DEENDAYAL PORT TRUST
(Erstwhile: KANDLA PORT TRUST)

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EG/WK/5202 (D)/ Part (CRZ 2)/140 Date: 08/02/2022

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: 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 Trust - Environmental & CRZ Clearance - **Six Monthly Compliance report for the stipulated conditions reg.**

Ref.: 1) EC & CRZ Clearance accorded by the MoEF&CC,GoI,New Delhi vide no. 10-1/2017-IA-III dated 20/11/2020.
2) Integrated Regional Office, Gandhinagar, MoEF&CC,GoI,Bhopal letter vide F.No. 6-1/2021 (ENV)/918 dated 10/3/2021 (Received by DPT on 19/3/2021).
3) DPT letter no. EG/WK/5202 (D)/ Part (CRZ 2) Dated : 19/04/2021 - Submission of details asked by the R.O., MoEF&CC,GoI, Bhopal reg.
4) DPT letter no. EG/WK/5202 (D)/ Part (CRZ 2)/30 Dated : 29/06/2021. - Submission of compliance report (Period upto May, 2021).

Sir,

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

In this regard, it is to state that, with reference to the Integrated Regional Office, MoEF&CC,GoI, Bhopal letter dated 10/03/2021 (ref. 2) , DPT vide above letter dated 19/4/2021 (ref.3) has submitted details/information asked by the Regional Office, MoEF&CC, GoI, Bhopal in connection with the EC & CRZ Clearance granted by the MoEF&CC, GoI dated 20/11/2020 for the subject mentioned above. Subsequently, DPT vide above referred letter dated 29/6/2021 had submitted compliance report of stipulated condition for the period upto May,2021.

Now, as directed in the above referred letter dated 10/3/2021 of the Regional Office, MoEF&CC, GoI, Bhopal, kindly find enclosed herewith compliance report of stipulated conditions mentioned in the EC & CRZ Clearance granted by the MoEF&CC, GoI dated 20/11/2020 **(Annexure 1)** & Monitoring Report in Data Sheet **(Annexure 2) (Period: up to November,2021)** for kind information and record please.

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Further, as per the MoEF&CC, Notification S.O.5845 (E) dated 26.11.2018, in which it is mentioned 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 above, in CD as well as through e-mail in ID rowz.bpl-mef@nic.in & eccompliance-guj@gov.in.

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

Yours faithfully,

9/2/22

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.

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 -I

CURRENT STATUS OF WORK PROGRESS

Sr. No.	Name of Project	Status
1	Oil Jetty No. 8 (Jetty & allied facilities)	Deendayal Port Trust issued work order to M/s Kargwal KM Joint Venture; Mumbai vide letter no. CN/WK/1571/Work/243 dated 3/2/2021. Work is in progress.
2	Oil Jetties no. 9, 10 & 11 to be implemented on BOT/PPP Mode.	The SFC recommendation and the MoPSW, GoI approval for Oil Jetties 9, 10 & 11, under PPP mode, has been received on 19/04/2021. • For Oil jetty no 09, RFQ & RFP invited. RFQ's received are under evaluation. • Oil Jetty no 10 & 11 will be implemented after construction of common trestle between the OJ 08 & 09 and OL 09 & 10 respectively. No construction activity started yet on project site.
3	Development of Land (area 554 acres) for associated facilities for storage.	Under Planning/Approval Stage. No construction activity started on project site.

Subject: Point wise compliance of stipulated conditions of EC & CRZ Clearance for ***"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 Trust".***

Sr. No.	Stipulated Conditions	Compliance
i	The Environmental and CRZ Clearance to the project is primarily under provisions of EIA Notification, 2006 and CRZ Notification, 2011. It does not tantamount to approvals/consent/permissions etc required to be obtained under any other Act/Rule/regulation. The Project Proponent is under obligation to obtain approvals/clearances under any other Acts/ Regulations or Statutes as applicable to the project.	The Consent to Establish (CTE) from the GPCB had already been obtained vide CTE No. 94118 granted by the GPCB vide letter no. PC/CCA-KUTCH 1524/GPCB ID 56985 dated 23/7/2018 **(Copy once again attached - Annexure A).**
ii	The project proponent shall abide by all the commitments and recommendations made in the Form-II, EIA and EMP report and also that have been made during their presentation to EAC.	It is hereby assured that DPT will abide by all the commitments and recommendations made in the Form-II, EIA and EMP report and also that have been made during presentation to EAC.
iii	Construction activity shall be carried out strictly according to the provisions of the CRZ Notification, 2011. No construction works other than those permitted in Coastal Regulation Zone Notification shall be carried out in Coastal Regulation Zone area.	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities). Construction activity is being carried out 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.
iv	All the recommendations and conditions specified by the Gujarat Coastal Zone Management Authority (GCZMA) vide letter No. ENV-I0-2018-24-T cell dated 30th July, 2020 shall be complied with.	The compliance report of CRZ Recommendation issued by the GCZMA dated 30/7/2020 is attached herewith as **Annexure B**.
v	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. Creek water monitoring program shall be implemented during the construction phase.	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities). It is hereby assured that, no creeks or rivers shall be blocked, due to any activities at the project site and free flow of water will be maintained.
vi	Dredging shall not be carried out during the fish breeding season. Dredging, etc. shall be carried out in confined manner to reduce the impacts on marine	No dredging activities have been started yet w.r.t. subject project. However, it is hereby assured that dredging activities shall be carried out strictly as per the requirement of the condition.

	environment. Silt curtains shall be used to minimize spreading of silt plume during dredging using online monitoring system. Turbidity should be monitored during the dredging. No removal of silt curtain unless baseline values are achieved.	
vii	As proposed the dredged material can be used to provide an engineered base for marine terminal i.e., oil jetties 8-11 and construction yard. The impact of dredging on the marine environment should be monitored and necessary measures shall be taken on priority basis if any adverse impact is observed.	The dredged material will be disposed at designated dumping ground (Latitude 22°51'00" & Longitude 70°10'00").
viii	Marine ecological monitoring and its mitigation measures for protection of phytoplankton, zooplanktons, macrobenthos, estuaries, sea-grass, algae, sea weeds, Crustaceans, Fishes, coral reefs and mangroves and migratory birds etc. as given in the EIA-EMP Report shall be complied with in letter and spirit through a reputed university/institute with financial support as desired. Six monthly reports of the studies to be provided to the regional office of MoEFCC.	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities). It is hereby assured that mitigation measures given in the EIA-EMP Report will be complied with by DPT & report in this regard will be provided to the Regional Office of the MoEF&CC,GoI. It is also relevant to mention here that, as suggested in the Mitigation measures, DPT had already undertaken Mangrove Plantation in an area of 1500 Ha. till date since the year 2005. A statement showing details of mangrove plantation with cost incurred is once again placed at **Annexure C**. Further, DPT assigned work for Green belt development in an area of about 32 hectares to the Forest Department, Govt. of Gujarat during August, 2019 at the cost of Rs. 352.32 lakhs. The work is completed. Further, DPT also undertook massive green belt development in and around the Port area and at Gandhidham area. Further, as per the EC dated 19/12/2016 for Development of 7 Integrated facilities, DPT assigned work to M/s GUIDE, Bhuj for analysis of dredged material (Period from 2018-2021 & period from 2021 to 2024). A copy of work order issued to M/s GUIDE,Bhuj dated 18/9/2021 (For period 2021- 2024) is attached herewith as **Annexure D**. The Reports are being submitted to the Regional Office, Bhopal as well as to the MoEF&CC, GoI, New Delhi along with compliance reports

		submitted from time to time. The said study for the period 2021-22 is under progress by M/s GUIDE, Bhuj.
ix	Continuous online monitoring of air and water covering the total area shall be carried out and the compliance report of the same shall be submitted along with the 6 monthly compliance report to the regional office of MoEF&CC.	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities). The tender for CAAQMS (Continuous Ambient Air Quality Monitoring System) at Two locations has already been invited by DPT during February, 2021. The tender has been opened and is under evaluation, after submission of shortfall documents by the bidders.
x	The actions shall be in accordance with proposed landscape planning concepts to minimise major landscape changes. The change in land use pattern shall be limited to the proposed port limits and be carried out in such a way as to ensure proper drainage by providing surface drainage systems including storm water network.	Point Noted. It is hereby assured that necessary surface drainage system including storm water network will be provided for proper drainage.
xi	Suitable preventive measures be taken to trap spillage of fuel / engine oil and lubricants from the construction site. Measures should be taken to contain, control and recover the accidental spills of fuel during cargo handling.	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities). DPT is already having Oil Spill Contingency Plan to meet with the any accidental oil spill.
xii	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 the RO, MoEF&CC along with half yearly compliance report.	Point Noted. It is hereby assured that all the Mitigation measures submitted in the EIA Report will be prepared in a matrix format and compliance of the same will be submitted in due course.
xiii	The company shall draw up and implement Corporate Social Responsibility Plan as per the Company's Act of 20I3.	As per the CSR Guidelines issued by the Ministry of Ports, Shipping & Waterways, Government of India, from time to time, DPT had undertaken CSR activities since the year 2011-12. The details of CSR Activities undertaken & planned is attached herewith as **Annexure E.**
xiv	As per the Ministry's Office Memorandum F. No. 22-65/2017-IA.III dated 30th September, 2020, the project proponent, based on the commitments made during the public hearing, shall include all the	Public Hearing is exempted. Hence, Not applicable.

	activities required to be taken to fulfill these commitments in the Environment Management Plan along with cost estimates of these activities, in addition to the activities proposed as per recommendations of EIA Studies and the same shall be submitted to the ministry as part of the EIA Report. The EMP shall be implemented at the project cost or any other funding source available with the project proponent.	
xv	In pursuance of Ministry's OM No. stated above the project proponent shall add one annexure in the EIA Report indicating all the commitments made by the PP to the public during public hearing and submit it to the Ministry and the EAC.	Public Hearing is exempted. Hence, Not applicable.
B. STANDARD CONDITIONS: **I. Statutory compliance:**		
i.	Construction activity shall be carried out strictly according to the provisions of CRZ Notification, 2011 and the State Coastal Zone Management Plan as drawn up by the State Government. No construction work other than those permitted in Coastal Regulation Zone Notification shall be carried out in Coastal Regulation Zone area.	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities). Construction activity is being carried out 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	A certificate of adequacy of available power from the agency supplying power to the project along with the load allowed for the project should be obtained.	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities). Necessary certificate of adequacy of available power will be provided in due course.
iii	All other statutory clearances such as the approvals for storage of diesel from Chief Controller of Explosives, Fire Department, Coast Guard, Civil Aviation Department shall be obtained, as applicable by project proponents from the respective competent authorities.	Point Noted for compliance.
II. Air quality monitoring and, preservation:		
i.	The project proponent shall install system to carryout Ambient Air Quality monitoring for common/criterion parameters relevant	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities).

	to the main pollutants released (e.g. PM 10 and PM 2.5 in reference to PM emission, and S02 and NOx in reference to S02 and NOx emissions) within and outside the project area at least at four locations, covering upwind and downwind directions.	However, for DPT area, it is also relevant to mention here that, 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 submitted. The monitoring reports are attached herewith as **Annexure F**.
ii.	Appropriate Air Pollution Control (APC) system shall be provided for all the dust generating points including fugitive dust from all vulnerable sources, so as to comply prescribed emission standards.	It is assured that Appropriate Air Pollution Control (APC) system shall be provided.
iii.	Shrouding shall be carried out in the work site enclosing the dock/proposed facility area. This will act as dust curtain as well achieving zero dust discharge from the site. These curtain or shroud will be immensely effective in restricting disturbance from wind in affecting the dry dock operations, preventing waste dispersion, improving working conditions through provision of shade for the workers.	Point noted for compliance.
ix.	Dust collectors shall be deployed in all areas where blasting (surface cleaning) and painting operations are to be carried out, supplemented by stacks for effective dispersion.	Point noted for compliance.
x.	The Vessels shall comply the emission norms prescribed from time to time.	Point noted for compliance.
xi	Diesel power generating sets proposed as source of backup power should be of enclosed type and conform to rules made under the Environment (Protection) Act, 1986. The height of stack of DG sets should be equal to the height needed for the combined capacity of all proposed DG sets. Use of low sulphur diesel. The location of the DG sets may be decided with in consultation with State Pollution Control Board.	Point noted for compliance.
xii	A detailed traffic management and traffic decongestion plan shall be drawn up to ensure that the current level of service of the roads within a 05 kms radius of the project is maintained and improved upon after the implementation of the project. This plan should be based on cumulative impact of all development and increased habitation being carried out or proposed to be carried out by the project or other	Point noted for compliance.

	agencies in this 05 Kms radius of the site in different scenarios of space and time and the traffic management plan shall be duly validated and certified by the State Urban Development department and the P.W.D.! competent authority for road augmentation and shall also have their consent to the implementation of components of the plan which involve the participation of these departments.	
III. Air quality monitoring and preservation:		
i.	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.	It is assured that no creeks are blocked due to any activities at the project site and free flow of water is maintained.
ii	Appropriate measures must be taken while undertaking digging activities to avoid any likely degradation of water quality. Silt curtains shall be used to contain the spreading of suspended sediment during dredging within the dredging area.	Point Noted for compliance. Dredging activities not started yet for the subject project.
iii	No ships docking at the proposed project site will discharge its on-board waste water untreated in to the estuary/ channel. All such wastewater load will be diverted to the proposed Effluent Treatment Plant of the project site.	Point Noted for compliance.
iv	Measures should be taken to contain, control and recover the accidental spills of fuel and cargo handle.	Point Noted for compliance. It is also relevant to mention here that DPT is already having Oil Spill Contingency Plan.
v	The project proponents will draw up and implement a plan for the management of temperature differences between intake waters and discharge waters.	Point Noted for compliance
vi	Spillage of fuel/engine oil and lubricants from the construction site are a source of organic pollution which impacts marine life. This shall be prevented by suitable precautions and also by providing necessary mechanisms to trap the spillage.	Point Noted for compliance.
vii	Total fresh water use shall not exceed the proposed requirement as provided in the project details. Prior permission from competent authority shall be	Agreed with the condition.

	obtained for use of fresh water.	
viii	Sewage Treatment Plant shall be provided to treat the wastewater generated from the project. Treated water shall be reused for horticulture, flushing, backwash, BVAC purposes and dust suppression.	Waste water will be treated in the existing STP of DPT.
ix	A certificate from the competent authority for discharging treated effluent/ untreated effluents into the Public sewer/ disposal/drainage systems along with the final disposal point should be obtained.	Point Noted for compliance.
x	No diversion of the natural course of the river shall be made without prior permission from the Ministry of Water resources.	Point Noted.
xi	All the erosion control measures shall be taken at water front facilities. Earth protection work shall be carried out to avoid erosion of soil from the shoreline/boundary line from the land area into the marine water body.	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities). However, it is assured that DPT will comply with the provisions of this stipulated condition.
IV. Noise monitoring and prevention:		
i	Noise level survey shall be carried as per the prescribed guidelines and report in this regard shall be submitted to Regional Officer of the Ministry as a part of six-monthly compliance report.	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities). However, for DPT area, DPT appointed M/s Detox Corporation, Surat for monitoring of Environmental parameters viz. Air, Water, Noise etc. since the year 2016 and reports are being submitted from time to time to the Regional Office as well as to the MoEF&CC, GoI, New Delhi. The monitoring reports are attached herewith as **Annexure G**.
ii	Noise from vehicles, power machinery and equipment on-site should not exceed the prescribed limit. Equipment should be regularly serviced. Attention should also be given to muffler maintenance and enclosure of noisy equipments.	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities). Point Noted for compliance.
iii	Acoustic enclosures for DG sets, noise barriers for ground-run bays, ear plugs for operating personnel shall be implemented as mitigation measures for noise impact due to ground sources.	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities). Point Noted for compliance.

iv	The ambient noise levels should conform to the standards prescribed under E(P)A Rules, 1986 viz. 75 dB(A) during day time and 70 dB(A) during night time.	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities). Point Noted for compliance.
V. Energy Conservation measures:		
i	Provide solar power generation on roof tops of buildings, for solar light system for all common areas, street lights, parking around project area and maintain the same regularly;	Point Noted.
ii	Provide LED lights in their offices and port areas.	Point Noted.
VI. Waste management:		
i.	Dredged material shall be disposed safely in the designated areas.	The dredged material will be disposed at designated dumping ground (Latitude 22°51'00" & Longitude 70°10'00").
ii	Shoreline should not be disturbed due to dumping. Periodical study on shore line changes shall be conducted and mitigation carried out, if necessary. The details shall be submitted along with the six monthly monitoring reports.	DPT issued work order vide no. EG/WK/4751/Part (EC- Shoreline study) Dated: 12/10/2021 **(Copy of work order – Annexure H)** to NCSCM, Chennai for Shoreline Change Study for Deendayal Port Trust, Kandla, Kachchh District, Gujarat, to Study the Effect of Dumping, if any reg. The work is in progress.
iii	Necessary arrangements for the treatment of the effluents and solid wastes must be made and it must be ensured that they conform to the standards laid down by the competent authorities including the Central or State Pollution Control Board and under the Environment (Protection) Act, 1986.	Waste water will be treated in the existing STP of DPT.
iv	The solid wastes shall be managed and disposed as per the norms of the Solid Waste Management Rules, 2016.	Point Noted for compliance.
v	Any wastes from construction and demolition activities related thereto shall be managed so as to strictly conform to the Construction and Demolition Waste Management Rules, 2016.	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities). It is assured that, DPT will comply with the condition stipulated.
vi	A certificate from the competent authority handling municipal solid wastes should be obtained, indicating the existing civic capacities of handling and their adequacy to cater to the M.S.W.	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities). However, it is assured that necessary certification from the competent authority will be obtained.

	generated from project.	
vii	Used CFLs and TFLs should be properly collected and disposed off/sent for recycling as per the prevailing guidelines/ rules of the regulatory authority to avoid mercury contamination.	Point Noted for compliance.
viii	Oil spill contingency plan shall be prepared and part of DMP to tackle emergencies. The equipment and recovery of oil from a spill would be assessed. Guidelines given in MARPOL and Shipping Acts for oil spill management would be followed. Mechanism for integration of terminals oil contingency plan with the overall area contingency plan under the co-ordination of Coast should be covered.	DPT is already having Oil Spill Contingency Plan and Disaster Management Plan **(Copies once again placed at Annexure I).**
VII. Green **Belt:**		
i	Green belt shall be developed in area as provided in project details with a native tree species in accordance with CPCB guidelines.	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities). However, it is assured that necessary Green belt will be provided as per the condition stipulated.
ii	Top soil shall be separately stored and used in the development of green belt.	Point noted for compliance.
VIII. Marine Ecology:		
i	The dredging schedule shall be so planned that the turbidity developed is dispersed soon enough to prevent any stress on the fish population.	It is assured that DPT will comply with the condition stipulated. No dredging activity started yet on project site.
ii	While carrying out dredging, an independent monitoring shall be carried out through a Government Agency/Institute to assess the impact and necessary measures shall be taken on priority basis if any adverse impact is observed.	Point Noted for compliance. No dredging activity started yet on project site.
iii	A detailed marine biodiversity management plan shall be prepared through the NIO or any other institute of repute on marine, brackish water and fresh water ecology and biodiversity and submitted to and implemented to the satisfaction of the State Biodiversity	A copy of Report entitled "Holistic Marine Ecological Monitoring of Deendayal Port Environment with Special Reference to Biodiversity and Preparation of Management Plan" prepared by M/s GUIDE,Bhuj and validated by Gujarat State Biodiversity Board vide letter dated 24/12/2019 was already communicated

	Board and the CRZ authority. The report shall be based on a study of the impact of the project activities on the intertidal biotopes, corals and coral communities, molluscs, sea grasses, sea weeds, sub-tidal habitats, fishes, other marine and aquatic micro, macro and mega flora and fauna including benthos, plankton, turtles, birds etc. as also the productivity. The data collection and impact assessment shall be as per standards survey methods and include underwater photography.	vide earlier compliance report submitted vide letter dated 29/6/2021. Further, it is once again to submit here that, DPT issued work order to M/s GUIDE vide its letter no. EG/WK/ 4751 /Part (Marine Ecology Monitoring) /12 dated 03/05/2021 for preparation of Detailed marine biodiversity plan. Copy of the work order is once again attached as **Annexure J.**
iv	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 biodiversity components including all micro, macro and mega floral and faunal components of marine biodiversity.	DPT assigned work to M/s GUIDE, Bhuj for regular monitoring of Marine Ecology since the year 2017 (From 2017 – 2021) and reports of the same are being submitted regularly to the Regional Office, MoEF&CC, GoI, Bhopal as well as to the MoEF&CC, GoI, New Delhi along with compliance reports submitted. The final report for the Holistic Marine Ecological Monitoring for the period upto May 2021 was submitted on 22.05.2021. Copy of the report was communicated vide earlier compliance report submitted vide letter **dated 29/6/2021** . Further, it is once again to submit her that, DPT issued work order to M/s GUIDE vide its letter no. EG/WK/ 4751 /Part (Marine Ecology Monitoring) /11 dated 03/05/2021 for Regular monitoring of Marine Ecology in and around Deendayal Port Trust and continuous Monitoring Program covering all seasons on various aspects of the Coastal Environs for the period 2021-24. Copy of the work order is once again attached as **Annexure K.**
v	The project proponent shall ensure that water traffic does not impact the aquatic wildlife sanctuaries that fall along the stretch of the river.	Not applicable.
IX. Public hearing and human health issues:		
i	The work space shall be maintained as per international standards for occupational health and safety with provision of fresh air respirators, blowers, and fans to prevent any accumulation and inhalation	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities). Point Noted for compliance.

	of undesirable levels of pollutants including VOCs.	
ii	Workers shall be strictly enforced to wear personal protective equipment's like dust mask, ear muffs or ear plugs, whenever and wherever necessary/ required. Special visco-elastic gloves will be used by labour exposed to hazards from vibration.	Point Noted for compliance.
iii	Safety training shall be given to all workers specific to their work area and every worker and employee will be engaged in fire hazard awareness training and mock drills which will be conducted regularly, All standard safety and occupational hazard measures shall be implemented and monitored by the concerned officials to prevent the occurrence of untoward incidents/ accidents.	Point Noted for compliance.
iv	Emergency preparedness plan based on the Hazard identification and Risk Assessment (HIRA) and Disaster Management Plan shall be implemented.	It is assured that Emergency preparedness plan based on the Hazard identification and Risk Assessment (HIRA) and Disaster Management Plan will be implemented.
v	Provision shall be made for the housing of construction labour within the site with all necessary infrastructure and facilities such as fuel for cooking, mobile toilets, mobile STP, safe drinking water, medical health care, creche etc. The housing may be in the form of temporary structures to be removed after the completion of the project.	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities). Point Noted for compliance.
vi	Occupational health surveillance of the workers shall be done on a regular basis.	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities). Point Noted for compliance.
X. Environment Responsibility:		
i	The company shall have a well laid down environmental policy duly approved by the Board of Directors. The environmental policy should prescribe for standard operating procedures to have proper checks and balances and to bring into focus any infringements/deviation/violation of the environmental/forest /wildlife norms/ conditions. The company shall have defined system of reporting infringements / deviation / violation of the environmental/ forest / wildlife	DPT is already having Environmental Policy **(Copy – Annexure L).**

	norms / conditions and / or shareholders / stake holders. The copy of the board resolution in this regard shall be submitted to the MoEF&CC as a part of six-monthly report.	
ii	A separate Environmental Cell both at the project and company head quarter level, with qualified personnel shall be set up under the control of senior Executive, who will directly report to the head of the organization.	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 M).**
iii	Action plan for implementing EMP and environmental conditions along with responsibility matrix of the company shall be prepared and shall be duly approved by competent authority. The year wise funds earmarked for environmental protection measures shall be kept in separate account and not to be diverted for any other purpose. Year wise progress of implementation of action plan shall be reported to the Ministry/Regional Office along with the Six Monthly Compliance Report.	Point Noted for compliance.
iv	Self-environmental audit shall be conducted annually. Every three years third party environmental audit shall be carried out.	Point Noted for compliance.
XI. **Miscellaneous:**		
i	The project proponent shall make public the environmental clearance granted for their project along with the environmental conditions and safeguards at their cost by prominently advertising it at least in two local newspapers of the District or State, of which one shall be in the vernacular language within seven days and in addition this shall also be displayed in the project proponent's website permanently.	DPT has given advertisement in two local news papers regarding Environmental Clearance granted by the MoEF&CC,GoI for the subject project as under : **1)** In English – EXIM INDIA dated 27/11/2020 **(Copy – Annexure N).** **2)** In Gujarati – AAJ KAL dated 25/11/2020 **(Copy – Annexure O).**
ii	The copies of the environmental clearance shall be submitted by the project proponents to the Heads of local bodies, Panchayats and Municipal Bodies in	DPT vide letter dated 23 (26)/11/2020 has already been communicated copy of EC & CRZ Clearance accorded by the MoEF&CC,GoI dated 20/11/2020 to the

	addition to the relevant offices of the Government who in turn has to display the same for 30 days from the date of receipt.	Heads of Local bodies ,Panchayats and Municiple Bodies etc. **(Copy – Annexure P).**
iii	The project proponent shall upload the status of compliance of the stipulated environment clearance conditions, including results of monitored data on their website and update the same on half-yearly basis.	It is assured that DPT will upload the status of compliance of the stipulated EC conditions including results of monitored data on website and will also update the same on half-yearly basis.
iv	The project proponent shall submit six-monthly reports on the status of the compliance of the stipulated environmental conditions on the website of the ministry of Environment, Forest and Climate Change at environment clearance portal.	Point Noted for compliance.
v	The project proponent shall submit the environmental statement for each financial year in Form-V to the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently and put on the website of the company.	Point Noted for compliance.
vi	The criteria pollutant levels namely; $PM_{2.5}$, PM_{10}, SO_2, NO_x (ambient levels) or critical sectoral parameters, indicated for the project shall be monitored and displayed at a convenient location near the main gate of the company in the public domain.	Point Noted for compliance. However, monitoring reports of entire DPT area already enclosed at **Annexure F**.
vii	The project proponent shall inform the Regional Office as well as the Ministry, the date of financial closure and final approval of the project by the concerned authorities, commencing the land development work and start of production operation by the project.	As per the stipulated condition, DPT vide letter dated 10/2/2021 **(Copy – Annexure R)** has already informed about the work to be started for "Construction of Oil Jetty no. 8 at Kandla" and also incorporating that for balance Oil Jetties no. 9, 10 & 11 to be implemented on BOT/PPP Mode (under approval stage) and for development of Land (under approval stage), the requisite details will be communicated in due course.
viii	The project authorities must strictly adhere to the stipulations made by the State Pollution Control Board and the State Government.	Point Noted.
ix	The project proponent shall abide by all the commitments and recommendations	Point Noted for compliance. However, it is relevant to submit here that Public

	made in the EIA/EMP report, commitment made during Public Hearing and also that during their presentation to the Expert Appraisal Committee.	Hearing was exempted for this project.
x	No further expansion or modifications in the port. Area shall be carried out without prior approval of the Ministry of Environment, Forests and Climate Change (MoEF&CC).	Point Noted for compliance.
xi	Concealing factual data or submission of false/fabricated data may result in revocation of this environmental clearance and attract action under the provisions of Environment (Protection) Act, 1986.	Point Noted.
xii	The Ministry may revoke or suspend the clearance, if implementation of any of the above conditions is not satisfactory.	Point Noted.
xiii	The Ministry reserves the right to stipulate additional conditions if found necessary. The Company in a time bound manner shall implement these conditions.	Point Noted.
xiv	The Regional Office of this Ministry shall monitor compliance of the stipulated conditions. The project authorities should extend full cooperation to the officer (s) of the Regional Office by furnishing the requisite data / information/monitoring reports.	It is assured that DPT will extend full cooperation to the officer (s) of the Regional Office & will also furnish all the requisite data/information/monitoring reports etc. to them as and when asked by them.
xv	The above conditions shall be enforced, inter-alia under the provisions of the Water (Prevention & Control of Pollution) Act, 1974, the Air (Prevention & Control of Pollution) Act, 1981, the Environment (Protection) Act, 1986, Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 and the Public Liability Insurance Act, 1991 along with their amendments and Rules and any other orders passed by the Hon'ble Supreme Court of India / High Courts and any other Court of Law relating to the subject matter.	Point Noted.
xvi	Any appeal against this EC shall 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.	---------

Annexure -II

ANNEXURE A

GPCB

GUJARAT POLLUTION CONTROL BOARD

PARYAVARAN BHAVAN
Sector-10-A, **Gandhinagar** 382 010
Phone : (079) 23222425
(079) 23232152
Fax : (079) 23232156
Website : www.gpcb.gov.in

By R.P.A.D

CONSENT TO ESTABLISH
CTE- 94118

No. PC/CCA-KUTCH-1524/GPCB ID 56985/ **Date:**

To,
Deendayal Port Trust Land,
Kandla Port Trust Land,
A.O Building,P.O box No. 50,
Tal.:Gandhidham,
Dist.Kutch-370201

Subject : **Consent to Establish (NOC)** under Section 25 of Water (Prevention and Control of Pollution) Act 1974 and Section 21 of Air (Prevention and Control of Pollution) Act 1981

Reference : Your CTE Application **Inward ID No 133847 dated 04/04/2018**

Sir,

Without prejudice to the powers of the Board under the Water (Prevention and Control of Pollution) Act-1974. the Air (Prevention and Control of Pollution) Act-1981 and the Environment (Protection) Act-1986 and without reducing your responsibilities under the said Acts in any way, this is to inform you that the Board grants **Consent to Establish (NOC)** of industrial activity at **Kandla Port Trust Land,A.O Building,P.O box No. 50,Tal.:Gandhidham,**For Creation of water front facilities of oil jetties of 8,9,10,&11 & development of land (1432 Areas).

1. The validity period of the order shall be up to **03/04/2023**

SUBJECT TO FOLLOWING SPECIFIC CONDITIONS:

1. Proposed jetties shall be handled of 3 5 MMTP/Annum of liquid cargo of edible oil. Fertilizer & food grains etc.
2. Unit shall strictly adhere to all condition of TOR issued by MoEF & CC, Delhi dated 04/08/2017 & shall not carry out any construction activities till obtaining EC & CRZ from competent authority
3. No ground water shall be withdrawn without prior approval from competent authority.

2. CONDITIONS UNDER WATER ACT 1974:

2.1 There shall be no industrial water consumption and hence there shall be no industrial waste water generation from manufacturing process and other ancillary operations.

2.2 Domestic water consumption shall not exceed 20 KL/day.

2.3 The quantity of domestic waste water (Sewage) shall not exceed **16** KL/Day.

2.4 The quality of the sewage shall conform to the following standards

PARAMETERS	GPCB NORMS
pH	6.5 to 9.0
BOD (5 days at 20^0 C)	30 mg/L
Suspended Solids	100 mg/L
Fecal Coliform	1000 MPN/ 100 ml

2.5 The domestic sewage shall be treated in Sewage Treatment Plant and treated sewage conforming to standards mentioned in 2.4 shall be reused in various activities shall not be used for gardening and plantation purpose in premises.

3. **CONDITIONS UNDER AIR ACT 1981:**

3.1 There shall be no use of fuel hence there shall be no flue gas emission from manufacturing process and other industrial operations.

3.2 There shall be no process gas emission from manufacturing process and other industrial operations.

3.3 The concentration of the following parameters in the ambient air within the premises of the industry shall not exceed the limits specified hereunder as per National Ambient Air Quality Standards issued by MoEF&CC dated 16th November-2009.

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

3.4 The level of Noise in ambient air within the premises of industrial unit shall not exceed following levels:

Between 6 A.M. to 10 P.M.	: 75 dB(A)
Between 10 P.M. to 6 A.M.	: 70 dB(A)

4. **CONDITIONS UNDER HAZARDOUS WASTE:**

4.1 The applicant shall provide temporary storage facilities and maintain the record for each type of Hazardous Waste as per Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2016 as amended from time to time

4.2 The applicant shall be obtain membership of common TSDF site for disposal Hazardous Waste as categorized in Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2016 as amended thereof

5. **GENERAL CONDITION**

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

5.2 The waste generator shall be totally responsible for (i.e. Collection, storage, transportation and ultimate disposal) of the wastes generated.

5.3 Records of waste generation, its management and annual return shall be submitted to Gujarat Pollution Control Board in Form – 4 by 31st January of every year.

5.4 In case of any accident, details of the same shall be submitted in Form – 5 to Gujarat Pollution Control Board

5.5 Applicant shall comply relevant provision of "Public Liability Insurance Act-91".

GPCB

GUJARAT POLLUTION CONTROL BOARD
PARYAVARAN BHAVAN
Sector-10-A, **Gandhinagar** 382 010
Phone : (079) 23222425
(079) 23232152
Fax : (079) 23232156
Website : www.gpcb.gov.in

5.6 Unit shall take all concrete measures to show tangible results in waste generation reduction. voidance, reuse and recycle. Action taken in this regards shall be submitted within 03 months and also along with Form 4

5.7 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 waste generated within the factory premises.

5.8 Adequate plantation shall be carried out all along the periphery of the industrial premises in such a way that the density of plantation is at least 1000 trees per acre of land and a green belt of 10 meters width shall be developed.

5.9 The applicant shall have to submit the returns in prescribed form regarding water consumption and shall have to make payment of water cess to the Board under the Water (Prevention and Control of Pollution) Cess Act- 1977.

For and on behalf of
Gujarat Pollution Control Board

(Sushil Vegda)
Senior Environment Engineer

ANNEXURE B

S. M. SAIYAD, IFS
DIRECTOR (ENVIRONMENT)&
ADDITIONAL SECRETARY

GOVERNMENT OF GUJARAT
Forests & Environment Department
Block no. 14, 8th floor
Sachivalaya, Gandhinagar - 382 010
Gujarat, INDIA
Ph: (079) 23251062,
Fax: (079) 23252156

Email: direnv@gujarat.gov.in

Ref: No.ENV-10-2018-24 -T cell

July *30, 2020*

To,
Shri W. Bharat Singh
Director(IA.III)
Ministry of Environment, Forests & Climate Change
Indira Paryavaran Bhavan, Jor Bugh,
Aliganj Road New Delhi - 110 003

Sub: CRZ Clearance for proposed project for for Creation of water front facilities (Oil Jetties 8,9,10&11) and development of land (1432acres – revised area 554 acres) for associated facilities for storage at Old Kandla, Tal- Gandhidham, Dist. – Kutch, Gujarat by Deendayal Port Trust - reg.

Dear Sir,

The Deendayal Port Trust (Formerly known as Kandla Port Trust), vide its application dated 01.03.2018 has approached this Department seeking recommendations from the GCZMA for obtaining CRZ Clearance from the, Ministry of Environment, Forests and Climate Change, Government of India for their proposed project for Creation of water front facilities (Oil Jetties 8,9,10&11) and development of land (1432acres – revised area 554 acres) for associated facilities for storage at Old Kandla, Gandhidham –Kutch, Gujarat.

Deendayal Port Trust has submitted following documents alongwith application:

1. Various undertakings as per the guidelines.
2. Form-I as per CRZ Notification 2011.
3. EIA prepared by M/s. SV Enviro Labs & Consultants , Visakhapatnam alongwith CRZ map indicating the High Tide Line, Low Tide Line, CRZ Boundary, etc. prepared by the Institute of Remote Sensing (IRS), Anna University, Chennai, alongwith superimposition of the proposed activities on CRZ map.

The EIA report prepared by SV Enviro Labs & Consultants , Visakhapatnam includes the details like Introduction(chapter 1), Project Description(chapter 2), Analysis of Alternatives (chapter 3), Description of the Environment (chapter 4), Anticipated Environmental Impact and Mitigation Measures (chapter 5), Environmental Monitoring Plan (chapter 6), Additional Studies (chapter 7), Project Benefits (chapter 8), Environmental Management Plan (chapter 9), Summary and Conclusion (chapter 10).

The main findings of EIA report prepared by SV Enviro Labs & Consultants , Visakhapatnam and their presentation made during 49th GCZMA meeting are summarized as follows :-

I. During construction of the oil jetties, piling of jetty will involve the use of anchored piling barges. The barges/rigs will use diesel generator sets to provide power for the pile hammer and boring equipment. The generators would produce exhaust emissions during the construction period, which could cause temporary and localized adverse impacts on local air quality around these barges. The expected emissions will depend on total diesel combustion, which can vary between 100 to 500 litres per hour.

II. The proposed project will have no major considerable stress/ pressure on the environment to give rise to any significant adverse impacts on environment. The only major impacts on air during construction phase are predicted to be caused due to airborne dust arising from the construction activities as well as gaseous pollutants from vehicles used for transportation of construction materials & emission from equipment used during construction phase. The dust particles in the form of particulate matter will strongly depend on various activities like movement of vehicles, their speed, excavation of earth, back filling etc during the construction phase.

III. Exhaust emissions due to vehicular movement for on land transport of construction material may marginally increase the air pollution load along the road. This impact is temporary and localized.

IV. The probable sources of the dust are the activities of excavation, filling, leveling etc. However it is noticed that, the area of the proposed project is situated close to the creek of Gulf of Kutch; hence the moisture in the soil will not allow the particles to travel to longer distance from the sources.

V. The dredging quantity is 16, 56,058 M3 will be capital dredging for 8-11 oil jetties. It is proposed that the dredged material would be directly disposed of at the CWPRS (Central Water & Power Research Station) approved site.

VI. Beside the texture of soil is mostly sandy, hence the size and density of particles also prevent them from longer travelling. However maximum care will be taken to prevent the particles to be airborne by using water sprinkler system & covering the excavated materials. Hence there will be no significant impacts due to the dust particles.

VII. There is no chemical process or manufacturing activity, hence there will not be any process emission. As the proposed project is only export and import of cargo, increase in vehicular movement and emissions from DG set may affect ambient air quality.

VIII. Noise generation is due to the noise generation by the operation of the machineries, equipments and some mechanical works. The impacts due to noise of these equipments will be local and temporary as well as negligible due to the efficient implementation of proper mitigation measures like provision of Ear Protective Safety Equipment (ear plug or ear muff) for the personnel likely to the exposed to high noise level. The noise level shall be minimized by proper lubrication, modernization, maintenance, muffling and provision of silencers wherever possible.

IX. The day and night noise levels near the pile-driving site reduce to within prescribed limits as per "Noise Rules 2000" at distance of 50m and 100m from the source. There is a potential for underwater noise from piling of the jetty to impact marine fauna. As there are no marine mammals identified in the DPT area, it is expected that the noise impact would be of low significance as the piling activity would be localised and temporary in nature and sensitive receptors are not located in the vicinity of the noise generating area.

X. The major expected source to increase the noise level at the jetty area are arrival of cargo and vehicular movement to transport export and import goods, conveyor system and operation of DG set for emergency power supply. However, this increase in noise level will be lower compared to the construction phase. Proper lubrication, muffling shall be done to reduce the noise, DG set with acoustic enclosure shall be provided.

XI. The workers working in the high noise area shall be provided with ear protected equipments. The propagation of noise way would be prevented by creating barrier in form of greenbelt development all around the project area boundary.

XII. Before commencing any dredging operations the dredging contractor will provide complete details of their vessels and equipment including anticipated noise levels at the source. The noise levels during the activity will also be continuously monitored and mitigated if needed.

XIII. The Gujarat Water Supply and Sewerage Board (GWSSB) is responsible for providing of water during construction and operation phase. It is estimated that approx. 20KLD will be required once all facilities are functional. Hence there would not be any impact on local water sources and its competitive users.

XIV. During construction phase, there would be generation of some sewage due to personnel involved in the construction work. With the implementation of mitigation measures, the potential for contamination of surface and ground water resources resulting from sewage disposal is expected to be insignificant.

XV. During operation phase, the waste water will be treated in a sewage treatment plant. The treated wastewater will be used for flushing, cooling water makeup and landscaping purposes. Disposal of industrial effluent and sewage without proper treatment into water bodies can pollute and degrade the water quality by making it unfit for usage and survival of aquatic life. Hence no waste water should be discharged outside the project premises. This will prevent any direct disposal of waste water in this stream.

XVI. Storm water drainage system will be developed by DPT at project site for collection of storm water. The storm water drain will be covered by a steel gutter grill that is level with the surrounding pavement. This collected water will be recharged into ground through injection wells. Development of storm water drainage system and RWH structures will regulate the run-off from the site & prevent flooding of the area during heavy rains. Injection well will be interlinked to prevent any overflow or waste of harvested water. Thus, no negative impact is anticipated on drainage of the area. Measures propose to prevent impact of project development on surface water bodies.

XVII. Land use patterns of the surrounding area would not changed as it already used for port activity with some open land/back-up area. The proposed project is in the water front of marine water course of Gulf of Kutch. The project requires 554 acres of land for the development of proposed project. The land is generally barren and saline soil having low nutrients. At present, the site is almost devoid of vegetation, so major clearance of vegetation in site for development of proposed project is not required. Hence there would not be any adverse impacts on land cover is envisaged.

XVIII. Some degraded mangrove colonies are noticed in the buffer area of the project. The project area is revised to 554 acres from 1432 acres maintaining 70 m buffer all around the mangrove colonies.

XIX. The proposed jetty site is within the limit of existing port where benthic diversity and abundance in the area is found to be low in comparison with other near-shore areas in the region. This is principally attributed to the fact that the area is surrounded by marine-based development projects related to the extension and development of the Deenadayal Port. Installation of the 210-240 steel piles will take place using a jack up rig, which will need to be repositioned to cover the entire piling operation. Piles shall be driven to the required depth by a suitably sized hydraulic hammer. Based on the geotechnical conditions found at the site no drilling is anticipated as area is known for soft sand.

XX. The disturbance caused by the direct impacts of the rig could cause a temporary loss in benthic habitat in the area occupied by the steel piles and the legs of the jack up rig (4 no. per pile). This habitat is likely to become re-established after end of rigging. There could also be localized, temporary smothering of habitat with finer materials and suspension of fine sediments into the water column. This could reduce light penetration in the vicinity, impacting the marine environment and directly affecting photosynthetic species, and increased sediment loading in the waters could affect filter feeding organisms. The impact on benthic habitat because of the piling is expected to be temporary and localized and is therefore predicted to be of low significance.

XXI. None of the species included in Schedule –I of the Indian Wildlife Act was reported from the core area. The project is not expected to bring about any major irreversible change in the terrestrial area. It can therefore be concluded that the proposed project and its activities will not have any adverse impacts in the terrestrial flora and fauna of the core area or its buffer zone.

XXII. The general water quality, and sediment quality parameters in the Port premises remained within normal limits during study period as ongoing capital and maintenance dredging, and no variations and fluctuations were observed. The phytoplankton, zooplankton, benthic organisms and fish populations in the Kandla did not show any abnormal variations in their quality and quantity during this period. This indicates that the ongoing dredging activities as well as and the port activities have already disturbed the marine environment. The project-specific dredging would cumulatively add to that disturbance though this disturbance will be more localized and for a duration of approximately 18 months. The overall impact of the dredging activities on the marine flora and fauna would be of medium significance, which after the implementation of mitigation measures is expected to be of low significance.

XXIII. The land is designated port land, which is currently not under any permanent use; hence there are no impacts in terms of displacement or livelihood loss.

XXIV. The impact significance during operation phase is expected to be low considering the fact the project will be at onshore and offshore with limited impact on socio-economic environment. However, the project will have positive impacts on socio-economic environment by increasing availability of power, creation of employment opportunities and procuring material locally.

XXV. There would be approximately 100 persons employed in the oil jetties 8 -11 (maximum number of permanent and contract workers at any given time). Expected waste generation quantity from proposed project is approximately 75kg/day (@0.75kg/capita/day) of non-hazardous domestic waste (food waste, general solid waste and plastic waste) that will need collection and disposal. With the implementation of standard waste handling practices in line with MARPOL requirements, potential impacts resulting from the generation of non-hazardous waste is expected to be of low significance.

The Gujarat Coastal Zone Management Authority discussed the proposal of Deendayal Port Trust in its 49th meeting, which was held on 15-06-2020 through Video Conferencing , wherein the Authority was apprised that the DPT has submitted Form-1, CRZ map prepared by the Institute of Remote Sensing (IRS), Anna University, Chennai and EIA report prepared by the SV Enviro Labs &

Consultants , Visakhapatnam as per ToR issued by MoEF&CC dated 04th August,2017.

The Authority was further apprised that the proposal of DPT was scrutinized by the Team of Officials in its 3rd meeting which was held on 12/04/2018 wherein the representative made a presentation on their proposed activities in CRZ areas, EIA report and CRZ Maps. Then the proposal was discussed in the 40th meeting of GCZMA which was held on 12th June, 2018. After deliberated discussion it was decided to carry out site inspection of the proposal by sub-committee of the GCZMA. Accordingly, the Site visit was carried out by the Sub- Committee of GCZMA on 12-07-2018. During inspection the subcommittee observed that mangroves and its buffer zone is part of the proposed area development. Therefore, the DPT was requested to revised their proposal and exclude the mangroves and its buffer zone and also requested to keep buffer zone of 70 mt. from mangrove areas. Accordingly, the DPT has revised proposal for development of land for 554 acres instead of 1432 acres of land. The revised planning details were superimposed on the Draft CZMP prepared by NCSCM, Chennai.
The Representative of the DPT made a presentation before the Authority and submitted that existing Port is having facilities such as –

- 16 Nos.Cargo Berths
- 6 Nos. Oil Jetties
- Barge Jetties (Bunder Basin & IFFCO captive)
- Total custom bonded Port Area inside custom fencing is about 330 Ha.
- Total Storage Capacity: 26.41 Lakh KL. (Chemical & Liquid Handling Complex)

Considering development of the existing port, they had proposed following facilities at the proposed site.

- The proposed project is creation of water front facilities (i.e. construction of oil jetties 8,9,10, &11) and development of lands for associated facilities. Area proposed for development : 1345 acres out of 1432 acres. The proposed jetties will be used for handling all types of Liquid Cargo (Capacity: 4 X 3.5 MMTPA = 14 MMTPA).
- Each jetty 110 m X 12.8 m (Main Platform) and mooring dolphins.
- Connecting approach each : 90 m X 10 m to common approach trestle of length 1225 m.
- Total plot for storage 22 Nos.

- Pipelines on each jetty 9 Nos. (chemicals, Edible Oil, Firefighting, water supply , air, etc)

It was further submitted that as per the suggestion of the subcommittee of GCZMA, now the revised proposal for facilities at the proposed site.

- The proposed project is creation of water front facilities (i.e. construction of oil jetties 8,9,10, &11) as above.
- Area proposed for development: 554 acres (Mangrove area including 70 m buffer etc., have been excluded from the total area of 1432 acres.)
- Total plot for storage 11 Nos.
- Tentative Tankage Capacity : 2.28 Million KL
- Pipelines on each jetty 9 Nos. (chemicals, Edible Oil, Firefighting, water supply , air, etc)

It was submitted by the representative of the DPT that approx. 16.0 KLD of waste water will be generated from the proposed project, and same will be treated in sewage treatment plant and treated water will be used for dust suppression, greenbelt development and toilet flushing.

It was submitted by the representative of DPT that Capital Dredging Requirement will be 16, 56,058 M3 (Berth basin + Patches in approach channel) and Maintenance Dredging will be 1, 07,500 m3 / Per annum. The dredging activities will be performed by the specialist contractors using purpose-built dredgers and under the active supervision of the port operator.

It was submitted by the representative of DPT that prior to commencing dredging works, a dredging management plan will be prepared; sophisticated dredgers will be used to avoid or minimize scattering of dredged sediments during dredging. Monitoring of turbidity and suspended sediments concentration will be ensured during dredging. They will avoid dredging operations at the time of high tidal disturbances; and Process of dredging and material transfer to be undertaken by experienced personnel only. The dredged material will be disposed of at the designated dumping location identified based on the scientific study done by the CWPRS and approved by the MOEF&CC, GOI.

The representative of DPT further submitted that the EIA study has determined that the construction and operational activities of the proposed project will have some overall low and medium impacts on the local environment. However, with the implementation of proposed pollution control and environment management measures, it is envisaged that these anticipated impacts will be largely mitigated for land, water, ar and Marine environment. It will not create any harmful impact on the surrounding environment.

Chairman, Gujarat Coastal Zone Management Authority asked Bhaskarya Institute for Space Application and Geo-informatics to submit the map to be superimposed on revised proposal of DPT and verify whether the revised areas are as per the proposal submitted by the DPT or not and also superimposed on SCZMP of Kutch prepared by the NCSCM, Chennai duly approved by the MOEF&CC, GOI and submit its report within one week. The Director, BISAG, was agreed upon it. Now GEC and BISAG has prepared map of the project site, copy of the same is put up herewith on pg. no. 151/c and 153/c. As per the map total plot area for development including the existing one is 554 acres.

As per CRZ map prepared by the IRS, Chennai The proposed project site falls under CRZ- IA(existence of mangrove buffer area at proposed site) , CRZ- IB, CRZ – IV. Now mangrove and its buffer zone is excluded, hence falls under CRZ-IB, CRZ- III and CRZ – IV.

The Gujarat Coastal Zone Management Authority deliberated the proposal of Gujarat Maritime Board and after detailed discussion, it is decided to recommend to the Ministry of Environment, Forests and Climate Change, Government of India to grant CRZ Clearance for the proposed project for Creation of water front facilities (Oil Jetties 8,9,10&11) and development of land (1432acres – revised area 554 acres) for associated facilities for storage at Old Kandla, Gandhidham –Kutch, Gujarat with some specific conditions.

In view of the above, the State Government hereby recommends to the Ministry of Environment, Forest and Climate Change, Government of India to grant CRZ Clearance for the proposed project for Creation of water front facilities (Oil Jetties 8,9,10&11) and development of land (1432acres – revised area 554 acres) for associated facilities for storage at Old Kandla, Tal – Gandhidham, Dist –Kutch, Gujarat with following specific conditions :-

1. **The DPT shall strictly adhere to the provisions of the CRZ Notification, 2011 issued by the Ministry of Environment, Forests and Climate Change, Government of India.**

2. **Necessary permissions from different departments/ agencies under different laws/ acts shall be obtained before commencing any activity (including the construction).**
3. **The DPT shall ensure that that the all the provisions of CRZ Notification 2011 shall be complied with and storage facilities in CRZ areas shall be in compliance with Annexure-II of the above said Notification**
4. **There shall not be any blockage of creek due to laying of pipeline. and free flow of water shall be maintained.**
5. **There shall not be any mangrove destruction/ damage due to proposed activities and adequate buffer zone of 70 mtrs shall be maintained from mangrove areas.**
6. **The DPT shall effectively implement the Mangrove Development, Protection & Management plan for control of indirect impacts on mangrove habitat.**
7. **The DPT shall have to make a provision that mangrove areas get proper flushing water and free flow of water shall not be obstructed.**
8. **The DPT shall have to dispose of the dredged material at the designated dredged material disposal point based on scientific study and approved by the MOEF&CC, GOI**
9. **The DPT shall have to maintain the record for generation and disposal of capital dredging and maintenance dredging**
10. **No dredging, reclamation or any other project related activities shall be carried out in the CRZ area categorized as CRZ I (i) (A) and it shall have to be ensured that the mangrove habitats and other ecologically important and significant areas, if any, in the region are not affected due to any of the project activities.**
11. *The* DPT *shall ensure that construction activities like dredging etc shall be carried out in confined manner to reduce the impact on marine environment.*
12. *The* DPT *shall ensure that the dredging shall not be carried out during the fish breeding season.*
13. *Construction waste including debris and dredged material shall be disposed safely in the designed areas as approved by MoEF&CC, GoI and it shall be ensured that there shall be no impact on flora and fauna.*
14. No effluent or sewage shall be discharged into the sea / creek or in the CRZ area and shall be treated to conform the norms prescribed by the Gujarat

Pollution Control Board and would be reused / recycled as per the approval of the Board.

15. All the recommendations and suggestions given by the Cholamandalam MS Risk Services Limited in their Environment Impact Assessment report shall be implemented strictly by DPT.
16. The DPT shall exercise extra precautions to ensure the navigation safety and mitigation of the risk associated with the project activities especially due to collision, sinking or accidents of the vessels and would deploy the latest communication and navigation aids for this purpose. The proposed facilities shall also be covered under the VTMS being developed by the GMB.
17. The cost of the external agency that may be appointed by this department for supervision / monitoring of the project activities during construction/ operational phases shall be paid by DPT
18. The DPT shall contribute financially for any common study or project that may be proposed by this Department for environmental management / conservation / improvement for the Gulf Kutch
19. The piling activities debris and any other type of waste shall not be discharged into the sea or creek or in the CRZ areas. The debris shall be removed from the site immediately after the piling activities are over.
20. The camps shall be located outside the CRZ area and the 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 labours.
21. The DPT shall prepare and regularly update their Local Oil Spill Contingency and Disaster Management Plan in consonance with the National Oil Spill and Disaster Contingency Plan.
22. The DPT 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.
23. The groundwater shall not be tapped to meet with the water requirements in any case.
24. DPT shall take up greenbelt development activities in consultation with the Gujarat Institute of Desert Ecology / Forest Department / Gujarat Ecology Commission.
25. The DPT shall have to contribute financially for taking up the socio-economic upliftment activities in this region in consultation with the Forests and

Environment Department and the District Collector / District Development Officer.

26. A six monthly report on compliance of the conditions mentioned in this letter shall have to be furnished by DPT on a regular basis to this Department and MoEF&CC,GoI.
27. The DPT shall ensure that the numbers of the Vessels and machinery deployed during marine construction, which are a source of low level organic and PHC pollution will be optimized to minimize risks of accidents involving these vessels.
28. The noise level during transport and construction of marine facilities shall be kept minimum.
29. The DPT shall regularly conduct the surveys to identify changes in the channel bathymetry to minimize navigation hazards. Proper navigational aids and guidance should be provided to ships navigating the channel and there should be a properly structured vessels traffic management strategy to avoid accidents.
30. The DPT shall carry out separate study for further erosion and deposition pattern in the area after dredging through a reputed agency and shall follow the suggestions of the study done by reputed agency ,for maintenance dredging, the recommendations/suggestions of the reputed agency shall be follow by the DPT.
31. Any other condition that may be stipulated by this Department and MoEF&CC,GoI from time to time for environmental protection / management purpose shall also have to be complied with by DPT.

Thanking You,

O/c
30/7/2020

Yours Sincerely,

(S. M. Saiyad)

Encl: As above

રવાના કર્યું
તા. 3 0 JUL 2020

Copy to:

The Chairman,
Deendayal Port Trust ,
Old Kandla, Tal – Gandhidham,
Dist –Kutch, Gujarat ---------------------for your kind information please.

DEENDAYAL PORT TRUST

ISO 9001:2015 & ISO 14001:2015 certified Port

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

www.deendayalport.gov.in

EG/WK/5202 (D)/ Part (CRZ/ /142 Dated 08 /02/2022

The Additional Secretary & Director (Environment),
Govt. of Gujarat,
Forest & Environment Department,
Block No.14, 8th floor, New Sachivalaya,
Gandhinagar - 382 010.

Sub: CRZ Clearance for "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 Trust" **Compliances of the stipulated conditions in CRZ Recommendations req.**

Ref.: (1) Letter No. ENV-10-2018-24-T Cell dated 30/7/2020 of Director (Environment) & Additional Secretary, Forest & Environment Department, GoG.
(2) DPT letter no. EG/WK/5202 (D)/ Part (CRZ 2)/28 dated 29/06/2021

Sir,

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

In this connection, it is to state that, the Gujarat Coastal Zone Management Authority vide above referred letter dated 30/7/2020 had recommended the subject project of Deendayal Port Trust. Subsequently, the MoEF&CC, GoI had accorded the Environmental & CRZ Clearance vide letter dated 20/10/2020 for the subject project. Subsequently, DPT vide above referred letter dated 29/06/2021 had submitted compliance report of the stipulated conditions for the period upto May, 2021.

Now, as directed under Specific Condition No. 26 mentioned in the CRZ Clearance letter dated 30/7/2020 i.e. ***A six-monthly report on compliance of the conditions mentioned in this letter shall have to be furnished by the OPT on a regular basis to this Department and MoEF&CC, GoI***, we have been regularly submitting the said report vide reference (2) cited letter. Further, please find enclosed herewith compliance report of the stipulated conditions for period June to November, 2021 along with necessary annexure, for kind information & record please **(Annexure I).**

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

Further, as per the MoEF&CC, Notification 5.0.5845 (E) dated 26.11.2018, in which it is mentioned 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 **in ID** gczma.crz@gmail.com & direnv@gujarat.gcv.in .

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

Yours Faithfully,

4/2/22

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

Copy to: -

Shri Amardeep Raju, MoEF&CC,GoI
Scientist E, Ministry of Environment, Forest and Climate Change,
& Member Secretary (EAC-Infra.1),
Indira Paryavaran Bhavan,
3rd Floor, Vayu Wing, Jor Bagh Road, Aliganj,
New Delhi-110003.
Email ID: ad.raju@nic.in

Annexure -I

Subject: Point-wise Compliance Status Report for CRZ clearance for proposed project for creation of water front facilities (oil jetties 8,9,10 and 11) and development of land (1432 acres – revised area 554 acres) for associated facilities for storage at old Kandla, Tal: Gandhidham Dist. Kutch, Gujarat by Deendayal Port Trust -reg

Ref No: - GCZMA CRZ recommendation vide Letter No- ENV-10-2018-24-T Cell dated 30.07.2020

S. No.	CRZ Conditions	Compliance Status
	SPECIFIC CONDITIONS	
1.	The DPT shall strictly adhere to the provisions of the CRZ Notification, 2011 issued by the Ministry of Environment, Forests and Climate Change, Government of India	It is assured that, the provisions of the CRZ Notification, 2011 shall be strictly adhere to by the DPT.
2.	Necessary permissions from different departments/ agencies under different laws/ acts shall be obtained before commencing any activity (including the construction)	The Consent to Establish (CTE) from the GPCB had already been obtained vide CTE No. 94118 granted by the GPCB vide letter no. PC/CCA-KUTCH 1524/GPCB ID 56985 dated 23/7/2018 (**Copy Annexure A**).
3.	The DPT shall ensure that that the all the provisions of CRZ Notification 2011 shall be complied with and storage facilities in CRZ areas shall be in compliance with Annexure-II of the above said Notification	It is assured that all the provisions of CRZ Notification, 2011 will be complied with and only storage of permissible cargo as per CRZ Notification, 2011, Annexure II will be allowed to store in storage facilities to be developed.
4.	There shall not be any blockage of creek due to laying of pipeline. and free flow of water shall be maintained.	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities). It is hereby assured that, no creeks or rivers shall be blocked, due to any activities at the project site and free flow of water will be maintained.
5.	There shall not be any mangrove destruction/ damage due to proposed activities and adequate buffer zone of 70 metres shall be maintained from mangrove areas	It is assured that all the proposed activities shall be carried out strictly as per the EC & CRZ Clearance accorded by the MoEF&CC, GoI dated 20/11/2020.
6.	The DPT shall effectively implement the Mangrove Development, Protection & Management plan for control of indirect impact on mangrove habitat	As per the directions of the GCZMA and MoEF&CC, GoI, till date (2005-06 to 2019-20), DPT had already undertaken Mangrove Plantation in an area of 1500 Ha. at various locations.

S. No.	CRZ Conditions	Compliance Status
		It is also relevent to submit here that, as per the direction of the Gujarat Coastal 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". DPT had already submitted final report along with compliance reports submitted to the GCZMA for the project of "Construction of 13th to 16th CB" dated 30/11/2019.
7.	The DPT shall have to make a provision that mangrove areas get proper flushing water and free flow of water shall not be obstructed	It is assured that necessary provisions will be made so that mangrove area get proper flushing water and to maintain free flow of water.
8.	The DPT shall have to dispose of the dredged material at the designated dredged material disposal point based on scientific study and approved by the MOEF&CC, GOI	No dredging activity has been started yet. However, it is assured that dredging activity will be carried out strictly as per the requirement of the condition and the same shall be disposed at designated dumping ground (25° 51′ 00″ N & 70°10′ 00″ E).
9.	The DPT shall have to maintain the record for generation and disposal of capital dredging and maintenance dredging	No dredging activity has been started yet. However, it is assured that necessary record will be maintained as per the requirement of the condition.
10.	No dredging, reclamation or any other project related activities shall be carried out in the CRZ area categorized as CRZ I (i) (A) and it shall have to be ensured that the mangrove habitat and other ecologically important and significant areas, if any, in the region are not affected due to any of the project activities.	It is assured that all the project related activities will be strictly carried out as per the EC & CRZ Clearance accorded by the MoEF&CC, GoI dated 20/11/2020.

S. No.	CRZ Conditions	Compliance Status
11.	The DPT shall ensure that construction activities like dredging etc shall be caried out in confined manner to reduce the impact on marine environment.	No dredging activities have been started yet. However, it is assured that construction activities like dredging will be carried out as per the requirement of the condition.
12.	The DPT shall ensure that the dredging shall not be carried out during the fish breeding season	No dredging activities have been started yet. Point Noted for compliance.
13.	Construction waste including debris and dredged material shall be disposed safely in the designed areas as approved by MoEF&CC, GoI and it shall be ensured that there shall be no impact on flora and fauna	Point Noted for compliance.
14.	No effluent or sewage shall be discharged into the sea / creek or in the CRZ area and shall be treated to conform the norms prescribed by the Gujarat Pollution Control Board and would be reused / recycled as per the approval of the Board	It is assured that No effluent or sewage will be discharged into the Sea/creek or in the CRZ area. Further, the same will be treated in STP as per the norms prescribed by the GPCB.
15.	All the recommendations and suggestions given by the Cholamandalam MS Risk Services Limited in their Environment Impact Assessment report shall be implemented strictly by DPT	It is assured that all the recommendations and suggestions given by the EIA Consultant, M/s SV Enviro, Vizag in EIA Report will be implemented.
16.	The DPT shall exercise extra precautions to ensure the navigation safety and mitigation of the risk associated with the project activities especially due to collision, sinking or accidents of the vessels and would deploy the latest communication and navigation aids for this purpose. The proposed facilities shall also be covered under the VTMS being developed by the GMB	It is assured that emergency preparedness plan based on the Hazard Identification and Risk Assessment (HIRA) will be implemented.
17.	The cost of the external agency that may be appointed by this department for supervision / monitoring of the project activities during construction/ operational phases shall be paid by DPT	Point Noted.
18.	The DPT shall contribute financially for any common study or project that may be proposed by this Department for environmental management / conservation / improvement for the Gulf Kutch	Point noted for compliance.

S. No.	CRZ Conditions	Compliance Status
19.	The piling activities debris and any other type of waste shall not be discharged into the sea or creek or in the CRZ areas. The debris shall be removed from the site immediately after the piling activities are over	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities). Point Noted for compliance.
20.	The camps shall be located outside the CRZ area and the 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 labours.	Point Noted for compliance.
21.	The DPT shall prepare and regularly update their Local Oil Spill Contingency and Disaster Management Plan in consonance with the National Oil Spill and Disaster Contingency Plan	Point Noted for compliance. DPT is already having Local Oil Spill contingency plan and updated DMP.
22.	The DPT 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	Point noted for compliance.
23.	The groundwater shall not be tapped to meet with the water requirements in any case	Point Noted for compliance.
24.	DPT shall take up greenbelt development activities in consultation with the Gujarat institute of Desert Ecology / Forest Department / Gujarat Ecology Commission	DPT has already developed Green belt in and around the Port area. Further, DPT assigned work for Green belt development in an area of about 32 hectares to the Forest Department, Govt. of Gujarat during August, 2019 at the cost of Rs. 352.32 lakhs. The work is completed. Further, DPT also undertook massive green belt development in and around the Port area and at Gandhidham area.
25.	The DPT shall have to contribute financially for taking up the socio-economic upliftment activities in this region in consultation with the Forests and Environment Department and the District Collector / District Development Officer	As per the CSR Guidelines issued by the Ministry of Ports, Shipping & Waterways, Government of India, from time to time, DPT had undertaken CSR activities since the year 2011-12. The details of CSR Activities undertaken & planned is attached herewith as **Annexure B.**
26.	A six-monthly report on compliance of the conditions mentioned in this letter shall have to be furnished by DPT on a regular basis to this Department and MoEF&CC, GoI.	DPT has been regularly submitting the six-monthly report on compliance of the conditions mentioned in the CRZ Recommendation letter dated 30/7/2020 to the CRZ Authority and to the MoEF&CC, GoI.
27.	The DPT shall ensure that the numbers of the Vessels and machinery deployed during	Point Noted for compliance.

S. No.	CRZ Conditions	Compliance Status
	marine construction, which are a source of low level organic and PHC pollution will be optimized to minimize risks of accidents involving these vessels.	Work is in progress (Oil Jetty No. 8 - Jetty & allied facilities).
28.	The noise level during transport and construction of marine facilities shall be kept minimum.	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 submitted. The monitoring reports are attached herewith as **Annexure C**.
29.	The DPT shall regularly conduct the surveys to identify changes in the channel bathymetry to minimize navigation hazards. Proper navigational aids and guidance should be provided to ships navigating the channel and there should be a properly structured vessels traffic management strategy to avoid accidents.	Point noted for compliance.
30.	The DPT shall carry out separate study for further erosion and deposition pattern in the area after dredging through a reputed agency and shall follow the suggestions of the study done by reputed agency, for maintenance dredging, the recommendations /suggestions of the reputed agency shall be follow by the DPT	No dredging activity has been started yet. However, it is assured that necessary will be conducted as per the requirement of the condition.
31.	Any other condition that may be stipulated by this Department and MoEF&CC, GoI from time to time for environmental protection / management purpose shall also have to be complied with by DPT.	Point noted.

ANNEXURE A

GPCB

GUJARAT POLLUTION CONTROL BOARD

PARYAVARAN BHAVAN
Sector-10-A, **Gandhinagar** 382 010
Phone : (079) 23222425
(079) 23232152
Fax : (079) 23232156
Website : www.gpcb.gov.in

By R.P.A.D

CONSENT TO ESTABLISH
CTE- 94118

No. PC/CCA-KUTCH-1524/GPCB ID 56985/ **Date:**

To,
Deendayal Port Trust Land,
Kandla Port Trust Land,
A.O Building,P.O box No. 50,
Tal.:Gandhidham,
Dist.Kutch-370201

Subject : **Consent to Establish (NOC)** under Section 25 of Water (Prevention and Control of Pollution) Act 1974 and Section 21 of Air (Prevention and Control of Pollution) Act 1981

Reference : Your CTE Application **Inward ID No 133847 dated 04/04/2018**

Sir,

Without prejudice to the powers of the Board under the Water (Prevention and Control of Pollution) Act-1974. the Air (Prevention and Control of Pollution) Act-1981 and the Environment (Protection) Act-1986 and without reducing your responsibilities under the said Acts in any way, this is to inform you that the Board grants **Consent to Establish (NOC)** of industrial activity at **Kandla Port Trust Land,A.O Building,P.O box No. 50,Tal.:Gandhidham,**For Creation of water front facilities of oil jetties of 8,9,10,&11 & development of land (1432 Areas).

1. The validity period of the order shall be up to **03/04/2023**

SUBJECT TO FOLLOWING SPECIFIC CONDITIONS:

1. Proposed jetties shall be handled of 3 5 MMTP/Annum of liquid cargo of edible oil. Fertilizer & food grains etc.
2. Unit shall strictly adhere to all condition of TOR issued by MoEF & CC, Delhi dated 04/08/2017 & shall not carry out any construction activities till obtaining EC & CRZ from competent authority
3. No ground water shall be withdrawn without prior approval from competent authority.

2. CONDITIONS UNDER WATER ACT 1974:

2.1 There shall be no industrial water consumption and hence there shall be no industrial waste water generation from manufacturing process and other ancillary operations.

2.2 Domestic water consumption shall not exceed 20 KL/day.

2.3 The quantity of domestic waste water (Sewage) shall not exceed 16 KL/Day.

2.4 The quality of the sewage shall conform to the following standards

PARAMETERS	GPCB NORMS
pH	6.5 to 9.0
BOD (5 days at 20^0 C)	30 mg/L
Suspended Solids	100 mg/L
Fecal Coliform	1000 MPN/ 100 ml

2.5 The domestic sewage shall be treated in Sewage Treatment Plant and treated sewage conforming to standards mentioned in 2.4 shall be reused in various activities shall not be used for gardening and plantation purpose in premises.

3. **CONDITIONS UNDER AIR ACT 1981:**

3.1 There shall be no use of fuel hence there shall be no flue gas emission from manufacturing process and other industrial operations.

3.2 There shall be no process gas emission from manufacturing process and other industrial operations.

3.3 The concentration of the following parameters in the ambient air within the premises of the industry shall not exceed the limits specified hereunder as per National Ambient Air Quality Standards issued by MoEF&CC dated 16th November-2009.

