with gentle slope preferred-Steep intertidal gradient and those with convex morphology are to be avoided to prevent water logging.
3	Tidal inundation	Only sites with gentle gradient with minimum of 15 days tidal flushing per month mostly preferred
4	Sediment Texture	Silty-clay or muddy substrate preferred. Though sandy substrate supports some mangrove species such as *A. marina* it has its own drawbacks like shifting sand, sediment deposition on pneumatophores, etc.
5	Water Salinity	Sites close to discharge points of run-off preferred which controls salinity fluctuations -Based on this candidate species are to be selected.
6	Intertidal Extent/Width	Sites with minimum 150-200 m width and gentle gradient close to the waterfront preferred
7	Tidal Currents	Sites with gentle and low velocity currents preferred
8	Mangrove Presence/ Absence in the Vicinity	Presence of natural mangroves in the vicinity is a reliable indication that the site can support good mangroves.
9	Accessibility of the site	Easy accessibility enables increased working hours for labours and easy labour transport
10	Labour Availability	Availability of good labour in nearby villages is a major factor
11	Seed Source	Seed source from nearby mangroves preferable-If new species are to be attempted seeds/propagules are to be acclimatized to higher salinity
12	Pressure-Grazing, Cattle visit, resource gathering etc.	To be avoided through constant vigil- Social fencing by educating villagers and implementing plantation in a community mode and sensitizing villagers not to send their cattle to the plantation.

5.2. Plantation Efforts

In all future plantation activities, the candidate species should be other than *A. marina*. It is suggested to prefer plantation of *R. mucronata*, *C. tagal* and *A.*

corniculatum, they being locally present in DPT environ though in very small numbers as individual plants at Sat Saida bet.

Based on the findings of current evaluation, it is evident that *Otla* bed plantation technique did not yield good survival percentage. Thus, it is recommended that in future plantation activities transplantation of nursery raised saplings and direct seed dibbling should be preferred to raised bed method.

There are several approaches to restore mangroves such as direct planting of saplings, seedlings, and propagules from adjacent mangrove trees; natural recruitment of propagules; hydrologic manipulation resulting in efforts to re-establish hydrologic regimes; and the combination of the aforementioned methods. However, these techniques may befit single species plantation such as *A. marina*. Thus, for plantation of multi-species, a thorough understanding of several crucial factors is quintessential. Certain mangrove species require more precise site conditions unlike others, which may in turn have implications on site selection and species association; *R. mucronata* may prefer seaward side than *A. marina*, which thrives well both in seaward and landward side. Thus, mangrove species may tend to confine themselves to a specific coastal stretch following a zonation pattern. Therefore, it is advised to consider integration of several factors during site selection, which are crucial for the success of mangrove plantation.

Of 193.19 km^2 mangrove formation within the port, dense mangroves are 53.55 km^2 (27.7%) and remaining are sparse/stunted mangroves. Through appropriate restoration measures, these sparse mangroves could be converted into dense patches. Thus, it is suggested to carry out restoration activities along with direct plantation to improve mangrove vegetation cover in Deendayal port area.

Sat Saida Bet could be an ideal site for all future mangrove plantation, restoration and rehabilitation activities with bio-physical amendments such as de-silting existing creeks, joining all the existing minor creeks with one another through new creek systems. To improve the flow of tidal water in the existing creek systems, the areas with uneven water depths are to be demarcated where de-silting and deepening the creeks will lead to better tidal flushing to mangrove formations gradually converting them to dense and healthy. Increased tidal flooding and hydroperiod will extend the mangrove formation in this location besides converting sparse into dense mangroves in due course of time. This creek re-construction, desilting existing minor creek systems and removing blocks in the natural creeks may be taken up in a phased manner with due budgetary allocation.

5.3. Promoting Natural Regeneration

In the GUIDE (2018) report on the holistic and integrated management of creeks and mangroves, a detailed account is provided on how creek systems and mangroves complement each other. In general, creeks as a bio-physical entity influences natural mangrove formation, regeneration and assist mangroves as a fully functional ecosystem. An elaborate account on how creek systems of Deendayal port promote the process of natural regeneration is given. Physical features of creek systems influence natural regeneration potential of the mangrove formation through their tidal inundation, spreading propagules and assist mangroves in colonizing new intertidal belts. Earlier mangrove vegetation analysis studies at Kandla and Tuna mangroves (GUIDE, 2012 and 2015) have clearly indicated that density and entrance of younger classes is good enough to become mature trees. This also indicates that the recruitment process in the mangrove ecosystem is normal and there is good transformation of younger classes into mature category. Nevertheless, GIS studies carried out on Deendayal port mangroves indicates that out of 193.19 km^2 of mangroves, 72.27% (139.64 km^2) of mangroves are sparse mostly due to inadequate inundation and tidal flushing. Earlier reports (GUIDE, 2012, 2015, and 2018) have clearly outlined the management approaches to promote natural regeneration and conversion of sparse mangroves into dense formation through bio-physical amendments such as desilting natural canals, connecting existing natural canals with each other in order to enhance tidal reach and creation of new canals at micro-levels. It is emphasized that adapting this bio-physical amendments will enhance natural regeneration process many fold besides converting sparse mangroves into dense formations. To sum up, these measures adapted through sustainable long term management practices will render the Deendayal port mangroves a fully grown and functional ecosystem with enhanced ecological services.

5.4. Assisting Natural Regeneration

In mangrove formations such as Sat Saida Island and in Sara and Pang creeks, extensive mudflats are present which are suitable for plantation activities. In addition to initiating plantation in such mudflats, mangrove formation in Sat Saida Island, Tuna region and Navlakhi creek regions could be classified as sparse, dense, mudflats and salt marshes and appropriate conservation initiatives could be taken for each zone.

Sparse mangroves constitute 72.3% of the total mangroves of the port. This could be restored to dense formation through physical amendment measures *viz*., canal digging, removing blockage in natural canal systems, and by other physical means. Thus, future mangrove plantation efforts could be focused on restoring sparse mangroves into dense formations through biophysical measures.

5.5. Comparison with Earlier Studies

From earlier studies (GUIDE, 2015) and present findings it is apparent that *Otla* bed plantation technique is inapt for good survival percentage. Thus, as recommended in earlier sections, nursery raised transplantation and/or direct seed dibbling techniques may be chosen over *Otla* bed.

Extensive mudflats are an indication of enormous potential the area may hold for restoration and conservation of mangrove ecosystem. According to GUIDE (2018), mudflats and creek systems in Deendayal Port and its surroundings are major ecological entities, with mudflats extending to 312.9 km^2. Therefore, management and conservation measures for mudflats are requisite in Deendayal port and it's environ. Hence, mangrove restoration efforts in DPT should continue even in the absence of any orders/instructions from MoEF & CC. In view of these specifics, it is recommended that DPT should prepare a long term mangrove restoration, management and monitoring plan in consultation with the experts.

5.6. Mangrove Biodiversity Enhancement

Though mangrove restoration activities in Gujarat are one of the best examples of habitat restoration in the world, the mangrove restoration in Gulf of Kachchh (GoK) is largely single species, comprising of *A. marina*. Given the topography of Gujarat state and in particular Kachchh region, finding continuous fresh water source is atypical. Mangroves require fresh water inundation at certain time intervals for propagation. This, in turn, makes mangroves restoration / plantation work more challenging and uncertain in semi-arid regions. Thus, these factors have contributed to the selection of single hardy species of mangrove i.e. *A. marina* during mangrove plantation in Kachchh coast.

Deendayal port is undertaking mangrove plantation in a massive manner since 2005 and 1300 ha of mangroves have already been planted in Sat Saida Island, Nakti creek and Kantiyajal. However, only *A. marina* is preferred during all the plantation activities due to its environmental plasticity and high salinity tolerance. Nevertheless, within DPT limits, three more mangrove species *viz*., *R. mucronata, C. tagal* and *A. corniculatum* have been sporadically recorded by GUIDE team. Thus, it is recommended that in future mangrove plantation efforts, these additional species which are naturally occurring in this region could be planted extensively. Plantation of these species is expected to create a seed bank in due course of time which would eventually convert single species stand of *A. marina* into multi-species formation.

5.7. Co-Management with the Community

Ideally, mangroves within the DPT jurisdiction should be the object of intense management program with a specific aim to protect them. Such intense management program is quite feasible in the case of DPT since all the mangrove formations are under its legal control and hence any management program could be implemented without any sectoral conflicts with forest or any other government departments. It was proven in many instances that involving the stakeholder communities in the surrounding villagers will yield better results in mangrove plantation and restoration activities. Though the population in the port surroundings has different livelihood activities, fishermen community could be targeted to involve them in community based mangrove management.

The fishermen communities living in Vera, Khari Rohar and Tuna villages close to the port could be involved in mangrove conservation by forming *Samithies*. The community based organization i.e. *Samithi* roles and responsibilities w.r.t. mangrove conservation in their vicinity should be well defined that would play a seminal role in conserving these mangrove patches. Nevertheless, their resource dependency, perception towards mangroves, level of involvement in such resource management activities, etc. need to be assessed before forming the *Samithi*. It is advised that the *Samithi* may be assigned the task of mangrove plantation/restoration activities, physical protection and other conservation measures. Sustained awareness programs about tangible and intangible benefits the community accrues by conserving mangroves should be strongly conveyed to them. Social structure of the villages in the vicinity could be better understood to see how they could participate in any mangrove centered management programs, preferably a community based resource management.

5.8. Physical Protection

The most common method of conserving mangrove ecosystem is by creation of protected areas. Mangroves of Deendayal port warrant intensive protection as a major means of conservation. Presently, the whole port limit is under the protection of Central Industrial Security Force (CISF). Thus, CISF personnel could be imparted with the ecological significance of mangroves through special awareness program and mangrove patrolling by them can be instituted to enhance the level of physical protection to mangroves. This could be done by appointing special squads for protecting this patch from incidents like cattle grazing, leaf and wood and other resource collection. Physical protection of natural stand is often the best conservation measure that will fetch positive results.

Employees of Deendayal port need to be made aware with the environmental and ecological significance of mangroves and other coastal resources within the port limits. Licenses for salt works and other port allied industries are awarded by port authorities without understanding the ecological and environmental rules and regulations governing them which often lead to legal and environmental bottleneck at a later stage. Short-term awareness programs to port employees could be conducted by seasoned marine/mangrove ecologists.

5.9. Identification of Stress Factors

It is important that in any conservation efforts, stressors acting on the mangroves are to be identified and removed in order to maintain the ecosystem balance. Mangrove environment will continue to be stable and balanced if there are no external stressors such as change in hydrology, elevation and slope, soil and water salinity and pH, soil texture and wave energy. In addition, human centered stress factors such as resource collection, tree felling and other habitat modification activities will act as major stressors. It would be necessary to find the factors causing stand degradation and scientifically addressing it would remove the stressors allowing mangroves to flourish.

5.10. Change in Hydrology

The most important factors in conserving any mangrove formation include maintaining the original hydrology, original tidal flow including depth, duration of tidal flooding, and frequency of tidal flooding. Understanding the existing mangrove hydrology at micro-level, applying the knowledge to protect mangroves, cost-effective restoration and regeneration, etc. are important. In majority of mangrove degradation instances, it is the modified hydrology and the resultant reduced tidal flushing and subsequently the critical period of dryness and flushing that determine health of a mangrove forest. Mostly, micro-topography controls the distribution and well-being of mangroves, and physical processes play a dominant role in the formation and functioning of mangrove ecosystem. Even disturbed by human impact, mangrove forest has the ability to self-repair over a period of time provided that the normal tidal hydrology is not disrupted and the availability of water borne seeds are not blocked. Regular monitoring of mangrove hydrology through simple scientific methods will go a long way in maintaining ecosystem balance.

5.11. Regular Mapping through GIS & RS

Mangrove plantation in 1300 ha should be regularly monitored / mapped using GIS and RS facilities as a part of conservation and management efforts. Based on mangrove density, interpolative maps using GIS tools could be prepared which will help in identifying the pockets, which require immediate attention for mangrove restoration. Thus, through a GIS software (Arc-GIS / ERDAS), these layers on yearly basis could be super imposed / overlaid to obtain the difference in mangrove density. This will bridge the gap between decision-making and interventions required for restoring sparse mangrove plantations into dense plantation in due course of time. It could also be used to check mangrove health in terms of canopy cover changes, regeneration potential, and general dynamic nature of mangrove forests. Apart from density, similar interpolative maps for porewater quality could also be prepared.

6. SUMMARY

Mangrove formations in Kachchh coast is predominated by a single species i.e. *A. marina*, with sporadic occurrence of *R. mucronata* and *C. tagal*. The present study was carried out at Sat Saida bet, Nakti creek and Kantiyajal in Kandla vicinity covering eight blocks to evaluate mangrove plantation in 1300 ha during 2005-2017. The major goal of this study was to assess the mangrove plantation survival percentage, assess carbon sequestration potential of planted mangroves, understand the ecological issues, and suggest conservation measures. The mangrove plantation work was carried out in phased out manner i.e. at i) Sat Saida bet: 20 ha during 2005-2006, 200 ha during 2011-2012, 300 ha during 2012-2013, and 330 ha during 2013-2014, ii) Nakti creek: 50 ha during 2008-2009 and 100 ha during 2010-2011, and iii) Kantiyajal: 150 ha during 2015-2016 and another 150 ha during 2016-2017. Due to the prevalence of high salinity in the region, *A. marina* was the preferred species for plantation. Nevertheless, *R. mucronata* and *C. tagal* were also planted in small pockets at Nakti creek. Similarly, *R. mucronata* was attempted at Kantiyajal along with *A. marina*.

The project envisaged three major aspects, i) evaluation of mangrove plantation activities carried out by GEC, and Forest & Environment Department of GoG, ii) investigation of threats being faced by the planted mangroves, iii) assessment of carbon sequestration potential of planted mangroves in the study environ, and iv) suggested conservation and management measures for planted mangroves.

Average density of planted *A. marina* at Sat Saida bet blocks varied from 2031 - 5387 individuals/ha with average height ranging from 39 - 113 cm. In the case of Nakti creek, block-wise average density of *A. marina* varied from 2340 – 2370 individuals/ha with average height from 53 - 84 cm. Nevertheless, the plantation of *R. mucronata* and *C. tagal* at Nakti creek was a failure with very few individuals' existence. *A. marina* average density at two blocks at Kantiyajal was between 1460 and 2220 individuals/ha with an average height between 32 -37 cm. Average density of *R. mucronata* at Kantiyajal was 1280 individuals/ha with an average

height of 30 cm. *R. mucronata* was found mostly as frontline vegetation along the fringes of the block.

Among the locations, maximum density and height was observed at Sat Saida bet. However, of the eight blocks assessed, the survival rate was highest (88.8%) for *A. marina* plantation in 150 ha during 2016-2017 at Kantiyajal followed by *A. marina* plantation in 20 ha at Sat Saida bet (81.6%) during 2005-2006. In rest of the blocks, irrespective of the mangrove species planted, the survival percentage did not reach the minimum expected percentage of 67%. Based on field monitoring and evaluation data it is advised to prefer nursery bed and direct seed sowing methods to *Otla* method since mangrove areas raised through *Otla* method undergo high mortality rate even when initial survival rates are high.

The carbon biomass of *A. marina* plantation varied from 0.041 to 0.202 Mg/ha. The average CO_2 equivalent for all the sites was 1.64%. Among the three locations, i.e. Sat Saida bet, Nakti creek and Kantiyajal, the highest Carbon sequestration potential was recorded for Nakti creek.

The present study indicates that six blocks are most viable for further promotion of mangrove plantation activities, as they have already shown survival failure. Thus, the following conservation measures are suggested for the planted mangroves in order to improve their survival make them a mature mangrove formation over due course of time:

- Appropriate site selection
- Opting for appropriate plantation technique to avoid high mortality
- Regular (in intervals) watering of nursery beds with fresh water
- Regular tidal flushing and inundation
- Manual removal of algal infestation on mangrove recruitment and regeneration classes.
- Monitoring of existing mangrove plantation
- Regular checking of grazing by camels and other livestock

- Containing human activities
- Mangrove plantation involving seed source from nearest area possible
- Restoration of mangroves in sparse areas instead of new plantation sites

Though the mangrove cover in Kachchh coast has reportedly been increasing, the dense mangrove cover has decreased in the region. Thus, to make the mangrove system provide the desired ecosystems services to its fullest, the sparse mangrove patches also need to be made dense through restoration efforts. Appropriate restoration efforts such as deepening and desilting natural canals, removing blocks, etc. are suggested.

Of the several mangrove restoration techniques available, at times they may be suitable for only a single species plantation. Thus, during plantation of multi-species, a thorough understanding of several factors should be considered for the success of mangrove plantation. Involvement of stakeholder communities from the nearby villagers will improve mangrove plantation and restoration activities.

GIS and RS facilities need to be used as a part of mangrove monitoring, conservation and management efforts. Interpolative maps w.r.t. mangrove density, etc. could come handy in identifying the areas that require mangrove restoration.

Above all appropriate awareness and outreach programmes for DPT staff and other stakeholders would strengthen the plantation efforts. The native denizens need to be made aware of the importance of mangroves, the need for their conservation, and the role of relevant authorities. Thus, accordingly these attempts will help in reducing the pressures and/or disturbances on the mangrove plantation efforts in the study area.

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Plate 1. Mangrove Plantation sites in DPT environ

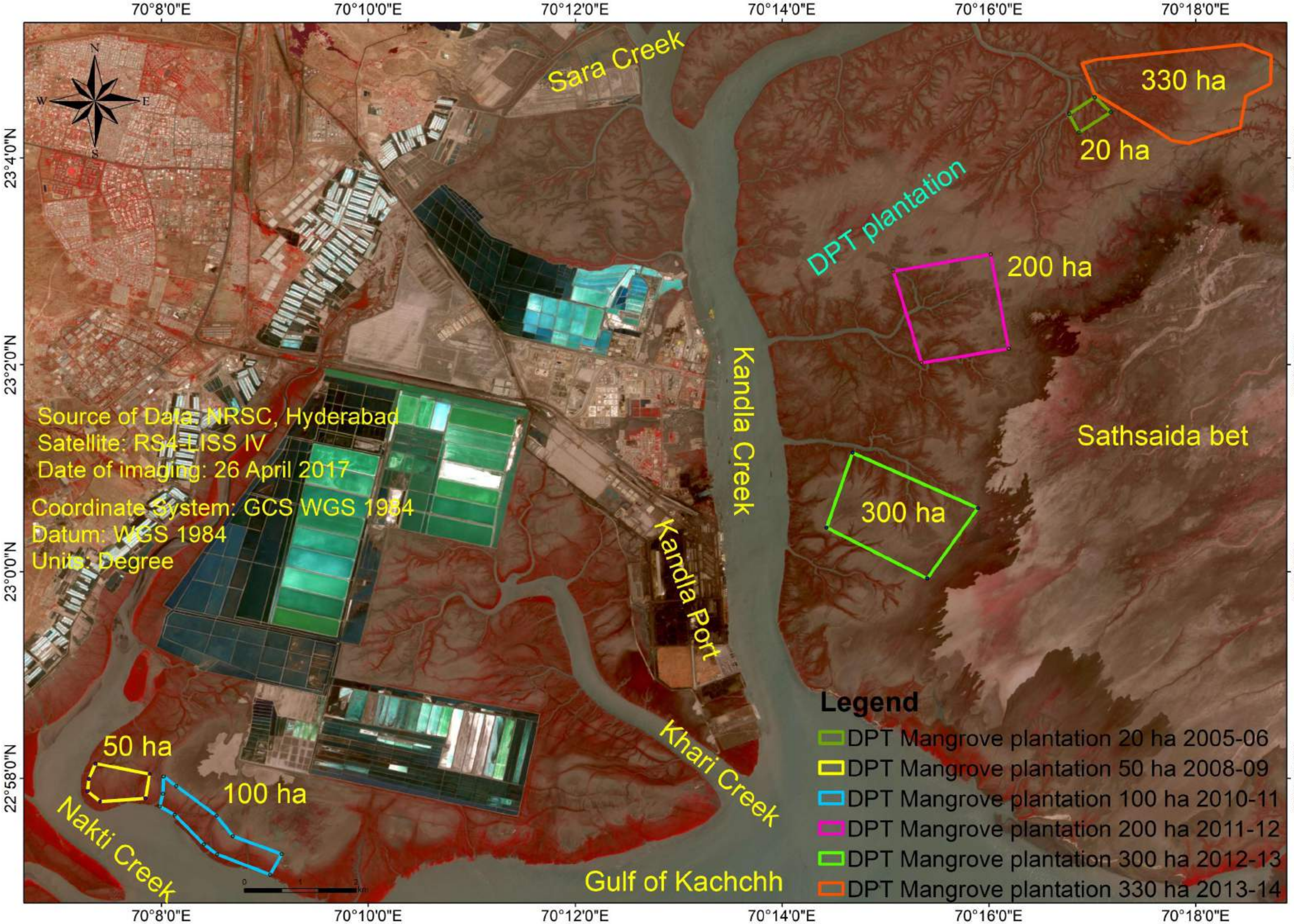


Plate 3. Satellite imageries of 20 ha mangrove plantation at Sat Saida Bet during 2007

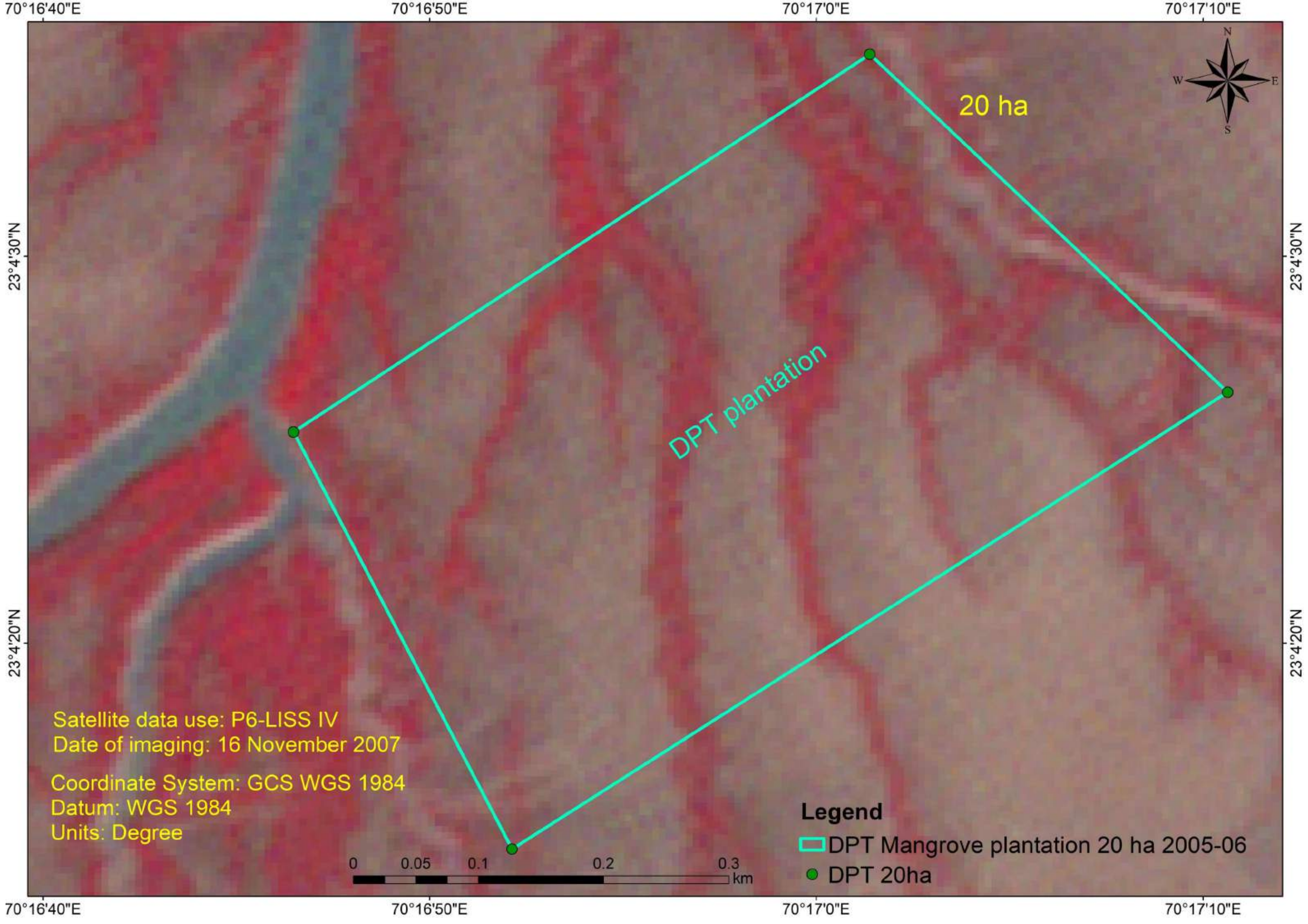


Plate 4. Satellite imageries of 20 ha mangrove plantation at Sat Saida Bet during 2014

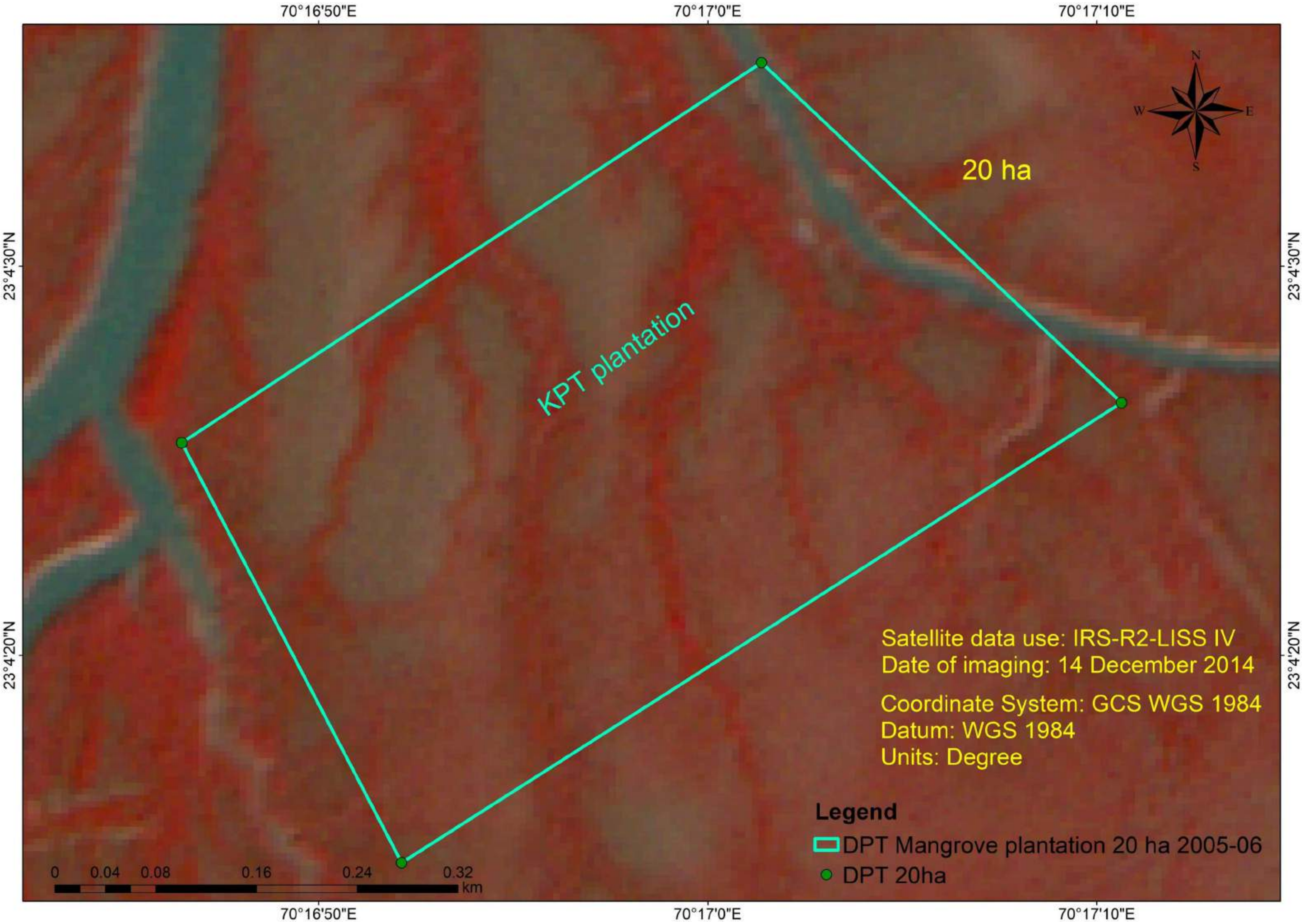


Plate 5. Satellite imageries of 20 ha mangrove plantation at Sat Saida Bet during 2017

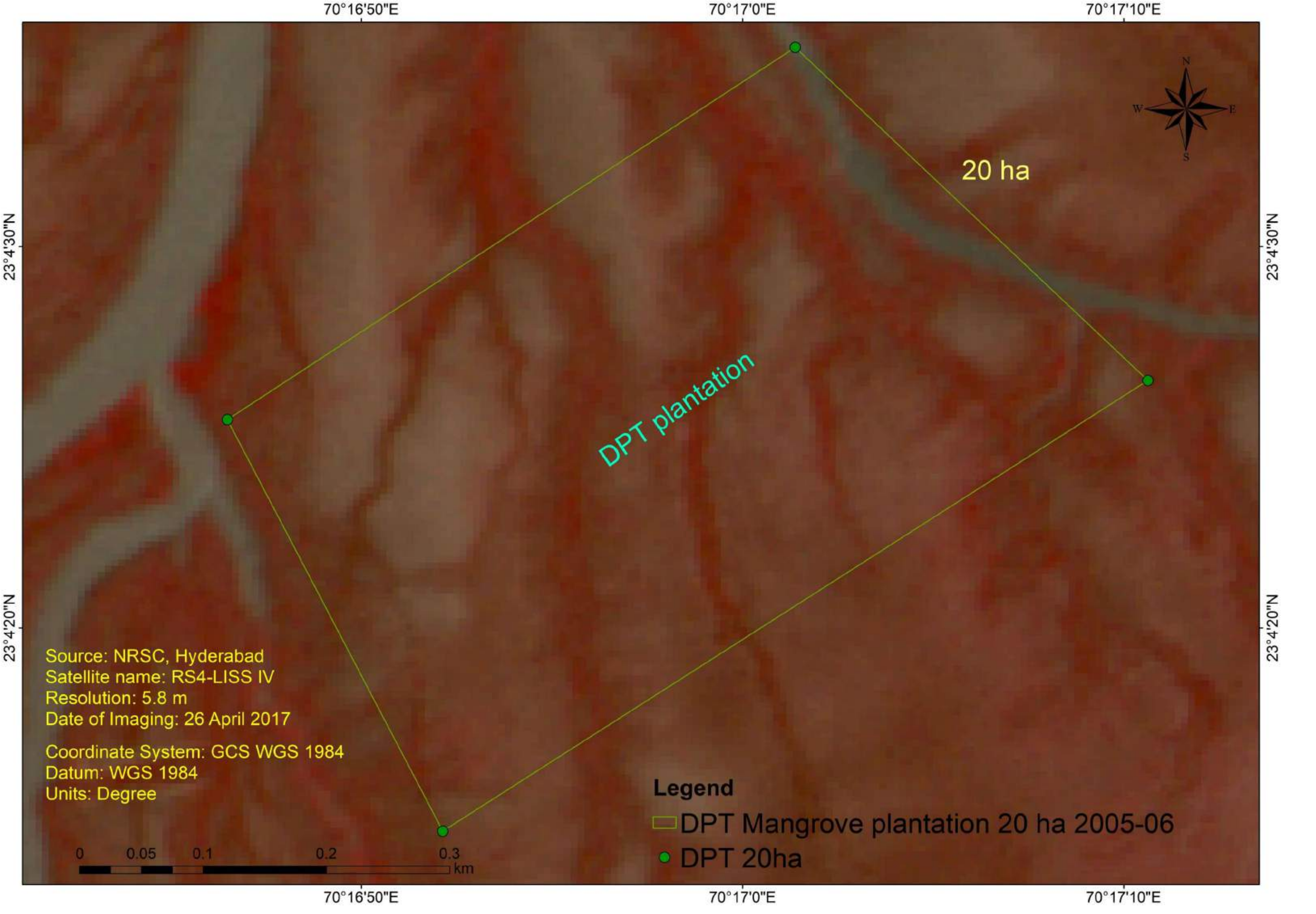


Plate 8. Satellite imageries of 200 ha mangrove plantation at Sat Saida Bet during 2007

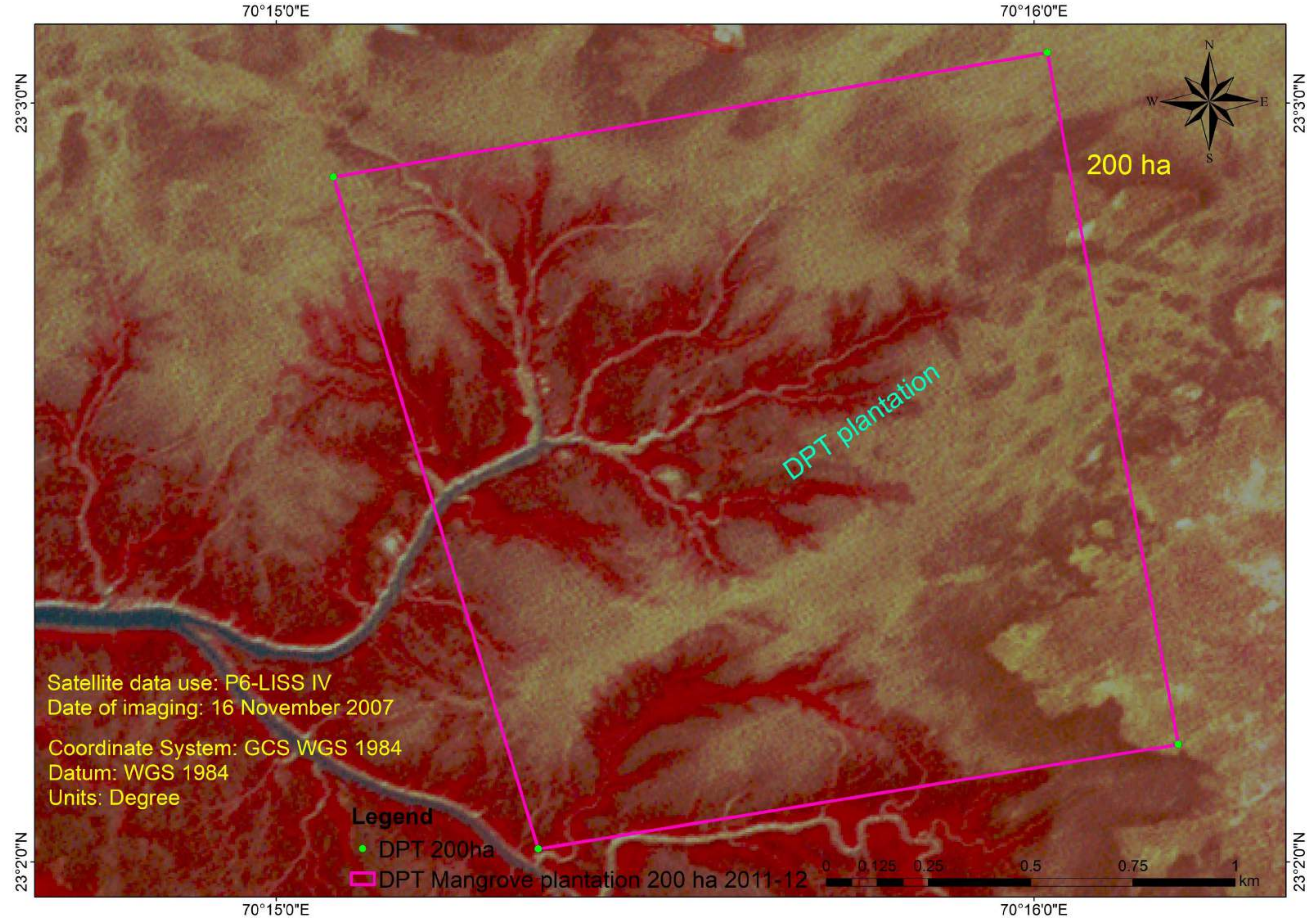
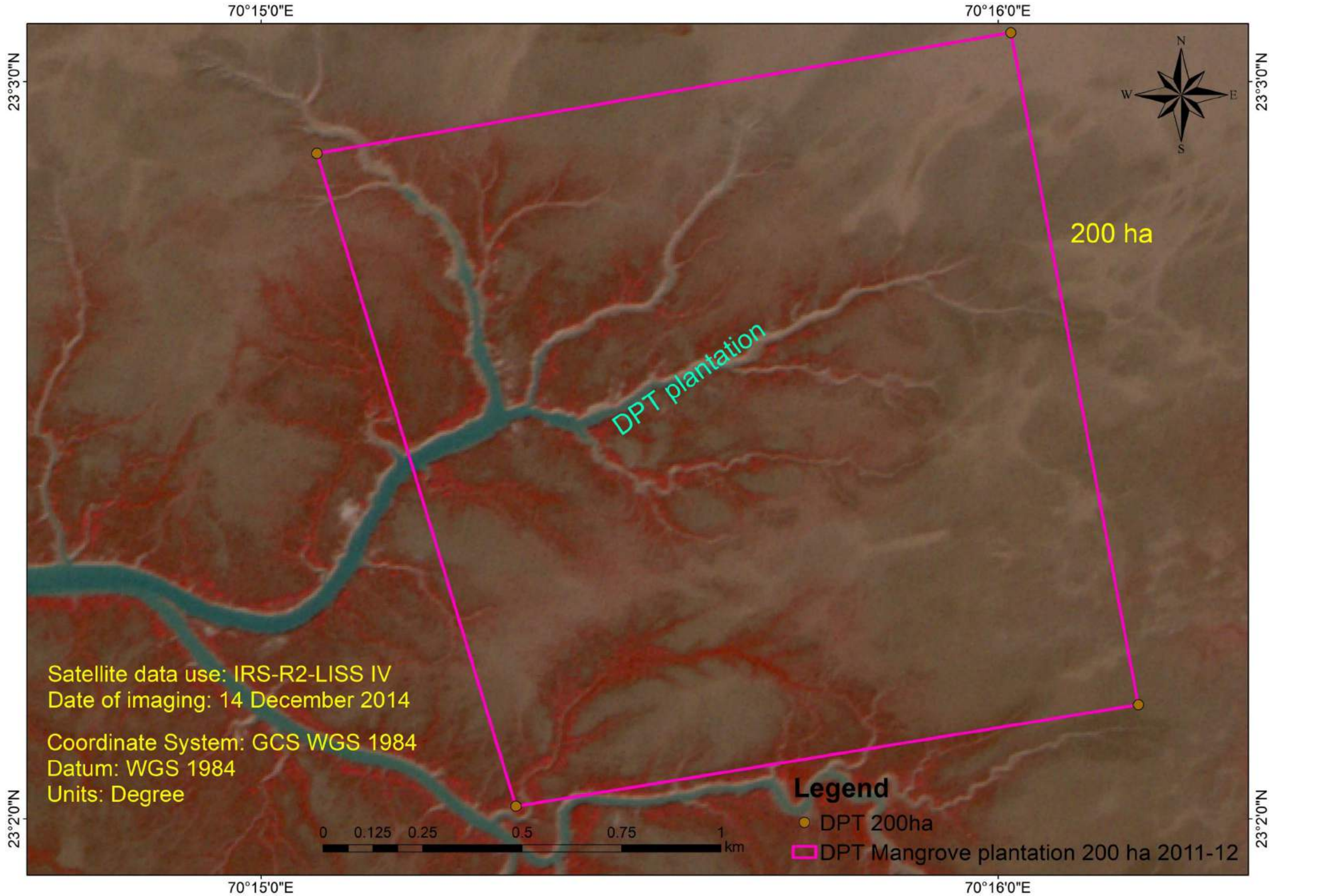


Plate 9. Satellite imageries of 200 ha mangrove plantation at Sat Saida Bet during 2014



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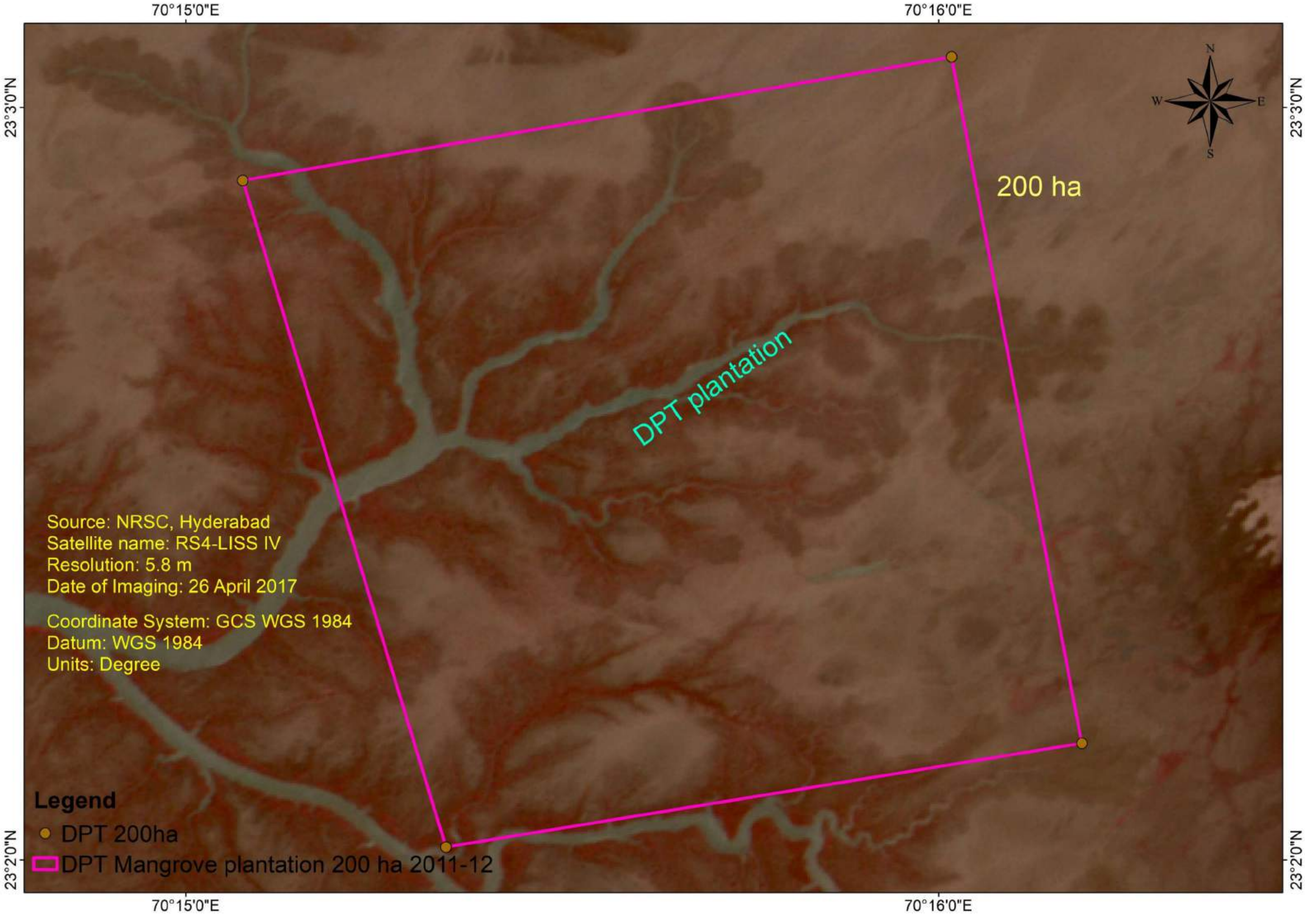

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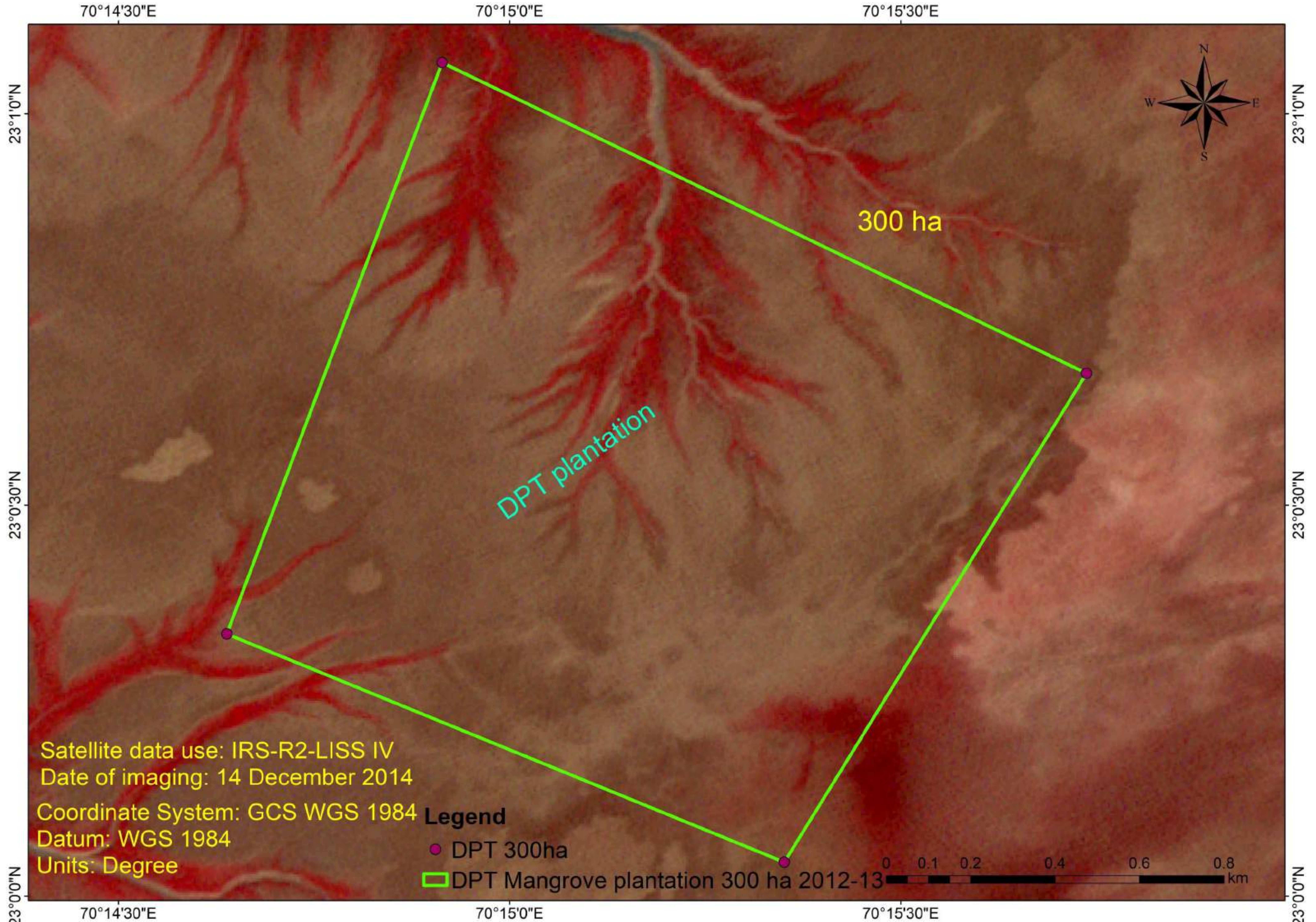

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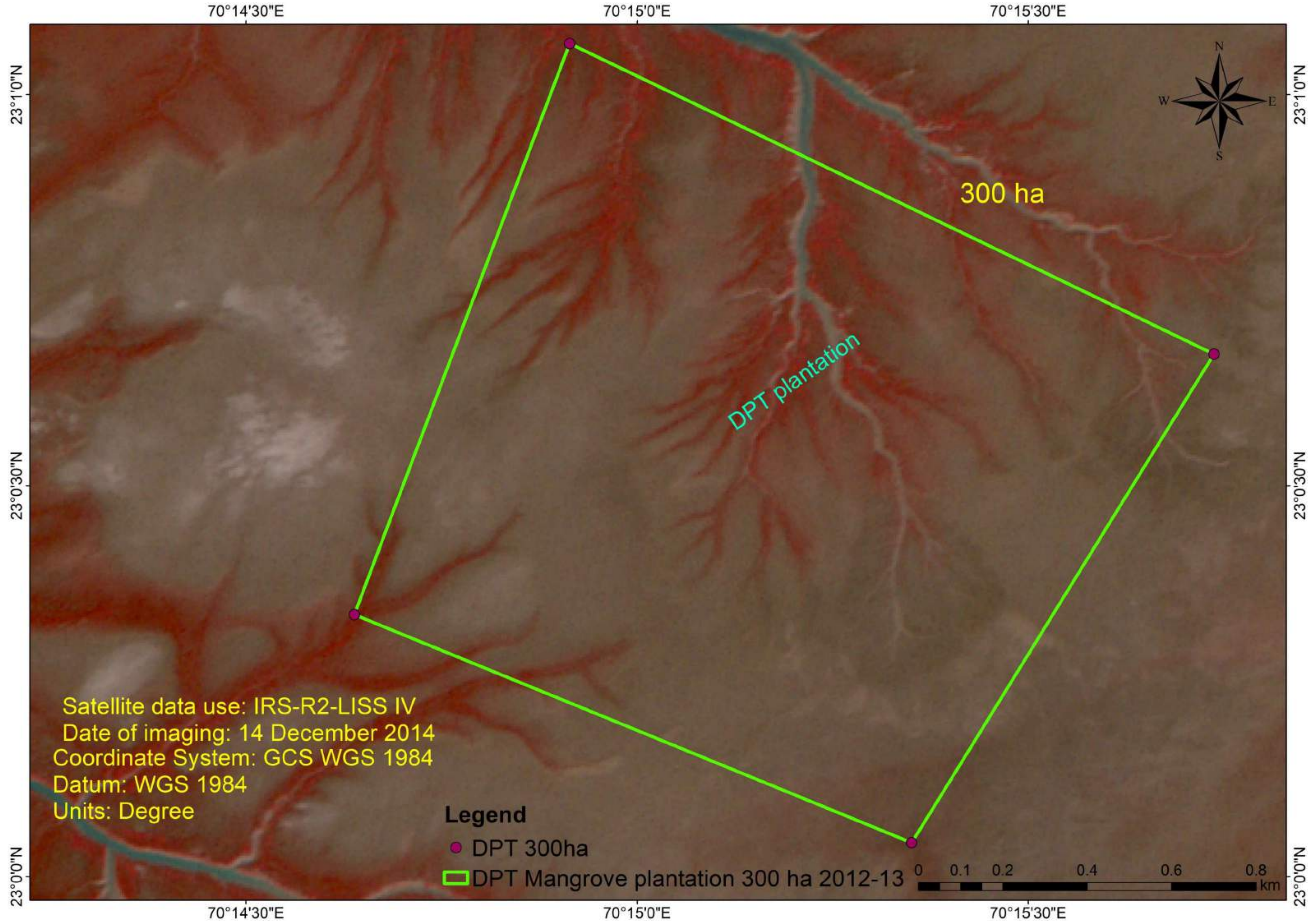

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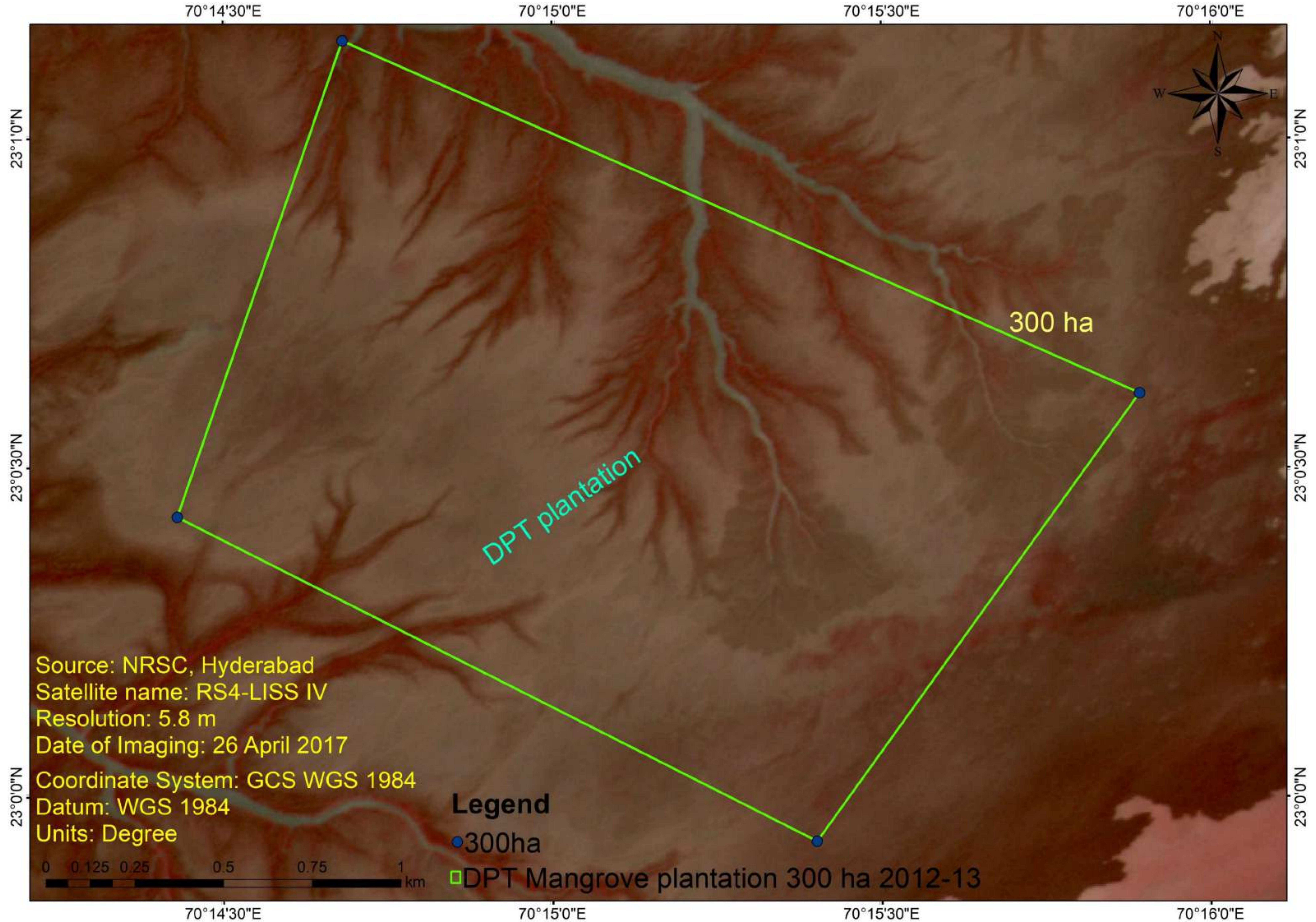

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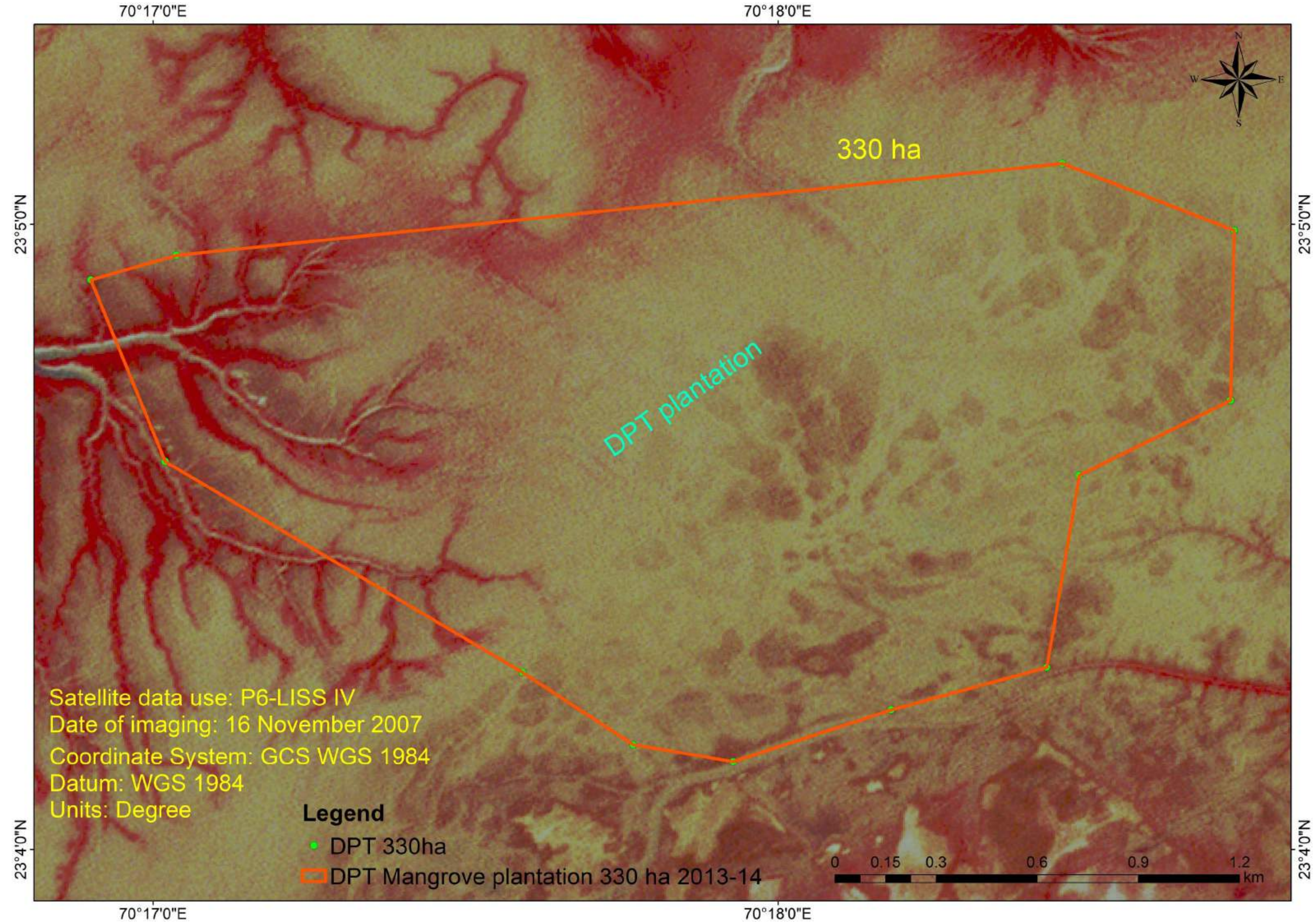

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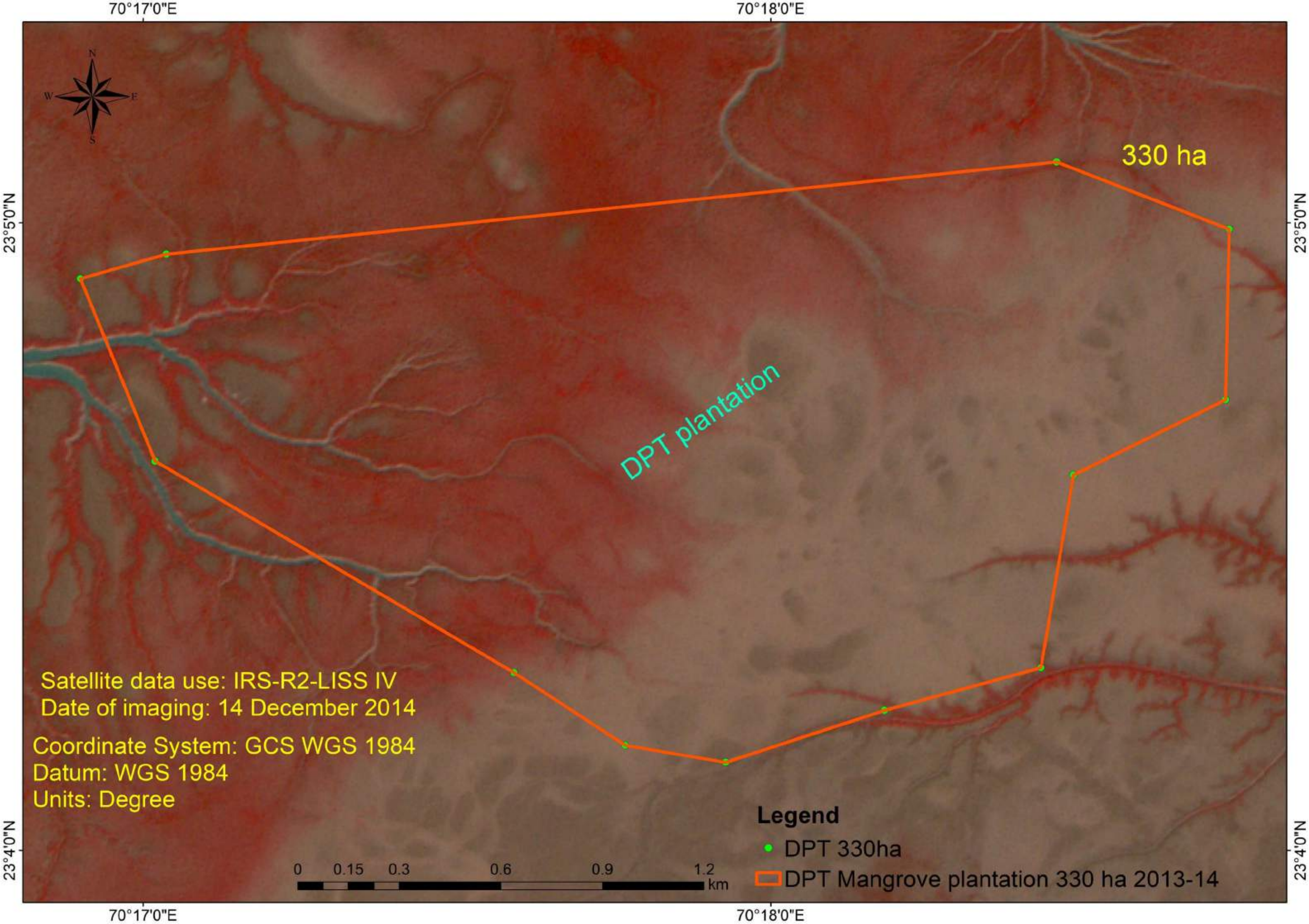

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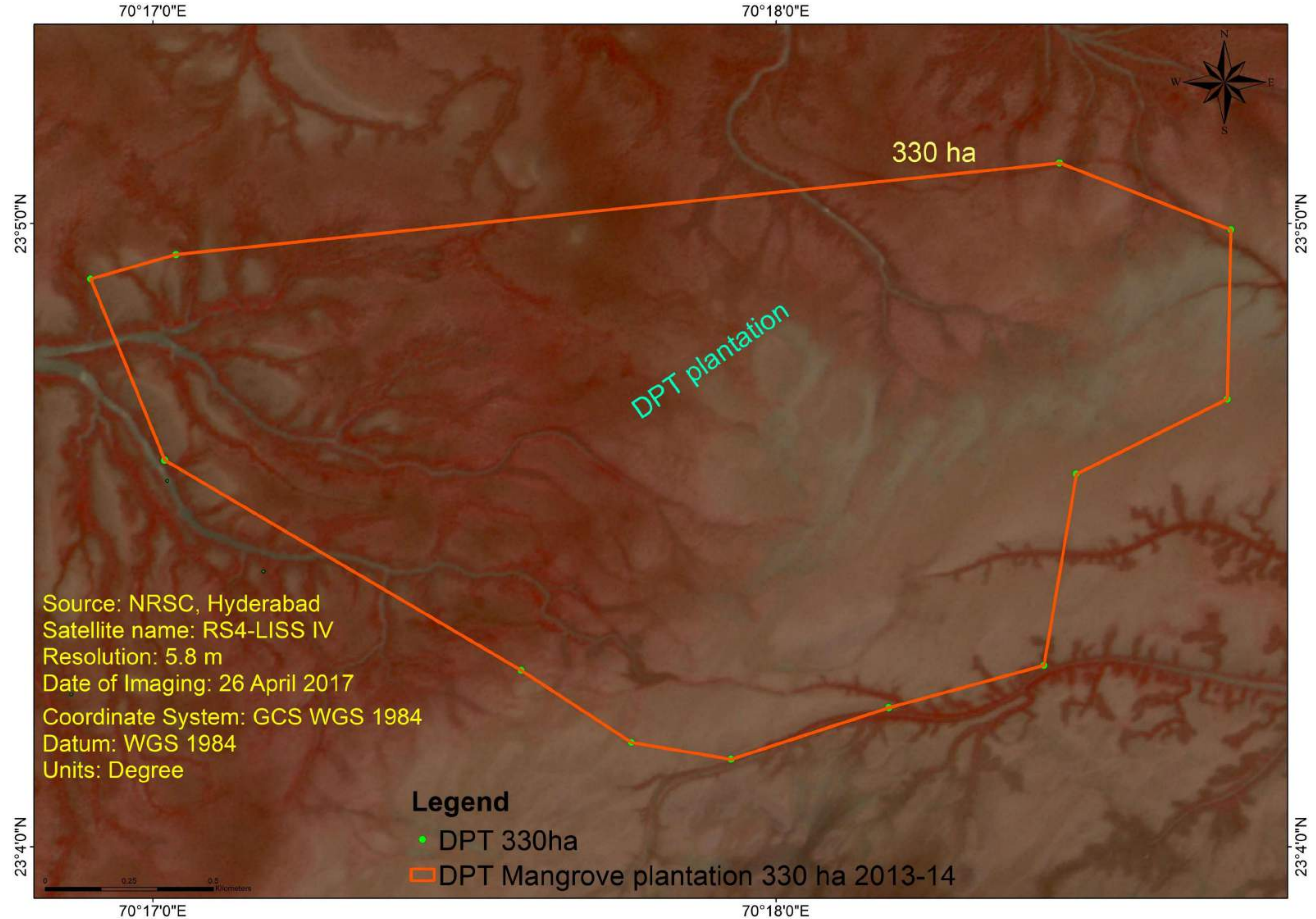

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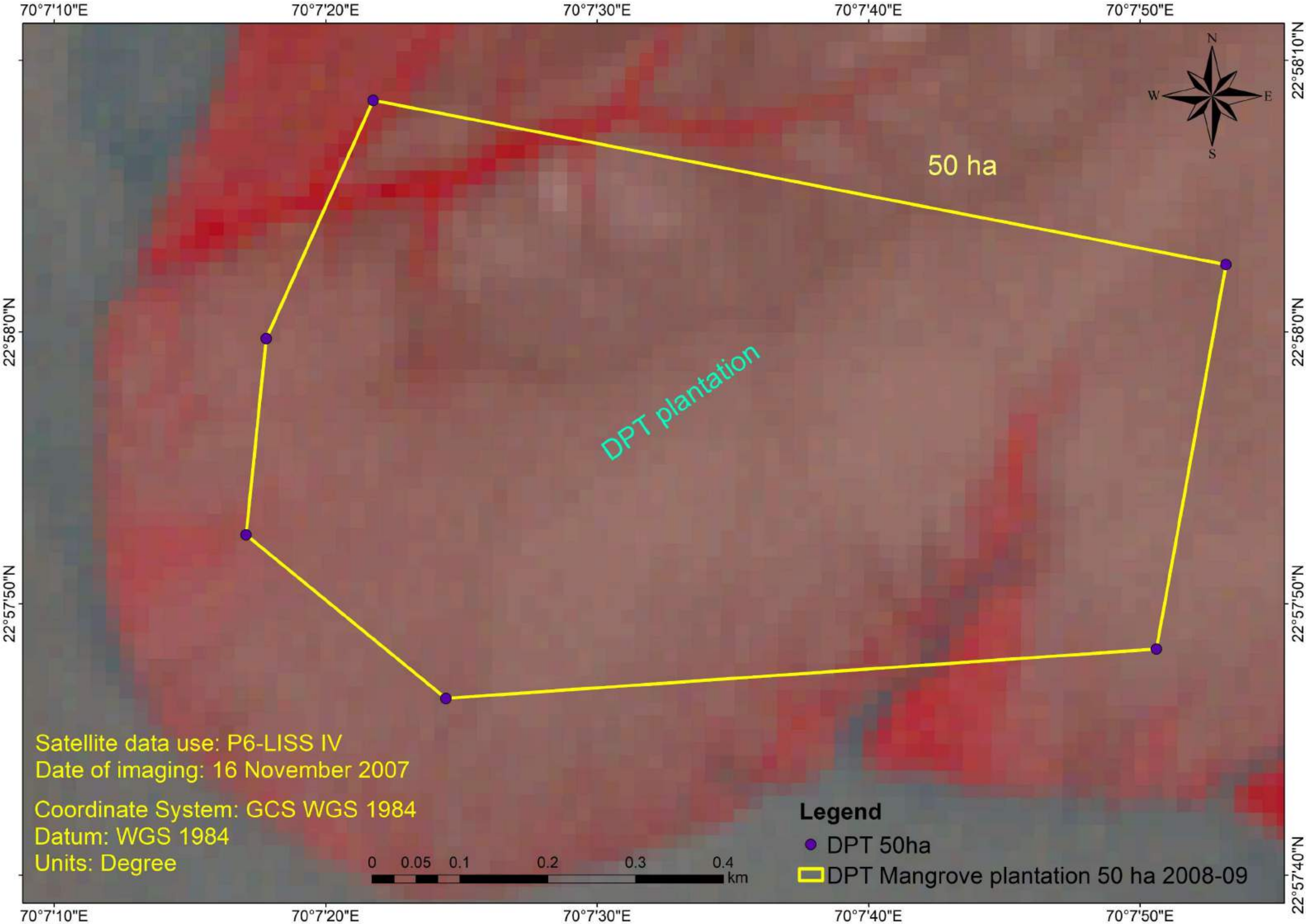

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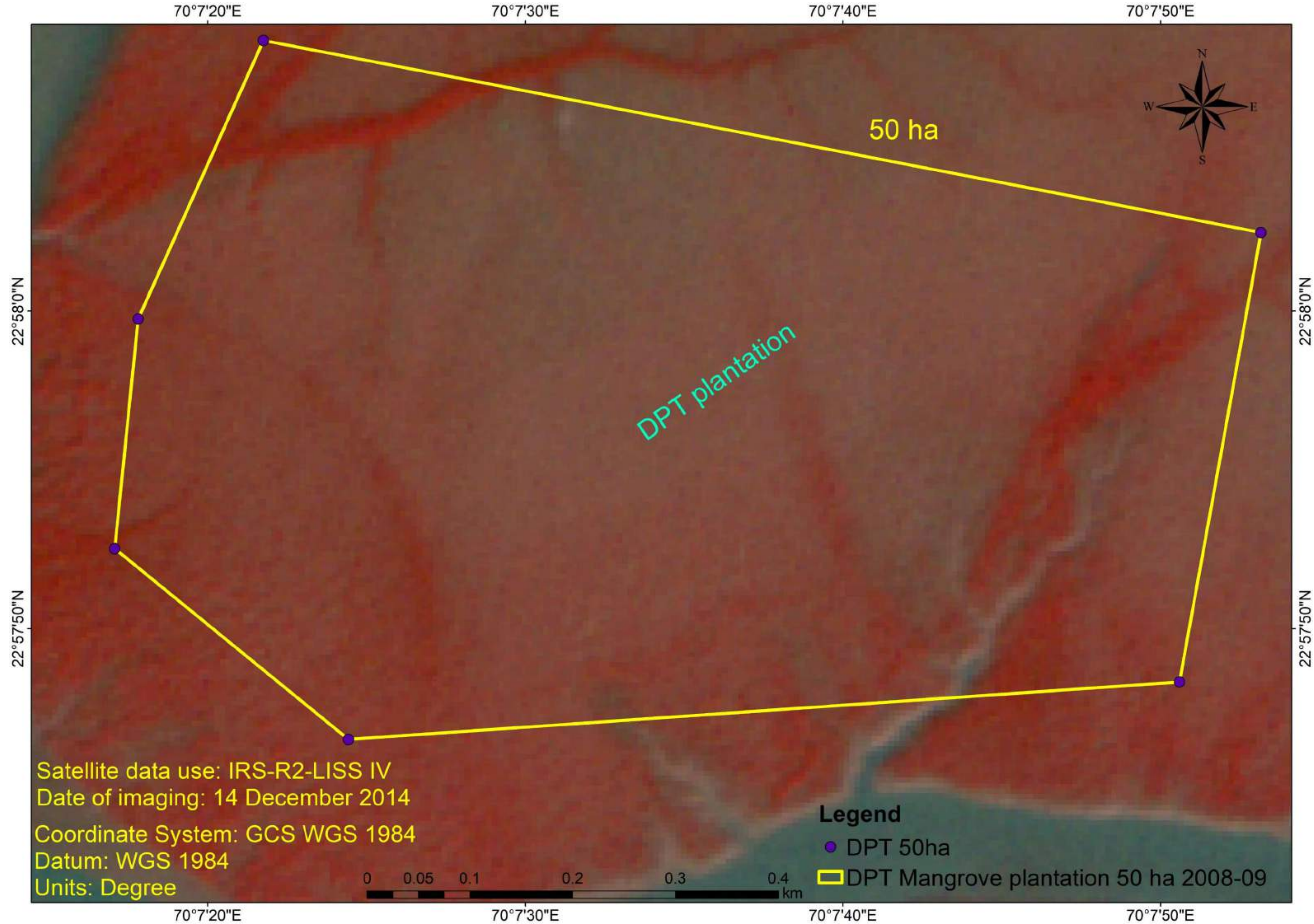

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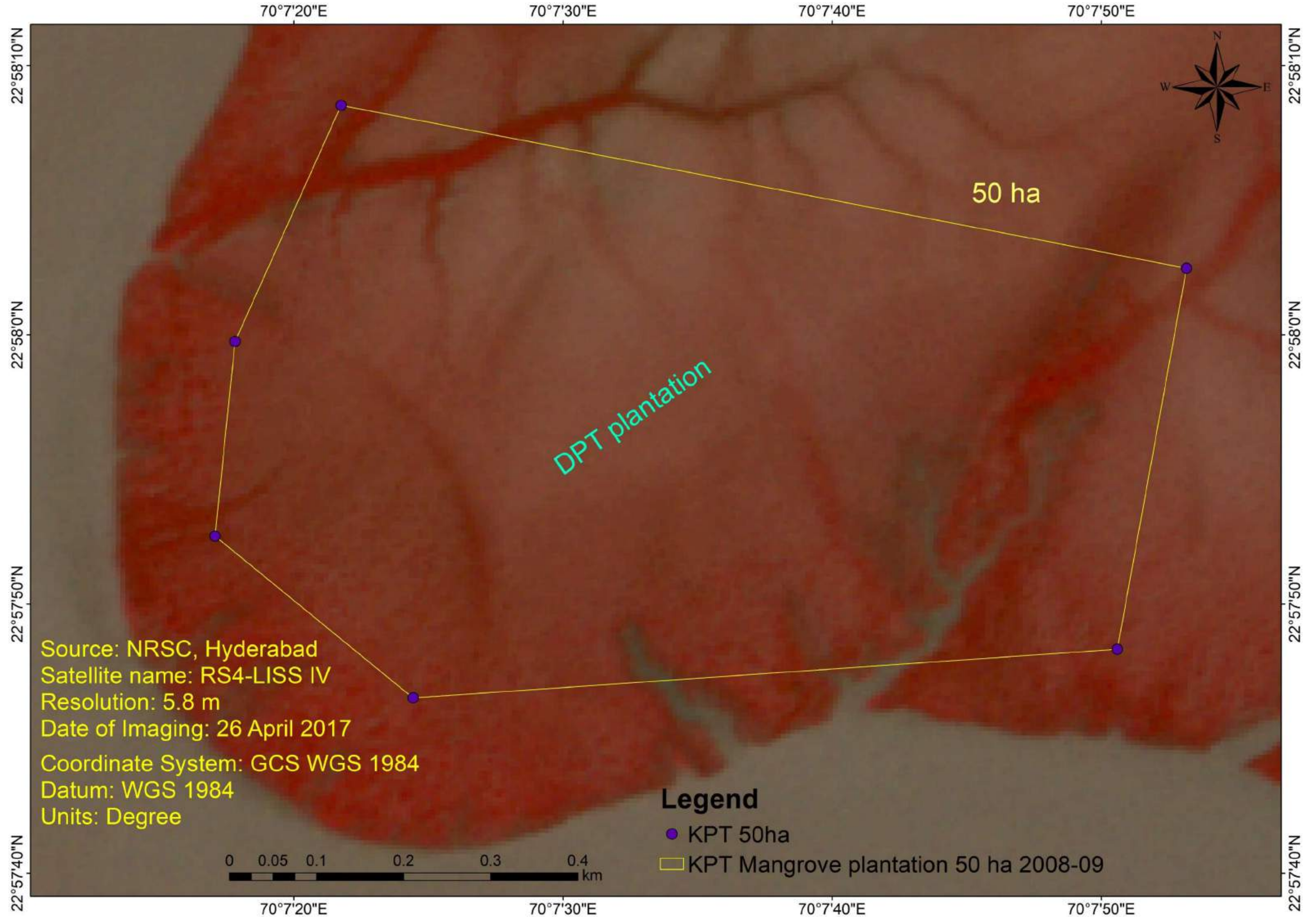

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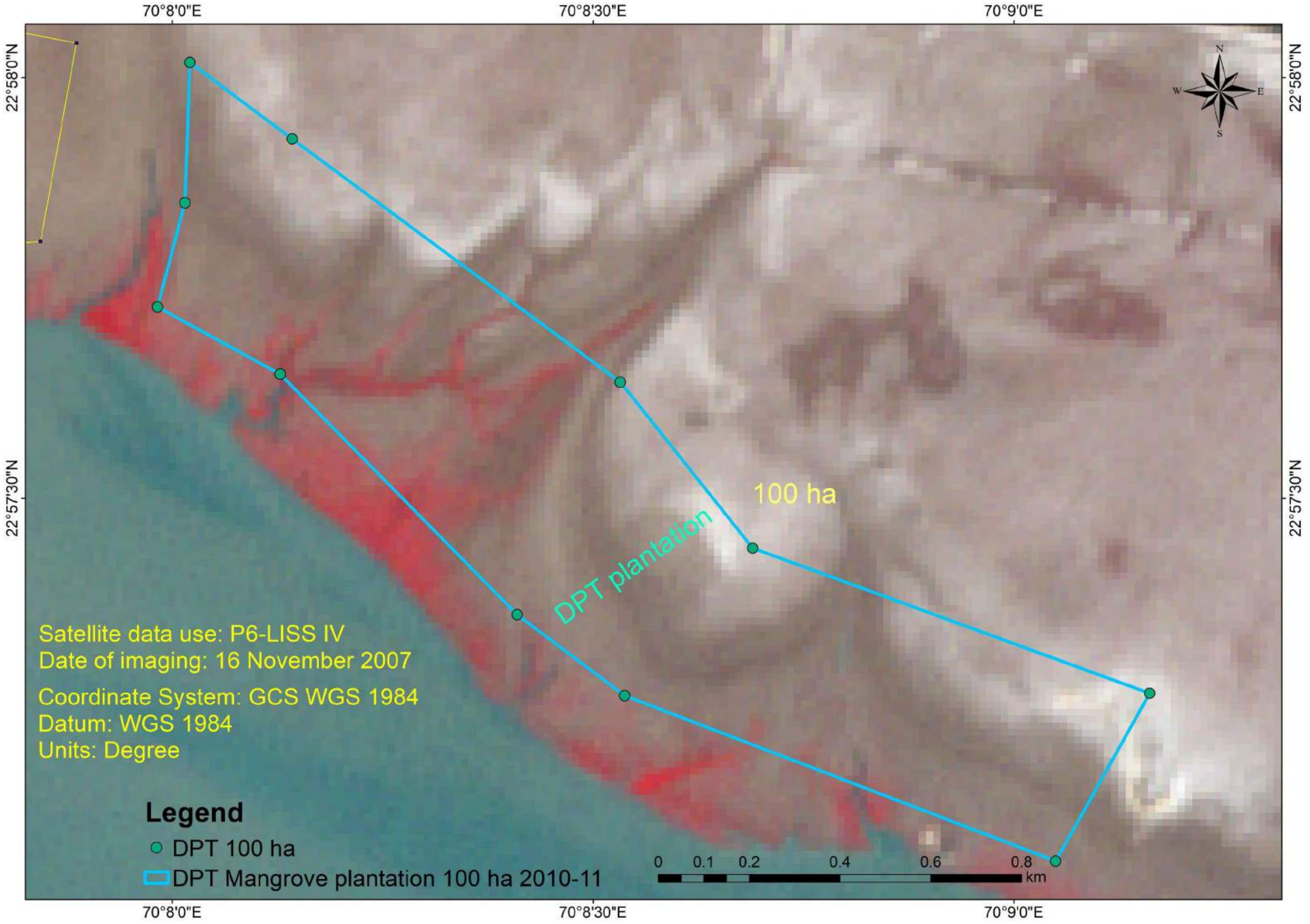

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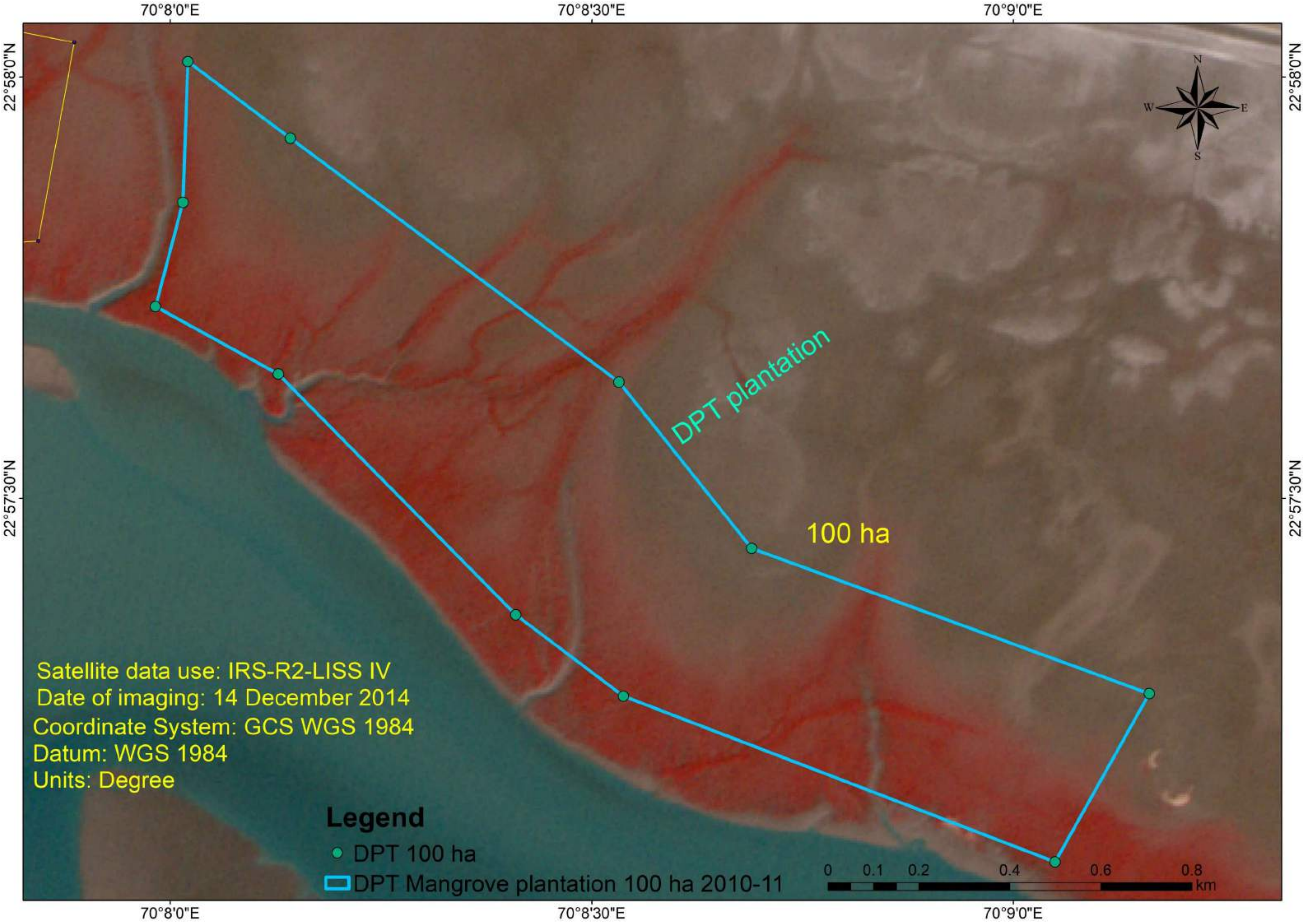

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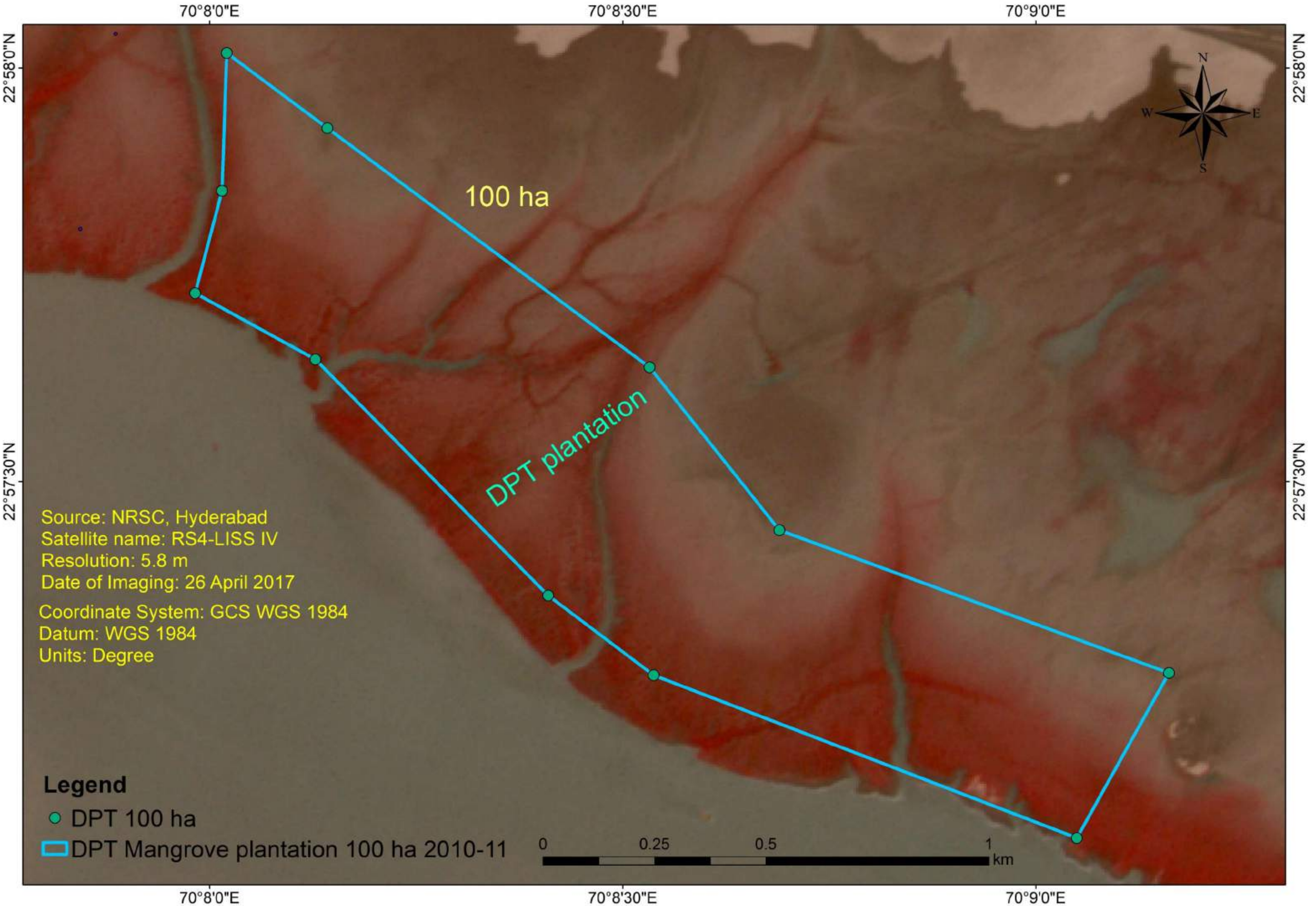

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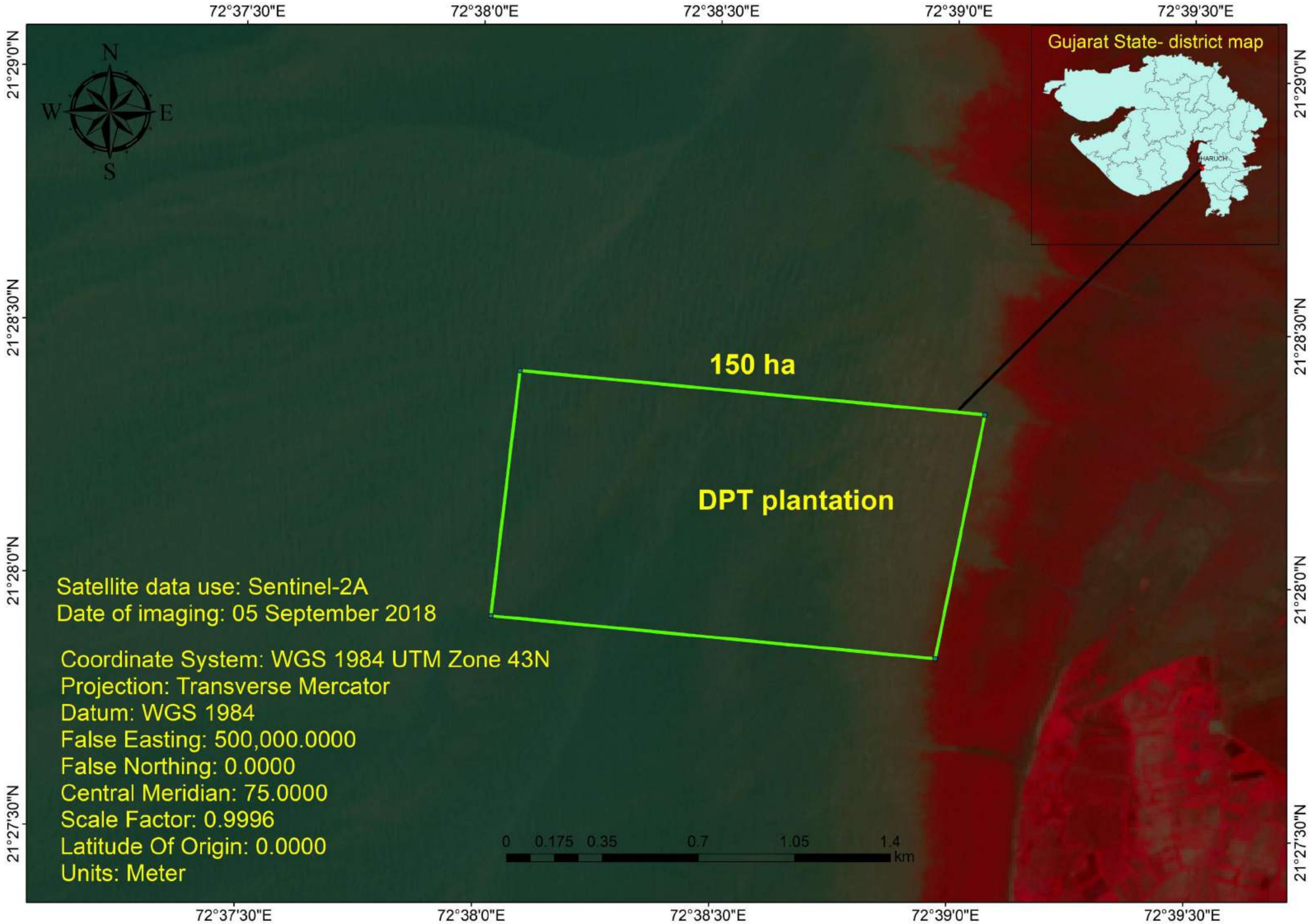

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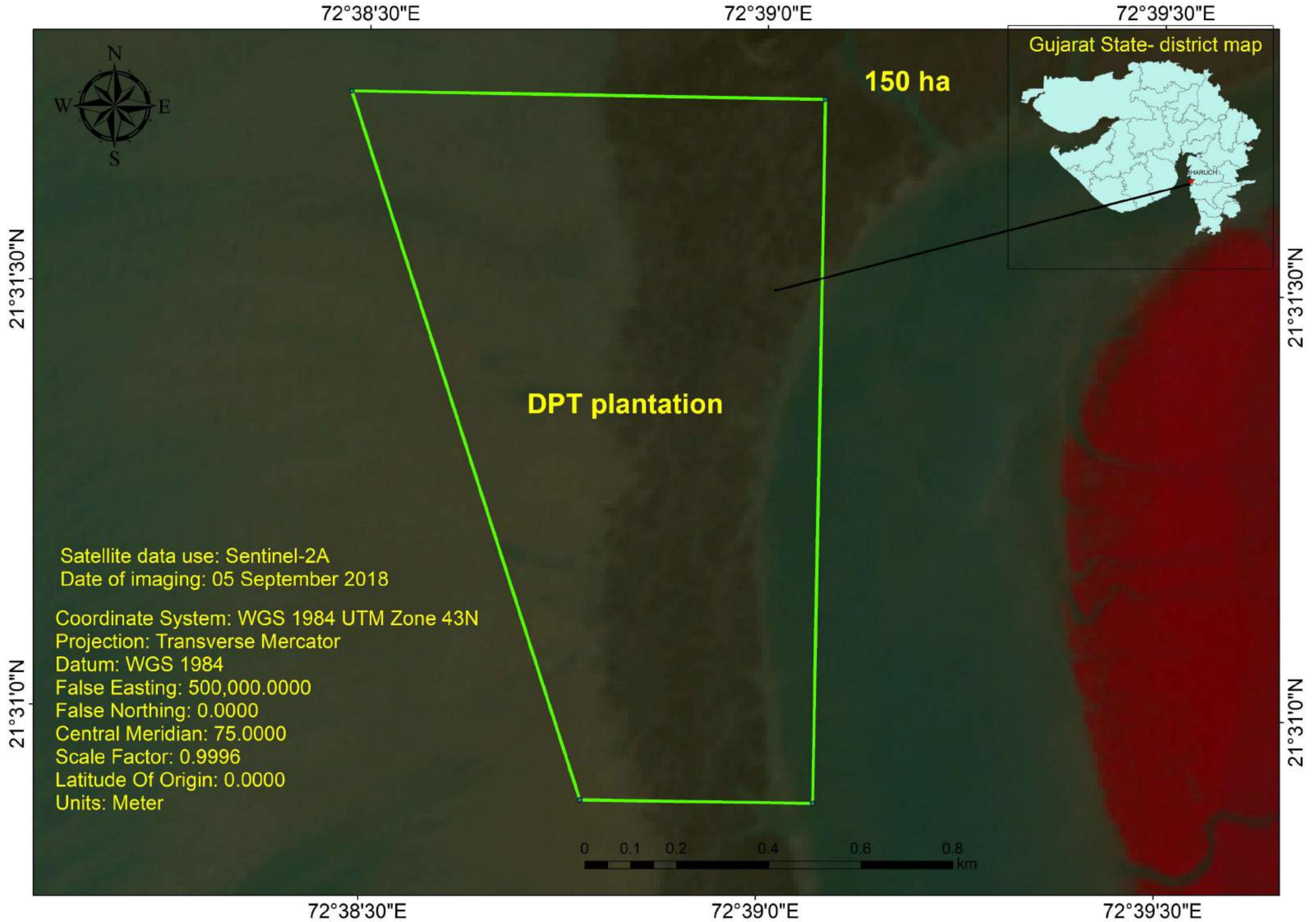

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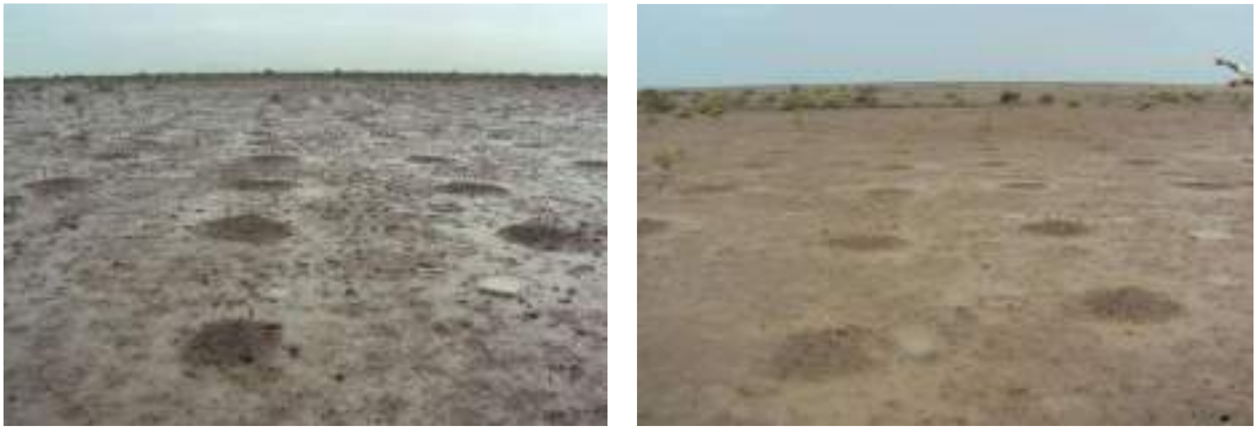

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Inception Report on “Monitoring of Mangrove Plantation carried out by DPA” by M/s GUIDE

(2021-2022)

INCEPTION REPORT

For the project entitled

Assessment and Regular Monitoring of Mangrove Plantation (1400 Ha) carried out by Deendayal Port Trust, Kandla

Submitted by

Gujarat Institute of Desert Ecology

P.B. No. 83, Mundra road

Opp. Changleshwar Temple, Bhuj-Kachchh,

Gujarat-370001

Submitted to

Deendayal Port Trust

Administrative office Building

Post Box No. 50, Gandhidham (Kachchh)

Gujarat-370201

September 2021

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September 2021

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Project Coordinator: Dr. V. Vijay Kumar, Director

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1. BACKGROUND

Mangrove forests are considered to be a unique and complex major component of coastal zones in the tropical, sub-tropical regions and with great socio-economic values. They are keystone ecosystems since they provide significant ecological amenities that extend far beyond their area of coverage. Mangrove distribution and abundance in intertidal areas could be considered as a direct indicator of the habitat wellbeing of the coastal ecosystem and are highly sensitive to environmental change. Mangrove ecosystems cover less than 0.4% of the world's forests (Spalding *et al.*, 2010) and are being lost at the rate of 1% per year (FAO, 2007). Since 1980, approximately 20 to 35% of the world's mangrove areas were lost. The mangrove loss has been higher in most of the developing countries for want of space to accommodate various coastal industries and maritime developmental activities. Over the years, the ecological role of mangroves and the services they provide have been widely realized by the global scientific community. Thus, several researchers eventually targeted mangrove plantation / conservation in order to restore their ecological and economical values.

India has a total of 7516.6 km coastline distributed among nine maritime states and four Union Territories (Anon, 2001) of which Gujarat possesses the longest coastline extending to 1650 km. A total of 46 true mangrove species belonging to 14 families and 22 genera are found in Indian mangrove habitats (Ragavan *et al.*, 2016). Around 3 % of the earth's total mangrove vegetation is found in India (FSI, 2019). Mangrove ecosystem in Gujarat is the second largest after Sundarbans in West Bengal in India and 15 mangrove species are reported from the 13 coastal districts. Of these, the Southern coast of Gulf of Kachchh (GoK) and Gulf of Khambat are important for mangrove diversity and distribution. The four species of mangroves i.e. *Avicennia* sp., *Rhizophora* sp., *Sonneratia* sp., and *Bruguiera* sp., were found to be dominated along the Gujarat coast. Though, mangrove restoration activities in Gujarat are one of the best examples of habitat restoration in the world, the mangrove formation / restoration in the GoK area is largely single species, comprising of *Avicennia marina*. Majority of the mangrove species require fresh water inundation for their propagation which is the major factor that determines the diversity and growth of mangroves. Given the topography of Gujarat state and in particular Kachchh region, continuous fresh water sources is atypical. Aridity is the most striking feature of the coastal belt of GoK which often renders plantation of mangrove species other than *A. marina* least promising. This, in turn, makes mangrove restoration / plantation work more challenging and uncertain in the arid regions like Kachchh.

1.1. Objectives of the Study

The aim of this study is to assess the growth and survival rate of mangrove plantation, factors affecting health of the mangrove and suggest appropriate remedial measures and techniques for conserving them. The specific objectives are as below:

i. To evaluate 1400 Ha of mangrove plantation at Sat Saida Bet, Nakti creek in Kachchh coast and Kantiyajal in Bharuch district carried out by Gujarat Ecology Commission (GEC), Forest & Environment Department, and Patel Construction
ii. To assess the extent of plantation, health status, survival of the sapling, mortality rate and growth of the planted mangroves.
iii. To provide a comprehensive overview of both the composition and distribution of the planted mangroves following phyto-sociological methods.
iv. To assess the carbon sequestration potential of the mangrove plantation in view of climate change.

1.2. Carbon Sequestration Potential of Planted Mangroves

Mangroves are considered as the most significant ecosystems that can be managed for adaptation and mitigation strategies against the impacts of climate change. They are considered as 'Blue Carbon systems' because of their capacity to store a large amount of organic carbon (OC) over long periods. The annual per capita emission of CO_2 from India is 1.67 metric ton and the population of India in 2020 was ~1378.6 million. According to Kaladharan *et al.* (2009) the total annual CO_2 emission from India was 1. 6

billion tons and it became 2.59 billion tons during 2019. However, forest ecosystem could help to reduce greenhouse gas concentrations by absorbing carbon from the atmosphere through the process of photosynthesis and pool carbon in their ecosystem as biomass and soil organic matter. In this concept, mangrove forests have been expected to function as sinks of carbon dioxide and greenhouse gases than other forest types, by their carbon dioxide sequestration ability due to their high primary productivity and large quantities of roots and organic matter in their substrata (Komiyama *et al.*, 2000, Fujimoto 2004). Therefore, the assessment of mangrove plantation becomes an important area of study in order to understand the overall ecosystem services provided by mangroves and to take necessary management practices to preserve this ecosystem from further deterioration or degradation.

1.3. Rationale

Deendayal Port Trust (DPT) is one of the largest ports of India in terms of volume of cargo handled. Among Indian ports, this port also has the largest coastal habitats such as mangroves (193.1 km^2) and mudflats (312.9 km^2). Since vast coastal resources are under its jurisdiction, the port authorities besides legal mandate, desired to conserve, protect and enhance these coastal habitats. The establishment of facilities over the years, buildings, etc. involves notable movement of materials and people in the area. Doubtlessly, this will alter the local ecological makeup of the area. Any long-term activity in the adjacent place will have serious repercussions on the coastal environment. Thus, measures should be taken to conserve and preserve mangroves within the DPT area, thus retaining several unsung ecological services of mangroves. Accordingly, DPT has implemented mangrove plantation in 1400 ha during the period between 2005 and 2021 through various implementing agencies at Sat Saida Bet, Nakti creek in Kandla and Kantiyajal in Bharuch district. The Deendayal Port Trust has entrusted the task of evaluating the status of 1400 ha of mangrove plantation in these locations to Gujarat Institute of Desert Ecology (GUIDE), Bhuj.

2. Details of the plantation sites

The present proposed study will mainly focus on the present status of the mangroves at Sat Saida bet, Nakti creek and Kantiyajal covering eight blocks occupying in 1300 Ha where plantation activities that have been conducted during the period between 2005 and 2017. However, the present study will also cover plantation at Sat Saida bet (50 Ha) and Kantiyajal (50 Ha) carried out during the year 2019 and 2020. The major goal of this study is to assess the survival rate of mangrove plantation, carbon sequestration potential of planted mangroves and to understand the ecological issues and suggest conservation measures accordingly. The details of the mangrove plantation works carried out in phased manner by the DPT are presented in Table.1 and the map showing the detail as per Fig.1.

Table 1 Details of the implemented mangrove plantation activities by DPT

Location	Year of Plantation	Area (ha)	Species planted	Implementing Agency
Sat Saida Bet, Kachchh district	2005-2006	20	*A. marina*	M/s Gujarat Institute of Desert Ecology, Bhuj
	2011-2012	200	*A. marina*	Forest & Environment Department, GoG
	2012-2013	300	*A. marina*	Forest & Environment Department, GoG
	2013-2014	330	*A. marina*	Forest & Environment Department, GoG
	2018-2019	50	*A. marina*	M/s Gujarat Ecology Commission
Nakti Creek, Kachchh district	2008-2009	50	*A. marina*	M/s Patel Construction Co, Gandhidham
	2010-2011	100	*A. marina* *R. mucronata* *C. tagal*	M/s Gujarat Ecology Commission
Kantiyajal, Bharuch District	2015-2016	150	*A. marina*	M/s Gujarat Ecology Commission
	2016-2017	150	*A. marina* *R. mucronata*	M/s Gujarat Ecology Commission
	2018-2019	50	*A. marina*	M/s Gujarat Ecology Commission
Total		**1400**		

Figure 1: Mangrove Plantation sites in DPT environ

2.1. Mangrove Plantation at Nakti Creek

A total of 150 Ha of mangrove plantations were carried out in Nakti creek with two blocks covering area of 50 Ha and 100 Ha each and plantation activities were carried out by two agencies such as M/s. Patel Construction Co, Gandhidham and M/s. Gujarat Ecology Commission, Gandhinagar respectively. The plantation was carried out through different plantation technique such as transplantation of nursery raised saplings, *otla* bed, and direct seed dibbling methods. For the 50 ha block *A.marina* was the candidate species for plantation (Fig.2).

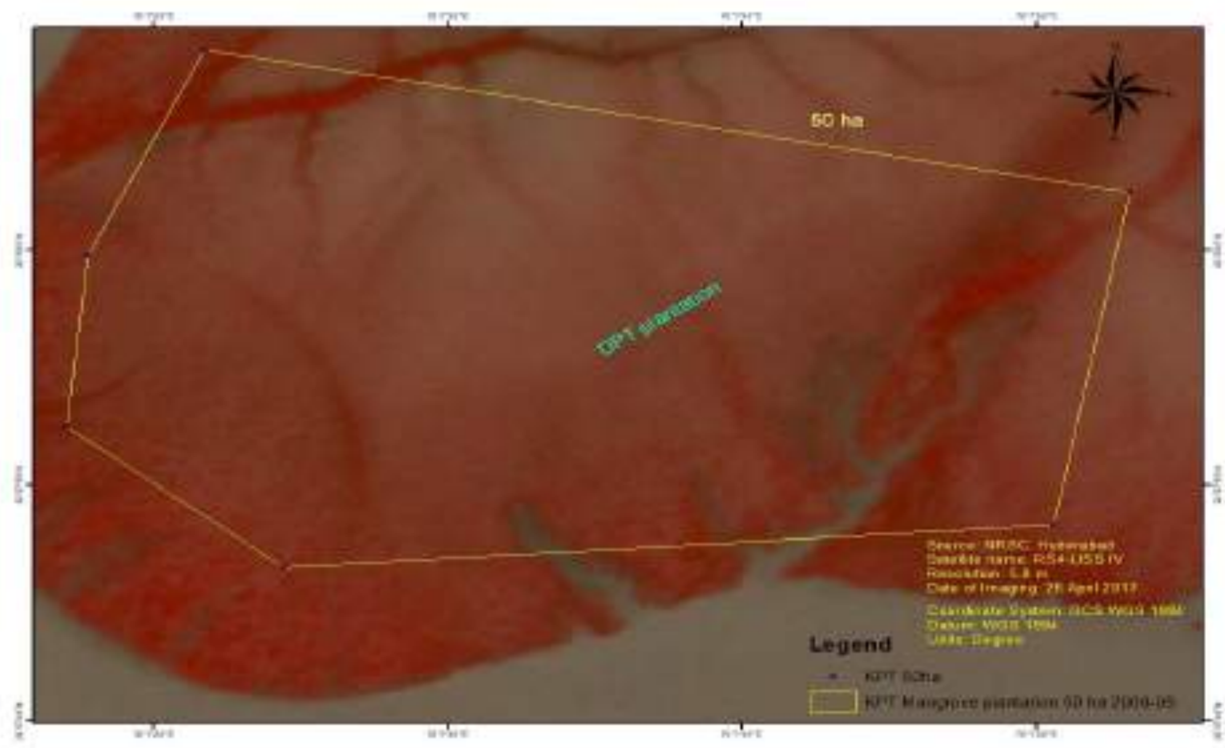

Figure 2: Mangrove plantation along the Nakti Creek (50 Ha)

However, the mangrove plantation of 100Ha executed by Gujarat Ecology Commission (GEC), Gandhinagar is located at different blocks along the Nakti creek (Fig. 3 & Table 2). The first block was along the Nakti creek and *A. marina* was the candidate species for plantation. In the second block (other side of Nakti creek) where *Ceriops tagal* sown along with *A.marina*. In the third block, which is located on the eastern side of the second block, seeds of *A. marina* were sown. The fourth block plantation was along the minor creek system located along the bund and road where propagules of *Rhizophora mucronata* and *Ceriops tagal* were planted. In this 100 Ha, *R. mucronata* and *C. tagal* were sown in 5 Ha each, and remaining 90 Ha area was planted with *A. marina*. Around 6 lakh seeds involving three species of true mangroves were planted in four different blocks. One lakh saplings each of *R. mucronata* and *C. tagal* were planted in Nakti creek. To evaluate the *A. marina* plantation success at Sat Saida bet and Nakti creek *i.e.* survival percentage and growth rate, initial plantation density of 6600 saplings/Ha as a baseline density was considered.

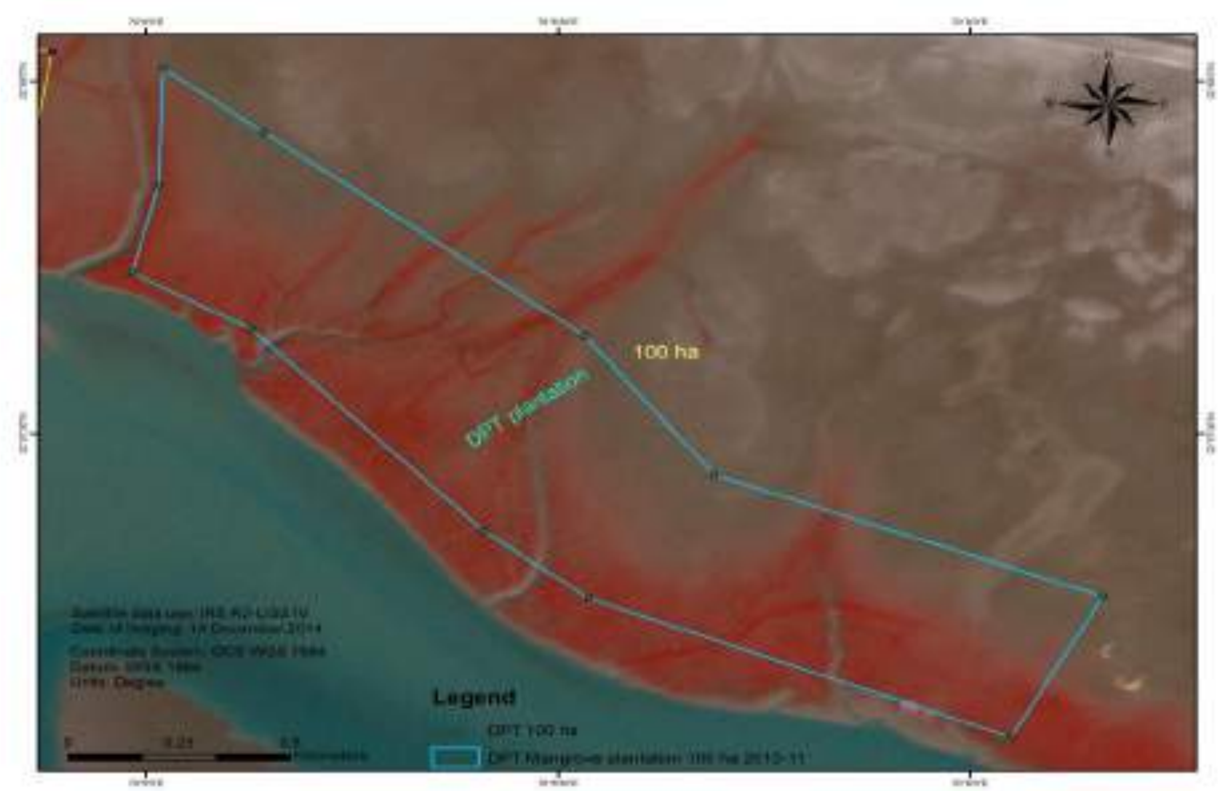

Figure 3: Mangrove plantation along the Nakti Creek (100 Ha)

2.2. Mangrove Plantation at Kantiyajal coast

Unlike other plantation sites, which are located in and around the Deendayal port, this 350 ha, plantation was carried out at Katpor village of Bharuch District near Kantiyajal in South Gujarat. The plantation was done in two blocks each with 150 ha during 2015-16 and 2016-17 respectively and 50ha during 2019-20 at the coastal stretch of Katpor, Hansot taluka, Bharuch District. Koteshwar Paryavaran Vikas Vyavasthapan Samiti, a Community based Organization was entrusted with the task of executing this plantation activities. The seeds of both *A. marina* and *R. mucronata* were collected from the nearby natural mangrove areas. Village level CBO in association with GEC maintains the plantation by gap-filling activities and protection through social fencing. Saplings of *A. marina* were transplanted at the distance of 2.5 x 2.5 m i.e. 2500 saplings/Ha. A total of 4,62,500 plants were transplanted in all plantation years. Further, due to the vast intertidal region as compared to other costal districts of South Gujarat, human habitations are far off from the mangrove habitats. In total of 70,000 propagules of *R. mucronata* were planted to cover 300 ha of area at the intertidal belt. The *R. mucronata* propagules were imported from Sindhudurg district of Maharashtra State and propagules were planted at the distance of 2.5 x 2 m along the banks of small and medium creeks.

Table 2: Mangrove plantation details of Kantiyajal, South Gujarat

Sl. No.	Year of Plantation	Method adopted	Species	Area (ha)
1	2015-2016	Nursery Method and Raised Beds	*A. marina*	150
3	2016-2017	Nursery Method and Direct dibbling	*A. marina, R. mucronata*	150
4.	2019-2020	Direct dibbling	*A. marina*	50
			Total	**350**

2.2.1. Plantation during 2015-2016 in 150 ha

The site of plantation at Katpor has naturally growing *A. marina* extending from lower littoral to the mid-littoral zone. The plantation site is near to this luxuriantly growing mangrove patch. The site is behind the naturally growing plants away from the waterline; however, every day tidal flushing keeps this site quite healthy. The 150 ha mangrove plantation during 2015-2016 at Kantiyajal was carried out in two blocks. Of the total 150 ha, 70 Ha plantation activities were carried out following nursery method and remaining 80Ha area by Otla bed (Fig. 4). The *Otla* beds of 1 x 1 x 1 m were prepared to improve the mangrove density. *A. marina* saplings were transplanted at a distance of 2.5 x 2 m. Totally 32,000 such beds were prepared in the 80 Ha and the plantation activities were taken care by M/s. Gujarat Ecology Commission. *A. marina* was the preferred species for plantation in both the blocks.

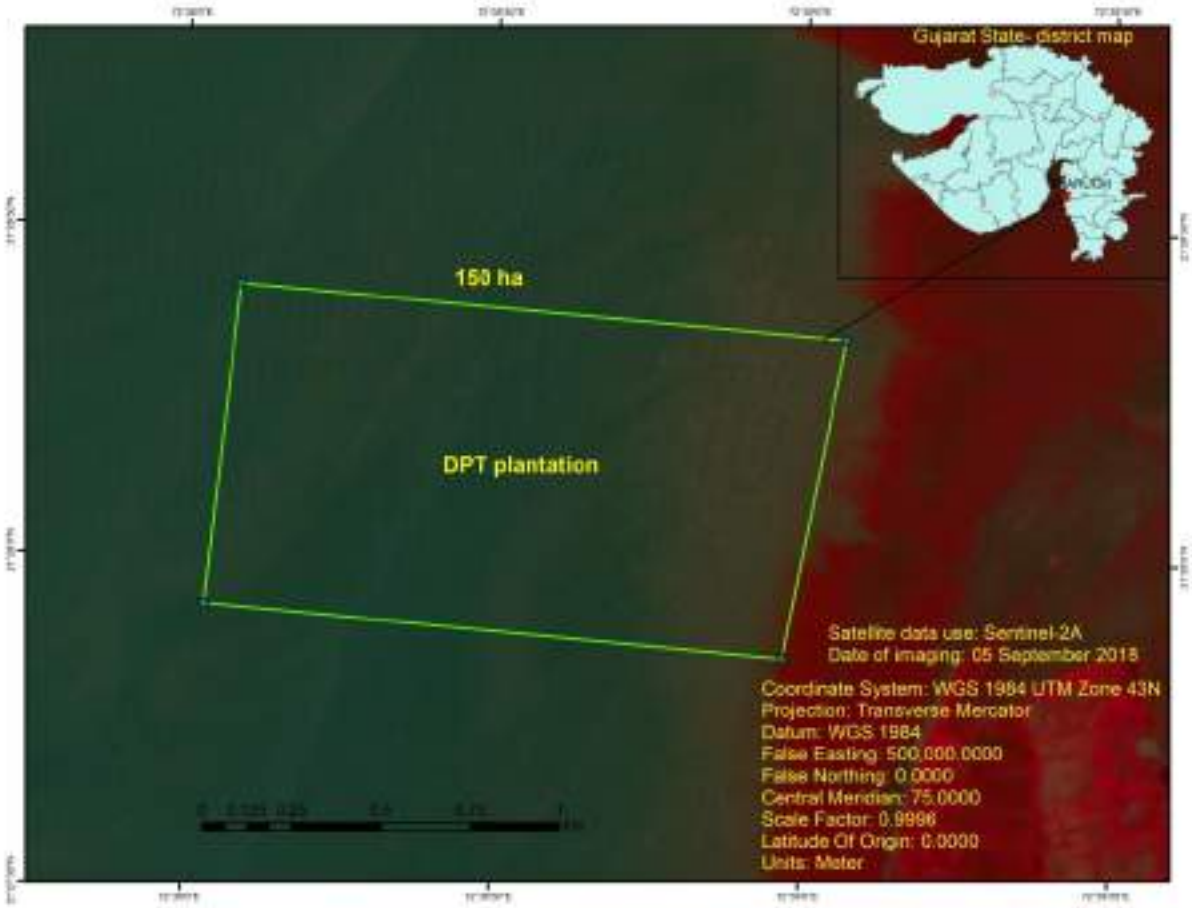

Figure 4: Mangrove plantation along the coastal region of Kantiyajal (150 ha)

2.2.2. Plantation during 2016-2017 at AliaBet (150 ha)

The plantation site is locally called as "Lalavi area of Alia Bet". The site is little far away from the approach road and is closer to water front (Fig.5). The plantation site is situated near the aquaculture ponds and a small creek passes through the plantation site. The 150 Ha mangrove plantations during 2016-2017 were carried out in two blocks. Of the total 150 ha plantation, 115 ha was carried out following nursery method and in the remaining area by direct seed dibbling method. All plantation activities were taken care by M/s. Gujarat Ecology Commission. *A. marina* was transplanted in 115 ha and *R. mucronata* was planted in 35 Ha.