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

3.4 The level of Noise in ambient air within the premises of industrial unit shall not exceed following levels:

Between 6 A.M. to 10 P.M. : 75 dB(A)
Between 10 P.M. to 6 A.M. : 70 dB(A)

4. **CONDITIONS UNDER HAZARDOUS WASTE:**

4.1 The applicant shall provide temporary storage facilities and maintain the record for each type of Hazardous Waste as per Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2016 as amended from time to time.

4.2 The applicant shall be obtain membership of common TSDF site for disposal Hazardous Waste as categorized in Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2016 as amended thereof.

5. **GENERAL CONDITION**

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

5.2 The waste generator shall be totally responsible for (i.e. Collection, storage, transportation and ultimate disposal) of the wastes generated.

5.3 Records of waste generation, its management and annual return shall be submitted to Gujarat Pollution Control Board in Form – 4 by 31st January of every year.

5.4 In case of any accident, details of the same shall be submitted in Form – 5 to Gujarat Pollution Control Board.

5.5 Applicant shall comply relevant provision of "Public Liability Insurance Act-91".

GUJARAT POLLUTION CONTROL BOARD
PARYAVARAN BHAVAN
Sector-10-A, **Gandhinagar** 382 010
Phone : (079) 23222425
(079) 23232152
Fax : (079) 23232156
Website : www.gpcb.gov.in

GPCB

5.6 Unit shall take all concrete measures to show tangible results in waste generation reduction, voidance, reuse and recycle. Action taken in this regards shall be submitted within 03 months and also along with Form 4

5.7 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 waste generated within the factory premises.

5.8 Adequate plantation shall be carried out all along the periphery of the industrial premises in such a way that the density of plantation is at least 1000 trees per acre of land and a green belt of 10 meters width shall be developed.

5.9 The applicant shall have to submit the returns in prescribed form regarding water consumption and shall have to make payment of water cess to the Board under the Water (Prevention and Control of Pollution) Cess Act- 1977.

For and on behalf of
Gujarat Pollution Control Board

(Sushil Vegda)
Senior Environment Engineer

ANNEXURE B

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					
				64 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**

List of CSR applications received from various NGOs , Organizations , Village Sharpanchs etc for the FY 2021-22 .

Sr.No	Name of Scheme	Proposal Received from / Name of Organization / N.G.O	Brief Details
1	CSR activities for the development of gardening at Sector -5 , Gim	Shri Sarvodaya Co-Operative Housing Society Ltd	**Appx Cost – Rs 25.00 Lakhs** **Cost for** – Comp wall, Benches, Plantation, walkway, other facilities (Land is reserved for Garden development only since from 50 years)
2	CSR activities for providing various facilities in SHRI GANESHNAGAR GOVT HIGHSCHOOL, GANDHIDHAM	Principal of School	**Appx cost –Rs 20.00 Lakhs** (Two times CSR works carried out at school by DPT)
3	CSR activities for the VadhiyarVankarSamajvaadi, NaviSunderpuriGim	SmtMaltiben K Maheswari, MLA	**Appx Cost Rs 6.00 Lakhs** Cost for Const. of Comp Wall
4	CSR activities for Construction work of Cabin at Oslo Area- Gim	SmtMaltiben& Shri VinadChavda	Cost not mentioned.
5	CSR activities & Land requirement forAkhil Kutch SamastaMeghvanshiGurjarmeghwal Charitable Trust ,Gim.	Shri Akhil Kutch SamastaMeghvanshiGurjarmeghwal Charitable Trust. Shri Dharmendra R Gohil	Cost Not mentioned. (demand of Land for development of SAMAJ VADI in Gandhidham)
6	CSR Activities for providing Water supply pipe line, Play ground and sports equipment, electric facilities, drinking water facilities for poor people & Fishermen at VANDI Village.	Shri R RKhambhra, PRO , Collector Office, Bhuj.	**Appx Cost Rs 51.00 Lakhs** (Last year also applied by village Sarpanch) & Recommended by Shri VASANBHAI AHIR, MLA, Shri V L Chavda, MP)
7	CSR activities for the Tuna village,	Sarpanch, Tuna village	**Appx Cost Rs. 25 Lakhs** **Cost for :-**

List of CSR applications received from various NGOs , Organizations , Village Sharpanchs etc for the FY 2021-22 .

Sr.No	Name of Scheme	Proposal Received from / Name of Organization / N.G.O	Brief Details
	Ta -Gim		2 No Fab shed 20’x20’x1250= 10 Lakh 2 Nos of Agnawadi =10 Lakh Fab shed for school=5 Lakh
8	CSR activities for the Global Vision India Foundation, Gim	Global vision India Foundation, G’dham	Requirement of Land –OR- Old building at Gandhidham for foundation of welfare activities.
9	CSR activities for the UNITED ORPHANAGE FOR THE DISABLED, TAMIL NADU	UNITED ORPHANAGE FOR THE DISABLED, TAMIL NADU	**Cost Rs 25,000.00** (Winter sweaters for children)
10	CSR activities for the Garden Development on already bounded area with Compound wall near Plot no 448 Sector-1/A, Gandhidham.	Residents, near Plot no 448, Sector-1/A, Gim.	**AppxCost Rs 20.00 Lakhs** (Requirement to provide benches, drinking water facility, plantation, lightings & walkways in side bounded area)
11	CSR activities for donation of Land for the Shri SUNDARPUI Govt Primary School, Gim	SmtMalti ben Maheshwari, MLA	(request for Land Requirement)
12	CSR activities for Extension of Adarsh Primary School building, Adipur	GandhidhamMatri Mandal, English Medium School, Adipur	**Appx Cost Rs. 40.00 Lakhs** (Construction for 4 Rooms extension) (Trust registered under Societies Registration Act XXI -1860, Reg No F-42 dtd 23.9.1965. Land belong to Trust)
13	CSR Activities for providing HD projector for KANYA MAHA VIDYALAYA, Adipur	Principal, KANYA MAHA VIDYALAYA, Adipur	**Cost Rs 1.50 Lakhs** (School Managed by G’dhamMaitry Mandal, Adipur)

List of CSR applications received from various NGOs , Organizations , Village Sharpanchs etc for the FY 2021-22 .

Sr.No	Name of Scheme	Proposal Received from / Name of Organization / N.G.O	Brief Details
14	CSR activities for DONATION various Medical Equipment for the Hospital of Gandhidham Jain SevaSamiti, Adipur	Gandhidham Jain SevaSamiti, Adipur	**Cost for** :- 1) Fresenius Haemodialysis Machine Rs 38.00 Lakh 2) Maltislice Helical CT Scanner- Rs 52.00 Lakhs 3) Others Rs 54.00 Lakhs (**Total Appx Cost Rs 144 Lakhs**)
15	CSR activities for SHRI VIDI JUTH GRAM PANCHAYAT, Vidi, Anjar	Sarpanch, Vidi Gram	**Appx Cost Rs 30.00 Lakhs** Cost for- Drainage , Garbage vehicle, and Cattle shed (Already applied earlier at Sr-5/12)
16	CSR activities for SOS CHILDRESN'S VILLAGES INDIA, Madhapar, Bhuj	Director, SOS Children's Village of India-Bhuj	**Appx Cost Rs 31.00 Lakhs** (request for Financial support towards parentless and abandoned Children Education support located at Bhuj) & support to women working in SOS.
17	Gujarat Biodiversity Board, Gandhinagar invites to involved National & Global endeavour of conservation of biodiversity by creating financial partnership with GBB under CSR programme of expenditure to be incurred 187 Lakh.	GUJARAT BIODIVERSITY BOAD, GANDHINAGAR	**Requirement-** Financial Support from DPT for **AppxRs 1.88 Cr.** (Cost for various meetings, collection of primary data from villagers , processing of documentation, printing , TA DA of Technical support &Miscexp for 150 Peoples Biodiversity Register (PBR).

List of CSR applications received from various NGOs , Organizations , Village Sharpanchs etc for the FY 2021-22 .

Sr.No	Name of Scheme	Proposal Received from / Name of Organization / N.G.O	Brief Details
18	CSR activities for providing furniture & Home appliances for ROJAVANAM TRUST at Madurai.	Shri Arul Kannan, Director	**Appx Cost Rs 30 Lakhs** (seeking help to provide facilities to Aged & Homeless people living in Trust and Purchasing of New Ambulance)
19	CSR activities for providing Dialysis Machine for treatment of Kidney patients at "ST JOSEPH'S HOSPITAL TRUST" at Gandhidham.	Sr. Franciline, Administrator of Hospital.	**Appx Cost Rs 31.36 Lakhs** (Cost of 5 Nos of Dialysis Machines for treatment of kidney patients)
20	CSR activities for providing facilities in Girls Hostel of Gasturba Gandhi BalikaVidhyalay, Gandhidham.	Shri Vinod L Chavda, MP	**Appx cost Rs 30 Lakhs.** (Cost of Comp Wall, Entrance gate, Girls toilets etc)
21	CSR works for providing Oxygen Generator Plant and 45 KV Silent Generator for COVID HOSPITAL at Swami LilashahKutia, Adipur.	Secretary, BHARAT VIKAS PARISHAD, Gandhidham	**Appx Cost Rs 80.00 Lakhs** (Facilities for 100 Beds of COVID patient which it to be extend upto 240 Beds)
22	CSR works for providing Two Numbers of Oxygen Concentrator and others medical equipment for the Trust ,Antarjal, Gim.	President SHRI SARV JEEV KALYAN TRUST, ANTARJAL, Gandhidham	**Appx Cost Rs21.50 Lakhs** (Facilities to be provided for the treatment of CORONA PATIENTS at their trust.)
23	CSR works for providing Fabricated Shed , Construction of Compound Wall and Land levelling for the Cattle of **GauSevaSamiti-Tappar** at Gram-Tappar, Ta Anjar.	Shri Vinod Chavda, MP &Presedent , GauSevaSamiti, village Tappar, Ta-Anjar	**Appx Cost Rs84 Lakhs** (Facilities to be provided for Cattle shelters at Village.) (Land belongs to Gram-panchayat)
24	CSR works for Construction of Auditorium Hall at RSETI (Rural Self Employment Training Institute) at	Shri Vinod Chavda, MP & Director of RSETI, Bhuj	**Cost not mentioned.** (Facilities to be provided

List of CSR applications received from various NGOs , Organizations , Village Sharpanchs etc for the FY 2021-22 .

Sr.No	Name of Scheme	Proposal Received from / Name of Organization / N.G.O	Brief Details
	Bhujodi-Bhuj.		for the people needs Self-employment activities.)
25	CSR works for Providing of Furniture for the School “SHRI GALPADAR PANCHAYAT PRATHMIC KUMAR GROUP SALA “ atGalpadar Village Ta Gim.	Principal, SHRI GALPADAR PANCHAYAT PRATHMIC KUMAR GROUP SALA “ atGalpadar Village Ta Gim.	**Cost not mentioned.** (Facilities to be provided for the Students of Workers & poor village people who study in the school.)
26	Construction of Shed, hall and Gate for the DADA Bhagwandas Charitable Trust, Adipur. (Sr no -4)	Shri Vinod Chavda, MP & DADA BHAGWANDAS CharitableTrust, Gandhidham	As per CSR Guideline- ➢ Promoting gender equality and empowering women ➢ Eradicating extreme hunger and poverty (Considered shed and hall) Fab Shelter Shed - 30’x100’ x 1250=37.00 Lakh & RCC Hall – 20’x100’x1500=30.00 Lakh (**Appx Cost Rs67.00 Lakhs**) Land authority belongs to Trust given by GDA and NOC given by SRC.Doc submitted.
27	CSR work for reconstruction of the Internal Roads of the Sector-9B-C and Sector-10 area in Gandhidham.	President, Shri TejaKangad, The Gandhidham Chamber of Commerce and Industry, Gandhidham.	Cost not mentioned.

List of CSR applications received from various NGOs , Organizations , Village Sharpanchsetc for the FY 2021-22 .

Sr.No	Name of Scheme	Proposal Received from / Name of Organization / N.G.O	Brief Details
	CSR Applications kept pending in last year Agenda:-		
27	CSR Activities for providing Water supply pipe line, Play ground and sports equipment, electric facilities, drinking water facilities for poor people & Fishermen at VANDI Village. (Sr no-3)	Sarpanch ,Village-VANDI , Ta- Anjar (Recommd. By Shri VASANBHAI AHIR, MLA, Shri V L Chavda, MP)	As per CSR Guideline- ➢ Env Sustainability ➢ Eradicating extreme hunger and poverty (to be Consider for health Center ,Drainage line, Water sump etc activities) **(Appx Cost - 51.00 Lakhs)** (Land authorization of Gram Panchayat)
28	Construction of Shed, hall and Gate for the DADA Bhagwandas Charitable Trust, Adipur. (Sr no -4)	DADA BHAGWANDAS CharitableTrust, Gandhidham (Recommd. By Shri V L Chavda, MP)	As per CSR Guideline- ➢ Promoting gender equality and empowering women ➢ Eradicating extreme hunger and poverty (Considered shed and hall) Fab Shed - 30'x100' x 1250=37.00 Lakh & RCC Hall – 20'x100'x1500=30.00 Lakh (**Appx Cost Rs 67.00 Lakhs**) Land authority belongs to Trust given by GDA and NOC given by SRC. Doc submitted.
29	10 Nos of Computers required for ShirMaheswarinagar Panchayat Girls Primary School, Gandhidham& Boys Group School, Gandhidham. (Sr no-8)	Maheswarinagar Panchayat Primary Kanya Sala, Gandhidham (Contact no 9913903686)	**AppxRs 5.00 Lakhs** As per CSR Guideline- ➢ Promotion of Education (to be consider for 20 Computers)

List of CSR applications received from various NGOs , Organizations , Village Sharpanchsetc for the FY 2021-22 .

Sr.No	Name of Scheme	Proposal Received from / Name of Organization / N.G.O	Brief Details
			Visited the site. Land belongs to MahewariMeghwadSamaj given by SRC for school purpose, doc are awaited.
30	Construction of Shed and Roof at JeparMatiyadev, shamsanbhumi at Kidana village &Maheswari Community Hall at JuniSundarpuri ,Gandhidham. (Sr no-10)	Shri VINOD CHAVDA, MP	**AppxRs 15.00 Lakhs** (Land authorization not mentioned)
31	Drainage, road, Dust bins, & shed for Cattle shelters at VIDI Village, Ta –Anjar. (Sr no- 12)	Village- VIDI, Ta: Anjar	**AppxRs 30.00 Lakhs** As per CSR Guideline- ➢ Env Sustainability ➢ Eradicating extreme hunger and poverty (Consider for Garbage vehicle & Drainage Cost)
32	Education, Women empowerment and Primary health care services at Kutch area. (Sr no-13)	Light of Life Trust, **Mumbai.**	Cost not mentioned.
33	Request for Help Divyang persons to employment by providing machineries. (Sr no-14)	Kutch DivyangSangthan, Gandhidham.	Cost not mentioned
34	Construction of 2nd Floor of Shri MaheswariMeghwadSamaj, Gandhidham. (Sr no-20)	Shri MaheswariMeghwadSamaj, Gandhidham	**AppxRs. 15.00 Lakhs** (Visited the site and Land ownership documents awaited) (Name plate of DPT fixed at the Asset)

List of CSR applications received from various NGOs , Organizations , Village Sharpanchsetc for the FY 2021-22 .

Sr.No	Name of Scheme	Proposal Received from / Name of Organization / N.G.O	Brief Details
35	Installation of Mini Science Center at Anjar and Gandhidham. (Sr no-21)	STEM Learning Pvt Ltd, Mumbai.	Cost not mentioned.
36	CSR work for Shri Rampar Gram Panchayat. ➢ Wall Plastering for Cattles -7 Lakhs ➢ Shed for Cattel's-15 Lakhs (Sr no-25)	Shri Sarpanch, Rampar Village.	**AppxRs 22.00 Lakhs** (Land authorization of Gram Panchayat and under taking submitted by applicant)
37	CSR activities for the 45,000 Patients over the period of 3 years by "SMILE FOUNDATION", Mumbai. 1. Concept for Nutrition covering 3 years 2. Concept for Mobile Health Unit reaching beneficiaries for 3 years 3. Concept for Vocational Training with NGO (Sr no-29)	Proposal from "SMILE FOUNDATION " Mumbai.	Appx Cost- **Rs 539 Lakhs** for 3 years
38	Development of Park in Public utility plot in between Block "C" & "D" of Sapna Nagar (NU-4) , Gandhidham (Sr no -31)	Shri RAVI MAHESHWARI, DPT	Land belongs to DPT earmarked for recreational purpose. (Total Cost –Rs**88.75 Lakhs**)
39	CSR works for NariJanshsktiVikas Foundation at Gandhidham near Shakti Nagar. (Sr no-33)	NariJanshsktiVikas Foundation, Ahmedabad	➢ Promoting gender equality and empowering women ➢ Env Sustainability ➢ Under promotion of education (Consider for Computers with printers, Sewing machine & RO plant**Cost Rs 48 Lakhs**)

ANNEXURE C

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

TABLE OF CONTENTS

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

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.

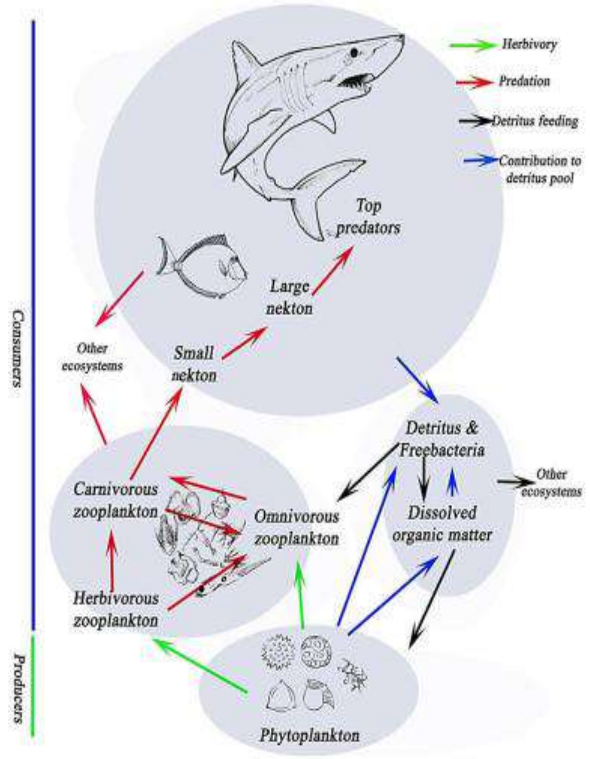
Based on the duration of planktonic life, zooplankton are categorised into Holoplankton (organisms which complete their entire lifecycle as plankton) and Meroplankton (organisms which are planktonic during the early part of their lives such as the larval stages of benthic and nektonic organisms). Tychoplankton 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

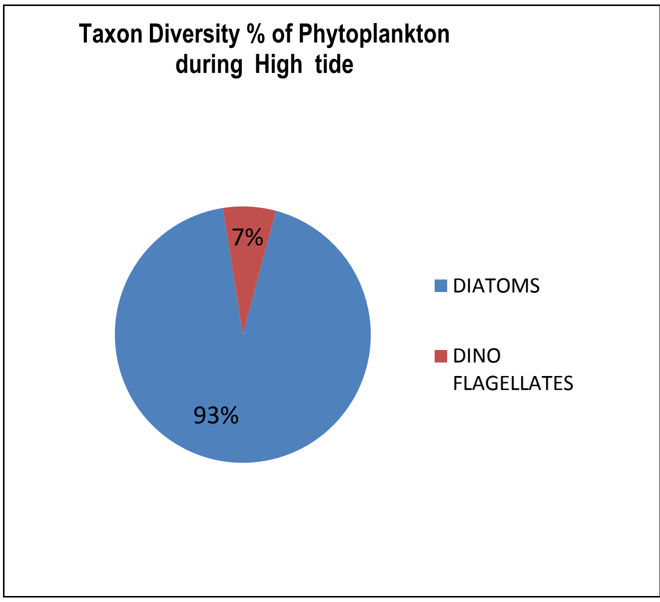
Table # 6 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING SPRING TIDE IN JUNE,2021

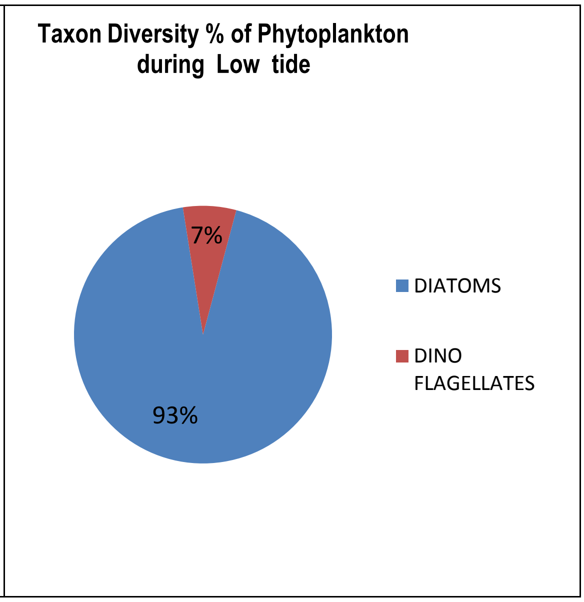
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	112-214	14/15	93.33
			DINO FLAGELLATES	0-2	1/15	6.67
			TOTAL PHYTO PLANKTON	112-216	15	-
LOW TIDE	Sub 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

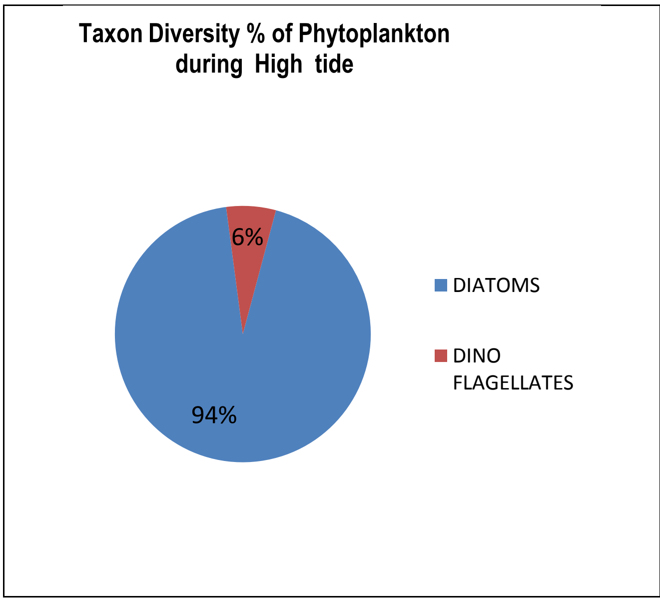
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	72-291	15/16	93.75
			DINO FLAGELLATES	0-2	1/16	6.25
			TOTAL PHYTO PLANKTON	72-293	16	-
LOW TIDE	Sub surface	5	DIATOMS	202-374	15/16	93.75
			DINO FLAGELLATES	0-1	1/16	6.25
			TOTAL PHYTO PLANKTON	202-375	16	

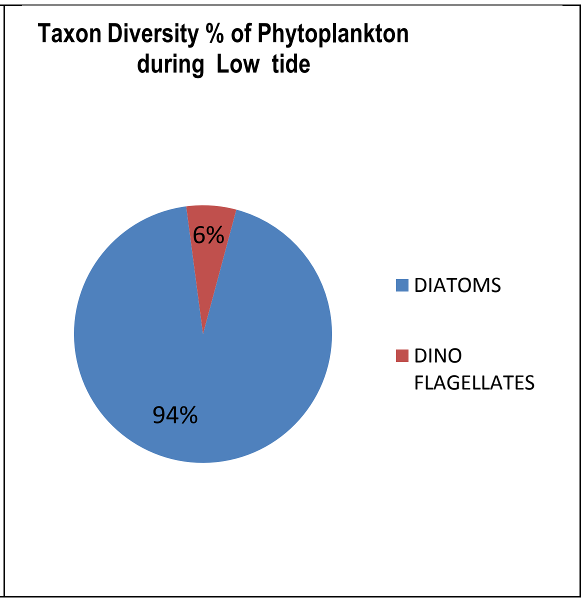
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide





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

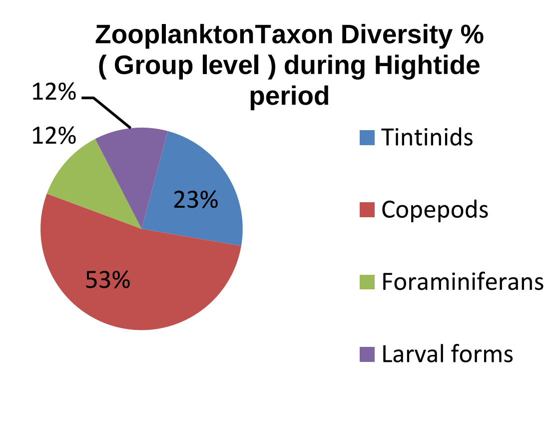
Table # 10 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN JUNE,2021

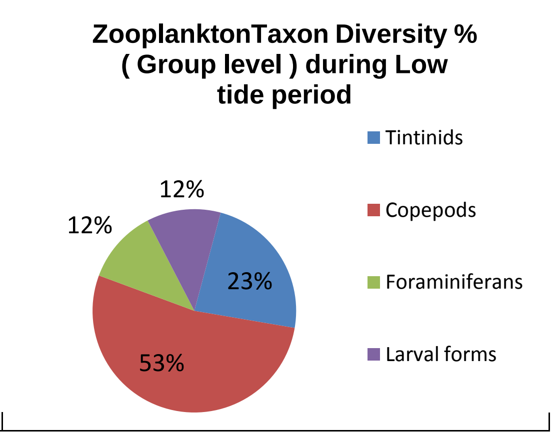
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	10-16	4/17	23.53
			Copepods	31-72	9/17	52.95
			Foraminiferans	0-4	2/17	11.76
			Larval forms	15-50	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

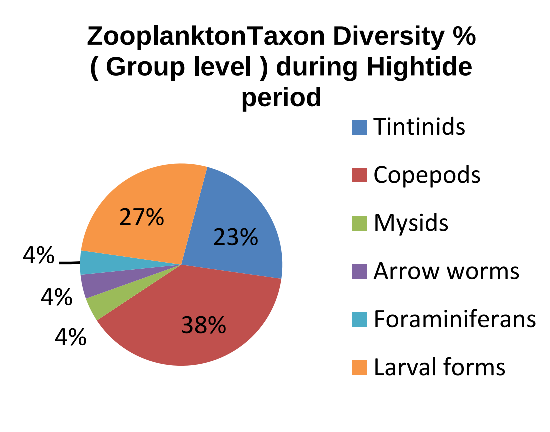
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	4-15	6/26	23.07
			Copepods	25-98	10/26	38.46
			Mysids	1-2	1/26	3.85
			Arrow worms	1-2	1/26	3.85
			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



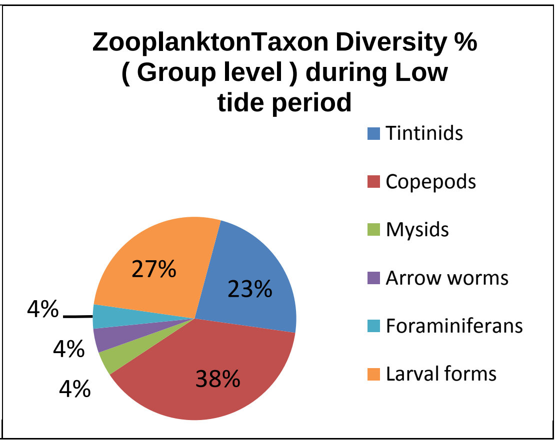


TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURINGSPRING TIDE OF JUNE,2021

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	*Planktoniellasp*	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	*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/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	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/m³ The mean PM_{10} values were 496 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were below the permissible limit (mean = 47 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 4.25 µg/m³, 28.61 µg/m³ and 12.48 µg/m³ respectively.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Oil Jetty. The mean Benzene concentration was 1.27 µg/m³ .Well below the permissible limit of 5.0 µg/m³. , HC's were below the detectable limit and Carbon Monoxide concentration was 1.74 mg/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

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/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
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/m³, The mean PM_{10} values were 230 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were slight above the permissible limit (mean= 63 µg/m³). The average values of SO_2, NO_x and NH_3 were 2.00 µg/m³, 18.82 µg/m³ and 7.16 µg/m³ 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/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.61 mg/m³, well below the permissible limit of 4.0 mg/m³.

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/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	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, 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 354 µg/m^3. The mean PM_{10} values were 206 µg/m^3, which is well above the permissible limit. $PM_{2.5}$ values were below the permissible limit (mean = 40 µg/m^3). The average values of SO_2, NO_x and NH_3 were 6.94 µg/m^3, 33.50 µg/m^3 and 15.55 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 1.23 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 1.83 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	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.

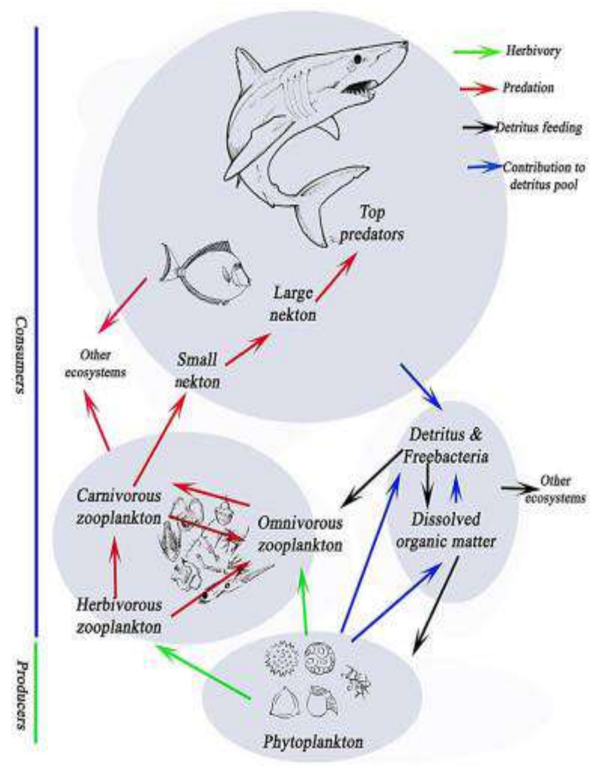
Based on the duration of planktonic life, zooplankton are categorised into Holoplankton (organisms which complete their entire lifecycle as plankton) and Meroplankton (organisms which are planktonic during the early part of their lives such as the larval stages of benthic and nektonic organisms). Tychoplankton 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

$$H' = -\sum_{j=1}^{s} \frac{n_j}{N} \ln\left(\frac{n_j}{N}\right)$$

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

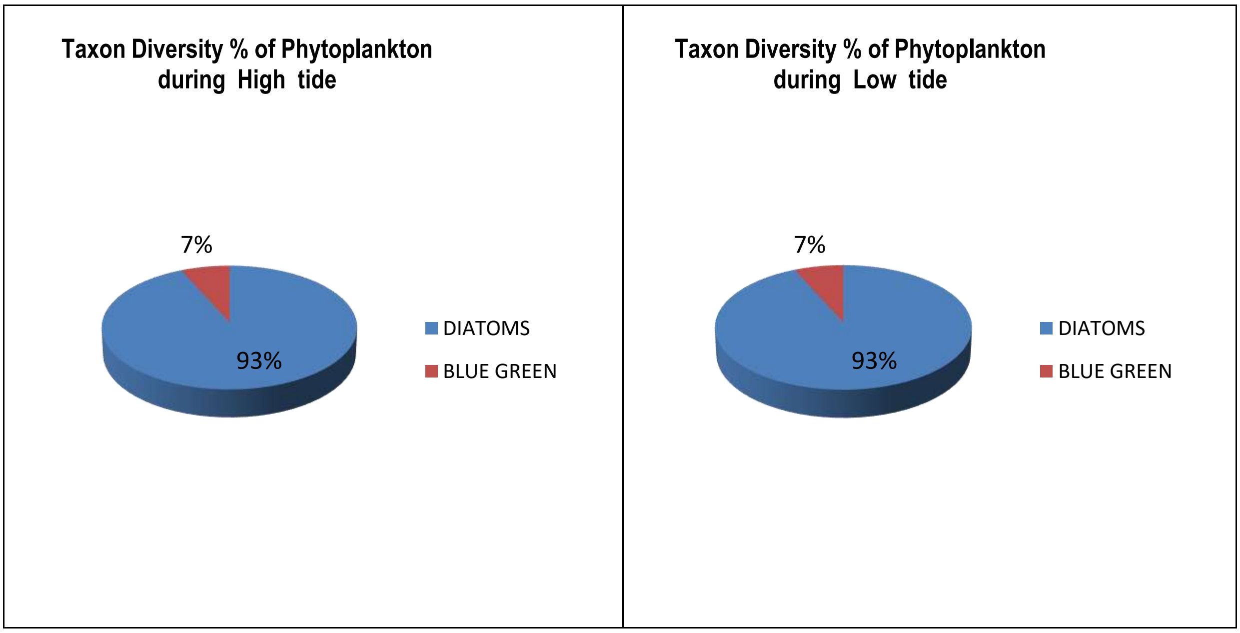
Table # 6 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING SPRING TIDE IN JULY,2021

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	-

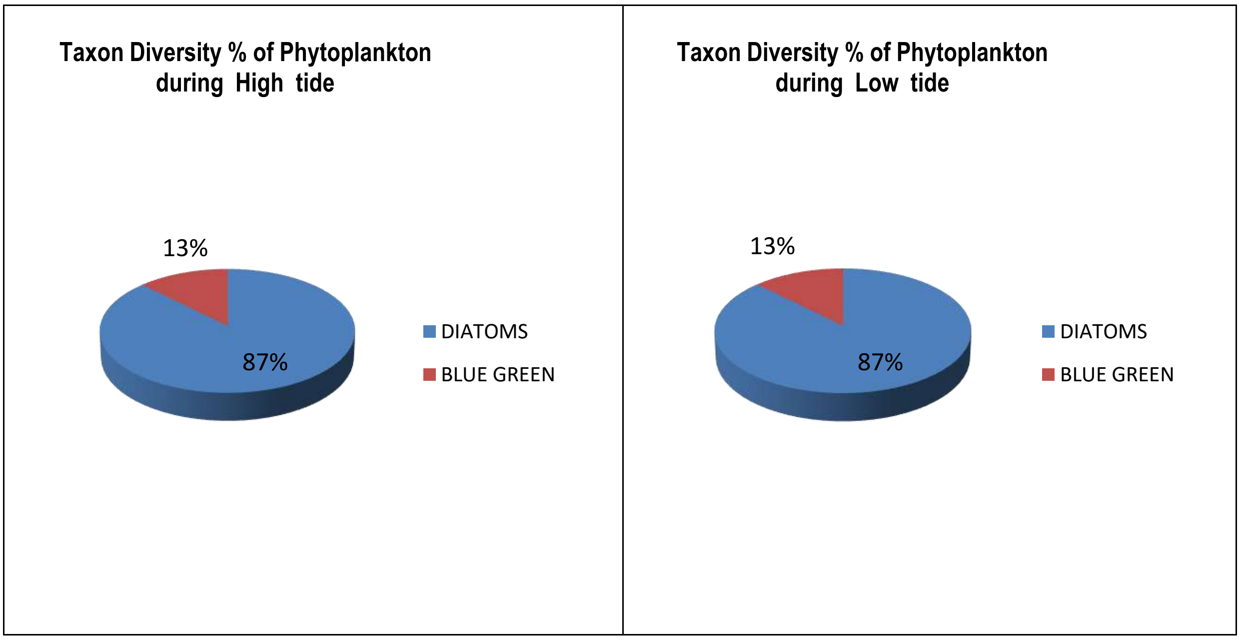
Table # 7 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING NEAP TIDE IN JULY,2021

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

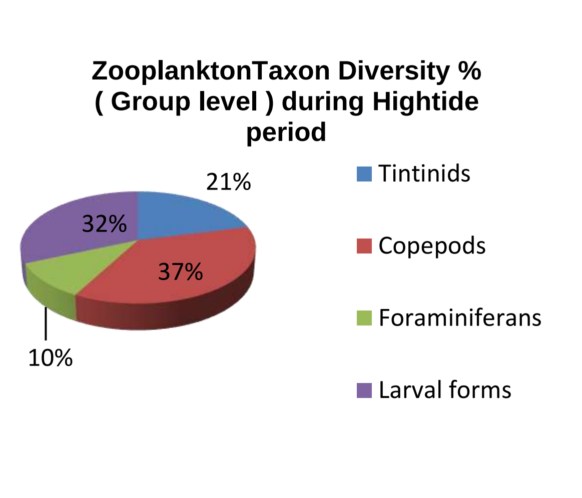
Table # 10 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN JULY2021

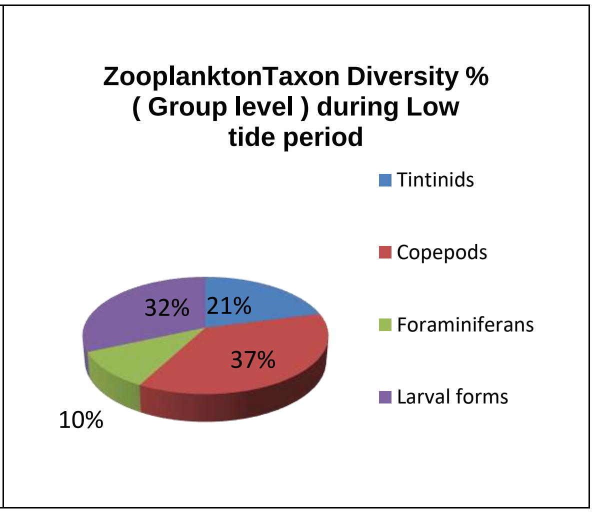
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	3-10	4/19	21.05
			Copepods	34-77	7/19	36.84
			Foraminiferans	2-6	2/19	10.53
			Larval forms	20-57	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

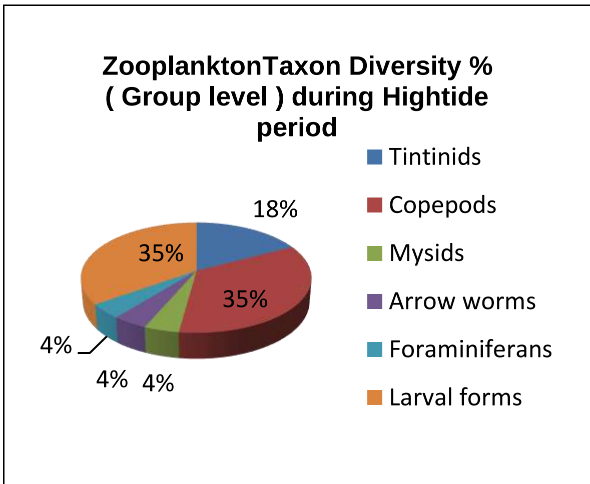
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	4-13	4/23	17.39
			Copepods	37-83	8/23	34.78
			Mysids	0-2	1/23	4.35
			Arrow worms	1-2	1/23	4.35
			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



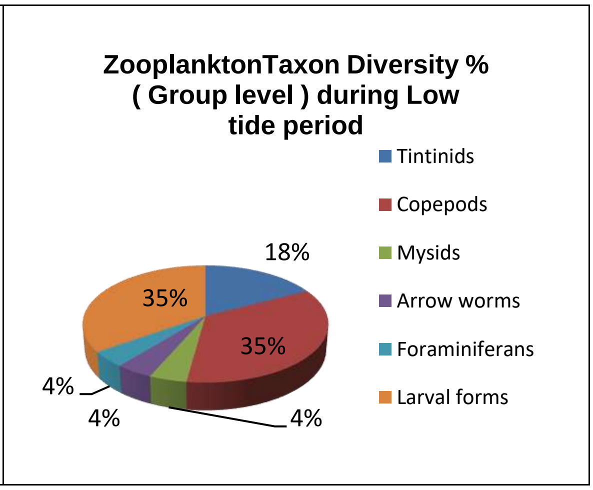


TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURINGSPRING TIDE OF JUlY,2021

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/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	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/m³. The mean PM_{10} values were 327 µg/m³, which is well above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 80 µg/m³). The average values of SO_2, NO_x and NH_3 were 4.54 µg/m³, 21.70 µg/m³ and 11.55 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 1.24 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.91 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	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.

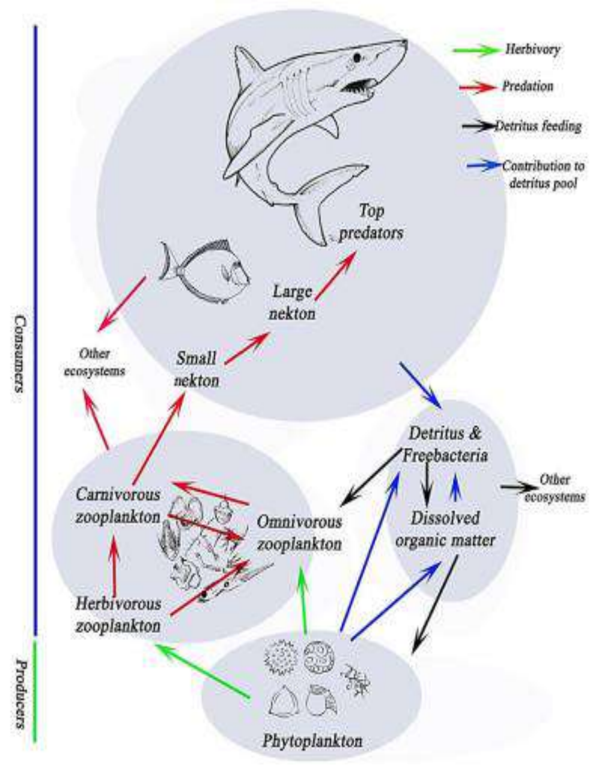
Zooplankton can be subdivided into holoplankton, i.e., permanent members of the plankton (e.g., Calanoid copepods), and meroplankton, i.e., temporary members in the plankton e.g., larvae of fish,

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

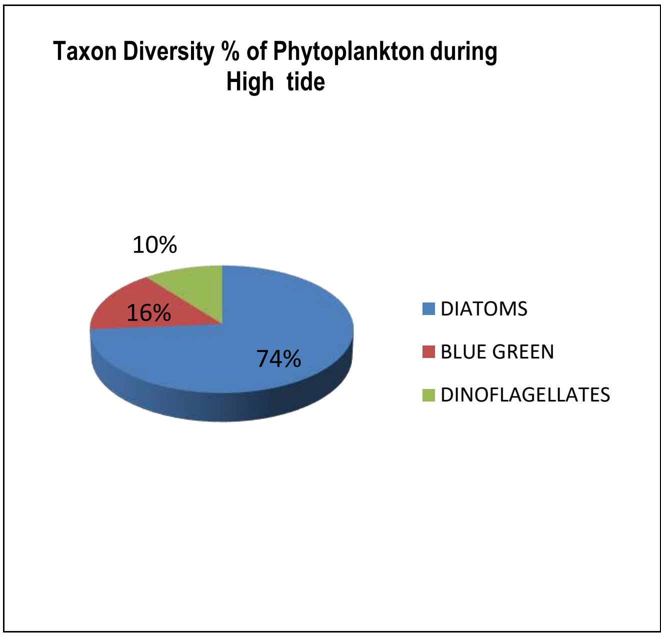
Table # 6 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING SPRING TIDEIN AUGUST, 2021

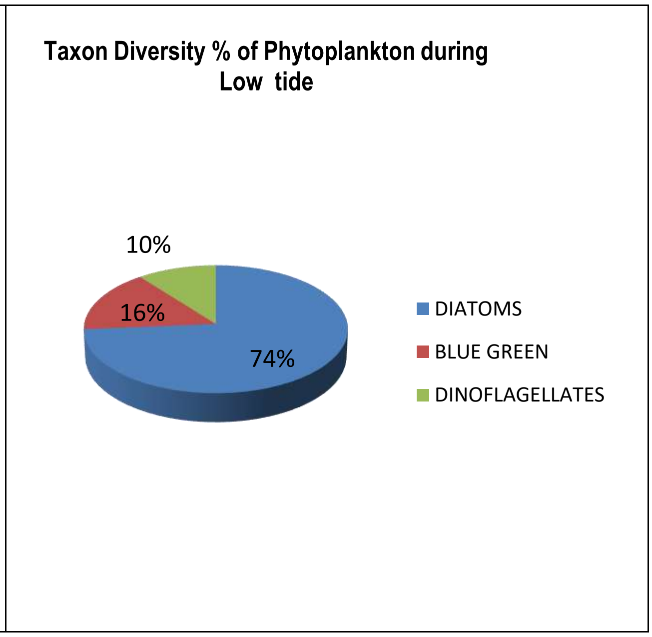
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	94-215	14/19	73.68
			BLUE GREEN	4-13	3/19	15.79
			DINOFLAGELLATES	0-1	2/19	10.53
			TOTAL PHYTO PLANKTON	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

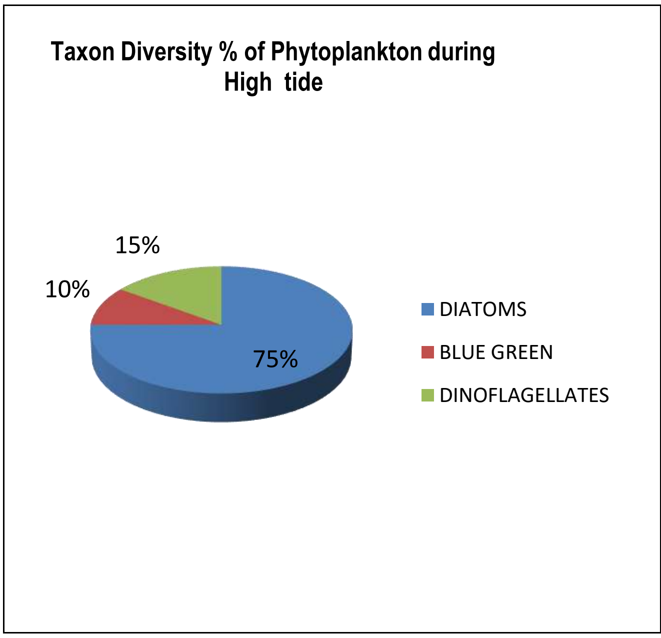
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	64-298	15/20	75
			BLUE GREEN	0-6	2/20	10
			DINOFLAGELLATES	0-5	3/20	15
			TOTAL PHYTO PLANKTON	65-307	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	-

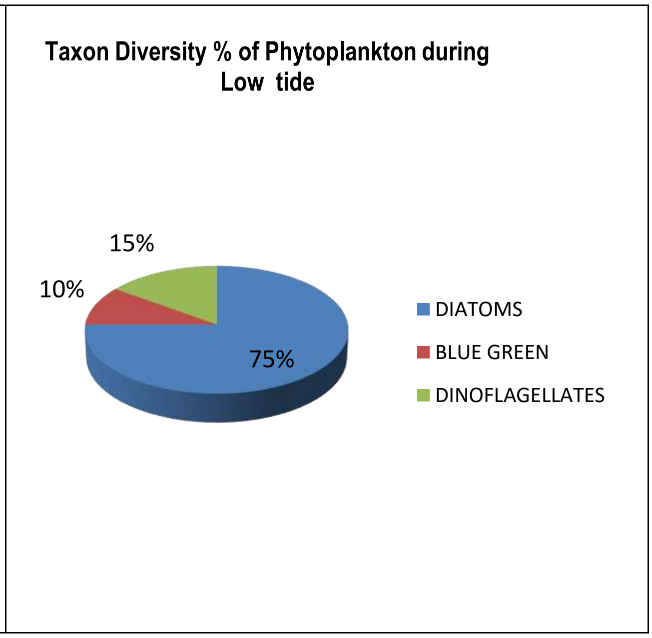
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide





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

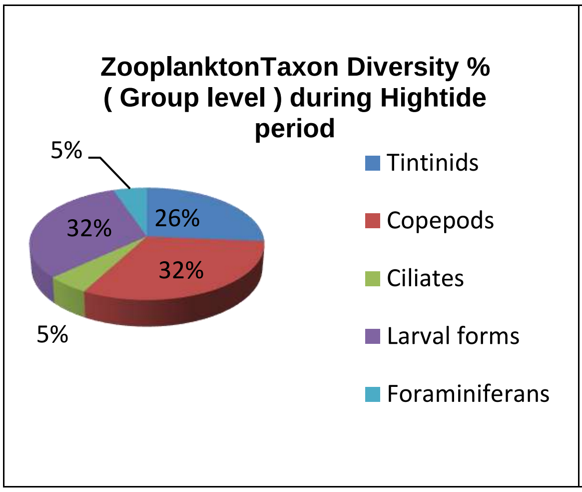
Table # 10 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN AUGUST,2021

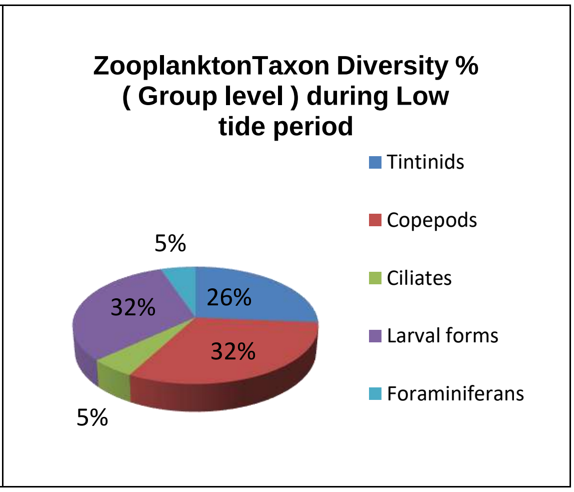
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton $x10^3$ Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	1-28	5/19	26.32
			Copepods	17-49	6/19	31.58
			Ciliates	1-6	1/19	5.26
			Larval forms	9-46	6/19	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

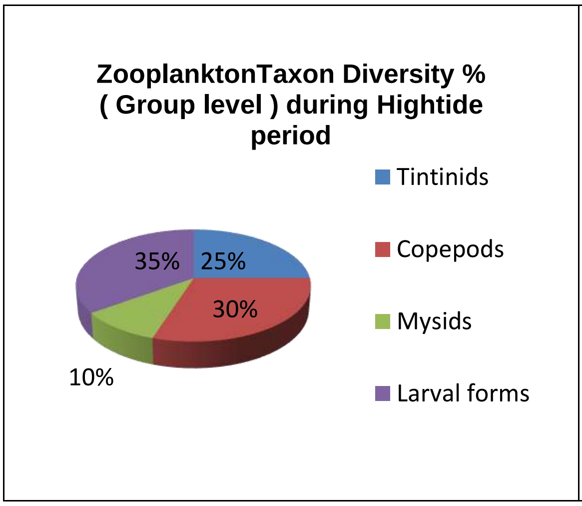
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton $x10^3$ Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	1-11	5/20	25
			Copepods	7-26	6/20	30
			Mysids	0-6	2/20	10
			Larval forms	15-84	7/20	35
			TOTAL 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



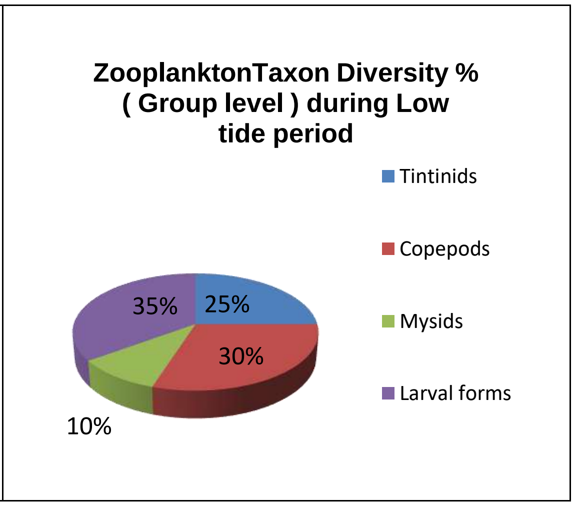


TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURINGSPRING TIDE OF AUGUST, 2021

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	*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.

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ENVIRONMENTAL MONITORING REPORT
FOR
DEENDAYAL PORT TRUST

REPORT NO.	**:**	**DCPL/DPT/20-21/17**
Month	**:**	**September 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 September 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	03.09.2021	412	314	76	3.96	5.13	10.80	29.22	5.36	9.53
					6.59		32.39		13.02	
					4.84		44.46		10.21	
AL1 – 2	08.09.2021	673	579	50	3.52	3.81	13.34	26.25	12.25	12.85
					3.08		49.54		12.76	
					4.84		15.88		13.53	
AL1 – 3	10.09.2021	706	552	53	3.08	4.25	11.43	17.78	15.32	16.17
					6.15		17.15		14.55	
					3.52		24.77		18.64	
AL1 – 4	15.09.2021	357	260	82	6.15	4.84	17.78	39.80	18.12	15.06
					3.52		52.72		16.34	
					4.84		48.91		10.72	
AL1 – 5	17.09.2021	297	178	89	1.76	4.40	17.78	28.58	16.34	15.49
					5.28		24.77		15.57	
					6.15		43.19		14.55	
AL1 - 6	22.09.2021	387	309	72	3.52	3.08	40.02	38.53	5.36	9.53
					3.96		45.10		11.23	
					1.76		30.49		12.00	
AL1 - 7	24.09.2021	288	176	67	3.08	3.52	12.70	19.27	20.42	21.95
					4.84		23.50		22.46	
					2.64		21.60		22.98	
AL1 – 8	28.09.2021	471	299	163	17.14	13.48	27.95	27.31	20.68	21.53
					18.90		33.66		19.66	
					4.40		20.33		24.25	
Monthly Average		449	333	81		5.31		28.34		15.26
Standard Deviation		160	153	36		3.37		7.89		4.73

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	03.09.2021	1.11	BDL	1.89	492
AL1 – 2	08.09.2021	1.2	BDL	1.92	499
AL1 – 3	10.09.2021	1.3	BDL	1.9	486
AL1 – 4	15.09.2021	1.22	BDL	1.86	496
AL1 – 5	17.09.2021	1.27	BDL	1.88	501
AL1 - 6	22.09.2021	1.16	BDL	1.79	492
AL1 – 7	24.09.2021	1.18	BDL	1.86	496
AL1 – 8	28.09.2021	1.22	BDL	1.92	488
Monthly Average		**1.21**	**-**	**1.88**	**494**
Standard Deviation		**0.06**	**-**	**0.04**	**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 449 µg/m^3, The mean PM_{10} values were 333.0 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 81 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 5.31 µg/ m^3, 28.34 µg/ m^3 & 15.26 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 1.21 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 1.88 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	03.09.2021	645	423	158	6.15	4.84	23.50	16.30	17.87	14.72
					3.52		13.34		16.08	
					4.84		12.07		10.21	
AL2 – 2	08.09.2021	697	594	45	4.40	4.40	12.07	37.26	13.53	13.87
					5.28		45.73		10.21	
					3.52		53.99		17.87	
AL2 – 3	10.09.2021	673	561	62	3.52	4.25	28.58	18.84	9.45	10.81
					4.40		21.60		13.02	
					4.84		6.35		9.96	
AL2 – 4	15.09.2021	604	481	103	2.20	3.52	28.58	42.56	16.59	16.93
					3.08		46.37		17.87	
					5.28		52.72		16.34	
AL2 – 5	17.09.2021	616	571	38	6.15	3.81	46.37	38.53	11.74	8.34
					3.08		55.89		6.13	
					2.20		13.34		7.15	
AL2 – 6	22.09.2021	673	563	102	2.20	4.54	57.16	51.66	10.47	9.02
					5.28		45.10		9.70	
					6.15		52.72		6.89	
AL2 – 7	24.09.2021	245	159	71	6.15	3.52	23.50	38.11	10.47	14.81
					3.08		50.81		15.32	
					1.32		40.02		18.64	
AL2 – 8	28.09.2021	280	178	82	4.40	8.94	15.88	18.42	13.02	15.06
					8.79		13.34		8.42	
					13.63		26.04		23.74	
Monthly Average		554	442	83		4.73		32.71		12.94
Standard Deviation		183	177	39		1.77		13.12		3.14

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	03.09.2021	1.12	BDL	1.56	490
AL2 -2	08.09.2021	1.16	BDL	1.62	488
AL2 -3	10.09.2021	1.06	BDL	1.66	496
AL2 -4	15.09.2021	1.13	BDL	1.72	501
AL2 – 5	17.09.2021	1.23	BDL	1.76	490
AL2 – 6	22.09.2021	1.06	BDL	1.7	488
AL2 -7	24.09.2021	1.19	BDL	1.68	486
AL2 – 8	28.09.2021	1.22	BDL	1.74	493
Monthly Average		**1.15**	**-**	**1.68**	**492**
Standard Deviation		**0.07**	**-**	**0.07**	**5**

* 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 554 µg/m^3 .The mean PM_{10} values were 442 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 83 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 4.73 µg/m^3, 32.71 µg/m^3 and 12.94 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 1.15 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 1.68 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	03.09.2021	239	162	61	3.96	4.54	41.29	37.69	9.45	11.49
					4.40		38.11		11.49	
					5.28		33.66		13.53	
AL3 – 2	08.09.2021	412	288	97	2.64	3.37	20.96	35.36	12.00	12.59
					4.40		40.02		15.57	
					3.08		45.10		10.21	
AL3 – 3	10.09.2021	248	121	41	5.28	4.69	17.78	23.08	15.06	15.57
					5.71		28.58		16.08	
					3.08		22.87		15.57	
AL3 – 4	15.09.2021	195	123	68	4.40	3.08	15.88	17.15	12.00	9.36
					1.76		11.43		7.15	
					3.08		24.14		8.93	
AL3 – 5	17.09.2021	256	194	55	3.08	3.22	32.39	31.55	16.59	14.81
					2.20		30.49		16.85	
					4.40		31.76		10.98	
AL3 – 6	22.09.2021	554	153	39	3.52	3.52	24.14	35.78	18.12	15.06
					3.08		40.02		12.25	
					3.96		43.19		14.81	
AL3 – 7	24.09.2021	467	399	52	2.64	3.08	27.31	34.72	5.36	6.72
					1.76		32.39		6.38	
					4.84		44.46		8.42	
AL3 – 8	28.09.2021	355	253	64	8.79	16.41	7.62	14.19	14.04	10.55
					34.73		14.61		6.13	
					5.71		20.33		11.49	
Monthly Average		341	211	60		5.24		28.69		12.02
Standard Deviation		128	96	18		4.56		9.22		3.11

NS: Not Specified

Table 3B : Results of Air Pollutant Concentration at Kandla Port Colony					
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**
AL3 -1	03.09.2021	1.1	BDL	1.77	492
AL3 -2	08.09.2021	1.06	BDL	1.82	480
AL3 -3	10.09.2021	1.11	BDL	1.86	479
AL3 -4	15.09.2021	1.16	BDL	1.8	482
AL3 – 5	17.09.2021	1.18	BDL	1.92	477
AL3 – 6	22.09.2021	1.26	BDL	1.96	486
AL3 – 7	24.09.2021	1.22	BDL	1.86	478
AL3 – 8	28.09.2021	1.21	BDL	1.78	482
Monthly Average		**1.16**	**-**	**1.85**	**482**
Standard Deviation		**0.07**	**-**	**0.07**	**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 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 341 µg/m³, The mean PM_{10} values were 211 µg/m³, which is above the permissible limit. $PM_{2.5}$ values within the permissible limit (mean = 60 µg/m³). The average values of SO_2, NO_x and NH3 were 5.24 µg/m³, 28.69 µg/m³ and 12.02 µg/m³ 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 1.16 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.85 mg/m³, well below the permissible limit of 4.0 mg/m³.

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	03.09.2021	167	118	37	4.40	3.52	13.34	14.40	8.42	6.30
					2.64		23.50		5.36	
					3.52		6.35		5.11	
AL4 -2	08.09.2021	256	178	63	3.08	3.66	13.34	21.17	8.42	8.85
					1.76		36.84		5.36	
					6.15		13.34		12.76	
AL4 -3	10.09.2021	165	122	26	1.32	2.34	30.49	30.06	12.25	9.36
					3.96		36.20		8.17	
					1.76		23.50		7.66	
AL4 -4	15.09.2021	189	124	54	3.08	4.54	48.91	41.29	5.62	8.59
					4.40		40.02		9.45	
					6.15		34.93		10.72	
AL4 – 5	17.09.2021	185	104	48	2.20	4.40	11.43	24.56	12.00	11.15
					6.15		22.23		7.91	
					4.84		40.02		13.53	
AL4 – 6	22.09.2021	249	101	45	1.76	3.08	17.15	14.40	9.19	8.59
					3.08		12.07		6.89	
					4.40		13.97		9.70	
AL4 – 7	24.09.2021	167	116	43	2.20	2.49	24.14	16.94	9.70	11.83
					0.88		15.88		13.53	
					4.40		10.80		12.25	
AL4 – 8	28.09.2021	177	122	48	0.88	0.88	5.08	6.14	5.87	5.87
					1.32		5.72		7.15	
					0.44		7.62		4.60	
Monthly Average		194	123	46		3.11		21.12		8.82
Standard Deviation		37	24	11		1.20		10.89		2.07

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	03.09.2021	1.01	BDL	1.76	485
AL4 -2	08.09.2021	1.1	BDL	1.62	480
AL4 -3	10.09.2021	1.06	BDL	1.7	490
AL4 -4	15.09.2021	1.11	BDL	1.59	494
AL4 – 5	17.09.2021	1.18	BDL	1.7	486
AL4 – 6	22.09.2021	1.16	BDL	1.81	490
AL4 – 7	24.09.2021	1.08	BDL	1.79	487
AL4 – 8	28.09.2021	1.06	BDL	1.73	497
Monthly Average		**1.10**	**-**	**1.71**	**489**
Standard Deviation		**0.06**	**-**	**0.08**	**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 Gopalpuri Hospital was attributed by vehicle emission produced from light motor vehicles of the colony residents. The mean TSPM values at Oil Jetty were 194 µg/m^3, The mean PM_{10} values were 123 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were in within the permissible limit (mean= 46 µg/m^3). The average values of SO_2, NO_x and NH_3 were 3.11 µg/m^3, 21.12 µg/m^3 and 8.82 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 1.10 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 1.71 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	03.09.2021	380	115	86	3.52	4.10	32.39	30.28	13.79	14.30
					3.96		37.47		12.25	
					4.84		20.96		16.85	
AL5 – 2	08.09.2021	275	176	80	2.64	4.40	18.42	30.06	6.38	5.79
					6.59		33.66		5.11	
					3.96		38.11		5.87	
AL5 – 3	10.09.2021	302	225	74	2.20	3.66	52.72	48.91	9.45	10.64
					4.84		31.12		6.38	
					3.96		62.88		16.08	
AL5 – 4	15.09.2021	378	242	97	3.08	4.98	13.34	31.33	9.70	10.72
					5.28		50.81		12.76	
					6.59		29.85		9.70	
AL5 – 5	17.09.2021	210	138	70	4.84	4.10	12.07	27.31	9.70	10.98
					3.52		48.91		10.21	
					3.96		20.96		13.02	
AL5 – 6	22.09.2021	402	305	92	5.28	5.71	19.05	28.37	14.55	12.08
					6.15		26.04		12.25	
					5.71		40.02		9.45	
AL5 – 7	24.09.2021	268	151	73	2.64	4.69	32.39	33.66	18.64	17.61
					4.84		31.76		16.08	
					6.59		36.84		18.12	
AL5 – 8	28.09.2021	375	248	70	5.71	6.15	26.04	18.00	15.32	16.00
					6.15		5.72		19.91	
					6.59		22.23		12.76	
Monthly Average		324	200	80		4.73		30.99		12.26
Standard Deviation		69	65	10		0.96		8.61		3.69

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	03.09.2021	1.22	BDL	1.9	489
AL5 – 2	08.09.2021	1.26	BDL	1.86	499
AL5 – 3	10.09.2021	1.3	BDL	1.79	501
AL5 – 4	15.09.2021	1.22	BDL	1.88	486
AL5 – 5	17.09.2021	1.21	BDL	1.86	488
AL5 – 6	22.09.2021	1.35	BDL	1.8	492
AL5 – 7	24.09.2021	1.34	BDL	1.92	496
AL5 – 8	28.09.2021	1.30	BDL	1.93	502
Monthly Average		**1.28**	**-**	**1.87**	**494**
Standard Deviation		**0.06**	**-**	**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 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 324 µg/m^3. The mean PM_{10} values were 200 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 4.73 µg/m^3, 30.99 µg/m^3 and 12.26 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 Coal Storage Area. The mean Benzene concentration was 1.28 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 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	03.09.2021	186	104	52	7.03	5.13	12.70	38.11	14.30	16.34
					4.40		57.16		16.85	
					3.96		44.46		17.87	
AL6 – 2	08.09.2021	253	123	75	4.40	4.69	11.43	17.36	6.38	10.64
					6.15		18.42		14.04	
					3.52		22.23		11.49	
AL6 – 3	10.09.2021	214	128	57	3.52	3.66	25.41	23.29	9.96	13.87
					5.28		32.39		21.70	
					2.20		12.07		9.96	
AL6 – 4	15.09.2021	166	108	49	2.20	4.54	30.49	20.96	9.70	9.70
					4.84		19.05		9.19	
					6.59		13.34		10.21	
AL6 – 5	17.09.2021	253	177	50	3.08	4.69	52.72	45.52	12.25	12.51
					4.84		45.10		15.57	
					6.15		38.74		9.70	
AL6 – 6	22.09.2021	441	135	49	1.32	3.22	27.31	31.97	13.02	13.79
					3.08		38.74		15.57	
					5.28		29.85		12.76	
AL6 – 7	24.09.2021	216	130	46	3.08	3.81	33.66	40.44	16.08	12.00
					5.28		44.46		10.47	
					3.08		43.19		9.45	
AL6 – 8	28.09.2021	179	106	62	1.76	3.37	13.34	7.20	5.87	7.23
					3.96		4.45		5.36	
					4.40		3.81		10.47	
Monthly Average		238	126	55		4.14		28.11		12.01
Standard Deviation		88	24	10		0.71		13.08		2.82

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	03.09.2021	1.19	BDL	1.86	478
AL6 – 2	08.09.2021	1.16	BDL	1.92	492
AL6 – 3	10.09.2021	1.21	BDL	1.78	486
AL6 – 4	15.09.2021	1.06	BDL	1.92	482
AL6 – 5	17.09.2021	1.1	BDL	1.86	478
AL6 – 6	22.09.2021	1.02	BDL	1.8	492
AL6 – 7	24.09.2021	1.21	BDL	1.79	488
AL6 – 8	28.09.2021	1.2	BDL	1.86	478
Monthly Average		**1.14**	**-**	**1.85**	**484**
Standard Deviation		**0.07**	**-**	**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 Tuna Port were 238 µg/m³, The mean PM_{10} values were 126 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were within the permissible limit (mean = 55 µg/m³). The average values of SO_2, NO_x and NH_3 were 4.14 µg/m³, 28.11 µg/m³ and 12.01 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 1.14 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.85 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	03.09.2021	158	88	43	3.96	12.60	9.53	10.80	5.62	6.21
					30.77		8.89		4.60	
					3.08		13.97		8.42	
AL7 -2	08.09.2021	158	93	59	3.96	3.52	13.97	14.61	9.96	9.28
					4.40		17.78		6.64	
					2.20		12.07		11.23	
AL7 -3	10.09.2021	180	108	53	3.08	3.22	19.05	12.28	5.62	4.51
					3.52		10.80		4.85	
					3.08		6.99		3.06	
AL7 -4	15.09.2021	169	102	33	5.28	4.25	13.97	12.70	6.13	8.85
					3.52		10.16		9.96	
					3.96		13.97		10.47	
AL7 -5	17.09.2021	160	87	27	5.28	3.66	10.80	9.74	8.42	5.87
					2.64		8.26		5.62	
					3.08		10.16		3.57	
AL7 -6	22.09.2021	177	95	64	3.52	4.40	13.97	8.79	10.47	9.87
					3.96		10.80		9.96	
					5.71		1.59		9.19	
AL7 -7	24.09.2021	139	94	32	2.20	3.52	13.97	12.91	6.38	6.72
					4.40		12.70		8.42	
					3.96		12.07		5.36	
AL7 -8	28.09.2021	168	107	43	2.64	3.08	14.61	12.49	8.68	7.40
					3.08		8.89		6.13	
					3.52		13.97		7.40	
Monthly Average		164	97	44		5		12		7
Standard Deviation		13	8	13		3		2		2

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	03.09.2021	1.12	BDL	1.8	456
AL7 – 2	08.09.2021	1.06	BDL	1.78	462
AL7 – 3	10.09.2021	1.11	BDL	1.86	470
AL7 – 4	15.09.2021	1.18	BDL	1.8	455
AL7 – 5	17.09.2021	1.25	BDL	1.72	469
AL7 – 6	22.09.2021	1.16	BDL	1.68	460
AL7 – 7	24.09.2021	1.2	BDL	1.77	463
AL7 – 8	28.09.2021	1.26	BDL	1.7	460
Monthly Average		**1.17**	**-**	**1.76**	**462**
Standard Deviation		**0.07**	**-**	**0.06**	**5**

* 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 164 µg/m^3. The mean PM_{10} values were 97 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 44 µg/m^3). The average values of SO_2, NO_x and NH_3 were 5.0 µg/m^3, 12.0 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 1.17 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 1.76 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	03.09.2021	164	83	24	3.96	4.25	13.34	12.28	5.87	4.77
					3.96		12.07		5.87	
					4.84		11.43		2.55	
AL8 -2	08.09.2021	198	130	35	4.40	5.28	20.96	20.54	5.11	5.70
					6.15		17.78		4.85	
					5.28		22.87		7.15	
AL8 -3	10.09.2021	177	86	64	2.64	3.81	8.89	12.91	8.42	8.34
					3.96		13.97		9.19	
					4.84		15.88		7.40	
AL8 -4	15.09.2021	150	78	25	2.64	2.07	20.96	16.94	8.42	6.98
					3.08		17.78		4.08	
					0.48		12.07		8.42	
AL8 -5	17.09.2021	156	84	46	2.20	3.52	247.71	91.46	5.62	6.72
					3.96		12.70		6.89	
					4.40		13.97		7.66	
AL8 -6	22.09.2021	198	123	55	3.52	4.10	11.43	13.97	4.60	4.85
					4.40		14.61		4.34	
					4.40		15.88		5.62	
AL8 -5	24.09.2021	172	101	54	3.08	2.34	9.53	9.10	8.68	7.83
					3.52		6.99		11.23	
					0.44		10.80		3.57	
AL8-6	28.09.2021	135	79	34	4.84	5.57	7.62	9.95	3.57	6.30
					5.71		9.53		5.62	
					6.15		12.70		9.70	
Monthly Average		169	95	42		4		23		6
Standard Deviation		22	20	15		1		28		1

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	03.09.2021	1.06	BDL	1.78	460
AL8-2	08.09.2021	1.1	BDL	1.8	472
AL8 -3	10.09.2021	1.02	BDL	1.68	460
AL8-4	15.09.2021	1.1	BDL	1.72	461
AL8 -5	17.09.2021	1.17	BDL	1.81	452
AL8-6	22.09.2021	1.06	BDL	1.76	460
AL8-7	24.09.2021	1.1	BDL	1.66	470
AL8-8	28.09.2021	1.11	BDL	1.6	465
Monthly Average		**1.09**	**-**	**1.73**	**463**
Standard Deviation		**0.04**	**-**	**0.07**	**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 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 169 µg/m^3. The mean PM_{10} values were 95 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 42.0 µg/m^3). The average values of SO_2, NO_x and NH_3 were 4.0 µg/m^3, 23.0 µg/m^3 and 6.0 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 1.09 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.