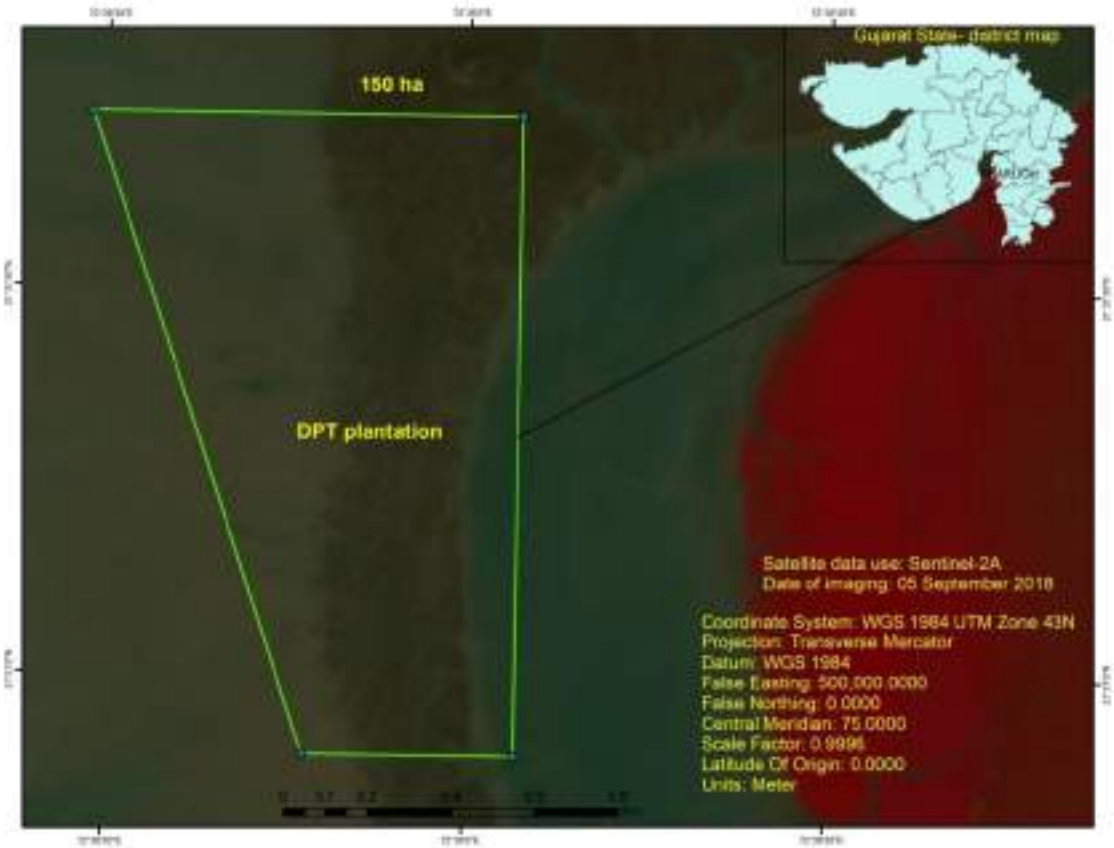

Figure 5: Mangrove plantation at Alia bet (150 ha)

3. METHODOLOGY FOR PLANTATION ASSESSMENT

3.1. Evaluation of Biomass, survival rate and growth of plantation

The field surveys will be undertaken for the year 2021-22 to assess the overall plantation status at Sat Saida bet, Nakti creek of Kandla and Kantiyajal in Bharuch district. To assess the survival rate (%) of the mangrove plantation, the area will be divided into uniform grids and will be randomly chosen to count the surviving saplings in each grid and density of the plants. The assessment will be carried out during low tides by using quadrate method, making plots of 10×10 m size. In each quadrate, the number of planted saplings and their corresponding height will be recorded. The present will be conducted study to evaluate the success of plantation *i.e.*, percentage of survival rate, growth, and plant density the baseline density will be fixed at the rate of 1×1.5 m.

Based on the GIS co-ordinates all the plantation sites will be plotted on Google earth before the initiation of the survey. Detailed discussion will be held with the officials of implementing agencies, *i.e.*, Kachchh forest division and the Field supervisor and all relevant information and documents such as plantation registers, local maps, address and personnel involved will be gathered. Further, assistance will be requested to intimate the respective Range forest office to support the investigation team.

3.2. Carbon Sequestration Potential of Planted Mangroves

3.2.1. Sampling of Soil and Plant Biomass

The sites for collection of soil and mangrove plants will be identified through surveys and satellite imageries obtained from NRCC, Hydrabad. The survey and sampling involves (i) identification of sampling sites in and around the mangrove plantation based on different age/height classes of mangroves, (ii) collection of sediment and mangrove plants from the selected study area to ascertain the above ground biomass and below ground biomass and (iii) processing the samples for Total organic carbon (TOC) (%), bulk density and plant biomass estimations.

a. Analysis of Soil

Based on the above criteria one time random sampling will be carried out following standard protocol for all the analysis. Sediment samples will be collected using an Auger from 100 cm depth *i.e.* 0-25,25-50,50-75 cm and 7- cm from few locations to get composite samples (Plate 1). The samples will be placed in pre-cleaned airtight plastic bags which are labeled and subsequently transferred to the laboratory for further processing and analysis. The samples will be air-dried at normal room temperature (Jackson, 1958), homogenized using an agate mortar and pestle, and sieved through a standard sieve of 2-mm mesh (Tandon, 2005). The particles with size less than 2mm will be retained in pre-cleaned plastic bottles for bulk density and Total Organic Carbon (%) estimations.

Plate 1: Sediment core sampling at Mangrove plantation sites

b. Analysis of bulk density of soil

A known quantity (20 g) of dry soil samples will be taken to which a known volume of water (50 ml) will be added. At least 5 ml of water above the soil surface will be kept in an undisturbed condition for 30 min. The final volume of soil plus water will be noted and bulk density will be calculated as follows:

Bulk density = weight of soil (g) / Volume of soil (g/ml)

c. Total organic carbon in the soil (El Wakeel and Riley, 1956)

The total organic carbon (TOC) (%) will be estimated following the chromic acid digestion and phenonthroline indicator method (El Wakeel and Riley, 1956), wherein the organic matter is oxidized with a mixture of potassium dichromate and concentrated sulphuric acid, utilizing the heat of dilution of the acid to speed up the process. The unspent potassium dichromate will be back titrated against ferrous sulphate solution. The total carbon calculation will be as follows:

Ferrous ammonium sulphate (ml) (T) = Titerate for Blank – Titrate for sample

Total organic carbon (TOC) in sediment (mgC/g) (X) = 1.14 × 0.6 × T

Total organic carbon (TOC) in sediment (%) = X / 10

Total carbon in sediment (%) = TOC ÷ 2

Calculation of carbon stock in sediment soil

Carbon stock in sediment up to 100 cm will be calculated as follows:

Carbon stock in sediment (%) = Bulk density (g/cm^3) × Total carbon (%) × Soil depth interval (cm)

Calculation of CO_2 equivalent

CO_2 equivalent will be calculated as follows:

CO_2 equivalent (%) = carbon stock × 3.67

d. Carbon content in Mangrove Biomass

Effective management and conservation of the mangrove forests are often dependent on spatially explicit assessments, involving nature of mangroves, estimation of biomass and carbon through routine field-based inventories which represents a challenging task and impractical for large-scale plantation. Alternative approaches based on geospatial technologies are needed to support this estimation in large areas. However, spatial data processing and analysis approaches for estimation of mangrove biomass and carbon have not been adequately investigated. A spatially explicit analytical framework that integrate remotely sensed data and spatial analyses approaches to support the estimation of mangrove biomass and carbon stock and their spatial patterns (Tang *et al.*, 2016) widely used in tropical countries was found more appropriate and hence it will be adopted in this monitoring programme. The spatial analysis framework and software toolkit provide solid support for the estimation and relative comparisons of mangrove related metrics as a feasible solution for estimating the distribution of mangrove biomass and carbon.

For biomass estimation, the mangrove girth is generally measured at 1.3 m height for large trees. Since the plantation stands are young, the whole plant will be uprooted for assessing the biomass. In each pit, two mangrove plants will be collected by complete uprooting of the individuals at each site. Individual plants will be packed and labeled. In the laboratory, the plant samples will be washed thoroughly under tap water several times followed by rinsing with deionized water, drained, and then chopped and separated into root and shoot using a plant cutter. Fresh weight of the samples will be taken and subsequently oven dried at constant temperature. Total biomass will be directly estimated by summing the dry weight of above ground and below ground biomass.

Carbon biomass

The biomass will be converted into carbon biomass by multiplying by a factor of 0.42, *i.e*. Carbon biomass = Total Biomass× 0.42

Carbon biomass per hectare

Carbon biomass per hectare will be calculated by multiplying the carbon biomass with tree density per hectare, i.e.

Carbon biomass (kg/ha) = Carbon biomass × Density of plants per hectare.

Carbon biomass (t/ha) = (Carbon Biomass × Density of Plants per hectare) / 1000

Calculation of CO_2 equivalent

Carbon biomass value will be converted into carbon dioxide equivalent by multiplying carbon biomass with 3.67 *i.e.*

CO_2 equivalent (%) = Carbon Biomass × 3.67

4. RESULTS:-

4.1. Mangrove Plantation Evaluation at Nakti creek

The assessment of mangrove plantation at Nakti creek is detailed in Table 5 and 6. Two mangrove plantation sites covering an area of 50 ha and 100 ha were developed along the north-eastern bank of Nakti creek, one of the major creek system of Kandla. The main creek and its branches are getting inundated by 3-4 m of tidal water during high tide period. The two mangrove plantation sites were developed in this site which is adjacent to each other that experiences good tidal flooding. The present study includes site visits and evaluation of the plant growth, canopy cover, survival rate and carbon sequestration potential of plantation area. The findings based on site visits and subsequent data analyses are given below:

4.1.2. The 50 Ha Mangrove plantation area

The 50 ha mangrove plantation at carried by the Patel construction, Gandhidham during the year 2008-2009, *Avicenna marina* was the candidate species. To evaluate the *A. marina* plantation success at Nakti creek i.e. survival percentage and growth rate, initial plantation density of 6600 saplings/ha as a baseline density was considered. Therefore, in the present study six (6) quadrates (10×10m) were laid to evaluate the growth and survival of *A. marina*. The results revealed that the survival rate of *A. marina* in this block was moderate with 33.33%. The density ranged between 900 individuals/Ha and 2400 individuals / Ha with an average density of 2200 individuals /Ha (Table 5 & Plate 2). Similarly, the plant height ranged between 0.70 m to 2.10 m with an average of 1.10 m. The canopy cover ranged between 0.30 m^2 to 6.75 m^2 with an average of 2.02 m^2. The plant girth (GBH) values were ranged from 7 cm to 37 cm with an average of 15.04 cm.

The larger values of girth indicate the presence of multistem plants. It is known that direct dibbling and nursery raised transplantation are superior to *Otla* bed technique. Moderate survival of planted *A. marina* could be ascribed to mixed plantation techniques as more than two species, namely *Rhizophora mucronata* and *Ceriops tagal* were planted at this site.

4.2. *Avicennia marina* plantation during 2010-2011 in 100 Ha

4.2.1. *A. marina* plantation in 90 Ha

In total, 10 quadrates were laid at this site to assess the *A. marina* survival percentage. As observed at the *A. marina* plantation in 50 ha of Nakti creek block, this site also showed reduced survival rate (24.2%). The plantation density ranged between 900 individuals/ ha and 3400 individuals/Ha with an average density of 1600 individuals/Ha. In this block, the height of the plants ranged between 0.70- 2.80 m with an average height of 1.14 cm was recorded (Table 6; Plate 3). The GBH in this plantation varied from 6 - 45 cm with an average value of 14.3 cm. The minimum and maximum canopy index in this plantation stand ranged from 0.30 to 14.0 m^2 with a mean value of 2.83 m^2. Even though the plantation activities were carried out near the creek system, moderate survival of planted mangroves could be due to mixed plantation techniques.

4.2.2. *Rhizophora mucronata* plantation in 5 ha

During the surveys, no plants were found inside the quadrates laid because *R. mucronata* was planted along the creeks. Nevertheless, *R. mucronata* saplings were recorded outside the quadrates with height varying from 50-60 cm. Around 10 individuals were seen during the entire survey. Thus, it was apparent that growth status of *R. mucronata* in 5 ha was poor. Unlike *A. marina*, *R. mucronata* needs 20 - 25 days of tidal flushing in a month and can tolerate only moderate salinity. The high water current and soil erosion might have affected the survival of *R. mucornata* plantation. During the field surveys, it was recorded that the saplings were invaded by the alga *Enteromorpha* sp. and lack of regular tidal flushing was another factor such status. All these factors could have been attributed to the survival of *R. mucronata* plantation at on meager rate. Kachchh is the semi-arid region has high salinity and low rainfall, the survival of mangroves is always a challenging task. The habitat conditions suits *A.marina* was bringing out multispecies in such area will be more important to enhance the coastal biodiversity, even though, the survival of the other species was low due to environmental conditions.

4.2.3. *Ceriops tagal* plantation in 5 ha

Similar to *R. mucronata* plantation in 5 ha at Nakti creek, no individuals of *C. tagal* could was found inside the laid quadrates. A total of 20 individuals of *C. tagal* with 40-45 cm height were noticed outside the quadrates. Similar to *R. mucronata*, plantation site of *C. tagal* was also invaded by algae and regular flushing by tidal water was lacking. *C. tagal* and *R. mucronata* are frontline mangroves and thus regular tidal flushing is essential. Algal infestation on mangroves needs regular monitoring and manual removal to help the plant to survive. Physical protection and regular monitoring of mangrove plantation stand are the best conservation efforts that will yield positive results (Plate 4).

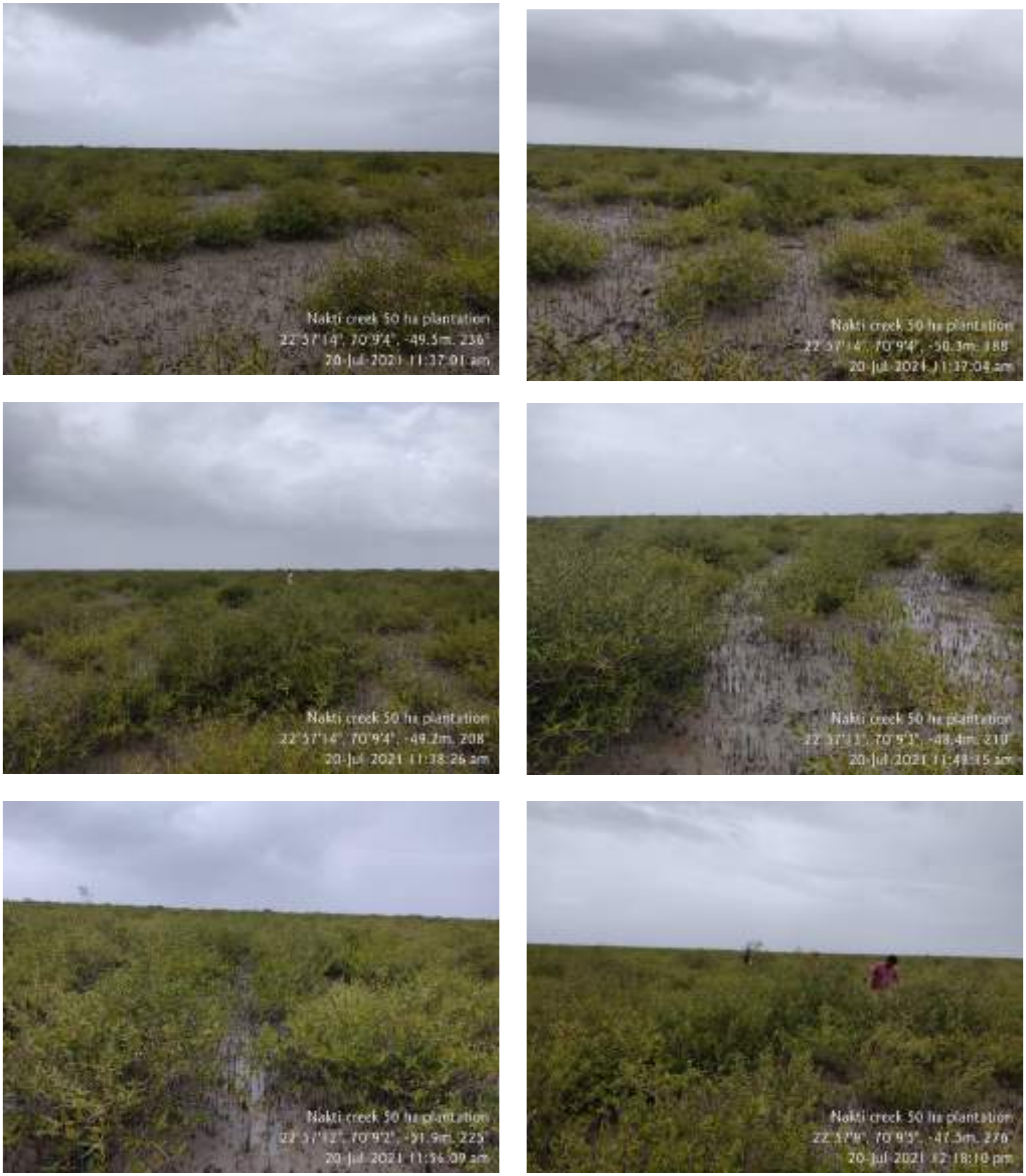

Plate 2: Mangrove plantation of *A.marina* (50 ha) at Nakti creek

Plate 3: Mangrove plantation of *A.marina* (100 ha) at Nakti creek

Plate 4: Plantation of *Ceriops tagal* at Nakti creek area

4.3. Katpor Mangrove Plantation

The 350 ha mangrove plantation was carried out at the coastal stretch of Katpor village near Kantiyajal at Bharuch district. This plantation was carried out in two blocks of 150 Ha each during the year 2015-16 and 2016-17 and 50 ha during the year 2018-19. Gujarat Ecology Commission (GEC), Gandhinagar executed this plantation with the community participation through *Samiti* at the Katpor village.

4.3.1. A. marina and *R. mucronata* plantation during 2015-2016 (150 ha)

A total of 16 quadrates were laid in this block for assessing mangrove survival success. As per earlier report by GEC (2015-2017), at this site only *A. marina* individuals were planted. However, our field surveys revealed that this block had *R. mucronata* saplings in addition to *A. marina* (Table 7 and Plate 5). An average density of 3000 individuals/Ha was recorded for *A. marina*. The maximum of 5200 individuals/ha was reported at Q1 and minimum of 1200 individuals/Ha is reported at Q8 and Q10. The height of the plants ranged between 0.90m to 2.20 m with an average of 2.23 m. The GBH of the plants ranged from 7 cm to 25 cm with an average of 12.08 cm. The canopy circumstance of the mangrove plants varied between 0.56 m^2 and 4.40 m^2 with an average of 1.37 m^2

Similarly, average density of *R. mucronata* with 3520 individuals/ha was recorded (**Error! Reference source not found.** 8, Plate 6). The average height of *R. mucronata* as 56.85 cm and that average canopy circumstance was 138.99 cm^2 in this block. *R. mucronata* being a frontline mangrove, its plantation was carried out towards the lower intertidal region. Continuous tidal flushing and following appropriate zonation pattern during plantation could have been attributed to higher survival percentage of *R. mucronata*. The survival and growth of mangrove plantation at this site was excellent because of continues water inundation, large extended inertial mudflats.

Plate 5: *Avicennia marina* plantation at Katpor coast

Plate 6: *Rhizophora mucronata* plantation at Katpor coast

4.4. Soil Carbon sequestration potential at Nakti creek mangrove site

At Nakti creek the average carbon biomass of *A. marina* plantation was 45.27t/ha. Whereas, at 50 ha mangrove plantation area, the soil carbon biomass ranged from 53.79 to 42.364 t/ha with an average of 51.757 t/ha. Irrespective of the height, the Carbon sequestration potential was better in 100Ha plantation when compared with 50Ha plantation at Nakti creek. The average CO_2 equivalent in percentage (dry weight and soil) of *A. marina* plantation of 100Ha and 50Ha at Nakti creek was 230.25 and 189.95 respectively. Among the two locations, 100 ha plantation sites showed the highest Carbon sequestration potential for Nakti creek (Table 3 & 4).

Table 3: Soil Carbon stock in Nakti mangrove plantation site- 100 ha

Sampling Blocks	Depths	% of TOC	Total carbon (%)	Bulk Density (g/ cm^3)	Carbon stock (%)	Carbon stock in 1 m (t/ha)	CO_2 equivalent (%)
NC 1	25 cm	0.34	0.18	1.28	5.83	84.315	309.43
	50 cm	0.37	0.20	1.30	12.85		
	75 cm	0.43	0.23	1.25	21.56		
	100 cm	0.61	0.33	1.35	44.08		
NC 2	25 cm	0.43	0.23	1.33	7.66	58.63	215.17
	50 cm	0.4	0.21	1.25	13.37		
	75 cm	0.34	0.18	1.32	17.94		
	100 cm	0.28	0.15	1.31	19.65		
NC 3	25 cm	0.24	0.13	1.32	4.22	45.27	166.13
	50 cm	0.27	0.14	1.27	9.14		
	75 cm	0.21	0.11	1.28	10.80		
	100 cm	0.3	0.16	1.32	21.11		
Average Carbon stock (%)						**62.737**	**230.25**

Table 4: Soil Carbon stock in Nakti mangrove plantation site- 50 ha

Sampling Blocks	Depths	% of TOC	Total carbon (%)	Bulk Density (g/ cm^3)	Carbon stock (%)	Carbon stock in 1 m	Carbon equivalent (%)
NC 4	25 cm	0.21	0.11	1.41	3.95	42.364	155.48
	50 cm	0.24	0.13	1.25	8.02		
	75 cm	0.24	0.13	1.28	12.34		
	100 cm	0.27	0.14	1.25	18.05		
NC 5	25 cm	0.33	0.18	1.37	6.04	59.12	216.96
	50 cm	0.24	0.13	1.33	8.56		
	75 cm	0.3	0.16	1.39	16.71		
	100 cm	0.39	0.21	1.33	27.81		
NC 6	25 cm	0.51	0.27	1.28	8.74	53.79	197.40
	50 cm	0.33	0.18	1.32	11.61		
	75 cm	0.27	0.14	1.33	14.44		
	100 cm	0.27	0.14	1.32	19.00		
Average of Carbon stock (%)						**51.757**	**189.95**

Table 5: Density of mangrove plantation at Nakti creek (50 ha)

S. No	GPS Coordinates		Density (Plants/Ha)	Height (m)			GBH (cm)			Canopy cover (m^2)		
				Min	Max	Average	Min	Max	Average	Min	Max	Average
1	22°5745.3N	70°0936.7E	2400	0.70	1.75	1.12	7.00	37.00	17.04	0.42	6.75	2.97
2	22°5744.0N	70°0940.2E	2300	1.00	1.85	1.23	7.00	37.00	17.61	0.30	6.16	2.39
3	22°5952.3 N	70°0913.9E	2800	1.00	2.10	1.30	7.00	46.00	18.36	0.30	6.24	2.04
4	22°5741.6 N	70°0944.6E	2300	1.00	1.60	1.13	7.00	26.00	11.30	0.30	6.75	1.42
5	22°5939.4 N	70°0942.5E	2500	0.80	1.20	0.97	7.00	34.00	12.72	0.56	3.06	1.63
6	22°5740.9N	70°0946.5E	900	0.70	1.50	0.86	8.00	22.00	13.22	1.00	3.24	1.67
Overall average Density (plants/ha)			**2200**	**0.87**	**1.67**	**1.10**	**7.17**	**33.67**	**15.04**	**0.48**	**5.37**	**2.02**

Table 6: Density of mangrove plantation at Nakti creek (100 ha)

S. No	GPS Coordinates		Density (Plants/Ha)	Height (m)			GBH (cm)			Canopy cover (m^2)		
				Min	Max	Average	Min	Max	Average	Min	Max	Average
1	22°5745.3N	70°0936.7E	2200	0.70	1.70	1.15	7.00	31.00	17.18	0.42	8.40	3.23
2	22°5744.0N	70°0940.2E	1700	1.00	2.80	1.69	6.00	39.00	19.40	0.42	14.00	5.43
3	22°5952.3 N	70°0913.9E	2300	1.00	2.35	1.45	7.00	37.00	18.45	1.32	10.50	3.64
4	22°5741.6 N	70°0944.6E	1700	0.70	1.70	1.19	7.00	27.00	16.53	0.30	4.20	2.84
5	22°5939.4 N	70°0942.5E	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	22°5740.9N	70°0946.5E	3400	7.00	1.80	1.30	7.00	36.00	14.70	1.32	4.83	2.30
7	22°5738.9N	70°0950.3E	2900	1.00	1.90	1.40	8.00	26.00	15.70	1.56	4.20	2.70
8	22°5733.9N	70°0951.3E	900	0.80	2.10	1.50	7.00	25.00	18.30	0.56	8.40	4.40
9	22°5735.6N	70°0950.3E	900	1.00	2.52	1.75	7.00	45.00	28.06	0.72	6.25	3.74
10	22°5736.4N	70°0945.6E	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Overall average Density (plants/ha)			**1600**	**1.32**	**1.69**	**1.14**	**5.60**	**26.60**	**14.83**	**0.66**	**6.08**	**2.83**

Table 7: Density of mangrove plantation of A. marina at Katpor (150 ha)

Quadrates	Density	Height (m)			DBH (cm)			Canopy cover (m2)		
		Max	Min	Average	Max	Min	Average	Max	Min	Average
Q1	5200	1.90	1.00	1.57	20.00	7.00	14.23	1.82	0.56	1.21
Q2	3600	2.00	1.20	1.56	25.00	11.00	16.00	2.10	1.10	1.57
Q3	4000	1.90	0.90	1.37	16.00	8.00	10.80	1.56	0.90	1.26
Q4	3600	1.90	1.25	1.42	25.00	9.00	15.11	2.40	0.72	1.47
Q5	3600	1.75	1.10	1.44	22.00	9.00	11.56	4.40	0.72	1.81
Q6	3200	2.10	1.00	1.44	20.00	7.00	13.63	1.82	0.72	1.32
Q7	2800	2.10	1.20	1.57	23.00	12.00	16.14	2.40	1.20	1.79
Q8	1200	1.60	1.10	1.30	13.00	7.00	10.60	1.20	1.10	1.13
Q9	1600	2.20	1.20	1.58	18.00	8.50	11.63	2.10	0.72	1.21
Q10	1200	1.20	1.00	1.10	7.00	8.00	1.10	1.10	0.72	0.91
	3000	**1.87**	**1.10**	**1.44**	**18.90**	**8.65**	**12.08**	**2.09**	**0.85**	**1.37**

Table 8: Density of mangrove plantation of Rhizophora mucronata at Katpors (150 ha)

Quadrate	**Density**	**Height (cm)**			**Canopy cover (cm^2)**		
		Max	**Min**	**Average**	**Max**	**Min**	**Average**
Q1	5200	60.00	30.00	40.70	150.00	30.00	69.23
Q2	2400	100.00	70.00	85.80	300.00	120.00	196.00
Q3	4400	70.00	65.00	78.60	500.00	72.00	305.60
Q4	3200	65.00	25.00	45.00	30.00	10.00	20.00
Q5	2400	45.00	20.00	34.16	150.00	25.00	104.10
Overall average	**3520**	68.00	42.00	56.85	226.00	51.40	138.99

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Annexure –K

Grant of License/Permission of collection and disposal of "Hazardous Waste/Sludge/ Waste Oil" from Vessels calling at Deendayal Port

DEENDAYAL PORT TRUST

ISO 9001:2008 PORT
ISO 14001:2004

Administrative Office Building,
Post Box No: - 50,
Gandhidham- Kachchh,
Gujarat State – India
Ph- (02836) 233585, 220235
FAX : (02836) 233585

e-mail:dyconservator@kandlaport.gov.in

No.MR/WK/1101 (36)/ 3267

Date :- 18/10/2021

M/s. Atlas Organics Pvt. Ltd.,
204/206, Ellisbridge, Shopping Centre,
Opp. Town Hall Ashram Road,
Ahmedabad - 380006

Sub: - **Grant of License/Permission to carry out the work of collection and disposal of "Hazardous Waste/Sludge/ Waste Oil" from Vessels calling at Kandla Port.**

Sir,

Your request for renewal Permission/License has been considered and permission is hereby granted for removal of **"Hazardous Waste/ Sludge"** from Vessels calling at Deendayal Port for the period of **One year** from the date of issue of license subject to submission of valid NOCs of PHO, Municipality, Customs and proof towards **Incinerator facility** immediately after expiry of its validity, recovery of wharfage charges and change in policy or guidelines of Kandla Port trust, Government of India and competent authority from time to time and issuance of instructions accordingly under the following terms & conditions: -

1. The Licensee should comply with the Hazardous Waste (Management & Handling Rules) 1989 as amended from time to time. **all regulations of GPCB Viz Water (Prevention & control of pollution) Act-1974, Hazardous waste (Management & Handling & Trans boundary movement rules, 2008) under Environmental Protection Act, 1986.**

2. The Licensee shall be authorized to act as occupier and operator for the purpose of collection of **Sludge, Waste/Used Oil, Dirty Ballast, Pre-wash etc.** from ships and collection of **floating Oils from Port waters, collection of Oily Wastes from Port's reception tank and any other place within Deendayal Port and same can be undertaken with** the permission of the Deputy Conservator free of cost subject to the Rules given at (1) above.

3. The Port Trust shall not be responsible for any payment to the Licensee for collecting aforesaid Waste from the Vessels, which should be settled by Licensee with the concerned Shipping Agent or Master of the Vessel.

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4. In case the Port wants to deliver any Oily Bilges/ Waste Oils etc. from the Port area, the same has to be collected by the Licensee free of charge at his own cost and responsibility.

5. Permission of the Deputy Conservator or his authorized representative has to be obtained before collection of any Sludge, Waste/Used Oils, Oily Bilges, Floating Oils, etc. from anywhere in the Port.

6. The Licensee shall collect the waste materials as above within a reasonable time as would be determined by the Deputy Conservator. The Licensee shall also ensure that the removal of Waste Oils etc. from ships will be undertaken without causing any hindrance to Port activities.

7. The Licensee shall bear the cost of the damages (without any demur, Reservation, recourse, contest and protest) if any, caused by him or by his employee to any properties of the Port or its employees.

8. The Licensee for collection of aforesaid wastes shall undertake the work with the permission of Port authorities, Master of the Vessel or Shipping Agent, Custom authorities, GPCB and Pollution Board of the respective State where dumping /recycling yard is located, for every act of collection.

9. The License would be valid as detailed above. However on satisfactory performance and compliance with the License conditions, the License may be renewed for a further period of one year at a time.

10. The Port reserves the right to alter the conditions of the License or even cancels the License at any point of time without assigning any reason thereof.

11. The License will automatically stand cancelled if the licensee does not meet any of the statutory /legal requirements of the work including those applicable for the protection of environment, deployment of man, machinery, vehicles, floating crafts etc.

12. The mode of transport / road tankers being utilized by the licensee should have proper License from the respective statutory authorities, the barges and other floating crafts being used for undertaking the subject work must have proper validity and License from Kandla Port authorities/ Sate /Central Government authorities as the case may be. The Wastes collected should be disposed off strictly in accordance with Statutory Regulation prevailing from time to time and Report to be made on Swach Sagar Portal and other Statutory bodies as required.

13. The Waste Oils should not be carried in open drums and should not cause pollution within the Port limits during transportation from Port area.

14. If the Authorization is cancelled in terms of Hazardous Waste (Management and Handling) Rules 1989 and amendments thereof by the Competent Authority any License granted by DPT shall automatically lapse till the Authorization so cancelled /suspended is restored.

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15. In the event of any dispute or interpretation of the terms of and condition or any alleged breach thereof the same shall be referred to the Sole Arbitrator of the Chairman, Kandla Port Trust or to an Authority appointed by him for the purpose. The Arbitration shall be conducted in accordance with the provisions of the Arbitration and Conciliation Act. 1996. The award of Arbitrator shall be final and binding. The Court at Gandhidham shall alone have exclusive jurisdiction to entertain and try all matter arising out of this License Agreement.

17. The Licensee shall submit a return to the Deputy Conservator during the 1st week of every Month, furnishing the details of Hazardous Waste /Sludge /Waste Oil etc. collected from the Port area under this License and the manner in which the same has been disposed off.

18. A report may be submitted to PHO on collection, if any from each Vessel before sailing of Vessels.

19 The License will be renewed further subject to conditions that work is **carried out** during the license period.

20. The permission/License fee payable shall be as under:-

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(ii) The quantum of License fee will be escalated every three years by 25%.

(xvii) Levy of Charges @ 790/- per MT for removal of sludge/waste oil subject to approval of 'TEMP' by inclusion of the same in SOR (Only for Hazardous waste /sludge).

(iv) Levying of Wharfage charges as specified in SOR from time to time.

Yours faithfully,

18/1/21

Deputy Conservator
Deendayal Port Trust

Copy to: -
TM/CME/CE/HM/FCSO/CISF/COM (OOT)

16/10/21 O/C 16/10/21

DEENDAYAL PORT TRUST

ISO 9001:2008 PORT
ISO 14001:2004

Administrative Office Building,
Post Box No: - 50,
Gandhidham- Kachchh,
Gujarat State – India
Ph- (02836) 233585, 220235
FAX : (02836) 233585

e-mail:dyconservator@kandlaport.gov.in

No.MR/WK/1101(B)/878

Date :- 15/06/2021

To,
M/s. Aviation Corporation,
67-2-1, Shikarpur,
Bhachau – 370150.

Sub: - **Grant of License/Permission to carry out the work of collection and disposal of "Hazardous Waste/Sludge/ Waste Oil" from Vessels calling at Kandla/Vadinar/ Tuna Port.**

Sir,

Your request for renewal Permission/License has been considered and permission is hereby granted for removal of **"Hazardous Waste/ Sludge"** from Vessels calling at Deendayal Port for the period of **One year** from the date of issue of license subject to submission of valid NOCs of PHO, Municipality, Customs and proof towards **Incinerator facility** immediately after expiry of its validity, recovery of wharfage charges and change in policy or guidelines of Kandla Port trust, Government of India and competent authority from time to time and issuance of instructions accordingly under the following terms & conditions: -

1. The Licensee should comply with the Hazardous Waste (Management & Handling Rules) 1989 as amended from time to time. **all regulations of GPCB Viz Water (Prevention & control of pollution) Act-1974, Hazardous waste (Management & Handling & Trans boundary movement rules, 2008) under Environmental Protection Act, 1986.**

2. The Licensee shall be authorized to act as occupier and operator for the purpose of collection of **Sludge, Waste/Used Oil, Dirty Ballast, Pre-wash etc.** from ships and collection of **floating Oils from Port waters, collection of Oily Wastes from Port's reception tank and any other place within Deendayal Port and same can be undertaken with** the permission of the Deputy Conservator free of cost subject to the Rules given at (1) above.

3. The Port Trust shall not be responsible for any payment to the Licensee for collecting aforesaid Waste from the Vessels, which should be settled by Licensee with the concerned Shipping Agent or Master of the Vessel.

Contd..

4. In case the Port wants to deliver any Oily Bilges/ Waste Oils etc. from the Port area, the same has to be collected by the Licensee free of charge at his own cost and responsibility.

5. Permission of the Deputy Conservator or his authorized representative has to be obtained before collection of any Sludge, Waste/Used Oils, Oily Bilges, Floating Oils, etc. from anywhere in the Port.

6. The Licensee shall collect the waste materials as above within a reasonable time as would be determined by the Deputy Conservator. The Licensee shall also ensure that the removal of Waste Oils etc. from ships will be undertaken without causing any hindrance to Port activities.

7. The Licensee shall bear the cost of the damages (without any demur, Reservation, recourse, contest and protest) if any, caused by him or by his employee to any properties of the Port or its employees.

8. The Licensee for collection of aforesaid wastes shall undertake the work with the permission of Port authorities, Master of the Vessel or Shipping Agent, Custom authorities, GPCB and Pollution Board of the respective State where dumping /recycling yard is located, for every act of collection.

9. The License would be valid as detailed above. However on satisfactory performance and compliance with the License conditions, the License may be renewed for a further period of one year at a time.

10. The Port reserves the right to alter the conditions of the License or even cancels the License at any point of time without assigning any reason thereof.

11. The License will automatically stand cancelled if the licensee does not meet any of the statutory /legal requirements of the work including those applicable for the protection of environment, deployment of man, machinery, vehicles, floating crafts etc.

12. The mode of transport / road tankers being utilized by the licensee should have proper License from the respective statutory authorities, the barges and other floating crafts being used for undertaking the subject work must have proper validity and License from Kandla Port authorities/ Sate /Central Government authorities as the case may be. The Wastes collected should be disposed off strictly in accordance with Statutory Regulation prevailing from time to time and Report to be made on Swach Sagar Portal and other Statutory bodies as required.

13. The Waste Oils should not be carried in open drums and should not cause pollution within the Port limits during transportation from Port area.

14. If the Authorization is cancelled in terms of Hazardous Waste (Management and Handling) Rules 1989 and amendments thereof by the Competent Authority any License granted by DPT shall automatically lapse till the Authorization so cancelled /suspended is restored.

Contd..

15. In the event of any dispute or interpretation of the terms of and condition or any alleged breach thereof the same shall be referred to the Sole Arbitrator of the Chairman, Kandla Port Trust or to an Authority appointed by him for the purpose. The Arbitration shall be conducted in accordance with the provisions of the Arbitration and Conciliation Act. 1996. The award of Arbitrator shall be final and binding. The Court at Gandhidham shall alone have exclusive jurisdiction to entertain and try all matter arising out of this License Agreement.

17. The Licensee shall submit a return to the Deputy Conservator during the 1st week of every Month, furnishing the details of Hazardous Waste /Sludge /Waste Oil etc. collected from the Port area under this License and the manner in which the same has been disposed off.

18. A report may be submitted to PHO on collection, if any from each Vessel before sailing of Vessels.

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Yours faithfully

15/6

Deputy Conservator
Deendayal Port Trust

14/6 . O/C 14/6/21

Copy to: -
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DEENDAYAL PORT TRUST

ISO 9001:2008 PORT
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Administrative Office Building,
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Gujarat State – India
Ph- (02836) 233585, 220235
FAX : (02836) 233585

e-mail:dyconservator@kandlaport.gov.in

No.MR/WK/1101(20)/ 982 Date :- 22/06/2021

M/s. Fine Refiners Pvt. Ltd.,
105, Aangi, Arcade, Opp. Jawahar Ground,
Atabhai Road,
Bhavnagar – 364002.

Sub: - **Grant of License/Permission to carry out the work of collection and disposal of "Hazardous Waste/Sludge/ Waste Oil" from Vessels calling at Kandla/Vadinar/ Tuna Port.**

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(iv) Levying of Wharfage charges as specified in SOR from time to time.

Yours faithfully

Deputy Conservator
Deendayal Port Trust

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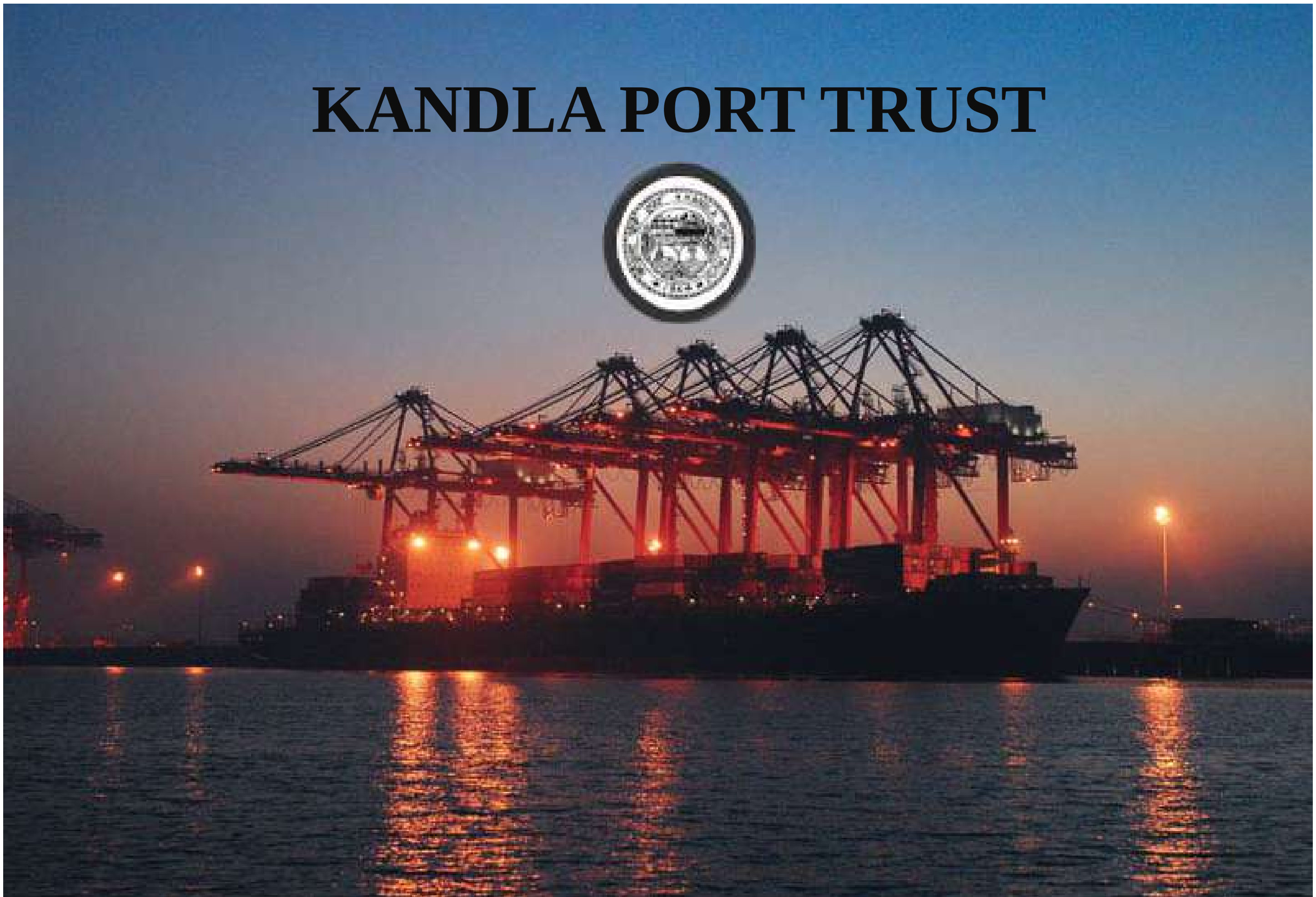
Annexure –L

Oil Spill Contingency Plan

KANDLA PORT TRUST



Conducting Various Studies for Oil Spill Contingency Plan for Kandla

Final Report

August, 2016

Femith's P.B No: 4407,
Puthiiya Road, NH Bypass,
Vennala, Kochi

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ABBREVIATIONS

CCA	Central Coordinating Authority
CIC	Chief Incident Controller
CMG	Crisis Management Groups
COMDIS	District Commander
CoC	Chain of Custody
DCP	Disaster contingency plan
DDMA	District Disaster Management Authority
DGICG	Director General Indian Coast Guard
DOSC	Deputy On-scene Commander
ECC	Emergency Control Centre
EEZ	Exclusive Economic Zone
ELO	Environmental Liaison Officer
ERU	Emergency response units
ESA	Environmental Sensitive Areas
ESC	Environmental and Scientific Coordinator
ESI	Environmental Sensitivity Index
ETV	Emergency Towing Vessel
FPSO	Floating production, storage and offloading
GoK	Gulf of Kachchh
GoKh	Gulf of Khambat
GPS	Global Positioning System
GSDMA	Gujarat State Disaster Management Authority
GSPCB	Gujarat State Pollution Control Board
HOD	Head of the Department
IAP	Incident Action Plans
IBA	Important Bird and Biodiversity Areas
ICG	Indian Coast Guard
ICMBA	Important Coastal and Marine Biodiversity Areas
IMO	International Maritime Organization
IMT	Incident Management Team
INCOIS	Indian National Centre for Ocean Information Services
IOCL	Indian Oil Corporation Limited
IPIECA	The International Petroleum Industry Environmental Conservation Association
ITOPF	The International Tanker Owners Pollution Federation Limited
KPT	Kandla Port Trust
LAG	Local Action Group
LOSCP	Local Oil Spill Contingency Plan
LRK	Little Rann of Kachchh

LST	Local Action Group Support Team
MMD	Mercantile Marine Department
MNPS	Marine National Park and Sanctury
MoD	Ministry of Defence
MoPNG	Ministry of Petroleum & Natural Gas
MoS	Ministry of Shipping
MRCC	Maritime Response Control Centre
MRC	Marine Response Centre
MRU	Marine Response Unit
NCMC	National Crisis Management Committee
NEBA	Net Environmental Benefit Analysis
NEC	National Executive Committee
NOAA	National Oceanic and Atmospheric Administration
NOS-DCP	National Oil Spill Disaster Contingency Plan
NOS	National oil spill
OCU	Offshore Control Unit
OGP	International Association of Oil & Gas Producers
OIM	Offshore Installation Manager
OOSA	Online Oil Spill Advisory
OOT	Offshore Oil Terminal
OPRC	Oil Pollution Preparedness, Response and Cooperation
OSC	On-Scene Commander
OSCP	Oil Spill Contingency Plan
OSRL	Oil Spill Response Limited
OSR	Oil Spill Response
OSRRI	Oil Spill Response Resource Inventory
PAH	Poly Aromatic Hydrocarbons
P&I	Protection and Indemnity
PPE	Personal Protection Equipment
POR	Place Of Refuge
ROS-DCP	Regional Oil Spill Contingency Plan
SCAT	Shoreline Cleanup Assesment Technique
SIC	Site Incident Controller
SEZ	Special Economic Zone
SLCP	State Level Oil Spill Disaster Contingency Plan
SMCU	Salvage Monitoring and Control Unit
SOPEP	Ship Oil Pollution Emergency Plan
SOP	Standard Operating Practices
SPM	Single Point Mooring
SRC	Shoreline Response Centre
SRU	Shoreline Response Unit
STS	Ship to Ship

TEZ	Temporary Exclusion Zone
UNEP	United Nation Environment Programme
VHF	Very High Frequency
VLCC	Very Large Crude Oil Vessels
VOC	Volatile Organic Carbon
WLS	Wild Life Sanctuary

EXECUTIVE SUMMARY

Major Port Kandla *is the northwest gateway of lndia, located strategically on western coast of the India, inside natural harbor at the head of Gulf of Kachchh. The all-weather port lying close to the important international trade routes is facilitating easy trade with various countries all over the world. Vadinar Terminal located within Kandla Port Trust limit is an integral part of it.*

Being a major port with oil handling facilities belonging to a unique ecological area in the Gulf of Kachchh region, it has to give highest priority on the environmental protection aspects including combating of adverse effects from it.

At present, Indian Coast Guard is the Central Coordinating Agency for any oil spill events in sea including the territorial water limit of the country. In this context, they have published National Oil Spill Disaster Contingency Plan (NOS-DCP). The Ministry of Shipping, the Department of Ocean Development, the Ministry of Petroleum and Natural Gas, Oil companies, Port authorities and Maritime States are the important stakeholders in the plan. In line with this, the Ports and the Oil Handling agencies have to develop local oil spill disaster contingency plan and Tier-1 pollution response capacity to address oil spills up to 700 tonnes in their respective area of jurisdictions.

Accordingly, the Kandla Port Trust (KPT) at Gandhidham, Gujarat proposes to develop "Oil Spill Disaster Contingency Plan for Kandla Port" and studies to supplement the same have been entrusted to M/s KITCO Ltd. Kochi, Kerala.

This Final Report presents the studies made in this regard in the sections such as Review of Indian Coast Guard Documents, Resources Assessment & Sensitivity Mapping Development of Response Strategy, Incident Management Mechanism, Operations Planning, Mutual Aid and Waste Disposal Plan. Summary of the study are as follows:

- *Port handles ships with a capacity above 50,000 Dead Weight Tonnage (DWT) while Single Point Moorings (SPMs) handle Very Large Crude Carriers (VLCC) having capacities ranging from 87,000 to 3,25,000 DWT. Important types of oil handled includes Crude Oil, Petroleum Oil and Lubricants (POL) products, Edible Oil and Bunker Fuel Oil. Hence, KPT* *limit is unreasonably under the oil spill threat. Vadinar being the hub, extreme caution is required for this area.*

- *Majority areas towards the coast within port limit are essentially the part of the protected areas such as Marine National Park & Sanctuary (MNPS) and Important Bird and Biodiversity Areas (IBAs). Hence, the risk of oil spill here is determined to be very high.*

- *Corals and Mangroves should be given the highest priority, followed by mudflats, fishing grounds and intake locations while responding to oil spill. Rocky Coast is having the lowest priority and can be used as sacrificial areas.*

- *From the present Oil Spill Response Resource inventory available, it can be seen that, sufficient shoreline protection and clean-up resources are not available at KPT. Hence additional resources have been proposed.*

- *Dy. Conservator, KPT have been proposed as the Chief Incident Controller who will be coordinating the response activities through Emergency Control Centre will be established at KPT office with 24 hr control room at the Port office under the supervision Crisis Management Group headed by Chairman.*

- *Circumstances of the possible spill and the surrounding environment within KPT limit calls for an early declaration of Tier-2 even in case of a smaller spill. Hence actual level of response should be fixed based on realistic observation and projections from spill scene. MoUs should be executed and maintained in such a way that optimization of resources and minimization of response time can be achieved.*

- *Temporary storage of oil waste shall be done at suitable location close to the staging area after ensuring that there is no threat for ground water utilized for domestic and industrial purpose. Later the same can be transported to KPT and can be handed over to approved oil waste dealer or recyclers.*

1

INTRODUCTION

Oil spill is one of the major threats for marine environment for the consequences from an oil spill is profound and can adversely affect harbors, beach, wild life, fisheries, human health, tourism and industrial plants that located far away from the original spill location. When these resources are affected, there may be a serious impact to the local economy of the affected coastal area.

Continuously increasing maritime activities, like oil tanker transportation and exploration-cum-exploitation of oil from the sea bed have focused attention on the need for an adequate system to monitor, legislate and ensure quick response to an eventuality of oil spill disaster that may take place due to an accident, releases of crude oil from tankers, accidental release of heavier fuels used by large ships such as bunker fuel or the spill of any oily refuse or waste oil.

The Oil Pollution Preparedness, Response and Cooperation (OPRC) Convention, 1990 established by the International Maritime Organisation (IMO) provides all states to establish measures for dealing with pollution incidents either nationally or in cooperation with other countries in which India is a signed party. In India, Indian Coast Guard (ICG) is the Central Coordinating Agency (CCA). As per National Oil Spill Disaster Contingency Plan (NOS-DCP) promugulated by ICG the emergency response operations with in the port limit is the resposiblity of the port authority.

Kandla port is one among the thirteen major ports of India located in Gulf of Kachchh (GoK) which hosts one of the world’s splendid ecosystems and its rich & highly bio-diversified intertidal flora and fauna. During the financial year 2014-15 the port handled 92.50 MMT cargo. Kandla & Vadinar terminals were visited by 1724 & 530 ships respectively during the same period including Very Large Crude Carriers (VLCC). Also the coast is active and occupied with human settlements and other socio-economic resources, co-existing with the nature, its treasures and threats. Being situated in coastline which has ecological, biodiversity, historical and economic significance at the same time oil spill can cause long term impacts, including threatening the life of these distinguished resources. Also high tidal ranges and strong tidal streams of the area escalate the impacts of oil spill. Hence oil spill events in the region of Kandla Port will turn out to be sensitive. In this context the protection of coastline with distinct & highly productive ecosystems is a responsible task. Therefore preparedness or contingency planning for adressing oil spills is highly required for KPT.

In view of the above, the KPT, Gandhidham, Gujarat proposes to develop "Oil Spill Disaster Contingency Plan for Kandla Port " and studies related with the same has been entrusted to M/s KITCO Ltd. Kochi, Kerala.

Since Kandla port and its surroundings have been extensively studied, primary data collection is not generally anticipated and included in the present proposal. From the various published reports and research papers and through reconnaissance surveys, the sensitivity of the shoreline will be documented which will form the basis of the study. Site visit was conducted by KITCO, detailed discussion was held with Marine Department and also interactions were done with various other departments for the collection of relevant detail for supporting oil spill contingency planning studies, based on the above and the comments received from time to time this Final Report was presented herewith.

2

PROJECT BACKGROUND

In India, the responsibility for coordination of oil spill emergency response was transferred from Director General of Shipping to Indian Coast Guard (ICG), Ministry of Defense, Govt. of India on 7th March, 1986 by an Office Memorandum of the Ministry of Defence dated 07 March 1986 and further, by amendment to the Government of India (Allocation of Business) Rules, 1961 vide Gazette notification dated 12 December 2002. The Indian Coast Guard has been designated as the Central Coordinating Authority (CCA) for combating oil spills in Indian waters and undertaking oil spill prevention and control. Maintaining of pollution response resources by a singular government agency like Indian Coast Guard for a developing country such as India is not cost effective. The most economical solution is achieved through pooling of resources and integrating the capability available with other agencies for national cause. Pollution response unlike other crisis management, is a specialized subject and requires elaborate preparatory measures and availability of skilled manpower. In this context in order to delineate entire national preparedness and response system including both public and private resources for responding to an oil spill emergency, ICG had prepared a NOS-DCP which describes the basic framework and guidelines for a national response to a significant spill at sea.

NOS DCP is the apex guidance document for acting on emergencies within the geographical profile of coastal water in India. This plan is intended to delineate functions of various concerned departments and agencies for the operational responsibility to marine incidents which could result due to spillage of oil into water. The plan also provides the frame work of co-ordination of integrated response by various government departments and agencies to protect the environment from the deleterious effects of pollution by oil. It is intended to promote the development of regional and local contingency plans in the three coast guard regions, various ports, offshore petroleum exploration and production agencies, and coastal state pollution control boards for prevention and response of water pollution and other authorities to be able to respond to any further national oil spill disaster contingency. The NOS-DCP has been in operation since July 1996 and brings together the combined resources of:

- The Government of India including that of the Indian Coast Guard;
- The State Governments including emergency services; and

- Ship, ports, and oil industries.

Since 1993 the year when the NOS-DCP was formalized, the Indian Coast Guard has been very persistent in endorsing two preventive measures, the first one establishing a “Contingency Plan” and the second “Maintenance of Tier – 1 pollution response capability” by the ports, oil handling companies and the State Government. The latest NOS-DCP has been published in 2015. Further, NOS-DCP circulars on oil spill response preparedness has been published time to time which gives guidance on the preparation of oil spill contingency plan at various levels. In order to plan for the range of potential spill sizes, from small operational spills to worst-case scenarios, local authorities need to develop their plan based on the internationally recognised tiered response that classifies oil spills into three categories by IMO as follows:

(a) Tier-1 is concerned with preparedness and response to a small spill within the capabilities of an individual facility or harbour authority. 700 tonnes is often cited as the upper limit of ‘Tier-1’. However, the circumstances of the spill and the surrounding environment will determine the actual level of response.

(b) Tier–2 is concerned with preparedness and response to a spill that requires the co-ordination of more than one source of equipments and personnel. For a Tier-2 response, assistance can come from a number of entities within a port area or from sources outside the immediate geographic area. Tier-2 describes a wide range potential spill scenarios and deals with operational spills upto 10,000 tons.

(c) Tier-3 is concerned with a major spill requiring the mobilization of all available national resources and depending upon the circumstances will likely involve mobilization of regional and international systems. It deals with the spills of more than 10,000 tonnes.

As per the directives of the Ministry of Shipping (MoS) and Department of Oil Industry Safety Directorate (Ministry of Petroleum and Natural Gas), the Ports and the Oil Handling agencies are to establish oil pollution contingency plan and Tier-1 pollution response capacity to address oil spills upto 700 Tonnes in their respective area of jurisdictions. With the initiative made by the Indian Coast Guard, a major step has been instituted since the 9th NOS-DCP meeting to conduct audit of Tier –1 facilities of Port and Oil handling agencies. Regional co-orperation is required to combat Tier 2 & 3 spills. ICG recommends the maritime facilities and the coastal states to undertake mutual aid agreements for the same and present escalations of resources considering potential pooling in the regional scale.

This report have been prepared in this context to support the oil spill contingency planning studies of Kandla Port Trust for catering Tier-1 spill. The port belong to the Risk Category –A for an oil handling port with SPMs & STSs.

Located in the Kandla Creek, in the western most part of Little Rann of Kachchh (LRK) at the mouth of GoK, the port area is immedately surrounded by high density of creeks, mangrove swamps, mud, patches of dry salt waste Rann, vast salt pan and aquaculture ponds. However the port limit extends to Vadinar in the southern arm which is located admist of the extremely sensitive coastline with rich corals and islands, where the SPMs and other oil handling facilities are operating for various petroleum companies, which are essentially part of the protected areas Marine National Park & Sanctuary (MNPS) and Important Bird and Biodiversity Areas (IBAs). Flora constitutes the alage, sea grass, herbs, shrubs and trees is dominated by mangroves and fauna constitutes the mammals, birds, reptiles, arthropods, amphibians, fishes etc. Eventhough less productive segment compared to the southern arm of GoK, area between Mundra and Kandla is having comparitively higher sensitivity than the rest of northern coastline of Gujarat with exception to the Kori creek area (Vijayalakshmi Nair, NIO).

The area is located close to the international shipping line and is an aproach for another 5 ports. Presently there are oil handling facilities of Reliance, IOCL, BORL including SPMs within the Kandla port limit near Kandla, Oil berths at Kandla creek and another SPM is to be operational off Veera, also being located close to the busy international shipping routes, the area is unreasonably under the oil spill threat. Hence the risk of oil spill in this area is determined to be very high (Sensitive Coastal Marine Areas of India, Oil Spills and their Impacts, Indian Coast Guard). The port is already having an Oil Spill Contingency Plan in place and Oil Spill Response (OSR) resources are inplace. In this context supplementing studies for the contingency planning for Kandla Port Trust was conducted covering the following aspects.

- Review of Indian Coast Guard Documents including NOS-DCP 2015 and relevant circulars.
- Environmental Resources Assessment, Identification of Coastal and Shoreline Zones and Sensitivity Mapping
- Development of Response Strategy including- selection of response resources and infrastructure facilities to be in place.
- Detailing of Incident Management Mechanism
- Operations Planning
- Oil Waste Disposal Plan
- Mutual Aid Provisions available

3

SCOPE & OBJECTIVE

3.1 Scope

To support the preparation of Oil Spill Contingency Planning for Kandla Port Trust which will be base document for the emregency preoardness, response and mitigation during an oil spill in accordance with NOS-DCP 2015 and is to comply with its ammendment issued from time to time.

3.2 Objective

- To ensure the protection of marine as well as coastal environment including its dependents within its jurisdictional limit
- To assist the national cause by supporting distressed group affected by oil spill through Mutual Aid outside its jurisdictional limit

3.3 Responsibility

The details of responsible combat agaency during various spill scenarios are given as **Table 3.1** below.

Table 3.1. Responsible Combat Agencies

Sl. No	Jurisdictional Limit	Type of Spill	Responsible Combat Agency	
1	Within Port Limit	Tier-1	KPT based on NOS-DCP,2015	ICG may assist if requested by Port Authority
		Tier-2/3	ICG	
2	Outside Port Limit Marine	Tier-1/2/3	ICG	
3	Outside Port Limit Shoreline	Tier-1	Gujarat State Government	ICG may assist if requested by Port Authority
		Tier-2/3	ICG	

This document is to support the Local Oil Spill Contingency Plan (LOSCP) of Kandla port and is a property of Kandla Port Trust which is to be maintained, reviewed and updated as per ICG guidelines For executing the responsibility assigned in NOS-DCP 2015 as the Responsible Combat Agency within their Port Limit.

3.4 Statutory Requirements

As per NOS- DCP, Kandla Port is to maintain Risk Category-A. The details are already given as **Annexure.**

3.5 Geographical Limit

This facility level plan applies to the port limit of Kandla Port Trust which includes the Vadinar Terminal within the limits of Tier -1 response level.

3.6 Mutual Aid

Mutual Aid is applicable to the stakeholders of the area including ESSAR, RELIANCE, Bharat Oman Refineries Limited (BORL) & IndianOil Corporation Ltd (IOCL) terminals & operators which are operating within the port limit and also having individual facility level contingency plan and also for the ports located in the locality Navlakhi under taken by Gujarat Maritime Board and Adani Port & Special Economic Zone, Mundra for combating Tier-2 spills upto 10,000 Tonnes under the coordination of Onscene Command of Regional Commander ICG.

3.7 Interface with ROSDCP & NOSDCP

The plan provides the structure for an effective oil spill disaster contingency for Kandla Port Trust inline with the objectives of the NOS-DCP, 2015 and Regional Oil Spill Contingency Plan (ROS-DCP) & District Oil Spill Contingency Plan (DOS-DCP) prepared under North-West Region (NW) CGRHQ Gandhinagar & DHQ-1 Porbandar through the Indian Coast Guard Station (ICGS) Gandhinagar, Pipavav, Jakhau, Mundra, Veraval, Vadinar & Okha also the Coast Guard Air Enclave (CGAE) Porbandar.

During a severe spill event due to its nature, extent or both, ICG through its predesignated On-scene Commander. As already discussed in the previous section, The Regional Pollution Response Officer will be the On-Scene Commander (OSC) and act as the representative of the Regional Commander to co-ordinate all activities at the scene of pollution through the relevant District Commander (COMDIS) in the vicinity of the region/area. The Coast Guard District Commander (COMDIS) will designate an officer as Pollution Response Officer for the district who will act as the Deputy On-scene Commander (DOSC) and lead the initial response team to the scene of incidence within his area of jurisdiction under the overall guidance of the Regional Pollution Response Officer. He will be responsible for the following:

- Directing the employment of needed resources for prevention of pollution, containment, cleanup, and disposal of any pollutants, and restoration of the site
- Providing a focal point of information for all agencies concerned

- Preparing cost analysis and detailed report covering all aspects of the spill
- Collecting samples for possible analysis.

The OSC will pass on regular reports to the Regional Headquarters and the Coast Guard Headquarters, of his assessment, and of resources and assistance required. Incase if situation further worses, Tier -3 will be declared and the National On-Scene Commander will take over the authority.

4

REVIEW ON NATIONAL OIL SPILL DISASTER CONTINGENCY PLAN (NOS-DCP)

NOS-DCP published by ICG is the apex mannual for the response towards any oil spil event. In NOS-DCP efforts are taken in the direction for preparing a basic frame work towards an oil spill emergency prepardness & response towards the preparation of response plan for state/regional/port/oil installation. Inspite of its exhaustive nature NOS-DCP provides enough flexibility in the preparation of response plan for state/regional/port/oil installation.

4.1. Scope of NOS-DCP

- The plan is action oriented and covers aspects such as reporting, communication, alerting, assessment, operations, administration, finances, public relations and arrangements with other contiguous states. The plan assigns responsibility for various tasks to relevant government departments and agencies, identifies trained personnel, equipment, and surface craft, and aircraft and means of access to these resources.
- It delineates functions of various departments and agencies for the operational responsibility for marine incidents that could result due to spillage of oil into water.
- The plan also provides the framework for co-ordination of integrated response by various government departments and agencies to protect the environment from the deleterious effects of pollution by oil.
- The plan outlines combined stakeholder arrangements designed to allow a rapid and cooperative response to marine oil spills within the defined area. This plan also coordinates the provision of national and international support.
- This plan parallels similar documents dealing with the Government of India's responsibility for saving life at sea, for search and rescue and for caring for survivors brought ashore.
- The plan co-exists with incident and security plans operated by ships, ports and offshore installations. Mutual respect between those in command and control of this

plan and those in charge of all other relevant plans is imperative to ensure that all of the plans can continue to function efficiently, whatever the circumstances.

4.2. Objectives of the Plan

The objectives of the plan are:-

- To establish an effective system for detection and reporting of spills;
- To establish adequate measures for preparedness for oil and chemical pollution;
- To facilitate rapid and effective response to oil pollution;
- To establish adequate measures for crew, responders, and public health and safety, and protection of the marine environment;
- To establish appropriate response techniques to prevent, control, and combat oil and chemical pollution, and dispose-off recovered material in an environmentally sound manner
- To establish record-keeping procedures to facilitate recovery of costs.
- To maintain the evidences for the purpose of identifying the polluter and taking suitable administrative, civil or criminal action against the polluter.

4.3. National Pollution Response Areas of NOS-DCP

NOS-DCP applies to all incidents of marine casualty or acts relating to such casualty occurring with grave and imminent danger to Indian coast line or related interests from pollution or threat of pollution in the sea by deliberate, negligent or accidental release of oil, ballast water, noxious liquid and other harmful substances into the sea including such incidents occurring on the high seas.

The plan also covers all incidents in any part of the sea, or inland, that are likely to affect the maritime zones of India, that includes all the Territorial Waters and the Exclusive Economic Zone (EEZ) of India, as detailed in **Figure 4.1** , and the High Seas where an oil or chemical spill has the potential to impact on Indian interests in the maritime zones of India.

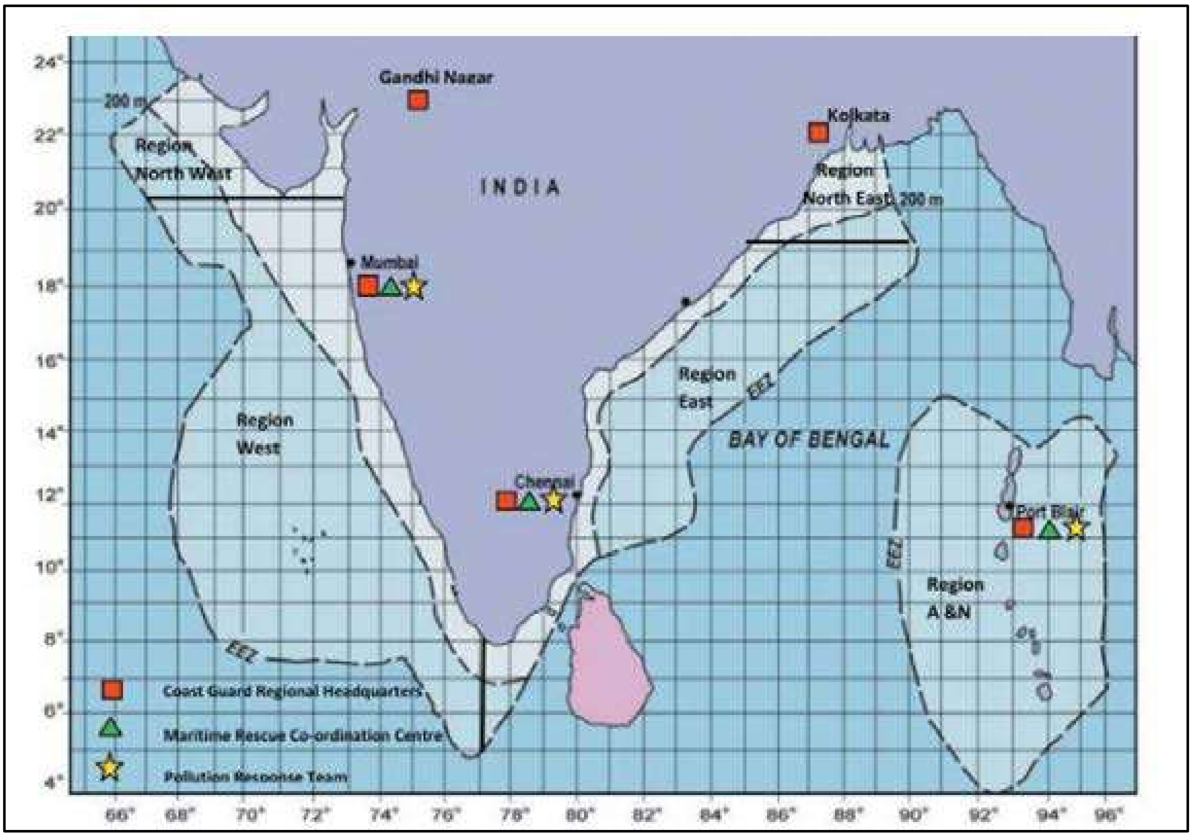


Figure 4.1. National pollution response areas

4.4. Designed spill size

The designed spill size for planning and operational reasons is 10,000 tonnes. This spill size was decided at the meeting with national plan stakeholders as the appropriate level for which to plan national equipment inventory and other resource requirements. Additionally, the oil exploration and production industries hold membership with private international oil spill response organisations for access to their equipment stockpiles.

4.5. Concept of tiered response

The size, location and timing of an oil spill are unpredictable. Spills can arise from oil loading, unloading or pipeline operations, and from a collision or grounding of vessels carrying crude oil and products in local ports or coastal waters. They can also arise from tankers or barges operating on inland waterways, or from exploration and production operations and tankers operating in international waters. Oil spill risks and the responses they require should be classified according to the size of spill and its proximity. This leads to the concept of 'Tiered Response' to oil spills. International Maritime Organization (IMO) classifies oil spills into three categories as follows.

(a) ***Tier-1*** is concerned with preparedness and response to a small spill within the capabilities of an individual facility or harbour authority. 700 tonnes is often cited as the upper limit of 'Tier-1'.

However, the circumstances of the spill and the surrounding environment will determine the actual level of response.

(b) ***Tier–2*** is concerned with preparedness and response to a spill that requires the co-ordination of more than one source of equipment and personnel. For a Tier-2 response, assistance can come from a number of entities within a port area or from sources outside the immediate geographic area. Tier-2 describes a wide range potential spill scenarios and deals with operational spills up to 10,000 tons.

(c) ***Tier-3*** is concerned with a major spill requiring the mobilization of all available national resources and depending upon the circumstances will likely involve mobilization of regional and international systems. It deals with the spills of more than 10,000 Tonnes.

4.6. Emergency Organizational Structure for Oil Spill Disasters

NOS-DCP delineated the organization structure for handling the oil spill disasters and is presented in **Figure 4.2**. In the oil spill response profile, the emergency organisation has responsibilities allocated within various groups dealing with Management Support, Coordination of Activities, Emergency Response Units and Incident Management team in place. The details of the above groups are presented below:

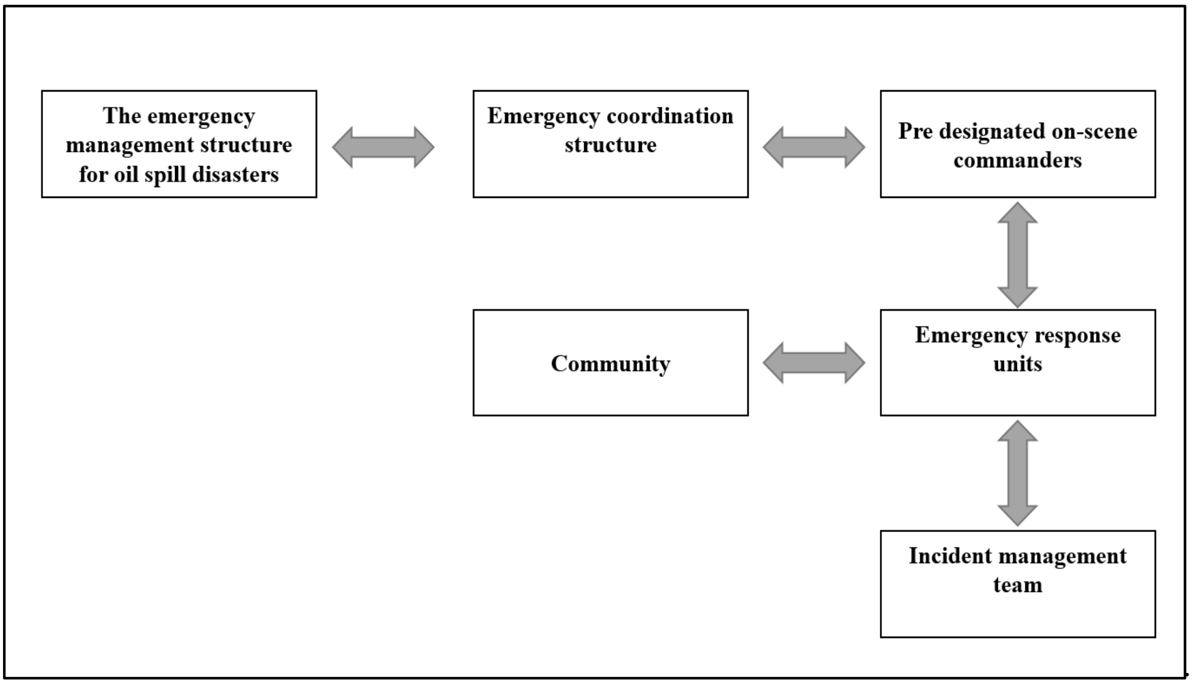


Figure 4.2. Organization structure for handling the oil spill disasters in India

4.6.1. The Emergency Management Structure for Oil Spill Disasters

Emergency management structure take the managerial responsibility at the apex operational level, in the event of an oil spill. TheNational Crisis Management Committee (NCMC) headed by the Cabinet

Secretary constitutes institutional framework of emergency management structure for the oil spill disasters. NCMC is supported by the Crisis Management Groups (CMGs) of the various central nodal ministries .

The NCMC supported by Crisis Managemnet Group will provide management, operational, technical and environmental advice and support to the combat agencies as required inregards of response to a crisis.

The Structure of Disaster Management System in India playing key managerial role in oil spill emergencies is represented in **Figure 34.3**. The composition, functional responsibilities and reporting requirements of CMG is as presented in **Annexure I**.

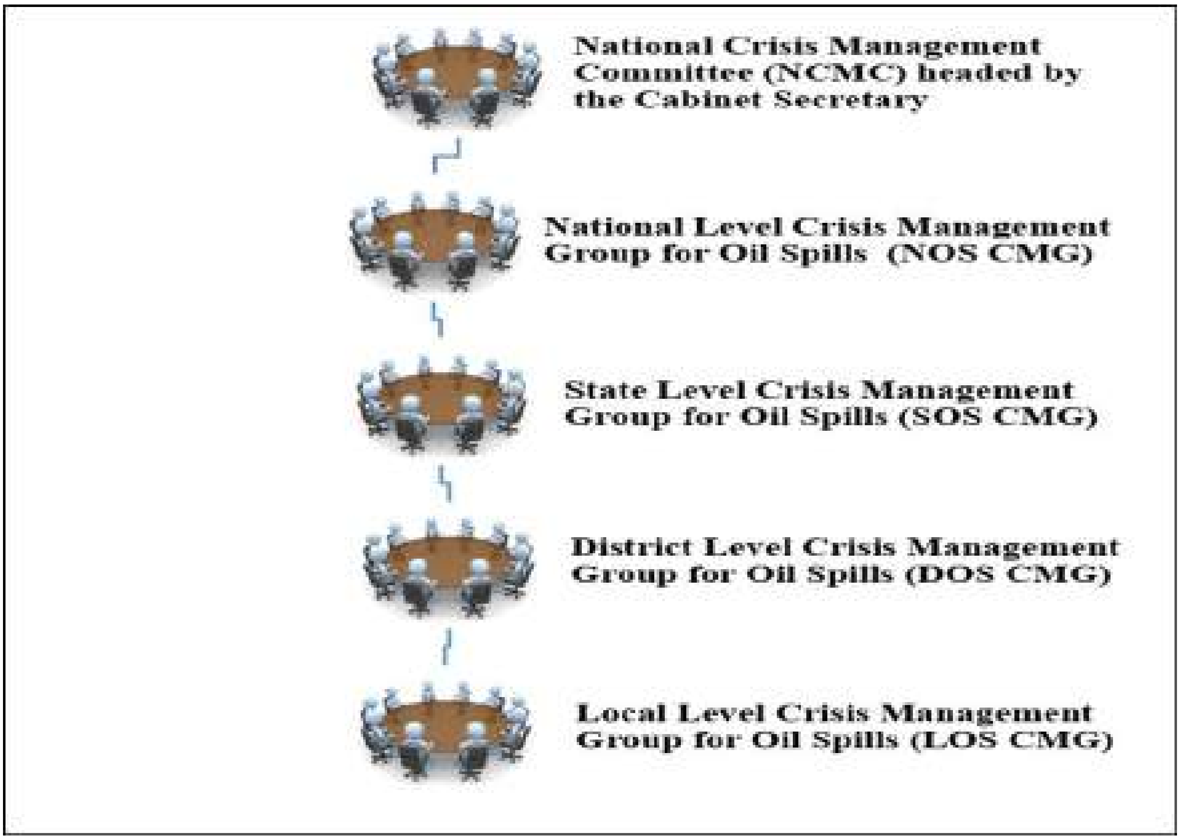


Figure 4.3. The Structure of Disaster Management System in India Playing in the Key Managerial Role in Oil Spill Emergencies

4.6.2. The Emergency Coordination Structure for Oil Spill Disasters

The coordination of an oil spil response action is executed through a well framed emegency coordination structre. The Director General Indian Coast Guard (DGICG) is the Central Coordinating Authority (CCA) and has the overall responsibility to ensure that appropriate response is made to any incidence in the seas around India. He will direct the various aspects of the pollution response operations and will be assisted by the Commanders, Coast Guard Region North West (NW), West (W), East (E), North East (NE), and Andaman & Nicobar (A&N) as required, depending on the proximity to the scene of contingency. The Regional Commanders will in turn be assisted by the Coast Guard District Commanders in the coordination of response to oil pollution within a coastal State. The emergency coordination structure as presented in NOS DCP is presented in **Figure 4.4** below.

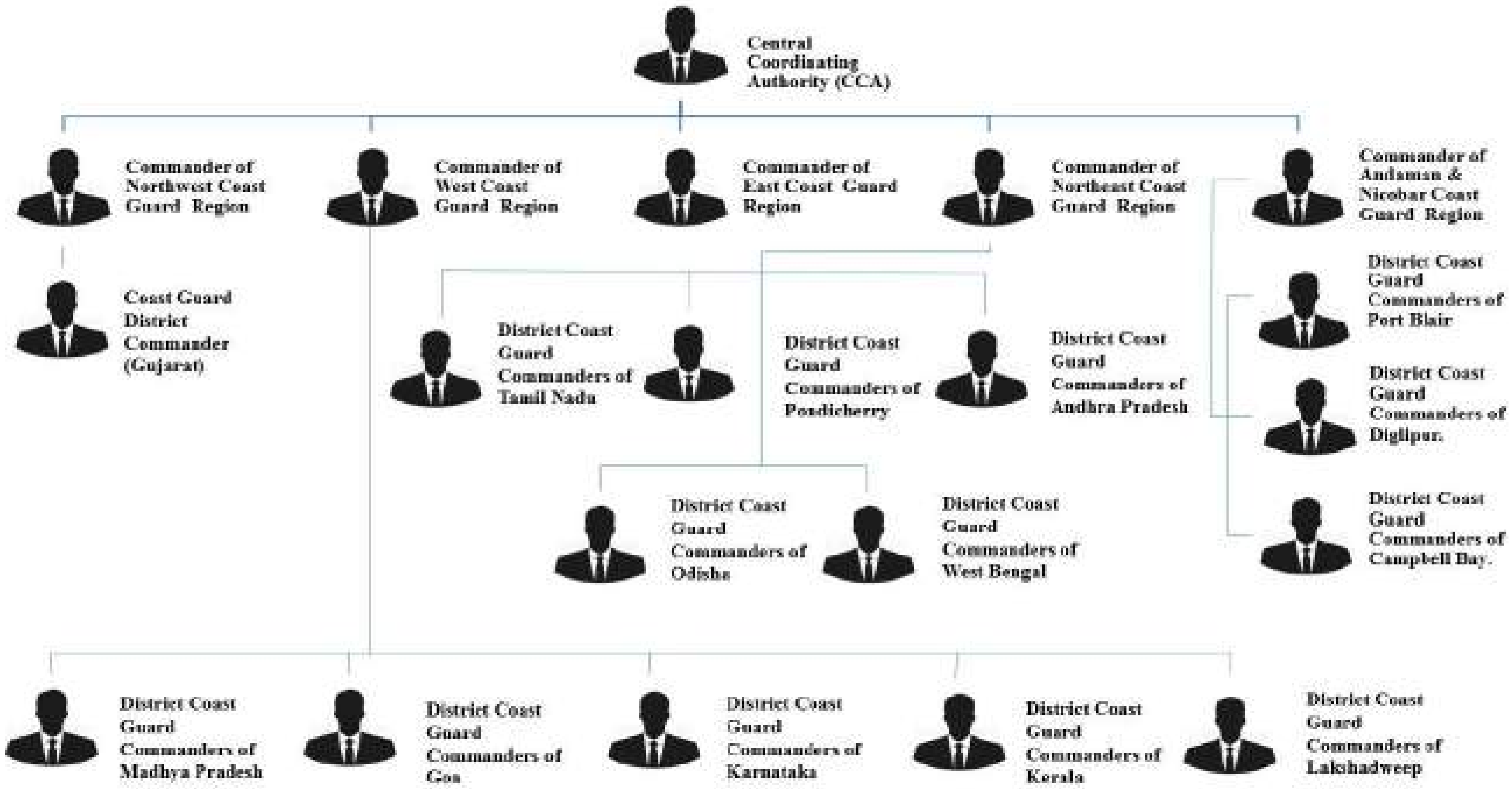


Figure 4.4. The Emergency Coordination Structure

4.6.3. Predestinated On-Scene Commanders

The management of oil spil responseaction is executed through a well structred onscene comanders group under the coordination of emergency coordination structre described above.On scene commander is a person responsible for the control and management of the marine oil spill clean-up.The Director (Environment) at Coast Guard Headquarters serves as the National On scene Commander in the event of a spill of national significance. The Regional Pollution Response Officer will be the On-Scene Commander (OSC) and act as the representative of the Regional Commander to co-ordinate all activities at the scene of pollution through the relevant District Commander (COMDIS) in the vicinity of the region/area. The Coast Guard District Commander (COMDIS) will designate an officer as Pollution Response Officer for the district who will act as the Deputy On-scene Commander (DOSC) and lead the initial response team to the scene of incidence within his area of jurisdiction under the overall guidance of the Regional Pollution Response Officer. He will be responsible for the following:

- Directing the employment of needed resources for prevention of pollution, containment, cleanup, and disposal of any pollutants, and restoration of the site
- Providing a focal point of information for all agencies concerned
- Preparing cost analysis and detailed report covering all aspects of the spill
- Collecting samples for analysis.

The OSC will pass on regular reports to the Regional Headquarters and the Coast Guard Headquarters, of his assessment, and of resources and assistance required. Organogram of predesignated On-scene Commanders is presented in **Figure 4.5**

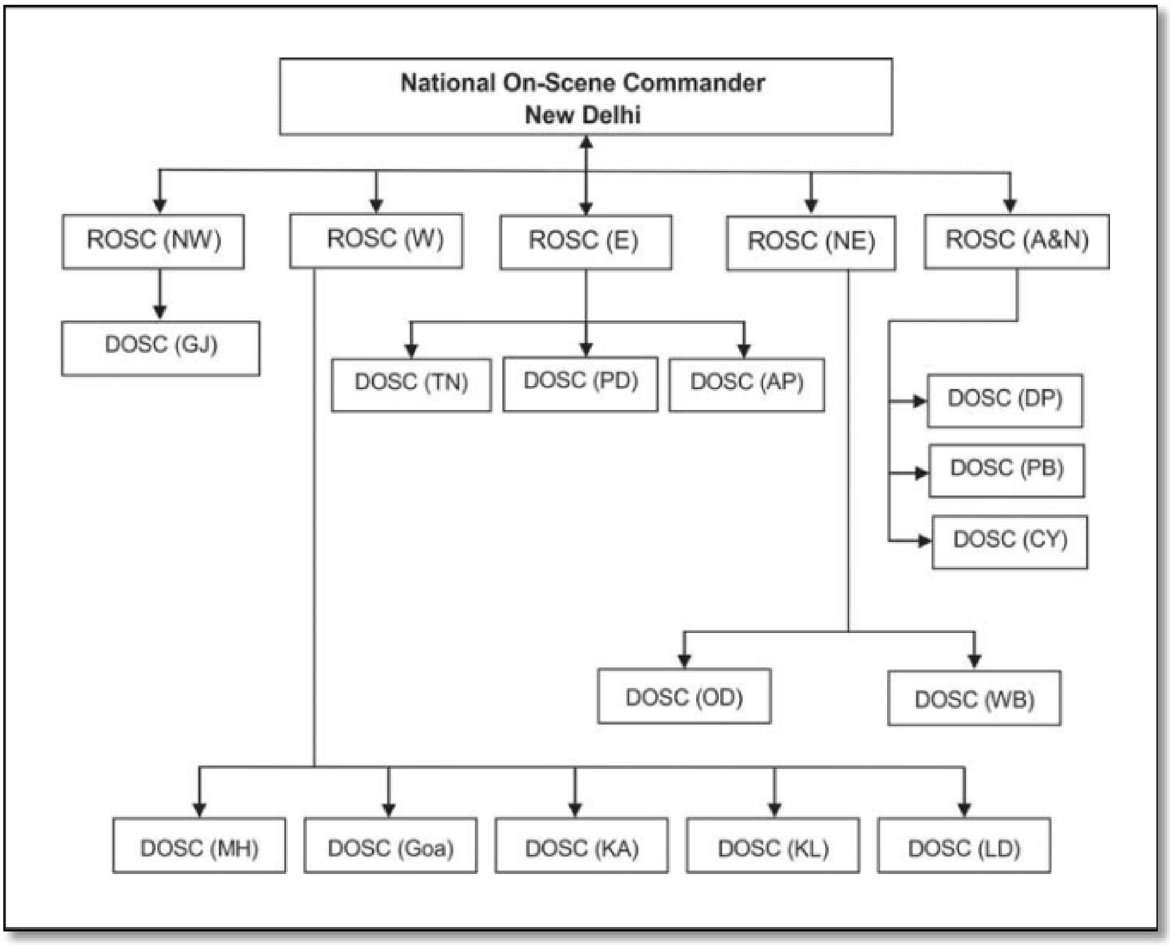


Figure 4.5. Hierarchical arrangement of On Scene Commander

4.6.4. Emergency Response Units (ERU)

The Emergency response units (ERU) may be defined as the place from which the operations to handle an emergency are directed and coordinated. It will be attended by the chief incident controller, key personnel and the senior officers responsible for control of emergency. The Emergency response unit will be equipped to receive and transmit information and directions from all the areas of the marine terminal as well as outside and will be located in an area of minimum risk.

The ERU shall be away from the potential hazards and provide maximum safety to personnel and equipment and should be preferably made of non-combustible building of either steel frame or reinforced concrete with two exists and adequate ventilation.The objective of the ERU is

- First, to prevent pollution from occurring;
- Second, to minimize the extent of any pollution that occurs;
- Third, to mitigate the effects of that pollution

Different modules of emergency units, separate, but linked, were established at fedral level inorder to direct operations in the event of an incident requiring response. These modules are presnted in **Table 4.1**

Table 4.1. Emergency response units

Sl. No	Response Unit	Title	Role
a	Salvage Monitoring and Control Unit	SMCU	To monitor and control salvage operations
b	Marine Response Centre	MRC	To direct response action at sea
c	Shoreline Response Centre	SRC	To direct shoreline response
d	Emergency Control Centre	ECC	To monitor operations to contain any potential pollution within an offshore installation and its reservoir and apart facility jurisdiction
e	Environment Group	EG	To provide environmental and public health advice to all these centers
f	Offshore Control Unit	OCU	To direct response action at offshore Installations

Not all incidents require all these emergency response units. However, the arrangements for managing the incidents must allow for the possibility of salvage operations, action at sea and action or shore taking place simultaneously.

4.6.4.1. Salvage Monitoring and Control Unit (SMCU)

Salvage Monitoring and Control Unit (SMCU) is set up by Indian Coast Guard District or Regional Commander as per the necessasity of the salvage operations involved in an event. The members of the SMCU are :

- The Indian Coast Guard District or Regional Commander;
- The Salvage Manager from the salvage company appointed by the ship owner,
- The harbour master, if the incident involves a harbour or its services;
- A single representative nominated by agreement between the ship owner and insurers (for both the physical property and their liabilities);
- The District or Regional Pollution Response Officer;
- A Surveyor from the Mercantile Marine Department
- A Surveyor from the Indian Register of Shipping, if required; and
- An Environment Liaison Officer, nominated by the Environment Group.

4.6.4.2. Marine Response Centre (MRC)

In almost all cases involving a national response, whether ship or offshore installation related, the Indian Coast Guard establishes a Marine Response Centre (MRC) at the nearest Maritime Response Control Centre (MRCC) which is a communication hub between all response centres. It contains the following persons, although some of the Coast Guard staff may play more than one role.

- An ICG Pollution Response Officer, to manage sea borne and air borne operations;
- Where a ship is involved, an Mercantile Marine Department (MMD) officer to manage cargo transfer operators;
- A Coast Guard Logistics Officer, to organize the deployment of the equipment needed and control all Coast Guard financial commitments;
- If the incident involves a port or its services, a representative of the port authority;
- An officer of the state fisheries department, to advise on the impact on fisheries and to liaise with fishing organization;
- A local administration official to act as liaison officer with the Shoreline Response Centre;
- An Environmental Liaison Officer (ELO) nominated by the Environment Group; and
- Defense Public Relations Officer, to liaison with the media

The SMCU may be co-located with the MRC, if needed and in such case , the membership of the SMCU needs to include the members of the MRC with Indian Coast Guard staff fulfilling more than one role.

4.6.4.3. Shoreline Response Centre (SRC).

When the threat of pollution at the shoreline exceeds the capability of the most affected local authority, the Coast Guard initiates a national response, and that local authority (or authorities) sets up a Shoreline Response Centre (SRC) in order to continue the response action.

Each local authority’s own contingency plan details the mechanism for escalating the response in accordance with the tiered response concept and specifies how to set up the SRC in the light of its own practices and organisation. These plans also contain the necessary authorisation to each local authority to enable the designated officer directing the SRC to take decision on behalf of the other local authorities concerned.

An SRC needs to contain representative of all the local authority services that may need to participate in the clean-up operation, and representative of all local and port authorities that may become involved. In addition, it contains an Environment Liaison Officer (ELO) nominated by the Chair of the Environment Group.

4.6.4.4. Emergency Control Centre (ECC)

Emergency Control Center (ECC) provides a centralized location where key staff members can monitor, track and make decisions regarding the oil spil response. Each oil installation and sea-port facility shall have the provision of an Emergency Control Centre (ECC) preferably with a back- up arrangement. The ECC shall be away from potential hazards and provide maximum safety to personnel and equipment. ECC should ba a noncombustible building of either steel frame or reinforced concrete construction and should have at least two exits and adequate ventilation

Each response unit, including the ECC at seaports and oil installations, should be provided with the following basic supplies and dedicated equipment.

- A copy of the Oil Spill Contingency Plan (OSCP).
- Maps and display charts and diagrams showing buildings, roads, underground fire mains, important hazardous material and process lines, drainage trenches, and utilities such as steam, water, natural gas and electricity
- Situation boards (continuously updated to present a summary of the current situation and response actions being taken).
- Aerial photographs, if possible, and maps showing the site, adjacent industries, the surrounding community, high-ways, rivers, etc., help determine how the disaster may affect the community so that the proper people can be notified, adequate roadblocks established, and the civil authorities advised sufficient telephone lines to enable full liaison with outside bodies
- Names, addresses, and telephone numbers of employees, off-site groups and organizations that might have to be contacted; all telephone lists being reviewed for accuracy on a scheduled basis and updated, as necessary
- Dedicated and reliable communication equipment; enough telephones and at least one fax line to serve the organization for calls both on-and off-the-site
- Fixed and portable two-way radio equipment to keep in contact with activities on-scene and to maintain continuity of communications when other means fail

- Plan board, logbook, tape recorder, television, DVD and Video facilities for playing back records from aircraft and helicopters, as well as monitoring media coverage of the incident with a person assigned to record pertinent information and to assist in investigating causes, evaluating performance, and preparing reports
- Emergency lights so that operations can continue in the event of power failure
- Photocopy, fax and e-mail facilities
- Dedicated computers with LAN/ internet facility to access the installation data and the latest and updated soft copies of all standard operating practices (SOP) etc.

Each response unit will be supported by an Administration Team responsible for the general management of the unit and providing personnel for:

- Communication links between the units
- The distribution of messages within the units
- Keeping records of messages and expenditure
- Taking minutes during meetings to record decision
- Typing services
- Updating situation boards and charts
- Providing catering to the units.

4.6.4.5. Environment Group

Response to any maritime incident requiring a regional or national response would involve the establishment of an Environment Group since all those involved in operations at sea (including salvage) and shoreline clean up need timely environment advice. The Coast Guard would initiate the request on the relevant civil administrative authority for the formation of the Environment Group. The core membership of the Group would come from the relevant statutory authorities and include relevant civil administration authorities, forest and wildlife authorities, fisheries authorities, Block Development Officer, local public health officials and relevant non governmental organisations for appropriate expert advice. The Group may also include a Coast Guard representative

Environment Group would perform a purely advisory role and provide advice on environment aspects and public health impacts of the incidents . Being a common facility, they will provide comprehensive advice to all response units and represent all environmental and public health interest considered being at risk. The expert advice based on immediately available and prepared data and information, may encourage the collection of real time environmental data by the relevant government agencies. Such environment data may provide accurate baseline data of vulnerable environmental features immediately before impact of the pollution plume, so that risk can be identified and the damage can be quantified.

Environment Group will track the success of preventive and counter pollution measures throughout the incident, and begin to assess the overall long term environment impact, dependent on timely provision, from each response unit, of all relevant information on the fate and modeling of pollutants, and each unit's forecasts, plans actions and outcomes. If a marine pollution incident is expected to have a significant impact on the marine environment, or the shoreline, the group may promptly make the arrangements to monitor and assess the impact in the longer term.

During the time of an oil spill event, response units shall make all reasonable efforts to consult the Environment Group, or its chair, about any proposed action that is likely to have lasting impact on the environment. If time does not permit the response unit to consult before acting, it will circulate a written report to the Environment Group and all other response units as soon as after the action (or decision) has been taken.

4.6.4.6. Offshore Control Unit (OCU)

Apart from above described respose units each offshore instalations should identify the location for an Offshore Control Unit (OCU) in close proximity to the operators ECC as part of instalation's oil spil response plan .

The OCU requires the same support and structure as an SCU and similar links to their operations units engaged in other tasks including search and rescue, at sea clean up and shoreline clean up, as appropriate. The administrative support required by the OCU will be provided by Ministry of Petroleum & Natural Gas (MoPNG).

The members of the OCU are:-

- The Coast Guard Commander
- The Emergency Operations Manager, a role defined in the operator's oil spill contingency plan, acts a link between Coast Guard and the Emergency Response Centre where is a line to the Offshore Installation Manager;
- The Operator's Representative, a role defined in the operator's oil spill contingency plan, representative the interests of the owner, operator, contractors, and liability underwriters of the offshore installation,

- An Environmental Liaison Officer, nominated by the Environment Group, advises the Coast Guard on the environmental implications of any proposed actions;
- The DGH provides the Coast Guard with advice on the importance of the installation to strategic supplies and other matters of public interest; and
- A specialist or technical advisor to the Coast Guard, either from the operator, the DGH or an independent source, provides advice as circumstances require

4.6.5. Incident Management Team (IMT)

The Incident Management Team(IMT) is the team who actually takes up the response activities at the time of an event.The IMT is headed by a Chief Incident Controller (CIC) and he will be assisted by a Site Incident Controller (SIC) and other supporting groups, who actually deals with the response activities at field. **Figure 4.6** illustrate composition of a typical Incident Management Team (IMT) for control of an oil spill emergency. Any entity of IMT can merge the functions as per their other statutory requirements and based on level of risk and range of operations.

The number of staff required to fill positions in the IMT of the emergency organisation can be varied according to the size and complexity of the incident and the number of staff available. In a major incident all positions may be filled, but in a lesser incident one person may fill a number of positions. In a very small incident, SIC will be able to carry out all management functions.

Persons in charge of sea ports and oil installations ensure that persons with appropriate experience and skills are identified so that they can be appointed to the various positions in the emergency organisation in the event of a marine pollution incident. If agency input into a response is required the Coast Guard may place its liaison officer/s within the IMT, so as not to burden personnel that will be fully engaged in response activities.

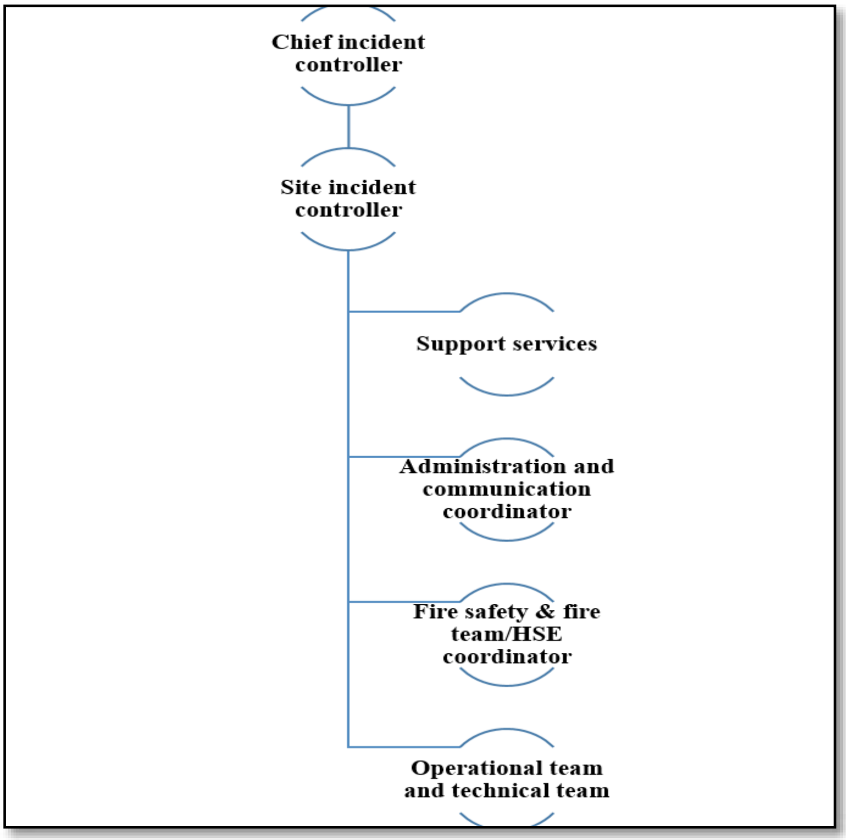


Figure 4.6. Composition of a typical Incident Management Team (IMT)

The section below presents the functional responsibilities and reporting requirements of IMT and facilities established as a part of it..

4.6.5.1. Chief Incident Controller (CIC)

Chief Incident Controller (CIC) is the key responsible officer for the management and coordination of response operations at the scene of a pollution incident to achieve the most cost effective and least environmentally damaging resolution to the problem. Persons in charge of sea ports and oil installations shall identify appropriate individuals to act as a Chief Incident Controller (CIC). CIC shall have overall responsibility to protect personnel, site facilities, and the public before, during, and after an emergency or disaster. The CIC shall be present at the main emergency control centre for counsel and overall guidance. Responsibilities of the Chief Incident Controller shall include the following:-

- Preparation, review and updating of the OSCP
- Assessment of situation and declaration of an oil spill emergency
- Mobilization of main coordinators and key personnel
- Activation of Emergency Control Centre

- Taking decision on seeking assistance from mutual aid members and external agencies
- Continuous review of situation and decide on appropriate response strategy;
- Taking stock of casualties and ensure timely medical attention;
- Ensuring correct accounting and position of personnel after the emergency
- Ordering evacuation of personnel as and when necessary;
- Taking decision in consultation with local Coast Guard and District Authorities when a tier 2 or tier 3 spill is to be declared.

During a major incident the CIC will act under the purview of the relevant Coast Guard Commanders.

4.6.5.2. Site Incident Controller (SIC)

The Site Incident Controller (SIC) shall be identified by the Chief Incident Controller and will report directly to him. During lesser incidents the SIC shall have overall responsibility for managing the response. Persons in charge of sea ports and oil installations should ensure that the SIC is assisted by a response team with appropriate planning, operational, technical, scientific, chemical, environmental, logistical, administrative, financial, and media liaison skills.

Responsibilities of the Site Incident Controller shall include the following:-

- To maintain a workable oil spill emergency control plan, establish emergency control centers, organize and equip the organization with OSCP and train the personnel;
- To make quick decisions and take full charge
- To communicate to the Emergency Control Centre where it can coordinate activities among groups
- To be responsible for ensuring that appropriate local and national government authorities are notified, preparation of media statements, obtaining approval from the CIC and releasing such statements once approval received
- To ensure that the response to the oil pollution emergencies is in line with entity procedures, and to coordinate business continuity or recovery plan from the incident;
- To co-ordinate any specialist support required for the above purpose
- To decide on seeking assistance of mutual aid members and external agencies.

4.6.5.3. Administration and Communication Coordinator

The SIC will be assisted by an administration and communication coordinator whose dutes shall include the following:-

- To coordinate with mutual aid members and other external agencies;
- To direct them on arrival of external agencies to respective coordinators at desired locations;
- To mobilize oil spill responders and resources for facilitating the response measures;
- To monitor mobilization and demobilization of personnel and resources;
- To provide administrative and logistics assistance to various teams.
- To be responsible for all financial, legal, procurement, clerical, accounting and recording
- Activities including the contracting of personnel, equipment and support resources
- To be responsible for the management of the Emergency Control Centre (ECC)

4.6.5.4. Support Services

Along with administration and comunication coordinator following additional coordinators will be nominated at the sea ports and oil installations and delegated the specific responsibilities falling under the basic functions of SIC and/ or CIC for Human Resources Services, Logistics Services, Media and Public Relations Coordinator,Operations and Technical Coordinator, Environmental and Scientific Coordinators and Fire Safety & Fire Team. The important responsibilities of support services that are to be executed through respective coordintors are detailed in the following section:

Human Resources Services Coordinator

Logistics Services Coordinator: In any response there is a vital need to ensure that response personnel are provided with adequate resources to enable an effective response to be mounted. The Logistics Services Coordinator shall ensure that all resources are made available as required. This includes the procurement and provision of personnel, equipment and support services for operations in the field and for the management of resource staging areas.

Media and Public Relations Coordinator: The Media and Public Relations Coordinator shall ensure adequate liaison between the incident management team and the media. All queries received from the media should be directed to this person. Before releasing any information, the Media and Public

Relations Coordinator, action should have the approval of either the relevant Coast Guard Commander or CIC, depending on the size of the spill.

Operations and Technical Coordinator: The Operations and Technical Coordinator is responsible for the provision of scientific and environmental information, maintenance of incident information services and the development of Strategic and Incident Action Plans. He shall ensure the distribution of all information to the Incident Management Team and to all response personnel generally. He is responsible to the CIC for all response operational activities. This includes ensuring that the requirements of Incident Action Plans (IAP) are passed on to operational personnel in the field, and for ensuring that the plans are implemented effectively.

Environmental and Scientific Coordinator: The State Government shall pre-appoint the Environmental and Scientific Coordinator (ESC), either on a State, regional or local area basis. During a spill response the ESC will normally form part of the Operations team. In this role the Operations Team is to provide the CIC with an up-to-date and balanced assessment of the likely environmental effects of an oil spill. The Planning Section will advise on environmental priorities and preferred response options, taking into account the significance, sensitivity and possible recovery of the resources likely to be affected. In major incidents, the ESC may directly advise the relevant Coast Guard Commander.

Fire Safety & Fire Team/HSE Coordinator:Fire and safety officer of Port/ local Fire Station shall be acting as the Fire and Safety Coordinator. Fire and Safety officer will be reporting to the Cheif Incident Controller and responsibilities are as follows

- Development & execution of emergency response plan
- Train all team members for fire response
- Overall responsible for fire prevention
- To ensure that everyone is evacuating and none is entering the restricted area during emergency
- Operation and maintenance fire detection, notification and suppression systems
- Providing first aid to the injured person and transportation of the patient
- Recommend the Site Incident Controller to impose as well as release fire emergency

4.6.6. Community

Support of the local community is essential for the success of any response operation, particularly shoreline response. The community will include volunteers from the National Cadet Corps, National

Disaster Mitigation Resource Centres, National Service Scheme, Nehru Yuva Kendra, and Non Governmental Organisations. The specialized National Disaster Response Force may be called in addition to the community volunteers. Awareness programmes are to be conducted for the local inhabitants and also their resepresentives are to be trained for dealing with the emergencies.

4.7. Local Action Group and Local Action Group Support Team

4.7.1. Local Action Group

Inorder to aid the support to the Union and State Governments in the event of a major oil pollution incident a Local Action Group (LAG) will be formulated in coastal states . LAG provides support managemnet team , specifically in the roles of response managers, and response team leaders. Each coastal State nominates personnel to the LAG as indicated in **Table 4.2** except Goa, Puducherry Daman and Diu, Lakshadweep and Minicoy, and Andaman and Nicobar which will nominate one response team leader instead of five.

Table 4.2. Composition of Local Action Group

Role	Positions per State
Planning Coordinator	1
Operations and Technical Coordinator	1
Logistics and Administration Coordinator	1
Response Team Leader	5

4.7.2. Local Action Group Support Team

The local Action Group (LAG) is supported by a subgroup Local Action Group Support Team (LST) at the time of event. LST will comprises of following componets ,

- Environmental Advisers
- Finance & Administration Officer
- Wildlife Officer
- Equipment Operator
- Offshore Containment/Recovery
- Inshore Containment/Recovery
- Engine driver and Lascar
- Vessel-based dispersant spraying
- Shoreline Assessment
- Shoreline Cleanup

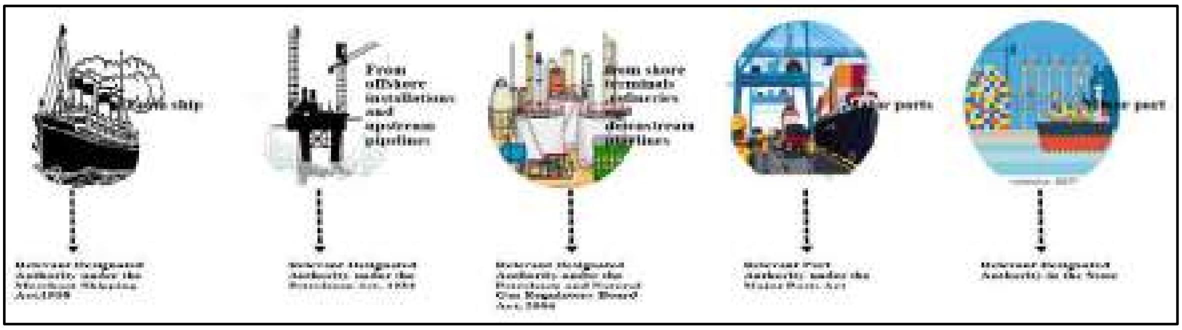
The Equipment Operator role has been broken down into areas of specific expertise. Equipment Operators may be competent in more than one area.

Each coastal State would identify personnel to fulfil these roles, as these personnel would be required when responding to major incidents within their own jurisdictions, and will become part of the LAG when succession planning. Sea ports and oil installations are expected to nominate personnel to these positions. Certified personnel of private oil spill response organisations may also be considered for such roles. Training of LST is the responsibility of the respective coastal States with support of the sea ports, oil agencies, Coast guard and other government agencies, non-governmental organisations, etc.During an oil spill incident ,if required , the relevant combat or statutory agency is responsible for activation of LAG and LST in accordance with applicable contingency plans or State arrangements.

Also during anoil spill incident the Chief Incident Controller or the relevant Coast Guard Commander may requisition for personnel from other coastal States to become part of the Incident Management Team or the incident response team. At that time suitable personnel will be selected by Coast Guard from the LAG or the LST of the coastal State with a maximum release period of ten days (including travel time) unless both Coast Guard and the LAG/ LST member's organisation reach a separate agreement. The selected personnel will remain in the employment of their own agency, and all entitlements in relation to their contract of employment will remain unchanged.

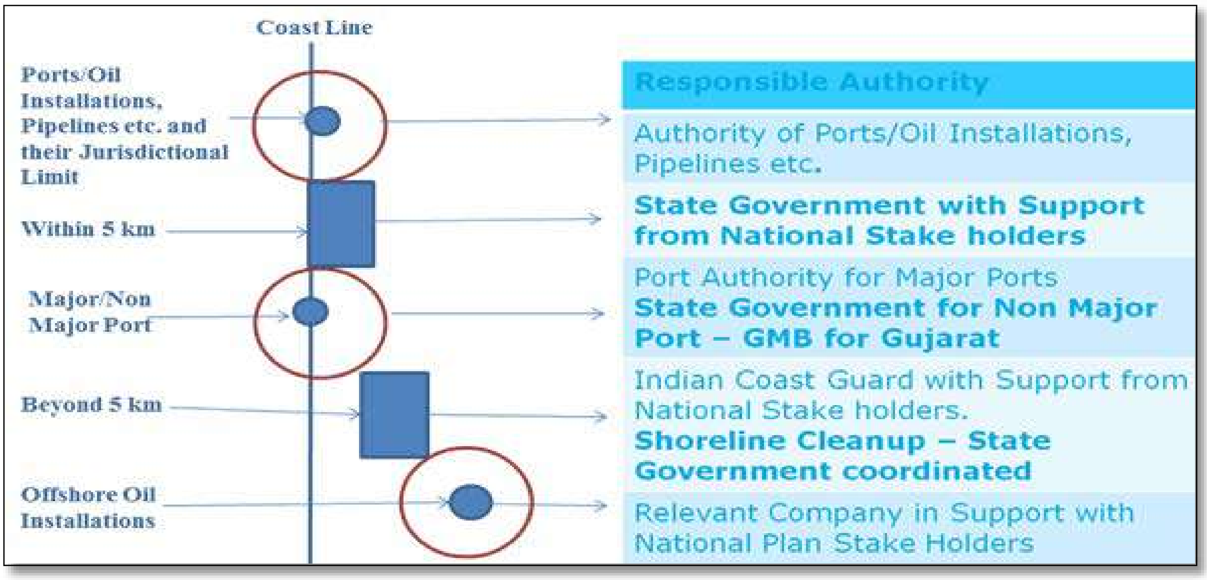
4.8. Responsibility for Responding to Oil Spills

Responsibilities for responding to an oil spills in Indian waters are shared between the Indian Coast Guard, State Governments, Port Authorities and Corporations. Liability for clean-up of both, oil and HNS spills remains with the polluter.The details of the combat agencies and satutary agencies responsible for the oils pill response accoring to the nature of origin of the spill is shown in **Figure 4.7** and **Figure 4.8.** The resources of the Combat Agency will need to be supplemented by other local, regional, and national resources.



Note : The Statutory Agency is responsible for the institution of prosecutions and the recovery of cleanup costs on behalf of all participating agencies.

Figure 4.7. The Statutory Agencies Responsible for Oil Spills



Note: Combat Agencies have the operational responsibility to take action in order to respond to an oil spill in the marine environment in accordance with the relevant contingency plan

Figure 4.8. Combat Agencies Responsible for the Oil Spill Response

Each port facilities, oil terminal and. Installations should have capability to provide first response to oil spill in their areas(ie Tier 1 level pollution). The capability includes trained manpower and equipment in line with NOS-DCP provision for which are given as **Annexure II**. In cases where additional resources are required, these will generally be available from the local port authority, or from adjacent industry operators under mutual aid arrangements or locally from the Indian Coast Guard.

In case of tier 2 event preparedness and response requires the co-ordination of more than one source of equipment and personnel. 'Tier 2' event response requires the assistance from multiple entities within a port area or from national sources outside the immediate geographic area.

Incase of Tier 3 events mobilization of all available regional /national/ international resources are required depending upon the circumstances, will likely involve mobilization of and systems. It is this tier ofresponse where positive advance customs arrangements are critical to facilitate a successful effort. If required, internationalresources can be facilitated by the Statutory Agency through the Ministry of External Affairs.

Incase of oil industry, each company will designate an Industry Adviser. During a tier 2 or tier 3 incident, the Industry Adviser of the affected company will provide a direct high-level linkage to the response organisation. Industry personnel will nominate their personnel to the respective State, District, and Local CMG, Local Action Group, and Local Action Support Team (LST). Each company will designate its CIC and IC. During lesser incidents the CIC shall be responsible for overall response strategy. The CIC shall keep the Statutory Agency informed of progress with the response. The response actions will be supported by the LAG and LST.

4.9. Discovery and Notification of an Event

Marine pollution needs an immediate response in order to minimize the damage to marine environment. The Indian Coast Guard is the national operational contact point for the receipt and transmission of reports on oil pollution in Indian waters.

4.9.1. Reporting of an Event

Masters or other persons having charge of ships and persons having charge of offshore facilities involved in an incident (any event involving probable discharge of oil, of any quantity,in Indian waters) shall report the particulars of such incidents without delay and to the to the fullest extent possible to the nearest Indian Coast Guard Maritime Rescue Coordination Centre (MRCC).

In the event of the ship or offshore facility involved in an incident being abandoned, or in the event of a report from such a ship or offshore facility being incomplete or unobtainable, the obligations shall, to the fullest extent possible, be assumed by the owner, charterer, manager or operator of the ship, or offshore facility, or the agent in case of a ship.

Masters or other persons having charge of ships and persons having charge of offshore facilities involved in an incident shall report the particulars of such incidents without delay and to the to the fullest possible extent to the nearest Indian Coast Guard MRCC any observed event at sea involving a discharge or probable discharge of oil, of any quantity, or the presence of oil in Indian waters.

Persons having charge of sea ports and oil handling facilities in India shall report without delay to the nearest Indian Coast Guard MRCC any event at their sea port or oil handling facilities involving a discharge or probable discharge of oil, of any quantity, or the presence of oil in Indian waters.

Maritime inspection vessels and aircraft of other services including the Air Force, Navy, Border Security Force, Customs department, Forest department, Police, Marine Police, Fisheries Survey of India and Port Pilots, or officials and civil organisations such as Air India and other private aircraft operators shall report without delay to the nearest Indian Coast Guard MRCC any observed event at sea or at a sea port or oil handling facility involving a discharge of oil, of any quantity, or the presence of oil in Indian waters.

Any other organisation (for example, a local authority, harbour authority or environmental organisation) receiving a report of marine pollution of any quantity, or a threat of marine pollution, whether from a ship, offshore installation or unknown sources, should send that information immediately to the nearest Indian Coast Guard MRCC. The MRCC contacts the concerned Duty Staff Officer. The format for reporting an event is presented in **Annexure III.**

Oil spil event shall be reported in the following events

- Discharge above the permitted level or probable discharge of oil or of noxious liquid substances for whatever reason including those for the purpose of securing the safety of the ship or for saving life at sea; or
- A discharge or probable discharge of harmful substances in packaged form, including those in freight containers, portable tanks, road and rail vehicles and ship borne barges; or
- Damage, failure or breakdown of a ship of 15 meters in length or above which:
- Affects the safety of the ship; including but not limited to collision, grounding, fire, explosion, structural failure, flooding and cargo shifting
- Results in impairment of the safety of navigation; including but not limited to, electrical generating system, and essential ship borne navigational aids; or failure or breakdown of steering gear, propulsion plant,
- A discharge during the operation of the ship of oil or noxious liquid substances in excess of the quantity or instantaneous rate permitted under the MARPOL Convention.

Organizations sending information should make every practicable effort to identify :

- Identity of ships or offshore facilities involved;
- Time, type and location of incident;
- Quantity and type of harmful substance involved;
- The weather, sea state and tidal conditions in the area;
- Assistance and salvage measures; and
- Events and actions so far

The initial report send to the authority regarding oil spill identification can be supplemented as necessary, and provide information concerning further developments; and comply as fully as possible with requests for additional information. The report on identification of any oil spill can be made by radio or telephone or facsimile.

When an incident ,which could result in marine pollution, is reported to the relevent Indain Coast Guard Maritime Rescue Coordination Centre (MRCC), the details of the event will be recorded and respective agency or departments will be intimated for the necessary action.The flow chart of the information flow from the site of incident to the cabinet secretariant in the event of an oil spill is dipicted in **Figure 4.9.**

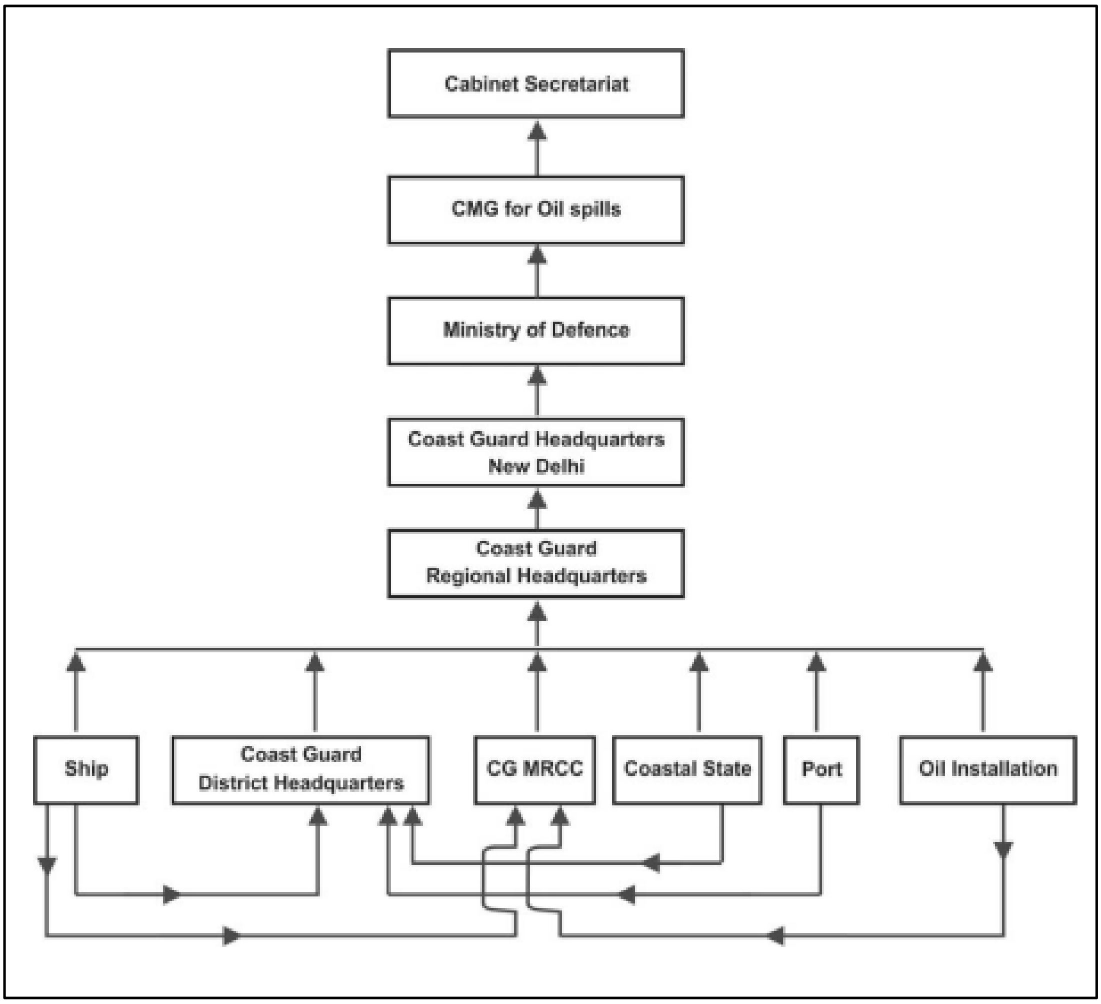


Figure 4.9. Flow Chart of the Information Flow from the Site of Incident to the Cabinet Secretariat

Follow-up on the submitted report regarding the identification of oil spill event wil be monitored by MRCC. The MRCC contacts the ship or offshore installation to ascertain, following :

- The nature of incident (collision, loss of containment, etc.)
- The number of people on board;
- The type, size and name of the ship or installation;
- The precise location, course and speed of the ship, and its proximity to other ships, offshore installations, shallow water and the shore;

- Information on the ship's cargo, stores or bunkers, and whatever any are dangerous;
- The structural and mechanical integrity of the ship or installation;
- The weather, sea state and tidal conditions;
- Any assistance available to the casualty and the intentions of the Master or Offshore Installation Manager (OIM);

When an incident is reported MRCC initiates any search and rescue response required and then reports any pollution incident or a risk of significant pollution (whether or not known to involve oil or any other hazardous substance, and even if of unknown origin) to the concerned Duty Staff Officer for response action.

After reporting of a tier 2 or tier 3 incident to the Coast Guard, the Regional On-Scene Commander or/ and the National On-Scene Commander will have responsibility of informing all concerned authorities and will coordinate with appropriate level in the State or/ and Central Government till termination of response.

4.9.2 Initial Actions Taken

When an incident is reported to Indian Coast Guard MRCC the following actions will be intiated under the purview of Coast Guard District or Regional Commander as appropriate. ordering aerial surveillance of the ship, if possible with an experienced observer;

- Arranging for inspection of the ship by an IRS surveyor or other qualified person;
- Putting on stand-by or deploying:
- Dispersant spraying aircraft and ships,
- Oil recovery equipment,
- Booms
- Emergency Tow Vehicles (ETVs) or other tugs
- Establishing the availability of salvage and lightering ships;
- Moving the ship to shelter;
- Exercising the power of intervention;
- Obtaining specific weather forecasts
- Requesting control of airspace in vicinity of the casualty; and

- Establishing a Temporary Exclusion Zone (TEZ).

4.9.3 Assessment of the Event

The Regional Headquarters of the Coast Guard are to prepare for combating a major oil spill up to 10,000 tonnes. The requirement of combating a major oil spill above 10,000 tonnes will be undertaken by pooling all available resources and equipment in the country. There for in case of major spill a rapid assessment of the threat presented by the marine accident is essential. If an actual spill has occurred, then the designated Regional Commander, On Scene Commander should, if possible, conduct aerial surveillance of the oil slick and from weather and hydrographic data, predict probable trajectory of the oil slick. If the oil slick is moving offshore towards the open sea, then monitoring on a regular basis is the preferred control option. If the oil slick is moving onshore, then the response could be either containment and recovery, chemical dispersion or shoreline cleanup. The On Scene Commander must evaluate whether the required response is within the local resource capability or requires resources/equipment from other agencies and accordingly advise the Director General, Coast Guard

4.9.4 Criteria for Triggering Regional or National Response

When the Indian Coast Guard MRCC is notified of a major incident, the Coast Guard District or Regional Commander will decide if a regional or national response is warranted. In a local response, the Coast Guard has no role other than to maintain records of any pollution for statistical purposes. In a regional response, the Coast Guard Regional Commander may deploy regional Coast Guard equipment and facilities to support the port authorities, contracted responders or local authorities.

In the event of an incident involving an offshore installation the decision on the level of response will be in consultation with the owner or operator of the offshore installation involved in the incident. NOSDCP lays down no rigid criteria for triggering a regional or national response. However, the Coast Guard District or Regional Commander may trigger a regional or national response as appropriate if;

- A shipping casualty gives rises to the risk of significant pollution requiring a salvage operation;
- An oil spill from an offshore installation requires the deployment of vessels and/or aircraft by the Indian Coast Guard to contain, disperse or neutralize it;
- An oil spill within the jurisdiction of a port authority requires the deployment of regional or national resources to contain, disperse or neutralize its, or other action beyond the capacity of the harbour authority with support of mutual aid arrangements; or

- A local authority requests the deployment of shoreline response resources and manpower with other states or under national control because the action is beyond the local capacity with mutual aid arrangements

4.9.5 Action after Initiating a National or Regional Response

When a threat of significant pollution justifies a regional or national response, the Coast Guard District or Regional Commander notifies the CCA of the incident. The CCA may decide to supplement the response or stand down.

4.9.6 Situation Reports

A situation report is exactly what the name implies: a report on a situation containing verified, factual information that gives a clear picture of the "who, what, where, when, why and how" of an incident or situation.

In relation to incidents involving ships, Indian Coast Guard with support of the Directorate General of Shipping takes the lead in providing the Ministry of Defence and other concerned ministries officials of the devolved administration affected or potentially affected by the incident, with situations reports.

In relation to incidents involving offshore installations, the Ministry of Petroleum and Natural Gas takes the lead in providing both operations and policy advice. The Indian Coast Guard also disseminates situation reports to the Ministry of Defence and other concerned ministries and and the coastal state affected or potentially affected by the incident.

4.9.7 Final Report

A final closure report of all major incidents viz., Tier 2 and Tier 3 oil pollution incidents will be submitted post investigations and analysis to the Central Coordinating Authority and other concerned authorities within 45 days of termination of response by the facility or installation where the discharge occurred.

4.10 International Assistance

Generally the oil industry maintains membership with an oil spill response organisation, such as Oil Spill Response Limited (OSRL), Singapore. M/s OSRL holds a Tier 3 stockpile and provides response training, and other services. The oil industry membership provides for access to OSRL equipment and personnel at Singapore and in the United Kingdom. If resources in addition to the national resources are required to respond to an incident in India, then Oil Spill Response Limited (OSRL) will be called out invoking the membership of the concerned oil company. The Global Response Network is a collaboration of seven major oil industry funded spill response organisations whose mission is to harness cooperation and maximise the effectiveness of oil spill response services worldwide.

The Indian Coast Guard, in accordance with current MoU and relevant International Conventions, may also assist neighbouring countries in relation to oil spill incidents in their waters. Also in the event of a major oil spill incident, it is likely that additional overseas assistance may be sought from overseas in accordance with the International Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC 1990). In such cases, customs and immigration authorities of ports and air ports need to provide immediate facilitation for temporary import of equipment and personnel in order to transfer them in the scene of action expeditiously.

4.11 Cross Border Incidents

In case of incidents close to International Maritime Boundary Line, or incidents which are likely to result in transboundary pollution, high-level consultation and cooperation will be maintained with the Competent National Authority or Authorities of concerned State (s), with due regard to the provisions of any Regional Contingency Plan or Memorandum of Understanding or other arrangement, with an objective to ensure a clear delineation of responsibility for the response. In case of incidents close to State or Union Territory borders, high-level consultation and cooperation will be maintained between the two Statutory Agencies, with an objective to ensure a clear delineation of responsibility for the response.

4.12 Allocation of Responsibilities in the Management of Oil Spills

In the event of a oil spill various responsibilities are allocated to various fedral departments in order to aid the speedy recovery and the same is detailed in **Annexure IV.**

4.13 Specialist Advice and Assistance

Specialist technical advice is available to response team from a variety of sources. Advice can vary from the fate of oil, selection and deployment of pollution control equipment, and dispersant use, to the associated environmental effects of an oil spill. Specialist advice can also be provided in relation to the safety and stability of ships.

The range of specialist environmental and operational technical advice in the event of an oil spill in the marine environment that can be provided by varied departments and organisations of the Government of India and other agencies is enumerated in the **Annexure V.**

4.14 Inventory for the Oil Spill Response

As mentioned in previous sections each port facilities, oil terminal and. Installations should required to maintain the equipments and manpower for the response towards a teir 1 level pollution. The standard inventory required for ports, oil agencies, and coastal states in regards of oil spil response is already presented in **Annexure II.** In addition to this, the Indian Coast Guard maintains stockpiles of equipment at its pollution response centre at Mumbai, Chennai, Port Blair and at Vadinar. The Indian Coast Guard also operates two dedicated pollution response vessels. The third pollution response vessel in the series is in the final stages of commissioning. Stocks of oil spill dispersant are additionally held at each Coast Guard Station/ Air Station. The current national inventory is at **Annexure VI**. The national oil spill response capability supported by the concerned Ministries is presesnted in **Annexure VII.**

4.15. Provision for Mutual Aid

In case of a major emergencies it is not possible to combat an event by a induvidual unit since it will be beyond its capability. Hence it is essential to have mutual aid arrangements with neighbouring industries. Consideration shall be given to the following while preparing mutual aid arrangements:-

- Written mutual aid arrangements are to be worked out to facilitate additional help in the event of Level-II emergencies by way of rendering manpower, medical aid or firefighting equipments, etc.
- The mutual aid arrangement shall be such that the incident controller of the affected installation shall be supported by neighbouring industries on call basis for the support services materials and equipments already agreed. Further, all such services deputed by member industry shall work under the command of the site incident controller of the affected installation.
- Mutual aid associations shall conduct regular meetings, develop written plans and test the effectiveness of their plans by holding drills. Drills are essential to establish a pattern for operation, detect weaknesses in communications, transportation and training. Periodic drills also develop experience in handling problems and build confidence in the organization.
- To make the emergency plan a success, the following exchange of information amongst the member organizations of mutual aid association is considered essential: -
- The types of hazards in each installation and firefighting measures.
- The type of equipment, that would be deployed and procedure for replenishment.
- Written procedures which spell out the communication system for help and response. This is also required to get acquainted with operation of different firefighting equipment available at mutual aid members and compatibility for connecting at users place.

- Familiarization of topography and drills for access and exit details carried out by mutual aid members.

4.16 Inspections

The preparedness of ports and oil handling agencies will be inspected periodically, by nominated Coast Guard officers, acting on behalf of the Central Coordinating Authority, and if deemed necessary, jointly with the concerned statutory authority. The periodicity and manner of such inspections will be as decided by the Central Coordinating Authority. Report of such inspection will be rendered as per the *pro forma* provided in **Annexure XII.**

4.17 Online Oil Spill Advisory System

The Online Oil Spill Advisory (OOSA) system has been developed by INCOIS for use by the Indian Coast Guard and other statutory authorities and combat agencies involved in oil spill cleanup and control measures in the event of oil spill. OOSA delivers the trajectory of the spilled oil immediately, and enables the combat agency to plan clean up activity. On submission of necessary information like location of the spill, date, time, pollutant type and its quantity, the trajectory prediction set up is triggered in the background, along with the forecasted forcing parameters such as wind and currents. The trajectory prediction for a period of 48 to 90 hrs is generated and disseminated to registered users.

OOSA is launched as an experimental set up, and a full-fledged system will be in place after obtaining the feedback/ suggestions from the user community.

4.18 24-Hour Emergency Advice Center

Ensuring access to the initial risk assessment capability 24-hours a day, 365 days a year should be a central element of the contingency planning to deal with chemical spills on water. At a national level, there should ideally be one contact point for ensuring immediate access to information on chemical hazards. It would be linked to the ICE (International Chemical Environment) scheme - a voluntary programme, co-ordinated through The European Chemical Industry Council (CEFIC), to create an international network for chemical distribution incidents. The aim of ICE is to ensure that information on the chemical hazards posed by an incident, practical help and, if necessary and possible, appropriate equipment is provided to the emergency services to minimise adverse effects.

However, it will take time in India to have a complete database and to establish a monitoring agency for the chemicals of its origin, to its hinterland movements, the destination, the customer, the chemical characteristics, the possible threats, the response to such threats and the likely threat to environment. In the interim, it is necessary as much information available through open sources and from the manufacturers and exporters of the characteristics of the chemical substances that are moved from the Indian ports is gathered and a database maintained by Indian Ports Association (IPA) for supporting an effective spill response.

4.19. Provision for Salvage

If there is a threat of significant pollution the MRCC contacts the salvor or, if not yet appointed, the master or owner of the ship, and the harbour master, if the incident is in a port or its approaches, and offers assistance. The MRCC states that intervention powers may be exercised and instructs those in command of the vessel to provide the Indian Coast Guard information which must include:

- Whether the owner has appointed a salvor and, if so, its name and contact details;
- The broad nature of the contract between owner and salvor;
- Information on the intentions of the salvor; and
- Any other important information that has not yet been gathered.

Simultaneously, as a pollution prevention tactic, the MRCC may also task the contracted Emergency Towing Vessel (ETV) to proceed to the area. The Indian Coast Guard District or Regional Commander decides whether it is necessary to set up a Salvage Monitoring and Control Unit (SMCU) based on the merits of the incident. The members of the SMCU are;

- The Indian Coast Guard District or Regional Commander;
- The Salvage Manager from the salvage company appointed by the ship owner,
- The harbour master, if the incident involves a harbour or its services;
- A single representative nominated by agreement between the ship owner and insurers (for both the physical property and their liabilities);
- The District or Regional Pollution Response Officer;
- A Surveyor from the Mercantile Marine Department
- A Surveyor from the Indian Register of Shipping, if required; and
- An Environment Liaison Officer, nominated by the Environment Group.

In the event that the SMCU is co-located with an MRC, the membership of the SMCU needs to include the members of the MRC with Indian Coast Guard staff fulfilling more than one role.

If it is necessary for the salvage operation in adition to the SMCU another on board salvage team will be established in consultation with India Coast Guard . This team will comprising a coast guard representative ,salvage master , crew and a special casuality centre (as per the decesion of ship owner).

The Salvage Master will, in consultation with the Coast Guard, strictly monitor and, if necessary, control access to the casualty, establishing any necessary protocols, through the SCR, with the security plan operated by the casualty in compliance with the Interventional Ship and Port Security Code (ISPSC).

Consultation with Coast Guard is essential because every additional body increase he potential problem of rescue, and every additional person increase the risk of confusion as to what the Salvage Master and his crew are doing.

4.20 Requirement of Communication Aids

In a pollution incident it is important that the CIC has access to adequate communication facilities. In addition to the facilities available through the ECC it is envisaged that port and oil installation should have Very High Frequency (VHF) radio facilities, the Coast Guard communications networks would be available to coordinate a response. In a major incident it may be necessary to seek assistance from other Government agencies and utilise the Government Radio Network or the emergency services or Naval radio communications network.

4.21 Training and Exercises

The Indian Coast Guard conducts regular training programs and exercises for personnel likely to be involved in a response to an oil spill in the marine environment. These training programs and exercises are designed to enable India to have sufficient numbers of trained personnel to mount a credible and effective response to an oil spill incident.

Training programs are regularly conducted at two levels, which recognise the overall technical complexity of managing an oil spill response and that the associated knowledge required by personnel varies depending on their level of responsibilities. The two levels of training conducted are:

- Level 2 for middle management personnel responsible for managing the operational response, e.g. incident controllers, their deputies and environment and coordinators, and Fire Brigade (Hazardous Materials) specialists
- Level 1 for operator level personnel, i.e. those undertaking on-site clean-up operations. In a major incident this would also include supervisors appointed as site managers.

A certificate of level 1 course is deemed to be valid for a period of five years from the date of its issue. It is imperative that personnel designated for oil spill response operations undergo periodic training to maintain currency of certification.

The persons qualified in level 2 course will be designated for carrying out duties as Chief Incident Controller and Incident Controller.

Mock drills and exercises will be conducted by every port facility and oil installation at such periodicity and at such scales as required by the Central Coordinating Authority. However, such mock drills and exercises shall in any case be conducted at least once every three months and a record shall be maintained of its conduct including the personnel participated, resources mobilized, etc. Area or regional level exercises will be conducted at least once every six months. National level pollution response exercises will be conducted at least once a year and involve mobilization of stakeholder resources.

4.22 Provision for Place of Refuge

It is generally recognised that when a ship has suffered an incident, the best way of preventing damage or pollution from its progressive deterioration is to transfer its cargo and bunkers, and to repair the damage. Such an operation is best carried out in a Place Of Refuge (POR), that is, a place where a ship in need of assistance can take action to stabilise its condition and reduce the hazards to navigation, and to protect human life and the environment.

It is ideal to pre-designate places of refuge; however, where no pre-designated place exists, it is imperative to have policies in place to enable the selection of a place of refuge.

The State Government is required to adopt specific policies on places of refuge as part of its contingency plan, and these should be followed as appropriate. Regardless of whether places of refuge are pre-designated or not, the following criteria form the basis for their selection:

- Adequate water depth
- Good holding ground
- Shelter from the effect of prevailing wind/swell
- Relatively unobstructed approach from seaward
- Environmental classification of adjacent coastline and fisheries activity
- Access to land/air transport
- Access to loading/unloading facilities for emergency equipment

4.23. Financial Arrangements

Detailed financial records, including all supporting information, are required, and are of particular importance when submitting claims to the Protection and Indemnity (P&I) insurers, as all claims will be assessed to ensure that the costs are reasonable, and are supported by satisfactory documentation.

Agencies should have in place appropriate systems to ensure that these requirements are met and that these are adequately outlined in contingency plans. In general, costs will be considered "reasonable" if they result from actions that:

- were undertaken on the basis of a technical appraisal of the incident
- sought to enhance the natural processes of recovery
- were not undertaken purely for public relations reasons.

4.24 Record Keeping and Preparation of Claims

In order that claims may be processed with minimum delay, it is essential that accurate records are maintained to support claims. It should be noted that claims should be based on expenses actually incurred, that these are made as a direct result of an incident, and that the expenses incurred are reasonable. In the case of economic loss, documentation supporting the claims should demonstrate how the claim has been calculated. The following aspects are to be considered while assessing cost of an oil spill combating and operating, and preparation of claims:-

- Delineation of the area affected describing the extent of pollution and identifying areas most heavily contaminated. This may be best presented as a map or chart accompanied by photographs.
- Summary of events including a description of the work carried out in different areas and of the working methods chosen in relation to the circumstantial evidence linking an oil pollution with the ship involved in the incident (e.g. chemical analysis).
- Labour costs (numbers and categories of labourers, rates of pay days, hours worked, total costs etc).
- Data on which work was carried out (weekly or daily costs).
- Material costs (consumable materials, fuel utilized, food, shelter, etc.).

4.25 Responsibility Allocation for the Preparation of Oils Spill Response Contingency Plan

Statutory Agencies supported by Combat Agencies, are primarily responsible for ensuring that contingency plans are developed at national. state, regional and local levels, and that these plans complement adjacent plans.

Responsibility allocation for maintaining contingency plans is as follows

- The National Oil Spill Disaster Management Plan will be maintained by the Indian Coast Guard Headquarters with inputs from, and in consultation with, stakeholders to the national plan.
- The Regional Oil Spill Disaster Management Plan will be maintained by the Regional Headquarters of the Indian Coast Guard at Gandhinagar, Mumbai, Chennai, Kolkata, and Port Blair with inputs from, and in consultation with, stakeholders to the regional plan.
- The District Oil Spill Disaster Management Plan will be maintained by the District Headquarters of the Indian Coast Guard in each coastal state with inputs from, and in consultation with, stakeholders to the district plan.
- The Local Contingency Plan for shoreline clean-up will be maintained by the Coastal State with inputs from, and in consultation with, stakeholders in the respective coastal state. The local contingency plan should include the following or a cross reference to where such advise can be located:
- The mechanism for escalating the response in accordance with the tiered response concept; guidance on what equipment and personnel is at the disposal of the SRC, including neighbouring local authority resources;
- Arrangements for establishing working accommodation and catering arrangements for members of the SRC and Environment Group and other groups involved in the incident who may need to be in the area away from their own base;
- Arrangements for handing the media, including the logistics of their presence;
- Temporary, intermediate and final sites and routes for the recovery, rescue or final disposal of waste.
- Maps, clearly depicting sensitive sites, access points, terrain types etc;
- Guidance on the health and safety of workers involved in preventing measures and clean-up activities;
- Financial implications of coastal pollution and actions that can be taken for cost recovery.
- Every ship is required by MARPOL regulations to maintain a The Ship Oil Pollution Emergency Plan (SOPEP) approved by the Flag State Administration. The Merchant Shipping (Prevention of Pollution by Oil) Rules, 2010 requires maintenance of a

pollution emergency plan by Indian ships approved by the Administration or Recognized Organisation acting on its behalf.

- Every sea port facility and offshore oil installation and every oil installation on shore with risk of marine oil or chemical pollution is required to maintain a facility contingency plan approved by the Coast Guard.

4.26. Revision of Contingency Plan

The facility contingency plans are to be updated at least annually and revised at least once in every five years or whenever there is a significant change in any of the elements underlying the plan. The occasions for revision could include, but may not be limited to, an addition to capacity, change in traffic density, change in risk, etc. A revision of a facility contingency plan will necessitate fresh approval and the procedure the approval is explained.

The Ministry of Shipping, State Government of the coastal states and Ministry of Petroleum and Natural Gas should have to up date the details of sea port facilities required to maintain a facility oil spill contingency plan, to the Ministry of Defence and the Indian Coast Guard on timely basis.

Also every plan holder should submit an annual return of preparedness to the Central Coordinating Authority viz., the Director General Coast Guard with a copy to the local Coast Guard authority, the District Administration and such other authorities as may be necessary.

4.27. Fishing Restrictions

The State Fisheries Authorities may temporarily prohibit or restrict fishing, on precautionary basis, if resources are, or are likely to become, contaminated to prevent health risk to consumers. A delay in revocation of such prohibition or restrictions must take into consideration the implications for reimbursement of claims for damages from the Protection and indemnity insurance, (P&I) Club (P & I Club is a mutual insurance association that provides risk pooling, information and representation for its members) and The International Oil Pollution Compensation Funds (IOPC) Fund. Guidance on sensory testing of sea food following an oil spill and imposition of fishing restriction is published separately by the Coast Guard.

4.28. Oil Spill Clean up

Procedure for cleaning up of the spilled oil is not an easy task. Various factors need to be considered before carrying out operations. Some of them being amount of oil spilled, temperature of water, type of beaches and many more. When an oil spill occurs, there are very clear rules about who pays for the direct response activities, the cost of assessing environmental damages, and implementing the necessary restoration.The Oil Pollution Act of 1990, spells out that those responsible for the pollution pay for all costs associated with the cleanup operations.

The responsibility for cleanup of pollution on the water and at jetties wharves/ structure within jurisdiction, and at beach/shoreline owned by the port authority, whatever the source of the pollution, lies with the port authority. Cleanup of shoreline (including land exposed by falling tide) beyond port jurisdiction vests with the local State. In case of major events the Coast Guard District or Regional Commander decides on actions to contain, disperse, or neutralise pollution, and to remove potential pollutants from the scene.

After an oil spill, urgent decisions need to be made about how to minimize environmental and socio-economic impacts. Diffrent response technics are available for claenup process. The advantages and disadvantages of different responses need to be compared with each other and with natural clean-up. This process is called Net Environmental Benefit Analysis (NEBA). Net Environmental Benefit Analysis (NEBA) is a methodology for identifying and comparing net environmental benefits of alternative management options, usually applied to contaminated sites. The use of NEBA should result in better decisions, resulting in greater improvements in environmental quality at lower cost.

From time to time India Coast Guard issues circulars for detailing various clauses of NOSDCP. The relevant circulars published by ICG is detailed in following section

4.29 Over view of Circular No: 02/2012

Subject: Guideline on Elements of Facility Oil Spill Contingency Plan

Over view: Every owner or operator of a port facility, oil installation or offshore installation is required to maintain an oil spill contingency plan duly approved by the India coast guard. This circular set outs the desired elements of a typical facility oil spill contingency plan. As per the circular a typical facility level contingency plan should require following three components

- A strategy section, which describes the scope of the plan, its geographical coverage, perceived risks, roles and responsibilities of those charged with implementing the plan and the proposed response strategy;
- An action and operations section, which specifies the emergency procedures that will allow rapid assessment of the spill and the mobilization of appropriate response resources; and
- A data directory, which should contain all relevant maps, resource lists and data sheets required to support an oil spill response effort and conduct the response according to an agreed strategy.

The guiding template for the preparing of a new facility level contingency plan is as presented in **Annexure VIII.** It should be noted that this is only a guideline for structuring the plan.

4.30 Over view of Circular No: 01/2013

Subject: Annual; Returns on Preparedness for Oil Spill Response

Over view: Apart from an approved facility oil spill contingency plan, an inventory of oil spill response equipment proportional to the estimated risk and adequate pool of trained manpower for operating and maintaining the pollution response equipment is required to be maintained by all ports and oil handling agencies. A combined database of such inventories as part of its preparedness for oil spill contingencies in all facilities is maintained by Indian Coast Guard for the smooth execution of oil spill response. With a view to regularly update the national database of inventory andtrained manpower every contingency plan holder should pass the updated details of their own oil spill response inventor on annual basis and the same is called as Annual Return .

Every plan holder will submit an annual return of preparedness to the Central Coordinating Authority viz., the Director General Coast Guard with a copy to the local Coast Guard authority, the District Administration and such other authorities as may be necessary. This circular details the required informations and format of annual return. The annual return should be submitted to the Coast Guard Headquarters as on 31st December in each year and the same should be submitted by 15th February at dte-fe@indiancoastguard.nic.in. The format of Annual Return is presented in **Annexure IX.**

Further, the preparedness of ports and oil handling agencies is inspected periodically by the Coast Guard jointly with the concerned statutory authority and the report on inspections will be made according to a pre structured *pro forma*.

4.31. Over view of Circular No: 02/2013

Subject: Radar Oil Spill Detection System at sea port and Handling Facilities

Over view: In 16 the NOSDCP meeting held on 19th April 2011, discussions on a fool proof system to monitor and detect the presence or discharge of oil spill in order to intensify the oil spill response was made.The committee of secretaries in its meeting on 2nd December 2011 decided to study the effectiveness of the installations of oil spill detection software in VTMS radars at ports and VATMS radars of oil companies along the coastline. According to the study result it was identified that the radar detection of oil spill may be achieved by way of IMO type approved SOLAS compliant radar or by installing a software patch on existing radar

Through this circular Indian Coast Guard urged to establish radar oil spill detection system in seaports and oil handling facilities.

4.32. Over view of Circular No: 03/2013

Subject: certification of facility oil spill risk assessment and response preparedness

Over view: The facility contingency plans are to be updated at least annually and revised at least once in every five years or whenever there is a significant change in any of the elements underlying the plan. Every new or updated contingency plan should require an approval from the Coast Guard .For the approval from the coast guardevery owner of a port facility, oil installation or offshore installation should submit their contingency plan accompanied with a certificate of endorsement of the facility oil spill risk assessment and response preparedness as per the format prescribed at **Annexure X** ,duly endorsed by an officer not below the post of Deputy Conservator of a port facility or the installation Manager of an oil installation , or offshore installation , or equivalent legally responsible authority.

4.33. Over view of Circular No: 01/2014

Subject: Pre-booming of tankers at alongside berths and SPMs

Over view: Pre-booming is the process of completely surrounding any vessels, facilities, or dock areas that are involved in the process of transferring oil. It is a preventative measure to keep potential spills from spreading beyond reasonable limits and driving up costs and damage to the environment. Pre booming of the oil tankers engaged in discharge of cargo at alongside berths and at SPM was the topic of discussion in 17th NOSDCP meeting held on 12th June 2012 and subsequently coast guard examined the feasibility of implementing pre-booming at each port and SPM. The study by the coast guard reveals following facts;

- Pre-booming is practiced at oil berths at Karaikkal, Tuticorin, Chennai, Ennore and Vishakapatanam port and permanent boom is laid on dockside at Sikka Reliance terminal.
- Pre-booming was reported feasible and recommended for oil berths at Mumbai and Kochi.
- Pre-booming was reported feasible but not recommended for oil berths at Mormugao and New Mangalore view obstruction to adjacent berths and low shoreline sensitivity respectively.
- The study further brought out that pre- booming is also not being practiced at any of the SPMs within the port jurisdiction.
- Reported constraints in pre-booming included strong currents and tidal streams, high tidal ranges, periodic change of direction with flood and eddy stream, as also the swing

of tanker at SPM with tide change and presence of standby tug in vicinity for immediate assistance.

However, ecological sensitivity is of significant concern, particularly in the GoK and at Kochi, Kakinada, and Paradip.

With a view to curtail the risk of oil spill, every deliverer will pre-boom oil transfers as a Standard Operating Procedure (SOP). However, when it is determined that it is not safe and effective to pre-boom the oil transfer, a suitable oil spill response craft will be stationed during cargo discharge, in the vicinity of the tanker for immediate response and backed by capability to track a spill in low visibility conditions. The SOP for pre-booming is placed at **Annexure XI.**

4.34. Over view of Circular No: 03/2014

Subject: Measures for Prevention and Control of Oil Pollution from FPSOS and FSUS Operating in Indian Exclusive Economic Zone

Over view: Floating production, storage and offloading (FPSO) unit used by the offshore oil and gas industry for the production, processing of hydrocarbons and for storage of oil designed to receive hydrocarbons produced by itself or from nearby platforms or subsea template, process them, and store oil until it can be offloaded onto a tanker or, less frequently, transported through a pipeline are preferred in frontier offshore regions. FPSOs can store up to 350,000 m3 of crude oil. Operation of FPSOs, therefore, poses a significant threat of oil pollution in the event of a contingency.

This circular details the guidelines for the Measures for prevention and control of oil pollution from FPSOs and FSUs operating in Indian Exclusive Economic Zone and the same is detailed in following section

4.34.1 Measures for prevention and control of oil pollution from FPSOs and FSUs operating in Indian Exclusive Economic Zone.

The measures for the prevention and control of oil pollution required to be complied by masters, owners, operators, charterers of FPSOs and FSUs operating in the Exclusive Economic Zone of India with a view to protect and preserve the marine environment are appended in the succeeding paragraphs.

Recognizing that the unified interpretation of regulation 37.1 requires that FPSOs and FSUs be provided with an oil pollution emergency plan approved in accordance with the procedures established by the Coastal State, no FPSO or FSU shall be used for the offshore production and storage or for offshore storage of produced oil in the Exclusive Economic Zone of India without a shipboard oil pollution emergency plan conforming to the Guidelines contained in Chairman NOSDCP Circular 02/2012 dated 09 August 2012 as amended, and duly approved by the Indian Coast Guard.

- Prior to positioning of the FPSO or FSU in the Exclusive Economic Zone of India, the owner/operator/Indian agent of FPSO of FSU shall submit the following to the nearest Indian Coast Guard authority:-
- Copy of Issue or endorsement of certificate as per revised MAEPOL Annex I;
- Copy of Shipboard Oil Pollution Emergency Plan as per revised MARPOL Annex I;
- Copy of International Oil Pollution Prevention Certificate as per revised MARPOL Annex I;
- Copy of Record of Construction and Equipment for FPSOs and FSOs as per resolution MEPC.139 (53) adopted on 22 July 2005;
- Copy of International Sewage Pollution Prevention Certificate as per revised MARPOL Annex IV;
- Copy of Record of oil discharge monitoring and control system for the last ballast voyage as per revised MARPOL Annex I;
- Copy of Certificate of insurance or other financial security in respect of civil liability for oil pollution damage as per CLC 1969, article VII;
- Copy of Certificate of insurance or other financial security in respect of civil liability for oil pollution damage as per CLC 1992, article VII;
- Details of intended position and operation; and
- Details and contact particulars of the Designated Person Ashore.
- The FPSO/ FSU or the owner/ operator/ agent acting on behalf is required to provide prior intimation to the Indian Coast Guard of the occurrences of the following:-
- The vessel leaving field for passage to any port outside India;
- On leaving the area of operations for operational turn around;
- As and when any crew change takes place;
- As and when vessel is off hired;
- As and when production stopped for more than 48 hrs; and
- Any discharge of oil, as required by the National Oil Spill Disaster Contingency Plan promulgated by the Indian Coast Guard.

With a view to curtail the risk of oil spill, every FPSO and FSU will pre-boom oil transfers as a Standard Operating Procedure (SOP). If owing to metrological or other factors it is not feasible to safely and effectively implement pre-booming as a SOP. The following alternate measures will be taken by the owner/operator/ agent of the FPSO to address any oil spill:-

- As an alternative to pre-booming, a suitable oil spill response craft will be stationed during offloading, in the vicinity of the FPSO for immediate response;
- On being made aware of a spill, the FPSO will have the ability to safely commence tracking of the spill in low visibility conditions; and
- Within one hour of being made aware of a spill, the FPSO will be able to completely surround the vessel(s) or pre-boom the portion of the vessel and transfer area which will provide for maximum containment of any oil spilled into the water.
- The FPSOs and FSUs will be inspected for MARPOL compliance and oil spill response preparedness by the Indian Coast Guard, independently or with other concerned authorities.
- The Coast Guard may undertake boarding and surprise inspections. The FPSOs and FSUs are to take all measures to facilities safe boarding and provide full cooperation as required for the inspection of the vessel/ presentation of documents.

4.35 Over view of Circular No: 02/2015

Subject: Net Environmental Benefit Analysis (NEBA)

Over view: After an oil spill, urgent decisions need to be made about how to minimize environmental and socio-economic impacts. The advantages and disadvantages of different responses need to be compared with each other and with natural clean-up. This process is called Net Environmental Benefit Analysis (NEBA). This circular explains how the process takes into account the circumstances of the spill, the practicalities of clean-up response, the relative impacts of oil and clean-up options, and the process by which judgments are made on the relative importance of social, economic and environmental factors.

The NEBA for oil dispersants is an assessment of positive and negative consequences of dispersant use, as compare to the use of other response techniques, taking into consideration the biological resources and socio-economics of the region, such as the season, state of fisheries, economic and social values, and other biological resources.

The following documents are to be prepared before proceeding with the NEBA, in order to determine which resources may be damaged and which ones should be preserved:-

- An inventory of the local sensitive resources;
- The vulnerability of the resources identified; and
- The definition of the importance of the resources identified.

The NEBA may performed as follows:

- As a preliminary measure at the facility oil spill response plan development stage; or
- In a specific situation during an oil spill.

A preliminary NEBA is preferred in order for oil spill scenarios of 10 tons, and its exponential values up to and including the worst-case scenario. Each scenario will be supplemented with recommendations on practicability, from an ecological point of view, of dispersant usage or its prohibition. Each potential oil spill scenario must address the following;-

- Description of assets where oil spills are possible;
- Potential oil spill scenarios and spill volumes including worst case spill, physical and chemical properties of oil;
- Results of mathematical simulation of oil spill behavior on water (spreading, possible drift directions, quantitative changes of oil, when presented on the sea surface, which occur due to evaporation and dispersion under the influence of wave energy and currents; amount of oil stranded onshore, oil remaining on the sea surface and penetrating into water column);
- List of ecosystem components that exist within the action zone of the facility contingency plan, depending on the priority of their protection in time of potential emergency scenarios, from the point of view of preserving natural resources, and taking into account their seasonal changes;
- List of economically and socially valuable assets which require protection;
- Prioritization of the identified environmental and economic resources, decided with the local stakeholders;
- Advantages and disadvantages of various available, in-place oil spill response methods including dispersion and an in-principle, assessment of the expected results of each possible response technique: dispersion, containment and recovery, monitoring for action; and

- Impact of floating and dispersed oil on selected ecosystem components and state of the environment in general.

Both natural and economic resources should considered. In general, endangered species, highly productive areas, sheltered habits with poor flushing rates, and habitats which take a long time to recover should receive top protection priority. The list should take into account factors like possible seasonal variation variations as well as the time needed by each impacted resource to recover (damage on a resource which can regenerate quickly is often more acceptable than damage to one which needs a very long restoration time). These factors will affect priorities.

Habitats and resources should be considered as a whole and not independently, as the decision to apply dispersant may benefit particular habitats or resources and at the same time affect adjacent ecosystems.

In terms of priority, it is better to protect the habitat before the species themselves, as the species are dependent on the preservation of their habitat. In terms of species, the objective must be to protect the reproductive potential.

The NEBA for the use of dispersant in particular, must take the following into consideration:-

- Consider the behavior (drift and weathering) of the treated oil (drift according to the current and speed of dilution of the plume) and of the untreated oil (drift according to the current and wind):
- Identify resources potentially affected by the treated oil or untreated surface oil;
- Assess possible vulnerability of these resources (vulnerability = sensitivity + restoration time);
- Rank these resources according to their vulnerability and/or importance and decide on the priorities (what must be preserved, what could be sacrificed);
- Predict the possible impacts for the different response options 9e.g. chemical dispersion or not and make a decision on the use of dispersants;
- In case of conflicting conclusions,
- Preserve the habitat before the species, and
- Preserve reproductive potential.
- Where local birds are concentrated, accord special concern for application of dispersants to ensure that direct contact between dispersants and feathers of seabirds is absolutely avoided.

The NEBA results must include mapping of areas where dispersants should not be used according to different criteria (e.g. seasonal or at any time of year, tides or current, weather conditions, or the size of the spill – tier 1,2,3).

The plot of valuable ecosystem components on environmental sensitivity maps and mathematical modeling of spilled oil behavior constitutes the basis for a NEBA. The results of preliminary NEBA are to be arranged in the form of a set of oil spill response scenarios. The scenarios are to be supplemented with recommendations on practicability, from an ecological point of view, of dispersant usage or its prohibition. The scenarios are to be then included in the relevant facility oil spill contingency plan.

Consequent to conduct of NEBA, consideration of certain response options may be immediately ruled out because of their ineffectiveness in the given conditions and, others ranked in terms of effectiveness and preference. The use of different techniques may be recommended for different parts of the slick. With respect to chemical dispersion, the recommendations must indicate whether it is possible or impossible to use dispersants in a given situation or which parts of the slick should be treated with dispersants.

At the time of an actual spill, approval for the use of dispersants will be given based on positive results of NEBA. Also, decisions will be made on the basis of NEBA, with adjustment if the real spill situation differs significantly from the pre-studied scenarios.

The NEBA results must be documented in a report approved by the relevant pollution control board, or environment ministry.

NEBA is a time intensive process. It is required to be conducted on scientific basis by a team of stakeholders, which preferably includes specialists in several fields (e.g. ecology; bird, mammal, fish, and benthos biology; mathematical modeling of the behavior of spilled oil). Running the scenarios will require specialized models designed for impact assessment.

4.36 Over view of Circular No: 03/2015

Subject: Online Oil Spill Advisory –Stake holder registration and table top exercise

Over view:The Online Oil Spill Advisory (OOSA) is a system to generate the predicted trajectory of oil spill after submitting the details of the spilled oil.. OOSA has been developed by INCOIS for use by the Indian Coast Guard and other statutory authorities and combat agencies involved in oil spill cleanup and control measures in the event of oil spill. OOSA integrates high resolution current and delivers the trajectory of the spilled oil immediately, and thereby enables planning of clean up activity. On submission of necessary information like location of the spill, date, time, pollutant type and its quantity, the trajectory prediction set up is triggered in the background, along with the forecasted forcing parameters such as wind and currents. The trajectory prediction for a period of forty eight to ninety hours is generated and disseminated to registered users. The OOSA system providestrajectory prediction for both, continuous and instantaneous spills. All stakeholders to the national plan can register as user and access OOSA under http://www.incois.gov.in/portal/osf/osf.jsp#, or alternately athttp://115.113.76.60/OilSpill/Login.jsp.The step by step procedure for "OOSA" Table top excersice is provided in following section

Step1: Create word document with the name of the Company and date of exercise which will be forwarded to the Coast Guard Headquarters with all the relevant outputs. (e.g. MbPT_12 May 15.docx)

Step2: Log into OOS at http://115.113.76.60/OilSpill/Login.jsp with e-mail ID and password.

Step3:

- After login, select type of spill as appropriate;
- Region of spill as appropriate;
- In type of spill continuous, enter data in Start date and End date; or in type of spill instantaneous, enter data in Start date and run duration (hrs);
- For start position specify latitude and longitude of the jetty, terminal, installation, fairway, outer harbour, SPM as appropriate;
- Mention pollutants;
- Select quantity released;
- Select units as appropriate;

Step4:On submitting, "Oil spill trajectory prediction system" will appear. Before proceeding, take a screen shot and save in word document for onward submission.

Step5:View output in web map. Take screen shots of the spill trajectory, in small scale and medium scale, and save in word document. Download the output as required. Repeat steps for each scenario and log out.

Step6: Forward the soft copy of word document to the Coast Guard Headquarters at dte-fe@indiancoastguard.nic.in.

4.37 Over view of Circular No: 04/2015

Subject: Revised pro forma for annual return on preparedness for oil spill response and joint inspection.

Over view: As per the NOSDCP 2015, every plan holder is required to submit an annual return of preparedness for oil spill response. The pro forma of the annual return is prescribed at at Appendix E7 to NOSDCP 2015. Further, the preparedness of ports and oil handling agencies is inspected periodically by the Coast Guard jointly with the concerned statutory authority and the report on inspections is rendered in the pro forma prescribed in appendix G to NOSDCP 2015.

Through this circular the coast guard had merged the both preformas to a common perfoma which is as shown in **Annexure XII**.

5

PORT PROFILE

Kandla Port establishd under Major Port Act, 1963 is now one of the busiest major multi-product port of India located in the Kachchh district of Gujarat. The port has been achieved the first position among all major ports of India, in most of the years of last decade. Presently the port can handle dry bulk, break bulk, liquid bulk and container cargo.Being located in an arid region, food grains is one among the most important commodity handled by the port. Other important commodities handled at the port is Coal, Petroleum Oil and Lubricants (POL) and Container Cargo.

5.1 Location

Major Port of Kandla, is situated about 90 km off the mouth of Gulf of Kachchh in the Kandla Creek at Latitude 23 degree 1 minute North and Longitude 70 ° 13’ East, is the lone Major Port on the Gujarat coast. Kandla Port has good connectivity by rail and road. It is closest to International Sea Routes. The port has two lane & four lane approaches to NH 8A from the Port Gates. Kandla Port has dual gauge railway system in operation. It is connected by BG link to Mumbai and Delhi via Ahmedabad.The port is well connected with the hinterland by National Highway No. 8-A and broad gauge railway system. The nearest railway station & airport is located at Gandhidham.

Vadinar Oil Terminal is located close to Jamnagar. It is connected by road through SH-25. 12.5km spur line connects the rail gantry of Vadinar Terminal to Modpur railway station. Nearest railway station is Jamnagar.

The location of the Kandla port and Vadinar Terminal is depicted in **Figure 5.1.**

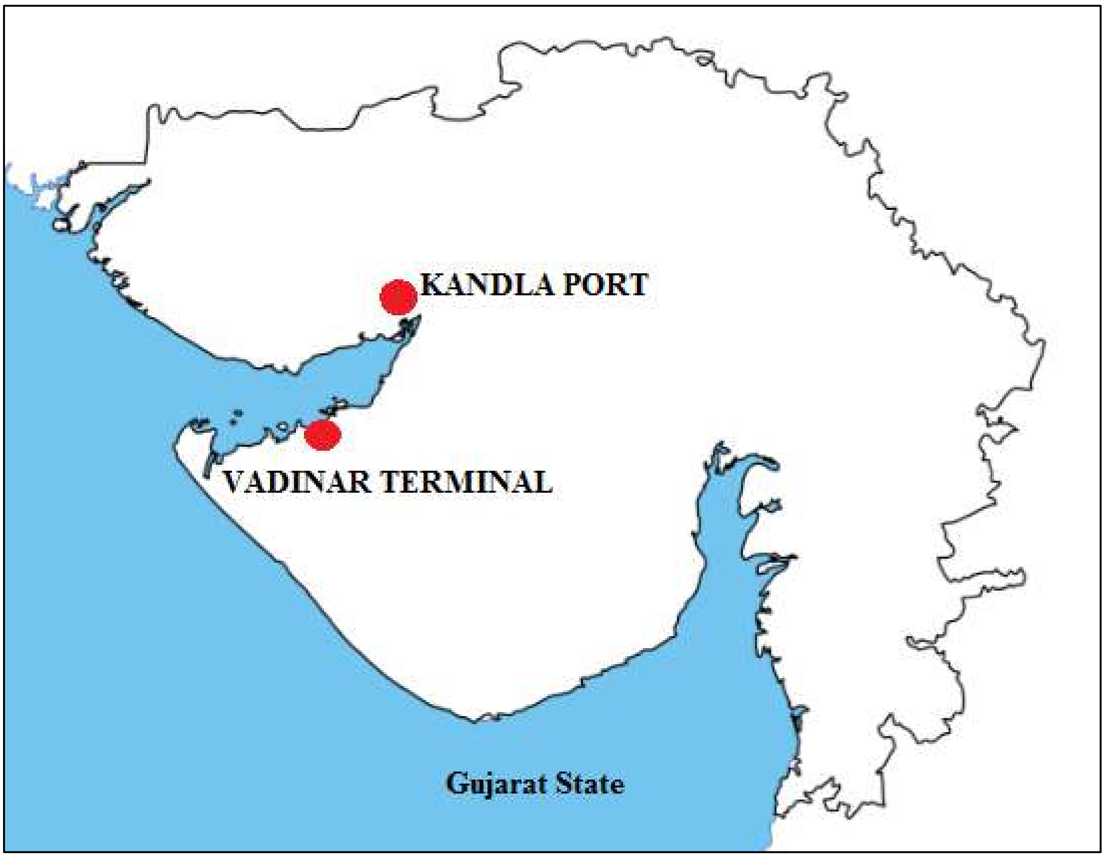


Figure 5.1 Location map of Kandla Port & Vadinar Terminal

5.2. Port Description

It has 12 dry cargo berths with a total of 2.57km in a straightline and 6 dedicated oil berths for handling POL and chemicals.Also there are three Single Point Moorings (SPMs) in Vadinar which can handle Very Large Crude Oil Vessels (VLCC) with a capacity 87,000T to 325,000 Dead Weight Tonnage (DWT) with a maximum pumping capacity of 10000 tonnes per hour. During 2014-15 the port handled 92.5 MT of cargo and thereby retaining number one position for volume of cargo handled among the Major Ports of India.

The total length of the port approach channel is around 26 km. The minimum with is 250 m. The contour depth along the shipping channel is around 10 meters. The KPT & Vadinar Terminal is given in **Figure 5.2**

Being located in the NW Coast of India,Kandla is the closest major port to the Middle East and Europe also it is the en-route port for ships calling at Karachi in Pakistan. Located at the head of Gulf of

Kachchh, it is well protected from strong monsoon winds and high waves of the coast, so is operational throughout the year.

Kandla Port

Vadinar Terminal

Figure 5.2 Layout of Kandla Port & Vadinar Terminal

Source: KPT

5.2.1. Existing Facilities at Kandla Port

5.2.1.1. Terminals

Kandla port has 10 berths, 6 oil jetties, 1 maintenance jetty, 1 dry dock and a few small jetties for small vessels.Adjacent to all these terminals and jetties there are storage facilities for covering cargo received in containers to petroleum products.

5.2.1.2. Steel Floating Dry Dock

The existing steel floating dry dock within the port caters the need of Port crafts as well as outside organizations and has capacity to accommodate vessels of following parameters.

- Length overall (LOA) - maximum up to 95 meters.
- Breadth - maximum up to 20 meters.
- Draft - maximum up to 4.5 meters.
- Lift displacement - maximum up to 2700 tones.

5.2.1.3 Chemical & Liquid Handling Complex

The Port of Kandla's Chemical and Liquid Handling Complex has total storage capacity for 21.9 Lakh kiloliters. Private sector storage terminals have capacity for 9.8 Lakh kiloliters.

5.2.1.4 Storage Facilities

Port consist of 185 hectares of custom bonded port area. Port offers an excellent and vast Dry Cargo Storage Facilities inside the Custom Bonded Area for storage of Import and Export cargoes, on very competitive rates. Also it has the largest capacity in India for storing liquid cargoes, and it is served by a modern pipeline network. The storage facility for liquefied petroleum gas has capacity for 30 thousand cubic meters.The container handling facilities include 545 m of quays equipped with four rail-mounted quay cranes and two harbor mobile cranes. The container facilities include an almost 11-hectare container yard, a 6.5 thousand square meter container freight station, and 90 reefer points for refrigerated containers.

The existing storage facilities at the dry cargo jetty area arepresented in **Table 5.1,** the liquid storage facilities under private sector is presented in **Table 5.2** and other liquid storage facilities is presented in **Table 5.3**

Table 5.1 Existing Storage Facilities at the Dry Cargo Jetty Area

Sl No	Description	No	Area (Sq. M)	Capacity in (Tones)
1	Warehouses	33	1.68 Lakhs	4.47 Lakh
2	Open storage space	67	13.10 Lakhs	32.27 Lakh

Source: http://www.kandlaport.gov.in/

Table 5.2 Private Sector Liquid Storage Facilities

Sl No	Name of the Terminal Operator	No of Tanks	Capacity (KL)
1	CRL (Chemicals & Resins Ltd)	112	247000
2	FSWAI (Friend Salt Works & Allied Industries)	132	271650
3	Kesar Enterprise	44	90081
4	N P Patel Pvt Ltd	09	38497
5	FOCT (Friend Oil & Chemicals Terminal)	21	39263
6	USTTL – Liquid Terminal	22	63038
7	Agencies & Cargo Care Limited	27	50000
8	J K Synthetics	14	25176
9	IMC Limited	04	25288
10	J R Enterprises	15	25320
11	Indo Nippon Chemicals Ltd	10	17200
12	Liberty Investment	06	16016
13	Bayer ABS Ltd	11	13310
14	Deepak Estate Agency	09	13212
15	Tejmalbhai & Company	08	12577
16	Avean International Care Ltd	11	12160
17	USTTL Gas Terminal	04	5720
18	Parker Agrochem Export Ltd	06	15000
Total Capacity		**465**	**980508**

Source: http://www.kandlaport.gov.in/

Table 5.3 Public Sector Liquid Storage Facilities

Sl. No	Name of the Terminal Operator	No.of Tanks	Capacity (KL)
01	Indian Oil Corporation	38	575838
02	Bharat Petroleum Corporation	21	230000
03	Hindustan Petroleum Corporation	28	204000
04	IOC– LPG	02	30000
05	IFFCO	11	110000
06	NDDB	09	58530
Total Capacity		109	1208360

Source: http://www.kandlaport.gov.in/

5.2.1.5. Port Equipments

5.2.1.5.1. Wharf Cranes

Sixteen Wharf cranes are available at the port that include 4 wharf cranes of 3/6 tons capacity and 4 heavy duty, modern, state of the art, having lifting capacity of 12/16 tons.

5.2.1.5.2. Weighbridges

Nine weighbridges are there inside the port, which include four weighbridge of 40 MT capacity, One Weighbridge of 50 MT capacity, One Weighbridge of 60 MT capacity, One Weighbridge of 80 MT capacity, Two Private Weighbridge of 40 MT & 20 MT capacities respectively.

5.2.1.5.3. Other Support Equipments

Port contain loading equipment such as Forklifts, Tractor, Trailers, Pay loaders of various capacities. Also private handling equipment like Mobile cranes, Top lifters, Pay loaders, Forklifts, Heavy duty Trailers, etc. available on hire at competitive rates.

5.2.1.5.4. Various Facilities

Other facilities available within the port area are

- One deep draft mooring and four cargo moorings in the inner harbour area for stream handling.
- Loading/Unloading facilities for barges available for stream handling.
- Seventy licensed private barges available at competitive rates.
- Adequate storage capacity in both dry and liquid areas.
- 66 KV power supply.
- Standby power to the extent of 2000 kV available for emergency operations.
- Well-developed road network directly connecting the national highway.
- Railway network connecting the broad gauge main line, which is being upgraded.

5.2.1.5.5. Navigation Facilities within the Port

Kandla port facilitate round-the-clock navigation. It offers maximum permissible draft of 12 meters, but projects are underway to deepen the port to 14 meters. presently, the Port can accommodate ships up to 240 meters in length and 65 thousand DWT. Also, the Port offers a huge anchorage area for vessels waiting to enter the port and for lighterage services in the outer harbor. Navigation channel of the port is marked with 22 lighted navigational buoys, and a light house also assists navigation.

5.2.1.5.6. Offshore Oil Terminal (OOT), Vadinar

KPT had commissioned offshore oil terminal facilities atVadinar in 1978, jointly with Indian Oil Corporation. It has a capacity of 58 MMTPA and handles crude oil and petroleum products. Vadinar is one of the deepest natural draft terminals in India and it does not require any maintenance dredging. The facilities consist of three offshore Single Point Mooring (SPM)/ Single buoy mooring (SBM), two jetties for handling liquid petroleum products, tanks for storage of crude oil and petroleum products and rail and road gantries for dispatch of petroleum products.2nd SBM was commissioned in the year 1998.3rd SBM at Vadinar is for importing crude for the oil refinery of Essar Oil.

The features of the OOT Vadinar is as presented below .

- A draft of up to 33 m at SBMs and Lighterage Point Operations (LPO)
- Handling VLCCs of 300000 DWT and more.
- Providing crude oil for the refineries of Koyali (Gujarat), Mathura (Uttar Pradesh), Panipat (Haryana) and Essar Refinery, Jamnagar (Gujarat)
- Simultaneous handling of three VLCCs possible at the SBMs with vast crude tankage facility.
- Two nos. of 50 Tons state-of-art B.R SRP Pull-back tugs are available for smooth and simultaneous shipping operations on the SBMs and product jetty.
- One oil and debris recovery tug for oil pollution control has been acquired and stationed at Vadinar.
- Excellent infrastructure facilitating transshipment operations, even during the monsoon.

5.3 Operational Profile of the Port

Ongoing operational profile of Kandla port is described in following section :

5.3.1 Commodities Handled

Coal is the largest commodity handled by the port with respect to tonnage. The details of commodity handled at the port during 2014-15 and 2013-14 are given as **Table 5.4** below.

Table 5.4. Traffic Handled at Kandla Port during 2013-14

Sl. No.	Commodity	Tonnage Handled (in Lakh Tonne)		% Increase
		2014-15	203-14	
Imports				
1	POL	8.67	7.02	(+) 24
2	Edible Oil	34.58	24.90	(+) 39
3	Phosphoric Acid	10.85	9.91	(+) 09
4	Fertiliser	38.47	26.44	(+) 45
5	Iron & Steel	11.82	8.42	(+) 4
6	Ores	11.96	5.98	(+) 100
7	Thermal Coal	97.25	60.80	(+) 60
8	Sugar	12.67	6.11	(+) 107
9	Timber Logs	28.51	26.52	(+) 08
Exports				

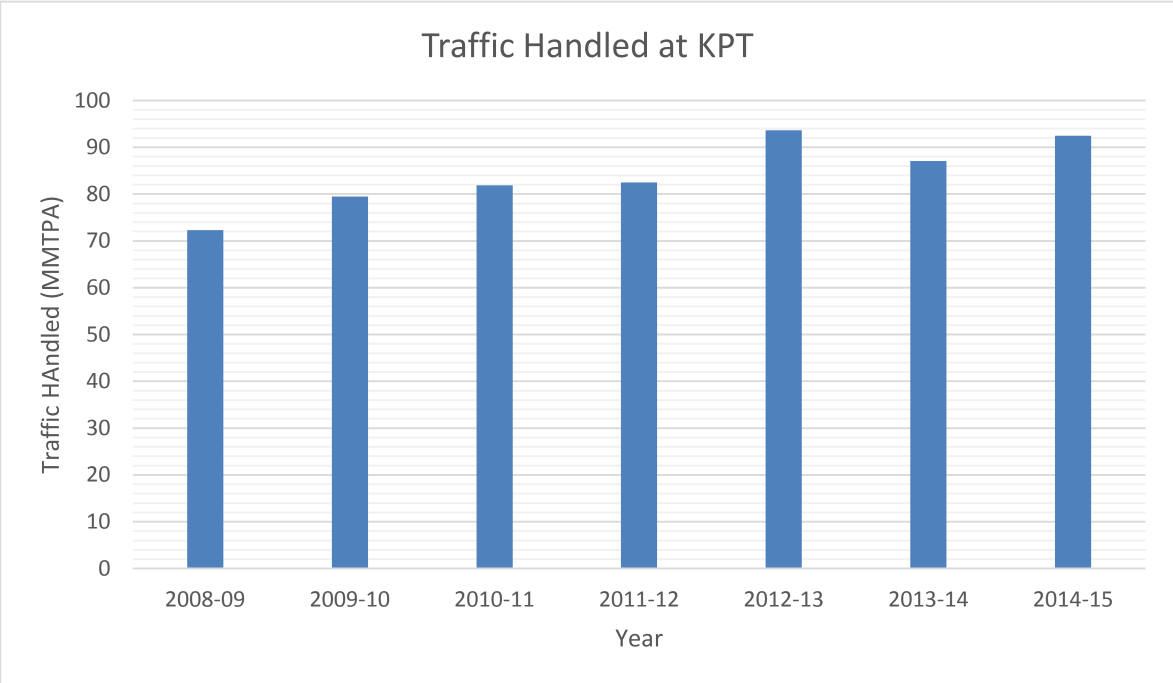
1	Edible Oil	2.10	1.66	(+) 27
2	Bauxite	3.39	0.86	(+) 294
3	Other Food	3.82	3.79	(+) 01

Source: Administrative Report 2014-15

From the above table it may be inferred that 8.67 Lakh Tonne of POL is being handled at Kandla. Also it can be seen that +24 % increase is shown by the POL commodity compared to the previous year.

5.3.2 Traffic Handled at Kandla

Kandla Port has shown buoyant growth in cargo handling in the recent past. The port's share in traffic handled by all major ports has risen steadily over the years. The past traffic profile of the port is shown in **Figure 5.3.** During 2013 -14 & 2014 -15 total traffic handled are 870.05 and 924.97 lakh tones respectively.

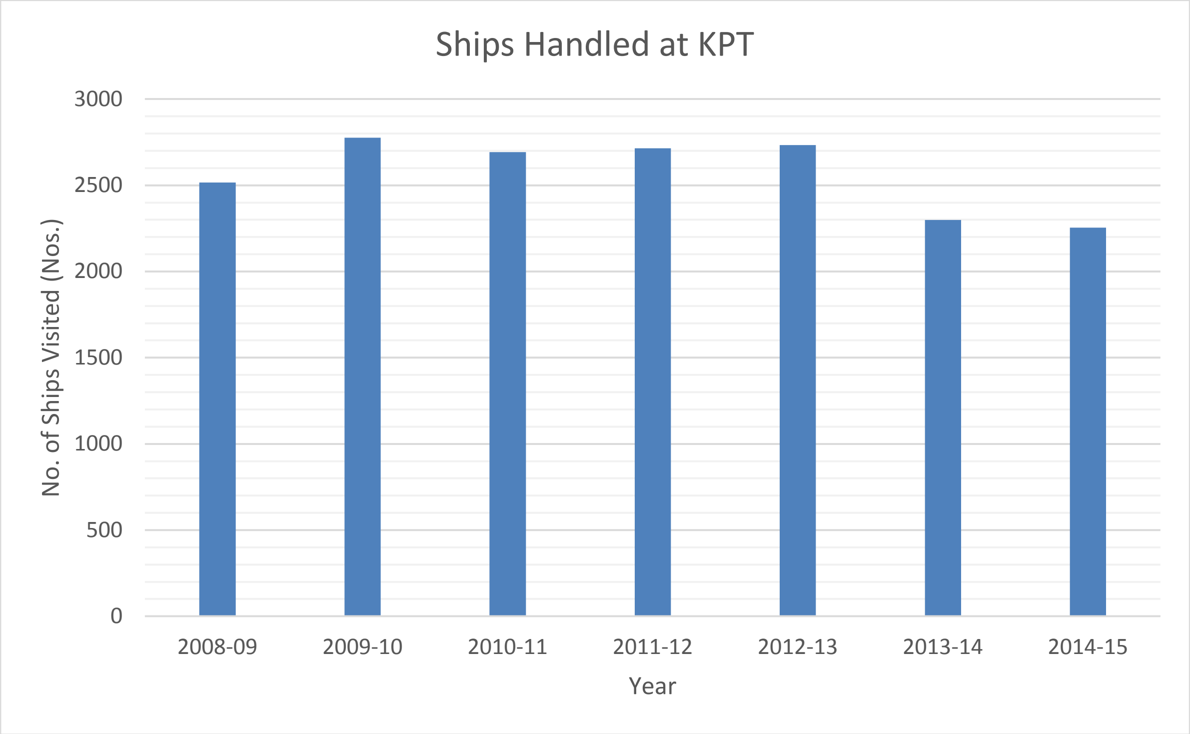


Source: http://www.kandlaport.gov.in/

Figure 5.3 Traffic Profile of Kandla Port

5.3.3 Ships Handled at KPT

Total number of ships visited KPT during the year 2008-2015 are given as shown in **Figure.5.4.** During 2013-14 & 2014-15 a total number of 2299 & 2254 vessels entered the port respectively. Among them more than 75 % visted KPT and remaining 25 % visited Vadinar.



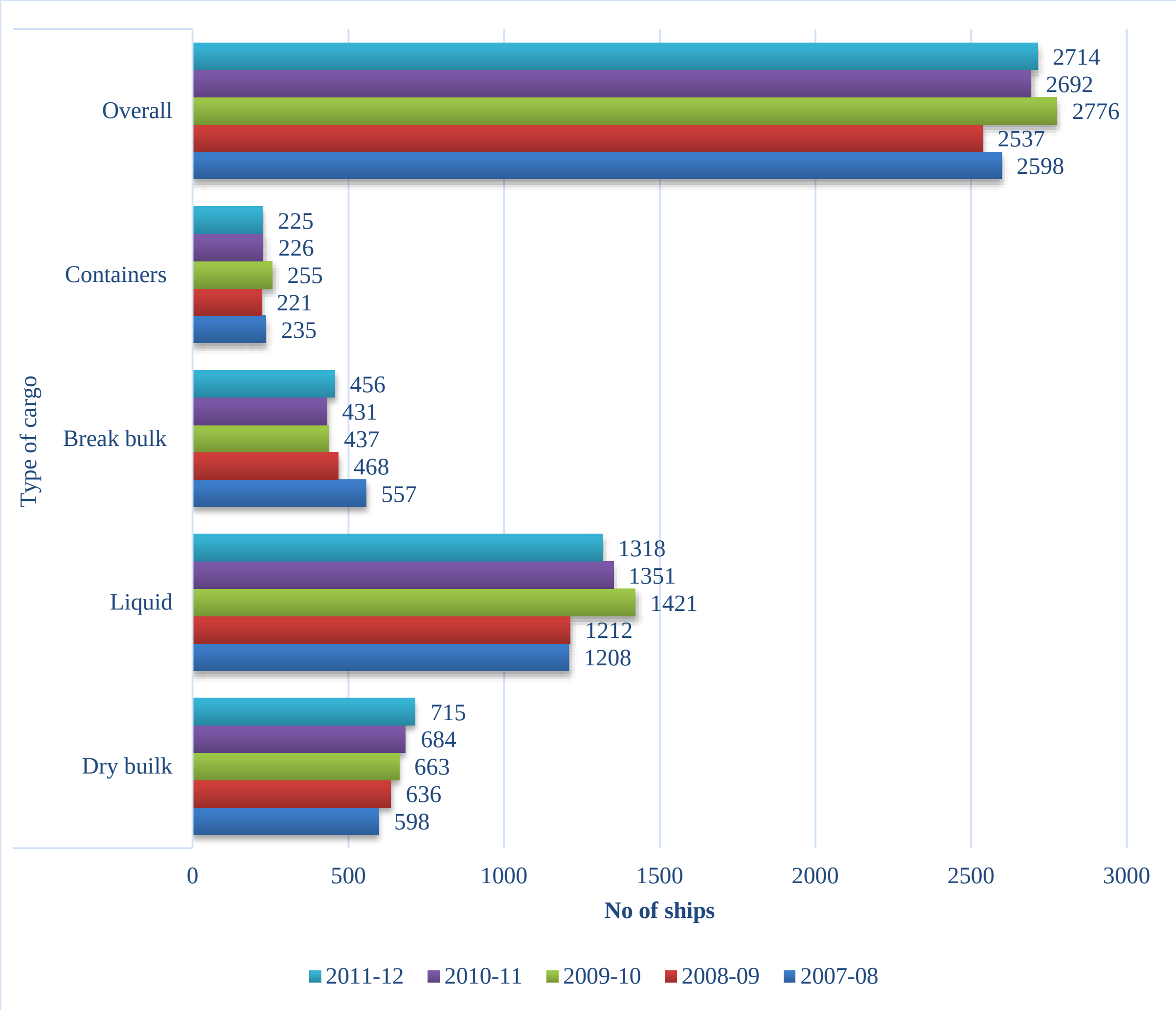
Source: http://www.kandlaport.gov.in/

Figure 5.4 Ships Handled at KPT

Total number of ships handled at KPT commoditywise during the period of 2007 – 2012 is as presented in **Figure 5.5**

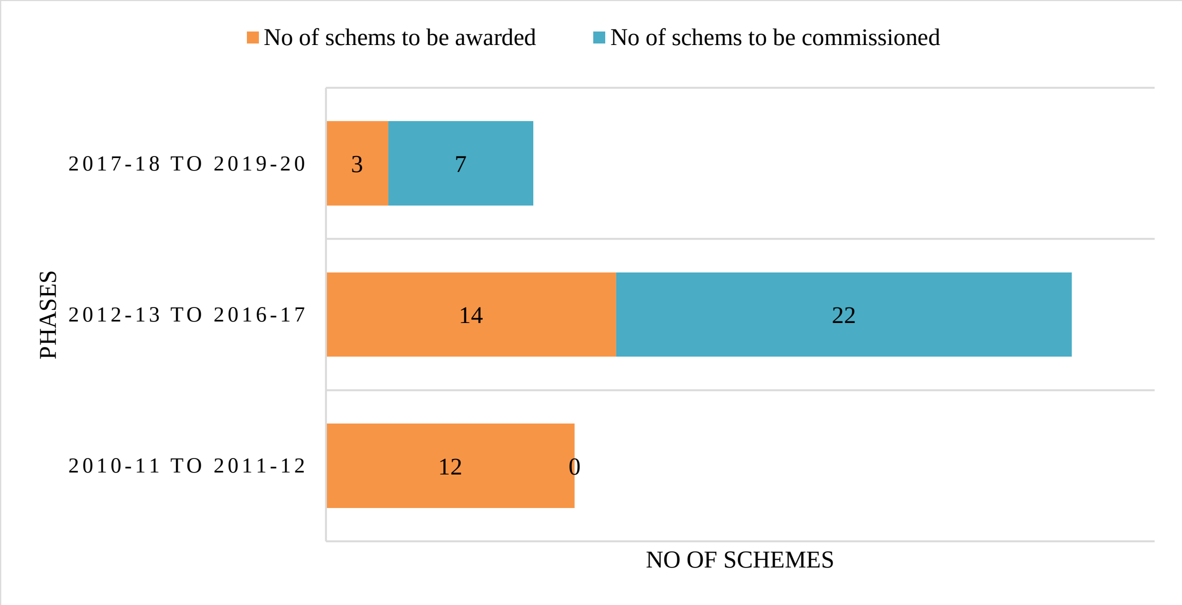
5.4 Future Perspective of Kandla Port

Inorder to increase the productivity and to reduce the turnaround time KPT have a well-defined futre plan. This will inturn demands the capacity addition of the port .The future perspective of Kandla port upto 2020 is shown in **Figure 5.6** and future capacity addition plan up to 2020 is given in **Figure 5.7 .**



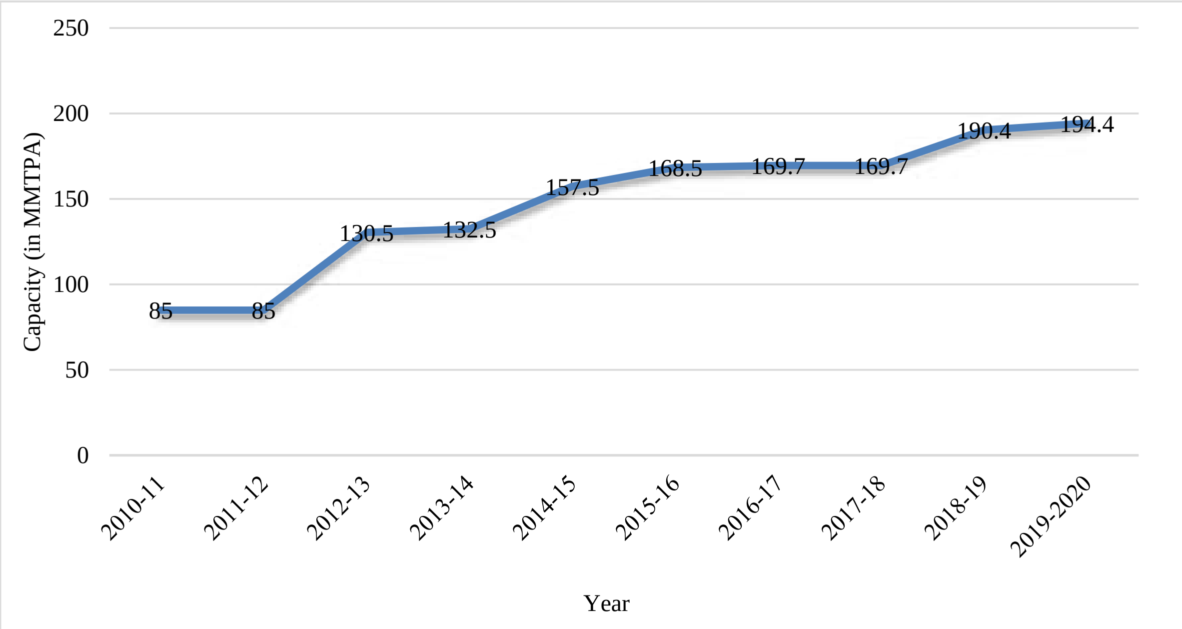
Source: http://www.kandlaport.gov.in/

Figure 5.5 Total number of ships handled at KPT



Source: http://www.kandlaport.gov.in/

Figure 5.6 The future perspective of Kandla port up to 2020



Source: http://www.kandlaport.gov.in/

Figure 5.7 The Future Capacity Addition Plan of Kandla Port upto 2020

Considering the ever increasing traffic at the Port which is also handling the POL, a sound contingency plan should be maintained to cater the threat posed by an uncertain oil spill event.Also it may be noted that Vadinar being the POL hub, extreme caution is required for this area.

6

SENSITIVITY MAPPING

The area within Kandla Port limit as well as its surroundings is rich in both ecological and socioeconomic resources. As per the It is important to identify the areas of highest risk, so that prioritisation of resources is possible. Appendix E3 of NOS-DCP 2015 - Environmental Sensitivity Index Mapping Guidelines, the role of sensitivity mapping is the " Basis for the definition of priorities for protection, development of response strategy and cleanup operations, considering the oil spill sensitive elements including protected areas, important areas of biodiversity, sensitive ecosystems, critical habitats, endangered resources and key natural resources". In this context,realising the importance of protection of these resources from the impacts of oil spill, resources within the Kandla Port Limit were assesed, and strategic oil spill sensitivity map was prepared for the port limit. This map provides information on the Shoreline Classification, Biological Resources & Human-use resources as per NOS-DCP guidelines. These three are the most important consideration as, it directly implies to the risk from an oil spill interms of vulnerability, persistance and ease of cleanup. The subsequent sections details are as follows:

- Resources assessment
- Sensitivity Mapping
- Response Considerations

6.1 Resources Assessment

Kandla port located in the northern plank of the GoK, in an area with irregular and dissected configurations, with numerous creeks surrounded by marshy landson the bank of Kandla creek. Located at the juncture of Kathiawar and Saurashtra peninsula, ie., at a transition zone between arid and semi-arid zone having striking characteristics of the arid area.

Figure 6.1. Kandla Port - An Ariel View

At Kandla, the Gulf of Kachchhnarrows down in to a distinct constriction getting itself dividing into a creek system often called the Little Gulf of Kachchh, leading to an an area called Little Rann of Kachchh (LRK) which receives water supply only during the high tide.Hence close to the port area are vast mudflats and many of them are hard flats, which gets submerged only during the spring tide.Among them Sathsaida bet is the largest.Areal view of Kandla port is given as **Figure 6.1**. The top of the picture depicts the Sathsaida bet where as the bottom is the port area with its tank farms and warehouses.

The port limits extends from Navlakhi at the head of GoK to Narara Bet in the southern arm. While from Tuna in the north coast to Kalumbhar Bet in the southern arm. The limit is bounded by Kachchh in the North & North-East, Morbi at East and and Devbhoomi Dwaraka& parts of Jamnagar district towards South & South- East respectively. Along the coast there are numerous coastal villages with people engaded in traditional occupation of fishing hosting large and small fish landing centres. Also being the adjoing land masses of ports, many of them have been developed into port towns and subsequently developed as industrial pockets.

Within the port limit is the most productive and diversified habitats along the West coast of India. The high tidal influx covers vast low lying areas comprising a network of creeks, marshy tidal flats and rocky regions which provide congenial environment to a wide variety of marine biota. The northern shore is predominantly sandy or muddy confronted by numerous shoals and creeks also sustains large stretches of mangroves. There are vast mudflats towards the Mundra coast.There are narrow beaches along the coast behind the mudflats. Towards the southern limit, shoreline is comprised of numerous islands and inlets which harbour vast areas of mangroves and coral reefs with living corals.

Important organisms includes algae, mangroves, corals, sponges, molluscs, prawns, fishes, reptiles, birds and mammals. In order to protect the rich biodiversity of the Gulf of Kachchh, several intertidal mudflats and coral reefs along its southern shore are declared as Marine National Park and Marine Sanctuary (MNPS). There are also areas decleared as Important Bird and Biodiversity Areas (IBAs) which are large bird flocking areas, Important Coastal and Marine Biodiversity Areas (ICMBAs).

Thus the peculiarities of Kandla Port Area which are to be duly considered with respect to oil spill sensitivity can be briefed as follows:

- An all-weather Major Port with several oil handling facilities including SPMs within port limits
- Dry Weather and Mild Monsoon
- High tidal ranges and strong tidal currents
- Extensive creek system acting as tidal channels
- Valuable ecological resources such as Corals, Mangroves, Mudflats and bird flocking areas around the vast creek system
- Extensive socio-economic activities including Special Economic Zone (SEZ), saltpans, fishing areas and intake points of shore based industries.

Important features of the port area are discussed below which directly has relevance to oil spill sensitivity and its response. Map showing KPT limit with its facilities, adjoining land and marine features of the areas are given as **Figure 6.1** below.

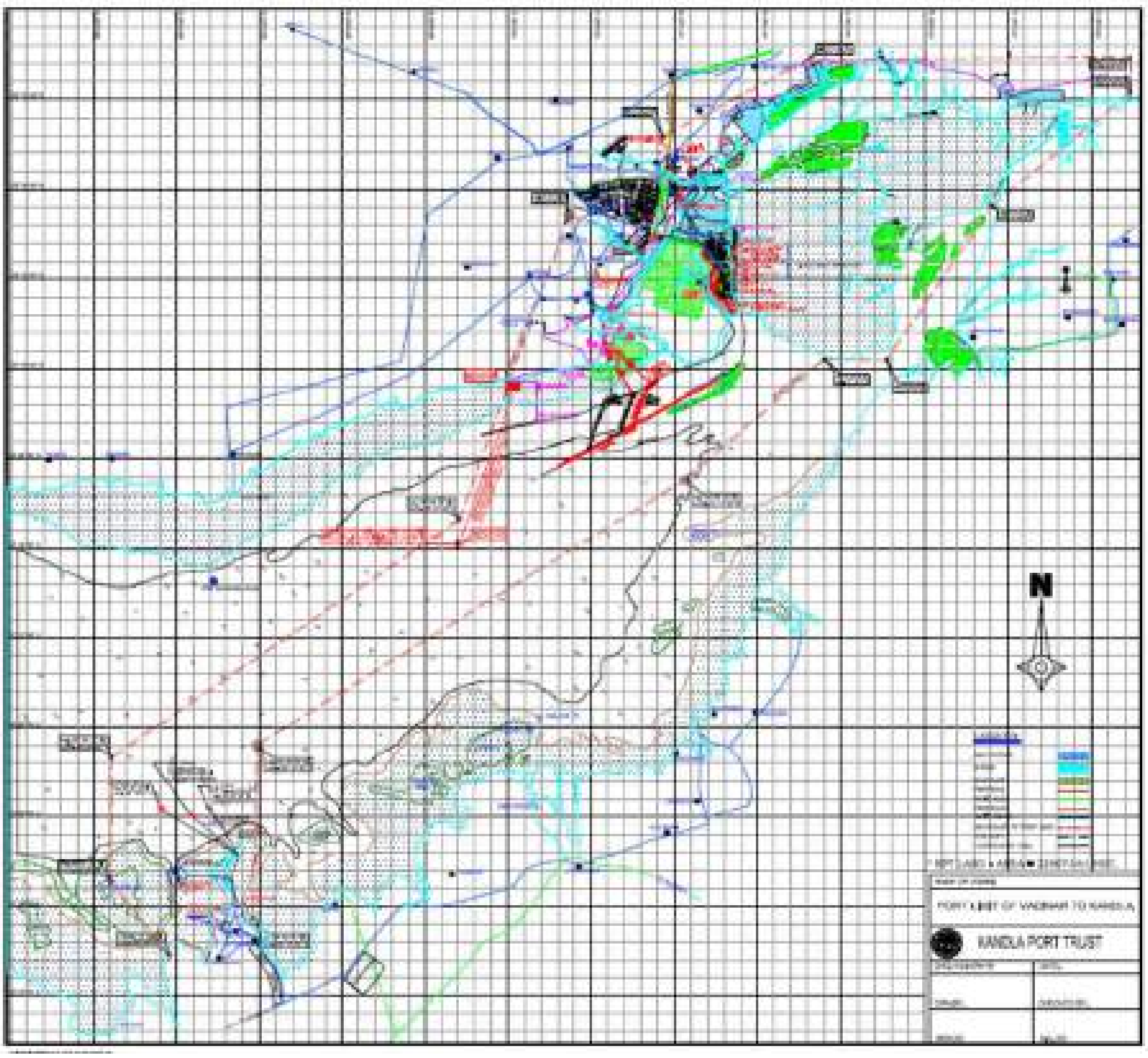


Figure 6.2. KPT Limit

Kandla Port is located inside extensive creek system surrounded by bets including intertidal and high tidal mudflats, while its limit extends to the MNPS where the Vadinar Terminal is located. Because of its geographical extent the area is described as two zones- Kandla Zone for the areas in Northern side of the port limit and Vadinar Zone is located towards the southern side of port limit. The inner portion of Gulf area has more uniform and stabile environmental conditions. Kandla port regionis free from significant wave disturbances while the Vadinar has marine meterological conditions dominated by tides and monsoons. The important features of the port limit is given as **Table 6.1**.

Table 6.1. Important Features of the Port Limit

Sl. No.	Nature of Coast	Coastal Stretch	Length (km)	Major Geomorphic Feature
1	Mix- Wave & Tide dominating Coast	Mundra - Tuna	45	Mudflat, Paleomudflat/ Salt Pan, Ebb Delta/ Sand Ridges
2	Tide Dominating Coast	Tuna - Kandla	15	Mudflat including Hard Mudflats bordering LRK, Paleomudflat/ Salt Pan, Mangrove
3	Tide Dominating Coast	Kandla - Vadinar	60	Islands of southern arm such as Kalumbhar and Narara with Corals, Mangroves & Mudflats.

Source: S.B. Sukla et al, Indian Journal of Geo-sciences, 2010

6.1.1. Kandla Zone

Kandla Zone includes the area near urban settlement Gandhidam towards West abarren land including Sathsaida bet occupying the South-West portion of LRK and adjoining creek system. The areas as a whole have a marshy nature and the high water balance make the area hypersaline. Almost the entireshoreline of Kandla zone is highly corrugated , which are the extension of LRK ie., the fringing Rann with mangroves on banks of the creek. The port area is immedeiately surrounded by barren marshy lands especially in the North & North East. There is growth of mangroves including plantations towards North, North East and South and South West. Also there are extensive salt pans surrounding the port. Settlements are there within the port area as well as towards the West of the port.

Aveage depth of the area at head of Gulf of Kachchh is 20m. Near the Kandla creek the depth reaches 5m or less. The present channel is called the Sogal Channel. And dredging is concentrated for about 2.3km length out of the approach channel 23km. (Coastal Environments- Problems and Perspectives, K.S Jayappa, A.C. Narayana). The width of the channel varies from 200 meters to 1,000 meters. The contour depth along the shipping channel is around 10 meters.

Tides in the Gulf are of mixed, predominantly semidiurnal type with a large diurnal inequality. The high tidal factor can be attributed to the shallow inner regions and narrowing cross-section. Tidal range in the area is around 7m. Tidal expense of along the shores of Kandla increases the Gulf up to 2 km Kandla. There are strong currents up to 3 knots.

Extensive Mudflats

Pagadiyas Fishing

Salt Pans

Figure 6.3. Important Resources of Kandla Zone

6.1.1.1. Creek

The vast creek systems of Kandla functions as tidal channels. The width of the channels are highly variable and there are smaller channels are mud during the low tide and submerges during the high tide. Kandla creek is the major creek of the area. Two large creeks, Sara and Phang creeks join the Kandla creek and act as its tributaries. Besides that, one more creek, Nakti creek also joins the Kandla creek at the confluence of Sara and Phang creeks.

All these creeks bring water from Little Rann into the Kandla creek, which has a fairly good depth and stable banks. The width of the creek channel varies from 200 m in the upstream to 1000 m at the mouth and the depth varies from 8 to 12 m, while the tidal height ranges from 0.83 to 7.2 m, with tidal currents varying from 0.08 to 2 m/s. Kandla and Nakti creeks however retain high salinities (> 35 ppt) even during monsoon.(Vijayalakshmi Nair).Tuna area is having smaller creeks.

6.1.1.2. Mudflats

The port is surrounded by vast mudflats that get inundated during high tide. Sathsaida Bet, Khengriji bet are important of them. They consist of thick deposits of very soft marine clay upto a depth of 12-15m underlain by calcareous sand and highly weathered, weak sedimentary rock formations comprising of compact sand, siltstone, claystone and sandstone (Vijayalakshmi Nair). The mud flats of Kandla port area are important bird flocking sites.

Sat Saida Bet is located opposite to the Kandla Port and falls within the port jurisdiction. It is a vast tidal inundated area mostly made of mudflats and tidal swamps.Small creek systems arising from Kandla creek, Nakti creek and other creek systems brings tidal wate to this Bet and vast area along the fringes gets flushed tidally. Sat Saida has natural but degraded mangroves of around 10sq.km which are mostly present along the banks of the minor tidal creeks and seawater inlets. Sat Saida Bet is surrounded in all the three sides by creek systems creating a conductive environment for the mangrove plantation. Remoteness of the site and presence of vast mudflats renders Sat Saida Bet an ideal site for mangrove plantation activities. The southwest portion of the Sathsaida bet is known as Flamingo flats which are many times reffered to as shoals. Birds like Pelicans are often found swimming the water near these flats. Tidal Pools are often formed in the mudflats which forms habitat various small marine organisms. Khejranji Bet is another important bets of the area.

6.1.1.3. Salt Marshes

Salt marshes are halophytic areas with grass, shrubs or dwarf wood on alluvial sediments bordering salinewater bodies with tidal fluctuations either tidally. Vast complex of marshland is present lying crisscrossed by innumerous creeks.

6.1.1.4. Salt Pans

Saltpans are unique tide water impounded enclosed system adjacent to creek environment. They are characteristically exposed to a wide range of environmental stress and perturbation which manifest mainly through salinity changes. The distinct feature of the brine ecosystem is its biotic simplicity and stability. saltpans are immature ecosystem as compared with a typical marine system and harbour a high proportion of opportunistic and fugitive species These saltpans serve as feeding grounds for a variety of resident as well as migrant birds. They are small shallow more or less rectanguar man made depressions where saline water accumulated and evaporates leaving salt deposites. There are aquaculture activties occuring in the area were coastal waterbodies used for breeding and rearing of brackish/ saline water in capitivity. Mainly salt pans are used seasonally as aquaculture ponds.

6.1.1.5. Sandy Ridges & Beaches

There are narrow ridges of coarse sand and shell from 0.3m to 1.8m height from the Rann on the Western side of the Nakti Creek. Flamingo flat of dry mud extends up to 4km off the South-Western side of the Sathsaida Bet is an important mudflat of the area. Also the southern side of the Sathsaida bet on the eastern side of the entrance of Kandla creek is fronted by ridges of coarse sand and broken shell. Also between Mundra and Kandla there narrow sandy beaches.

6.1.1.6. Shoals

Sand bars and islands which change their location frequently are present in the area parallel to the entrance of Kandla creek from Jodiya onwards. The important them are as follows:

- Kaladara Shoals - Hard dry sand dries 2.7m south-westward of the Flamingo flat consisting of hard sand
- Kapoor shoal – Parallel to Kaladara with least depth 1.2m consists of ridges and pinnacles of coarse sand , small stones and broken shells

- Mid shoal
- Sangvi Shoals

6.1.2. Vadinar Zone

Vadinar Zone is located in the border of Jamnagar and Devbhoomi Dwaraka Districts. Ecologically important coastal ecosystems or habitats such as corals, mangroves, mudflats, flocking areas of birds are present in the area with peak concentration of including the migrants during the winter season ie., from October to February. The important features in Narara Zone is given as **Figure 6.4**.

Bird flocks near

Mangrove of MNPS Islands

Narara Island

Figure 6.4. Important features in Vadinar Zone

6.1.2.1. Coral Islands

Towards the southern port limit near Vadinar there exists two coral islands Kalumbhar and Narara.

6.1.2.1.1. Kalumbhar Island

Kalumbhar is the largest island in the GoK having some agricultural land, excellent corals and associated reef flora and fauna in North, North-Eastern and Western side of reef. Narara bet also has coral reef associated with it which gets covered at 0.8m fringing Narara Bet and extending about 3.2km North and North East of the island. The seaward edges of all reefs are generally steep (NBDB & MSSRF). They form an integral part of the MNPS. There are mudflats in the centre and sandy beaches towards North and North-West. These mudflats and beaches are intervened by many creeks which supplies tidal water.

6.1.2.1.2. Narara Island

Narara has Hard Coralline Areas, Sandy, Muddy habitats with Mangroves, Sea Weeds and Sea Grass. Northern areas along the reef edge support subtidal corals. Reef flora and fauna in good condition, diversity is good, mangroves in excellent condition. Nesting sites of many birds (NBDB & MSSRF) are present here.The intertidal expanse at Narara Bet varies from 2.5 km to 3.8 km. The main algal zone is however confined to 1.2 to 2.5 km (Vijayalakshimi Nair, 2002).

6.3 Biological Resources

The marine vegetation is highly varied, which includes sand dune vegetation, mangroves, sea grasses, macrophytes and phytoplankton. In general, the northern shore of the Gulf supports very poor algal diversity.

6.3.1. Corals

Most of the Islands in the Souther arm GoK support fringing reefs and the coral patches are also found between Islands. The present day coral growth is patchy rather than reefs as they are supported by intertidal sandstones or wave cut eroded shallow banks. There are also coral pacthes near Off Mundra-Mandvi Coast.

Corals near Vadinar have a moderate live coral population with variety. These corals are already under environmental stress due to heavy sedimentation. The sturdy corals like Goniopora, Porites, Favia and Goniastrea are the common species. Live corals are mainly confined to the lower littoral and shallow subtidal zones (< 8 m). The distribution of live corals along the intertidal reef flat of Kalubhar is closely comparable with that of Narara Bet. Live coral colonies are relatively more especially at the lower reef flat of Kalubhar as compared to Narara Bet. The corals are mainly represented by the genera Favia, Favites, Porites, Goniastrea, Goniopora, Pseudosiderastrea, Cyphastrea, Symphyllia and Turbinaria. The live corals are absent at the reef edge of 50 m width while their coverage increases (90 to 100%) at the reef slope below 1 m depth. These corals are under high environmental stress due to heavy sedimentation which is more prevalent along the eastern side. Hence live corals are mostly confined to the subtidal and the lower reef flat and absent at the upper reef flat.

Figure 6.5. Corals of Narara

Eastern segment of Narara Bet, have as vast mud flat and hence the presence of coral is less. The live corals are restricted to the subtidal regions upto 8 m depth while they are absent beyond 15 m depth due to sandy/ muddy bottom. Kalubhar Island has relatively better live corals diversity as well as density at the lower intertidal and subtidal (< 1 m depth) as compared to Narara Bet in its north and north-west regions. (Vijayalakshmi Nair, 2002).

6.3.2. Mangroves

Kandla zone is dominated by extenssive patches of mangroves predominated by *A. marina* including natural ones and plantation. Other dominant species are A officinalis, Bruguiera parviflora, B gymnorphiza, Rhizophora mucronata, R. apiculata, Ageiceros corniculata and Sonneratia apetata alongwith the associated species of Salicornia brachiata, Sueda fruticosa, Artiplex stocksii and a lichen, Rosella Montana.

A. marina

A officinalis

Bruguiera parviflora

B gymnorphiza Rhizophora mucronata Ageiceros corniculata

Figure 6.6. Important Mangrove species within KPT limit

Middle and downstream portions of Kandla Creek was seen with dense patches of mangroves with species of Avicennia marina. The Nakti Creek sustained dense mangrove vegetation at both the banks. The average density of plants was seen between 150-225 plants/100m2 with average height varying 0.5-3.5m in Kandla and Nakti Creek. Also there are natural mangroves in the Tuna region within the jurisdiction. A total plantation of 520 ha has been covered till the end of April 2013 in the Sat Saida Bet, mainly Avicinneia marina and in the Nakti Creek total area of 150 ha. Higher & better vegetation is seen in Tuna mangroves and also they have better regeneration potential.

Narara bet harbours a dense mangrove forest covering an area of 116.57 ha where as sparse mangroves for 135.55 ha along the eastern and western side. Avicennia marina is the dominant species having a height between 0.5 to 2m. About 0.5 km2 area of Narara Bet was afforested with A. marina by the MNPs Authorities. About 6 species of mangroves and 4 associated species are recorded at Narara Bet. Salvadora persica, Salicornia brachiata and Suaeda fruticosa are occasionally seen along high saline zones at the supralittoral and nearby saltpans. (Vijayalakshmi Nair, 2002).

There are natural formation of open scrubby type, with isolated and discontinuous distribution from Kandla- Navlakhi.

6.3.3. Sand dune flora

Seashores of the port limit mainly hosts shrubby and herbaceous vegetation. Most of the plants on the shore are prostrate and xeromorphic in nature, e.g. Euphorbia caudicifolia, E. nerifolia, Aloevera sp, Ephedra foliata, Urochodra setulosa, Sporobolus maderaspatenus, Eragrostis unioloides, Calotropis procera, Fimbristylis sp, Indigofera sp and Ipomoea sp. and Launea sarmentosa. The vegetation becomes gradually stable at a distance away from the tidemark with the stabilization of the soil.

6.3.4. Marine Algae

Marine algal species within the port limit are mainly found in the Narara and Khalumbhar Islands. Most common among them are Ulva fasciata, U. reticulata,Enteromorpha intenstinalis, Dictyota sp, Hypnea musciformis, Sargassum tennerimum, S. ilicifolium, Gracilaria corticata, Cystocera sp, Padina tetrastomatica,Corallina sp, Laurencia sp, Caulerpa racemosa, C. peltata, Bryopsis sp, Turbinariasp, Ectocarpus sp, Acanthophora sp, Chondria sp, and Codium sp. The Narara reef flat immediately behind the reef ridge upto 1 km from the low tide level supports diverse and abundant algal flora.. Extensive intertidal mudflats at the upper zone are dominated by filamentous algae like Enteromorpha clathrata, L. mujuscula and Polysiphonia platycarpa. Ulva lactuca and E. clathrata are commonly associated with mangroves at the upper intertidal area. The salt pans and water pools in the saline bank regions are also dominated by E. clathrata.The main channel with silt/ clay bottom does not sustain significant populations of marine algae (Vijayalakshmi Nair, 2002).

The open mudflats at Narara Bet are covered with algae like Enteromorpha, Ulva, Lyngbya and Polysiphonia. The upper sandy shore and mangrove areas are associated with Enteromorpha and Ulva. Lyngbya, Caulerpa cladophota, Ulva cystoseira, Dictyota, Hydroclathrus, Padina, Sargassum, Acanthopora, Amphiroa, Champia, Centroceros, Gracilaria, Hypnea and Polysiphonia are common. Padina and Gracilaria are most dominant (50-70%) at the lower reef flat.

The intertidal segments of Kalumbhar harbour 47 species of marine algae and three species of seagrasses. The reef areas are dominated by Digenia, Gracilaria, Padina, Hydroclathrus, Ulva and Hypnea. The open mudflats and sandy regions at the upper intertidal zone are represented by Enteromorpha, Ulva, Lyngbya and Polysiphonia. (Vijayalakshmi Nair, 2002).

6.3.5. Sea Grasses

Seagrasses such as Halophila ovata and Halodule uninervis are common in patches on sandy regions of the reef. Halophila beccarii occasionally occur at the mudflat along the water channels of Narara Reef (Vijayalakshmi Nair, 2002). Seagrass species exist in the subtidal regions. Two Halophila species exist off Kalubhar The sandy region of the reef flat supports the growth of seagrasses like Halophila and Halodule(Vijayalakshmi Nair, 2002).

6.3.6. Terrestrial Mammals

Eleven species of mammals were recorded in the study area of KPT (Integrate EIA, KPT, 2013). But they have no direct relation with water other than frequenting water for water or food. There are namely Pteropus gigantus, Presbytis entellus entellus, Canis pallipes, Canis aures aures, Canis bengalensis, Herpestes auropunctatus, Felis silvestris ornata, Sus scrofa cristatus, Funambulus pennanti, Rattus rattus, Gazella bennetti.

Sus scrofa cristatus(Indian Wild Boar)

Gazalle benetti (Indian Gazalle)

Presbytis entellus entellus (Common Langur)

Indian Flying Fox

Figure 6.7. Some Mammals in the areas adjoining KPT Limit

6.3.7. Reptiles

Six species of reptiles were reported from the area. Out of these two were of under the lizard category and rests 04 were snakes. *Mabuya macularis, Eryx johni, Ptyas mucosus, Sphalerosophis diadema, Cytrodactylus kachhensis, Hemidactylus leschenaulti* are them.

Rana cyanophlyctis

Mabuya macularis

Eryx johni(Indian Sand Boa)

Figure 6.8. Major Amphibians & Reptails of KPT Area

6.3.8. Amphibians

Two species of amphibians were also recorded Rana cyanophlyctis & Bufo melanostictus

6.3.9. Zooplankton

The inner Gulf sustained a higher rate of zooplankton production. The composition was fairly diverse and consisted mainly of cope pods and decapods. (Bio Resource Status of Selected Coastal Regions). As per recent EIA studies including copepoda, Decapoda, Lamellibranchiata, Lucifer, Mysids, Polychaete, Stamatopod larva with an average density of 250 no./l is present in the waters around Kandla Port Area.(Integrated EIA Study, KPT Area, 2013). Fish eggs are rarely represented. Fish larval population have been recorded more during monsoon.

6.3.10. Benthos

Benthic macro fauna includes Amphipodes, Bivalves, Porifers, Gastropoda, Oligochaete. In Kandla the most common groups are polychaetes, amphipods, crabs and mysids while in Nakti Fish larvae, brachyurans, macrurans, insects are commonm. Subtidal macro benthos include Polychaetes, brachyurans & insects. Meio Benthos includes Gastrotrichs, Happacticoidea, Nematoda, Tubellaria havving around 500nos/10cm2.

6.3.11. Mollusca

11 species of mollusca, seven species of shrimps (Prawn) Arthopodes and seven species of annelids were recorded. Larvae of P.merguiensis, M.kutchensis, M.brevicornis and M.monoceros are the penaeid species available in the region. M. affins is dominant during t he monsson.

6.3.12. Turtles

In the Gulf, the reptiles are mainly represented by marine turtles Chelonia mydas and Lepidochelys olivacea. They have been known to breed and spawn on the sandy beaches along the coast as well as on the Islands particularly along the southern Gulf between Okha and Okha Madhi and Vadinar-Sikka coast as well as on the Islands within the MNP and MS (Vijayalakshmi Nair, 2002). Goose reef have sand dunes. But active sites are less in this area which can be attributed to the presence of mudflats. They are not present in the Kalumbhat area, as there are no potential nesting site for their breeding exists here. Sandy beaches here are located close to marshes or mudflats and hence are not so easily approached these species. Hence presently there exist no potential breeding site.

6.3.13. Marine Mammals

Marine mammals are chiefly represented by dolphin (Dolphinusdelphia) and Dugong (Dugong dugon) in the Gulf especially along the Jamnagar coast. Common dolphins, Bottle-nosed dolphins and Pacific hump-back dolphins are the important dolphin species often found in the GoK area. A highly isolated breeding population of Dugongs exists in the Marine National Park, GoK. It is the only population remaining in western India. Whale Sharks and Porpoises also frequent the area.

Dolphin Dugong Whale Shark Porpoise

Figure 6.9. Marine Mammals

Dolphins and Porpoises are found in the shallow water near Narara reefs of the area (H.S Singh, 2003). Balaenoptera borealis was repoted from Salaya by Khacher (1998). Dolphins, Porpoises and Dugongs also exists in the area (H.S Singh, 2003). Rich sea grass beds off Kalubhar islands indicate high prospects of the presence of the rare and endangered species Dugong dugon, the sea cow(Vijayalakshmi Nair, 2002).

6.3.14. Fishes

The common species in Kandla creek are Chiloscyllium arabicum, Lepturacanthus savala, Ilisha metastoma, Otolithoides biauritus, Pampus argenteus, Harpadon nehereus, Parapenaeopsis hardwickii and Exopalaemon styliferus. The common species are Pampus argenteus, Polynemus tetradactylus and Harpodon nehereus. Nakti Creek hosts Lagocephalus sp., Escualosa thoracata, Ilisha sp. Prawns such as Parapenaeopsis stylifera, Exopalaemon styliferus,Metapenaeus sp. Are available in the Nakti creek.

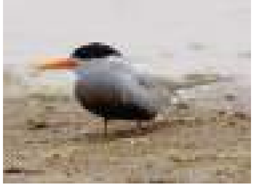
Vadinar- Salaya accounts for about 4-19% of the total landings of Jamnagar district. Fish landings at Salaya indicate a fluctuating trend. Composition of marine fish landing at Salaya during 1990 to 1994 shows the occurrence of 22 groups of fishes. The dominant group found in the area is sciaenids followed by shrimps, mullets, white pomfret, catfish and shark .Total number of fishing crafts at Salaya amounts to 330 and the fishermen population engaged in fishery operations are 1220 (GEC).

6.3.15. Birds

The Gulf area which has many salt pans, Islands and intertidal coastal system with mangroves offers favourable conditions for feeding, breeding and shelter to a variety of birds. Birds find the most congenial environment in the mangrove forests lining the Islands and along the coasts. A large number of migratory species pass through the Gulf and a small population of most species comprising mainly of juveniles and non breeding adults take shelter during summer.

On the whole, 140 species are documented; 85 terrestrial and 55 aquatic. Out of these, 71 are resident species, 44 migrant and another 25 resident migrant. The area is located in the Central Asian Flyway of migratory birds, also a portion of West Asian – East African Flyway.Thousands of waterfowls can be seen in the salt- pans from October to March. These include flamingos, godwits, sandpipers, plovers, stilts, terns and so forth. Mycteris leucocephala, Sterna acuticauda, Pelecanus crispus, Limnosa limnosa, Numenius arquata are the important birds of the area.

Mycteris leucocephala



Sterna acuticauda

Limnosa limnosa

Numenius arquata

Figure 6.10. Some Birds found in the area within KPT Limit

Though salt pans are the man-made habitats, they are also valuable congregaring for many resident and migratory birds as they provide food such as shrimps for them.

6.4. Human Use Resources

6.4.1. Salt Pan

95% of salt produced in Gujarat State belongs to GoK. The port has allotted approximately 16112 acres of land for manufacture of salt and allied industries connected with the salt manufacturing. There are 16 major lessees having land varying in area from 99 acres to 3890 acres and 25 minor lessees having land admeasuring 10 acres each for the salt works. Near Vadinar there are saltpans of in small area. Salt pans are important bird congregating area as they provide food such as fishes & shrimps. Many times brackish aquaculture ponds are function seasonally associated with salt pans.

Woman at work in the Salt Pan

Birds Congregation in the Salt Pan

Figure 6.11. Salt Pans

6.4.2. Fisheries

No fishing activities are found in the area except using small craft in Kandla Creek area. There is a fishing harbour exists north of the Kandla port. Unlike the other parts of GoK there are no fish ponds functioning in the area. High tidal movements and unusually strong currents make trawling or gill-netting for fish difficult and risky in Kandla creek. Evidently, no large-scale commercial fishing operations are conducted in the area except for minor shore -based hand-net and gill net operations.

The northern areas of Kachchh were found to be the most productive areas and had a dominance of Silver Grunt and Cat Fish species. In Kachchh, the largest fish landings occur at Jakhau (66.2%), while Kandla and Mitha Port account only for 3% of the Kachchh landings.

Figure 6.12. Fishermen

Among the different creeks in the Northern arm, Kandla is the most productive system comparable with Kori , but the production potential decreases interiors. The expansions of Kandla port and increase in saltpans in the mouth of the Gulf of Kachchh have affected the fishery in the region. Thus, negative growth observed in these two talukas (Ecoprofile of Coastal Taluks of Gulf of Kachchh, GEC, 2014). During monsoon period, penaeid larvae are abundant in the inner creeks leading to a flourishing backwater fishery off Surajbari.

Fishery is prawns exists only on the area of 1200sq.km on the southern border ie., in the head of GoK, where the bottom is muddy. The prawn fishery is more seasonal. (Marine Fisheries Research and Management, V.S Pillai and N. G. Menon, CMFRI). The details of prawn fishery in Kandla and Tuna is given as **Table 6.2**.

Table 6.2. Details on Prawn Fishery at Kandla and Tuna

Sl. No:	Location	Season	Nature of Bottom	Prawn Species
1	Kandla	May-February	Muddy	M. monoceros 64.7 % ; P. indicus 20.8 % ; Leander sp. 9.3% ; M. brevicornis 4.2%; P. sculptilis, P. stylifera and Palaeomon sp. 2.0%
2	Tuna-Sangdha	September-February	Muddy	M. monocarps 47.5% ; P. indicus15.6% ; M. brevicornis 15.3% ; Leander sp. 14.5% ; P. sculptilis 5.8% ; P. canalicu-latus, P. stylifera and Palaeomon sp. 1.3%.

Source: *http://eprints.cmfri.org.in/1654/1/Ramamurthy_146-148.pdf*

The three districts around GoKnamely Rajkot (now Morbi), Jamnagar (now Jamnagar and Devbhoomi Dwararka) and Kachchh have 1, 23 and 51fishing centres respectively. The collective contribution ofGoKis about 22 % to the total production of Gujarat State. The major share is Jamnagar(now Jamnagar and DevbhoomiDwaraka) and Kachchh districts with very low landings from Rajkot (now Morbi). Around 200 species of fish were recorded from the Gulf. Sciaenids predominated the area.

Common fishes in the area were pomfrets, Bombay duck, shrimps, ribbon fish, clupeids, shark and catfish. Details of fishermen population in the three (now four) districts indicate that active fishermen are more in Kachchh as compared to Jamnagar and Rajkot districts. The number of trawlers are more at Jamnagar while the gill netters are more at Kachchh district.

6.4.3. Kandla & Tuna SEZ

Two SEZ have been proposed with in the KPT limit one at Kandla (3600 ha.) and another at Tuna (1400 ha) is to be located southwest of Kandla port at a distance of around 2 km from its periphery.

Land cover in the terrain is mostly sparse halophytic vegetation like scrubby mangroves, creek water and salt encrus ted land mass. Creek water occupies a major area. Also there are mud flats in the south and east. Kandla area is having mangroves such as A. marina, Suaeda, Salicornia And Salvadora. Salt pans and mudflats are more in the Kandla area compared to the Tuna area (Final Environemntal Impact Assesment Report for Port Based Multiproduct SEZ at Kandla Port , Part I Terrestrial EIA & EMP, Gujarat Institute of Desert Ecology March , 2015).

Figure 6.13. Location of Kandla and Tuna SEZs*

Note: Boundaries are indicative only

6.4.4. Intake Points of Industries

Vadinar and Mundra are the important industrial areas within the port limit. There are intake points of ESSAR at Vadinar and CGPL, Mundra.

6.4.5. Protected Ecosystems

Being these areas are of high biodiversity and as well as vulnerability, southern area of GoK have been declared as Ecologically Sensitive Areas (ESA) and categorized as under / as protected areas under Marine National Park and Sanctuary. Marine National Park and Marine Sanctuary (**Figure 7.11**) are situated along the southern shore of the Gulf from Okha (22°30’N, 69°00’E) eastwards to the vicinity of Khijadia (22°30’N, 70°40’E).

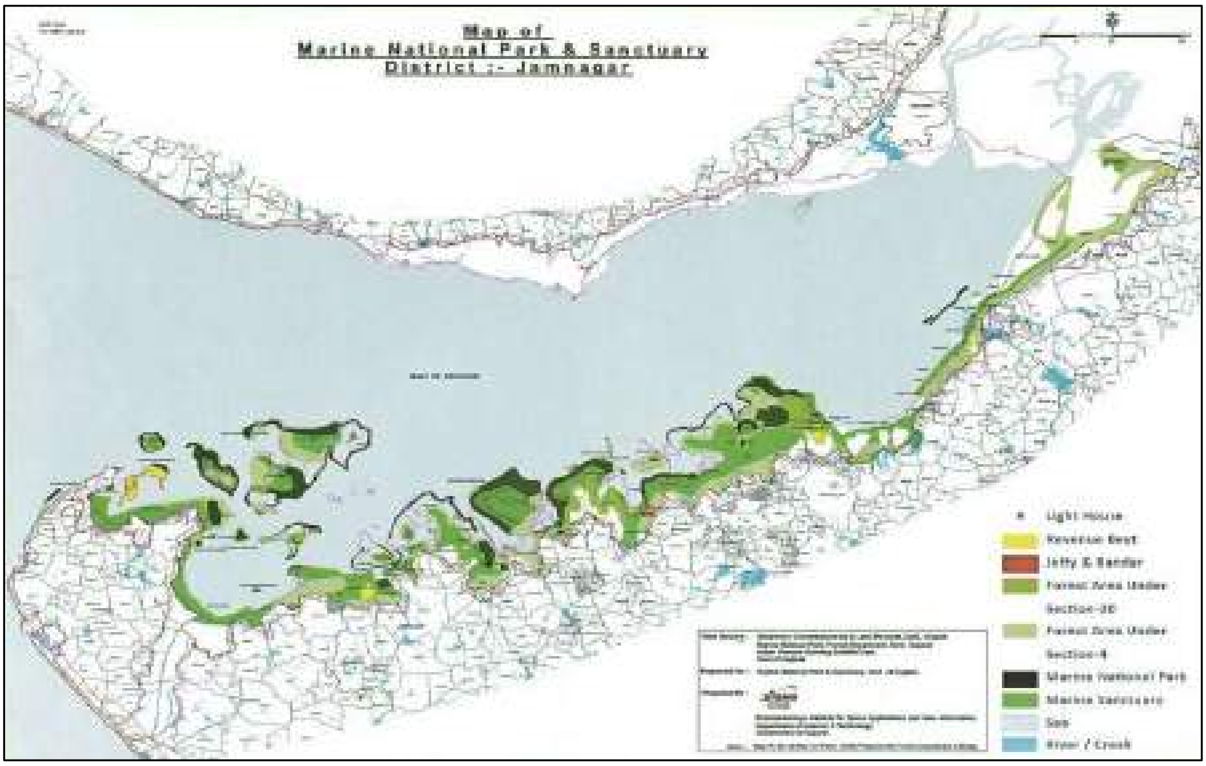


Figure 6.14. Marine National Park and Sanctuary

It is India's first Marine Protected Area declared by Govt. of Gujarat in 1980. This include 42 islands and a complex of fringing reefs backed by mudflats and sand flats, coastal salt marsh and mangrove forests, sand and rocky beaches which support a great diversity of fauna and flora. The area also has many islands fringing with corals and mangroves which provide a disturbance free habitats for many species of nesting birds. Besides these islands there are a number of wavecuts, eroded shallow banks like the Narara & Kalumbhar within the Kandla Port Limit near Vadinar.

6.5. Environmental Sensitivity Mapping

Sensitivity mapping is an essental step of oil spill prepardness. Environmental Sensitivity Index (ESI) map will serve as a basis for combating oil spill and help in the identification of resources at immediate risk and thus end up in prioritization of resources. This colour coded map accommodates the vulnerability of the shoreline to oil spill based on the Environmental Sensitivity Index (ESI) ranging between 1-10, where the each colour stands for a single ESI. In this map the shoreline and intertidal zones are ranked based on their vulnerability to oil spill, which is determined by shoreline type, exposure to wave & tides and its biodiversity. ESI maps gives emphasis to areas of threatened and endangered species, high concentration, sensitive life stages, protected areas and socio-economic resources that may be impacted by oiling, response or clean-up.

While preparation of the sensitivity map vast secondary data was utilised including those on Ecology, Hydrography, Coastal Geomorphology, Wetland, Landuse.

6.5.1. Environmental Sensitivity Index

Environemntal Sensitivity Index (ESI) is an international scheme used for classifying as well as ranking the shoreline based on their sensitivity towards oil spill. This methodology was prepared by NOAA further promugulated jointly by IMO, IPIECA, & OGP. NOS-DCP-2015 put forwards the same scheme for the preparation oil spill contingency plan at various levels in the Indian context.

ESI index is based on three parameters including:

- Shoreline Classification, which takes sensitivity of the shore habitats, natural persistence of oil and ease of cleanup.
- Biological Resources including oil-sensitive animals, rare plants
- Human-Use Resources that have sensitivity because of their typical use, such as beaches, parks and marine sanctuaries, water intakes, and archaeological sites.

While preparing the ESI maps, the sensitivity of the shore is represented by color-codes along the coast while, biological and human-use resources are represented by symbols.

Areas requireing special consideration include,

- Presence of protected areas such as National Park, Sanctuaries
- Threatened species
- Birding Areas and other animal frequenting areas.
- Estuaries, Mangroves & Fish Breeding Areas
- Tourist Areas including Recreational & Heritage Areas
- Industrial Water Intake Points
- Resource Extraction such as Salt Pans and Aquaculture ponds
- Multi-features - especially in the 42 island with variable features within a short distance

6.5.1.1. Shoreline Classification

- Depends on Relative exposure to wave and tidal energy
- Shoreline Slope
- Substrate Type and biological productivity

6.5.1.2. Biological Resources

Marine, coastal, and aquatic/wetlandspecies may be present over a very large geographic area. Maps or data indicating the entire distribution of a large number of species potentially located in an area may not be very helpful to responders setting protection priorities. Therefore, it is important to identify the types of species that tend to be vulnerable to spilled oil,the most sensitive life-stages, and in which habitats these life-stages occur, as habitat type plays an important role in the persistence of oil and species exposure to oil. Biological resources are most at risk when :

- Large numbers of individuals are concentrated in a relatively small area;
- Marine or aquatic species come ashore during special life stages or activities, such as nesting, birthing, resting, or molting;
- Early life stages or important reproductive activities occur in sheltered, near shore environments where oil tends to accumulate;
- Limited suitable habitat exists within an area for specific life stages or along critical
- critical migratory routes;
- Specific areas are known to be vital sources for seed or propagation;
- A species is threatened, endangered, or rare; or
- A significant percentage of the population is likely to be exposed to oil

6.5.1.3. Human- Use Resource

There are mainly four types of four major components.

- High-use recreational areas and shoreline access locations
- Management Areas
- Resource Extraction area Salts and Minerals
- Archeological & historical cultural Resources

The ESI classification which consider the ecological sensitivity alone is given as **Table 6.3.**

Table 6.3. ESI Classification as per NOAA Guidelines

Sl. No	Shoreline Type	Rank	Colour Scheme
1	Exposed, Impermeable Vertical Substrates	1	
2	Exposed, Impermeable Substrates, Non-Vertical	2	
3	Semi-Permeable Substrate, Low Potential for Oil Penetration and Burial; infauna present but not usually abundant	3	
4	Medium Permeability, Moderate Potential for Oil Penetration and Burial; in fauna present but not usually abundant	4	
5	Medium-to-High Permeability, High Potential for Oil Penetration and Burial; infauna present but not usually abundant	5	
6	High Permeability, High Potential for Oil Penetration and Burial	6	
7	Exposed, Flat, Permeable Substrate; in fauna usually abundant	7	
8	Sheltered Impermeable Substrate, Hard; epibiota usually abundant	8	
9	Sheltered, Flat, Semi-Permeable Substrate, Soft; in fauna usually abundant	9	
10	Vegetated Emergent Wetlands	10	

(Source: NOAA)

This ranking of the mapped resources is in order to locate the most sensitive sites and establish priorities for protection and also to work out efficient clean-up strategies. The ESI ranking reflects the general sensitivity of shoreline habitats for ex., all fine-grained sand eaches have an ESI = 3. Tidal flats are ranked high on the ESI scale because of their high benthic productivity and importance as feeding areas for fish and birds. The presence of other sensitive resources on a specific shoreline segment, such as turtle nesting on a fine-grained sand beach, does not affect the ESI ranking. The seasonal presence of other resources on a shoreline segment is addressed by mapping biological and human-use resources.(NOAA). Color scheme are used for representing the shoreline habitats ranking while sensitive biological receptors and human use resources are given as standard symbols and are given as **Figure 6.15.**.

Figure 6.15. ESI symbols for Ecological and Socio-economic Resources

6.6. Environmental Sensitivity of KPT Limit

KPT and its limir are part of the highly sensitive region of Gulf of Kachchh which is a part of Indian coastline already ear marked as Environmental Sensitivity Areas (ESAs) realising the importance of their protection. ESA are defined as areas of coastal zone which need special protection and play an important role in maintaining the functional integrity of the coastal and marine environment. The following ecosystems were shortlisted as ESAs :

Mangroves, Coral reefs, Mud flats, Lagoons, Beaches, Estuaries, Sea grass beds, Sand dunes , Creeks Sea weed beds, Littoral forests, Salt marshes, Mud banks , Rocky shores by various studies conduted on Coastal Management *(ICMAM).* Also ESAs have been evaluated and risk level against oil spill have been assigned by ICG *(Ecosensitive Areas, ICG).* In the case GoK all these habitats are present on the shoreline and islands blending to one resulting in a highly diverse ecosystem. These areas of extreme ecological significance and declared as Marine National Park and Sanctuary (MNPS). The area within Kandla Port limit have been studied to identify resources at risk were identified after studying the nature of the resources both ecological and socio-economic, shoreline characteristic, ecological interrelationship etc. for determining their sensitivity towards oil spill.

Since the area has almost equal distribution of ecological and socio economic resources, the determination of sensitivity parameters and resource prioritisation is an integral part of sensitivity mapping. The following section describes the sensitivity parameters used for preparation of oil spill sensitivty map,the shoreline characteristics, Marine- Meterological Condition and the sensitivity of receptors.

6.6.1. Sensitivity Parameters

Sensitivity of the shoreline was determined based on the ecological and socio- economic importance vulnerability of the specific geographic region.This result will be useful for oil spill risk assesment, modelling and selection of response and clean up operations. It is assumed that the area is biologically stable at present and the shipping canal which is undergoing periodic dreadging is already having lesser sensitivity for the floating species over the area have been already shifted to better premises.Sensitivity parameters considered for identification of vulnerable sub groups and group features around Kandla are given as **Table 6.4.**

Table 6.4. Sensitivity Parameters for determine ESI

Sl. No	Sensitivity Parameter	Sub Groups	Group Features
1	Shoreline Classification	Land Forms	Creeks, Bays, Estuary, Beaches, Swamps, Tidal Flats.
		Geological	Grain Size, Geomorphology, Slope
		Hydrological	Tides, Waves, Currents
2	Ecological	Sensitive Species	Birds, Corals, Mangrove, Turtles
		Wild Life Areas	High no. of individuals along the area, especially congregation, breeding, nesting, feeding, resting sites.
3	Socio-economic	Commercial	Salt Pans, Fishing Areas, Agriculture
		Recreational	Beaches

		Historical	Onshore, Underwater sites
		Industrial	Intake Points
		Strategic	Restricted Entry Areas, Frontiers

(Source: Data Analysis)

Gulf of Kachchh has a very dynamic ecosystem. They have both abiotic and biotic recepters. Abiotic receptors include the water, soil, air of the area while biotic resources includes all the living components. The abiotic receptors influence to biotic ones through their interaction in food chain , respiratory systems etc. Their sensitivty is described in the sections below. Final aim of oil spill response should be after considering their interreations and solving the issue holistically.

Impacts of oil spill to biotic as well as abiotic environment were identified considering the features of GoK. The effects of oil on Ecological and Socio economic resources are discussed. There are a number of ecological effects from oil spill. These includes physical and chemical changes to habitats as well as organisms. There effects mainly depend on the physical contamination of oil in to water, sea bed and land. The magnitude and persistence of oil contamination in the intertidal area depends greatly on the energy of waves, shoreline/ sediment characteristics (IMO).

Oil spill into an aquatic environment including tidally influnenced adjoining land, will harm organisms that live on or around the water surface and those that live under water. Spilled oil can also damage parts of the food chain, including human food resources. Oil spills will affect, contaminate and may even kill the organisms like algae, plants, invertebrates, fish, amphibians and reptiles, birds, and mammals. These species and communities are at risk of smothering, hydrocarbon toxicity, hypothermia, and chronic long-term effects that may result from the physical and chemical properties of the spilled oil. Severity of the impact depends on a variety of factors such characteristics of oil, natural conditions, such as water temperature, weather etc., and sensitivity of aquatic habitats to oil spills.

Both petroleum and non-petroleum oil can affect the environment surrounding during an oil spill. All types of oils have chemical and physical properties that produce similar adverse effects on the environment. In some cases, non-petroleum oil spills can produce more harmful effects than petroleum oil spills. Some toxic substances in an oil spill may evaporate quickly and hence plants, animal and human exposure to the most toxic substances are reduced with time. It is usually limited to the initial spill area. Although some organisms may be seriously injured or killed very soon after contact with the oil in a spill, non-lethal toxic effects can be often long lasting. The area where an organism spends most of its time in open water, near coastal areas or on the shoreline will determine the effects an oil spill is likely to have on that organism. Hence aquatic life on reefs and shorelines is at higher risk of being smothered by oil that washes ashore. It can also be poisoned slowly by long-term exposure to oil trapped in shallow water or on beaches.

For higher organsims the primary effects of oil contamination include loss of the insulative capability of feathers or fur which can lead to hypothermia, dehydration resulting from lack of uncontaminated water, stomach and intestinal disorders and destruction of red blood cells resulting from ingestion of oil, pneumonia resulting from inhalation of oil vapors, skin and eye irritation from direct contact with oil and impaired reproduction. Fauna can also suffer during capture and rehabilitation operations, potential ailments include infectious diseases, skin problems, joint swellings, and lesions. In addition, eggs and juveniles are particularly susceptible to contamination from oil. Even a very small quantity of oil on bird eggs may result in the death of embryos. From a purely economic perspective, the economic loss to the tourism and fishing industries alone from a major oil spill within GoK would be massive. The loss can be divided into on three broad areas like Loss of jobs and wages, Loss of fishing & allied activities in the closure period of ports, Loss on tourism.

Considering the case of Kandla- Vadianr Zones, high tidal ranges and strong tidal streams escalate the impacts of oil spill. Extreme tidal ranges and extensive creek system will guide oil landward during high tide while there a few outflows at its mouth will expel oil offshore. These creeks accomplish the connection during the monsson with Little Ran of Kachch through epherimal rivers emtying in to GoK during rain. Hence there is also a chance that they get trapped into the high tidal flats during this time.Thus making the escape of difficult.

6.6.1.1. Shoreline Characteristics

The geomorphology of Kandla Port Limit, suggest the area with in and adjoining the KPT limit can be divided in to three. They are the portions of the Western flank between Kori Creek to Mundra with extensive mudflats, they are highly disected and the important resource are the mangroves. The coast is tide dominated having a mximum width of 2km. Eastern Flank between Mundra to Kandla is having narrow beaches, wide mudflats and salt marshes. They are having narrow littoral zone. This area is characterised by very low wave energy but high currents inside the channel.