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	7.36	7.31	7.4	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1343	1312	1350	500	2000
3	Turbidity	NTU	0	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	2630	2600	2690	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/l	420.94	365.81	370.82	250.0	1000.0
9	Ca as Ca	mg/l	72.14	56.11	52.10	75.0	200.0
10	Mg as Mg	mg/l	85.05	72.90	65.61	30.0	100.0
11	Total Hardness	mg/l	350	300	270	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	0.35	0.54	0.21	1.0	1.5
14	Sulphate as SO4	mg/l	228	210	258	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	%	0.76	0.66	0.67	NS*	NS*
18	Sodium as Na	mg/l	301	243	265	NS*	NS*
19	Potassium as K	mg/l	3.24	3.68	3.51	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	7.55	7.6	7.83	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1390	1360	1500	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	2700	2680	2950	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/l	430.96	360.80	380.85	250.0	1000.0
9	Ca as Ca	mg/l	60.12	56.11	60.12	75.0	200.0
10	Mg as Mg	mg/l	63.18	80.19	85.05	30.0	100.0
11	Total Hardness	mg/l	260	330	350	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	0.58	0.79	0.25	1.0	1.5
14	Sulphate as SO4	mg/l	164.4	282	276	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	%	0.78	0.65	0.69	NS*	NS*
18	Sodium as Na	mg/l	274	251	263	NS*	NS*
19	Potassium as K	mg/l	4.23	3.88	4.21	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	7.61	7.57	7.45	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1326	1320	1520	500	2000
3	Turbidity	NTU	2	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	2650	2610	3010	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	410.91	320.71	425.95	250.0	1000.0
9	Ca as Ca	mg/l	48.10	56.11	48.10	75.0	200.0
10	Mg as Mg	mg/l	77.76	82.62	77.76	30.0	100.0
11	Total Hardness	mg/l	320	340	320	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.16	0.20	0.77	1.0	1.5
14	Sulphate	mg/l	213.6	195.6	276	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	%	0.74	0.58	0.77	NS*	NS*
18	Sodium as Na	mg/l	215	206	166	NS*	NS*
19	Potassium as K	mg/l	3.87	3.73	3.56	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	7.53	7.56	7.59	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1370	1350	1450	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	2690	2700	2990	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	335.75	375.84	821.83	250.0	1000.0
9	Ca as Ca	mg/l	76.15	52.10	72.14	75.0	200.0
10	Mg as Mg	mg/l	87.48	70.47	92.34	30.0	100.0
11	Total Hardness	mg/l	360	290	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	0.48	0.14	0.81	1.0	1.5
14	Sulphate	mg/l	336	228	237.6	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	%	0.61	0.68	1.48	NS*	NS*
18	Sodium as Na	mg/l	211	196	202	NS*	NS*
19	Potassium as K	mg/l	4.08	4.01	3.99	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	7.64	7.61	7.69	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1400	1850	1190	500	2000
3	Turbidity	NTU	2	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	2780	3670	2310	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	410.91	471.05	385.86	250.0	1000.0
9	Ca as Ca	mg/l	64.13	76.15	44.09	75.0	200.0
10	Mg as Mg	mg/l	85.05	99.63	80.19	30.0	100.0
11	Total Hardness	mg/l	350	410	330	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.34	0.22	0.48	1.0	1.5
14	Sulphate	mg/l	252	284.4	303.6	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	%	0.74	0.85	0.70	NS*	NS*
18	Sodium as Na	mg/l	202	184	192	NS*	NS*
19	Potassium as K	mg/l	3.49	3.50	3.56	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	7.56	7.42	7.32	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1230	1590	1020	500	2000
3	Turbidity	NTU	1	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	2450	3150	2000	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	375.84	511.14	604	250.0	1000.0
9	Ca as Ca	mg/l	40.08	60.12	80.16	75.0	200.0
10	Mg as Mg	mg/l	85.05	97.20	60.75	30.0	100.0
11	Total Hardness	mg/l	350	400	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	0.59	0.36	0.46	1.0	1.5
14	Sulphate	mg/l	260.4	174	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	%	0.68	0.92	1.09	NS*	NS*
18	Sodium as Na	mg/l	162	206	210	NS*	NS*
19	Potassium as K	mg/l	2.18	4.01	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	7.5	7.4	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1160	1150	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	2390	2300	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	NS*	NS*
8	Chloride	mg/l	425.95	415.92	250.0	1000.0
9	Ca as Ca	mg/l	56.11	64.13	75.0	200.0
10	Mg as Mg	mg/l	75.33	70.47	30.0	100.0
11	Total Hardness	mg/l	310	290	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.71	0.62	1.0	1.5
14	Sulphate	mg/l	30.60	28.80	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	9.85	9.71	45.0	No Relaxation
17	Salinity	%	0.76	0.75	NS*	NS*
18	Sodium as Na	mg/l	192.0	183.0	NS*	NS*
19	Potassium as K	mg/l	2.2	2.7	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 1000 -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 September ranged from 2000-3700 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 400-900 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 40 - 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 60 – 99 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 260-410 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 30 – 350 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 0.5 to 1.4 %. There are no prescribed Indian standards for salinity in Drinking water.

Sodium and Potassium Salts

Sodium values in the samples collected ranged from 100 - 300 mg/l and Potassium salts ranged from 2.2 to 4.0 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	58.0	50.4
2	Nirman Building 1	55.3	49.1
3	Tuna Port	52.8	46.5
4	Main Gate North	60.3	55.2
5	West Gate I	67.2	60.6
6	Canteen Area	58.7	50.9
7	Main Road	70.5	59.5
8	ATM Building	69.2	62.3
9	Wharf Area /Jetty Area	73.7	65.4
10	Port & Custom Office	55.2	49.6
	Vadinar Port		
11	Entrance Gate of Vadinar Port	69.6	58.4
12	Nr. Port Colony, Vadinar	61.3	55.8
13	Nr. Vadinar Jetty	68.2	61.5

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 13 locations at Deendayal Port ranged from 52.0 dB(A) to 73.7 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 13 locations of Deendayal Port ranged from 46.5 dB to 65.4 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 September 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	-	8.58	8.16	8.46	8.26	8.02	8.56
3	Electrical Conductivity	µs/cm	18,400.0	25,620.0	17,880.0	16,520.0	523.0	420.0
4	Moisture	%	21.00	22.20	24.10	18.80	8.66	9.02
5	Total Organic Carbon	%	0.48	1.24	0.48	3.93	0.18	0.21
6	Alkalinity	mg/kg	72.07	36.04	190.19	90.09	60.06	100.10
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
8	Chloride	mg/kg	1,506.6	6,381.0	1,701.0	1,878.9	52.0	67.8
9	Sulphate	mg/kg	202.0	196.0	112.0	112.0	12.0	18.0
10	Phosphorus	mg/kg	0.89	0.92	1.05	1.10	0.78	0.86
11	Potassium	mg/kg	386.0	820.0	345.0	422.0	110.0	172.0
12	Sodium	mg/kg	1,585.0	3,386.0	2,303.0	1,990.0	990.0	810.0
13	Calcium	mg/kg	228.46	741.50	248.50	468.94	118.00	72.00
14	Copper as Cu	mg/kg	52.2	78.2	46.2	33.8	18.6	28
15	Lead as Pb	mg/kg	4.9	5.6	3.2	4.8	3.2	1.1
16	Nickel as Ni	mg/kg	46.2	28	33.2	26.1	18.2	16.2
17	Zinc as Zn	mg/kg	66.20	41.60	68	49.55	24.00	38.50
18	Cadmium as Cd	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL

4.3 Discussion

- The data shows that value of pH ranges from 8.02 at Nakti Creek to 8.58 at Tuna Creek indicating that all soil samples are neutral to slight basic. Iffco Plant samples showed maximum conductivity of 25,620µmhos/cm, while Nakti Creek location showed minimum conductivity of 16,520 µmhos/cm. Conductivity at Vadinar Port was 523 and 420 µmhos/cm at Admin site and Vadinar Port colony respectively.
- Total organic Carbon ranged from 0.1 % to 3.9 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 1.10 mg/kg and 300.0 to 800 mg/kg respectively at Deendayal Port. The mean concentration of Phosphorous at Vadinar site was 0.82 mg/kg and mean concentration of Potassium at Vadinar site was 145 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	**04.09.2021**

Sr. No.	**Parameters**	**Unit**	**Results**	
			KPT STP I/L	**KPT STP O/L**
1	pH	pH unit	7.56	7.44
2	Total Suspended Solids	mg/l	64.2	26.6
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	424.2	103.0
5	BOD @ 27 °C	mg/l	141.0	29.0
6.	Fecal Coliform	MPN Index / 100 ml	-	20.0
Aeration Tank				
7.	MLSS	mg/l	6.0	
8.	MLVSS	%	93.0	

Table 19: Sewage Water Monitoring at Kandla STP (2nd Week)

Date of Sampling	09.09.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.6	7.2
2	Total Suspended Solids	mg/l	152.2	72.4
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	384	103.0
5	BOD @ 27 °C	mg/l	120.0	24.0
6.	Fecal Coliform	MPN Index / 100 ml	-	31.0
Aeration Tank				
7.	MLSS	mg/l	9.0	
8.	MLVSS	%	89.0	

Table 20: Sewage Water Monitoring at Kandla STP (3rd Week)

Date of Sampling	16.09.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.71	7.18
2	Total Suspended Solids	mg/l	417.8	159.8
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	383.8	102
5	BOD @ 27 °C	mg/l	128.0	23.0
6.	Fecal Coliform	MPN Index / 100 ml	-	<1.8
Aeration Tank				
7.	MLSS	mg/l	9.0	
8.	MLVSS	%	89.0	

Table 21: Sewage Water Monitoring at Kandla STP (4th Week)

Date of Sampling	21.09.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.53	7.32
2	Total Suspended Solids	mg/l	172.4	75.9
3	Residual Chlorine	mg/l	<1.0	<1.0
4	COD	mg/l	151.5	102.0
5	BOD @ 27 °C	mg/l	106.0	52.0
6.	Fecal Coliform	MPN Index / 100 ml	-	110.0
Aeration Tank				
7.	MLSS	mg/l	16.0	
8	MLVSS	%	82.0	

- **Gopalpuri Colony STP**

Table 22: Sewage Water Monitoring at Gopalpuri STP (1st Week)

Date of Sampling	04.09.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.35	7.21
2	Total Suspended Solids	mg/l	108.8	26
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	316.0	98.0
5	BOD @ 27 °C	mg/l	110.0	28.0
6.	Fecal Coliform	MPN Index / 100 ml	-	>1600.0
Aeration Tank				
7.	MLSS	mg/l	11.0	
8	MLVSS	%	87.0	

Table 23: Sewage Water Monitoring at Gopalpuri STP (2nd Week)

Date of Sampling	09.09.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.6	7.41
2	Total Suspended Solids	mg/l	406	107.4
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	414.1	101
5	BOD @ 27 °C	mg/l	139.0	28.0
6.	Fecal Coliform	MPN Index / 100 ml	-	>1600.0
Aeration Tank				
7.	MLSS	mg/l	14.0	
8	MLVSS	%	90.0	

Table 24: Sewage Water Monitoring at Gopalpuri STP (3rd Week)

Date of Sampling	16.09.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.7	7.36
2	Total Suspended Solids	mg/l	276.6	92.1
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	373.7	104
5	BOD @ 27 °C	mg/l	125.0	28.0
6.	Fecal Coliform	MPN Index / 100 ml	-	>1600.0
Aeration Tank				
7.	MLSS	mg/l	12.0	
8	MLVSS	%	86.0	

Table 25: Sewage Water Monitoring at Gopalpuri STP (4th Week)

Date of Sampling	05.09.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.4	7.22
2	Total Suspended Solids	mg/l	182.4	117.8
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	171.7	101
5	BOD @ 27 °C	mg/l	80.0	23.0
6.	Fecal Coliform	MPN Index / 100 ml	-	920.0
Aeration Tank				
7.	MLSS	mg/l	12.0	
8.	MLVSS	%	88.0	

- **Vadinar STP**

Table 26: Sewage Water Monitoring at Vadinar STP (1st Week)

Date of Sampling	05.09.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.22	7.10
2	Total Suspended Solids	mg/l	62	28.0
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	88.0	56.0
5	BOD @ 27 °C	mg/l	26.0	15.0

Table 27: Sewage Water Monitoring at Vadinar STP (2nd Week)

Date of Sampling	09.09.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.33	7.10
2	Total Suspended Solids	mg/l	72	24.0
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	88.0	60.0
5	BOD @ 27 °C	mg/l	29.0	18.0

Table 28: Sewage Water Monitoring at Vadinar STP (3rd Week)

Date of Sampling	16.09.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.32	7.12
2	Total Suspended Solids	mg/l	60	58.0
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	80.0	55.0
5	BOD @ 27 °C	mg/l	26.0	16.0

Table 29: Sewage Water Monitoring at Vadinar STP (4th Week)

Date of Sampling	**21.09.2021**

Sr. No.	**Parameters**	**Unit**	**Results**	
			Vadinar STP I/L	**Vadinar O/L**
1	pH	pH unit	7.18	7.10
2	Total Suspended Solids	mg/l	72	42.0
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	80.0	58.0
5	BOD @ 27 °C	mg/l	26.0	12.0

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.

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 7th& 8th September-2021 in harbor regions of KPT and on 7th September-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 14th& 15th September 2021 in harbor regions of KPT. 15th September -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	7.20	7.35	7.31	7.27
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.6	32.0	31.0	31.8
5	Turbidity	NTU	37	35	32	28
6	Total Dissolved Solids	mg/l	59704	58025	34000.0	37060.0
7	Total Suspended Solids	mg/l	282	357	382	303.5
8	Total Solids	mg/l	59986	58382	34382.0	37363.5
9	DO	mg/l	4.5	4.7	4.7	5.3
10	COD	mg/l	78.0	82.0	80.0	86.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	6.09	7.49	0.53	0.42
13	Phosphate	mg/l	0.17	0.16	0.18	0.18
14	Sulphate	mg/l	2640	2280	2808	2568
15	Nitrate	mg/l	2.60	1.43	2.26	2.29
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	761.52	921.84	521.04	721.44
18	Magnesium	mg/l	1409.4	1263.6	1749.6	1749.6
19	Sodium	mg/l	11280.0	10920.0	11360.0	11062.0
20	Potassium	mg/l	289.0	320.0	296.0	310.0
21	Iron	mg/l	1.95	1.89	1.85	1.79
22	Chromium	mg/l	0.11	0.13	0.11	0.12
23	Copper	mg/l	0.07	0.08	0.08	0.07
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.04	0.05	0.04	0.05
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.17	0.18	0.13	0.14
28	Zinc	mg/l	0.05	0.06	0.05	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	7.40	7.28	7.4	7.43
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.8	31.6	32.5	32.0
5	Turbidity	NTU	26	27	36	27
6	Total Dissolved Solids	mg/l	55555	51116	34060.0	33780.0
7	Total Suspended Solids	mg/l	363	174	242	582.9
8	Total Solids	mg/l	55918	51290	34302.0	34362.9
9	DO	mg/l	4.9	5.2	5.5	4.6
10	COD	mg/l	96.0	90.0	90.0	88.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	5.16	6.84	0.67	0.71
13	Phosphate	mg/l	0.20	0.18	0.16	0.19
14	Sulphate	mg/l	2820	2376	2832	2496
15	Nitrate	mg/l	2.36	2.89	4.00	3.37
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	721.44	961.92	601.2	681.36
18	Magnesium	mg/l	1409.4	1215	1822.5	1773.9
19	Sodium	mg/l	11862.0	11060.0	11652.0	11110.0
20	Potassium	mg/l	290.0	312.0	299.0	310.0
21	Iron	mg/l	1.96	1.93	1.86	1.93
22	Chromium	mg/l	0.13	0.13	0.13	0.14
23	Copper	mg/l	0.09	0.08	0.06	0.05
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.06	0.05	0.06	0.04
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.19	0.16	0.17	0.18
28	Zinc	mg/l	0.08	0.08	0.07	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	7.19	7.38	7.53	7.34
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.5	32.2	32.6	31.6
5	Turbidity	NTU	35	36	34	33
6	Total Dissolved Solids	mg/l	48086	54880	41460.0	39690.0
7	Total Suspended Solids	mg/l	220	220	376.6	359.9
8	Total Solids	mg/l	48306	55100	41836.6	40049.9
9	DO	mg/l	5.0	5.1	4.8	5.2
10	COD	mg/l	89.0	92.0	81.0	78.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	4.67	4.95	0.47	0.71
13	Phosphate	mg/l	0.16	0.21	0.18	0.19
14	Sulphate	mg/l	2376	2964	2376	2352
15	Nitrate	mg/l	2.04	2.26	4.82	4.60
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	801.60	921.84	440.88	521.04
18	Magnesium	mg/l	1336.5	1287.9	1701	1773.9
19	Sodium	mg/l	12042.0	11910.0	12150.0	11956.0
20	Potassium	mg/l	366.0	372.0	358.0	376.0
21	Iron	mg/l	2.11	2.30	1.96	2.01
22	Chromium	mg/l	0.12	0.15	0.12	0.16
23	Copper	mg/l	0.07	0.09	0.08	0.07
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.04	0.07	0.05	0.07
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.19	0.19	0.17	0.2
28	Zinc	mg/l	0.07	0.07	0.05	0.07

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	7.40	7.38	7.27	7.22
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.4	31.8	31.8	31.6
5	Turbidity	NTU	27	23	39	45
6	Total Dissolved Solids	mg/l	53390	47930	42746.0	35470.0
7	Total Suspended Solids	mg/l	262	354	561.7	520.9
8	Total Solids	mg/l	53652	48284	43307.7	35990.9
9	DO	mg/l	4.8	4.9	5.5	4.7
10	COD	mg/l	78.0	80.0	86.0	82.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	6.98	6.35	0.98	0.85
13	Phosphate	mg/l	0.23	0.21	0.21	0.19
14	Sulphate	mg/l	2220	2268	2412	2568
15	Nitrate	mg/l	2.87	2.03	2.81	3.32
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	801.60	881.76	601.2	480.96
18	Magnesium	mg/l	1312.2	1360.8	1773.9	1773.9
19	Sodium	mg/l	12220.0	12052.0	12012.0	12110.0
20	Potassium	mg/l	300.0	278.0	289.0	280.0
21	Iron	mg/l	2.31	2.22	1.88	2.02
22	Chromium	mg/l	0.16	0.14	0.18	0.16
23	Copper	mg/l	0.06	0.08	0.06	0.05
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.06	0.08	0.06	0.07
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.19	0.17	0.19	0.16
28	Zinc	mg/l	0.09	0.07	0.06	0.08

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	7.47	7.45	7.22	7.39
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.6	31.9	32.0	31.9
5	Turbidity	NTU	35	37	36	48
6	Total Dissolved Solids	mg/l	52041	55010	35620.0	38755.0
7	Total Suspended Solids	mg/l	360	425	387.9	525.7
8	Total Solids	mg/l	52401	55435	36007.9	39280.7
9	DO	mg/l	4.5	4.7	5.4	5.1
10	COD	mg/l	86.0	82.0	92.0	90.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	8.67	9.40	0.82	0.53
13	Phosphate	mg/l	0.17	0.18	0.22	0.18
14	Sulphate	mg/l	2820	2844	2268	2136
15	Nitrate	mg/l	2.56	1.91	2.42	3.81
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	761.52	721.44	521.04	601.2
18	Magnesium	mg/l	1409.4	1458	1676.7	1749.6
19	Sodium	mg/l	11958.0	11628.0	11990.0	11558.0
20	Potassium	mg/l	366.0	376.0	360.0	320.0
21	Iron	mg/l	2.35	2.36	2.05	2.10
22	Chromium	mg/l	0.19	0.20	0.18	0.16
23	Copper	mg/l	0.08	0.09	0.05	0.06
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.06	0.08	0.05	0.08
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.19	0.21	0.17	0.18
28	Zinc	mg/l	0.09	0.08	0.07	0.08

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	7.36	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	31.6		31.8	
5	Turbidity	NTU	38		37	
6	Total Dissolved Solids	mg/l	54144		35040.0	
7	Total Suspended Solids	mg/l	394		327	
8	Total Solids	mg/l	54538		35367.0	
9	DO	mg/l	4.9		5.6	
10	COD	mg/l	78.0		90.0	
11	BOD	mg/l	<2.0		<2.0	
12	Silica	mg/l	6.96		0.67	
13	Phosphate	mg/l	0.19		0.20	
14	Sulphate	mg/l	2964		2340	
15	Nitrate	mg/l	2.21		25.70	
16	Nitrite	mg/l	<0.05		<0.05	
17	Calcium	mg/l	921.84		641.28	
18	Magnesium	mg/l	1263.6		1725.3	
19	Sodium	mg/l	13125.0		13052.0	
20	Potassium	mg/l	360.0		388.0	
21	Iron	mg/l	2.41		2.30	
22	Chromium	mg/l	0.20		0.19	
23	Copper	mg/l	0.09		0.08	
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	0.18		0.2	
28	Zinc	mg/l	0.09		0.05	

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	7.72	7.56	7.4	7.52
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.6	32.0	32.0	32.0
5	Turbidity	NTU	33	34	35	31
6	Total Dissolved Solids	mg/l	41457	45920	34437.0	38630.0
7	Total Suspended Solids	mg/l	299	267	512.6	396
8	Total Solids	mg/l	41756	46187	34949.6	39026.0
9	DO	mg/l	4.7	4.8	5.5	4.8
10	COD	mg/l	90.0	86.0	86.0	89.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	7.27	8.55	0.78	0.77
13	Phosphate	mg/l	0.17	0.18	0.19	0.20
14	Sulphate	mg/l	2316	2388	2388	2532
15	Nitrate	mg/l	3.03	3.15	3.32	2.59
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	841.68	961.92	561.12	601.2
18	Magnesium	mg/l	1385.1	1263.6	1846.8	1822.5
19	Sodium	mg/l	13820.0	13962.0	13762.0	13888.0
20	Potassium	mg/l	310.0	285.0	316.0	296.0
21	Iron	mg/l	1.96	1.99	1.89	2.00
22	Chromium	mg/l	0.19	0.21	0.17	0.16
23	Copper	mg/l	0.08	0.07	0.07	0.06
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.07	0.05	0.07	0.06
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.21	0.16	0.17	0.18
28	Zinc	mg/l	0.08	0.07	0.06	0.05

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 - 4	KPT - 5	Jetty
1	Texture	-	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	mg/kg	1.16	1.12	0.83	0.75	0.86
3	Organic Carbon	mg/kg	0.67	0.65	0.48	0.44	0.50
4	Inorganic Phosphate	mg/kg	111.0	126.0	132.0	142.0	175.0
5	Moisture	%	26.00	27.20	42.60	41	28.20
6	Aluminium	mg/kg	ND	ND	ND	ND	ND
7	Silica	mg/kg	18.0	16.0	13.0	16.0	20.0
8	Phosphate	mg/kg	9.20	10.60	10.66	8.40	8.60
9	Sulphate	mg/kg	219.0	253.0	189.0	211.0	186.0
10	Nitrite	mg/kg	0.12	0.13	0.11	0.12	0.13
11	Nitrate	mg/kg	10.20	8.88	9.25	8.69	9.74
12	Calcium	mg/kg	362.0	322.0	410.0	365.0	310.0
13	Magnesium	mg/kg	210.0	192.0	265.0	196.0	188.0
14	Sodium	mg/kg	3824.0	4012.0	2611.0	2978.0	3777.0
15	Potassium	mg/kg	240.0	202.0	160.0	145.0	178.0
16	Chromium	mg/kg	42.5	16	79	19.2	28.7
17	Nickel	mg/kg	24	20.4	16.9	11	19.3
18	Copper	mg/kg	31.8	36.4	34.2	16.8	31.2
19	Zinc	mg/kg	37.10	32.60	28.00	10.20	24.00
20	Cadmium	mg/kg	ND	ND	ND	ND	ND
21	Lead	mg/kg	3.2	3.9	4.8	3	ND
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 at KPT – 3 & Vadinar SBM location.

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	1.78	0.90	1.03	2.03	0.81	1.31
3	Organic Carbon	mg/kg	1.03	0.52	0.60	1.18	0.47	0.76
4	Inorganic Phosphate	mg/kg	116.0	136.0	142.0	146.0	149.0	166.0
5	Moisture	%	27.00	19.00	27.0	19.0	27.00	19.00
6	Aluminium	mg/kg	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	22.20	19.62	18.0	20.2	18.00	16.66
8	Phosphate	mg/kg	7.6	8.2	8.90	10.60	11.20	9.8
9	Sulphate	mg/kg	234.0	268.0	245.0	210.0	265.0	206.0
10	Nitrite	mg/kg	0.11	0.13	0.12	0.1	0.11	0.12
11	Nitrate	mg/kg	8.88	9.20	7.66	9.75	8.88	7.82
12	Calcium	mg/kg	378.0	325.0	389.0	378.0	378.0	296.0
13	Magnesium	mg/kg	216.0	206.0	233.0	186.0	210.0	198.0
14	Sodium	mg/kg	4428.0	3971.0	4554.0	2491.0	3036.0	3798.0
15	Potassium	mg/kg	221.0	152.0	167.0	149.0	116.0	160.30
16	Chromium	mg/kg	38.5	12.1	34.9	77.8	18.7	29.4
17	Nickel	mg/kg	27.3	20.4	36.9	21.6	13.1	19.3
18	Copper	mg/kg	11.8	33.5	40.7	20.2	11	41.2
19	Zinc	mg/kg	47.10	61.00	64.10	38.70	5.20	24.00
20	Cadmium	mg/kg	ND	ND	ND	ND	ND	ND
21	Lead	mg/kg	4.4	4.4	5.6	5.7	2.8	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

SEPTEMBER,2021

INTRODUCTION:

Sampling Stations:

The monitoring of marine environment for the study of biological and ecological Parameters was carried out on8thSeptember 2021 in harbour region of DPT, and on 9thSeptember2021 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 14thSeptember 2021 in harbour region of DPT and on 15thSeptember 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 litre 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.

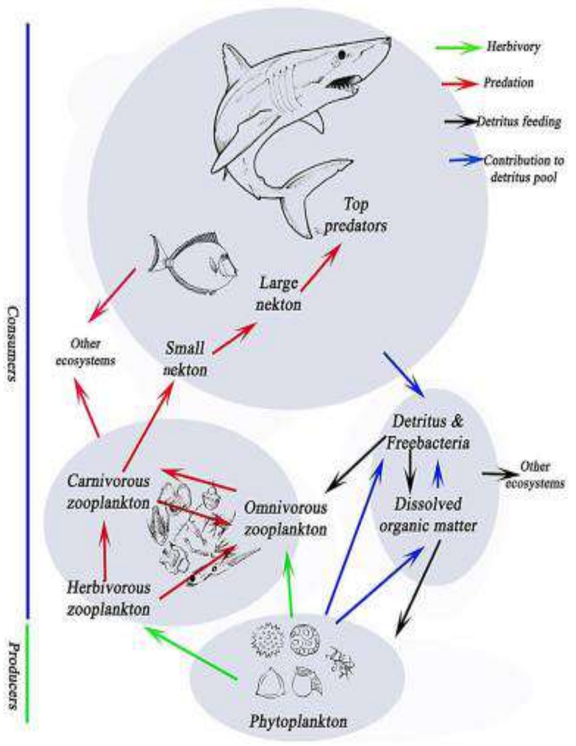
Based on the duration of planktonic life, zooplankton are categorised into Holoplankton (organisms which complete their entire lifecycle as plankton) and Meroplankton (organisms which are planktonic during the early part of their lives such as the larval stages of benthic and nektonic organisms). Tychoplankton 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 10-15 minutes, 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 0.366 -0.613mg/m^3.in harbour region of DPT during sampling done in spring tide period of September 2021. In the nearby creeks chlorophyll-a was varying from 0.101-0.851mg/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 0.322 -0.645mg/m^3.in harbour region of DPT during sampling done in neap tide period of September 2021 . In the nearby creeks chlorophyll-a was varying from 0.291-0.614 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 SEPTEMBER,2021

Sr. No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPT HARBOUR AREA					
1	KPT1	High tide	0.410	BDL	27.47
		Low tide	0.366	BDL	24.52
2	KPT 2	High tide	0.409	BDL	27.40
		Low tide	0.467	BDL	31.29
3	KPT 3	High tide	0.512	BDL	34.30
		Low tide	0.613	BDL	41.07
CREEKS					
4	KPT-4 Khori-I	High tide	0.645	BDL	43.22
		Low tide	0.748	BDL	50.12
5	KPT-5 Nakti-I	High tide	0.818	BDL	54.81
		Low tide	0.851	BDL	57.02
6	KPT-5 Nakti-II	High tide	0.101	BDL	6.76

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 SEPTEMBER,2021

Sr. No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPT HARBOUR AREA					
1	KPT1	High tide	0.322	BDL	21.57
		Low tide	0.323	BDL	21.64
2	KPT 2	High tide	0.630	BDL	42.21
		Low tide	0.615	BDL	41.21
3	KPT 3	High tide	0.527	BDL	35.31
		Low tide	0.645	BDL	43.22
CREEKS					
4	KPT-4 Khori-I	High tide	0.511	BDL	34.24
		Low tide	0.599	BDL	40.13
5	KPT-5 Nakti-I	High tide	0.529	BDL	35.44
		Low tide	0.614	BDL	41.14
6	KPT-5 Nakti-II	High tide	0.291	BDL	19.50

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 andblue green algae during spring tide period.Diatoms were represented by 18 genera. Blue green were represented by 3 generaduring the sampling conducted in spring tide in September,2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 85-116 units/ L during high tide period and103-133 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 duringNeap tide period.Diatoms were represented by 15genera and Blue green algae were represented 3 genera during the sampling conducted in Neap tide in September, 2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from45 -155 units/ L during high tide period and 131-182 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 1.801-3.197 with an average of 2.642 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 12.458-2.904 with an average of 2.697 during the consecutive low tide period .

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was varying from 1.808-2.461 with an average of 2.087 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. 1.961-2.882 with an average of 2.371 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 0.771-0.988 (H'(log10)) between selected sampling stations with an average value of 0.934during high tide period of spring tide. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.893-0.932 (H'(log10)) between selected sampling stations with an average value of 0.916 during consecutive lowtide. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.781-0.911 (H'(log10)) between selected sampling stations with an average value of 0.862 during high tide period of neap tide. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.823-0.969 (H'(log10)) between selected sampling stations with an average value of 0.904during 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 0.797- 0.882 between selected sampling stations with an average of 0.862 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 0.845- 0.867 between selected sampling stations with an average of 0.854during 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 0.821-0.857 with an average value of 0.845 between selected sampling stations during high tide period and varying from 0.824-0.870 with an average

value of 0.853 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 SEPTEMBER,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	109	16/21	76.19	3.197	0.9854	0.8739
	2	110	13/21	61.90	2.553	0.9544	0.8754
	3	107	13/21	61.90	2.568	0.9737	0.8824
	4	105	14/21	66.66	2.793	0.9885	0.8811
	5	116	15/21	71.43	2.945	0.9317	0.8627
	6	85	9/21	42.86	1.801	0.7711	0.7978
LOW TIDE	1	103	13/21	61.90	2.589	0.9277	0.8667
	2	132	13/21	61.90	2.458	0.9324	0.8648
	3	124	15/21	71.43	2.904	0.91	0.8451
	4	130	14/21	66.66	2.671	0.8926	0.8458
	5	133	15/21	71.43	2.863	0.9185	0.8479

Table # 5 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN SEPTEMBER,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	131	13/18	72.22	2.461	0.881	0.8452
	2	144	12/18	66.66	2.213	0.8693	0.8503
	3	145	10/18	55.55	1.808	0.8678	0.8511
	4	155	11/18	61.11	1.983	0.8653	0.8484
	5	153	12/18	66.66	2.187	0.911	0.8573
	6	42	8/18	44.44	1.873	0.7809	0.8211
LOW TIDE	1	131	11/18	61,11	2.051	0.8234	0.8243
	2	153	12/18	66.66	2.187	0.8951	0.8542
	3	182	16/18	88.88	2.882	0.9697	0.8703
	4	155	15/18	83.33	2.776	0.9374	0.8618
	5	164	11/18	61.11	1.961	0.8971	0.8564

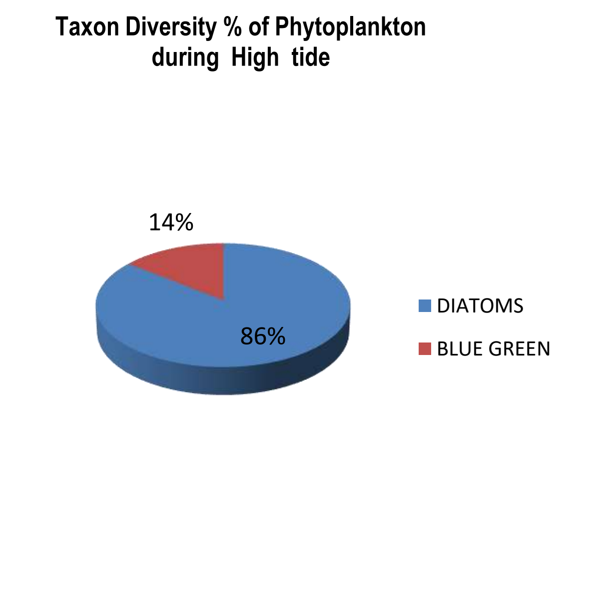
Table # 6 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING SPRING TIDE IN SEPTEMBER, 2021

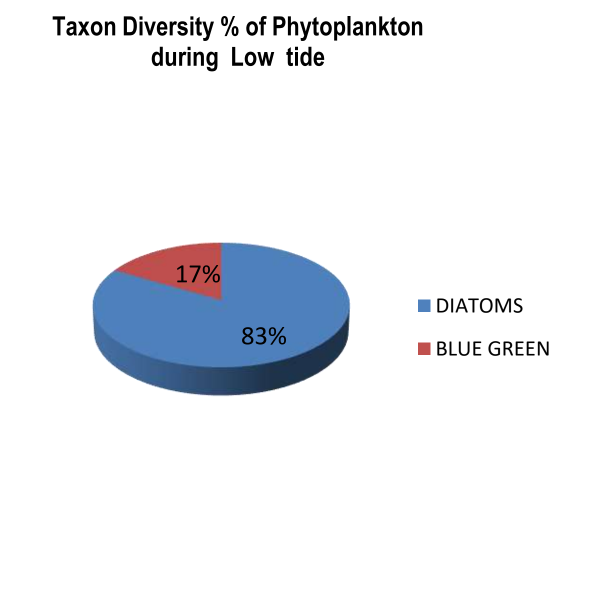
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	83-110	18/21	85.71
			BLUE GREEN	2-12	3/21	14.29
			TOTAL PHYTO PLANKTON	**85-116**	**21**	-
LOW TIDE	Sub surface	5	DIATOMS	93-129	18/21	85.71
			BLUE GREEN	4-13	3/12	14.29
			TOTAL PHYTO PLANKTON	103-133	**21**	-

Table # 7 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING NEAP TIDE IN SEPTEMBER,2021

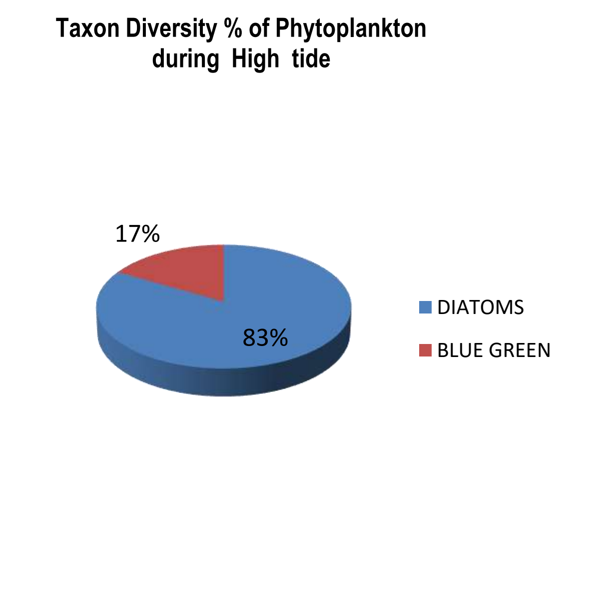
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	38-154	15/18	83.33
			BLUE GREEN	1-4	3/18	16.67
			TOTAL PHYTO PLANKTON	**42-155**	**18**	-
LOW TIDE	Sub surface	5	DIATOMS	131-177	15/18	83.33
			BLUE GREEN	0-5	3/18	16.67
			TOTAL PHYTO PLANKTON	**131-182**	**18**	-

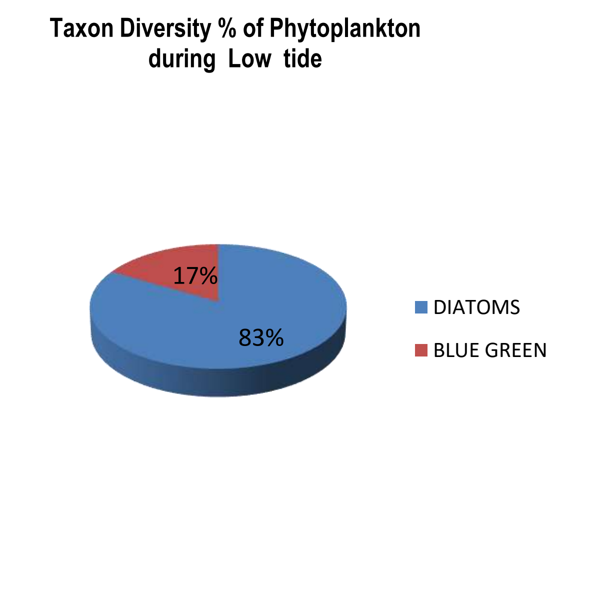
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide





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 September,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 Seven groups, Tintinids, Copepods, Arrow worms , Ciliates ,Mysids,Foraminiferans 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 32-86x10^3 N/ m^3 during high tide and 64-100 x103 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 43-173 x103 N/ m^3 during high tide and115-184x10^3 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 2.825-3.507 with an average of 3.009during the sampling conducted in High tide period.Margalef's diversity index (Species Richness) S of Zooplankton communities varying from. 2.645-3.423 with an average of 3.020 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 from3.722- 4.463with an average of 4.061 during the sampling conducted in high tide and varying from. 4.163-4.647 with an average of 4.458 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 0.909-1.014 (H'(log10)) between selected sampling stations with an average value of 0.966 (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 0.929-0.989(H'(log10)) between selected sampling stations with an average value of 0.963 (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 0.925-1.248 (H'(log10)) between selected sampling stations with an average value of 1.155 (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 1.185-1.254 (H'(log10)) between selected sampling stations with an average value of 1.214 (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 0.849-0.889between selected sampling stations with an average of 0.872 during high tide period and was varying from 0.845- 0.880 with an average value of 0.868 between selected sampling stations during low tide

Simpson diversity index (1-D) of Zooplankton communities was above 0.9 at all sampling stationsin the Kandla Harbour region and nearby creeks except few during high tide and low tide period, which was varying from 0.834-0.939between selected sampling stations with an average of 0.914 during high tide period and was varying from 0.920- 0.939 with an average value of 0.929 between selected sampling stations during consecutive low tide

This high species diversity suggests a relatively more number of successful species in this habitat during September ,2021 sampling.

Table # 8 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN SEPTEMBER,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	72 $X10^3$	16/23	69.56	3.507	0.9864	0.8725
	2	70 $X10^3$	13/23	56.52	2.825	0.9094	0.8584
	3	81 $X10^3$	14/23	60.87	2.958	0.9324	0.8494
	4	82 $X10^3$	15/23	65.22	3.177	1.014	0.8871
	5	86 $X10^3$	14/23	60.87	2.918	1.008	0.8892
	6	32 $X10^3$	12/23	52.17	3.174	0.9456	0.875
LOW TIDE	1	80 $X10^3$	16/23	69.56	3.423	0.9692	0.8661
	2	64 $X10^3$	12/23	52.17	2.645	0.9299	0.873
	3	70 $X10^3$	13/23	56.52	2.825	0.9384	0.8451
	4	82 $X10^3$	14/23	60.87	2.95	0.9894	0.8802
	5	100 $X10^3$	16/23	69.56	3.257	0.9872	0.8772

Table # 9 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN SEPTEMBER,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	107 $X10^3$	21/29	72.41	4.28	1.16	0.9185
	2	123 $X10^3$	19/29	65.52	3.741	1.19	0.9315
	3	168 $X10^3$	22/29	75.86	4.098	1.205	0.9328
	4	173 $X10^3$	24/29	82.76	4.463	1.248	0.9389
	5	137 $X10^3$	21/29	72.41	4.065	1.203	0.9342
	6	43 $X10^3$	15/29	51.72	3.722	0.9255	0.8339
LOW TIDE	1	115 $X10^3$	22/29	75.86	4.426	1.185	0.9202
	2	122 $X10^3$	21/29	72.41	4.163	1.19	0.9252
	3	175 $X10^3$	25/29	86.21	4.647	1.254	0.9395
	4	184 $X10^3$	25/29	86.21	4.602	1.23	0.9342
	5	140 $X10^3$	23/29	79.31	4.452	1.21	0.9274

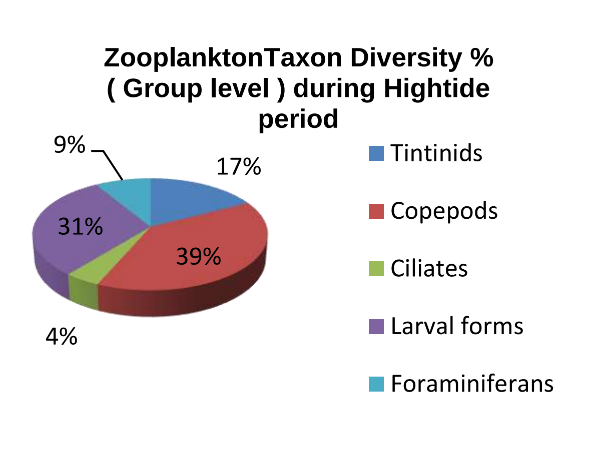
Table # 10 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN SEPTEMBER,2021

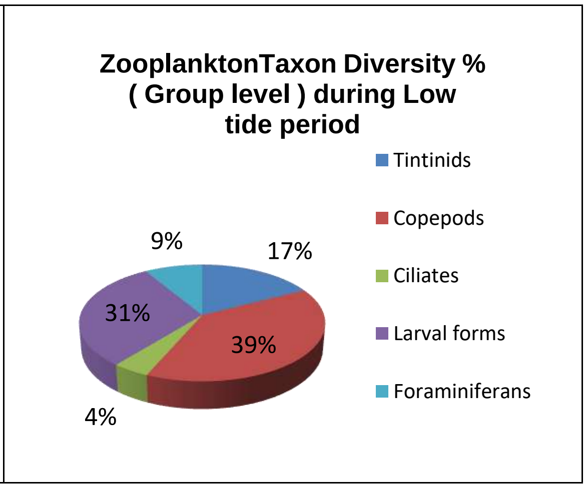
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	0-8	4/23	17.39
			Copepods	16-51	9/23	39.13
			Ciliates	0-1	1/23	4.35
			Larval forms	14-35	7/23	30.44
			Foraminiferans	0-3	2/23	8.69
			TOTAL ZOOPLANKTON NO/L	**32-86**	**23**	**23**
LOW TIDE	Sub surface	5	Tintinids	2-6	4/23	17.39
			Copepods	29-53	9/23	39.13
			Ciliates	0-1	1/23	4.35
			Larval forms	26-39	7/23	30.44
			Foraminiferans	1-4	2/23	8.69
			TOTAL ZOOPLANKTON NO/M3	**64-100**	**23**	**23**

Table # 11 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING NEAP TIDE IN SEPTEMBER, 2021

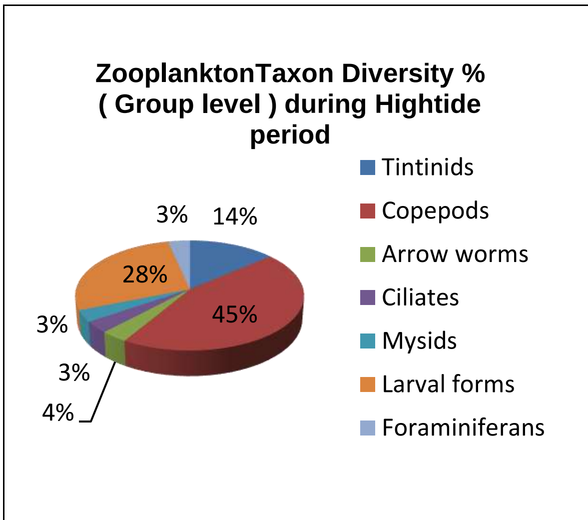
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	1-8	4/29	13.79
			Copepods	17-71	13/29	44.83
			Arrow worms	0-1	1/29	3.45
			Ciliates	1-7	1/29	3.45
			Mysids	0-4	1/29	3.45
			Larval forms	22-87	8/29	27.58
			Foraminiferans	0-2	1/29	3.45
			TOTAL ZOOPLANKTON	**43-173**	**29**	**-**
LOW TIDE	Sub surface	5	Tintinids	2-8	4/29	13.79
			Copepods	38-70	13/29	44.83
			Arrow worms	0-1	1/29	3.45
			Ciliates	3-7	1/29	3.45
			Mysids	1-4	1/29	3.45
			Larval forms	67-106	8/29	27.58
			Foraminiferans	**0-1**	1/29	3.45
			TOTAL ZOOPLANKTON NO/M3	**115-184**	**29**	**-**

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



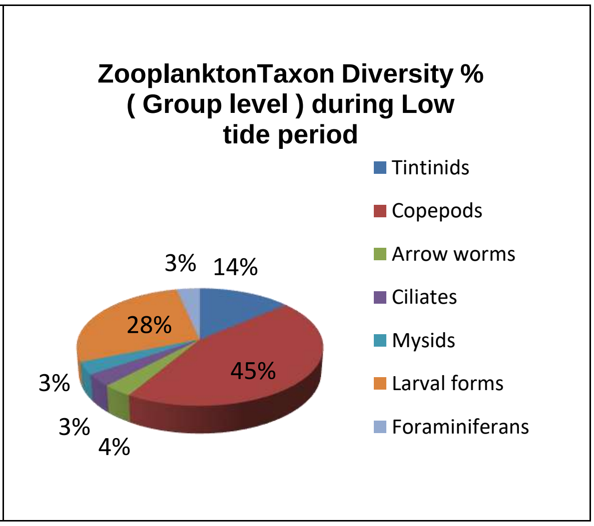


TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURINGSPRING TIDE OF SEPTEMBER 2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALGAE	Cyanophyta	Cyanophyceae	Nostocales	Oscillatoriaceae	*Oscillatoria* sp.	B1	Occasional
					Arthrospira sp.	B2	Rare
			Stigonematales	Stigonemataceae	*Stigonema sp.*	B3	Rare
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Occasional
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D2	Abundant
			Triceratiales	Triceratiaceae	*Odontella sp*	D3	Frequent
					Triceratium sp.	D4	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D5	Dominant
			Hemiaulales	Bellerocheaceae	*Bellerochea* sp	D6	Rare
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D7	Rare
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp	D8	Occasional
			Lithodesmiales	Lithodesmiaceae	*Ditylum sp*	D9	Abundant
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma* sp	D10	Rare
					Navicula sp	D11	Rare
			Surirellales	*Surirellaceae*	*Surirella* sp	D12	Rare
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D13	Frequent
					Thalassionema sp.	D14	Rare
			Fragilariales	Fragilariaceae	*Asterionellopsis sp.*	D15	Rare
					Fragilaria sp	D16	Occasional
					*Synedra*sp	D17	Rare
			Tabellariales	Tabellariaceae	*Tabellaria* sp	D18	Rare

TABLE # 13 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURING AND NEAP TIDE OF SEPTEMBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALGAE	Cyanophyta	Cyanophyceae	Nostocales	Oscillatoriaceae	*Oscillatoria* sp.	B1	Rare
					Arthrospira 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	Frequent
					Triceratium sp.	D4	Occasional
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D5	Dominant
			Hemiaulales	Bellerocheaceae	*Bellerochea* sp	D6	Occasional
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp	D7	Rare
			Lithodesmiales	Lithodesmiaceae	*Ditylum sp*	D8	Abundant
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma* sp	D9	Occasional
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D10	Abundant
					Thalassionema sp.	D11	Rare
			Fragilariales	Fragilariaceae	*Asterionellopsis sp.*	D12	Rare
					Fragilaria sp	D13	Occasional
					*Synedra*sp	D14	Frequent
			Tabellariales	Tabellariaceae	*Tabellaria* sp	D15	Rare

TABLE #14 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS IN DPT HARBOUR AREA, AND NEAR BY CREEKS DURING SPRING TIDE OF SEPTEMBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnus sp.*	T1	Rare
				Codonellidae	*Tintinnopsis gracilis*	T2	Occasional
					Tintinnopsis radix	T3	Rare
					Tintinnopsis tocantinensis	T4	Rare
COPEPODS	ATHROPODA	Crustacea Sub class copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Abundant
				Eucalanidae	*Pareucalanus sp.*	C2	Rare
				Clausocalanidae	*Clausocalanus sp.*	C3	Occasional
				Acartiidae	*Acartia sp.*	C4	Rare
				Temoridae	*Temora sp.*	C5	Occasional
			Cyclopoida	Oithonidae	*Oithona sp.*	C6	Frequent
			Harpacticoida	Ectinosomatidae	*Microsetella* sp.	C7	Frequent
				Euterpinidae	*Euterpina sp.*	C8	Rare
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C9	Rare
CILIATES	CILIOPHORA	Oligohymenophorea	Sessilida	Zoothamniidae	*Zoothamnium sp.*	CI1	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L2	Occasional
POLYCHAETE LARVAE	ANNELIDA	Polychaeta			Trochophore larvae	L3	Rare
BARNACLE LARVAE	ATHROPODA CRUSTACEA	Maxillopoda Thecostraca			Cirripede larvae	L4	Rare
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda,Streptoneura			Opisthobranchia larvae	L5	Occasional
CYPHONAUTES LARVAE	BRYOZOA				Cyphonautes larvae	L6	Rare
BRACHYURA LARVAE	ARTHROPODA (CRUSTACEA)	Malacostraca Decapoda			Brachyuran Zoea larvae	L7	Rare
FORAMINIFERA	FORAMINIFERA	Globothalamea	Rotaliida	Globigerinidae	*Globigerina* sp.	F1	Rare
				Rotalliidae	*Rotalia* sp.	F2	Rare

TABLE # 15 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS IN DPT HARBOUR AREA, AND NEAR BY CREEKS DURING NEAP TIDE OF SEPTEMBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnus sp.*	T1	Rare
				Codonellidae	*Tintinnopsis gracilis*	T2	Occasional
					Tintinnopsis radix	T3	Rare
					Tintinnopsis failakkaensis	T4	Rare
COPEPODS	ATHROPODA	Crustacea Sub class copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Frequent
					Parvocalanus sp.	C2	Rare
				Eucalanidae	*Pareucalanus sp.*	C3	Rare
					Subeucalanus sp.	C4	Rare
				Clausocalanidae	*Clausocalanus sp.*	C5	Occasional
				Centropagidae	*Centropages sp.*	C6	Rare
				Tortanidae	*Tortanus sp.*	C7	Rare
				Acartiidae	*Acartia sp.*	C8	Frequent
				Temoridae	*Temora sp.*	C9	Occasional
			Cyclopoida	Oithonidae	*Oithona sp.*	C10	Abundant
			Harpacticoida	Ectinosomatidae	*Microsetella* sp.	C11	Frequent
				Euterpinidae	*Euterpina sp.*	C12	Occasional
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C13	Rare
ARROW WORMS	CHAETOGNATHA	Sagittoidea	Aphragmophora	Sagittidae	*Sagitta sp.*	A1	Rare
CILIATES	CILIOPHORA	Oligohymenophorea	Sessilida	Zoothamniidae	*Zoothamnium sp.*	CI1	Occasional
MYSIDS	ATHROPODA CRUSTACEA	Malacostraca	Mysida, Decapoda	Penaeidae	*Penaeus sp.*	M1	Occasional
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BRACHYURA LARVAE	ARTHROPODA (CRUSTACEA)	Malacostraca Decapoda			Brachyuran Zoea larvae	L2	Abundant

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
BARNACLE LARVAE	ATHROPODA CRUSTACEA	Maxillopoda Thecostraca			Cirripede larvae	L3	Frequent
CYPHONAUTES LARVAE	BRYOZOA				Cyphonautes larvae	L4	Occasional
ECHINODERMATA LARVAE	ECHINODERMATA				Ophipluutes larvae/ Echinoplutes larvae	L5	Occasional
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L6	Occasional
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L7	Frequent
POLYCHAETE LARVAE	ANNELIDA	Polychaeta			Trochophore larvae	L8	Frequent
FORAMINIFERA	FORAMINIFERA	Globothalamea	Rotaliida	Rotalliidae	*Rotalia* sp.	F1	Rare

BENTHIC ORGANISMS:

Few Benthic organismswere observed in the collected sediments by using the Van-veen grabs during the sampling conducted during spring tide period and while no benthic organisms were observed during sampling conducted in Neap tide period from DPT harbour region and nearby creek except few dead shells.The meiobenthic organisms during spring tide were represented by Polychaetes,and Nematodes. The polychaetes were represented by *Scyphoproctus sp*. and *Branchiocapitelida* sps*,*during spring tide sampling*.* The meiobenthic organisms in the collected samples were varying from 0-80N/M ^{2}.

Table # 16 BENTHIC FAUNA IN THE SAMPLING LOCATIONS IN DPT HARBOUR AREA CREEKS DURING SPRING TIDE IN SEPTEMBER ,2021

Benthic fauna	ABUNDANCE IN NO/M ^{2} DIFFERENT SAMPLING STATIONS REPRESENTATION BY GROUP						
	DPT HARBOUR			CREEKS			
POLYCHAETES	KPT-1	KPT-2	KPT-3	KPT-4	KPT-5	KPT-6	
Family : Capitellidae **Scyphoproctus** *sp.*	40	0	0	0	0	NS	
Family : Capitellidae **Branchiocapitelida** *sp.*	0	20	0	0	0		
Total Polychates N/M^{2}	40	20	0	00	0	NS	
Un identified Nematode worms	40	20	0	10	0	NS	
TOTAL Benthic Fauna NUMBER/ M^{2}	80	40	0	10	0	-	

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 29.0 °C. The day-time maximum temperature was 36.2 °C. The mean night time temperature was 26.7 °C. The minimum mean night time temperature recorded was 29.4 °C.

Air Pressure

The mean absolute air pressure for the month of September was 1003.7 hpa, whereas the mean relative pressure was 1002.3 hpa. The maximum absolute air pressure recorded for the month of September was 1010.1 hpa.

Heat Index

The mean day-time heat index for the month of September was 33.5 ^{o}C. The maximum heat index recorded was 49^{o}C.

Solar Radiation

The mean Solar Radiation in September was 136.4 w/m^2. The maximum solar radiation recorded in the month of September was 808.9 w/m^2.

Humidity

The mean day-time humidity was 83.5 % for the month of September and mean night time humidity was 98.0%. Maximum humidity recorded during day-time was 90.3 % and maximum humidity recorded during night-time was 96.0%.

Wind Velocity and Wind Direction

The mean wind velocity for the entire month of September was 6.88 km/hour. Maximum wind velocity recorded was 43.2 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 September, 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.

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ENVIRONMENTAL MONITORING REPORT
FOR
DEENDAYAL PORT TRUST

REPORT NO.	:	DCPL/DPT/20-21/18
Month	:	October 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 October 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	06.10.2021	349	165	80	2.20	2.64	26.04	25.19	12.76	13.44
					3.96		24.14		12.25	
					1.76		25.41		15.32	
AL1 – 2	08.10.2021	474	229	103	4.40	3.22	15.24	19.27	12.51	13.02
					3.08		16.51		13.02	
					2.20		26.04		13.53	
AL1 – 3	13.10.2021	280	162	58	7.47	7.33	28.58	26.04	10.72	10.81
					8.79		31.12		12.51	
					5.71		18.42		9.19	
AL1 – 4	15.10.2021	404	227	95	3.08	2.49	16.51	15.24	13.79	14.89
					2.64		13.97		15.83	
					1.76		15.24		15.06	
AL1 – 5	20.10.2021	336	156	73	3.52	3.96	18.42	20.54	5.87	9.28
					4.84		20.96		10.72	
					3.52		22.23		11.23	
AL1 - 6	22.10.2021	453	267	85	2.64	3.52	15.88	15.67	10.72	6.47
					5.28		19.69		5.62	
					2.64		11.43		3.06	
AL1 - 7	27.10.2021	338	163	76	3.52	3.37	12.07	16.73	10.47	10.55
					3.96		20.96		11.49	
					2.64		17.15		9.70	
AL1 – 8	29.10.2021	275	152	88	2.64	3.08	24.14	25.19	12.51	9.02
					2.20		29.22		6.64	
					4.40		22.23		7.91	
Monthly Average		364	190	82		3.70		20.48		10.93
Standard Deviation		74	44	14		1.54		4.50		2.75

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	06.10.2021	1.12	BQL	1.89	492
AL1 – 2	08.10.2021	1.11	BQL	1.75	489
AL1 – 3	13.10.2021	1.32	BQL	1.82	499
AL1 – 4	15.10.2021	1.15	BQL	1.76	492
AL1 – 5	20.10.2021	1.13	BQL	1.84	493
AL1 - 6	22.10.2021	1.15	BQL	1.86	501
AL1 – 7	27.10.2021	1.21	BQL	1.88	488
AL1 – 8	29.10.2021	1.13	BQL	1.95	511
Monthly Average		**1.17**	**-**	**1.84**	**496**
Standard Deviation		**0.07**	**-**	**0.07**	**8**

* NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification Limit – NMHC: 0.5 ppm)
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 364 µg/m³, The mean PM_{10} values were 190.0 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 82 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 3.70 µg/ m³, 20.48 µg/ m³ & 10.93 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 1.17 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.84 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	06.10.2021	380	162	82	4.40	5.28	33.66	33.66	8.93	9.96
					5.28		36.84		10.21	
					6.15		30.49		10.72	
AL2 – 2	08.10.2021	486	284	103	1.76	3.96	8.89	11.01	6.38	9.62
					4.84		9.53		10.98	
					5.28		14.61		11.49	
AL2 – 3	13.10.2021	451	300	89	7.47	9.52	32.39	24.35	3.57	6.30
					9.23		18.42		6.13	
					11.87		22.23		9.19	
AL2 – 4	15.10.2021	480	335	100	2.20	2.05	16.51	14.82	7.40	8.93
					2.64		14.61		10.47	
					1.32		13.34		8.93	
AL2 – 5	20.10.2021	464	190	76	2.64	2.49	20.33	19.48	9.19	7.32
					1.76		24.77		4.85	
					3.08		13.34		7.91	
AL2 – 6	22.10.2021	509	280	100	4.84	5.28	20.96	14.82	5.62	8.00
					7.03		10.16		7.91	
					3.96		13.34		10.47	
AL2 – 7	27.10.2021	448	215	71	1.76	1.76	22.87	19.48	9.19	10.04
					1.32		14.61		12.51	
					2.20		20.96		8.42	
AL2 – 8	29.10.2021	504	204	92	1.32	2.49	14.61	17.36	6.38	9.10
					2.20		22.87		9.96	
					3.96		14.61		10.98	
Monthly Average		465	246	89		4.10		19.37		8.66
Standard Deviation		41	61	12		2.59		7.01		1.34

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	06.10.2021	1.11	BQL	1.88	499
AL2 -2	08.10.2021	1.21	BQL	1.78	495
AL2 -3	13.10.2021	1.26	BQL	1.86	468
AL2 -4	15.10.2021	1.11	BQL	1.83	466
AL2 – 5	20.10.2021	1.22	BQL	1.89	458
AL2 – 6	22.10.2021	1.18	BQL	1.87	488
AL2 -7	27.10.2021	1.01	BQL	1.77	498
AL2 – 8	29.10.2021	1.14	BQL	1.82	501
Monthly Average		**1.16**	**-**	**1.84**	**484**
Standard Deviation		**0.08**	**-**	**0.05**	**17**

* NMHC- Non- Methane Hydrocarbons

BQL- Below Quantification Limit (Quantification 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 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 465 µg/m³ .The mean PM_{10} values were 246 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 mean concentration of SO_2, NO_x and NH3 were 4.10 µg/m³, 19.37 µg/m³ and 8.66 µg/m³ respectively.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Oil Jetty. The mean Benzene concentration was 1.16 µg/m³ .Well below the permissible limit of 5.0 µg/m³. , HC's were below the detectable limit and Carbon Monoxide concentration was 1.84 mg/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											
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	06.10.2021	355	161	79	4.84	3.37	12.70	23.08	14.30	12.00	
					3.52		24.14		12.25		
					1.76		32.39		9.45		
AL3 – 2	08.10.2021	280	121	76	3.96	2.64	13.34	12.49	10.47	9.10	
					1.32		9.53		11.49		
					2.64		14.61		5.36		
AL3 – 3	13.10.2021	420	282	98	3.08	3.52	13.97	19.48	7.91	5.87	
					4.84		19.69		6.38		
					2.64		24.77		3.32		
AL3 – 4	15.10.2021	530	287	101	4.40	2.93	8.89	8.05	12.25	9.10	
					2.64		8.26		9.19		
					1.76		6.99		5.87		
AL3 – 5	20.10.2021	401	239	98	5.28	3.66	18.42	23.50	8.93	9.19	
					3.08		32.39		9.70		
					2.64		19.69		8.93		
AL3 – 6	22.10.2021	381	244	93	5.28	4.40	18.42	19.27	10.47	8.25	
					1.76		14.61		8.93		
					6.15		24.77		5.36		
AL3 – 7	27.10.2021	466	194	90	4.84	2.93	19.69	17.36	11.23	10.81	
					2.64		16.51		10.72		
					1.32		15.88		10.47		
AL3 – 8	29.10.2021	380	222	87	1.76	2.93	15.88	16.94	12.00	9.10	
					4.40		15.24		9.70		
					2.64		19.69		5.62		
Monthly Average		402	219	90		3.30		17.52		9.18	
Standard Deviation		74	58	9		0.56		5.20		1.79	

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	06.10.2021	1.01	BQL	1.85	489
AL3 -2	08.10.2021	1.12	BQL	1.98	496
AL3 -3	13.10.2021	1.02	BQL	1.79	488
AL3 -4	15.10.2021	1.11	BQL	1.81	499
AL3 – 5	20.10.2021	1.06	BQL	1.88	480
AL3 – 6	22.10.2021	1.18	BQL	1.79	485
AL3 – 7	27.10.2021	1.26	BQL	1.96	472
AL3 – 8	29.10.2021	1.14	BQL	1.88	498
Monthly Average		**1.11**	**-**	**1.87**	**488**
Standard Deviation		**0.08**	**-**	**0.07**	**9**

* NMHC- Non- Methane Hydrocarbons

BQL- Below Quantification Limit (Quantification 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 402 µg/m^3, The mean PM_{10} values were 219 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 90 µg/m^3). The average values of SO_2, NO_x and NH3 were 3.30 µg/m^3, 17.52 µg/m^3 and 9.18 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 1.11 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 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	06.10.2021	158	96	40	6.15	4.40	18.42	25.83	3.83	5.87	
					3.96		25.41		7.40		
					3.08		33.66		6.38		
AL4 -2	08.10.2021	246	115	77	3.96	5.28	12.70	10.37	4.85	5.70	
					5.28		9.53		5.11		
					6.59		8.89		7.15		
AL4 -3	13.10.2021	302	129	66	2.20	2.64	10.16	11.22	3.83	4.25	
					3.08		12.70		4.85		
					2.64		10.80		4.08		
AL4 -4	15.10.2021	414	267	89	2.20	2.20	10.16	8.68	6.38	5.45	
					2.64		9.53		4.60		
					1.76		6.35		5.36		
AL4 – 5	20.10.2021	268	128	90	2.64	2.64	14.61	14.61	4.85	6.64	
					3.08		9.53		8.42		
					2.20		19.69		6.64		
AL4 – 6	22.10.2021	219	114	93	2.64	2.49	13.34	12.49	4.85	8.51	
					3.08		9.53		9.19		
					1.76		14.61		11.49		
AL4 – 7	27.10.2021	274	132	84	2.64	3.08	17.78	15.88	6.38	6.55	
					3.08		13.34		7.91		
					3.52		16.51		5.36		
AL4 – 8	29.10.2021	311	142	96	2.20	3.22	13.34	12.70	7.40	8.25	
					3.52		13.97		8.42		
					3.96		10.80		8.93		
Monthly Average		274	140	79		3.24		13.97		6.40	
Standard Deviation		75	53	18		1.06		5.30		1.43	

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	06.10.2021	1.02	BQL	1.88	496
AL4 -2	08.10.2021	1.11	BQL	1.68	482
AL4 -3	13.10.2021	1.32	BQL	1.65	501
AL4 -4	15.10.2021	1.25	BQL	1.79	499
AL4 – 5	20.10.2021	1.52	BQL	1.65	501
AL4 – 6	22.10.2021	1.32	BQL	1.82	508
AL4 – 7	27.10.2021	1.23	BQL	1.7	487
AL4 – 8	29.10.2021	1.58	BQL	1.76	496
Monthly Average		**1.29**	**-**	**1.74**	**496**
Standard Deviation		**0.19**	**-**	**0.08**	**8**