The presence of bars cause later high tides and longer low tides. Between Hansthal and Kandla creek there lies the vast sathsaida bet. Kandla creek futher bifrucates into branches, Sara & Phang. The flood streams in the Kandla creek are 3 to 5 knots. In the Western approach to the Kandla and Hansthal creeks the tidal streams in general are extremely irregular and appear to be gently influenced by a strong wind from any quarter. They gradually increase from outer to inner areas from 2.5 knots up to 4 -7 knots. (Source:Comprehensive Environmental Impact Assesment Report for Port Based MultiProduct Based SEZ at Kandla by Kandla Port Trust). Vadinar area, which is a part of the Navlakhi - Dwaraka segment of the Saurashtra Coast. They are having numerous offshore islands which are having corals both reef and live. The shoreline is having a very low gradient resulting wider impact of oil during a spill. Wave energy is slightly higher compared to that of Kandla Port Area. The details on the same are given as **Table 6.5**.

Table 6.5. Geomorphology of Kandla Port Area

Sl. No.	Segments	Alignment	Feature	Sediment	Substrate	Intertidal Zone	Processes
Gulf of Kachchh							
1	Western Flank-Kori Creek to Mundra	NW-SE	Dissected, facing Arabian sea, Extensive mud flats known as Thars, Mangroves, Small sluggish seasonal streams, creeks	Muddy	Muddy Alluvium and Soft Rocks	Maximum width 2km	Tides dominant shoreline currents, moderate wave energy, low currents.
2	Eastern Flank from Mundra to Kandla	E-W	Comparatively less dissected with narrow beaches and wide mudflats & salt wastes	Sand, Silty		Narrow littoral zone	Tide dominant shoreline currents, low wave energy, high tides, turbid and saline to hypo saline water
Saurashtra Coast							
1	Navlakhi - Dwaraka	E-W	Highly crenulated coastline with extensive mudflats, offshore islands, rocky platform ,narrow beaches, coral reefs etc.,prominent drainage	Sandy, Silty as well as Muddy	Coralline, limestone and Deccan trap basalt	Width of 5-10km, low gradient with calcareous sediment	Long shore currents low wave energy, high tidal energy moderate tides 3 to 5m water turbid and hypo saline

Source: Gujarat Ecology Society

6.6.1.2. Marine- Meteorological Condition

The port is located in the tropical dry climate. The winter temperatures vary between 10 to 25 deg C and between 25 to 44 deg C during winter. Dry weather, short spell and scanty monsoon is the most important feature of the area. Tides are highly irregular and is influenced by strong winds. Mean spring tide is 6.66m. Thus the port has high tidal impact, low water depth and high rate of evaporation. Water tempaerature varies between 20 to 28 deg C and surface tidal pools may reach a temperature of 32 deg C.

6.6.1.3. Sensitivity of Ecological and Socio-economic Receptors

6.6.1.3.1. Abiotic Receptors

Aquatic environments are made up of complex interrelations between plant and animal species and their physical environment.. The nature, extent, depth and mobility of the water body determine the sensitivity of aquatic habitats. GoK and the adjoining coastal area where different types of aquatic habitats such as creek, bays, beaches, reefs and mudflats coexist, show sensitivities to the harmful effects of oil contamination and varied abilities to recuperate from oil spills. Harm to the physical environment will often lead to harm for one or more species in a food chain, which may lead to damage for other species further up the chain through bioaccumulation and biomagnification

Spilled oil immediately begins to move, weather and breaking down, changing its physical and chemical properties. As these processes occur, the oil threatens surface resources as well as a wide range of subsurface aquatic organisms linked in a complex food chain.

In some areas, habitats and populations can recover quickly while in others the recovery from persistent or stranded oil may take years. These detrimental effects are caused by both petroleum and non-petroleum oil.

In the case of open water, fishes have the ability to swim away from a spill by going deeper in the water or further out to sea. Thus they have reduced susceptibility that they get harmed by even a major spill. Other aquatic animals that spent more time closer to shore, such as turtles, seals, and dolphins are at the risk of contamination by oil that washes onto beaches or by consuming oil-contaminated prey. In shallow waters, oil may harm sea grasses and kelp beds, which are either food, shelter or nesting sites by many species. Along with spilled oil, cleanup operations can also threaten different types of aquatic habitats. The sensitivity of different aquatic habitats of the Kandla Port area are enumerated as follows:

Tidal Creeks: A number of tidal creek is the portion of a stream that is affected by ebb and flow of ocean tides, in the case that the subject stream discharges to an ocean, sea or strait. There are unique biota associated with tidal creeks which are specialised to such zones. Creeks may often dry to a muddy channel with little or no flow at low tide.They often have significant depth of water at high tide.

Tidal flats: They are broad, low-tide zones, usually containing rich plant, animal, and bird communities. Deposited oil may seep into the muddy bottoms of these flats, creating potentially harmful effects on the ecology of the area. Vast mudflats infringes the entire coastline of GoK.

Mudflats: Mudflats spreading all along the Gulf, which are very sensitive to oil in comparison to sandy coast, due to their geographical locations. They are found in the areas of high tidal amplitude. Hence an oil spill during high tide can leave serious traces. (Kankra et al)

Marshes and swamp: These two habitats have little water movement and are likely to incur more severe impacts oil spill. In such calm water conditions, the affected habitat will take years to restore.

Other standing water bodies: Salt pans and aquaculture ponds are coastal standing water bodies of GoK, support a variety of fishes and birds. The food chain can be affected by spills in these environments and can reach up to the highest order of ecological pyramid the humans.

Coral reefs: The reefs in and around the islands of MNPS. They are important nurseries for shrimp, fish, and other animals and have ecological value. Coral reefs and the aquatic organisms that live within and around them are at risk from exposure to the toxic substances within oil as well as smothering.

Important Manmade abiotic resources are:

Fishing Industry: Fishing may not be feasible due to oil slick or imposition of fishing bans. Aquaculture facilities may be severely affected by direct oiling or loss of market confidence.

Harbour and Marinas: Functioning of commercial ports and harbours can be disrupted by oil slicks and subsequent cleaning activities. Boats in marinas are also have to be cleaned.

Industrial Sea Water Intakes: Sea water intakes may be at risk from floating and/ or dispersed oil leading need for protection or even shutting down activities.

6.6.1.3.2. Bio receptors

Sensitivity of biodiversity varies from species to species. Rare animals or Plants or those with limited geographic distribution may be particularly vulnerable to oil impacts and raise specific concerns.An oil spill can harm animals especially birds and mammals in several ways. Direct physical contact, toxic contamination, destruction of food sources and habitats, and reproductive problems. When fur or feathers come into contact with oil, they get matted down. This matting causes fur and feathers to lose their insulating properties, placing animals at risk of freezing to death. For birds, the risk of drowning increases, as the complex structure of their feathers that allows them to float or to fly becomes damaged. Some species are susceptible to the toxic effects of inhaled oil vapors. Oil vapors can cause damage to the animal’s central nervous system, liver and lungs. Animals are also at risk from ingesting oil, which can reduce the animal’s ability to eat or digest its food by damaging cells in the intestinal tract.

Even species which are not directly in contact with oil can be harmed by a spill due to destruction of food resources and habitats. Predators that consume contaminated prey can be exposed to oil through ingestion. Since oil contamination gives fish and other animals unpleasant tastes and smells. Predators will sometimes refuse to eat their prey. They will begin to starve especially when a local population of prey organisms gets destroyed completely. In some environments, the spilled oil may linger in the environment for long periods of time, adding to the detrimental effects where as in calm water conditions, oil that interacts with rocks or sediments can remain in the environment indefinitely. Oil can be transferred from birds' plumage to the eggs they are hatching. Oil can smother eggs by sealing pores in the eggs and preventing gas exchange. Developmental deffects in bird embryos that were exposed to oil have been also observed. The number of breeding animals and of nesting habitats can be considerably reduced by the spill. Long-term reproductive problems have also been shown in some studies in animals that have been exposed to oil. Sensitivity of various bioreceptors are described below:

Fishes: Fishes may be exposed to spilled oil in different ways. They may come into direct contact and contaminate their gill, the water column may contain toxic and volatile components of oil that may be absorbed by their eggs, larvae, and juvenile stages and they may eat contaminated food. Fish that are exposed to oil may suffer from changes in heart and respiratory rate, enlarged livers, reduced growth, fin erosion, a variety of biochemical and cellular changes, and reproductive and behavioral responses. Chronic exposure to some chemicals found in oil may cause genetic abnormalities or cancer in sensitive species. If chemicals such as dispersants are used to respond to a spill, there may be an increased potential for tainting of fish and shellfish by increasing the concentration of oil in the water column. This can affect humans in areas that have commercial and recreational fisheries.

Eggs and Larvae : In shallow bays may suffer heavy mortalities under slicks, particularly when dispersants are used. Adult fishes tend to swim away from oil. No evidences to date exist for an oil spill that has significantly affected adult population in open sea. But adult fish in aquaculture cages may be killed or lose their market value at least because of training. Adult population survive even when many fish larvae have been killed possibly beca Fish eggs and larvae: They are sensitive to oil, may experience mortality,which may affect the fish production, even though the extent of damage is insignificant and to a greater extent for short term.use they have a competitive advantages such as ,ore food and lower vulnerability to predators. (Kankra et al)

Invertebrates: Invertebrates such as shellfish –molluscs and crustaceans, worms, sea urchin and corals suffer heavy casualities when directly exposed to fresh oil. Barnacles, winkles and limpets living on rocks can been seen surviving in the presence of residual weathered oil.

Birds: Birds are very susceptible to oil spills. Seabirds, for example, spend a lot of time on the ocean's surface, dive when disturbed, and have low reproductive rates, making them particularly vulnerable to oil spills. In addition, the populations of species with small numbers of individuals, a restricted geographic range, or threatened and endangered species may be very adversely affected by oil spill contamination. A bird's feathers overlap to trap air and provide the bird with warmth and buoyancy. Birds that contact an oil slick may get oil on their feathers and lose their ability to stay waterproof, they may ingest oil while trying to clean their feathers or when they try to eat contaminated food, and they may suffer long-term reproductive effects.

Heaviliy oiled birds usually die. Their treatment requires specialised expertise and appropriate facilities. Recovery of local population mainly depends on existence of reservoir of young non-breeding adults from which breeding colonies can be replenished or high reproductive rate. No evidences to date exist for an oil spill that has permanently damaged any sea bird population. But species with very local distribution could be at risk in exceptional circumstances.

Also there is every possibility that the reduced wave action dur to surface oil will attract the birds to coastal waters. Hence they get trapped in the sticky emulsified layer of oil. A 0.1 mm thick oil layer is assumed to cause high risk to sea birds (Kankra et al., 2008). Thus oil spill is fatal to birds and its eggs. (Kankra et al)

Mammals: Mammals that may be affected include whales, porpoises, dugongs, dolphins and other land mamals occupying the intertidal area. The sensitivity of mammals to spilled oil is highly variable. The amount of damage appears to be most directly related to how important the fur and blubber are to staying warm, which is called thermoregulation. Land mammals need clean fur to remain warm. Hence they are more vulnerable while whales, dolphins etc., are rarely affected by oil spill. Direct exposure to oil can result in temporary eye problems. Ingestion of oil can result in digestive tract bleeding and in liver and kidney damage. Ingestion of oil is of greater concern for species that groom themselves with their mouth, such as sea otters and polar bears. Breathing hydrocarbon vapors can result in nerve damage and behavioral abnormalities to all mammals. Capturing and cleaning oiled marine mammals generally is not feasible. While procedures for dealing with oiled birds have been developed, no such procedures have been developed for most of the marine mammals. Procedures for capturing, treating, and releasing animals may hurt them more than the oil does.

The cetaceans such as porpoises, dolphins, and whales have not been reported in the area. Their Blubber for insulation and do not depend on fur to stay warm. This characteristic makes them less susceptible to oil spills than other mammals. When they come to the surface to breathe they may inhale hydrocarbon vapors that may result in lung injuries, oil that comes in contact with the animals' sensitive mucous membranes and eyes may produce irritations. Young cetaceans may be injured due to ingestion of oil from contaminated teats when nursing. There may be long-term chronic effects as a result of migration through oil-contaminated waters.

Planktons: Serious effects of oil spill on plankton have not been observed so far in open sea. This is probably due to high reproductive rates and immigration from unaffected areas. The plankton population in shallow water is moderate of range and may be affected to some extent, which may take few weeks to recover.

Algae: Oil does not stick on to larger algae because of their mucilaginous coating. Intertidal areas denuded of algae in oil spill, readily gets repopulated after the removal of oil. Algae cultured for the economically important products such as Agar lose their commercial value if tained.

Marsh Plants: There are variations in the effect of oil spill among different species of marsh plants. Perennials with robust underground root system are more resistant than annuals and shallow rooted plants. But annuals such as Glasswort recolonise faster that perennials like grass Spartina since they produce large number of tidally dispersed seeds at a time.

Mangroves: Mangroves are home to diverse of plant and animal life. The term mangroves applies to several species of trees and bushes having some form of aerial breathing root which enable them to live in fine, poorly, oxygenated mud.The long roots, called prop roots stick out well above the water level and help to hold the mangrove tree in place. A coating of oil on these prop roots can be fatal to the tree. Since the growth rate of mangroves are very so slow, replacing a mangrove tree will take decades (IMO). Mangroves: are very sensitive to oil. Natural recovery of oiled mangroves will take many years. They are also breeding and nursing grounds of fishes and prawns. They are also home to many species living in harmony with them. They are highly prodcuitive ecosystems and have very high sensitivity interms of both biodiversity and slow recovery.

Protected Areas:When a large area is covered by important ecosystems and highly bodiverse species they become relatively sensitive as the impact of oil on these will be highly dangerous.

6.7. Oil Spill Sensitivity Map

The coastal area has been extensively studied and the ecological resources have been mapped for the Kandla Port Area. The oil spill sensitivity map of the Kandla Port Limit have been given as **Figure 6.3** below.

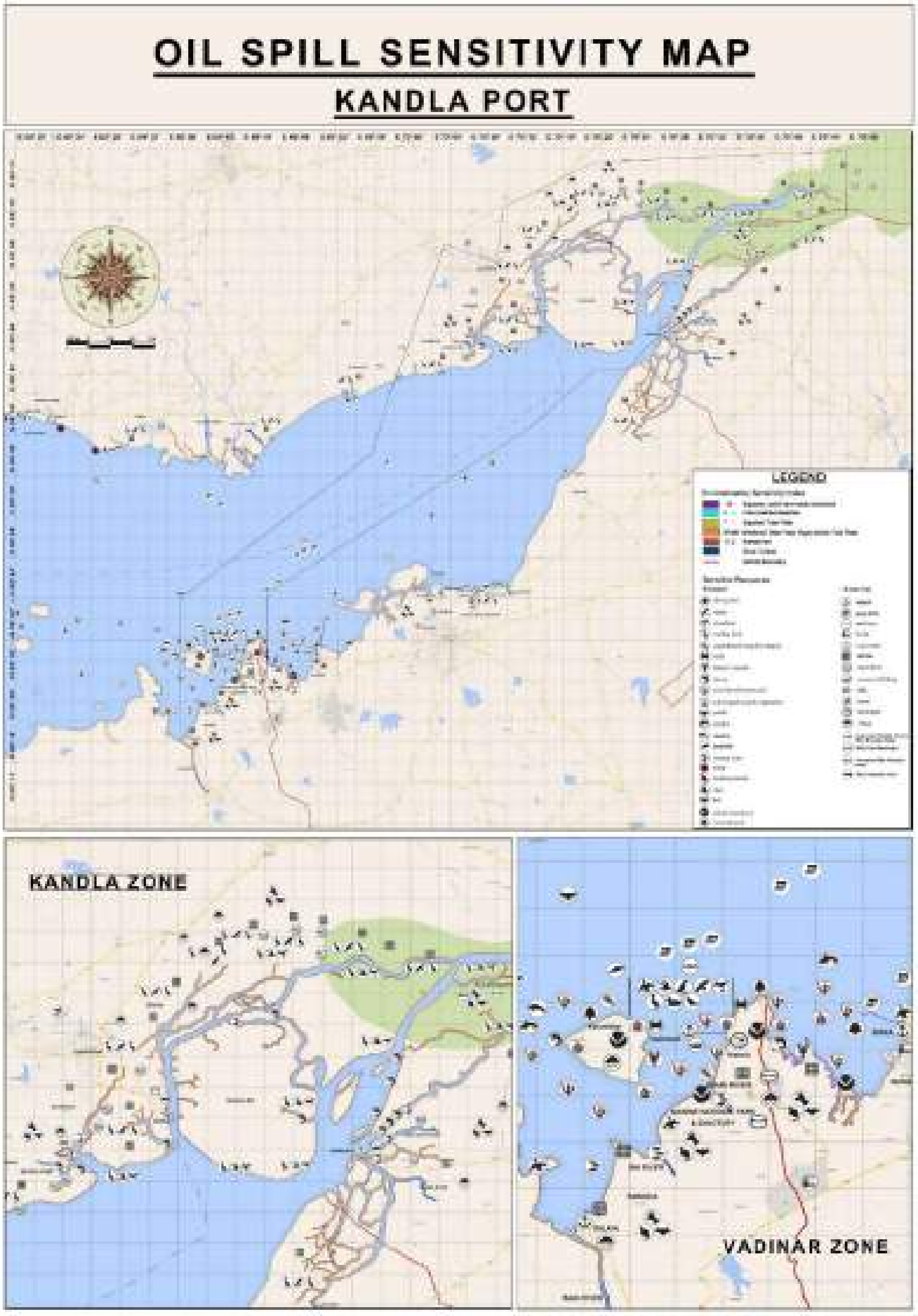


Figure 6.16. Oil Spill Sensitivity Map for Kandla Port

6.8. Response Consideration

As discussed in the previous section, there are highly vulnerable resources and sensitive shoreline throughout the KPT limit. Mangroves are the most sensitive shore, followed by shelteretd hypersaline mudflats, exposed mudflats, exposed manmade structures within the KPT limit. In additiona to this there are small streches of exposed shores, wavecut rocky platforms, salt marshes and fine sand beaches adjoining the coral islands but the shores and dominated by mangroves or mudflats having higher sensitivity. Also there are very small ridges of shell and coarse grained beaches adjoining mudflats.

Again small strips of Rip- Raps or Seawalls will be asscoiated with areas of human interferences and low stablity such as Beaches.

Corals, Birds nesting and flocking areas, etc., are occurring simultaneously and hence are to be considered as multi-resources area under the biological resources category. All these multi-resource area are the most sensitive part in the KPT limit. The details of the Shoreline Type, Sensitivity Index and Response Considerations are to be given as **Table 6.6** below. The sensitivity of biological resources have been already discussed in the previous sections.

Table 6.6. Shoreline Type, Sensitivity Index & Response Considerations

Sl. No.	Type of Shoreline	Locations	Oil Behavior
1	Exposed Rocky Shore (1A)	Islands of MNPS near Vadinar Terminal	• Oil is held offshore by waves reflecting off the steep, hard surface in exposed settings • Oil readily adheres to the dry, rough surfaces, but it does not adhere to wet substrates • Most resistant oil would remain as a patchy band at or above the high-tide line
2	Exposed Solid Vertical Structures (1B)	Areas near Port, Jetties and Terminals	• Seawalls and piers are particularly common in developed areas to provide protection to residential and industrial developments. • They are common along inlets, urbanized areas, and developed beachfront sites. • They are composed of concrete and stone, wooden, or metal bulkheads and wooden pilings. • Organisms, such as barnacles, shellfish, and algae may be common on pilings. • Biota on concrete structures along the upper intertidal or supratidal zones is sparse. • Oil would percolate between the joints of the structures. • Oil would coat the intertidal areas of solid structures. • Biota would be damaged or killed under heavy accumulations
3	Fine to Medium - Sand Beaches (3)	Islands of MNPS near Vadinar Terminal are having narrow beaches and between Mundra & Tuna. Shell beach ridges are found near Kandla	• These beaches are generally flat, wide, and hard-packed. • They are commonly backed by dunes or seawalls along exposed, outer coasts. • Along sheltered bays, they are narrower, often fronted by tidal flats. • Upper beach fauna are scarce. • Light oil accumulations will be deposited as oily swashes or bands along the upper intertidal zone. • Heavy oil accumulations will cover the entire beach surface, although the oil will be lifted off the lower beach with the rising tide. • Maximum penetration of oil into fine-grained sand will be 10 cm. • Burial of oiled layers by clean sand within the first few weeks will be less than 30 cm along the upper beach face. • Organisms living in the beach sands may be killed either by smothering or by lethal oil concentrations in the interstitial water. • Shorebirds may be killed if oiled, though they may shift to clean sites
4	Rip Rap (6B)	Adjoining Port areas & terminals either exposed	• Riprap structures are composed of cobble- to boulder-sized rock fragments. • Riprap structures are placed for shoreline protection and inlet Stabilization.

		or sheltered corresponding to 1B & 8B	• Mid- and low-intertidal zone biota on the riprap may be plentiful and varied. • Deep penetration of oil between the boulders is likely. • Oil adheres readily to the rough rock surfaces. • If oil is left uncleansed, it may cause chronic leaching until the oil asphaltizes. • Resident fauna and flora may be killed by the oil
5	Exposed Tidal Flats (7)	Throughout the GoK Coast	• Oil does not usually adhere to the surface of exposed tidal flats, but rather moves across the flat and accumulates at the high-tide line. • Deposition of oil on the flat may occur on a falling tide if concentrations are heavy. • Oil does not penetrate the water-saturated sediments. • Biological damage may be severe, primarily to in fauna, thereby reducing food sources for birds and other predators.
6	Sheltered Manmade Structures (8B)	At sea ports/terminals such as Kandla, Vadinar, Navlahi & Mundra, Bedi	• Oil will adhere readily to rough surfaces, particularly along the high-tide line, forming a distinct oil band • • the lower intertidal zone usually stays wet (particularly if algae covered), preventing oil from adhering to the surface
7	Vegetated River Bank	Along major River Sihan & Ghi near Vadinar & Aji, Demi & Machu near Navalakhi, Devalia near Kandla, & Kalagogha near Mundra	• These areas are composed of low banks with grasses (subject to flooding) or steeper banks with trees going to the water's edge. • They are found in fresh or brackish water localities. • They are composed of a variety of plant species. • Light oil concentrations will coat the outer fringes of the area. • Heavy oil concentrations will penetrate into the area and heavily coat the plant and ground surfaces. • Biological impact may be severe if oil concentrations are heavy. • Oil persistence may be several months if not cleaned. • During winter, shore-fast ice could prevent or limit oil impact. • Odor and taste of fresh water supplies could be impacted by trace contamination
8	Sheltered Mud Flats(9A)/ Hypersaline Mudflats (9B)	Present all along the coast, inside the creeks and towards the inner portion of islands near Vadinar & Inner creeks of Kandla	• oil does not usually adhere to the surface of sheltered tidal flats, but rather moves across the flat and accumulates at the high-tide line • deposition of oil on the flat may occur on a falling tide if concentrations are heavy • oil will not penetrate the water -saturated sediments, but could penetrate burrows or other crevices in muddy sediments

			• in areas of high suspended sediments, sorption of oil can result in deposition of contaminated sediments on the flats • • biological damage may be severe
10	Freshwater Swaps/ Marshes(10B)	On the banks of rivers emptying into the GoK	• Oil in any appreciable quantity may be very persistent due to minimal flushing and organic soils. • Degree of vegetation oiling is a function of tidal range and local topography. • Season of oiling is important; dormant vegetation is least sensitive to oil; blooming and seeding plants are most sensitive. • Resident biota are likely to be heavily impacted, particularly reptiles, amphibians, and crustaceans, with high mortality predicted. • Odor and taste of fresh water supplies could be impacted by trace contamination • Freshwater marshes/swamps are found in the upper reaches of tidal streams, rivers or tributaries Marshes are characterized by typical soft-bodied, non-persistent, herbaceous vegetation such as grasses. • Swamps have dense stands of water-tolerant shrubs and trees. • These areas have an extremely high degree of species diversity and abundance in flora and fauna; may harbor rare, threatened, or endangered species on the local, regional, or national level. • They are extremely valuable as breeding and nursery areas for wetland-dependent amphibians and reptiles, as well as other fish, birds, and mammals. • Sediment generally consists of organic rather than mineral soils, resulting in a rather soupy consistency, and making foot travel difficult to impossible
11	Fringing and Extensive Salt Marshes (10 C)	Kandla adjoining the creeks of Kandla, Nakti, Phang , Sara	• Intertidal wetlands containing emergent, herbaceous vegetation. • Width of the marsh can vary widely, from a narrow fringe to extensive. • Relatively sheltered from waves and strong tidal currents. • Resident flora and fauna are abundant and consist of numerous species. • Provide a nursery ground for numerous fish species. • Bird life is seasonally abundant. • Oil adheres readily to marsh vegetation. • The band of coating will vary widely, depending upon the tidal stage at the time oil slicks are in the vegetation. There may be multiple bands. • Large slicks will persist through multiple tidal cycles and coat the entire stem from the high-tide line to the base. • If the vegetation is thick, heavy oil coating will be restricted to the outer fringe, with penetration and lighter oiling to the limit of tidal influence.

			• Medium to heavy oils do not readily adhere or penetrate the fine sediments, but they can pool on the surface and in burrows. • Light oils can penetrate the top few centimeters of sediment and deeply into burrows and cracks (up to one meter)
12	Mangroves (10 D)	All along the creeks in and around Kandla, on the margins of mudflats and also in the islands of MNPS near Vadinar.	• Mangrove Forests are composed of salt tolerant trees that form dense stands with distinct zonation. • The fringing forests have relatively high wave activity and strong currents. • But those found in bays and estuaries are well sheltered. • Attached to the prop roots are moderate densities of algae, snails and crab. • They are also nursery grounds of prawns. • Fresh spills of light refined products have acute, toxic impacts to both trees and intertidal biota. These products will penetrate deep into the forests, stopping only at high-tide line resulting in sediment contamination. • Fresh crude will have great persistence where it penetrates burrows and prop root cavities. • Heavier oils tend to coat the intertidal zone, with heaviest concentrations at the high-tide line. • Heavy Oil will coast the intertidal section of prop roots, resulting in defoliation and eventual death of the tree if significant coverage occurs. In the sheltered areas, oil may persist for many years.
13	Corals Reefs	Around the Islands of MNPS near Vadinar, including Kalumbhar and Narara.	• Live corals are unlikely to become oiled, since they are rarely exposed at the sea surface except those in the intertidal area. But once oiled

In addition to the above the areas and features requireing special attention are given as **Table 6.7** below.

Table 6.7. Areas Requiring Important Considerations

Sl. No.	Areas requiring special consideration	
1	Oil Spill Threat Zones	• Ports, Oil Handling Facilities, Refineries
2	Corals	•
3	Sub tidal Habitats	• Submerged aquatic vegetation
4	Birds	• Nesting sites, Waterfowl overwintering concentration areas • High concentration migration stopovers • High concentration resident bird colonies
5	Marine Mammals	• Migration corridors • Population concentration areas
6	Terrestrial Mammals	• Concentration & frequenting areas
7	Fish and Shellfish	• Anadromous fish spawning streams • Estuarine areas which are important fish nursery areas • Special concentration areas for estuarine and demersal fish • Shellfish seed beds, leased beds, high concentration areas • Crab, shrimp, and lobster nursery areas
8	Reptiles	• Marine turtle nesting beaches
9	Recreation	• High-use recreational beaches • Marinas and boat ramps • High-use boating, fishing, and diving areas
10	Management Areas	• MNPS, WLSs, ICMBA • Research Stations • Mangrove Plantations • Other Wildlife management areas • Estuaries of rivers like Narmada & Tapti
11	Resource Extraction	• Commercial fishing areas • Water intakes • Salt Pans • Aquaculture sites • Offshore Exploration Sites • Defense Installations
12	Cultural & Heritage Resources	• Archaeological and other historically significant sites

Source: Data Analysis

7

DEVELOPMENT OF OIL SPILL RESPONSE STRATEGY

The oil spill response strategy is finalized based on vulnerability of the coastline which can be described based on different factors namely source of spill, location of oil slick containment, type and quantity of oil spilled, marine meteorological condition, shoreline characteristics and sensitivity to oil spill in the area. The following section deals with development of oil spill response strategy.

7.1. Potential Sources

Ports, SPMs, other Oil handling facilities & Ships are the sources of oil spill with in Kandla Port Limit. The location map of Ports, SPMs & Capitive Jetties of Gulf of Kachchh which are the most probable location of oil spill within Kandla Port limit is given as **Figure 7.1**.The likelihood and the consequence of specific spills should be calculated based on the out comes of a 'Detailed Risk Assesment Study'.

Figure 7.1. Location Port and allied facilities in Gulf of Kachchh

Oil Jetties can handle up to a maximum size of vessel 56,000 DWT.SPM handle Very Large Crude Oil Vessels (VLCC) with a maximum pumping capacity of 10000 tonnes per hour. Hence it should be inferred that the area is having high density of potential sources.

7.2. Types of Oil Handled & Characteristics

Oil is an important commodity handled at the port. The details of oil handled by the facilities in the KPT area and their characteristics are given as **Table 7.1** below.

Table 7.1. Details of Oil Handled & Characteristics

Sl. No:	Type of Oil	Specific Gravity	Genre	Characteristics	Examples
1	Light Oil	< 0.84	White Oil	Non- persistent, Volatile	Products including Aviation Fuel, Kerosene, Motor Spirit, Naphtha, HSD
2	Crude Oil	>0.84	Black Oil	Persistent, Viscous, Emulsion, Fresh Oil amenable to dispersants	Arabian Light, Arabian Heavy etc.,
3	Heavy Oil	>0.95	Black Oil	Persistent, Viscous, Emulsion, Generally not amenable to dispersants	Fuel Oils, LSWR
4	Edible Oil Crude/ Refined	>0.92	Black Oil	Persistent, Viscous,	

(Source: Annual Report)

7.3. Sensitivity of the Shoreline

As already discussed the port limit extends between the Northern and Southern arms of Gulf of Kachchh. Northern and North - Eastern portions are rich in mangroves and the Southern shore is rich in a wide variety of organisms including Corals, Fishes, Birds and Mangoves. The area of Marine National Pak adjoining and extending on both sides of Vadinar will be the worst affected area during a recognisable spill scenario. There is also a chance that due the presence of extensive creek systems, the oil can directly spilt into inner areas of GoK. There are rivers system entering into the GoK near Vadinar. During high tide oil can enter inland through these inlets. Also it is important that due to the presence of circulating currents of GoK the contaminants on entering the any part of the inner GoK can exert stress on the Marine National Park and Sanctuary (MNPS) and is a cause of concern. Also fisheries are concentrated in the creek section of Sathsaida Bet and the Surajbari area is famous for seasonal prawn fishery. There are vast salt pans functioning in the Kandla creek area and also there are patches near Mundra, Navlakhi and Vadinar. There are also prominent water intake points at Vadinar and Mundra.

7.4. Prioritization of Resources

Prioritization of resources is an integral part of sensitivity mapping since it will be helpful in determining the response priorities, achieving optimal resource use and essentially ensure maximum resource protection. This was done by giving ranks to each resource types which has been already described under the heads of Environmental sensitivity ie., Sensitivity to Oil Pollution, Environmental Value, Cultural & Social values and Economic values (Kankra et al, 2008). Ranks between1-10 was assigned for the resource. Same rank was given to different resource when they occupied same position in different heads. Two resource may take a same value as required by the circumstance. Hence, it is not necessary that all the values must be present under one category at a time. Intake points considered here are only of industrial use. Weightages were given to each head ie., Sensitivity to Oil Pollution (30), Environmental Value (30), Cultural & Social values (20) and Economic values (20). Priority Index (PI) was worked out based on this. Details of Prioritisation of Resources is given as **Table 7.2** below.

Table 7.2. Prioritization of resources

Resources	Sensitivity for Oil Pollution (1-10) Weight (30%)	Cultural & Social Values (10%)	Scientific Values (20%)	Environmental Importance (30%)	Economic Considerations (10%)	Total Relative Response of Sensitivity	Risk Value	Priority	
								Index	Order
Rocky Coast	3	1	2	2	1	2.1	1	2.1	D
Port/ Harbour/ Jetties	1	7	2	4	8	3.4	2	6.8	C
Intake Locations	10	2	1	1	2	3.9	3	11.7	B
Salt Pans	3	8	2	6	5	4.4	1	4.4	D
Sandy Beach	6	8	3	5	2	4.9	2	9.8	D
Fishing Grounds	7	8	5	6	8	6.2	2	12.4	B
Subtidal Coral Reefs	2	9	10	9	6	6.8	1	6.8	C
Intertidal Mudflats	7	4	7	8	3	6.6	2	13.2	B
Mangroves	9	10	8	10	8	9.1	3	27.3	A

Resources	Sensitivity for Oil Pollution (1-10) Weight (30%)	Cultural & Social Values (10%)	Scientific Values (20%)	Environmental Importance (30%)	Economic Considerations (10%)	Total Relative Response of Sensitivity	Risk Value	Priority	
								Index	Order
Intertidal Corals	10	9	10	9	9	9.5	3	28.5	A

(Source: Adopted Kankra)

S- Sensitivity to Oil Pollution, Wi- Weightage, E-Environmental Value, PI- Priority Index

C& S – Cultural & Social, Ec- Economic

7.5. Development of Response Strategy

Based on the above characteristics, suitable response strategy to be adopted is discussed below. The rating process was based upon independent data, manufacturers' information, experience and engineering estimates. Important consideration for the response technology assesment are discussed below:

7.5.1. Highest Effective Speed

The highest effective speed rating assumes that the equipment being rated is used by people who have been trained and are experienced in fast water response with that technology. The speed in knots represents the highest practical current or speed of advance, as applicable, that the technology can still effectively deflect, contain or skim oil from the water. Effectiveness will generally be diminished at the higher velocities, however, the majority of the oil (more than 50 percent) encountering the device will be controlled or recovered as desired at that upper limit speed rating.

7.5.2. Effective in Waves

Effectiveness in waves is dependent upon the oil recovery rate and oil recovery efficiency or deflection/containment capability. Generally, a technology that has good reserve buoyancy, adequate freeboard and draft, or can be decoupled from the influences of waves, will continue to be effective in waves. Short-crested waves usually degrade the performance of equipment more than large long-period swells. A low (L) rating represents effectiveness in calm water conditions up to one-foot short crested waves. A medium (M) rating indicates effectiveness in short crested waves between 1 and 3-feet high, while a high (H) rating represents satisfactory performance in waves 3 to 6-feet high. Effectiveness in these conditions means that the technology will contain or collect the majority of the oil it encounters.

7.5.3. Effective in Debris

Floating debris will cause problems with equipment by damaging it, moving it or rendering it ineffective. Some equipment is less affected by debris due to its robust nature or method of containment/recovery. Some skimmers use debris screens that protect the pump but often require manual tending to remove the debris. A high (H) rating means that the skimmer will continue to function well in floating debris with minimal manual tending required. Medium (M) rating represents a degraded performance level in debris, while a low (L) rating indicates serious problems with performance in debris. Both M and L ratings require significant manual tending to remove debris.

7.5.4. Effective in Shallow Water

Effectiveness in shallow water indicates the technology has a low or no draft requirement and that it will effectively contain, deflect or remove oil as designed. A yes (Y) indicates that a skimmer or boom system is manufactured that is effective in 2-feet deep water or it is not limited by a water depth of two feet. It is possible that some skimmers or boom systems receiving a no (N) rating could be produced by the manufacturer to function in shallow water.

7.5.5. Ease of Deployment

The ease of deployment rating reflects the amount of complexity, training required, people and logistics involved to deploy and use the technology successfully. The more resources and training required to deploy the technology and use it effectively, the lower the rating. The faster a technology can be deployed with a minimum number of people and support equipment, the higher the rating. Generally, technology with a good (G) or a very good (VG) ease of deployment rating will continue to be effective close to the highest effective speed rating when using inexperienced personnel.

7.5.6. Oil Viscosity Range

A low (L) rating indicates that a skimmer is effective in light oil with a viscosity between 1 and 100 cSt. Medium (M) indicates effectiveness in medium grade oils with a viscosity between 100 and 1,000 cSt, while high (H) means the skimmer was effective at recovering heavy oil with a viscosity between 1,000 and 60,000 cSt. A skimmer was considered effective if tests recorded reasonable recovery rates and recovery efficiencies of at least 50 percent. If a viscosity range is not listed for a skimmer, then the skimmer is not effective at recovering oil in that viscosity range.

7.5.7. Oil Recovery Efficiency & Recovery Rate

Skimmer specific performance ratings are based upon independent performance test data when available and manufacturer claims. When data were not available, physics and engineering principles were used to approximate performance. Generally, oil recovery efficiency will decrease and oil recovery rate will increase with speed. Technologies with the higher efficiencies and recovery rates that were not significantly degraded by increases in speed were given higher ratings. Skimmers with comparatively lower efficiencies and recovery rates that degraded quickly at faster speeds were given lower ratings. Skimmers that demonstrated a poor (P) performance for recovery efficiency and/or oil recovery rate in currents above one knot were not included in this.

As per above consideration, booming strategies, specialized boom requirements, alternate containment methods and high-speed skimmers are rated in several categories and presented in **Table 7.3** and **7.4** below.

Table 7.3. Booming Strategies

Sl. No.	Technology Name	Highest Effective Speed kts.	Eff. in Waves	Eff. in Debris	Eff.in Shallow	Ease of Deployment	Comments
1	Cascade *	4	L	M	Y	F	Short sections independently moored to shore.
2	Deflection *	4	L	M	Y	F/G	Longer sections with shore tiebacks downstream.
3	Chevron (closed)*	3	M	M	Y	G	Quick to deploy because it uses fewer anchor points.
4	Chevron (open)*	3	M	M	Y	G	Allows for vessel traffic between openings.
5	Current Rudder*	3	M	H	N	F	Allows for vessel traffic by control of rudder from shore.
6	Double Boom*	3	M	H	Y	F	Improved containment but hard to keep separated properly.
7	Boom Deflectors *	4	M	M	Y	G	Deflectors used to keep boom at an angle without anchors.
	Boom (Specialized)						
1	Fast Sweep (V-Shaped)	2.	H	L	N	G	Net across foot of boom keeps it in a V-shape.
2	Rapid Current Boom	3.	L	L	N	P	Inclined plane, fabric bottom with outlet holes in pocket.
3	Horizontal Oil Boom	3.	M	L	N	F	Two booms connected by net & filter fabric.
4	Holes in lower draft*	2	M	L	N	G	Larger draft with relief holes in lower skirt to reduce drag.

5	Net in foot of boom	1.	H	L	N	G	Short vertical net at foot of the boom.
6	Foam 6"X 6",two tension lines*	4	L	L	Y	VG	Typical fast water diversion boom with upper & lower tension.
7	External Tension Line foam	2	M	L	N	F	High stability, limited reserve buoyancy.
8	Shell High Current "Boom"	3	L	M	Y	P	Rigid aluminum perforated inclined plane structure, diversion system.
	Alternate Methods						
10	Pneumatic Boom	2.	M	H	N	G	High power required (30 hp/ft).
11	Water Jet (Horizontal)	4.	M	M	Y	F	Reasonable power requirements (3 hp/ft).
12	Water Jet (Plunging)	4	M	M	N	F	Reasonable power requirements.
13	Air Jet	3	M	M	Y	F	Low power required (1 hp/ft).
14	Flow Diverters	6	H	M	Y	VG	No power, changes surface currents to direction of anchor point.
15	Floating Paddle Wheel	3	M	M	Y	G	Low power required (0.25 hp/ft), high-energy transfer.
16	Earth Dam (underflow)*	2	M	M	Y	P	Barrier blocking low flow into an inlet or out of a stream.

Table 7.4. Skimmer Specific Performance

Sl. No:	Technology Name	Highest Effective Speed (kts.)	Eff. in Waves	Eff. In Debris	Eff. In Shallow	Ease of Deployment	Oil Viscosity Range	Oil Recovery Efficiency	Oil Recovery Rate	Comments
Incline Skimmers										
1	Dynamic	3	M/H	M	Y	G	L,M,H	G	G	VOSS & Self Propelled versions.
2	Static	5	M/H	M	N	G	L,M,H	G	G	VOSS, low maintenance
ZRV Skimmer										
1	Rope Mop	5	H	H	N	G	L,M,H	VG	F	VOSS & Self propelled catamarans

2	Sorbent Belt	6	M	M	N	G	L,M, H	VG	F	Very high maintenance but effective
Quiescent Zone										
1	Expansion Weir *	3	L	L	Y	G	L,M	F	G	Expansion slows flow
2	Circulation Weir	3	M	L	Y	G	L,M, H	G	G	VOSS, portable lagoon
3	Brush Conveyor	3	M/ H	M/ H	N	G	M,H	VG	F	VOSS, barge & self-propelled
4	Streaming Fiber & Belt	3	M	L	N	G	L,M	G	F	Fibers slow flow, belt & weir remove oil
Lifting Belt										
1	Filter Belt	3.5	M/ H	M/ H	Y	G	M,H	VG	F	Self-propelled & induction impeller
2	Rotating Disk Brush									
3	Rotating Brushes	3	M/ H	M/ H	Y	G	M,H	VG	F	VOSS, barge & self-propelled
Surface Slicing										
1	High Current Oil Boom	6	L	L	N	G	L,M, H	F	G	Weir with foil bow
2	Multi-purpose Oil Skimmer Sys.	3	M/ H	L	N	G	L,M, H	F	G	Wave following weir
3	Russian Debris Skimmer	3	L	M/ H	N	G	L,M, H	G	G	Debris filter, weir and gravity separator tank.
4	Trailing Adsorption									
5	Trailing Rope Mop	4	H	H	N	F	L,M, H	VG	F	Batch processing requires retrieval of rope mops
6	Free Floating Sorbent*	5	H	H	Y	G	L,M, H	VG	F	Free drifting sorbents and recover them downstream
Legend		*H*	*Hig h*		*Y*	*Yes*		*VG*	*Very Good*	
		M	*Med ium*		*N*	*No*		*G*	*Good*	
		L	*Low*					*F*	*Fair*	
								P	*Poor*	

Notes:	*1.Low is effective in calm water to 1 foot waves, Medium is effective in 1 to 3 foot waves, and High is effective in 3 to 6 foot waves* *2.Yes indicates that a skimmer or boom system is effective in 2 foot of (shallow) water.* *3. Low indicates a skimmer is effective in light oil 1-100 cSt viscosity, Medium 100-1,000 cSt and High 1,000-60,000 cSt* *4.Oil recovery efficiency is the percent of oil recovered compared to the total volume or oil and free water collected.* *5. Oil recovery rate is the rate of oil collected which is a combination of recovery efficiency and throughput efficiency. "Controlled tests results with oil were not available so ratings were based on engineering principles, expert opinions and field experience. Technology names with no asterisk were rated based upon data obtained from controlled tests with oil.*

7.5.8. Shoreline Consideration

Shoreline Response Team should follow Shore Line Clean Up Assessment Technique (SCAT which is a standardized method of assessing, recording and reporting the degree of oiling of the shoreline. The steps during SCAT include:

- Identify sensitive resources
- Evaluate shoreline oiling conditions
- Recommend clean-up methods and end points
- Apply the concept of Net Environment Benefit Analysis (NEBA) to the shoreline response strategies

The shorelines are to be divided into segments. Segments are defined geographic areas with a similar character in terms of physical features and sediment types. Sub segments can be used if the extent of oiling varies significantly between a given segments. Results are to be standardised. Descriptions are used to describe the oil observed. The SCAT Team should calibrate their classifications of oil observed prior to conducting full scale surveys.

Report / log form (with clipboard), Method of communications (e.g. mobile, satellite phones, VHF radio), Handheld GPS, Digital Camera, Compass, Additional batteries shall be available with the shoreline response team.

The shoreline assessment will be followed by selection of appropriate shoreline clean-up measures. The selection of most appropriate methods and equipment to be used in each case will be determined by presence of hazard:

- Character and amount of stranded oil
- Character of shoreline
- Tidal range and times
- Prevailing sea weather conditions
- Availability of equipment
- Accessibility of the contaminated area for equipments
- Availability of personnel
- Presence of sensitive wildlife or other features which may be damaged by cleaning operations, availability of local transport
- Storage treatment and disposal facilities for the recovered materials and cost and local, state, national or international policies and priorities.

Shoreline character comprises mainly four components ie., Substrate type- the material that the shore is comprised of, Shoreline form- the shape of the shoreline, Energy- a function of currents, wind and waves, Biological character- the plant and animal communities present. Each component is to be analysed separately before choosing the response option. Parameters used to describe the distribution of the oil on shorelines are given below:

- Length (m) - The distance along a shoreline that is oiled
- Width (m)- The distance from the top of the highest elevation of the shore that is oiled to the bottom
- Percentage cover-An estimate of the percentage of the substrate surface within the area that is oiled
- Thickness (mm or cm) - The distance from the substrate surface to the top of the oil layer. Often this cannot be measured accurately because the surface layer is too thin.
- Depth-The depth below the surface that is oiled. For buried oil, depth should be measures from the top of the substrate surface to the oily layer.

After completing the SCAT survey based on the observation, Shoreline Clean-up operations are to be initiated and guideline for the clean-up of various shoreline types are given as **Table 7.5** below.

Table 7.5. Shoreline Response Operations

Sl. No.	Type of Shoreline	Response Operations
1	Exposed Rocky Shore (1A)	• In the case of Gujarat they are many times associated with corals. Hence, have rich biota. Hence immediate severe biological impacts will be occurring especially in tidal pools but, the oil will not remain stranded. • When exposed coral become oiled, it is best left undisturbed and to recover naturally. • Natural cleaning of coral platforms that dry out at low water can be assisted by low pressure flushing with seawater to minimize exposure of reef communities to oil.
2	Exposed Solid Vertical Structures (1B)	• These areas require high-pressure spraying in order to: remove oil; prepare substrate for decolonization of barnacle and oyster communities; minimize aesthetic damage; prevent the chronic leaching of oil from the structure. • Walls and other vertical structures may exhibit a band of oil throughout the tidal range that can be removed by pressure washing from boats or rafts. • Oil that has migrated under quays, jetties or other structures built on piles or columns can be difficult to remove, particularly when headspace is restricted. • Wash created by vessels’ propellers may assist removal of bulk oil but fine cleaning may not be possible and the oil can be left to degrade naturally. • Wooden structures, particularly where rot is established, may be damaged by more aggressive clean-up techniques.
3	Fine to Medium - Sand Beaches (3)	• Among the easiest beach types to clean. • Cleanup should concentrate on the removal of oil from the upper swash zone after all oil has come ashore. • Removal of sand from the beach should be minimal to avoid erosion problems; special caution is necessary in areas backed by seawalls. • Activity through both oiled and dune areas should be severely limited, to prevent contamination of clean areas. • Manual cleanup, rather than road graders and front-end loaders, is advised. • All efforts should focus on preventing the mixture of oil deeper into the sediments by vehicular and foot traffic. • Sand beaches are often regarded as valuable amenity resources, with priority given to cleaning them. • Beaches usually have good access and because the depth of oil penetration into the beach for many oils is limited, are generally considered the easiest shoreline type to clean. • However, oil can become buried in the beach by successive tides and low viscosity oils will penetrate into coarse grained sands.

		• Flushing, surf washing or harrowing techniques may be appropriate to address buried oil.
4	Rip Rap (6B)	• When the oil is fresh and liquid, high-pressure spraying and/or water flooding may be effective, making sure to recover all released oil. • Heavy and weathered oils are more difficult to remove, require scrapping and/or hot-water spraying. • It may be necessary to remove heavily oiled riprap and replace it. • In favourable weather conditions, floating oil may be collected at the base from boats. • Workers on the structure, and to some extent within it (as far as it is safe to do so), can remove oiled debris and clean boulders and tetrapods with pressure washers or manually with rags and sorbents. • Passive cleaning, hereby sorbents are placed along the face of this structures, allows oil washed out with the movement of tides, swell and wave action to be recovered. • In certain situations, this natural action can be augmented by pumping water into the structure to flush out the oil. • Pressure washing and passive cleaning is recommended in accessible place where as use of sorbents and natural cleaning is preferred in place of inaccessible places.
5	Exposed Tidal Flats (7)	• Currents and waves can be very effective in natural removal of the oil. • Cleanup is very difficult (and possible only during low tides). • The use of heavy machinery should be restricted to prevent mixing of oil into the sediments. • On sand flats, oil will be removed naturally from the flat and deposited on the adjacent beaches where cleanup is more feasible.
6	Sheltered Manmade Structures (8B)	• cleanup of seawalls is usually conducted for aesthetic reasons or to prevent leaching of oil • • low - to high-pressure spraying at ambient water temperatures is most effective when the oil is fresh
7	Vegetated River Bank (9B)	• Cleanup should proceed cautiously. • Under light coatings, cleanup is probably unnecessary; under heavy accumulations, oil on the sediment surface might be removed to enable new growth. • Low-pressure spraying (ambient) may aid oil removal. • Plant cutting should be closely supervised if undertaken.
8	Sheltered Mud Flats(9A)/ Hyper	• These are high-priority areas necessitating the use of spill protection devices to limit oil-spill impact; deflection or sorbent booms and open water skimmers should be used • cleanup of the flat surface is very difficult because of the soft substrate; many methods may be restricted

	saline Mudflats (9C)	• low -pressure flushing and deployment of sorbents from • Shallow - draft boats may be helpful
10	Freshwater Swaps/ Marshes(10B)	• These are high-priority area necessitating the use of spill protection devices to limit oil spill impact; deflection or sorbent booms and skimmers. • Under light oiling, the best practice is to let the area recover naturally. • Any cleanup activity which would mix the oil into organically rich sediments should be avoided. • Manual pickup should be conducted from a floating platform (e.g., jon boat or inflatable). • Only the least-intrusive cleanup methods should be employed to avoid compounding the environmental impact of a spill. • Quick flushing and removal of oil while it is still fluid can reduce long-term impacts
11	Fringing and Extensive Salt Marshes (10 C)	• Under light oiling, the best practice is to let the area recover naturally. • Heavy accumulations of pooled oil can be removed by vacuum, sorbents, or low-pressure flushing. During flushing, care must be taken to prevent transport of oil to sensitive areas down slope or along shore. • Cleanup activities should be carefully supervised to avoid vegetation damage. • Any cleanup activity must be sure not to mix the oil deeper into the sediments. Trampling of the roots must be minimized. • Cutting of oiled vegetation should only be considered when other resources present are at great risk from leaving the oiled vegetation in place
12	Mangroves (10 D)	• Under light accumulations of any type of oil, no clean-up is recommended • If sheen are present, use sorbent booms to pick up the oil as it is naturally removed, being sure to change the booms frequently. • Only light fuel oil requiring clean-up is diesel oil. • Heavy accumulations could be skimmed or flushed with low- pressure water flooding as long as there is no serious disturbance to substrate. • Oil debris should be removed without disturbing substrate. • Live vegetation should never be cut or otherwise removed. • Sorbents can be used to remove wide heavy coatings from prop roots in the areas of firm substrate with close supervision.
13	Corals Reefs	• However, should exposed coral become oiled, it is best left undisturbed and to recover naturally. • Natural cleaning of coral platforms that dry out at low water can be assisted by low pressure flushing with seawater to minimize exposure of reef communities to oil utilizing water of the same locality can be done.

		• Where recovery of oil is necessary, for example to prevent its embolization, this should be undertaken with care to minimise damage to the fragile structures. • Rehabilitation should be done in worst scenario utilizing undisturbed native fragments.

7.6. OSR Inventory for KPT Limit

As per risk classification of ports and allied facilities as per NOS-DCP, based on type of cargo handled, quantity of bunkers carried onboard ships calling at the port, single point mooring facility at the port, and ship-to-ship transfer operations at the port KPT belongs to Risk Category A. The risk categorization is appended at **Table 7.6.**

Table 7.6. Risk categorization of ports

Risk Category	Description
A	Ports handling crude oil/ tanker visits/ SPM/ STS
B	Ports handling ships carrying more than 1000 tons of fuel/ bunker oil
	Ports handling products only
C	Other than Cat 'A' and Cat 'B'

Source: NOSDCP

The planning standards for oil spill response resources for each risk category of ports is appended at **Table 7.7.**

Table 7.7. Oil Spill Response equipment for each risk category of ports

	Description		Risk category A	Risk category B	Risk category C
Equipment	Inflatable Boom (metres)		2000	1000	600
	Skimmer (20 TPH)		4	4	2
	OSD Applicator (no.)		6	2	2
	Oil Spill Dispersant (litres)		10,000	5,000	3,000
	10 Tons Flex Barge (no.)		4	02	2
	Current Buster booms if tidal current >2 knots (meters)		400	400	
	Sorbent boom (meters)		500	200	
	Sorbent Pads (no.)		2000	1000	
	Shoreline cleanup Equipment	Mini Vacuum pumps	5		
		OSD Applicator	5		
		Fast tanks	5		
Vessel	Work Boats		2	1	1
	Tugs		2	1	
Man Power	IMO Level 1		10	6	2
	IMO Level 2		4	2	
	Other		10	10	5

Source: NOSDCP

As per the above categorization Kandla and Vadinar port falls into Category A., which should have minimum inflatable Boom of capacity 2000m. Inflatable booms of capacity 1200m which is already available with the ports. Considering the minimum standards for Category A and the ecological sensitivity areas along the coast and the creek mouth of length not less than 1 km it is preferably to have 1000m more booms in the deck. Similarly as per NOSDCP, the minimum number of skimmers required is 20 TPH x 3. KANDLA Port is having 49 TPH x 2 fast flow skimmer and Brush skimmer of capacity 12TPH which satisfies the minimum requirement. Oil Spill Dispersant Storage on board with 12000 L in 3 Tugs.

As per NOS-DCP to cater a Tier 1 spill at KANDLA Port, the port should have to have response equipment for containing 700 MT of Oil. The following section evaluates the sufficiency of OSR equiment at KPT. As per the data sheet available, the oil thickness of various types of oil and concentrations with respect to area is shown as **Table 7.8**.

Table 7.8. Oil Appearance, Thickness & Concentration of Spill

Code	Description	Layer-Thickness Interval		Concentration	
		microns (µm)	inches (in.)	m^3 per Km^2	bbl/acre
S	Sheen (silver/gray)	0.04 – 0.30	1.6×10^{-6} – 1.2×10^{-5}	0.04 – 0.30	1×10^{-3} – 7.8×10^{-3}
R	Rainbow	0.30 – 5.0	1.2×10^{-5} – 2.0×10^{-4}	0.30 – 5.0	7.8×10^{-3} – 1.28×10^{-1}
M	Metallic	5.0 – 50	2.0×10^{-4} – 2.0×10^{-3}	5.0 – 50	1.28×10^{-1} – 1.28
T	Transitional Dark (or True) Color	50 – 200	2.0×10^{-3} – 8×10^{-3}	50 – 200	1.28 – 5.1
D	Dark (or True) Color	>200	$> 8 \times 10^{-3}$	>200	> 5.1
E	Emulsified	Thickness range is very similar to dark oil.			

Source:Chart from Bonn Agreement Oil Apperance Code (BAOAC) May 20,2006 modifies by A. Allen

Considering the worse Tier-1 spill, the area of impact is estimated as follows:

- Volume of Oil = 700 MT
- Thickness of Oil at the point of Spill (at zero time) = 200 µm (approx.)
- Area of Impact= (700MT/200µ) = 3.5×10^6 m^2 (approx.)
- Length of the coast immediately impacted = sqrt (Area of Impact) approx. ≈ 1870m
- Average response time = 60 minutes (Mobilization of Resources +Deployment of Boom, Skimmer etc + considering Flotilla speed of 10 Knots/hr).

As per the above examination it was found that , the OSR equipments available at Kandla is sufficient to cater the requirements of Kandla Zone, but considering the minium requirement for Category A ports and distance between Kandla & Vadinar seriously extending the response time and thus imposing severe treat to sensitive life, preferabely the inventroy at Vadinar could be expanded in a phased manner.

However shoreline response resources are not provided in the present inventory and provision for the same shall be incorporated to it at the earliest through Mutual Aid pooling.Considering the presence of bets within the shoreline and their characteristics, essential resources for shoreline response are to be provided such as River boom, Deflection boom, Intertidal Boom, Shoreline Cleanup Equipments etc. As the entire KPT limit is ecologically important, part of MNPS and supporting species like mangroves and corals calls for the more number of shore line equipments inclusive of Sorbent booms, Absorbent Pads, Pillows, Rolls, Sheets. Details for the same are given as **Table 7.9** below.

Table 7.9. Details of Shoreline Cleanup Equipments for Kandla

Sl No.	Equipments	Unit	Kandla	Vadinar
1	BOOM			
a	Beach sealing Boom(500mtr)	No.		
b	Auto/River Boom(200mtr)	No.	5	2
c	Fence Boom(150mtr)	No.		
2	SORBENT			
a	Boom-50 mtr	No.	6	6
b	Pillows	No.	50	50
c	Rolls	No.	50	50
d	Sheets	No.	50	50
e	Pads	No.	50	100
3	CLEAN UP Equipment			
a	Hot Water Pressure Cleaner, Showels, Rakes, Diggers etc.	set	5	8
4	Miscellaneous			
a	Light set Generator, PPE, Safety Items (Safety Shoes, Hard Hats, etc.),Personal Items (Coveralls, Boots, etc.)	set	10	10
5	Trained minimum man power	set	10	10

8

INCIDENT MANAGEMENT MECHANISM

Incident management is essential part of efficient emergency response operations. It makes the entire process structured at the same will add flexibility to operations to meet the response goals. It involves command, control and coordination of activities, individuals, organizations and the community.

8.1 Organisation of Oil Emergency Preparedness & Response Team

Effective emergency plans require that, in the event of an accident nominated personnel are given specific responsibilities, often separate from their daily routine activities. It is recommended to setup an Emergency Organisation for responding to a oil spill incident which will be activated from the moment of spill to the termination of operation and even extending to decision making, record keeping etc. The Oil Spill Response Organisation Chart proposed for the Kandla Port Trust is given as **Figure 8.1 below.**

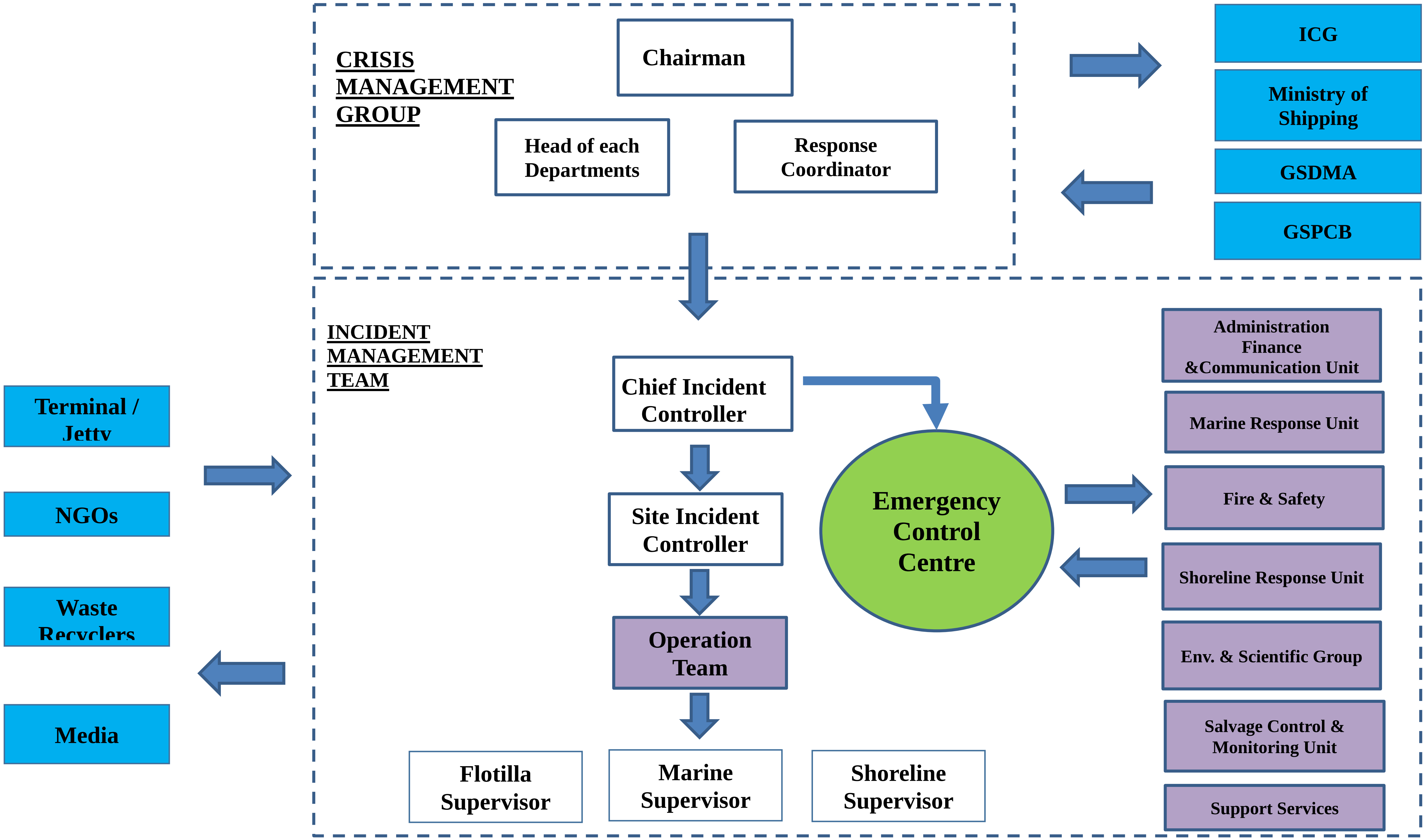


Figure 8.1. Oil Spill Response Organization Chart

8.1.1 Crisis Management Group

Crisis Management Group is the principal authority for oil spill prepardness & response within Kandla Port Limit. It shall be established at Kandla Port Trust utilizing the following key personnels:

- Chairman
- Deputy Chairman
- Chief Engineer (Civil Department)
- Chief Engineer (Mechanical Department)
- Secretary (General Administration)
- Chief Vigilance Officer (Vigilance Department)
- Traffic Manager (Traffic Department)
- FA & CAO (Finance & Accounts Officer)
- Chief Medical Officer (Medical Officer)

An appropriate person shall be nominated as the Response Co-ordinator who will be directly in touch various division, departments & agencies as and when required.

8.1.1.1 Roles & Responsibilities

- Responsible for the preparation and review of Oil Spill Contingency Plan for Kandla Port
- Procurement & development of OSR Equipments and facilities
- Responsible for getting the port personnel trained at IMO level 1 & 2
- Responsible for formulating MoU with Mutual Aid Group
- Review of Oil Spill Response Preparedness
- Site Visit & Review of report prepared by Chief Incident Controller (CIC)
- Responsible for communication with various National and State Level Authorities and media
- Responsible for Coordination, Communication with State Level Agencies such as State Disaster Management Agency (SDMA), State Pollution Control Board, Coast Guard Headquarters NW Region, Dept. of Fisheries, Forest, Wildlife.
- Constitution of Incident Management Teams as nominated by Chief Incident Controller (CIC)
- Responsible for allocation & deployment of personnel for handling oil spill incidents

- Providing Guidance to Emergency Response Units including arranging external assistance to
- Providing administrative and financial assistance to operations
- Declaration of the closure of Oil Spill Response Operations

8.1.1.2 Specific Duties of Response Coordinator

- Communicate between the Crisis Management Group and Incident Management Team
- Co-ordinate the activities of Incident Management Team after incorporating the recommendation of CMG
- Organise CMG meetings including joint meetings with IMT.
- Give proper instruction to CIC from time to time after consulting with CMG
- Arranging supporting as and when required by the IMT on approval of Chairman

8.1.2 Incident Management Team (IMT)

Oil spill response facility to be established will have an Incident Management Team. The Incident Management Team is the team who takes up the response activities under a Chief Incident Controller with its opertation team and independent supporting units, who actually deals with the response activities at field. Incident facilities including Emergency Control Centre, Incident Command Centre, Forward Command Point, Staging Areas, Safe Forward Point, Joint Information Centre, Waste Management & De-contamination blocks will be directly functioning under IMT.

The section below presents the functional responsibilities and reporting requirements of IMT and facilities established as a part of it..

8.1.2.1 Chief Incident Controller (CIC)

CIC is the key responsible officer for the management and co-ordination of response operations at the scene of a pollution incident to achieve the most cost effective and least environmentally damaging resolution to the problem. CIC shall have overall responsibility to protect personnel, site facilities, and the public before, during, and after an emergency or disaster. The CIC shall be present at the emergency control centre (ECC) for counsel and overall guidance. He will be the contact point to the coordinators of individual units under ECC and resources & personnels under this unit will be transferred to the operations team depending upon the requirement of the situation. CIC can also delegate the power to pool the resources and personnel to SIC or SICs depending upon the intensity & extent of the incident and ask for briefing from time to time. In the case of small spills CIC itself can act as the SIC.

8.1.2.2 Official in Charge of CIC

Dy.Conservator, Kandla Port will act as the CIC in an event of oil spill.

8.1.2.3 Responsibilities of the Chief Incident Controller

The key responsibilities of CIC shall include the following:

- Preparation, review and updation of the OSCP
- Assessment of situation and declaration of an oil spill emergency
- Activation of Emergency Control Centre
- Approval of Incident Action Plan prepared by the SIC/SICs during spill
- Mobilisation of Oil Spill Response Resources
- Coordinate Surveillance and Monitoring Oil Spill Events
- Coordination with CMG and other personnels on direction from CMG
- Continuous review of situation and decide on appropriate response strategy
- Taking stock of casualties and ensure timely medical attention
- Ordering evacuation of personnel as and when necessary
- To be responsible for ensuring that appropriate local and national government authorities are notified, preparation of media statements, obtaining approval from the CMG and releasing such statements once approval received
- Assessing the situation and requesting to CMG for organizing consultation with ICG and District Authorities when a Tier 2 or Tier 3 spill is to be declared.
- Ensuring correct accounting and position of personnel after the emergency

8.1.2.4 Reporting Requirements of CIC

The Chief Incident Controller shall report to the Crisis Management Group through the Response Coordinator.

8.1.3 Emergency Control Centre (ECC)

Emergency Control Centre will be established at KPT office with 24 hr control room at the port office under the supervision CIC. ECC acts as the key coordinating centre for responding to any oil spill incidents. The emergency control center may be defined as the place from which the operations to handle the emergency are directed and coordinated. CIC will be assisted by an In-Charge who will be taking care the reporting requirements of various response units, operation team and other stakeholders of the event and other interested parties.

ECC equipped to receive and transmit information and directions from all the areas of the marine terminal as well as outside and will be located in an area of minimum risk. The ECC shall be away from the potential hazards and provide maximum safety to personnel and equipment and should be preferably made of non-combustible building of either steel frame or reinforced concrete with two exists and adequate ventilation. Preferable it should be placed in connection with KPT Pollution Response Centre or integrated with exiting VTMS. It should also act a data repositrory that will be a point of gathering and dessimination of all information significant to the situation. Thus the Centre shall be equipped with facilities for Communication, Coordination, Survillience, Monitoring, Conferencing – Real & Virtual and Repository.

8.1.3.1 Officer In charge of ECC

Dy. Conservator, the CIC himself will be Official In Charge of ECC.

8.1.3.2 Role of ECC

8.1.3.3 Facilities to be maintained with ECC

- A copy of the Oil Spill Contingency Plan (OSCP); maps and display charts and diagrams showing buildings, roads, underground fire mains, important hazardous material and process lines, drainage trenches, and utilities such as steam, water, natural gas and electricity;
- Situation boards (continuously updated to present a summary of the current situation and response actions being taken);
- Aerial photographs, if possible, and maps showing the site, adjacent industries, the surrounding community, high-ways, rivers, etc., help determine how the disaster may affect the community so that the proper people can be notified, adequate roadblocks established, and the civil authorities advised sufficient telephone lines to enable full liaison with outside bodies;
- Names, addresses, and telephone numbers of employees, off-site groups and organizations that might have to be contacted; all telephone lists being reviewed for accuracy on a scheduled basis and updated, as necessary;
- Dedicated and reliable communication equipment; enough telephones and at least one fax line to serve the organization for calls both on-and off-the-site;
- Fixed and portable two-way radio equipment to keep in contact with activities on-scene and to maintain continuity of communications when other means fail;
- Meeting room including conference rooms

- Plan board, logbook, tape recorder, television, DVD and Video facilities for playing back records from aircraft and helicopters, as well as monitoring media coverage of the incident with a person assigned to record pertinent information and to assist in investigating causes, evaluating performance, and preparing reports;
- Emergency lights so that operations can continue in the event of power failure; Photocopy, fax and e-mail facilities; and dedicated computers with LAN/ internet facility to access the installation data and the latest and updated soft copies of all standard operating practices (SOP),Reference material such as applicable government regulations, emergency equipment lists etc.

8.1.3.4 Reporting Requirements of ECC

CIC, the head of ECC will report the Crisis Management Group through the response coordinator.

8.1.4 Site Incident Controller (SIC)

CIC shall identify SIC, who will be reporting directly to him and SIC shall be nominated for full day shifts of operation for Port. SIC will have a operational team under him which will be supported with appropriate planning, technical, scientific, chemical, environmental, logistical, administrative, financial units as and when required on request to CIC.

8.1.4.1 Official in Charge of SIC

Dy. HOD, Marine Department/ Chief Operational Manager of port may act as the SIC in an event of oil spill. If EE is given the chart the port officer can be given the charge of operational team.

8.1.4.2 Responsibilities of the Site Incident Controller

The key responsibilities of SIC shall include the following

- Assist in developing and updating workable oil spill emergency contingency plan based on the experience specific to the area, organize and equip the organization inline with OSCP based on the and train the personnel;
- Preparation of Incident action plan (IAP) describing activities and logistical support covering the basic elements the situation, mission, execution, administration and logistics, command, control, co-ordination and communication with functional responsibilities.
- To communicate to the Emergency Control Centre through which it can communicate among groups and organize joint activities
- To ensure that the response to the oil pollution emergencies is in line with entity procedures, and to coordinate business continuity or recovery plan from the incident

- Request for any specialist support to the CIC
- Give feedback on seeking assistance of mutual aid members and external agencies.

Also SIC through respective coordinators will be responsible for:

- Communication links between the units
- Distribution of messages within the units
- Taking Minutes during meetings to record decision
- Typing Services
- Updation of situation boards & Charts
- Providing catering to the units and also forward a copy of the same to CIC.

8.1.4.3 Reporting Requirements of Site Incident Controller

The site incident controller shall report to the CIC

8.1.5 Operational Team

Operations unction is responsible for the management of all activities that are undertaken to resolve the incident and the management of all resources deployed in the field. The operations are organized in to divisions on the basis of the geography or operations being conducted. Divisions are major areas of activities which can be broken down in to the type of activity or geographical area according to the type and demands of the incident. Operations as well as functions involved as given as **Table 8.1** below:

Table 8.1. Functions of the Operation Team

Sl.No:	**Operations**	**Functions**
Offshore		
1	Marine operations	Marine containment and recovery
2	Salvage	
3	OSD	Aerial dispersants, Marine dispersants
Onshore		
1	Shoreline operations	
2	Offshore & Onshore	
3	Aerial operations	Aerial surveillance
4	Wildlife response	
5	Waste management	

8.1.5.1 Official In charge for Operational Team

Manpower trained at Level I of IMO Training from Technical wing shall constitute operational team. There may be a team leader to command the operational team as the official Incharge or it can be under the command of SIC himself. The operational team will have ability to conduct marine as well as shoreline response operations. Marine response include offshore and coastal water operations whereas shoreline team will be positioned on the land area of the coastline. In the interface areas like creeks, salt pans etc, that they may work together. Number of members in each such team may be varied depending upon the incident.

8.1.5.2 Responsibilities

He is responsible for the provision of scientific and environmental information, maintenance of incident information services, and assist in the development of Strategic and Incident Action Plans. He shall ensure the distribution of all information to the operational team as well as take back details from them to Crisis Management Group and to all response personnel generally.

He is responsible to the CIC for all response operational activities. This includes ensuring that the requirements of Incident Action Plans (IAP) are passed on to operational personnel in the field, and for ensuring that the plans are implemented effectively and complied throughout the operation.

Responsibilities of Operational Team in general is described below:

- Obtain briefing from incident command
- Identifying level of priority
- Surveillance of Oil Spill, Monitoring of Water Quality
- Estimation of Quantity of Spill , possible trajectory identification
- Developing Tactics in support of Incident Action Plan (IAP)
- Response resources Allocation for each division or sector and assessment
- Deployment of response resources including flotilla
- Maintain a log of activities
- Review of Operations

8.1.5.3 Reporting Requirements

Operational Team is to report the SIC through its team leader if SIC himself is not in charge. In addition to the regular reporting special incidents, accidents and change overs are to be reported to CIC also. Incase of activation of Units from emergency control centre they will be also coming under the operational team with its own team leaders reporting to the Site Incident Controller even though they will be activated by ECC head the Chief Incident Controller

8.1.6. Emergency Response Units

Seven emergency response units are proposed for achieving effective managemnet of emeregency. There will different units having specific roles under the ECC dealing with administration, fire & safety, salvage monitoring and control, marine response activities, shoreline response, environmental and scientific aspects to act on emergencies as required. Response units are directly coming under the CIC through a coordinator. He will arranging the additional supports by of the CMG responsible for management of the ECC. Of which some sepcialised one will be activated only if the situation recommends. under the recommendation of site incident controller to the CIC.

Table 8.2. Responsibility allocation for Emergency Response Unit

Sl. No.	Emergency Response Unit	Status	Co-ordinator*
1	Shoreline Response Unit	Specialised	Dy. HOD, Civil Department
2	Marine Response Unit	Essential part of OT	Dy. HOD, Marine Department/ Chief Operational Manager #
3	Salvage, Control & Monitoring Unit	Specialised	Dy. HOD, Traffic Department
4	Environmental & Scientific Unit	Specialised	Dy. HOD, Medical Department
5	Fire & Safety Unit	Regular	Dy. HOD, Mechanical Department
6	Administration Unit	Regular	Dy. HOD, General Administration Department
7	Finance Unit	Regular	Dy. HOD, Finance & Accounts Department
8	Support Services – including –		
	Logistics	Regular	Dy. HOD, Vigilance Department
	HR, Media & Public Relations	Regular	Dy. HOD, General Administration Department

Note:

* In the case the organisation is lacking inhouse strength in any of these area, outsourcing can be done and in that case the team leader of the contract agency will be functioning under the respective co-ordinator.

Depending the location of Spill whether Kandla Zone or Vadinar Zone.

8.1.6.1. Administration Unit

Administration and Communication Coordinator is responsible for providing administerial support during the emergency.

Administration team is responsible for the general management of the unit and providing personnel for Communication links between the units, Distribution of messages within the units, keeping records of messages and expenditure, taking minutes during meetings to record decision; typing services, updating situation boards and charts; and providing catering to the units. He shall also ensure adequate liaison between the incident management team and the media. All queries received from the media should be directed to this person. Before releasing any information, there should be have the approval of either the relevant Coast Guard Commander or CIC, depending on the size of the spill.

8.1.6.2 Official In charge

Dy. HOD, General Administration Department will act as the coordinator.

8.1.6.3 Responsibilities

The key responsibilities shall include

- to coordinate with mutual aid members and other external agencies
- to direct them on arrival of external agencies to respective coordinators at desired locations
- to mobilize oil spill responders and resources for facilitating the response measures
- to monitor mobilization and demobilization of personnel and resources
- to provide administrative and logistics assistance to various teams
- to be responsible for all financial, legal, procurement, clerical, accounting and recording activities including the contracting of personnel, equipment and support resources detail out

8.1.6.4 Reporting Requirements

He is to report the CIC.

8.1.6.5 Fire & Safety Unit

The implementation of operational guidelines and oversight of work practices to ensure the safety of response personnel and the public is integral to any response operation. Monitoring of operations to ensure there are safe working conditions is required throughout the response.

8.1.6.5.1 Official In charge

Dy. HOD, Mechanical Department shall be acting as the Fire and Safety Coordinator.

8.1.6.5.2 Responsibilities

- Development & execution of emergency response plan
- Train all team members for fire response
- Overall responsible for fire prevention

- To ensure that everyone is evacuating and none is entering the restricted area during emergency
- Operation and maintenance fire detection, notification and suppression systems
- Providing first aid to the injured person and transportation of the patient
- Recommend the Site Incident Controller to impose as well as release fire emergency

8.1.6.5.3 Reporting Requirements

He will be reporting to the CIC.

8.1.7 Salvage Monitoring & Control Unit (SMCU)

Salvage operations undertaken by the SMCU shall include:

- Lightering- Transferring Cargo, Pumping, deploying fenders etc., towing after refloating in case of grounding
- Air Lift
- Tidal Lift & Heaving- beach gear
- Refloating of breaking out stranded vessels

8.1.7.1 Role of SMCU

The SMCU will be the agency to monitor and control salvage operations

8.1.7.2 Official In charge of SMCU

Dy. HOD, Traffic Department will act as the official in charge.

8.1.7.3 Reporting Requirements of SMCU

He will be reporting to the CIC.

8.1.8 Marine Response Unit (MRU)

To direct response action at sea/ coastal waters.

8.1.8.1 Role of MRU

Marine response operations include surveillance, monitoring, containment and recovery and temporary storage of recovered oil.

8.1.8.2 Official In charge of MRU

Dy. HOD, Marine Department/ Chief Operational Manager will act as the official in charge.

8.1.8.3. Reporting Requirements of MRU

He will be reporting to the CIC.

8.1.9 Shoreline Response Unit

To direct response action at shore. The shoreline surveys will be conducted by shoreline response unit forming the part of operations team. The results of shoreline surveys will need to be communicated to the crisis management group to plan priority areas for clean-up for the next operational period. It will help to identify and prioritize shorelines for clean up, confirming the shoreline ranking with the ground data based on over flights, aerial photography, remotely sensed data, ground truthing, existing maps and data.

8.1.9.1 Role of SRU

Shoreline assessment survey, Shoreline Cleaning, storage, disposal and transportation are the important duties of SRU

8.1.9.2 Official in charge

Dy. HOD, Civil Department will act as the official in charge.

8.1.9.3 Reporting Requirements of SRC

He will be reporting to the CIC.

8.1.10 Environmental and Scientific Unit

The principal aim of pollution response operations is to minimize impacts upon ecological and socio-economic resources. Effective planning here for requires up to date and co ordianted information about the resources within a given area. Resources map, sensitivity charts and risk level matrices for 10km radial distance of each port will provide guidelines for identification of resources at immediate risk. The environment unit identifies and priortises resources at risk, recommends acceptable method of clean up and the end point at which cleanup activities should cease.

8.1.10.1 Official in Charge

Dy. HOD, Medical Department shall act as the Environmental and Scientific Coordinator at present. The port may pre appoint Environmental Scientist as an In Charge to support the E & S co-ordinator.

8.1.10.2 Role of Environmental and Scientific Coordinator (ESC)

ESC is to provide the CIC with an up-to-date and balanced assessment of the likely environmental effects of an oil spill based on the nature and extent of spill tendency of drift and direction of drift. The Planning Section will advise on environmental priorities and preferred response options, taking into account the significance, sensitivity and possible recovery of the resources likely to be affected. In major incidents, the ESC may directly advise the relevant Coast Guard Commander.

8.1.10.3 Reporting Requirements of ESC

The Environmental and Scientific Coordinator shall report to the CIC.

8.1.11 Financial Services

Finance function monitors and maintains records about cost incurred in responding to the incident including the provision of accounting, time recording and costs analysis. The function is particularly relevant to the oil and has incidents due to the ability to recover costs under relevant compensation conventions. E.g., CLC Bunkers convention, fund etc. Finance may also be responsible for handling of claims for damages, loss of use or inconveniences.

8.1.11.1 Official in Charge

Dy. HOD, Finance & Accounts Department is the Financial Unit Coordinator

8.1.11.2 Role of Financial Unit Coordinator

Accounts: Accounts refer to arrangement for the payment of services, materials, etc procured during response operations. These payments may be arranged directly by individual organizations involved in the incident in which case accounts becomes more focused on record maintenance for the purposes of cost recover at a later date.

Insurance/ compensation: Insurance or compensation arraignments may be required to cover losses, damages or injury to response resources and personnel. Again these requirements may be covered by individual organsistion. There may be a need to create an office of function within the command structure to specifically address compensation arrangements.

Cost recovery:The polluter pays principle is fundamental to responding to ship sourced pollution incidents. The preparation of claims and in particular co ordination across agencies requires specific attention within the response organsiation. Consideration should be given to the early contact and exchange of information with insurers, IOP fund etc on anticipated costs.

8.1.11.3 Reporting Requirements

The financial coordinator shall report to the CIC.

8.1.12 Support Services

Human Resources & Logistics are the major support services.

8.1.12.1 Official in Charge

Dy. HOD, General Administration Department & Dy. HOD, Vigilance Department are the coordinators for the Human Resources & Logistics services respectively.

Human Resources:This section support the response operations with trained and skilled manpower by evaluating existing manpower, providing additional manpower as requirement arises.

Logistics: Logistic unction supports the operations function through the provision and maintenance of all resources and services. There are strong links between logistics and planning due to the implementation of strategies being depended upon the supply of resources

8.1.12.2 Responsibility

Support Services Coordinators shall ensure that all resources are made available as required. This include the procurement and provision of personnel, equipment and support services for operations in the field and for the management of resources staging areas.

8.1.12.3 Reporting Requirements

He will be reporting to the CIC.

In addition to this the following facilities will be established at the incident location which is important in the case of a large spill. SIC will be responsible for the operation of these facilities.

Incident Command Centre (ICC): The incident command centre is where the incident management team directs response activities in an emergency situation at site. Every incident will have an ICC which can take a number of forms, depending on the type and size of incident and may be a vehicle trailer, tend or offices.

Even in Tier -2 & Tier- 3 Situation - There should be only one ICC for an incident, no matter how many organizations are involved. If the various agencies and or jurisdictions are separated physically, it can be difficult to implement an effective system of management. Each organsiation should be therefore be represented in the ICC.

ICC should be equipped with communication systems. A joint information centre may be established to provide a central point of coordination for information and communications representatives from key organizations.

Important considerations while setting up an ICC are given below:

- Be positions away from the general Nosie and confusion associated with the incident
- Be positions outside the actual and potential hazard zone particularly for HNS incidents
- Have the ability to expand and adapt as the indent demands increases

- Have the ability to provide security for the control access to the ICC as necessary
- Be clearly identified
- Be sheltered from weather.

Staging Area: Staging areas are to be identified where prepared personnel and equipment are gathered prior to deployment. The staging area may include provision for the crew welfare and equipment maintenances.

- Staging areas should provide for
- A secure location for resources prior to deployment
- Greater accountability by having available personnel and resources together in one location
- Keeping track of resources
- Assisting in the check in of personnel arriving at the incident
- Facilitating the planning of resources deployment
- Mitigating traffic congestion

Further considerations in establishing staging areas are:

They should be close to the location of the tactical assignments. They should be close to a safe area. They should have separate entrance and exit routes. They should be large enough to accommodate the anticipated levels of resources flowing through. They should be located in an area where vehicles and personnel will cause minimal environmental damage.

Safe forward point: It is a safe location near the incident from which forward operations can be supported outside the immediately affected as of vapour plume.

Major response programs such as Containment, Recovery shall be followed by associated activities such as decontamination of equipment and temporary waste management whose responsibility will be covered by the incident management team. The SIC shall divide the responsibilities between different team such as operation, logistics etc depending on the situation. Decontamination facilities should be established to wash down both equipment and personnel in order to minimize secondary contamination. Ideally there would be associates with other waste management facilities; however, special requirements, such as bunding, etc., may require separate facilities to be established. Temporary waste management facilities should be established in the early stages of a response operation. Consideration should be given to the establishment of both temporary ad long term storage facilities as well as transportation and final disposal requirements. The positioning of the facilities should also take account of logistics i.e., ability to handle predicted amounts of waste, as well as public health and environmental considerations and transportation routes.

9

INITIAL PROCEDURES

9.1. Notification of Oil Spill to Concerned Authorities

9.1.1. Identification of Oil Spill

Master or other persons having charge of ships and persons having charge of ships will be many times the first person to identify the spill. Otherwise a representative of the Port authority will be identifying the spill during his routine surveillance or by chance. Sometimes any other organization or individual may report a spill.

Occasions of report:

- a discharge above permitted level or probable discharge of oil
- damage, failure or breakdown of a ship of 15m length
- a discharge during operation of the ship

The pollution shall be reported in a specified format which is usually referred as Marine Pollution Incident Report POLREP. In all these cases the spills within the port limit / premises are to be reported to the respective port authority. The report shall have the following information:

- Identity of ship/ facility
- Time, type and location of the incident
- Quantity and type of the substance involved
- Weather, sea state and tidal conditions in the area

The report of the incident recieved will be communicated to the emergency control centre by the CIC to the SIC as per the instructions of Crisis Management Group. Irrespective of the quantity of spill even a threat of marine pollution shall be immediately reported to Indian Coast Guard MRCC. Any way in local response of Tier 1 for the Coast Guard has no other role than to monitoring and guidance. After giving due consideration to the importance of the situation, the notification shall be sent to:

- District Disaster Management Authority (DDMA) of all coastal states
- State, District & Local Disaster (Oil Spill Crisis) Management Groups
- All port and terminal/facility operators in Gujarat, with call for attention to the regional ones
- Coast Guard (Regional HQ in Gandhi Nagar and nearby stations-Porbandar)
- Gujarat Pollution Control Board (GPCB)

9.2. Estimating Fate of Slick & Preliminary Estimate of Reponses Tier

Quantity of the spill can be assessed from the ship Master or designated person in case of a known source with which the Response Tier could be fixed. Otherwise visual judgment of experienced hands will help to determine it. OOSA of INCOIS can be effectively utilised for this.

9.2.1 Quantifying Floating Oil

Gauging the thickness and coverage of floating oil is a difficult task. Therefore an accurate assessment of the quantity of any oil observed at sea is virtually impossible. At best, the correct order of magnitude can be estimated by considering certain factors. The gravity-assisted spread of spilt oil is quite rapid and most liquid oils will soon reach an equilibrium thickness of about 0.1 mm characterised by a black or dark brown appearance. Similarly, the colouration of sheen roughly indicates its thickness. Approximate quantity of floating oil can be determined from relation between the appearance, thickness and volume of floating oil at sea as given in the **Table 9.1** below.

Table 9.1. Approximate Quantity of Floating Oil

Sl. No	Oil Type	Appearance	Approximate Thickness	Approximate Volume (m1/3/km1/2)
1	Oil Sheen	Silvery	0.0001 mm	0.1
2	Oil Sheen	Iridescent	0.0003 mm	0.3
3	Crude And Fuel Oil	Black/Dark brown	0.1 mm	100
4	Water-In-Oil Emulsions (Mousse)	Brown/Orange	>1 mm	>1000

Source: NOS-DCP

By estimating the percentage coverage of the oil type in question, the actual area covered relative to the total sea area affected can be calculated from timed over flights at constant speed. Aerial photography will sometimes allow the percentage of floating oil to be calculated more accurately and the use of a polaroid or other types of instant picture camera can therefore be valuable. “Response to Marine Oil Spills,” ITOPF ltd. 1987, Page 1.16 o illustrate further the process of estimating oil quantities the following example is given: “During aerial reconnaissance flown at a constant speed of

180 knots, crude oil ‘mousse’” and silver sheen were observed floating within a sea area, the length and width of which required respectively 75 seconds and 45 seconds to overfly. The percentage cover of ‘mousse’ patches within the contaminated sea area was estimated at 10% and the percentage cover of sheen at 90%”. From this information it can be calculated that the length of the contaminated area of sea measured is: 75 (seconds) x 180 (knots) = 3,75 nautical miles or 6.945 kilometres ie.,3600 (seconds in one hour). Similarly, the width is: 45 x 180 = 2.25 nautical miles or 4.167 kilometres The total area is 8.4375 square nautical miles which is approximately 29 square kilometres.

The volume of “mousse” can be calculated as 10% (percentage coverage) of 29 (square kilometres) x 1000 (approximate volume in m^3 per km^2 - from the **Table 9.1.** As 50 % of this mousse would be water, the volume of oil present would amount to approximately 1450 m^3. A similar calculation for the volume of sheen yields 90% of 29 x 0.1 which is equivalent to approximately 2.61 m^3 of oil. It can be seen from the example that the sheen, through may cover a relatively large area of sea surface, the volume of oil contained will be negligible. Therefore, it is crucial that the observer is able to distinguish between sheen, thicker oil, and emulsion.

9.2.2. Forecasting Slick Movement

It is important to be able to forecast the probable movement of a slick as well as likely changes in properties of the oil after it has been spilled. This helps in identifying sensitive resources in the path of the slick and to take appropriate response measures. The task of forecasting the position of an oil slick can only be accomplished if data on winds and currents are available since both contribute to the movement of floating oil. Other factors to be considered are waves and tides.

It has been found empirically that floating oil will move downwind at about 3% of the wind speed. In the presence of surface water current, an additional movement of the oil equivalent to the current strength will be imposed in any wind-driven motion. If the wind is negligible, which is rarely the case, the oil will move only under the influence of currents and tides. Surface currents dominate the movement of the slick unless the winds are extremely strong. Close to land, tidal currents must be taken into account, but farther out to sea their contribution is minimal since they are cyclic and tend to cancel out over time, although rarely ever completely. This gives rise to a residual current, which will determine the long-term movement of the slick.

9.3. Notifying Key Team Members and Authorities

DDMA will inform the key team members and authorities within and outside the organization after getting due consent of the District Collector.

9.4. Manning Control Room

Control room will be established at ECC with sufficient facilities for control and coordination.

9.5. Collecting Information

Information collected from the field shall be collected in the Field Logbook. This can be maintained as a descriptive notebook detailing site activities and observations so that an accurate, factual account of field procedures may be reconstructed. Logbook entries will be signed by the individuals making them. Entries should include, at a minimum, the following:

- Site name and reference number.
- Names of personnel on-site.
- Dates and times of all entries.
- Description of all site activities, including site entry and exit times.
- Noteworthy events and discussions.
- Weather conditions.

Site observations include oil type, sea/ wind forecast, surveillance, beach reports. Surveillance and sampling are the initial responses immediately started after the occurrence of a spill.

9.5.1 Identifying Resources Immediately at Risk for Informing Parties

Based on the already available data from the resources map and sensitivity maps resources immediately at risk and requiring protection based on priority is identified. Identification of the responsible party or source for an oil spill incident may require the laboratory analysis of oil samples. This is one part of the overall task of investigating the oil spills and suspected sources. Comparison of the spilled oil with its potential source samples can provide evidence of the source of the oil. It is possible to identify the difference between one oil and another and similarities between spilled oil and its source. Early detection of accident and emergency response is essential.

9.6. Surveillance

The aim of surveillance is to detect, characterize and preferably quantify spilled oil that may be present in a range of settings (on-water, in-water and onshore). This is of critical importance in enabling the incident command to effectively determine the scale and nature of the oil spill scenario, make decisions on where and how to respond, control various response operations and, over time, confirm whether or not the response is effective.

Irrespective of the final response strategy selected monitoring of oil spill will commence immediately after the oil spill and will continue until the response operation is terminated. The information gathered through monitoring and evaluation will be used by the Incident Management Team to steer the response, and ensure that the most effective and efficient response strategies are being adopted.

Five monitoring and evaluation methods are discussed in this section:

- Aerial Surveillance
- Vessel Surveillance
- Satellite Surveillance
- Surface Plume Tracking
- Spill Trajectory Modelling.

9.6.1. Aerial Surveillance

Aerial surveillance is the first response for any ongoing reportable incident as it allows the Incident Management Team to quickly gather initial information about the incident and formulate tactical plans to combat the spill. Aerial surveillance can be carried out throughout the incident management process to provide feedback to the command centre on daily progress and to help evaluate the success of the response strategies.

A written or verbal flight task is given to the aerial observer detailing the purpose of the mission, such as:

- Confirming the location of the spill using ladder or spiral search path
- Quantifying the amount of oil on the water and verifying the results from modelling
- Directing response operations such as directing vessels/aerial dispersant application planes onto the thickest part of the oil
- Conducting shoreline surveys to identify areas that may have been, or may be impacted.

Followed by the aerial surveillance and preliminary shoreline survey substantiated by notes, sketches, photographs and videos supported by GPS readings. In case considerable part of oil spill sunk due to environmental conditions, oil characteristics or both, under water survey may be required. The survey may be undertaken using visual assessment, divers, remotely operated vehicles, acoustic sensors or sorbents. Environmentally hazardous areas must be marked specifically based on the secondary data already available so that many accidents resulting in loss of life and property can be averted.

The accuracy of visual assessments can be compromised by the presence of naturally occurring substances similar in appearance, behaviour, or odour to petroleum hydrocarbons. These include mineral sands, rotting vegetation, peats, mud, lichens, marine stains or bacterial films. In the case of an unknown source sampling from suspected sources both offshore and land based installations such as mobile drilling rigs, fixed or moored production systems, pipelines, oil terminals etc.

9.6.2. Vessel Surveillance

Before the arrival of aircraft for aerial surveillance, vessels available on the scene can help to conduct initial visual surveillance by following the leading edge of the slick. This location information can then be communicated to the Incident Management Team to guide the aerial surveillance aircraft to the slick. This is only a temporary measure as the vessel's visibility range is restricted and there is a risk of secondary contamination of the vessel.

9.6.3. Satellite Surveillance

Surveillance of oil spill is also possible through satellites with sensors such as SAR (Synthetic Aperture RADAR – an active sensor that sends out a microwave pulse and reads the return) and Optical sensors – (Relies on reflected energy). RADAR imagery is the preferred option as the active pulse from space reacts with surface textures giving all-weather day/night imaging. This service may be engaged through Space Application Centre, Ahmedabad.

9.7 Sampling

Identification of the responsible source for an oil spill incident is essential because of its legal implication. Laboratory analysis of the oil samples is thus required following a spill incident. From that is possible to identify differences between one type of oil & the other and also to determine the similarities between spilled oil and its source. Source of the oil could be identified by the comparison of the spilled with the potential source samples. Sampling is as important as laboratory analysis and investigation.

Sampling of both biotic and abiotic resources from spill effected area is the first and foremost part of the oil spill testing. Resources can be water, oil, sediment, air or biota. Samples should be representative, since they are used to quantify the oil, predict its weathering characteristics and to identify the source.

Improper samples or sampling will lead to wrong results and conclusions that will not stand up in legal examination and subsequently laboratory analysis and investigations will become mere wastage. Personnels who are supposed to collect the samples should be given minimum training and practice to do better response in a real spill situation. A sampling plan shall be adopted that will be describe the sampling procedures in brief and will ensure that all the required operations are taking place accurately and sequentially without any missing.

Sampling of oil from different environment site, from vessel engine to water body or even from an organism will be required. Also they can be of varied forms mainly of heterogeneous nature some of which are given below.

- Oil, oily water, heavily emulsified oil, tar balls or lumps on the water surface
- Mixtures of oil, sorbents or other materials which are soaked with oil
- Oiled animals on the water surface or on beaches mainly in the intertidal area
- Oil in tanks on ships, offshore constructions or land facilities
- Oily water bilges and slop tanks on ships, offshore constructions or land facilities
- Oily sludge in the sludge tanks on ships, offshore oil installations/ drilling rigs or land facilities.

Sampling equipment shall be pre cleaned to remove any oil residues including finger oils that may mix with the oil collected and interfere with the laboratory analysis. Oil contaminated sampling containers should be avoided. Sampling equipment if not purchased pre cleaned shall be cleaned with a detergent wash, rinsed with distilled water and then rinsed with solvents like dichloromethane, hexanes etc. Pre cleaned supplies can be wrapped in aluminium foil to prevent contamination while being stored or transported to the spill.

Table 9.2. Details for Oil Spill Sampling

<table>
<tr><th>Sl. No</th><th>Sample Type</th><th>Sample Container</th><th colspan="2">Quantity of Sample</th></tr>
<tr><td rowspan="3">1</td><td rowspan="3">Oil</td><td rowspan="5">Glass Bottle 500ml Clean. Coloured (dark) glass is preferred for water samples.
Preferably supplied by laboratory.
Top should be sealed with aluminium foil under the cap.</td><td>Pure Oil Source Sample</td><td>30-50 ml</td></tr>
<tr><td>Contaminated Oil (Emulsified Oil, oil from the sea or shore, sandy tar ball)</td><td>10-20g</td></tr>
<tr><td>Debris with oil, oil stained sand</td><td>Sufficient quantity that oil content is approx.10g</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Water</td><td>Water sample with visible oil</td><td>1 litre</td></tr>
<tr><td>Water sample with no visible oil</td><td>3-5 litre</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Sediment</td><td>Fine: Silt - Pebble</td><td colspan="2">Glass Jar 250ml Clean. Coloured (dark) glass is preferred for water containing samples.
Preferably supplied by laboratory.
Top should be sealed with aluminium foil under the cap.</td></tr>
<tr><td>Coarse: Cobble</td><td colspan="2">Wrapped in aluminium foil Once wrapped they can be stored in plastic bags.</td></tr>
</table>

Sl. No	Sample Type	Sample Container	Quantity of Sample	
4	Biota	Glass Jar Same as Glass Bottle/ Jar	Oiled Feather	5-10 feathers depending on the quantity of oil present
		Wrapped in aluminium foil Whole specimens. Once wrapped they can be stored in plastic bags.	Fish, shellfish (flesh and organs)	Multiple individuals of the same species totaling 30g

Source: ITOPF

A sampling kit may be arranged for this with necessary sampling equipments as described in the **Table 9.3** given below.

Table 9.3. Components of the Sampling Kit

Sl. No	Item	Details
1	Sample jars (250 ml or other size)	Pre cleaned, teflon or aluminium cap or alfoil barrier as required. Plastic should not be used
2	Slick/pooled oil sampling equipment	Wooden spatulas/tongue depressors or stainless steel spatulas/spoons.
3	Sheen sampling equipment	TFE fluorocarbon polymer nets or small squares of sorbent. Polymer nets or bags with rings and extension poles, TFE polymer sheets of mesh fabric can also be used.
4	Disposable gloves	100% nitrile medical examination gloves
5	Sorbent padding for storage cooler.	
6	Sample storage coolers with pre-frozen freezer blocks.	
7	Waterproof plastic envelope.	
8	Sample identification labels	>1/sample. White Adhesive 5cm to 10cm water and oil resistant
9	Sample Log Sheets.	
10	Chain of Custody Forms.	
11	Decontamination equipment if needed,	
12	Cardboards Shipping Tubes, & Fibre board boxes	(25cmx25cmx25cm), For packing sample jars for shipment
	Sorbent material	
	Grease proof plastic bags 50cmx 65cm	
13	Tape for sealing jars, shipment tubes and fiberboard box 2 to 10cm wide	
14	Towels absorbent cloth or paper, twine	
15	Tongue depressors or pre-cleaned metal scoop	To aid collecting samples of heavy oil or tar balls

Sl. No	Item	Details
16	Sediment Sampler	
17	Onsite Probes	Eg. DO, Turbidity, Conductivity, Odour, Ambient Hydrocarbon Detector, Mutli Wavelength Fluorimeter etc.
18	Kit/ Pouch to hold all sampling equipment to spill location	

Source:IMO

9.8 Sample Identification and Security

Sampling identification, labelling and security is very important part of oil spill sampling, especially when it has a forensic value. The sample jar is to be sealed using tape to seal the lid to the jar, before placing the labels on the jar. While placing the labels on the jar, two labels should be kept one for the purpose of sample identification and the other for chain of custody. Writings on the jar should be legible and written using indelible ink. A sample identification label has been shown in **Figure 9.3** below.

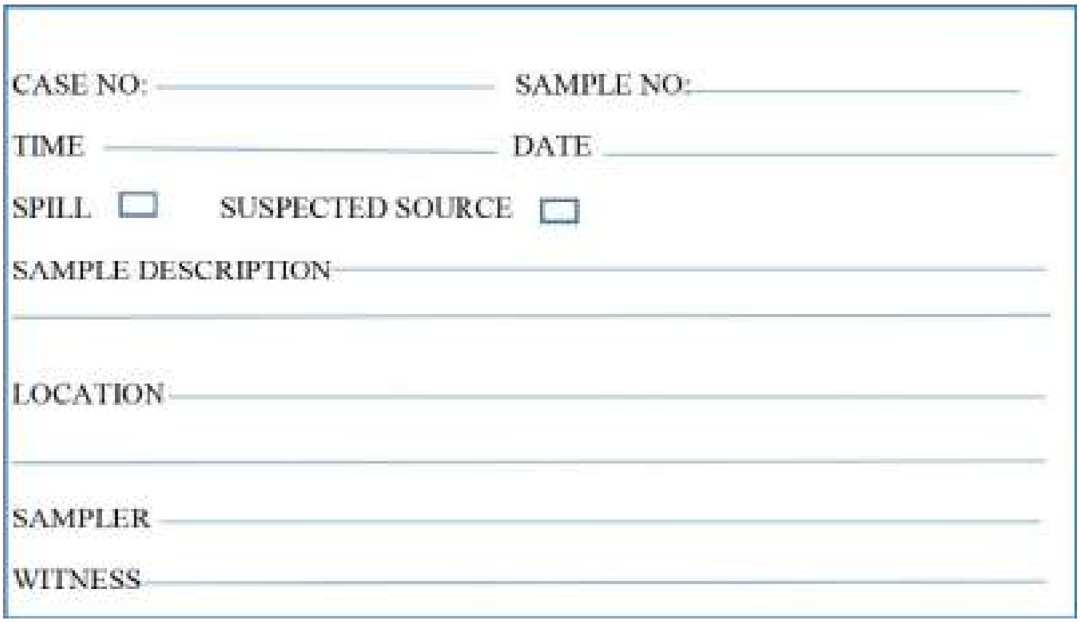

CASE NO: SAMPLE NO:
TIME DATE
SPILL SUSPECTED SOURCE
SAMPLE DESCRIPTION
LOCATION
SAMPLER
WITNESS

Figure 9.1. Sample Identification Label

9.8.1 Labelling and Sealing

All necessary information required for identification of the sample shall be there on the label such as geographic location, signature on suspected source sample from master or crew man, dates sealed and who sealed sample, etc., should be a part of the label.

Case number is a unique number assigned by investigator to help keep track of spills over time. Sample number stands for serial number given for each sample 1, 2, 3 etc. Sample description used to distinguish one sample from another sample. For water samples the description should have information relating the sample to a fixed point like name of creek, distance form a bridge pier or any other identifiable structure. For sample from suspected vessels the description should have the name of the vessel and specific location of the sample such as engine oil bilge. Samples taken from a shore facility should include the name of the facility including a city, location of the sample on the facility (IMO).

9.8.2 Sample Log

For each sampling operation a sample log should be prepared and transferred along with along with sampling jars and kept in safe custody. It should contain all the available details regarding the sample including the necessary things given below.

- Sample number or code (Optional, but advisable for multiple sampling at a single location).
- Sample description (oil, debris, thick slick, film, sediment, air and biota etc).
- Time and Date (24 hr clock, Day/Month/Year).
- Location (GPS coordinates or other description).
- Name of person taking the sample.
- Witness (If a sample for legal purposes).
- Identification and description of samples and locations.
- Subcontractor information and names of on-site personnel.
- Dates and times of sample collections and chain-of-custody information.
- Records of photographs.
- Site sketches of sample location including identification of nearest roads and surrounding developments.
- Calibration results.

Additional notes may be added as and when required as follows as:

Sediment type (sand, mud, pebble), colour& texture, biological (shellfish, marine worms, sea grass, algae), visible oil, length of core, Sample leakage or loss during collection, sample disturbance.

9.8.3 Chain of Custody (CoC)

After sampling it is important that a samples are to be kept in a person's custody or possession so that either he can see them or they are locked up. The sample description here should be exactly same as that of sample label. All persons who have control of the samples need to sign in the signature part of the CoC as well as the chain of custody label on the sample. CoC document should be sent with the samples to the laboratory. Format for chain of custody is attached as **Table 9.4**.

Table 9.4. Format for Chain of Custody

Chain of Custody Record					
Organization's name					
Address:					
Spill	Source	Sample no	Description of samples for case no:		
Person Assuming Responsibility for Samples			Time/ Date		
Sample number	Relinquished by:	Time/ date	Received by	Time/ date	Reason for change of custody
Sample number	Relinquished by:	Time/ date	Received by	Time/ date	Reason for change of custody
Sample number	Relinquished by:	Time/ date	Received by	Time/ date	Reason for change of custody
Page of _					

9.9 Handling the samples

Samples must be handled, stored and transported with care so that they remain uncontaminated, intact and fit for purpose. Handling procedures should also be documented such that sample integrity can be demonstrated. Containers should be filled as full as possible to exclude air and avoid evaporative losses of light hydrocarbons. All samples should be labelled immediately. Labels should not be placed inside the sample container. Labels should be applied to containers after the sample has been sealed. This will allow the container's exterior to be cleaned and dried before the label is attached. While sampling care should be taken that there is no contamination from exhausts of engines or cooling water of sampling vehicles.

9.10 Storing the samples

Samples should be held overnight or for any extended time in a secure room, within a suitable container ie. a refrigerator. A sample room may be established and a sample room controller may be appointed and log may also be kept for the room. Samples should have a Chain of Custody record attached to track the location and handling of samples. Samples are stored in a cool dark room. Weathering may be accelerated in the presence of heat and sunlight. The samples may be placed in an insulated pouch or Styrofoam cooler. A closed vehicle is no desirable especially in summer even when a cooler is used. Hence it is better to avoid such journeys or for the optimum condition i.e., keep the samples in an explosion proof refrigerator at 2 to 7 °C. Samples should not be freezed and hence the temperature should be maintained above -4°celcius. The preservation methods are given **Table 9.5** below.

Table 9.5. Preservation Methods for Different Types of Samples

Sl.No	Sample Type	Preservation Method
1	Sediment	Chilled to < 4 °C- but not frozen
2	Oil	Chilled to < 4 °C- but not frozen
3	Soft Marine Fauna/Fish	10 % formalin in sea water Or freshwater if sample is from fresh water
4	Crustaceans/ Fish	Freezing (for large fish and crustaceans)

All areas where samples are handled or stored must be decontaminated before and after use, designated to be NO smoking areas, isolated from combustion engines, exhausts or other sources of hydrocarbon contamination. Samples will be transferred to the sample intake team to be frozen as soon as possible especially for sediment and tissue chemistry samples. Water samples will be analyzed immediately due to holding time limitations, while sediment and tissue samples collected for VOC and PAH analyses will be archived. Sediment samples collected for nutrient analyses will be analyzed within the 28-day holding time. (*MC 252 Oil Spill – Jean Lafitte National Historic Park and Preserve Submerged Aquatic Vegetation NRDA*)

9.11 Shipping of Samples

The guidelines for this are laid down by International Air Transport Association (IATA). This ensure safe, intact arrival of samples and prevent damage to other parcels. Packaging and Shipping of them is regulated under IATA's Dangerous Goods Regulations. Most of the samples belongs to the following to categories Flammable Liquid, packaging group II consists of oils with flash points less than 23°C eg. gasoline, naptha and most of the crude oil. Flammable Liquid, packaging group III with flash points more than 23°C but less than 60.5 °C eg. Kerosene, jet fuels, turbine fuels, No.1 fuel oils etc.

10

OPERATIONS PLANNING

10.1. Assembling full Response Team

The chief incident controller is ultimately responsible for assembling the response team. First of all he shall assess the incident, by consider the problems in detail, identifying the severity and possible development of the situation and response resources. Once the operations are started he will assume the command, appoint Site Incident Controller the delegate the power of incident command to the site incident controller. The incident command centre shall be established under the direct control of emergency response centre which is already established at each ports.

Further operational team will be constituted with staff appointed to the operational team according to the size and complexity of the incident. He will anticipate management requirements and make appointments as early as possible. Specific Incident Action Plan (IAP) shall be developed by the site incident controller and get it approved by the command. Its objectives, strategies and tactics should reflect the policy and aims of the response.

10.2. Identifying Immediate Response Priorities

Combinations of response options are needed even for small spills since all the response option are not equally feasible at all places as well as in all situations. Especially when the pollution status changes with time.

The possible response options are:

- No action other than monitoring and evaluating the oil
- Containment and recovery of the oil at sea
- Chemical dispersion of oil at sea
- Burning the floating oil at sea
- Shoreline Clean-up

Immediate response priority may be exercised depending of the quantity of oil spilt and location of spill proximity of resources and their sensitivity.

10.3. Mobilizing Immediate Response

After estimating the quantity of spill, analysing the sea and wind state and determining the constraints of operation, immediate response resources including the equipment's and personnel shall be mobilized. Since Tier 1 response facilities are already available at each port, generally no resources need not be channelized from other operators including those within the organisation unless there is an intensive response operation planned that is to be completed in a very short span or there is a breakdown of the equipment.

10.4. Media Briefing

The Chief Incident Controller or in his absence the Incident Command the SIC shall take the task of making statements to the media on behalf of the KPT after getting the consent of the Crisis Management Group. All the statements shall be made consistent with the overall aims of the effort. As need arises a public information officer may be appointed or a joint information centre may be established.

10.5. Planning Medium Term Operations

Regular meetings shall be conducted with the incident management team should focus on the critical success factors for the incident and asses the effectiveness. It will help to revise the plans and better respond to similar situations. The flow diagrams showing the operation planning for response is given as **Figures 10.1.**

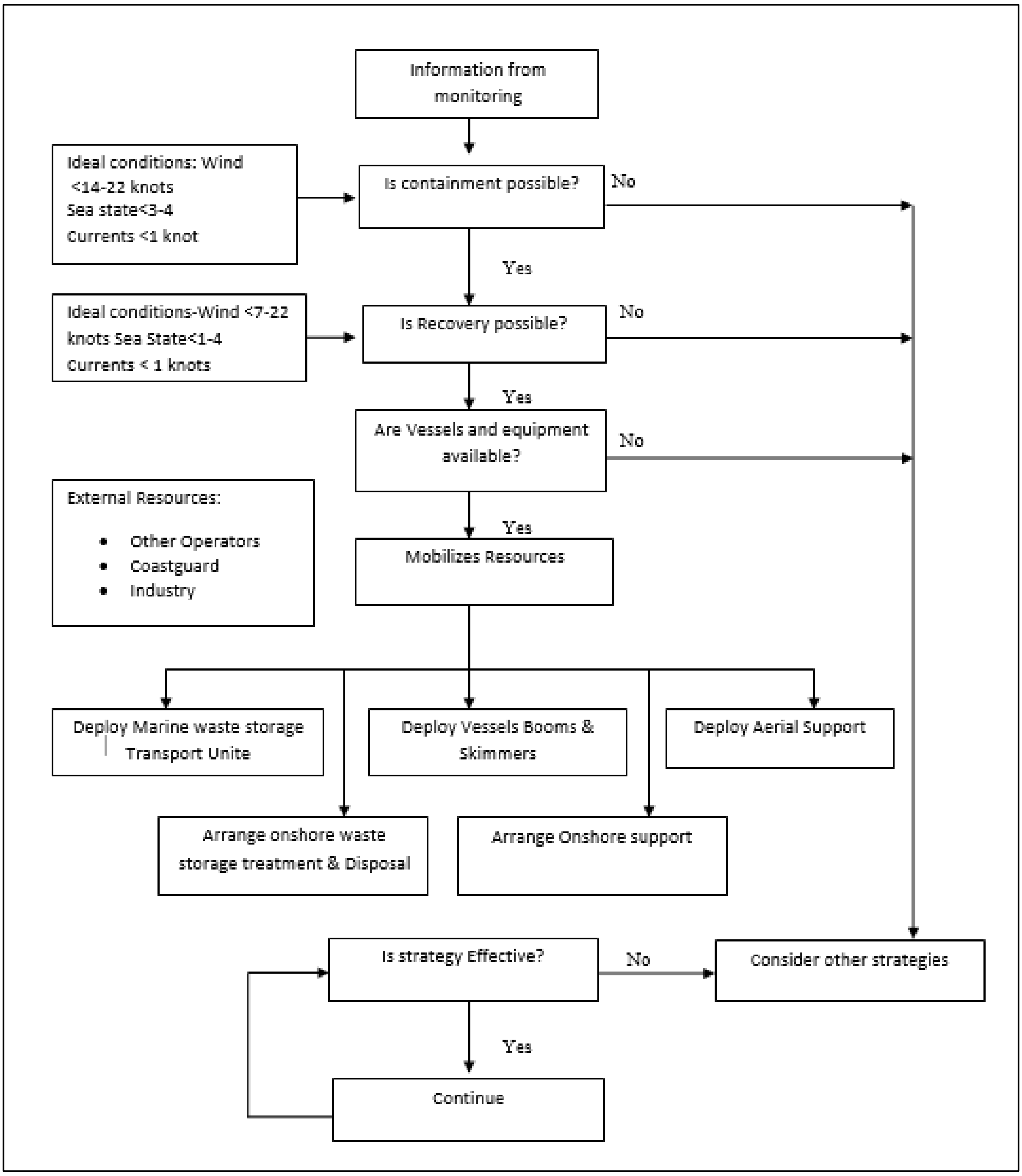


Figure 10.1. Oil Spill Response Planning Chart

(Source:http://www.au.pttep.com/wp-content/uploads/2013/10/PTTEP-Oil-Spill-Contingency-Plan.pdf)

In case of threat perception, the response decision is to be arrived at after prioritising the threat perception and areas where the threat perception is likely to cause maximum damage. Certain 'sacrificial areas 'may have to be considered for the overall response to the threat perception. The general strategy would be ordered for containment and recovery using existing techniques, which may involve mechanical recovery equipment or use of chemical dispersants. Dispersion decision tree is given as **Figure 10.2**.

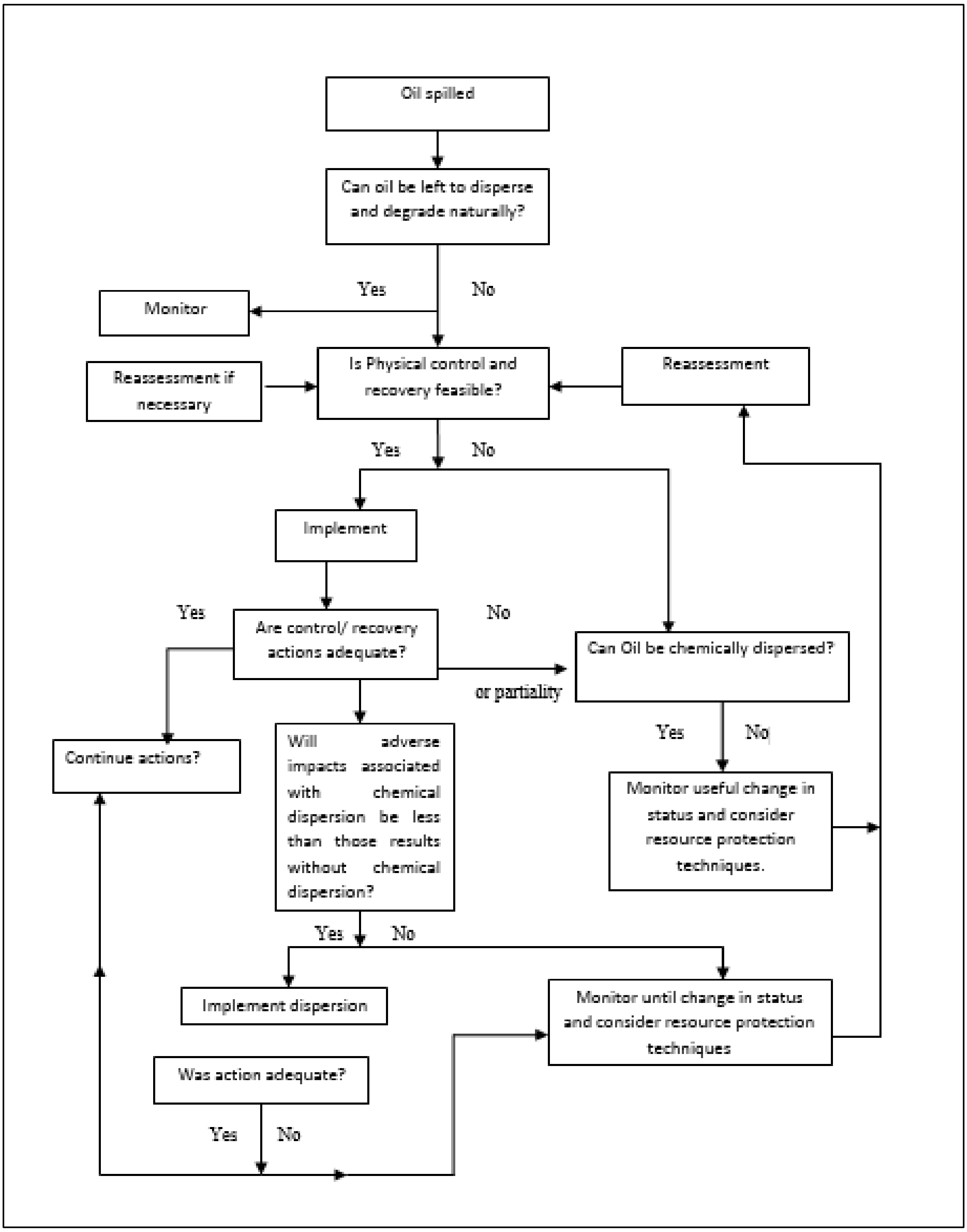


Figure 10.2. Dispersant Decision Tree

11

CONTROL OF OPERATIONS

11.1. Establishing a management team with experts an advisors

A management team may be constituted with members of the KPT as well as from industry, government and non-government organization with an advisory role to implement following points:

- Ensuring expertise in all fields
- Unbiased review of the situation
- Independent decision making
- Wide confidence and approval

During a spill, the situation will be appraised by the Environmental & Scientific Team will be reported to the Crisis Management team who will pool the expertise as required and request for the ensuring their dedicated availability on-scene. Often experts are required in the areas of Spill Response, Wildlife, Marine Environment especially when the organization is not having any previous experience in oil spill response operations.

Specialist technical advisors may be required to address specific aspects of the incident such as public health and safety, hazardous materials and cultural issues specific to the situation. There specialists may be added to the planning function, though could also be linked directly to the command function if required.

11.2 Organisation of Operation

Staging areas have been selected to accommodate various modes of transportation including overland, air and water. Each location has the means to move equipment and materials quickly and efficiently. These locations have been selected so that they are strategic to coastal terminals and main shipping routes where there is the highest risk of spills.

11.3 Updating Information

Sea weather shall be regularly monitored. Weather forecasts shall be availed from the local and regional meteorological department. Aerial surveillance shall be done as and when required.

11.4 Reviewing and Planning Operations

Studies made of the oil spill risk as well as response measures be done for the area shall be review, especially for determining the possible oil spill trajectories. Available meteorological and hydrographic data should be analyzed to give rough but early predictions of the spill movement. More sophisticated prediction methods may be subsequently used based on the situation. Visual observation of any spill is essential to plan every oil spill response operation.

11.5 Obtaining Additional Equipments, Supplies and Manpower

The equipments and facilities for combating Tier 1 spill is already available at each KPT. Additional response is beyond the scope of the local contingency plan for each port. But MoUs shall be signed between the neighbouring operators to pool the resources for better response during a Tier 1 spill. The spills beyond Tier1 is the responsibility of Coast Guard. The Coast Guard would take over the operation if the spill were beyond the capability of the facility concerned and also when the spill is beyond the port limit ever for a smaller spill.

The Regional Contingency Plan for South Asia sponsored by the United Nations Environment Programme (UNEP) under the UN Regional Seas Programme has been finalised. The participating countries are India, Sri Lanka, Maldives, Bangladesh and Pakistan. The Plan envisages mutual cross border assistance and movement of equipment and personnel for response to an oil spill (Country Profiles, A summary of Oil Response Arrangements & Resources Worldwide, ITOPF).

11.6 Preparing Daily Incident Log and Reports

Daily reports shall be made in the form of incident logs, minutes of meeting, notes on briefing etc. They shall be circulated between respective groups and their officials for different purposes such as informing, evaluation, recommending, approving, documentation, record keeping and circulation.

11.7. Preparing Releases for Public and Press Conferences

Effective public relations are an integral part of any oil spill clean-up operation. In the event of spillage, Chief incident controller will make coordinated arrangements for an experienced public relations officer to disseminate pertinent information to the public and the media to ensure that those who need to know have a full and timely appreciation of the incident and of the actions taken and progress made during the response.

It is essential that the media team:

- Identifies the agencies that are responsible for handling various aspects of the situation;
- Ensures that media activity does not interfere with the operational activity of the emergency services and
- Ensures that the media do not harass human casualties

A sample initial press release shall include the following details:

- An oil spill has occurred at (location) from (responsible party, if known).
- It was discovered at (time and date).
- The following areas have been affected: (fill in)
- Cause of the spill is being investigated by (fill in) and clean-up operations are underway by (fill in).
- The amount of product spilled is (amount) (or is not known, or is being calculated by the (fill in).
- Brief statement of operations being undertaken and by whom:
- The spilled material is/is not considered to be a health hazard.
- The following precautions should be taken by members of the public in the (fill in area(s)).
- Further updates will be given at (time, date).

11.8. Briefing Local and Government Officials

Briefings shall be done with the local in matter related to health and safety, environmental issues, oil pollution impacts and mitigation. This help them to evacuate from the affected area until everything is cleared.

Regular meetings shall be held with government official to plan the response strategies especially the operation requiring evacuation of locals, selection of disposal options, monitoring of water resources, selection of pre-booming locations etc.

12

TERMINATION OF OPERATIONS

12.1. Marine Oil Spill Response Termination

Marine response operations are terminated under the following circumstances:

- Entire oil spill has been removed
- Surface oil slick has broken up and there is negligible chance to impact a shoreline
- Slick has gone out to sea and is beyond the range of response options and is highly likely to degrade naturally
- Oil has already impacted shorelines and is unlikely to be re-floated.

For the last case, marine response resources will remain on standby until shoreline response has been terminated.

12.2. Shoreline Spill Response Termination

Shoreline clean-up operations may be terminated only in consultation with instruction from the respective government authorities under the following circumstances:

- All accessible shorelines are free of oil
- Clean up is having no further net beneficial effect or having a deleterious effects on the shoreline or associated plants or animals
- Remaining oil is judged to be acceptable or of little or no adverse effect.

The shoreline inspection team will determine when each shoreline segment has been cleaned to a reasonable degree, based on minimizing risk of impact to the environment and preventing human contact with the spilled oil. Guidelines provide criteria for assessing marine/shoreline status before the declaration of termination of operation is given as **Table 12.1.**

Table 12.1. Criteria for declaration of Termination of Operation

Sl. No:	Type of Environment	Decision Criteria
1	Water surface	No recoverable floating oil should remain on the water surface.
2	Sand beaches	The shoreline should be free of liquid oil. Tarballs, tar patties, oiled stranded vegetation and oiled debris that could contaminate wildlife should be removed to the extent removal using reasonable clean-up techniques is feasible. Oil stain on sand that does not produce rainbow sheen may be allowed to weather and degrade naturally
3	Marshes	Marsh vegetation should be free of oil that could contact and contaminate wildlife. Oil that is not likely to affect wildlife may be allowed to weather and degrade naturally.
4	Riprap, seawalls and other manmade structure:	Oiled riprap and seawalls should be free of bulk oil except for oil stain (defined as a thin layer that cannot be scraped off using a fingernail), which may be allowed to weather and degrade naturally.

(Source: Oil Spill Response Plan, Shell, 2011)

12.3. Declaration of Termination

Chief incident controller will be announcing the termination on consultation with the Crisis Management Group after receiving the report from the Site incident controller. The following checks are to be done before announcing the Termination:

- All personnel are accounted for
- All equipment is recovered and cleaned
- All vessels return to their respective berths
- All equipment is cleaned / repaired
- All external equipment is returned to the correct owner/location

12.4. Decontamination and Demobilization

12.4.1. Decontamination Plan

This serves to identify general procedures to be followed by vessels involved with oil spill response operations. As these operations involve transiting through slicks, operating within oiled waters or recovery operations, the vessel hulls, decks, machinery, tanks, piping, deck gear and other areas will be impacted with oil. This plan will be used for all vessels and support equipment, either contaminated or suspected of being contaminated with oil, to return to a non-oiled state.

In view of the extensive equipment inventory involved in the response effort, the responsible party will

- Over see gross decontamination of vessels;

- Establish and oversee temporary berthing of oiled vessels; and
- Over see final decontamination of oil spill recovery vessels and equipment.

The primary focus of this operation will be to expedite clean-up of oiled vessels and response equipment in a safe, organized and efficient manner while minimizing further damage to the environment and waste generation. Equipment decontamination is planned to occur in two phases. Recovered oil is to be off-loaded from skimmers cargo tanks to portable storage tanks and or vacuum trucks pending disposal as per the "Approved" Disposal Plan. Equipment to be transferred into a bermed area and decontaminated. All equipment will undergo full decontamination prior to demobilization.

12.4.2. Methodology

The affected area will be placed inside standard containment boom during the decontamination process. If weather conditions permit, smaller vessels will be used as platforms to facilitate clean-up operations. For Tug/Vessel the hull of the vessel will be wiped by hand with cotton rags. A citrus-based cleaning solution will be used to remove residue oil from the hull. All oil will be wiped from the hull in this manner.

Personnel involved in this operation shall wear modified PPE Level D including raingear, gloves, eye protection and floatation work vest. Preplanning for protection of adjacent areas shall be accomplished in order to minimize cross contamination. Floating oil from sheen-emanating vessels will be minimized with sorbents as necessary to reduce potential loss outside the containment boom. Floating sorbent materials shall be utilized in natural collection points as needed to retain free-floating oil. These sorbents will be tended daily.

12.4.3. Equipment priority

A priority assessment shall be attached to each piece of equipment to ensure a timely flow of equipment through the cleaning process. The Decontamination team leader will work with the appropriate OSR representative to prioritize the vessels to be cleaned.

12.4.4. Cleaning process

A Hypalon liner or like (secondary containment) will be placed under each decontamination pool with the perimeter sufficiently bermed to allow for wastewater and rainwater evacuation. All wastewater will be pumped to a poly portable storage tank vacuum truck for disposal. All pumps, hoses and piping will be left in place to facilitate speedy evacuation of retained oil / water. The final disposal of wash water, oiled sorbents and materials will be accomplished in accordance with the "approved" Disposal

Plan. A citrus-based cleaning solution (PES 51 or like) will be utilized as a degreaser and will be applied by a Hudson sprayer as applicable. By utilizing the PES 51 product, which will not emulsify the oily water, it is possible to recycle/reclaim the rinsates. Because this cleaning solution is citrus based it does not leave a petroleum sheen on the equipment after the cleaning process. Actual pressure washing, if required, will utilize a Landa (or like) hot/cold pressure washer with a temperature range up to 220° F and a pressure rating up to 3000 psi. Every attempt will be exercised to mitigate noise-generating equipment by placing it in insulated areas. Once the piece has been determined clean to the owner's standard, the equipment will be demobilized.

12.5 Preparing formal detailed report

Once the response stand down has been announced, GMB and other stake holders will conduct a formal joint incident investigation considering the following aspects:

- Cause of the incident and other contributing factors
- Mitigating actions taken
- Effectiveness of the response
- Preventive actions required in future

The formal incident investigation will be followed by the preparation of a formal detailed report. It will form the basis for a review of the Crisis Management Group and notes will be circulated with other members of the response organization.

12.6 Reviewing plans and procedures

Feedback will be collected from various levels of the organisation from each stakeholders. The opinions will be finalised in review meetings. Recommendations after the review shall include improvements to the contingency plan, incident actions plans and operating procedures. Independent reviews shall be also to be done with the help of an independent agency which will be helpful in getting correct insight of the cause and impact of spills as well as the response measures taken.These reviews will be especially helpful in developing fine-tuned the communication, demobilization, decontamination and disposal plans and incorporating them in the Area Plan. A review of the spill is the only way to establish the shoreline assessment control points and clean-ups in a region and endpoint documents. From incident assessment it is possible to pre-identify suitable command post locations, tracking of the spill response work can be efficiently assigned and tracked, to ensure the public involvement to save their best interest as well as channelize stakeholder inputs so that the concerned personnel can influence the process.

13

MUTUAL AID

Other ports of the region, terminals, SPMs and other oil handling facility are the important stakeholders for mutual aid. They are supposed to assist the KPT on executing MoU during a spill greater than Tier-1. Also it may be noted that a spill eventhough happening within Tier-1 limit of 700T, its occurrence in a sensitive area can be make it escalated to higher Tiers.

13.1. Oil Spill Response Resources Inventory (OSRRI)

13.1.1. OSRRI available at KPT

Presently KPT is having OSR equipments corresponding to the Risk Category-A ports for combating Tier-1 spill, as per the existing Oil Spill Contingency Plan. The latest annual return submitted to ICG in this regard is given as **Table 13.1** below.

Table 13.1. Annual Return on Preparedness for Oil Spill Response under KPT

Name Of Port/Oil Handling Agency	**Kandla Port Trust, Kandla & Vadinar**			
Containment Equipment	**Description**	**Length**	**Quantity (No.)**	**Operational Status**
	1.Pressure inflatable Boom	200 Mtrs	6	Working
	2.Boom Reels	200 Mtrs	6	Working
	3. Permanent Boom	1000 mtrs	1	Working
	4. Diesel Hydraulic Power Unit		2	Working
	5. Pollution Response Centre		1	Working
	6. Signal Station for communi.		1	Working
	7 Anti-Pollution Craft		1	Working
	8 Oil Absorbent Boom(IOCL)	3'X8" Dia	130	Working
	9 Inflatable Boom(Essar)	450Mtrs	1	Working
	10. Light duty Oil Contain. Book	600 Mtrs	1	Working
	(Coastal Room)(IOCL)			
Recovery Equipment	Description	Capacity	Quantity (No.)	Oerational Status
	Fast flow skimmer	40-49 m3/h	2	Working

	(Inclined plane)	-		
	Brush Skimmer	12 cub.m/hr	1	Working
	Disc Skimmer(IOCL)	20 cub.m/hr	1	Working
	Disc oil Absorbent Pillow(IOCL)	12'X8' size	80	
	Disc Slimmer (Essar)	20 cub.m/hr	1	Working
Temporary Storage Facility	Description	Capacity	Quantity (No.)	Operational Status
	Storage Tank	$10M^3$	5	Working
	Storage Tank	250KL	One	Working
	Portable Tank	4000 Lit.	One	Working
	Floating Tank (IOCL)	25 CUM	2	Working
	Floating Tank (IOCL)	12.5 CUM	4	Working
	Floating Tank (Essar)	5 T	2	Working
	Storage Tank (Essar)	25 T	2	Working
Osd Spraying System	Description		Quantity (No.)	Operational Status
	OSD Spraying booms fitted on tugs- Spray system-1		3 Tugs, for Kandla MT Mehul, MT Kalinga, MT Heera tank for storage on board 4000 Lit. each tug. 3 Tugs, for Vadinar MT Cheeta, 35TBP MT Gajaraj 35 TBP & MT Ashawani 59 TBP Plus 5 Hired Tugs.(3 at Vadinar & 2 at Kandla).	Working
	OSD Booms - 5 mtr long-2			
	Pump unit 70 Ipm-2			
	Off-loading pump-1(10C)			
	Oil Transfer pump-30 cub. m/hr-2 (Essar)			
	Dispersasnt Spray System-2 (IOCL)			
	Dispersasnt Spray System-1(Essar)			
Oil Spill Dispersant	Make		Quantity (1(9.)	Expiry Date Mfg-(3/2015) Life 5
	NIO & CG approved(Nova Chemicals)dispersant-II & II		5000 Ktrs	
	NIO approved dispersant- Ill (IOCL)		3300 Ltrs	
	NIO &ICG approved dispersant (Essar)		25000 Itrs	
	OSD			
Shortline Response Equipment	Description	Capacity	Quantity	Operational Status
	Permanent Storage Tank	5000	1	Working

IMO OPCR Level Trained Responders	Name	Designation	Contact No.	Imo Oprc Level 1/2
	M.N. Kakani	Safety Inspector	02836-	2
	S.J. Makwana	Safety Inspector	02836-270427	2
	M S Bather	Safety Inspector	02836-	2
	D.S. Pandey	Dy FcSO	02836-270176	1
	G.C.Sharma	Station officer	02836-	1
	6.R.R.Dubey	Station officer	02836-	1
	7. D.S.Gurjar	Station officer	02836-	1
	8.K.G.Khalsa	Station officer	02836-	1
	9 M.K.Maheshwan	Station officer	02836-270176	1
	10.D.R.Solanki	Station officer	02836-	1
	11.A.J.Chaudhari	Station officer	02836-	1
	12.G.Nethaji	Station officer	02836-	2
	13. M.R.Vadaviya	POCD	02836-	
Oil Spill Response Craft	Craft Name	Discription	Response Capability	
	MT Karishma	Oil recovery cum debri collection	Please provide particulars at Sections 2-6	
	Tug Heera			
	Tug Mehul			
OSRL Particulars (If Outsourced)	Operator Name		Na	
	Address		Na	
	Phone No.		Na	
	Fax No.		Na	
	E-Mail		Na	
	Engagement Expiry Date		Na	
	Equipment On Hire		Please Provide Particulars At Sections 2-7	
	Imo Oprc Level Trained		Please Provide Particulars At Sections 8	
	Personnel On Hire			
	Manpower On Call			
	Craft On Hire		Please Provide Particulars At Section 9	
	Year Published	Date Of Last Revision	Status Of Approval By Coast Guard	

Spill Contingency Plan	2011	2014-Revision Under Process	Observations Raise By Coast Guard Are Under Compliance		
Personnel To *Be* Contacted C-¯Ase Of Spill	Name	Designation	Contact Particulars		
	Capt. T.Sreenivas For Kandla	Deputy Conservator	Landline	02836-233585	
			Mobile	9825232982	
			Fax	02836-233585	
			E-Mail	dckpt@kpt.gov.in	
	Dr. G.S.Rao For Vadinar	COM	Landline	02833-256749	
			Mobile	9825212360	
			Fax	02833-256543	
			E-Mail	drgsrao001@yahoo.com	
MoU Details (If Any)	MoU has been made between KPT & Oil Companies for r procurement of Tier-1 facilities for Oil Spill Combat equipments.				

Source: KPT

13.1.2. OSRRI available at ports and allied facilities of the region

Oil spill response capabilities existing as well as proposed at the ports and marine terminals as well as ICG stations in and around Gulf of Kachchh (GoK), in rest of Gujarat and West Coast is given as **Tables13.1 to 13.4** below.

Table 13.2. Details of Oil Pollution Response Capability at Mundra Port, GoK

Sl. No	Particulars	Details
1.	Pollution response equipments held	Three powerful tugs are fitted with OSD spraying boom. All three tugs have 4000 litre of oil Spill dispersant (Approved by NIO) on board for immediate use.
2.	Future plan for acquisition of equipment are	Inflatable boom.
		One more tug with OSD spraying boom and 4000 litre of OSD.
		Absorbent Pads.
3.	Whether any vessel/aircraft available for pollution response capabilities	Tugs are fitted with OSD Booms and OSD and can be used in emergency however there is no dedicated vessel/craft to operations.

Table 13.3. Details of Oil Pollution Response Capability at each GMB Port, GoK

Sl. No:	Equipments	Details
1	Boom	Boom, Air blower, Towing end, Boom reel (300m capacity.), Hydraulic hose set, Beach sealing boom, Towing end, Boom

		repair kit, Storage bag, Water pump, Spare part kit, Air blower & Spare part kit.
2	Skimmer	Multi-skimmer,Spate pump/power pack,Lifting straps & Hose set
3	Flex barge	Flex barge 10t, Tank fittings, Towing equipment
4	Dispersant	Dispersant spray system (osd apllicator),Spray arm, Hose set for DSS
5	Shore clean up set	Absorbent boom, Absorbent pad, Beach broom, Mini vaccum pump,Vaccum dome,Vac aluminium hopper,PPE (5 persons kit),Collapsible tank 6m3,Skimmer rock cleaner,Hydraulic power pack w oil transfer pump, Chalwyn valve and spark arrestor,Oil transfer hose set,Hydraulic hose set, Spare part kit for rock cleaner, Spare part kit for chalwyn valve

Source: Proposed in DPR submitted by KITCO

Table13.4. Oil Spill Response Capability at Pipav Port, Saurashtra Coast

Sl. No	Particulars	Details
1.	Pollution response equipment held	(a) Floating Skimmers -01 No
		(b) Oil Spill combat boat -01 No
		(c) Dispersant Spray System -01 No
		(d) Oil Collection pump -01 No
		(e) Sorbent Pads -01 No
		(f) Sorbent Booms -01 No
		(g) Sorbent Sheets -01 No
		(h) Sorbent Pillows -01 No
		(j) High pressure cleaning pump -01 No
		(l) Oil Spill Dispersant - Nil
		(k) Oil collection Concentrate -01 Unit
2.	Vessels/ Air effort available	Nil

Table 13.5. Oil spill Response Capability at Reliance Industries Limited – Hazira, Gulf of Khambat (GoKh)

Sl. No	Particulars	Details
1.	Pollution response equipment held	No response equipment available. (operations have been rated as “Low risk” in terms of pollution hazard).
2.	Vessels/ Air effort available	Two tugs, Reltug-3 and Reltug-4, with spray booms on both sides and dispersant capacity of 1000 litre are available at RIL, Hazira. These tugs can be shifted to other Reliance locations are per the requirements.

Table 13.6. Oil Spill Response Capability at Coast Guard Region (West)

Sl. No	Particulars	Details
1.		1.RO Boom OSA 2000 with deck Reel - 04(200 m each)

Sl. No	Particulars	Details
	Pollution response equipment held	2. RO Boom Powerpack (old) - 02
		3. RO Boom Powerpack (New) - 02
		4. Vikoma Hi-Sprint Boom with deck Reel - 04
		5. Vikoma PN Diesel Hydraulic Powerpack - 03
		6. Vikoma Hi-Sprint Boom air blower (Echo)- 02
		7. Vikoma air Blower (Honda) - 02
		8. VimkomaSentinal Boom - 01
		9. VikomaSenital Boom Deck Reel - 01
		10. RO Boom 610 (16 x 25) -16
		11. Air Blower for Sl. 10 - 05
		12. Boom Washing Chamber -01
		13. Fresh water Chemical Pump set for Sl. 12 -02
		14. Powerpack for Sl. 12 - 01
		15. RO set (Settling Tank) - 01
		16. RO Clean Unit -01
		17. Beach Cleaning equipment - 01
		18. Hot water cleaner (KEW) - 04
		19. Hot Water Cleaner (L&T) -01
		20. CCN-100 off loading pump -01
		21. Powerpack for Sl. 20 -01
		22. TC-3 Aerial spray unit with bucket -03
		23. TC-3 Aerial Spray Arm set - 05
		24. Spill Spray Pump -04
		25. Spill Spray Arm (set)for Sl.24 -05
		26. Wide Spray System -02
		27. OMI Oil Mop MK-II-9D - 02
		28. SS-50 Disk Skimmer (Vikoma) -04
		29. Powerpack for Sl.28 -04
		30. Welosep Vertex Skimmer - 02
		31. Powerpack for Sl.30 -02
		32. DesmiDestroil Skimmer DS-250 - 04
		33. Powerpack for Sl. 32 - 04
		34. DesmiDestroil Skimmer DS 210 - 02
		35. Powerpack for Sl. 34 - 02
		36. Dunlop Salvage Barge 100 M3 - 02
		37. Dunlop Salvage Barge 30 M3 - 03
		38. Linductor Oil recovery - 02
		39. Vikoma Sea Devil Skimmer - 03
		40. Powerpack for Sl. 39 - 03
		41. Hydraulic Control for Sl. 39 - 03
		42. Hydraulic hand pallet -03
		43. Hydraulic drum lifter -01
		44. Hydraulic power pack lifter -01
		45. Hand trolley -01
		46.Fork lift -01
		47.SeaVac Heli Skimmer -01

Sl. No	Particulars	Details
		48.Pallet Stacking System -56 (Ex Jay24 & Ex Godrej32)
		49.Container top for OSA 200 Boom reel - 03
		50.Oil spill response kit - 01 At Kochi
		51. Seavac 330 Heli skimmer system - 01 -do-
		52. RO Boom -01 -do-
		53. DS 250 Skimme - 01 -do-
		54. Spill Spray equipment - 01 -do-
		55. Spray Pod - 02 747 SQNat Kochi
		56. Spray Pod - 08 750 SQN at Daman
		57. IR/UV System - 02 -do-
		58. TC-3 Bucket with boom S/N 7584 - 01 841 SQN at Daman
		59. Oil Water separator - 01 At Vadinar
		60. Petrol Engine General Purpose - 01 -do-
		61. Rop Mop skimmer(Diesel engine & power pack) - 02 -do-
		62. Oil Spill Kit with accessories - 02 -do-
		63. Dunlop Dragon Barge 30 Ton -03 -do-
		64. Sea Curtain Boom - 2400 m -do-
		65. Sea vacHeli skimmer - 01 -do-
		66. High Pressure Steam Jet Cleaner - 02 -do-
		67. TC-3 Bucket - 01 CGAE Goa
		68. TC-3 Bucke - 01 800 SQN at Goa
		69. TC-3 Bucket - 01 Veera Flight at Kochi
2.	Other efforts/ facilities available	a) Ships and aircraft of Indian Navy as available on West Coast of India.
		(b)Vessels, equipments and facilities in ports and with other authorities engaged in handling / transporting oil on the West Coast of India.
3.	Vessels / Aircraft available	Offshore Patrol Vessel, IPCs/SDBs, IBs and Workboats, Dorniers and Helicopters.

Source: NOS-DCP

Hence it can be concluded that with enough resources, mutual aid for combating with higher Tier requirements of worst case oil spill with in KPT limit can be achieved with other regional ports and operators. MoUs should be executed and manitained in such as way that optimisation of resources and minimisation of response time can be achieved.

14

OIL WASTE DISPOSAL MECHANISM

Oil waste disposal is one of the most serious trouble faced during an oil spill. Oil waste generated during and oil spill include recovered oil, oily debris including items of protective clothing, equipment used for cleanup operations etc. The sppropriate disposal option depends upon type and amount of oil, location of spill, environmental and legal aspects, economic considerations. It can be seen that only heavier oils such as Crude Oil, Fuel Oil , Lubricants etc., require cleanup and response operations while non-persistant oils doesnot require cleanup hence disposal.

Extreme care is to be taken while oil collection since earlier it is collected, less likely the contamination and hence easier the recovery operations. Weathering makes the oil more viscous. Oil directly collected from the water will be having less debris but will be highly emulsified. Thus the oil waste can be classified as:

- Oil contaminated with water
- Emulsified Oil contaminated with water
- Oil collected from the shore contaminated with sand
- Oil collected from the shore contaminated with wood, plastic or seaweed
- Solid Tarballs

Hence it can be easily inferred that each type of waste will require a different method of treatment and disposal.

Storage of oil waste collected during spill is important prior to disposal. Initially they will be stored in the temporary staging areas located close to the spill location and further they may be collected and transffered to a suitable location with in the KPT area before disposal if possible. Steps involved in oil waste disposal are the following Construction of waste storage areas,Sampling of disposed materials, Testing of accumulated materials for identification of hazardous materials, Segregation and transportation of waste, Dismantling of waste staging areas, Decontamination of the location and Collection & dispose of washdown/ rinsate. Following section details the important steps involved in the oil waste disposal mechanism:

14.1. Temporary/ Onfield Storage

Wastes acumulated in temporary storage location should be categorised, segregated, inventories and transported off-site fro recysling or disposal. No additional permits are needed for collection and temporary storage of the waste from an oil spill emergency as long as the waste is properly contained, labeled and stored. Different types of containers used for oil waste collection and transportation are given as **Table 14.1** below.

Table 14.1. Types of Oil Waste Handled

Sl. No.	Type of Container	Type of Waste	Volume (m3)	Instructions for Use
1	Plastic Bags	Soild & Liquid [C]	0.04/bag	Not suitable for light oils, sharps or long term storage. Half fill only. Should be moved using
2	200 Litre Drums with Cover	Soild & Liquid [C]	0.2	Half fill only.
3	Flexible bags/ containers	Liquid	1 to 10	Recommended during on vessel operations. Finds difficulty while loading into trucks for final disposal.
4	Barges which are covered during operations.	Liquid	Already available available sizes at KPT	
5	Rigid Tanks	Liquid	Variable	At locations close to the public area requiring additional safety implications
6	Plastic- lined pits	Liquid [C]	Variable	Needs to be well lined at areas of low water table, away from importannt water sources.

c- Conditional- Adapted only if other preferred options are not available.

Bulk oil should be stored separately from oily debris so that effective treatment and disposal methods can be followed. It is better that in the bulk storage facility for highly viscous materials, the tanks are to be fitted with heating coils.

Highly viscous oils are best stored in open containers such as barges, skips or drums to facilitate treatment and transfer operations. If special purpose containers are not available, bulk oil from shorelines can often be held within compacted earth walls or in simple storage pits lined with suitable oil-proof material like heavy gauge polyethylene. Pits should be filled in after complete removal of the oil and, as far as possible, the area restored to its original state. Plastic bags should be regarded as a means of transporting oily material rather than storage since they tend to deteriorate rapidly under the effect of sunlight. It should also be borne in mind that if the contents are ultimately to be treated in some way prior to disposal, it will usually be necessary to empty the bags and dispose them off separately.

It is beneficial to reduce the amount of material to be transported by separating oil from water and from sand during temporary storage. Water-in-oil emulsions can be broken to release the water; oil seeping from heaped beach material and debris can be collected in a ditch surrounding the storage area; and sieving techniques can be used to separate clean sand from tar balls.

14.2. Transportation

This phase involves in water and land phase. In water phase floating tanks driven by tugs or inbuilt tanks in tugs. In land phase terrestrial vehicles can be utilised for hauling.

14.3. Segregation

Segregation of the waste can be done prior to transportation or after it. Many times segregation of different types of waste help in reducing the quantity of material to be transported. Preferred segregation of oil waste are given as **Table 14.2** below.

Table 14.2. Preferred Segragation for Various Types of Oil

Sl. No.	Phase & Type of Waste		Preferred Segregation
1	Liquid	Oil	Non-emulsified Oils
			Emulsified Oil
		Wastewater	Waterfrom temporary storage
			Water from emulsion seperators
			Water from Chemically demulsified oil
2	Soild	Oil	High pour point oils
			High viscosity emulsions
			Tar ballls
		Oily Debris	Oil mixed with cobble or sand
			Oil mixed with wood, vegetation, plastics or sorbents

14.4. Disposal

Disposal of the oil waste is to done considering the type of oil, availability of space, expenditure etc.Important methods of oil waste disposal are given as **Table 14.3** and are detailed in the following sections.

Table 14.3. Disposal Methods for Oil Waste

Sl. No.	Type of Material	Nature	Disposal Methods
1	Liquid Oil Waste	Mainly oil with some water	Recovery & Recycling
			Incineration
2	Oily water	Mainly water with some oil	Oil water seperation unit
			Bioremediation

3	Soild Oil + Inorganic Waste	Including sediments	Bioremediation
			Landfill. Only after oil content reduced to <30ppm or 20%.
4	Soild Oil + Organic Waste	Dead vegetation,animals & birds and other biodegradable materials	Bioremediation
			Landfill
5	Other soild waste materials	Including synthetic materials	Landfill
6	Hazardous materials		Offsite disposal

14.4.1. Recovery and Recycling

To the maximum possible extent, the oil is to be recovered for eventual processing or blending with fuel oils. Possible recipients for processing or blending are refineries, power stations, cement and brick works and contractors who specialize in recycling waste oils. There are approved waste oil recycler for KPT, the details of are given as **Annexure XIII.**

But for recovery and recycling the oil should be have the following characteristics:

- Pumpable
- Low in solids
- Salt content of less than 0.1% for processing through a refinery or less than 0.5% for blending into fuel oil.

Oil collected from the water is likely to be the easiest to prepare for processing since the requirement will be only to separate water. This separation can frequently be achieved by gravity either in collection devices such as vacuum trucks or in portable tanks, where the water is allowed to run-off or pumped from the bottom of the tank.

The extraction of water from water-in oil emulsions is sometimes more difficult. Unstable emulsions can usually be broken by heating up to 80°C and allowing the oil and water to separated by gravity. More stable emulsions may require the use of chemicals known as emulsion breakers or demulsifiers, which also tend to reduce the viscosity of most oils rendering them more pumpable. But disposal of water collected will contain high percentaged of the emulsion breaker and oil. From oiled sedmiments waterwashing using low pressure hoses can be used to loosen and lift off oil from debris contained in a temporary storage pit. The resulting oil/water mixture can then be pumped away and separated by gravity. Separation can also be achieved in a closed system using water or a solvent. Cleaning of large amount of oiled shore material on site will reduce the cost considerably but avoiding the transportation of large quanity of sediments.

14.4.2. Landfill

This is a disposal option when the recovery of oil is impractical. The oiled waste is directly dumped into the designated landfill sites. Materials intended for direct dumping should have maximum oil content of about 20%. The guidelines to be followed while selecting the landfill sites are the following:

- Landfill Sites should be located well away from fissured or porous strata to avoid the risk of contamination of ground water, particularly if this is abstracted for domestic or industrial use.
- Disused quarries and mines are often ideal.
- Co-disposal of oil and domestic waste is often an acceptable method even though degradation of the oil is likely to be slow due to the lack of oxygen.
- The total quantity of oil should not exceed 1.5% of the total volume of the site.

In the case of shorelines lightly contaminated with oily debris or tar balls, it may be possible to bury the collected material at the back of the beach well above high water mark provided there is no risk of damage to vegetation and with sufficient covering so that the oiled beach is not uncovered through normal beach erosion.

Stabilising agents such as Quicklime or Calcium oxide, cement and pulverized fuel ash can be used to bind oily sand, provided there are no large pieces of debris. This will result in the formation of an inert product which will prevent the oil from leaching out. Then it can be disposed under less stringent conditions than unstabilised oily sand.

14.4.3. Bioremmediation

Bioremediation utilizing a group of naturally occurring microorganisms which can break down hydrocarbons either through aerobic or anaerobic processes can be used for disposing oil contaminated debris. It can be done either in-situ or ex-situ. Land farming and disposal in sand dunes are ex-situ techniques which have been practiced over long span of time and are better options that make use of biodegradation. The techniques of bioremediation which utilizes existing microorganisms and manipulating oxygen and nutrient levels are termed as bio stimulation whereas introduction of supplementary organisms to supplement those present is called bio augmentation. Plans are also utilized in some cases and then the technique is termed as phytoremediation. The process is highly temperature dependent. Lighter oils are toxic to microorganisms and many times inhibit their growth while weathered heavier oils may contain large quantity of poorly degradable compounds.

Land farming involves the spreading of the oily materials over the soil in this layers. Hence the aerobic decomposition is largely completed in one to three years. It requires adequate area within reasonable distance and all parts of the site should be accessible to trucks. Located away from surface and underground water sources. The soil should be of low permeability. In the case of biodegradable organic waste composting can be adopted. Dune disposal another option where significant quantities can be buried in stable coastal sandy areas and dune pastures. It will work well only when the area is not water logged.

14.4.4. Incineration

The open burning of oily debris is recommend only in remote areas. When oil is burnt in the open it also tend to spread and can leach into the ground. Tarry residue will remain since it is really possible to achieve complete combustion. Portable incinerators which are able to contain oily waste and can create very high temperatures. Rotary kiln and open hearth types are most appropriate. Fixed industrial incinerators are an option if long term storage is available. The combustion will be self-sustaining if the fuel content is around 25 % and water content is not more than 50%. Monitoring should be done for noxious gases in this case.

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CONCLUSION AND RECOMMENDATION

KPT is already having an Oil Spill Contingency Plan in place and Oil Spill Response (OSR) resources are also in place. Considering the ever increasing traffic at the Port which also handle POL commodities, contingency plan shall be maintained in such as way as to cater the threat posed by an uncertain oil spill event. Based on the observation of the study, to supplement the existing plan, the following conclusion and recommendations are made:

- Kandla port is one among the thirteen major ports of India located in Gulf of Kachchh (GoK) which hosts one of the world's splendid ecosystems and its rich & highly bio-diversified intertidal flora and fauna. The area is located close to the international shipping line and is an approach for another 5 ports. Presently, there are oil handling facilities of Reliance, IOCL, BORL including SPMs within the Kandla port limit near Vadinar. Also there are Oil berths at Kandla creek and an SPM is to be operational off Veera. Along with this, its location close to the busy international shipping routes, place the area unreasonably under the oil spill threat. Vadinar being the POL hub, extreme caution is required for this area.
- Port handles ships with a capacity above 50,000 DWT while SPMs handle Very Large Crude Carriers (VLCC) having capacities ranging from 87,000 to 3,25,000 DWT. During the financial year 2014-15 the port handled 92.50 MMT cargo. Kandla & Vadinar terminals were visited by 1724 & 530 ships respectively during the same period. The port handles different kinds of oil including Crude Oil,POL, Edible Oil and Bunker Fuel Oil.
- Presently, KPT holds minimum OSR equipments for Risk Category-A port as per NOS-DCP to cater Tier-1 facilities. Eventhough, Tier-1 is concerned with preparedness and response to a small spill within the capabilities of an individual facility or harbour authority with 700 tonnes cited as the upper limit for quantity, the circumstances of the spill and the surrounding environment will determine the actual level of response. This factor is very critical in the KPT limit, located with in an extremely sensitive as well as vulnerable locality.

- Located in the Kandla Creek, in the western most part of Little Rann of Kachchh (LRK) at the mouth of GoK, the port area is immedately surrounded by high density of creeks, mangrove swamps, mudflats, patches of dry salt waste (Rann), vast salt pans and aquaculture ponds. However, the port limit extends to Vadinar in the southern arm which is located admist the extremely sensitive coastline with rich corals and islands, where the SPMs and other oil handling facilities are operating for various petroleum companies. These areas are essentially the part of the protected areas Marine National Park & Sanctuary (MNPS) and Important Bird and Biodiversity Areas (IBAs). Hence the risk of oil spill here is determined to be very high.

- Environmental Sensitivity Map was prepared for the KPT limit. Mangroves are the most sensitive shore feature, followed by shelteretd hypersaline mudflats, exposed mudflats, exposed manmade structures within the KPT limit. In addition to this there are small streches of exposed rocky shore shores, wavecut rocky platforms, salt marshes and fine sand beaches adjoining the coral islands.But the shores and dominated by mangroves or mudflats having higher sensitivity. Also there are very small ridges of shell and coarse grained beaches adjoining mudflats. Small strips of rip- raps or seawalls will be asscoiated with areas of human interferences, low stablity sections etc. Important biological resources such as Corals, Birds nesting and flocking areas etc., are occurring simultaneously in the MNPS area in the Vadinar Zone. Hence this zone of KPT Limit is to be considered as multi-resources are and is the most sensitive part in the KPT limit.

- While prioritising resources inaddtion to the oil spill sensitivity, other consideration of the resource such as ecological value, economic value, social and cultural value is to be taken into account. Thus first priority is to be given for Corals and Mangroves, followed by mudflats, fishing grounds and intake locations. Rocky Coast is having the lowest priority.

- Port is responsible for the cleanup operations within port limit. In the case of KPT due to the presence of islands, bets in hard mudflats, shoals etc., the port has to give equal importance to offshore and onshore response operations. From the present inventory available, it can be seen that, sufficient shoreline protection and cleanup resources are not available at KPT. Hence, Beach sealing Boom, Auto/River Boom,Fence Boom,Sorbent in the form of Boom, Pillows, Rolls, Sheets and Pads, Clean up equipment such as Hot Water Pressure Cleaner,Showels,Rakes,Diggers etc., have been proposed.

- Incident Magagement Mechanism for KPT for ensuring proper Oil Spill Response and Preparedness is porposed. Crisis Management Group headed by the Chairman will be the prime authority of the Oil Spill Response Mechanism. Dy.Conservator, KPT have been porposed as the Chief Incident Controller. Emergency Control Centre will be established at KPT office with 24 hr control room at the port office under the supervision CIC for coordinating the response activities.Incidnet Management Team will be lined up under the CIC though the Site Incident Controller and other response unit coordinators. Cheif Operating Manager at Vadinar is given the charge of Marine Resposne Unit incase of spill in Vadinar Zone.

- Presently, KPT is in MoU with ESSAR and IOCL. Mutual Aid is applicable to the other stakeholders of the area including facility operators RELIANCE, BORL (which are operating within the port limit,also having individual facility level contingency plan for 500m area surrounding the facility) and to the local ports of the region Navlakhi (under taken by Gujarat Maritime Board) and Adani Port & Special Economic Zone, Mundra for combating Tier-2 spills upto 10,000 Tonnes under the Onscene Command of Regional Commander ICG. MoUs may be updated including all stakeholders of the region for optimising the resources and minimising the response time.
- Storage of oil waste collected during spill is important prior to disposal. Initially, they will be stored in the temporary staging areas located close to the spill location and further they may be collected and transfered to a suitable location within the KPT area before disposal if possible. Landfill sites should be located well away from fissured or porous strata to avoid the risk of contamination of ground water, particularly if this is utilised for domestic or industrial use. Materials intended for direct dumping should have a maximum oil content of about 20% only. Incase of the absence of suitable disposal sites, the same can be transfered to the approved waste oil recycler of KPT.

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Annexure

Annexure I

The composition, functional responsibilities and reporting requirements of CMG

The composition, functional responsibilities and reporting requirements of CMG				
Sl. No	**Crisis Management Groups (CMGs)**	**Functions**	**Composition**	**Reporting Requirements**
1	National Level Crisis Management Group for Oil Spills (NOS CMG)	• Continuously monitor the post incident situation arising out of a major oil pollution incident and suggest measures for prevention and to check recurrence of such incidents; • Arrange, in the event of an oil pollution incident, all manpower, equipments, resources financial assistance as may be necessary; • Conduct post-accident analysis of such major oil pollution incidents and evaluate responses; and • Review the adequacy of national and other contingency plans, and suggest measures to reduce risks of oil pollution from sea ports and oil installations.	• **Chairperson** – Defense Secretary • **Members-**Defense Secretary, Foreign Secretary, the Secretaries of Environment and Forests, Shipping, Petroleum and Natural Gas, Urban Development, Ocean Development, Science and Technology, Agriculture and Co-operation, Chemicals and Petrochemicals, Industrial Development, Secretary (Security) in the Cabinet Secretariat.,Director General Coast Guard, Chairman of the Concerned Port, Director General Hydro Carbons, Any member co-opted as deemed necessary	The NOS-CMG is the apex body to deal with major oil pollution incidents and to provide expert guidance for handling major oil spills.
2	State Level Crisis Management Group for Oil Spills (SOS CMG)	• Review local oil spill contingency plan for the State local and all facility oil spill contingency plans with a view to examine its adequacy and forward a report to the Central Coordinating Authority (CCA) for oil spills once in three months; • Nominate personnel to the Local Action Group (LAG) and Local Action Group Support Team (LST) and review the status of these teams; • Assist the State Government in managing oil pollution incident at a site in the State; • Assist the State Government in the planning,	• **Chairperson -** Chief Secretary • **Member Secretary-** Chairman State Maritime Board • **Members-** Secretary (Labour), Secretary (Environment) ,Secretary (Health) ,Secretary (Industries), Secretary (Public Health Engg.), Secretary (Fisheries), Chairman, State Pollution Control Board, 4- Experts (Industrial Safety & Health) nominated by State Govt., Secretary/ Commissioner(Transport), Director (Industrial Safety)/ Chief Inspector of Factories ,Fire Chief, Commissioner of Police, One Industry Representative nominated by	The SOS-CMG is the apex body in the State to deal with major oil pollution incidents and to provide expert guidance for handling major oil pollution incidents.

		preparedness and mitigation of major oil pollution incident at a site in the State; • Continuously monitor the post incident situation arising out of a major oil pollution incident in the State and forward a report to the Central Coordinating Authority for oil spills review the progress report submitted by the District Crisis Management group respond to queries addressed to it by the District Crisis Management groups; • Publish a list of experts and officials in the State who are concerned with the management of oil pollution incidents.	State Govt., State Civil Defense Chief ,Secretary (Revenue/Home), Directorate of Industrial Safety and Health, Any other member deemed necessary by the Chairman	
3	District Level Crisis Management Group for Oil Spills (DOS CMG)	• Review all the facility oil spill contingency plans prepared by the occupier of Major Accident Hazards installation viz., sea ports and oil installations for the preparation of the district oil spill contingency plan; • Assist in the preparation of the district oil spill contingency plan; • Assist the district administration in the management of oil pollution incidents; • Continuously monitor every oil pollution incident; • Ensure continuous information flow from the district to the NOS-CMG and SOS-CMG regarding oil pollution incident situation and mitigation efforts; forward a report of the oil pollution incident within fifteen days to the SOS-CMG; and conduct at least one full scale mock-drill of an oil pollution incident at a facility each year	• **Chairperson -** District Collector • **Member Secretary-** Inspector of Factories • **Members-** District Energy Officer, Chief Fire Officer, District Information Officer, Controller of Explosives, Chief Civil Defense, One Trade Union Representative nominated by District Collector, Deputy Superintendent of police , District Health Officer/Chief Medical Officer, Commissioner Municipal Corporations, Representative of the Department of Public Health Engineering, Representative of Pollution Control Board, District Agriculture Officer, 4 Experts (Industrial Safety & Health) nominated by District Collector, Commissioner (Transport), One Representative of Industry to be nominated by the District Collector, Chair-person/Member-Secretary of Local Crisis Groups, Representative of the Port,	The DOS-CMG is the apex body in the district to deal with major oil pollution incidents and to provide expert guidance for handling oil pollution incidents;

		• Forward a report of the oil pollution incident within fifteen days to the SOS-CMG. • Conduct at least one full scale mock-drill of an oil pollution incident at a facility each year and forward a report of the strength and the weakness of the plan to the SOS-CMG. conduct at least one full scale mock-drill of an oil pollution incident at a facility each year	Representative of State Maritime Board, District Forest Officer/ Wildlife advisor, Any other member deemed necessary by the Chairman	

4	Local Level Crisis Management Group for Oil Spills (LOS CMG)	• Prepare local oil spill contingency plan for the industrial pocket; • Ensure dovetailing of the local oil spill contingency plan with the district oil spill contingency plan; • Train personnel involved in oil pollution incident management; • Educate the population likely to be affected in an oil pollution incident about the remedies and existing preparedness in the area; • Conduct at least one full scale mock-drill of an oil pollution incident at a site every six months forward a report to the DOS-CMG • Respond to all public inquiries on the subject. Months forward a report to the DOS-CMG; and respond to all public inquiries on the subject.	• **Chairperson** - Sub-divisional Magistrate / District Emergency Authority • **Member Secretary-** Inspector of Factories • **Members-** Industries in the District/Industrial area/ industrial pocket, Transporters of Hazardous Chemicals(2 Numbers), Fire Officer, Station House Officer (Police), Block Development Officer, One Representative of Civil Defense, Primary Health Officer, Editor of local Newspaper, Community leader/ Sarpanch/ Village Pradhan nominated by Chairperson, One Representative of Non-Government Organization to be nominated by the Chairperson ,Two Doctors eminent in the Local area, nominated byChairperson, Two Social Workers to be nominated by the Chair-person, Environmental NGOs preferably dealing with corals, mangroves, marine environment, Representative of oil agencies, Any other member deemed necessary by the Chairman	The LOS-CMG is the body in the industrial pocket to deal with oil pollution incidents and coordinate efforts in planning, preparedness and mitigation of an oil pollution incident

Annexure II

Inventories for the tier 1 pollution response

Inventory Standards at Port Facilities

The ports are classified into a risk category based on type of cargo handled, quantity of bunkers carried onboard ships calling at the port, single point mooring facility at the port, and ship-to-ship transfer operations at the port. The risk categorization is appended at Table A1

Table A1 Risk categorization of ports

Risk Category	Description
A	Ports handling crude oil/ tanker visits/ SPM/ STS
B	Ports handling ships carrying more than 1000 tons of fuel/ bunker oil
	Ports handling products only
C	Other than Cat 'A' and Cat 'B'

The planning standards for oil spill response resources for each risk category of ports is appended at Table A2.

Table A2 Oil Spill Response equipment for each risk category of ports

	Description		Risk category A	B	C
Equipment	Inflatable Boom (metres)		2000	1000	600
	Skimmer (20 TPH)		4	4	2
	OSD Applicator (no.)		6	2	2
	Oil Spill Dispersant (litres)		10,000	5,000	3,000
	10 Tons Flex Barge (no.)		4	02	2
	Current Buster booms if tidal current >2 knots (meters)		400	400	
	Sorbent boom (meters)		500	200	
	Sorbent Pads (no.)		2000	1000	
	Shoreline cleanup Equipment	Mini Vacuum pumps	5		
		OSD Applicator	5		
		Fast tanks	5		
Vessel	Work Boats		2	1	1
	Tugs		2	1	
Man Power	IMO Level 1		10	6	2
	IMO Level 2		4	2	
	Other		10	10	5

Inventory Standards at Oil Installations

The oil installations are classified into risk categories based on the number of offshore platforms operated in the area, SPMs in area, drilling and production of crude oil, type of product handled viz., LPG, LNG or Naphtha, or whether FPSO. The risk categorization of oil installations is appended at Table A3

Table A3 Risk categorization of oil installations

Risk Category	Description
Super 'A'	Operating more than five offshore platforms in one area
A	Offshore E&P Installations for crude oil
B	SPMs handling crude oil/FPSO
C	Ship/ platform involved in ship to ship crude oil transfer

The planning standards for oil spill response resources for each risk category of oil installations is appended at Table A4 .

Table A4 Oil Spill Response resources for each risk category of oil installations

	Description		Risk category			
			SUPER A	**A**	**B**	**C**
Equipment	Inflatable Boom in metres		2000	1000	600	600
	Skimmer (20TPH)		4	4	2	2
	OSD Applicator (no.)		6	2	2	2
	Oil Spill Dispersant (litres)		10,000	5,000	3,000	3,000
	Flex Barge 10 tons (no.)		4	2		
	Current Buster booms atports where tidal current is>2 Kn (no.)		2	2		
	Sorbent boom pack (meters)		500	200		
	Sorbent Pads (no.)		2000	1000		
	Shoreline Cleanup Equipment	Mini Vacuumpumps	5			
		OSD Applicator	5			
		Fast tanks	5			
Vessel	Work Boats		2	1		1
	MSV/OSV/Tugs		2	1	1	
Man Power	IMO Level 1		10	6	2	2
	IMO Level 2		4	2		
	OTHER		10	10	5	5

Inventory Standards at Coastal States

Sl no	Palletized contents
1	Inflatable Boom 240m in 10m & 20m lengths
2	Boom ancillary pallet
3	Shore Sealing Boom 400m in 10m & 20m lengths
4	Minivac System
5	Multi Skimmer 10TPH and 20 TPH
6	Portable temporary Storage Devices x 8 nos.
7	Inflatable Shelters
8	Decontamination Station Equipment
9	Spate pumps x 3
10	Suitable Power pack
11	Discharge hose
12	Command pallet (Walkie Talkie, Torch, Folding Table, Folding Chair Map of the Area, etc)

Annexure III

The format for reporting an event

(Refers to Para 12)

OIL SPILL REPORT FORM

Particulars of Person/Organisation Reporting Incident

a. Title :

b. Company :

c. Telephone/Telex Numbers :

d. Date/Time :

e. Spill Location :

f. Type and Quality of Oil Spill :

g. Cause of Spill :

h. Response to Spillage, if any :

j. Any Other Information :

Annexure

POLREP MESSAGE FORMAT

(See amplification in succeeding table)

Reference : IMO - 560 (1995)

Address	From	To ....
Date		Time Group
Identification		
Serial Number		

Part 1	1.	Date and time
(POLWARN)	2.	Position
	3.	Incident
	4.	Outflow
	5.	Acknowledge
	40.	Date and Time
	41.	Position
	42.	Characteristics of pollution
	43.	Source and cause of pollution
	44.	Wind direction and speed
	45.	Current or tide
	46.	Sea state and pollution
	47.	Drift of pollution
Part II	48.	Forecast
(POLINF)	49.	Identify of observer and ships on scene
	50.	Action taken
	51.	Photographs or samples
	52.	Names of other agencies informed
	53-59.	Spare
	60.	Acknowledge
	80.	Date and time
	81.	Request for assistance
	82.	Coast
	83.	Pre-arrangements for the delivery
	84.	Assistance to where and how
	85.	Other agencies requested
Part III	86.	Change of command
(POLFAC)	87.	Exchange of information
	88.	Names and number of
	89.	Description of equipment
	90.	ETA and arrival information
	91.	Place of embarkation
	92.	Place of disembarkation
	93-98.	Spare

Appendix E

Annexure IV

Allocation of responsibilities in the management of oil spills

Responsibility allocation for various department in management of oil spill		
Sl no	**Authority**	**Responsibility**
1	Ministry of Defence	The Ministry of Defence with administrative responsibility for the Coast Guard organization is the Ministry responsible for central coordination of oil spills of national significance in coastal and marine environment of various maritime zones. Their responsibilities are listed as below • Surveillance of maritime zones against oil spills • Combating oil spills in various maritime zones except in the waters of major ports • Central Co-ordinating Agency for combating of oil pollution in the coastal and marine environment of various maritime zones of the country • Implementation of national contingency plan for oil spill disaster. • (Following) controlling activities in various maritime zones except within the limits major ports • Inspection of oil record books • Apprehending violators of anti-pollution provisions mentioned under Sections 356 G (1) and (2) of the Merchant Shipping Act. • Checking of vessels for carrying necessary insurance certificates against oil pollution damage
2	Indian Coast Guard	• Responsible for maintaining and implementing the National Oil Spill Disaster Contingency Plan. • Responsible for acting as the Central Coordinating Agency for combating of oil pollution in various maritime zones, except in the waters of ports and within five hundred meters of offshore exploration and production platforms, coastal refineries, and associated facilities such as single buoy mooring, crude oil terminal and pipeline • They will review the progress reports submitted by the State Crisis Management Groups; • Respond to queries addressed to it by the State Crisis Management Groups and the District Crisis Management Groups; • Publish State-wise list of experts and officials who are concerned" with the handling of oil pollution incidents.
3	Ministries and departments of the government of India	**Ministry of Environment and Forests-** • Enactment of legislation for prevention and control of marine pollution from land and sea based sources • Prevention and control of marine pollution at source, on land or the sea • Monitoring of pollution up to the shore • Cleaning of beaches affected by oil pollution through coastal states and Union Territories.

		Ministry of Shipping- • They are responsible for prevention and control of pollution arising from ships all over the sea including the major ports areas, • Responsible for enactment and administration of the legislation related to prevention and control and combating of pollution arising from the ships • **Functions through DG (Shipping)-** To Comply with provision made in section 356 G(1) and (2) of Merchant Shipping Act, 1958 (Amendment) for the Purpose of Inspection of construction of ships and tankers in order to comply with provision of MARPOL 73/78 or of the other convention on maritime pollution formulated by IMO and/or other related bodies, Merchant Shipping Act and issue of necessary certificates, and Penalizing the offenders apprehended by the Indian Coast Guard and port authority for violations of the above provisions of the Act, including processing of pollution damage claims etc. • **Functions through major ports authorities within port limits-** Inspection of oil record books, apprehending of violators of anti-pollution provisions mentioned under section 356 G(1) and (2) of the Merchant Shipping Act, checking of vessels for carrying necessary insurance certificate against oil pollution damage, empowered to handle necessary anti-pollution provisions mentioned under Indian Ports Act, 1908 (Amendment), monitoring and combating of oil pollution in the port areas
		Ministry of Petroleum and Natural Gas- • Combating of oil pollution around offshore exploration and production platforms up to 500 mtrs • Combating of oil pollution around coastal refineries through the concerned refineries
		Department of Ocean Development– Scientific monitoring of marine pollution arising from land based ship-based and other resources in various maritime zones including coastal waters, but excluding monitoring of oil pollution within the limits of major ports, oil platforms, installations and structures
4	State Governments	• The State Governments of coastal states are responsible for coordinating the district and local administration and operation of the National Plan for shore line response and as per the provisions of the National Disaster Management Act, 2005 • The State and District Authorities will provide a wide range of site-specific information and resources, either in relation to environmental impacts, or response activities through authorities, such as Transport, Conservation and Resource Management Departments, Environmental Protection Authorities, emergency services, port/ Harbour authorities, and local conservation groups.

5	Support agencies	The following responsibilities are allocated to various support agencies for implementation of the National Oil Spill Disaster Contingency Plan: • **The Navy/ coastal state authorities/ port authorities** will make their communication/ operation centers facilities available to receive and disseminate reports of marine pollution accidents. • **The Indian Navy and the Indian Air Force** will provide fixed wing aircrafts or helicopters to conduct aerial surveillance or provide logistic support in movement of men and materials to the incident site. They will also provide ground to air communication link at the site for use by the on scene Commander. • **The Port Authority** will provide tugs and pollution control equipment at the incident site within port limits. • **The Ministry of Shipping, and Ministry of Petroleum and Natural Gas** will provide tankers or tank barges for storage of recovered oil or oil in water emulsions, and will arrange for storage and eventual disposal of recovered oil. • **Director General of Shipping,** Ministry of Shipping, will be responsible for all negotiations with the vessel, cargo owners, and insurers and will also conduct all negotiations regarding compensations and indemnification. • **The Ministry of Environment and Forest and Ministry of Agriculture** will provide scientific advice regarding species at risk, shore-line sensitivity, restriction of fishing activities, use of dispersant chemicals, beach cleaning methods, etc. • **The Ministry of Finance** will provide authorization for expenditure and funds for initial response and ensure adequate financial records are maintained. • **Coastal state authorities/ district administration/ departments/ public works/civil defence** corps will provide personnel and equipment, as required, for shoreline clean-up and ensure safety and protection of the local population and resources.

Annexure V

Specialist advice and assistance

Specialist Advice and Assistance		
Sl no	**Authority**	**Responsibility**
1	Directorate General of Shipping	• Issuance of statutory notice to the polluting ship as per the provision of Merchant Shipping Act, 1958. • Invoking relevant provision of the Merchant Shipping Act, 1958 in case the polluting ship fails to the action as required by the act to prevent or minimize pollution. • Advising concerned affected ports or other entities to deal with evidences for the purpose of raising claims on accounts of damage caused by the pollution and initiating legal action against the polluted. • Reporting such incidents to the Flag State of the ship or the neighboring Coastal State which is effected due to pollution. • Supervising salvage operations while dealing with oil pollution casualty if requested by the ports or other entity. • Investigating oil pollution contravention under the provisions of MS Act, 1958. • To keep Ministry of Shipping, Government of India and other concerned authorities posted on the pollution, action taken, progress report on combatment and follow-up action till normalcy of situation. • To advice Indian Coast Guard on pollution related matters under the provision of Merchant Shipping Act, 1958 whenever requested. • To take administrative and legal action for processing claims against damages incurred by Coast Guard and other agencies relating to any other oil pollution incidents • Advice concerned agencies to collect evidences for the purpose of claims pollution ships. • To advice the receiver of wreck with respect to pollution aspect and response. • To advice Indian ship-owners to mobilize ships for the purpose of oil transshipment if required
2	Indian Register of Shipping	• To provide advice relating to ship safety, structural integrity and stability of marine casualties; • To depute representatives to attend to a casualty and salvage at the SMCU when established.
3	Maritime Rescue Co-Ordination Centre	• In addition to coordinating the rescue and saving of life, to provide drift calculations and advice on offshore currents • Enabling messages to be communicated directly to vessels, during an incident, with its range of communication facilities including International Maritime Satellite (INMARSAT) systems,
4	DG Shipping Communication Centre	To provide advice relating to ship safety, structural integrity and stability of marine casualties and other details of the ship through coordination established with the Flag State of the stricken vessel.

5	Ministry of Environment, Forest and Climate Change	• To develop and implement national policy, programs and legislation to protect and conserve India's natural environment including regulation of dumping of wastes at sea, declaration and management of marine protected areas in Indian waters and conservation of listed threatened, migratory and marine species • To advise on matters relating to the Environment Protection from Dumping at Sea including the permitting and reporting of emergency dumping of material at sea; • To advise on potential impacts of oil spills on threatened marine and migratory species, such as seabirds, marine turtles, whales and dolphins. • To advice on likely to impact of oil spill on marine protected areas in Indian waters • To provide advice on habitats in marine protected areas, seabirds, marine mammals, marine invertebrates and macro algae, along with advice on rates of hydrocarbon biodegradation, dispersal and the use of dispersants. • To determine policy for usage of dispersants in the sea areas of the territorial waters over which the state exercises jurisdiction.
6	Archeological Survey of India	• Conduct underwater archaeological studies in Indian Waters • Assist/ advise in protection and maintenance of cultural heritage of the nation near to shore. • Documentation of underwater sites and ancient shipwrecks
7	Indian National Centre for Ocean Information Services	• To provide ocean state forecast. • To provide software based prediction of the trajectory of spilled oil.
8	Indian Navy	• Augment aerial surveillance capability of Coast Guard as necessary in the area when oil spill has occurred. • To make arrangements for oil transshipment operations from any tanker which has caused or is causing or is expected to cause oil spillage. • Promulgate general cautionary messages.
9	Indian Air Force	• Augment aerial surveillance capability of Coast Guard as necessary in the area when oil spill has occurred. • To make available its C-130 J Super Hercules aircraft for aerial monitoring of spills and aerial spraying of oil spill dispersants.

10	Ministry of Earth Sciences/ Department of Ocean Development/ National Institute of Oceanography	• Mapping of ecologically sensitive areas in the coastal and offshore region in consultation with Ministry of Environment and Forests. • Review of the sensitivity mapping listed by other agencies. • To provide scientific support through Coastal Ocean Monitoring and Prediction System (COMAPS) Centre and Units in investigations of oil pollution monitoring during oil spills and also deployment of its research vessels for this purpose, whenever necessary. • To organize research on impact of pollution on marine life based on actual oil pollution incidents.
11	Ministry of Agriculture/ Department Of Animal Husbandry, Dairying and Fisheries	• To arrange for suitable fishing vessels on which oil dispersant equipment can be mounted if the local action group concerned is unable to mobilize this requirement locally. • Sensitivity mapping of the sea areas within the territorial waters of the state with specific information on fish breeding grounds. • To provide Fishery Survey of India vessels for spraying of oil spill dispersants or other response measures
12	Ministry of Petroleum and Natural Gas and Oil Agencies	• To assist, when required, in consultation with DG Shipping, with chartering of tanker/s for oil transshipment operations. • To make available anti-pollution equipment and chemicals as are available with them. • To assist in the storage ashore of oil transshipped from wrecked or damaged tanker. • To assist in the assessment of the value of the oil transshipped. • To provide equipment and personnel resources and advice on a range of issues, including oil characteristics and local industry resource availability • To depute an Industry Adviser to the MRC during response to a major oil spill.
13	Shipping Corporation of India	• To arrange for tankers or ships or tank barges for transport and collection of recovered oil. • To arrange for any personnel required to assist oil transshipment operation or to assist otherwise as may be required.

14	Major ports/Non Major ports/Oil Terminals/Oil Installations/SPM operators	• To be in charge of the overall co-ordination of actions in the area within port limits as regards to anti-oil pollution • To identify a suitable sea going tug when required for the operations. • To identify surface crafts, on which dispersant spraying equipment can be mounted, and which can be used for rigging the boom. • To ensure that for the purpose of part XIII of the Merchant Shipping Act, 1958, actions are taken by the various authorities under the overall legal responsibility of the receiver of wrecks and dock concerned. • To ensure that at least the minimum equipment are kept available locally at all times • To arrange for training of personnel expected to be engaged in above operations. • To arrange for periodical exercise under the guidance of the RCC to keep equipment and personnel on continuous readiness for oil spill response operations. • To consult the ICG, DG Shipping, or other authority, when further advice/ assistance is required. • To keep the I CG apprised of action being taken.
15	Coastal State Governments and State Pollution Control Boards	• To take all suitable measures to prevent pollution on shoreline. • To render all possible assistance to the coordinator of the On Scene Commander, Local Action Group and district Commander particularly in accordance with the contingency plan. • To maintain adequate quantity of basic pollution response equipment like deflective booms, fence booms, spray equipment along with specialized equipment for beach protection and shoreline cleanup. • To identify suitable type of tug/boat/fishing vessel in consultation with On-Scene Commander/ Coast Guard for mounting the dispersant spraying equipment. • To take actions as applicable to the major ports, in respect of incidents at ports under jurisdiction.
16	Mercantile Marine Department	• To render all possible assistance to the coordinator of the Local Contingency/ Action Plan. • To provide technical advice to Local Action Group and CCA. • To assist Local Action Group in identifying surface craft suitable for mounting dispersant spraying equipment. • To assist Local Action Group in preparation of Local Contingency / Action Plan. • To assist the CG/RCC in examining ships for efficiency of anti-pollution equipments fitted on board as per Merchant Shipping Act, 1958. • If deemed necessary, to restrict movement of ships and personnel involved in oil pollution on receipt of related information.

17	Local Fisheries Authority	• To assist/advise Local Groups in identifying the rich fishing grounds so as to give priority for protection of such grounds from oil spills as well as use of dispersants • The local action groups in consultation with Coast Guard regional headquarters to identify the fishing vessels suitable for mounting the oil spill dispersant equipment.
18	Coastal Refineries and Crude Unloading Terminals	• To assist the local action group in the implementation of the Local Action Plan. • To assist the local action group in obtaining from their headquarters available additional equipment and chemicals if and when required. • To assist in chartering of tankers to undertake transportation / transshipment operations • To arrange for the storage of oil transshipped. • To assess value of oil transshipped and cost of refining or disposal as the case may be.
19	Offshore Oil Installations	• Occupiers of offshore oil installations are to maintain an oil spill contingency plan meeting specified requirements and maintain appropriate manpower, equipment and resources for oil spill response taking into consideration any guidelines and suggestions that may be issued by the Government of India/ Coast Guard from time to time. • To periodically forward a list of response inventory to the Coast Guard for scrutiny, evaluation and updating holdings. • To provide response equipment, material, trained personnel, and ships when required by the Coast Guard/ OSC on as available basis and without affecting safety of operations. • To immediately combat oil pollution around its installations up to 500 metres and continue to provide equipment, material, trained manpower, sampling efforts, and vessels as may be required by OSC when such oil spill spreads beyond 500 metres. • To provide data on crude oil and oil discharges. • To provide data on sub-sea pipe lines as required by OSC or MRC or CG MRCC. • To provide transshipment facilities in case the offshore installation, or any agency under its control is the polluter. • To provide staging facilities for helicopters in the offshore areas when engaged in pollution response in the vicinity whether or not the installation and agencies under its control are the polluters.
20	Receiver of Wrecks	• To assist Local Action Groups in whatever manner necessary and possible. • To take all actions necessary under Part XIII of the Merchant Shipping Act, 1958 (In this connection, the receiver of wreck shall consult the DGS, as and when required). • In situations where he has the local responsibility for certain actions and/or operations, he may authorize other agencies, who are better equipped.

21	Bombay Natural History Society	• Advise in restoration and cleaning of affected wildlife • Assist in estimating affected birds, mangroves in the area • Identifying, monitoring and mitigating the adverse impact of oil spill to the bio-diversity • Identifying Important Bird Areas (IBA) • ENVIS (Environmental Information System) Centre to study Avian Ecology and Inland Wetlands • Ecological Benchmarking in association with corporates, government and other NGOs
22	Central Marine Fisheries Research Institute	• Assist in estimating the effect of spill to fish and livelihood of fishermen in the area • Assist in identifying the types of fishes in the area • Assist in restoration of fishing in area after cleanup • Assist in estimating the Economic loss due to ban of fishing in the affected area • To understand the fluctuations in abundance of marine fisheries resources in relation to change in the environment • To develop suitable mariculture technologies for finfish, shellfish and other culturable organisms in open seas to supplement capture fishery production. • To act as a repository of information on marine fishery resources with a systematic database. • To provide consultancy services.
23	Integrated Coastal And Marine Area Management Project Directorate	• Responsible for preservation and conservation of marine environment in India • Identify the high risk areas • Promulgate the sensitivity mapping and area of priority
24	Mangrove Society of India	• To protect and conserve Indian mangroves by adopting environment friendly, scientifically sound techniques/methodologies. • To build up their capacities for protection and conservation of Indian mangroves. • To act as watchdog and advise in matters concerning the conservation of mangroves. • To train younger generations and will create awareness amongst them to conserve and protect mangroves • To organize alliances and networks with partners to develop an appropriate developmental perspective to conserve mangroves. • To organize issue-based Forums to achieve appropriate solutions to mangrove protection. • Capacity building of port and oil agencies, Central government and other state government agencies, stakeholders etc. By providing necessary training for their personnel. • To assist and coordinate activities pertaining to mangrove restoration consequent to oil pollution. • To play an active role in ensuring the participation of local people in making decisions in respect of mangroves. • To provide necessary scientific information in respect of mangroves

25	National Biodiversity Authority	• To regulate and advise the Government of India on issues of conservation, sustainable use of biological resources and fair and equitable sharing of benefits arising out of the use of biological resources. • To advise the Central Government agencies on matters relating to the conservation of biodiversity, sustainable use of its components and equitable sharing of benefits arising out of the utilization of biological resources; and advise the State Governments in the selection of areas of biodiversity importance to be notified under Sub-Section (1) of Section 37 as heritage sites and measures for the management of such heritage sites; • The State Biodiversity Boards (SBBs) advise the State Governments, on matters relating to the conservation of biodiversity, sustainable use of its components and equitable sharing of the benefits arising out of the utilization of biological resources; 3Mangrove Society of India (MSI) is a non-profit and non-political organization working for protection, conservation and sustainable use of mangroves. Many of its members are consultants/advisers to various Government agencies. Some are on the National and International mangrove committees. MSI has affiliation with research and government institutions, corporate houses, NGO's and stakeholders etc. from Maharashtra, Gujarat, Kerala, Karnataka, Tamil Nadu etc. • The local level Biodiversity Management Committees (BMCs) promote conservation, sustainable use and documentation of biological diversity including preservation of habitats, conservation of land races, folk varieties and cultivars, domesticated stocks and breeds of animals and microorganisms and chronicling of knowledge relating to biological diversity.
26	Reef Watch Marine Conservation	• To conduct education, awareness, training and capacity building programs for stakeholders • To provide expertise through its Information Network of institutions and individuals working on marine and coastal issues for development of OSCPs and incident response • To provide environmental information / education on biodiversity hotspots • To provide policy support • To facilitate a dialogue and consensus at various levels for conservation, management and sustainable utilization of coastal and marine resources / ecosystems in the development of protection priorities in OSCPs, NEBA and incident response.
27	Ms Swaminathan Research Foundation	• To provide advice on conservation of mangrove wetlands and sustainable utilization of their resources.
28	Wildlife Trust of India	• To assist in managing or preventing wildlife crises and mitigating threats to individual wild animals, their populations and habitats through holistic strategies and practical interventions. • To maintain national database on wildlife protected area and share the data with stakeholders for development of OSCPs and incident response. .

Annexure VI

The current national inventory in regards of oil spill response

National Oil Spill Response Capability

Aid to response	**Provision by**
Capping device (rating ≥ 10,000 PSI, 3000m depth, possibility of offset installation)	Ministry of Petroleum & Natural Gas
Subsea oil spill dispersant system	
Large scale OSD stockpile	
Emergency towing vessels (bollard pull ≥ 200 tons) x two	Ministry of Shipping
Salvage vessel	
Hot Tapping Device	
High Volume Offshore Skimming System	Ministry of Defence
Incineration Boom	
Aerial Dispersant Delivery System	
Ecological Sensitivity Index Map	Ministry of Environment and Forests
Oil Finger Printing Laboratory	Dept. of Science and Technology
Radar oil spill detection capability	MoD, MoPNG, MoS

Annexure VII

The national oil spill response capability supported by the concerned Ministries

National Oil Spill Response Capability

AID TO RESPONSE	PROVISION BY
Capping device (rating ≥ 10,000 PSI, 3000m depth, possibility of offset installation)	Ministry of Petroleum & Natural Gas
Subsea oil spill dispersant system	
Large scale OSD stockpile	
Emergency towing vessels (bollard pull ≥ 200 tons) x two	Ministry of Shipping
Salvage vessel	
Hot Tapping Device	
High Volume Offshore Skimming System	Ministry of Defense
Incineration Boom	
Aerial Dispersant Delivery System	
Ecological Sensitivity Index Map	Ministry of Environment and Forests
Oil Finger Printing Laboratory	Dept. of Science and Technology
Radar oil spill detection capability	MoD, MoPNG, MoS

Annexure VIII

The guiding template for the preparing of a new facility level contingency plan

The guiding template for the preparing of a new facility level contingency plan

Strategy

1. Introduction
    1.1 Authorities and responsibilities
    1.2 Coordinating committee
    1.3 Statutory requirements
    1.4 Mutual aid agreements
    1.5 Geographical limits of plan
    1.6 Interface with ROSDCP and NOSDCP

2. Risk assessment
    2.1 Identification of activities and risks
    2.2 Types of oil likely to be spilled
    2.3 Probable fate of spilled oil
    2.4 Development of oil spill scenarios including worst case discharge
    2.5 Shoreline sensitivity mapping
    2.6 Shoreline resources, priorities for protection
    2.7 Special local considerations

3. Response strategy
    3.1 Philosophy and objectives
    3.2 Limiting and adverse conditions
    3.3 Oil spill response in offshore zones
    3.4 Oil spill response in coastal zones
    3.5 Shoreline oil spill response
    3.6 Storage and disposal of oil an doily waste

4. Equipment
    4.1 Marine oil spill response equipment
    4.2 Inspection, maintenance and testing
    4.3 Shoreline equipment, supplies and services

5. Management
    5.1 Crisis manager and financial authorities
    5.2 Incident organization chart
    5.3 Manpower availability (on-site, on-call)
    5.4 Availability of additional manpower
    5.5 Advisors and experts – spill response, wildlife, and marine environment
    5.6 Training/safety schedules and drill/exercise Programme

6. Communications
    6.1 Incident control room and facilities
    6.2 Field communications equipment
    6.3 Reports, manuals, maps, charts and incident logs

Action and operations

7. Initial procedures
    - 7.1 Notification of oil spill to concerned authorities
    - 7.2 Preliminary estimate of response Tier
    - 7.3 Notifying key team members and authorities
    - 7.4 Manning control room
    - 7.5 Collecting information (oil type, sea/wind forecasts, aerial surveillance, beach reports)
    - 7.6 Estimating fate of slick (24, 48 and 72 hours)
    - 7.7 Identifying resources immediately at risk, informing parties

8. Operations planning
    - 8.1 Assembling full response team
    - 8.2 Identifying immediate response priorities
    - 8.3 Mobilizing immediate response
    - 8.4 Media briefing
    - 8.5 Planning medium-term operations (24-, 48-and 72-hour)
    - 8.6 Deciding to escalate response to higher Tier
    - 8.7 Mobilizing or placing on standby resources required
    - 8.8 Establishing field command post and communications

9. Control of operations
    - 9.1 Establishing a management team with experts and advisors
    - 9.2 Updating information (sea/wind/weather forecasts, aerial surveillance, beach reports)
    - 9.3 Reviewing and planning operations
    - 9.4 Obtaining additional equipment, supplies and manpower
    - 9.5 Preparing daily incident log and management reports
    - 9.6 Preparing operations accounting and financing reports
    - 9.7 Preparing releases for public and press conferences
    - 9.8 Briefing local and government officials

10. Termination of operations
    - 10.1 Deciding final and optimal levels of beach clean-up
    - 10.2 Standing-down equipment, cleaning, maintaining, replacing
    - 10.3 preparing formal detailed report
    - 10.4 Reviewing plans and procedures from lessons learnt

Data directory

Maps/charts

1. Coastal facilities, access roads, telephones, hotels, etc.
2. Coastal charts, currents, tidal information (ranges and streams), prevailing winds
3. Risk locations and probable fate of oil
4. Shoreline resources for priority protection
5. Shoreline types

6. Sea zones and response strategies
7. Coastal zones and response strategies
8. Shoreline zones and clean-up strategies
9. Oil and waste storage/disposal sites
10. Sensitivity maps/atlas

Lists

1. *Primary oil spill equipment:* booms, skimmers, spray equipment, dispersant, absorbents, oil storage, radio communications, etc (manufacturer, type, size, location, transport, contact, delivery time, cost and conditions)

2. *Auxiliary equipment:* tugs and work boats, aircraft, vacuum trucks, tanks and barges, loaders and graders, plastic bags, tools protective clothing, communications equipment, etc (manufacturer, type, size location, transport, contact, delivery time, cost and conditions)

3. *Support equipment:* aircraft, communications, catering, housing, transport, field sanitation and shelter etc (availability, contact, cost and conditions).

4. *Sources of manpower:* contractors, local authorities, caterers, security firms (availability, numbers, skills, contact, cost and conditions)

5. *Experts and advisors*: environment, safety, auditing (availability, contact, cost and conditions)

6. *Local and national government contacts*: (name, rank and responsibility, address, telephone, fax, telex)

Data

1. Specifications of oils commonly traded
2. Wind and weather
3. Information sources

Annexure IX

The format of Annual Return

ANNUAL RETURNS ON PREPAREDNESS FOR OIL SPILL RESPONSE					
1	NAME OF PORT / OIL HANDLING AGENCY				
2	CONTAINMENT EQUIPMENT	DESCRIPTION	LENGTH	QUANTITY (No.)	OPERATIONAL STATUS
3	RECOVERY EQUIPMENT	DESCRIPTION	CAPACITY	QUANTITY (No.)	OPERATIONAL STATUS
4	TEMPORARY STORAGE FACILITY	DESCRIPTION	CAPACITY	QUANTITY (No.)	OPERATIONAL STATUS
5	OSD SPRAYING SYSTEM	DESCRIPTION		QUANTITY (No.)	OPERATIONAL STATUS
6	OIL SPILL DISPERSANT	MAKE		QUANTITY (Kg.)	EXPIRY DATE
7	SHORELINE RESPONSE EQUIPMENT	DESCRIPTION	CAPACITY (if applicable)	QUANTITY (No.)	OPERATIONAL STATUS
8	IMO OPRC LEVEL TRAINED RESPONDERS	NAME	DESIGNATION	CONTACT No.	IMO OPRC LEVEL 1/ 2

9	OIL SPILL RESPONSE CRAFT	CRAFT NAME	DESCRIPTION	RESPONSE CAPABILITY	
				PLEASE PROVIDE PARTICULARS AT SECTIONS 2-6	
10	OSRO PARTICULARS (IF OUTSOURCED)	OPERATOR NAME			
		ADDRESS			
		PHONE NO.			
		FAX NO.			
		E-MAIL			
		ENGAGEMENT EXPIRY DATE			
		EQUIPMENT ON HIRE		PLEASE PROVIDE PARTICULARS AT SECTIONS 2-7	
		IMO OPRC LEVEL TRAINED PERSONNEL ON HIRE		PLEASE PROVIDE PARTICULARS AT SECTION 8	
		MANPOWER ON CALL			
		CRAFT ON HIRE		PLEASE PROVIDE PARTICULARS AT SECTION 9	
11	OIL SPILL CONTINGENCY PLAN		YEAR PUBLISHED	DATE OF LAST REVISION	STATUS OF APPROVAL BY COAST GUARD
12	PERSONNEL TO BE CONTACTED IN CASE OF SPILL	NAME	DESIGNATION	CONTACT PARTICULARS (a) LANDLINE (b) MOBILE (c) FAX (d) E-MAIL	
13	MoU DETAILS (IF ANY)				

Annexure X

The certificate of endorsement

Certificate of Endorsement

(To be certified personally by an officer not below the post of Deputy Conservator of a port facility or the Installation Manager of an oil installation, or offshore installation, or equivalent legally responsible authority)

I hereby certify that:

1. The oil spill contingency plan for the facility under my charge has been prepared with due regard to the relevant international best practices, international conventions, and domestic legislation.
2. The nature and size of the possible threat including the worst case scenario, and the resources consequently at risk have been realistically assessed bearing in mind the probable movement of any oil spill and clearly stated
3. The priorities for protection have been agreed, taking into account the viability of the various protection and clean-up options and clearly spelt out.
4. The strategy for protecting and cleaning the various areas have been agreed and clearly explained.
5. The necessary organization has been outlined, the responsibilities of all those involved have been clearly stated, and all those who have a task to perform are aware of what is expected of them
6. The levels of equipment, materials and manpower are sufficient to deal with the anticipated size of spill. If not, back-up resources been identified and, where necessary, mechanisms for obtaining their release and entry to the country have been established.
7. Temporary storage sites and final disposal routes for collected oil and debris have been identified.
8. The alerting and initial evaluation procedures are fully explained as well as arrangement for continual review of the progress and effectiveness of the clean-up operation
9. The arrangements for ensuring effective communication between shore, sea and air have been described.
10. All aspects of plan have been tested and nothing significant found lacking.
11. The plan is compatible with plans for adjacent areas and other activities.
12. The above is true to the best of my knowledge and belief.
13. I undertake to keep the plan updated at all times and keep the Indian Coast Guard informed of any changes through submission of a fresh certificate of endorsement.

Seal

Signature
Name
Designation
Organisation

Place

Date

Annexure XI

The SOP for pre-booming

Standard Operating Procedure

The Standard Operating Procedures (SOP) for pre-booming will be as follows:-

- The deliverer will deploy the boom such that it completely surrounds the vessel(s) and facility/terminal dock area directly involved in the oil transfer operation or the deliverer may pre-boom the portion of the vessel and transfer area which will provide for maximum containment of any oil spilled into the water.
- The boom will be deployed with a minimum stand-off of five feet away from the sides of a vessel, measured at the waterline. This stand-off may be modified for short durations needed to meet a facility or ship's operational needs.
- The deliverer will periodically check the boom positioning and adjust as necessary throughout the duration of the transfer and specifically during tidal changes and significant wind or wave events.
- For pre-boomed transfers, within one hour of being made aware of a spill, the deliverer will be able to complete deployment of the remaining boom, should it be necessary for containment, protection, or recovery purposes.
- The determination of safe and effective booming must be made prior to starting a transfer or, if conditions change, during a transfer.
- The deliverer must be able to quickly disconnect the entire boom in the event of an emergency.

Alternative Measures

If owing to metrological or other factors or mobility desired of the tanker and it's assisting craft it is not feasible to safely and effectively implement pre-booming as a SOP, the following alternate measures will be taken by the deliverer to address ecological sensitivity concerns of the areas likely to be affected by the spill:-

- As an alternative to pre-booming, a suitable oil spill response craft will be stationed during cargo discharge, in the vicinity of the tanker for immediate response.
- On being made aware of a spill, the deliverer will have the ability to safely commence tracking of the spill in low visibility conditions.
- Within one hour of being made aware of a spill, the deliverer will be able to completely surround the vessel(s) and facility/terminal dock area directly involved in the oil transfer

operation, or the deliverer may pre-boom the portion of the vessel and transfer area which will provide for maximum containment of any oil spilled into the water.

Annexure XII

Pro forma for Annual Returns on preparedness for oil spill response and joint inspection

Pro forma for Annual Returns on Preparedness for Oil Spill Response and Joint Inspection

Appendix E7/G.Rev.1 to NOS-DCP 2015
(Para 4.7 & 4.9 refers)

MAIN PARTICULARS		
1.	Name *	
2.	Place *	
3.	Head of Agency *	
4.	Head of HSE *	

OIL HANDLING INFORMATION						
5.	Total quantity handled *					
6.	Oil handling jetties	*Sl no.*	1	2	3	4
		Jetty				
		Length (m)				
7.	No. of SPM's (if any)					
8.	Average no. of Ships handled		Daily	Weekly	Monthly	Annually
9.	Other oil facilities					

OIL SPILL RESPONSE ORGANISATION				
10.	Chief incident Controller			
11.	Site Incident Controller(s) *		1*	
			2	
			3	
			4	
12.	Administration & Communication Coordinator			
13.	Support Services	Human Resource Services Coordinator		
14.		Logistics Service Coordinator		
15.		Media and Public Relation Coordinator		
16.		Operations and Technical Coordinator		
17.		Environmental and Scientific Coordinator		

18.	Training	Date	No. of participants	Nature of training and brief remarks

19.	Mock drills and exercises	Date	Scale/ level of exercise/ drill	Agency conducting exercise	No. of participants	Agencies participated

STATUS OF CONTINGENCY PLAN		
20.	Plan date *	
21.	Plan approval date	
22.	Plan last resubmission date	
23.	Date of last revision	
24.	Remarks on status	

ASSESSMENT OF CONTINGENCY PLAN			
25.	Has there been a realistic assessment of	the nature and size of the possible threat?	
		the resources at risk?	
		the probable movement of oil spill?	
26.	Have priorities for protection been agreed?		
27.	Has strategy for protecting and cleaning the various areas been agreed and clearly explained?		
28.	Has the necessary organisation been outlined and the responsibilities of all those involved been clearly stated with no 'Grey areas'?		
29.	Will all who have a task to perform be aware of what is expected of them?		
30.	Are the levels of following sufficient to deal with the anticipated size of spill?	Equipment?	
		Materials?	
		Manpower?	
	If not	have back-up resources been identified?	
		have mechanisms for obtaining their release and entry to the country been established?	
31.	Have the following been identified for collected oil and debris?	temporary storage sites	
		final disposal routes	
32.	Are the alerting and initial evaluation procedures fully explained?		
33.	Are the arrangements for continual review of the progress and effectiveness of the clean-up operation fully explained?		
34.	Have arrangements for ensuring effective communication been described?		
35.	Have all aspects of the plan been tested and nothing significant found lacking?		
36.	Is the plan compatible with plans for adjacent areas and other activities?		

RESOURCES AT RISK IN WORST CASE SCENARIO						
37.	Environment	Coral reefs (m^2)	Swamps/ marshes (m^2)	Fish/ spawning grounds (m^2)	Bird breeding/ flocking areas (m^2)	Estuaries (m^2)
38.	Commercial *	Agricultural land (km^2)	Fish farms (m^2)	Aquaculture farms (m^2)	Water intakes (Name & no)	Salt Pans (m^2)
39.	Plankton		Marine mammals	Sheltered shoreline	Shallow sub- tidal	
40.	Recreational		Tourist beaches (Names)	Amenity beaches (Names)	Bathing beaches (Names)	Pilgrimage beaches (Names)
41.	Wildlife and forest		Mangroves (m^2)	Endangered Species (names)	Marine National parks (m^2)	Wild life habitats parks (m^2)

RESPONSE RESOURCES					
42.	Containment equipment *	Description	Length	Quantity (no.)	Operational status
43.	Recovery equipment *	Description	Capacity	Quantity (no.)	Operational status
44.	Temporary storage facility *	Description	Capacity	Quantity (no.)	Operational status
45.	OSD spraying system *	Description		Quantity (no.)	Operational status
46.	Oil spill dispersant	Make		Quantity (liters.)	Expiry date
47.	Shoreline response equipment	Description (if applicable)	Capacity	Quantity(no.)	Operational status
TRAINED RESPONDERS					
48.	IMO OPRC level 1 Trained Responders *	*Name*	*Designation*	*Contact no.*	*Date of certificate*
49.	IMO OPRC level 2 Trained Responders *				
50.	Oil spill response craft	*Craft name*	*Description*	*Response capability*	
				Please fill particulars at Sl. 42-46	

E7/G.Rev.1

EXTERNAL RESOURCES				
51.	OSRO particulars	Operator name		
		Address		
		Phone no.		
		Fax no.		
		E-mail		
		Engagement expiry date		
		Equipment on hire	Yes/No	Please fill particulars at Sl. 42-47
		Trained responders on hire	Yes/No	Please fill particulars at Sl. 48-49
		Manpower on call	Yes/No	Please fill particulars at Sl. 48-49
		Craft on hire	Yes/No	Please fill particulars at Sl. 50
52.	MoU details (if any)			
FUTURE PLAN				
53.	Proposed jetty/ terminal/ SPM			
54.	Proposed acquisition of response equipment			
CERTIFICATION				
(To be certified personally by an officer not below the post of Deputy Conservator of a port facility or the Installation Manager of an oil installation, or offshore installation, or equivalent legally responsible authority)				
55.	Certified By	Name: *		
		Designation: *		
		Contact No: *		
		Mobile No: *		
		Fax No:*		
		Email Id: *		
		Date: *		

INTERACTION WITH AUTHORITIES RELEVANT FOR SPILL MANAGEMENT			
56.	Interaction Date	Official interacted with	Brief outcome of interaction

COMMENTS (for Coast Guard Use Only)					
			(Check relevant box)		
			Unsatisfactory	*Satisfactory*	*Very Satisfactory*
57.	Response Preparedness				
58.	Efficiency	Equipment handling			
59.	Adequacy	Equipment			
		Trained Manpower			
		Crafts and vessels			
		Infrastructure			
		Support			
60.	Overall assessment				
61.	Final assessment comments				

Name:	*Designation:*	*Signature:*
Date:		
Note : (*) Required field mandatory		

Oil Spill Disposal ⇒ Agencies.
21/06/2016
from.
KPT.

STATEMENT SHOWING KANDLA PORT REGISTERED PARTIES FOR REMOVAL OF GARBAGE, USED OIL/WASTE OIL ETC.

Sr. No.	Name of Party	License for Removal of	Last Validity of License	Remarks
1	M/s. Harish A. Pandya 15, Brahm Samaj Bldg,Plot-106,Sec-08 Behind Oslo Cinema, G'dham- Kachchh	Dry Solid Waste (Non-hazardous) Kandla,Vadinar& Tuna	From 18/12/2015 to 17/12/2016	info@harishpandya.com
2	M/s. Alicid Organic Industries Ltd., Fact.- 207/208 Hanumant Henduva, Opp. Gujcomasol, Near Khari River,Highway Post - Palavasana, Mehsana - 2.(Guj)	Waste Oil/Used Oil Kandla & Vadinar	From 5/12/2015 to 4/12/2016	alicidorganic@gmail.com naazshippingservice@hahoo.co.in
3	M/s. Shree Venkatesh Engineering Works, Valsura Road Jamnagar-361 002	Dry Solid Waste (Non-hazardous) Vadinar Port	From 12/12/2012 to 11/12/2013	admin@venkateshengg.com Not renewed
4	M/s Continental Petroleum Limited A-166 & F-162-165, RIICO Industrial Area, Behror - 301 701 Dist :- Alwar (Rajasthan)	Used Oil/ Waste Oil Kandla	From 14/10/2015 to 13/10/2016	conpetco@gmail.com Not renewed
5	M/s. Industrial Esters & Chemicals P. Ltd., 202, Madhav Appartment, Jawahar Road, Ghatkopar (East), Mumbai- 400 077	Waste Oil/Used Oil Kandla	From 2/12/2015 to 1/12/2016	sludgeoil16@yahoo.co.in
6	M/s. Anna Pertrochem Pvt. Ltd., E-49, RICCO Growth Center, Phase-II P.O. :Maval, Ambaji Industrial Area, Abu Road - 307 026 (Rajasthan)	Waste Oil /used oil Kandla & Vadinar	From 4/9/2015 to 3/9/2016	annapetrochemempvtltd@yahoo.com annapetrochemempvltd@gmail.com
7	M/s. Jay Ambe Thinchem, Plot No.- C-1/B-2010, IV Phase, GIDC, Vapi -396 195	Waste Oil/Used Oil Kandla	From 7/5/2015 to 6/5/2016	sludgeoilindia@yahoo.com
8	M/s Gujarat Petrochem Plot No.48-50, GIDC, Vartej Bhavnagar	Waste Oil/Used Oil Kandla	24/12/2009 to 23/12/2010	gujoilad1@yahoo.com Not renewed
9	M/s. Reliance Barrel supply Company 200/34, Behind Kashiram Textile Mill, Narol - Ahmedabad-382 405	Waste Oil/ Used Oil Kandla Port	From 11/03/2013 to 10/03/2014	Not renewed
10	M/s. Hind Petrochem & Refinery Survey No.109 & 111, Part of village Pratapnagar Ta.Savli Dist :- Vadodara	Waste Oil/ Used Oil Kandla Port	From 11/08/2014 to 10/08/2015	hindpetro@hotmail.com Not renewed
11	M/s Gujarat Mobil Pvt.Ltd. R.Survey No.62, Paiki,Behind Plot No.62/A,B,C Vill :- Mamsan Dist : Bhavnagar	Waste Oil/ Used Oil Kandla Port	From 21/12/2011 to 20/12/2012	gmpl1996@gmail.com Not renewed

12	M/s Sanna Oil Process, New Good Luck Market, Opp.PWD stores, Chandola lake, Narol Road, A'bad-380028	Waste oil/ Used oil Kandla Port	From 21/01/2016 to 20/01/2017	kandla.sludgeremoval35@gmail.com shanaoilprocess@yahoo.com
13	M/s Balaji Rang Udyog Pvt. Ltd. Plot No.44,MIDC, Taloja Industrial Area(NCZ), Taloja - 410208 Dist : Raigad(MS)	Waste Oil Kandla Port	From 28/12/2011 to 30/06/2012	Not renewed
14	M/s Shri Rang Petrochem Industries 51/A, AKVN Industrial Area, Meghnagar-457779 Dist : Jhabua (M.P.)	Waste Oil/Used Oil Kandla Port	From 26/02/2013 to 25/02/2014	srpimp06@rediffmail.com Not renewed
15	M/s. United Shipping Company Plot No.167, Sector-1/A G'dham- Kachchh	Waste Oil/Used Oil Kandla Port	From 10/06/2015 to 9/06/2016	info@risinggroup.co sunil@risinggroup.co pritam@risinggroup.co
16	M/s Tanu Petrochem Pvt.Ltd. Plot No.238, PHASE-II,IDA, Pashamailaram (U), Patancheru(M) Medak District - 502 307 (AP)	Used Oil/ Waste Oil Kandla	From 6/07/2012 to 5/07/2013	Tanu_Petrochem@yahoo.com Not renewed
17	M/s Navkar Enterprise, Block - 185/186,Village :- Chachravadi, Tehsil :- Sanand, Dist :- Ahmedabad (Guj)	Waste Oil/Used Oil Kandla/ Vadinar	From 8/09/2015 to 7/09/2016	pjani885@gmail.com
18	M/s. Fine Refiners Pvt. Ltd. Plot-40, GIDC, Vartej, Bhavnagar - 364 401 (Guj)	Used Oil/ Waste Oil Kandla	From 20/04/2016 to 19/04/2017	info@finerefiners.com
19	M/s Vishwa Trade Link Inc., Plot No.170/2/A, TP-03, Anjar - Kachchh	Dry Soild Waste (Non-hazardious) Kandla/Vadinar	From 3/12/2014 to 2/12/2015	vishwatradelink@gmail.com umit_jani@yahoo.com
20	M/s. Chirag Enterprise, SRC Shop No.05, Khanna Market, G'dham- Kachchh	Dry Soild Waste Non-hazardious Kandla	From 18/5/2012 to 17/5/2013	nur_sekh@yahoo.com Not renewed
21	M/s. Naaz Shipping Services, Office No.35, First Floor, Grain Merchant Association Bldg. Plot No.297, Ward-12-B, Near Old Court, Gandhidham	Dry Soild Waste Non-hazardious Kandla /Vadinar	From 23/9/2015 to 22/9/2016	naazshippingservice@hahoo.co.in nasirkhan685@gmail.com
22	M/s Jai Ambe Industries 11,Uma Industrial Estate,Opp. Mahalaxmi Rubtech,Vasna, Iyava village Ta:-Sanand- Dist.A'bad	Used Oil/ Waste Oil Kandla	From 7/11/2012 to 6/11/2013	hapandya2003@yahoo.com Not renewed

23	M/s Daman Ganga Paper Mill Pvt.Ltd. Plot No.257/258, Silvasa Road, GIDC, Vapi Valsad	Used Oil/ Waste Oil Kandla	From 17/12/2013 to 16/12/2014	damanganga@damanganga.com Not renewed
24	M/s abc Petrochem Pvt.Ltd Gut No.10, Vill :-Vardha, Tal. Wada, Dist.:- Thane (MS)	Used Oil/ Waste Oil Kandla	From 12/12/2012 to 11/12/2013	Not renewed
25	M/s R.S.Oil Industries Junglepur, Jalan Industrial Complex, Baniyara, P.O.Begri, Domjur Howrah-711411	Used Oil/ Waste Oil Kandla	From 7/1/2013 to 6/1/2014	rsoilindgo@gmail.com Not renewed
26	M/s Kutch Petrochem Pvt Ltd. Plot No.121, Sect- 9-C, Behind Ashok Leyland Gandhidham-Kachchh	Used Oil/ Waste Oil Kandla/Vadinar	From 29/1/2016 to 28/1/2017	kutchppl@rediffmail.com karanpandya@yahoo.in thakarjimmy@gmail.com
27	M/s Talha Traders Plot No.B-510, NU-4, Sapnanagar Gandhidham-Kachchh	Dry Soild Waste Non-hazardious Kandla	From 26/7/2013 to 25/7/2014	Not renewed
28	M/s Omega Marine Services Shop No.2, Brahm samaj Building Plot No. 106, Sector-8, Gandhidham	Dry Soild Waste Non-hazardious Kandla	From 12/5/2016 to 11/5/2017	omegamvn@hotmail.com karanpandya@yahoo.in thakarjimmy@gmail.com
29	M/s North East Lubricia Pvt.Ltd. Factory :- Survey No.404, Village Abitghar, Tal :- Wada, Dist :- Thane -421 303 (MS)	Used Oil/ Waste Oil Kandla	From 24/1/2014 to 23/1/2015	www.nelubrica.com Not renewed
30	M/s Rajdeep Enterprise, Factory :- Survey No.246, Plot No.5, Opp. Galaxy, Bearings Ltd., Rajkot-Gondal N.H.No.8-B, Shapar (Veraval)	Used Oil/ Waste Oil Kandla	From 19/5/2015 to 18/5/2016	rajdeep_enterprise@yahoo.co.in
31	M/s Poonam Petrochem Pvt. Ltd. 513, Nasibullah Compound, Kurla- Kalina Road, Near Baghadad Hotel, Kurla (W) Mumbai- 400 070	Used Oil/ Waste Oil Kandla	From 6/12/2014 to 5/12/2015	poonampetro@gmail.com Not renewed
32	M/s Priyanshi Corporation C/o Maruti Petroleum, Shop No.2 N.H.-8 B, Shapar Veraval Ta.Kotda, Sangani, Dist-Rajkot-360 024	Used Oil/ Waste Oil Kandla	From 19/8/2015 to 18/8/2016	Contact No.7383599838 Mr.Sharad Jain
33	M/s Atlas Organic Pvt.Ltd. Office No.204/206, Elisbridge Shopping Centre, Opp Town Hall, Ashram Road, A'bad -380 006	Used Oil/ Waste Oil Kandla	From 17/9/2015 to 16/9/2016	atlasorganics@yahoo.com
34	M/s Shine Petrochem A-804, Samudra Complex, Near Classic Gold Hotel, Off-C.G.Road Navrangpura- A'bad	Used Oil/ Waste Oil Kandla	From 9/9/2015 to 8/9/2016	shinepetrochem@gmail.com
35	M/s Amar Hydro Carbon Pvt Ltd. Plot No.36, Survey No.165/1 to 180/1+2, Narayan Estate, Near IOC Pump, Iyava Tal. Sanand, Dist- A'bad	Used Oil/ Waste Oil Kandla	From 14/10/2015 to 13/10/2016	amarhydrocarbon@gmail.com

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e-mail: kitcotvm@gmail.com

Annexure –M

Port Certification (ISO 14001:2015) for “Providing port facility and related maritime services for vessel and Cargo handling including storage”

Your Quality Partner

JOVIAL

Certificate of Registration

This is to certify that

Environmental Mangement System

of

Deendayal Port Trust

Administrative Office Building,
Post Box No.50,
Gandhidham (Kutch)-370 201.
Gujarat State, INDIA.

complies with the requirements of

ISO 14001 : 2015

This certificate is valid concerning all activities related to

"Providing Port Facility and Related Maritime Services for Vessels and Cargo Handling Including Storage."

Jan. 01, 2020
Date of Initial Registration

Jan. 01, 2020	**Jan 01, 2023**	**E:201002**	
Date of Issue	Valid untill*	Certificate No.	Managing Director

AHMEDABAD

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United Kingdom www.globalaccreditation.org

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** Lake of fulfillment of conditions set out for the issuance of this certificate and timely completion of periodic surveillance audit may render this certificate invalid.*
Version 1.2

Annexure –N

Final Report on “Making Deendayal Port a Green Port– Intended Sustainable Development under the Green Port Initiatives” by M/s GEMI, Gandhinagar (2021)

Making DEENDAYAL PORT a Green Port

Intended Sustainable Development under the Green Port Initiatives

FINAL REPORT

Prepared for:

DEENDAYAL PORT TRUST
(ERSTWHILE KANDLA PORT TRUST)
Administrative Office Building, Post Box No. 50,
Gandhidham (Kutch), Gujarat: 370 201

Prepared by:

GUJARAT ENVIRONMENT MANAGEMENT INSTITUTE (GEMI)
(An Autonomous Institute of Government of Gujarat)
Block No. 13, 3rd Floor, Dr. Jivraj Mehta Bhawan,
Sec-10B, Gandhinagar-382010

We Provide Environmental Solutions

Report No. GEMI/DPT/782/2020-21/46
March, 2021

Disclaimer:

This report has been prepared by Gujarat Environment Management Institute (GEMI), solely as a part of the project "Making Deendayal Port a Green Port – Intended Sustainable Development under the Green Port Initiatives". GEMI has taken all reasonable precautions in the preparation of this report. GEMI believes that the information and facts presented in the report are accurate as on the date it was written. However, it is impossible to dismiss absolutely, the possibility of errors or omissions. GEMI therefore specifically disclaims any liability resulting from the use or application of the information contained in this report. The information is not intended to serve as legal advice related to the individual situation.

ABOUT THIS DOCUMENT

Name of the Document:	Making Deendayal Port a Green Port – Intended Sustainable Development under the Green Port Initiatives: Final Report
Version:	2.0
Report No.	GEMI/DPT/782/2020-21/46
Prepared by:	Gujarat Environment Management Institute (GEMI)
Prepared for:	Deendayal Port Trust (erstwhile Kandla Port Trust)
Project Period:	July-2019 to March-2021

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CHAPTER-1: INTRODUCTION

1.1. About Deendayal Port

Deendayal Port (erstwhile Kandla Port) is the busiest port of India and serves as the gateway for the trade generating from/to the entire Northern India. In the terms of cargo handling, Kandla Port has achieved the first position among all the Major Ports of India, in most of the years in last decade. To enhance the cargo handling capacity and to handle bigger size vessels, Deendayal Port has long been focusing on various measures like adding the new facilities, strengthening the existing facilities, etc.

Deendayal Port is situated at Latitude 23º 01' N and Longitude 70º 13' E on the shores of the Kandla Creek. It is in the district of Kutch and is located on the west bank of Kandla creek which runs into the Gulf of Kutch at a distance of 90 nautical miles from the Arabian Sea. The width of the channel varies from 200 meters to 1,000 meters. The contour depth along the shipping channel is around 10 meters. The total length of the Deendayal Port approach channel is around 23 kms. Navigation is permitted during the day and night according to the draft of the ship. Pilots board the ships at Outer tuna buoy (OTB) at least two hours before high tide. Dredging is undertaken throughout the year. Ships with 13 meters draft can also be brought in during the tidal window.

The port is operational throughout the year as it is an all-weather port. There are no adverse wave effects as it is a sheltered port situated in a creek. There is scanty rainfall in this region which is one of the main reasons that the port can handle food grains. The port is well connected with the hinterland by broad gauge railway system and National Highway No. 8-A. The port can handle dry bulk, break bulk, liquid bulk and container cargo. Deendayal Port is the closest major port to the Middle East and Europe. It is also enroute port for ships calling at Karachi, Pakistan's only major port handling its seaborne cargo.

1.2. About Green Ports Initiative

Weighing in the environmental perspective for sustained growth, the Ministry of Shipping, Govt. of India has started 'Project Green Ports' which will help in making the Major Ports across India cleaner and greener. 'Project Green Ports' will have two verticals - one is 'Green Ports Initiatives' related to environmental issues and second is 'Swachh Bharat Abhiyaan'.

The Green Port Initiatives include twelve initiatives which will be implemented under strict time bound fashion in order to achieve the targets. Some of these initiatives are preparation and monitoring plan, acquiring equipments required for monitoring environmental pollution, acquiring dust suppression system, setting up of sewage/waste water treatment plants/ garbage disposal plant, setting up projects for energy generation from renewable energy sources, completion of shortfalls of Oil Spill Response (OSR) facilities (Tier-1), prohibition of disposal of almost all kind of garbage at sea, improving the quality of harbour wastes etc.

1.3. Scope of Project

The scope of work entrusted to GEMI vide DPT's letter no. EG/WK/4751/Part (Green Port)/221 dated 29/06/2019 is as below:

- To study the existing Port layouts, existing infrastructure facilities, existing Environmental related issues including Green Cover area developed by the Port viz. a viz. requirement as per Environmental guidelines, Sewage Treatment facility, water supply, sanitation, energy generation from renewable energy sources, Oil spill response system, Solid Waste Treatment Facility, Pollution Control measures taken by the Port, etc.
- To study all EIA Reports, EC & CRZ Clearances conditions etc. and suggest measures for implementation of EMP's and the said stipulated conditions.
- To study other available reports like DMP, Oil Spill Plan etc. and suggest corrective measures for effective implementation.

- To suggest measures for preservation & Improvement in existing Green area developed by DPT, improvement in existing monitoring mechanism of Environmental Parameters, Oil Spill Plans, Sewage Treatment Facilities etc.
- To suggest green area development in and around the port, as per the statutory requirements in compliance of stipulated criteria for developing Green cover by the MoEF&CC,GoI/CPCB/GPCB.
- To suggest suitable measures for solar/wind energy generation in and around the Port area.
- To suggest measures for effective implementation of coal handling guidelines issued by the GPCB for handling & storage of coal at Port area.
- To suggest suitable Green Port Initiatives for improvement & making DPT a Green Port.
- Prepare photo imagery of landscape ideas, for future planning.
- Prepare Tentative Financial Modeling for implementation of entire planning.
- Submission of 3D Scale Model of the entire Green Planning.

1.4. Documents Referred:

GEMI studied and referred the following information, data and documents provided to it by DPT:

Table 1.1: Documents referred by GEMI

S. No.	Name of activity	Documents / information required by GEMI	Documents / Information provided by DPT
1.	Port infrastructure	Existing port layouts	• Cargo jetty Layout • Master Plan • Land Use Plan • Layout of STP – Kandla • Layout of STP- Gopalpuri • Layout – Gopalpuri Colony • Layouts of office buildings (Admin Office, Gandhidham, Nirman Bhawan, Port & Customs Office, Marine Building, Sewa Sadan-I, II and III)
2.	Green cover	Map or layout of existing green cover	Details of greenbelt development by Forests Dept.
		Details of species	Not available
3.	Sewage Treatment Facility	CC&A of Port (latest copy containing all amendments)	Consolidated CCA of Port
		List with details of sewage treatment facilities	Total two STP's: • Kandla STP – 1.5 MLD capacity • Gopalpuri STP – 0.8 MLD capacity (Under up gradation)

<table>
<tr><td rowspan="2"></td><td rowspan="2"></td><td>Quantity of sewage generated</td><td>Sewage generated at Port area and Port colonies is being properly treated through Sewage Treatment Plants outside Port area at Kandla (capacity 1.5 MLD) and Port Colony at Gopalpuri (capacity 0.8 MLD). The said STP’s are operated & maintained by DPT. The quality of outlet water is being monitored by M/s Detox Corporation (NABT accredited lab).</td></tr>
<tr><td>Quality of treated sewage (analysis reports) and mode of disposal</td><td>3rd Annual Environment Monitoring Report (February 2018 to January 2019) prepared by M/s Detox Corporation, Surat</td></tr>
<tr><td rowspan="2">4.</td><td rowspan="2">Water supply and sanitation</td><td>Water balance diagram showing daily water requirement</td><td>Copy of water balance diagram</td></tr>
<tr><td>Source of raw water, water treatment facilities if any</td><td>GWSSB and through tankers</td></tr>
<tr><td rowspan="3">5.</td><td rowspan="3">Energy generation from renewable energy sources</td><td>Details of renewable energy sources within port</td><td rowspan="3">Total Power requirement of Port was 13.54 MUs in FY- 2018-19.
The sources of power are PGVCL & Renewable Energy.
20.7 MW wind Farm was commissioned by DPT, from which 6.0 MW was commissioned in the year 2017 and 14.7 MW was commissioned in the year 2019.<table><tr><td>S.N</td><td>Power Generation capacity</td><td>Installed capacity in MW</td><td>Location</td><td>Year of installation/ commissioning</td><td>Capital cost in Rs.</td></tr></table></td></tr>
<tr><td>Units of energy generated from them</td></tr>
<tr><td>% contribution to total energy consumption of port</td></tr>
</table>

<table>
<tr><td></td><td></td><td></td><td><table><tr><td>1</td><td>Wind Power</td><td>6 MW</td><td>Sukhpur, Amreli, Rajkot</td><td>29/3/2018</td><td>34.71 cr.</td></tr><tr><td>2</td><td>Wind power</td><td>14.7 MW</td><td>Jodiya-II, Jamnagar</td><td>30/3/2019</td><td>91.54 cr.</td></tr></table></td></tr>
<tr><td>6.</td><td>Oil spill response system and oil spill plan</td><td>Oil spill plans</td><td>Copy of Oil Spill Plan</td></tr>
<tr><td>7.</td><td>Solid Waste Treatment Facility</td><td>CC&A of Port (latest copy containing all amendments)</td><td>Consolidated CCA of Port</td></tr>
<tr><td rowspan="3">8.</td><td rowspan="3">Pollution Control measures taken by the Port</td><td>Details of ETPs and STPs</td><td>Total two STP's:
• Kandla STP – 1.5 MLD capacity
• Gopalpuri STP – 0.8 MLD capacity (Under upgradation)</td></tr>
<tr><td>Details of Air pollution control measures (e.g. dust suppression systems)</td><td>As a preventive measures DPT has installed fixed water sprinklers at 40 hectares plot to control the dust emission from coal. Whereas other coal storage areas, the port users are deploying tank lorries for water sprinkling and physical covering by tarpaulin.
Copy of SOP for coal handling</td></tr>
<tr><td>Details of any other pollution control measures</td><td>The roads are cleaned by deploying sweeping machines by port users. It is done frequently every day.</td></tr>
</table>

			For cleaning and housekeeping of the dirty cargo areas, the port users are deploying labours and sweeping machines for cleaning the surrounding areas etc. DPT has been constantly striving to improve its environmental performance by Implementing various pollution control measures.
9.	EIA Reports & EC letters	EIA Reports and EC letters of DPT in chronological order	EIA Reports and EC Letters of the following projects: • Construction of 13th to 16th Cargo berths at Kandla Port • Development of Plots for construction of Liquid Storage Tank Farms at Kandla Port • Development of Plots for construction of Warehouse/Godowns Stage II at Kandla Port • Setting up of SPM and allied facilities at Veera on BOT basis • Development of 7 integrated facilities within existing Kandla Port at Kandla • Smart Industrial Port City – Location 1 & 2
10.	CRZ Clearances	CRZ clearance letters in chronological order	CRZ Clearance Letters of the following projects: • Developing Integrated facility within the existing Kandla Port • Construction of 13th to 16th Cargo Berth at Kandla, District Kachchh • Development of plots for construction of Liquid Storage Tank Farm • Development of Plots for Construction of Warehouse/Godown-Stage-II

			• Setting up of single point Mooring (SPM) and allied facilities off veera in Gulf of Kuchchh for handling crude oil on BOT basis
11.	Disaster Management Plan	Disaster management plan	Copy of Disaster management plan
12.	Coal handling and storage	Details of coal handling and storage operations viz. area, method of loading and unloading, storage	Presently area of 66 ha, 40 Ha and Bunder Basin are being used for handling of coal. Copy of SOP for coal handling
		Dust suppression systems	As a preventive measures DPT has installed fixed water sprinklers at 40 hectares plot to control the dust emission from coal. Whereas other coal storage areas, the port users are deploying tank lorries for water sprinkling and physical covering by tarpaulin.

In addition, GEMI referred the latest compliance reports of EC, CRZ and CCA available on DPT website.

CHAPTER-2: GREENBELT DEVELOPMENT

2.1. Statutory requirements w.r.t. greenbelt development:

In India, we do not have any exclusive green belt policy or green belt regulation, as available in other countries. However, on the basis of other environmental policies and Acts, we do have certain areas of land as green belts where no industrial and residential projects is encouraged. The Ministry of Environment & Forests (MoEF) has taken up different initiatives and has always promoted integration of environmental issues in developmental projects. We do have the Environmental Impact Assessment (EIA) of developmental projects, issued in 1994 and then revised in 2006.

However, the National Forest Policy, 1988 in section 4.2.2 states that, *"It is necessary to encourage the planting of trees alongside of roads, railway lines, rivers and streams and canals, and on other unutilized lands under State/corporate, institutional or private ownership. Green belts should be raised in urban/industrial areas as well as in arid tracts. Such a programme will help to check erosion and desertification as well as improve the microclimate."*

Whereas, the National Environment Policy, 2006 has recommended to *"Formulate an innovative strategy for increase of forest and tree cover from the 2003 level of 23.69 percent of the country's land area, to 33 percent in 2012, through afforestation of degraded forest land, wastelands, and tree cover on private or revenue lands."*

The conditions in various EC / CRZ clearance letters issued to DPT pertaining to greenbelt development have been summarized in the below table:

Table 2.1: Conditions in various EC / CRZ clearances pertaining to greenbelt development

Project	EC Condition	CRZ Condition
Development of 7 integrated facilities (Stage I) within	As proposed, green belt over an area of 36.8 ha shall be developed with at least 10-meter-wide green belt on all sides along the	The KPT shall take up massive greenbelt development activities

<table>
<tr><td>existing Deendayal Port at Kandla</td><td>periphery of the project area, in downward direction and along road side etc. Selection of plant species shall be as per the CPCB guidelines in consultation with the DFO.
<table><tr><th>Project</th><th>Plantation (ha)</th></tr><tr><td>Development of Oil Jetty at Old Kandla</td><td>1.82</td></tr><tr><td>Multi-purpose Cargo Jetty at Tekra off Tuna on BOT basis</td><td>33.33</td></tr><tr><td>Upgradation of Barge handling facility at Bunder basin</td><td>1.65</td></tr></table></td><td>in and around Kandla and also within the KPT limits</td></tr>
<tr><td>Construction of 13th to 16th Cargo Berths at Deendayal Port Trust</td><td>Green belt area shall be developed along the project and budget earmarked.</td><td>The KPT shall take up massive greenbelt development activities in and around Kandla and also within the KPT limits.</td></tr>
<tr><td>Development of plots for construction of Liquid Storage Tank Farm at Kandla</td><td>The greenbelt of the adequate width and density preferably with local species along the periphery of the plot shall be raised so as to provide protection against particulates and noise</td><td>The project proponents shall take up mangrove plantation in an area of 50 ha. As well as green belt development activities in consultation with the Gujarat Institute of</td></tr>
</table>

		Desert Ecology/Forest Department.
Development of plots for construction of Warehouses / Godowns (Stage II) at Kandla	KPT shall take up massive greenbelt development activities in and around Kandla and also within the KPT limit	KPT shall take up massive greenbelt development activities in and around Kandla and also within the KPT limit
Development of plots for construction of Warehouses / Godowns (Stage II) at Kandla	The green belt shall be developed along the boundary and internal roads. The open spaces inside the project shall be suitably landscaped and covered with vegetation of indigenous variety. The area earmarked as green area shall be used only for greenbelt and shall not be altered for any other purpose. Drip irrigation / low-volume, low-angle sprinkler system shall be used for the lawns and other green area including tree plantation.	-
Setting up of single point Mooring (SPM) and allied facilities off veera in Gulf of Kachchh for handling crude oil on BOT basis by Kandla Port Limited	-	The KPT shall take up mangrove plantation in an area of 50 Ha. as well as greenbelt development activities in consultation with the Gujarat ecology commission/ forest department.

In view of the above conditions, GEMI has prepared the greenbelt development plan of the entire port area.

2.2. Existing Greenbelt (Afforestation by Forests Dept.)

2.2.1. Afforestation by Forests Dept.

Details of the afforestation carried out by Forests Dept. as provided by DPT are given in the table below:

Table 2.2: Afforestation by Forests Dept. in DPT area

Location	**Length (m)**	**Area as per MoU (Ha)**	**Area afforested (Ha)**	**Remarks**
SEZ to Hand Circle	5560	10	-	Both side of road, (each side 8 m) and central verge (2 m)
Khori Rohar to Old Kandla	7270	13.086	4.05	Both side of road, (each side 8 m) and central verge (2 m)
Hand Circle to Gate-1	2330	4.194	2.14	Both side of road, (each side 8 m) and central verge (2 m)
Hand Circle to Gate-2	2590	4.662	8.08	Both side of road, (each side 8 m) and central verge (2 m)
Hand Circle to Gate-3	4420		1.10	
Statue to KPT colony & Opp. Colony	2100		4.88	
Total		**31.942**	**30.770**	Out of 35200 plants, total 33814 Plants have been completed (94.25 %)


JETTY
GATE

Fig. 2.1 Photographs of existing greenbelt at various locations

2.2.2. Sites earmarked for greenbelt development by DPT

A total area of 1300 acre has been earmarked for greenbelt in Gandhidham township by DPT. At present, the following sites and corresponding area are being developed as greenbelt:

Table 2.3: Sites and corresponding area being developed as greenbelt

Sr. No.	Name of Area	Area of Plot in acres
1.	Rotary Club of Gandhidham for developing for Dense plantation Area (forest) in the phase-1, in about 30 acres (250mts X 500 mts = 125000 sq.mts) of land in green belt area of DPT	30.88
2.	Amdekar Hall area 35000 Aq.Mt.	8.64
3.	Gujarat Forest Department, Urban Forestry Project Kachchh by Deputy Conservator of Forest at DPT owned plot.	49.42
4.	Reserved for Lake and Green Forest	86.48
	Total	**175.42 Acres**

2.2.3. Mangrove plantation by DPT

Details of mangrove plantation already carried out and proposed to be carried out by DPT are given in Table 2.4.

Table 2.4. Mangrove plantation already carried out and proposed to be carried out by DPT

Sr. No	**Name of the Organization**	**Total Mangrove Plantation carried out in Hectares till date, place of plantation and agency responsible for plantation**	**Cost incurred**
	(A) MANGROVE PLANTATION ALREDY CARRIED OUT		
1	DEENDAYAL PORT TRUST (CRZ Recommendation 13th to 16th CB issued by the GCZMA) (Total 1000 ha.)	20 Hectares – 2005-06 Satsida Bet,Kandla, by GUIDE,Bhuj	Rs. 8.8 lakhs
		50 Hectares – 2008-09 Nakti Creek, Kandla by Patel Construction	Rs. 27.4 lakhs
		100 Hectares – 2010-11 Nakti Creek, Kandla by GEC. (Board 29/1/2010)	Rs.24.5 lakhs
		200 Hectares – 2011-12 by Forest Department, GoG at Satsaida Bet	Rs. 66.5 lakhs
		300 Hectares – 2012-13 by Forest Department, GoG at Satsaida Bet	Rs. 157.5 lakhs (total 630 hectares)
		330 Hectares – 2013-14 by Forest Department, GoG at Satsaida Bet	
		TOTAL 1000 Ha.	
2	Creation of Berthing & allied Facilities off- tekra near Tuna (Outside Kandla Creek) – EC & CRZ Clearance. (Total 500 ha. – 250Ha. by DPT & 250 ha by Adani (concessionaire)	300 Hectares – 2015-17 by GEC at Kantiyajal, Bharuch District	Rs. 90.0 lakhs

	MOU signed with GEC during Vibrant Gujarat Summit 2015 for 300 Ha.		
3.	EC & CRZ Clearance dated 19/12/2016 for Developing 7 integrated facilities (Condition 100 Ha)	100 Ha. –2018- 20 by GEC	Rs. 45 lakhs
TOTAL MANGROVE Plantation till date by DPT 1400 Ha. (Total 419.7 lakhs)			
(B) Proposed Mangrove Plantation			
1.	Development of Integrated facilities (Stage-II) within the existing Deendayal Port Trust (Erstwhile Kandla Port Trust) at District Kutch, Gujarat. (1. Setting up of Oil Jetty No.7 ; 2. Setting up of Barge jetty at Jafarwadi ; 3. Setting up of Barge port at Veera; 4. Administrative office building at Tuna Tekra; 5. Road connecting from Veera barge jetty to Tuna gate by M/s Deendayal Port Trust (Erstwhile : Kandla Port Trust) - **Environmental & CRZ Clearance accorded by the MoEF&CC,GoI dated 19/12/2020.**	**50 Ha. as per CRZ Recommendation issued by the GCZMA dated 29/6/2016.**	Rs. 45 lakhs
2.	Development of 3 Remaining Integrated Facilities (stage I) within the existing Deendayal Port Trust (Erstwhile: Kandla Port Trust) at Gandhidham, Kutch, Gujarat - **Environmental & CRZ Clearance accorded by the MoEF&CC, GoI dated 18/2/2020.**	**50 Ha. as per CRZ Recommendation issued by the GCZMA dated 29/6/2016.**	

2.3. Preservation and improvement of existing greenbelt

i. **Support Irrigation:**

- For existing greenbelt, support irrigation should be done through flood irrigation once in a month except monsoon season. The estimated quantity of water is 5 litre per plant per month.

ii. **Application of fertilizer and pesticide / insecticide:**

- Application of fertilizer to be done during monsoon and at the time of flood irrigation.
- Pesticide / insecticide to be applied as per requirement.

iii. **Maintenance:**

Table 2.5: Yearly maintenance of plantation

Activity	1st year	2nd year	3rd year	4th year
Casualty replacement	20% casualty for 1st and 2nd year			
Soil working	• During monsoon soil working is mandatory after rains. • In case of flood watering, each support watering should be followed by soil working.			
Support watering	Through flood irrigation; 10 support watering per year			
Application of fertilizer	Application of fertilizer to be done during monsoon and at the time of flood irrigation			
Application of pesticide / insecticide	To be applied as per requirement			

iv. **Supervision:**

Day-to-day supervision is mandatory for successful plantation. Therefore, it is advisable to appoint one retired forest official of minimum rank of Range Forest

Officer (RFO) or Forester. He will day-to-day supervise / monitor the plantation and will carry out the tasks as per site specific requirements.

The financial estimate for preservation and improvement of existing greenbelt in port area is provided in **section 2.7**.

2.4. Greenbelt Development Plan for Deendayal Port Trust

This plan proposes to develop greenbelt in the following 3 sections viz.

1) DPT Port Area
2) Offices, Gopalpuri colony and other important buildings
3) Gandhidham Township

The section-wise plantation plan is as follows:

2.4.1. Section-1: DPT Port Area:

For ease of understanding and implementation, the **port area** has been further divided into eight (8) sub-sections as presented below:

A - Coal Handling and Storage Area

B - Plots near berth no. 11 to 16

C - Oil Jetty Area & Tank Farms

D - Plots of Godowns and Sheds near berth no. 1 to 6

E - Plots and Godowns along NH-8

F - Quay and Transit Area (from North Gate to Berth No. 10)

G - Plantation along column / pillar of Godowns

H - Roadside Plantation

Sections **A to F** have also been demarcated on a satellite image in Fig. Sections **G and H** have been shown separately.