* NMHC- Non- Methane Hydrocarbons

BQL- Below Quantification Limit (Quantification 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 TSPM values at Oil Jetty were 274 µg/m^3, The mean PM_{10} values were 140 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean= 79 µg/m^3). The average values of SO_2, NO_x and NH_3 were 3.24 µg/m^3, 13.97 µg/m^3 and 6.40 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 1.29 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 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	06.10.2021	266	122	92	4.40	5.71	44.46	49.33	15.32	14.04
					6.15		49.54		13.53	
					6.59		53.99		13.27	
AL5 – 2	08.10.2021	360	208	79	3.96	3.96	20.33	18.84	15.57	16.25
					2.64		22.23		17.61	
					5.28		13.97		15.57	
AL5 – 3	13.10.2021	647	226	110	10.11	8.65	22.23	22.87	7.91	7.32
					6.15		26.04		6.13	
					9.67		20.33		7.91	
AL5 – 4	15.10.2021	760	217	118	1.32	2.93	16.51	18.84	12.51	9.62
					3.52		19.69		8.42	
					3.96		20.33		7.91	
AL5 – 5	20.10.2021	597	244	110	4.84	4.25	19.69	20.75	10.72	11.32
					4.40		17.78		10.98	
					3.52		24.77		12.25	
AL5 – 6	22.10.2021	647	206	106	3.52	4.54	14.61	17.15	14.30	14.47
					3.96		15.88		15.06	
					6.15		20.96		14.04	
AL5 – 7	27.10.2021	614	249	107	4.40	4.25	13.34	16.51	9.96	9.36
					4.84		17.78		9.19	
					3.52		18.42		8.93	
AL5 – 8	29.10.2021	324	151	117	4.84	4.10	22.87	25.41	12.51	14.04
					3.96		27.95		14.30	
					3.52		25.41		15.32	
Monthly Average		527	203	105		4.80		23.71		12.05
Standard Deviation		182	44	13		1.73		10.76		3.11

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	06.10.2021	1.22	BQL	1.85	498
AL5 – 2	08.10.2021	1.32	BQL	1.86	488
AL5 – 3	13.10.2021	1.22	BQL	1.89	485
AL5 – 4	15.10.2021	1.16	BQL	1.84	501
AL5 – 5	20.10.2021	1.33	BQL	1.86	496
AL5 – 6	22.10.2021	1.24	BQL	1.9	500
AL5 – 7	27.10.2021	1.15	BQL	1.84	490
AL5 – 8	29.10.2021	1.18	BQL	1.98	498
Monthly Average		**1.23**	**-**	**1.88**	**495**
Standard Deviation		**0.07**	**-**	**0.05**	**6**

* NMHC- Non- Methane Hydrocarbons

BQL- Below Quantification Limit (Quantification 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 527µg/m³. The mean PM_{10} values were 203 µg/m³, which is well above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 105 µg/m³). The average values of SO_2, NO_x and NH_3 were 4.80 µg/m³, 23.71 µg/m³ and 12.05 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 1.88 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	06.10.2021	280	134	98	4.40	4.10	15.88	29.85	5.62	7.40
					6.15		33.66		7.66	
					1.76		40.02		8.93	
AL6 – 2	08.10.2021	293	130	92	1.76	3.22	13.34	12.49	13.53	11.49
					3.08		13.97		12.25	
					4.84		10.16		8.68	
AL6 – 3	13.10.2021	438	251	103	6.15	4.69	16.51	16.94	6.38	5.96
					5.71		20.96		4.08	
					2.20		13.34		7.40	
AL6 – 4	15.10.2021	466	153	100	2.20	1.76	5.08	6.78	5.62	6.47
					1.76		8.26		7.15	
					1.32		6.99		6.64	
AL6 – 5	20.10.2021	480	180	94	1.32	2.64	20.33	16.94	12.25	11.57
					2.64		13.97		11.49	
					3.96		16.51		10.98	
AL6 – 6	22.10.2021	310	123	88	4.84	3.22	32.39	27.31	9.96	12.76
					2.20		20.96		15.57	
					2.64		28.58		12.76	
AL6 – 7	27.10.2021	275	140	93	2.20	2.49	15.24	15.88	9.19	9.36
					1.76		16.51		8.42	
					3.52		15.88		10.47	
AL6 – 8	29.10.2021	352	191	98	2.20	2.93	15.88	15.03	10.72	10.30
					2.64		10.80		8.93	
					3.96		18.42		11.23	
Monthly Average		362	163	96		3.13		17.65		9.41
Standard Deviation		86	43	5		0.92		7.54		2.55

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	06.10.2021	1.03	BQL	1.79	510
AL6 – 2	08.10.2021	1.11	BQL	1.84	502
AL6 – 3	13.10.2021	1.14	BQL	1.72	511
AL6 – 4	15.10.2021	1.11	BQL	1.69	496
AL6 – 5	20.10.2021	1.18	BQL	1.88	499
AL6 – 6	22.10.2021	1.06	BQL	1.87	502
AL6 – 7	27.10.2021	1.10	BQL	1.74	506
AL6 – 8	29.10.2021	1.01	BQL	1.7	512
Monthly Average		**1.09**	**-**	**1.78**	**505**
Standard Deviation		**0.06**	**-**	**0.08**	**6**

* NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification Limit – NMHC: 0.5 ppm)
NS- Not Specified

The mean TSPM values at Tuna Port were 362 µg/m^3, The mean PM_{10} values were 163 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 96 µg/m^3). The average values of SO_2, NO_x and NH_3 were 3.13 µg/m^3, 17.65 µg/m^3 and 9.41 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 1.09 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 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	06.10.2021	115	73	30	4.40	3.52	19.69	18.63	6.89	6.21
					3.52		22.23		6.38	
					2.64		13.97		5.36	
AL7 -2	08.10.2021	111	62	34	3.96	2.78	16.51	16.94	8.42	8.42
					1.76		20.33		6.13	
					2.64		13.97		10.72	
AL7 -3	13.10.2021	198	107	52	3.08	3.08	16.51	16.51	4.60	5.45
					3.96		23.50		5.11	
					2.20		9.53		6.64	
AL7 -4	15.10.2021	146	72	50	3.96	4.40	15.24	12.91	7.91	7.06
					5.28		11.43		9.96	
					3.96		12.07		3.32	
AL7 -5	20.10.2021	171	85	44	3.08	2.64	8.89	9.32	6.89	7.23
					2.20		8.26		8.93	
					2.64		10.80		5.87	
AL7 -6	22.10.2021	178	88	71	3.08	4.54	14.61	12.49	8.42	8.17
					4.84		9.53		8.68	
					5.71		13.34		7.40	
AL7 -7	27.10.2021	160	80	52	3.08	3.81	6.35	11.22	10.98	8.25
					2.64		15.24		5.36	
					5.71		12.07		8.42	
AL7 -8	29.10.2021	177	89	56	2.20	3.52	9.53	10.16	8.42	5.96
					3.96		12.07		3.32	
					4.40		8.89		6.13	
Monthly Average		157	82	49		3.5		13.5		7.1
Standard Deviation		31	14	13		0.7		3.4		1.1

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	06.10.2021	1.10	BQL	1.71	466
AL7 – 2	08.10.2021	1.13	BQL	1.62	488
AL7 – 3	13.10.2021	1.06	BQL	1.66	479
AL7 – 4	15.10.2021	1.11	BQL	1.72	480
AL7 – 5	20.10.2021	1.16	BQL	1.59	486
AL7 – 6	22.10.2021	1.17	BQL	1.66	477
AL7 – 7	27.10.2021	1.04	BQL	1.79	468
AL7 – 8	29.10.2021	1.10	BQL	1.64	470
Monthly Average		**1.11**	**-**	**1.67**	**477**
Standard Deviation		**0.04**	**-**	**0.06**	**8**

*

*NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification Limit – NMHC: 0.5 ppm)
NS_ Not Specified

The mean TSPM values at Vadinar Port were 157 µg/m³. The mean PM_{10} values were 82 µg/m³, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 49 µg/m³). The average values of SO_2, NO_x and NH_3 were 3.5 µg/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 Vadinar Port. The mean Benzene concentration was 1.11 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.67 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	06.10.2021	221	113	82	2.64	3.22	8.89	12.28	7.40	5.79
					3.08		14.61		5.87	
					3.96		13.34		4.08	
AL8 -2	08.10.2021	218	126	73	4.40	5.42	27.95	18.21	4.08	6.81
					5.28		15.88		10.72	
					6.59		10.80		5.62	
AL8 -3	13.10.2021	197	104	72	3.08	3.22	10.16	17.57	5.87	9.02
					3.96		26.68		11.74	
					2.64		15.88		9.45	
AL8 -4	15.10.2021	227	111	75	2.20	3.37	20.96	15.24	8.42	6.30
					4.40		14.61		4.08	
					3.52		10.16		6.38	
AL8 -5	20.10.2021	185	88	54	4.40	3.52	15.24	16.73	8.42	6.98
					2.64		20.96		6.64	
					3.52		13.97		5.87	
AL8 -6	22.10.2021	248	121	94	3.96	3.81	8.89	10.37	5.36	5.19
					2.20		8.26		4.08	
					5.28		13.97		6.13	
AL8 -5	27.10.2021	210	138	62	3.08	3.66	13.97	13.76	15.06	10.64
					1.32		6.35		11.49	
					6.59		20.96		5.36	
AL8-6	29.10.2021	186	128	50	3.08	3.23	15.88	11.01	4.08	5.53
					2.20		8.89		5.87	
					4.40		8.26		6.64	
Monthly Average		211	116	70		3.7		14.4		7.0
Standard Deviation		22	16	15		0.7		3.0		1.9

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	06.10.2021	1.30	BQL	1.86	451
AL8-2	08.10.2021	1.09	BQL	1.79	450
AL8 -3	13.10.2021	1.20	BQL	1.71	462
AL8-4	15.10.2021	1.11	BQL	1.82	455
AL8 -5	20.10.2021	1.16	BQL	1.69	469
AL8-6	22.10.2021	1.06	BQL	1.77	470
AL8-7	27.10.2021	1.30	BQL	1.82	459
AL8-8	29.10.2021	1.10	BQL	1.74	466
Monthly Average		**1.17**	**-**	**1.78**	**460**
Standard Deviation		**0.09**	**-**	**0.06**	**8**

* NMHC- Non- Methane Hydrocarbons

BQL- Below Quantification Limit (Quantification 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 211 µg/m^3. The mean PM_{10} values were 116 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 70.0 µg/m^3). The average values of SO_2, NO_x and NH_3 were 3.7 µg/m^3, 14.4 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 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 1.78 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	7.3	7.4	7.3	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	970	1310	1250	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	1860	2560	2430	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/l	476.06	440.98	506.13	250.0	1000.0
9	Ca as Ca	mg/l	64.13	68.14	72.14	75.0	200.0
10	Mg as Mg	mg/l	63.18	70.47	65.61	30.0	100.0
11	Total Hardness	mg/l	420	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	0.32	0.35	0.17	1.0	1.5
14	Sulphate as SO4	mg/l	286.8	289.2	194.4	200.0	400
15	Nitrite as NO2	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate as NO3	mg/l	6.41	7.88	13.02	45.0	No Relaxation
17	Salinity	%	0.86	0.80	0.91	NS*	NS*
18	Sodium as Na	mg/l	199	193	258	NS*	NS*
19	Potassium as K	mg/l	3.24	3.68	3.51	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	7.7	7.4	7.2	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1340	980	1040	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	2600	1940	2040	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/l	526.17	496.10	481.07	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	65.61	70.47	30.0	100.0
11	Total Hardness	mg/l	440	430	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	0.46	0.50	0.52	1.0	1.5
14	Sulphate as SO4	mg/l	186	194.4	288	200.0	400
15	Nitrite as NO2	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate as NO3	mg/l	8.59	10.21	9.22	45.0	No Relaxation
17	Salinity	%	0.95	0.90	0.87	NS*	NS*
18	Sodium as Na	mg/l	215	209	231	NS*	NS*
19	Potassium as K	mg/l	4.23	3.88	4.21	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	7.4	7.8	7.5	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1190	1420	1160	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	1920	2870	2180	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	616.37	591.31	491.09	250.0	1000.0
9	Ca as Ca	mg/l	64.13	68.14	60.12	75.0	200.0
10	Mg as Mg	mg/l	68.04	58.32	65.61	30.0	100.0
11	Total Hardness	mg/l	440	410	420	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.90	0.57	0.63	1.0	1.5
14	Sulphate	mg/l	217.2	205.2	289.2	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	13.52	9.93	12.74	45.0	No Relaxation
17	Salinity	%	1.11	1.07	0.89	NS*	NS*
18	Sodium as Na	mg/l	265	218	323	NS*	NS*
19	Potassium as K	mg/l	3.87	3.73	3.56	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	7.3	7.6	7.2	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1090	1460	940	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	2090	2850	1860	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	445.99	466.04	496.10	250.0	1000.0
9	Ca as Ca	mg/l	56.11	68.14	60.12	75.0	200.0
10	Mg as Mg	mg/l	75.33	72.90	80.19	30.0	100.0
11	Total Hardness	mg/l	450	470	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	0.87	0.68	0.92	1.0	1.5
14	Sulphate	mg/l	294	318	210	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	9.29	10.14	11.69	45.0	No Relaxation
17	Salinity	%	0.81	0.84	0.90	NS*	NS*
18	Sodium as Na	mg/l	101	221	402	NS*	NS*
19	Potassium as K	mg/l	4.08	4.01	3.99	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	7.4	7.4	7.3	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1020	1340	1100	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	2010	2660	2140	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	466.04	506.13	466.04	250.0	1000.0
9	Ca as Ca	mg/l	52.10	72.14	68.14	75.0	200.0
10	Mg as Mg	mg/l	77.76	55.89	63.18	30.0	100.0
11	Total Hardness	mg/l	450	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	0.60	0.81	1.08	1.0	1.5
14	Sulphate	mg/l	291.6	294	283.2	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	9.29	10.63	9.36	45.0	No Relaxation
17	Salinity	%	0.84	0.91	0.84	NS*	NS*
18	Sodium as Na	mg/l	275	300	130	NS*	NS*
19	Potassium as K	mg/l	3.49	3.50	3.56	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	7.4	7.38	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1120	1090	1080	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	2210	2190	2160	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	576.28	521.16	520	250.0	1000.0
9	Ca as Ca	mg/l	72.14	76.15	78.56	75.0	200.0
10	Mg as Mg	mg/l	55.89	65.61	54.92	30.0	100.0
11	Total Hardness	mg/l	410	460	422	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	0.93	0.46	1.0	1.5
14	Sulphate	mg/l	265.2	238.8	180	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	9.86	7.88	8.2	45.0	No Relaxation
17	Salinity	%	1.04	0.94	0.98	NS*	NS*
18	Sodium as Na	mg/l	235	235	260	NS*	NS*
19	Potassium as K	mg/l	2.18	4.01	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	7.5	7.6	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1030	1010	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	2020	1960	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	NS*	NS*
8	Chloride	mg/l	425.95	415.92	250.0	1000.0
9	Ca as Ca	mg/l	60.12	52.10	75.0	200.0
10	Mg as Mg	mg/l	75.33	94.26	30.0	100.0
11	Total Hardness	mg/l	460	440	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.92	0.67	1.0	1.5
14	Sulphate	mg/l	22.44	22.20	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	7.39	9.99	45.0	No Relaxation
17	Salinity	%	0.90	0.92	NS*	NS*
18	Sodium as Na	mg/l	51.1	44.1	NS*	NS*
19	Potassium as K	mg/l	2.2	<2.0	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 900 -1500 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 October ranged from 1800-3000 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 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 400-650 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 50 - 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 50 – 99 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 400-480 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 20 – 350 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 6.41 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 0.5 to 1.4 %. There are no prescribed Indian standards for salinity in Drinking water.

Sodium and Potassium Salts

Sodium values in the samples collected ranged from 50 - 400 mg/l and Potassium salts ranged from 2.0 to 4.5 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	73.9	53.4
2	Nirman Building 1	62.3	51.0
3	Tuna Port	57.2	50.9
4	Main Gate North	67.0	61.8
5	West Gate I	70.5	65.1
6	Canteen Area	64.5	51.0
7	Main Road	68.4	51.5
8	ATM Building	80.4	57.3
9	Wharf Area /Jetty Area	72.9	68.1
10	Port & Custom Office	67.8	41.8
	Vadinar Port		
11	Entrance Gate of Vadinar Port	66.4	53.2
12	Nr. Port Colony, Vadinar	60.7	54.1
13	Nr. Vadinar Jetty	72.4	66.5

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 13 locations at Deendayal Port ranged from 57.0 dB(A) to 73.9 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 13 locations of Deendayal Port ranged from 41.8 dB to 68.4 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 October 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	-	8.62	8.10	8.75	8.33	8.10	8.22
3	Electrical Conductivity	µs/cm	16,200.0	26,820.0	16,252.0	17,520.0	560.0	480.0
4	Moisture	%	17.00	18.20	19.10	20.22	7.26	8.22
5	Total Organic Carbon	%	0.52	1.02	0.62	3.10	0.12	0.20
6	Alkalinity	mg/kg	60.06	80.44	140.20	80.44	60.06	80.44
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
8	Chloride	mg/kg	1,620.0	5,380.0	1,820.0	2,078.0	62.0	77.0
9	Sulphate	mg/kg	230.0	198.0	120.0	118.0	16.0	20.0
10	Phosphorus	mg/kg	0.90	0.82	0.96	1.02	0.80	0.72
11	Potassium	mg/kg	396.0	810.0	366.0	460.0	120.0	160.0
12	Sodium	mg/kg	1,620.0	3,400.0	2,122.0	2,012.0	910.0	888.0
13	Calcium	mg/kg	230.32	722.20	252.00	470.42	110.00	82.00
14	Copper as Cu	mg/kg	17.40	38.80	21.20	35.10	16.6	17.0
15	Lead as Pb	mg/kg	6.40	7.90	29.10	7.60	4.8	2.0
16	Nickel as Ni	mg/kg	33.50	13.90	34.50	13.20	13.2	12.2
17	Zinc as Zn	mg/kg	55.90	91.90	77.9	81.90	28.00	36.22
18	Cadmium as Cd	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL

4.3 Discussion

- The data shows that value of pH ranges from 8.10 at IFFCO Plant to 8.75 at Khori Creek indicating that all soil samples are neutral to slight basic. Iffco Plant samples showed maximum conductivity of 26,820 µmhos/cm, while Tuna Port location showed minimum conductivity of 16,200 µmhos/cm. Conductivity at Vadinar Port was 560 and 480 µmhos/cm at Admin site and Vadinar Port colony respectively.
- Total organic Carbon ranged from 0.5 % to 3.1 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 0.7 to 1.0 mg/kg and 300.0 to 800 mg/kg respectively at Deendayal Port. The mean concentration of Phosphorous at Vadinar site was 0.76 mg/kg and mean concentration of Potassium at Vadinar site was 140 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	08.10.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.62	7.4
2	Total Suspended Solids	mg/l	99.2	64.7
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	424.2	98.0
5	BOD @ 27 °C	mg/l	141.0	23.0
6.	Fecal Coliform	MPN Index / 100 ml	-	79.0
Aeration Tank				
7.	MLSS	mg/l	6.0	
8.	MLVSS	%	93.0	

Table 19: Sewage Water Monitoring at Kandla STP (2nd Week)

Date of Sampling	12.10.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.6	7.2
2	Total Suspended Solids	mg/l	152.2	72.4
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	384	103.0
5	BOD @ 27 °C	mg/l	120.0	24.0
6.	Fecal Coliform	MPN Index / 100 ml	-	8.0
Aeration Tank				
7.	MLSS	mg/l	12.0	
8.	MLVSS	%	84.0	

Table 20: Sewage Water Monitoring at Kandla STP (3rd Week)

Date of Sampling	21.10.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.65	7.41
2	Total Suspended Solids	mg/l	223.4	99.8
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	181.8	101
5	BOD @ 27 °C	mg/l	68.0	24.0
6.	Fecal Coliform	MPN Index / 100 ml	-	11.0
Aeration Tank				
7.	MLSS	mg/l	9.0	
8.	MLVSS	%	87.0	

Table 21: Sewage Water Monitoring at Kandla STP (4th Week)

Date of Sampling	25.10.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.72	7.5
2	Total Suspended Solids	mg/l	284.6	113.6
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	212	101.0
5	BOD @ 27 °C	mg/l	98.0	26.0
6.	Fecal Coliform	MPN Index / 100 ml	-	3.6
Aeration Tank				
7.	MLSS	mg/l	14.0	
8	MLVSS	%	84.0	

- **Gopalpuri Colony STP**

Table 22: Sewage Water Monitoring at Gopalpuri STP (1st Week)

Date of Sampling	08.10.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.6	7.4
2	Total Suspended Solids	mg/l	195.6	84.0
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	304.0	104.0
5	BOD @ 27 °C	mg/l	120.0	26.0
6.	Fecal Coliform	MPN Index / 100 ml	-	49.0
Aeration Tank				
7.	MLSS	mg/l	10.0	
8	MLVSS	%	87.0	

Table 23: Sewage Water Monitoring at Gopalpuri STP (2nd Week)

Date of Sampling	12.10.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.7	7.5
2	Total Suspended Solids	mg/l	388	131.8
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	414.1	106.00
5	BOD @ 27 °C	mg/l	139.0	28.0
6.	Fecal Coliform	MPN Index / 100 ml	-	6.0
Aeration Tank				
7.	MLSS	mg/l	14.0	
8	MLVSS	%	90.0	

Table 24: Sewage Water Monitoring at Gopalpuri STP (3rd Week)

Date of Sampling	21.10.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.52	7.21
2	Total Suspended Solids	mg/l	354.2	103.3
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	161.6	90.9
5	BOD @ 27 °C	mg/l	80.0	26.0
6.	Fecal Coliform	MPN Index / 100 ml	-	46.0
Aeration Tank				
7.	MLSS	mg/l	14.0	
8	MLVSS	%	84.0	

Table 25: Sewage Water Monitoring at Gopalpuri STP (4th Week)

Date of Sampling	25.10.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.45	7.19
2	Total Suspended Solids	mg/l	345.8	105
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	232	106
5	BOD @ 27 °C	mg/l	82.0	28.0
6.	Fecal Coliform	MPN Index / 100 ml	-	32.0
Aeration Tank				
7.	MLSS	mg/l	10.0	
8.	MLVSS	%	89.0	

- **Vadinar STP**

Table 26: Sewage Water Monitoring at Vadinar STP (1st Week)

Date of Sampling	08.10.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.62	7.4
2	Total Suspended Solids	mg/l	99.2	64.7
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	88.0	60.0
5	BOD @ 27 °C	mg/l	32.0	16.0

Table 27: Sewage Water Monitoring at Vadinar STP (2nd Week)

Date of Sampling	12.10.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.7	7.5
2	Total Suspended Solids	mg/l	133.5	59.9
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	188.0	60.0
5	BOD @ 27 °C	mg/l	60.0	16.0

Table 28: Sewage Water Monitoring at Vadinar STP (3rd Week)

Date of Sampling	21.10.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.7	7.5
2	Total Suspended Solids	mg/l	105	38
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	161.6	70.7
5	BOD @ 27 °C	mg/l	62.0	20.0

Table 29: Sewage Water Monitoring at Vadinar STP (4th Week)

Date of Sampling	25.10.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.7	7.2
2	Total Suspended Solids	mg/l	105	58.8
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	202	80.8
5	BOD @ 27 °C	mg/l	60.0	20.0

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.

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 6th& 7th October-2021 in harbor regions of KPT and on 7th October-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 13th& 14th October 2021 in harbor regions of KPT. 14th October -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	7.14	7.16	7.42	7.36
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.5	32.0	32.6	32.0
5	Turbidity	NTU	38	29	36	31
6	Total Dissolved Solids	mg/l	42450	39030	42122.0	41187.0
7	Total Suspended Solids	mg/l	685	950	764.9	558.1
8	Total Solids	mg/l	43135	39980	42886.9	41745.1
9	DO	mg/l	4.1	4	4.3	4.2
10	COD	mg/l	78.0	80.0	80.0	78.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.75	0.64	0.65	0.53
13	Phosphate	mg/l	0.36	0.26	0.16	0.18
14	Sulphate	mg/l	3060	2892	2256	2532
15	Nitrate	mg/l	2.89	2.46	2.50	3.48
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	601.20	521.04	561.12	521.04
18	Magnesium	mg/l	1628.1	1603.8	0	0
19	Sodium	mg/l	9473.0	8438.0	9368	8523
20	Potassium	mg/l	362.1	314.0	360.8	302.8
21	Iron	mg/l	1.63	1.34	1.35	1.24
22	Chromium	mg/l	0.11	0.13	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	0.04	0.05	0.04	0.04
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.09	0.11	0.11	0.09
28	Zinc	mg/l	0.07	0.06	0.06	0.05

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	7.25	7.21	7.51	7.1
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.8	31.9	31.8	31.9
5	Turbidity	NTU	36	25	39	45
6	Total Dissolved Solids	mg/l	33930	47550	40323.0	40031.0
7	Total Suspended Solids	mg/l	658	769	569.8	528.6
8	Total Solids	mg/l	34588	48319	40892.8	40559.6
9	DO	mg/l	4.4	3.8	4.4	4.1
10	COD	mg/l	82.0	86.0	88.0	80.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.51	0.60	0.80	0.75
13	Phosphate	mg/l	0.23	0.26	0.18	0.19
14	Sulphate	mg/l	2784	3252	2388	2652
15	Nitrate	mg/l	3.03	3.59	2.89	4.04
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	561.12	641.28	480.96	561.12
18	Magnesium	mg/l	1555.2	1628.1	0	0
19	Sodium	mg/l	9670.0	9156.0	9686	9192
20	Potassium	mg/l	380.0	326.1	354.2	278.2
21	Iron	mg/l	1.90	1.73	1.68	1.33
22	Chromium	mg/l	0.13	0.11	0.11	0.15
23	Copper	mg/l	0.07	0.05	0.07	0.07
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.05	0.04	0.04	0.05
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.12	0.12	0.09	0.11
28	Zinc	mg/l	0.05	0.06	0.08	0.09

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	7.40	7.52	7.2	7.41
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.2	32.0	32.0	31.7
5	Turbidity	NTU	36	28	33	41
6	Total Dissolved Solids	mg/l	45010	41120	40162.0	42404.0
7	Total Suspended Solids	mg/l	586	838	492.9	627.8
8	Total Solids	mg/l	45596	41958	40654.9	43031.8
9	DO	mg/l	4.1	5	4.5	5.2
10	COD	mg/l	88.0	90.0	79.0	74.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.69	0.76	0.53	0.71
13	Phosphate	mg/l	0.27	0.37	0.16	0.19
14	Sulphate	mg/l	3300	1872	2688	2256
15	Nitrate	mg/l	3.87	4.36	2.96	2.59
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	601.20	681.36	521.04	480.96
18	Magnesium	mg/l	1676.7	1652.4	0	0
19	Sodium	mg/l	9421.0	8958.0	9328	8688
20	Potassium	mg/l	354.2	343.7	283.8	332.6
21	Iron	mg/l	1.56	1.88	1.93	1.57
22	Chromium	mg/l	0.14	0.14	0.14	0.11
23	Copper	mg/l	0.06	0.07	0.06	0.06
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.05	0.04	0.06	0.05
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.13	0.10	0.08	0.10
28	Zinc	mg/l	0.07	0.08	0.06	0.07

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	7.28	7.40	7.3	7.4
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.5	32.6	32.4	32.0
5	Turbidity	NTU	46	36	50	30
6	Total Dissolved Solids	mg/l	42910	48900	40963.0	41643.0
7	Total Suspended Solids	mg/l	660	562	711.1	509.7
8	Total Solids	mg/l	43570	49462	41674.1	42152.7
9	DO	mg/l	4.7	4.6	5.8	5.6
10	COD	mg/l	72.0	76.0	82.0	78.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.73	0.62	0.65	0.49
13	Phosphate	mg/l	0.28	0.24	0.22	0.19
14	Sulphate	mg/l	1500	3336	2412	2124
15	Nitrate	mg/l	1.76	2.89	2.78	2.02
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	521.04	601.20	440.88	601.2
18	Magnesium	mg/l	1676.7	1555.2	0	0
19	Sodium	mg/l	9979.0	9708.0	9808	9629
20	Potassium	mg/l	373.2	343.9	327.8	305.6
21	Iron	mg/l	1.73	1.67	1.02	1.68
22	Chromium	mg/l	0.15	0.17	0.09	0.09
23	Copper	mg/l	0.05	0.08	0.07	0.07
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.03	0.06	0.07	0.04
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.09	0.01	0.09	0.08
28	Zinc	mg/l	0.06	0.08	0.07	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	7.20	7.40	7.2	7.4
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.1	31.9	31.6	31.2
5	Turbidity	NTU	34	46	33	29
6	Total Dissolved Solids	mg/l	48700	49900	40306.0	38117.0
7	Total Suspended Solids	mg/l	867	848	441.1	513
8	Total Solids	mg/l	49567	50748	40747.1	38630.0
9	DO	mg/l	4.2	4.8	4.8	4.7
10	COD	mg/l	96.0	98.0	90.0	92.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.53	0.84	0.73	0.60
13	Phosphate	mg/l	0.25	0.24	0.20	0.17
14	Sulphate	mg/l	3504	3780	2772	2364
15	Nitrate	mg/l	3.24	3.59	2.74	4.60
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	521.04	601.20	480.96	521.04
18	Magnesium	mg/l	1652.4	1676.7	0	0
19	Sodium	mg/l	10156.0	10254.0	10268	10438
20	Potassium	mg/l	336.9	336.4	278.6	297.8
21	Iron	mg/l	1.54	1.83	1.55	1.50
22	Chromium	mg/l	0.12	0.11	0.14	0.16
23	Copper	mg/l	0.08	0.07	0.05	0.05
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.04	0.06	0.06	0.04
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.12	0.13	0.11	0.13
28	Zinc	mg/l	0.08	0.09	0.05	0.09

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	7.50	Sampling not possible during Low Tide	7.5	Sampling not possible during Low Tide
2	Color	-	Colorless		Colorless	
3	Odor	-	Odorless		Odorless	
4	Salinity	ppt	31.8		31.0	
5	Turbidity	NTU	34		34	
6	Total Dissolved Solids	mg/l	43730		40522.0	
7	Total Suspended Solids	mg/l	635		432.9	
8	Total Solids	mg/l	44365		40954.9	
9	DO	mg/l	4.6		5.2	
10	COD	mg/l	98.0		90.0	
11	BOD	mg/l	<2.0		<2.0	
12	Silica	mg/l	1.00		0.51	
13	Phosphate	mg/l	0.24		0.17	
14	Sulphate	mg/l	3576		2352	
15	Nitrate	mg/l	3.03		3.37	
16	Nitrite	mg/l	<0.05		<0.05	
17	Calcium	mg/l	561.12		601.2	
18	Magnesium	mg/l	1725.3		0	
19	Sodium	mg/l	10760.0		10536	
20	Potassium	mg/l	335.1		335.1	
21	Iron	mg/l	1.80		1.33	
22	Chromium	mg/l	0.16		0.10	
23	Copper	mg/l	0.07		0.06	
24	Arsenic	mg/l	<0.01		<0.01	
25	Cadmium	mg/l	0.03		0.05	
26	Mercury	mg/l	<0.001		<0.001	
27	Lead	mg/l	0.12		0.11	
28	Zinc	mg/l	0.09		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	7.50	7.80	7.54	7.45
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.0	32.0	32.1	31.9
5	Turbidity	NTU	46	36	46	42
6	Total Dissolved Solids	mg/l	47700	46610	37421.0	38258.0
7	Total Suspended Solids	mg/l	483	476	553.6	490
8	Total Solids	mg/l	48183	47086	37974.6	38748.0
9	DO	mg/l	4.3	4.5	4.6	4.8
10	COD	mg/l	86.0	88.0	88.0	86.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.85	0.93	0.71	0.89
13	Phosphate	mg/l	0.23	0.25	0.18	0.17
14	Sulphate	mg/l	2784	2556	2532	2448
15	Nitrate	mg/l	2.46	2.89	3.60	3.37
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	641.28	561.12	561.12	521.04
18	Magnesium	mg/l	1506.6	1579.5	0	0
19	Sodium	mg/l	10233.0	10490.0	10860.0	10880.0
20	Potassium	mg/l	331.3	363.9	336.0	333.0
21	Iron	mg/l	1.38	1.69	1.34	1.2
22	Chromium	mg/l	0.15	0.19	0.11	0.12
23	Copper	mg/l	0.06	0.08	0.06	0.06
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.04	0.04	0.06	0.05
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.11	0.11	0.09	0.09
28	Zinc	mg/l	0.06	0.08	0.06	0.05

Table 36 (a): Marine Water Quality Monitoring Parameters for locations Nr. Vadinar SPM

Sr. No.	Parameters	Unit	Nr.Vadinar SPM			
			22°30'56.15"N 69°42'12.07"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.70	7.50	7.42	7.36
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.5	32.6	32.0	31.8
5	Turbidity	NTU	34	32	38	44
6	Total Dissolved Solids	mg/l	40230	39870	40119.0	40011.0
7	Total Suspended Solids	mg/l	470	447	496.1	457.4
8	Total Solids	mg/l	40700	40317	40615.1	40468.4
9	DO	mg/l	4.2	4.1	4.4	4.5
10	COD	mg/l	88.0	90	88.0	86
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.82	0.93	0.62	0.76
13	Phosphate	mg/l	0.24	0.25	0.17	0.17
14	Sulphate	mg/l	2688	2340	2352	2472
15	Nitrate	mg/l	2.68	2.82	3.27	3.60
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	601.20	641.28	0	0
18	Magnesium	mg/l	1579.5	1652.4	0	0
19	Sodium	mg/l	10575	10639	10936.0	10886.0
20	Potassium	mg/l	370.1	367.9	331	402
21	Iron	mg/l	1.57	1.81	1.07	1.63
22	Chromium	mg/l	0.17	0.18	0.09	0.11
23	Copper	mg/l	0.06	0.08	0.06	0.04
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.04	0.05	0.04	0.06
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.13	0.12	0.08	0.08
28	Zinc	mg/l	0.06	0.07	0.07	0.08

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 - 4	KPT - 5	Jetty	SPM
1	Texture	-	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	mg/kg	1.10	1.08	1.01	1.02	0.98	2.03	0.81
3	Organic Carbon	mg/kg	0.65	0.52	0.60	0.56	0.56	1.08	0.47
4	Inorganic Phosphate	mg/kg	110.0	131.0	132.0	145.0	145.0	132.0	149.0
5	Moisture	%	18.96	19.65	21.0	22.10	23.5	17.7	27.00
6	Aluminium	mg/kg	ND	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	16.5	15.6	12.0	16.3	15.5	18.7	18.00
8	Phosphate	mg/kg	8.02	10.99	7.22	11.00	7.65	9.52	11.20
9	Sulphate	mg/kg	205.0	265.0	266.0	198.0	221.0	197.6	265.0
10	Nitrite	mg/kg	0.1	0.15	0.11	0.13	0.13	0.09	0.11
11	Nitrate	mg/kg	9.35	7.32	7.06	8.65	8.99	7.65	8.88
12	Calcium	mg/kg	325.0	306.0	396.0	388.0	324.0	324.0	378.0
13	Magnesium	mg/kg	195.0	185.0	243.0	244.0	188.0	175.0	210.0
14	Sodium	mg/kg	3745.0	3945.0	4660.0	2566.0	2899.0	2253.0	2854.0
15	Potassium	mg/kg	238.0	194.0	186.0	178.0	138.0	152.0	110.0
16	Chromium	mg/kg	8.1	48.3	30.7	40.3	23.3	36.4	6.6
17	Nickel	mg/kg	16.4	31.8	22.9	25.8	14	46.6	3.7
18	Copper	mg/kg	27.7	36.9	8.7	14.3	4.2	19.2	1.9
19	Zinc	mg/kg	32.40	40.50	35.10	36.20	21.20	21.30	5.00
20	Cadmium	mg/kg	ND	ND	ND	ND	ND	ND	ND
21	Lead	mg/kg	3.8	5.8	3.3	4.4	4.9	ND	1.2
22	Mercury	mg/kg	ND	ND	ND	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND	ND	ND	ND

*ND - Not Detected

Table 34B: Results of Analysis of Sediment of Kandla & Vadinar Port (Neap Tide)

Sr. No.	Parameters	Unit	KPT – 1	KPT - 2	KPT - 4	SPM
1	Texture	-	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	mg/kg	1.99	0.85	1.11	1.08
3	Organic Carbon	mg/kg	1.12	0.41	0.65	0.65
4	Inorganic Phosphate	mg/kg	120.0	130.0	148.0	152.0
5	Moisture	%	19.20	18.50	17.7	17.56
6	Aluminium	mg/kg	ND	ND	ND	ND
7	Silica	mg/kg	21.88	18.00	17.5	14.72
8	Phosphate	mg/kg	5.62	8	7.65	8.65
9	Sulphate	mg/kg	225.0	240.0	211.5	195.0
10	Nitrite	mg/kg	0.1	0.11	0.09	0.1
11	Nitrate	mg/kg	7.66	8.11	6.65	6.85
12	Calcium	mg/kg	321.0	310.0	345.0	265.0
13	Magnesium	mg/kg	205.0	197.0	202.0	169.0
14	Sodium	mg/kg	4120.0	3842.0	4465.0	3589.0
15	Potassium	mg/kg	201.0	147.0	154.0	154.00
16	Chromium	mg/kg	13.3	10.5	13	16.8
17	Nickel	mg/kg	8.8	6	8.2	10.5
18	Copper	mg/kg	4.3	2	2.2	5.5
19	Zinc	mg/kg	18.20	9.90	10.30	12.10
20	Cadmium	mg/kg	ND	ND	ND	ND
21	Lead	mg/kg	2.1	2.5	2.8	1.8
22	Mercury	mg/kg	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND

*Grab samples could not be collected due high current at KPT – 3,KPT – 5 Location.
*ND - Not Detected

REPORT

ON

ECOLOGICAL MONITORING

OF MARINE ENVIRONMENT

IN

DPT HARBOUR AREA, NEAR BY CREEKS

AND

VADINAR JETTY AND SPM

FOR

DEENDAYAL PORT TRUST

OCTOBER, 2021

INTRODUCTION:

Sampling Stations:

The monitoring of marine environment for the study of biological and ecological Parameters was carried out on6thOctober, 2021 in harbour region of DPT at Kandla Creek, and on 7thOctober,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 13thOctober ,2021 in harbour region of DPT at Kandla Creek and on 14thOctober 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 KPT 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 Neap tide and spring 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 at Path Finder Creek during spring tide period and during neap tide. Sampling was conducted at only during Neap tide period nearSPM both during High tide period and low 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 Vadinar jetty SPM	3 in Kandla creek 2 in Nakti creek 1 in Khori creek 1 near Vadinar Jetty 1 near I stSPM
Total Number of locations	**8**

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 litre 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, and 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.

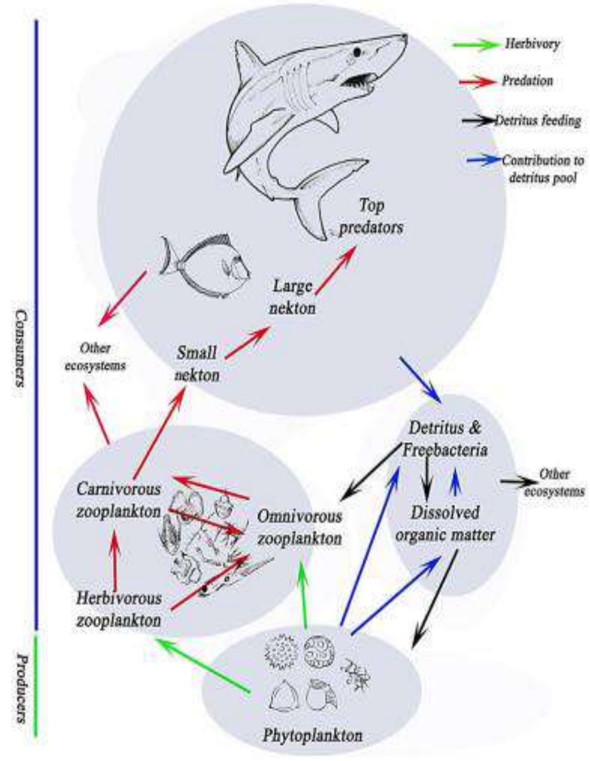
Zooplankton can be subdivided into holoplankton, i.e., permanent members of the plankton (e.g., Calanoid copepods), and meroplankton, i.e., temporary members in the plankton e.g., larvae of fish,

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**) reproduces 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 0.615 -1.459mg/m^3.in harbour region of DPT in Kandla Creek during sampling done in spring tide period of October, 2021. In the nearby creeks chlorophyll-a was varying from 0.153 -1.497mg/m^3.Pheophytin –a level was below detectable limit- the all the sampling stations during springtide except at KPT-I in the harbour region of DPT.

In the sub surface water chlorophyll-a was varying from 0.204 -0.749mg/m^3.in harbour region of DPT in Kandla Creek during sampling done in neap tide period of October , 2021 . In the nearby creeks chlorophyll-a was varying from 0.184-0.610 mg/m^3. Pheophytin –a level was below detectable limit- the all the sampling stations during neap tide in the harbour region of DPT.

In the sub surface water chlorophyll-a was varying from 0.527 -0.733 mg/m^3.in harbour region of DPT OOT in path finder Creek during sampling done in spring tide period of October, 2021. In the sub surface water chlorophyll-a was varying from 0.750 -1.175 mg/m^3.in harbour region of DPT OOT in path finder Creek during sampling done in Neap Tide period of October, 2021

TABLE #2 VARIATIONS IN CHLOROPHYLL –a PHEOPHYTIN- a AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA IN KANDLA CREEK ,NEAR BY CREEKS AND DPT OOT JETTY IN PATH FINDER CREEK AND SPM NEAR VADINAR DURING SPRING TIDE IN OCTOBER,2021

Sr.No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREAKANDLA CREEK					
1	KPT1	High tide	1.459	0.821	97.75
		Low tide	1.187	0.661	79.53
2	KPT 2	High tide	0.765	BQL	51.25
		Low tide	0.852	BQL	57.08
3	KPT 3	High tide	0.968	BQL	64.85
		Low tide	0.615	BQL	41.20
CREEKS					
4	KPT-4 Khori-I	High tide	1.056	BQL	70.75
		Low tide	1.497	BQL	100.2
5	KPT-5 Nakti-I	High tide	0.764	BQL	51.19
		Low tide	0.612	BQL	41.00
6	KPT-5 Nakti-II	High tide	0.153	BQL	10.24
PATHFINDER CREEK VADINAR					
7	VADINAR-I jetty	Low tide	0.527	BQL	35.31
8		High tide	0.733	BQL	49.11
9	SPM	High tide	No sample	--	--
10	SPM	Low tide	No sample	-	--

BDL: Below Quantification Limit.

TABLE #3 VARIATIONS IN CHLOROPHYLL –a PHEOPHYTIN- a AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS AND DPT OOT JETTY IN PATH FINDER CREEK AND SPM NEAR VADINAR DURING NEAP TIDE IN OCTOBER,2021

Sr.No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREA KANDLA CREEK					
1	KPT1	High tide	0.307	BQL	20.57
		Low tide	0.529	BQL	35.44
2	KPT 2	High tide	0.749	BQL	50.18
		Low tide	0.614	BQL	41.14
3	KPT 3	High tide	0.204	BQL	13.67
		Low tide	0.542	BQL	36.31
CREEKS					
4	KPT-4 Khori-I	High tide	0.441	BQL	29.54
		Low tide	0.426	BQL	28.54
5	KPT-5 Nakti-I	High tide	0.610	BQL	40.87
		Low tide	0.441	BQL	29.55
6	KPT-5 Nakti-II	High tide	0.184	BQL	12.33
PATHFINDER CREEK VADINAR					
7	VADINAR-I jetty	Low tide	0.750	0.435	50.25
8		High tide	0.820	0.484	54.94
9	SPM	High tide	1.071	0.610	71.76
10	SPM	Low tide	1.175	0.680	78.73

BDL: Below Quantification 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 dinoflagellatesduring spring tide period.Diatoms were represented by 19genera. Blue green were represented by 3 genera and dinoflagellates were represented by two generaduring the sampling conducted in spring tide in OCTOBER,2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 46-209units/ L during high tide period and183-229 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 20genera Blue green algae were represented 3 genera and dinoflagellates with two genera during the sampling conducted in Neap tide in October,2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from88-170units/ L during high tide period and 120-157 units/ L during low tide of Neap Tide.

For the evaluation of the Phytoplankton population in DPT OOT jetty area in Path Finder creek sampling was conducted from one sampling locations ; jetty area during high tide period and low tide of spring tide. For the evaluation of the Phytoplankton population in DPT OOT jetty area in Path Finder creek in Vadinar sampling was conducted from 2 sampling locations ; jetty area and one near SPM during high tide period and low tide of Neap tide.

The phytoplankton community of the sub surface water in the path finder creeks was represented by only Diatoms spring tide period.Diatoms were represented by 9 genera during the sampling conducted in spring tide in October, 2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 131 units/ L during high tide period and 147 units/ L during low tide of Spring Tide.

The phytoplankton community of the sub surface water in the path finder creeks was represented by Diatoms, Blue green algae and Dinoflagellatesduring Neap tide period.Diatoms were represented by 10 genera Blue green algae were represented single genera and dinoflagellates by four genera during the sampling conducted in Neap tide in October, 2021. Phytoplankton of the sampling stations at sub surface path finder creek was varying from 203-427 units/ L during high tide period and 544-744 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 Kandla creek and nearby creeks sampling stations was varying from 2.059-3.212 with an average of 2.632during the sampling conducted in High tide period of spring tide.While Margalef's diversity index (Species Richness) S of phytoplankton communities in the Kandla creek region and nearby creeks was varying from2.687-3.144 with an average of 2.923 during the consecutive low tide period.

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations in Kandla creek and nearby creeks was varying from 1.582-3.384 with an average of 2.477 during the sampling conducted in High tide period of Neaptide. While Margalef's diversity index (Species Richness) S of phytoplankton communities in the Kandla creek region and nearby creeks was varying from1.582-3.040 with an average of 2.141 during consecutive low tide.

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was 1.641 during the sampling conducted in High tide period of spring tide at Path Finder Creek, Vadinar . While Margalef's diversity index (Species Richness) S of phytoplankton communities in the path finder creek was1.603 during the consecutive low tide period at Path Finder Creek, Vadinar .

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was varying from 1.981-2.064 during the sampling conducted in consecutive High tide period and low tide period of Neap Tide at jetty area of Path finder Creek. While Margalef's diversity index (Species Richness) S of phytoplankton communities near the SPM was varying from 2.259- 1.512 during the consecutive high tide and low tide period of Neap tide.

Shannon-Wiener's index:

Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.802- 0.935 (H'(log10)) between selected sampling stations with an average value of 0.860 during high tide period of spring tide at Kandla creek and nearby creeks. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.858-0.979 (H'(log10)) between selected sampling stations with an average value of 0.909 during consecutive lowtide at Kandla creek and nearby creeks. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.774 -0.934 (H'(log10)) between selected sampling stations with an average value of 0.868 during high tide period of neap tide at Kandla creek and nearby creeks. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.773 -0.927 (H'(log10)) between selected sampling stations with an average value of 0.842during consecutive low tideat Kandla creek and nearby creeks.

Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations in the stations was 0.684 during the sampling conducted in High tide period of spring tide at Path Finder Creek, Vadinar. Shannon-Wiener's Index (H)of phytoplankton communities in the path finder creek was 0.695 during the consecutive low tide period at Path Finder Creek, Vadinar .

Shannon-Wiener's Index (H) of phytoplankton communities in the stations was varying from 0.356-0.255 during the sampling conducted in consecutive High tide period and low tide period of Neap Tide at jetty area of Path finder Creek. While Shannon-Wiener's Index (H) of phytoplankton communities near the SPM was varying from 0.508-0.234 during the consecutive high tide and low tide period of Neap 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 0.809- 0.852 between selected sampling stations with an average of 0.827 during high tide period of spring tide. Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stationsin the Kandla Harbour region and nearby creeks, which was varying from 0.819- 0.865 between selected sampling stations with an average of 0.840during consecutive low tide .

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 0.809-0.853 with an average value of 0.835 between selected sampling stations during high tide period and varying from 0.809-0.852 with an average value of 0.831 between selected sampling stations during consecutive low tide period Low species diversity suggests a relatively few successful species in this habitat.

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 path finder Creek, which was 0-720 during high tide period and 0.751 during low tide period of spring tide at Jetty region . Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in the in path finder Creek, which was varying from 0.720-0.751 at jetty region of path finder creek during consecutive high tide and low tide period of Spring Tide and recorded below 9 at SPM during consecutive high tide and low tide period of Neap tide also , 0.329 - 0.499 during high tide and 0.218-0.201 during low tide

Table # 4PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA AT KANDLA CREEK AND ,NEAR BY CREEKS DURING SPRING TIDE IN OCTOBER,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	199	18/24	75	3.212	0.9355	0.8519
	2	209	12/24	50	2.059	0.8018	0.8091
	3	204	14/24	58.3	2.444	0.8451	0.8244
	4	204	17/24	70.83	3.009	0.9095	0.837
	5	199	14/24	58.3	2.456	0.8497	0.8167
	6	46	11/24	45.83	2.612	0.8208	0.8232
LOW TIDE	1	223	18/24	75	3.144	0.9797	0.8653
	2	214	17/24	70.83	2.982	0.9126	0.8446
	3	193	17/24	70.83	3.04	0.919	0.8416
	4	229	16/24	66.66	2.761	0.8806	0.8312
	5	183	15/24	62.5	2.687	0.858	0.8193

Table # 5 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA AT KANDLA CREEK AND ,NEAR BY CREEKS DURING NEAP TIDE IN OCTOBER,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	170	18/25	72	3.31	0.9214	0.8451
	2	133	14/25	56	2.658	0.8621	0.8308
	3	142	11/25	44	2.018	0.8693	0.847
	4	152	18/25	72	3.384	0.9173	0.8463
	5	128	12/25	48	2.267	0.8398	0.828
	6	88	14/25	56	2.904	0.9345	0.8406
LOW TIDE	1	143	11/25	44	2.015	0.8355	0.832
	2	149	13/25	52	2.398	0.8822	0.842
	3	139	16/25	64	3.04	0.9274	0.8526
	4	157	9/25	36	1.582	0.7937	0.8176
	5	120	9/25	36	1.671	0.7738	0.8094

Table # 6 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA AT KANDLA CREEK AND , NEAR BY CREEKS DURING SPRING TIDE IN OCTOBER, 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	39-204	19/24	79.2
			BLUE GREEN	3-8	3/24	12.5
			DINOFLAGELLATES	2-9	2/24	8.3
			TOTAL PHYTO PLANKTON	**46-209**	**24**	-
LOW TIDE	Sub surface	5	DIATOMS	176-222	19/24	79.2
			BLUE GREEN	3-8	3/24	12.5
			DINOFLAGELLATES	2-6	2/24	8.3
			TOTAL PHYTO PLANKTON	183-229	**24**	-

Table # 7 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA AT KANDLA CREEK AND , NEAR BY CREEKS DURING NEAP TIDE IN OCTOBER,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	81-164	20/25	80
			BLUE GREEN	1-6	3/25	12
			DINOFLAGELLATES	0-4	2/25	8
			TOTAL PHYTO PLANKTON	**88-170**		
LOW TIDE	Sub surface	5	DIATOMS	117-157	20/25	80
			BLUE GREEN	0-7	3/25	12
			DINOFLAGELLATES	0-4	2/25	8
			TOTAL PHYTO PLANKTON	**120-157**		

Table # 8 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT OOTAT PATH FINDER CREEK , VADINAR &NEAR BY SPM, DURING SPRING TIDE IN OCTOBER, 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	jetty	131	9/9	100	1.641	0.6874	0.7201
LOW TIDE	jetty	147	9/9	100	1.603	0.6956	0.7508

Table # 9 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT OOTAT PATH FINDER CREEK , VADINAR & NEAR BY SPM, DURING NEAP TIDE IN OCTOBER, 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	jetty	427	13/15	86.67	1.981	0.3559	0.3291
	SPM	203	13/15	86.67	2.259	0.5079	0.499
LOW TIDE	jetty	544	14/15	93.33	2.064	0.2555	0.2188
	SPM	744	11/15	73.33	1.512	0.2343	0.2011

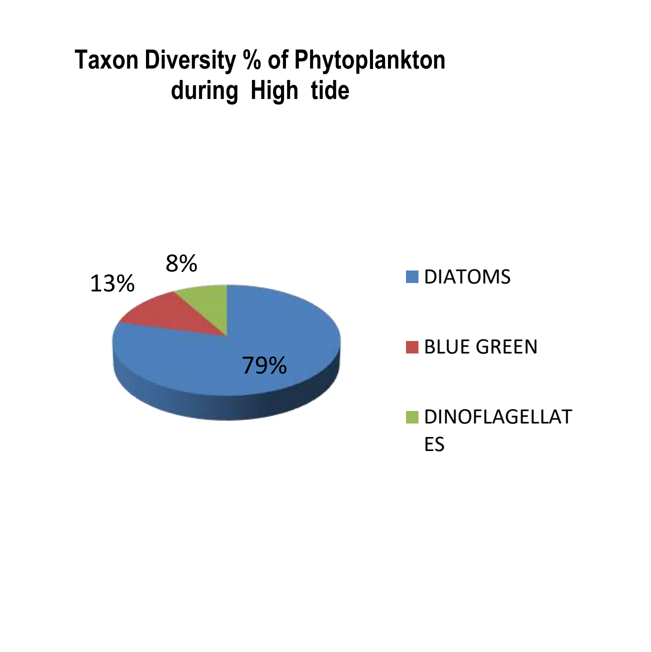
Table # 10 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT DPTOOT AT PATH FINDER CREEK , VADINAR & NEAR BY SPM, DURING SPRING TIDE IN OCTOBER, 2021

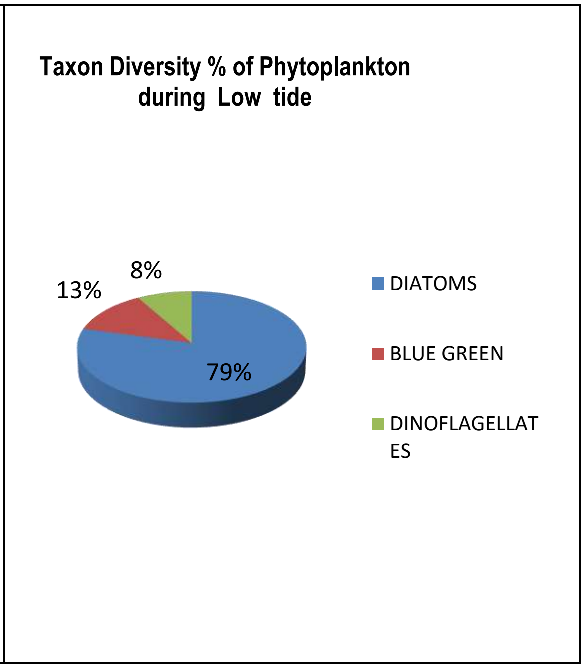
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	1	DIATOMS	131	9/9	100
			TOTAL PHYTO PLANKTON	**131**	**9**	
LOW TIDE	Sub surface	1	DIATOMS	147	9/9	100
			TOTAL PHYTO PLANKTON	147	**9**	

Table # 11 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT DPTOOT AT PATH FINDER CREEK , VADINAR & NEAR BY SPM, DURING NEAP TIDE IN OCTOBER, 2021

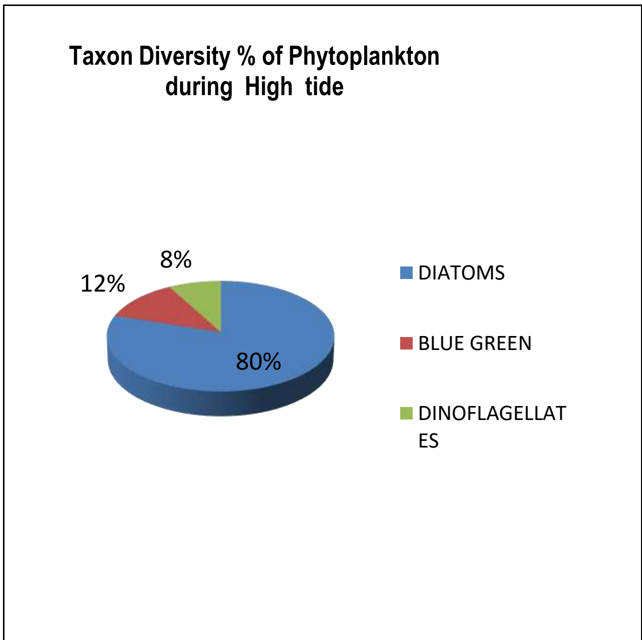
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	2	DIATOMS	189-424	10/15	66.5
			BLUE GREEN	1-4	1/15	7.5
			DINOFLAGELLATES	4-10	4/15	26.0
			TOTAL PHYTO PLANKTON	**203-427**		
LOW TIDE	Sub surface	2	DIATOMS	480-664		
			BLUE GREEN	2	10/15	66.5
			DINOFLAGELLATES	5-10	1/15	7.5
			TOTAL PHYTO PLANKTON	544-744	4/15	26.0

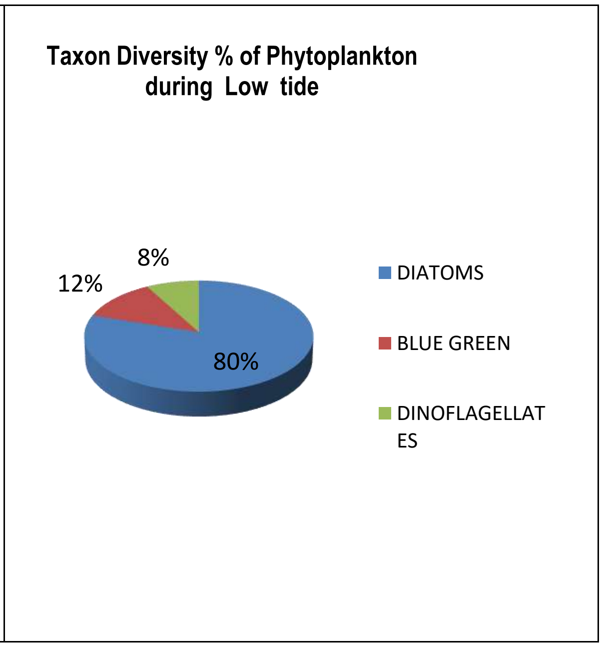
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide in Kandala creek and nearby creeks



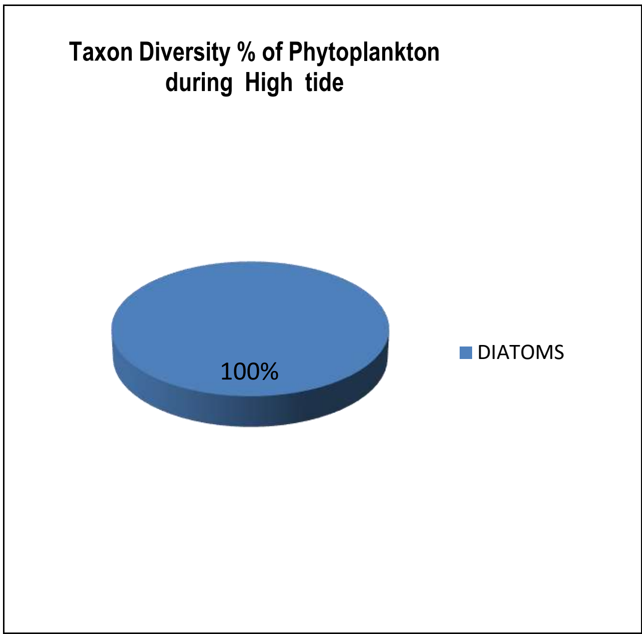


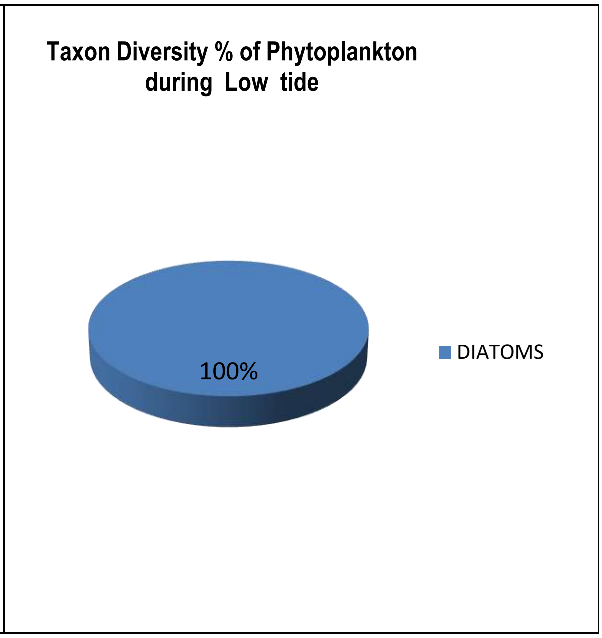
Taxon Diversity % of Phytoplankton during High tide and Low tide period during Neap tide inKandala creek and nearby creeks



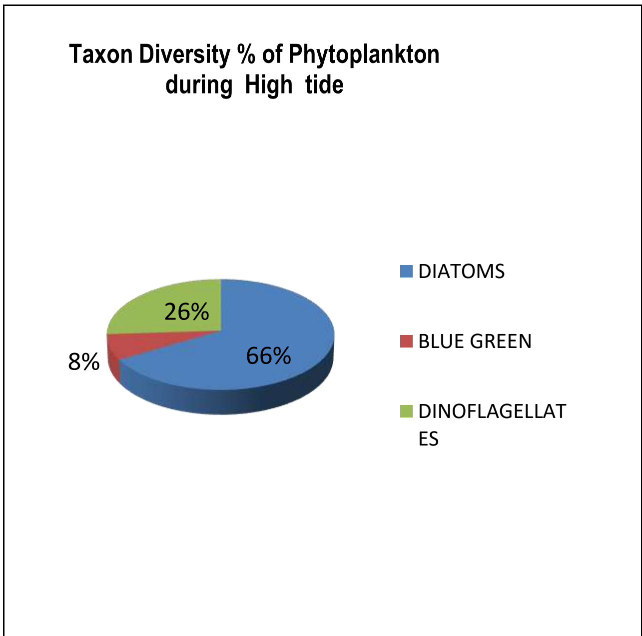


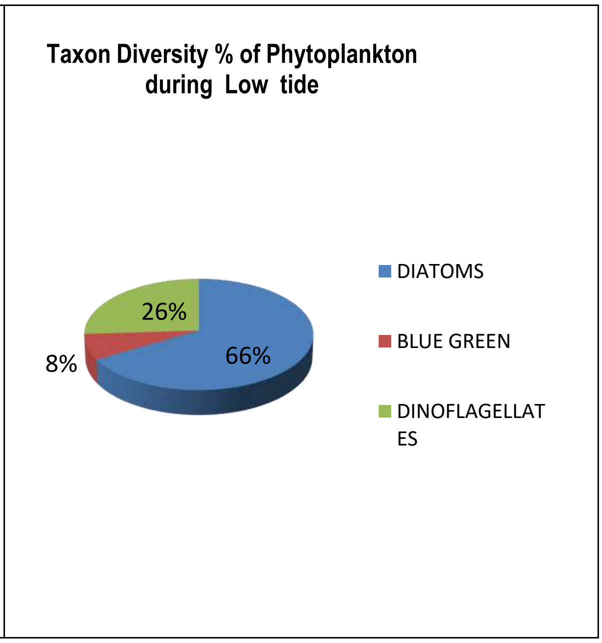
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide in Path Finder Creek, Vadinar





Taxon Diversity % of Phytoplankton during High tide and Low tide period during Neap tide in Path Finder Creek, Vadinar





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 October,2021. The Zooplankton community of the sub surface water in the harbour and nearby creeks during spring tide was represented by mainly 9 groups, and 7 larval forms; Tintinids, Copepods,Rotifers, Arrow worms, Mysids, Urochordates ,Ciliates ,Unidentified medusa and Foraminiferans.Larval forms represented from the group of Crustacea, Molluscansand Polychaetes. The Zooplankton community of the sub surface water in the harbour and nearby creeks during neap tide was represented by mainly 9groups, and Eight larval forms . The major zooplankton group was Tintinids, Copepods, Rotifers, Arrow worms ,Mysids, Urochordata, Ciliates , Medusa and Foraminiferans . Larval forms were represented from the group of Crustaceans ,Echinodermata, Bryozoans , Molluscansand Polychaetes,

Zooplankton of the sampling stations at sub surface layer in the DPT harbour area and nearby creek was varying from 33-132 x10^3 N/ m^3 during high tide and 81-107x10^3 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 47-167x10^3 N/ m^3 during high tide and9-112x10^3 N/ m^3during low tide of Neap Tide period.

For the evaluation of the Zoo plankton population in DPT OOT jetty area in Path Finder creek and SPM in Vadinar selected 2 sampling locations (1 in jetty area and one near SPM) Duringspring tide sampling plankton sample were collected only at Jetty area during consecutive high tide period and low tide period. During Neap tide sampling Plankton samples were collected from jetty area and SPM during consecutive high tide period and low tide period.
The Zooplankton community of the sub surface water in the path finder creek creeks during spring tide was represented by mainly two groups, Tintinids, Copepods, and larval forms of Crustacea and Molluscans. The Zooplankton community of the sub surface water in the path Finder creeks at Jetty region and SPM during neap tide was represented by mainly Five groups, Tintinids, Copepods, Arrow worms , Urochordata and ,Mysids .Larval forms were represented from the major group of Crustaceans , Molluscans , Echinodremataand Polychaetes,.

Zooplankton of the sampling stations at sub surface layer in the DPT OOTjetty area of path finder creek was 76 x10^3 N/ m^3 during high tide and 74 x10^3 N/ m^3 during low tide of Spring Tide period. Zooplankton of the sampling stations at sub surface layer in the DPT OOTjetty area in path finder creekwas recorded 54x10^3 N/ m^3during high tide and 73 x10^3 N/ m^3 during consecutive low tide period of Neap . Zooplankton of the sampling stations at sub surface layer in the DPT SPM area in path finder creek was recorded 78 x10^3 N/ m^3during high tide and 82 x10^3 N/ m^3 during consecutive low tide period 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 Zooplankton communities in the stations Kandla creek region and nearby creeks was varying from 3.146-4.804 with an average of 3.874during the sampling conducted in High tide period.Margalef's diversity index (Species Richness) S of Zooplankton communities varying from.2.842-4.280 with an average of 3.393 during the sampling conducted in low tide period during Spring tide.

Margalef's diversity index (Species Richness) S of Zooplankton communities in the Kandla creek region and nearby creeks sampling stations was varying from3.117- 6.839 with an average of 5.036 during the sampling conducted in high tide and varying from. 3.034 -4.570 with an average of 3.769 during the sampling conducted in low tide during Neap tide period

Margalef's diversity index (Species Richness) S of Zooplankton communities in the sampling stationnear jetty at Path Finder Creek, Vadinar during the sampling conducted in consecutive High tide period and low tide of spring tide was recorded as 1.847 and 1. 859 respectively..

Margalef's diversity index (Species Richness) S of Zooplankton communities in the two stations at Path finder creek was varying from 3.259-3.443 during the sampling conducted in High tide period of Neap tide. While Margalef's diversity index (Species Richness) S of Zooplankton communities in the two stations at Path finder creekwas varying from 2.797-4.085 during the consecutive low 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 -1.060 (H'(log10)) between selected sampling stations with an average value of 0.992 (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 0.844-0.965(H'(log10)) between selected sampling stations with an average value of 0.894 (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 0.834 -1.336 (H'(log10)) between selected sampling stations with an average value of 1.146 (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 0.949-1.139 (H'(log10)) between selected sampling stations with an average value of 1.043 (H'(log10)) during consecutive low tide period.

Shannon-Wiener's Index (H) of Zooplankton communities in the sampling station near jetty at Path Finder Creek, Vadinar during the sampling conducted in consecutive High tide period and low tide of spring tide was recorded as 0.775 and 0.822 respectively..

Shannon-Wiener's Index (H)of Zooplankton communities in the two stations at Path finder creek was varying from 0.991-0.927 during the sampling conducted in High tide period of Neap tide. While Shannon-Wiener's Index (H)of Zooplankton communities in the two stations at Path finder creek was varying from 0.815-1.004 during the 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 0.848-0.881between selected sampling stations with an average of 0.865 during high tide period and was varying from 0.812- 0.845 with an average value of 0.827 between selected sampling stations during low tide

Simpson diversity index (1-D) of Zooplankton communities was blow 0.9 at all sampling stationsin the Kandla Harbour region and nearby creeks except few during high tide and low tide period, which was varying from 0.793- 0.937 between selected sampling stations with an average of 0.894 during high tide period and was varying from 0.861- 0.910 with an average value of 0.884 between selected sampling stations during consecutive low tide

This high species diversity suggests a relatively more number of successful species in this habitat during October ,2021 sampling.

Simpson diversity index (1-D) of Zooplankton communities in the sampling station near jetty at Path Finder Creek, Vadinar during the sampling conducted in consecutive High tide period and low tide of spring tide was recorded as 0.800 and 0.827 respectively..

Simpson diversity index (1-D) of Zooplankton communities in the two stations at Path finder creek was varying from 0.884 -0.838 during the sampling conducted in High tide period of Neap tide. While Shannon-Wiener's Index (H)of Zooplankton communities in the two stations at Path finder creek was varying from 0.816 -0.863 during the consecutive low tide period.

Table # 12 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA AT KANDLA CREEK AND NEAR BY CREEKS DURING SPRING TIDE IN OCTOBER,2021

Tide	Sampling Station	Abundance In N / 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	120 $x10^3$	24/32	75	4.804	1.06	0.8695
	2	105 $x10^3$	21/32	65.62	4.297	1.045	0.8753
	3	132 $x10^3$	18/32	56.25	3.482	0.9555	0.8523
	4	117 $x10^3$	18/32	56.25	3.57	1.032	0.8811
	5	123 $x10^3$	20/32	62.50	3.948	0.9513	0.8481
	6	33 $x10^3$	12/32	37.5	3.146	0.9125	0.8636
LOW TIDE	1	97 $x10^3$	14/32	43.75	2.842	0.8439	0.8174
	2	107 $x10^3$	21/32	65.63	4.28	0.9654	0.8455
	3	81 $x10^3$	15/32	46.87	3.186	0.9009	0.8315
	4	93 $x10^3$	16/32	50	3.309	0.8669	0.8125
	5	88 $x10^3$	16/32	50	3.35	0.8971	0.8325

Table # 13 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREAAT KANDLA CREEK AND NEAR BY CREEKS DURING NEAP TIDE IN OCTOBER,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	167 $x10^3$	36/37	97.30	6.839	1.336	0.9367
	2	124 $x10^3$	28/37	75.68	5.601	1.282	0.9373
	3	133 $x10^3$	24/37	64.86	4.703	1.163	0.9108
	4	144 $x10^3$	29/37	78.38	5.634	1.19	0.8993
	5	102 $x10^3$	21/37	56.75	4.324	1.075	0.8893
	6	47 $x10^3$	13/37	35.13	3.117	0.834	0.7928
LOW TIDE	1	112 $x10^3$	18/37	48.65	3.603	0.9973	0.8637
	2	90 $x10^3$	19/37	51.35	4	1.065	0.8974
	3	99 $x10^3$	22/37	59.46	4.57	1.139	0.9105
	4	107 $x10^3$	18/37	48.65	3.638	1.068	0.8889
	5	101 $x10^3$	15/37	40.54	3.034	0.9498	0.861

Table # 14 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREAATKANDLA CREEK AND ,NEAR BY CREEKS DURING SPRING TIDE IN OCTOBER,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	3-21	6/32	18.75
			Copepods	13-68	10/32	31.25
			Rotifers	0-4	1/32	3.13
			Arrow worms	0-2	1/32	3.13
			Mysids	0-2	2/32	6.25
			Urochordata	0-1	1/32	3.12
			Ciliates	1-7	1/32	3.12
			Medusa	0-1	1/32	3.12
			Larval forms	11-43	7/32	21.88
			Foraminiferans	0-1	2/32	6.25
			TOTAL ZOOPLANKTON N/ M^3	**33-132**	**32**	
LOW TIDE	Sub surface	5	Tintinids	4-15	6/32	18.75
			Copepods	45-59	10/32	31.25
			Rotifers	0-1	1/32	3.13
			Arrow worms	0-1	1/32	3.13
			Mysids	0-1	2/32	6.25
			Urochordata	0-1	1/32	3.12
			Ciliates	1-6	1/32	3.12
			Medusa	0	1/32	3.12
			Larval forms	22-33	7/32	21.88
			Foraminiferans	0-2	2/32	6.25
			TOTAL ZOOPLANKTON N/M^3	**81-107**	**32**	

Table # 15 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA IN KANDLA CREEK AND , NEAR BY CREEKS DURING NEAP TIDE IN OCTOBER, 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	2-26	6/37	16.22
			Copepods	18-76	11/37	29.73
			Rotifers	0-2	1/37	2.70
			Mysids	0-6	4/37	10.81
			Arrow worms	0-4	1/37	2.70
			Urochordata	0-4	1/37	2.70
			Ciliates	0-8	1/37	2.70
			Medusa	0-4	1/37	2.70
			Larval forms	20-46	9/37	24.32
			Foraminiferans	0-6	2/37	5.42
			TOTAL ZOOPLANKTON N/M^3	**47-165**		
LOW TIDE	Sub surface	5	Tintinids	13-22	6/37	16.22
			Copepods	42-47	11/37	29.73
			Rotifers	0	1/37	2.70
			Mysids	0-4	4/37	10.81
			Arrow worms	0-1	1/37	2.70
			Urochordata	0-2	1/37	2.70
			Ciliates	1-5	1/37	2.70
			Medusa	0	1/37	2.70
			Larval forms	21-40	9/37	24.32
			Foraminiferans	**0-5**	2/37	5.42
			TOTAL ZOOPLANKTON N/M^3	**89-112**		

Table # 16 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT OOT AREA AT PATH FINDER CREEK AND NEAR BY SPM DURING SPRING TIDE IN OCTOBER,2021

Tide	Sampling Station	Abundance In N / 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	Jetty	76 x10^3	9/9	100	1.847	0.7749	0.8004
LOW TIDE	Jetty	74 x10^3	9/9	100	1.859	0.8222	0.8278

Table # 17 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT OOT AREA AT PATH FINDER CREEK AND NEAR BY SPM DURING NEAP TIDE IN OCTOBER,2021

Tide	Sampling Station	Abundance In N / 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	Jetty	54 $x10^3$	14/23	60.87	3.259	0.9911	0.884
	SPM	78 $x10^3$	16/23	69.56	3.443	0.9276	0.8385
LOW TIDE	Jetty	73 $x10^3$	13/23	56.52	2.797	0.8156	0.8166
	SPM	82 $x10^3$	19/23	82.61	4.085	1.004	0.863

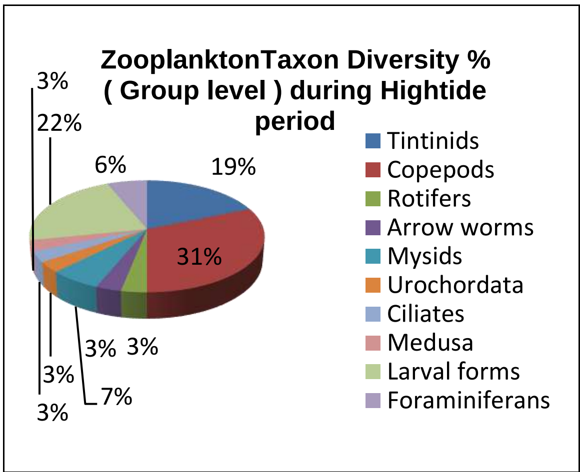
Table # 18 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT OOT AREAAT PATH FINDER CREEK AND NEAR BY SPM DURING SPRING TIDE IN OCTOBER,2021

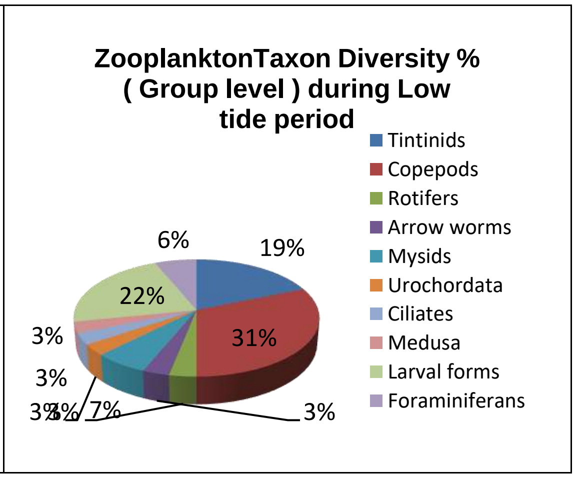
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton $x10^3$ Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	1	Tintinids	40	5/9	55.56
			Copepods	18	2/9	22.22
			Larval forms	18	2/9	22.22
			TOTAL ZOOPLANKTON NO/L	**76**	**9**	
LOW TIDE	Sub surface	1	Tintinids	38	5/9	55.56
			Copepods	16	2/9	22.22
			Larval forms	20	2/9	22.22
			TOTAL ZOOPLANKTON NO/M3	**74**	**9**	

Table # 19 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT OOT AREAAT PATH FINDER CREEK AND NEAR BY SPM DURING NEAP TIDE IN OCTOBER, 2021

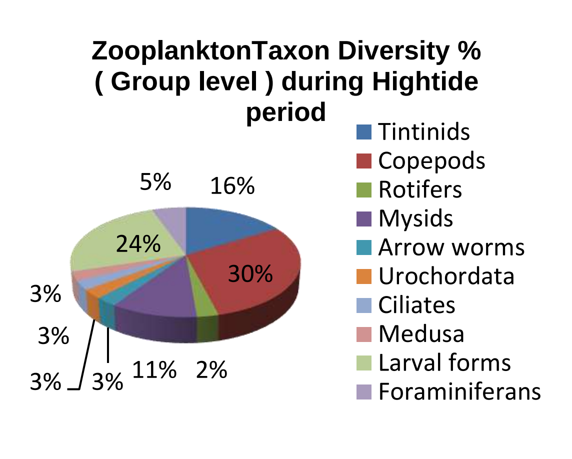
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	2	Tintinids	1-2	2/23	8.70
			Copepods	30-45	8/23	34.78
			Arrow worms	0-1	1/23	4.35
			Mysids	4-9	4/23	17.39
			Urochordata	2-4	1/23	4.35
			Larval forms	12-22	7/23	30.43
			TOTAL ZOOPLANKTON	**41-60**		
LOW TIDE	Sub surface	2	Tintinids	1-2	2/23	8.70
			Copepods	49-53	8/23	34.78
			Arrow worms	1	1/23	4.35
			Mysids	2-5	4/23	17.39
			Urochordata	1	1/23	4.35
			Larval forms	19-20	7/23	30.43
			TOTAL ZOOPLANKTON NO/M3	**73-82**		

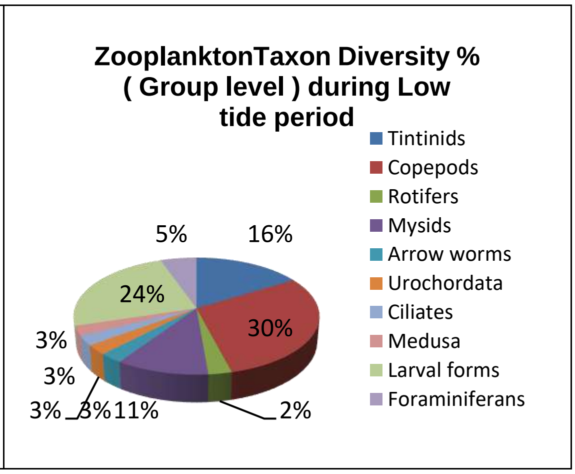
Taxon Diversity % of Zooplankton during High tide and Low tide period of Spring tide In Kandla Creek and nearby Creeks



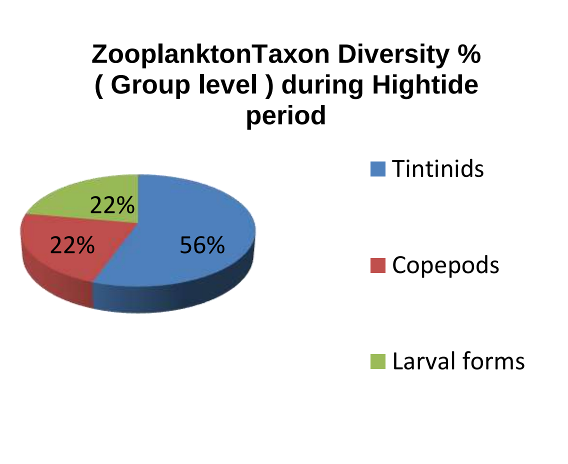


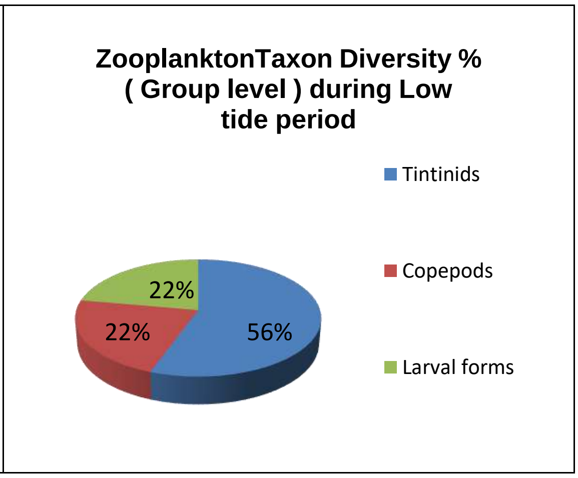
Taxon Diversity % of Zooplankton during High tide and Low tide period of Neap tide In Kandla Creek and nearby Creeks



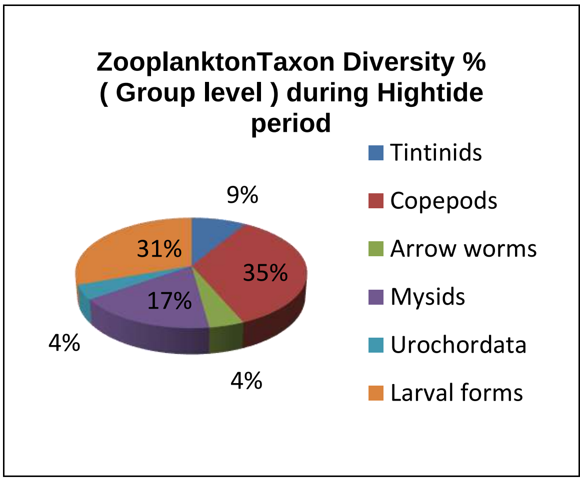


Taxon Diversity % of Zooplankton during High tide and Low tide period of Spring tide In Path Finder Creek and near Jetty





Taxon Diversity % of Zooplankton during High tide and Low tide period of Neap tide In Path Finder Creek near jetty and nearby SPM



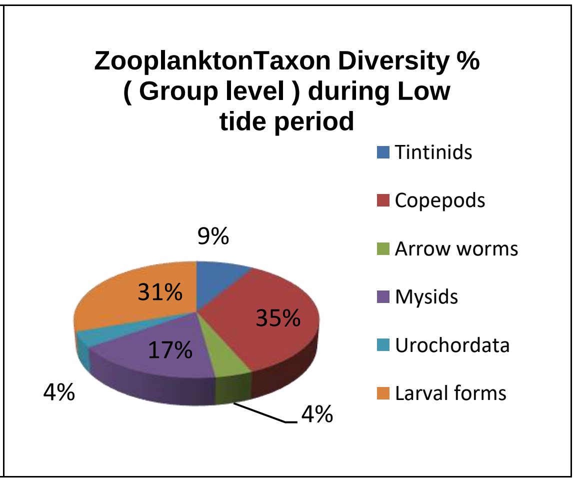


TABLE # 20SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS OF DPT HARBOUR AREA AT KANDLA CREEK AND NEARBY CREEKS DURINGSPRING TIDE OF OCTOBER 2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALGAE	Cyanophyta	Cyanophyceae	Nostocales	Oscillatoriaceae	*Oscillatoria* sp.	B1	Occasional
					Arthrospira sp.	B2	Rare
			Stigonematales	Stigonemataceae	*Stigonema sp.*	B3	Occasional
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Occasional
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D2	Dominant
			Triceratiales	Triceratiaceae	*Odontella*sp	D3	Occasional
					*Triceratium*sp.	D4	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D5	Abundant
			Hemiaulales	Bellerocheaceae	*Bellerochea*sp	D6	Rare
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D7	Rare
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros*sp	D8	Frequent
			Leptocylindrales	Leptocylindraceae	*Leptocylindrus*sp	D9	Occasional
			Lithodesmiales	Lithodesmiaceae	*Ditylum*sp	D10	Dominant
			Melosirales	Melosiraceae	*Melosira*sp	D11	Rare
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*sp	D12	Rare
			Surirellales	Surirellaceae	*Surirella*sp	D13	Rare
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D14	Abundant
					Thalassionema sp.	D15	Rare
			Fragilariales	Fragilariaceae	*Asterionellopsis sp.*	D16	Occasional
					*Fragilaria*sp	D17	Frequent
					*Synedra*sp	D18	Rare
			Tabellariales	Tabellariaceae	*Tabellaria*sp	D19	Rare
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium sp.*	DF1	Rare
			Gonyaulacales	Ceratiaceae	*Ceratiumfurca*	DF2	Occasional

TABLE # 21 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AT KANDLA CREEK AND NEARBY CREEKS DURING AND NEAP TIDE OF OCTOBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALGAE	Cyanophyta	Cyanophyceae	Nostocales	Oscillatoriaceae	*Oscillatoria* sp.	B1	Rare
					Arthrospira sp.	B2	Rare
			Stigonematales	Stigonemataceae	*Stigonema sp.*	B3	Rare
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniellasp*	D1	Occasional
					Thalassiosirasp	D2	Rare
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D3	Dominant
			Triceratiales	Triceratiaceae	*Odontellasp*	D4	Occasional
					*Triceratium*sp.	D5	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphiasp*	D6	Abundant
			Hemiaulales	Bellerocheaceae	*Bellerochea*sp	D7	Rare
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D8	Rare
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros*sp	D9	Frequent
			Leptocylindrales	Leptocylindraceae	*Leptocylindrus*sp	D10	Occasional
			Lithodesmiales	Lithodesmiaceae	*Ditylum*sp	D11	Dominant
		Bacillariophyceae	Naviculales	Naviculaceae	*Naviculasp*	D12	Rare
				Pleurosigmataceae	*Gyrosigmasp*	D13	Rare
					Pleurosigmasp	D14	Rare
			Surirellales	Surirellaceae	*Surirella*sp	D15	Rare
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D16	Abundant
					Thalassionema sp.	D17	Rare
			Fragilariales	Fragilariaceae	*Fragilaria*sp	D18	Frequent
					*Synedra*sp	D19	Rare
			Tabellariales	Tabellariaceae	*Tabellaria*sp	D20	Rare
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium sp.*	DF1	Rare
			Gonyaulacales	Ceratiaceae	*Ceratiumfurca*	DF2	Occasional

TABLE # 22 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT OOT AREA AT PATH FINDER CREEK AND NEARBY SPM AT VADINAR DURING SPRING TIDE OF OCTOBER 2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D1	Occasional
			Triceratiales	Triceratiaceae	*Triceratium*sp.	D2	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D3	Rare
			Hemiaulales	Bellerocheaceae	*Bellerochea*sp	D4	Rare
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D5	Rare
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros*sp	D6	Dominant
			Lithodesmiales	Lithodesmiaceae	*Ditylum*sp	D7	Occasional
			Bacillariales	Bacillariaceae	*Pseudo-Nitzschia*sp	D8	Abundant
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D9	Frequent

TABLE # 23 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT OOT AREA AT PATH FINDER CREEK AND NEARBY SPM AT VADINAR DURING AND NEAP TIDE OF OCTOBER, 2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALGAE	Cyanophyta	Cyanophyceae	Nostocales	Oscillatoriaceae	*Oscillatoria* sp.	B1	Rare
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Occasional
				Lauderiaceae	*Lauderia*sp	D2	Rare
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D3	Abundant
			Hemiaulales	Bellerocheaceae	*Bellerochea*sp	D4	Occasional
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D5	Rare
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros*sp	D6	Dominant
			Lithodesmiales	Lithodesmiaceae	*Ditylum*sp	D7	Occasional
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*sp	D8	Rare
			Bacillariales	Bacillariaceae	*Pseudo-Nitzschia*sp	D9	Frequent
			Fragilariales	Fragilariaceae	*Synedra*sp	D10	Rare

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium sp.*	DF1	Rare
			Gonyaulacales	Ceratiaceae	*Ceratiumfurca*	DF2	Occasional
					Ceratiumfusus	DF3	Rare
					Ceratiumtripos	DF4	Rare

TABLE #24 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS OF DPT HARBOUR AREA AT KANDLA CREEK AND NEARBY CREEKSDURING SPRING TIDE OF OCTOBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Occasional
				Codonellidae	*Tintinnopsisdadayi*	T2	Rare
					Tintinnopsisgracilis	T3	Occasional
					Tintinnopsis radix	T4	Rare
					Tintinnopsisfailakkaensis	T5	Occasional
				Xystonellidae	*Favella* sp.	T6	Rare
COPEPODS	ATHROPODA	Crustacea Subclass: Copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Abundant
					Bestiolina sp.	C2	Rare
				Eucalanidae	*Subeucalanus sp.*	C3	Rare
				Clausocalanidae	*Clausocalanus sp.*	C4	Occasional
				Centropagidae	*Centropages sp.*	C5	Rare
				Acartiidae	*Acartia sp.*	C6	Rare
			Cyclopoida	Oithonidae	*Oithona sp.*	C7	Dominant
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C8	Rare
				Euterpinidae	*Euterpina sp.*	C9	Frequent
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C10	Rare
ROTIFERS	ROTIFERA	Rotifera Subclass: Eurotatoria	Superorder: Monogononta Order:Ploimida	Brachionidae	*Brachionusplicatilis*	R1	Rare
ARROW WORMS	CHAETOGNATHA	Sagittoidea	Aphragmophora	Sagittidae	*Sagitta sp.*	A1	Rare
MYSIDS	ATHROPODA CRUSTACEA	Malacostraca	Mysida, Decapoda	Penaeidae	*Metapenaeussp.*	M1	Rare
					Penaeussp.	M2	Rare

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
UROCHORDATA	CHORDATA SUB PHYLUM UROCHORDATA	Appendicularia		Oikopleuridae	*Oikopleura sp.*	U1	Rare
CILIATES	CILIOPHORA	Oligohymenophorea	Sessilida	Zoothamniidae	*Zoothamniumsp.*	CI1	Occasional
MEDUSA	PHYLUM CNIDARIA	Hydrozoa			Unidentified medusa	ME1	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BRACHYURA LARVAE	ARTHROPODA (CRUSTACEA)	Malacostraca Decapoda			Brachyuran Zoea larvae	L2	Rare
BARNACLE LARVAE	ATHROPODA CRUSTACEA	Maxillopoda Thecostraca			Cirripede larvae	L3	Rare
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L4	Rare
CHORDATA	VERTEBRATA	Pisces			Fish larvae	L5	Rare
POLYCHAETE LARVAE	ANNELIDA	Polychaeta			Trochophore larvae	L6	Occasional
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L7	Rare
FORAMINIFERA	FORAMINIFERA	Globothalamea	Rotaliida	Globigerinidae	*Globigerina* sp.	F1	Rare
				Rotalliidae	*Rotalia* sp.	F2	Rare

TABLE # 25 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING OF DPT HARBOUR AREA AT KANDLA CREEK AND NEARBY CREEKSDURING NEAP TIDE OF OCTOBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Frequent
				Codonellidae	*Tintinnopsisdadayi*	T2	Rare
					Tintinnopsisgracilis	T3	Rare
					Tintinnopsis radix	T4	Occasional
					Tintinnopsisfailakkaensis	T5	Rare
				Codonellopsidae	*Codonellopsis* sp.	T6	Rare
COPEPODS	ATHROPODA	Crustacea Subclass: Copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Abundant
				Eucalanidae	*Pareucalanus sp.*	C2	Rare
					Subeucalanus sp.	C3	Rare
				Clausocalanidae	*Clausocalanus sp.*	C4	Occasional
				Centropagidae	*Centropages sp.*	C5	Rare
				Temoridae	*Temora sp.*	C6	Rare
				Acartiidae	*Acartia sp.*	C7	Occasional
			Cyclopoida	Oithonidae	*Oithona sp.*	C8	Abundant
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C9	Occasional
				Euterpinidae	*Euterpina sp.*	C10	Frequent
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C11	Rare
ROTIFERS	ROTIFERA	Rotifera Subclass: Eurotatoria	Superorder: Monogononta Order:Ploimida	Brachionidae	*Brachionusplicatilis*	R1	Rare
ARROW WORMS	CHAETOGNATHA	Sagittoidea	Aphragmophora	Sagittidae	*Sagitta sp.*	A1	Rare
MYSIDS	ATHROPODA CRUSTACEA	Malacostraca	Mysida, Decapoda	Solenoceridae	*Solenocerasp.*	M1	Rare
				Penaeidae	*Metapenaeussp.*	M2	Rare
					Penaeussp.	M3	Rare
				Luciferidae	*Lucifer sp.*	M4	Rare
UROCHORDATA	CHORDATA SUB PHYLUM UROCHORDATA	Appendicularia		Oikopleuridae	*Oikopleura sp.*	U1	Rare
CILIATES	CILIOPHORA	Oligohymenophorea	Sessilida	Zoothamniidae	*Zoothamniumsp.*	CI1	Occasional

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
MEDUSA	PHYLUM CNIDARIA	Hydrozoa			Unidentified medusa	ME1	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BRACHYURA LARVAE	ARTHROPODA (CRUSTACEA)	Malacostraca Decapoda			Brachyuran Zoea larvae	L2	Occasional
BARNACLE LARVAE	ATHROPODA CRUSTACEA	Maxillopoda Thecostraca			Cirripede larvae	L3	Rare
CYPHONAUTES LARVAE	BRYOZOA				Cyphonautes larvae	L4	Occasional
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L5	Rare
ECHINODERMATA LARVAE	ECHINODERMATA				Ophipluutes larvae/ Echinoplutes larvae	L6	Rare
CHORDATA	VERTEBRATA	Pisces			Fish larvae	L7	Rare
POLYCHAETE LARVAE	ANNELIDA	Polychaeta			Trochophore larvae	L8	Occasional
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L9	Rare
FORAMINIFERA	FORAMINIFERA	Globothalamea	Rotaliida	Globigerinidae	*Globigerina* sp.	F1	Occasional
				Rotalliidae	*Rotalia* sp.	F2	Rare

TABLE # 26 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS OF DPT OOT AREA AT PATH FINDER CREEK AND NEARBY SPM AT VADINAR DURING SPRING TIDE OF OCTOBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Dominant
				Codonellidae	*Tintinnopsisgracilis*	T2	Occasional
					Tintinnopsis radix	T3	Occasional
					Tintinnopsistocantinensis	T4	Occasional
				Xystonellidae	*Favella* sp.	T5	Rare
COPEPODS	ATHROPODA	Crustacea Subclass: Copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Occasional
			Cyclopoida	Oithonidae	*Oithona sp.*	C2	Frequent
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Abundant
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L2	Rare

TABLE # 27 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS OF DPT OOT AREA AT PATH FINDER CREEK AND NEARBY SPM AT VADINAR DURING NEAP TIDE OF OCTOBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Rare
				Xystonellidae	*Favella* sp.	T2	Rare
COPEPODS	ATHROPODA	Crustacea Subclass: Copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Dominant
				Eucalanidae	*Pareucalanus sp.*	C2	Rare
					Subeucalanus sp.	C3	Rare
				Clausocalanidae	*Clausocalanus sp.*	C4	Occasional
				Tortanidae	*Tortanus sp.*	C5	Rare
			Cyclopoida	Oithonidae	*Oithona sp.*	C6	Abundant
			Harpacticoida	Euterpinidae	*Euterpina sp.*	C7	Frequent
			Poicilostomatatoida	Corycaeidae	*Corycaeus sp.*	C8	Rare

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
ARROW WORMS	CHAETOGNATHA	Sagittoidea	Aphragmophora	Sagittidae	*Sagitta sp.*	A1	Rare
MYSIDS	ATHROPODA CRUSTACEA	Malacostraca	Mysida, Decapoda	Solenoceridae	*Solenocerasp.*	M1	Rare
				Penaeidae	*Metapenaeussp.*	M2	Rare
					Penaeussp.	M3	Rare
				Luciferidae	*Lucifer sp.*	M4	Rare
UROCHORDATA	CHORDATA SUB PHYLUM UROCHORDATA	Appendicularia		Oikopleuridae	*Oikopleura sp.*	U1	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Frequent
BRACHYURA LARVAE	ARTHROPODA (CRUSTACEA)	Malacostraca Decapoda			Brachyuran Zoea larvae	L2	Rare
BARNACLE LARVAE	ATHROPODA CRUSTACEA	Maxillopoda Thecostraca			Cirripede larvae	L3	Rare
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L4	Rare
ECHINODERMATA LARVAE	ECHINODERMATA				Ophipluutes larvae/ Echinoplutes larvae	L5	Rare
POLYCHAETE LARVAE	ANNELIDA	Polychaeta			Trochophore larvae	L6	Occasional
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L7	Rare

BENTHIC ORGANISMS:

Few Benthic organismswere observed in the collected sediments by using the Van-veen grabs during the sampling conducted during spring tide period and while no Benthic organisms were observed during sampling conducted in Neap tide period from DPT harbour region and nearby creek except few dead shells.The meiobenthic organisms during spring tide were represented by Polychaetes,and Nematodes. The polychaetes were represented by *Scyphoproctus sp*. ,during spring tide sampling.The meiobenthic organisms in the collected samples were varying from 40-60N/M ^{2}during spring tide

Table # 28BENTHIC FAUNA IN THE SAMPLING LOCATIONS IN DPT HARBOUR AREA CREEKS DURING NEAP TIDE IN OCTOBER ,2021

Benthic fauna	ABUNDANCE IN NO/M ^{2} DIFFERENT SAMPLING STATIONS REPRESENTATION BY GROUP						
	DPT HARBOUR			CREEKS			
POLYCHAETES	KPT-1	KPT-2	KPT-3	KPT-4	KPT-5	KPT-6	
Family : Capitellidae **Scyphoproctus** *sp.*	20	40	20	20	20	NS	
Total Polychates N/M^2	20	40	20	20	20	NS	
Un identified Nematode worms	40	20	20	40	20	NS	
TOTAL Benthic Fauna NUMBER/ M^2	60	60	40	60	40	-	

NS : No sample

7. Meteorological Data

Automatic Weather station have been installed in Seva Sadan -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 30.3 °C. The day-time maximum temperature was 38.6 °C. The mean night time temperature was 26.5 °C. The minimum mean night time temperature recorded was 30.6 °C.

Air Pressure

The mean absolute air pressure for the month of October was 1009.9 hpa, whereas the mean relative pressure was 1009.3 hpa. The maximum absolute air pressure recorded for the month of October was 1016.5 hpa.

Heat Index

The mean day-time heat index for the month of October was 33.8 ^{o}C. The maximum heat index recorded was 55^{o}C.

Solar Radiation

The mean Solar Radiation in October was 252.2 w/m^2. The maximum solar radiation recorded in the month of October was 746.6 w/m^2.

Humidity

The mean day-time humidity was 60.0 % for the month of October and mean night time humidity was 72.4%. Maximum humidity recorded during day-time was 94.0 % and maximum humidity recorded during night-time was 93.0%.

Wind Velocity and Wind Direction

The mean wind velocity for the entire month of October was 4.6 km/hour. Maximum wind velocity recorded was 29.2 Km/hr . The wind direction was mostly S to N.

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 October, 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.

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ENVIRONMENTAL MONITORING REPORTFOR

DEENDAYAL PORT TRUST

REPORT	:	**DCPL/DPT/20-21/19**
Mont	:	**November**
Issue	:	**01**
Revision	:	**00**
Prepare	:	**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 November 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	01.11.21	326	193	86	3.52	3.96	22.23	21.60	9.70	10.21
					4.84		19.69		9.96	
					3.52		22.87		10.98	
AL1 – 2	09.11.21	303	156	90	5.71	6.15	15.88	20.54	13.02	13.36
					6.15		17.15		12.76	
					6.59		28.58		14.30	
AL1 – 3	12.11.21	402	191	96	7.47	6.74	28.58	27.31	11.49	11.49
					7.03		32.39		13.27	
					5.71		20.96		9.70	
AL1 – 4	17.11.21	438	180	90	3.08	2.64	19.69	16.73	15.57	16.00
					2.20		14.61		18.12	
					2.64		15.88		14.30	
AL1 – 5	19.11.21	530	156	88	4.40	4.40	20.96	20.54	5.62	9.19
					5.28		18.42		11.49	
					3.52		22.23		10.47	
AL1 - 6	24.11.21	468	182	90	2.64	3.52	14.61	16.30	10.98	7.49
					5.28		20.96		6.64	
					2.64		13.34		4.85	
AL1 - 7	26.11.21	597	274	92	3.52	2.93	14.61	17.78	14.30	10.89
					3.08		19.69		9.96	
					2.20		19.05		8.42	
AL1 – 8	29.11.21	613	210	90	2.20	2.78	26.04	24.98	10.47	8.00
					2.64		29.22		6.38	
					3.52		19.69		7.15	
Monthly Average		460	193	90		4.14		20.72		10.83
Standard Deviation		116	38	3		1.55		3.90		2.82

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	1.11.21	1.27	BQL	2.15	581
AL1 – 2	9.11.21	1.12	BQL	1.9	497
AL1 – 3	12.11.21	1.11	BQL	1.94	361
AL1 – 4	17.11.21	1.05	BQL	2.04	357
AL1 – 5	19.11.21	1.12	BQL	1.85	541
AL1 - 6	24.11.21	1.38	BQL	1.91	561
AL1 – 7	26.11.21	1.07	BQL	1.98	567
AL1 – 8	29.11.21	1.14	BQL	2.21	541
Monthly Average		**1.16**	**-**	**2.00**	**501**
Standard Deviation		**0.11**	**-**	**0.13**	**91**

* NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification Limit – NMHC: 0.5 ppm)
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 460 µg/m^3, The mean PM_{10} values were 193.0 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean 90.0 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 4.14 µg/ m^3, 20.72 µg/ m^3 & 10.83 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 1.16 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 2.0 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	01.11.21	421	151	92	3.96	3.66	17.15	15.67	13.79	14.81
					4.40		13.34		15.06	
					2.64		16.51		15.57	
AL2 – 2	09.11.21	532	176	89	1.76	2.93	13.34	12.49	6.13	9.70
					2.64		11.43		11.23	
					4.40		12.70		11.74	
AL2 – 3	12.11.21	539	180	96	7.03	8.79	32.39	25.19	4.85	7.32
					9.23		20.96		7.91	
					10.11		22.23		9.19	
AL2 – 4	17.11.21	510	200	101	3.96	2.93	15.88	15.24	7.91	9.79
					2.20		16.51		11.49	
					2.64		13.34		9.96	
AL2 – 5	19.11.21	407	234	98	3.52	2.49	17.78	19.48	9.19	8.00
					2.20		24.77		5.87	
					1.76		15.88		8.93	
AL2 – 6	24.11.21	520	152	100	7.03	6.45	20.96	15.88	5.87	8.42
					8.35		11.43		8.93	
					3.96		15.24		10.47	
AL2 – 7	26.11.21	434	150	98	1.32	1.90	22.87	19.69	9.19	10.04
					1.76		15.24		13.02	
					2.64		20.96		7.91	
AL2 – 8	29.11.21	551	278	100	2.20	2.93	16.51	18.42	6.64	9.02
					2.64		22.87		9.45	
					3.96		15.88		10.98	
Monthly Average		489	190	97		4.01		17.76		9.64
Standard Deviation		59	46	4		2.37		3.86		2.29

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	1.11.21	1.12	BQL	2	618
AL2 -2	9.11.21	1.09	BQL	1.91	583
AL2 -3	12.11.21	1.07	BQL	2.08	509
AL2 -4	17.11.21	1.19	BQL	2.04	487
AL2 – 5	19.11.21	1.27	BQL	2.07	590
AL2 – 6	24.11.21	1.16	BQL	2.05	549
AL2 -7	26.11.21	1.17	BQL	1.99	578
AL2 – 8	29.11.21	1.09	BQL	1.98	624
Monthly Average		**1.15**	**-**	**2.02**	**567**
Standard Deviation		**0.07**	**-**	**0.06**	**49**

* NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification 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 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 489 µg/m^3 .The mean PM_{10} values were 190 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 97 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 4.01 µg/m^3, 17.76 µg/m^3 and 9.79 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 1.15 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 2.02 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	01.11.21	205	114	80	2.20	2.64	22.87	22.23	13.79	16.34	
					2.64		30.49		16.85		
					3.08		13.34		18.38		
AL3 – 2	09.11.21	302	134	90	3.08	3.08	13.97	13.97	9.70	7.49	
					2.64		11.43		7.40		
					3.52		16.51		5.36		
AL3 – 3	12.11.21	422	215	92	3.52	3.81	13.34	19.27	8.93	6.98	
					4.84		19.69		7.40		
					3.08		24.77		4.60		
AL3 – 4	17.11.21	610	270	108	5.28	3.08	10.80	9.32	13.02	10.21	
					2.64		10.16		10.47		
					1.32		6.99		7.15		
AL3 – 5	19.11.21	459	269	100	5.28	3.96	26.04	25.41	8.93	9.19	
					3.96		33.66		9.96		
					2.64		16.51		8.68		
AL3 – 6	24.11.21	736	363	102	5.71	4.84	19.69	19.48	10.47	8.93	
					2.64		14.61		9.70		
					6.15		24.14		6.64		
AL3 – 7	26.11.21	483	180	98	5.28	3.81	20.96	17.57	11.49	10.98	
					3.96		15.24		10.98		
					2.20		16.51		10.47		
AL3 – 8	29.11.21	677	189	105	2.20	3.22	15.88	16.73	12.25	9.02	
					4.84		14.61		8.93		
					2.64		19.69		5.87		
Monthly Average		487	217	97		3.55		18.00		9.89	
Standard Deviation		182	81	9		0.69		4.93		2.91	

NS: Not Specified

Table 3B : Results of Air Pollutant Concentration at Kandla Port Colony					
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**
AL3 -1	1.11.21	1.07	BQL	2.07	577
AL3 -2	9.11.21	1.1	BQL	1.91	583
AL3 -3	12.11.21	1.19	BQL	1.8	510
AL3 -4	17.11.21	1.11	BQL	1.91	480
AL3 – 5	19.11.21	1	BQL	2.1	652
AL3 – 6	24.11.21	1.1	BQL	1.84	672
AL3 – 7	26.11.21	1.26	BQL	2.12	364
AL3 – 8	29.11.21	1.26	BQL	2.01	426
Monthly Average		**1.14**	**-**	**1.97**	**533**
Standard Deviation		**0.09**	**-**	**0.12**	**108**

* NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification 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 487 µg/m³, The mean PM_{10} values were 217 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 97 µg/m³). The average values of SO_2, NO_x and NH3 were 3.55 µg/m³, 18.0 µg/m³ and 9.89 µg/m³ 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 1.14 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.97 mg/m³, well below the permissible limit of 4.0 mg/m³.

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	01.11.21	145	81	36	3.52	2.78	8.26	12.91	9.19	8.93
					2.20		15.88		10.47	
					2.64		14.61		7.15	
AL4 -2	09.11.21	254	132	89	2.64	2.05	9.53	12.28	5.87	5.36
					1.32		13.34		5.36	
					2.20		13.97		4.85	
AL4 -3	12.11.21	309	136	92	2.20	2.78	10.16	9.95	3.83	5.02
					3.52		8.26		5.87	
					2.64		11.43		5.36	
AL4 -4	17.11.21	474	249	101	3.52	2.78	9.53	10.16	6.64	5.70
					2.64		11.43		4.60	
					2.20		9.53		5.87	
AL4 – 5	19.11.21	298	127	90	2.64	2.64	16.51	15.46	5.87	6.81
					3.52		10.16		8.42	
					1.76		19.69		6.13	
AL4 – 6	24.11.21	351	170	98	3.08	2.49	15.88	13.13	5.87	8.85
					2.64		10.16		9.19	
					1.76		13.34		11.49	
AL4 – 7	26.11.21	285	132	87	2.64	3.22	17.78	16.73	6.38	6.55
					3.96		16.51		7.91	
					3.08		15.88		5.36	
AL4 – 8	29.11.21	738	469	104	3.52	3.37	13.34	13.34	8.17	8.34
					3.96		14.61		8.93	
					2.64		12.07		7.91	
Monthly Average		357	187	87		2.77		12.99		6.95
Standard Deviation		180	124	21		0.41		2.33		1.58

NS: Not Specified

Table 4B : Results of Air Pollutant Concentration at Gopalpuri Hospital					
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**
AL4 -1	1.11.21	1.02	BQL	2.01	609
AL4 -2	9.11.21	1.15	BQL	2.04	509
AL4 -3	12.11.21	1.26	BQL	1.94	487
AL4 -4	17.11.21	1.09	BQL	1.73	450
AL4 – 5	19.11.21	1.08	BQL	1.88	544
AL4 – 6	24.11.21	1.2	BQL	2.13	580
AL4 – 7	26.11.21	1.18	BQL	1.91	559
AL4 – 8	29.11.21	1.14	BQL	2.2	505
Monthly Average		**1.14**	**-**	**1.98**	**530**
Standard Deviation		**0.08**	**-**	**0.15**	**52**

* NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification 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 TSPM values at Oil Jetty were 357 µg/m³, The mean PM_{10} values were 187 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean= 87 µg/m³). The average values of SO_2, NO_x and NH_3 were 2.77 µg/m³, 12.99 µg/m³ and 6.95 µg/m³ 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 1.14 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.98 mg/m³, well below the permissible limit of 4.0 mg/m³.

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	01.11.21	306	154	89	2.20	3.22	20.96	20.33	8.93	9.79
					3.08		21.60		7.40	
					4.40		18.42		13.02	
AL5 – 2	09.11.21	590	288	106	9.67	6.15	19.69	19.69	15.83	16.34
					4.84		23.50		17.61	
					3.96		15.88		15.57	
AL5 – 3	12.11.21	680	351	104	10.55	9.08	22.87	26.68	8.68	7.83
					7.03		26.04		6.64	
					9.67		31.12		8.17	
AL5 – 4	17.11.21	712	355	108	2.20	2.49	19.69	20.96	13.53	10.21
					1.76		20.96		9.19	
					3.52		22.23		7.91	
AL5 – 5	19.11.21	696	380	110	5.28	5.13	20.96	22.44	10.72	11.23
					6.15		19.69		9.96	
					3.96		26.68		13.02	
AL5 – 6	24.11.21	622	352	101	3.52	4.40	14.61	17.57	15.83	14.64
					3.96		18.42		15.06	
					5.71		19.69		13.02	
AL5 – 7	26.11.21	578	218	106	3.52	3.96	16.51	18.63	10.98	9.36
					4.84		20.96		9.19	
					3.52		18.42		7.91	
AL5 – 8	29.11.21	596	241	108	5.28	3.37	22.23	26.25	10.98	12.76
					2.64		27.31		13.02	
					2.20		29.22		14.30	
Monthly Average		598	292	104		4.73		21.57		11.52
Standard Deviation		128	81	7		2.10		3.36		2.87

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	1.11.21	1.1	BQL	1.97	593
AL5 – 2	9.11.21	1.28	BQL	1.56	582
AL5 – 3	12.11.21	1.07	BQL	2.1	453
AL5 – 4	17.11.21	1.02	BQL	1.98	494
AL5 – 5	19.11.21	1.17	BQL	2.07	544
AL5 – 6	24.11.21	1	BQL	1.91	571
AL5 – 7	26.11.21	1.23	BQL	1.78	636
AL5 – 8	29.11.21	1.20	BQL	2.07	511
Monthly Average		**1.13**	**-**	**1.93**	**548**
Standard Deviation		**0.10**	**-**	**0.18**	**59**

* NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification 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 598µg/m³. The mean PM_{10} values were 292 µg/m³, which is well above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 104 µg/m³). The average values of SO_2, NO_x and NH_3 were 4.73 µg/m³, 21.57 µg/m³ and 11.52 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 1.13 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.93 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	01.11.21	214	97	61	3.52	2.64	20.96	14.82	14.04	12.08
					2.64		12.07		12.51	
					1.76		11.43		9.70	
AL6 – 2	09.11.21	314	149	102	1.76	1.90	10.16	10.59	6.38	7.15
					2.64		11.43		6.64	
					1.32		10.16		8.42	
AL6 – 3	12.11.21	425	208	104	4.84	4.25	16.51	17.57	6.64	6.55
					5.28		20.96		4.85	
					2.64		15.24		8.17	
AL6 – 4	17.11.21	504	280	110	2.20	2.34	5.08	7.20	6.13	7.06
					1.76		7.62		8.42	
					3.08		8.89		6.64	
AL6 – 5	19.11.21	432	242	106	2.64	2.20	22.87	18.21	13.02	11.74
					2.20		13.34		11.74	
					1.76		18.42		10.47	
AL6 – 6	24.11.21	315	149	96	5.28	3.66	30.49	26.89	9.96	12.76
					1.76		22.23		15.57	
					3.96		27.95		12.76	
AL6 – 7	26.11.21	326	140	98	2.20	2.93	13.34	15.03	9.19	9.53
					3.08		15.24		8.93	
					3.52		16.51		10.47	
AL6 – 8	29.11.21	569	298	104	2.20	2.93	15.88	15.88	10.72	10.30
					2.64		13.34		8.93	
					3.96		18.42		11.23	
Monthly Average		387	195	98		2.86		15.77		9.65
Standard Deviation		116	73	15		0.78		5.79		2.48

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	01.11.21	1.2	BQL	1.91	586
AL6 – 2	09.11.21	1.02	BQL	2.1	600
AL6 – 3	12.11.21	1.08	1.91	1.91	452
AL6 – 4	17.11.21	1.26	BQL	1.94	507
AL6 – 5	19.11.21	1.21	BQL	2.08	593
AL6 – 6	24.11.21	1.01	BQL	1.98	568
AL6 – 7	26.11.21	1.203	BQL	2.08	577
AL6 – 8	29.11.21	1.19	BQL	2.04	517
Monthly Average		**1.15**	**-**	**2.01**	**550**
Standard Deviation		**0.10**	**-**	**0.08**	**52**

* NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification Limit – NMHC: 0.5 ppm)
NS- Not Specified

The mean TSPM values at Tuna Port were 387 µg/m³, The mean PM_{10} values were 195 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 98 µg/m³). The average values of SO_2, NO_x and NH_3 were 2.86 µg/m³, 15.77 µg/m³ and 9.65 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 1.15 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 2.01 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	01.11.21	251	137	109	2.20	3.22	7.62	11.86	6.89	5.70
					3.96		13.34		6.13	
					3.52		14.61		4.08	
AL7 -2	09.11.21	215	115	84	5.71	6.30	26.04	17.36	4.60	6.98
					6.15		14.61		10.47	
					7.03		11.43		5.87	
AL7 -3	12.11.21	202	104	76	3.52	3.96	10.16	16.51	6.38	8.68
					4.84		26.04		10.72	
					3.52		13.34		8.93	
AL7 -4	17.11.21	200	103	84	2.64	3.96	19.69	14.40	7.91	6.13
					5.28		13.34		4.60	
					3.96		10.16		5.87	
AL7 -5	19.11.21	224	104	94	5.71	3.96	13.97	16.30	9.19	7.66
					3.52		19.69		7.15	
					2.64		15.24		6.64	
AL7 -6	24.11.21	238	118	77	4.40	4.40	10.16	10.59	5.87	5.96
					2.64		6.99		4.60	
					6.15		14.61		7.40	
AL7 -7	26.11.21	213	120	64	2.64	3.52	15.88	14.40	14.04	10.38
					2.20		7.62		10.72	
					5.71		19.69		6.38	
AL7 -8	29.11.21	207	115	84	5.71	3.22	10.16	13.34	8.17	7.66
					2.64		15.24		7.91	
					1.32		14.61		6.89	
Monthly Average		219	115	84		4		14		7
Standard Deviation		18	11	13		1		2		2

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	01.11.21	1.03	BQL	1.75	569
AL7 – 2	09.11.21	1.16	BQL	1.85	629
AL7 – 3	15.11.2021	1.35	BQL	1.78	501
AL7 – 4	18.11.2021	1.09	BQL	2	449
AL7 – 5	19.11.2021	1	BQL	1.89	458
AL7 – 6	22.11.2021	1.22	BQL	1.87	510
AL7 – 7	25.11.2021	1.08	BQL	1.99	541
AL7 – 8	29.11.2021	1.18	BQL	1.88	565
Monthly Average		**1.14**	**-**	**1.88**	**528**
Standard Deviation		**0.11**	**-**	**0.09**	**60**

*NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification Limit – NMHC: 0.5 ppm)
NS_ Not Specified

The mean TSPM values at Vadinar Port were 219 µg/m^3. The mean PM_{10} values were 115 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 84 µg/m^3). The average values of SO_2, NO_x and NH_3 were 4.0 µg/m^3, 14.0 µg/m^3 and 7.0µg/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 1.14 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 1.88 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	01.11.21	204	83	73	4.84	3.22	20.96	18.63	6.38	5.96
					2.64		19.69		5.87	
					2.20		15.24		5.62	
AL8 -2	09.11.21	193	86	75	4.40	3.08	13.34	15.67	8.93	8.85
					2.64		20.33		6.64	
					2.20		13.34		10.98	
AL8 -3	12.11.21	241	126	107	2.64	2.49	15.88	16.09	4.85	5.96
					3.08		22.87		5.62	
					1.76		9.53		7.40	
AL8 -4	17.11.21	167	100	53	3.52	3.81	17.78	12.91	8.42	7.57
					4.84		10.16		10.47	
					3.08		10.80		3.83	
AL8 -5	19.11.21	183	151	72	2.20	2.49	10.16	10.59	5.36	6.55
					1.76		9.53		8.17	
					3.52		12.07		6.13	
AL8 -6	24.11.21	197	104	80	3.52	5.28	15.88	13.55	8.93	7.66
					5.71		10.16		7.91	
					6.59		14.61		6.13	
AL8 -5	26.11.21	226	111	88	3.52	3.37	10.16	11.43	11.74	8.85
					1.76		13.34		5.87	
					4.84		10.80		8.93	
AL8-6	29.11.21	226	104	106	2.64	2.78	10.16	13.13	9.19	7.40
					3.52		20.96		5.87	
					2.20		8.26		7.15	
Monthly Average		205	108	82		3		14		7
Standard Deviation		25	22	18		1		3		1

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	01.11.21	1.23	BDL	1.88	571
AL8-2	09.11.21	1.09	BDL	2.04	581
AL8 -3	15.11.2021	1.29	BDL	2.17	465
AL8-4	18.11.2021	1.05	BDL	1.82	452
AL8 -5	19.11.2021	1.01	BDL	1.92	482
AL8-6	22.11.2021	1.28	BDL	1.73	496
AL8-7	25.11.2021	1.15	BDL	1.85	524
AL8-8	29.11.2021	1.13	BDL	2.02	561
Monthly Average		**1.15**	**-**	**1.93**	**517**
Standard Deviation		**0.10**	**-**	**0.14**	**50**

* NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification 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 205 µg/m³. The mean PM_{10} values were 108 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 82.0 µg/m³). The average values of SO_2, NO_x and NH_3 were 3.0 µg/m³, 14.0 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 Admin Building, Vadinar Port. The mean Benzene concentration was 1.15 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.93 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	7.3	7.4	7.2	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	990	1280	1310	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	1860	2430	2540	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	BQL	BQL	BQL	NS*	NS*
8	Chloride as Cl	mg/l	491.09	461.02	516.15	250.0	1000.0
9	Ca as Ca	mg/l	64.13	68.14	60.12	75.0	200.0
10	Mg as Mg	mg/l	63.18	70.47	68.04	30.0	100.0
11	Total Hardness	mg/l	420	460	430	200.0	600.0
12	Iron as Fe	mg/l	BQL	BQL	BQL	0.3	No Relaxation
13	Fluorides as F	mg/l	0.32	0.35	0.34	1.0	1.5
14	Sulphate as SO4	mg/l	286.8	289.2	283.2	200.0	400
15	Nitrite as NO2	mg/l	<0.1	<0.1	<0.1	NS*	NS*
16	Nitrate as NO3	mg/l	6.41	7.88	6.20	45.0	No Relaxation
17	Salinity	%	0.86	0.80	0.89	NS*	NS*
18	Sodium as Na	mg/l	202	225	277	NS*	NS*
19	Potassium as K	mg/l	5.08	3.26	5.26	NS*	NS*
20	Manganese	mg/l	BQL	BQL	BQL	0.1	0.3
21	Hexavalent Chromium	mg/l	BQL	BQL	BQL	NS*	NS*
22	Copper	mg/l	BQL	BQL	BQL	0.05	1.5
23	Cadmium	mg/l	BQL	BQL	BQL	0.003	0.003
24	Arsenic	mg/l	BQL	BQL	BQL	0.01	0.05
25	Mercury	mg/l	BQL	BQL	BQL	0.001	0.001
26	Lead	mg/l	BQL	BQL	BQL	0.01	0.01
27	Zinc	mg/l	BQL	BQL	BQL	5.0	15.0
28	Bacterial Count	CFU/100 ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified
BQL- Below Quantification Limit, (BOD-2.0 mg/l, Fe-0.009 mg/l, Mn- 0.01 mg/l, Cr^{+6}- 0.03 mg/l, Cu-0.004 mg/l, Cd-0.003 mg/l, As-0.003mg/l, Hg-0.001 mg/l, Pb-0.006mg/l, Zinc-0.021 mg/l).

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	7.5	7.3	7.2	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1410	1350	1420	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	2710	2560	2730	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	BQL	BQL	BQL	NS*	NS*
8	Chloride as Cl	mg/l	541.20	486.08	491.09	250.0	1000.0
9	Ca as Ca	mg/l	64.13	56.11	64.13	75.0	200.0
10	Mg as Mg	mg/l	68.04	68.04	72.90	30.0	100.0
11	Total Hardness	mg/l	440	420	460	200.0	600.0
12	Iron as Fe	mg/l	BQL	BQL	BQL	0.3	No Relaxation
13	Fluorides as F	mg/l	0.41	0.29	0.34	1.0	1.5
14	Sulphate as SO4	mg/l	291.6	204.0	194.4	200.0	400
15	Nitrite as NO2	mg/l	<0.1	<0.1	<0.1	NS*	NS*
16	Nitrate as NO3	mg/l	8.10	12.25	8.87	45.0	No Relaxation
17	Salinity	%	0.83	0.93	0.98	NS*	NS*
18	Sodium as Na	mg/l	201	195	279	NS*	NS*
19	Potassium as K	mg/l	4.28	4.08	4.69	NS*	NS*
20	Manganese	mg/l	BQL	BQL	BQL	0.1	0.3
21	Hexavalent Chromium	mg/l	BQL	BQL	BQL	NS*	NS*
22	Copper	mg/l	BQL	BQL	BQL	0.05	1.5
23	Cadmium	mg/l	BQL	BQL	BQL	0.003	0.003
24	Arsenic	mg/l	BQL	BQL	BQL	0.01	0.05
25	Mercury	mg/l	BQL	BQL	BQL	0.001	0.001
26	Lead	mg/l	BQL	BQL	BQL	0.01	0.01
27	Zinc	mg/l	BQL	BQL	BQL	5.0	15.0
28	Bacterial Count	CFU/100 ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

BQL- Below Quantification Limit, (BOD-2.0 mg/l, Fe-0.009 mg/l,Mn- 0.01 mg/l, Cr^{+6}- 0.03 mg/l, Cu-0.004 mg/l, Cd-0.003 mg/l, As-0.003mg/l, Hg-0.001 mg/l, Pb-0.006mg/l, Zinc-0.021 mg/l).

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 as per IS 10500 : 2012	Permissible Limits in the absence of Alternate Source as per IS 10500 : 2012
1	pH	pH Unit	7.4	7.7	7.5	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1360	1325	1430	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	2530	2480	2680	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	BQL	BQL	BQL	NS*	NS*
8	Chloride	mg/l	656.46	611.36	516.15	250.0	1000.0
9	Ca as Ca	mg/l	56.11	60.12	64.13	75.0	200.0
10	Mg as Mg	mg/l	75.33	65.61	72.90	30.0	100.0
11	Total Hardness	mg/l	450	420	460	200.0	600.0
12	Iron as Fe	mg/l	BQL	BQL	BQL	0.3	No Relaxation
13	Fluorides	mg/l	0.23	0.45	0.46	1.0	1.5
14	Sulphate	mg/l	198.0	290.4	230.4	200.0	400
15	Nitrite	mg/l	<0.1	<0.1	<0.1	NS*	NS*
16	Nitrate	mg/l	10.42	9.57	13.94	45.0	No Relaxation
17	Salinity	%	0.88	0.89	1.19	NS*	NS*
18	Sodium as Na	mg/l	303	248	327	NS*	NS*
19	Potassium as K	mg/l	4.30	5.61	8.26	NS*	NS*
20	Manganese	mg/l	BQL	BQL	BQL	0.1	0.3
21	Hexavalent Chromium	mg/l	BQL	BQL	BQL	NS*	NS*
22	Copper	mg/l	BQL	BQL	BQL	0.05	1.5
23	Cadmium	mg/l	BQL	BQL	BQL	0.003	0.003
24	Arsenic	mg/l	BQL	BQL	BQL	0.01	0.05
25	Mercury	mg/l	BQL	BQL	BQL	0.001	0.001
26	Lead	mg/l	BQL	BQL	BQL	0.01	0.01
27	Zinc	mg/l	BQL	BQL	BQL	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

BQL- Below Quantification Limit, (BOD-2.0 mg/l, Fe-0.009 mg/l,Mn- 0.01 mg/l, Cr^{+6}- 0.03 mg/l, Cu-0.004 mg/l, Cd-0.003 mg/l, As-0.003mg/l, Hg-0.001 mg/l, Pb-0.006mg/l, Zinc-0.021 mg/l).

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	7.6	7.3	7.2	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1310	1410	1430	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	2540	2690	2740	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<0.1	<0.1	<0.1	NS*	NS*
8	Chloride	mg/l	481.07	531.18	516.15	250.0	1000.0
9	Ca as Ca	mg/l	72.14	76.15	64.13	75.0	200.0
10	Mg as Mg	mg/l	55.89	58.32	68.04	30.0	100.0
11	Total Hardness	mg/l	410	430	440	200.0	600.0
12	Iron as Fe	mg/l	BQL	BQL	BQL	0.3	No Relaxation
13	Fluorides	mg/l	0.48	0.85	0.52	1.0	1.5
14	Sulphate	mg/l	210.0	291.6	301.2	200.0	400
15	Nitrite	mg/l	<0.1	<0.1	<0.1	NS*	NS*
16	Nitrate	mg/l	10.28	13.24	9.79	45.0	No Relaxation
17	Salinity	%	1.10	0.93	0.87	NS*	NS*
18	Sodium as Na	mg/l	154	384	218	NS*	NS*
19	Potassium as K	mg/l	3.26	4.69	4.03	NS*	NS*
20	Manganese	mg/l	BQL	BQL	BQL	0.1	0.3
21	Hexavalent Chromium	mg/l	BQL	BQL	BQL	NS*	NS*
22	Copper	mg/l	BQL	BQL	BQL	0.05	1.5
23	Cadmium	mg/l	BQL	BQL	BQL	0.003	0.003
24	Arsenic	mg/l	BQL	BQL	BQL	0.01	0.05
25	Mercury	mg/l	BQL	BQL	BQL	0.001	0.001
26	Lead	mg/l	BQL	BQL	BQL	0.01	0.01
27	Zinc	mg/l	BQL	BQL	BQL	5.0	15.0
28	Bacterial Count	CFU/100 ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

BQL- Below Quantification Limit, (BOD-2.0 mg/l, Fe-0.009 mg/l,Mn- 0.01 mg/l, Cr^{+6}- 0.03 mg/l, Cu-0.004 mg/l, Cd-0.003 mg/l, As-0.003mg/l, Hg-0.001 mg/l, Pb-0.006mg/l, Zinc-0.021 mg/l).

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	7.4	7.6	7.5	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1400	1720	1090	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	2640	2730	2130	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	BQL	BQL	BQL	NS*	NS*
8	Chloride	mg/l	496.10	526.17	481.07	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	80.19	77.76	65.61	30.0	100.0
11	Total Hardness	mg/l	480	460	440	200.0	600.0
12	Iron as Fe	mg/l	BQL	BQL	BQL	0.3	No Relaxation
13	Fluorides	mg/l	0.60	0.81	0.63	1.0	1.5
14	Sulphate	mg/l	314.4	214.8	289.2	200.0	400
15	Nitrite	mg/l	<0.1	<0.1	<0.1	NS*	NS*
16	Nitrate	mg/l	10.91	12.39	10.00	45.0	No Relaxation
17	Salinity	%	0.96	0.93	0.90	NS*	NS*
18	Sodium as Na	mg/l	287	106	246	NS*	NS*
19	Potassium as K	mg/l	5.28	6.29	2.25	NS*	NS*
20	Manganese	mg/l	BQL	BQL	BQL	0.1	0.3
21	Hexavalent Chromium	mg/l	BQL	BQL	BQL	NS*	NS*
22	Copper	mg/l	BQL	BQL	BQL	0.05	1.5
23	Cadmium	mg/l	BQL	BQL	BQL	0.003	0.003
24	Arsenic	mg/l	BQL	BQL	BQL	0.01	0.05
25	Mercury	mg/l	BQL	BQL	BQL	0.001	0.001
26	Lead	mg/l	BQL	BQL	BQL	0.01	0.01
27	Zinc	mg/l	BQL	BQL	BQL	5.0	15.0
28	Bacterial Count	CFU/100 ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

BQL- Below Quantification Limit, (BOD-2.0 mg/l, Fe-0.009 mg/l,Mn- 0.01 mg/l, Cr^{+6}- 0.03 mg/l, Cu-0.004 mg/l, Cd-0.003 mg/l, As-0.003mg/l, Hg-0.001 mg/l, Pb-0.006mg/l, Zinc-0.021 mg/l).

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	7.6	7.3	7.42	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1020	1250	1150	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	1950	2380	2000	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	BQL	BQL	BQL	NS*	NS*
8	Chloride	mg/l	611.36	576.28	520	250.0	1000.0
9	Ca as Ca	mg/l	64.13	60.12	76.15	75.0	200.0
10	Mg as Mg	mg/l	55.89	72.90	55.89	30.0	100.0
11	Total Hardness	mg/l	390	450	420	200.0	600.0
12	Iron as Fe+3	mg/l	BQL	BQL	BQL	0.3	No Relaxation
13	Fluorides	mg/l	0.86	0.57	0.75	1.0	1.5
14	Sulphate	mg/l	301.2	285.6	274.8	200.0	400
15	Nitrite	mg/l	<0.1	<0.1	<0.1	NS*	NS*
16	Nitrate	mg/l	10.91	10.07	9.93	45.0	No Relaxation
17	Salinity	%	0.95	0.87	1.10	NS*	NS*
18	Sodium as Na	mg/l	235	235	248	NS*	NS*
19	Potassium as K	mg/l	3.98	5.54	4.8	NS*	NS*
20	Manganese	mg/l	BQL	BQL	BQL	0.1	0.3
21	Hexavalent Chromium	mg/l	BQL	BQL	BQL	NS*	NS*
22	Copper	mg/l	BQL	BQL	BQL	0.05	1.5
23	Cadmium	mg/l	BQL	BQL	BQL	0.003	0.003
24	Arsenic	mg/l	BQL	BQL	BQL	0.01	0.05
25	Mercury	mg/l	BQL	BQL	BQL	0.001	0.001
26	Lead	mg/l	BQL	BQL	BQL	0.01	0.01
27	Zinc	mg/l	BQL	BQL	BQL	5.0	15.0
28	Bacterial Count	CFU/100 ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

BQL- Below Quantification Limit, (BOD-2.0 mg/l, Fe-0.009 mg/l,Mn- 0.01 mg/l, Cr^{+6}- 0.03 mg/l, Cu-0.004 mg/l, Cd-0.003 mg/l, As-0.003mg/l, Hg-0.001 mg/l, Pb-0.006mg/l, Zinc-0.021 mg/l).

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	7.5	7.3	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1060	1120	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	1960	2150	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	BQL	BQL	NS*	NS*
8	Chloride	mg/l	486.08	521.16	250.0	1000.0
9	Ca as Ca	mg/l	68.14	60.12	75.0	200.0
10	Mg as Mg	mg/l	68.04	68.04	30.0	100.0
11	Total Hardness	mg/l	450	430	200.0	600.0
12	Iron as Fe+3	mg/l	BQL	BQL	0.3	No Relaxation
13	Fluorides	mg/l	0.86	0.69	1.0	1.5
14	Sulphate	mg/l	23.04	22.56	200.0	400
15	Nitrite	mg/l	<0.1	<0.1	NS*	NS*
16	Nitrate	mg/l	7.88	10.63	45.0	No Relaxation
17	Salinity	%	0.88	0.94	NS*	NS*
18	Sodium as Na	mg/l	52.8	40.2	NS*	NS*
19	Potassium as K	mg/l	3.3	2.1	NS*	NS*
20	Manganese	mg/l	BQL	BQL	0.1	0.3
21	Hexavalent Chromium	mg/l	BQL	BQL	NS*	NS*
22	Copper	mg/l	BQL	BQL	0.05	1.5
23	Cadmium	mg/l	BQL	BQL	0.003	0.003
24	Arsenic	mg/l	BQL	BQL	0.01	0.05
25	Mercury	mg/l	BQL	BQL	0.001	0.001
26	Lead	mg/l	BQL	BQL	0.01	0.01
27	Zinc	mg/l	BQL	BQL	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent

*NS: Not Specified
BQL- Below Quantification Limit, (BOD-2.0 mg/l, Fe-0.009 mg/l,Mn- 0.01 mg/l, Cr^{+6}- 0.03 mg/l, Cu-0.004 mg/l, Cd-0.003 mg/l, As-0.003mg/l, Hg-0.001 mg/l, Pb-0.006mg/l, Zinc-0.021 mg/l).

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 7.1 to 7.7 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 900 -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 November ranged from 1800-3000 μs/cm. Electrical conductivity standards do not appear in BIS standards for drinking water.

BOD

BOD value in the studied area was found Below Quantification Limit (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 400-700 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 50 - 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 50-85 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 350-480 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 found Below Quantification Limit (0.009 mg/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 20 – 350 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 found Below Quantification Limit (0.1 mg/l). There are no specified standard values for Nitrites in Drinking water. The minimim Nitrate value in drinking water of KPT was 6.20 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 0.5 to 1.4 %. There are no prescribed Indian standards for salinity in Drinking water**.**

Sodium and Potassium Salts

Sodium values in the samples collected ranged from 40 - 400 mg/l and Potassium salts ranged from 2.0 to 8.5 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 Quantification 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	73.9	53.4
2	Nirman Building 1	62.3	51.0
3	Tuna Port	57.2	50.9
4	Main Gate North	67.0	61.8
5	West Gate I	70.5	65.1

6	Canteen Area	64.5	51.0
7	Main Road	68.4	51.5
8	ATM Building	74.4	57.3
9	Wharf Area /Jetty Area	72.9	68.1
10	Port & Custom Office	67.8	41.8
	Vadinar Port		
11	Entrance Gate of Vadinar Port	66.4	53.2
12	Nr. Port Colony, Vadinar	60.7	54.1
13	Nr. Vadinar Jetty	72.4	66.5

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 13 locations at Deendayal Port ranged from 57.2 dB(A) to 74.4 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 13 locations of Deendayal Port ranged from 41.8 dB to 68.4 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 November 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	-	8.42	7.92	8.44	8.23	7.79	8.43
3	Electrical Conductivity	µs/cm	14,070.0	16,210.0	13,680.0	9,240.0	387.0	314.0
4	Moisture	%	18.17	9.01	21.39	21.08	3.46	3.95
5	Total Organic Carbon	%	0.20	0.49	0.20	0.72	0.85	0.43
6	Alkalinity	mg/kg	80.08	120.12	60.06	100.10	60.06	80.08
7	Total Nitrogen	%	BQL	BQL	BQL	BQL	BQL	BQL
8	Chloride	mg/kg	1,956.8	4,112.2	1,800.9	514.7	21.7	113.4
9	Sulphate	mg/kg	212.0	279.0	93.3	165.1	44.7	27.7
10	Phosphorus	mg/kg	2.20	1.89	1.41	2.15	BQL	1.74
11	Potassium	mg/kg	539.0	327.4	409.2	667.6	70.4	62.0
12	Sodium	mg/kg	5,752.0	4,061.6	3,954.0	1,477.0	72.8	65.9
13	Calcium	mg/kg	200.40	488.98	252.00	470.42	436.87	256.51
14	Copper as Cu	mg/kg	14.90	29.50	9.80	27.60	88.4	48.4
15	Lead as Pb	mg/kg	5.80	6.40	3.50	8.20	BQL	4.2
16	Nickel as Ni	mg/kg	35.30	16.60	23.50	37.70	33.8	27.3
17	Zinc as Zn	mg/kg	40.60	104.80	25.4	55.20	66.00	30.50
18	Cadmium as Cd	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL

BQL- Below Quantification Limit, (TN:0.001%, Cd: 1.0mg/kg).

4.3 Discussion

The data shows that value of pH ranges from 7.92 at IFFCO Plant to 8.44 at Khori Creek indicating that all soil samples are neutral to slight basic. Iffco Plant samples showed maximum conductivity of 16,210.0 µmhos/cm, while Tuna Port location showed minimum conductivity of 14,070.0 µmhos/cm. Conductivity at Vadinar Port was 387 and 314 µmhos/cm at Admin site and Vadinar Port colony respectively.

Total organic Carbon ranged from 0.2 % to 0.72 at Deendayal Port. At Vadinar Port, organic carbon content ranged from 0.85 % to 0.43 %.