Most of the port infrastructure contains storage yards, sheds, godowns, tank farms etc. Broadly in port area, the plantation is proposed along:

i. Periphery of plots
ii. Along roadside (including dividers)

Section-wise plantation plan has been worked out by calculating the periphery of plots as well as length of roads through high resolution satellite images. All efforts have been made to calculate the exact measurements, however, the actual length / periphery may slightly vary. All the locations were personally visited jointly by officials of GEMI and DPT to get an overview of the port operations and activities, existing plantation in the port area and scope for new plantation.

Each section has been further divided into smaller sub-sections in the form of plots. For ease of identification, each plot contains either its name or location information along with a unique nomenclature, for example **Tank farm of M/s N.P. Patel adjoining Oil Jetty No. 1** has been given nomenclature **'E2'**. For ease of identification, the periphery of plantation and nomenclature of plots have been demarcated and shown on satellite images in the subsequent sections.

The section-wise plantation plan contains the following information:

a) Dimension and periphery of the plot
b) Service area (e.g. entry and exit gates for transport vehicles, intersecting roads, railway lines etc.)
c) Length available for plantation (in metre)
d) Proposed species to be planted
e) Spacing
f) Number of rows
g) Number of plants (section-wise and species-wise)
h) Plantation model and methodology
i) Item-wise estimated quantities
j) Section-wise, item-wise and year-wise financial estimate

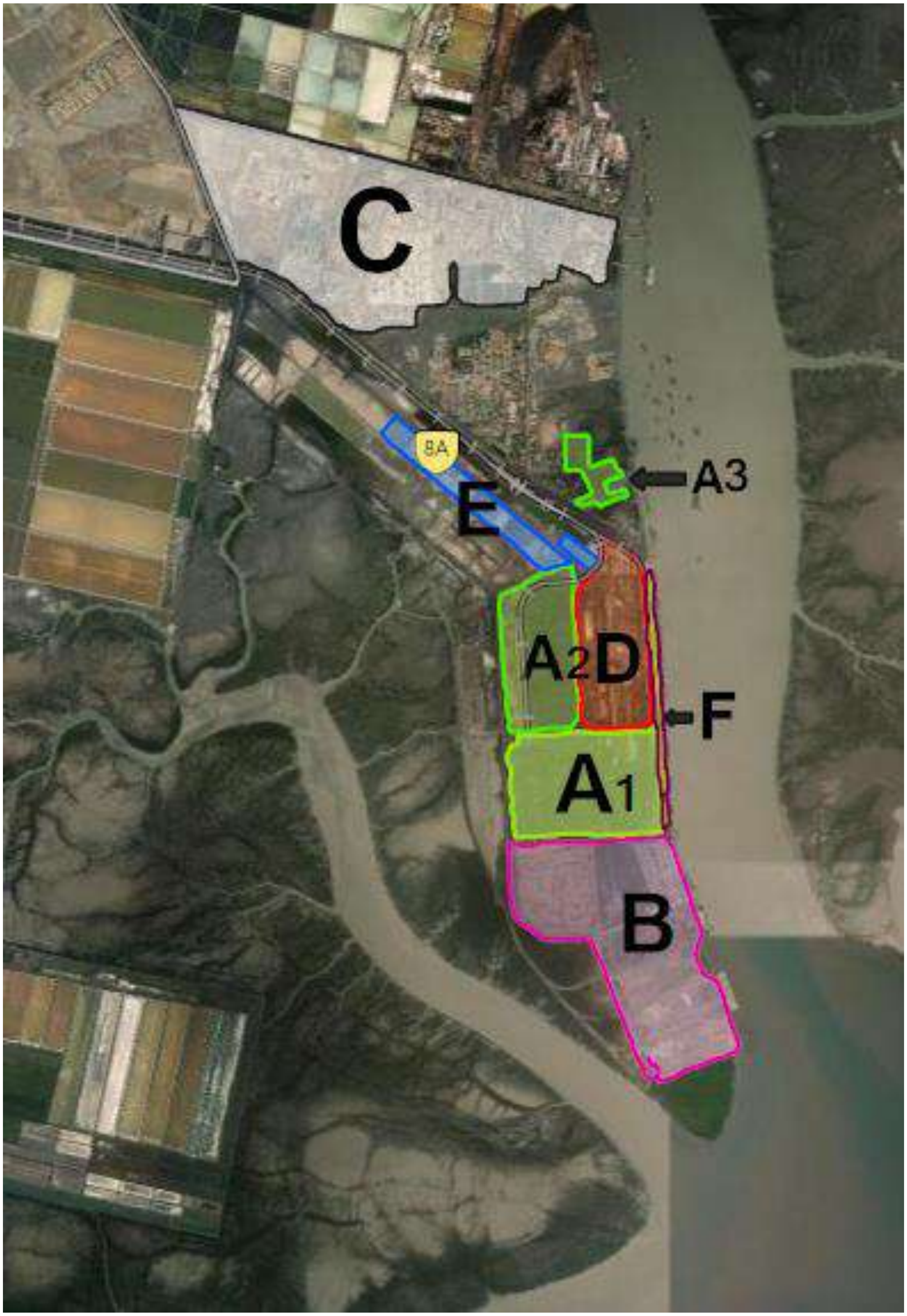


Fig. 2.1: Demarcation of port sections on satellite image

A) Coal Handling and Storage Area

Table 2.6: Plantation Plan for Coal Handling and Storage Area

Sr. No.	Location	Nomen-clature	Dimensions (m)	Periphery (m)	Service area (m)	Length available for plantation (m)	Plantation Plan				Area (sq.m.)
							Species	Spacing (m)	No. of rows	No. of plants	
1.	Coal Storage yards opposite berth no. 7-10	A1	570 * 780	2700	100	2600	Conocarpus, Pilu, Gundi	2 × 2	3	3900	7800
2.	Coal Storage yards opposite berth no. 7-10	A2	570 * 800	2740	100	2640		2 × 2	3	3960	7920
3.	Coal Storage yards opposite berth no. 1-6	A3	-	3430	100	3330		2 × 2	3	4995	9990
4.	Coal storage area near barge jetty	A4	-	725	100	625		2 × 2	3	937.5	1875
5.	Coal storage area near barge jetty	A5	248 * 80	656	50	606		2 × 1	3	909	1818
6.	Coal storage area near barge jetty	A6	-	375	50	325		2 × 2	3	487.5	975
7.	Coal storage area near barge jetty	A7	243 * 158	802	100	702		2 × 2	3	1053	2106
	Total									**16242**	**32484**

Species-wise no. of plants:

Conocarpus	5,414	**Gundi**	5414	**Pilu**	5414

Note:

- *Due to poor soil quality, high coal dust and constant movement of dumpers and other vehicles, the plantation is proposed only along the periphery.*
- *Past results have shown that success rate of Conocarpus is high in DPT area and therefore, more than 30% of saplings of Conocarpus have been proposed.*

Fig. 2.3: Demarcation of plots in Coal Handling and Storage Area

Fig. 2.4: Demarcation of plots in Coal Handling and Storage Area

Fig. 2.5: Demarcation of plots in Coal Handling and Storage Area

B) Plots near berth no. 11 to 16

Table 2.7: Plantation Plan for plots near berth no. 11 to 16

Sr. No.	Location	Nomen-clature	Dimensions (m)	Periphery (m)	Service area (m)	Length available for plantation (m)	Plantation Plan				Area (Sq.m.)
							Species	Spacing (m)	No. of rows	No. of plants	
1.	Backup area of berth no. 11 (container berth)	P2	-	1495	100	1395	Conocarpus, Saptaparni, Champo, Bougainvillea, Karen, Sharu, Millettia, *Bauhinia variegata*, *Tecoma stans*	2 × 2	3	2093	4185
2.	Backup area of berth no. 12 (container berth)	P4	-	1295	50	1245		2 × 2	3	1892	3735
3.	Plot opposite berth no. 11 and 12	P5	-	2400	100	2300		2 × 2	3	3450	6900
4.	Backup area of berth no. 13	P6	680 × 254	1543	100	1443		2 × 2	3	2595	4329
5.	Backup area of berth no. 14	P7	615 × 284	1600	100	1500		2 × 2	3	2547	4500
6.	Backup area of berth no. 15	P8	717 × 260	1700	100	1600		2 × 2	3	2781	4800
7.	Backup area of berth no. 16	P9	675 × 285	1630	100	1530		2 × 2	3	2730	4590
8.	Boundary of proposed railway track opp. Berth no. 13 to 16	P10	1118 × 62	2314	500	1814		2 × 2	3	2721	5442
	Total									**20809**	**38481**

Species-wise no. of plants

Conocarpus	5000	**Saptaparni**	2000	**Champo**	2000	**Bougainvillea**	2000
Karen	2000	**Sharu**	2000	**Millettia**	2000	***Bauhinia variegata***	1,810
Tecoma stans	2000						

Note:

- *Plantation within area having RCC flooring is not proposed in this plan.*
- *Past results have shown that success rate of Conocarpus is high in DPT area and therefore, more saplings of Conocarpus have been proposed.*

Fig. 2.6: Demarcation of plots near berth no. 11 to 16

C) Oil Jetty Area & Tank Farms

Table 2.8: Plantation Plan for Oil Jetty Area & Tank Farms

Sr. No.	Location	Nomen-clature	Dimensions (m)	Periphery (m)	Service area (m)	Length available for plantation (m)	Plantation Plan				Area(sq.m)
							Species	Spacing (m)	No. of rows	No. of plants	
1.	Open land adjoining Oil Jetty No. 1	E1	-	1215	100	1115	Conocarpus, Champo, Milletia	1 × 1	1	1115	1115
2.	Tank farm of M/s N.P. Patel adjoining Oil Jetty No. 1	E2	-	695	50	645		1 × 1	1	645	645
3.	Open land adjoining Oil Jetty No. 2	E3	-	650	50	600		1 × 1	1	600	600
4.	M/s Kesar Entp. Unit-1 (adjoining Oil Jetty No. 2)	E4	-	848	100	748		1 × 1	1	748	748
5.	Plot of Dharamshala, Shopping Complex (near Oil Jetty No. 2)	E5	-	445	50	395		1 × 1	1	395	395
6.	NDDB Tank farm	E6	-	420	50	370		1 × 1	1	370	370
7.	M/s Chemicals & Resins (tank farm)	E7	-	1250	50	1200		1 × 1	1	1200	1200
8.	Plot of Old Thermal Power Plant	E8	-	1750	100	1650		1 × 1	1	1650	1650
9.	Plot near Byar Ind. Ltd. tank farm	E9	83 × 66	298	50	248		1 × 1	1	248	248
10.	Byar Ind. Ltd. tank farm	E10	156 × 66	444	50	394		1 × 1	1	394	394
11.	Plot near Kiran Logistics tank farm	E11	84 × 78	324	50	274		1 × 1	1	274	274
12.	Kiran Logistics tank farm	E12	154 × 84	476	50	426		1 × 1	1	426	426

13.	Plot near Kesar Entp. (DTC Div.) Unit-II	E13	-	742	50	692		2 × 1	3	1038	2076
14.	Kesar Entp. (DTC Div.) Unit-II	E14	-	886	50	836		1 × 1	1	836	836
15.	United Storage Tank Terminal Ltd.	E15	-	527	50	477		1 × 1	1	477	477
16.	J.R. Entp.	E16	148 × 90	476	50	426		1 × 1	1	426	426
17.	Indi Nippon	E17	-	483	50	433		1 × 1	1	433	433
18.	Synthetic Chemical	E18	-	467	50	417		1 × 1	1	417	417
19.	Open area opp. E15, E16, E17, E18	E19	-	1226	200	1026		1 × 1	1	1026	1026
20.	Open land near IOC tank farms	E20	-	2150	100	2050		2 × 1	3	3075	6150
21.	IOC tank farms	E21	-	4216	200	4016		1 × 1	1	4016	4016
22	United Storage & Tank Terminals Ltd.	E22	280 × 162	884	100	784		1 × 1	1	784	784
23	Tank farms no. 3 to 10, FOCT and BPCL	E23	-	3045	500	2545		1 × 1	1	2545	2545
24	Tank farms no. 14 to 19	E24	-	1242	300	942		1 × 1	1	942	942
25	Tank farms no. 11 to 13	E25	-	920	150	770		1 × 1	1	770	770
26	Tank farms no. 1 and 2	E26	-	982	150	832		2 × 1	3	1248	2496
27	M/s IOC for LPG Area	E27	-	4680	200	4480		1 × 1	1	4480	4480
28	M/s Agency and Cargo Care and M/s Avean Ent.	E28	-	987	100	887		1 × 1	1	887	887
29	-	E29	-	390	50	340		1 × 1	1	340	340

30	-	E30	-	640	100	540		1 × 1	1	540	540
31	Block I (Open area near light house)	E31	-	805	50	755		1 × 1	1	755	755
32	Light house	E32	-	352	30	322		1 × 1	1	322	322
	Total									33422	38783

Species-wise no. of plants

Champo	9200	Conocarpus	15000	Millettia	9222

Note:

- *Due to limited peripheral width, only 1 row is proposed for this section at most of the plots.*
- *Past results have shown that success rate of Conocarpus is high in DPT area and therefore, more saplings of Conocarpus have been proposed.*

Fig. 2.7: Demarcation of plots Oil Jetty Area & Tank Farms

Fig. 2.8: Demarcation of plots in Tank Farms and open spaces near barge jetty

D) Plots of Godowns and Sheds near berth no. 1 to 6

Table 2.9: Plantation Plan for Plots of Godowns and Sheds near berth no. 1 to 6

Sr. No.	Location	Nomen-clature	Dimensions (m)	Periphery (m)	Service area (m)	Length available for plantation (m)	Plantation Plan				Area(sq.m)
							Species	Spacing (m)	No. of rows	No. of plants	
1.	Plot of G25, G26, G27, G35 and CWC Godown	S1	-	1246	200	1046	Conocarpus, Champo, Karen, Miletia, *Tecoma stans*, Saptaparni, Bougainvillea, Sharu	2 × 1	1	523	1046
2.	-	S2	-	895	200	695		2 × 1	1	348	695
3.	-	S3	-	950	100	850		2 × 1	1	425	850
4.	Plot of Godown no. G1, G2, G3, G4 and empty container stacking ground	S4	-	2394	500	1894		2 × 1	1	947	1894
5.	Plot of Godown no. G19, G20, G21	S5	-	861	100	761		2 × 1	1	381	761
6.	Plot of Godown no. G22, G23, G28	S6	200 × 182	764	100	664		2 × 1	1	332	664
7.	-	S7	371 × 80	902	100	802		2 × 1	1	401	802
8.	Plot of Godown no. G29 and G31	S8	375 × 88	926	100	826		2 × 1	1	413	826
9.	Plot of Pump room and UG Tank and WB No. 3	S9	184 × 67	502	100	402		2 × 1	1	201	402
10.	Plot of Godown no. G9 and G32	S10	320 × 100	840	100	740		2 × 1	1	370	740
11.	Plot of Godown G8, Crane Shed, Auction Yard	S11	324 × 140	928	100	828		2 × 1	1	414	828
12.	Plot of Godown G10 and G33	S12	-	670	100	570		2 × 1	1	285	570
13.	Plot of Godown G24, G18 and G30	S13	-	1260	150	1110		2 × 1	1	555	1110
14.	Plot of Godown G10 to G17 and Indian Molasses	S14	-	1308	300	1008		2 × 1	1	504	1008

15.	Plot of jetty office and labour amenity centre	S15	-	618	100	518		2 × 1	1	259	518
16.	Chemicals and Resins tank farms	S16	-	863	50	813		2 × 1	1	407	813
	Total									**6764**	**13527**

Species-wise no. of plants

Conocarpus	3000	Saptaparni	500	Champo	500
Bougainvillea	400	Karen	500	Sharu	400
Millettia	564	*Bauhinia variegata*	400	*Tecoma stans*	500

Note:

Past results have shown that success rate of Conocarpus is high in DPT area and therefore, more saplings of Conocarpus have been proposed.

Fig. 2.9: Demarcation of plots of Godowns and Sheds near berth no. 1 to 6

E) Plots and Godowns along NH-8

Table 2.10: Plantation Plan for Plots and Godowns along NH-8

Sr. No.	Location	Nomen-clature	Dimensions (m)	Periphery (m)	Service area (m)	Length available for plantation (m)	Plantation Plan				Area (sq.m.)
							Species	Spacing (m)	No. of rows	No. of plants	
1.	Chemicals and Resins tank farms	N1	-	863	50	813	Conocarpus, Champo, Karen, Miletia, *Tecoma stans*, Saptaparni, Bougainvillea, Sharu	2 × 1	1	407	813
2.	Plot of Truck parking area, ICL and M/s Ambika Warehouse	N2	-	1004	100	904		2 × 1	1	452	904
3.	Warehouse no. 2, 3, 4, 5, 6	N3	485 × 150	1270	250	1020		2 × 1	1	510	1020
4.	Warehouse no. 7 to 16	N4	492 × 160	1304	300	1004		2 × 1	1	502	1004
5.	-	N5	300 × 150	900	100	800		2 × 1	1	400	800
	Total									**2271**	**4541**

Species-wise no. of plants

Conocarpus	1000	Saptaparni	160	Champo	171
Bougainvillea	160	Karen	160	Sharu	150
Millettia	160	*Bauhinia variegata*	150	*Tecoma stans*	160

Note:

Past results have shown that success rate of Conocarpus is high in DPT area and therefore, more saplings of Conocarpus have been proposed

Fig. 2.10: Demarcation of Plots and Godowns along NH-8

F) Quay and Transit Area (from North Gate to Berth No. 10)

Table 2.11: Plantation Plan for Quay and Transit Area (from North Gate to Berth No. 10)

Sr. No.	Location	Dimensions (m)	Plantation Plan		
			Species	Spacing (m)	No. of plants
1.	Quay and Transit Area (from North Gate to Berth No. 10)	2160	Conocarpus	5	432

Note:

- *Due to RCC flooring and continuous movement of vehicles, construction of parapet for plantation is not feasible and hence pot plantation is proposed*
- *Past results have shown that success rate of Conocarpus is high in DPT area and therefore, Conocarpus have been proposed.*

Fig. 2.11: Demarcation of Quay and Transit Area (from North Gate to Berth No. 10)

G) Plantation along column / pillar of Godowns

Table 2.12: Plantation Plan for Plantation along column / pillar of Godowns

Total length of all godowns (m)	Approx. spacing between each column (m)	Approx. no. of columns	Species	No. of plants
6034	5	1206	Sharu, Conocarpus, Palm	1206

Species-wise no. of plants

Sharu	402	Palm	402	Conocarpus	402

H) Roadside Plantation

Table 2.13: Plantation Plan for Roadside Plantation

Sr. No.	Road Type	Total Road Length (m)	Plantation Plan				Area (sq.m.)
			Species	Spacing (m)	No. of rows	No. of plants	
1.	National Highway (on median)	6,040	Conocarpus, Neem, Pilu, Bougainvillea, Karen, Tecoma, Champo	1 × 1	2	12080	12080

Species-wise no. of plants

Conocarpus	5880	Neem	2600	Pilu	2600
Bougainvillea	250	Tecoma	250	Karen	250
Champo	250				

Note:

- *1st row will be of only Conocarpus while 2nd row will comprise of Neem as well as Pilu. Every 10th sapling will be of flowering plant (Bougainvillea, Tecoma, Karen, Champo)*
- *Past results have shown that success rate of Conocarpus is high in DPT area and therefore, more saplings of Conocarpus have been proposed.*

2.4.2. Section-2: Offices, Gopalpuri colony and other important buildings

Table 2.14: Plantation Plan for Offices, Gopalpuri colony and other important buildings

Sr. No.	Particulars	Periphery (m)	Service area (m)	Length available for plantation (m)	Plantation Plan				Area (sq.m.)
					Species	Spacing (m)	No. of rows	No. of plants	
1.	Administrative office, Gandhidham	890	100	790	Conocarpus, Champo, Karen, Millettia, *Tecoma stans*, Saptaparni, Bougainvillea, *Bauhinia variegata*, Borselli, Neem, Vad, Pipal	1 × 1	1	790	790
2.	Gopalpuri colony, Gandhidham	3390	200	3190		1 × 1	1	3190	3190
3.	Port & Customs Office	400	50	350		1 × 1	1	350	350
4.	Nirman Bhawan	260	50	210		1 × 1	1	210	210
5.	Sewa Sadan I and II	228	50	178		1 × 1	1	178	178
6.	Sewa Sadan III	230	50	180		1 × 1	1	180	180
7.	Marine Building	284	50	234		1 × 1	1	234	234
8.	CDC Building	284	50	234		1 × 1	1	234	234
9.	Open space behind Sewa Sadan I & II	236	-	236		1 × 1	1	236	236
	Total							**5602**	5602

Species-wise no. of plants

Champo	520	*Bauhinia variegata*	500	Karen	520	Bougainvillea	502
Millettia	520	*Tecoma stans*	520	Borselli	500	Pipal	500
Saptaparni	520	Neem	500	Vad	500		

Fig. 2.12: Demarcation of important office buildings

Fig. 2.13: Demarcation of Marine and CDC Building

Fig. 2.14: Demarcation of DPT Administrative Building

Fig. 2.15: Demarcation of Gopalpuri Colony

2.4.3. Section-3: Gandhidham Township

Table 2.15: Plantation Plan for Gandhidham Township

Location	Area proposed for plantation (ha)	Type of plantation	Plantation Plan		
			Species	Spacing (m)	No. of plants
Area designated for greenbelt development in Gandhidham Township	100	Block plantation	Conocarpus, Pilu, Neem, Gundi, *Bauhinia variegata*, Cassia fistula, *Albizia lebbeck*, *Peltophorum pterocarpum*, *Cassia siamea*	2*2	**2,50,000**

Species-wise no. of plants

Conocarpus	1,25,000	Pilu	15,625	Neem	15,625
Gundi	15,625	*Bauhinia variegata*	15,625	Cassia fistula	15,625
Albizia lebbeck	15,625	*Peltophorum pterocarpum*	15,625	*Cassia siamea*	15,625

Note:

Past results have shown that success rate of Conocarpus is high in DPT area and therefore, more saplings of Conocarpus have been proposed.

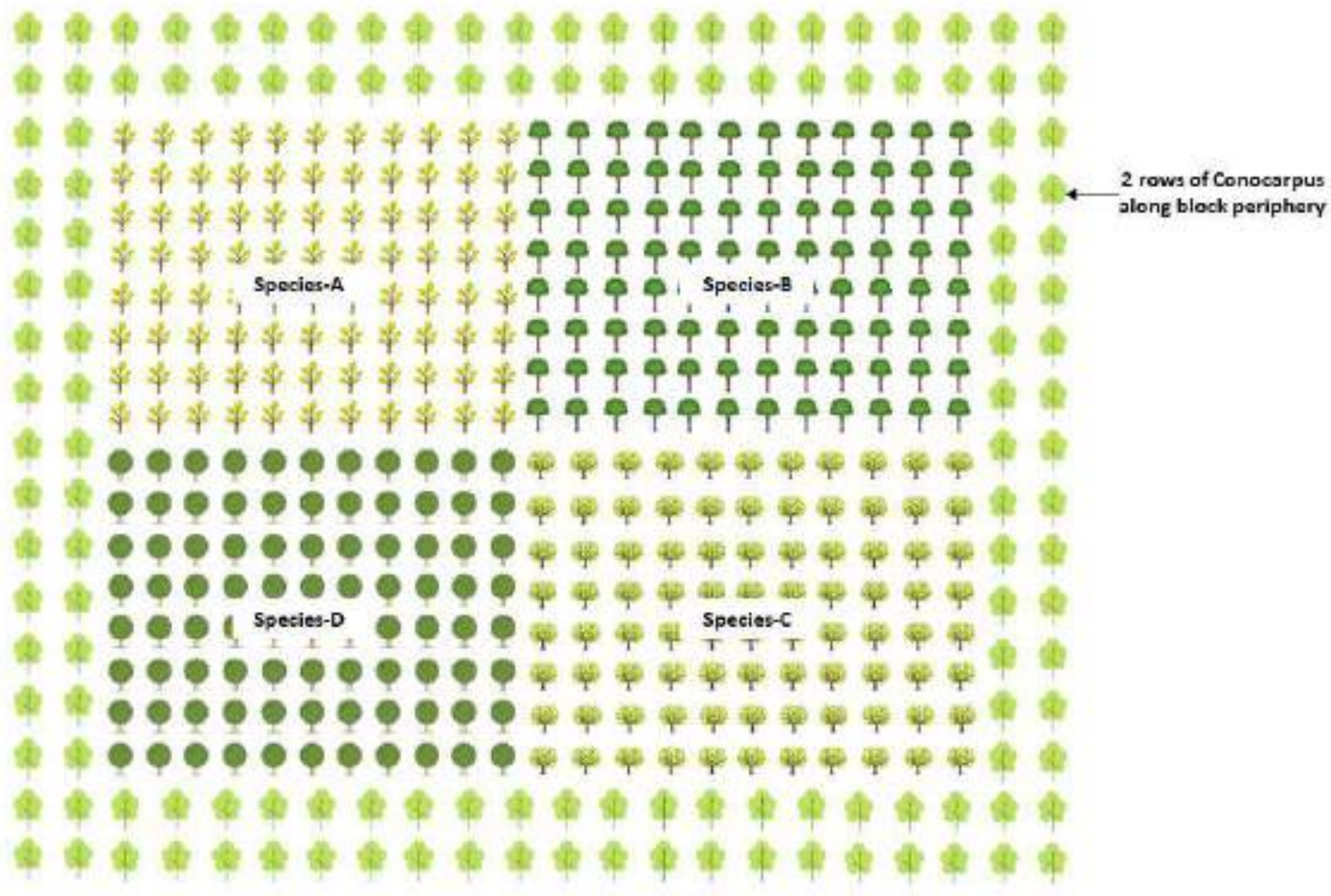


Fig. 2.16: Block plantation layout proposed for Gandhidham Township

2.5. General Plantation Methodology

In general, tree plantation involves the following broad steps

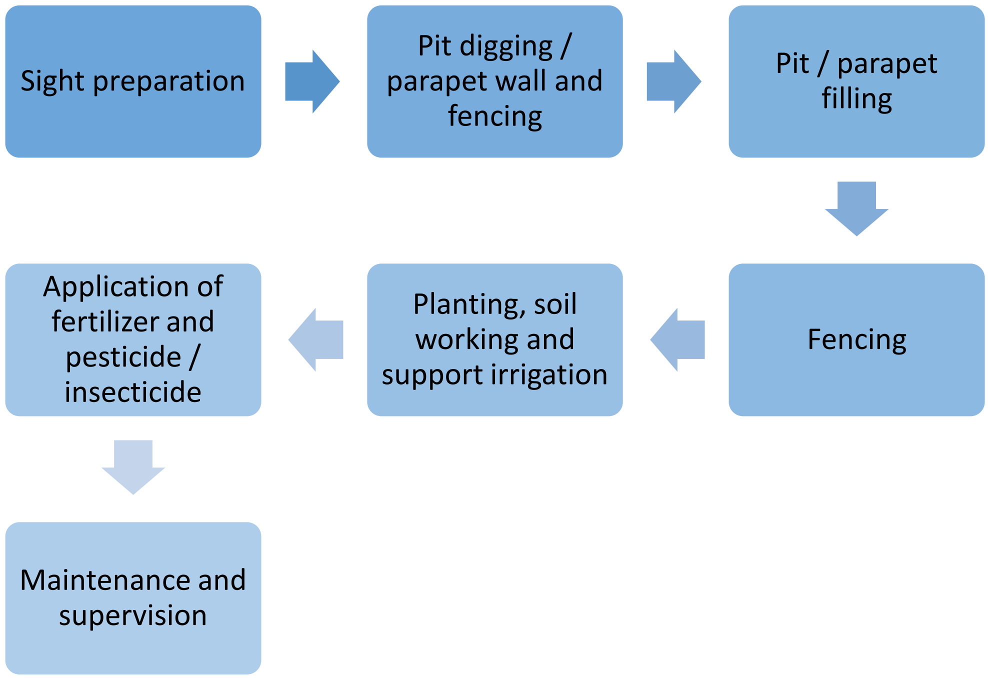


Fig. 2.17: Flow chart of general plantation methodology

The steps are explained in brief in the following sections:

i. **Sight preparation:**

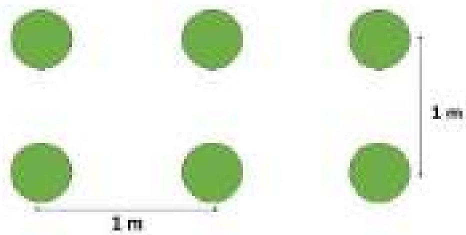
- It involves site cleaning and removal of any unwanted debris or coal dust that may have accumulated over the top soil.

ii. **Pit digging:**

- In areas where the tree is to be planted in the soil, dig a pit of dimension 45 cm × 45 cm × 45 cm. (approx. 0.091 m^3)

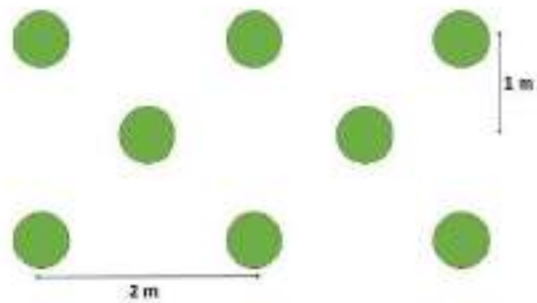
iii. **Spacing:**

- Ensure the necessary Spacing to be provided as recommended in the plan. Spacing can be understood from the following diagrams:



Spacing of 1 × 1 (two rows)

Spacing of 2 × 1 (two rows)



Spacing of 2 × 1 (three rows)

Fig. 2.18: Spacing between plants and rows

- For plantations involving 3 rows, staggered pattern shall be adopted as shown below:

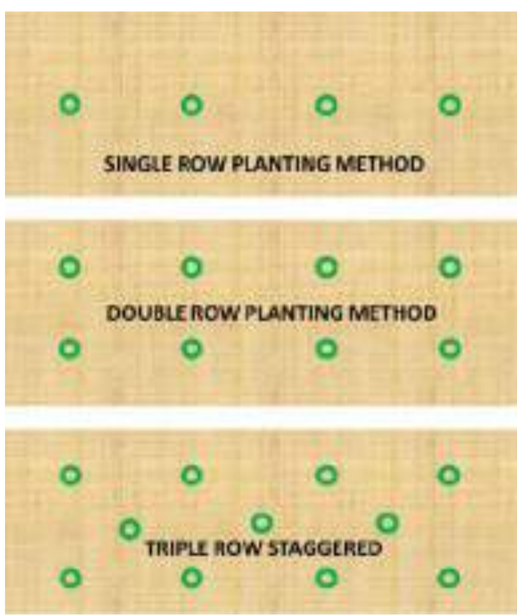


Fig. 2.19: Pattern for single row, double row and triple row (staggered) tree plantation

iv. Planting and pit filling:

- Pit filling is to be done with 70% rich clay soil, 20% gypsum and 10% cow dung manure.

v. Planting and Soil working:

- Planting of sapling of minimum 3 feet height is preferred that too during onset of monsoon.
- 3 soil working shall be done during monsoon season.
- Every flood support watering (irrigation) should be followed by soil working.

vi. Support Irrigation (watering):

- For support irrigation, flood irrigation is recommended in port area, while drip irrigation is recommended for Gandhidham township.
- The estimated quantity of water is 5 litre per plant per month.

vii. Application of fertilizer and pesticide / insecticide:

- Application of fertilizer to be done during monsoon and at the time of flood irrigation.
- Pesticide / insecticide to be applied as per requirement.

viii. Maintenance:

Table 2.16: Yearly maintenance of plantation

Activity	**1st year**	**2nd year**	**3rd year**	**4th year**
Casualty replacement	20% casualty for 1st and 2nd year			
Soil working	• During monsoon soil working is mandatory after rains. • In case of flood watering, each support watering should be followed by soil working. • In case of drip irrigation, soil working should be done twice in a month.			
Support watering	In case of flood irrigation; 10 support watering per year			

Application of fertilizer	Application of fertilizer to be done during monsoon and at the time of flood irrigation
Application of pesticide / insecticide	To be applied as per requirement

ix. Supervision:

- Day-to-day supervision is mandatory for successful plantation. Therefore, it is advisable to appoint one retired forest official of minimum rank of Range Forest Officer (RFO) or Forester. He will day-to-day supervise / monitor the plantation and will carry out the tasks as per site specific requirements.

2.5.1. Drip Irrigation System:

- Drip Irrigation is proposed for plantation blocks in Gandhidham township area only.
- A typical drip irrigation system consists of the following components:
  - Pump unit
  - Control head
  - Main and submain lines
  - Laterals
  - Emitters or drippers.
- The pump unit takes water from the source and provides the right pressure for delivery into the pipe system.
- The control head consists of valves to control the discharge and pressure in the entire system. Some control head units contain a fertilizer or nutrient tank. These slowly add a measured dose of fertilizer into the water during irrigation. This is one of the major advantages of drip irrigation over other methods.
- Mainlines, submains and laterals supply water from the control head to the plants. They are usually made from PVC or polyethylene. Hose /pipelines

should be buried below ground because they easily degrade when exposed to direct solar radiation. Lateral pipes of 12-16 mm diameter are recommended.

- Drippers are devices used to control the discharge of water from the lateral to the plants. They are spaced at 2 m interval and dripper should be placed near the plant.
- For one hectare of block, the system would comprise of one main of atleast 5000 litre capacity tank, mains and sub-mains of minimum 100 mm diameter, 2500 nos. drippers and 5000 rmt (running metre) laterals.

2.5.2. Fencing:

- In order to protect the plants from the menace of damage by cattle or theft or vehicular traffic, it is advisable to have fencing around the plantation done on the roadside as well as on the dividers of the road.
- The dimensions of the fencing is shown below:

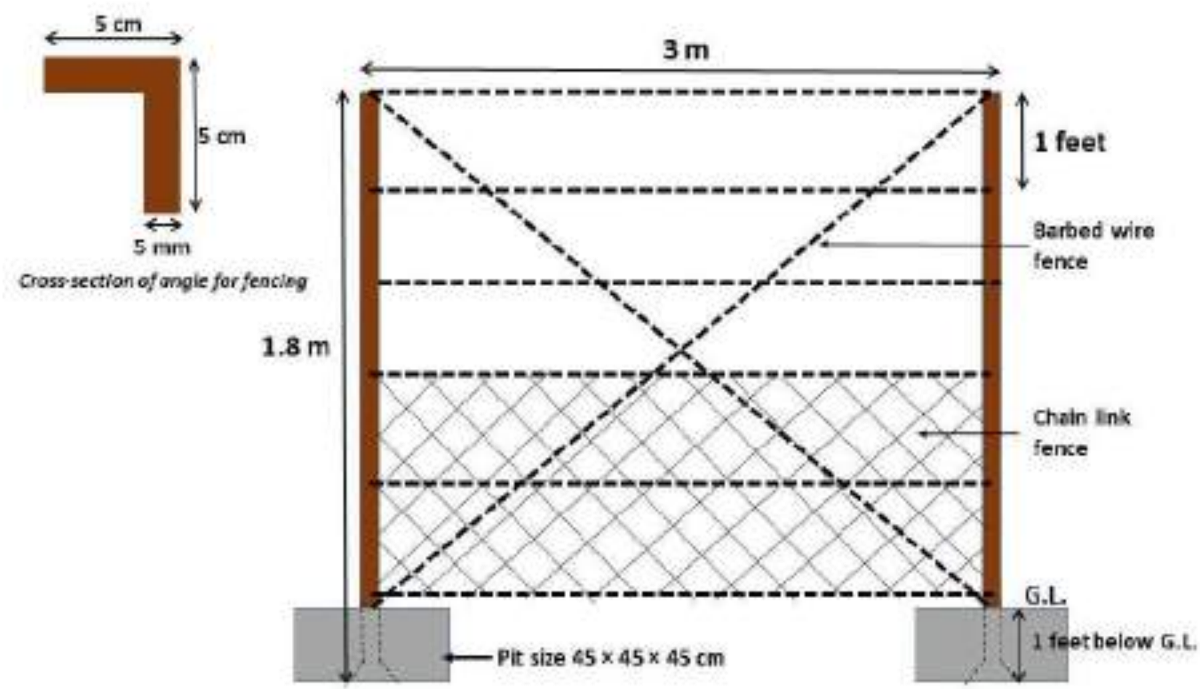


Fig. 2.20: Dimensions for fencing

2.5.3. Plantation of multiple species in a row(s):

- Multiple species of plants have been proposed in the plan and therefore to promote diversity as well as improve aesthetic appearance, it is recommended to vary the species after every 100 m length. An example of the same has been shown in the figure below:

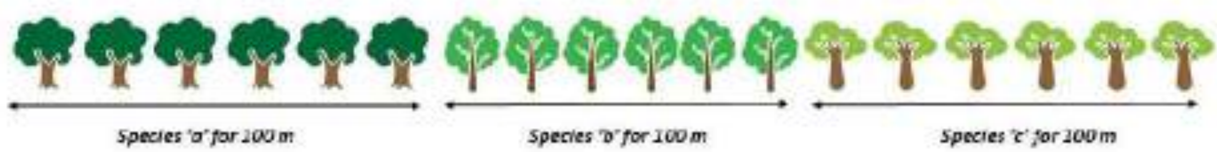


Fig. 2.21: Plantation of multiple species in a row(s)

2.6. Estimation of Quantities

2.6.1. Total estimated number of plants:

Table 2.17: Total estimated number of plants

S.N.	Species	No. of saplings		
		Current Year	**1st year casualty replacement @ 20%**	**2nd year casualty replacement @ 20%**
1.	Neem	18,725	3745	3745
2.	Gundi	21,039	4208	4208
3.	Pilu	23,639	4728	4728
4.	Conocarpus	1,61,128	32,226	32,226
5.	Champo	12,641	2528	2528
6.	Karen	3,430	686	686
7.	Millettia	12,466	2493	2493
8.	*Tecoma stans*	3,430	686	686
9.	Saptaparni	3,180	636	636
10.	Bougainvillea	3,312	662	662
11.	Sharu	2,952	590	590
12.	Palm	402	80	80
13.	*Peltophorum pterocarpum*	15,625	3125	3125
14.	*Cassia fistula*	15,625	3125	3125
15.	*Bauhenia variegata*	18,485	3697	3697
16.	Borselli	500	100	100
17.	Vad	500	100	100
18.	Pipal	500	100	100
19.	*Cassia siamea*	15,625	3125	3125
20.	*Albizia lebbeck*	15,625	3125	3125
	Total	**3,48,829**	**69,765**	**69,765**
	Grand Total	**4,88,359**		

Table 2.18: Year-wise estimated no. of plants

S.N.	Year	No. of plants
1	Current	3,48,829
2	1st year casualty replacement @ 20%	69,765
3	2nd year casualty replacement @ 20%	69,765
Total		**4,88,359**

2.6.2. Section-wise and species-wise no. of plants:

The sections-wise and species-wise no. of plants for **current year** is presented in the below table:

Table 2.19: Section-wise and species-wise no. of plants

S.N.	Name of section	Species	No. of plants
Section-1: Port Area			
1.	A - Coal Handling and Storage Area	Conocarpus	5,414
		Pilu	5414
		Gundi	5414
	Total (A)		**16,242**
2.	B - Plots near berth no. 11 to 16	Conocarpus	5000
		Champo	2000
		Karen	2000
		Millettia	2000
		Tecoma stans	2000
		Saptaparni	2000
		Bougainvillea	2000
		Sharu	2000
		Bauhinia variegata	1,810
	Total (B)		**20,810**
3.	C - Oil Jetty Area & Tank Farms	Champo	9200
		Millettia	9222
		Conocarpus	15000
	Total (C)		**33,422**
4.	D – Plots of Godowns and Sheds near berth no. 1 to 6	Conocarpus	3000
		Champo	500
		Karen	500
		Millettia	564

		Tecoma stans	500
		Saptaparni	500
		Bougainvillea	400
		Sharu	400
		Bauhinia variegata	400
	Total (D)		**6764**
5.	E - Plots and Godowns along NH-8	Conocarpus	1000
		Champo	171
		Karen	160
		Millettia	160
		Tecoma stans	160
		Saptaparni	160
		Bougainvillea	160
		Sharu	150
		Bauhinia variegata	150
	Total (E)		**2,271**
6.	F- Quay and Transit Area (from North Gate to Berth No. 10**)**	Conocarpus	432
	Total (F)		**432**
7.	G - Plantation along column / pillar of Godowns	Sharu	402
		Conocarpus	402
		Palm	402
	Total (G)		**1,206**
8.	H - Roadside Plantation	Conocarpus	5880
		Neem	2600
		Pilu	2600
		Bougainvillea	250
		Karen	250
		Tecoma	250

		Champo	250
	Total (H)		**12,080**
9.	**Section-2: Offices, Gopalpuri colony and other important buildings**	Champo	520
		Karen	520
		Millettia	520
		Tecoma stans	520
		Saptaparni	520
		Bougainvillea	502
		Bauhinia variegata	500
		Borselli	500
		Neem	500
		Vad	500
		Pipal	500
	Total (I)		**5,602**
10.	**Section-3: Gandhidham Township**	Conocarpus	1,25,000
		Pilu	15,625
		Neem	15,625
		Gundi	15,625
		Cassia fistula	15,625
		Cassia siamea	15,625
		Bauhinia variegata	15,625
		Albizia lebbeck	15,625
		Peltophorum pterocarpum	15,625
	Total		**2,50,000**
	Grand Total		**3,48,829**

2.6.3. Section-wise area proposed for plantation

Table 2.20: Section-wise area proposed for planatation

S.N.	Name of Section	Area (Ha)
1	Coal Handling and Storage Area	3.2484
2	Plots near Berth No. 11 to 16	3.8481
3	Oil Jetty Area & Tank Farms	3.8783
4	Plots of Godowns and Sheds near Berth no. 1 to 6	1.3527
5	Plots of Godowns along NH-8	0.4541
6	Quay and Transit Area (from North Gate to Berth No. 10)	N.A.
7	Plantation along column / pillar of Godowns	N.A.
8	Roadside Plantation	1.208
9	Offices, Gopalpuri Colony and other important buildings	0.5602
10	Gandhidham Township Area	100
Grand Total		**114.5498**

2.6.4. Water requirement for support irrigation:

Table 2.21: Water requirement for support irrigation

S.N.	Particulars	Water requirement per plant (lit.)	No. of plants	No. of support irrigation per year	Total quantity of water (KL) per year
1.	Fresh water for support irrigation	5	3,48,829	10	17,441

2.6.5. Summary of section-wise estimation of quantities

Table 2.22: Summary of section-wise estimation of quantities

S.N.	Activity / Particulars	Port Sections										Total
		1								2	3	
		A	B	C	D	E	F	G	H			
1	Site preparation	To be carried out as per requirement										-
2	Pits (nos.)	16,242	20,809	33,422	6,764	2,271	-	-	12,080	5,602	2,50,000	
3	Pots of 1 m^3	-	-	-	-	-	432	1,206	-	-		**1,638**
4	Fencing (length in m) Proposed only on NH-8 on both sides of road and both sides of divider	-	-	-	-	-	-	-	12,080	-		**12,080**
5	Filling with rich clay (70%) in m^3	1,036	1,327	2,132	431	145	28	77	771	357	0	**6,304**
6	Filling with gypsum (20%) in m^3	296	379	609	123	41	8	22	220	102	4,556	**6,357**
7	Filling with cow dung manure (10%) in m^3	148	190	305	62	21	4	11	110	51	2,278	**3,179**
8	Planting (no. of saplings)	16,242	20,809	33,422	6,764	2,271	432	1,206	12,080	5,602	2,50,000	**3,48,829**
i)	Saplings – 1st year casualty replacement	3,248	4,162	6,684	1,353	454	86	241	2,416	1,120	50,000	**69,766**

ii)	Saplings – 2nd year casualty replacement	3,248	4,162	6,684	1,353	454	86	241	2,416	1,120	50,000	**69,766**
9	Soil working	• During monsoon soil working is mandatory after rains. • In case of flood watering, each support watering should be followed by soil working.										**-**
10	Support watering (flood irrigation) in KL/year	812	1,040	1,671	338	114	22	60	604	280	12,500	**17,441**
11	Drip Irrigation System – Tank, pump, mains, sub-mains, laterals and drippers (per ha)	-	-	-	-	-	-	-	-	-	100	**100**
12	Fertilizer (kg) For 3 years	5,847	7,491	12,032	2,435	817	156	434	4,349	2,017	90,000	**1,25,578**
13	Maintenance (Current year, 1st year, 2nd year, 3rd year and 4th year)	As per Section 2.5 (xiii)										**-**
14	Supervision	As per Section 2.5 (ix)										**-**

2.7. Financial Estimation:

A detailed financial estimation of the entire greenbelt development has been prepared and proposed. The estimate has been prepared section-wise for all the individual sections **(Annexure-1)**. The estimation comprises of advance work activities (pit digging etc.), plantation and other plantation-related activities and casualty replacement and maintenance for two subsequent years. The estimate also comprises of casualty replacement and maintenance of existing plantation.

The plantation activities can be undertaken phase-wise subject to budget availability.

2.7.1. Section-wise Financial Estimate:

Table 2.23: Section-wise Financial Estimate

S.N.	Name of Section	Amount
Section-1: Port Area		
1	A- Coal Handling and Storage Area	69,91,565
2	B- Plots near Berth No. 11 to 16	89,61,745
3	C- Oil Jetty Area & Tank Farms	1,47,34,896
4	D- Plots of Godowns and Sheds near Berth no. 1 to 6	30,58,210
5	E- Plots of Godowns along NH-8	10,00,996
6	F- Quay and Transit Area (from North Gate to Berth No. 10)	7,14,661
7	G- Plantation along column / pillar of Godowns	19,74,397
8	H- Roadside Plantation	1,11,46,883
Section-2		
9	Offices, Gopalpuri Colony and other important buildings	23,46,591
Section-3		
10	Gandhidham township	9,86,60,140
11	Preservation and maintenance of existing greenbelt	15,80,350
Grand Total		**15,11,70,434**
Round off		**15,12,00,000**
In words: Rupees fifteen crore twelve lakh only.		

2.7.2. Item-wise Financial Estimate:

Table 2.24: Item-wise Financial Estimate

S.N.	Particulars	Unit	Qty.	Rate	Amount			Total	Remarks
					Current Year (A)	First Year (B)	Second Year (C)	(A+B+C)	
2	Pots of 1 m^3	Nos.	1,638	1,000	16,38,000	1,63,800	1,63,800	19,65,600	• Amount includes procurement, and 10% replacement for two subsequent years • Rates as per market rates
3	Fencing	Metre	12,080	400	48,32,000	4,83,200	4,83,200	57,98,400	• Amount includes procurement, repair and maintenance for two subsequent years • Rates as per market rates
4	Rich clay	Cubic m	6,304	1,000	63,04,050	-	-	63,04,050	As per market rates
5	Gypsum	Cubic m	6,357	1,500	95,35,290	-	-	95,35,290	As per market rates
6	Cow dung manure	Cubic m	3,179	3,000	95,35,575	-	-	95,35,575	As per market rates
7	Drip Irrigation System – Tank, pump, mains, sub-mains, laterals and drippers (per ha)	Ha	100	50,000	50,00,000	-	-	50,00,000	As per market rates (Lumpsum)

8	Fertilizer	Kg	1,25,578	25	10,46,487	10,46,487	10,46,487	31,39,461	As per market rates
9	Saplings	Nos.	4,88,359	60 (For Conocarpus, Palm) 25 (For others)	1,43,74,275	29,13,855	29,13,855	2,02,01,985	• Amount includes procurement and casualty replacement @ 20% for two subsequent years • Rates as per Forest Dept. rates
10	Labour Cost for Plantation related activities	Not Applicable	Not Applicable	As per SOR	3,06,89,519	2,73,42,954	3,00,77,249	8,81,09,722	• 10% rise in labour cost has been estimated for each subsequent year. • Rates as per prevailing SOR of Forest Department, GoG
Grand Total					**8,37,17,130**	**3,27,68,712**	**3,46,84,591**	**15,11,70,433**	

2.7.3. Year-wise Financial Estimate

Table 2.25: Year-wise Financial Estimate

S.N.	Year	Particulars	Amount
1	Current Year	a) Greenbelt Development b) Preservation and maintenance of existing greenbelt	8,37,17,130
2	First Year	a) Preservation and maintenance of new greenbelt b) Preservation and maintenance of existing greenbelt	3,27,68,712
3	Second Year	Preservation and maintenance of new greenbelt	3,46,84,591
Grand Total			**15,11,70,433**

2.8. 3D Model of Proposed Greenbelt Development

Fig. 2.22 Proposed Greenbelt Development at DPT Administrative Building

Fig. 2.23 Proposed Greenbelt Development at DPT Administrative Building

Fig. 2.24 Proposed Greenbelt Development at Coal handling and storage yards

Fig. 2.25: Proposed Greenbelt Development at Plots of Godowns and Warehouses

Fig. 2.26: Proposed Greenbelt Development at Plots of Godowns and Warehouses

Fig. 2.27: Proposed Greenbelt Development at Plots of Godowns and Warehouses

Fig. 2.28: Proposed Greenbelt Development at Plots of Godowns and Warehouses and both sides of roads

Fig. 2.29: Proposed Greenbelt Development at Plots of Godowns and Warehouses and both sides of roads

Fig. 2.30: Proposed Greenbelt Development at important office buildings

Fig. 2.31: Proposed Greenbelt Development at important office buildings

Fig. 2.32: Proposed Greenbelt Development at open plots along berth no. 11-12

Fig. 2.33: Proposed Greenbelt Development around tank farms

Fig. 2.34: Proposed Greenbelt Development around tank farms

CHAPTER-3: Study of EIA Reports, EC & CRZ Clearances conditions etc. and suggest measures for implementation of EMPs and the said stipulated conditions

3.1. EIA Reports, EC & CRZ Clearances conditions studied by GEMI

GEMI studied the EIA Reports, EC & CRZ Clearances conditions of the following projects as provided by DPT:

- Construction of 13th to 16th Cargo berths at Kandla Port
- Development of Plots for construction of Liquid Storage Tank Farms at Kandla Port
- Development of Plots for construction of Warehouse/Godowns Stage II at Kandla Port
- Setting up of SPM and allied facilities at Veera on BOT basis
- Development of 7 integrated facilities within existing Kandla Port at Kandla
- Smart Industrial Port City – Location 1 & 2

3.2. Suggestions sought by DPT:

During meetings and discussions with the concerned officials of DPT, suggestion and scope for improvement has been sought for the following conditions from GEMI:

Table 3.1: Conditions requiring suggestions/improvements

Project	Condition No.	Condition	Remarks / Suggestions
Smart Industrial Port City (SIPC) at green Field Site 1 (Adipur side-Northeast of Antarjaal, South of Tagore Road, 580 Acres), Gandhidham, Kutch and Smart Industrial Port City (SIPC) at green	Specific Condition no. 23 (Construction Phase)	Use of water saving devices/ fixtures (viz. low flow flushing systems; use of low flow faucets tap aerators etc) for water conservation shall be incorporated in the building plan	There are several manufacturers in the market that offer water saving devices/ fixtures and claim to save 50-80% water as compared to conventional devices.
	Specific Condition no. 24 (Construction Phase)	Installation of dual pipe plumbing for supplying fresh water for drinking, cooking and bathing etc and other for supply of recycled water for flushing, Landscape irrigation, car washing, thermal	For recycling of grey and black water and installation of dual plumbing, refer the following technical documents:

Field Site 2 (KPT Complex, 850 Acres), Gandhidham, Kutch		cooling, conditioning etc. shall be done.	• Technical Guide for Greywater Recycling System • Technical Information for Dual Plumbed Sites *Link to the above documents has been provided below.*
	Specific Condition no. 25 (Construction Phase)	Separation of grey and black water should be done by the use of dual plumbing system. In case of single stack system separate recirculation lines for flushing by giving dual plumbing system be done	
	Specific Condition no. 10 (Operation Phase)	Solar, wind or other Renewable Energy shall be installed to meet electricity generation equivalent to 1% of the demand load or as per the state level/ local building bye-laws requirement, whichever is higher	Plan for solar PV rooftop system has been provided in Chapter-6 for existing buildings. The same may be replicated in new buildings. Information related to the same is available on the website of Ministry of New & Renewable Energy, Govt. of India

	Specific Condition no. 11 (Operation Phase)	Solar power shall be used for lighting in the apartment to reduce the power load on grid. Separate electric meter shall be installed for solar power. Solar water heating shall be provided to meet 20% of the hot water demand of the commercial and institutional building or as per the requirement of the local building bye-laws, whichever is higher. Residential buildings are also recommended to meet its hot water demand from solar water heaters, as far as possible.	Detailed specifications and information related to solar lighting, solar panels are available on website of Ministry of New & Renewable Energy, Govt. of India and on website of Bureau of Energy Efficiency (BEE).
Development of 7 integrated facilities (Stage I) within existing	Specific Condition no. 13	PP shall install continuous automatic ambient air quality monitoring system (24 x 7) for all relevant parameters at two locations to monitor ambient air	It has been submitted by DPT in the compliance reports that it has initiated the process of inviting tenders for continuous automatic ambient air quality monitoring

Deendayal Port at Kandla		quality status of the project area. Data should be transferred online to CPCB and SPCB website.	system. The system should be as per "Technical Specifications for Continuous Ambient Air Quality Monitoring (CAAQM) Station (Real Time)" issued by CPCB in July-2019. *Link to the above documents has been provided below.*
	Specific Condition no. 4	Shoreline should not be disturbed due to dumping. Periodical study on shore line changes shall be conducted and mitigation carried out, if necessary. The detail shall be submitted along with the six monthly monitoring report	It is recommended to conduct study of shoreline change through a reputed institution. Such studies have been undertaken in the past by institutions like National Centre for Coastal Research (NCCR), Space Applications Centre (SAC), Anna University etc.
	Specific Condition no. 7	Dredged materials should be analyzed for presence of contaminants and also to decide the disposal options. Monitoring	The work of analysis of dredged materials has already been

		of dredging activities should be conducted and the findings should be shared with the Gujarat SPCB and regional office of the ministry.	assigned to M/s Gujarat Institute of Desert Ecology (GUIDE), Bhuj.
	Specific Condition no. 18	Marine ecology shall be monitored regularly also in terms of sea weeds, sea grasses, mudflats, sand dunes, fisheries, echinoderms, shrimps, turtles, corals, coastal vegetation, mangroves and other marine bio diversity components as part of the management plan. Marine ecology shall be monitored regularly also in terms of all micro, macro and mega floral and faunal components of marine biodiversity	The work “Holistic Marine Ecological Monitoring in Deendayal Port Environment with Special reference to Biodiversity and Preparation of Management Plan” has already been assigned to M/s Gujarat Institute of Desert Ecology (GUIDE), Bhuj.

- Technical Guide for Greywater Recycling System https://www.pub.gov.sg/Documents/greywaterTech.pdf

- Technical Information for Dual Plumbed Sites

https://www.sdcwa.org/sites/default/files/files/water-management/recycled/dual_plumbed_sites.pdf

- Technical Specifications for Continuous Ambient Air Quality Monitoring (CAAQM) Station (Real Time)

https://www.jspcb.nic.in/upload/5d6f49fd8daebCAAQMSGuideline.pdf

CHAPTER-4: OIL SPILL CONTINGENCY AND DISASTER MANAGEMENT PLAN

4.1. Introduction

Deendayal port is one among the thirteen major ports of India located in GoK, the area is located close to the international shipping line and is an approach for another 5 ports, which hosts one of the world's splendid ecosystems, its rich intertidal flora and fauna.

Oil spill is one of the major threats for marine environment as the consequences from an oil spill is profound and can adversely affect harbours, beach, wild life, fisheries, human health, tourism and industrial plants that located far away from the original spill location. When these resources are affected, there may be a serious impact to the local economy of the affected coastal area.

For reviewing the Oil spill contingency Plan and Disaster management plan, Documents provided by DPT for reference are-

1. Oil Spill Contingency Plan for DPT prepared by M/s KITCO Ltd., Kochi, Kerala
2. Comprehensive Marine EIA for Proposed SPM to Handle Crude Oil and Allied Facilities off Veera in Gulf of Kachchh (Chapter 6- oil spills)
3. Disaster Management Plan for DPT

4.2. Key observations and suggestions

Based on this, certain key observations and suggestions drawn are summarized below:

- The port is already having an Oil Spill Contingency Plan and Oil Spill Response (OSR) resources in place, which is in line with the Oil Spill Disaster Contingency Plan (NOS-DCP) promulgated by ICG.

- As per the directives of the Ministry of Shipping (MoS) and Department of Oil Industry Safety Directorate under Ministry of Petroleum and Natural Gas, the ports and the oil handling agencies are to establish oil pollution contingency plan and Tier-1 pollution response capacity to address oil spills upto 700 Tonnes in their respective area of jurisdictions.
- Presently there are oil handling facilities of Reliance, Indian Oil Corporation Limited (IOCL), Bharat Oman Refinery Limited (BORL) including SPMs within the Deendayal port limit near Kandla, Oil berths at Kandla creek and another SPM is to be operational off Veera, also being located close to the busy international shipping routes, hence the risk of oil spill in this area is determined to be very high.
- As per National Oil Spill Disaster Contingency Plan (NOS-DCP) promulgated by ICG, the emergency response operations within the port limit is the responsibility of the port authority (DPT).
- Majority areas towards the coast within port limit are essentially the part of the protected areas such as MNPS and IBAs (Vadinar Terminal). Corals and Mangroves should be given the highest priority, followed by mudflats, fishing grounds and intake locations while responding to oil spill.
- Dy. Conservator, DPT have been proposed as the Chief Incident Controller who is coordinating the response activities through Emergency Control Centre at DPT office with 24 hr control room at the Port office under the supervision Crisis Management Group headed by Chairman, DPT
- Circumstances of the possible spill and the surrounding environment within DPT limit calls for an early declaration of Tier-2 even in case of a smaller spill. Hence actual level of response should be fixed based on realistic observation and projections from spill scene.
- Risk assessment Audit of Tier 1 facilities of Port and Oil handling agencies should be done periodically.
- Regional co-operation is required to combat Tier 2 and 3 spills. MoUs should be executed and maintained in such a way that optimization of resources and minimization of response time can be achieved.

- Temporary storage of oil waste shall be done at suitable location close to the staging area after ensuring that there is no threat for ground water utilized for domestic and industrial purpose. Later the same can be transported to DPT and can be handed over to approved oil waste dealer or recyclers.
- The document On-site Disaster Management Plan is prepared with the objective of defining the functions and responsibilities of all concerned managerial, operational and supporting services department personnel with respect to detection and effective implementation of action plan.
- The format and contents of the Disaster Management Plan (DMP) have been developed taking into consideration the guidelines of National Disaster Management Authority & Plan 2016, and other accepted industry good practice principles formulated as a result of lessons learned in actual emergencies requiring extensive emergency response.
- Master document is to be studied in advance and used for training purpose also. This master document is to be upgraded once in every three years and reviewed annually (as mentioned in the Disaster Management Plan by DPT)
- Proper maintenance of signage board in prominent locations, awareness cum training programs related to disaster management among internal and external stakeholders should be organised on frequent basis.

CHAPTER-5: ENVIRONMENTAL MONITORING AND SEWAGE TREATMENT

5.1. Environmental Monitoring:

DPT has appointed M/s Detox Corporation Pvt. Ltd. for environmental monitoring, which includes the following components:

- Air Quality Monitoring
- Drinking Water Monitoring
- Monitoring of Marine Water Quality and Biological Parameters
- Noise Monitoring
- Metrological Data Monitoring
- Soil Quality Monitoring
- Sewage Treatment Plant Monitoring

GEMI reviewed the 3rd Annual Environment Monitoring Report (February 2018 to January 2019) provided by DPT.

Certain measures to improve the existing monitoring mechanism of environmental parameters are suggested below:

- As per requirement of environmental clearance conditions, it is recommended to install continuous automatic ambient air quality monitoring system (24 x 7) for all relevant parameters at two locations to monitor ambient air quality status of the port area. The location of the station should be decided in consultation with GPCB/CPCB officials. The data should be transferred online to CPCB and SPCB website.
- Ambient air quality monitoring should be carried out for the parameters specified in the CCA (PM_{10}, $PM_{2.5}$, SO_2 and NO_x).
- The report does not specify the height at which the samplers are placed. In order to collect the most representative sample, the samplers must be placed at a height

of 3 – 10 m from ground level. In the absence of a proper sampling location, a sampling station of the above mentioned height may be constructed.

- The statutory parameters of STP viz. BOD, Suspended Solids and Residual Chlorine should be periodically monitored and reported in the report both for the purpose of performance assessment and compliance to CCA condition.
- Marine water quality has been monitored at six locations in Kandla Port harbour waters. The quarterly values of all six locations have been averaged out which is statistically incorrect. Values of all six locations should be reported separately. Moreover, the values should be compared with the relevant standards. The prevailing standards in this case are "Primary Water Quality Criteria for Class SW-IV Waters (for Harbour Waters)" according to the Environment (Protection) (Second Amendment) Rules, 1998.
- In case of noise monitoring, the duration of monitoring (1 hour, 8 hours etc.) should be specified.
- To ensure authenticity and reliability, test reports of all samples should be annexed with the monitoring report.
- If an NABL accredited laboratory has been preferred, it should be ensured that the samples are tested in the premises accredited by NABL and not at any field or on-site laboratory.

5.2. Sewage Treatment Facility:

Sewage generated at Port area and Port colonies is being treated through Sewage Treatment Plants outside Port area at Kandla (capacity 1.5 MLD) and Port Colony at Gopalpuri (capacity 0.8 MLD). The said STPs are operated & maintained by DPT. The quality of outlet water is being monitored by M/s Detox Corporation (NABL accredited lab).

According to the CCA granted to DPT by GPCB, Consent Order No. AWH 72820 dt. 31/08/2015, according to condition no. 3.5, the sewage shall be treated in the sewage treatment plant and conforming to the below standards shall be utilized for plantation / gardening within the premises of the plant:

Parameter	Permissible Limit
BOD (3 days at 27°C)	Less than 30 mg/L
Suspended Solids	Less than 20 mg/L
Residual Chlorine	Minimum 0.5 mg/L

GEMI reviewed the 3rd Annual Environment Monitoring Report (February 2018 to January 2019) provided by DPT.

The objective as stated in the report is “Monitoring of Performance of the Sewage Treatment Plant (STP) at Gopalpuri Township, Deendayal Port & Vadinar”. The monitoring method, frequency and monitoring stations as described in the report is as below:

Method of Monitoring:
The parameters monitored are pH, BOD, COD, residual chlorine, MLSS, MLVSS and TSS. The data collected is analyzed as per the standards. The performance of the Sewage Treatment plant is studied by collecting samples of the influent, aeration tank and effluent tank.

Frequency of monitoring:
Sampling is done at all stations from inlet, aeration tank and outlet of an STP once in week.

Monitoring Stations:

- STP at Kandla
- STP at Gopalpuri
- STP at Vadinar

However, the monitoring results w.r.t. statutory as well as performance parameters viz. pH, BOD, COD, residual chlorine, MLSS, MLVSS and TSS were missing in the report. Hence, no comments or conclusion could be drawn with respect to sewage treatment facilities and their performance.

CHAPTER-6: RENEWABLE ENERGY

Solar power in Gujarat is a fast developing industry given that the large state is mostly arid. Gujarat was one of the first states to develop solar generation capacity in India. A total of about 1100 MW were commissioned as of March 2016, with individual solar parks ranging from hundreds of kW to 40 MW capacity.

Environmental clearance conditions of various projects also stress on using renewable energy particularly solar energy.

The details of existing renewable energy sources as provided by DPT are described below:

Total Power requirement of Port was 13.54 MUs in FY- 2018-19. The sources of power are PGVCL & Renewable Energy.

20.7 MW wind Farm was commissioned by DPT, from which 6.0 MW was commissioned in the year 2017 and 14.7 MW was commissioned in the year 2019.

Table 6.1: Details of existing renewable energy sources of DPT

Sr. No.	Power Generation capacity	Installed capacity in MW	Location	Year of installation/ commissioning	Capital cost in Rs.
1	Wind Power	6 MW	Sukhpur, Amreli, Rajkot	29/3/2018	34.71 cr.
2	Wind power	14.7 MW	Jodiya-II, Jamnagar	30/3/2019	91.54 cr.

6.1. Rooftop Solar Plants:

The solar irradiation and sunshine hours are high in Kutch region and therefore, there is a huge potential for development and installation of solar projects in the region. It is recommended to install rooftop solar plants (solar photo-voltaic cells) on the roofs of all major office buildings of DPT, a plan of which has been provided in Table below:

Table 6.2: Description of Solar PV Roof-top Systems recommended for DPT office buildings

Sr. No.	Particulars	Approx. roof top area (m^2)	Estimated roof top area available for installation (m^2)	Size of Plant (kW)	Annual Electricity Generation from Plant (kWh)	Lifetime (25 years) Electricity Generation from Solar Plant (kWh)	Cost of plant per kW (based on MNRE benchmark cost)	Total cost of plant	Estimated savings (Annual)	Estimated lifetime savings (25 years)
1.	Administrative office, Gandhidham	2604	1822	260.4	3,90,600	97,65,000	53,000	1,38,01,199	19,53,000	4,88,25,000
2.	Port & Customs Office	660	462	66.0	99,000	24,75,000	55,000	36,30,000	4,95,000	1,23,75,000
3.	Nirman Bhawan	693	485	69.3	1,03,950	25,98,750	55,000	38,11,500	5,19,750	1,29,93,750
4.	Sewa Sadan I	100	70	10.0	15,000	3,75,000	60,000	6,00,000	75,000	18,75,000
5.	Sewa Sadan II	581	407	58.1	87,150	21,78,750	55,000	31,95,500	4,35,750	1,08,93,750
6.	Sewa Sadan III	443	310	44.3	66,450	16,61,250	55,000	24,36,500	3,32,250	83,06,250
7.	Marine Building	1000	700	100.0	1,50,000	37,50,000	55,000	55,00,000	75,40,000	1,87,50,000
8.	CDC Building	2025	1417	202.5	3,03,750	75,93,750	53,000	1,07,32,500	15,18,750	3,79,68,750
	Total			**810.6**	**12,15,900**			**4,37,07,199**	**1,28,69,500**	**15,19,87,500**

Factors taken into consideration:

- Average solar irradiation in Gujarat state is 1266.52 W / sq.m
- Average 70% rooftop area has been assumed for installation of solar PV cells 1kWp solar rooftop plant will generate on an average over the year 5.0 kWh of electricity per day (considering 5.5 sunshine hours)
- For calculation of savings, Tariff @ Rs.5/ kWh (for top slab of traffic) has been assumed with no increase assumed over 25 years
- The calculation is indicative in nature. Generation may vary from location to location

6.2. Solar Street Lights

In addition, it is recommended to install all new street lights powered by solar and all existing street lights may be replaced with solar street lights in a phased manner. Detailed specification of the same is described below:

I. Introduction:

A standalone solar photovoltaic street lighting system comprises a compact fluorescent lamp, lead acid battery, PV module(s), control electronics, inter-connecting wires/cables, module mounting hardware, battery box, Operation, instruction and maintenance manual.

II. Duty Cycle:

The system should be designed to automatically switch ON at dusk, operate throughout the night and automatically switch OFF at the down, under average daily insolation of 5.5 kWh/ sq.m. on a horizontal surface.

III. Lamp:

i. The lamp will be of compact fluorescent (CFL) of 11W, 4 - Pin type with adequate pre-heating circuit.
ii. The light output from the lamp should be around 850 +/- 5 % lumens. Also please see (iii) of V given below.
iii. The lamp should be housed in a weather proof assembly suitable for outdoor use, with a reflector on its back. While fixing the assembly, the lamp should be held in a base up configuration.

IV. Battery:

i. Flooded electrolyte type, positive tubular plate, low maintenance lead acid or gel type VRLA.
ii. The battery will have a minimum rating of 12V, 75 Ah (at C/10) discharge rate.
iii. 75 % of the rated capacity of the battery should be between fully charged & load cut off conditions.

V. Electronics:

i. The inverter should be of quasi sine wave/ sine wave type, with frequency in the range of 20 - 30 KHz. Half-wave operation is not acceptable.
ii. The total electronic efficiency should be not less than 80 %.
iii. No blackening or reduction in the lumen output by more than 10% should be observed after 1000 ON/OFF cycles (two minutes ON followed by four minutes OFF is one cycle).
iv. The idle current consumption should not be more than 10 mA.
v. The PV module itself will be used to sense the ambient light level for switching ON and OFF the lamp.

VI. PV Modules:

i. The PV module (s) shall contain mono/ multi crystalline silicon solar cells. It is preferable to have certificate for the supplied PV module as per IEC 61215(revised) specifications or equivalent National or International Standards. In case if the supplied PV module is not a regular PV module of the manufacturer and does not have certificate as per IEC 61215(revised) specifications, then the manufacturer should have the required certification for at least one of their regular modules. Further, the manufacturer should certify that the supplied module is also manufactured using same material design and process similar to that of certified PV module.
ii. The power output of the module(s) under STC should be a minimum of 74 W. Either two modules of minimum 37 W output each or one module of 74 W output should be used.
iii. The operating voltage corresponding to the power output mentioned above should be 16.4 V.
iv. The open circuit voltage of the PV modules under STC should be at least 21.0 Volts.
v. The terminal box on the module should have a provision for opening for replacing the cable, if required.

vi. A strip containing the following details should be laminated inside the module so as to be clearly visible from the front side: a) Name of the Manufacturer or distinctive Logo b) Model or Type No. c) Serial No. d) Year of make

VII. Electronic Protections:

i. Adequate protection is to be incorporated under no load conditions e.g. when the lamp is removed and the system is switched ON.
ii. The system should have protection against battery overcharge and deep discharge conditions.
iii. Fuses should be provided to protect against short circuit conditions.
iv. A blocking diode should be provided as part of the electronics, to prevent reverse flow of current through the PV module(s), in case such a diode is not provided with the solar module(s).
v. Full protection against open circuit, accidental short circuit and reverse polarity should be provided.
vi. Electronics should operate at 12 V and should have temperature compensation for proper charging of the battery throughout the year.

VIII Mechanical Hardware:

i. A metallic frame structure (with corrosion resistance paint) to be fixed on the pole to hold the SPV module(s). The frame structure should have provision to adjust its angle of inclination to the horizontal between 0 and 45, so that the module(s) can be oriented at the specified tilt angle.
ii. The pole should be made of mild steel pipe with a height of 4 metres above the ground level, after grouting and final installation. The pole should have the provision to hold the weather proof lamp housing. It should be painted with a corrosion resistant paint.
iii. A vented, acid proof and corrosion resistant painted metallic box for outdoor use should be provided for housing the battery.

IX. Other Features:

i. The system should be provided with 2 LED indicators: a green light to indicate charging in progress and a red LED to indicate deep discharge condition of the battery. The green LED should glow only when the battery is actually being charged.

ii. There will be a Name Plate on the system, which will give:

(a) Name of the Manufacturer or Distinctive Logo.

(b) Serial Number.

iii. Components and parts used in the solar street lighting systems should conform to the latest BIS specifications, wherever such specifications are available and applicable.

iv. The PV module(s) will be warranted for a minimum period of 15 years from the date of supply and the street lighting system (including the battery) will be warranted for a period of two years from the date of supply. The Warranty Card to be supplied with the system must contain the details of the system. The manufacturers can also provide additional information about the system and conditions of warranty as necessary.

v. Necessary lengths of wires/cables and fuses should be provided.

vi. An Operation, Instruction and Maintenance Manual, in English and the local language, should be provided with the solar street lighting system.

CHAPTER-7: COAL HANDLING AND STORAGE

7.1. Introduction:

At present, an area of 66 ha, 40 ha and Bunder Basin are being used for handling of coal.

As a preventive measure, DPT has installed fixed water sprinklers at 40 hectares plot to control the dust emission from coal. Whereas other coal storage areas, the port users are deploying tank lorries for water sprinkling and physical covering by tarpaulin.

Gujarat Pollution Control Board (GPCB) has issued detailed guidelines for coal handling units which are required to be adhered to in order to minimize any adverse impact on environment and maintain the ambient air quality within the prescribed permissible limits.

DPT vide its letter no. TF/SH/Circulars/2019/5362 dt. 24/01/2019 and TF/SH/Circulars/2019/5441 dt. 13/02/2019 issued circulars to the port users containing Standard Operating Procedure (SOP) regarding control of dust pollution arising out of coal handling and ensuring safety in coal handling.

7.2. Observations related to coal handling

- Coal is unloaded from vessels with the help of grab connected with crane.
- There are two methods adopted for unloading coal in dumpers:

- Direct unloading in the dumper through the grab
- Grab unloads coal on wharf floor and subsequently JCB machine transfers coal to the dumper.
    - The dumpers haul the coal to the storage yard of respective port user. At the yard, the coal is unloaded/loaded from/into the dumpers with the help of JCB machines.
    - All dumpers are not covered with tarpaulin covers.

- At many places, the height of the coal heap was more than 5 m and distance between adjacent heaps at G.L. was not enough. (should be minimum 5 m as per GPCB guidelines)
- At wharf, the secondary transfer of coal from JCB to dumpers increase dust loading due to high wind velocity.
- Heavy coal dust spillage on internal roads was observed which due to continuous movement of dumpers gets re-suspended.
- Storm water lines for carrying excess water after sprinkling were clogged with coal.
- A compound wall of height approx. 9 m has been constructed.
- Plantation of trees around yards or along compound wall was not observed.

Fig. 7.1: Unloading of coal on wharf floor with the help of grab and subsequently to dumper through JCB machine

Fig. 7.2: Unloading of coal directly into dumper from the vessel

Fig. 7.3: Uncovered transportation of coal

Fig. 7.4: Re-suspension of coal dust due to movement of vehicles

Fig. 7.5: Compound wall along coal yard periphery

Fig. 7.6: Water sprinkler for suppression of coal dust

Fig. 7.7: Clogged storm water drain along coal yards

(All photographs are taken by GEMI's team)

7.3. Remarks with respect to implementation of coal handling guidelines of GPCB

Table 7.1: Remarks wrt implementation of coal handling guidelines of GPCB

Requirement of guidelines	Remarks
A) Location Criteria	
Minimum distance of 250 meters away from the surrounding agriculture land	Complied
Minimum 500 meters away from the residential area, school/colleges, Historical Monuments, Religious Places, Ecological sensitive area as well as forests area	Complied
Minimum 500 meters away from the Railway line, Express ways, National Highways, State ways and District Roads and from water bodies like River, Nala, Canal, Pond etc	Complied
In case of coal handling activities at the ports and jetties or extension thereof, the distance and land use criteria may be relaxed and compensated by advanced/sophisticated pollution control measures and mechanization & thick plantation, however all such ports and jetties, where coal handling is carried out, shall provide closed conveyor belt and mechanization for handling of coal	No thick plantation around coal yards was observed. Closed conveyors have not been installed and the handling is through grabs, JCB machines and dumpers
B) Storage and handling criteria	
Coal handling unit/Agency shall store coal in such a way that coal heap should not be higher than 5 meter and clear distance between two adjoining	In several cases, the height of the heaps was > 5 m and the distance between adjacent heaps was

heaps at G.L. should be 5 meters, so that in case of fire, approach is available.	observed < 5 m at almost all locations.
There should be mechanized loading/ unloading system from the loading /unloading area to the stacking yards and in to the vehicles.	There are two methods adopted for unloading coal in dumpers: - Direct unloading in the dumper through the grab - Grab unloads coal on wharf floor and subsequently JCB machine transfers coal to the dumper. The dumpers haul the coal to the storage yard of respective port user. At the yard, the coal is unloaded/loaded from/into the dumpers with the help of JCB machines.
Coal handling unit/Agency shall take all corrective steps to resolve the issue of air pollution at permitted coal storage/handling area where coal is being stored	As a preventive measures DPT has installed fixed water sprinklers at 40 hectares plot to control the dust emission from coal. Whereas other coal storage areas, the port users are deploying tank lorries for water sprinkling and physical covering by tarpaulin.
C) Transport criteria	
All trucks before leaving the storage yard shall be showered with water with adequate system, Shall be covered with tarpaulin or any other effective measure/device completely and also that trucks are	No mechanism for sprinkling water on trucks leaving the yard was observed. The dumpers are covered with tarpaulin but the practice is not ensured at all times as during visits,

not over loaded as well as there is no spillage during transportation.	the teams observed uncovered transportation of coal by dumpers.
The vehicle carrying the coal should not be overloaded by raising the height of carriage. Weigh scale shall be provided within the loading area only and port / coal park authority shall ensure that no overloading is done.	The vehicles are generally not overloaded. Weigh scales are available at exit gates.
The top of the vehicle should be covered with fixed cover instead of tarpaulin cover to avoid spillage or dusting of coal.	No dumpers have installed fixed covers.
Coal handling unit/Agency shall obtain transport permission from the local administration under the relevant rules.	-
(D) Pollution prevention criteria	
Coal handling unit/Agency shall provide paved approach with adequate traffic carrying capacity	All roads are paved, however, frequent maintenance should be ensured
Coal handling unit/Agency shall construct compound wall all along periphery of the premises with minimum 9 meters height	Compound wall has been constructed on the outer side of the yards
Continuous water sprinkling shall be carried out on the top of the heap at regular intervals to prevent dusting, fire & smoke. To prevent fugitive emission during loading/unloading, fixed pipe network with sufficient water storage and pump shall be installed. Water sprinkling shall be carried out at each and every stage of handling to avoid generation of coal dust or other dust within premises	DPT has installed fixed water sprinklers at 40 hectares plot to control the dust emission from coal. Whereas other coal storage areas, the port users are deploying tank lorries for water sprinkling.

Coal handling unit/Agency shall ensure regular sweeping of coal dust from internal and main road and also ensure that there is adequate space for free movement of vehicles	Mechanical sweeping vehicles have been deployed. Within the yards, there are no defined routes for movement of dumpers.
The following adequate Air Pollution Control Measures shall be installed and to be operated efficiently. a) Dust containment cum suppression system for the coal stack, loading and unloading. b) Construction of effective wind breaking wall suitable to local condition to prevent the suspension of particles from the heaps. c) Construction of metal road & RCC Pucca flooring in the plot area/ godown etc. d) System for regular cleaning and wetting of the floor area within the premises. e) Entire coal storage area/ godown should be covered with permanent weather shed roofing and side walls i.e., in closed shed, in case of crushing/sieving/grading activity is carried out (i.e. G. I. Sheet) along with adequate additional APCM should be installed.	a) DPT has installed fixed water sprinklers at 40 hectares plot to control the dust emission from coal. b) Compound wall has been constructed on the outer side of the yards c) All roads are paved. Plots/yards are not of RCC flooring. d) The port users are deploying tank lorries for water sprinkling. e) Not applicable since no crushing/sieving/grading activity is carried out
Coal handling unit/Agency shall carryout three rows plantation with tall growing tress all along the periphery of the coal handling premises, inside & outside of the premises along with road.	There is no plantation within or outside the coal yards/plots or roads.
Proper drainage system shall be provided in all coal storage area so that water drained from sprinkling & runoff is collected at a common tank and can be	Open drainage system is available

reused after screening through the coal slit or any other effective treatment system.	
All the engineering control measures and state of art technology including covered conveyer belts, mechanized loading and unloading, provision of silo etc. shall be provided in addition to the measures recommended in the environmental guidelines for curbing the pollution.	Mechanical grabs have been installed to transfer coal from vessels to dumpers/floor.
E) Safety requirement	
Coal handling unit/Agency shall provide adequate firefighting measure to avoid any fire or related hazards including adequate water storage facility, and the premises shall be exclusively used for storage of the coal.	Fixed water sprinklers have been installed
An onsite emergency plan shall be prepared and implemented by coal handling unit	Such plans have been prepared as part of the EIA reports.
F) Legal criteria	
Necessary permission from all the applicable regulatory authorities and adequate steps under the provisions of applicable environmental acts/ rules shall be taken	Environmental Clearance (EC) and Consent to Operate (CTE) has been obtained.
Coal handling unit/Agency shall prepare EMP (Environment Management Plan) and implement the same in true spirit and thus maintain overall environment of that area	EMPs have been prepared as part of the EIA reports. EMP has also been prepared as part of the annual environment monitoring report prepared by M/s Detox Corporation Pvt. Ltd.

<table>
<tr><td>Coal handling unit/Agency shall not carry out the operation of loading/unloading of coal/coal dust at any place, till adequate air pollution control equipment for dust control/suppression are installed and efficiently operated and the consent under the provisions of Air (Prevention & Control of Pollution) Act, 1981 is obtained by the coal yard owners/ Coal handling unit/Agency / coal importers</td><td>DPT has obtained valid CTE from GPCB</td></tr>
<tr><td>Coal handling unit/Agency shall operate continuous Ambient Air Quality Monitoring Stations as per CPCB guideline. The results of parameters like SPM, RSPM, and SO2 and NOx shall be submitted to the SPCB every month.</td><td>Continuous Ambient Air Quality Monitoring Stations as per CPCB guideline have not been installed.</td></tr>
<tr><td>In case of port which provides the facility to individual developers an agreement /MoU shall be made between port authority and developer for curtailment of pollution. Port authority shall be responsible for supervising and controlling the pollution control related activities and implementation of the environmental guidelines.</td><td>DPT vide its letter no. TF/SH/Circulars/2019/5362 dt. 24/01/2019 and TF/SH/Circulars/2019/5441 dt. 13/02/2019 issued circulars to the port users containing Standard Operating Procedure (SOP) regarding control of dust pollution arising out of coal handling and ensuring safety in coal handling</td></tr>
<tr><td>The concentration of the following parameters in the ambient air within the premises and a distance of 10 meters from the source (other than the stack/vent) shall not exceed the following levels.
<table>
<tr><td rowspan="2">Parameters</td><td colspan="2">Permissible Limits</td></tr>
<tr><td>Annual</td><td>24 hrs Average</td></tr>
<tr><td>PM_{10}</td><td>60 µg/m^3</td><td>100 µg/m^3</td></tr>
</table></td><td>DPT has appointed M/s Detox Corporation Pvt. Ltd. for environmental monitoring. The ambient air quality monitoring is carried out at 8 locations for 3 parameters namely TSPM, PM_{10}</td></tr>
</table>

$PM_{2.5}$	40 µg/m^3	60 µg/m^3
SO_2	50 µg/m^3	80 µg/m^3
NO_x	40 µg/m^3	80 µg/m^3

$PM_{2.5}$ and the frequency is twice a week. The results for coal storage area are summarized below:

Month	Value in µg/m^3		
	TSPM	PM_{10}	$PM_{2.5}$
Feb-18	390	263	55
Mar-18	386	274	69
Apr-18	373	264	66
May-18	332	230	51
Jun-18	407	278	50
Jul-18	319	221	42
Aug-18	106	81	5
Sept-18	470	365	54
Oct-19	470	387	35
Nov-18	436	321	68
Dec-18	662	479	115
Jan-19	697	324	66
Permissible Limit	**-**	**100**	**60**

7.4. Measures for effective environment management in coal handling areas:

The guidelines for coal handling units issued by GPCB are sufficient in itself and contain several action-oriented points which if implemented effectively in true spirit would result in drastic improvement related to the environmental issues in coal handling areas.

Following measures are recommended which may be implemented for effective environment management in coal handling areas:

- The schedule of operation may be planned in such a manner that the dumpers carry the cargo directly from the vessel to the railway yards thereby reducing the requirement of storing the coal onto storage yards. In addition, the time period for storing coal in the yards may be reduced so that minimum amount of coal is lying in the yards at a time. DPT may think of imposing a penalty in case the storage exceeds a certain time limit.
- Coal should be stored coal in such a way that coal heap should not be higher than 5 meter and clear distance between two adjoining heaps at G.L. should be 5 meters.
- There should be mechanized loading/ unloading system from the loading /unloading area to the stacking yards and in to the vehicles. Secondary loading should be avoided (i.e. first unloading coal from vessel onto the ground and then into the dumpers through JCB), instead, the coal should be directly unloaded into the dumpers through closed hoppers.
- All trucks before leaving the storage yard may be showered with water with adequate system and they should be covered with tarpaulin or any other effective measure/device completely and also that trucks are not over loaded as well as there is no spillage during transportation. *(see below picture)*

Fig. 7.8: Mechanism for showering water on dumpers

- The vehicle carrying the coal should not be overloaded by raising the height of carriage. A free board of minimum 9 inches may always be kept.
- The users / contractors maybe encouraged to deploy dumpers with fixed cover instead of tarpaulin cover to avoid spillage or dusting of coal. *(see picture)*

Fig. 7.9: Fixed covers for dumpers

- There should be a speed limit for movement of vehicles (especially trucks and dumpers) in the coal handling areas. Speed control on vehicles has a linear effect on dust emissions. Speed reduction from 30 km/hr to 15 km/hr will achieve a 50% reduction in dust emissions.

- Accumulated dust should be removed / swept regularly with the help of sweeping machines and water the area after sweeping.
- Mobile water sprinklers are known to be most effective measure for control of fugitive emissions resulting from transportation of coal. Additional mobile water sprinklers are required to be deployed. The sprinklers may be designed in such a way that it covers maximum road width. (see picture below)

Fig. 7.10: Mobile water sprinklers

- The selection of appropriate nozzle is also important for dust suppression as well as dust prevention. The spray type and spray patterns of different nozzles are described in the below figure.

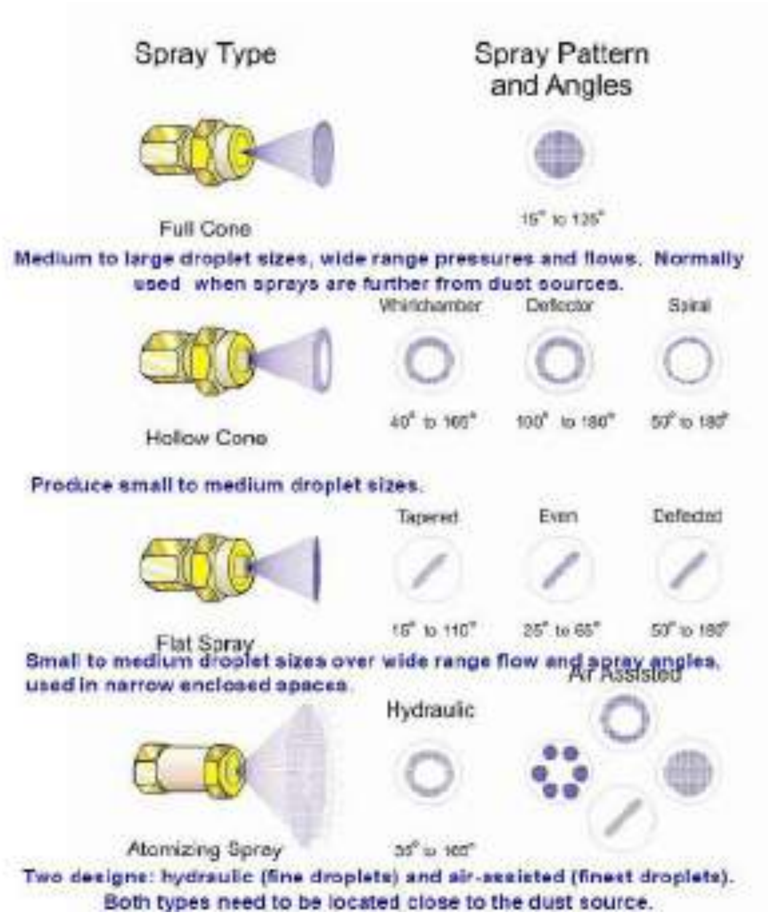


Fig. 7.11: Design of different nozzles and their spray pattern

- When the goal is to knock down existing dust in the air, the water droplets should be in size ranges similar to the dust particles.
- Droplets in the range of 10 to 50 microns have been shown to be most effective.
- Applications for different type of nozzles is shown in below table:

Table 7.2: Applications for different type of nozzles

Activity type	Air Atomizing	Hydraulic Fine Spray	Hollow Cone	Flat Spray	Full Cone
Transfer points	✓	✓	✓		✓
Stockpiles		✓		✓	
Transport areas and roads			✓		

- To achieve optimal spray coverage, it is best to orient the nozzles in a manner to minimize overlap of the water spray from other nozzles.
- It is also important that the water reaches the desired target location and is not blown away by the ambient wind.
- Porous wind fence (wind screens) may in some cases prove better to curtail strong winds as compared to solid walls. A comparison of wind flow in case of solid walls and that in case of wind screens is shown in the below figure.

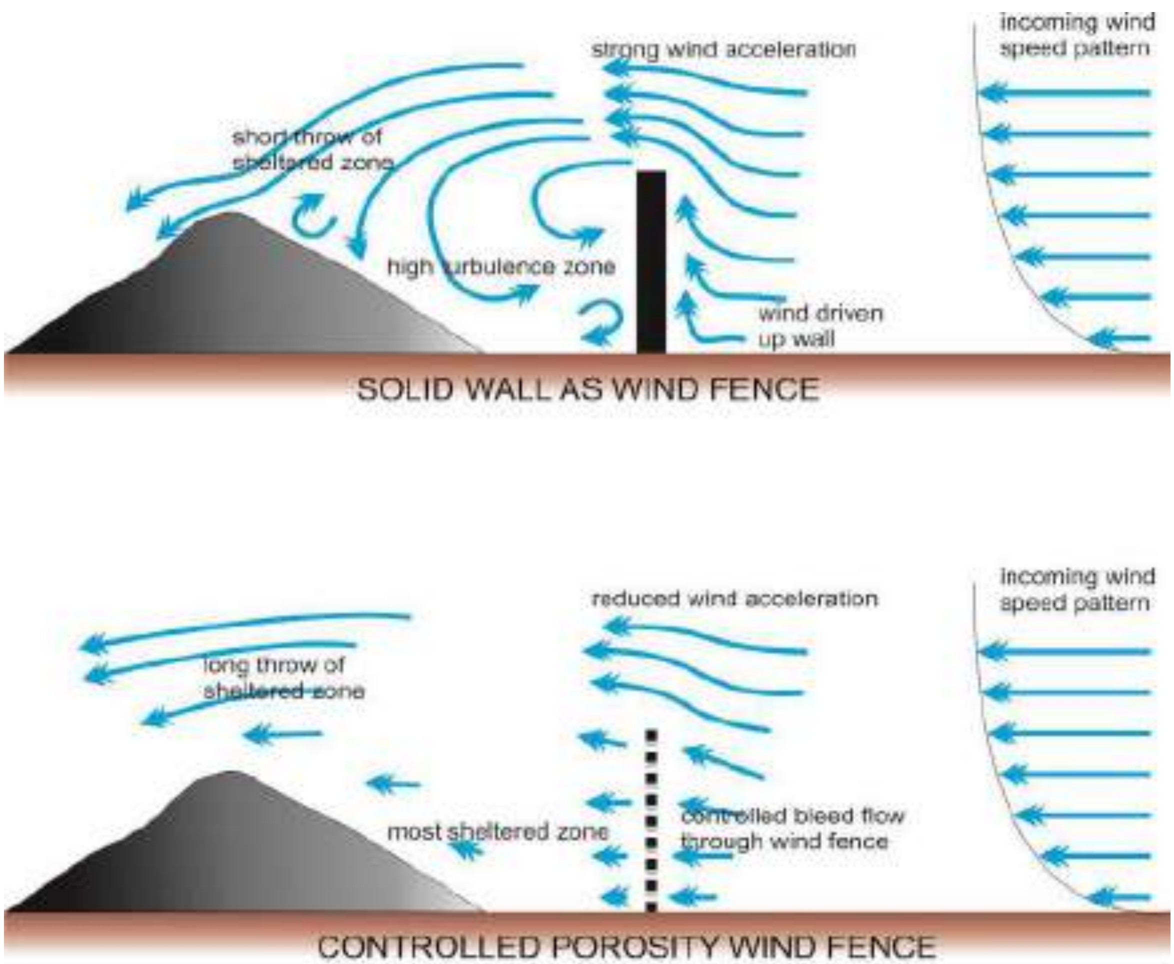


Fig. 7.12: Comparison of wind flow in case of solid walls v/s wind screens

- Three rows plantation with tall growing tress all along the periphery of the coal handling premises, inside & outside of the premises along with road. (recommended in greenbelt development plan)
- The existing drains carrying water drained after sprinkling should be cleaned periodically as accumulated dust chokes the drains. The water may be reused after appropriate treatment (preferably screening followed by primary sedimentation).

Annexure-1

Section-wise detailed financial outlay for Greenbelt Development (for 3 years)

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Section-1: DPT Port Area

A – Coal Handling and Storage Area

Table A: Financial Estimate for Greenbelt Development in Coal Handling and Storage Area

Current Year							
(a) Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Rich clay	cubic mt	1000	1036.0	1036000	-	Market rates
2	Gypsum	cubic mt	1500	296.0	444000	-	Market rates
3	Cow dung manure	cubic mt	3000	148.0	444000	-	Market rates
4	Fertilizer	kg	25	1949.04	48726	-	Market rates
	Sub-total (a)				**1972726**	-	
(b) Saplings (Rates of saplings are inclusive of transportation, loading, unloading at pit site)							
1	Conocarpus	nos.	60	5414	324840	-	
2	Gundi	nos.	25	5414	135350	-	
3	Pilu	nos.	25	5414	135350	-	
	Sub-total (b)			16242	**595540**	-	
(c)Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	15.15	16242	246066	20 pits / person	
2	Planting with polypot	per plant	3.8	16242	61720	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	295.45	17000	5023	1000 plants / person	
4	First soil workings during monsoon	per plant	5.1	48726	248503	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.55	16242	251751	200 plants / person	10 support watering per year
6	Subsequent soil workings	per plant	3.8	16242	617196	80 plants / person	10 subsequent soil working per year

	Sub-total (c)				**1430258**	-	
	Total of Current Year (a+b+c)				**3998524**	-	
First Year							
Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Fertilizer	kg	25	1949.04	48726	-	
	Sub-total (a)				**48726**	-	
Saplings (Casualty Replacement @ 20%)							
1	Conocarpus	nos.	60	1083	64968	-	
2	Gundi	nos.	25	1083	27070	-	
3	Pilu	nos.	25	1083	27070	-	
	Sub-total (b)			3248	**119108**	-	
Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	16.665	1083	18045	20 pits / person	
2	Planting with polypot	per plant	4.18	1083	4526	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	324.995	17000	13650	1000 plants / person	
4	First soil workings during monsoon	per plant	5.61	48726	273353	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.705	16242	276926	200 plants / person	10 Times/year (In case of flood irrigation)
6	Subsequent soil workings	per plant	4.18	16242	678916	80 plants / person	10 Times/year
	Sub-total (c)				**1265416**	-	
	Total of First Year (a+b+c)				**1433250**	-	
Second Year							
Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Fertilizer	kg	25	1949.04	48726	-	

	Sub-total (a)				**48726**	-	
Saplings (Casualty Replacement @ 20%)							
1	Conocarpus	nos.	60	1083	64968	-	
2	Gundi	nos.	25	1083	27070	-	
3	Pilu	nos.	25	1083	27070	-	
	Sub-total (b)			3248.4	**119108**	-	
Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	18.33	1083	19849	20 pits / person	
2	Planting with polypot	per plant	4.60	1083	4979	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	357.49	17000	15015	1000 plants / person	
4	First soil workings during monsoon	per plant	6.17	48726	300688	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.88	16242	304619	200 plants / person	10 Times/year (In case of flood irrigation)
6	Subsequent soil workings	per plant	4.60	16242	746807	80 plants / person	10 Times/year
	Sub-total (c)				**1391957**	-	
	Total of Second Year (a+b+c)				**1559791**	-	
	Total of Current, First & Second Year				**6991565**	-	

B – Plots near Berth No. 11 to 16

Table B: Financial Estimate for Greenbelt Development in Plots near Berth No. 11 to 16

Current Year							
(a) Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Rich clay	cubic mt	1000	1327.35	1327350	-	Market rates
2	Gypsum	cubic mt	1500	379.24	568860	-	Market rates
3	Cow dung manure	cubic mt	3000	189.6	568800	-	Market rates
4	Fertilizer	kg	25	2497.2	62430	-	Market rates
	Sub-total (a)				**2527440**	-	
(b) Saplings							
1	Conocarpus	nos.	60	5000	300000	-	
2	Champo	nos.	25	2000	50000	-	
3	Karen	nos.	25	2000	50000	-	
4	Millettia	nos.	25	2000	50000	-	
5	*Tecoma stans*	nos.	25	2000	50000	-	
6	Saptaparni	nos.	25	2000	50000	-	
7	Bougainvillea	nos.	25	2000	50000	-	
8	Sharu	nos.	25	2000	50000	-	
9	Bauhenia variegata	nos.	25	1810	45250	-	
	Sub-total (b)			20810	**695250**	-	
(c)Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	15.15	20810	315272	20 pits / person	
2	Planting with polypot	per plant	3.8	20810	79078	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	295.45	21000	6204	1000 plants / person	
4	First soil workings during monsoon	per plant	5.1	62430	318393	60 plants / person	Thrice during monsoon

5	Support watering	per plant	1.55	20810	322555	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	3.8	20810	790780	80 plants / person	10 Times/year
	Sub-total (c)				**1832282**	-	
	Total of Current Year (a+b+c)				**5054972**	-	
First Year							
Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Fertilizer	kg	25	2497.2	62430	-	
	Sub-total (a)				**62430**	-	
Saplings							
1	Conocarpus	nos.	60	1000	60000	-	
2	Champo	nos.	25	400	10000	-	
3	Karen	nos.	25	400	10000	-	
4	Millettia	nos.	25	400	10000	-	
5	*Tecoma stans*	nos.	25	400	10000	-	
6	Saptaparni	nos.	25	400	10000	-	
7	Bougainvillea	nos.	25	400	10000	-	
8	Sharu	nos.	25	400	10000	-	
9	Bauhenia variegata	nos.	25	362	9050	-	
	Sub-total (b)			4162	**139050**	-	
Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	16.67	4,162	69360	20 pits / person	
2	Planting with polypot	per plant	4.18	4,162	17397	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	325	21,000	6825	1000 plants / person	
4	First soil workings during monsoon	per plant	5.61	62430	350232	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.71	20810	354811	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	4.18	20810	869858	80 plants / person	10 Times/year

	Sub-total (c)				**1668483**	-	
	Total of First Year (a+b+c)				**1869963**	-	
Second Year							
Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Fertilizer	kg	25	2497.2	62430	-	
	Sub-total (a)				**62430**	-	
Saplings							
1	Conocarpus	nos.	60	1000	60000	-	
2	Champo	nos.	25	400	10000	-	
3	Karen	nos.	25	400	10000	-	
4	Millettia	nos.	25	400	10000	-	
5	*Tecoma stans*	nos.	25	400	10000	-	
6	Saptaparni	nos.	25	400	10000	-	
7	Bougainvillea	nos.	25	400	10000	-	
8	Sharu	nos.	25	400	10000	-	
9	Bauhenia variegata	nos.	25	362	9050	-	
	Sub-total (b)			4162	**139050**	-	
Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	18.3315	4162	76296	20 pits / person	
2	Planting with polypot	per plant	4.598	4162	19137	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	357.4945	21000	7507	1000 plants / person	
4	First soil workings during monsoon	per plant	6.171	62430	385256	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.8755	20810	390292	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	4.598	20810	956844	80 plants / person	10 Times/year
	Sub-total (c)				**1835331**	-	
	Total of Second Year (a+b+c)				**2036811**	-	
	Total of Current, First & Second Year				**8961745**	-	

C – Oil Jetty Area and Tank Farms

Table C: Financial Estimate for Greenbelt Development in Oil Jetty Area and Tank Farms

Current Year							
(a) Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Rich clay	cubic mt	1000	2132	2132000		Market rates
2	Gypsum	cubic mt	1500	609	913500		Market rates
3	Cow dung manure	cubic mt	3000	304.5	913500		Market rates
4	Fertilizer	kg	25	4010.64	100266		Market rates
	Sub-total (a)				**4059266**		
(b) Saplings							
1	Conocarpus	nos.	60	15000	900000		
2	Champo	nos.	25	9200	230000		
3	Millettia	nos.	25	9222	230550		
	Sub-total (b)			33422	**1360550**		
(c)Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	15.15	33422	506343	20 pits / person	
2	Planting with polypot	per plant	3.8	33422	127004	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	295.45	34000	10045	1000 plants / person	
4	First soil workings during monsoon	per plant	5.1	100266	511357	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.55	33422	518041	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	3.8	33422	1270036	80 plants / person	10 Times/year
	Sub-total (c)				**2942826**		
	Total of Current Year (a+b+c)				**8362642**		
First Year							
Civil work and other items							

S.N.	Particulars	Unit	Rate	Quantity	Amount	Work Norms	Remarks
1	Fertilizer	kg	25	4010.64	100266		
	Sub-total (a)				**100266**		
Saplings							
1	Conocarpus	nos.	60	3000	180000		
2	Champo	nos.	25	1840	46000		
3	Millettia	nos.	25	1844	46110		
	Sub-total (b)			6684	**272110**		
Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	16.665	6684.4	111396	20 pits / person	
2	Planting with polypot	per plant	4.18	6684.4	27941	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	324.995	34000	11050	1000 plants / person	
4	First soil workings during monsoon	per plant	5.61	100266	562492	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.705	33422	569845	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	4.18	33422	1397040	80 plants / person	10 Times/year
	Sub-total (c)				**2679763**		
	Total of First Year (a+b+c)				**3052139**		
Second Year							
Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Fertilizer	kg	25	4010.64	100266		
	Sub-total (a)				**100266**		
Saplings							
1	Conocarpus	nos.	60	3000	180000		
2	Champo	nos.	25	1840	46000		
3	Millettia	nos.	25	1844.4	46110		
	Sub-total (b)			6684.4	**272110**		

Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	18.3315	6684.4	122535	20 pits / person	
2	Planting with polypot	per plant	4.598	6684.4	30735	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	357.4945	34000	12155	1000 plants / person	
4	First soil workings during monsoon	per plant	6.171	100266	618741	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.8755	33422	626830	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	4.598	33422	1536744	80 plants / person	10 Times/year
	Sub-total (c)				**2947739**		
	Total of Second Year (a+b+c)				**3320115**		
	Total of Current, First & Second Year				**14734896**		

D – Plots of Godowns and Sheds near Berth No. 1 to 6

Table D: Financial Estimate for Greenbelt Development in Plots of Godowns and Sheds near Berth No. 1 to 6

Current Year							
(a) Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Rich clay	cubic mt	1000	431.4	431400		Market rates
2	Gypsum	cubic mt	1500	123.2	184800		Market rates
3	Cow dung manure	cubic mt	3000	61.6	184800		Market rates
4	Fertilizer	kg	25	811.68	20292		Market rates
	Sub-total (a)				**821292**		
(b) Saplings							
1	Conocarpus	nos.	60	3000	180000		
2	Champo	nos.	25	500	12500		
3	Karen	nos.	25	500	12500		
4	Millettia	nos.	25	564	14100		
5	*Tecoma stans*	nos.	25	500	12500		
6	Saptaparni	nos.	25	500	12500		
7	Bougainvillea	nos.	25	400	10000		
8	Sharu	nos.	25	400	10000		
9	Bauhenia variegata	nos.	25	400	10000		
	Sub-total (b)			6764	**274100**		
(c)Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	15.15	6764	102475	20 pits / person	
2	Planting with polypot	per plant	3.8	6764	25703	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	295.45	7000	2068	1000 plants / person	
4	First soil workings during monsoon	per plant	5.1	20292	103489	60 plants / person	Thrice during monsoon

5	Support watering	per plant	1.55	6764	104842	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	3.8	6764	257032	80 plants / person	10 Times/year
	Sub-total (c)				**595609**		
	Total of Current Year (a+b+c)				**1691001**		
First Year							
Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Fertilizer	kg	25	811.68	20292		
	Sub-total (a)				**20292**		
Saplings							
1	Conocarpus	nos.	125	600	75000		
2	Champo	nos.	25	100	2500		
3	Karen	nos.	25	100	2500		
4	Millettia	nos.	25	112.8	2820		
5	*Tecoma stans*	nos.	25	100	2500		
6	Saptaparni	nos.	25	100	2500		
7	Bougainvillea	nos.	25	80	2000		
8	Sharu	nos.	25	80	2000		
9	Bauhenia variegata	nos.	25	80	2000		
	Sub-total (b)			1352.8	**93820**		
Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	16.665	1352.8	22544	20 pits / person	
2	Planting with polypot	per plant	4.18	1352.8	5655	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	324.995	7000	2275	1000 plants / person	
4	First soil workings during monsoon	per plant	5.61	20292	113838	60 plants / person	Thrice during monsoon
5	Support watering	per plant	1.705	6764	115326	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	4.18	6764	282735	80 plants / person	10 Times/year
	Sub-total (c)				**542374**		
	Total of First Year (a+b+c)				**656486**		

S.N.	Particulars	Unit	Rate	Quantity	Amount	Work Norms	Remarks
Second Year							
Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Fertilizer	kg	25	811.68	20292		
	Sub-total (a)				**20292**		
Saplings							
1	Conocarpus	nos.	125	600	75000		
2	Champo	nos.	25	100	2500		
3	Karen	nos.	25	100	2500		
4	Millettia	nos.	25	112.8	2820		
5	*Tecoma stans*	nos.	25	100	2500		
6	Saptaparni	nos.	25	100	2500		
7	Bougainvillea	nos.	25	80	2000		
8	Sharu	nos.	25	80	2000		
9	Bauhenia variegata	nos.	25	80	2000		
	Sub-total (b)			1352.8	**93820**		
Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	18.3315	1352.8	24799	20 pits / person	
2	Planting with polypot	per plant	4.598	1352.8	6220	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	357.4945	7000	2502	1000 plants / person	
4	First soil workings during monsoon	per plant	6.171	20292	125222	60 plants / person	Thrice during monsoon
5	Support watering	per plant	1.8755	6764	126859	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	4.598	6764	311009	80 plants / person	10 Times/year
	Sub-total (c)				**596611**		
	Total of Second Year (a+b+c)				**710723**		
	Total of Current, First & Second Year				**3058210**		

E – Plots and Godowns along NH-8

Table E: Financial Estimate for Greenbelt Development in Plots and Godowns along NH-8

Current Year							
(a) Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Rich clay	cubic mt	1000	145	145000		Market rates
2	Gypsum	cubic mt	1500	41.3	61950		Market rates
3	Cow dung manure	cubic mt	3000	20.7	62100		Market rates
4	Fertilizer	kg	25	272.52	6813		Market rates
	Sub-total (a)				**275863**		
(b) Saplings							
1	Conocarpus	nos.	60	1000	60000		
2	Champo	nos.	25	171	4275		
3	Karen	nos.	25	160	4000		
4	Millettia	nos.	25	160	4000		
5	*Tecoma stans*	nos.	25	160	4000		
6	Saptaparni	nos.	25	160	4000		
7	Bougainvillea	nos.	25	160	4000		
8	Sharu	nos.	25	150	3750		
9	Bauhenia variegata	nos.	25	150	3750		
	Sub-total (b)			2271	**91775**		
(c)Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	15.15	2271	34406	20 pits / person	
2	Planting with polypot	per plant	3.8	2271	8630	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	295.45	3000	886	1000 plants / person	
4	First soil workings during monsoon	per plant	5.1	6813	34746	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.55	2271	35201	200 plants / person	10 Times/year

6	Subsequent soil workings	per plant	3.8	2271	86298	80 plants / person	10 Times/year
	Sub-total (c)				**200167**		
	Total of Current Year (a+b+c)				**567805**		
First Year							
Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Fertilizer	kg	25	272.52	6813		
	Sub-total (a)				**6813**		
Saplings							
1	Conocarpus	nos.	60	200	12000		
2	Champo	nos.	25	34.2	855		
3	Karen	nos.	25	32	800		
4	Millettia	nos.	25	32	800		
5	*Tecoma stans*	nos.	25	32	800		
6	Saptaparni	nos.	25	32	800		
7	Bougainvillea	nos.	25	32	800		
8	Sharu	nos.	25	30	750		
9	Bauhenia variegata	nos.	25	30	750		
	Sub-total (b)			454.2	**18355**		
Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	16.665	454.2	7569	20 pits / person	
2	Planting with polypot	per plant	4.18	454.2	1899	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	324.995	3000	975	1000 plants / person	
4	First soil workings during monsoon	per plant	5.61	6813	38221	60 plants / person	Thrice during monsoon
5	Support watering	per plant	1.705	2271	38721	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	4.18	2271	94928	80 plants / person	10 Times/year
	Sub-total (c)				**182312**		
	Total of First Year (a+b+c)				**207480**		
Second Year							

Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Fertilizer	kg	25	272.52	6813		
	Sub-total (a)				**6813**		
Saplings							
1	Conocarpus	nos.	60	200	12000		
2	Champo	nos.	25	34.2	855		
3	Karen	nos.	25	32	800		
4	Millettia	nos.	25	32	800		
5	*Tecoma stans*	nos.	25	32	800		
6	Saptaparni	nos.	25	32	800		
7	Bougainvillea	nos.	25	32	800		
8	Sharu	nos.	25	30	750		
9	Bauhenia variegata	nos.	25	30	750		
	Sub-total (b)			454.2	**18355**		
Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	18.3315	454.2	8326	20 pits / person	
2	Planting with polypot	per plant	4.598	454.2	2088	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	357.4945	3000	1072	1000 plants / person	
4	First soil workings during monsoon	per plant	6.171	6813	42043	60 plants / person	Thrice during monsoon
5	Support watering	per plant	1.8755	2271	42593	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	4.598	2271	104421	80 plants / person	10 Times/year
	Sub-total (c)				**200543**		
	Total of Second Year (a+b+c)				**225711**		
	Total of Current, First & Second Year				**1000996**		

F – Quay and Transit Area (from North Gate to Berth No. 10)

Table F: Financial Estimate for Greenbelt Development in Quay and Transit Area (from North Gate to Berth No. 10)

Current Year							
(a) Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Rich clay	cubic mt	1000	27.5	27500		Market rates
2	Gypsum	cubic mt	1500	7.87	11805		Market rates
3	Cow dung manure	cubic mt	3000	4	12000		Market rates
4	Fertilizer	kg	25	51.84	1296		Market rates
	Pots of 1 cu. M	nos.	1000	432	432000		Market rates
	Sub-total (a)				**484601**		
(b) Saplings							
1	Conocarpus	nos.	60	432	25920		
2	Champo	nos.	25	0	0		
3	Karen	nos.	25	0	0		
4	Millettia	nos.	25	0	0		
5	*Tecoma stans*	nos.	25	0	0		
6	Saptaparni	nos.	25	0	0		
7	Bougainvillea	nos.	25	0	0		
8	Sharu	nos.	25	0	0		
	Sub-total (b)			432	**25920**		
(c)Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	15.15	0	0	20 pits / person	
2	Planting with polypot	per plant	3.8	432	1642	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	295.45	1000	295	1000 plants / person	
4	First soil workings during monsoon	per plant	5.1	1296	6610	60 plants / person	3 times during monsoon

5	Support watering	per plant	1.55	432	6696	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	3.8	432	16416	80 plants / person	10 Times/year
	Sub-total (c)				**31659**		
	Total of Current Year (a+b+c)				**542180**		
First Year							
Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Fertilizer	kg	25	51.84	1296		
	Pots of 1 cu. M				43200		Add repair / replacement @ 10%
	Sub-total (a)				**44496**		
Saplings							
1	Conocarpus	nos.	60	86.4	5184		
2	Champo	nos.	25	0	0		
3	Karen	nos.	25	0	0		
4	Millettia	nos.	25	0	0		
5	*Tecoma stans*	nos.	25	0	0		
6	Saptaparni	nos.	25	0	0		
7	Bougainvillea	nos.	25	0	0		
8	Sharu	nos.	25	0	0		
	Sub-total (b)			86.4	**5184**		
Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	16.665	86.4	1440	20 pits / person	
2	Planting with polypot	per plant	4.18	86.4	361	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	324.995	1000	325	1000 plants / person	
4	First soil workings during monsoon	per plant	5.61	1296	7271	60 plants / person	Thrice during monsoon
5	Support watering	per plant	1.705	432	7366	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	4.18	432	18058	80 plants / person	10 Times/year
	Sub-total (c)				**34820**		

	Total of First Year (a+b+c)				**84500**		
Second Year							
Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Fertilizer	kg	25	51.84	1296		
	Pots of 1 cu. M				43200		Add repair / replacement @ 10%
	Sub-total (a)				**44496**		
Saplings							
1	Conocarpus	nos.	60	86.4	5184		
2	Champo	nos.	25	0	0		
3	Karen	nos.	25	0	0		
4	Millettia	nos.	25	0	0		
5	*Tecoma stans*	nos.	25	0	0		
6	Saptaparni	nos.	25	0	0		
7	Bougainvillea	nos.	25	0	0		
8	Sharu	nos.	25	0	0		
	Sub-total (b)			86.4	**5184**		
Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	18.3315	86.4	1584	20 pits / person	
2	Planting with polypot	per plant	4.598	86.4	397	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	357.4945	1000	357	1000 plants / person	
4	First soil workings during monsoon	per plant	6.171	1296	7998	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.8755	432	8102	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	4.598	432	19863	80 plants / person	10 Times/year
	Sub-total (c)				**38302**		
	Total of Second Year (a+b+c)				**87982**		
	Total of Current, First & Second Year				**714661**		

G – Plantation along column / pillar of Godowns

Table G: Financial Estimate for Greenbelt Development along column / pillar of Godowns

Current Year							
(a) Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Pots of 1 cu. M	nos.	1000	1206	1206000		Market rates
2	Rich clay	cubic mt	1000	77	77000		Market rates
3	Gypsum	cubic mt	1500	22	33000		Market rates
4	Cow dung manure	cubic mt	3000	11	33000		Market rates
5	Fertilizer	kg	25	144.72	3618		Market rates
	Sub-total (a)				**1352618**		
(b) Saplings							
1	Conocarpus	nos.	60	402	24120		
2	Sharu	nos.	25	402	10050		
3	Palm	nos.	60	402	24120		
	Sub-total (b)			1206	**58290**		
(c)Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	15.15	0	0	20 pits / person	
2	Planting with polypot	per plant	3.8	1206	4583	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	295.45	2000	591	1000 plants / person	
4	First soil workings during monsoon	per plant	5.1	3618	18452	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.55	1206	18693	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	3.8	1206	45828	80 plants / person	10 Times/year
	Sub-total (c)				**88147**		
	Total of Current Year (a+b+c)				**1499055**		

First Year							
Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Pots of 1 cu. M	nos.			120600		Add repair / replacement @ 10%
2	Fertilizer	kg	25	144.72	3618		
	Sub-total (a)				**124218**		
Saplings							
1	Conocarpus	nos.	60	80.4	4824		
2	Sharu	nos.	25	80.4	2010		
3	Palm	nos.	60	80.4	4824		
	Sub-total (b)			241.2	**11658**		
Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	16.665	241.2	4019.598	20 pits / person	
2	Planting with polypot	per plant	4.18	241.2	1008.216	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	324.995	2000	649.99	1000 plants / person	
4	First soil workings during monsoon	per plant	5.61	3618	20296.98	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.705	1206	20562.3	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	4.18	1206	50410.8	80 plants / person	10 Times/year
	Sub-total (c)				**96947.884**		
	Total of First Year (a+b+c)				**232823.884**		
Second Year							
Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Pots of 1 cu. M	nos.			120600		Add repair / replacement @ 10%

2	Fertilizer	kg	25	144.72	3618		
	Sub-total (a)				**124218**		
Saplings							
1	Conocarpus	nos.	60	80.4	4824		
2	Sharu	nos.	25	80.4	2010		
3	Palm	nos.	60	80.4	4824		
	Sub-total (b)			241.2	**11658**		
Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	18.3315	241.2	4422	20 pits / person	
2	Planting with polypot	per plant	4.598	241.2	1109	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	357.4945	2000	715	1000 plants / person	
4	First soil workings during monsoon	per plant	6.171	3618	22327	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.8755	1206	22619	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	4.598	1206	55452	80 plants / person	10 Times/year
	Sub-total (c)				**106643**		
	Total of Second Year (a+b+c)				**242519**		
	Total of Current, First & Second Year				**1974397**		

H – Roadside Plantation (At Median)

Table H: Financial Estimate for Greenbelt Development at Road Median

Current Year							
(a) Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Fencing	length in mt	400	12080	4832000		Market rates
2	Rich clay	cubic mt	1000	770.5	770500		Market rates
3	Gypsum	cubic mt	1500	220	330000		Market rates
4	Cow dung manure	cubic mt	3000	110	330000		Market rates
5	Fertilizer	kg	25	1449.6	36240		Market rates
	Sub-total (a)				**6298740**		
(b) Saplings							
1	Neem	nos.	25	2600	65000		
2	Conocarpus	nos.	60	5880	352800		
3	Champo	nos.	25	250	6250		
4	Pilu	nos.	25	2600	65000		
5	Bougainvillea	nos.	25	250	6250		
6	Karen	nos.	25	250	6250		
7	Tecoma	nos.	25	250	6250		
8	Kigelia	nos.	25	0	0		
9	Australian baval	nos.	25	0	0		
10	Rain Tree	nos.	25	0	0		
	Sub-total (b)			12080	**507800**		
(c)Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	15.15	12080	183012	20 pits / person	
2	Planting with polypot	per plant	3.8	12080	45904	80 plants / person	

3	Fertilizer / Insecticide Application	per 1000 plant	295.45	13000	3841	1000 plants / person	
4	First soil workings during monsoon	per plant	5.1	36240	184824	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.55	12080	187240	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	3.8	12080	459040	80 plants / person	10 Times/year
	Sub-total (c)				**1063861**		
	Total of Current Year (a+b+c)				**7870401**		
First Year							
Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Fencing	length in mt	NA	NA	483200		Add. Repair / maintenace @ 10%
2	Fertilizer	kg	25	1449.6	36240		
	Sub-total (a)				**519440**		
Saplings							
1	Neem	nos.	25	520	13000		
2	Conocarpus	nos.	60	1176	70560		
3	Champo	nos.	25	50	1250		
4	Pilu	nos.	25	520	13000		
5	Bougainvillea	nos.	25	50	1250		
6	Karen	nos.	25	50	1250		
7	Tecoma	nos.	25	50	1250		
8	Kigelia	nos.	25	0	0		
9	Australian baval	nos.	25	0	0		
10	Rain Tree	nos.	25	0	0		
	Sub-total (b)			2416	**101560**		
Plantation related activities (Labour Cost)							

1	Pit Digging	per pit	16.665	2416	40263	20 pits / person	
2	Planting with polypot	per plant	4.18	2416	10099	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	324.995	13000	4225	1000 plants / person	
4	First soil workings during monsoon	per plant	5.61	36240	203306	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.705	12080	205964	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	4.18	12080	504944	80 plants / person	10 Times/year
	Sub-total (c)				**968801**		
	Total of First Year (a+b+c)				**1589801**		
Second Year							
Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Fencing	length in mt			483200		Add. Repair / maintenace @ 10%
2	Fertilizer	kg	25	1449.6	36240		
	Sub-total (a)				**519440**		
Saplings							
1	Neem	nos.	25	520	13000		
2	Conocarpus	nos.	60	1176	70560		
3	Champo	nos.	25	50	1250		
4	Pilu	nos.	25	520	13000		
5	Bougainvillea	nos.	25	50	1250		
6	Karen	nos.	25	50	1250		
7	Tecoma	nos.	25	50	1250		
8	Kigelia	nos.	25	0	0		
9	Australian baval	nos.	25	0	0		
10	Rain Tree	nos.	25	0	0		

	Sub-total (b)			2416	**101560**		
Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	18.3315	2416	44289	20 pits / person	
2	Planting with polypot	per plant	4.598	2416	11109	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	357.4945	13000	4647	1000 plants / person	
4	First soil workings during monsoon	per plant	6.171	36240	223637	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.8755	12080	226560	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	4.598	12080	555438	80 plants / person	10 Times/year
	Sub-total (c)				**1065681**		
	Total of Second Year (a+b+c)				**1686681**		
	Total of Current, First & Second Year				**11146883**		

Section-2: Offices, Gopalpuri Colony and other important buildings

Table I: Financial Estimate for Greenbelt Development in Offices, Gopalpuri Colony and other important building premises

Current Year							
(a) Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Rich clay	cubic mt	1000	357.3	357300		Market rates
2	Gypsum	cubic mt	1500	102	153000		Market rates
3	Cow dung manure	cubic mt	3000	51	153000		Market rates
4	Fertilizer	kg	25	672.24	16806		Market rates
	Sub-total (a)				**680106**		
(b) Saplings							
1	Neem	nos.	25	500	12500		
2	Conocarpus	nos.	60	0	0		
3	Champo	nos.	25	520	13000		
4	Karen	nos.	25	520	13000		
5	Millettia	nos.	25	520	13000		
6	*Tecoma stans*	nos.	25	520	13000		
7	Saptaparni	nos.	25	520	13000		
8	Bougainvillea	nos.	25	502	12550		
9	Bauhenia variegata	nos.	25	500	12500		
10	Borselli	nos.	25	500	12500		
11	Vad	nos.	25	500	12500		
12	Pipal	nos.	25	500	12500		
	Sub-total (b)			5602	**140050**		
(c)Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	15.15	5602	84870	20 pits / person	
2	Planting with polypot	per plant	3.8	5602	21288	80 plants / person	

3	Fertilizer / Insecticide Application	per 1000 plant	295.45	6000	1773	1000 plants / person	
4	First soil workings during monsoon	per plant	5.1	16806	85711	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.55	5602	86831	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	3.8	5602	212876	80 plants / person	10 Times/year
	Sub-total (c)				**493348**		
	Total of Current Year (a+b+c)				**1313504**		
First Year							
Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Fertilizer	kg	25	672.24	16806		
	Sub-total (a)				**16806**		
Saplings							
1	Neem	nos.	25	100	2500		
2	Conocarpus	nos.	60	0	0		
3	Champo	nos.	25	104	2600		
4	Karen	nos.	25	104	2600		
5	Millettia	nos.	25	104	2600		
6	*Tecoma stans*	nos.	25	104	2600		
7	Saptaparni	nos.	25	104	2600		
8	Bougainvillea	nos.	25	100	2510		
9	Bauhenia variegata	nos.	25	100	2500		
10	Borselli	nos.	25	100	2500		
11	Vad	nos.	25	100	2500		
12	Pipal	nos.	25	100	2500		
	Sub-total (b)			1120	**28010**		
Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	16.665	1120	18671	20 pits / person	
2	Planting with polypot	per plant	4.18	1120	4683	80 plants / person	

3	Fertilizer / Insecticide Application	per 1000 plant	324.995	6000	1950	1000 plants / person	
4	First soil workings during monsoon	per plant	5.61	16806	94282	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.705	5602	95514	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	4.18	5602	234164	80 plants / person	10 Times/year
	Sub-total (c)				**449264**		
	Total of First Year (a+b+c)				**494080**		
Second Year							
Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Fertilizer	kg	25	672.24	16806		
	Sub-total (a)				**16806**		
Saplings							
1	Neem	nos.	25	100	2500		
2	Conocarpus	nos.	60	0	0		
3	Champo	nos.	25	104	2600		
4	Karen	nos.	25	104	2600		
5	Millettia	nos.	25	104	2600		
6	*Tecoma stans*	nos.	25	104	2600		
7	Saptaparni	nos.	25	104	2600		
8	Bougainvillea	nos.	25	100	2510		
9	Bauhenia variegata	nos.	25	100	2500		
10	Borselli	nos.	25	100	2500		
11	Vad	nos.	25	100	2500		
12	Pipal	nos.	25	100	2500		
	Sub-total (b)			1120	**28010**		
Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	18.33	1120	20539	20 pits / person	
2	Planting with polypot	per plant	4.60	1120	5152	80 plants / person	

3	Fertilizer / Insecticide Application	per 1000 plant	357.49	6000	2145	1000 plants / person	
4	First soil workings during monsoon	per plant	6.17	16806	103710	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.88	5602	105066	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	4.60	5602	257580	80 plants / person	10 Times/year
	Sub-total (c)				**494190**		
	Total of Second Year (a+b+c)				**539006**		
	Total of Current, First & Second Year				**2346591**		

Section-3: Gandhidham Township

Table J: Financial Estimate for Greenbelt Development in Gandhidham township

Current Year							
(a) Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Rich clay	cubic mt	1000	0.0	0		Market rates
2	Gypsum	cubic mt	1500	4556.3	6834375		Market rates
3	Cow dung manure	cubic mt	3000	2278.1	6834375		Market rates
4	Fertilizer	kg	25	30000	750000		Market rates
5	Drip Irrigation System	ha	50000	100	5000000		Market rates (Lumpsum)
	Sub-total (a)				**19418750**		
(b) Saplings (Rates of saplings are inclusive of transportation, loading, unloading at pit site)							
1	Conocarpus	nos.	60	125000	7500000		
2	Others	nos.	25	125000	3125000		
	Sub-total (b)			250000	**10625000**		
(c)Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	15.15	250000	3787500	20 pits / person	
2	Planting with polypot	per plant	3.8	250000	950000	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	295.45	250000	73863	1000 plants / person	
4	First soil workings during monsoon	per plant	5.1	750000	3825000	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.55	250000	3875000	200 plants / person	10 support watering per year
6	Subsequent soil workings	per plant	3.8	250000	9500000	80 plants / person	10 subsequent soil working per year

S.N.	Particulars	Unit	Rate	Quantity	Amount	Work Norms	Remarks
	Sub-total (c)				**22011363**		
	Total of Current Year (a+b+c)				**62055113**		
First Year							
Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Fertilizer	kg	25	30000	750000		
	Sub-total (a)				**750000**		
Saplings (Casualty Replacement @ 20%)							
1	Conocarpus	nos.	60	25000	1500000		
2	Others	nos.	25	25000	625000		
	Sub-total (b)			50000	**2125000**		
Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	16.665	25000	416625	20 pits / person	
2	Planting with polypot	per plant	4.18	25000	104500	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	324.995	250000	13650	1000 plants / person	
4	First soil workings during monsoon	per plant	5.61	750000	4207500	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.705	250000	4262500	200 plants / person	10 Times/year (In case of flood irrigation)
6	Subsequent soil workings	per plant	4.18	250000	10450000	80 plants / person	10 Times/year
	Sub-total (c)				**19454775**		
	Total of First Year (a+b+c)				**22329775**		
Second Year							
Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Fertilizer	kg	25	30000	750000		
	Sub-total (a)				**750000**		

Saplings (Casualty Replacement @ 20%)							
1	Conocarpus	nos.	60	25000	1500000		
2	Others	nos.	25	25000	625000		
	Sub-total (b)			50000	**2125000**		
Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	18.33	25000	458288	20 pits / person	
2	Planting with polypot	per plant	4.60	25000	114950	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	357.49	250000	15015	1000 plants / person	
4	First soil workings during monsoon	per plant	6.17	750000	4628250	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.88	250000	4688750	200 plants / person	10 Times/year (In case of flood irrigation)
6	Subsequent soil workings	per plant	4.60	250000	11495000	80 plants / person	10 Times/year
	Sub-total (c)				**21400252**		
	Total of Second Year (a+b+c)				**24275252**		
	Total of Current, First & Second Year				**98660140**		

Financial Estimate for Casualty Replacement, Preservation and Maintenance of Existing Greenbelt

Table K: Financial Estimate for Casualty Replacement, Preservation and Maintenance of Existing Greenbelt

First Year							
Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Fertilizer	kg	25	844.8	21120		
	Sub-total (a)				**21120**		
Saplings							
1	Same as existing species	nos.	25	7040	176000		
	Sub-total (b)			7040	**176000**		
Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	16.67		0	20 pits / person	
2	Planting with polypot	per plant	4.18	7,040	29427	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	325	8,000	2600	1000 plants / person	
4	First soil workings during monsoon	per plant	5.61	21120	118483	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.71	7040	120032	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	4.18	7040	294272	80 plants / person	10 Times/year
	Sub-total (c)				**564814**		
	Total of First Year (a+b+c)				**761934**		
Second Year							
Civil work and other items							
S.N.	**Particulars**	**Unit**	**Rate**	**Quantity**	**Amount**	**Work Norms**	**Remarks**
1	Fertilizer	kg	25	844.8	21120		
	Sub-total (a)				**21120**		
Saplings							

2	Same as existing species	nos.	25	7040	176000		
	Sub-total (b)			7040	**176000**		
Plantation related activities (Labour Cost)							
1	Pit Digging	per pit	18.3315	0	0	20 pits / person	
2	Planting with polypot	per plant	4.598	7040	32370	80 plants / person	
3	Fertilizer / Insecticide Application	per 1000 plant	357.4945	8000	2860	1000 plants / person	
4	First soil workings during monsoon	per plant	6.171	21120	130332	60 plants / person	3 times during monsoon
5	Support watering	per plant	1.8755	7040	132035	200 plants / person	10 Times/year
6	Subsequent soil workings	per plant	4.598	7040	323699	80 plants / person	10 Times/year
	Sub-total (c)				**621296**		
	Total of Second Year (a+b+c)				**818416**		
	Total of Current, First & Second Year				**1580350**		

About Gujarat Environment Management Institute (GEMI)

The Gujarat Environment Management Institute (GEMI); set up in 1999; is an **Autonomous Institute under the aegis of the Forests & Environment Department, Government of Gujarat**. The Institute is engaged in carrying out various projects and research activities pertaining to environment management through techno-scientific interventions. The Institute has obtained numerous National and International accreditations/recognitions which includes:

- ISO 9001:2015
- ISO 14001:2015
- ISO 45001:2018
- Environmental Laboratory recognized under the provisions of Environment Protection Act, 1986
- 'State Water Lab' and 'State Air Lab' under the provisions of Water Act,1974 and Air Act,1981 respectively
- NABL accreditation under Chemical and Biological disciplines (for air, water, wastewater, soil and noise)
- QCI-NABET accreditation as EIA Consultant Organization in eight sectors
- National e-Governance award for its e-LMS software for the year 2015-16
- Recognition as 'Scientific & Industrial Research Organization (SIRO)' by Department of Scientific & Industrial Research, Ministry of Science & Technology, Govt. of India.
- Recognized by Revenue Department, Govt. of Gujarat, Govt. of Rajasthan and Dadra & Nagar Haveli Administration as SIA Team
- Centre for organizing in-service training of IFS officers

The Institute over the years has established itself as one of the Premier Institutes in the country in the field of environment management. It has the most modern State-of-the-Art infrastructure and facilities and a team of highly skilled and experienced manpower.