The concentration of Phosphorus and Potassium in the soil samples varies from 1.41 to 2.15 mg/kg and 327.0 to 670.0 mg/kg respectively at Deendayal Port. The mean concentration of Phosphorous at Vadinar site was 1.74 mg/kg and mean concentration of Potassium at Vadinar site was 132 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 below detection limit 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	02.11.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.82	7.46
2	Total Suspended Solids	mg/l	206	116.1
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	393.0	152.0
5	BOD @ 27 °C	mg/l	110.0	53.0
6.	Fecal Coliform	MPN Index / 100 ml	-	>1600.0
Aeration Tank				
7.	MLSS	mg/l	35.0	
8.	MLVSS	%	6.0	

Table 19: Sewage Water Monitoring at Kandla STP (2nd Week)

Date of Sampling	11.11.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.6	7.2
2	Total Suspended Solids	mg/l	152.2	72.4
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	384	103.0
5	BOD @ 27 °C	mg/l	120.0	24.0
6.	Fecal Coliform	MPN Index / 100 ml	-	9.2
Aeration Tank				
7.	MLSS	mg/l	7.0	
8.	MLVSS	%	90.0	

Table 20: Sewage Water Monitoring at Kandla STP (3rd Week)

Date of Sampling	17.11.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.35	7.14
2	Total Suspended Solids	mg/l	204	144
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	162	71
5	BOD @ 27 °C	mg/l	60.0	20.0
6.	Fecal Coliform	MPN Index / 100 ml	-	24.0
Aeration Tank				
7.	MLSS	mg/l	12.0	
8.	MLVSS	%	93.0	

Table 21: Sewage Water Monitoring at Kandla STP (4th Week)

Date of Sampling	22.11.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.82	7.46
2	Total Suspended Solids	mg/l	306	116
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	242	103.0
5	BOD @ 27 °C	mg/l	86.0	26.0
6.	Fecal Coliform	MPN Index / 100 ml	-	170.0
Aeration Tank				
7.	MLSS	mg/l	9.0	
8	MLVSS	%	98.0	

Gopalpuri Colony STP

Table 22: Sewage Water Monitoring at Gopalpuri STP (1st Week)

Date of Sampling	02.11.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.50	7.20
2	Total Suspended Solids	mg/l	210	120
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	414.0	142.0
5	BOD @ 27 °C	mg/l	122.0	53.0
6.	Fecal Coliform	MPN Index / 100 ml	-	>1600.0
Aeration Tank				
7.	MLSS	mg/l	86.0	
8	MLVSS	%	97.0	

Table 23: Sewage Water Monitoring at Gopalpuri STP (2nd Week)

Date of Sampling	11.11.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.46	7.2
2	Total Suspended Solids	mg/l	379.2	118
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	454	163.00
5	BOD @ 27 °C	mg/l	148.0	56.0
6.	Fecal Coliform	MPN Index / 100 ml	-	21.0
Aeration Tank				
7.	MLSS	mg/l	94.0	
8	MLVSS	%	92.0	

Table 24: Sewage Water Monitoring at Gopalpuri STP (3rd Week)

Date of Sampling	17.11.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.35	7.14
2	Total Suspended Solids	mg/l	204	144
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	162	71
5	BOD @ 27 °C	mg/l	60.0	20.0
6.	Fecal Coliform	MPN Index / 100 ml	-	24.0
Aeration Tank				
7.	MLSS	mg/l	12.0	
8	MLVSS	%	93.0	

Table 25: Sewage Water Monitoring at Gopalpuri STP (4th Week)

Date of Sampling	22.11.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.82	7.46
2	Total Suspended Solids	mg/l	306	116
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	242	103.0
5	BOD @ 27 °C	mg/l	86.0	26.0
6.	Fecal Coliform	MPN Index / 100 ml	-	170.0
Aeration Tank				
7.	MLSS	mg/l	9.0	
8.	MLVSS	%	98.0	

Vadinar STP

Table 26: Sewage Water Monitoring at Vadinar STP (1st Week)

Date of Sampling	02.11.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.62	7.41
2	Total Suspended Solids	mg/l	121	69
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	89.0	72.0
5	BOD @ 27 °C	mg/l	34.0	15.0

Table 27: Sewage Water Monitoring at Vadinar STP (2nd Week)

Date of Sampling	11.11.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.5	7.2
2	Total Suspended Solids	mg/l	109	31
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	173.0	62.0
5	BOD @ 27 °C	mg/l	48.0	20.0

Table 28: Sewage Water Monitoring at Vadinar STP (3rd Week)

Date of Sampling	17.11.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.7	7.5
2	Total Suspended Solids	mg/l	105	38
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	150	62
5	BOD @ 27 °C	mg/l	48.0	18.0

Table 29: Sewage Water Monitoring at Vadinar STP (4th Week)

Date of Sampling	25.10.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.5	7.3
2	Total Suspended Solids	mg/l	117	69
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	192	101
5	BOD @ 27 °C	mg/l	60.0	24.0

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.

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 19th& 20th November-2021 in harbor regions of KPT and on 19th November-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 26th& 27th November 2021 in harbor regions of KPT. 26th November -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**

5.4 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	7.26	7.45	7.26
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.6	31.9	32.0	31.5
5	Turbidity	NTU	36	31	33	32
6	Total Dissolved Solids	mg/l	41592	42007	41300.0	41443.0

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
7	Total Suspended Solids	mg/l	655	870	754.2	571.1
8	Total Solids	mg/l	42247	42877	42054.2	42014.1
9	DO	mg/l	4	4.2	4.1	4.3
10	COD	mg/l	82.0	90.0	80.0	78.0
11	BOD	mg/l	BQL	BQL	BQL	BQL
12	Silica	mg/l	0.65	0.60	0.76	0.65
13	Phosphate	mg/l	0.35	0.24	0.16	0.18
14	Sulphate	mg/l	2772	2700	2184	2580
15	Nitrate	mg/l	2.89	2.46	2.45	3.44
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	561.12	480.96	480.96	521.04
18	Magnesium	mg/l	1725.3	1530.9	1676.7	1603.8
19	Sodium	mg/l	9038.0	8014.0	8629.0	9638.0
20	Potassium	mg/l	313.0	271.0	336.0	378.0
21	Iron	mg/l	1.42	1.30	1.32	1.10
22	Chromium	mg/l	0.12	0.11	0.13	0.12
23	Copper	mg/l	BQL	BQL	BQL	BQL
24	Arsenic	mg/l	BQL	BQL	BQL	BQL
25	Cadmium	mg/l	0.05	0.06	0.06	0.05
26	Mercury	mg/l	BQL	BQL	BQL	BQL
27	Lead	mg/l	0.07	0.09	0.06	0.08
28	Zinc	mg/l	BQL	BQL	BQL	BQL

BQL- Below Quantification Limit, (BOD-2.0 mg/l,Cu-0.1 mg/l, As-0.1mg/l, Hg-0.01 mg/l, Zinc-0.1 mg/l).

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	7.12	7.31	7.30	7.20
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.0	31.6	32.2	31.4
5	Turbidity	NTU	35	28	38	42
6	Total Dissolved Solids	mg/l	39062	40035	40245.0	36627.0
7	Total Suspended Solids	mg/l	784	773	528.3	504
8	Total Solids	mg/l	39845	40808	40773.3	37131.0
9	DO	mg/l	4.3	3.9	4.2	4
10	COD	mg/l	88.0	86.0	92.0	90.0
11	BOD	mg/l	BQL	BQL	BQL	BQL
12	Silica	mg/l	0.56	0.53	0.76	0.69
13	Phosphate	mg/l	0.24	0.26	0.19	0.20
14	Sulphate	mg/l	2580	3132	2340	2700
15	Nitrate	mg/l	3.03	3.31	2.80	3.98
16	Nitrite	mg/l	BQL	BQL	BQL	BQL
17	Calcium	mg/l	601.20	681.36	561.12	601.2
18	Magnesium	mg/l	1555.2	1652.4	1676.7	1628.1
19	Sodium	mg/l	9530.0	9278.0	9116.0	9368.0
20	Potassium	mg/l	349.0	336.0	272.0	302.0
21	Iron	mg/l	1.88	1.70	1.48	1.55
22	Chromium	mg/l	0.12	0.11	0.11	0.14
23	Copper	mg/l	BQL	BQL	BQL	BQL
24	Arsenic	mg/l	BQL	BQL	BQL	BQL
25	Cadmium	mg/l	0.04	0.05	0.06	0.04
26	Mercury	mg/l	BQL	BQL	BQL	BQL
27	Lead	mg/l	0.10	0.09	0.09	0.10
28	Zinc	mg/l	BQL	BQL	BQL	BQL

BQL- Below Quantification Limit, (BOD-2.0 mg/l,Nitrite: 0.05mg/lCu-0.1 mg/l, As-0.1mg/l, Hg-0.01 mg/l, Zinc-0.1 mg/l).

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	7.46	7.30	7.36
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.0	31.8	32.7	31.0
5	Turbidity	NTU	34	29	36	40
6	Total Dissolved Solids	mg/l	43205	41674	43606.0	40029.0
7	Total Suspended Solids	mg/l	590	863	500.2	604.3
8	Total Solids	mg/l	43795	42537	44106.2	40633.3
9	DO	mg/l	4	5.1	4.5	4.4
10	COD	mg/l	90.0	86.0	88.0	79.0
11	BOD	mg/l	BQL	BQL	BQL	BQL
12	Silica	mg/l	0.69	0.75	0.56	0.64
13	Phosphate	mg/l	0.28	0.34	0.17	0.20
14	Sulphate	mg/l	3240	2016	2676	2148
15	Nitrate	mg/l	3.87	4.58	2.95	2.62
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	641.28	601.20	480.96	521.04
18	Magnesium	mg/l	1628.1	1749.6	1749.6	1749.6
19	Sodium	mg/l	9425.0	8408.0	9423.0	8709.0
20	Potassium	mg/l	339.0	299.0	306.0	230.0
21	Iron	mg/l	1.41	1.78	1.76	1.56
22	Chromium	mg/l	0.11	0.13	0.13	0.12
23	Copper	mg/l	BQL	BQL	BQL	BQL
24	Arsenic	mg/l	BQL	BQL	BQL	BQL
25	Cadmium	mg/l	0.06	0.05	0.05	0.07
26	Mercury	mg/l	BQL	BQL	BQL	BQL
27	Lead	mg/l	0.08	0.09	0.09	0.07
28	Zinc	mg/l	BQL	BQL	BQL	BQL

BQL- Below Quantification Limit, (BOD-2.0 mg/l,Cu-0.1 mg/l, As-0.1mg/l, Hg-0.01 mg/l,Zinc-0.1 mg/l).

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	7.35	7.50	7.50	7.20
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.1	32.6	31.9	31.6
5	Turbidity	NTU	43	39	45	33
6	Total Dissolved Solids	mg/l	42399	39089	38986.0	39711.0
7	Total Suspended Solids	mg/l	743	577	681.8	530.3
8	Total Solids	mg/l	43142	39666	39667.8	40241.3
9	DO	mg/l	4.6	4.5	5.2	5.6
10	COD	mg/l	92.0	90.0	82.0	89.0
11	BOD	mg/l	BQL	BQL	BQL	BQL
12	Silica	mg/l	0.82	0.58	0.58	0.51
13	Phosphate	mg/l	0.28	0.25	0.22	0.20
14	Sulphate	mg/l	1620	3492	2388	2100
15	Nitrate	mg/l	1.97	3.03	2.71	2.06
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	561.12	641.28	561.12	440.88
18	Magnesium	mg/l	1579.5	1603.8	1603.8	1822.5
19	Sodium	mg/l	9423.0	9014.0	9526.0	9468.0
20	Potassium	mg/l	341.0	301.0	218.0	221.0
21	Iron	mg/l	1.62	1.33	1.74	1.21
22	Chromium	mg/l	0.16	0.12	0.14	0.16
23	Copper	mg/l	BQL	BQL	BQL	BQL
24	Arsenic	mg/l	BQL	BQL	BQL	BQL
25	Cadmium	mg/l	0.04	0.05	0.06	0.04
26	Mercury	mg/l	BQL	BQL	BQL	BQL
27	Lead	mg/l	0.08	0.06	0.09	0.08
28	Zinc	mg/l	BQL	BQL	BQL	BQL

BQL- Below Quantification Limit, (BOD-2.0 mg/l,Cu-0.1 mg/l, As-0.1mg/l, Hg-0.01 mg/l, Zinc-0.1 mg/l).

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	7.30	7.20	7.30	7.40
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.6	31.2	31.2	31.1
5	Turbidity	NTU	36	42	36	31
6	Total Dissolved Solids	mg/l	40770	38329	38644.0	38955.0
7	Total Suspended Solids	mg/l	766	853	494.2	474
8	Total Solids	mg/l	41536	39182	39138.2	39429.0
9	DO	mg/l	4.1	4.7	4.6	4.8
10	COD	mg/l	98.0	96.0	96.0	98.0
11	BOD	mg/l	BQL	BQL	BQL	BQL
12	Silica	mg/l	0.53	0.89	0.75	0.64
13	Phosphate	mg/l	0.24	0.24	0.21	0.18
14	Sulphate	mg/l	3456	3732	2820	2424
15	Nitrate	mg/l	2.75	3.38	2.77	4.31
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	561.12	521.04	480.96	561.12
18	Magnesium	mg/l	1676.7	1725.3	1773.9	1676.7
19	Sodium	mg/l	9839.0	10125.0	10118.0	10168.0
20	Potassium	mg/l	399.0	402.0	387.0	390.0
21	Iron	mg/l	1.20	1.13	1.45	1.10
22	Chromium	mg/l	0.11	0.13	0.14	0.14
23	Copper	mg/l	BQL	BQL	BQL	BQL
24	Arsenic	mg/l	BQL	BQL	BQL	BQL
25	Cadmium	mg/l	0.05	0.07	0.07	0.08

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
26	Mercury	mg/l	BQL	BQL	BQL	BQL
27	Lead	mg/l	0.07	0.09	0.10	0.09
28	Zinc	mg/l	BQL	BQL	BQL	BQL

BQL- Below Quantification Limit, (BOD-2.0 mg/l,Cu-0.1 mg/l, As-0.1mg/l, Hg-0.01 mg/l,Zinc-0.1 mg/l).

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	7.52	Sampling not possible during Low Tide	7.52	Sampling not possible during Low Tide
2	Color	-	Colorless		Colorless	
3	Odor	-	Odorless		Odorless	
4	Salinity	ppt	31.8		32.2	
5	Turbidity	NTU	35		35	
6	Total Dissolved Solids	mg/l	41695		42152.0	
7	Total Suspended Solids	mg/l	684		452	
8	Total Solids	mg/l	42379		42604.0	
9	DO	mg/l	4.8		5.1	
10	COD	mg/l	100.0		94.0	
11	BOD	mg/l	BQL		BQL	
12	Silica	mg/l	0.96		0.53	
13	Phosphate	mg/l	0.23		0.17	
14	Sulphate	mg/l	3780		2376	
15	Nitrate	mg/l	3.24		3.61	
16	Nitrite	mg/l	<0.05		<0.05	
17	Calcium	mg/l	480.96		601.2	

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
18	Magnesium	mg/l	1725.3		1628.1	
19	Sodium	mg/l	10308.0		10319.0	
20	Potassium	mg/l	409.0		364.0	
21	Iron	mg/l	1.20		1.35	
22	Chromium	mg/l	0.11		0.12	
23	Copper	mg/l	BQL		BQL	
24	Arsenic	mg/l	BQL		BQL	
25	Cadmium	mg/l	0.06		0.06	
26	Mercury	mg/l	BQL		BQL	
27	Lead	mg/l	0.08		0.11	
28	Zinc	mg/l	BQL		BQL	

BQL- Below Quantification Limit, (BOD-2.0 mg/l,Cu-0.1 mg/l, As-0.1mg/l, Hg-0.01 mg/l,Zinc-0.1 mg/l).

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	7.70	7.41	7.52
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.2	32.0	31.5	31.4
5	Turbidity	NTU	45	39	42	40
6	Total Dissolved Solids	mg/l	38510	42661	40025.0	40250.0
7	Total Suspended Solids	mg/l	585	523	548.9	505
8	Total Solids	mg/l	39095	43184	40573.9	40755.0
9	DO	mg/l	4.4	4.6	4.7	4.6

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
10	COD	mg/l	76.0	80.0	72.0	70.0
11	BOD	mg/l	BQL	BQL	BQL	BQL
12	Silica	mg/l	0.85	1.02	0.75	0.82
13	Phosphate	mg/l	0.22	0.25	0.18	0.17
14	Sulphate	mg/l	2580	2700	2592	2508
15	Nitrate	mg/l	2.75	3.59	3.67	3.39
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	601.20	521.04	641.28	480.96
18	Magnesium	mg/l	1603.8	1676.7	1652.4	1676.7
19	Sodium	mg/l	10968.0	10848.0	11126.0	10829.0
20	Potassium	mg/l	344.0	382.0	355.0	392.0
21	Iron	mg/l	1.06	1.70	1.12	1.42
22	Chromium	mg/l	0.12	0.13	0.14	0.13
23	Copper	mg/l	BQL	BQL	BQL	BQL
24	Arsenic	mg/l	BQL	BQL	BQL	BQL
25	Cadmium	mg/l	0.05	0.04	0.08	0.07
26	Mercury	mg/l	BQL	BQL	BQL	BQL
27	Lead	mg/l	0.10	0.08	0.10	0.09
28	Zinc	mg/l	BQL	BQL	BQL	BQL

BQL- Below Quantification Limit, (BOD-2.0 mg/l,Cu-0.1 mg/l, As-0.1mg/l, Hg-0.01 mg/l, Zinc-0.1 mg/l).

Table 36 (a): Marine Water Quality Monitoring Parameters for locations Nr. Vadinar SPM

Sr. No.	Parameters	Unit	Nr.Vadinar SPM			
			22°30'56.15"N 69°42'12.07"E			
			Spring Tide		Neap Tide	
	Tide		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.40	7.60	7.45	7.26

Sr. No.	Parameters	Unit	Nr.Vadinar SPM			
			22°30'56.15"N 69°42'12.07"E			
			Spring Tide		Neap Tide	
	Tide		High Tide	Low Tide	High Tide	Low Tide
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.2	32.1	32.0	31.8
5	Turbidity	NTU	33.0	34.0	36.0	33.0
6	Total Dissolved Solids	mg/l	41700.0	41987	40610.0	40925
7	Total Suspended Solids	mg/l	635.0	480	513.0	548
8	Total Solids	mg/l	43340.0	43924	41384.0	42000
9	DO	mg/l	4.3	4.1	4.5	4.3
10	COD	mg/l	90.0	92.0	78.0	70.0
11	BOD	mg/l	BQL	BQL	BQL	BQL
12	Silica	mg/l	0.92	0.96	0.6	0.78
13	Phosphate	mg/l	0.24	0.25	0.2	0.16
14	Sulphate	mg/l	2628.0	2364	2316.0	2556
15	Nitrate	mg/l	3.10	3.38	3.34	3.68
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	481.0	561.12	521.0	561.12
18	Magnesium	mg/l	1652.4	2065.5	1676.7	1701
19	Sodium	mg/l	10318	10829	10418	10786
20	Potassium	mg/l	354	355	377	354
21	Iron	mg/l	1.60	1.80	1.27	1.90
22	Chromium	mg/l	0.14	0.14	0.13	0.12
23	Copper	mg/l	BQL	BQL	BQL	BQL
24	Arsenic	mg/l	BQL	BQL	BQL	BQL
25	Cadmium	mg/l	0.05	0.04	0.08	0.08
26	Mercury	mg/l	BQL	BQL	BQL	BQL
27	Lead	mg/l	0.09	0.08	0.11	0.09

Sr. No.	Parameters	Unit	Nr.Vadinar SPM			
			22°30'56.15"N 69°42'12.07"E			
			Spring Tide		Neap Tide	
	Tide		High Tide	Low Tide	High Tide	Low Tide
28	Zinc	mg/l	BQL	BQL	BQL	BQL

BQL- Below Quantification Limit, (BOD-2.0 mg/l,Cu-0.1 mg/l, As-0.1mg/l, Hg-0.01 mg/l,Zinc-0.1 mg/l).

5.4.1 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.

5.5Results

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 - 4	KPT - 5	Jetty	SPM
1	Texture	-	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	mg/kg	1.72	1.34	1.36	2.74	1.53	2.31	2.00
3	Organic Carbon	mg/kg	0.99	0.78	0.79	1.59	0.89	1.34	1.16
4	Inorganic Phosphate	mg/kg	112.0	121.0	116.0	124.0	128.0	122.0	133.0
5	Moisture	%	29.43	23.11	31.0	27.25	25.69	27.4	43.00
6	Aluminium	mg/kg	ND	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	11.2	10.5	12.3	11.4	10.5	13.2	13.00
8	Phosphate	mg/kg	2.57	2.73	9.48	6.12	11.84	5.96	6.68
9	Sulphate	mg/kg	283.0	257.0	411.0	182.0	338.0	209.0	494.7
10	Nitrite	mg/kg	0.12	0.11	0.12	0.12	0.11	0.1	0.11
11	Nitrate	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL
12	Calcium	mg/kg	364.7	152.3	505.0	76.2	325.0	225.0	177.0
13	Magnesium	mg/kg	260.0	241.0	158.0	175.0	308.0	58.3	228.4

14	Sodium	mg/kg	1819.0	2881.0	876.0	1858.0	4022.0	3159.0	8637.0
15	Potassium	mg/kg	119.0	166.0	102.0	113.0	263.0	283.0	1036.7
16	Chromium	mg/kg	60	46.6	51.2	43.2	58	46.40	65.00
17	Nickel	mg/kg	32.1	33.7	24.9	28	32.5	28.00	45.60
18	Copper	mg/kg	39.9	14.6	33	16.8	31.8	26.80	21.00
19	Zinc	mg/kg	81.90	52.70	60.80	42.70	68.70	64.30	65.90
20	Cadmium	mg/kg	2.0	BQL	BQL	BQL	BQL	BQL	BQL
21	Lead	mg/kg	18.50	5.4	9.0	5.70	11.4	10.90	5.20
22	Mercury	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL
23	Arsenic	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL

*ND - Not Detected, BQL: Below Quantification Limit (NO3:10.0mg/kg, Cd: 1.0mg/kg, Hg: 1.0mg/kg, As: 1.0mg/kg)

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	SPM
1	Texture	-	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	mg/kg	1.12	1.50	2.88	1.41	0.69	1.43	1.69
3	Organic Carbon	mg/kg	0.65	0.87	1.67	0.82	0.40	0.83	0.98
4	Inorganic Phosphate	mg/kg	118.0	126.0	120.0	130.0	128.0	112.0	130.0
5	Moisture	%	17.76	22.98	20.4	14.01	22.6	34.3	32.16
6	Aluminium	mg/kg	ND	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	12.0	11.3	10.5	11.3	9.8	11.4	12.60
8	Phosphate	mg/kg	17.14	2.91	7.83	0.49	2.54	15.65	2.20
9	Sulphate	mg/kg	255.0	427.0	290.0	440.0	390.0	564.0	595.0
10	Nitrite	mg/kg	0.1	0.11	0.1	0.11	0.12	0.1	0.11
11	Nitrate	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL
12	Calcium	mg/kg	180.0	188.0	172.0	180.0	176.0	116.0	140.0
13	Magnesium	mg/kg	38.9	102.1	82.6	150.7	58.3	158.0	179.8

Sr. No.	Parameters	Unit	KPT - 1	KPT - 2	KPT - 3	KPT - 4	KPT - 5	Jetty	SPM
14	Sodium	mg/kg	325.0	853.6	743.8	656.1	414.0	1895.0	1810.0
15	Potassium	mg/kg	25.7	72.3	52.3	52.3	40.0	248.0	307.0
16	Chromium	mg/kg	25.7	38.6	28.6	27.3	31.3	51.90	56.20
17	Nickel	mg/kg	18.0	29.2	20.1	18.4	17.8	32.40	72.70
18	Copper	mg/kg	12.30	20.30	6.70	9.40	7.90	22.20	41.10
19	Zinc	mg/kg	24.90	57.40	32.80	27.90	25.50	46.40	1511.00
20	Cadmium	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL
21	Lead	mg/kg	4.60	6.7	7.5	3.70	3.3	24.70	29.60
22	Mercury	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL
23	Arsenic	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL

*ND - Not Detected, BQL: Below Quantification Limit (NO3:10.0mg/kg,Cd: 1.0mg/kg,Hg: 1.0mg/kg, As: 1.0mg/kg)

REPORT

ON

ECOLOGICAL MONITORING

OF MARINE ENVIRONMENT

IN

DPTHARBOURAREA, NEAR BY CREEKS

AND

VADINAR JETTY AND SPM

FOR

DEENDAYAL PORT TRUST

November, 2021

***INTRODUCTION*:**

Sampling Stations:

The monitoring of marine environment for the study of biological and ecological Parameters was carried out on19thNovember, 2021 in harbour region of DPT at Kandla Creek, and on 20thNovember, 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 26thNovember, 2021 in harbour region of DPT at Kandla Creek and on27thNovember 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 KPT 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 Neap tide and spring 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 at Path Finder Creek during neap tide on 11/11/2021 and spring tide period on 26/11/2021 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	3 in Kandla creek
Nakti creek	2 in Nakti creek
Khori Creek	1 in Khori creek
Vadinar jetty	1 near Vadinar Jetty
SPM	1 near I stSPM
Total Number of locations	**8**

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 litre 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, and 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.

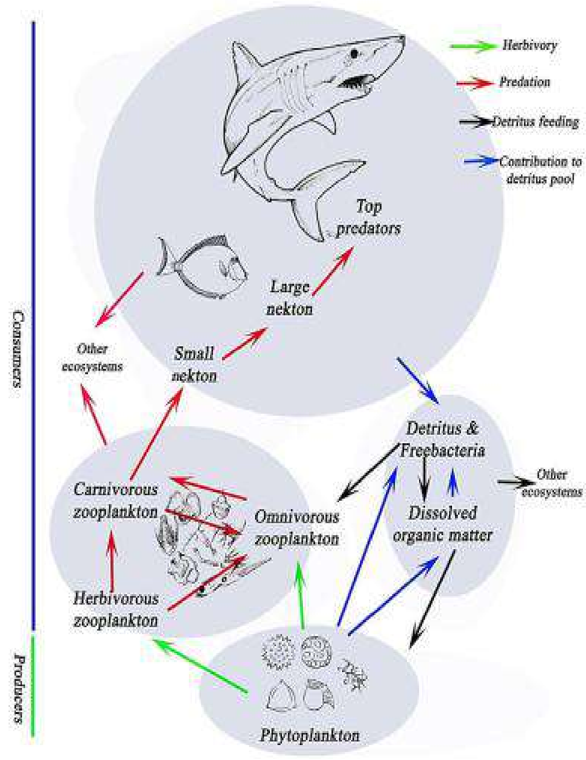
Based on the duration of planktonic life, zooplankton are categorised into Holoplankton (organisms which complete their entire lifecycle as plankton) and Meroplankton (organisms which are planktonic during the early part of their lives such as the larval stages of benthic and nektonic organisms). Tychoplankton 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**) reproduces 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 0.559 -0.868 mg/m^3.in harbour region of DPT in Kandla Creek during sampling done in spring tide period of November, 2021. In the nearby creeks chlorophyll-a was varying from 0.246 -0.954 mg/m^3.Pheophytin –a level was below detectable limit- the all the sampling stations during springtide

In the sub surface water chlorophyll-a was varying from 0.535 -0.921mg/m^3.in harbour region of DPT in Kandla Creek during sampling done in neap tide period of November , 2021 . In the nearby creeks chlorophyll-a was varying from 0.425 –1.923 mg/m^3.·Pheophytin –a level was below detectable limit- the all the sampling stations except KPT-4 Khori-I during low tide and high tide and KPT-5 Nakti-I during High tide period.

In the sub surface water chlorophyll-a was varying from 0.393 -0.338 mg/m^3.in harbour region of DPT OOT in path finder Creek during sampling done in spring tide period ofNovember, 2021. In the sub surface water chlorophyll-a was varying from 1.356 -0.500 mg/m^3.in harbour region of DPT OOT in path finder Creek during sampling done in Neap Tide period of November, 2021

In the sub surface water chlorophyll-a was varying from 0.424 -0.290 mg/m^3.in SPM region of DPT OOT in path finder Creek during sampling done in spring tide period of November, 2021. In the sub surface water chlorophyll-a was varying from 0.703 -0.409 mg/m^3.in SPM region of DPT OOT in path finder Creek during sampling done in Neap Tide period of November, 2021

TABLE #2 VARIATIONS IN CHLOROPHYLL –a PHEOPHYTIN- a AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA IN KANDLA CREEK ,NEAR BY CREEKS AND DPT OOT JETTY IN PATH FINDER CREEK AND SPM NEAR VADINAR DURING SPRING TIDE IN NOVEMBER,2021

Sr. No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin-a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPT HARBOUR AREAKANDLA CREEK					
1	KPT1	High tide	0.748	BDL	50.15
		Low tide	0.559	BDL	37.45
2	KPT 2	High tide	0.677	BDL	45.36
		Low tide	0.764	BDL	51.19
3	KPT 3	High tide	0.835	BDL	55.94
		Low tide	0.868	BDL	58.16
CREEKS					
4	KPT-4 Khori-I	High tide	0.661	BDL	44.29
		Low tide	0.720	BDL	48.24
5	KPT-5 Nakti-I	High tide	0.848	BDL	56.82
		Low tide	0.954	BDL	63.92
6	KPT-5 Nakti-II	High tide	0.246	BDL	16.48
PATHFINDER CREEK VADINAR					
7	VADINAR-I jetty	Low tide	0.393	BDL	26.33
8		High tide	0.338	BDL	22.65
9	SPM	High tide	0.424	BDL	28.41
10	SPM	Low 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 AND DPT OOT JETTY IN PATH FINDER CREEK AND SPM NEAR VADINARDURING NEAP TIDE IN NOVEMBER,2021

Sr. No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin-a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREAKANDLA CREEK					
1	KPT1	High tide	0.748	BDL	50.12
		Low tide	0.535	BDL	35.85
2	KPT 2	High tide	0.713	BDL	47.77
		Low tide	0.713	BDL	47.77
3	KPT 3	High tide	0.882	BDL	59.09
		Low tide	0.921	BDL	61.71
CREEKS					
4	KPT-4 Khori-I	High tide	1.669	0.484	111.82
		Low tide	1.178	0.380	78.93
5	KPT-5 Nakti-I	High tide	1.923	0.570	128.84
		Low tide	0.882	BDL	59.09
6	KPT-5 Nakti-II	High tide	0.425	BDL	28.47
PATHFINDER CREEK VADINAR					
7	VADINAR-I jetty	Low tide	1.356	0.415	90.85
8		High tide	0.500	BDL	33.50
9	SPM	High tide	0.703	BDL	47.10
10	SPM	Low tide	0.409	BDL	27.40

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 dinoflagellatesduring spring tide period.Diatoms were represented by 16genera. Blue green were represented by 2 genera and dinoflagellates were represented by two generaduring the sampling conducted in spring tide in November,2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 43-198 units/ L during high tide period and133-220 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 20genera Blue green algae were represented 1genera and Dinoflagellates with two genera during the sampling conducted in Neap tide in November, 2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from83-327 units/ L during high tide period and 108 -252 units/ L during low tide of Neap Tide.

For the evaluation of the Phytoplankton population in DPT OOT jetty area in Path Finder creek sampling was conducted from one sampling locations ; jetty area during high tide period and low tide of spring tide. For the evaluation of the Phytoplankton population in DPTOOT jetty area in Path Finder creek in Vadinar sampling was conducted from 2 sampling locations ; jetty area and one near SPM during high tide period and low tide of Neap tide.

The phytoplankton community of the sub surface water in the path finder creeks was represented by only Diatoms spring tide period. Diatoms were represented by 11 genera during the sampling conducted in spring tide in November, 2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area was varying from 162 units/ L during high tide period and 178 units/ L during low tide of Spring Tide. Phytoplankton of the sampling stations at sub surface layer in the SPM area was varying from 154 units/ L during high tide period and 130 units/ L during low tide of Spring Tide.

The phytoplankton community of the sub surface water in the path finder creeks was represented by Diatoms,and Dinoflagellatesduring Neap tide period.Diatoms were represented by 15 generaand dinoflagellates by two genera during the sampling conducted in Neap tide in November, 2021. Phytoplankton of the sampling stations at sub surface path finder creek nearOOT Jetty was varying from 227 units/ L during high tide period and 182 -744 units/ L during low tide of Neap Tide. Phytoplankton of the sampling stations at sub surface path finder creek near SPM area was varying from 158 units/ L during high tide period and 158 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 Kandla creek and nearby creeks sampling stations was varying from 1.595-3.091 with an average of 2.396during the sampling conducted in High tide period of spring tide. While Margalef's diversity index (Species Richness) S of phytoplankton communities in the Kandla creek region and nearby creeks was varying from2.236 -2.863 with an average of 2.554 during the consecutive low tide period.

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations in Kandla creek and nearby creeks was varying from 2.339-2.984 with an average of 2.696 during the sampling conducted in High tide period of Neaptide. While Margalef's diversity index (Species Richness) S of phytoplankton communities in the Kandla creek region and nearby creeks was varying from2.450-2.713 with an average of 2.624 during consecutive low tide.

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was 1.769 at OOT jetty area and 1.588 at SPM area during the sampling conducted in High tide period of spring tide. While Margalef's diversity index (Species Richness) S of phytoplankton communities in the path finder creeknear OOT jetty was 1.737 and 1.644 at SPM during the consecutive low tide period.

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was 2.561 at OOT jetty area and 2.370 at SPM area during the sampling conducted in High tide period of Neap tide. While Margalef's diversity index (Species Richness) S of phytoplankton communities in the path finder creek near OOT jetty was 2.114 and SPM area was 2.195 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 0.727-0.907 (H'(log10)) between selected sampling stations with an average value of 0.805 during high tide period of spring tide at Kandla creek and nearby creeks. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.787 -0.895 (H'(log10)) between selected sampling stations with an average value of 0.853 during consecutive low tide at Kandla creek and nearby creeks. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.695 -0.931 (H'(log10)) between selected sampling stations with an average value of 0.823 during high tide period of neap tide at Kandla creek and nearby creeks. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.759-0.867 (H'(log10)) between selected sampling stations with an average value of 0.810 during consecutive low tide at Kandla creek and nearby creeks.

Shannon-Wiener's Index (H) of phytoplankton communities in the stations was 0.798 atOOT jetty area and 0.7551 at SPM area during the sampling conducted in High tide period of spring tide. While Shannon-Wiener's Index (H) of phytoplankton communities in the path finder creek near OOT jetty was 0.715 and 0.771 at SPM during the consecutive low tide period.

Shannon-Wiener's Index (H) of phytoplankton communities in the stations was 0.787 at OOT jetty area and 0.7330 at SPM area during the sampling conducted in High tide period of Neap tide. While Shannon-Wiener's Index (H) of phytoplankton communities in the path finder creek near OOT jetty was 0.729 and at SPM area was 0.712 during the 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 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 0.742- 0.830 between selected sampling stations with an average of 0.788 during high tide period of spring tide. Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stationsin the Kandla Harbour region and nearby creeks, which was varying from 0.786- 0.832

between selected sampling stations with an average of 0.809during consecutive low tide .

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 0.664-0.841 with an average value of 0.774 between selected sampling stations during high tide period and varying from 0.732-0.824 with an average value of 0.771 between selected sampling stations during consecutive low tide period Low species diversity suggests a relatively few successful species in this habitat.

Simpson diversity index (1-D) of phytoplankton communities in the stations was 0.813 atOOT jetty area and 0.779 at SPM area during the sampling conducted in High tide period of spring tide at Path finder creek . While Simpson diversity index (1-D) of phytoplankton communities in the path finder creek near OOT jetty was 0.753 and 0.794 at SPM during the consecutive low tide period in the path finder creek.

Simpson diversity index (1-D) of phytoplankton communities in the stations was 0.765 at OOT jetty area and 0.737 at SPM area during the sampling conducted in High tide period of Neap tide at Path finder Creek. While Simpson diversity index (1-D) of phytoplankton communities in the path finder creek near OOT jetty was 0.738 and at SPM area was 0.708 during the consecutive low tide period.

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.

Table # 4PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA AT KANDLA CREEK AND ,NEAR BY CREEKS DURING SPRING TIDE IN NOVEMBER,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	177	17/20	85	3.091	0.9004	0.8193
	2	152	16/20	80	2.986	0.9067	0.8305
	3	192	11/20	55	1.902	0.7268	0.7421
	4	167	13/20	65	2.345	0.7525	0.7454
	5	198	14/20	70	2.458	0.7886	0.7683
	6	43	7/20	35	1.595	0.7583	0.825
LOW TIDE	1	133	15/20	75	2.863	0.8948	0.8214
	2	153	15/20	75	2.783	0.893	0.832
	3	190	14/20	70	2.478	0.8679	0.8106
	4	137	12/20	60	2.236	0.8213	0.7966
	5	220	14/20	70	2.41	0.7872	0.786

Table # 5 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA AT KANDLA CREEK AND ,NEAR BY CREEKS DURING NEAP TIDE IN NOVEMBER,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	131	15/24	62.5	2.872	0.9308	0.8406
	2	120	13/24	54.16	2.507	0.8561	0.8136
	3	213	17/24	70.83	2.984	0.8315	0.7733
	4	259	14/24	58.33	2.339	0.7394	0.7223
	5	327	17/24	70.83	2.763	0.6955	0.6641
	6	83	13/24	54.16	2.716	0.8861	0.8316
LOW TIDE	1	108	13/24	54.16	2.563	0.791	0.7606
	2	134	13/24	54.16	2.45	0.8677	0.8239
	3	177	15/24	62.5	2.705	0.7892	0.7325
	4	252	16/24	66.66	2.713	0.7591	0.7444
	5	182	15/24	62.5	2.69	0.8458	0.7939

Table # 6 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA AT KANDLA CREEK AND , NEAR BY CREEKS DURING SPRING TIDE IN NOVEMBER, 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	41-197	16/20	80
			BLUE GREEN	0-4	2/20	10
			DINOFLAGELLATES	0-3	2/20	10
			TOTAL PHYTO PLANKTON	**43-198**	**20**	-
LOW TIDE	Sub surface	5	DIATOMS	129-216	16/20	80
			BLUE GREEN	0-4	2/20	10
			DINOFLAGELLATES	0-2	2/20	10
			TOTAL PHYTO PLANKTON	**133-220**	**20**	-

Table # 7 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA AT KANDLA CREEK AND , NEAR BY CREEKS DURING NEAP TIDE IN NOVEMBER,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	81-326	21/24	87.6
			BLUE GREEN	0-2	1/24	4.16
			DINOFLAGELLATES	0-2	2/24	8.33
			TOTAL PHYTO PLANKTON	**83-327**	**24**	
LOW TIDE	Sub surface	5	DIATOMS	108-251	21/24	87.6
			BLUE GREEN	0-2	1/24	4.16
			DINOFLAGELLATES	0-1	2/24	8.33
			TOTAL PHYTO PLANKTON	**108-252**	**24**	

Table # 8 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT OOTAT PATH FINDER CREEK , VADINAR &NEAR BY SPM, DURING SPRING TIDE IN NOVEMBER, 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	jetty	162	10/11	90.90	1.769	0.7989	0.8132
	SPM	178	10/11	90.90	1.737	0.7149	0.7536
LOW TIDE	jetty	154	9/11	81.82	1.588	0.7441	0.7796
	SPM	130	9/11	81.82	1.644	0.7712	0.7937

Table # 9 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT OOTAT PATH FINDER CREEK , VADINAR & NEAR BY SPM, DURING NEAP TIDE IN NOVEMBER, 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	Jetty	227	15/17	88.24	2.581	0.7875	0.7647
	SPM	182	12/17	70.59	2.114	0.7288	0.7383
LOW TIDE	Jetty	158	13/17	76.47	2.37	0.733	0.7374
	SPM	150	12/17	70.59	2.195	0.7123	0.7087

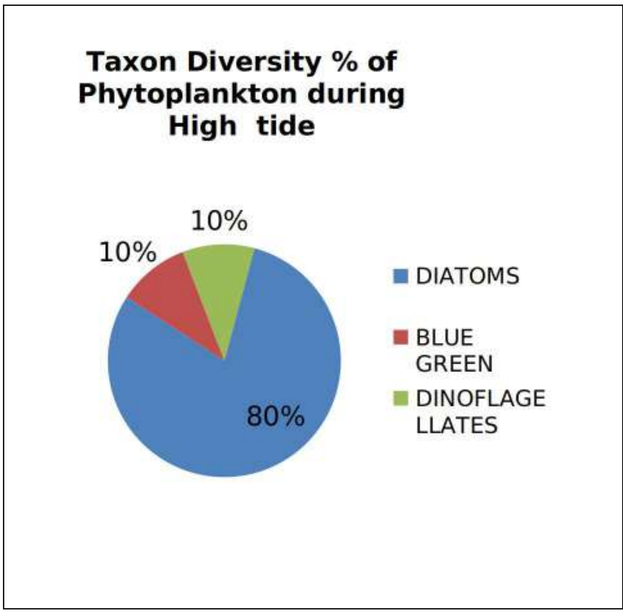
Table # 10 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT DPTOOT AT PATH FINDER CREEK , VADINAR & NEAR BY SPM, DURING SPRING TIDE IN NOVEMBER, 2021

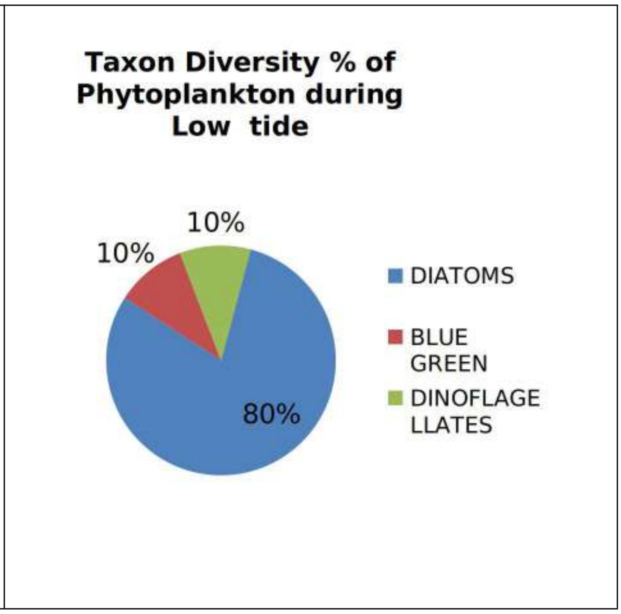
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	1	DIATOMS	162-178	11/11	100
			TOTAL PHYTO PLANKTON	162-178	**11**	
LOW TIDE	Sub surface	1	DIATOMS	130-154	11/11	100
			TOTAL PHYTO PLANKTON	130-154	**11**	

Table # 11 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT DPTOOT AT PATH FINDER CREEK , VADINAR & NEAR BY SPM, DURING NEAP TIDE IN NOVEMBER, 2021

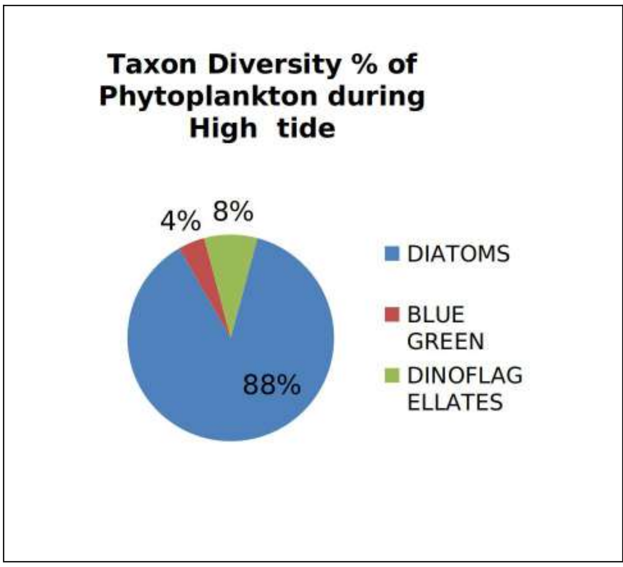
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	2	DIATOMS	182-226	15/17	88.24
			DINOFLAGELLATES	0-1	2/17	11.76
			TOTAL PHYTO PLANKTON	**182-227**	**17**	
LOW TIDE	Sub surface	2	DIATOMS	148-157	15/17	88.24
			DINOFLAGELLATES	0-1	2/17	11.76
			TOTAL PHYTO PLANKTON	148-158	**17**	

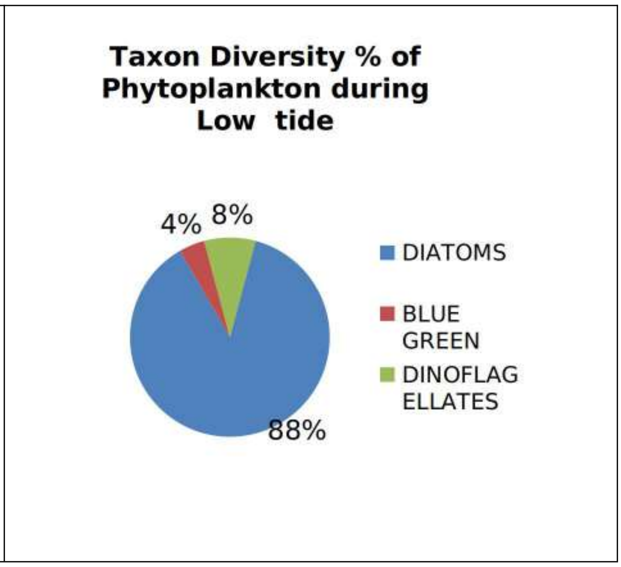
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide in Kandala creek and nearby creeks



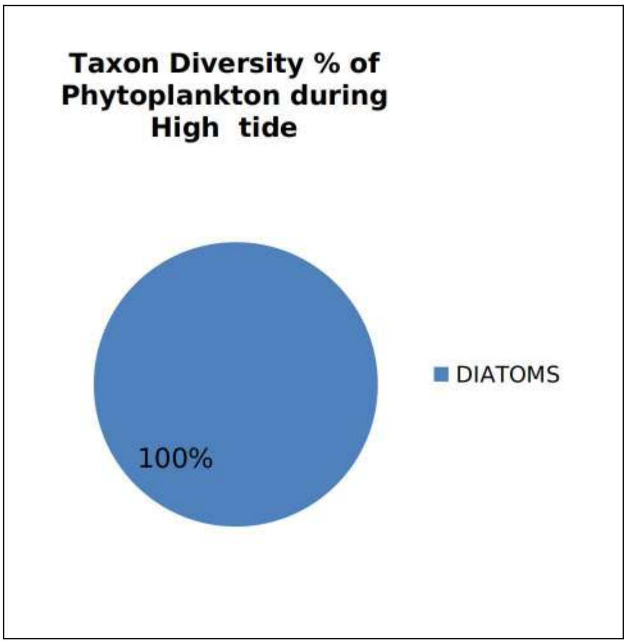


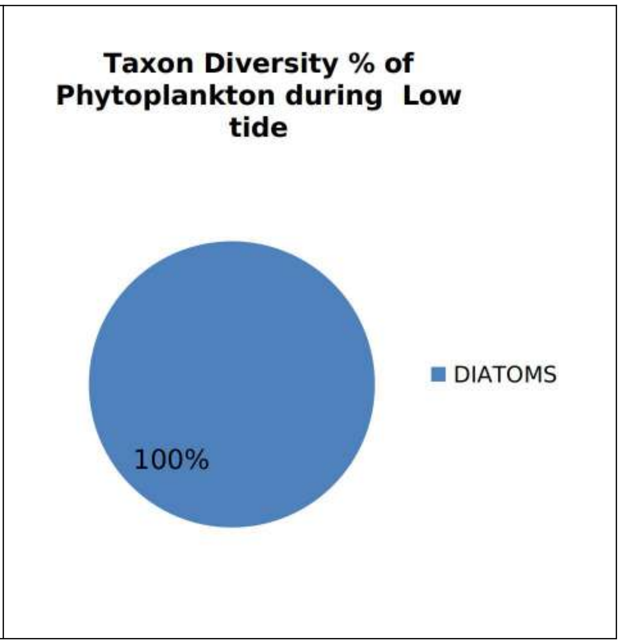
Taxon Diversity % of Phytoplankton during High tide and Low tide period during Neap tide in Kandala creek and nearby creeks



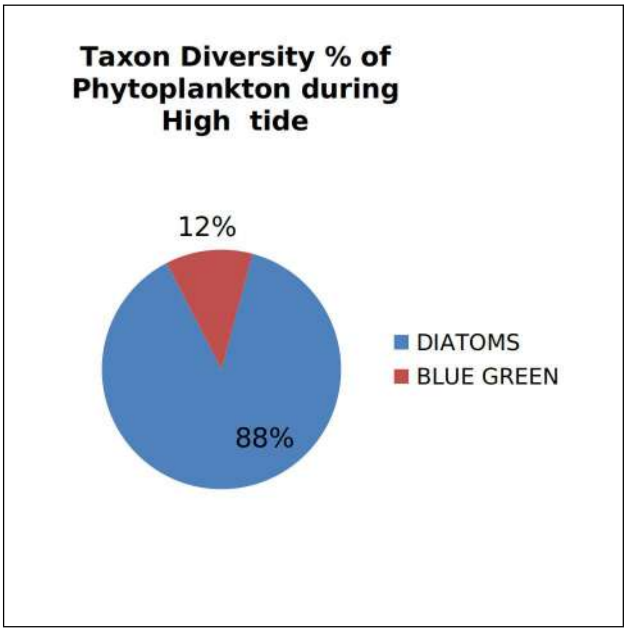


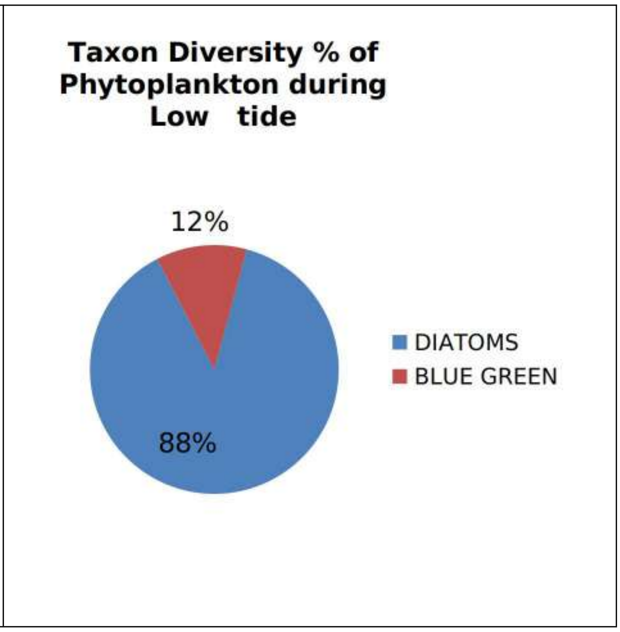
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide in Path Finder Creek, Vadinar





Taxon Diversity % of Phytoplankton during High tide and Low tide period during Neap tide in Path Finder Creek, Vadinar





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 November,2021. The Zooplankton community of the sub surface water in the harbour and nearby creeks during spring tide was represented by mainly 4 groups, and 5 larval forms; Tintinids, Copepods,Rotifers, Urochordatesand larval forms represented from the group of Crustacea, Molluscansand Polychaetes. The Zooplankton community of the sub surface water in the harbour and nearby creeks during neap tide was represented by mainly Six groups, Tintinids, Copepods, Arrow worms, Mysids, Urochordata, Ciliates and unidentified Cnidarian member and larval forms of Crustacea Molluscans and Echinodermata Larvae Polychaete Larvae..,

Zooplankton of the sampling stations at sub surface layer in the DPT harbour area and nearby creek was varying from 25-106x10^3 N/ m^3 during high tide and 58-85x10^3 N/ m^{3}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 40-143 x10^3 N/ m^3 during high tide and83-129x10^3 N/ m^{3}during low tide of Neap Tide period.

For the evaluation of the Zoo plankton population in DPT OOT jetty area in Path Finder creek and SPM in Vadinar selected 2 sampling locations (1 in jetty area and one near SPM) Duringspring tide sampling plankton sample were collected only at Jetty area during consecutive high tide period and low tide period. During Neap tide sampling Plankton samples were collected from jetty area and SPM during consecutive high tide period and low tide period.
The Zooplankton community of the sub surface water in the path finder creek creeks during spring tide was represented by mainly Titinids , Copepods and larval forms of Crusracens, Molluscs and Polychaetes .The Zooplankton community of the sub surface water in the path Finder creeks at Jetty region and SPM during neap tide was represented by mainly three groups, Tintinids, Copepods , Urochordates and , five Larval forms were represented from the major group of Crustaceans , Molluscans , and Polychaetes,.

Zooplankton of the sampling stations at sub surface layer in the DPT OOTjetty area of path finder creek was 87 x103 N/ m^3 during high tide and 117 x103 N/ m^3 during low tide of Spring Tide period. Zooplankton of the sampling stations at sub surface layer in the DPT SPM area of path finder creek was 85 x10^3 N/ m^3 during high tide and 109 x10^3 N/ m^3 during low tide of Spring Tide period. Zooplankton of the sampling stations at sub surface layer in the DPT OOT jetty area in path finder creekwas recorded 54x10^3 N/ m^{3}during high tide and 86x10^3 N/ m^3 during consecutive low tide period of Neap . Zooplankton of the sampling stations at sub surface layer in the DPT SPM area in path finder creek was recorded 72 x10^3 N/ m^3during high tide and 92 x10^3 N/ m^3 during consecutive low tide period 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 Zooplankton communities in the stations Kandla creek region and nearby creeks was varying from 1.733-2.796 with an average of 2.196 during the sampling conducted in High tide period. Margalef’s diversity index (Species Richness) S of Zooplankton communities varying from.1.871-2.217 with an average of 2.026 during the sampling conducted in low tide period during Spring tide.

Margalef’s diversity index (Species Richness) S of Zooplankton communities in the Kandla creek region and nearby creeks sampling stations was varying from2.771-3.983with an average of 3.445 during the sampling conducted in high tide and varying from2.635- 3.054 with an average of 3.049 during the sampling conducted in low tide during Neap tide period

Margalef’s diversity index (Species Richness) S of Zooplankton communities in the sampling station near jetty at Path Finder Creek, Vadinar during the sampling conducted inconsecutive High tide period and low tide of spring tide was recorded as 1.769 and 1. 588 respectively..

Margalef’s diversity index (Species Richness) S of Zooplankton communities near SPmat Path finder creek was varying from 2.256-2.572 during the sampling conducted in High tide period of Neap tide. While Margalef’s diversity index (Species Richness) S of Zooplankton communities in the two stations at Path finder creek was varying from2.020- 1.769 during the consecutive low 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 0.725-0.945 (H'(log10)) between selected sampling stations with an average value of 0.811 (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 0.703-0.884 (H'(log10)) between selected sampling stations with an average value of 0.780 (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 0.782-1.119 (H'(log10)) between selected sampling stations with an average value of 1.000 (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 0.855-1.059 (H'(log10)) between selected sampling stations with an average value of 0.950(H'(log10)) during consecutive low tide period.

Shannon-Wiener’s Index (H) of Zooplankton communities in the sampling station near jetty at Path Finder Creek, Vadinar during the sampling conducted in consecutive High tide period and low tide of spring tide was recorded as 0.799 and 0.7441 respectively.. Shannon-Wiener’s Index (H) of Zooplankton communities in the sampling station near jetty at Path Finder Creek, Vadinar during the sampling conducted in consecutive High tide period and low tide of Neap tide was recorded as 0.742 and 0.709 respectively

Shannon-Wiener’s Index (H) of Zooplankton communities in the two stations at Path finder creek was varying from 0.715-0.798 during the sampling conducted in High tide period of Spring tide. While Shannon-Wiener’s Index (H)of Zooplankton communities in the two stations at Path finder creek was varying from -0.771-0.7441during the consecutive low tide period.

Shannon-Wiener’s Index (H) of Zooplankton communities in the two stations at Path finder creek was varying from 0.743-0.849 during the sampling conducted in High tide period of Neap tide. While Shannon-Wiener’s Index (H) of Zooplankton communities in the two stations at Path finder creek was varying from -0.641 - 0.709 during the 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 0.751- 0.910between selected sampling stations with an average of 0.804 during high tide period and was varying from 0.722- 0.854 with an average value of 0.780 between selected sampling stations during low tide

Simpson diversity index (1-D) of Zooplankton communities was blow 0.9 at all sampling stationsin the Kandla Harbour region and nearby creeks except few during high tide and low tide period, which was varying from 0.766 - 0.912 between selected sampling stations with an average of 0.863 during high tide period and was varying from 0.795- 0.896with an average value of 0.843 between selected sampling stations during consecutive low tide

This low species diversity suggests a relatively few of successful species in this habitat during November, 2021 sampling.

Simpson diversity index (1-D) of Zooplankton communities in the sampling station near jetty at Path Finder Creek, Vadinar during the sampling conducted in consecutive High tide period and low tide of spring tide was recorded as 0.813and 0.779 respectively. Simpson diversity index (1-D) of Zooplankton communities in the sampling station near SPM at Path Finder Creek, Vadinar during the sampling conducted in consecutive High tide period and low tide of spring tide was recorded as 0.753 and 0.779 respectively.

Simpson diversity index (1-D) of Zooplankton communities in the sampling station near jetty at Path Finder Creek, Vadinar during the sampling conducted in consecutive High tide period and low tide of Neap tide was recorded as 0.778 - 0.729 respectively. Simpson diversity index (1-D) of Zooplankton communities in the sampling station near SPM at Path Finder Creek, Vadinar during the sampling conducted in consecutive High tide period and low tide of spring tide was recorded as 0.817 and 0.697 respectively.

Table # 12 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA AT KANDLA CREEK AND NEAR BY CREEKS DURING SPRING TIDE IN NOVEMBER,2021

Tide	Sampling Station	Abundance In $Nx10^3/m^3$	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	75	10/16	62.5	2.085	0.7569	0.751
	2	82	11/16	68.75	2.269	0.8385	0.8154
	3	66	10/16	62.5	2.148	0.8294	0.8224
	4	106	11/16	68.75	2.144	0.7752	0.7641
	5	101	9/16	56.25	1.733	0.7251	0.7651
	6	25	10/16	62.5	2.796	0.9451	0.91
LOW TIDE	1	69	9/16	56.25	1.889	0.8145	0.809
	2	58	10/16	62.5	2.217	0.8838	0.8542
	3	72	9/16	56.25	1.871	0.7031	0.7218
	4	69	10/16	62.5	2.126	0.7896	0.7899
	5	85	10/16	62.5	2.026	0.7112	0.7272

Table # 13 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREAAT KANDLA CREEK AND NEAR BY CREEKS DURING NEAP TIDE IN NOVEMBER,

Tide	Sampling Station	Abundance In No $x10^3/m^3$	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	118	20/28	71.42	3.983	1.119	0.9122
	2	102	17/28	60.71	3.459	0.9987	0.875
	3	108	19/28	67.86	3.844	1.085	0.8974
	4	143	18/28	64.29	3.425	1.118	0.9087
	5	101	16/28	57.14	3.25	0.9028	0.8212
	6	40	11/28	39.29	2.711	0.7823	0.7667
LOW TIDE	1	83	13/28	46.43	2.716	0.8552	0.7949
	2	128	18/28	64.29	3.504	1.059	0.8958
	3	129	18/28	64.29	3.498	1.055	0.8815
	4	89	14/28	50	2.896	0.8648	0.7975
	5	95	13/28	46.43	2.635	0.9189	0.8434

2021

Table # 14 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREAATKANDLA CREEK AND ,NEAR BY CREEKS DURING SPRING TIDE IN NOVEMBER,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	3-13	3/16	18.75
			Copepods	11-40	6/16	37.5
			Rotifers	0-2	1/16	6.25
			Urochordata	1-4	1/16	6.25
			Larval forms	5-52	5/16	31.25
			TOTAL ZOOPLANKTON N/ M^3	**25-106**	**16**	
LOW TIDE	Sub surface	5	Tintinids	5-9	3/16	18.75
			Copepods	20-27	6/16	37.5
			Rotifers	0	1/16	6.25
			Urochordata	0-4	1/16	6.25
			Larval forms	30-53	5/16	31.25
			TOTAL ZOOPLANKTON N/M^3	**58-85**	**16**	

Table # 15 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA IN KANDLA CREEK AND , NEAR BY CREEKS DURING NEAP TIDE IN NOVEMBER, 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	7-36	5/28	17.86
			Copepods	11-49	8/28	28.58
			Mysids	0-1	2/28	7.14
			Arrow worms	0-2	1/28	3.57
			Urochordata	0-2	1/28	3.57
			Ciliates	0-4	1/28	3.57
			Medusa	0-4	1/28	3.57
			Larval forms	20-58	7/28	25
			Foraminiferans	0-4	2/28	7.14
			TOTAL ZOOPLANKTON N/M^3	**40-143**	**28**	
LOW TIDE	Sub surface	5	Tintinids	10-32	5/28	17.86
			Copepods	17-54	8/28	28.58
			Mysids	0-2	2/28	7.14
			Arrow worms	0-1	1/28	3.57
			Urochordata	0-2	1/28	3.57
			Ciliates	0-1	1/28	3.57
			Medusa	0-1	1/28	3.57
			Larval forms	50-62	7/28	25

			Foraminiferans	**0-3**	2/28	7.14
			Total Zooplankton N/M3		**28**	

Table # 16 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT OOT AREA AT PATH FINDER CREEK AND NEAR BY SPM DURING SPRING TIDE IN NOVEMBER,2021

Tide	Sampling Station	Abundance In x10^3N / m³	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	Jetty	87	11/13	84.62	2.239	0.6821	0.6864
	SPM	85	12/13	92.31	2.476	0.7967	0.788
LOW TIDE	Jetty	117	10/13	76.92	1.89	0.7264	0.7265
	SPM	109	10/13	76.92	1.918	0.6599	0.6624

Table # 17 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT OOT AREA AT PATH FINDER CREEK AND NEAR BY SPM DURING NEAP TIDE IN NOVEMBER,2021

Tide	Sampling Station	Abundance In Nx10^3/ m³	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	Jetty	227	15/17	88.23	2.581	0.7875	0.7647
	SPM	182	12/17	70.59	2.114	0.7288	0.7383
LOW TIDE	Jetty	158	13/17	76.47	2.37	0.733	0.7374
	SPM	150	12/17	70.59	2.195	0.7123	0.7087

Table # 18 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT OOT AREAAT PATH FINDER CREEK AND NEAR BY SPM DURING SPRING TIDE IN NOVEMBER,2021

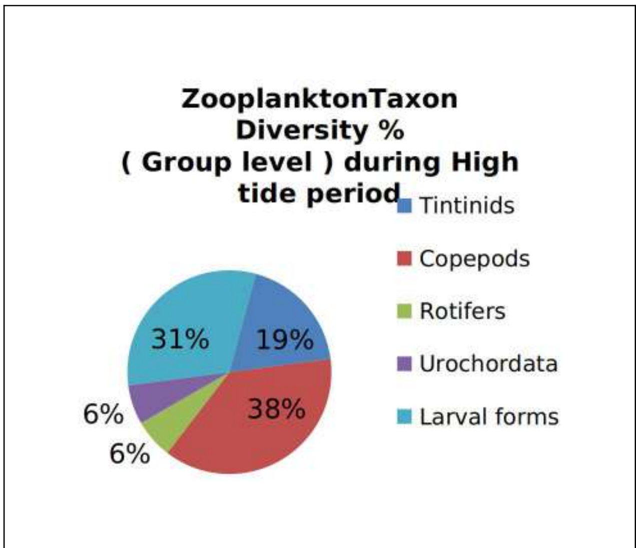
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	2	Tintinids	6-7	3/13	23.08
			Copepods	30-39	6/13	46.15
			Larval forms	39-51	4/13	30.77
			TOTAL ZOOPLANKTON NO/L	**85-87**	**13**	
LOW TIDE	Sub surface	2	Tintinids	15-16	3/13	23.08
			Copepods	30-35	6/13	46.15
			Larval forms	67-73	4/13	30.77

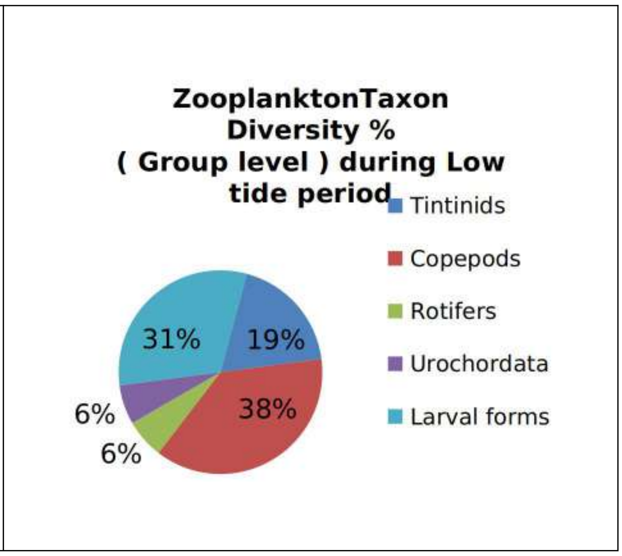
			TOTAL ZOOPLANKTON NO/M3	**109-117**	**13**	

Table # 19 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT OOT AREA AT PATH FINDER CREEK AND NEAR BY SPM DURING NEAP TIDE IN NOVEMBER, 2021

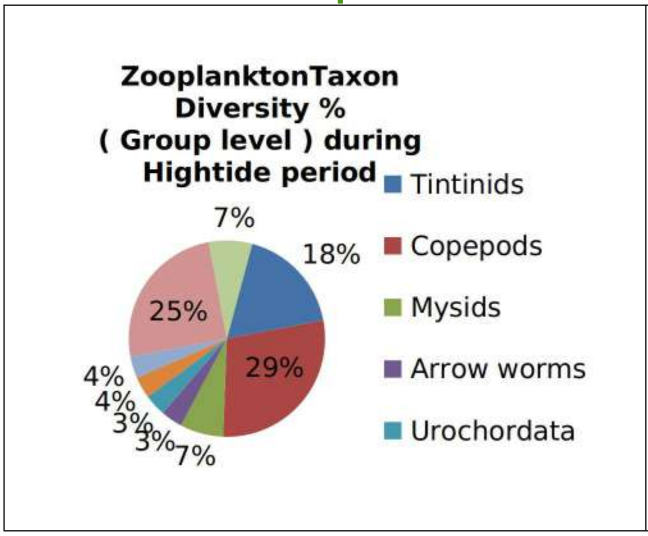
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton on x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	2	Tintinids	6-9	4/17	23.53
			Copepods	25-31	7/17	41.18
			Urochordata	0-1	1/17	5.88
			Larval forms	23-41	5/17	29.41
			TOTAL ZOOPLANKTON	**48-63**	**17**	
LOW TIDE	Sub surface	2	Tintinids	9-10	4/16	25
			Copepods	43-47	7/16	43.75
			Urochordata	0	0	0
			Larval forms	43-47	5/16	31.25
			TOTAL ZOOPLANKTON NO/M3	**77-83**	**16**	

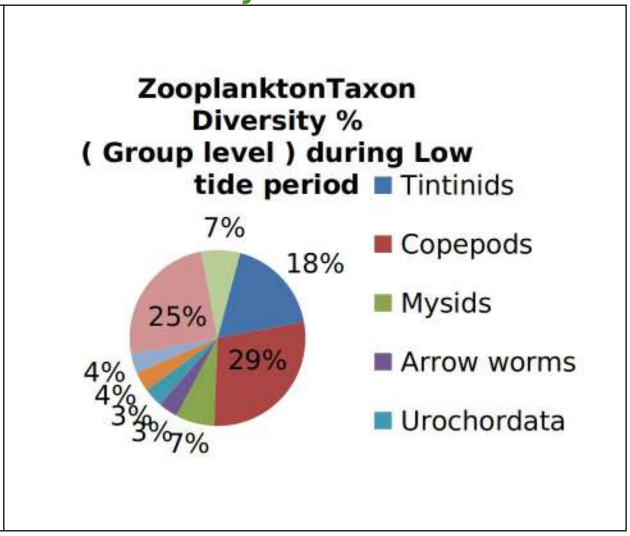
Taxon Diversity % of Zooplankton during High tide and Low tide period of Spring tide In Kandla Creek and near by Creeks