Services of GEMI

GEMI is a one-stop solution for all kind of environment-related services like

- Environmental Monitoring & Audit
- Environment Impact Assessment (EIA) & Environment Carrying Capacity
- Social Impact Assessment
- Environment Training & Awareness
- Environmental Education
- Laboratory Services
- Environmental Management System Design and Consultancy
- Inventorization of Different Types of Wastes
- Accreditation and Rating
- Development of Environmental Indices
- Environmental Planning and Policy Research

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Annexure –O

Form IV

(Annual Return of Hazardous waste) for the year 2021-2022

DEENDAYAL PORT AUTHORITY
(Erstwhile: DEENDAYAL PORT TRUST)

दीनदयाल पत्तन प्राधिकरण
DEENDAYAL PORT AUTHORITY

Administrative Office Building
Post Box NO. 50
GANDHIDHAM (Kutch).
Gujarat: 370 201.
Fax: (02836) 220050
Ph.: (02836) 220038

www.deendayalport.gov.in

EG/WK/EMC/CCA/ Part(III)/ 131

Date: 06/07/2022

To,
The Member Secretary
Gujarat Pollution Control Board
Paryavaran Bhavan,
Sector 10A, Gandhinagar - 382010

Sub: Submission of Annual Return of Hazardous waste in format form IV for the financial year 2021-22 reg.

Ref.: 1) KPT letter no. EG/WK/4660(EC)/549 dated 20/6/2012
2) KPT letter no. MR/GN/1527(Part I)/2012 dated 20/5/2013
3) KPT letter no. MR/GN/1527(Part I)/336 dated 17/05/2014
4) KPT letter no. MR/GN/1527/ (Part I)/dated 27/04/2015
5) KPT letter no. EG/WK/EMC/CCA (Part II)/217 dated 27/6/2016
6) KPT letter no. EG/WK/EMC/CCA (Part II)/213 dated 19/6/2017
7) DPT letter no. EG/WK/EMC/CCA (Part II)/294 dated 13/6/2018
8) DPT letter no. EG/WK/EMC/CCA (Part II) dated 27/5/2019
9) DPT letter no. EG/WK/4751 (CCA Renewal) dated 22/5/2020
10) DPT letter no. EG/WK/4751 (CCA Renewal)/13 dated 30(4)/4(5)/2021

Sir,

It is requested to kindly refer above cited references for the said subject.

In this connection, it is to state that, the Deendayal Port Authority had obtained renewal of consent order from the GPCB Vide order no. AWH – 110594 dated 22/01/2021 valid up to 21/07/2025 for Deendayal Port Authority area.

In this regard, as per statutory requirement, the DPA has regularly submitted Annual Returns (as mentioned in reference above) in format Form IV to the GPCB.

Now please find the enclosed herewith Annual Return of Hazardous Waste in Form IV for the year 2021-22

This is for kind information and record please.

Encl: As above

Yours faithfully

Manager (Environment)
Deendayal Port Authority

Enclosure – A

Annual Return of Hazardous waste Return (Form IV)
For Deendayal Port Trust, Kandla
For the FY @ 2021-2022

"FORM-IV"

[(See rule 6(%), 13(8), 16(6) and 20(21)
(To be submitted to State Pollution Control Board by 30th day of June of every year for the preceding period April 21 to March 22)

Sr. No.	Particulars	Details
1.	Name and Address of the Facility	**Deendayal Port Authority** Administrative Office Building Post Box No. 50 Gandhidham Dist.: Kutch- 370201 Gujarat State Tel. No.: 02836-233192 Fax No.: 02836-220050
2.	Authorization No. and Date of issue	Consent order no. AWH – 110594 granted by the GPCB dated 22/01/2021 and correction to consent order done dated 09/04/2021
3.	Name of Authorized Person and full address with telephone, Fax number and E-Mail	**Mr. Raveendra Reddy** **Chief Engineer** **Deendayal Port Authority** Administrative Office Building Post Box No. 50 Gandhidham Dist.: Kutch- 370201 Gujarat State Tel. No.: 02836-233192 Fax No.: 02836-220050
4.	Production during the year (product wise) wherever applicable	NA Deendayal Port Authority has only loading & unloading activities for dry cargo and liquid cargo. During FY 2021-22 Total Cargo Handled is **127.10** MMTPA

PART A. To be filled by Hazardous Waste Generator

1.	Total quantity of waste generated category wise	Used oil/Waste residue containing oil **9585.85 MT/A**
2.	Quantity Dispatched a. To disposal Facility b. To recycler or co-processor or pre-processor c. Others	Used Oil/Waste residue containing oil has been disposed of through CPCB/GPCB authorized vendor (Annexure-1)
3.	Quantity utilized inhouse -if any	NA
4.	Quantity in storage at the end of the year	NA

PART B To be filled Treatment, Storage and Disposal Facility Operator

1.	Total Quantity Received 1. Direct Landfill 2. Incineration 3. Land fill after treatment	NA
2.	Quantity at stock at the beginning of the year 1. Direct Landfill 2. Incineration 3. Land fill after treatment	
3.	Quantity treated (Landfill) Land fill after Treatment	
4.	Quantity disposed in landfill as such and after treatment 1. Direct Landfill 2. Land fill after treatment 3. Incineration Ash 4. Salts from Spray Dryer 5. Total	
5.	Quantity incinerated (if applicable)	
6.	Quantity processed other than specified above	
7.	Quantity in storage at the end of the year 1. Incineration 2. Landfill after treatment	

PART C To be filled by recyclers or co-processor or other users

1.	Quantity of the waste received during the year 1. Domestic sources 2. Imported (if applicable)	NA
2.	Quantity in stock at the beginning of the year	
3.	Quantity recycled or co processed or used	
4.	Quantity of products dispatched (wherever applicable)	
5.	Quantity of waste generated	
6.	Quantity of waste disposed	
7.	Quantity re-exported (wherever Applicable)	
8.	Quantity in storage at the end of the year	

Manager (Environment)

Deendayal Port Authority

Date: 06/07/2022
Place Gandhidham

ANNEXURE - 1

Annexure -1

DEENDAYAL PORT AUTHORITY
MARINE DEPARTMENT

Statement of Hazardous & Non Hazardous Waste disposal from the vessels at Kandla & Vadinar Port
YEAR 2021-22

Sr. No.	MONTH	YEAR	Hazardous (Sludge)	Non Hazardous (Garbage)
1	APRIL	**2021**	3006.02	95.13
2	MAY	**2021**	1014.18	118.78
3	JUNE	**2021**	830.21	148.35
4	JULY	**2021**	863.36	105.89
5	AUGUST	**2021**	762.38	133.90
6	SEPTEMBER	**2021**	898.80	208.42
7	OCTOBER	**2021**	193.08	175.53
8	NOVEMBER	**2021**	210.06	194.18
9	DECEMBER	**2021**	381.77	167.02
10	JANUARY	**2022**	261.94	109.80
11	FEBRUARY	**2022**	254.66	96.03
12	MARCH	**2022**	909.39	171.05
	TOTAL		**9585.85** MT	**1724.08** MT

Deputy Conservator
Deedayal Port Authority

03/2164
30/6/22

Marine Department

Statement showing the Collection and disposal of Hazardous and Non-Harardous Wastes carried out by various parties from April - 2021 to Mar - 2022

Sr. No.	Name of Party	Validity of License	Type of Licence	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21
1	Alcid Organic Industries Limited	27-Oct-22	Hazardous	-	70.45	-	-	19.81	-
2	Amar Hydrocarbon Pvt. Ltd	22-Feb-23	Hazardous	-	-	-	-	-	-
3	Atlas Organics Pvt. Ltd	17-Oct-22	Hazardous	20.17	-	-	18.78	19.81	50.85
4	Aviation Corporation	14-Jun-22	Hazardous	-	-	-	151.18	71.53	133.63
5	Fine Refiners Pvt. Ltd	22-Jun-22	Hazardous	48.59	31.88	115.80	-	-	14.88
6	Priyansi Corporation	16-Dec-22	Hazardous	-	-	33.83	9.62	-	-
7	Revolution Petrochem LLP	01-Apr-22	Hazardous	2,658.01	531.52	442.73	546.48	524.09	456.01
8	Shana Oil Process	12-Feb-22	Hazardous	-	-	-	-	-	-
9	United Shipping Company	13-Sep-22	Hazardous	279.25	380.33	237.85	137.30	127.14	243.43
10	**Vaccant**	-	-	-	-	-	-	-	-
11	Chitrakut Trading & Industries	17-Nov-22	Non-Hazardous	-	0.98	-	0.65	0.39	-
12	Golden Shipping Services	30-May-23	Non-Hazardous	25.76	19.01	72.77	28.84	36.86	49.81
13	Green Earth Marine Solutions	23-Mar-23	Non-Hazardous	-	-	-	-	-	-
14	Harish A. Pandya	03-Feb-23	Non-Hazardous	4.86	0.68	3.95	0.90	1.23	8.00
15	K M Enterprise	04-May-23	Non-Hazardous	-	57.04	43.81	53.40	29.93	28.26
16	Naaz Shipping Services Ent	05-Jun-22	Non-Hazardous	6.40	-	2.80	-	0.60	12.30
17	New India Marine Works	22-Feb-23	Non-Hazardous	-	-	-	-	-	-
18	Omega Marine Services	28-Jun-22	Non-Hazardous	46.01	30.99	18.29	-	27.59	61.62
19	Vishwa Trade-link Inc.	25-Jun-22	Non-Hazardous	-	-	-	10.80	17.28	15.12
20	V K Enterprise	16-Nov-22	Non-Hazardous	12.10	10.08	6.73	11.30	20.02	33.31
			Hazardous - Total	**3,006.02** MT	**1,014.18** MT	MT **830.21**	MT **863.36**	MT **762.38**	MT **898.80**
			Non-Hazardous - Total	MT **95.13**	MT **118.78**	MT **148.35**	MT **105.89**	MT **133.90**	MT **208.42**

Copy to : GPCB, Gandhidham / Harbour Master

Marine Department

Statement showing the Collection and disposal of Hazardous and Non-Harardous Wastes carried out by various parties from April - 2021 to Mar - 2022

Sr. No.	Name of Party	Validity of License	Type of Licence	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Total
1	Alicid Organic Industries Limited	27-Oct-22	Hazardous	-	-	-	-	-	-	90.26
2	Amar Hydrocarbon Pvt. Ltd	22-Feb-23	Hazardous	-	-	-	-	-	-	-
3	Atlas Organics Pvt. Ltd	17-Oct-22	Hazardous	30.82	140.02	-	-	-	92.47	372.92
4	Aviation Corporation	14-Jun-22	Hazardous	-	-	-	-	-	-	356.34
5	Fine Refiners Pvt. Ltd	22-Jun-22	Hazardous	-	-	-	6.20	-	-	217.35
6	Priyansi Corporation	16-Dec-22	Hazardous	-	-	-	-	-	-	43.45
7	Revolution Petrochem LLP	01-Apr-22	Hazardous	-	-	-	-	-	507.63	5,666.47
8	Shana Oil Process	12-Feb-22	Hazardous	-	-	-	-	-	-	-
9	United Shipping Company	13-Sep-22	Hazardous	162.26	70.04	381.77	255.74	254.66	309.29	2,839.06
10	**Vaccant**	-	-	-	-	-	-	-	-	-
11	Chitrakut Trading & Industries	17-Nov-22	Non-Hazardous	0.27	0.10	-	-	-	0.10	2.49
12	Golden Shipping Services	30-May-23	Non-Hazardous	43.90	41.41	66.73	51.67	42.02	95.34	574.12
13	Green Earth Marine Solutions	23-Mar-23	Non-Hazardous	-	-	-	-	-	-	
14	Harish A. Pandya	03-Feb-23	Non-Hazardous	0.27	0.27	-	-	-	2.82	22.98
15	K M Enterprise	04-May-23	Non-Hazardous	78.13	106.72	100.29	58.13	23.80	27.75	607.26
16	Naaz Shipping Services Ent	05-Jun-22	Non-Hazardous	-	-	-	-	-	-	22.10
17	New India Marine Works	22-Feb-23	Non-Hazardous	-	-	-	-	-	10.80	10.80
18	Omega Marine Services	28-Jun-22	Non-Hazardous	24.34	40.28	-	-	16.20	25.56	290.88
19	Vishwa Trade-link Inc.	25-Jun-22	Non-Hazardous	-	-	-	-	-	-	43.20
20	V K Enterprise	16-Nov-22	Non-Hazardous	28.62	5.40	-	-	14.01	8.68	150.25
			Hazardous - Total	**193.08** MT	**210.06** MT	**381.77** MT	**261.94** MT	**254.66** MT	**909.39** MT	**9,585.85** MT
			Non-Hazardous - Total	**175.53** MT	**194.18** MT	**167.02** MT	**109.80** MT	**96.03** MT	**171.05** MT	**1,724.08** MT

Copy to : GPCB, Gandhidham / Harbour Master

LIST OF AUTHORIZED RECYCLERS

Marine Department

STATEMENT SHOWING DEENDAYAL PORT REGISTERED PARTIES FOR
REMOVAL OF GARBAGE, USED OIL/WASTE OIL ETC.

Sr. No.	Name of Party	Licensce of Removal	Last Validity of License	Remarks
1	**M/s. Alicid Organic Industries Ltd** Office No. 35, First Floor, Grain Marchan Association Building, Plot No. 297, Ward 12/B, Near Old Court, Gandhidham Email: naazshipping service@yahoo.com Phone: 02836- 237106	Hazardous	**27-Oct-22**	
2	**M/s. Atlas Organics Pvt. Ltd** Office No. 204-206, Elisbridge Shopping Center, Opp. Town Hall, Ashram Road, Ahmedabad - 380006 Email : atlasorganics@yahoo.com Mobile : 9825063459 / 9909723532	Hazardous	**17-Oct-22**	
3	**M/s. Fine Refiners Pvt. Ltd** Plot No. 40, GIDC, Chitra Vartej, Bhavanagar - info@finerefiners.com Mobile : 9825209314 / 9979898686	Hazardous	**21-Jun-22**	
4	**M/s. Amar Hydrocarbon Pvt. Ltd.** FF-12, Sahara Complex, B/h Navajivan Hotel, S. G. Highway, Sarkhej, Ahmedabad – 382210. amarhydrocarbon@gmail.com	Hazardous	**22-Feb-22**	
5	**M/s. Aviation Corporation** 62/2/1, Shikarpur Taluka Bhachau - Kutch - Gujarat aviationcorporation1983@gmail.com	Hazardous	**14-Jun-22**	
6	**M/s. Priyansi Corporation** C-1, 804 - 806, GIDC, Bamanbore, Ta. Chotila, Dist - Surendranagar Email: operation.priyansicorporation@gmail.com Mob: 09825226095	Hazardous	**16-Dec-22**	

Marine Department

STATEMENT SHOWING DEENDAYAL PORT REGISTERED PARTIES FOR
REMOVAL OF GARBAGE, USED OIL/WASTE OIL ETC.

Sr. No.	Name of Party	Licensce of Removal	Last Validity of License	Remarks
7	**M/s. SHANA OIL PROCESS** New Good Luck Market, Nr. Aksha Masjid Chandola Lake, Narol Raod, Ahmedabad Email: kandla_sludgeremoval35@gmail.com Mob : 09824286952	Hazardous	**11-Feb-22**	
8	**M/s. United Shipping Company** Rising House-I, Ground Floor, Plot No. 82, Sector No. 1/A, Gandhidham - Kutch 370201 Email: sunil@risinggroup.co Phone : 02836 - 233060	Hazardous	**13-Sep-22**	
9	**M/s. Revolution Petrochem LLP** Office No. C-214, 2nd Floor, Shop No. 234-235, Kutch Arcade Platinum, Mithirohar **Gandhidham - 370201**	Hazardous	**31-Mar-23**	
12	**M/s. Chitrakut Trading & Industries** 15, Brahm Samaj Building, Plot No. 106, Sector No. 8, Behind OSLO Cinema, Gandhidham - Kutch 370201. Email: info@harishpandya.com Mob: 09426218125	Non-Hazardous	**17-Nov-22**	
13	**M/s. Golden Shipping Services** Kidana Nirmal Nagar, Survey No. 133, Plot No. 83 Gandhidham - Kutch	Non-Hazardous	**30-May-23**	
14	**M/s. Harish A. Pandya** 15, Brahm Samaj Building, Plot No. 106, Sector No. 8, Behind OSLO Cinema, Gandhidham - Kutch 370201. Email: info@harishpandya.com Mob: 09426218125	Non-Hazardous	**03-Feb-23**	

Marine Department

STATEMENT SHOWING DEENDAYAL PORT REGISTERED PARTIES FOR
REMOVAL OF GARBAGE, USED OIL/WASTE OIL ETC.

Sr. No.	Name of Party	Licensce of Removal	Last Validity of License	Remarks
15	**M/s. Naaz Shipping Services Enterprise** Office No. 35, First Floor, Grain Marchan Association Building, Plot No. 297, Ward 12/B, Near Old Court, Gandhidham Email: naazshipping.service@yahoo.com Phone: 02836- 237106	Non-Hazardous	**05-Jun-22**	
16	**M/s. Omega Marine Services** Reg. Office No. 2, Plot NO. 106, Sector - 8, Braham Samaj Building Gandhidham - Kutch Email: operations@omegamarineservices.com Mob: 9537329203 - 9727589185	Non-Hazardous	**28-Jun-22**	
17	**M/s. VISHWA TRADE-LINK INC.** 214, 2nd Floor, "Kutch Arcade" - Platinium Building Mithi Rohar Road, NH 8/A, GANDHIDHAM Email : vishwatradelink@gmail.com Mob: 09879595087 - 02836-283261	Non-Hazardous	**16-Nov-22**	
18	**Green Earth Marine Solutions** Office No. 202, Plot No. 578, Ward 12-C, Shakti Avenue, Gandhidham - Kutch operation@greenearthmarine.com	Non-Hazardous	**23-Mar-23**	
19	**M/s. V. K. Enterprise** 2, Plot No. 16, Sector 1/A, Shakti Nagar Road, Gandhidham - Kutch Email: vkenterprise2001@gmail.com Mob : 9825246142	Non-Hazardous	**25-Jun-23**	
20	**M/s. K. M. Enterprise** Plot No. 13, Sector – 8, Near BM Petrol Pump, Opp. Sharma Motors, Gandhidham – Kutch. Email: kmenterprisekandla@gmail.com Mob: 9427792986 - 9879986952	Non-Hazardous	**04-May-23**	

Annexure –P

Form V

(Environmental Statement) for the year 2021-2022

DEENDAYAL PORT AUTHORITY
(Erstwhile: DEENDAYAL PORT TRUST)

दीनदयाल पत्तन प्राधिकरण
DEENDAYAL PORT AUTHORITY

Administrative Office Building
Post Box NO. 50
GANDHIDHAM (Kutch).
Gujarat: 370 201
Fax: (02836) 220050
Ph.: (02836) 220038

www.deendayalport.gov.in

EG/WK/4751 (CCA Renewal)/ 132

Date: 08/07/2022

To,
The Member Secretary
Gujarat Pollution Control Board
Paryavaran Bhavan,
Sector 10A, Gandhinagar - 382010

Sub: Submission of Environmental statement in format form V for the financial year 2021-22 reg.

Ref.: 1) KPT letter no. MR/GN/1527(Part I)/535 dated 16/6/2012
2) KPT letter no. MR/GN/1527(Part I)/2011 dated 20/5/2013
3) KPT letter no. MR/GN/1527(Part I)/337 dated 17/05/2014
4) KPT letter no. MR/GN/1527/ (Part I)/dated 27/04/2015
5) KPT letter no. EG/WK/EMC/CCA (Part II)/218 dated 27/6/2016
6) KPT letter no. EG/WK/EMC/CCA (Part II)/214 dated 19/6/2017
7) DPT letter no. EG/WK/EMC/CCA (Part II)/294 dated 13/6/2018
8) DPT letter no. EG/WK/EMC/CCA (Part II) dated 27/5/2019
9) DPT letter no. EG/WK/4751 (CCA Renewal) dated 22/5/2020
10) DPT letter no. EG/WK/4751 (CCA Renewal)/14 dated (30)04/(4)5/2021

Sir,

It is requested to kindly refer above cited references for the said subject.

In this connection, it is to state that, the GPCB has renewed the consolidated consent & Authorization granted to Deendayal Port Authority (Erstwhile Deendayal Port Trust) and issued CCA order no. AWH-110594 vide PC/CA-KUTCH-812 (5)/GPCB ID 28494/581914 dated 21/01/2021 valid upto 21/07/2025

In this regard, as per statutory requirement, the DPA has regularly submitted Annual Returns (as mentioned in reference above) in format Form V to the GPCB.

Now please find the enclosed herewith Environmental Statement in Form V for the year 2021-22

This is for kind information and record please.

Encl : As above

Yours faithfully

Manager (Environment)
Deendayal Port Authority

Enclosure – A

Environmental Statement (Form V)
For Deendayal Port Authority, Kandla
For the FY @ 2021-2022

“FORM-V”
(See rule -14)

From:
Deendayal Port Authority,
Administrative Office Building,
Post Box No.: 50, Gandhidham,
Dist.: Kutch – 370 207. Gujarat State.
Tel No.: O: 02836-220038
Fax No.: 02836-220050

To,
The Member Secretary,
Gujarat Pollution Control Board,
Paryavaran Bhavan, Sector - 10A,
Gandhinagar – 382043

Environmental statement for the financial year ending the 31st March, 2022

“PART-A”

1) Name and Address of the owner/occupier of the industry or process		
➢ NAME	:	Mr. Raveendra Reddy Chief Engineer
➢ ADDRESS	:	**Deendayal Port Authority** Administrative Office Building, Post Box No.: 50, Gandhidham, Dist.: Kutch – 370 207. Gujarat State. Tel No.: O: 02836-220038 Fax No.: 02836-220050
➢ Industry Category Primary – (STC code) Secondary – (STC code)	:	Major port Authority under the administrative control of Ministry of Ministry of Ports, Shipping and waterways, GOI
➢ Year of Establishment	:	8th April 1955
➢ Date of the last Environment audit report submitted	:	27th June, 2016

"PART-B"

WATER AND RAW MATERIAL CONSUMPTION

Sr.No.	WATER CONSUMPTION	(M^3/Day)
1.	Process	2030.7
2.	Cooling	
3.	Domestic Purpose	
Total water consumption for the period from April 2021 to March 2022 was **741205.47 KL** hence, average water consumption for per day – **2030.7 M^3/day**		

I. Water Consumption

Sr. No.	Name of Products	Process Water Consumption per unit of products output	
		During the current financial year 2020-21	During the current financial year 2021-22
01.	Dry Cargo Handling	**117.558 MT**	**127.10 MT**
02.	Liquid Cargo Handling		
Deendayal Port Authority has only loading & unloading activities for dry cargo and liquid cargo. Hence consumption of process water consumption per unit of output with respective to production is not applicable. During FY 2021-22 Total Cargo Handled is **127.10** MMTPA However, Details of the Domestic water consumption for the financial year 2021-22 please refer **Annexure-1**			

II. Raw material Consumption

Sr.No.	Name of Raw Material	Name of Products	Consumption of Raw material per unit of output	
			During the current financial year 2020-21	During the current financial year 2021-22
1.	Deendayal Port Authority has only loading & unloading activities for dry cargo and liquid cargo. Hence consumption of raw material per unit of output with respective to production is not applicable			

<u>"PART-C"</u>

POLLUTION DISCHARGED TO ENVIRONMENT/UNIT OF OUTPUT (PARAMETERS AS SPECIFIED IN THE CONSENT)

Pollutant	Quantity of Pollutant Discharged (mass/day)	Concentration of Pollution in Discharge (mass/volume)	% of Variation from prescribed standard with reasons
Please Refer Annexure -II for Environmental Monitoring Reports of • Ambient Air Quality Monitoring • Drinking Water Quality Monitoring • Marine Water Monitoring • Noise Level Monitoring			

<u>"PART-D"</u>
HAZARDOUS WASTE
[AS SPECIFIED UNDER HAZARDOUS WASTE (MANAGEMNET AND HANDLING) RULES -1989 & AMENDMENT RULES -2008]

Sr.No.	Hazardous Waste	Total Quantity in MT/Year	
		During the current financial year 2020-21	During the current financial year 2021-22
1.	5.1- Waste Residue containing Oil	9874.84	9585.85
2.	5.2- Used Spent Oil		
• Details of Hazardous Waste generated during the financial year 2021-22 please refer Annexure-III			
a. From Process: NA b. From Pollution Control facility: NA			

"PART-E"
SOLID WASTE

Sr.No.	Solid Waste	Total Quantity in MT/year	
		During the current financial year 2020-21	**During the current financial year 2021-22**
1.	From Process	Nil	Nil
2.	From pollution Control Facility	Nil	Nil
a.	Quantity Recycled or Reutilized within the unit	Nil	Nil
b.	Sold	Nil	Nil
c.	Disposed Off	**817.94 MT**	**1724.08 MT**
Details of Solid Waste (Non-Hazardous Waste) generated during the financial year 2021-22 please refer Annexure-IV			

"PART-F"

PLEASE SPECIFY THE CHARACTERISTICS (IN TERMS OF CONCENTRATION AND QUANTUM) OF HAZARDOUS AS WELL AS SOLID WASTES AND INDICATE DISPOSAL PRACTICE ADOPTED FOR BOTH THESE CATEGORIES OF WASTES.

Hazardous Waste:
Companies authorized by Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB) have been awarded the work of collection, transporting and disposal of hazardous Waste by the Deendayal Port Authority. The same will be hand over to authorize parties for further Treatment & disposal.
Solid Waste:
Garbage facility is provided as per MARPOL Act 73/78 to the vessel berthed at Deendayal Port Authority. Companies authorized by Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB) have been awarded the work of collection, transporting and disposal of solid waste by the Deendayal Port Authority. The same will be hand over to authorize parties for further treatment and disposal.

"PART-G"

IMPACT OF THE POLLUTION ABATEMENT MEASURES TAKEN ON CONSERVATION OF NATURAL RESOURCES AND ON THE COST OF PRODUCTION.
DPA has awarded Environmental Monitoring Contract to Detox Corporation Pvt. Ltd., Surat for regularly monitoring of ambient air quality monitoring, Noise level monitoring, waste water and Marine water and sediment. Detox is a private laboratory and approved by NABL.

Further for Pollution Abatement measures taken for Conservation of Natural Resources DPA appointed renowned agency i.e M/s. GUIDE, Bhuj for the following work.

1. Regular Monitoring of Mangrove Plantation.

2. Preparation of detailed marine Biodiversity management plan for the impact of the project activities as per the requirement of EC & CRZ Clearance accorded by the MoEF&CC, GOI for the project "Creation of water front facilities (Oil jetties 8,9,10,11) and development of land of area 554 acres for associated facilities for storage at old Kandla, Gandhidham, kutch, Gujarat by M/s Deendayal Port Authority"

3. Regular monitoring of marine ecology in and around the Deendayal Port Authority area and continuous monitoring programme covering all season on various aspects of the coastal environ covering physico-chemical parameters of marine sediments samples coupled with biological indices, as per the requirement of EC & CRZ clearance accorded by the MoEF&CC,GOI to the various projects of the Deendayal port Authority.

4. Study on dredged material for presence of contaminant as per EC and CRZ clearance accorded by the MoEF&CC, GOI dated 19/12/2016 – specific condition vii

“PART-H”

ADDITIONAL MEASURES / INVESTMENT PROPOSAL FOR ENVIRONMENTAL PROTECTION INCLUDING ABATEMENT OF POLLUTION, PREVENTION OF POLLUTION

The allocation made under the scheme of “Environmental Services & Clearance there of other related Expenditure” during BE 2022-2023 is Rs. 345 Lakhs

“PART-I”

ANY OTHER PARTICULAR FOR IMPROVING THE QUALITY OF THE ENVIRONMENT

1. DPA is ISO 140001:2015 certified port for “Providing port facility and related maritime services for vessel and Cargo handling including storage
2. DPT has appointed M/s GEMI, Gandhinagar for the work “Making Deendayal Port a Green Port– Intended Sustainable Development under the Green Port Initiatives”. M/s GEMI, Gandhinagar had submitted the Final Report on 10/03/2021
3. DPA has accorded the work of Afforestation project in Deendayal Port Area to Forest Department, GoG which includes plantation and maintenance work of 1100 plants per ha.
4. DPA has accorded the work of green belt development in Deendayal port Authority and its Surrounding areas charcoal site to GUIDE vide its work order dated 31/05/2022
5. DPA has planted 7500 trees in Deendayal port trust area during the year 2014-15 6000 trees during financial year 2016-17 and the same has been regularly maintained.
6. DPA has planted 4000 trees at A.O building, Gopalpuri residential colony and along the road side at Kandla. Further, approximately 885 no. of trees have been planted since September 2015 onwards.
7. Continuous water sprinkling has been carried out on the top of the heap of coal, at regular intervals to prevent dusting, fire and smoke. DPA already installed sprinkling system inside Cargo Jetty area for coal dust suppression in coal yard (40 Ha. Area) at the cost of Rs. 14.44 crores.
8. DPA has installed Mist Canon at the Port area to minimize the coal dust.
9. Deendayal port Authority (traffic department) issued a Circular (SOP) to the trade with regard to control of dust pollution arising out of coal handling and ensuring safety in coal handling. In case of any violations of SOP, provision of impose of penalty of Rs. 10000/- has been made and if violation is repeated thrice, the same will lead to ban of concerned party into port area. The DPA is taking all the measures to reduce coal dust by implementing the coal handling guidelines through port users.
10. All trucks before leaving the storage yard have been covered with tarpaulin and also trucks are also not over loaded as well as there is no spillage during

transportation and there is adequate space for movement of vehicles at the surrounding area.

11. DPA has constantly improving the house keeping in the dry cargo storage yard and nearby approved areas leading to roads. Adequate steps under the provisions of air prevention and control of pollution Act 1981, Environmental Protection Act 1986 are taken.
12. DPA appointed M/s. Detox Corporation, Surat for continuous monitoring of Environmental parameters (Air, Water, Noise etc)
13. DPA commissioned STP of capacity 1.5 MLD for treatment of domestic waste water for entire DPA area.
14. Deendayal Port Authority had carried out mangrove plantation in an area of 1500 ha. through various government agencies like Gujarat Ecology Commission, State Forest Department.
15. It is also relevant to mention here that, DPA entrusted work to Forest Department, GoG (Social Forestry Division, Bhuj) during August, 2019 for green belt development in and around port area 31.942 hectares (approx. 35200 plants at various locations) at a cost of Rs. 352.32 lakhs.
16. DPA is involved in various CER activities like providing the proper sanitation and development of better roads for connectivity
17. DPA is managing its plastic waste as per Plastic Waste Management Rules – 2016 and amendments made therein. In order to strictly implement the said rules, DPT had issued a circular regarding plastic waste minimization, source segregation, recycling etc. vide its Circular no. EG/WK/4751/Part 243(A) dated 03/09/2021

ANNEXURE – 1

WATER CONSUMPTION DETAILS

Statement Showing the quantity of water consumed from GWSSB from April 2021 to March 2022

Sr. No.	Month	Total Quantity Consumed In KL
1.	April 2021	47342.46
2.	May 2021	48920.55
3.	June 2021	47342.46
4.	July 2021	57490
5.	August 2021	67265.75
		2634.25
6.	September 2021	65095.89
		4694.11
7.	October 2021	67265.75
		4794.24
8.	November 2021	65095.89
		4644.11
9.	December 2021	64130
10.	January 2022	58490
11.	February 2022	60756.17
		11343.84
12.	March 2022	63900
Total	**741205.47**	

SE (PL) and EMC (I/C)

ANNEXURE – 2

ENVIRONMENTAL MONITORING REPORT

ENVIRONMENT MONITORING REPORT OF DEENDAYAL PORT AUTHORITY

(Annual Report)

(March 2021 to February 2022)

(Report No-DCPL/DPA (19-22)/AMR/21-22/02)

Submitted to

Deendayal Port Authority

Prepared by

Detox Corporation Pvt. Ltd.
Detox House, Udhna Darwaja, RingRoad
Surat - 395002

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1. Introduction

The environmental Monitoring plan is the key document in the environmental management system and sets out the detailed targets, objectives and procedures that will be adopted in order to achieve the goals set out in the environmental policy. EMP document is a collation of background information relevant to the Kandla Port Environmental Management and Monitoring Plan (EMMP).

1.1 The Environment (Protection) Act, 1986

The EPA 1986 came into force in all of India in November of 1986, under an official notification. The Act contains 26 sections divided into 4 chapters. The Act has its genesis in Indian Constitution's Article 48(A) and Article 51 (A)g. The Act is a part of Article 253 of the Indian Constitution.

The rules of Environment protection came into force on 19th November1986 and these rules provide for the following:

- The standards of quality of air, soil and water for various areas and purposes of environment.
- The standard set up to know about the limits of the environmental pollutants.
- Rules include the procedure and safeguards needed to handle the hazardous substance.
- Restrictions and some prohibitions on handling the hazardous substances in different areas and premise
- The procedures and safeguards required for the prevention of accidents which may cause environmental pollution and also the remedies for it.
- The prohibition and restrictions possessed on the location of industries in different areas.

1.2 EIA and CRZ Notification

The Ministry of Environment, Forests & Climate Change (MoEF & CC), Government of India, exercising the powers conferred upon it under the provisions of the Environment (Protection) Act, 1986, issued the Environment Impact Assessment Notification, 2006 and its sub sequent amendments.

1.2.1 EIA Notification

The basic objective of the Environment Impact Assessment is to identify, predict, mitigate and communicate the possible impacts due the proposed project to the Government authority and people likely to be affected and incorporate the conditions for construction, operation, maintenance and waste disposal phases of the project to mitigate the negative (adverse) impacts and enhance the positive impacts for the sustainable development of the region.

Environmental Impact NotificationS.O.1533 (E), dtd.14th September2006as amended 2009, issued under Environment (Protection) Act 1986, has made it mandatory to obtain prior environmental clearance (EC)for scheduled development projects. The notification has classified projects under two categories A & B. Category A projects (including expansion and modernization of existing projects) require clearance from The Ministry of Environment, Forests & Climate Change (MoEF & CC), Govt. of India (GoI) and for category B from State Environmental Impact Assessment Authority(SEIAA),constituted by Govt. of India.

Some important features of the said Notification are:

I. Prior Environmental Clearance (EC) is required by all new projects or activities listed in the Schedule of the EIA Notification2006 and subsequent amendments thereafter.EC are required before Commencement of any construction work or preparation of land by the project management.

II. Prior EC is also required by the existing projects or activities if its capacity is likely to exceed the threshold limit mentioned in the said Schedule.

III. All category B projects where general condition does not apply, the project proponents are required to apply to the SEAC who will hear the case according to the procedure laid down in the EIA notification and based on whose recommendation, EC may be granted or rejected by the SEIAA.

IV. For all category A projects and also category B projects where general condition applies, the project proponents are required to apply directly to The Ministry of Environment, Forests & Climate Change (MoEF & CC), Government of India, who would consider the project for grant or rejection of the EC based on the recommendation of the Expert Appraisal Committee at the central level.

V. If projects attract CRZ clearance, then clearance under CRZ rules is also required.

1.2.2. Coastal Regulation Zone (CRZ)

The Union Cabinet approved the Coastal Regulation Zone (CRZ) Notification,2018 which were last reviewed and issued in 2011. The notification was released after a series of representations received by the Ministry of Environment, Forest & Climate Change (MoEF&CC) from various Coastal States/UTs for a comprehensive review of the provisions of the CRZ Notification, 2011.

1.2.2.1. Classification of CRZ

For the purpose of conserving and protecting the coastal areas and marine waters, the CRZ area shall be classified as follows, namely:-

CRZ-I A

CRZ-I A shall constitute the ecologically sensitive areas (ESAs) and the geomorphologic features which play a role in maintaining the integrity of the coast viz.: Mangroves, corals, biologically active mudflats, Marine national parks, turtle nesting grounds etc.

CRZ-I B

The intertidal zone i.e. the area between Low Tide Line and High Tide Line shall constitute the CRZ-IB.

CRZ-II

CRZ-II shall constitute the developed land areas up to or close to the shoreline, within the existing municipal limits or in other existing legally designated urban areas, which are substantially built-up with a ratio of built-up plots to that of total plots being more than 50 per cent and have been provided with drainage and approach roads and other infrastructural facilities, such as water supply, sewerage mains, etc.

CRZ-III

Land areas that are relatively undisturbed (viz. rural areas, etc.) and those which do not fall under CRZ-II, shall constitute CRZ-III, and CRZ-III shall be further classified into following categories:-

CRZ-III A

Such densely populated CRZ-III areas, where the population density is more than 2161 per square kilometer as per 2011 census base, shall be designated as CRZ-III A and in CRZ-III A, area up to 50 meters from the HTL on the landward side shall be earmarked as the "No Development Zone (NDZ)‟, provided the CZMP as per this notification, framed with due consultative process, have been approved, failing which, a NDZ of200meters shall continue to apply.

CRZ-III B

All other CRZ-III areas with population density of less than 2161 per square kilometer, as per 2011 census base, shall be designated as CRZ-III B and in CRZ-III B, the area up to 200 meters from the HTL on the landward side shall be earmarked as the " No Development Zone(NDZ)‟.

Land area up to 50meters from the HTL, or width of the creek whichever is less, along the tidal influenced water bodies in the CRZ III, shall also be earmarked as the NDZ in CRZ III.

CRZ-IV

The CRZ-IV shall constitute the water area and shall be further classified as under:

CRZ-IV A

The water area and the sea bed area between the Low Tide Line up to twelve nautical miles on the seaward side shall constitute CRZ-IV A.

CRZ-IV B

CRZ-IV B areas shall include the water area and the bed area between LTL at the bank of the tidal influenced water body to the LTL on the opposite side of the bank, extending from the mouth of the water body at the sea up to the influence of tide, i.e., salinity of five parts per thousand (ppt) during the driest season of the year.

1.2.3. EMMP Plan

As per the guidelines of Ministry of Environment Forests and Climate Change and also as per the environment management plans submitted by various agencies during their EIA studies, DPA has appointed M/s. Detox Corporation Pvt. Ltd. For the work of "Preparing and Monitoring of Environmental Management Plan for Deendayal Port Authority at Kandla vide Work Order No.EG/WK/EMC/11023/2011/IV/213Dated-07/12/2019.

As part of this assignment, M/s. Detox Corporation Pvt. Ltd. prepared an Environmental Management and Monitoring Plan (EMMP) and submitted this EMMP prior to commencement of the Environment Monitoring of Deendayal Port in February2020.The EMMP summarized the background information as are source to develop Environment Monitoring Plan, based on the results of the EIA studies carried out at Deendayal Port by several agencies.
This environmental Management and Monitoring Plan (EMMP) plan submitted in February2020 was the key document in the environmental management system and set out the detailed targets, objectives and procedures that are adopted in order to achieve the goals to efficiently manage the environmental policy of Deendayal Port Authority.

2. DEENDAYAL PORT Authority

Deendayal Port is one of the most important ports of India. This port is situated at Latitude23º01‟N and Longitude70º13‟E on the shores of the Kandla Creek. The Deendayal Port came into existence in the year 1931 with a single Pier construction. Later on with the loss of Karachi port to Pakistan during partition, after independence the Government of India chose Kandla as an ideal sea outlet. Thus the Deendayal Port was developed and since then Deendayal Port has played a pivotal role in enhancing country`s maritime trade.

The Port of Kandla was declared a major port in 1955. The Deendayal Port Authority was created by law in 1963 to manage the new port. In 1978, The Deendayal Port had commissioned the off-shore Oil Terminal facilities at Vadinar jointly with Indian Oil Corporation, by providing Single Buoy Mooring (SBM) system, having a capacity of 54 MMTPA, which was first of its kind in India. Further, significant quantum of infrastructure up-gradation has been effected, excellent maritime infrastructure has been created having capacity of 32 MMTPA by M/s Essar Oil Refinery in Jamnagar district.

The port governed by Deendayal Port Authority (DPA) is a gateway port to the hinterland in western and northern states of Jammu & Kashmir, Delhi, Punjab, Himachal Pradesh, Haryana, Rajasthan, Gujarat and parts of Madhya Pradesh, Uttaranchal and Uttar Pradesh. It is in the district of Kutch and is located on the west bank of Kandla creek which runs into the Gulf of Kutch at a distance of 90 nautical miles from the Arabian Sea. The Port is well connected by the network of rail and road and is a gateway port for export and import of goods for northern states (Map1). The width of the channel varies from 200 meters to 1,000 meters. The contour depth along the shipping channel is around 10 meters. The total length of the Deendayal Port approach Channel is around 23kms. Presently, the Port has sixteen cargo berths for handling dry cargo traffic, six oil jetties for handling Petroleum Oil products and other liquid cargo traffic at Kandla Creek and 3 Single Buoy Mooring (SBM) at Vadinar for handling crude oil and two product jetties for handling petroleum products.

2.1. Environment Management Policy of Deendayal Port Authority

In 2013, the DPA achieved certification of its Environmental Management System to ISO 14001. In 2019, DPA obtained ISO 14001:2015 certifications. One of the key requirements of the ISO 14001 series is that the systems, plans and controls are under the operational control of the entity committed to managing the activity. The DPA also manages environmental risk to land and marine areas under its control arising from third party industrial activities. While these parties and the associated risks are covered in the risk register, the controls are managed by standalone EMP,s of the third party in accordance with the DPA development Approval Process and /or through direct state or central Government requirements as part of an:

- Environmental Clearance, CRZ Clearance, in the case of a new project; and
- Consent to Establish /NOC for an establishment, and Consent to Operate/NOC for operation of the projects.

2.1.1 The Key Objectives of Deendayal Port Authority

- To provide our Clientele, efficient and economical Port services. To render value for money and value added services to our Customers to their utmost satisfaction.
- To create facilities of international standards, and facilitate quicker turnaround of vessels.To maintain peaceful industrial relations by recognizing our work force as an asset and develop them to adopt to the changing Port scenario.
- To participate in social development by contributing our mite to the society at large.
- To be Environment friendly.

2.2. QHSE Policy of Deendayal Port

Quality, Occupational health, Safety and Environmental Policy (QHSE) of Deendayal Port Authority is the statement of its intentions, principles & commitment in relation to its overall QHSE performance, which provides a frame work for the action and for the setting of QHSE objectives & targets. QHSE policy has been developed through initial status review of quality, Occupational health, Safety and Environment Management comprising of following key areas namely;

- Legislative, regulatory and other requirements
- Identification of equipment and services supporting quality of final services.
- Identification of significant OH&S risks and Environmental aspects.
- Examination of all existing environmental & Occupational health and safety management practices and procedures.
- Evaluation and feedback from the investigation of previous incidents and accidents.

The QHSE policy of Deendayal Port Authority has been communicated at all levels through display in all the relevant places. The policy has also been communicated to external parties by way of displaying it at the main gate of Deendayal Port Authority in Hindi/English/local (vernacular) language.

Management representative of Deendayal Port Authority has established, implemented and maintaining the QHSE management system and continually improves its effectiveness by regular monitoring in accordance with the requirements of this international standard. MR has identified the various processes needed for the QHSE management system and their application throughout the organization.

The sequence and interrelation of these processes are determined to control the effectiveness of these processes & operations. The criteria & methods are determined necessary resources & information/details are made available at the point of use so that operations & processes can be monitored. (Ref: Department Operational Manual and their Process Flow Chart).

Measurement of these processes are timely analyzed and the relevant actions are implemented to achieve planned results & for continual improvement.

2.3. The Physical Environment

Deendayal Port ($23^0$02‟29.92”N, $70^0$13‟08.99”E) is located at the tail end of Gulf of Kachchh (GoK), an east west oriented Gulf system in the western part of Gujarat. It is about 90 nautical miles from the open waters of Arabian Sea. Kandla creek harboring the Deendayal Port is one of the major creeks of the inner Gulf of Kachchh. Gulf of Kachchh (GoK) is 75 km wide at its mouth and after running about 170 km away from the Arabian sea towards east, narrows down into a constriction at 70^0 20‟ E at *Sat Saida*Bet and then bifurcates into many creek systems (Map1).The Little Ran at the tail end of GoK has a network of many small and large creeks, intermingling with marshy tidal flats rich in fine clays. Kandla creek is one of the major tributaries of this creek system, which empties into the inner GoK. All these creeks bring water from the Little Ran into Kandla creek, which has a fairly good depth and stable banks.

Coastal and inland environmental setting of Kandla, similar to other parts of Kachchh, has marked climatological peculiarities like aridity, geomorphology and coastal and terrestrial ecosystems. Annual rainfall in Kachchh district was 458 mm during 2001- 10 whereas it was 443 mm at Gandhidham taluka during the same period which is often irregular. Rain during monsoon is confined to only 15-20 days and occurs as an instant downpour. The mean rainfall in year 2019 was 194mm.

On the terrestrial side there are no major rivers or rivulets or fresh water streams. Winter and summer temperatures range from 7^o- 47^oC with a yearly average humidity of 60% which increases to 80% during southwest monsoon and decreases to 50% during November-December. Average wind speed is 4.65 m/s with a maximum of 10.61 m/s during June. Drought is a common phenomenon in Kachchh with 2 drought year in a cycle of 5years. Annual temperature fluctuation in the district is extreme, rangingfrom$4^oC$to 47.5^oC.

2.4. Biophysical Environment

a. Creek system

The creek system consists of 3 main creeks the Nakti, the Kandla and the Hansthal, and the Little Gulf of Kutch interconnecting through many other big and small creeks, all along the coast. Very few rivers drain into the Gulf and they carry only a small quantity of freshwater, except during the brief monsoon. They are broad-valleyed and their river bed is mostly composed of coarse sand and gravel. The Gulf is uniquely characterized by numerous hydrographic features like pinnacles, as much as 10 m high. The southern shore has numerous is lands and inlets covered with mangroves and surrounded by coral reefs. The northern shore is predominantly sandy or muddy confronted by numerous shoals.

The Marine water of Gulf of Kutch and its creeks like Kandla creek, Nakti creek and Khori creek are providing the suitable habitat for marine vegetation. The Gulf abounds in marine wealth and is considered as one of the biologically rich marine habitat along the west coast of India. The marine vegetation is highly varied, which includes sand dune vegetation, mangroves, sea grasses, macrophytes and phytoplankton. The dominant species of sand dune flora are *Euphorbia caudicifolia, E. nerifolia, Aloeverasp, Ephedrafoliata, Urochodrasetulosa, Sporobolus maderaspatenus, Eragrostis unioloides, Calotropis procera, Fimbristylis* sp, *Indigofera* sp and*Ipomoea pescaprae*. The common sea grasses found growing on the mud flats are *Halophila* *ovate* and *H.beccarii*.

b. Mangroves

Deendayal Port Authority (DPA) is one of the largest ports of India in terms of volume of cargo handled. Among Indian ports, this port also has the largest coastal habitats such as mangroves (193.1km2)and mudflats(312.9 km2). DPA has implemented mangrove plantation in 1500 Ha during2005 - 2017 through various implementing agencies at Sat Saida Bet, Nakti creek and Kantiyajal. The Deendayal Port Authority has enauthorityed the task of evaluating 1500 ha of mangrove plantation in these three locations to Gujarat Institute of Desert Ecology (GUIDE), Bhuj.

Coastal belt in and around Kandla region is characterized by a network of creek systems and mudflats which are covered by sparse halophytic vegetation like scrubby to dense mangroves, creek water and salt encrusted land mass which forms the major land component. The surrounding environment in a radius of 10 km from the Port is mostly built up areas consisting salt works, human habitations and Port related structures on west and north, creek system, mangrove formations and mudflats in the east and south. Deendayal Port and its surroundings have mangroves, mud flats and creek systems as major ecological entities.

Mangrove plantation activity by DPA was initiated in 2005 as mandated by the Ministry of Environment, Forests & Climate Change (MoEF&CC). Subsequently, 1300 ha of mangrove plantation has been completed till the end of 2017 in different years in order to meet the legal mandate of Ministry of Environment, Forests and Climate Change (MoEF & CC). The mangrove plantation activities were carried out at Sat Saida Bet, Nakti creek and Kantiyajal of Bharuch district in South Gujarat. At Sat Saida Bet, Plantation activities were carried out in phased out manner i.e.20 ha during2005-2006, 200 ha during 2011-2012, 300 ha during 2012-2013, and 330 ha during 2013-2014 (Plate1). At Nakti creek plantation was carried out during 2008-2009 and 2010-2011 in 50 ha and 100 ha,respectively(GUIDE,2018).In 2015-17 300 ha by GEC at Kantiyajal, Bharuch District and 2018- 20 by GEC (At Satsaida bet : 50 Ha. And 300 ha at Kantiyajal 50 Ha Taluka : Hansot, District : Bharuch). In 2020-2021 -100 ha GEC, Gandhinagar.

A. marina was the preferred species for plantation activities in all the three locations due to prevailing high salinity and high success rate of this species. At Nakti creek *Rhizophora mucronata* and *Ceriops tagal* were also planted in small numbers along with*A. marina*. Likewise, at Kantiyajal attempts were made for planting *R.mucronata*a long with *A.marina*.

c. Marine Fauna

In the marine environment of Deendayal Port, there are eleven species of mollusca, seven species of shrimps (Prawn) and seven species of annelids. Besides these, there are twelve groups of phytoplankton, 7 groups of zooplanktons. The density of meio-fauna ranged from 382 to 670 nos/10cm^2. The density of benthic macro fauna ranged from 952 to 1092 no/m^2.Thedominant macro-faunal group was porifera (Mantec, 2014).

d. Terrestrial Biodiversity

Sensitive ecological habitats like forest, grassland, agricultural land, wetlands are absent within and in the proximity of the Deendayal Port due to its highly built-up nature. The species richness and abundance of aquatic birds and terrestrial fauna (reptiles, mammals) in the port environ and its surrounding was low with least conservation significance.

There are 11 species of herpetofauna (reptiles and amphibians), 53 species of terrestrial birds, 49 species of aquatic birds in the Port Environs. Due to absence of forest habitat in the immediate vicinity of Deendayal Port, only nine species of mammals were recorded with very low abundance.

3.0 Environment Management Plan

Port activities can often affect the quality of air, noise and marine water in the surrounding areas due to the wide range of port operation activities. For the determination of environment quality, need for identification of sources, control and disposal of waste from various point and non-point sources and for prediction of various parameters of sound environmental quality, regular monitoring and assessment are required.

The Environment management plan is the key document in the environmental management system and sets out the detailed targets, objectives and procedures that will be adopted in order to achieve the goals set out in the environmental policy.

It is extremely essential that port and harbour projects should have an environmental management plan (EMP), which also incorporates monitoring of air, noise, soil and marine water quality along with the collection of meteorological data.

Deendayal Port Authority targets the achievement of high environmental standards and strives to ensure that activities within the Port are environmentally and ecologically sustainable and have minimal impact on the natural environment.

Several developmental projects have been initiated and EIAs have been carried out for the said projects. These EIA studies have also submitted the suggestions on the environmental management of the project area and Deendayal Port in general. These suggestions and mitigation measures have also been considered in framing the current environment management plan.

The present Environment Management Plan summarizes the suggestions of the ECs received from the Ministry of Environment, Forests & Climate Change (MoEF & CC), and consents granted by Gujarat Pollution Control Board(GPCB).

The projects for which ECs were granted and which formed the frame work of the present EMP are as below;

- EC and CRZ Clearance for Construction of 13th to 16th Cargo berth at Kandla in year 2008
- EC & CRZ clearance for development of plots for construction of liquid storage tank farms at Kandla, district Kutchinyear2009
- Environmental and CRZ Clearance to DPA for development of plots for construction of warehouses/Godowns (stage II) in year2012.
- Environmental and CRZ clearance for Single Point Mooring (SPM) and Allied facilities off Veera in the Gulf of Kachchh for handling Crude Oil on BOT basis in year 2013.
- Developing seven integrated facilities within the Existing Kandla port at Kandla, Gujarat–December2016
- Proposed Smart Industrial Port City (SIPC) at green Field Site 1 (Adipur side– Northeast of Antarjaal, South of Tagore Road, 580Acres),Gandhidham, Kutch-Gujarat"-October2017
- Proposed Smart Industrial Port City (SIPC) at Green Field Site 2 (DPA Complex, 849.96Acres), Gandhidham, Kutch –Gujarat.–October2017.
- Construction of Interchange cum road over bridged (SIA/GJ/NCP/19832/2017)
- Creation of water front facilities of oil jetties of 8,9,10 & 11 & development of land (1432 areas) (IA/GI/MIS/61679/2017)
- Development of plots for constructing of warehouse/ godowns ad measuring 11,50,000 m2 area at outside west gate no 1 on national highway no 8A at Kandla (SIA/GJ/MIS/122861/2019)

- Up gradation of Barge handling facility at Sunder Basin at Kandla
- Multipurpose Cargo Terminal at Tekra off Tuna on BOT basis
- Construction of Rail Over Bridge at NH-8A near Nakti Bridge (crossing of NH 8A)
- Strengthening of oil jetty no. 1
- Modification and strengthening of Cargo Berth no. 6 at Kandla Port Trust
- Container terminal Tuna Tekra (Capacity 2.19 Million TEUs)
- Railway line (NH 8A to Tuna 11 km)
- Construction of port craft jetty & SNA section
- Development of integrated facility stage II (IA/GJ/MIS/27227/2015)
- Setting up 7th oil jetty at old Kandla
- Setting up Barge jetty at Veera
- Setting up Barge jetty at JafraWadi
- One administrative building at Tuna Tekra
- Construction of 15.5 km long road from Veera Barge Jetty to Tuna Gate
- Single point Mooring and allied facilities off Veera in Gulf of Kutch for handling crude oil on BOT basis in the state of Gujarat (IA/GJ/MIS/178779/2020)

Table: 1 Yearly Monitoring schedule

Yearly Monitoring schedule				
Sr. No	**Sampling Activity Description**	**Locations**	**Monthly Monitoring**	**Yearly Monitoring**
1	Ambient Air	6 locations (Kandla)	8	96
		2 locations (Vadinar)	8	96
2	Drinking Water	18 locations (Kandla)	1	12
		2 locations (Vadinar)	1	12
3	Waste water	2 locations (Gopalpuri Township & Kandla)	4	48
		1 location (Vadinar)	4	48
4	Soil	4 locations (Kandla)	1	12
		2 locations (Vadinar)	1	12
5	Noise	10 locations (Kandla)	1	12
		2 locations (Vadinar)	1	12
6	Marine Water sampling for Physico - Chemical Parameters, Biological parameters and sediments (Twice a month)	8 Locations (6- Kandla & 2- Vadinar)	2	24

4. Environment Monitoring Plan

Environment Monitoring Plan is very important for monitoring the environmental status of the port for sustainable development. The EMP mainly consists of monitoring of the Air quality, Marine water quality, Ecological and Biological quality and Noise quality of the Deendayal Port area. The monitoring program is also required to suggest suitable mitigation measures for the deviation found in the results of the monitoring, so as to keep the pollution level with in control.

The list of main elements for which Environmental monitoring is carried out is mentioned below.

- Air Quality Monitoring
- Drinking Water Monitoring
- Noise Monitoring
- Marine Water Monitoring
- Soil Monitoring
- Sewage Treatment Plant Monitoring
- Meteorological Monitoring

M/s Detox Corporation Pvt. Ltd. appointed by Deendayal Port Authority will carry out monitoring of the various environmental aspects of the port with following objectives;

- To review the locations of ambient air and marine water quality monitoring stations within the impacted region in and around DPA establishment, in view of the developmental projects.
- To assess the ambient air quality and marine water quality at selected stations in terms of gases and particulate matter, physical, chemical and biological parameters for the assignment period.
- To assess the marine water quality in terms of aquatic flora and fauna and sediment quality in terms of benthic flora and fauna.
- To assess the trends of air and water quality by comparing the data collected over a specified time period.
- To assess the trends of water quality in terms of marine ecology by comparing the data collected over a specified time period.
- To review the results and to check compliance with environmental quality standards.
- To suggest mitigation measures, if necessary, based on the findings of this study.
- To recommend future action plans on air and marine water quality monitoring programmed based on the findings of this study.
- Drinking Water samples at twenty stations will also be monitored for various physical, chemical and biological parameters viz., color, odor, turbidity, conductivity, pH, EC, total dissolved solids, chlorides, total hardness, iron, sulfate, NH3N, PO4, Turbidity, salinity, BOD, Hardness, Calcium, Magnesium, Sodium, Potassium, metals and bacterial count on a monthly basis.
- Every week a sample (inlet and outlet) of the Sewage Treatment Plant (STP) shall be analyzed to see the water quality being discharged by DPA. However, the results will be submitted every month. If in a particular month any deviation is observed, the same shall be submitted immediately to the Employer.
- Noise monitoring will be carried out twice a day at the representative stations for a period of 24 hours. A report of the same will be submitted to DPA.
- Meteorological parameters are very important from air pollution point of view and precise and continuous

data collection is of utmost importance. The data collected is analyzed as per the standards. Meteorological data on wind speed, wind direction, temperature, relative humidity, solar radiation and rainfall will be collected from one permanent station at DPA and one permanent station at Vadinar.

- All Locations & Monitoring parameters are tentative and subject to change as per GPCB/CPCB/MoEF &CC Guideline.

4.1 Selection of Sampling Locations

Sampling locations have been selected by Deendayal Port Authority considering various activities of Deendayal Port Authority and its environs and various Environment Impact Assessment Studies carried out in Deendayal Port. The sampling locations of various air, water and marine water surveys will be reviewed periodically and may be altered if required as per the suggestions/discussions with the Deendayal Port Authority and Environmental consultants engaged by the Deendayal Port Authority.

The major components of the monitoring are:

4.1.1. Air Quality Monitoring

Air Monitoring is done at eight fixed locations in port area. The description of stations is depicted in Table1. The monitoring cycle at all eight monitoring stations is twice in a week.

Method of Monitoring

Sampling and analysis will be carried out as per CPCB guidelines for Ambient Air Quality monitoring. The monitoring is carried-out for air quality parameters mentioned in the National Ambient Air Quality Standards (NAAQS), CPCB Notification published in 2019. Sampling for Particulate Matter PM_{10}, $PM_{2.5}$ and Total Suspended Particulate Matter (TSPM) is done for a twenty four hour period.

Frequency of AAQ Monitoring

The monitoring cycle at all eight monitoring Stations is twice in a week. Sampling for Particulate matter (PM_{10}, $PM_{2.5}$) and total suspended particulate matter is done for a twenty four hour period. Sampling for gaseous samples like SO_x, NOx will be done for a twenty four hour period with sample collection at every eight hour. Table 2 gives description of Ambient Air Monitoring Stations.

Table 2: Ambient Air Monitoring Stations

Sr. No.	Location	Station Description	Location Codes
1	6 Stations at Kandla	Marine Bhavan	AL-1
2		Oil Jetty	AL-2
3		Kandla Port Colony	AL-3
4		Gopalpuri Hospital	AL-4
5		Coal Storage Area	AL-5
6		Tuna Port	AL-6
7	2 Stations at Vadinar	Signal Building	AL-7
8		Vadinar Colony	AL-8

4.1.2. Monitoring of Drinking Water Quality Method of monitoring

The sampling and analysis will be done as per standard methods IS 10500:2012. The water samples will be analyzed for various parameters via; Color, Odor, Turbidity, Conductivity, pH, Chlorides, TDS, Total hardness, Iron, Sulphate, Salinity, Biological Oxygen Demand (BOD), Chlorides, Sodium(Na), Potassium(asK+), Calcium(asCa), Magnesium(Mg), Fluorides (F), Nitrate (NO_3), Nitrite (NO_2), Manganese (Mn), Iron (Fe), Chromium(Cr_6+), Copper(asCu), Cadmium(Cd), Arsenic(As), Mercury(Hg), Lead (Pb), Zinc (Zn), CFU, & bacterial count. The method will be manual at all monitoring stations.

- **Frequency of Drinking Water Monitoring:**

  The monitoring at all twenty drinking water stations will be done monthly once.

- **Drinking Water Monitoring Stations**

  A list of locations for collecting the drinking water samples is depicted in Table 3.

Table 3: Monitoring locations for Drinking Water

Sr. No	Monitoring Locations	Location Code	Sr. No	Monitoring Locations	Location Code
Location at Kandla			11	Hospital Kandla	DW-11
1	Nirman Building1	DW-1	12	A.O. Building	DW-12
2	P& C Building	DW-2	13	School Gopalpuri	DW-13
3	Main Gate(North)	DW-3	14	Guest House	DW-14
4	Canteen	DW-4	15	E-Type quarter	DW-15
5	West gatel	DW-5	16	F-type quarter	DW-16
6	Wharf area	DW-6	17	Hospital Gopalpuri	DW-17
7	Sewasadan-3	DW-7	18	Tuna Port	DW-18
8	Workshop	DW-8	**Locations at Vadinar**		
9	Custom building	DW-9	19	Nr. Vadinar Jetty	DW-19
10	Port Colony Kandla	DW-10	20	Port colony	DW-20

4.1.3. Monitoring of Marine Water Quality and Biological Parameters Methodology for Physico-chemical Monitoring

Water samples will be collected for analyzing physico-chemical and biochemical parameters viz. pH, Temperature, Colour, Odour, Salinity, Turbidity, SS, TDS, TS, DO, COD, BOD, Silicate, PO_4, SO_4, NO_3, NO_2, Ca, Mg, Na, K, Iron (as Fe), Chromium (as Cr), Copper (As Cu), Arsenic (as As),Cadmium (as Cd), Mercury (Hg), Lead (as Pb), Zinc (as Zn), petroleum hydro carbons, trace metals total coliform & fecal coliform.

Methodology for Biological Monitoring

Sampling will be conducted from sub surface layer in high tide period and low tide period of the tide from all sampling stations during consecutive spring tide and neap tide.

Net sampling for qualitative evaluation of mixed plankton will be conducted only once during between maximum high water and slack water and maximum low water and Slack water.

Sediment sampling for qualitative and quantitative evaluation of benthic organisms will be conducted only once during one tidal cycle during maximum low water and slack water.

The collected samples will be first collected in a clean bucket to reduce the heterogeneity. From the collected water sample 1 liter of water sample will be taken in an opaque plastic bottle for chlorophyll estimation. Quantitative plankton samples will be collected by filtering rest of the water sample using plankton net of 20µm mesh size.

Methodology adopted for Plankton sampling

Mixed plankton sample for qualitative evaluation will be obtained from the sub surface layer, at each sampling locations by towing the net horizontally with the weight during highest high tide and slack period and lowest low tide and slack period. After the tow of about 15-20 minutes at speed of 1- 1.5 m/s. For quantitative evaluation 50 L sample will be collected from the sub surface during high tide and low tide period will be filtered through 20 µm mesh size net assembly.

Methodology adopted for benthic fauna sampling

Van veen sampler (0.1 m^2) will be used for sampling bottom sediments during lowest low tide. The fixation of benthic fauna will be normally done by bulk fixation of the sediment sample. The bulk fixation will be done by using 10% formalin (buffered with borate) with Rose Bengal as stain. The organisms will be preserved with sea water as diluting agent.

Frequency

Phytoplankton (Qualitative & Quantitative) Zooplankton (Qualitative & Quantitative) & Benthos (Qualitative & Quantitative) samples will be collected during high tide and low tide during each spring and neap tides of the month.

Sampling Stations

The monitoring of marine environment for the study of biological and ecological parameters will be carried out in harbour regions of DPA (Table3) during Spring tide period of full moon phase of Lunar Cycle.

Table 4: Sampling Locations for Marine Monitoring

Sr.No	Monitoring locations	Location Code
	Locations at Kandla	
1	Near passenger Jetty One	ML-1
2	Near Berth No.8&9	ML-2
3	Kandla Creek Near KPT colony	ML-3
4	Near13th&14thBerth	ML-4
5	Nakti Creek Near Tuna Port	ML-5
6	Nakti Creek Near NH-8A Bridge	ML-6
	Locations at Vadinar	
7	Nr.SBM 2	ML-7
8	Nr. Vadinar Jetty	ML-8

4.1.4. Noise Monitoring

Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading of cargo to/from ships. Noise Monitoring will be done at 10 stationsat Kandla, and three locations in Vadinar.

Method and Frequency of monitoring

Sampling will be done at all stations for 24 hour period once in month. Data will be recorded using automated sound level meter. The intensity of sound will be measured in sound pressure level (SPL) and common unit of measurement is decibel (dB).

Sampling Stations

The sampling locations for noise monitoring as listed in table 5.

Table 5: Locations for Noise Monitoring

Sr. No	Name of locations	Location Code	Sr. No	Name of locations	Location Code
Locations at Kandla			8	Nirman Building 1	NL-8
1	West Gate no 1	NL-1	9	Tuna Port	NL-9
2	Main gate(North)	NL-2	10	Port & customs office	NL-10
3	Wharf area/Jetty Area	NL-3	**Location at Vadinar**		
4	Main road/Central Road	NL-4	11	Nr. Port Gate-Vadinar	NL-11
5	Canteen Area	NL-5	12	Nr. Vadinar Jetty	NL-12
6	ATM building	NL-6	13	Port colony Vadinar	NL-13
7	Marine Bhavan	NL-7			

4.1.5. Soil Quality Monitoring

Soil quality monitoring is important for evaluating the effects of environment management practices of a region/area.

Method of Monitoring

The soil samples will be collected from four locations in Kandla and two locations in Vadinar Port. The soil samples will be filled in polythene bags, labeled in the field with number and site name and taken to the laboratory for analysis (as per IS 2720). Physical and chemical properties of soil at selected locations will be studied.

Frequency of monitoring

Sampling will be done at all stations in Kandla and Vadinar once in a month.

Soil Quality Monitoring Stations

List of the locations for collecting the soil samples are as per Table 6.

Table 6: List of sampling locations for Soil Quality Monitoring

Sr. No	Name of locations	Location Code
Locations at Kandla		
1	Tuna Port	SL-1
2	IFFCO Plant	SL-2
3	Khori Creek	SL-3
4	Nakti creek bridge at NH-8A	SL-4
Location at Vadinar		
5	Nr. Vadinar Port Office	SL-5
6	Nr. Vadinar Colony	SL-6

4.1.6. Monitoring of performance of the Sewage Treatment Plant (STP) at Gopalpuri Township, Deendayal Port & Vadinar

The principal objective of waste water treatment is generally to allow human and industrial effluents to be disposed off without danger to human health or unacceptable damage to the natural environment.

Method of Monitoring

The parameters monitored will be pH, BOD, COD, residual chlorine, MLSS, MLVSS and TSS. The data collected will be analyzed as per the standards. The performance of the Sewage Treatment plant will be studied by collecting samples of the aeration tank and effluent tank.

Frequency of monitoring

Sampling will be done at all stations from inlet, aeration tank and outlet of an STP once in week.

Monitoring Stations:

Lists of the location for collecting the STP samples are as per table 7.

Table 7: List of sampling locations for STP

Sr. No	Sampling location
1	STP at Kandla
2	STP at Gopalpuri
3	STP at Vadinar

5. Monitoring Results

Based on the EMMP submitted, M/s Detox Corporation Pvt. Ltd. carried out monitoring of the following environmental aspects of the port for the period of March 2021 to February 2022.

5.1 Ambient Air

The monitoring was carried out twice a week. The results obtained from the sampling and analysis is submitted to Deendayal Port authority on monthly basis. The monthly averaged and annual results for the ambient air monitoring are given in the sections followed.

I. Total Suspended Particulate Matter (TSPM)

The frequency of sampling was twice a week for every sampling station.

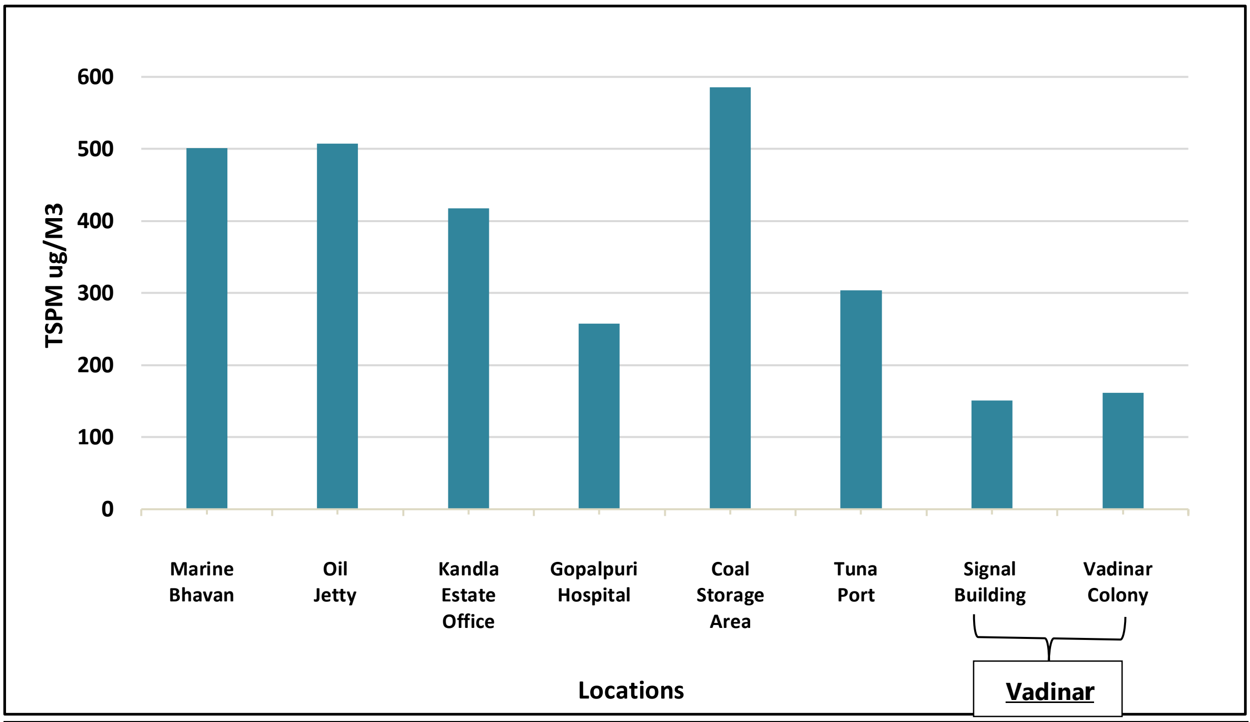
Table 8. TSPM (in $\mu g/m^3$) values at monitoring locations in Kandla and Vadinar Port

Months	Marine Bhavan	Oil Jetty	Kandla Estate Office	Gopalpuri Hospital	Coal Storage Area	Tuna Port	Signal Building	Vadinar colony
Mar-21	530	447	328	266	435	165	147	157
Apr-21	642	617	449	198	779	385	152	171
May-21	966	752	570	352	1341	273	134	161
Jun-21	374	312	267	173	596	125	59	60
Jul-21	467	578	463	307	354	372	105	146
Aug-21	495	520	488	229	548	347	155	138
Sep-21	449	554	341	194	324	238	164	169
Oct-21	364	465	402	274	527	362	157	211
Nov-21	460	489	487	357	598	387	219	205
Dec-21	442	480	427	251	518	362	176	183
Jan-22	417	480	417	251	484	348	164	164
Feb-22	412	393	371	243	523	284	171	186
Annual Mean	**502**	**507**	**418**	**258**	**586**	**304**	**150**	**163**

The mean TSPM values were highest at Coal Storage location and Marine Bhavan, followed by Oil Jetty. TSPM values were least at both the locations of Vadinar Port. The major cause of TSPM values at Coal Storage and Marine Bhavan is large amount of coal is handled at Berth No. 6, 7, 8and use of grabs for unloading of coal directly in the truck cause coal to spread in air as well as coal dust to fall on ground. This settled coal dust again mixes with the air during trucks movement through hit.

Also, the coal laden trucks are not always covered with tarpaulin sheets and these results in spillage of coal from trucks/dumpers during its transit from vessel to yard or storage site.

Fig 1. Observed values (annual mean) of TSPM at all eight monitoring stations



Interpretation of Results

- Maximum TSPM of 1341.0 µg/m^3 was recorded in the month of May‟21 at Coal storage site and the minimum value was recorded in the month of June„21at Tuna Port 125.0µg/m^3.
- At Vadinar, maximum TSPM of 219 µg/m^3 was recorded in the month of November at Vadinar Signal Building site and the minimum value was recorded in the month of June ‟21 at Vadinar Signal Building (59µg/m^3).

II. Particulate Matter (PM_{10})

PM_{10} is particulate matters which are 10 micrometers or less in diameter. The frequency of sampling was twice a week for every sampling station.

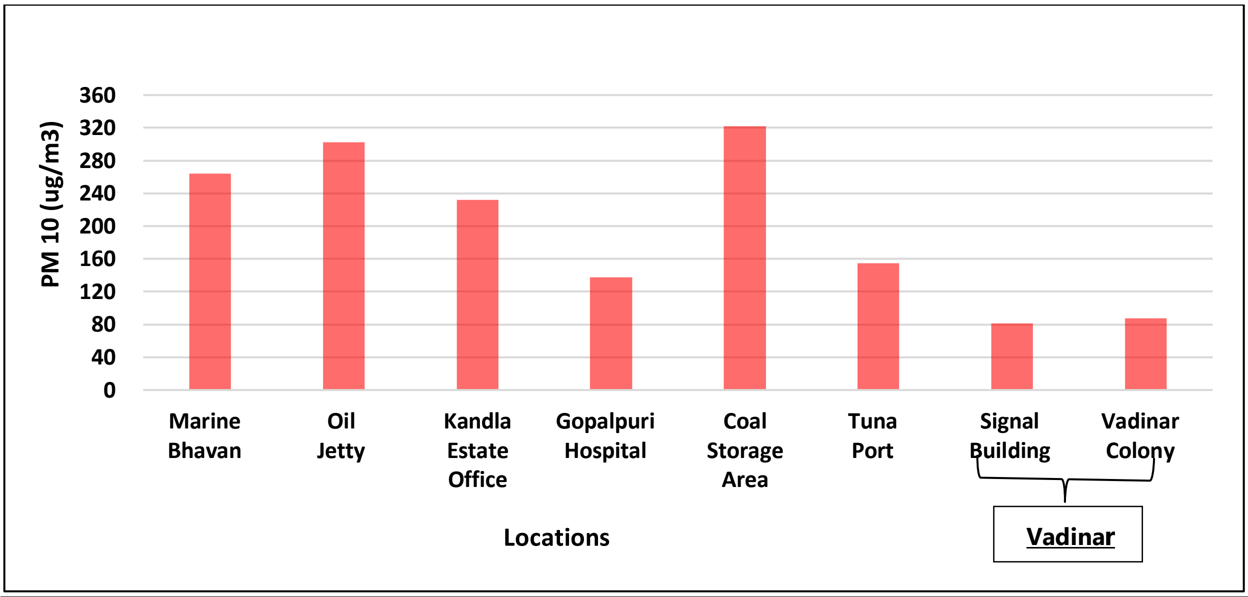
Table 9. PM_{10} (in µg/m^3) values at monitoring locations in Kandla and Vadinar Port

Months	Marine Bhavan	Oil Jetty	Kandla Estate Office	Gopalpuri Hospital	Coal Storage Area	Tuna Port	Signal Building	Vadinar colony
Mar-21	130	103	90	98	163	68	73	79
Apr-21	239	225	99	89	327	76	53	66
May-21	607	611	559	176	1149	160	73	99
Jun-21	130	82	69	52	140	59	33	33
Jul-21	373	496	366	230	206	250	75	81
Aug-21	262	322	276	133	327	217	98	77
Sep-21	333	442	211	123	200	126	97	95
Oct-21	190	246	219	140	203	163	82	116
Nov-21	193	190	217	187	292	195	115	108
Dec-21	245	263	243	142	295	194	88	98
Jan-22	227	437	217	142	264	184	93	97
Feb-22	237	213	215	139	300	161	98	104
Annual Mean	**264**	**303**	**232**	**138**	**322**	**154**	**82**	**88**

The mean PM_{10} Values were highest at Coal Storage location and Marine Bhavan, followed by Oil Jetty. PM_{10} values were least at both the locations of Vadinar Port. Higher PM_{10} values at Coal Storage and Marine Bhavan is a result of large amount of coal handling and its inappropriate transportation methods.

Coal laden trucks are seldom covered with tarpaulin sheets and these results in spillage of coal from trucks/dumpers resulting into higher PM_{10}values.

Fig 2. Observed values (annual mean) of PM_{10}at all eight monitoring stations



Interpretation of Results

- Maximum value of PM_{10} of 1149 µg/m^3 was recorded in the month ofMay"21 at Coal storage site and the minimum value was recorded in the month of June 2021 at Tuna Port 59.0µg/m^3.

- In Vadinar, maximum value of PM_{10} of 116 µg/m3 was recorded in the month of October 2021 at Vadinar Colony and the minimum value was recorded in the month of june- 2021atVadinarColony & Signal Building (33.0 µg/m3).

III. Particulate Matter ($PM_{2.5}$)

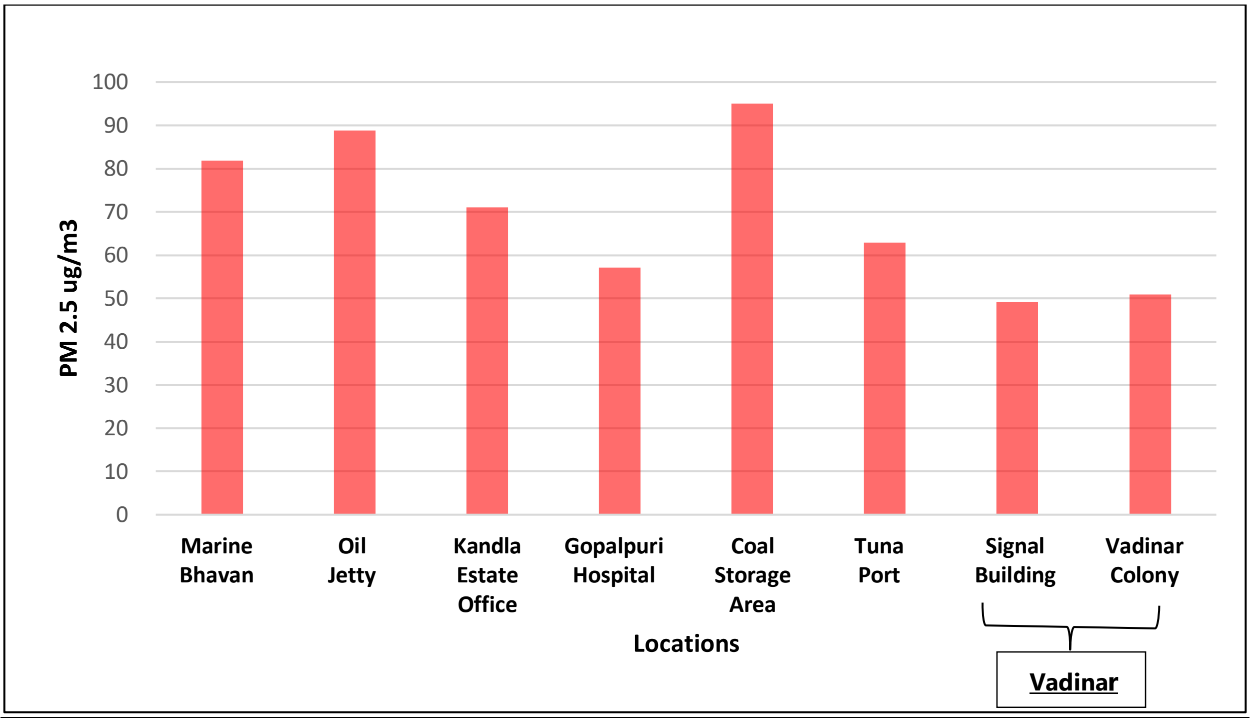
$PM_{2.5}$ particles are air pollutants with a diameter of 2.5 micrometers or less, small enough to invade even the smallest airways. $PM_{2.5}$ was also monitored twice a week for every sampling station.

Table 10. $PM_{2.5}$ (in µg/m^3) values at monitoring locations in Kandla and Vadinar Port

Months	Marine Bhavan	Oil Jetty	Kandla Estate Office	Gopalpuri Hospital	Coal Storage Area	Tuna Port	Signal Building	Vadinar colony
Mar-21	56	50	34	29	67	24	21	41
Apr-21	73	52	44	15	101	18	35	17
May-21	41	37	40	27	102	23	33	36
Jun-21	108	113	61	33	138	33	38	22
Jul-21	89	47	56	63	40	58	40	44
Aug-21	71	73	71	51	80	63	39	45
Sep-21	81	83	60	46	80	55	44	42
Oct-21	82	89	90	79	105	96	49	70
Nov-21	90	97	97	87	104	98	84	82
Dec-21	104	102	98	87	101	93	71	75
Jan-22	95	232	99	87	111	79	66	60
Feb-22	92	90	102	82	112	114	69	76
Annual Mean	**82**	**89**	**71**	**57**	**95**	**63**	**49**	**51**

Average $PM_{2.5}$ values were highest at Oil Jetty location (mean=232.0 µg/m^3) followed by Coal Storage Area (mean =138.0 µg/m³) and Gopalpuri Hospital (mean=57.0 µg/m³). $PM_{2.5}$ values At Vadinar Port the $PM_{2.5}$ values were significantly lower.

Fig 3. Observed values (annual mean) of $PM_{2.5}$ at all eight monitoring stations

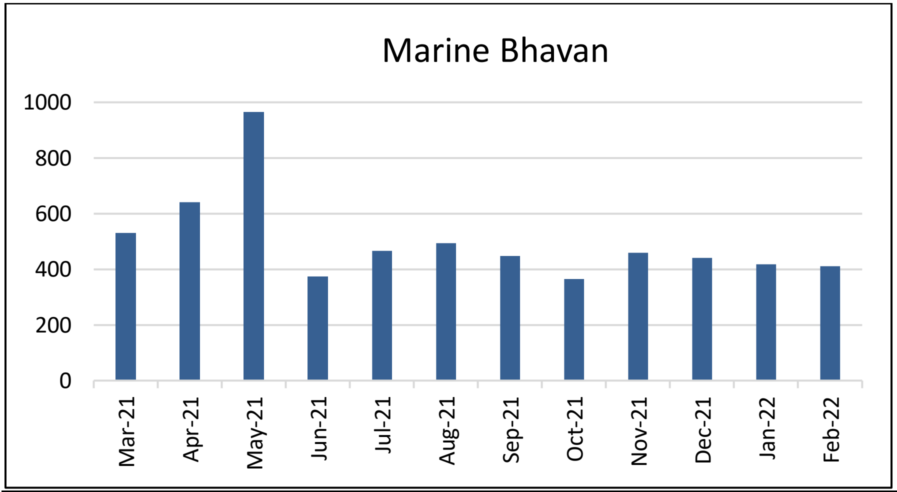


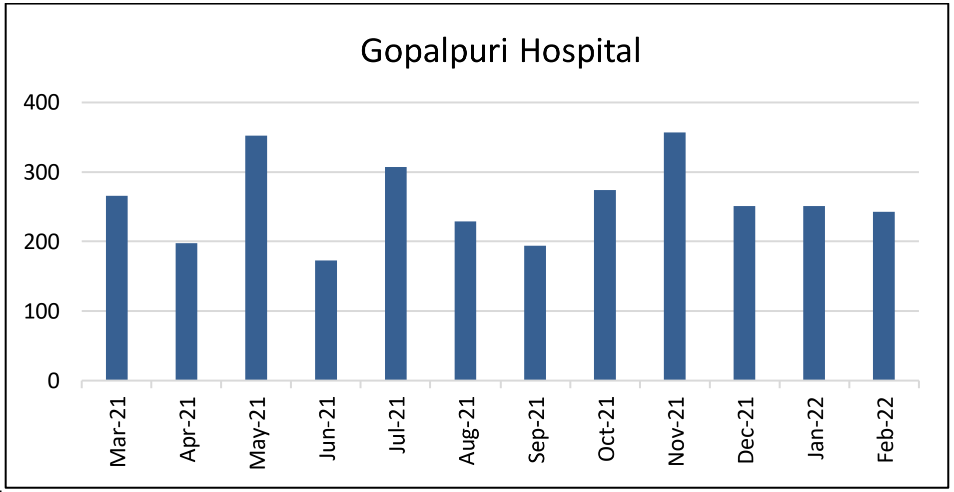
Interpretation of Results

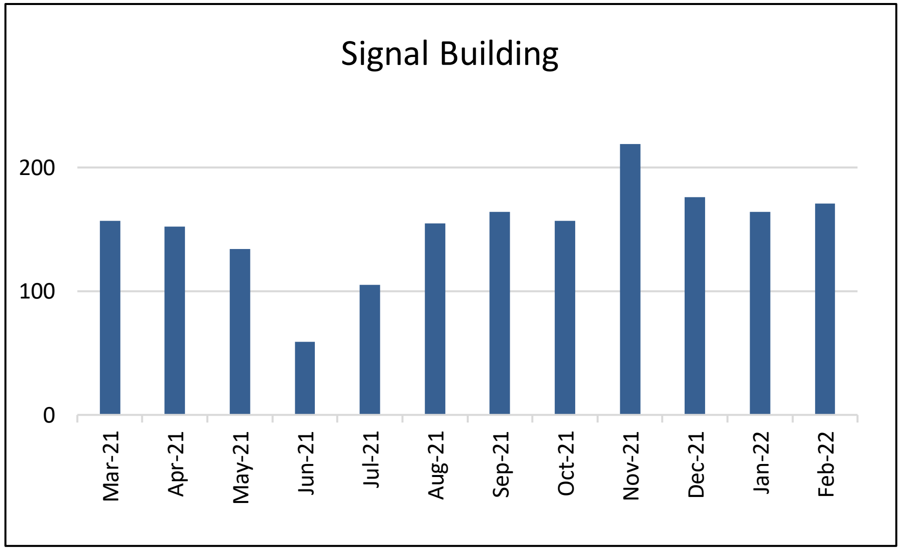
- Maximum value of $PM_{2.5}$232.0 µg/m³) was recorded in the month of January 2022 at Oil Jetty site and the minimum value was recorded in the month of May 2021 at Gopalpuri Hospital (27.0µg/m³).
- Annual mean values of $PM_{2.5}$ were highest at Coal Storage Area (95.0µg/m³).
- In Vadinar, maximum value of $PM_{2.5}$ of 84.0 µg/m³ was recorded in the month of November‟ 21 at Signal building site and the minimum value was recorded inthe month of April at Vadinar Port colony (17.0µg/m³).

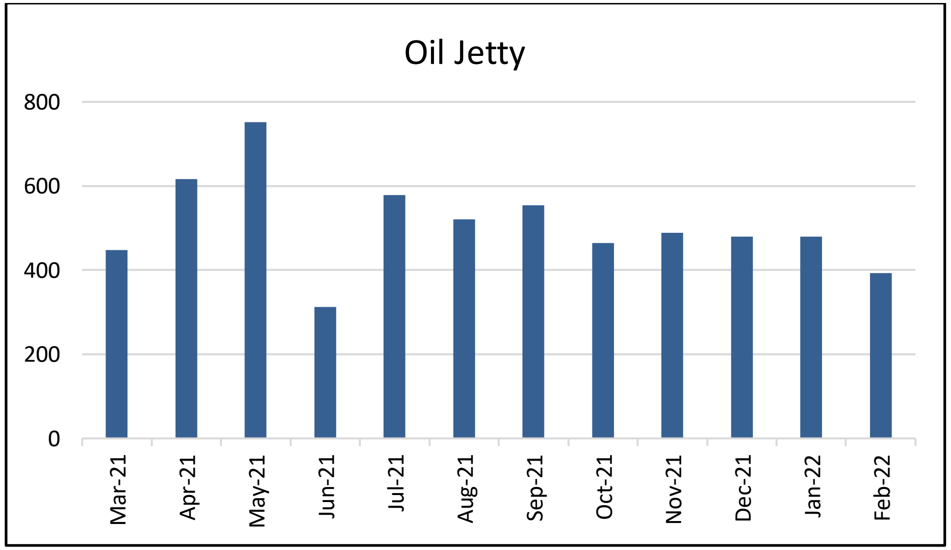
  Location wise graphs depicting trends in TSPM, PM_{10} and $PM_{2.5}$ in all locations of Kandla and Vadinar Port are depicted in 1 to 3.

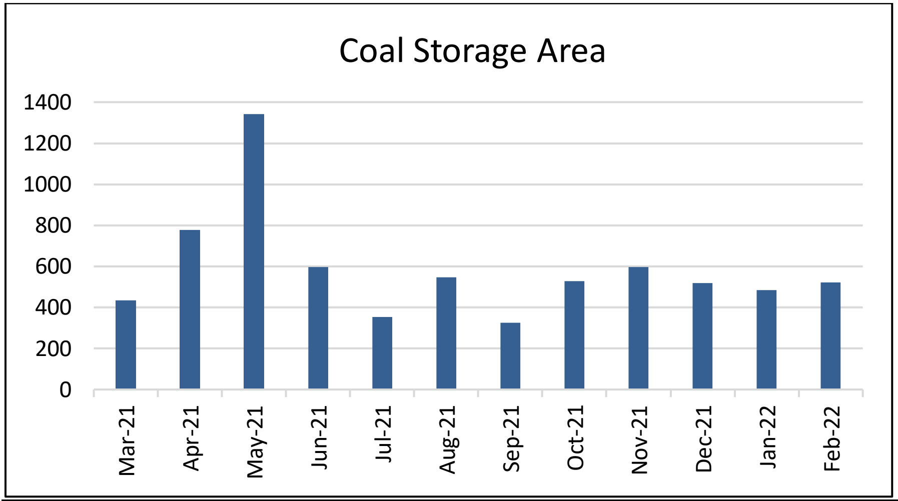
Fig 4. Trend in TSPM values of various AAQ Monitoring Locations

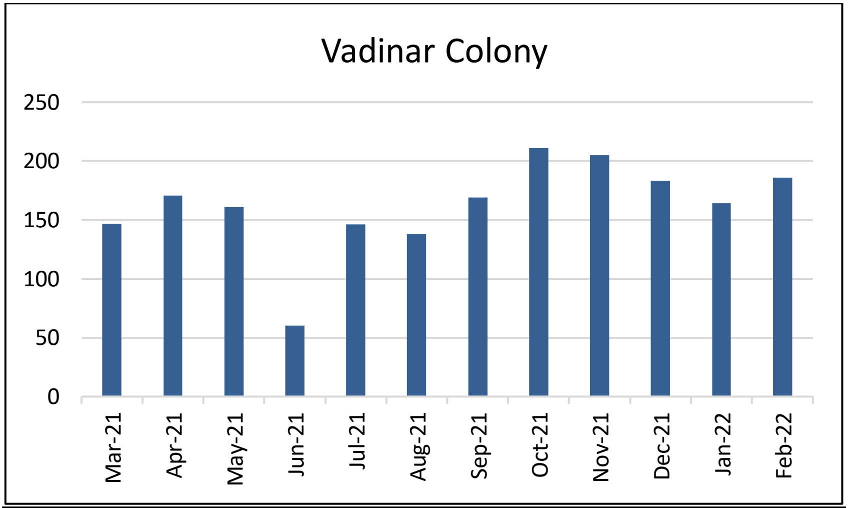


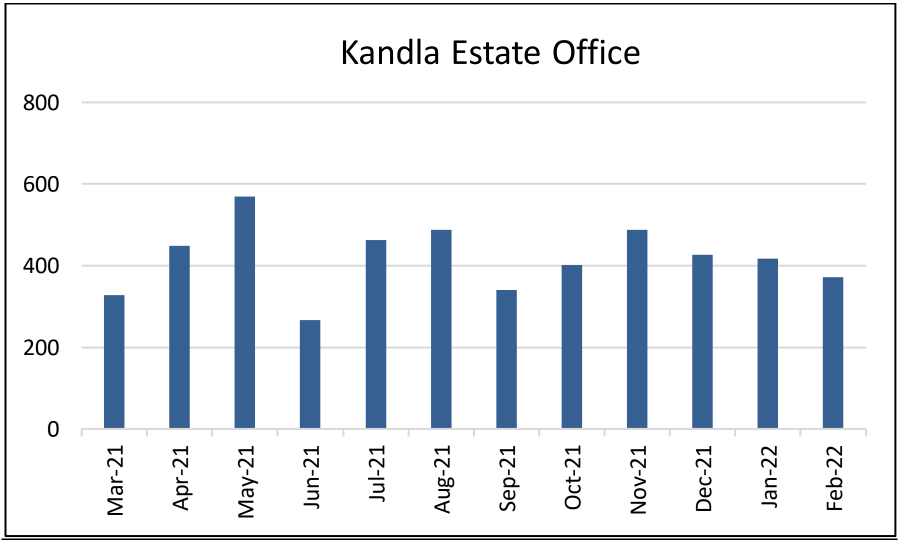







Coal Storage Area
1400
1200
1000
800
600
400
200
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22


Vadinar Colony
250
200
150
100
50
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22


Kandla Estate Office
800
600
400
200
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22

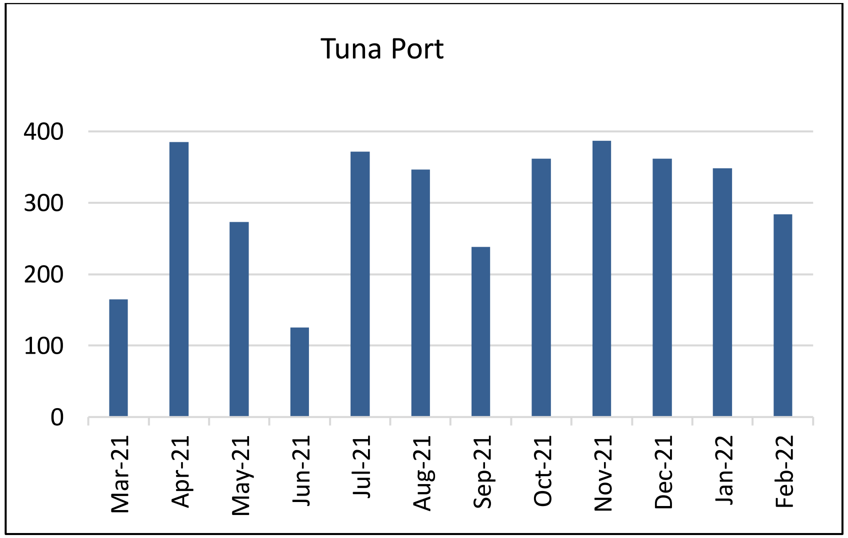
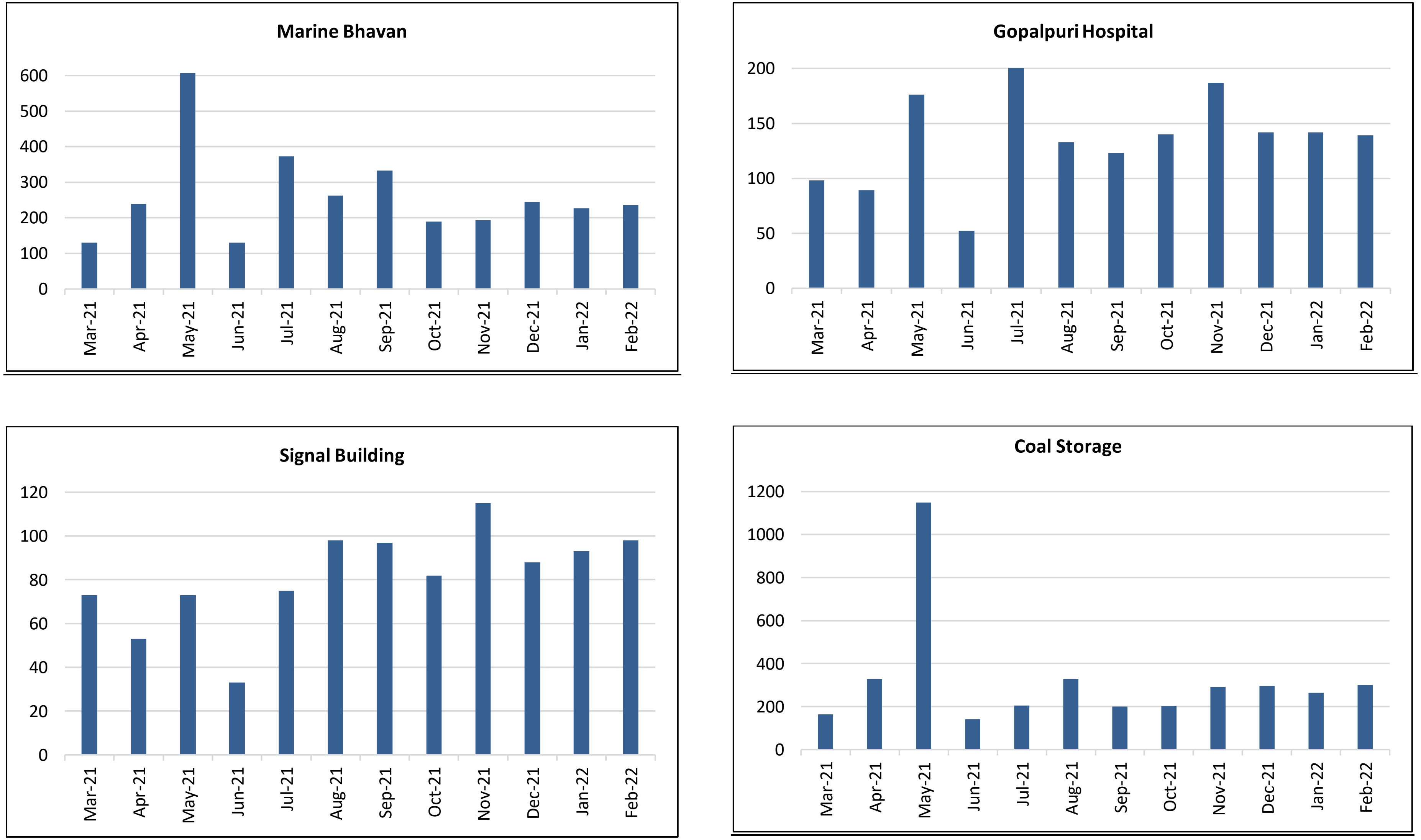
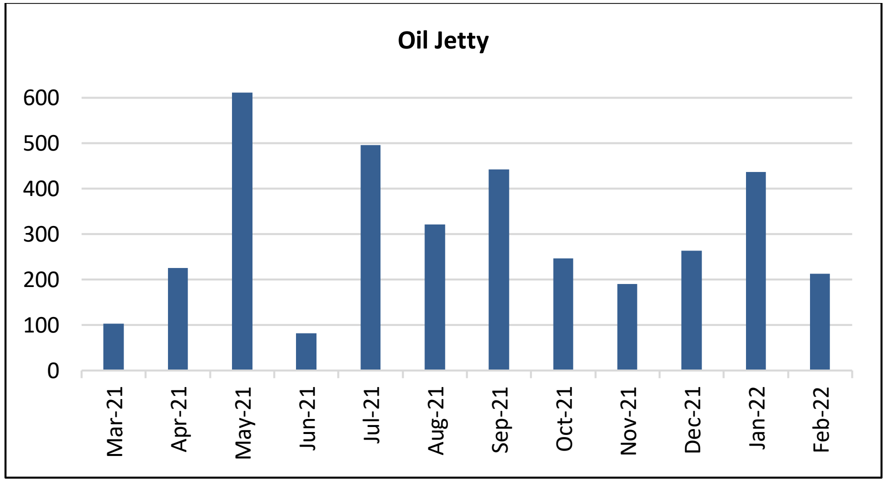
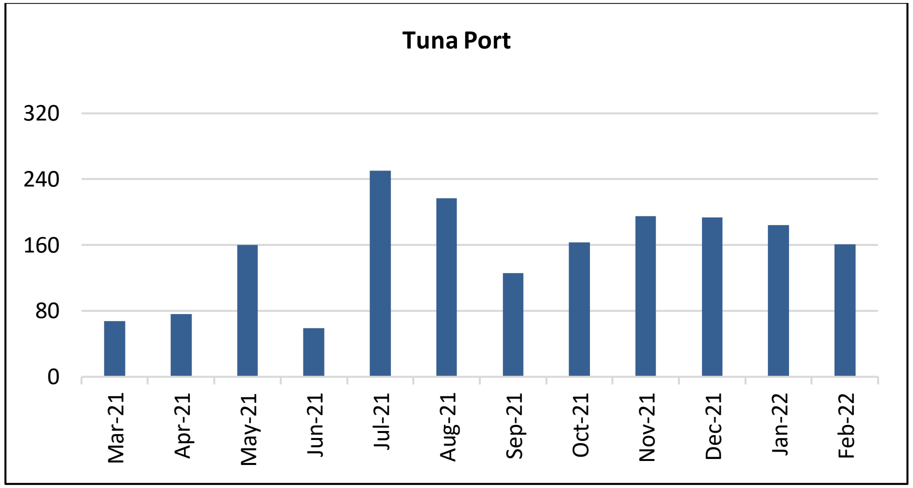
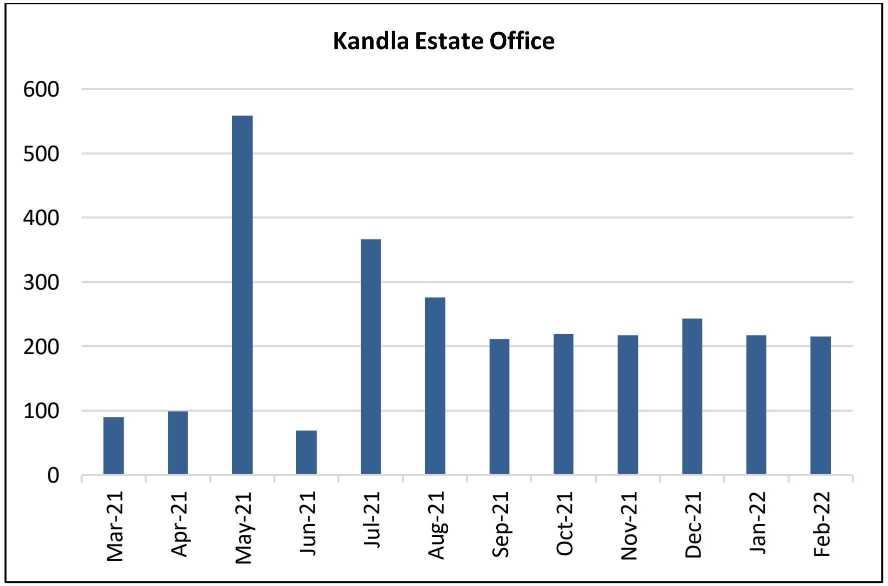

Tuna Port
400
300
200
100
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22

Fig 5. Trend in PM10 values of various AAQ Monitoring Locations




Oil Jetty
600
500
400
300
200
100
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22


Tuna Port
320
240
160
80
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22


Kandla Estate Office
600
500
400
300
200
100
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22

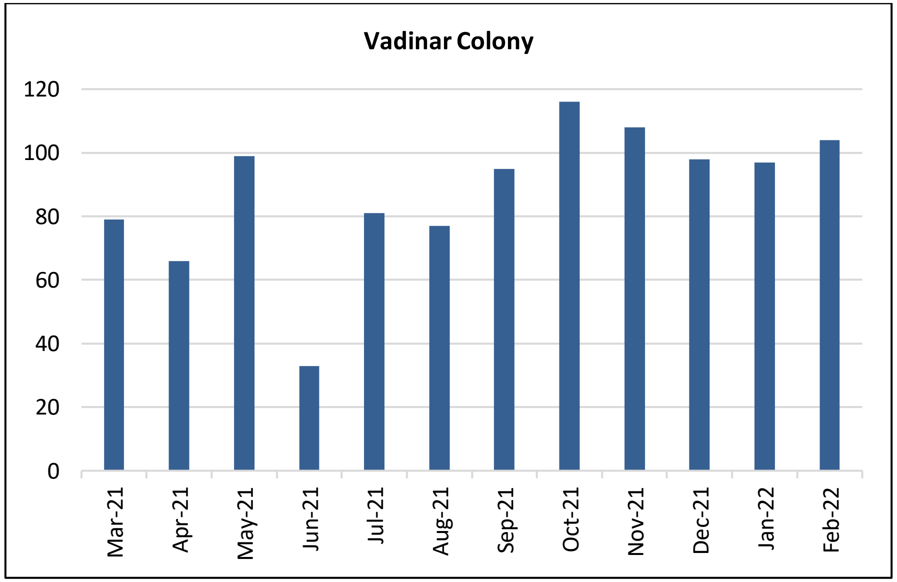
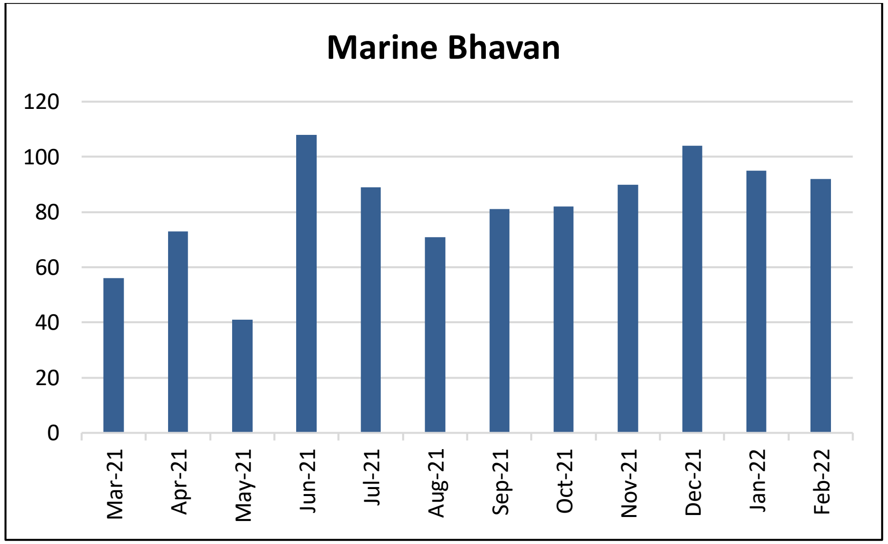
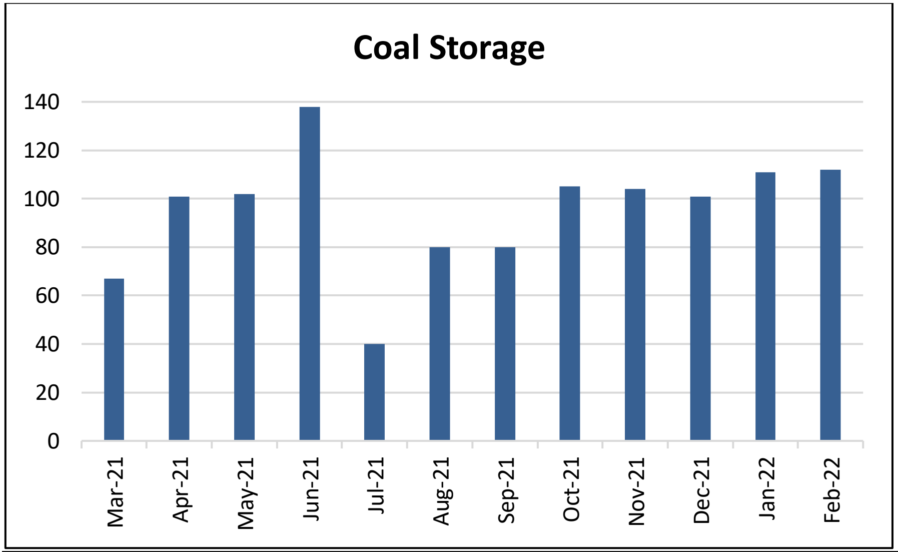
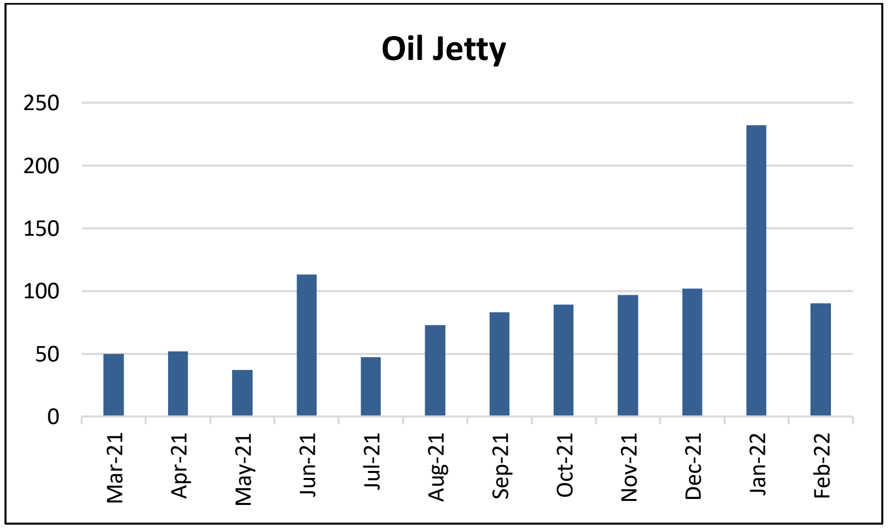
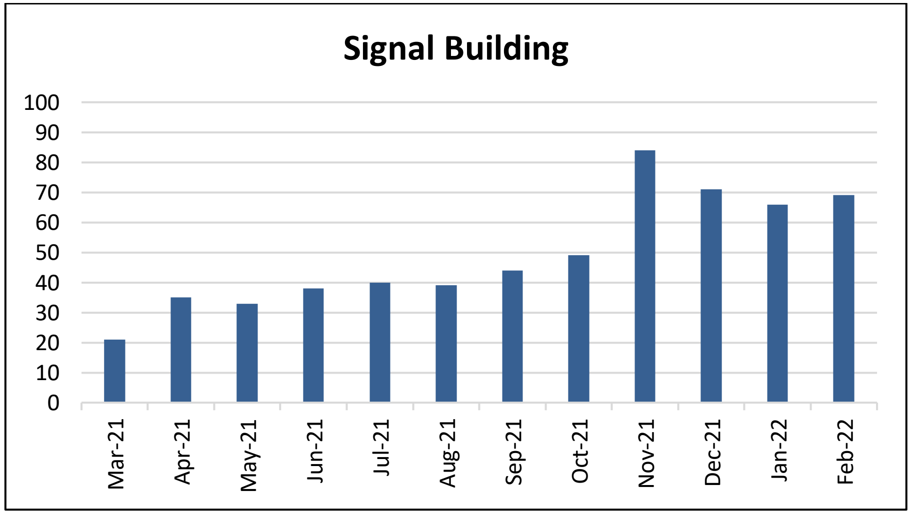

Vadinar Colony
120
100
80
60
40
20
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22

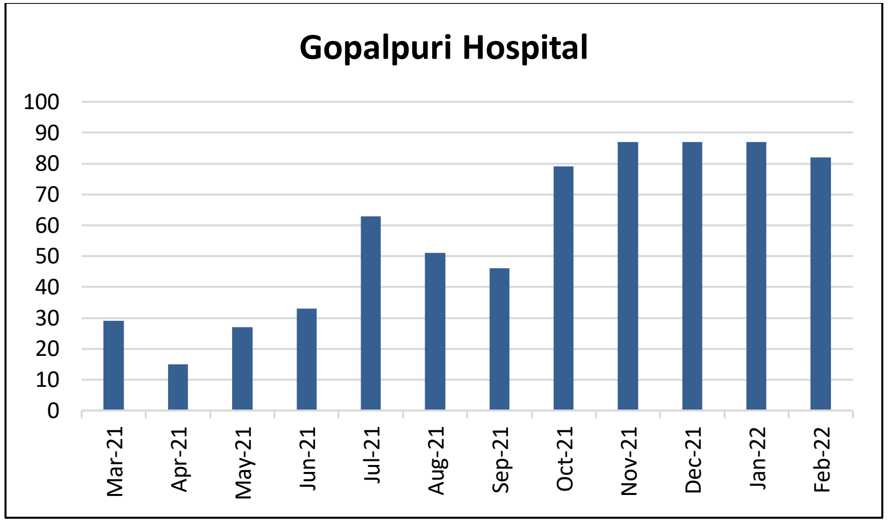
Fig 6. Trend in PM2.5 values of various AAQ Monitoring Locations

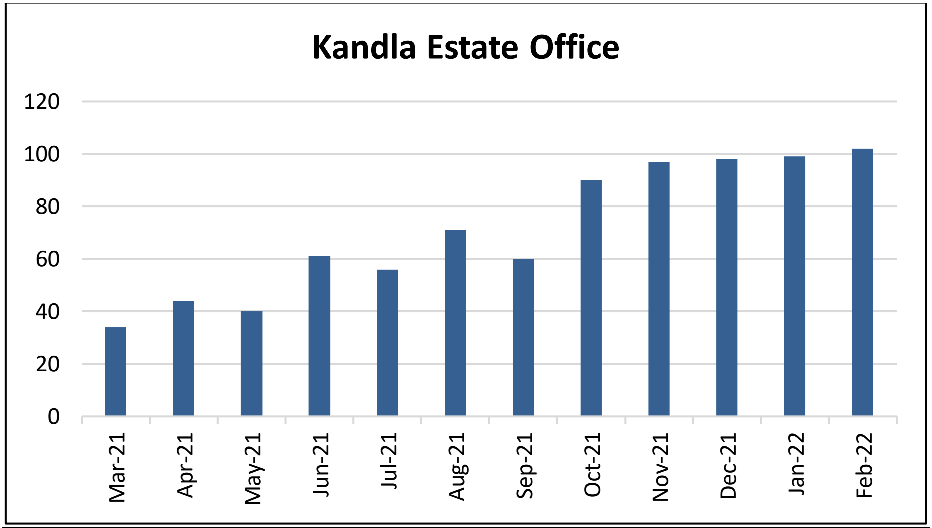


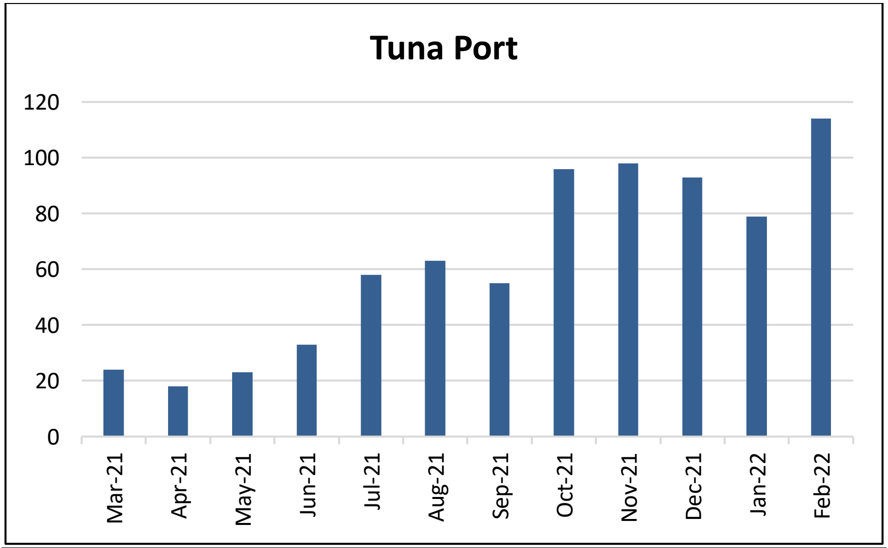


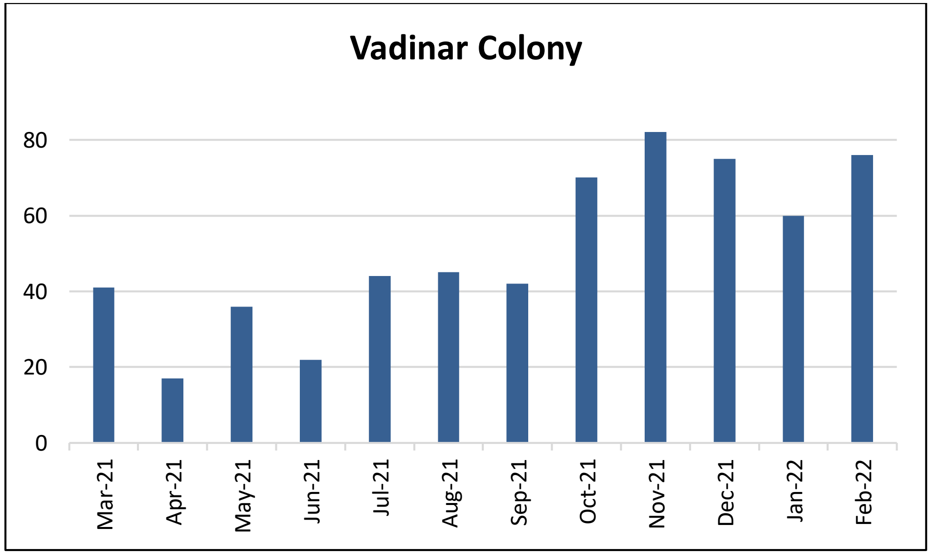





Gopalpuri Hospital
100
90
80
70
60
50
40
30
20
10
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22


Kandla Estate Office
120
100
80
60
40
20
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22


Tuna Port
120
100
80
60
40
20
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22


Vadinar Colony
80
60
40
20
0
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22

5.2 Drinking Water Quality Monitoring

Drinking Water Quality Monitoring was carried out at twenty stations at Kandla, Vadinar & Town ship Area of Deendayal Port.