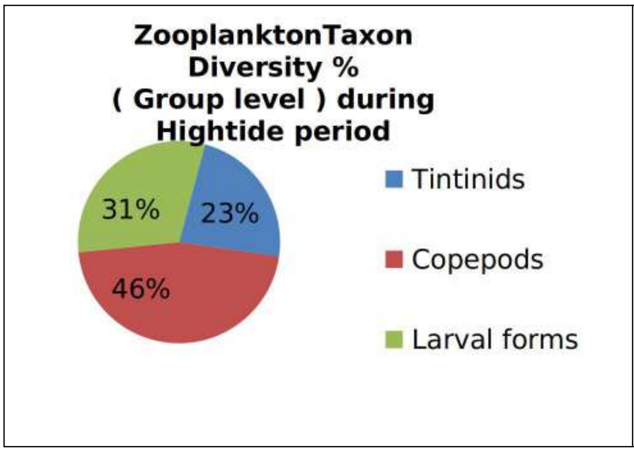


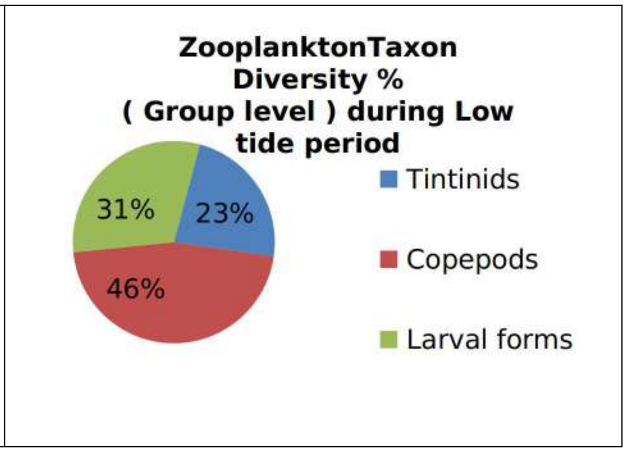
Taxon Diversity % of Zooplankton during High tide and Low tide period of Neap tide In Kandla Creek and nearby Creeks



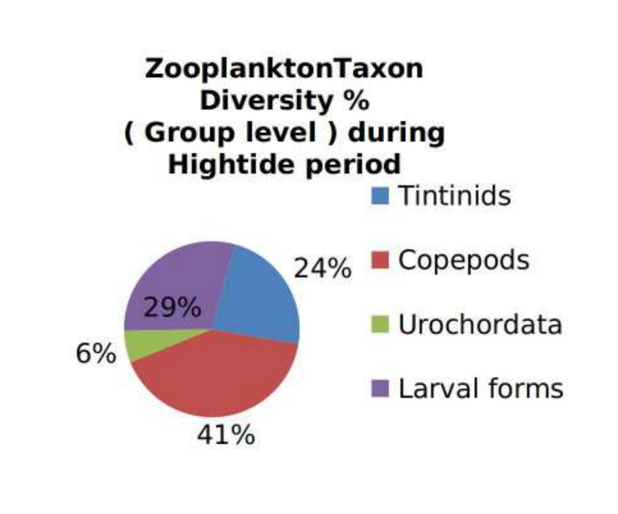


Taxon Diversity % of Zooplankton during High tide and Low tide period of Spring tide In Path Finder Creek and near Jetty





Taxon Diversity % of Zooplankton during High tide and Low tide period of Neap tide In Path Finder Creek near jetty and nearby SPM



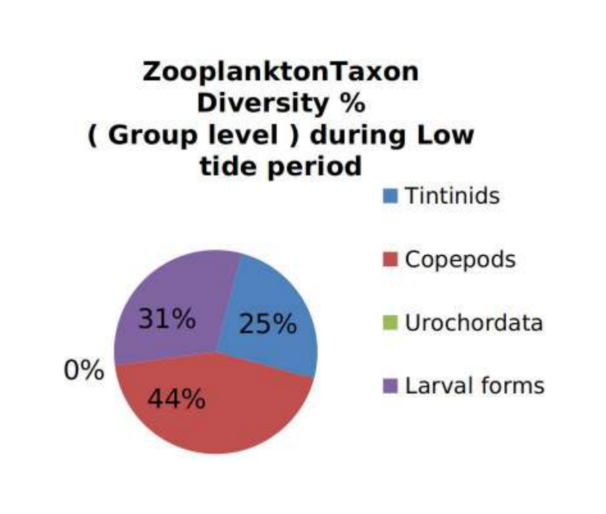


TABLE # 20SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS OF DPT HARBOUR AREA AT KANDLA CREEK AND NEARBY CREEKS DURINGSPRING TIDE OF NOVEMBER 2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALGAE	Cyanophyta	Cyanophyceae	Nostocales	Oscillatoriaceae	*Oscillatoria* sp.	B1	Rare
					Arthrospira sp.	B2	Rare
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Rare
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D2	Abundant
			Triceratiales	Triceratiaceae	*Odontella*sp	D3	Occasional
					*Triceratium*sp.	D4	Occasional
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D5	Dominant
			Hemiaulales	Bellerocheaceae	*Bellerochea*sp	D6	Rare
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D7	Occasional
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros*sp	D8	Occasional
			Leptocylindrales	Leptocylindraceae	*Leptocylindrussp*	D9	Occasional
			Lithodesmiales	Lithodesmiaceae	*Ditylumsp*	D10	Frequent
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*sp	D11	Occasional
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D12	Frequent
					Thalassionema sp.	D13	Rare
			Fragilariales	Fragilariaceae	*Fragilaria*sp	D14	Frequent
					*Synedra*sp	D15	Rare
			Tabellariales	Tabellariaceae	*Tabellaria*sp	D16	Rare
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium sp.*	DF1	Rare
			Gonyaulacales	Ceratiaceae	*Ceratiumfurca*	DF2	Rare

TABLE # 21 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AT KANDLA CREEK AND NEARBY CREEKS DURING AND NEAP TIDE OF NOVEMBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALGAE	Cyanophyta	Cyanophyceae	Nostocales	Oscillatoriaceae	*Oscillatoria* sp.	B1	Rare
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Occasional
					Thalassiosirasp	D2	Occasional
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D3	Frequent
			Triceratiales	Triceratiaceae	*Odontellasp*	D4	Rare
					*Triceratium*sp.	D5	Occasional
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D6	Dominant
			Hemiaulales	Bellerocheaceae	*Bellerochea*sp	D7	Rare
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D8	Occasional
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros*sp	D9	Rare
			Leptocylindrales	Leptocylindraceae	*Leptocylindrussp*	D10	Rare
			Lithodesmiales	Lithodesmiaceae	*Ditylumsp*	D11	Frequent
		Bacillariophyceae	Bacillariales	Bacillariaceae	*Bacillaria*sp.	D12	Occasional
					*Nitzschia*sp	D13	Rare
			Naviculales	Naviculaceae	*Naviculasp*	D14	Rare
				Pleurosigmataceae	*Pleurosigma*sp	D15	Rare
			Surirellales	Entomoneidaceae	*Entomoneissp*	D16	Rare
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D17	Abundant
					Thalassionema sp.	D18	Occasional
			Fragilariales	Fragilariaceae	*Fragilaria*sp	D19	Frequent
					*Synedra*sp	D20	Rare
			Tabellariales	Tabellariaceae	*Tabellaria*sp	D21	Rare
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Gonyaulacales	Ceratiaceae	*Ceratiumfurca*	DF1	Rare
					Ceratiumtripos	DF2	Rare

TABLE # 22 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT OOT AREA AT PATH FINDER CREEK AND NEARBY SPM AT VADINAR DURING SPRING TIDE OF NOVEMBER 2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D1	Dominant
			Triceratiales	Triceratiaceae	*Triceratium*sp.	D2	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D3	Abundant
			Hemiaulales	Bellerocheaceae	*Bellerochea*sp	D4	Rare
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D5	Occasional
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros*sp	D6	Frequent
			Lithodesmiales	Lithodesmiaceae	*Ditylum*sp	D7	Occasional
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*sp	D8	Rare
			Bacillariales	Bacillariaceae	*Bacillaria*sp.	D9	Rare
					*Pseudo-Nitzschia*sp	D10	Occasional
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D11	Frequent

TABLE # 23 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT OOT AREA AT PATH FINDER CREEK AND NEARBY SPM AT VADINAR DURING AND NEAP TIDE OF NOVEMBER, 2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Occasional
					Thalassiosirasp	D2	Rare
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D3	Dominant
			Triceratiales	Triceratiaceae	*Triceratium*sp	D4	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D5	Abundant
			Hemiaulales	Bellerocheaceae	*Bellerochea*sp	D6	Occasional
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D7	Occasional
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros*sp	D8	Rare
			Lithodesmiales	Lithodesmiaceae	*Ditylumsp*	D9	Frequent
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*sp	D10	Rare
			Bacillariales	Bacillariaceae	*Bacillaria*sp.	D11	Occasional
					*Nitzschia*sp	D12	Rare
					*Pseudo-Nitzschia*sp	D13	Frequent
		Fragilariophyceae	Fragilariales	Fragilariaceae	*Synedra sp.*	D14	Rare
			Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D15	Occasional
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Gonyaulacales	Ceratiaceae	*Ceratiumfusus*	DF1	Rare
					Ceratiumfurca	DF2	Rare

TABLE #24 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS OF DPT HARBOUR AREA AT KANDLA CREEK AND NEARBY CREEKSDURING SPRING TIDE OF NOVEMBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Rare
				Codonellidae	*Tintinnopsis radix*	T2	Rare
					Tintinnopsisfailakkaensis	T3	Occasional
COPEPODS	ATHROPODA	Crustacea Subclass: Copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Frequent
				Clausocalanidae	*Clausocalanus sp.*	C2	Rare
			Cyclopoida	Oithonidae	*Oithona sp.*	C3	Abundant
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C4	Rare
				Euterpinidae	*Euterpina sp.*	C5	Occasional
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C6	Rare
ROTIFERS	ROTIFERA	Rotifera Subclass: Eurotatoria	Superorder: Monogononta Order:Ploimida	Brachionidae	*Brachionusplicatilis*	R1	Rare
UROCHORDATA	CHORDATA SUB PHYLUM UROCHORDATA	Appendicularia		Oikopleuridae	*Oikopleura sp.*	U1	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BRACHYURA LARVAE	ARTHROPODA (CRUSTACEA)	Malacostraca Decapoda			Brachyuran Zoea larvae	L2	Occasional

MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L3	Rare
POLYCHAETE LARVAE	ANNELIDA	Polychaeta			Trochophore larvae	L4	Occasional
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L5	Rare

TABLE # 25 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING OF DPT HARBOUR AREA AT KANDLA CREEK AND NEARBY CREEKSDURING NEAP TIDE OF NOVEMBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Frequent
				Codonellidae	*Tintinnopsisgracilis*	T2	Occasional
					Tintinnopsis radix	T3	Frequent
					Tintinnopsisfailakkaensis	T4	Occasional
				Tintinnidae	*Amphorides sp.*	T5	Rare
COPEPODS	ATHROPODA	Crustacea Subclass: Copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Occasional
				Eucalanidae	*Pareucalanus sp.*	C2	Rare
				Clausocalanidae	*Clausocalanus sp.*	C3	Rare
				Centropagidae	*Centropages sp.*	C4	Rare
			Cyclopoida	Oithonidae	*Oithona sp.*	C5	Abundant
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C6	Frequent
				Euterpinidae	*Euterpina sp.*	C7	Occasional
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C8	Rare
ARROW WORMS	CHAETOGNATHA	Sagittoidea	Aphragmophora	Sagittidae	*Sagitta sp.*	A1	Rare

MYSIDS	ATHROPODA CRUSTACEA	Malacostraca	Mysida, Decapoda	Solenoceridae	*Solenocerasp.*	M1	Rare
				Luciferidae	*Lucifer sp.*	M2	Rare
UROCHORDATA	CHORDATA SUB PHYLUM UROCHORDATA	Appendicularia		Oikopleuridae	*Oikopleura sp.*	U1	Rare
CILIATES	CILIOPHORA	Oligohymenophorea	Sessilida	Zoothamniidae	*Zoothamniumsp.*	CI1	Rare
MEDUSA	PHYLUM CNIDARIA	Hydrozoa			Unidentified medusa	ME 1	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BRACHYURA LARVAE	ARTHROPODA (CRUSTACEA)	Malacostraca Decapoda			Brachyuran Zoea larvae	L2	Frequent
GROUP	**PHYLUM**	**CLASS**	**ORDER**	**FAMILY**	**GENUS/SPECIES**	**#**	**RELATIVE ABUNDANCE**
BARNACLE LARVAE	ATHROPODA CRUSTACEA	Maxillopoda Thecostraca			Cirripede larvae	L3	Occasional
CYPHONAUTES LARVAE	BRYOZOA				Cyphonautes larvae	L4	Occasional
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L5	Rare
ECHINODERMATA LARVAE	ECHINODERMATA				Ophipluutes larvae/ Echinoplutes larvae	L6	Rare
POLYCHAETE LARVAE	ANNELIDA	Polychaeta			Trochophore larvae	L7	Occasional
FORAMINIFERA	FORAMINIFERA	Globothalamea	Rotaliida	Globigerinidae	*Globigerina* sp.	F1	Rare
				Rotalliidae	*Rotalia* sp.	F2	Rare

TABLE # 26 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS OF DPT OOT AREA AT PATH FINDER CREEK AND NEARBY SPM AT VADINAR DURING SPRING TIDE OF NOVEMBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Occasional
				Codonellidae	*Tintinnopsisgracilis*	T2	Rare
					Tintinnopsis radix	T3	Occasional
COPEPODS	ATHROPODA	Crustacea Subclass: Copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Frequent
				Clausocalanidae	*Clausocalanus sp.*	C2	Rare
			Cyclopoida	Oithonidae	*Oithona sp.*	C3	Abundant
			Harpacticoida	Euterpinidae	*Euterpina sp.*	C4	Rare
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C5	Rare
				Corycaeidae	*Corycaeus sp.*	C6	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L2	Occasional
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L3	Occasional
POLYCHAETE LARVAE	ANNELIDA	Polychaeta			Trochophore larvae	L4	Occasional

TABLE # 27 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS OF DPT OOT AREA AT PATH FINDER CREEK AND NEARBY SPM AT VADINAR DURING NEAP TIDE OF NOVEMBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Occasional
				Codonellidae	*Tintinnopsisgracilis*	T2	Rare
					Tintinnopsis radix	T3	Occasional
				Codonellopsidae	*Codonellopsis* sp.	T4	Rare
COPEPODS	ATHROPODA	Crustacea Subclass: Copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Abundant
				Eucalanidae	*Subeucalanus sp.*	C2	Rare
				Clausocalanidae	*Clausocalanus sp.*	C3	Occasional
			Cyclopoida	Oithonidae	*Oithona sp.*	C4	Frequent
			Harpacticoida	Euterpinidae	*Euterpina sp.*	C5	Rare
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C6	Rare
				Corycaeidae	*Corycaeus sp.*	C7	Rare
UROCHORDATA	CHORDATA SUB PHYLUM UROCHORDATA	Appendicularia		Oikopleuridae	*Oikopleura sp.*	U1	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BRACHYURA LARVAE	ARTHROPODA (CRUSTACEA)	Malacostraca Decapoda			Brachyuran Zoea larvae	L2	Rare
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L3	Rare
POLYCHAETE LARVAE	ANNELIDA	Polychaeta			Trochophore larvae	L4	Occasional
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L5	Rare

BENTHIC ORGANISMS:

Few Benthic organismswere observed in the collected sediments by using the Van-veen grabs during the sampling conducted during spring tide period andNeap tide period from DPT harbour region and nearby creek.The meiobenthic organisms during spring tide were represented by Polychaetes,and Nematodes. The polychaetes were representedby *Scyphoproctus sp*. *Notomastus*sp,*Dasybranchus.* The meiobenthic organisms in the collected samples were varying from 50-180N/M ^{2}during spring tide and 60-130 N/M

Table # 28BENTHIC FAUNA IN THE SAMPLING LOCATIONS IN DPT HARBOUR AREA CREEKS DURING SPRING TIDE IN NOVEMBER ,2021

Benthic fauna	ABUNDANCE IN NO/M ^{2} DIFFERENT SAMPLING STATIONS REPRESENTATION BY GROUP						
	DPT HARBOUR			CREEKS			
POLYCHAETES	KPT-1	KPT-2	KPT-3	KPT-4	KPT-5	KPT-6	
Family : Capitellidae *c*	0	40	0	20	20	NS	
Family : Capitellidae *Notomastus* sp.	40	60	40	80	30	NS	
Total Polychates N/M²	40	100	40	120	50		
Un identified Nematode worms	10	20	40	60	20	NS	
TOTAL Benthic Fauna NUMBER/ M²	50	120	80	180	70	-	

NS : No sample

Table # 29 BENTHIC FAUNA IN THE SAMPLING LOCATIONS IN DPT HARBOUR AREA CREEKS DURING NEAP TIDE IN NOVEMBER ,2021

Benthic fauna	ABUNDANCE IN NO/M ^{2} DIFFERENT SAMPLING STATIONS REPRESENTATION BY GROUP						
	DPT HARBOUR			CREEKS			
POLYCHAETES	KPT-1	KPT-2	KPT-3	KPT-4	KPT-5	KPT-6	
Family : Capitellidae *Dasybranchus sp.*	10	20	10	10	20	NS	
Family : Capitellidae *Notomastus* sp.	50	60	20	40	20	NS	
Family : Glyceridae Glycera	10	20	10	0	0	NS	

Total Polychates N/M^2	70	100	40	50	40		
Un identified Nematode worms	20	30	30	30	20	NS	
TOTAL Benthic Fauna NUMBER/ M^2	90	130	70	80	60	-	

NS : No sample

Meteorological Data

Automatic Weather station have been installed in Seva Sadan -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 30.3 °C. The day-time maximum temperature was 38.6 °C. The mean night time temperature was 26.5 °C. The minimum mean night time temperature recorded was 30.6 °C.

Air Pressure

The mean absolute air pressure for the month of November was 1009.9 hpa, whereas the mean relative pressure was 1009.3 hpa. The maximum absolute air pressure recorded for the month of November was 1016.5 hpa.

Heat Index

The mean day-time heat index for the month of November was 33.8 ^{o}C. The maximum heat index recorded was 55^{o}C.

Solar Radiation

The mean Solar Radiation in November was 252.2 w/m^2. The maximum solar radiation recorded in the month of November was 746.6 w/m^2.

Humidity

The mean day-time humidity was 60.0 % for the month of November and mean night time humidity was 72.4%. Maximum humidity recorded during day-time was 94.0 % and maximum humidity recorded during night-time was 93.0%.

Wind Velocity and Wind Direction

The mean wind velocity for the entire month of November was 4.6 km/hour. Maximum wind velocity recorded was 29.2 Km/hr . The wind direction was mostly S to N.

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.

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 November, 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.

SOURCE OF LITERATURE AND ADDITIONAL REFERENCE FOR ECOLOGICAL STUDY

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ANNEXURE C

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 D

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 (EC & CRZ- 1) 84

Dated : 18 /09/2021

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: Development of 7 Integrated Facilities (Stage I) within the existing Kandla Port Trust limit at District Kutch (Gujarat) by M/s Deendayal Port Trust (Erstwhile: Kandla Port Trust) – Environmental & CRZ Clearance - **Studies on Dredged Material for presence of contaminants (EC & CRZ Clearance accorded by the MoEF&CC,GoI dated 19/12/2016- specific condition no. vii) for three years (2021- 2024) reg.**

Ref.: 1) DPT request letter dated 16/8/2021 to M/s GUIDE, Bhuj .

2) M/s GUIDE, Bhuj letter no. GUIDE/DPT/Offer/Dredging/236/2021-22 dated 25/8/2021 - Offer for Studies on Dredged Material for presence of contaminants.

Sir,

Your offer for the subject work submitted vide above referred letter dated 25/8/2021 amounting to Rs. 1,33,74,000.00 + applicable GST (for three years i.e. 2021- 2024 X per year cost Rs. 44,58,000 + GST) (Rupees One Crore Thirty Three lakhs seventy four thousand plus applicable GST) including all terms & conditions mentioned in the offer letter, has been accepted.

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

2. The terms of payment :

For the period (2021-22) :

1) 20% of the project cost (Rs. 44,58,000 /year) should be paid within 15 days from the date of submission of inception report by M/s GUIDE.
2) 20% of the project cost (Rs. 44,58,000/year) should be paid within 15 days from the date of submission of first season data by M/s GUIDE.
3) 20% of the project cost (Rs. 44,58,000 /year) should be paid within 15 days from the date of submission of second season data by M/s GUIDE.
4) 20% of the project cost (Rs. 44,58,000 /year) should be paid within 15 days from the date of submission of third season data by M/s GUIDE.
5) 20% of the project cost (Rs. 44,58,000 /year) should be paid within 15 days from the date of submission of Final report by M/s GUIDE.

For the period (2022-23) :

1) 20% of the project cost (Rs. 44,58,000 /year) should be paid within 15 days from the date of submission of inception report by M/s GUIDE.
2) 20% of the project cost (Rs. 44,58,000 /year) should be paid within 15 days from the date of submission of first season data by M/s GUIDE.
3) 20% of the project cost (Rs. 44,58,000 /year) should be paid within 15 days from the date of submission of second season data by M/s GUIDE.
4) 20% of the project cost (Rs. 44,58,000 /year) should be paid within 15 days from the date of submission of third season data by M/s GUIDE.
5) 20% of the project cost (Rs. 44,58,000 /year) should be paid within 15 days from the date of submission of Final report by M/s GUIDE.

For the period (2023-24) :

1) 20% of the project cost (Rs. 44,58,000 /year) should be paid within 15 days from the date of submission of inception report by M/s GUIDE.
2) 20% of the project cost (Rs. 44,58,000 /year) should be paid within 15 days from the date of submission of first season data by M/s GUIDE.
3) 20% of the project cost (Rs. 44,58,000 /year) should be paid within 15 days from the date of submission of second season data by M/s GUIDE.
4) 20% of the project cost (Rs. 44,58,000 /year) should be paid within 15 days from the date of submission of third season data by M/s GUIDE.
5) 20% of the project cost (Rs. 44,58,000 /year) should be paid within 15 days from the date of submission of Final report by M/s GUIDE.

3. Scope of work :

Dredged Material 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. The study will cover detailed studies on Physical, Chemical and Biological Characteristics of Dredged material in three different locations (three dumping locations per season for three seasons in a year).

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

4. Obligation of KPT :

- Assistance regarding the statutory clearance from authorities concerned to be rendered by DPT for field visits.
- Maps of sampling locations for the dumping sites have to be provided by DPT.

5. Time Period: Three years i.e. 2021-24 (three dumping locations per season for three seasons in a year).

6. Kindly send the acknowledgement of this work order & start the work w.e.f. 1/11/2021.

Thanking you.

Yours faithfully,

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

ANNEXURE E

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					
				64 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**

List of CSR applications received from various NGOs , Organizations , Village Sharpanchs etc for the FY 2021-22 .

Sr.No	Name of Scheme	Proposal Received from / Name of Organization / N.G.O	Brief Details
1	CSR activities for the development of gardening at Sector -5 , Gim	Shri Sarvodaya Co-Operative Housing Society Ltd	**Appx Cost – Rs 25.00 Lakhs** **Cost for –** Comp wall, Benches, Plantation, walkway, other facilities (Land is reserved for Garden development only since from 50 years)
2	CSR activities for providing various facilities in SHRI GANESHNAGAR GOVT HIGHSCHOOL, GANDHIDHAM	Principal of School	**Appx cost –Rs 20.00 Lakhs** (Two times CSR works carried out at school by DPT)
3	CSR activities for the VadhiyarVankarSamajvaadi, NaviSunderpuriGim	SmtMaltiben K Maheswari, MLA	**Appx Cost Rs 6.00 Lakhs** Cost for Const. of Comp Wall
4	CSR activities for Construction work of Cabin at Oslo Area- Gim	SmtMaltiben& Shri VinadChavda	Cost not mentioned.
5	CSR activities & Land requirement forAkhil Kutch SamastaMeghvanshiGurjarmeghwal Charitable Trust ,Gim.	Shri Akhil Kutch SamastaMeghvanshiGurjarmeghwal Charitable Trust. Shri Dharmendra R Gohil	Cost Not mentioned. (demand of Land for development of SAMAJ VADI in Gandhidham)
6	CSR Activities for providing Water supply pipe line, Play ground and sports equipment, electric facilities, drinking water facilities for poor people & Fishermen at VANDI Village.	Shri R RKhambhra, PRO , Collector Office, Bhuj.	**Appx Cost Rs 51.00 Lakhs** (Last year also applied by village Sarpanch) & Recommended by Shri VASANBHAI AHIR, MLA, Shri V L Chavda, MP)
7	CSR activities for the Tuna village,	Sarpanch, Tuna village	**Appx Cost Rs. 25 Lakhs** **Cost for :-**

List of CSR applications received from various NGOs , Organizations , Village Sharpanchs etc for the FY 2021-22 .

Sr.No	Name of Scheme	Proposal Received from / Name of Organization / N.G.O	Brief Details
	Ta -Gim		2 No Fab shed 20’x20’x1250= 10 Lakh 2 Nos of Agnawadi =10 Lakh Fab shed for school=5 Lakh
8	CSR activities for the Global Vision India Foundation, Gim	Global vision India Foundation, G’dham	Requirement of Land –OR- Old building at Gandhidham for foundation of welfare activities.
9	CSR activities for the UNITED ORPHANAGE FOR THE DISABLED, TAMIL NADU	UNITED ORPHANAGE FOR THE DISABLED, TAMIL NADU	**Cost Rs 25,000.00** (Winter sweaters for children)
10	CSR activities for the Garden Development on already bounded area with Compound wall near Plot no 448 Sector-1/A, Gandhidham.	Residents, near Plot no 448, Sector-1/A, Gim.	**AppxCost Rs 20.00 Lakhs** (Requirement to provide benches, drinking water facility, plantation, lightings & walkways in side bounded area)
11	CSR activities for donation of Land for the Shri SUNDARPUI Govt Primary School, Gim	SmtMalti ben Maheshwari, MLA	(request for Land Requirement)
12	CSR activities for Extension of Adarsh Primary School building, Adipur	GandhidhamMatri Mandal, English Medium School, Adipur	**Appx Cost Rs. 40.00 Lakhs** (Construction for 4 Rooms extension) (Trust registered under Societies Registration Act XXI -1860, Reg No F-42 dtd 23.9.1965. Land belong to Trust)
13	CSR Activities for providing HD projector for KANYA MAHA VIDYALAYA, Adipur	Principal, KANYA MAHA VIDYALAYA, Adipur	**Cost Rs 1.50 Lakhs** (School Managed by G’dhamMaitry Mandal, Adipur)

List of CSR applications received from various NGOs , Organizations , Village Sharpanchs etc for the FY 2021-22 .

Sr.No	Name of Scheme	Proposal Received from / Name of Organization / N.G.O	Brief Details
14	CSR activities for DONATION various Medical Equipment for the Hospital of Gandhidham Jain SevaSamiti, Adipur	Gandhidham Jain SevaSamiti, Adipur	**Cost for** :- 1) Fresenius Haemodialysis Machine Rs 38.00 Lakh 2) Maltislice Helical CT Scanner- Rs 52.00 Lakhs 3) Others Rs 54.00 Lakhs (**Total Appx Cost Rs 144 Lakhs**)
15	CSR activities for SHRI VIDI JUTH GRAM PANCHAYAT, Vidi, Anjar	Sarpanch, Vidi Gram	**Appx Cost Rs 30.00 Lakhs** Cost for- Drainage , Garbage vehicle, and Cattle shed (Already applied earlier at Sr-5/12)
16	CSR activities for SOS CHILDRESN'S VILLAGES INDIA, Madhapar, Bhuj	Director, SOS Children's Village of India-Bhuj	**Appx Cost Rs 31.00 Lakhs** (request for Financial support towards parentless and abandoned Children Education support located at Bhuj) & support to women working in SOS.
17	Gujarat Biodiversity Board, Gandhinagar invites to involved National & Global endeavour of conservation of biodiversity by creating financial partnership with GBB under CSR programme of expenditure to be incurred 187 Lakh.	GUJARAT BIODIVERSITY BOAD, GANDHINAGAR	**Requirement-** Financial Support from DPT for **AppxRs 1.88 Cr.** (Cost for various meetings, collection of primary data from villagers , processing of documentation, printing , TA DA of Technical support &Miscexp for 150 Peoples Biodiversity Register (PBR).

List of CSR applications received from various NGOs , Organizations , Village Sharpanchs etc for the FY 2021-22 .

Sr.No	Name of Scheme	Proposal Received from / Name of Organization / N.G.O	Brief Details
18	CSR activities for providing furniture & Home appliances for ROJAVANAM TRUST at Madurai.	Shri Arul Kannan, Director	**Appx Cost Rs 30 Lakhs** (seeking help to provide facilities to Aged & Homeless people living in Trust and Purchasing of New Ambulance)
19	CSR activities for providing Dialysis Machine for treatment of Kidney patients at “ST JOSEPH’S HOSPITAL TRUST” at Gandhidham.	Sr. Franciline, Administrator of Hospital.	**Appx Cost Rs 31.36 Lakhs** (Cost of 5 Nos of Dialysis Machines for treatment of kidney patients)
20	CSR activities for providing facilities in Girls Hostel of Gasturba Gandhi BalikaVidhyalay, Gandhidham.	Shri Vinod L Chavda, MP	**Appx cost Rs 30 Lakhs.** (Cost of Comp Wall, Entrance gate, Girls toilets etc)
21	CSR works for providing Oxygen Generator Plant and 45 KV Silent Generator for COVID HOSPITAL at Swami LilashahKutia, Adipur.	Secretary, BHARAT VIKAS PARISHAD, Gandhidham	**Appx Cost Rs 80.00 Lakhs** (Facilities for 100 Beds of COVID patient which it to be extend upto 240 Beds)
22	CSR works for providing Two Numbers of Oxygen Concentrator and others medical equipment for the Trust ,Antarjal, Gim.	President SHRI SARV JEEV KALYAN TRUST, ANTARJAL, Gandhidham	**Appx Cost Rs21.50 Lakhs** (Facilities to be provided for the treatment of CORONA PATIENTS at their trust.)
23	CSR works for providing Fabricated Shed , Construction of Compound Wall and Land levelling for the Cattle of **GauSevaSamiti-Tappar** at Gram-Tappar, Ta Anjar.	Shri Vinod Chavda, MP &Presedent , GauSevaSamiti, village Tappar, Ta-Anjar	**Appx Cost Rs84 Lakhs** (Facilities to be provided for Cattle shelters at Village.) (Land belongs to Gram-panchayat)
24	CSR works for Construction of Auditorium Hall at RSETI (Rural Self Employment Training Institute) at	Shri Vinod Chavda, MP & Director of RSETI, Bhuj	**Cost not mentioned.** (Facilities to be provided

List of CSR applications received from various NGOs , Organizations , Village Sharpanchs etc for the FY 2021-22 .

Sr.No	Name of Scheme	Proposal Received from / Name of Organization / N.G.O	Brief Details
	Bhujodi-Bhuj.		for the people needs Self-employment activities.)
25	CSR works for Providing of Furniture for the School "SHRI GALPADAR PANCHAYAT PRATHMIC KUMAR GROUP SALA " atGalpadar Village Ta Gim.	Principal, SHRI GALPADAR PANCHAYAT PRATHMIC KUMAR GROUP SALA " atGalpadar Village Ta Gim.	**Cost not mentioned.** (Facilities to be provided for the Students of Workers & poor village people who study in the school.)
26	Construction of Shed, hall and Gate for the DADA Bhagwandas Charitable Trust, Adipur. (Sr no -4)	Shri Vinod Chavda, MP & DADA BHAGWANDAS CharitableTrust, Gandhidham	As per CSR Guideline- ➢ Promoting gender equality and empowering women ➢ Eradicating extreme hunger and poverty (Considered shed and hall) Fab Shelter Shed - 30'x100' x 1250=37.00 Lakh & RCC Hall – 20'x100'x1500=30.00 Lakh (**Appx Cost Rs67.00 Lakhs**) Land authority belongs to Trust given by GDA and NOC given by SRC.Doc submitted.
27	CSR work for reconstruction of the Internal Roads of the Sector-9B-C and Sector-10 area in Gandhidham.	President, Shri TejaKangad, The Gandhidham Chamber of Commerce and Industry, Gandhidham.	Cost not mentioned.

List of CSR applications received from various NGOs , Organizations , Village Sharpanchsetc for the FY 2021-22 .

Sr.No	Name of Scheme	Proposal Received from / Name of Organization / N.G.O	Brief Details
	CSR Applications kept pending in last year Agenda:-		
27	CSR Activities for providing Water supply pipe line, Play ground and sports equipment, electric facilities, drinking water facilities for poor people & Fishermen at VANDI Village. (Sr no-3)	Sarpanch ,Village-VANDI , Ta- Anjar (Recommd. By Shri VASANBHAI AHIR, MLA, Shri V L Chavda, MP)	As per CSR Guideline- ➢ Env Sustainability ➢ Eradicating extreme hunger and poverty (to be Consider for health Center ,Drainage line, Water sump etc activities) **(Appx Cost - 51.00 Lakhs)** (Land authorization of Gram Panchayat)
28	Construction of Shed, hall and Gate for the DADA Bhagwandas Charitable Trust, Adipur. (Sr no -4)	DADA BHAGWANDAS CharitableTrust, Gandhidham (Recommd. By Shri V L Chavda, MP)	As per CSR Guideline- ➢ Promoting gender equality and empowering women ➢ Eradicating extreme hunger and poverty (Considered shed and hall) Fab Shed - 30’x100’ x 1250=37.00 Lakh & RCC Hall – 20’x100’x1500=30.00 Lakh (**Appx Cost Rs 67.00 Lakhs**) Land authority belongs to Trust given by GDA and NOC given by SRC. Doc submitted.
29	10 Nos of Computers required for ShirMaheswarinagar Panchayat Girls Primary School, Gandhidham& Boys Group School, Gandhidham. (Sr no-8)	Maheswarinagar Panchayat Primary Kanya Sala, Gandhidham (Contact no 9913903686)	**AppxRs 5.00 Lakhs** As per CSR Guideline- ➢ Promotion of Education (to be consider for 20 Computers)

List of CSR applications received from various NGOs , Organizations , Village Sharpanchsetc for the FY 2021-22 .

Sr.No	Name of Scheme	Proposal Received from / Name of Organization / N.G.O	Brief Details
			Visited the site. Land belongs to MahewariMeghwadSamaj given by SRC for school purpose, doc are awaited.
30	Construction of Shed and Roof at JeparMatiyadev, shamsanbhumi at Kidana village &Maheswari Community Hall at JuniSundarpuri ,Gandhidham. (Sr no-10)	Shri VINOD CHAVDA, MP	**AppxRs 15.00 Lakhs** (Land authorization not mentioned)
31	Drainage, road, Dust bins, & shed for Cattle shelters at VIDI Village, Ta –Anjar. (Sr no- 12)	Village- VIDI, Ta: Anjar	**AppxRs 30.00 Lakhs** As per CSR Guideline- ➢ Env Sustainability ➢ Eradicating extreme hunger and poverty (Consider for Garbage vehicle & Drainage Cost)
32	Education, Women empowerment and Primary health care services at Kutch area. (Sr no-13)	Light of Life Trust, **Mumbai.**	Cost not mentioned.
33	Request for Help Divyang persons to employment by providing machineries. (Sr no-14)	Kutch DivyangSangthan, Gandhidham.	Cost not mentioned
34	Construction of 2nd Floor of Shri MaheswariMeghwadSamaj, Gandhidham. (Sr no-20)	Shri MaheswariMeghwadSamaj, Gandhidham	**AppxRs. 15.00 Lakhs** (Visited the site and Land ownership documents awaited) (Name plate of DPT fixed at the Asset)

List of CSR applications received from various NGOs , Organizations , Village Sharpanchsetc for the FY 2021-22 .

Sr.No	Name of Scheme	Proposal Received from / Name of Organization / N.G.O	Brief Details
35	Installation of Mini Science Center at Anjar and Gandhidham. (Sr no-21)	STEM Learning Pvt Ltd, Mumbai.	Cost not mentioned.
36	CSR work for Shri Rampar Gram Panchayat. ➢ Wall Plastering for Cattles -7 Lakhs ➢ Shed for Cattel's-15 Lakhs (Sr no-25)	Shri Sarpanch, Rampar Village.	**AppxRs 22.00 Lakhs** (Land authorization of Gram Panchayat and under taking submitted by applicant)
37	CSR activities for the 45,000 Patients over the period of 3 years by "SMILE FOUNDATION", Mumbai. 1. Concept for Nutrition covering 3 years 2. Concept for Mobile Health Unit reaching beneficiaries for 3 years 3. Concept for Vocational Training with NGO (Sr no-29)	Proposal from "SMILE FOUNDATION " Mumbai.	Appx Cost- **Rs 539 Lakhs** for 3 years
38	Development of Park in Public utility plot in between Block "C" & "D" of Sapna Nagar (NU-4) , Gandhidham (Sr no -31)	Shri RAVI MAHESHWARI, DPT	Land belongs to DPT earmarked for recreational purpose. (Total Cost –Rs**88.75 Lakhs**)
39	CSR works for NariJanshsktiVikas Foundation at Gandhidham near Shakti Nagar. (Sr no-33)	NariJanshsktiVikas Foundation, Ahmedabad	➢ Promoting gender equality and empowering women ➢ Env Sustainability ➢ Under promotion of education (Consider for Computers with printers, Sewing machine & RO plant**Cost Rs 48 Lakhs**)

ANNEXURE F

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

TABLE OF CONTENTS

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 13.19 12.75	11.72	20.33 25.41 23.50	23.08	13.27 10.72 7.40	10.47
AL2 - 2	04-06-2021	353	108	210	9.23 14.07 10.11	11.14	18.42 14.61 18.42	17.15	10.72 11.23 10.72	10.89
AL2 - 3	09-06-2021	275	42	137	17.58 12.74 9.23	13.19	17.15 24.14 20.33	20.54	9.96 7.91 6.89	8.25
AL2 - 4	11-06-2021	257	37	145	5.27 5.71 5.27	5.42	23.50 18.42 15.88	19.27	3.32 4.85 9.45	5.87
AL2 - 5	16-06-2021	532	84	117	12.75 9.23 14.07	12.02	17.15 20.33 17.15	18.21	7.15 7.40 6.38	6.98
AL2 - 6	18-06-2021	192	111	65	11.87 8.35 3.52	7.91	26.68 27.95 31.12	28.58	10.72 12.51 10.98	11.40
AL2 - 7	23-06-2021	346	79	80	5.71 7.91 5.28	6.30	15.88 17.15 17.15	16.73	9.45 9.70 7.40	8.85
AL2 - 8	25-06-2021	256	125	31	11.87 13.63 19.78	15.09	18.42 18.42 19.69	18.84	3.83 8.93 10.72	7.83
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 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

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.

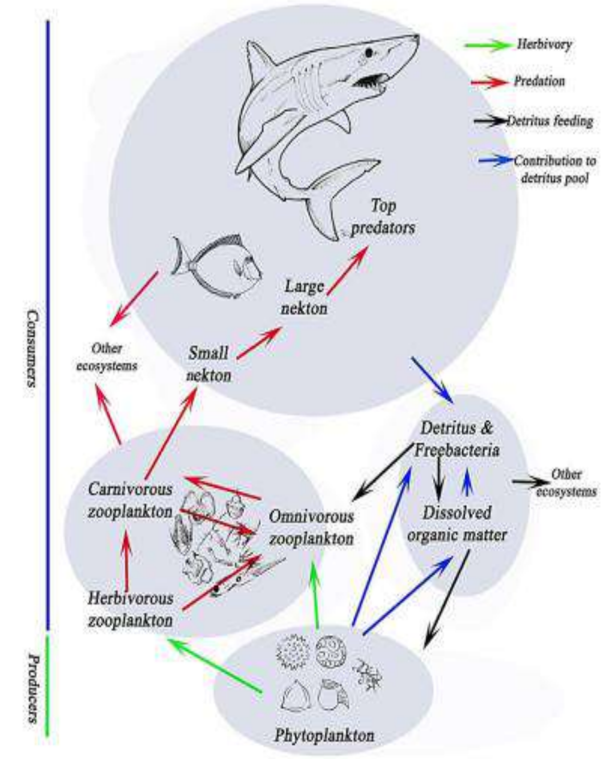
Based on the duration of planktonic life, zooplankton are categorised into Holoplankton (organisms which complete their entire lifecycle as plankton) and Meroplankton (organisms which are planktonic during the early part of their lives such as the larval stages of benthic and nektonic organisms). Tychoplankton 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

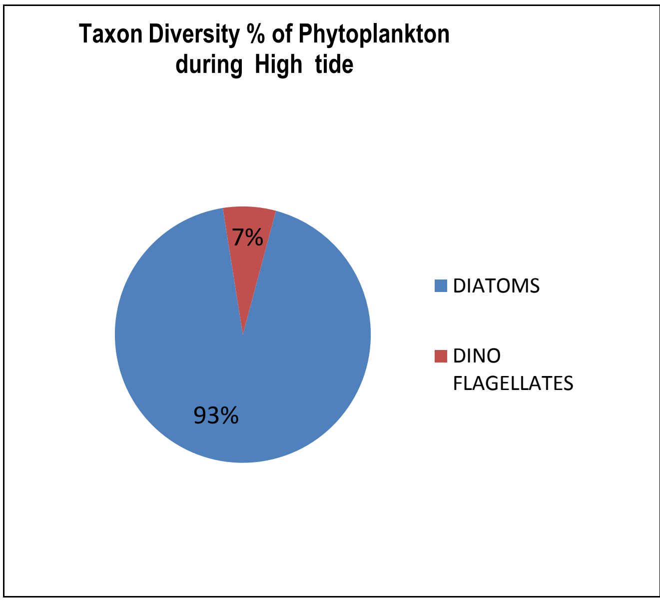
Table # 6 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING SPRING TIDE IN JUNE,2021

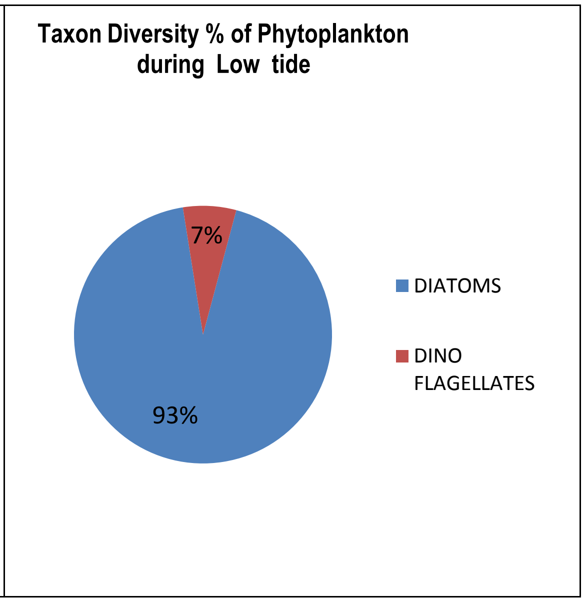
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	112-214	14/15	93.33
			DINO FLAGELLATES	0-2	1/15	6.67
			TOTAL PHYTO PLANKTON	112-216	15	-
LOW TIDE	Sub 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

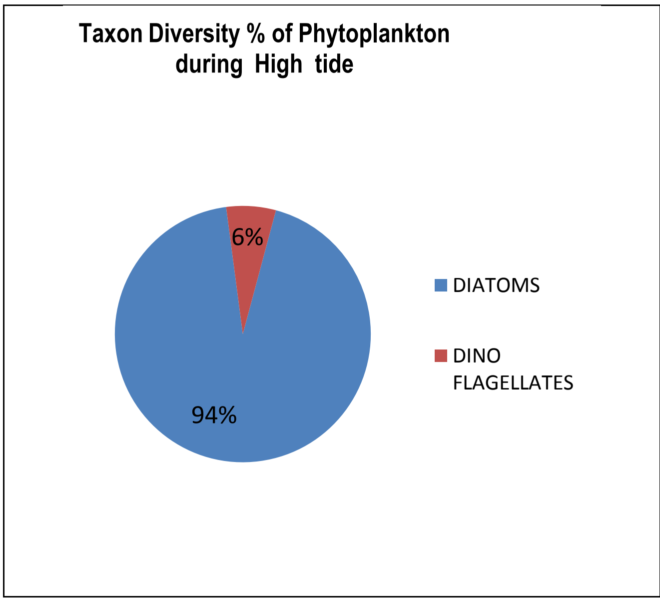
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	72-291	15/16	93.75
			DINO FLAGELLATES	0-2	1/16	6.25
			TOTAL PHYTO PLANKTON	72-293	16	-
LOW TIDE	Sub surface	5	DIATOMS	202-374	15/16	93.75
			DINO FLAGELLATES	0-1	1/16	6.25
			TOTAL PHYTO PLANKTON	202-375	16	

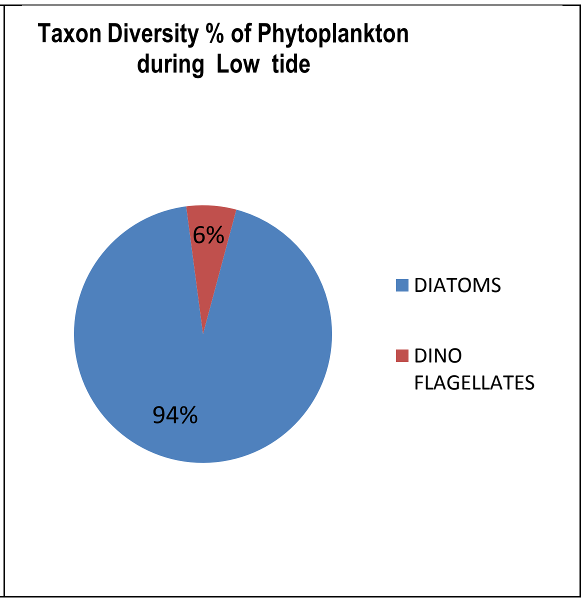
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide





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

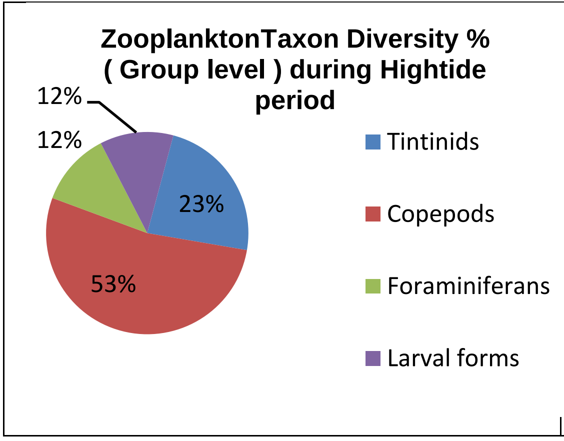
Table # 10 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN JUNE,2021

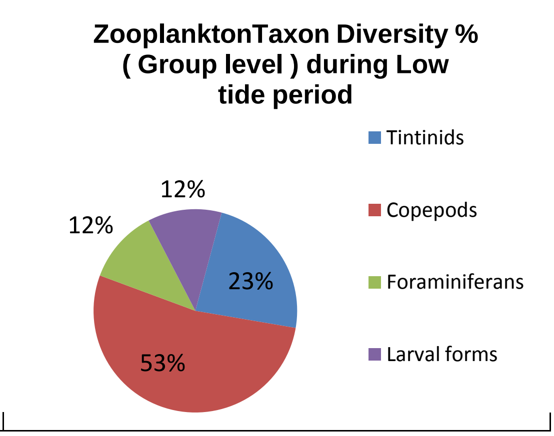
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	10-16	4/17	23.53
			Copepods	31-72	9/17	52.95
			Foraminiferans	0-4	2/17	11.76
			Larval forms	15-50	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

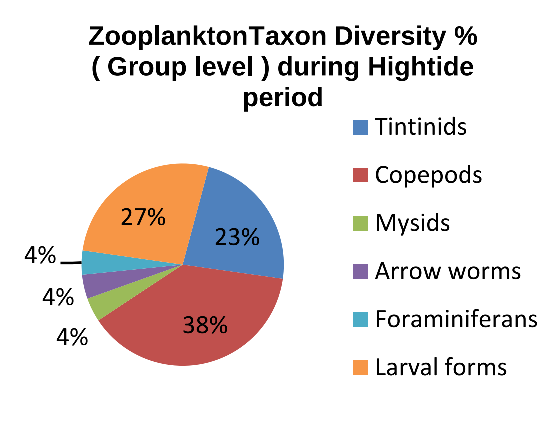
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	4-15	6/26	23.07
			Copepods	25-98	10/26	38.46
			Mysids	1-2	1/26	3.85
			Arrow worms	1-2	1/26	3.85
			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



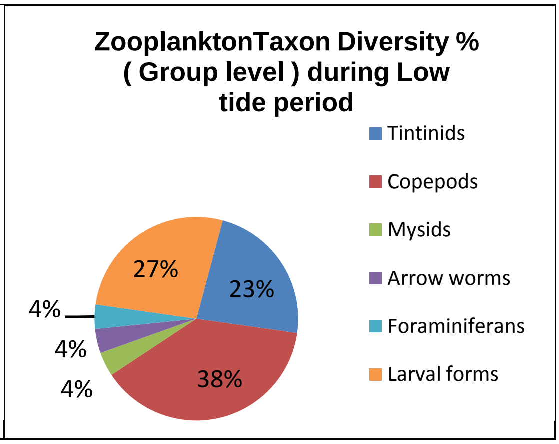


TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURINGSPRING TIDE OF JUNE,2021

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/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/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	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/m³ The mean PM_{10} values were 496 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were below the permissible limit (mean = 47 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 4.25 µg/m³, 28.61 µg/m³ and 12.48 µg/m³ respectively.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Oil Jetty. The mean Benzene concentration was 1.27 µg/m³ .Well below the permissible limit of 5.0 µg/m³. , HC's were below the detectable limit and Carbon Monoxide concentration was 1.74 mg/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										
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/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	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, 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 354 µg/m^3. The mean PM_{10} values were 206 µg/m^3, which is well above the permissible limit. $PM_{2.5}$ values were below the permissible limit (mean = 40 µg/m^3). The average values of SO_2, NO_x and NH_3 were 6.94 µg/m^3, 33.50 µg/m^3 and 15.55 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 1.23 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 1.83 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	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 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		7.37	
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	Sampling not possible during Low Tide	3036	Sampling not possible during Low Tide
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

***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.

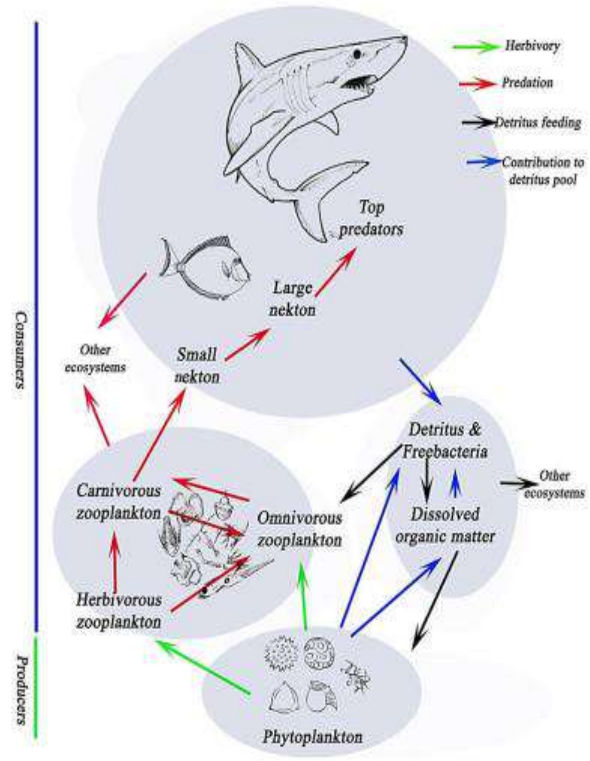
Based on the duration of planktonic life, zooplankton are categorised into Holoplankton (organisms which complete their entire lifecycle as plankton) and Meroplankton (organisms which are planktonic during the early part of their lives such as the larval stages of benthic and nektonic organisms). Tychoplankton 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

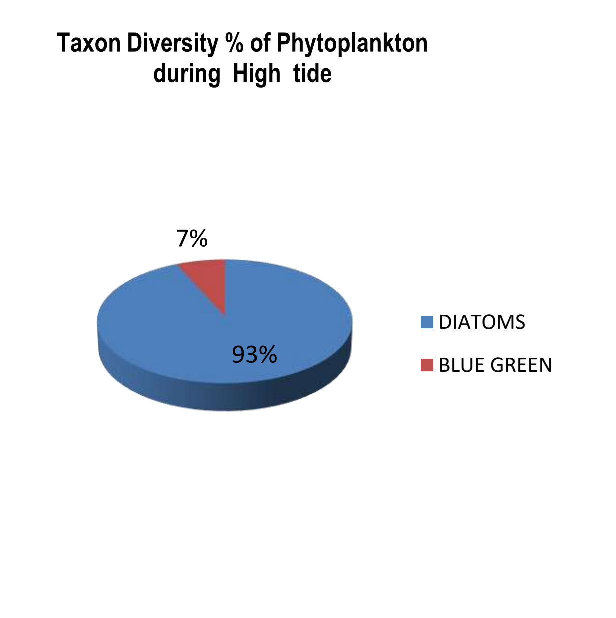
Table # 6 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING SPRING TIDE IN JULY,2021

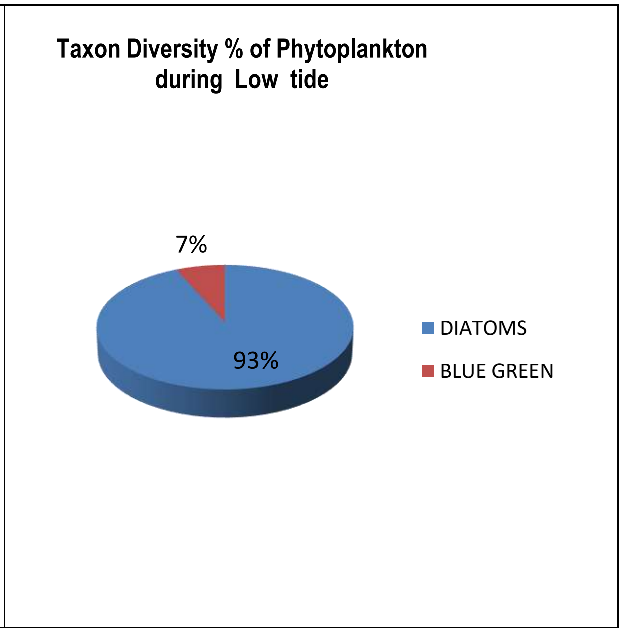
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	68-194	14/15	93.33
			BLUE GREEN	0-2	1/15	6.67
			TOTAL PHYTO PLANKTON	68-196	15	-
LOW TIDE	Sub surface	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

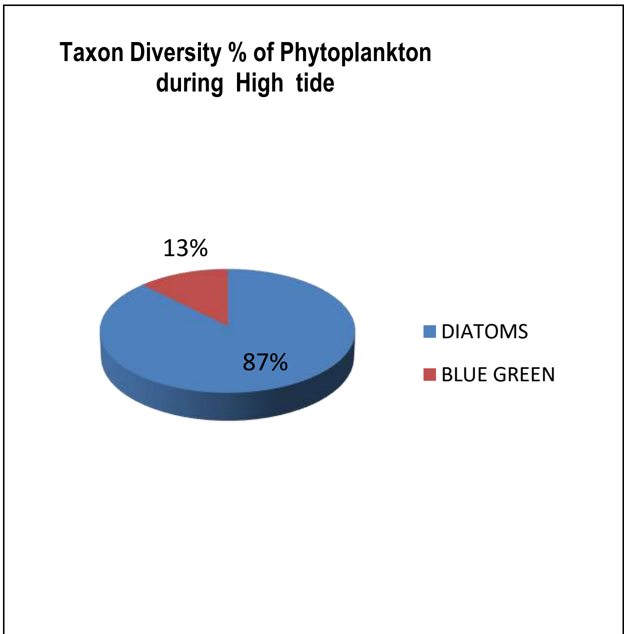
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	74-202	14/16	87.5
			BLUE GREEN	12-26	2/16	12.5
			TOTAL PHYTO PLANKTON	86-224	16	-
LOW TIDE	Sub surface	5	DIATOMS	201-236	14/16	87.5
			BLUE GREEN	16-21	2/16	12.5
			TOTAL PHYTO PLANKTON	222-254	16	-

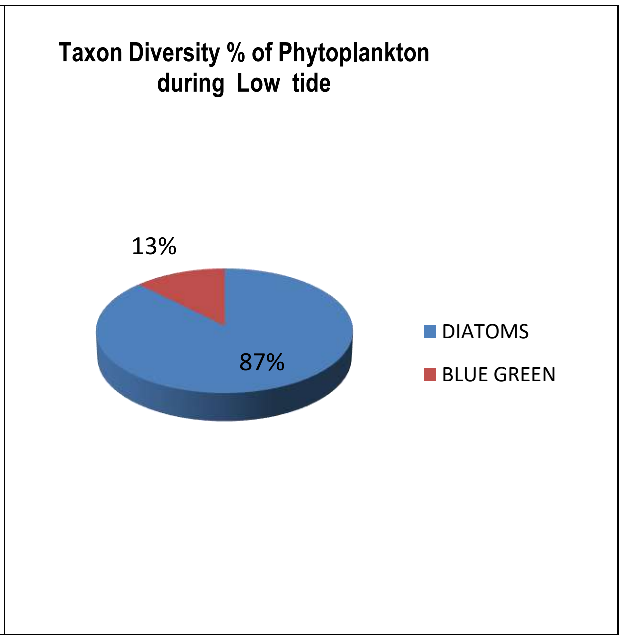
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide





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

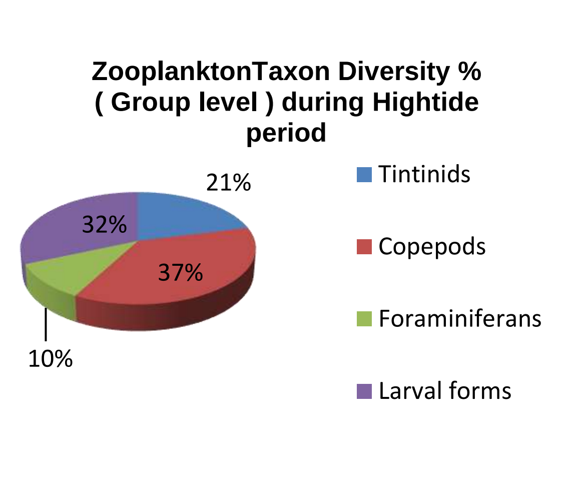
Table # 10 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN JULY2021

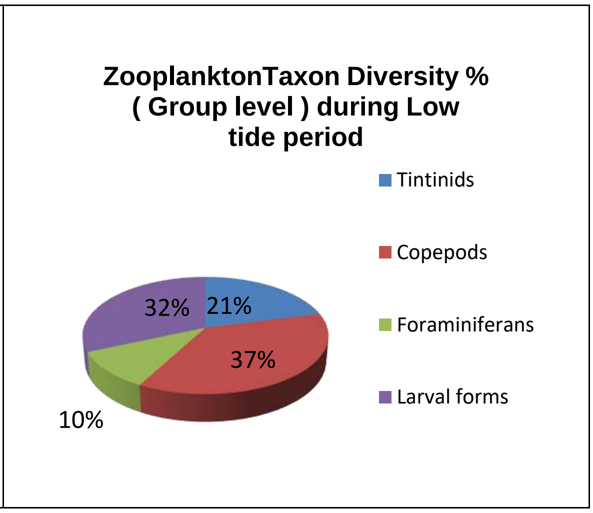
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	3-10	4/19	21.05
			Copepods	34-77	7/19	36.84
			Foraminiferans	2-6	2/19	10.53
			Larval forms	20-57	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

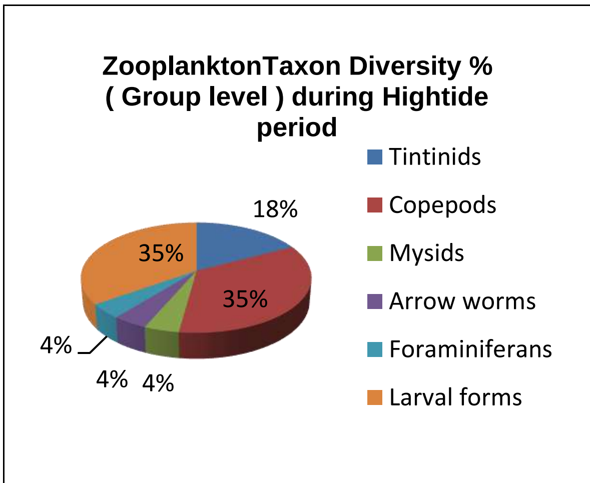
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	4-13	4/23	17.39
			Copepods	37-83	8/23	34.78
			Mysids	0-2	1/23	4.35
			Arrow worms	1-2	1/23	4.35
			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



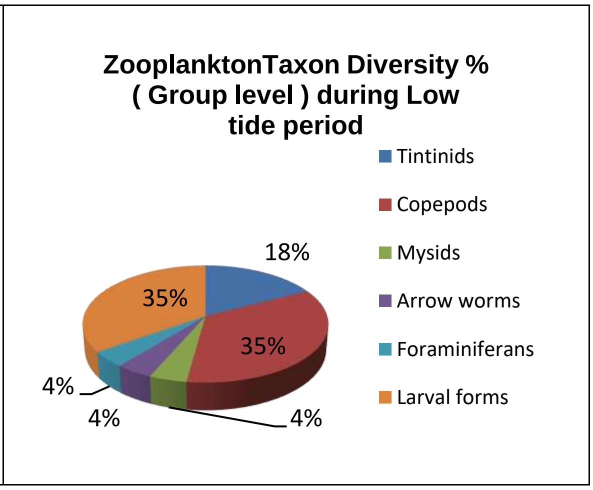


TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURINGSPRING TIDE OF JUlY,2021

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 2.20 2.64	2.05	25.41 33.66 12.70	23.92	14.04 17.36 18.64	16.68
AL3 – 2	06.08.2021	473	176	60	3.96 21.98 3.96	9.96	12.70 10.80 15.88	13.13	8.68 7.15 6.38	7.40
AL3 – 3	11.08.2021	379	253	74	3.96 5.28 3.52	4.25	15.24 20.96 26.04	20.75	8.42 7.15 3.83	6.47
AL3 – 4	13.08.2021	652	331	67	4.84 1.76 0.88	2.49	9.53 9.53 8.89	9.32	12.76 9.70 6.38	9.62
AL3 – 5	18.08.2021	643	457	92	4.84 3.52 2.20	3.52	24.14 34.30 15.88	24.77	9.70 10.47 94.45	38.21
AL3 – 6	20.08.2021	721	389	75	4.84 2.20 5.71	4.25	20.96 15.88 26.04	20.96	10.21 9.45 5.11	8.25
AL3 – 7	25.08.2021	298	208	68	4.40 3.52 1.76	3.22	22.23 17.78 17.15	19.05	12.00 12.00 10.98	11.66
AL3 – 8	27.08.2021	574	300	96	2.64 4.40 1.76	2.93	16.51 17.15 19.05	17.57	11.49 9.45 5.36	8.76
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/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
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/m³, The mean PM_{10} values were 133 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were slightly above the permissible limit (mean= 51 µg/m³). The average values of SO_2, NO_x and NH_3 were 2.82 µg/m³, 12.41 µg/m³ and 6.98 µg/m³ respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Gopalpuri Hospital. The mean Benzene concentration was 1.20 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.81 mg/m³, well below the permissible limit of 4.0 mg/m³.

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**
					3.08		7.62		7.66	
AL7 -1	04.08.2021	144	97	30	2.64	3.08	14.61	11.86	5.36	5.53
					3.52		13.34		3.57	
					3.96		28.58		4.60	
AL7 -2	06.08.2021	180	120	38	4.84	4.98	14.61	17.78	10.47	6.55
					6.15		10.16		4.60	
					2.20		8.89		5.36	
AL7 -3	11.08.2021	148	85	29	3.08	2.34	26.04	16.51	11.49	8.68
					1.76		14.61		9.19	
					2.64		20.33		9.19	
AL7 -4	13.08.2021	165	115	32	0.48	2.07	13.34	14.19	3.57	6.47
					3.08		8.89		6.64	
					4.84		14.61		8.93	
AL7 -5	18.08.2021	151	99	35	3.08	3.96	21.60	16.30	6.38	7.49
					3.96		12.70		7.15	
					3.96		9.53		4.85	
AL7 -6	20.08.2021	173	104	64	3.08	3.81	8.89	11.22	3.57	4.68
					4.40		15.24		5.62	
					3.96		13.34		16.85	
AL7 -7	25.08.2021	168	114	44	0.44	1.67	6.99	13.55	12.00	10.89
					0.62		20.33		3.83	
					6.15		7.62		9.70	
AL7 -8	27.08.2021	113	54	37	1.76	2.78	17.15	12.70	9.45	8.76
					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.