Drinking water samples are collected from 20 locations (18 locations in Kandla and 2 locations in Vadinar). Samples for physico-chemical analysis are collected and analysed in laboratory for various parameters, viz. Color, Odor, Turbidity, Conductivity, pH, Chlorides, TDS, Total Hardness, Iron, Sulphate, Salinity, DO, BOD, Na, K, Ca, Mg, F, NO3, NO2, Mn, Cu, Cd, As, Hg, Pb, Zn, Bacterial Count (CFU).

Monitoring Results

Mean values of drinking water of Deendayal Port Locations are given in table 6.4. The values shown are the annual average of all the locations of Deendayal Port Colony, Port and Harbor area as well as Deendayal Port Authority office buildings.

Table 11 : Annual average values of Drinking water at Deendayal Port Authority

Sr. No.	Parameter	Unit	1st Quarter Mean	2nd Quarter Mean	3rd Quarter Mean	4th Quarter Mean	Value (Annual Avg.)	Acceptable Limits	Permissible Limits
1	pH	pH Unit	7.38	7.41	7.46	7.38	7.41	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/L	1114.30	1083.67	1265.93	1155.75	1154.91	500	2000
3	Turbidity	NTU	0.53	0.48	0.47	0.45	0.48	1	5
4	Odor	-	Odorless	Odorless	Odorless	Odorless	Odorless	Agreeable	Agreeable
5	Color	Hazen Units	Colorless	Colorless	Colorless	Colorless	Colorless	5	15
6	Conductivity	µs/cm	2253.97	2064.35	2448.83	2108.38	2218.88	NS*	NS*
7	Bio.Oxygen Demand	mg/L	<2	<2	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/L	651.10	579.99	484.50	539.53	563.78	250	1000
9	Ca as Ca	mg/L	74.21	59.34	62.83	61.72	64.53	75	200
10	Mg as Mg	mg/L	62.90	68.23	71.90	65.22	67.07	30	100
11	Total Hardness	mg/L	443.03	415.20	403.03	436.67	424.48	200	600
12	Iron as Fe	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	0.3	1
13	Fluorides as F	mg/L	0.45	0.69	0.55	0.64	0.58	1	1.5
14	Sulphate as SO_4	mg/L	211.96	193.41	229.75	220.67	213.95	200	400
15	Nitrite as NO2	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate as NO3	mg/L	5.29	10.23	9.92	10.04	8.87	45	100
17	Salinity	%	1.26	1.05	0.88	0.97	1.04	NS*	NS*
18	Sodium as Na	mg/L	329.18	228.77	219.20	268.63	261.45	NS*	NS*
19	Potassium as K	mg/L	4.13	2.94	3.80	4.43	3.82	NS*	NS*
20	Manganese	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	0.1	0.3
21	Hexavalent Chromium	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	NS*	NS*
22	Copper	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	0.05	1.5
23	Cadmium	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	0.003	0.003
24	Arsenic	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	0.01	0.05
25	Mercury	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	0.001	0.001
26	Lead	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	0.01	0.01
27	Zinc	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	5	15
28	Bacterial Count	CFU/100 ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent

NS= Not specified, ND=Not detected

Discussion

The colour of all drinking water samples was colourless unit and odour of the samples was also agreeable. The values of turbidity, Iron as Fe and Ammonia as NH_3-N were observed to be below detection limits of measurement i.e. <0.1NT, <0.03mg/L and <0.1mg/L respectively. Apparently these parameters were not at alarming levels. Some important parameters for drinking water are discussed below in detail;

pH

pH value in the studied area varied from 7.37 to 7.47 pH unit during the first year of monitoring. The limit of pH value for drinking water is specified as 6.5 to 8.5. All the sampling points showed pH values within the prescribed limit by Indian Standards.

Total Dissolved Solids (TDS)

TDS values in the studied area varied between 1073.73-1201.26 mg/L. The mean TDS value was 1154.9 mg/L. None of the sampling points showed higher TDS values than the prescribed limit by Indian standards which are 500-2000mg/L.

Conductivity

Conductivity is used to measure the concentration of dissolved solids which have been ionized in a polar solution such as water. The conductivity in the samples collected during the month of June ranged from 2149.36-2320.63 µs/cm. Electrical conductivity standards do not appear in BIS standards for drinking water.

Chlorides

Chloride values in drinking water for the present year varied between 507.6 -647.63 mg/L. Excessive chloride concentration increase rates of corrosion of metals in the distribution system. This can lead to increased concentration of metals in the supply.

Calcium

Calcium value in drinking water for the present year the studied area varied between 62.32 – 68.91 mg/L. The mean Ca was observed to be 64.52 mg/L. If calcium is present beyond the maximum acceptable limit, it causes incrustation of pipes.

Magnesium

Magnesium value in the studied area for the present year varied from 65.80mg/L to 68.26 mg/L. All the locations had Magnesium within the prescribed limits of 30-100mg/L.

Total Hardness

Total Hardness value in the studied area for the present year varied between 389.03-447.43 mg/L. The prescribed limit by Indian Standards is 200-600mg/L.

Fluoride

Fluoride value in the studied area varied between 0.48 – 0.65 mg/L. The permissible limit as per Indian Standards is 1.0-1.5mg/L. Moderate amount of fluoride in water lead to dental effects, but long-term ingestion of large amounts can lead to potentially severe skeletal problems.

Sulphates

Sulphate value in the studied area varied between 195.75–225.46 mg/L. All the sampling points showed Sulphates values within the prescribed limits by Indian Standards (200-400 mg/L). Sulphate occurs naturally in water as are sult of leaching from gypsum and other common minerals. Sulphate content in drinking water exceeding the 400 mg/L imparts bitter taste.

Nitrites (NO_2)

Nitrite values in all the water samples were observed to be <0.01 mg/L. There are no specified standard values for Nitrites in drinking water. Ground water contains nitrate due to leaching of nitrate with the percolating water and by sewage and other wastes rich in nitrates.

Salinity

Salinity in drinking water in the present samples collected ranged from 0.92to 1.23 %. There are no prescribed Indian standards for salinity in Drinking water.

Heavy Metals in Drinking Water

In the present study period drinking water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals were well below/ the permissible limits of the Indian Standards for drinking water.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that total Coliform values is observed to be 0.1 to cfu/100 ml. total Coliform and E-Coli values showed that all the drinking water samples were safe from any bacteriological contamination.

Conclusion

The results are compared with acceptable limits as well as Permissible Limits as prescribed in IS10500:2012 – Drinking Water Specification. It was observed from the data analysis that during the Third year (March 2021 to February 2022) the drinking water was safe for human consumption as per tested parameters only at all drinking water monitoring stations.

5.3 Marine Water Monitoring

Marine Water Monitoring was carried out at six stations at Deendayal Port and two locations at Vadinar Port.

Water samples were analyzed for physico-chemical and Biochemical parameters. Besides these, Phytoplankton (Qualitative & Quantitative) Zooplankton (Qualitative & Quantitative) & Benthos (Qualitative & Quantitative) samples were collected during spring tide and neap tide from all the eight fixed monitoring stations.

Results

The annual average values of monitored parameters for marine waters of DPA are given as per table 12.

Table 12. Annual average values of various physico-chemical parameters at Deendayal Port during neap tide. (Marine Sampling Station at Gulf of Kutch).

Sr. No.	Parameters	Unit	1st	2nd	3rd	4th
			Quarter Mean	Quarter Mean	Quarter Mean	Quarter Mean
1	pH	-	7.30	7.35	7.36	7.39
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odourless	Odourless	Odourless	Odourless
4	Salinity	ppt	32.51	32.24	31.82	31.80
5	Turbidity	NTU	26.56	35.05	36.78	35.71
6	Total Dissolved Solids	mg/L	40307.26	39446.10	39151.25	34126.11
7	Total Suspended Solids	mg/L	468.54	393.35	503.95	630.73
8	Total Solids	mg/L	43192.33	41383.94	39672.71	34818.14
9	DO	mg/L	5.11	4.57	4.82	4.45
10	COD	mg/L	79.05	83.13	84.56	85.60
11	BOD	mg/L	0.00	0.00	0.00	0.00
12	Silica	mg/L	0.57	0.56	0.67	0.78
13	Phosphate	mg/L	0.29	0.25	0.19	0.20
14	Sulphate	mg/L	3499.62	2586.77	2451.53	2493.91
15	Nitrate	mg/L	4.15	3.23	3.80	3.97
16	Nitrite	mg/L	0.01	0.00	0.00	0.00
17	Calcium	mg/L	518.97	557.01	522.61	578.93
18	Magnesium	mg/L	1588.81	1739.01	1150.32	1680.46
19	Sodium	mg/L	9976.72	10571.44	10635.22	10265.40
20	Potassium	mg/L	314.39	367.85	324.11	343.54
21	Iron	mg/L	1.81	1.67	1.61	0.81
22	Chromium	mg/L	0.14	0.15	0.13	0.04
23	Copper	mg/L	0.07	0.10	0.04	0.00
24	Arsenic	mg/L	0.00	0.00	0.00	0.00
25	Cadmium	mg/L	0.06	0.07	0.06	0.02
26	Mercury	mg/L	0.00	0.00	0.00	0.00
27	Lead	mg/L	0.16	0.17	0.12	0.02
28	Zinc	mg/L	0.06	0.06	0.04	0.11

Discussion

Coastal ecosystems are characterized by daily fluctuations, driven by tidal amplitude, wind direction and also on the anthropogenic activities carried out on the coasts. Marine water parameters at Kandla Harbor and creek waters also showed an high array of fluctuations in several of its parameters such as TDS, TSS, salinity and salts. Some of the important parameters are explained below;

pH

The pH of all marine water samples collected from Deendayal Port variedfrom7.3to 7.39. The mean pH of all samples was 7.64pH unit.

Salinity

Salinity in the DPA marine water ranged from 31.8ppt to 32.51ppt. The mean salinity at was recorded to be 32.09 ppt.

Turbidity

Turbidity in the DPA marine water ranged from 26.56 – 36.78 NTU. The mean turbidity of all the locations of Deendayal Port was 33.52 NTU. Turbidity at Vadinar port was<1.0NTU.

Total Dissolved Solids (TDS)

TDS values varied from 34126.11 to 40307.26 mg/L at all locations of Deendayal Port. Mean TDS values at Deendayal Port was 38257.68mg/L.

Dissolved Oxygen (DO)

DO value in the studied area varied between 4.45-5.11 mg/L. The mean DO values of Kandla Marine waters were 4.7mg/L.

Nitrates (NO3)

The mean Nitrate values in all the marine water samples were of Deendayal Port was 3.78 mg/L at DPA waters. Nitrite was rarely detected from marine waters of Vadinar.

Sodium (Na)

Sodium value in the Deendayal Port marine waters varied between 9976.72-10635.22 mg/L. The mean Na recorded at DPA waters was 11448.78 mg/L.

Trace Metals

In the present study period water samples were analyzed for Mn, Cr, Cu, Cd, As, Hg, Pb and Zn. All these heavy metals reported below trace levels.

Bacteriological Study

Analysis of the bacteriological parameter at all location shows that total Coli form values is observed to be 0.1to cfu/100ml.

5.4 Productivity Study

Chlorophyll-A

Water Samples for the chlorophyll estimation collected from sub surface layer during high tide and low tide period of the tidal cycle for each sampling locations and analysed for Chlorophyll -a and after acidification for Pheophytin –a.

In the sub surface water chlorophyll-a was varying from 0.204 to 1.923 mg/m^3 in harbour region of DPA during sampling done in from March 2021 to February 2022. In the nearby creeks chlorophyll-a was varying from 0.153.93 to 1.923mg/m^3.

In the sub surface water chlorophyll-a was varying from 0.392 – 1.356mg/m3 at Vadinar jetty and 0.392 mg/m3 to 1.365 mg/m3near SPM during sampling done spring tide period and during Neap tide.

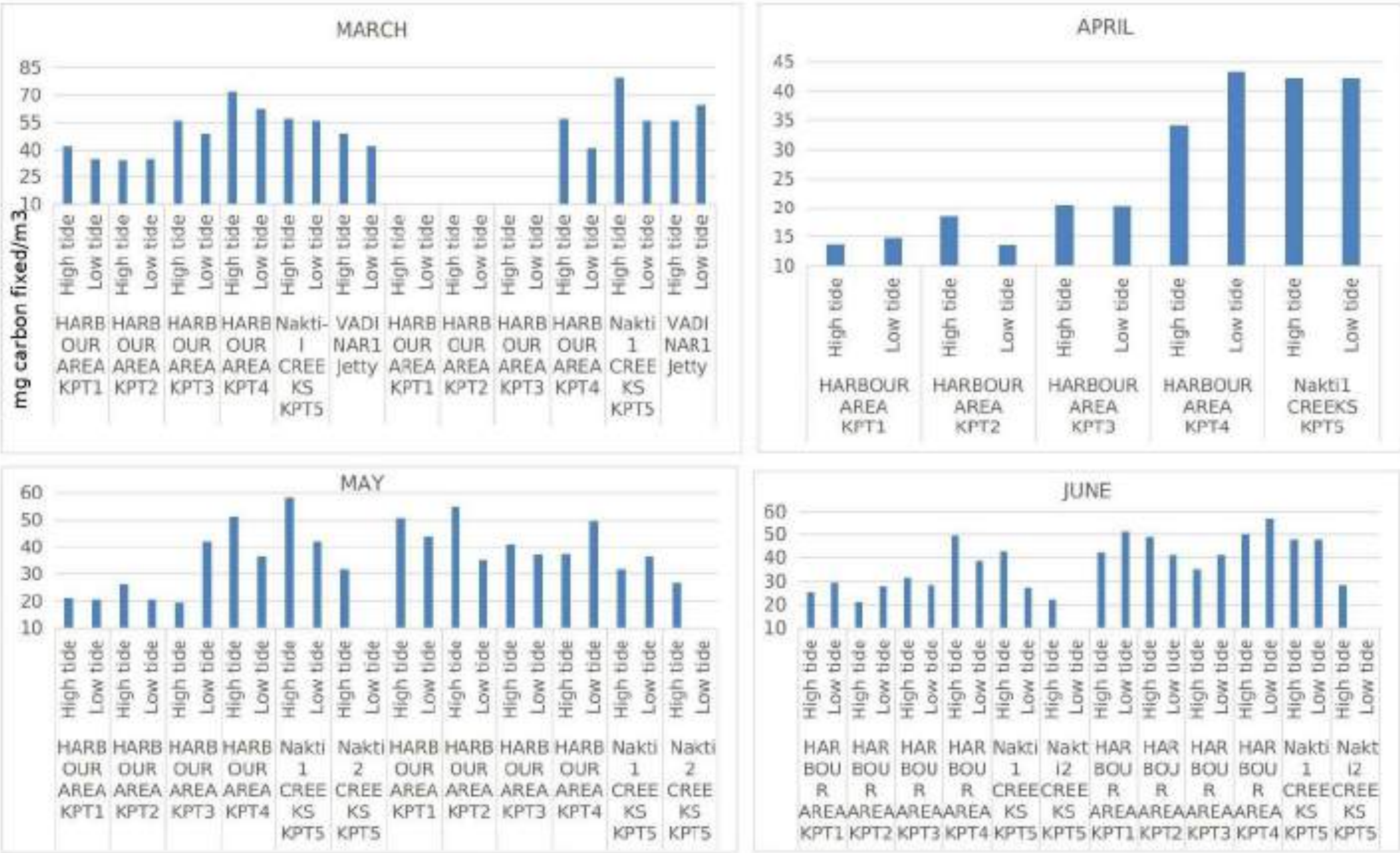
Algal Biomass

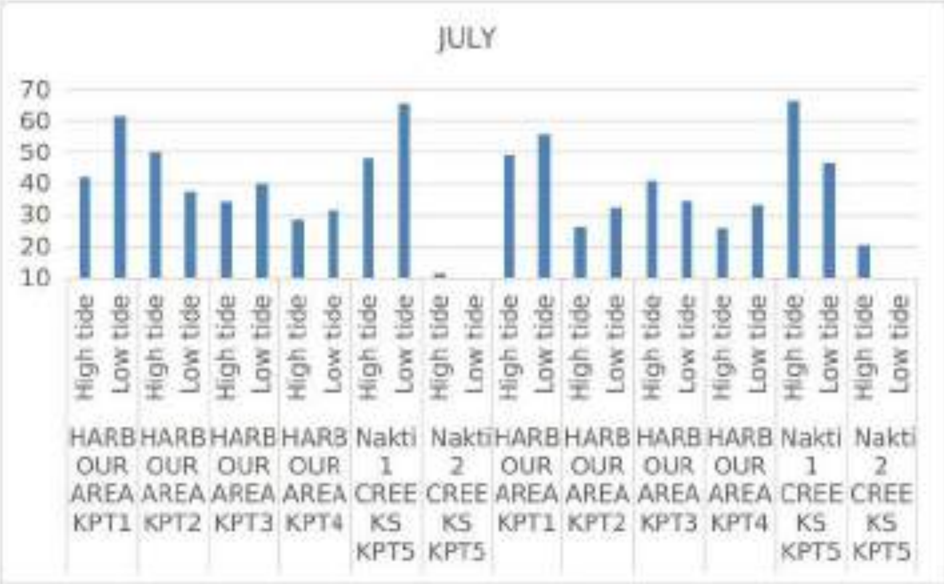
Chlorophyll-a value was used as algal biomass indicator (APHA 23rd Edition). Algal biomass was estimated by converting Chlorophyll value.

In the sub surface water algal biomass was varying from13.66to 128.84mg/m^3 in harbour region of DPA during sampling done in fromMarch2021 to February 2022. In the nearby creeks Algal Biomass was varyingfrom10.24to 128.84mg/m^3.

In the sub surface water algal biomass was varying from 26.26 – 90.85mg/m3 at Vadinar jetty and SPM during sampling done spring tide period and during Neap tide.

Fig 7. Monthly values of Algal Biomass in harbor waters of DPA

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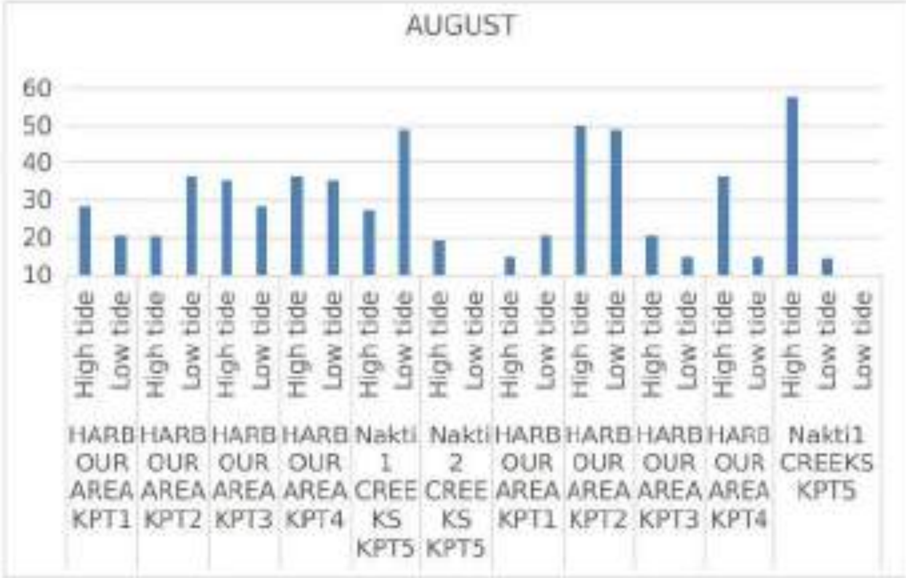
70
60
50
40
30
20
10
High tide
Low tide
HARBOUR AREA KPT1
HARBOUR AREA KPT2
HARBOUR AREA KPT3
HARBOUR AREA KPT4
Nakti 1 CREEKS KPT5
Nakti 2 CREEKS KPT5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30
20
10
High tide
Low tide
HARBOUR AREA KPT1
HARBOUR AREA KPT2
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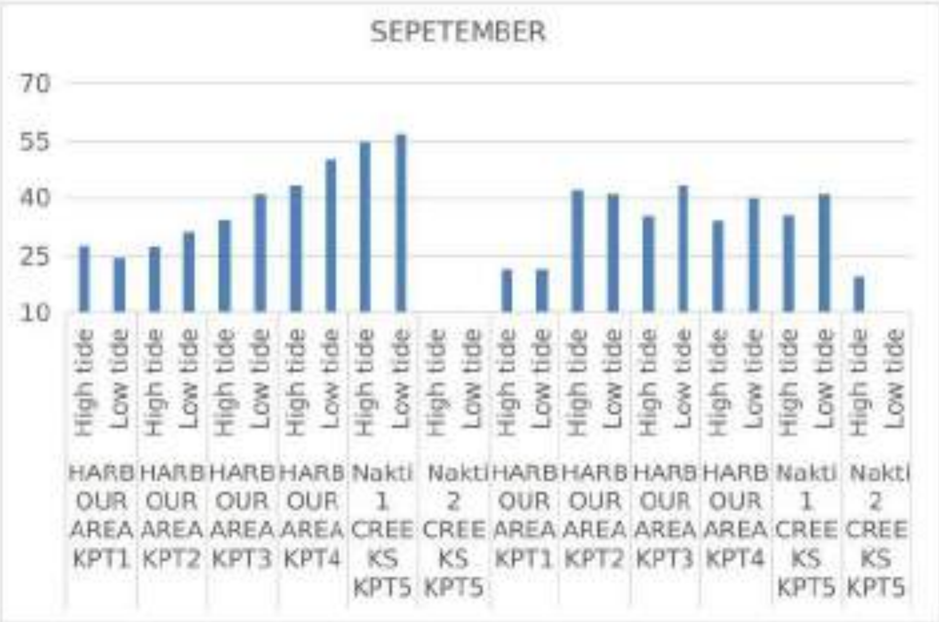
Nakti 2 CREEKS KPT5
Nakti1 CREEKS KPT5


SEPETEMBER
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55
40
25
10
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Low tide
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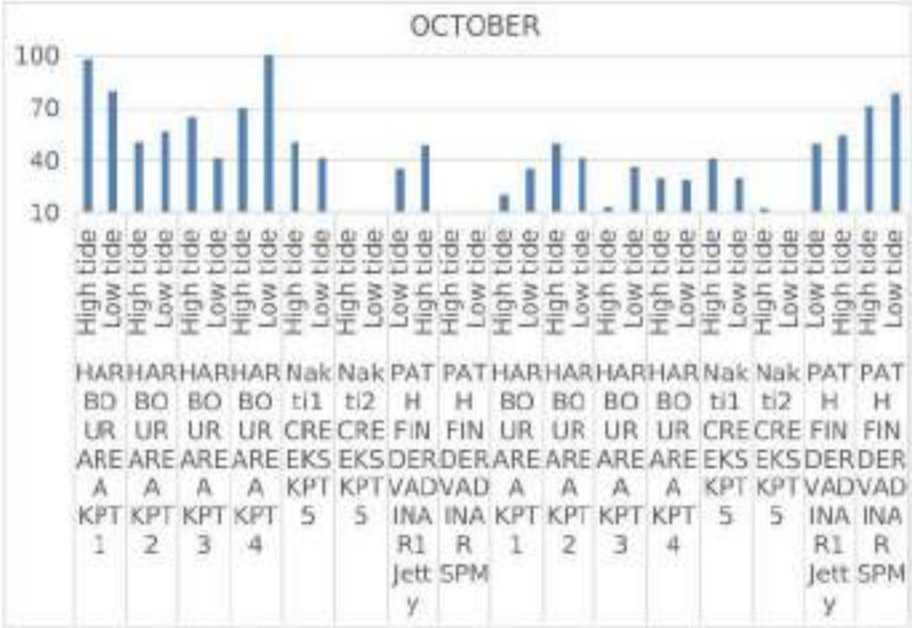
HARBOUR AREA KPT2
HARBOUR AREA KPT3
HARBOUR AREA KPT4
Nakti 1 CREEKS KPT5
Nakti 2 CREEKS KPT5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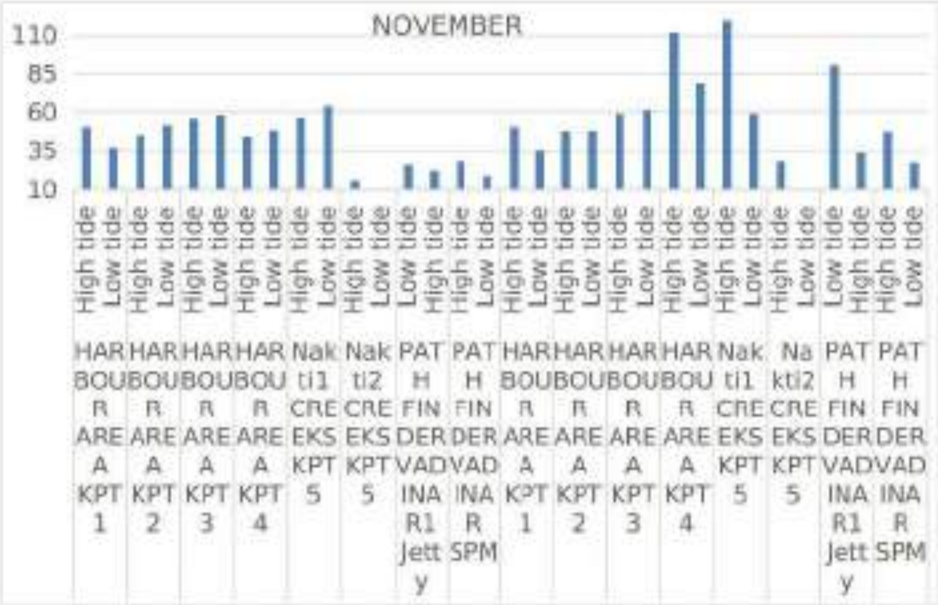
High tide
Low tide
HARBOUR AREA KPT 1
HARBOUR AREA KPT 2
HARBOUR AREA KPT 3
HARBOUR AREA KPT 4
Nakti1 CREEKS KPT 5
Nakti2 CREEKS KPT 5
PATH FINDER VADINAR1 Jetty
PATH FINDER VADINAR SPM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85
60
35
10
High tide
Low tide
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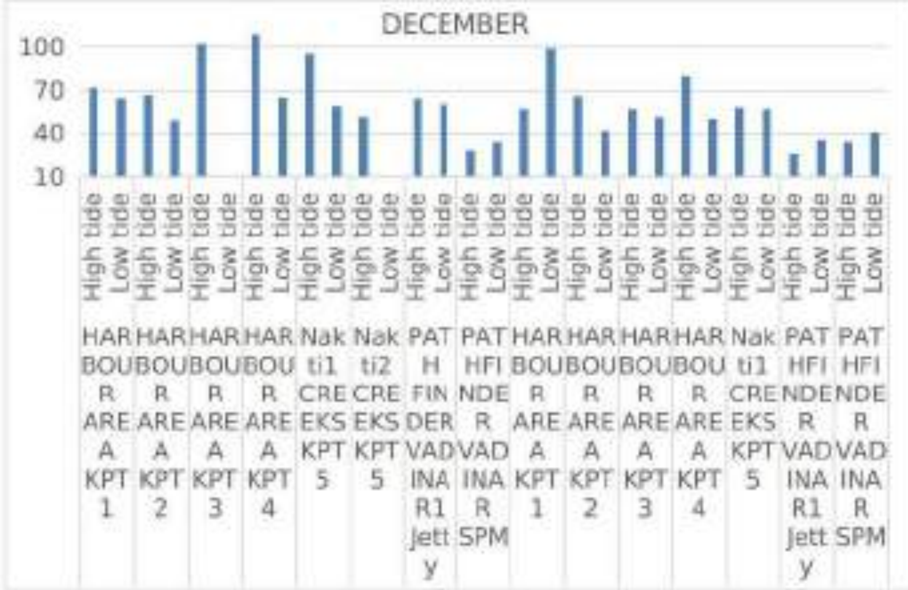
HARBOUR AREA KPT 3
HARBOUR AREA KPT 4
Nakti1 CREEKS KPT 5
Nakti2 CREEKS KPT 5
PATH FINDER VADINAR1 Jetty
PATH FINDER VADINAR SPM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100
70
40
10
High tide
Low tide
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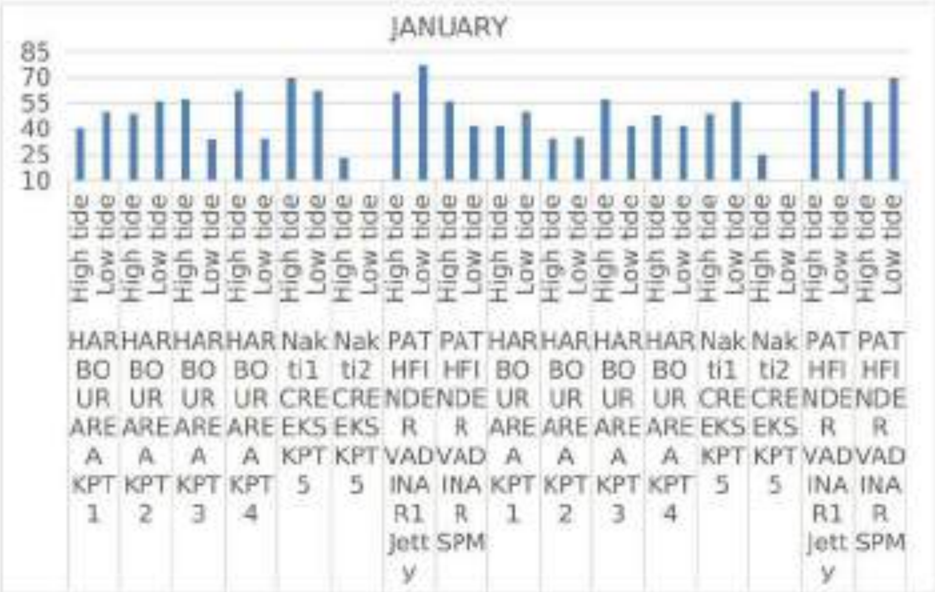
HARBOUR AREA KPT 4
Nakti1 CREEKS KPT 5
Nakti2 CREEKS KPT 5
PATH FINDER VADINAR1 Jetty
PATH HFINDER VADINAR SPM
PAT HFINDER VADINAR1 Jetty
PAT HFINDER VADINAR SPM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10
High tide
Low tide
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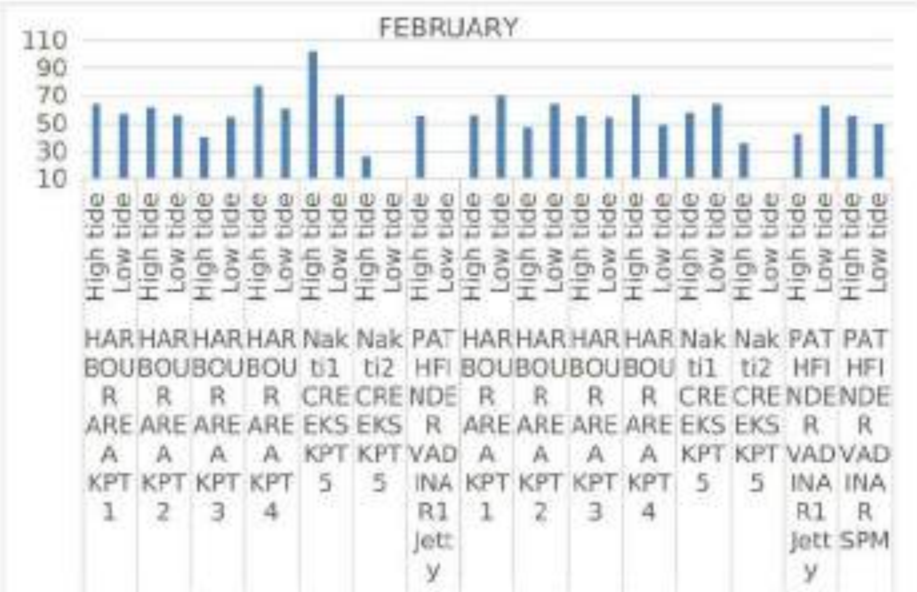
HARBOUR AREA KPT 4
Nakti1 CREEKS KPT 5
Nakti2 CREEKS KPT 5
PATHFINDER VADINAR1 Jetty
PATHFINDER VADINAR SPM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90
70
50
30
10
High tide
Low tide
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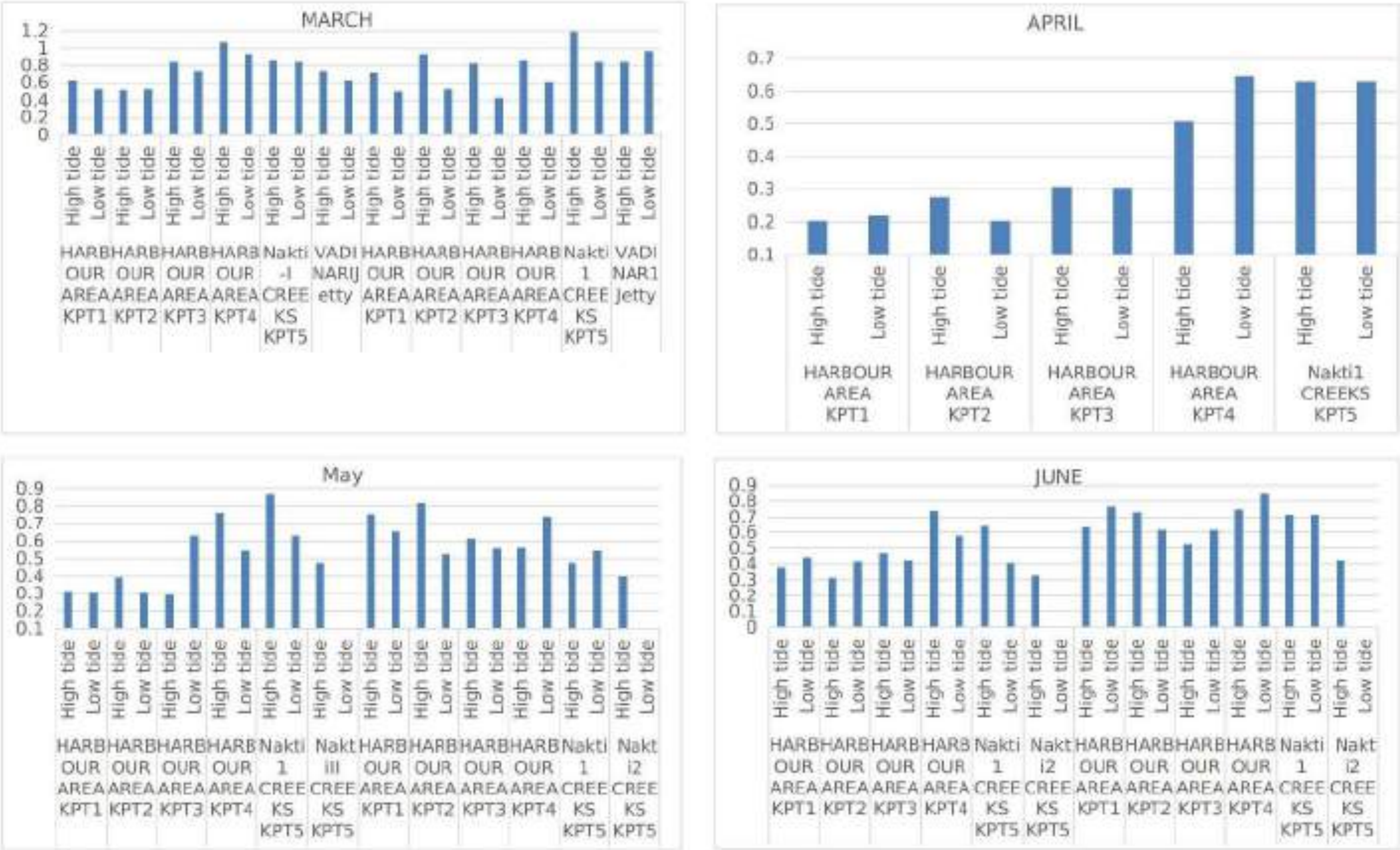
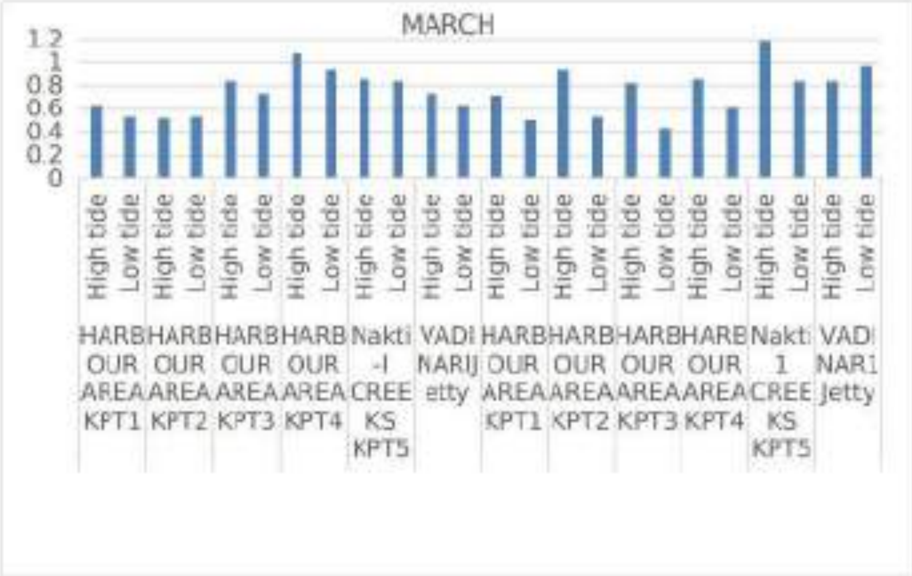
HARBOUR AREA KPT 3
HARBOUR AREA KPT 4
Nakti1 CREEKS KPT 5
Nakti2 CREEKS KPT 5
PATHFINDER VADINAR1 Jetty
PATHFINDER VADINAR SPM

Fig 8. Annual average values of Chlorophyll-a in harbor waters of DPA

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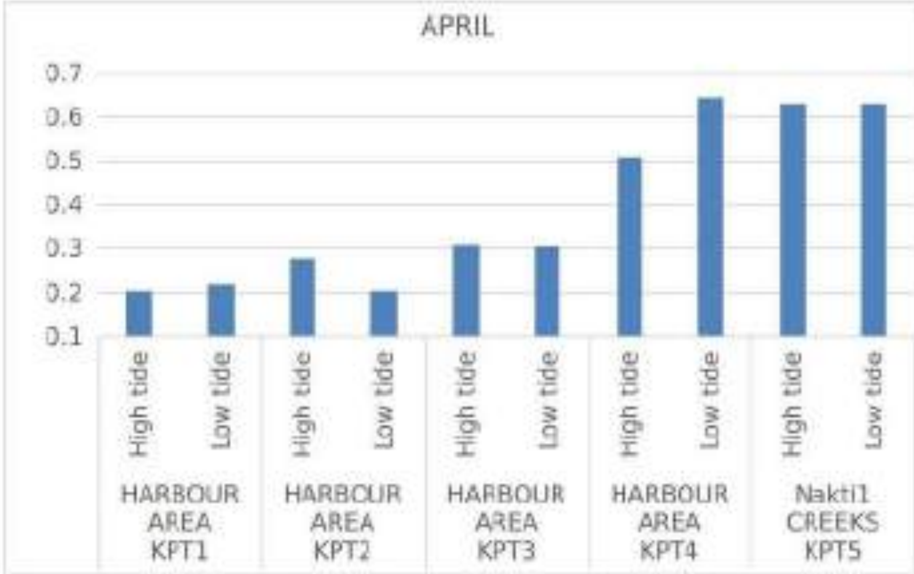
HARBOUR AREA KPT4
Nakti-I CREEKS KPT5
VADINARIJetty
Nakti 1 CREEKS KPT5
VADINAR1 Jetty
High tide
Low tide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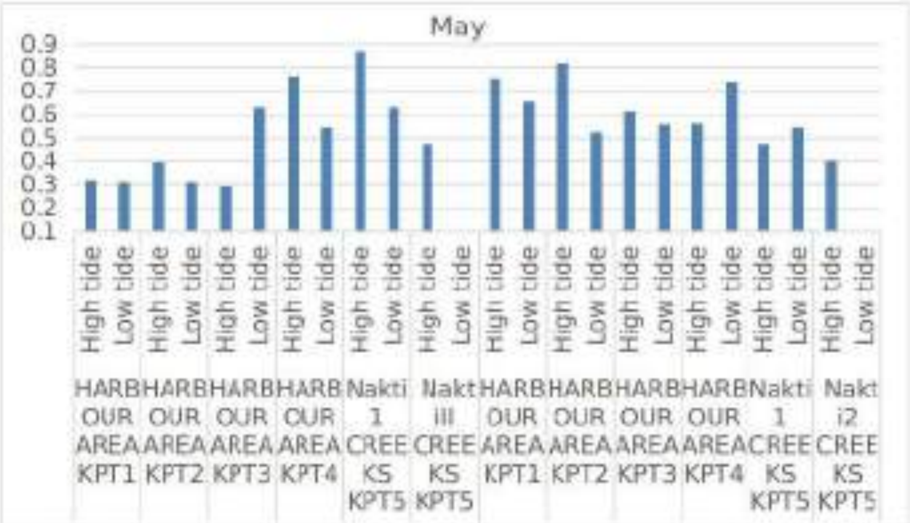
High tide
Low tide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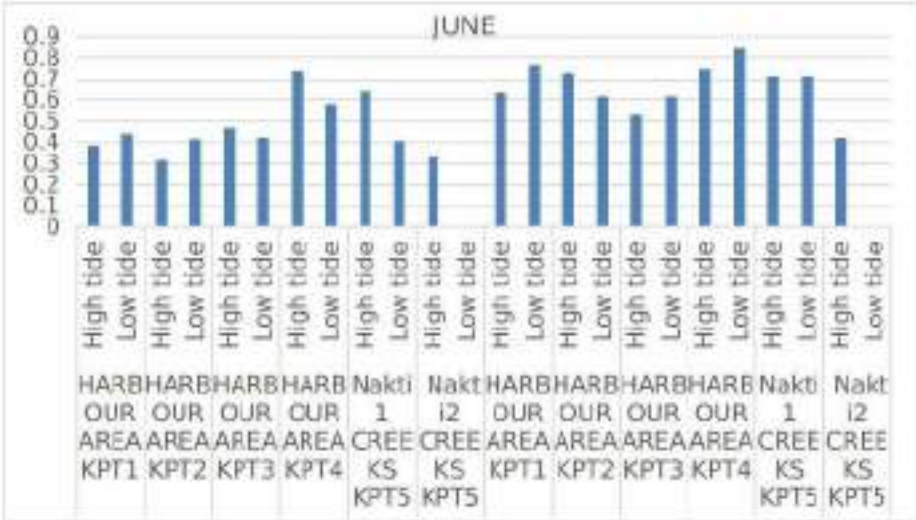
Nakti2 CREEKS KPT5
High tide
Low tide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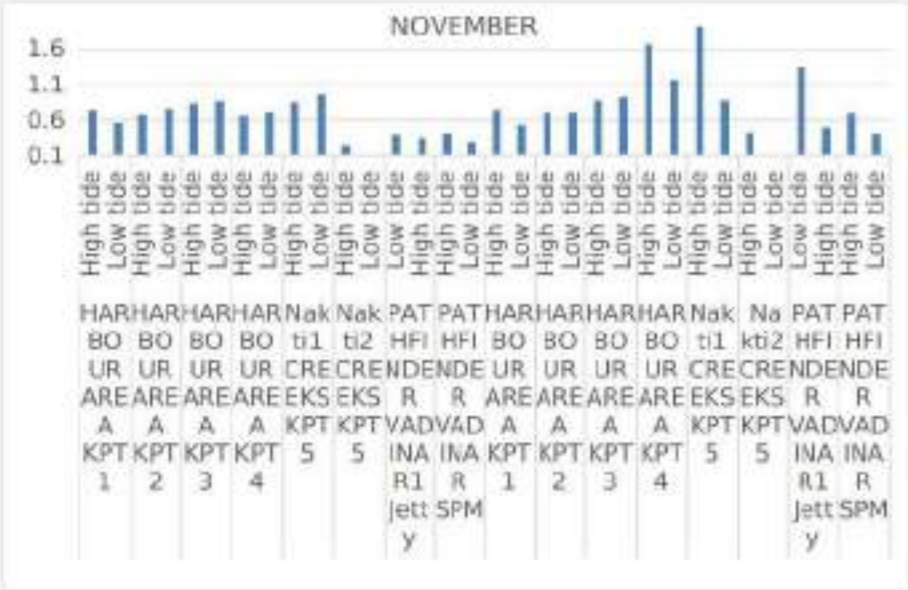
High tide
Low tide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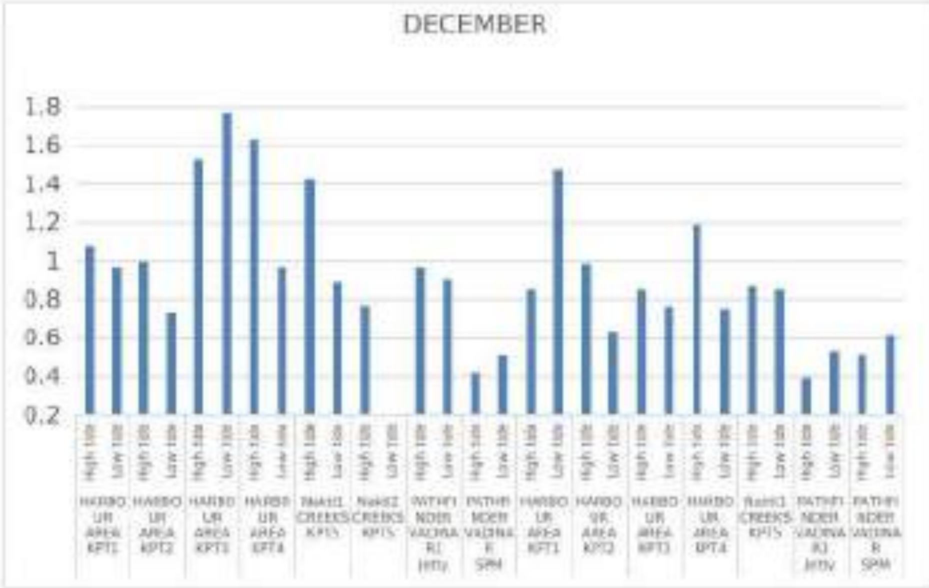
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0.4
0.2


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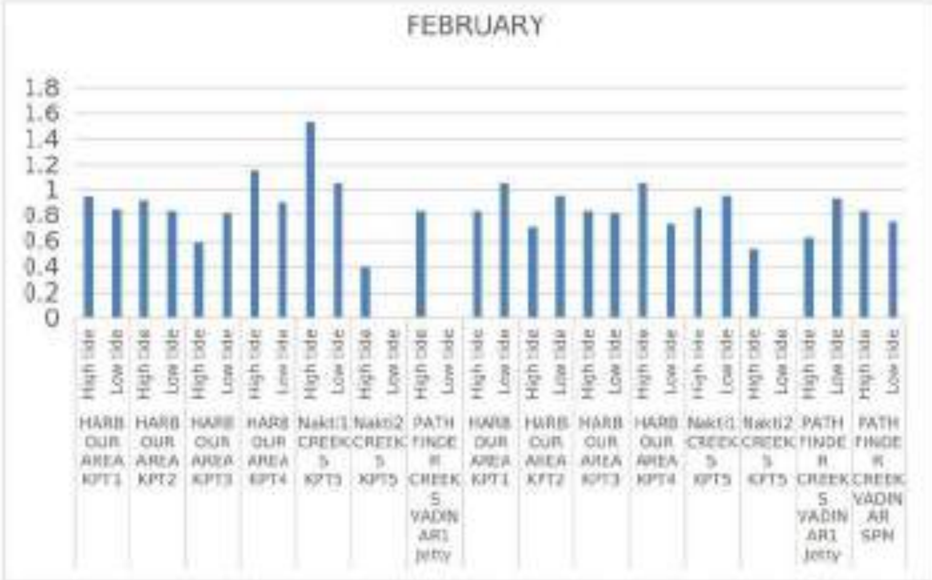
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1.4
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1
0.8
0.6
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0.2
0

5.5 Phytoplankton and Zooplankton

The phytoplankton community of the sub surface water in the harbour and nearby creeks was represented by Blue green algae and diatoms during spring tide period and neap tide period. Diatoms were represented by 13 genera belonging to 3 classes, 9 orders and 12 families.

The Zooplankton community of the sub surface water in the harbour and nearby creeks is comparatively low and represented by mainly four groups Tintinids, Copepods, Foramiferans, and larval forms of Crustaceans.

However, Vadinar waters were observed to be rich in terms of diversity and abundance of phytoplankton and zooplanktons.

5.6 Noise Monitoring

Noise monitoring is carried out as per "Noise Pollution" (Regulation and Control) Rules, 2000. The results of noise monitoring results are annual mean of each location of Kandla and Vadinar Port (Table 13).

Table 13. Annual avg. of noise level at locations of Kandla (10 locations) and Vadinar (3locations) Port

Sr. No.	Locations	Day Time Average Noise Level(SPL) in dB(A)	Night Time Average Noise Level(SPL) in dB(A)
	Time	**6 A.M.. And 10 P.M.**	**10 P.M. To 6 A.M.**
1	Marine Bhavan	62.35	55.14
2	Nirman Building 1	58.41	53.72
3	Tuna Port	55.51	48.87
4	Main Gate North	62.58	57.54
5	West Gate I	66.68	60.97
6	Canteen Area	59.64	51.94
7	Main Road	65.06	56.39
8	ATM Building	67.37	58.00
9	Wharf /Jetty Area	69.50	64.12
10	Port & Custom Office	58.51	48.77
	Vadinar Port		
11	Nr. Vadinar Port Gate	59.25	52.99
12	Port Colony Vadinar	57.42	54.11
13	Nr. Vadinar Jetty	63.58	59.08

Observations:

- The Day Time Average Noise Level in all ten locations at Deendayal Port ranged from 55.51dB to 69.50dB
- The noise levels were within the day time limits (75 dB (A)) of industrial area.
- The Night Time Average Noise Level in all ten locations of Deendayal Port ranged from 48.77 dB to 64.12 dB and it was within the permissible limits of 70 dB A for the industrial area for the night time.
- The mean day time noise levels at Vadinar were 60.08dB and the mean noise levels at night hours was 55.39dB.

5.7 Soil Monitoring

Sampling and analysis of soil samples was under taken at six locations with in the study area (Deendayal Port and Vadinar Port). The soil monitoring locations are coastal soils and exhibits saline soil characteristics, typical of a muddy shore.

The texture of soil of all locations was Sandy Loam. The soil at all the locations is saline in nature. The mean pH of the soil at all the locations of Kandla was 8.08 pH unit suggesting it to be slightly to medium alkaline.

Electrical conductivity of the soil was high with low moisture and organic carbon indicating less productivity of the soil and its unsuitability for any agriculture activities.

Other metals like copper, nickel and lead were detected in traces or within permissible limits. The overall surrounding soils were found to be less in essential nutrients, hence less suitable for plant growth.

Table 14. Tuna port Soil Analysis Result

Sr.No	Month		March.21	April.21	May.21	June.21	July.21	Aug.21	Sept.21	Oct.21	Nov.21	Dec.21	Jan.22	Feb.22
	Parameter	Unit	Result											
1	Texture		Sandy Loam											
2	pH	-	8.71	9.02	8.38	7.3	8.56	8.6	8.58	8.62	8.42	8.2	8.2	8.59
3	Electrical conductivity	µs/cm	10600	8650	29500	33400	26800	23400	18400	16200	14070	10805	10805	2839
4	Moisture	%	21.72	22.9	14	21.45	23.66	20.42	21	17	18.17	6.06	6.06	22
5	Total Organic Carbon	%	1.62	2.25	0.94	0.31	0.16	0.18	0.48	0.52	0.2	0.49	0.49	0.96
6	Alkalinity	mg/kg	40.04	80.08	80.08	100.1	140.14	60.06	72.07	60.06	80.08	70.07	70.07	40.04
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	BQL	BQL	BQL	BQL
8	Chloride	mg/kg	1244	2605.8	7896.2	6228.7	3908.6	4010	1506.6	1620	1956.8	709	709	3545
9	Sulphate	mg/kg	102	107.82	2502.08	2056.4	203	188	202	230	212	778.5	778.5	3891.18
10	Phosphorus	mg/kg	31.44	39.86	0.76	0.97	0.97	0.9	0.89	0.9	2.2	9.21	9.21	50.87
11	Potassium	mg/kg	1178	1028	1128	1161	779.4	786	386	396	539	143	143	192.3
12	Calcium	mg/kg	4843	228.4	320.64	641.3	2241	2341	1585	1620	5752	1315.7	1315.7	2466.12
13	Sodium	mg/kg	501	12092.4	11092.4	10821.6	144.29	160	228.46	230.32	200.4	152.3	152.3	284.57
14	Copper as Cu	mg/kg	52.2	62.2	10.2	11.21	42.6	32.2	52.2	17.4	14.9	35.9	35.9	26.2
15	Lead as Pb	mg/kg	5	4.8	5.4	3.1	4.2	3.8	4.9	6.4	5.8	13.4	13.4	7.5
16	Nickel as Ni	mg/kg	33.3	32.86	16.7	20.71	36.2	37.2	46.2	33.5	35.3	54.5	54.5	39.1
17	Zinc as Zn	mg/kg	56.2	58.26	22.6	32.26	58.6	59.36	66.2	55.9	40.6	89.7	89.7	58.2
18	Cadmium as Cd	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL

Table15. IFFCO Plant Soil Analysis Result

Sr.No	Month		March.21	April.21	May.21	June.21	July.21	Aug.21	Sept.21	Oct.21	Nov.21	Dec.21	Jan.22	Feb.22
	Parameter	Unit	Result											
1	Texture		Sandy Loam											
2	pH	-	7.98	8.78	8.25	8.16	8.11	8.1	8.16	8.1	7.92	7.77	7.77	8.6
3	Electrical conductivity	µs/cm	28900	36200	44400	48500	23800	20420	25620	26820	16210	22960	22960	1442
4	Moisture	%	23.97	22.1	20.91	13.94	22.09	21.16	22.2	18.2	9.01	6.4	6.4	28.37
5	Total Organic Carbon	%	6.29	1.4	1.52	0.19	0.24	0.18	1.24	1.02	0.49	0.69	0.69	0.71
6	Alkalinity	mg/kg	40.04	60.06	60.06	140.14	140.14	140.04	36.04	80.44	120.12	26.03	26.03	40.04
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	BQL	BQL	BQL	BQL
8	Chloride	mg/kg	2487	4510	6866.3	6032.5	4309.5	4324	6381	5380	4112.2	4325.9	4325.9	2481.5
9	Sulphate	mg/kg	204	311.7	804.5	75.86	177.9	179.2	196	198	279	3359.5	3359.5	1650.89
10	Phosphorus	mg/kg	21.25	52.7	2.45	1.41	0.8	0.86	0.92	0.82	1.89	10.56	10.56	5.33
11	Potassium	mg/kg	1715	747	762	592.2	644.4	656	820	810	327.4	199.8	199.8	155.01
12	Calcium	mg/kg	4710	468.9	661.32	561.12	3556.8	3618	3386	3400	4061.6	1116.4	1116.4	1500.32
13	Sodium	mg/kg	601	4840.2	5832.2	2992.8	128.22	130	741.5	722.2	488.98	360.72	360.72	432.86
14	Copper as Cu	mg/kg	60.8	52.5	26.2	27.22	61.2	58.2	78.2	38.8	29.5	29.9	29.9	35.6
15	Lead as Pb	mg/kg	1	1.52	8.5	6.2	3.2	3.8	5.6	7.9	6.4	9.3	9.3	10.8
16	Nickel as Ni	mg/kg	27.52	22.62	2020	1823	31.6	32.4	28	13.9	16.6	30.8	30.8	42.9
17	Zinc as Zn	mg/kg	43.2	59.2	89.1	72.62	39.25	38.32	41.6	91.9	104.8	153.2	153.2	102.7
18	Cadmium as Cd	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL

Table 16. Khori Creek Soil Analysis Result

Sr.No	Month		March.21	April.21	May.21	June.21	July.21	Aug.21	Sept.21	Oct.21	Nov.21	Dec.21	Jan.22	Feb.22
	Parameter	Unit	Result											
1	Texture		Sandy Loam											
2	pH	-	8.75	8.82	8.13	8.36	8.38	8.42	8.46	8.75	8.44	8.53	8.53	8.68
3	Electrical conductivity	µs/cm	8500	16380	39900	21800	23700	23700	17880	16252	13680	22260	22260	1950
4	Moisture	%	19.04	21.2	28.1	18.82	24.41	23.22	24.1	19.1	21.39	9.02	9.02	21
5	Total Organic Carbon	%	1.46	2.2	1.7	0.26	0.32	0.25	0.48	0.62	0.2	0.61	0.61	0.98
6	Alkalinity	mg/kg	60.06	60.06	70.05	80.08	100.1	140.04	190.19	140.2	60.06	52.05	52.05	40.04
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	BQL	BQL	BQL	BQL
8	Chloride	mg/kg	1144	3658.1	7160.6	2550.3	6114	5982	1701	1820	1800.9	3970.4	3970.4	2836
9	Sulphate	mg/kg	120	129.05	356.6	292	113.8	110	112	120	93.3	315.3	315.3	1292.27
10	Phosphorus	mg/kg	17.74	34.55	7.79	0.79	1.24	1.04	1.05	0.96	1.41	6.92	6.92	8.87
11	Potassium	mg/kg	903	698.4	578.4	700.2	1135.8	1162	345	366	409.2	139	139	160.36
12	Calcium	mg/kg	4235	284.6	460.92	701.4	3981.6	4220	2303	2122	3954	1234.8	1234.8	1839.79
13	Sodium	mg/kg	200	7437.6	6336.6	3164.4	168.3	170	248.5	252	252	144.29	144.29	232.46
14	Copper as Cu	mg/kg	40.6	38.6	29.4	28.2	38.2	42.2	46.2	21.2	9.8	30.8	30.8	31.8
15	Lead as Pb	mg/kg	4.2	3.62	31	23	3.6	3.6	3.2	29.1	3.5	11.1	11.1	5.4
16	Nickel as Ni	mg/kg	31.62	29.62	9	7.8	39.4	41.2	33.2	34.5	23.5	44.1	44.1	42
17	Zinc as Zn	mg/kg	46	42.62	95.8	65.9	52.4	53.4	68	77.9	25.4	76.8	76.8	76.7
18	Cadmium as Cd	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL

Table 17. Nakti Creek Soil Analysis Result

Sr.No	Month		March.21	April.21	May.21	June.21	July.21	Aug.21	Sept.21	Oct.21	Nov.21	Dec.21	Jan.22	Feb.22
	Parameter	Unit	Result											
1	Texture		Sandy Loam											
2	pH	-	8.39	8.68	7.91	8.26	8.33	8.3	8.26	8.33	8.23	8.02	8.02	8.47
3	Electrical conductivity	µs/cm	13340	4790	38200	37200	16260	17200	16520	17520	9240	14090	14090	2848
4	Moisture	%	22.65	4.13	26.2	14.26	23.65	20.12	18.8	20.22	21.08	23.84	23.84	24.88
5	Total Organic Carbon	%	1.61	0.7	1.58	0.24	0.1	0.11	3.93	3.1	0.72	0.87	0.87	0.84
6	Alkalinity	mg/kg	40.04	80.08	70.05	140.14	80.08	60.06	90.09	80.44	100.1	44.04	44.04	40.04
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	BQL	BQL	BQL	BQL
8	Chloride	mg/kg	1386	4359.7	9416.7	7160.6	3959	4001	1878.9	2078	514.7	3048.7	3048.7	3190.5
9	Sulphate	mg/kg	214	299.4	3966.5	87.84	93.8	100	112	118	165.1	574.7	574.7	4950.89
10	Phosphorus	mg/kg	35.87	50.04	1.66	1.59	1.77	1.62	1.1	1.02	2.15	4.76	4.76	8.5
11	Potassium	mg/kg	743	865.8	755.8	765	766.8	780	422	460	667.6	121.9	121.9	178.48
12	Calcium	mg/kg	3453	493	821.64	661.32	3038.4	3122	1990	2012	1477	1426.3	1426.3	2450.29
13	Sodium	mg/kg	501	7165.8	6355.8	3736.8	224.4	220	468.94	470.42	470.42	192.38	192.38	492.9
14	Copper as Cu	mg/kg	21.2	19.2	33.7	31.78	22.6	23.4	33.8	35.1	27.6	25.8	25.8	25
15	Lead as Pb	mg/kg	6.8	2.8	15.3	11.4	3.8	4.1	4.8	7.6	8.2	10.5	10.5	7.6
16	Nickel as Ni	mg/kg	22.02	19.22	25.4	15.1	22.6	24.5	26.1	13.2	37.7	39.6	39.6	31.9
17	Zinc as Zn	mg/kg	62	59.8	87.3	77.21	46.6	48.5	49.55	81.9	55.2	59.1	59.1	48.1
18	Cadmium as Cd	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL

Table 18. Vadinar DPA Admin Site Soil Analysis Result

Sr.No	Month		March.21	April.21	May.21	June.21	July.21	Aug.21	Sept.21	Oct.21	Nov.21	Dec.21	Jan.22	Feb.22
	Parameter	Unit	Result											
1	Texture		Sandy Loam											
2	pH	-	8.46	8.86	8.76	7.27	8.12	8.09	8.02	8.1	7.79	8.07	8.07	7.64
3	Electrical conductivity	µs/cm	585	439	260	511	509	510	523	560	387	1994	1994	1417
4	Moisture	%	7.16	4.62	7.26	6.28	9.44	9.04	8.66	7.26	3.46	4.22	4.22	8.49
5	Total Organic Carbon	%	2.53	0.87	1.16	0.15	0.2	0.21	0.18	0.12	0.85	1.16	1.16	0.32
6	Alkalinity	mg/kg	60.06	40.04	60.06	60.06	100.1	100.1	60.06	60.06	60.06	42.04	42.04	60.06
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	BQL	BQL	BQL	BQL
8	Chloride	mg/kg	280	90.2	29.43	68.66	39.3	42.2	52	62	21.7	567.2	567.2	141.8
9	Sulphate	mg/kg	330	268	23.2	14.37	13.4	14	12	16	44.7	52.7	52.7	250.38
10	Phosphorus	mg/kg	2.83	5.85	8.5	0.97	0.8	0.78	0.78	0.8	BQL	15.06	15.06	1..88
11	Potassium	mg/kg	131	212.8	302.8	626.4	129.6	130	110	120	70.4	73	73	30.01
12	Calcium	mg/kg	56	244.5	1703.4	124.2	1220	1224	990	910	72.8	65.1	65.1	153.5
13	Sodium	mg/kg	1303	236	246	2116.8	104.2	110	118	110	436.87	460.92	460.92	837.67
14	Copper as Cu	mg/kg	16.6	14.5	80.5	82.66	16.2	17.4	18.6	16.6	88.4	54	54	18.3
15	Lead as Pb	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	3.2	4.8	BQL	BQL	BQL	BQL
16	Nickel as Ni	mg/kg	26.42	18.26	35.3	25.46	18.3	19.3	18.2	13.2	33.8	42.1	42.1	60.2
17	Zinc as Zn	mg/kg	40	38.3	33.2	23.46	46.8	49.2	24	28	66	51	51	84.6
18	Cadmium as Cd	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL

Table 19. Vadinar DPA Colony Soil Analysis Result

Sr.No	Month		March.21	April.21	May.21	June.21	July.21	Aug.21	Sept.21	Oct.21	Nov.21	Dec.21	Jan.22	Feb.22
	Parameter	Unit	Result											
1	Texture		Sandy Loam											
2	pH	-	8.82	8.49	8.85	7.82	8.42	8.32	8.56	8.22	8.43	7.84	7.84	7.11
3	Electrical conductivity	µs/cm	875	634	513	464	419	400	420	480	314	490	490	299.6
4	Moisture	%	9.67	6.51	6.35	4.56	7.59	8.22	9.02	8.22	3.95	2.86	2.86	3.96
5	Total Organic Carbon	%	2.42	1.04	1.71	0.11	0.12	0.16	0.21	0.2	0.43	1.24	1.24	0.67
6	Alkalinity	mg/kg	60.06	60.06	70.05	100.1	60.06	80.04	100.1	80.44	80.08	40.04	40.04	40.04
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	BQL	BQL	BQL	BQL
8	Chloride	mg/kg	290	120.3	40.09	78.47	68.7	67.8	67.8	77	113.4	283.6	283.6	70.9
9	Sulphate	mg/kg	210	424	4.02	13.58	15.5	16.2	18	20	27.7	14.7	14.7	BQL
10	Phosphorus	mg/kg	3.36	7.79	7.35	0.97	0.97	0.88	0.86	0.72	1.74	7.06	7.06	BQL
11	Potassium	mg/kg	103	140	152	876.4	180	182	172	160	62	17	17	28.87
12	Calcium	mg/kg	94	196.4	1463	172.3	1445.4	1400	810	888	65.9	15.9	15.9	20.32
13	Sodium	mg/kg	501	126	166	2565	56.11	68	72	82	256.51	328.66	328.66	472.94
14	Copper as Cu	mg/kg	17.4	18.2	71.6	72.42	23	23	28	17	48.4	77	77	62.3
15	Lead as Pb	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	1.1	2	4.2	6.7	6.7	BQL
16	Nickel as Ni	mg/kg	22.1	21.22	31.8	27.73	21.2	20.4	16.2	12.2	27.3	36.7	36.7	33.3
17	Zinc as Zn	mg/kg	36	35.36	33.5	43.2	38.2	40.4	38.5	36.22	30.5	98.9	98.9	44
18	Cadmium as Cd	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL

pH

The pH was found at tuna port from 7.3 to 9.02, at IFFCO plant from 7.77 to 8.78, at Khori creek from 8.13 to 8.82, at Nakti creek from 7.91 to 6.68, at Vadinar DPA admin site from 7.7 to 8.86 and 7.11 to 8.85 at Vadinar DPA colony.

Moisture

The moisture was found at tuna port 6.06 to 23.66%, at IFFCO plant 6.4 to 28.37%, at Khori creek 9.02 to 28.1%, at Nakti creek 4.13 to 26.2%, at Vadinar DPA admin site 3.46 to 9.44%, and 2.86 to 9.67% at Vadinar DPA colony.

Electrical conductivity

The Electrical Conductivity was found at tuna port 2839 to 33400 µs/cm, at IFFCO plant 1442 to 48500 µs/cm, at Khori creek 1950 to 39900 µs/cm, at Nakti creek 2848 to 38200 µs/cm, at Vadinar DPA admin site260 to 1994 µs/cm, and 299.6 to 875 µs/cm at Vadinar DPA colony.

Total Organic Carbon

The total organic Carbon was found at tuna port 0.16 to 2.25%, at IFFCO plant 0.18 to 6.29%, at Khori creek 0.2 to 2.2%, at Nakti creek 0.1 to 3.93%, at Vadinar DPA admin site 0.12 to 2.53%, and 0.11 to 2.42% at Vadinar DPA colony.

Texture

The texture was found sandy loam for all location.

Cadmium as Cd

The Cadmium was found below quantification limit for all location.

Zinc as Zn

The zink as Zn was found at tuna port 22.6 to 89.7 mg/kg , at IFFCO plant 38.32 to 153.2 mg/kg , at Khori creek25.4 to 95.8 mg/kg, at Nakti creek 46.6 to 87.3 mg/kg ,at Vadinar DPA admin site 23.46 to 84.6 mg/kg, and 30.5 to 98.9 mg/kg at Vadinar DPA colony.

5.8 Sewage Treatment Monitoring

This involve safe collection of waste water (spent/used water) from wash areas, bathroom, cargo operational units, etc., waste from toilets of various buildings and its conveyance to the treatment plant and final disposal inconformity with the requirement and guide lines of State Pollution Control Board and other statutory bodies.

The waste water is let into sewer network (network of pipes and manholes) and let by gravity and intermittent pumping stations to the main Sewage Treatment Plant (STP).

The Sewage Treatment Monitoring is carried out at Deendayal Port Colony (Gopalpuri), Vadinar Port and Deendayal Port.

STP at Gopalpuri Port Colony

Gopalpuri STP is working properly and overall performance of the existing STP was found satisfactory. The removal efficiency of BOD, TSS was in order. The individual units were also performing well and their removal efficiency is satisfactory. Thus with the sample tested in laboratory the plant is working satisfactory and the individual units are also working well.

STP at Kandla Port

STP with improved capacity of 1.5 MLD at Deendayal Port is operational. The newly installed sewage treatment plant has 1500 cum/day fluidized media reactor based STP to treat domestic waste water generated from the campus and treated water will be utilized for gardening and plantation purpose.

Table 20. Gopalpuri STP Outlet Annual Results

Sr. No.	Parameter	Unit	1st Quarter Mean	2nd Quarter Mean	3rd Quarter Mean	Value (Annual Avg.)	GPCB Prescribed Limit
1	pH	-	7.21	7.36	7.32	7.30	6.5 - 8.5
2	Total Suspended Solids	mg/l	42.94	83.3	105.41	77.22	100
3	Residual Chlorine	mg/l	<0.5	<0.5	<0.5	<0.5	No Limit
4	Chemical Oxygen Demand	mg/l	85.19	96.43	111.01	97.54	100
5	Biochemical Oxygen Demand	mg/l	19.69	25.56	32.87	26.04	30

Table 21. KPT STP Outlet Annual Results

Sr. No.	Parameter	Unit	1st Quarter Mean	2nd Quarter Mean	3rd Quarter Mean	Value (Annual Avg.)	GPCB Prescribed Limit
1	pH	-	7.15	7.37	7.40	7.31	6.5 - 8.5
2	Total Suspended Solids	mg/l	50.21	81.04	100.72	77.32	100
3	Residual Chlorine	mg/l	<0.5	<0.5	<0.5	<0.5	No Limit
4	Chemical Oxygen Demand	mg/l	62.58	90.53	110.26	87.79	100
5	Biochemical Oxygen Demand	mg/l	15.87	24.68	27.25	22.60	30

Table 22. Vadinar STP Outlet Annual Results

Sr. No.	Parameter	Unit	1st Quarter Mean	2nd Quarter Mean	3rd Quarter Mean	Value (Annual Avg.)	GPCB Prescribed Limit
1	pH	-	STP not Working	7.25	7.34	7.30	6.5 - 8.5
2	Total Suspended Solids	mg/l		46.68	55.44	51.06	100
3	Residual Chlorine	mg/l		<0.5	<0.5	<0.5	No Limit
4	Chemical Oxygen Demand	mg/l		62.56	81.72	72.14	100
5	Biochemical Oxygen Demand	mg/l		16.62	22.37	19.5	30

The GPCB specification for pH, TSS, Residual Chlorine , COD and BOD for STP outlet are 6.5 to 8.5 , 100 mg/l, 0.5 mg/l, 100 mg/l and 30 mg/l respectively. The average values for pH at all locations from 7.30 to 7.31, The average values for Total Suspended Solids at all locations from 51.06 to 77.32 mg/l , The average values for COD at all locations from 72.14 to 97.54 mg/l, The average values for BOD at all locations from 19.5 to 26.04 mg/l, Residual Chlorine were found below detectable limit. All parameters for STP outlet are within limit.

5.9 Weather

The data collected from Automatic weather station have been installed and other secondary sources to represent the metrological conditions of the project area has been reviewed and presented below for various attributes such as Temperature, Wind velocity, Relative Humidity, solar radiation, wind direction, Air pressure and Heat index.

Table 23. Weather Results

MONTH		Temperature (°C)	Solar Radiation (w/m2)	Relative Humidity (%)	Wind Velocity (m/s)	Wind Direction	Air pressure (hpa)	Heat index (°C)
March.21	MIN	28.4	166.7	24.7	1.9	North West	1013.2	29.0
	MAX	36.2	292.3	93.0	10.6		1017.3	43.0
April.21	MIN	31.5	134.4	57.0	1.9	South East	1009.0	24.2
	MAX	42.4	576.6	94.0	9.9		1014.1	48.0
May.21	MIN	32.7	157.7	60.2	2.0	South East	1005.3	38.1
	MAX	37.3	383.3	89.0	8.1		1010.6	47.0
June.21	MIN	29.8	208.3	66.0	2.7	South West	1004.9	35.2
	MAX	34.1	654.8	84.0	13.0		1008.9	44.0
July.21	MIN	28.5	158.4	71.2	2.7	South West	1002.4	36.1
	MAX	32.1	751.7	89.0	13.0		1004.1	43.0
Aug.21	MIN	34.1	232.4	73.0	3.0	South West	1001.2	34.7
	MAX	26.1	682.8	90.0	9.7		1008.3	42.0
Sept.21	MIN	26.7	136.0	83.5	1.9	South West	1002.3	33.5
	MAX	36.2	808.9	98.0	12.0		1010.1	49.0
Oct.21	MIN	26.5	252.2	60.0	1.3	South North	1009.3	33.8
	MAX	38.6	746.6	94.0	8.1		1016.5	55.0
Nov.21	MIN	26.5	252.2	60.0	1.3	South North	1009.3	33.8
	MAX	38.6	746.6	94.0	8.1		1016.5	55.0
Dec.21	MIN	10.5	109.9	39.0	1.7	North West	1018.0	27.0
	MAX	31.8	534.3	93.0	4.4		1021.2	30.0
Jan.22	MIN	12.6	115.3	47.2	1.2	North West	1015.9	27.2
	MAX	30.8	530.7	96.0	5.8		1021.9	32.0
Feb.22	MIN	12.6	119.2	45.6	1.3	North West	1006.3	27.8
	MAX	29.2	530.7	98.0	9.6		1022.0	33.0

Temperature

The min temperature for Deendayal Port was 10.5 °C on December. The maximum temperature was recorded 42.4°C on April.

Solar Radiation

The min Solar Radiation was recorded 109.9 w/m2 on December . The maximum solar radiation recorded in the September was 808.9 w/m2.

Relative Humidity

The min Relative humidity was recorded 24.7 % on March and maximum Relative humidity recorded was 98.0 % on February.

Wind Velocity and Wind Direction

The min wind velocity was recorded 1.2 m/s on January. Maximum wind velocity recorded was

13 m/s on June. The wind direction was mostly North West and south west throughout the year.

Air pressure

The min Air pressure was recorded 1001.2 hpa in August. Maximum Air pressure recorded was 1022 hpa on February.

Heat index

The min heat index was recorded 24.22 °C in April. Maximum heat index recorded was 55 °C on November.

6.0 Conclusion

A. Ambient Air

Ambient Air Quality monitoring results for the Second year shows TSPM, PM_{10} and $PM_{2.5}$ concentrations of the ambient air were above the permissible limits as per the National Ambient Air Quality Standards (NAAQS2019). The concentration of $PM_{10}$and $PM_{2.5}$was above the permissible limit at Coal Storage Area, Marine Bhavan and occasionally at Oil Jetty Area and ,Kandla Estate Office, Gopalpuri Hospital Tuna Port area at some occasions.

The concentration of PM_{10} was within the permissible limit at Vadinar locations except Signal Building in November and Vadinar Colony in October & November above the permissible limit.

Deendayal Port has handled 117.5 MMT to 127 MMT of dry cargo in 2021-22. This huge volume of dry cargo handled at DPA along with high winds in coastal areas causes slight rise in the Ambient Air Quality near coal berth.

Very high volume of dry cargo is being handled (especially coal) at berth no. 7, 8 and 9. Besides handling of coal, thousands of vehicles laded with coal and other dry cargo criss-cross the port/harbor roads causing the rise in suspended particles in the air.

B. Drinking Water Quality

The results of the current year monitoring suggest that, the drinking water parameters of all the locations (18 at Kandla and 2 at Vadinar Port) were found within the permissible limits as per the BIS 10500 (2012) drinking water specification.

C. Noise Quality

The day and night time noise quality was found within the permissible limits of the Noise Pollution (regulation and control) rules, 2000. The Day Time and Night Time Average Noise Level (SPL) in all ten locations at Deendayal

Port were within the permissible limits of 75 dB A (for day time) and 70 dB A (for the night time)for an industrial area.

D. Marine Water Quality

The marine water samples were collected from the harbour area and the creek area and were monitored for 28 different parameters. The mean DO levels of DPA waters ranged from 4.9 mg/L to 6.0 mg/L (mean = 5.6 mg/L), which is normal for marine waters of ports and harbors.

Evaluation of the Phytoplankton and Zooplankton population in DPA harbour area and within the immediate surroundings of the port suggests that the Kandla waters harbours low to moderate diversity and abundance of phytoplankton and zooplanktons.

E. Soil

The soil samples were collected from six locations. The 4 locations of Kandla (Tuna port, Khori Creek, Nakti creek, IFFCO plant) and 2 locations of Vadinar (Vadinar DPA Admin site and Vadinar DPA colony). Soil samples were collected for monitored 18 different parameter.

The pH was found at tuna port from 7.11 to 9.02 Vadinar DPT colony and Tuna Port. Cadmium was found at all soil sample is BQL. (Below quantification limit).

F. Sewage Treatment Plant

Gopalpuri STP is working properly and overall performance of the existing STP was found satisfactory.

A new STP with improved capacity of 1.5 MLD at Deendayal Port is operational which is working as per the standards of CPCB/GPCB.

At Vadinar Port, a new STP was operational which is working as per the standards of CPCB/GPCB.

6.1. Steps taken by Deendayal Port to improve Environment

- "Safety Week" is being celebrated in Kandla Port by demonstrating mock drill, fire fighting, emergency preparedness, health checkup program etc.
- Regular Safety training and mock drill are being carried out and awareness is being created by lectures among the workers of the Port.
- Personal Protective Equipments (PPE like ear plugs, helmets, safety suits, etc are being used during Port Operational work.
- Sewage generated at Port Area as well as in Port colonies is being properly treated through Sewage Treatment Plants at outside Port area at Kandla and Port colony at Gopalpuri. However, DPA is planning to construct a new STP with the latest technology as the existing one is very old.
- Deendayal Port Authority have planted about one lakhs trees in road side dividers, colony areas at Kandla and Gopalpuri, in green belt area of Gandhidham & Adipur Township, Sewage Treatment Plants at Gopalpuri & Kandla and some green belt development plans initiated at different locations in Town ship areas.
- Deendayal Port Authority also carries out Environmental Audit through recognized till 2016 from environmental auditor (Schedule) of Gujarat Pollution Control Board from the year 2010 .Three Audit Reports for the year 2010, 2011 and 2012 were already submitted to GPCB as per the norms.
- DPA planted Mangroves in an area of 1500 hectares from 2005 to 2021: Mangrove Plantation Plan carried out in following phases;

1)	Year2005-06–20 hectares
2)	Year2008-09-50 hectares
3)	Year2010-11–100 hectares
4)	Year2011-12–200 hectares
5)	Year2012-13–300 hectares
6)	Year2013-14-330 hectares
7)	Year2015-17-300 hectares
8)	Year 2018- 20 - 100 hectares
9)	Year2020- 21-100 hectares
Total	**1500hectares**

- Water sprinkling on coal is regularly done to prevent coal dust pollution in the port area.

- To control the dust from bulk cargo like fertilizer, coal, sulphur, etc, the Port-users are encouraged to use hopper during discharge from vessels.
- Annual maintenance contracts have been awarded for garbage collection, cleaning of buildings and roads.
- Deendayal Port Authority is maintaining the records for collection and disposal of Solid Wastes generated from Port area, Residential area and Office Buildings.
- Deendayal Port Authority is regularly submitting the Hazardous Waste Statement in From – IV and Form V in environment sheet every financial year to the Gujarat Pollution Control Board, Gandhinagar.
- Are port on collection and disposal of the wastes from ships is submitted it to GPCB recognized body on regular basis.
- All trucks before leaving the storage yards are covered with tarpaulin and not over loaded as well as there is no spillage during transportation.
- Sewage generated at Port area and Port colonies is being properly treated through Sewage Treatment Plants outside Port area at Kandla and Port Colony at Gopalpuri.
- Deendayal Port has engaged CPCB/GPCB authorized agencies for the disposal of Hazardous waste (spent / used oil from ships) as per the Hazardous Wastes (Management and Handling) Rules.
- Pollution under Control (PUC) Certificate is mandatory for vehicles and equipments operating in the Port.
- Deendayal Port has awarded several projects to M/s Gujarat Institute of Desert Ecology(GUIDE) ,Bhuj relating to monitoring of Marine environment viz;

  - Regular Monitoring of Marine Ecology of Kandla Port Area since 2017-18
  - Creek Bathymetry
  - Analysis of dredging contaminants
  - Strategic Regional Impact Assessment Studies
  - Assessment and Monitoring of Mangrove Plantation in 1500 Ha area.
  - Biodiversity Action Plan for DPA and its surrounding areas

6.1.1 ISO 14001:2015 - Environmental Management System of Deendayal Port Authority

Deendayal port has appointed QMS India Ltd. As for Continual Improvement of ISO 14001:2015 - Environmental Management System with following scope;

- Review of environmental aspect-impacts,
- Review and monitoring of legal requirement
- Review and monitoring of emergency preparedness
- Management review by every six months
- Training of internal auditors and EMC members
- Active participation during external audit.

6.1.2 Green Ports Initiative

Deendayal Port is committed to sustainable development and adequate measures are being taken to maintain the Environmental well-being of the Port and its surrounding environs. Weighing in the environmental perspective for sustained growth, the Ministry of Shipping had started "Project Green Ports" which will help in making the Major Ports across India cleaner and greener. 'Project Green Ports‟ will have two verticals-one is "Green Ports Initiatives‟ related to environmental issues and second is **"Swachh Bharat Abhiyaan."**

The Green Port Initiatives include twelve initiatives such as preparation and monitoring plan, acquiring equipments required for monitoring environmental pollution, acquiring dust suppression system, setting up of sewage/waste water treatment plants/ garbage disposal plant, setting up Green Cover area, projects for energy generation from renewable energy sources, completion of shortfalls of Oil Spill Response (OSR) facilities (Tier-I), prohibition of disposal of almost all kind of garbage at sea, improving the quality of harbor wastes etc.

Deendayal port has also appointed GEMI as an Advisor for "Making Deendayal Port a Green Port- Intended Sustainable Development under the Green Port Initiatives.

- Deendayal Port has also signed MoU with Gujarat Forest Department in August 2019 for Green Belt Development in an area of 31.942 Ha of land owned by Deendayal Port Authority. The plantation is being carried out by the Social Forestry division of Kachchh.

7. Suggestions

7.1 Ambient Air Quality

PM_{10} values at Coal storage area, Marine Bhavan, Oil Jetty and Tuna Port were occasionally found above the permissible standards and $PM_{2.5}$ was occasionally found above permissible limits at Coal storage area. (100µg/m^3 for PM_{10}& 60 µg/m^3 for $PM_{2.5}$). The principle reason for higher PM_{10}values at Coal Storage and Marine Bhavan are bulk handling of coal, other dry cargo and heavy traffic of transport vehicles.

7.1.1 Sprinkling

- Heavy duty Water sprinklers should be used inside port where large scale dry cargo is handled.
- Mobile air Sprinklers should also be procured, which suppresses the fine dust from blowing during handling of dry cargo.

7.1.2 Enclosed conveyors

- Port users should be motivated to use enclosed conveyors which prevents secondary dust emissions due to wind in the port area.

7.1.3 Mechanized handling systems

- This involves using screw type un loaders which results in much less spillage and loss of material as compared to bucket un loaders. Mechanized systems can also use pre-packed containers for ease and pollution free loading unloading. Diligent use of various systems can keep the pollution due to ports at minimum level.

- Besides these prevention measures, Gujarat Pollution Control Board (GPCB) has also issued guidelines for handling of Coal. Guidelines for Coal Transport, Storage and Handling given below should be strictly followed; (***https://gpcb.gujarat.gov.in/uploads/coal-handling-guidelines1.pdf)***

7.2 GPCB Guidelines for Coal handling units:

(A) Location criteria

➢ In case of coal handling activities at the ports and jetties or extension thereof, the distance and land use criteria may be relaxed and compensated by advanced/sophisticated pollution control measures and mechanization & thick plantation, however all such ports and jetties, where coal handling is carried out, shall provide closed conveyor belt and mechanization for handling of coal.

(B) Storage and handling criteria

- Coal handling unit/Agency shall store coal in such a way that coal heap should not be higher than 5 meter and clear distance between two adjoining heaps at G.L. should be 5 meters, so that in case of fire, approach is available.

- There should be mechanized loading/unloading system from the loading /unloading area to the stacking yards and in to the vehicles.

- Coal handling unit/Agency shall take all corrective steps to resolve the issue of air pollution at permitted coal storage/handling area where coal is being stored.

(C) Transport criteria

- Coal handling unit/Agency shall ensure that all trucks before leaving the storage yard shall be showered with water with adequate system, Shall be covered with tarpaulin or any other effective measure/device completely and also that trucks are not overloaded as well as there is no spillage during transportation.
- The vehicle carrying the coal should not be overloaded by raising the height of carriage. Weigh scale shall be provided within the loading area only and port/coal park authority shall ensure that no over loading is done.
- The top of the vehicle should be covered with fixed cover to avoid spillage or dusting of coal.

(D) Pollution prevention criteria

- Coal handling unit/Agency shall provide paved approach with adequate traffic carrying capacity

- Coal handling unit/Agency shall construct compound wall all along periphery of the premises with minimum 9 meters height

- Continuous water sprinkling shall be carried out on the top of the heap at regular intervals to prevent dusting, fire & smoke. To prevent fugitive emission during loading/unloading, fixed pipe network with sufficient water storage and pump shall be installed. Water sprinkling shall be carried out at each and every stage of handling to avoid generation of coal dust or other dust within premises

- Coal handling unit/Agency shall ensure regular sweeping of coal dust from internal and main road and also ensure that there is adequate space for free movement of vehicles.

- The following adequate Air Pollution Control Measures shall be installed and to be operated efficiently.

- Construction of effective wind breaking wall suitable to local condition to prevent the suspension of particles from the heaps.

- Construction of metal road & RCC Pucca flooring in the plot area/godown etc.

- System for regular cleaning and wetting of the floor area within the premises.

- Entire coal storage area/godown should be covered with permanent weather shed roofing and side walls i.e., in closed shed, in case of crushing/sieving/grading activity is carried out (i.e. G. I. Sheet)along with adequate additional APCM should be installed. Coal handling unit/Agency shall carryout three rows plantation with tall growing tress all along the periphery of the coal handling premises, inside & outside of the premises along with road.

- Proper drainage system shall be provided in all coal storage area so that water drained from sprinkling & runoff is collected at a common tank and can be reused after screening through the coal slit or any other effective treatment system.
- All the engineering control measures and state of art technology including covered conveyer belts, mechanized loading and unloading, provision of silo etc. shall be provided in addition to the measurers commended in the environmental guidelines for curbing the pollution.

(E) Safety requirement

- Coal handling unit/Agency shall provide adequate fire-fighting measure to avoid any fire or related hazards including adequate water storage facility, and the premises shall be exclusively used for storage of the coal.

- An onsite emergency plan shall be prepared and implemented by coal handling unit.

(F) Legal criteria

- Necessary permission from all the applicable regulatory authorities and adequate steps under the provisions of applicable environmental acts/rules shall be taken.

- Coal handling unit/Agency shall prepare EMP (Environment Management Plan) and implement the same in true spirit and thus maintain overall environment of that area.

- Coal handling unit/Agency shall not carry out the operation of loading/unloading of coal/coal dust at any place, till adequate air pollution control equipment for dust control/suppression are installed and efficiently operated and the consent under the provisions of Air (Prevention & Control of Pollution) Act, 1981 is obtained by the coal yard owners/Coal handling unit/Agency/coal importers.

- Coal handling unit/Agency shall operate continuous Ambient Air Quality Monitoring Stations as per CPCB guideline.

- In case of port which provides the facility to individual developers an agreement/MoU shall be made between port authority and developer for curtailment of pollution. Port authority shall be responsible for supervising and controlling the pollution control related activities and implementation of the environmental guidelines.

7.3 Sewage Treatment Plant at Vadinar

- At Vadinar, the sewage waste water from the colony is connected in to new STP. Is commissioned and fully operational to handle the Sewage Waste Water.

8.0 ANNEXURE I-A
Ambient Air Quality Standards (NAAQS)

Pollutants	Time weighted average	Concentration in Ambient air µg/m³		
		Industrial Areas	Residential /Rural & Other areas	Sensitive Areas
Sulphur Dioxide (SO_2	Annual	50	50	20
	24hours**	80	80	80
Respirable Particulate Matter(size>10um) (RPM) PM_{10}	Annual	60	60	60
	24hours**	100	100	100
Particulate Matter(size>2.5um) $PM_{2.5}$	Annual	40	40	40
	24hours**	60	60	60
Nitrogen Dioxide (NO_2)	Annual	40	40	30
	24hours**	80	80	80

- Annual arithmetic mean of minimum of 104 measurements in a year taken twice a week. 24 hourly at uniform interval
- 24 hourly / 8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days

Note:

- National Ambient Air Quality Standard: The levels of air quality with an adequate margin of safety, to protect the public health, vegetation and property.
- Wherever and whenever two consecutive values exceeds the limit specified above for the respective category, it would be considered adequate reason to institute regular/continuous monitoring and further investigations.
- The State Government/State Board shall notify the sensitive and other areas in the respective states within a period of six months from the date of Notification of National Ambient Air Quality Standards.

[{S.O.384 (E), Air (Prevention & Cont. of Pollution) Act,1981 dated April 11,1994]

ANNEXURE I-B

Drinking Water Standards (BIS)

Sr. No.	Parameter	Unit	Acceptable Limits	Permissible Limits
1	pH	-	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/L	500	2000
3	Turbidity	NTU	1	5
4	Odor	-	Agreeable	Agreeable
5	Color	Hazen Units	5	15
6	Conductivity	µs/cm	NS*	NS*
7	Bio.Oxygen Demand	mg/L	NS*	NS*
8	Chloride as Cl	mg/L	250	1000
9	Ca as Ca	mg/L	75	200
10	Mg as Mg	mg/L	30	100
11	Total Hardness	mg/L	200	600
12	Iron as Fe	mg/L	0.3	NS*
13	Fluorides as F	mg/L	1	1.5
14	Sulphate as SO_4	mg/L	200	400
15	Nitrite as NO2	mg/L	NS*	NS*
16	Nitrate as NO3	mg/L	45	NS*
17	Salinity	%	NS*	NS*
18	Sodium as Na	mg/L	NS*	NS*
19	Potassium as K	mg/L	NS*	NS*
20	Manganese	mg/L	0.1	0.3
21	Hexavalent Chromium	mg/L	NS*	NS*
22	Copper	mg/L	0.05	1.5
23	Cadmium	mg/L	0.003	NS*
24	Arsenic	mg/L	0.01	0.05
25	Mercury	mg/L	0.001	NS*
26	Lead	mg/L	0.01	NS*
27	Zinc	mg/L	5	15
28	Bacterial Count	CFU/100ml	Absent	Absent

*Not specified in IS10500:2012

Bacteriological Standards (for Drinking water)

	Organisms	Requirements
All water intended for drinking		
	(a)E.coliorthermo-tolerant Coli form bacteria	Shall not be detectable in any 100 ml sample
Treated water entering the distribution system		
	a)E.coliorthermo-tolerant Coliformbacteria	Shall not be detectable in any 100 ml sample
	b)Total Coli form bacteria	Shall not be detectable in any 100 ml sample
Treated water in the distribution system		
	a)E.coliorthermo-tolerant Coli form bacteria	Shall not be detectable in any 100 ml sample
	b)TotalColiformbacteria	Shall not be detectable in any 100 ml sample

(BIS specifications (IS10500-2012)

ANNEXURE -I-C

Noise Quality Standards

Area Code	Category of Area	Limits in dB(A) Leq	
		Day Time	Night Time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

- Day Time is recorded in between 6.00 A.M. and 10.00 P.M.
- Night time is recorded in between 10.00 P.M. to 6.00 A.M.
- Silence zone is defined as areas up to 100 meters around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by the Competent Authority.
- Use of vehicular horns, loud speakers and bursting of crackers shall be banned in these zones.
- Mixed categories of areas should be declared as one of the four above mentioned categories by the Competent Authority and the corresponding standards shall apply.

[Source: EPA Notification [G.S.R.1063 (E) dt.26.12.1989 published in the Gazette No.643 dt.26.12.1989.]

ANNEXURE – 3

DETAILS OF HAZARDOUS WASTE GENERATED

Annexure - I

DEENDAYAL PORT AUTHORITY
MARINE DEPARTMENT

Statement of Hazardous & Non Hazardous Waste disposal from the vessels at Kandla & Vadinar Port
YEAR 2021-22

Sr. No.	MONTH	YEAR	Hazardous (Sludge)	Non Hazardous (Garbage)
1	APRIL	**2021**	3006.02	95.13
2	MAY	**2021**	1014.18	118.78
3	JUNE	**2021**	830.21	148.35
4	JULY	**2021**	863.36	105.89
5	AUGUST	**2021**	762.38	133.90
6	SEPTEMBER	**2021**	898.80	208.42
7	OCTOBER	**2021**	193.08	175.53
8	NOVEMBER	**2021**	210.06	194.18
9	DECEMBER	**2021**	381.77	167.02
10	JANUARY	**2022**	261.94	109.80
11	FEBRUARY	**2022**	254.66	96.03
12	MARCH	**2022**	909.39	171.05
	TOTAL		**9585.85** MT	**1724.08** MT

Deputy Conservator
Deedayal Port Authority

03/2164
30/6/22

Marine Department

Statement showing the Collection and disposal of Hazardous and Non-Harardous Wastes carried out by various parties from April - 2021 to Mar - 2022

Sr. No.	Name of Party	Validity of License	Type of Licence	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21
1	Alcid Organic Industries Limited	27-Oct-22	Hazardous	-	70.45	-	-	19.81	-
2	Amar Hydrocarbon Pvt. Ltd	22-Feb-23	Hazardous	-	-	-	-	-	-
3	Atlas Organics Pvt. Ltd	17-Oct-22	Hazardous	20.17	-	-	18.78	19.81	50.85
4	Aviation Corporation	14-Jun-22	Hazardous	-	-	-	151.18	71.53	133.63
5	Fine Refiners Pvt. Ltd	22-Jun-22	Hazardous	48.59	31.88	115.80	-	-	14.88
6	Priyansi Corporation	16-Dec-22	Hazardous	-	-	33.83	9.62	-	-
7	Revolution Petrochem LLP	01-Apr-22	Hazardous	2,658.01	531.52	442.73	546.48	524.09	456.01
8	Shana Oil Process	12-Feb-22	Hazardous	-	-	-	-	-	-
9	United Shipping Company	13-Sep-22	Hazardous	279.25	380.33	237.85	137.30	127.14	243.43
10	**Vaccant**	-	-	-	-	-	-	-	-
11	Chitrakut Trading & Industries	17-Nov-22	Non-Hazardous	-	0.98	-	0.65	0.39	-
12	Golden Shipping Services	30-May-23	Non-Hazardous	25.76	19.01	72.77	28.84	36.86	49.81
13	Green Earth Marine Solutions	23-Mar-23	Non-Hazardous	-	-	-	-	-	-
14	Harish A. Pandya	03-Feb-23	Non-Hazardous	4.86	0.68	3.95	0.90	1.23	8.00
15	K M Enterprise	04-May-23	Non-Hazardous	-	57.04	43.81	53.40	29.93	28.26
16	Naaz Shipping Services Ent	05-Jun-22	Non-Hazardous	6.40	-	2.80	-	0.60	12.30
17	New India Marine Works	22-Feb-23	Non-Hazardous	-	-	-	-	-	-
18	Omega Marine Services	28-Jun-22	Non-Hazardous	46.01	30.99	18.29	-	27.59	61.62
19	Vishwa Trade-link Inc.	25-Jun-22	Non-Hazardous	-	-	-	10.80	17.28	15.12
20	V K Enterprise	16-Nov-22	Non-Hazardous	12.10	10.08	6.73	11.30	20.02	33.31
			Hazardous - Total	**3,006.02** MT	**1,014.18** MT	MT **830.21**	MT **863.36**	MT **762.38**	MT **898.80**
			Non-Hazardous - Total	MT **95.13**	MT **118.78**	MT **148.35**	MT **105.89**	MT **133.90**	MT **208.42**

Copy to : GPCB, Gandhidham / Harbour Master

Marine Department

Statement showing the Collection and disposal of Hazardous and Non-Harardous Wastes carried out by various parties from April - 2021 to Mar - 2022

Sr. No.	Name of Party	Validity of License	Type of Licence	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Total
1	Alicid Organic Industries Limited	27-Oct-22	Hazardous	-	-	-	-	-	-	90.26
2	Amar Hydrocarbon Pvt. Ltd	22-Feb-23	Hazardous	-	-	-	-	-	-	-
3	Atlas Organics Pvt. Ltd	17-Oct-22	Hazardous	30.82	140.02	-	-	-	92.47	372.92
4	Aviation Corporation	14-Jun-22	Hazardous	-	-	-	-	-	-	356.34
5	Fine Refiners Pvt. Ltd	22-Jun-22	Hazardous	-	-	-	6.20	-	-	217.35
6	Priyansi Corporation	16-Dec-22	Hazardous	-	-	-	-	-	-	43.45
7	Revolution Petrochem LLP	01-Apr-22	Hazardous	-	-	-	-	-	507.63	5,666.47
8	Shana Oil Process	12-Feb-22	Hazardous	-	-	-	-	-	-	-
9	United Shipping Company	13-Sep-22	Hazardous	162.26	70.04	381.77	255.74	254.66	309.29	2,839.06
10	**Vaccant**	-	-	-	-	-	-	-	-	-
11	Chitrakut Trading & Industries	17-Nov-22	Non-Hazardous	0.27	0.10	-	-	-	0.10	2.49
12	Golden Shipping Services	30-May-23	Non-Hazardous	43.90	41.41	66.73	51.67	42.02	95.34	574.12
13	Green Earth Marine Solutions	23-Mar-23	Non-Hazardous	-	-	-	-	-	-	
14	Harish A. Pandya	03-Feb-23	Non-Hazardous	0.27	0.27	-	-	-	2.82	22.98
15	K M Enterprise	04-May-23	Non-Hazardous	78.13	106.72	100.29	58.13	23.80	27.75	607.26
16	Naaz Shipping Services Ent	05-Jun-22	Non-Hazardous	-	-	-	-	-	-	22.10
17	New India Marine Works	22-Feb-23	Non-Hazardous	-	-	-	-	-	10.80	10.80
18	Omega Marine Services	28-Jun-22	Non-Hazardous	24.34	40.28	-	-	16.20	25.56	290.88
19	Vishwa Trade-link Inc.	25-Jun-22	Non-Hazardous	-	-	-	-	-	-	43.20
20	V K Enterprise	16-Nov-22	Non-Hazardous	28.62	5.40	-	-	14.01	8.68	150.25
			Hazardous - Total	193.08 MT	210.06 MT	381.77 MT	261.94 MT	254.66 MT	909.39 MT	9,585.85 MT
			Non-Hazardous - Total	175.53 MT	194.18 MT	167.02 MT	109.80 MT	96.03 MT	171.05 MT	1,724.08 MT

Copy to : GPCB, Gandhidham / Harbour Master

LIST OF AUTHORIZED RECYCLERS

Marine Department

STATEMENT SHOWING DEENDAYAL PORT REGISTERED PARTIES FOR
REMOVAL OF GARBAGE, USED OIL/WASTE OIL ETC.

Sr. No.	Name of Party	Licensce of Removal	Last Validity of License	Remarks
1	**M/s. Alicid Organic Industries Ltd** Office No. 35, First Floor, Grain Marchan Association Building, Plot No. 297, Ward 12/B, Near Old Court, Gandhidham Email: naazshipping service@yahoo.com Phone: 02836- 237106	Hazardous	27-Oct-22	
2	**M/s. Atlas Organics Pvt. Ltd** Office No. 204-206, Elisbridge Shopping Center, Opp. Town Hall, Ashram Road, Ahmedabad - 380006 Email : atlasorganics@yahoo.com Mobile : 9825063459 / 9909723532	Hazardous	17-Oct-22	
3	**M/s. Fine Refiners Pvt. Ltd** Plot No. 40, GIDC, Chitra Vartej, Bhavanagar - info@finerefiners.com Mobile : 9825209314 / 9979898686	Hazardous	21-Jun-22	
4	**M/s. Amar Hydrocarbon Pvt. Ltd.** FF-12, Sahara Complex, B/h Navajivan Hotel, S. G. Highway, Sarkhej, Ahmedabad – 382210. amarhydrocarbon@gmail.com	Hazardous	22-Feb-22	
5	**M/s. Aviation Corporation** 62/2/1, Shikarpur Taluka Bhachau - Kutch - Gujarat aviationcorporation1983@gmail.com	Hazardous	14-Jun-22	
6	**M/s. Priyansi Corporation** C-1, 804 - 806, GIDC, Bamanbore, Ta. Chotila, Dist - Surendranagar Email: operation.priyansicorporation@gmail.com Mob: 09825226095	Hazardous	16-Dec-22	

Marine Department

STATEMENT SHOWING DEENDAYAL PORT REGISTERED PARTIES FOR
REMOVAL OF GARBAGE, USED OIL/WASTE OIL ETC.

Sr. No.	Name of Party	Licensce of Removal	Last Validity of License	Remarks
7	**M/s. SHANA OIL PROCESS** New Good Luck Market, Nr. Aksha Masjid Chandola Lake, Narol Raod, Ahmedabad Email: kandla_sludgeremoval35@gmail.com Mob : 09824286952	Hazardous	**11-Feb-22**	
8	**M/s. United Shipping Company** Rising House-I, Ground Floor, Plot No. 82, Sector No. 1/A, Gandhidham - Kutch 370201 Email: sunil@risinggroup.co Phone : 02836 - 233060	Hazardous	**13-Sep-22**	
9	**M/s. Revolution Petrochem LLP** Office No. C-214, 2nd Floor, Shop No. 234-235, Kutch Arcade Platinum, Mithirohar **Gandhidham - 370201**	Hazardous	**31-Mar-23**	
12	**M/s. Chitrakut Trading & Industries** 15, Brahm Samaj Building, Plot No. 106, Sector No. 8, Behind OSLO Cinema, Gandhidham - Kutch 370201. Email: info@harishpandya.com Mob: 09426218125	Non-Hazardous	**17-Nov-22**	
13	**M/s. Golden Shipping Services** Kidana Nirmal Nagar, Survey No. 133, Plot No. 83 Gandhidham - Kutch	Non-Hazardous	**30-May-23**	
14	**M/s. Harish A. Pandya** 15, Brahm Samaj Building, Plot No. 106, Sector No. 8, Behind OSLO Cinema, Gandhidham - Kutch 370201. Email: info@harishpandya.com Mob: 09426218125	Non-Hazardous	**03-Feb-23**	

Marine Department

STATEMENT SHOWING DEENDAYAL PORT REGISTERED PARTIES FOR REMOVAL OF GARBAGE, USED OIL/WASTE OIL ETC.

Sr. No.	Name of Party	Licensce of Removal	Last Validity of License	Remarks
15	**M/s. Naaz Shipping Services Enterprise** Office No. 35, First Floor, Grain Marchan Association Building, Plot No. 297, Ward 12/B, Near Old Court, Gandhidham Email: naazshipping.service@yahoo.com Phone: 02836- 237106	Non-Hazardous	**05-Jun-22**	
16	**M/s. Omega Marine Services** Reg. Office No. 2, Plot NO. 106, Sector - 8, Braham Samaj Building Gandhidham - Kutch Email: operations@omegamarineservices.com Mob: 9537329203 - 9727589185	Non-Hazardous	**28-Jun-22**	
17	**M/s. VISHWA TRADE-LINK INC.** 214, 2nd Floor, "Kutch Arcade" - Platinium Building Mithi Rohar Road, NH 8/A, GANDHIDHAM Email : vishwatradelink@gmail.com Mob: 09879595087 - 02836-283261	Non-Hazardous	**16-Nov-22**	
18	**Green Earth Marine Solutions** Office No. 202, Plot No. 578, Ward 12-C, Shakti Avenue, Gandhidham - Kutch operation@greenearthmarine.com	Non-Hazardous	**23-Mar-23**	
19	**M/s. V. K. Enterprise** 2, Plot No. 16, Sector 1/A, Shakti Nagar Road, Gandhidham - Kutch Email: vkenterprise2001@gmail.com Mob : 9825246142	Non-Hazardous	**25-Jun-23**	
20	**M/s. K. M. Enterprise** Plot No. 13, Sector – 8, Near BM Petrol Pump, Opp. Sharma Motors, Gandhidham – Kutch. Email: kmenterprisekandla@gmail.com Mob: 9427792986 - 9879986952	Non-Hazardous	**04-May-23**	

Annexure –Q

Disaster Management Plan

[already placed at Annexure V of Annexure B (Compliance Report of EC & CRZ condition issued by MoEF vide letter no. F. No. 11-70/2006-IA-III)]

Annexure –R

Work Order for appointing M/s Precitech Laboratories, Vapi for providing Environmental Experts dated 5/2/2021

DEENDAYAL PORT TRUST

Administrative Office Building
Post Box NO. 50
GANDHIDHAM (Kutch).
Gujarat: 370 201.
Fax: (02836) 220050
Ph.: (02836) 220038

www.deendayalport.gov.in

NO.EG/WK/4783/V/ 131 Dated : 05/02/2021

To,
M/s Precitech Laboratories Pvt Ltd,
1st Floor, Bhanujyot Complex,
Plot No C5/27, B/h Panchratna Complex,
Nr. GIDC Char Rasta,
VAPI-396195.

Sub: **Work order** for "STRENGTHENING OF EXISTING ENVIRONMENTAL MANAGEMENT CELL AT DEENDAYAL PORT TRUST: Appointment of environment experts for two years further extendable for one year"-**reg**.

Ref: 1) Tender dated 21.06.2019 submitted by M/s Precitech Laboratories Pvt.Ltd, Vapi.
2) Letter of Acceptance vide no-EG/WK/4783/V/100 dtd 01(04).01.2021
3) Letter from DPT no E/WK/4783/V/103 dtd 06.01.2021
4) Performance Guarantee submitted by M/s Precitech Laboratories Pvt Ltd in the form of Bank Guarantee of Rs. 3,60,000.00 vide Bank Guarantee no. 1102921BG0000016 dated 19.01.2021 issued by State Bank of India, Vapi.

Sir,

Kindly refer above cited Letter of Acceptance dtd 01(04).01.2021.

2) You shall have to provide Key Experts as per tender requirement during the entire contract period. Accordingly, you shall have to submit the qualification and experience certificates of the Key experts to be appointed at DPT, as per tender conditions for verification & approval.

3) Please submit the Agreement of contract as per tender conditions no 1.29.

4) Kindly commence the work on or before 15.02.2021.

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Please note that the time period for providing Consultancy services for the subject work will be initially for two years and further extendable for one year on mutual consent as per tender conditions.

Thanking you.

Yours faithfully,

Superintending Engineer (Design & EMC (i/c))
Deendayal Port Trust

Annexure –S

Office Order for appointing Environment Manager

DEENDAYAL PORT TRUST

ISO 9001 : 2008 : ISO 14001 : 2004

Ph. : 02836-220167
Fax: 02836-233172
website: deendayalport.gov.in
e-mail : secretary@deendayalportgov.in

General Administration Deptt.
Administrative Office Building,
Post Box No. 50,
Gandhidham (Kutch) 370 201

By Speed Post / E-mail

No. GA/PS/4292/HE(PF)/2017/ 304 Dated,17 January, 2022

OFFER OF CONTRACTUAL ENGAGEMENT AS MANAGER(ENVIRONMENT), IN DEENDAYAL PORT TRUST.

With Reference to your application for contractual engagement as Manager – Environment, in response to the advertisement, inviting applications for the subject position, on assessment and interview before the Services Selection Committee on 06.01.2022, the Competent authority has been pleased to offer the contractual engagement as Manager (Environment) in Deendayal Port Trust, purely on contractual basis, subject to the following terms and conditions :

a) Roles & Responsibilities

- Develop, implement and manage long term port environmental programmes such as the Green Marine Programme, sustainability plan, air strategies, tenant environment plan and tenant lease management.
- Represent the Port in local, state and federal agency meetings.
- Assist in the development and updating of the Port's comprehensive scheme of Harbour improvements and strategic plan.
- Monitor and conduct regular mock drills to train the employees at different levels.

b) Remuneration :-

Your consolidated remuneration per month will be Rs.1,00,000/- (Rupees One Lakh Only). Suitable increase depending upon the performance and variation in the AICP index may be given after successful completion of yearly service. Applicable taxes will be deducted at the time of payment.

c) Period of Contract :

The contract will be for a period of 3 years, extendable by another two years, subject to satisfactory performance.

d) Duty Hours :

You may be posted at/under any department/authority of Deendayal Port Trust, as per requirement, Duty Hours are from 10.00 AM to 06.00 PM or as may be decided by the Administration from time to time. In case of requirement, you may have to work beyond the normal duty hours, for which no other compensation, monetary or otherwise will be considered.

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(Mukkannawar Utkarsh Suresh)

Contd....

You will normally be entitled to a weekly off on Sunday. If situation warrants, the weekly day of rest may be changed with prior intimation. For work on any weekly day off / declared national holiday in exigencies of work, a compensatory day of rest as per the convenience of the Administration, in lieu thereof, will be granted and for which no other compensation, monetary or otherwise will be considered.

Failure to report for duty will entail deduction of wages on pro-rata basis.

e) Medical facility : Only Outdoor Medical treatment facility for self and your spouse will be provided in the Port Trust Hospital. No other medical facilities will be provided to you/ your family.

f) Leave entitlement : 10 days leave in a year and National Holidays will be given. No other leave will be admissible and for any absence beyond the said leave, pro-rata deduction will be made from the consolidated remuneration.

g) Accommodation : Suitable accommodation, if available, may be provided, subject to recovery of charges under FR-45A, and the element of HRA excluded from the lumpsum remuneration.

h) Your engagement on contractual basis is subject to strict adherence to the norms and conduct.

i) The engagement can be terminated by giving one month's notice in writing from either side. However, in case of unsatisfactory performance or for any act considered derogatory/ detrimental to the interest of Deendayal Port Trust, this contractual engagement will be terminated forthwith.

j) If you leave without notice or without acceptance of notice of termination, the amount due i.e., consolidated remuneration payable will be forfeited.

k) You shall not claim any right/title/interest on par with the regular employees of the Port or otherwise.

l) You shall not have any claim/right whatsoever for regular appointment / absorption in Deendayal Port Trust under any circumstances.

m) Your contractual engagement is subject to verification of antecedents by the police. If any adverse report is received from the Police, your contractual services are liable to be terminated forthwith.

n) You will not be permitted to take any other assignment during the period of contract with Deendayal Port Trust.

....

(Mukkannawar Utkarsh Suresh)

Contd....

l) On official tour outside Head Quarters, you will be entitled to TA/DA as admissible under the rules.

m) The terms and conditions shall be amended / modified depending upon the requirement of the Port. Any dispute(s)/difference(s) shall be decided solely by the Chairman, Deendayal Port Trust, which shall be final and binding.

n) You are required to submit discharge letter / relieving letter from your present employer at the time of joining Deendayal Port Trust, without you may not be allowed to join.

o) The contractual engagement is subject to your being found medically fit as per the requirements of Deendayal Port Trust.

2. You have to report for medical examination before the Medical Board of DPT at Gopalpuri Hospital on any working day between 10.00 hrs to 12.00 hrs.

3. If you agree to the above terms and conditions, you may convey acceptance by signing the duplicate of the letter in token of your acceptance and submit the same to this office and call at this office with all certificates and two copies of passport size photographs latest by 27th January, 2022 failing which the offer of contractual engagement stands automatically cancelled.

C. Harikumar

Secretary
Deendayal Port Trust

To
Shri. Mukkanawar Utkarsh Suresh,
21/1, Madhukunj Housing Society,
Near Canara Bank, Panchavati,
Pashan, Pune, Maharashtra – 411008.
Email : utkaish@gmail.com

I accept the above terms and conditions and will report for duty on __________.

Name :

Date :

Copy to: CMO – for conducting Medical Examination.