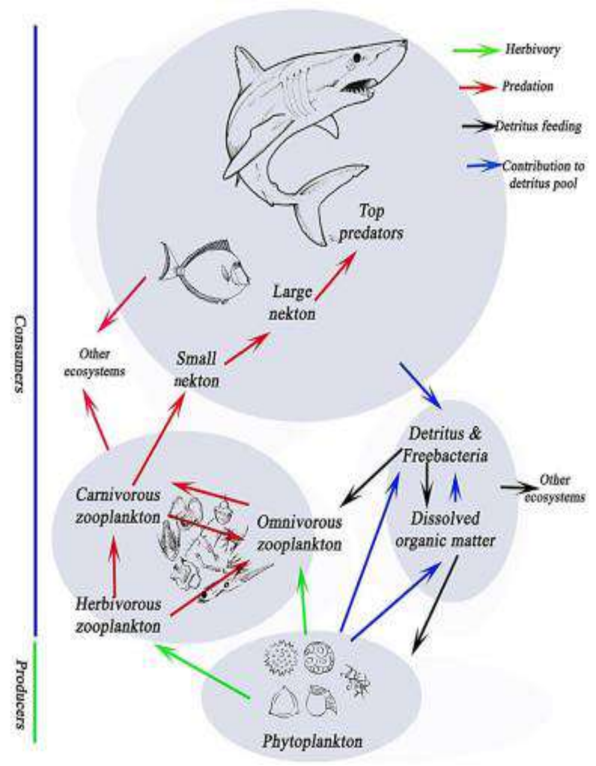
Zooplankton can be subdivided into holoplankton, i.e., permanent members of the plankton (e.g., Calanoid copepods), and meroplankton, i.e., temporary members in the plankton e.g., larvae of fish,

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

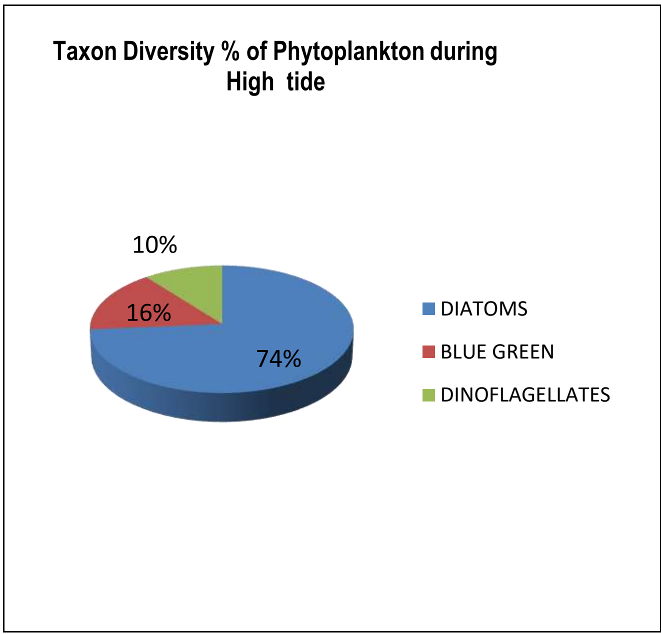
Table # 6 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING SPRING TIDEIN AUGUST, 2021

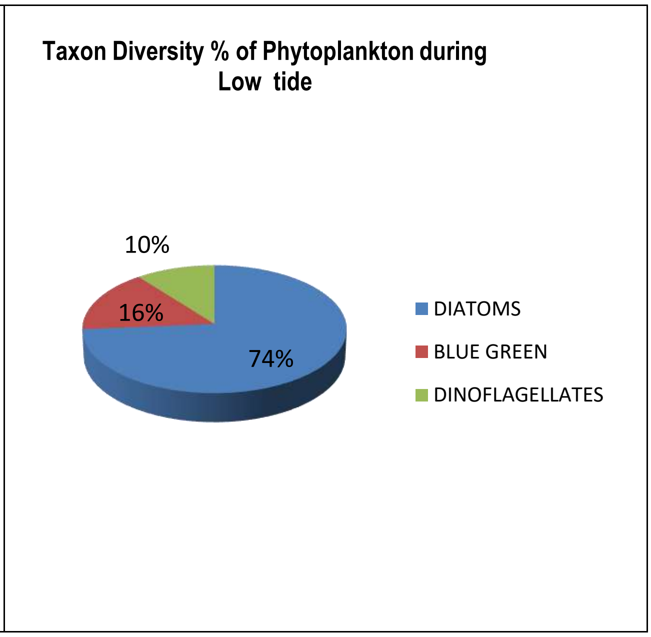
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	94-215	14/19	73.68
			BLUE GREEN	4-13	3/19	15.79
			DINOFLAGELLATES	0-1	2/19	10.53
			TOTAL PHYTO PLANKTON	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

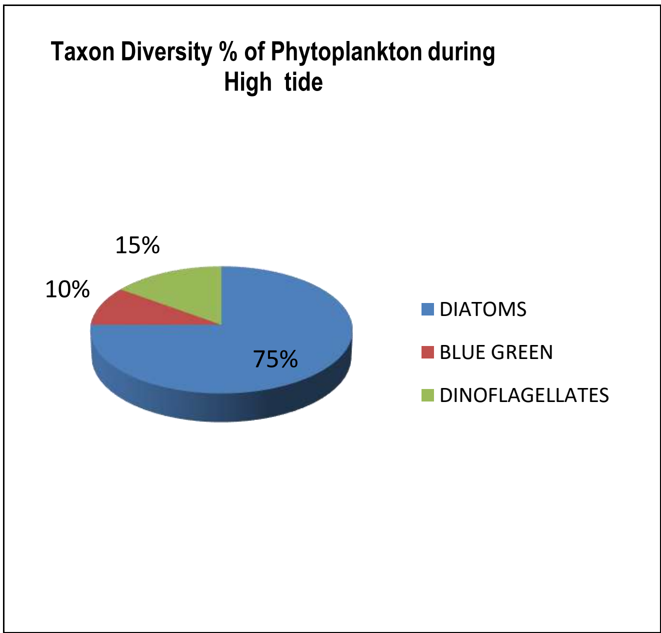
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	64-298	15/20	75
			BLUE GREEN	0-6	2/20	10
			DINOFLAGELLATES	0-5	3/20	15
			TOTAL PHYTO PLANKTON	65-307	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	-

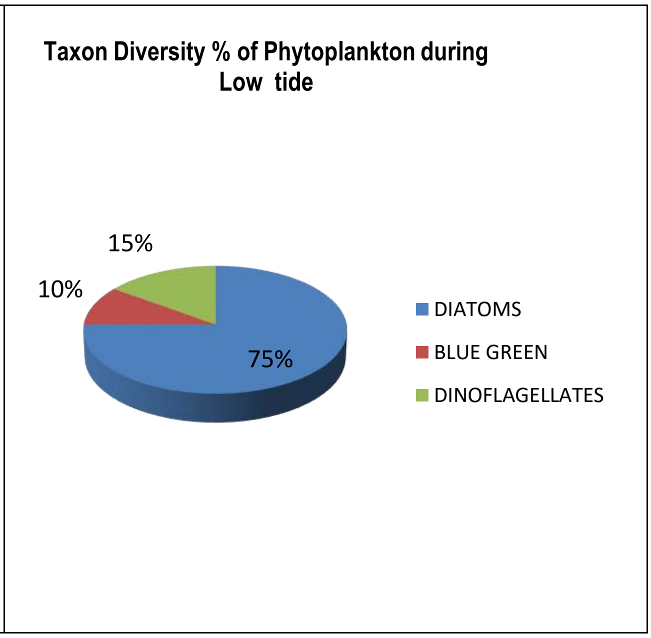
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide





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

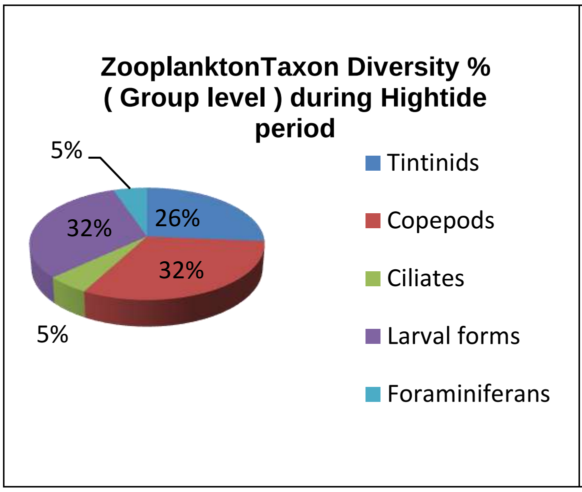
Table # 10 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN AUGUST,2021

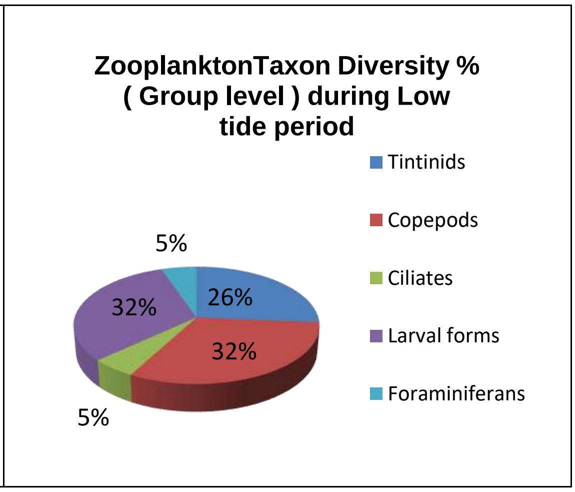
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	1-28	5/19	26.32
			Copepods	17-49	6/19	31.58
			Ciliates	1-6	1/19	5.26
			Larval forms	9-46	6/19	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

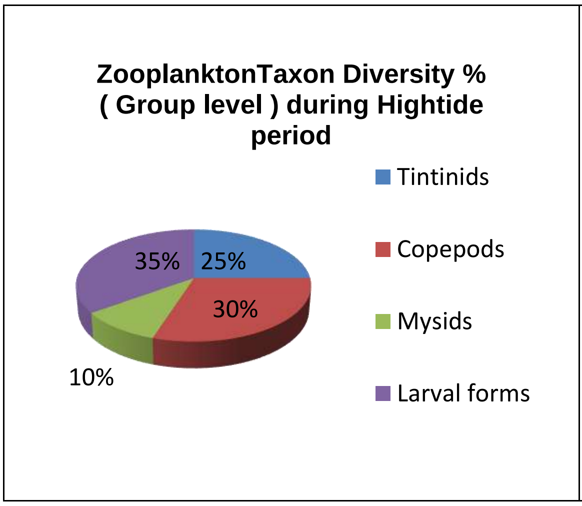
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	1-11	5/20	25
			Copepods	7-26	6/20	30
			Mysids	0-6	2/20	10
			Larval forms	15-84	7/20	35
			TOTAL 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



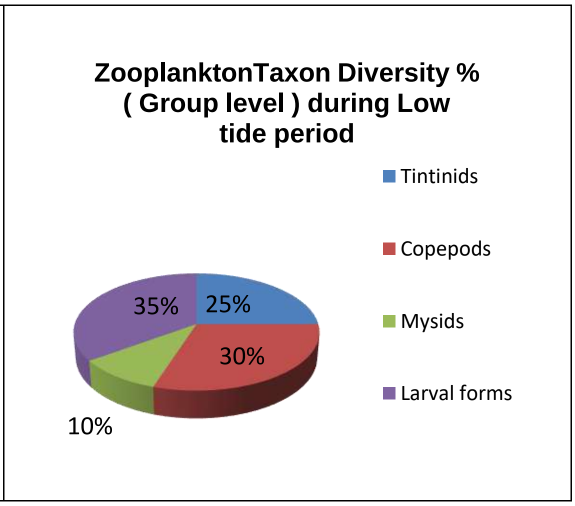


TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURINGSPRING TIDE OF AUGUST, 2021

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	*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.

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ENVIRONMENTAL MONITORING REPORT
FOR
DEENDAYAL PORT TRUST

REPORT NO.	:	DCPL/DPT/20-21/17
Month	:	September 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 September 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	03.09.2021	412	314	76	3.96	5.13	10.80	29.22	5.36	9.53
					6.59		32.39		13.02	
					4.84		44.46		10.21	
AL1 – 2	08.09.2021	673	579	50	3.52	3.81	13.34	26.25	12.25	12.85
					3.08		49.54		12.76	
					4.84		15.88		13.53	
AL1 – 3	10.09.2021	706	552	53	3.08	4.25	11.43	17.78	15.32	16.17
					6.15		17.15		14.55	
					3.52		24.77		18.64	
AL1 – 4	15.09.2021	357	260	82	6.15	4.84	17.78	39.80	18.12	15.06
					3.52		52.72		16.34	
					4.84		48.91		10.72	
AL1 – 5	17.09.2021	297	178	89	1.76	4.40	17.78	28.58	16.34	15.49
					5.28		24.77		15.57	
					6.15		43.19		14.55	
AL1 - 6	22.09.2021	387	309	72	3.52	3.08	40.02	38.53	5.36	9.53
					3.96		45.10		11.23	
					1.76		30.49		12.00	
AL1 - 7	24.09.2021	288	176	67	3.08	3.52	12.70	19.27	20.42	21.95
					4.84		23.50		22.46	
					2.64		21.60		22.98	
AL1 – 8	28.09.2021	471	299	163	17.14	13.48	27.95	27.31	20.68	21.53
					18.90		33.66		19.66	
					4.40		20.33		24.25	
Monthly Average		449	333	81		5.31		28.34		15.26
Standard Deviation		160	153	36		3.37		7.89		4.73

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	03.09.2021	1.11	BDL	1.89	492
AL1 – 2	08.09.2021	1.2	BDL	1.92	499
AL1 – 3	10.09.2021	1.3	BDL	1.9	486
AL1 – 4	15.09.2021	1.22	BDL	1.86	496
AL1 – 5	17.09.2021	1.27	BDL	1.88	501
AL1 - 6	22.09.2021	1.16	BDL	1.79	492
AL1 – 7	24.09.2021	1.18	BDL	1.86	496
AL1 – 8	28.09.2021	1.22	BDL	1.92	488
Monthly Average		**1.21**	**-**	**1.88**	**494**
Standard Deviation		**0.06**	**-**	**0.04**	**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 449 µg/m^3, The mean PM_{10} values were 333.0 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 81 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 5.31 µg/ m^3, 28.34 µg/ m^3 & 15.26 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 1.21 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 1.88 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	03.09.2021	645	423	158	6.15	4.84	23.50	16.30	17.87	14.72
					3.52		13.34		16.08	
					4.84		12.07		10.21	
AL2 – 2	08.09.2021	697	594	45	4.40	4.40	12.07	37.26	13.53	13.87
					5.28		45.73		10.21	
					3.52		53.99		17.87	
AL2 – 3	10.09.2021	673	561	62	3.52	4.25	28.58	18.84	9.45	10.81
					4.40		21.60		13.02	
					4.84		6.35		9.96	
AL2 – 4	15.09.2021	604	481	103	2.20	3.52	28.58	42.56	16.59	16.93
					3.08		46.37		17.87	
					5.28		52.72		16.34	
AL2 – 5	17.09.2021	616	571	38	6.15	3.81	46.37	38.53	11.74	8.34
					3.08		55.89		6.13	
					2.20		13.34		7.15	
AL2 – 6	22.09.2021	673	563	102	2.20	4.54	57.16	51.66	10.47	9.02
					5.28		45.10		9.70	
					6.15		52.72		6.89	
AL2 – 7	24.09.2021	245	159	71	6.15	3.52	23.50	38.11	10.47	14.81
					3.08		50.81		15.32	
					1.32		40.02		18.64	
AL2 – 8	28.09.2021	280	178	82	4.40	8.94	15.88	18.42	13.02	15.06
					8.79		13.34		8.42	
					13.63		26.04		23.74	
Monthly Average		554	442	83		4.73		32.71		12.94
Standard Deviation		183	177	39		1.77		13.12		3.14

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	03.09.2021	1.12	BDL	1.56	490
AL2 -2	08.09.2021	1.16	BDL	1.62	488
AL2 -3	10.09.2021	1.06	BDL	1.66	496
AL2 -4	15.09.2021	1.13	BDL	1.72	501
AL2 – 5	17.09.2021	1.23	BDL	1.76	490
AL2 – 6	22.09.2021	1.06	BDL	1.7	488
AL2 -7	24.09.2021	1.19	BDL	1.68	486
AL2 – 8	28.09.2021	1.22	BDL	1.74	493
Monthly Average		**1.15**	**-**	**1.68**	**492**
Standard Deviation		**0.07**	**-**	**0.07**	**5**

* 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 554 µg/m³ .The mean PM_{10} values were 442 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 83 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 4.73 µg/m³, 32.71 µg/m³ and 12.94 µg/m³ respectively.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Oil Jetty. The mean Benzene concentration was 1.15 µg/m³ .Well below the permissible limit of 5.0 µg/m³. , HC's were below the detectable limit and Carbon Monoxide concentration was 1.68 mg/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

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	03.09.2021	239	162	61	3.96	4.54	41.29	37.69	9.45	11.49
					4.40		38.11		11.49	
					5.28		33.66		13.53	
AL3 – 2	08.09.2021	412	288	97	2.64	3.37	20.96	35.36	12.00	12.59
					4.40		40.02		15.57	
					3.08		45.10		10.21	
AL3 – 3	10.09.2021	248	121	41	5.28	4.69	17.78	23.08	15.06	15.57
					5.71		28.58		16.08	
					3.08		22.87		15.57	
AL3 – 4	15.09.2021	195	123	68	4.40	3.08	15.88	17.15	12.00	9.36
					1.76		11.43		7.15	
					3.08		24.14		8.93	
AL3 – 5	17.09.2021	256	194	55	3.08	3.22	32.39	31.55	16.59	14.81
					2.20		30.49		16.85	
					4.40		31.76		10.98	
AL3 – 6	22.09.2021	554	153	39	3.52	3.52	24.14	35.78	18.12	15.06
					3.08		40.02		12.25	
					3.96		43.19		14.81	
AL3 – 7	24.09.2021	467	399	52	2.64	3.08	27.31	34.72	5.36	6.72
					1.76		32.39		6.38	
					4.84		44.46		8.42	
AL3 – 8	28.09.2021	355	253	64	8.79	16.41	7.62	14.19	14.04	10.55
					34.73		14.61		6.13	
					5.71		20.33		11.49	
Monthly Average		341	211	60		5.24		28.69		12.02
Standard Deviation		128	96	18		4.56		9.22		3.11

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	03.09.2021	1.1	BDL	1.77	492
AL3 -2	08.09.2021	1.06	BDL	1.82	480
AL3 -3	10.09.2021	1.11	BDL	1.86	479
AL3 -4	15.09.2021	1.16	BDL	1.8	482
AL3 – 5	17.09.2021	1.18	BDL	1.92	477
AL3 – 6	22.09.2021	1.26	BDL	1.96	486
AL3 – 7	24.09.2021	1.22	BDL	1.86	478
AL3 – 8	28.09.2021	1.21	BDL	1.78	482
Monthly Average		**1.16**	**-**	**1.85**	**482**
Standard Deviation		**0.07**	**-**	**0.07**	**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 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 341 µg/m^3, The mean PM_{10} values were 211 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values within the permissible limit (mean = 60 µg/m^3). The average values of SO_2, NO_x and NH3 were 5.24 µg/m^3, 28.69 µg/m^3 and 12.02 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 1.16 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 1.85 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	03.09.2021	167	118	37	4.40	3.52	13.34	14.40	8.42	6.30
					2.64		23.50		5.36	
					3.52		6.35		5.11	
AL4 -2	08.09.2021	256	178	63	3.08	3.66	13.34	21.17	8.42	8.85
					1.76		36.84		5.36	
					6.15		13.34		12.76	
AL4 -3	10.09.2021	165	122	26	1.32	2.34	30.49	30.06	12.25	9.36
					3.96		36.20		8.17	
					1.76		23.50		7.66	
AL4 -4	15.09.2021	189	124	54	3.08	4.54	48.91	41.29	5.62	8.59
					4.40		40.02		9.45	
					6.15		34.93		10.72	
AL4 – 5	17.09.2021	185	104	48	2.20	4.40	11.43	24.56	12.00	11.15
					6.15		22.23		7.91	
					4.84		40.02		13.53	
AL4 – 6	22.09.2021	249	101	45	1.76	3.08	17.15	14.40	9.19	8.59
					3.08		12.07		6.89	
					4.40		13.97		9.70	
AL4 – 7	24.09.2021	167	116	43	2.20	2.49	24.14	16.94	9.70	11.83
					0.88		15.88		13.53	
					4.40		10.80		12.25	
AL4 – 8	28.09.2021	177	122	48	0.88	0.88	5.08	6.14	5.87	5.87
					1.32		5.72		7.15	
					0.44		7.62		4.60	
Monthly Average		194	123	46		3.11		21.12		8.82
Standard Deviation		37	24	11		1.20		10.89		2.07

NS: Not Specified

Table 4B : Results of Air Pollutant Concentration at Gopalpuri Hospital					
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
AL4 -1	03.09.2021	1.01	BDL	1.76	485
AL4 -2	08.09.2021	1.1	BDL	1.62	480
AL4 -3	10.09.2021	1.06	BDL	1.7	490
AL4 -4	15.09.2021	1.11	BDL	1.59	494
AL4 – 5	17.09.2021	1.18	BDL	1.7	486
AL4 – 6	22.09.2021	1.16	BDL	1.81	490
AL4 – 7	24.09.2021	1.08	BDL	1.79	487
AL4 – 8	28.09.2021	1.06	BDL	1.73	497
Monthly Average		**1.10**	**-**	**1.71**	**489**
Standard Deviation		**0.06**	**-**	**0.08**	**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 Gopalpuri Hospital was attributed by vehicle emission produced from light motor vehicles of the colony residents. The mean TSPM values at Oil Jetty were 194 µg/m³, The mean PM_{10} values were 123 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were in within the permissible limit (mean= 46 µg/m³). The average values of SO_2, NO_x and NH_3 were 3.11 µg/m³, 21.12 µg/m³ and 8.82 µg/m³ 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 1.10 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.71 mg/m³, well below the permissible limit of 4.0 mg/m³.

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	03.09.2021	380	115	86	3.52	4.10	32.39	30.28	13.79	14.30
					3.96		37.47		12.25	
					4.84		20.96		16.85	
AL5 – 2	08.09.2021	275	176	80	2.64	4.40	18.42	30.06	6.38	5.79
					6.59		33.66		5.11	
					3.96		38.11		5.87	
AL5 – 3	10.09.2021	302	225	74	2.20	3.66	52.72	48.91	9.45	10.64
					4.84		31.12		6.38	
					3.96		62.88		16.08	
AL5 – 4	15.09.2021	378	242	97	3.08	4.98	13.34	31.33	9.70	10.72
					5.28		50.81		12.76	
					6.59		29.85		9.70	
AL5 – 5	17.09.2021	210	138	70	4.84	4.10	12.07	27.31	9.70	10.98
					3.52		48.91		10.21	
					3.96		20.96		13.02	
AL5 – 6	22.09.2021	402	305	92	5.28	5.71	19.05	28.37	14.55	12.08
					6.15		26.04		12.25	
					5.71		40.02		9.45	
AL5 – 7	24.09.2021	268	151	73	2.64	4.69	32.39	33.66	18.64	17.61
					4.84		31.76		16.08	
					6.59		36.84		18.12	
AL5 – 8	28.09.2021	375	248	70	5.71	6.15	26.04	18.00	15.32	16.00
					6.15		5.72		19.91	
					6.59		22.23		12.76	
Monthly Average		324	200	80		4.73		30.99		12.26
Standard Deviation		69	65	10		0.96		8.61		3.69

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	03.09.2021	1.22	BDL	1.9	489
AL5 – 2	08.09.2021	1.26	BDL	1.86	499
AL5 – 3	10.09.2021	1.3	BDL	1.79	501
AL5 – 4	15.09.2021	1.22	BDL	1.88	486
AL5 – 5	17.09.2021	1.21	BDL	1.86	488
AL5 – 6	22.09.2021	1.35	BDL	1.8	492
AL5 – 7	24.09.2021	1.34	BDL	1.92	496
AL5 – 8	28.09.2021	1.30	BDL	1.93	502
Monthly Average		**1.28**	**-**	**1.87**	**494**
Standard Deviation		**0.06**	**-**	**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 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 324 µg/m³. The mean PM_{10} values were 200 µg/m³, which is well above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 80 µg/m³). The average values of SO_2, NO_x and NH_3 were 4.73 µg/m³, 30.99 µg/m³ and 12.26 µg/m³ respectively and were all within the permissible limit.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Coal Storage Area. The mean Benzene concentration was 1.28 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.87 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	03.09.2021	186	104	52	7.03	5.13	12.70	38.11	14.30	16.34	
					4.40		57.16		16.85		
					3.96		44.46		17.87		
AL6 – 2	08.09.2021	253	123	75	4.40	4.69	11.43	17.36	6.38	10.64	
					6.15		18.42		14.04		
					3.52		22.23		11.49		
AL6 – 3	10.09.2021	214	128	57	3.52	3.66	25.41	23.29	9.96	13.87	
					5.28		32.39		21.70		
					2.20		12.07		9.96		
AL6 – 4	15.09.2021	166	108	49	2.20	4.54	30.49	20.96	9.70	9.70	
					4.84		19.05		9.19		
					6.59		13.34		10.21		
AL6 – 5	17.09.2021	253	177	50	3.08	4.69	52.72	45.52	12.25	12.51	
					4.84		45.10		15.57		
					6.15		38.74		9.70		
AL6 – 6	22.09.2021	441	135	49	1.32	3.22	27.31	31.97	13.02	13.79	
					3.08		38.74		15.57		
					5.28		29.85		12.76		
AL6 – 7	24.09.2021	216	130	46	3.08	3.81	33.66	40.44	16.08	12.00	
					5.28		44.46		10.47		
					3.08		43.19		9.45		
AL6 – 8	28.09.2021	179	106	62	1.76	3.37	13.34	7.20	5.87	7.23	
					3.96		4.45		5.36		
					4.40		3.81		10.47		
Monthly Average		238	126	55		4.14		28.11		12.01	
Standard Deviation		88	24	10		0.71		13.08		2.82	

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	03.09.2021	1.19	BDL	1.86	478
AL6 – 2	08.09.2021	1.16	BDL	1.92	492
AL6 – 3	10.09.2021	1.21	BDL	1.78	486
AL6 – 4	15.09.2021	1.06	BDL	1.92	482
AL6 – 5	17.09.2021	1.1	BDL	1.86	478
AL6 – 6	22.09.2021	1.02	BDL	1.8	492
AL6 – 7	24.09.2021	1.21	BDL	1.79	488
AL6 – 8	28.09.2021	1.2	BDL	1.86	478
Monthly Average		**1.14**	**-**	**1.85**	**484**
Standard Deviation		**0.07**	**-**	**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 Tuna Port were 238 µg/m^3, The mean PM_{10} values were 126 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were within the permissible limit (mean = 55 µg/m^3). The average values of SO_2, NO_x and NH_3 were 4.14 µg/m^3, 28.11 µg/m^3 and 12.01 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 1.14 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 1.85 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	03.09.2021	158	88	43	3.96	12.60	9.53	10.80	5.62	6.21
					30.77		8.89		4.60	
					3.08		13.97		8.42	
AL7 -2	08.09.2021	158	93	59	3.96	3.52	13.97	14.61	9.96	9.28
					4.40		17.78		6.64	
					2.20		12.07		11.23	
AL7 -3	10.09.2021	180	108	53	3.08	3.22	19.05	12.28	5.62	4.51
					3.52		10.80		4.85	
					3.08		6.99		3.06	
AL7 -4	15.09.2021	169	102	33	5.28	4.25	13.97	12.70	6.13	8.85
					3.52		10.16		9.96	
					3.96		13.97		10.47	
AL7 -5	17.09.2021	160	87	27	5.28	3.66	10.80	9.74	8.42	5.87
					2.64		8.26		5.62	
					3.08		10.16		3.57	
AL7 -6	22.09.2021	177	95	64	3.52	4.40	13.97	8.79	10.47	9.87
					3.96		10.80		9.96	
					5.71		1.59		9.19	
AL7 -7	24.09.2021	139	94	32	2.20	3.52	13.97	12.91	6.38	6.72
					4.40		12.70		8.42	
					3.96		12.07		5.36	
AL7 -8	28.09.2021	168	107	43	2.64	3.08	14.61	12.49	8.68	7.40
					3.08		8.89		6.13	
					3.52		13.97		7.40	
Monthly Average		164	97	44		5		12		7
Standard Deviation		13	8	13		3		2		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	03.09.2021	1.12	BDL	1.8	456
AL7 – 2	08.09.2021	1.06	BDL	1.78	462
AL7 – 3	10.09.2021	1.11	BDL	1.86	470
AL7 – 4	15.09.2021	1.18	BDL	1.8	455
AL7 – 5	17.09.2021	1.25	BDL	1.72	469
AL7 – 6	22.09.2021	1.16	BDL	1.68	460
AL7 – 7	24.09.2021	1.2	BDL	1.77	463
AL7 – 8	28.09.2021	1.26	BDL	1.7	460
Monthly Average		**1.17**	**-**	**1.76**	**462**
Standard Deviation		**0.07**	**-**	**0.06**	**5**

* 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 164 µg/m³. The mean PM_{10} values were 97 µg/m³, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 44 µg/m³). The average values of SO_2, NO_x and NH_3 were 5.0 µg/m³, 12.0 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 1.17 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.76 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	03.09.2021	164	83	24	3.96	4.25	13.34	12.28	5.87	4.77
					3.96		12.07		5.87	
					4.84		11.43		2.55	
AL8 -2	08.09.2021	198	130	35	4.40	5.28	20.96	20.54	5.11	5.70
					6.15		17.78		4.85	
					5.28		22.87		7.15	
AL8 -3	10.09.2021	177	86	64	2.64	3.81	8.89	12.91	8.42	8.34
					3.96		13.97		9.19	
					4.84		15.88		7.40	
AL8 -4	15.09.2021	150	78	25	2.64	2.07	20.96	16.94	8.42	6.98
					3.08		17.78		4.08	
					0.48		12.07		8.42	
AL8 -5	17.09.2021	156	84	46	2.20	3.52	247.71	91.46	5.62	6.72
					3.96		12.70		6.89	
					4.40		13.97		7.66	
AL8 -6	22.09.2021	198	123	55	3.52	4.10	11.43	13.97	4.60	4.85
					4.40		14.61		4.34	
					4.40		15.88		5.62	
AL8 -5	24.09.2021	172	101	54	3.08	2.34	9.53	9.10	8.68	7.83
					3.52		6.99		11.23	
					0.44		10.80		3.57	
AL8-6	28.09.2021	135	79	34	4.84	5.57	7.62	9.95	3.57	6.30
					5.71		9.53		5.62	
					6.15		12.70		9.70	
Monthly Average		169	95	42		4		23		6
Standard Deviation		22	20	15		1		28		1

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	03.09.2021	1.06	BDL	1.78	460
AL8-2	08.09.2021	1.1	BDL	1.8	472
AL8 -3	10.09.2021	1.02	BDL	1.68	460
AL8-4	15.09.2021	1.1	BDL	1.72	461
AL8 -5	17.09.2021	1.17	BDL	1.81	452
AL8-6	22.09.2021	1.06	BDL	1.76	460
AL8-7	24.09.2021	1.1	BDL	1.66	470
AL8-8	28.09.2021	1.11	BDL	1.6	465
Monthly Average		**1.09**	**-**	**1.73**	**463**
Standard Deviation		**0.04**	**-**	**0.07**	**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 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 169 µg/m^3. The mean PM_{10} values were 95 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 42.0 µg/m^3). The average values of SO_2, NO_x and NH_3 were 4.0 µg/m^3, 23.0 µg/m^3 and 6.0 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 1.09 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.

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	7.36	7.31	7.4	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1343	1312	1350	500	2000
3	Turbidity	NTU	0	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	2630	2600	2690	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/l	420.94	365.81	370.82	250.0	1000.0
9	Ca as Ca	mg/l	72.14	56.11	52.10	75.0	200.0
10	Mg as Mg	mg/l	85.05	72.90	65.61	30.0	100.0
11	Total Hardness	mg/l	350	300	270	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	0.35	0.54	0.21	1.0	1.5
14	Sulphate as SO4	mg/l	228	210	258	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	%	0.76	0.66	0.67	NS*	NS*
18	Sodium as Na	mg/l	301	243	265	NS*	NS*
19	Potassium as K	mg/l	3.24	3.68	3.51	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	7.55	7.6	7.83	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1390	1360	1500	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	2700	2680	2950	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/l	430.96	360.80	380.85	250.0	1000.0
9	Ca as Ca	mg/l	60.12	56.11	60.12	75.0	200.0
10	Mg as Mg	mg/l	63.18	80.19	85.05	30.0	100.0
11	Total Hardness	mg/l	260	330	350	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	0.58	0.79	0.25	1.0	1.5
14	Sulphate as SO4	mg/l	164.4	282	276	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	%	0.78	0.65	0.69	NS*	NS*
18	Sodium as Na	mg/l	274	251	263	NS*	NS*
19	Potassium as K	mg/l	4.23	3.88	4.21	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	7.61	7.57	7.45	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1326	1320	1520	500	2000
3	Turbidity	NTU	2	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	2650	2610	3010	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	410.91	320.71	425.95	250.0	1000.0
9	Ca as Ca	mg/l	48.10	56.11	48.10	75.0	200.0
10	Mg as Mg	mg/l	77.76	82.62	77.76	30.0	100.0
11	Total Hardness	mg/l	320	340	320	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.16	0.20	0.77	1.0	1.5
14	Sulphate	mg/l	213.6	195.6	276	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	%	0.74	0.58	0.77	NS*	NS*
18	Sodium as Na	mg/l	215	206	166	NS*	NS*
19	Potassium as K	mg/l	3.87	3.73	3.56	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	7.53	7.56	7.59	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1370	1350	1450	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	2690	2700	2990	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	335.75	375.84	821.83	250.0	1000.0
9	Ca as Ca	mg/l	76.15	52.10	72.14	75.0	200.0
10	Mg as Mg	mg/l	87.48	70.47	92.34	30.0	100.0
11	Total Hardness	mg/l	360	290	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	0.48	0.14	0.81	1.0	1.5
14	Sulphate	mg/l	336	228	237.6	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	%	0.61	0.68	1.48	NS*	NS*
18	Sodium as Na	mg/l	211	196	202	NS*	NS*
19	Potassium as K	mg/l	4.08	4.01	3.99	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	7.64	7.61	7.69	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1400	1850	1190	500	2000
3	Turbidity	NTU	2	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	2780	3670	2310	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	410.91	471.05	385.86	250.0	1000.0
9	Ca as Ca	mg/l	64.13	76.15	44.09	75.0	200.0
10	Mg as Mg	mg/l	85.05	99.63	80.19	30.0	100.0
11	Total Hardness	mg/l	350	410	330	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.34	0.22	0.48	1.0	1.5
14	Sulphate	mg/l	252	284.4	303.6	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	%	0.74	0.85	0.70	NS*	NS*
18	Sodium as Na	mg/l	202	184	192	NS*	NS*
19	Potassium as K	mg/l	3.49	3.50	3.56	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	7.56	7.42	7.32	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1230	1590	1020	500	2000
3	Turbidity	NTU	1	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	2450	3150	2000	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	375.84	511.14	604	250.0	1000.0
9	Ca as Ca	mg/l	40.08	60.12	80.16	75.0	200.0
10	Mg as Mg	mg/l	85.05	97.20	60.75	30.0	100.0
11	Total Hardness	mg/l	350	400	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	0.59	0.36	0.46	1.0	1.5
14	Sulphate	mg/l	260.4	174	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	%	0.68	0.92	1.09	NS*	NS*
18	Sodium as Na	mg/l	162	206	210	NS*	NS*
19	Potassium as K	mg/l	2.18	4.01	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	7.5	7.4	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1160	1150	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	2390	2300	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	NS*	NS*
8	Chloride	mg/l	425.95	415.92	250.0	1000.0
9	Ca as Ca	mg/l	56.11	64.13	75.0	200.0
10	Mg as Mg	mg/l	75.33	70.47	30.0	100.0
11	Total Hardness	mg/l	310	290	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.71	0.62	1.0	1.5
14	Sulphate	mg/l	30.60	28.80	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	9.85	9.71	45.0	No Relaxation
17	Salinity	%	0.76	0.75	NS*	NS*
18	Sodium as Na	mg/l	192.0	183.0	NS*	NS*
19	Potassium as K	mg/l	2.2	2.7	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 1000 -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 September ranged from 2000-3700 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 400-900 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 40 - 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 60 – 99 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 260-410 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 30 – 350 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 0.5 to 1.4 %. There are no prescribed Indian standards for salinity in Drinking water.

Sodium and Potassium Salts

Sodium values in the samples collected ranged from 100 - 300 mg/l and Potassium salts ranged from 2.2 to 4.0 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	58.0	50.4
2	Nirman Building 1	55.3	49.1
3	Tuna Port	52.8	46.5
4	Main Gate North	60.3	55.2
5	West Gate I	67.2	60.6
6	Canteen Area	58.7	50.9
7	Main Road	70.5	59.5
8	ATM Building	69.2	62.3
9	Wharf Area /Jetty Area	73.7	65.4
10	Port & Custom Office	55.2	49.6
	Vadinar Port		
11	Entrance Gate of Vadinar Port	69.6	58.4
12	Nr. Port Colony, Vadinar	61.3	55.8
13	Nr. Vadinar Jetty	68.2	61.5

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 13 locations at Deendayal Port ranged from 52.0 dB(A) to 73.7 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 13 locations of Deendayal Port ranged from 46.5 dB to 65.4 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 September 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	-	8.58	8.16	8.46	8.26	8.02	8.56
3	Electrical Conductivity	µs/cm	18,400.0	25,620.0	17,880.0	16,520.0	523.0	420.0
4	Moisture	%	21.00	22.20	24.10	18.80	8.66	9.02
5	Total Organic Carbon	%	0.48	1.24	0.48	3.93	0.18	0.21
6	Alkalinity	mg/kg	72.07	36.04	190.19	90.09	60.06	100.10
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
8	Chloride	mg/kg	1,506.6	6,381.0	1,701.0	1,878.9	52.0	67.8
9	Sulphate	mg/kg	202.0	196.0	112.0	112.0	12.0	18.0
10	Phosphorus	mg/kg	0.89	0.92	1.05	1.10	0.78	0.86
11	Potassium	mg/kg	386.0	820.0	345.0	422.0	110.0	172.0
12	Sodium	mg/kg	1,585.0	3,386.0	2,303.0	1,990.0	990.0	810.0
13	Calcium	mg/kg	228.46	741.50	248.50	468.94	118.00	72.00
14	Copper as Cu	mg/kg	52.2	78.2	46.2	33.8	18.6	28
15	Lead as Pb	mg/kg	4.9	5.6	3.2	4.8	3.2	1.1
16	Nickel as Ni	mg/kg	46.2	28	33.2	26.1	18.2	16.2
17	Zinc as Zn	mg/kg	66.20	41.60	68	49.55	24.00	38.50
18	Cadmium as Cd	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL

4.3 Discussion

- The data shows that value of pH ranges from 8.02 at Nakti Creek to 8.58 at Tuna Creek indicating that all soil samples are neutral to slight basic. Iffco Plant samples showed maximum conductivity of 25,620µmhos/cm, while Nakti Creek location showed minimum conductivity of 16,520 µmhos/cm. Conductivity at Vadinar Port was 523 and 420 µmhos/cm at Admin site and Vadinar Port colony respectively.
- Total organic Carbon ranged from 0.1 % to 3.9 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 1.10 mg/kg and 300.0 to 800 mg/kg respectively at Deendayal Port. The mean concentration of Phosphorous at Vadinar site was 0.82 mg/kg and mean concentration of Potassium at Vadinar site was 145 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	04.09.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.56	7.44
2	Total Suspended Solids	mg/l	64.2	26.6
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	424.2	103.0
5	BOD @ 27 °C	mg/l	141.0	29.0
6.	Fecal Coliform	MPN Index / 100 ml	-	20.0
Aeration Tank				
7.	MLSS	mg/l	6.0	
8.	MLVSS	%	93.0	

Table 19: Sewage Water Monitoring at Kandla STP (2nd Week)

Date of Sampling	09.09.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.6	7.2
2	Total Suspended Solids	mg/l	152.2	72.4
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	384	103.0
5	BOD @ 27 °C	mg/l	120.0	24.0
6.	Fecal Coliform	MPN Index / 100 ml	-	31.0
Aeration Tank				
7.	MLSS	mg/l	9.0	
8.	MLVSS	%	89.0	

Table 20: Sewage Water Monitoring at Kandla STP (3rd Week)

Date of Sampling	16.09.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.71	7.18
2	Total Suspended Solids	mg/l	417.8	159.8
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	383.8	102
5	BOD @ 27 °C	mg/l	128.0	23.0
6.	Fecal Coliform	MPN Index / 100 ml	-	<1.8
Aeration Tank				
7.	MLSS	mg/l	9.0	
8.	MLVSS	%	89.0	

Table 21: Sewage Water Monitoring at Kandla STP (4th Week)

Date of Sampling	21.09.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.53	7.32
2	Total Suspended Solids	mg/l	172.4	75.9
3	Residual Chlorine	mg/l	<1.0	<1.0
4	COD	mg/l	151.5	102.0
5	BOD @ 27 °C	mg/l	106.0	52.0
6.	Fecal Coliform	MPN Index / 100 ml	-	110.0
Aeration Tank				
7.	MLSS	mg/l	16.0	
8	MLVSS	%	82.0	

- **Gopalpuri Colony STP**

Table 22: Sewage Water Monitoring at Gopalpuri STP (1st Week)

Date of Sampling	04.09.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.35	7.21
2	Total Suspended Solids	mg/l	108.8	26
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	316.0	98.0
5	BOD @ 27 °C	mg/l	110.0	28.0
6.	Fecal Coliform	MPN Index / 100 ml	-	>1600.0
Aeration Tank				
7.	MLSS	mg/l	11.0	
8	MLVSS	%	87.0	

Table 23: Sewage Water Monitoring at Gopalpuri STP (2nd Week)

Date of Sampling	09.09.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.6	7.41
2	Total Suspended Solids	mg/l	406	107.4
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	414.1	101
5	BOD @ 27 °C	mg/l	139.0	28.0
6.	Fecal Coliform	MPN Index / 100 ml	-	>1600.0
Aeration Tank				
7.	MLSS	mg/l	14.0	
8	MLVSS	%	90.0	

Table 24: Sewage Water Monitoring at Gopalpuri STP (3rd Week)

Date of Sampling	16.09.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.7	7.36
2	Total Suspended Solids	mg/l	276.6	92.1
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	373.7	104
5	BOD @ 27 °C	mg/l	125.0	28.0
6.	Fecal Coliform	MPN Index / 100 ml	-	>1600.0
Aeration Tank				
7.	MLSS	mg/l	12.0	
8	MLVSS	%	86.0	

Table 25: Sewage Water Monitoring at Gopalpuri STP (4th Week)

Date of Sampling	05.09.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.4	7.22
2	Total Suspended Solids	mg/l	182.4	117.8
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	171.7	101
5	BOD @ 27 °C	mg/l	80.0	23.0
6.	Fecal Coliform	MPN Index / 100 ml	-	920.0
Aeration Tank				
7.	MLSS	mg/l	12.0	
8.	MLVSS	%	88.0	

- **Vadinar STP**

Table 26: Sewage Water Monitoring at Vadinar STP (1st Week)

Date of Sampling	05.09.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.22	7.10
2	Total Suspended Solids	mg/l	62	28.0
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	88.0	56.0
5	BOD @ 27 °C	mg/l	26.0	15.0

Table 27: Sewage Water Monitoring at Vadinar STP (2nd Week)

Date of Sampling	09.09.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.33	7.10
2	Total Suspended Solids	mg/l	72	24.0
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	88.0	60.0
5	BOD @ 27 °C	mg/l	29.0	18.0

Table 28: Sewage Water Monitoring at Vadinar STP (3rd Week)

Date of Sampling	16.09.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.32	7.12
2	Total Suspended Solids	mg/l	60	58.0
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	80.0	55.0
5	BOD @ 27 °C	mg/l	26.0	16.0

Table 29: Sewage Water Monitoring at Vadinar STP (4th Week)

Date of Sampling	21.09.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.18	7.10
2	Total Suspended Solids	mg/l	72	42.0
3	Residual Chlorine	mg/l	<1.0	<0.5
4	COD	mg/l	80.0	58.0
5	BOD @ 27 °C	mg/l	26.0	12.0

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.

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 7^{th}& 8^{th} September-2021 in harbor regions of KPT and on 7^{th} September-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 14^{th}& 15^{th} September 2021 in harbor regions of KPT. 15^{th} September -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	7.20	7.35	7.31	7.27
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.6	32.0	31.0	31.8
5	Turbidity	NTU	37	35	32	28
6	Total Dissolved Solids	mg/l	59704	58025	34000.0	37060.0
7	Total Suspended Solids	mg/l	282	357	382	303.5
8	Total Solids	mg/l	59986	58382	34382.0	37363.5
9	DO	mg/l	4.5	4.7	4.7	5.3
10	COD	mg/l	78.0	82.0	80.0	86.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	6.09	7.49	0.53	0.42
13	Phosphate	mg/l	0.17	0.16	0.18	0.18
14	Sulphate	mg/l	2640	2280	2808	2568
15	Nitrate	mg/l	2.60	1.43	2.26	2.29
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	761.52	921.84	521.04	721.44
18	Magnesium	mg/l	1409.4	1263.6	1749.6	1749.6
19	Sodium	mg/l	11280.0	10920.0	11360.0	11062.0
20	Potassium	mg/l	289.0	320.0	296.0	310.0
21	Iron	mg/l	1.95	1.89	1.85	1.79
22	Chromium	mg/l	0.11	0.13	0.11	0.12
23	Copper	mg/l	0.07	0.08	0.08	0.07
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.04	0.05	0.04	0.05
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.17	0.18	0.13	0.14
28	Zinc	mg/l	0.05	0.06	0.05	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	7.40	7.28	7.4	7.43
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.8	31.6	32.5	32.0
5	Turbidity	NTU	26	27	36	27
6	Total Dissolved Solids	mg/l	55555	51116	34060.0	33780.0
7	Total Suspended Solids	mg/l	363	174	242	582.9
8	Total Solids	mg/l	55918	51290	34302.0	34362.9
9	DO	mg/l	4.9	5.2	5.5	4.6
10	COD	mg/l	96.0	90.0	90.0	88.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	5.16	6.84	0.67	0.71
13	Phosphate	mg/l	0.20	0.18	0.16	0.19
14	Sulphate	mg/l	2820	2376	2832	2496
15	Nitrate	mg/l	2.36	2.89	4.00	3.37
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	721.44	961.92	601.2	681.36
18	Magnesium	mg/l	1409.4	1215	1822.5	1773.9
19	Sodium	mg/l	11862.0	11060.0	11652.0	11110.0
20	Potassium	mg/l	290.0	312.0	299.0	310.0
21	Iron	mg/l	1.96	1.93	1.86	1.93
22	Chromium	mg/l	0.13	0.13	0.13	0.14
23	Copper	mg/l	0.09	0.08	0.06	0.05
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.06	0.05	0.06	0.04
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.19	0.16	0.17	0.18
28	Zinc	mg/l	0.08	0.08	0.07	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	7.19	7.38	7.53	7.34
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.5	32.2	32.6	31.6
5	Turbidity	NTU	35	36	34	33
6	Total Dissolved Solids	mg/l	48086	54880	41460.0	39690.0
7	Total Suspended Solids	mg/l	220	220	376.6	359.9
8	Total Solids	mg/l	48306	55100	41836.6	40049.9
9	DO	mg/l	5.0	5.1	4.8	5.2
10	COD	mg/l	89.0	92.0	81.0	78.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	4.67	4.95	0.47	0.71
13	Phosphate	mg/l	0.16	0.21	0.18	0.19
14	Sulphate	mg/l	2376	2964	2376	2352
15	Nitrate	mg/l	2.04	2.26	4.82	4.60
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	801.60	921.84	440.88	521.04
18	Magnesium	mg/l	1336.5	1287.9	1701	1773.9
19	Sodium	mg/l	12042.0	11910.0	12150.0	11956.0
20	Potassium	mg/l	366.0	372.0	358.0	376.0
21	Iron	mg/l	2.11	2.30	1.96	2.01
22	Chromium	mg/l	0.12	0.15	0.12	0.16
23	Copper	mg/l	0.07	0.09	0.08	0.07
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.04	0.07	0.05	0.07
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.19	0.19	0.17	0.2
28	Zinc	mg/l	0.07	0.07	0.05	0.07

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	7.40	7.38	7.27	7.22
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.4	31.8	31.8	31.6
5	Turbidity	NTU	27	23	39	45
6	Total Dissolved Solids	mg/l	53390	47930	42746.0	35470.0
7	Total Suspended Solids	mg/l	262	354	561.7	520.9
8	Total Solids	mg/l	53652	48284	43307.7	35990.9
9	DO	mg/l	4.8	4.9	5.5	4.7
10	COD	mg/l	78.0	80.0	86.0	82.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	6.98	6.35	0.98	0.85
13	Phosphate	mg/l	0.23	0.21	0.21	0.19
14	Sulphate	mg/l	2220	2268	2412	2568
15	Nitrate	mg/l	2.87	2.03	2.81	3.32
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	801.60	881.76	601.2	480.96
18	Magnesium	mg/l	1312.2	1360.8	1773.9	1773.9
19	Sodium	mg/l	12220.0	12052.0	12012.0	12110.0
20	Potassium	mg/l	300.0	278.0	289.0	280.0
21	Iron	mg/l	2.31	2.22	1.88	2.02
22	Chromium	mg/l	0.16	0.14	0.18	0.16
23	Copper	mg/l	0.06	0.08	0.06	0.05
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.06	0.08	0.06	0.07
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.19	0.17	0.19	0.16
28	Zinc	mg/l	0.09	0.07	0.06	0.08

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	7.47	7.45	7.22	7.39
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.6	31.9	32.0	31.9
5	Turbidity	NTU	35	37	36	48
6	Total Dissolved Solids	mg/l	52041	55010	35620.0	38755.0
7	Total Suspended Solids	mg/l	360	425	387.9	525.7
8	Total Solids	mg/l	52401	55435	36007.9	39280.7
9	DO	mg/l	4.5	4.7	5.4	5.1
10	COD	mg/l	86.0	82.0	92.0	90.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	8.67	9.40	0.82	0.53
13	Phosphate	mg/l	0.17	0.18	0.22	0.18
14	Sulphate	mg/l	2820	2844	2268	2136
15	Nitrate	mg/l	2.56	1.91	2.42	3.81
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	761.52	721.44	521.04	601.2
18	Magnesium	mg/l	1409.4	1458	1676.7	1749.6
19	Sodium	mg/l	11958.0	11628.0	11990.0	11558.0
20	Potassium	mg/l	366.0	376.0	360.0	320.0
21	Iron	mg/l	2.35	2.36	2.05	2.10
22	Chromium	mg/l	0.19	0.20	0.18	0.16
23	Copper	mg/l	0.08	0.09	0.05	0.06
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.06	0.08	0.05	0.08
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.19	0.21	0.17	0.18
28	Zinc	mg/l	0.09	0.08	0.07	0.08

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	7.36	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	31.6		31.8	
5	Turbidity	NTU	38		37	
6	Total Dissolved Solids	mg/l	54144		35040.0	
7	Total Suspended Solids	mg/l	394		327	
8	Total Solids	mg/l	54538		35367.0	
9	DO	mg/l	4.9		5.6	
10	COD	mg/l	78.0		90.0	
11	BOD	mg/l	<2.0		<2.0	
12	Silica	mg/l	6.96		0.67	
13	Phosphate	mg/l	0.19		0.20	
14	Sulphate	mg/l	2964		2340	
15	Nitrate	mg/l	2.21		25.70	
16	Nitrite	mg/l	<0.05		<0.05	
17	Calcium	mg/l	921.84		641.28	
18	Magnesium	mg/l	1263.6		1725.3	
19	Sodium	mg/l	13125.0		13052.0	
20	Potassium	mg/l	360.0		388.0	
21	Iron	mg/l	2.41		2.30	
22	Chromium	mg/l	0.20		0.19	
23	Copper	mg/l	0.09		0.08	
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	0.18		0.2	
28	Zinc	mg/l	0.09		0.05	

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	7.72	7.56	7.4	7.52
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.6	32.0	32.0	32.0
5	Turbidity	NTU	33	34	35	31
6	Total Dissolved Solids	mg/l	41457	45920	34437.0	38630.0
7	Total Suspended Solids	mg/l	299	267	512.6	396
8	Total Solids	mg/l	41756	46187	34949.6	39026.0
9	DO	mg/l	4.7	4.8	5.5	4.8
10	COD	mg/l	90.0	86.0	86.0	89.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	7.27	8.55	0.78	0.77
13	Phosphate	mg/l	0.17	0.18	0.19	0.20
14	Sulphate	mg/l	2316	2388	2388	2532
15	Nitrate	mg/l	3.03	3.15	3.32	2.59
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	841.68	961.92	561.12	601.2
18	Magnesium	mg/l	1385.1	1263.6	1846.8	1822.5
19	Sodium	mg/l	13820.0	13962.0	13762.0	13888.0
20	Potassium	mg/l	310.0	285.0	316.0	296.0
21	Iron	mg/l	1.96	1.99	1.89	2.00
22	Chromium	mg/l	0.19	0.21	0.17	0.16
23	Copper	mg/l	0.08	0.07	0.07	0.06
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.07	0.05	0.07	0.06
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.21	0.16	0.17	0.18
28	Zinc	mg/l	0.08	0.07	0.06	0.05

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 - 4	KPT - 5	Jetty
1	Texture	-	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	mg/kg	1.16	1.12	0.83	0.75	0.86
3	Organic Carbon	mg/kg	0.67	0.65	0.48	0.44	0.50
4	Inorganic Phosphate	mg/kg	111.0	126.0	132.0	142.0	175.0
5	Moisture	%	26.00	27.20	42.60	41	28.20
6	Aluminium	mg/kg	ND	ND	ND	ND	ND
7	Silica	mg/kg	18.0	16.0	13.0	16.0	20.0
8	Phosphate	mg/kg	9.20	10.60	10.66	8.40	8.60
9	Sulphate	mg/kg	219.0	253.0	189.0	211.0	186.0
10	Nitrite	mg/kg	0.12	0.13	0.11	0.12	0.13
11	Nitrate	mg/kg	10.20	8.88	9.25	8.69	9.74
12	Calcium	mg/kg	362.0	322.0	410.0	365.0	310.0
13	Magnesium	mg/kg	210.0	192.0	265.0	196.0	188.0
14	Sodium	mg/kg	3824.0	4012.0	2611.0	2978.0	3777.0
15	Potassium	mg/kg	240.0	202.0	160.0	145.0	178.0
16	Chromium	mg/kg	42.5	16	79	19.2	28.7
17	Nickel	mg/kg	24	20.4	16.9	11	19.3
18	Copper	mg/kg	31.8	36.4	34.2	16.8	31.2
19	Zinc	mg/kg	37.10	32.60	28.00	10.20	24.00
20	Cadmium	mg/kg	ND	ND	ND	ND	ND
21	Lead	mg/kg	3.2	3.9	4.8	3	ND
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 at KPT – 3 & Vadinar SBM location.

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	1.78	0.90	1.03	2.03	0.81	1.31
3	Organic Carbon	mg/kg	1.03	0.52	0.60	1.18	0.47	0.76
4	Inorganic Phosphate	mg/kg	116.0	136.0	142.0	146.0	149.0	166.0
5	Moisture	%	27.00	19.00	27.0	19.0	27.00	19.00
6	Aluminium	mg/kg	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	22.20	19.62	18.0	20.2	18.00	16.66
8	Phosphate	mg/kg	7.6	8.2	8.90	10.60	11.20	9.8
9	Sulphate	mg/kg	234.0	268.0	245.0	210.0	265.0	206.0
10	Nitrite	mg/kg	0.11	0.13	0.12	0.1	0.11	0.12
11	Nitrate	mg/kg	8.88	9.20	7.66	9.75	8.88	7.82
12	Calcium	mg/kg	378.0	325.0	389.0	378.0	378.0	296.0
13	Magnesium	mg/kg	216.0	206.0	233.0	186.0	210.0	198.0
14	Sodium	mg/kg	4428.0	3971.0	4554.0	2491.0	3036.0	3798.0
15	Potassium	mg/kg	221.0	152.0	167.0	149.0	116.0	160.30
16	Chromium	mg/kg	38.5	12.1	34.9	77.8	18.7	29.4
17	Nickel	mg/kg	27.3	20.4	36.9	21.6	13.1	19.3
18	Copper	mg/kg	11.8	33.5	40.7	20.2	11	41.2
19	Zinc	mg/kg	47.10	61.00	64.10	38.70	5.20	24.00
20	Cadmium	mg/kg	ND	ND	ND	ND	ND	ND
21	Lead	mg/kg	4.4	4.4	5.6	5.7	2.8	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

SEPTEMBER,2021

DCPL/DPT/20-21/17 -SEPTEMBER - 2021

INTRODUCTION:

Sampling Stations:

The monitoring of marine environment for the study of biological and ecological Parameters was carried out on8th September 2021 in harbour region of DPT, and on 9th September2021 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 14th September 2021 in harbour region of DPT and on 15th September 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 litre 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.

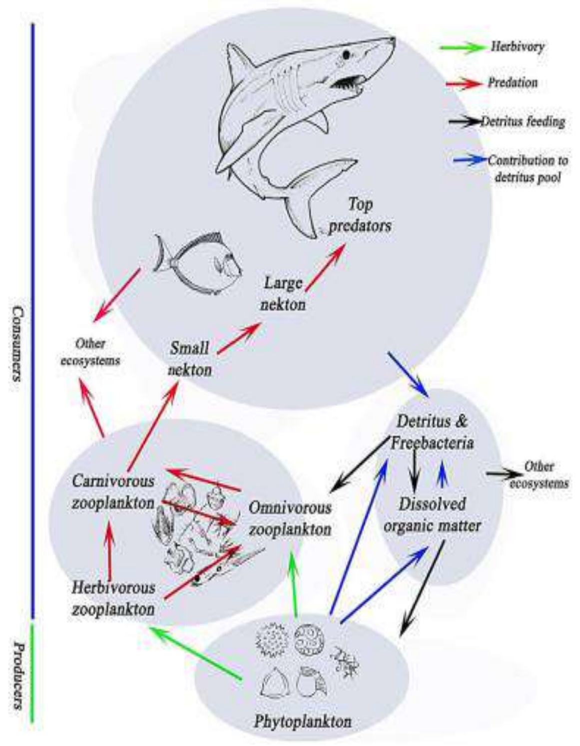
Based on the duration of planktonic life, zooplankton are categorised into Holoplankton (organisms which complete their entire lifecycle as plankton) and Meroplankton (organisms which are planktonic during the early part of their lives such as the larval stages of benthic and nektonic organisms). Tychoplankton 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 10-15 minutes, 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 0.366 -0.613mg/m^3.in harbour region of DPT during sampling done in spring tide period of September 2021. In the nearby creeks chlorophyll-a was varying from 0.101-0.851mg/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 0.322 -0.645mg/m^3.in harbour region of DPT during sampling done in neap tide period of September 2021 . In the nearby creeks chlorophyll-a was varying from 0.291-0.614 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 SEPTEMBER,2021

Sr. No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPT HARBOUR AREA					
1	KPT1	High tide	0.410	BDL	27.47
		Low tide	0.366	BDL	24.52
2	KPT 2	High tide	0.409	BDL	27.40
		Low tide	0.467	BDL	31.29
3	KPT 3	High tide	0.512	BDL	34.30
		Low tide	0.613	BDL	41.07
CREEKS					
4	KPT-4 Khori-I	High tide	0.645	BDL	43.22
		Low tide	0.748	BDL	50.12
5	KPT-5 Nakti-I	High tide	0.818	BDL	54.81
		Low tide	0.851	BDL	57.02
6	KPT-5 Nakti-II	High tide	0.101	BDL	6.76

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 SEPTEMBER,2021

Sr. No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPT HARBOUR AREA					
1	KPT1	High tide	0.322	BDL	21.57
		Low tide	0.323	BDL	21.64
2	KPT 2	High tide	0.630	BDL	42.21
		Low tide	0.615	BDL	41.21
3	KPT 3	High tide	0.527	BDL	35.31
		Low tide	0.645	BDL	43.22
CREEKS					
4	KPT-4 Khori-I	High tide	0.511	BDL	34.24
		Low tide	0.599	BDL	40.13
5	KPT-5 Nakti-I	High tide	0.529	BDL	35.44
		Low tide	0.614	BDL	41.14
6	KPT-5 Nakti-II	High tide	0.291	BDL	19.50

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 andblue green algae during spring tide period.Diatoms were represented by 18 genera. Blue green were represented by 3 generaduring the sampling conducted in spring tide in September,2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 85-116 units/ L during high tide period and103-133 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 duringNeap tide period.Diatoms were represented by 15genera and Blue green algae were represented 3 genera during the sampling conducted in Neap tide in September, 2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from45 -155 units/ L during high tide period and 131-182 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 1.801-3.197 with an average of 2.642 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 12.458-2.904 with an average of 2.697 during the consecutive low tide period .

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was varying from 1.808-2.461 with an average of 2.087 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. 1.961-2.882 with an average of 2.371 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 0.771-0.988 (H'(log10)) between selected sampling stations with an average value of 0.934during high tide period of spring tide. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.893-0.932 (H'(log10)) between selected sampling stations with an average value of 0.916 during consecutive lowtide. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.781-0.911 (H'(log10)) between selected sampling stations with an average value of 0.862 during high tide period of neap tide. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.823-0.969 (H'(log10)) between selected sampling stations with an average value of 0.904during 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 0.797- 0.882 between selected sampling stations with an average of 0.862 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 0.845- 0.867 between selected sampling stations with an average of 0.854during 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 0.821-0.857 with an average value of 0.845 between selected sampling stations during high tide period and varying from 0.824-0.870 with an average

value of 0.853 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 SEPTEMBER,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	109	16/21	76.19	3.197	0.9854	0.8739
	2	110	13/21	61.90	2.553	0.9544	0.8754
	3	107	13/21	61.90	2.568	0.9737	0.8824
	4	105	14/21	66.66	2.793	0.9885	0.8811
	5	116	15/21	71.43	2.945	0.9317	0.8627
	6	85	9/21	42.86	1.801	0.7711	0.7978
LOW TIDE	1	103	13/21	61.90	2.589	0.9277	0.8667
	2	132	13/21	61.90	2.458	0.9324	0.8648
	3	124	15/21	71.43	2.904	0.91	0.8451
	4	130	14/21	66.66	2.671	0.8926	0.8458
	5	133	15/21	71.43	2.863	0.9185	0.8479

Table # 5 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN SEPTEMBER,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	131	13/18	72.22	2.461	0.881	0.8452
	2	144	12/18	66.66	2.213	0.8693	0.8503
	3	145	10/18	55.55	1.808	0.8678	0.8511
	4	155	11/18	61.11	1.983	0.8653	0.8484
	5	153	12/18	66.66	2.187	0.911	0.8573
	6	42	8/18	44.44	1.873	0.7809	0.8211
LOW TIDE	1	131	11/18	61,11	2.051	0.8234	0.8243
	2	153	12/18	66.66	2.187	0.8951	0.8542
	3	182	16/18	88.88	2.882	0.9697	0.8703
	4	155	15/18	83.33	2.776	0.9374	0.8618
	5	164	11/18	61.11	1.961	0.8971	0.8564

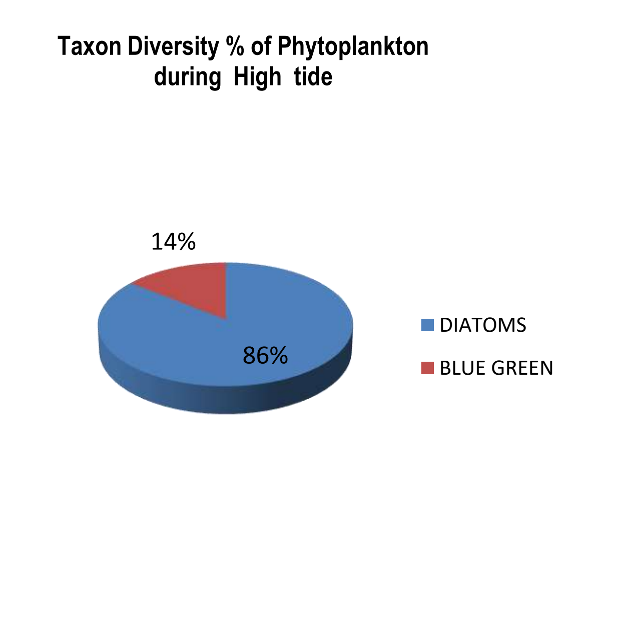
Table # 6 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING SPRING TIDE IN SEPTEMBER, 2021

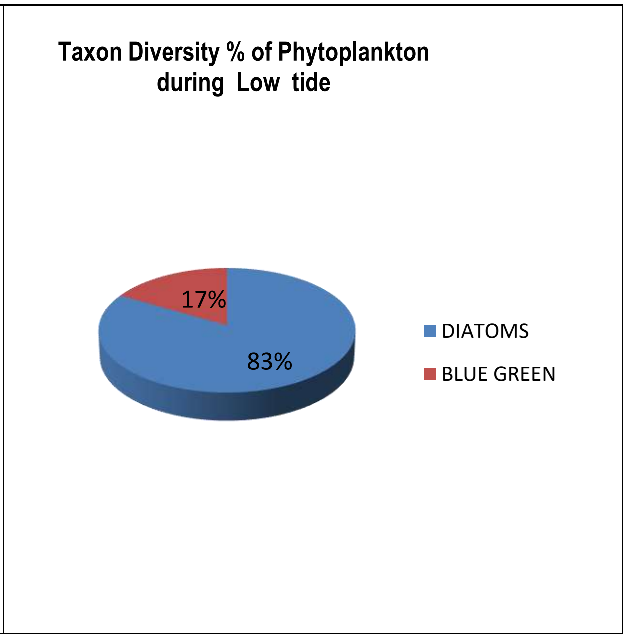
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	83-110	18/21	85.71
			BLUE GREEN	2-12	3/21	14.29
			TOTAL PHYTO PLANKTON	**85-116**	**21**	-
LOW TIDE	Sub surface	5	DIATOMS	93-129	18/21	85.71
			BLUE GREEN	4-13	3/12	14.29
			TOTAL PHYTO PLANKTON	103-133	**21**	-

Table # 7 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING NEAP TIDE IN SEPTEMBER,2021

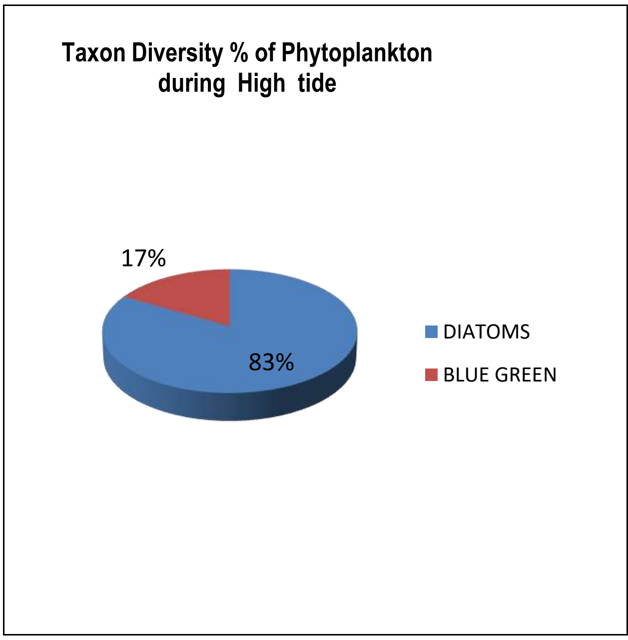
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	DIATOMS	38-154	15/18	83.33
			BLUE GREEN	1-4	3/18	16.67
			TOTAL PHYTO PLANKTON	**42-155**	**18**	-
LOW TIDE	Sub surface	5	DIATOMS	131-177	15/18	83.33
			BLUE GREEN	0-5	3/18	16.67
			TOTAL PHYTO PLANKTON	**131-182**	**18**	-

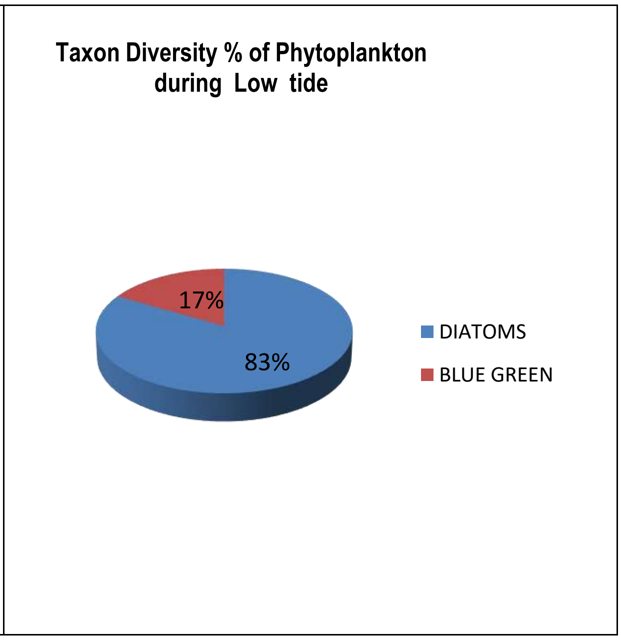
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide





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 September,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 Seven groups, Tintinids, Copepods, Arrow worms , Ciliates ,Mysids,Foraminiferans 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 32-86x10^3 N/ m^3 during high tide and 64-100 x103 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 43-173 x103 N/ m^3 during high tide and115-184x10^3 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 2.825-3.507 with an average of 3.009during the sampling conducted in High tide period.Margalef's diversity index (Species Richness) S of Zooplankton communities varying from. 2.645-3.423 with an average of 3.020 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 from3.722- 4.463with an average of 4.061 during the sampling conducted in high tide and varying from. 4.163-4.647 with an average of 4.458 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 0.909-1.014 (H'(log10)) between selected sampling stations with an average value of 0.966 (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 0.929-0.989(H'(log10)) between selected sampling stations with an average value of 0.963 (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 0.925-1.248 (H'(log10)) between selected sampling stations with an average value of 1.155 (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 1.185-1.254 (H'(log10)) between selected sampling stations with an average value of 1.214 (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 0.849-0.889between selected sampling stations with an average of 0.872 during high tide period and was varying from 0.845- 0.880 with an average value of 0.868 between selected sampling stations during low tide

Simpson diversity index (1-D) of Zooplankton communities was above 0.9 at all sampling stationsin the Kandla Harbour region and nearby creeks except few during high tide and low tide period, which was varying from 0.834-0.939between selected sampling stations with an average of 0.914 during high tide period and was varying from 0.920- 0.939 with an average value of 0.929 between selected sampling stations during consecutive low tide

This high species diversity suggests a relatively more number of successful species in this habitat during September ,2021 sampling.

Table # 8 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN SEPTEMBER,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	72 X10^3	16/23	69.56	3.507	0.9864	0.8725
	2	70 X10^3	13/23	56.52	2.825	0.9094	0.8584
	3	81 X10^3	14/23	60.87	2.958	0.9324	0.8494
	4	82 X10^3	15/23	65.22	3.177	1.014	0.8871
	5	86 X10^3	14/23	60.87	2.918	1.008	0.8892
	6	32 X10^3	12/23	52.17	3.174	0.9456	0.875
LOW TIDE	1	80 X10^3	16/23	69.56	3.423	0.9692	0.8661
	2	64 X10^3	12/23	52.17	2.645	0.9299	0.873
	3	70 X10^3	13/23	56.52	2.825	0.9384	0.8451
	4	82 X10^3	14/23	60.87	2.95	0.9894	0.8802
	5	100 X10^3	16/23	69.56	3.257	0.9872	0.8772

Table # 9 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING NEAP TIDE IN SEPTEMBER,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	107 X10^3	21/29	72.41	4.28	1.16	0.9185
	2	123 X10^3	19/29	65.52	3.741	1.19	0.9315
	3	168 X10^3	22/29	75.86	4.098	1.205	0.9328
	4	173 X10^3	24/29	82.76	4.463	1.248	0.9389
	5	137 X10^3	21/29	72.41	4.065	1.203	0.9342
	6	43 X10^3	15/29	51.72	3.722	0.9255	0.8339
LOW TIDE	1	115 X10^3	22/29	75.86	4.426	1.185	0.9202
	2	122 X10^3	21/29	72.41	4.163	1.19	0.9252
	3	175 X10^3	25/29	86.21	4.647	1.254	0.9395
	4	184 X10^3	25/29	86.21	4.602	1.23	0.9342
	5	140 X10^3	23/29	79.31	4.452	1.21	0.9274

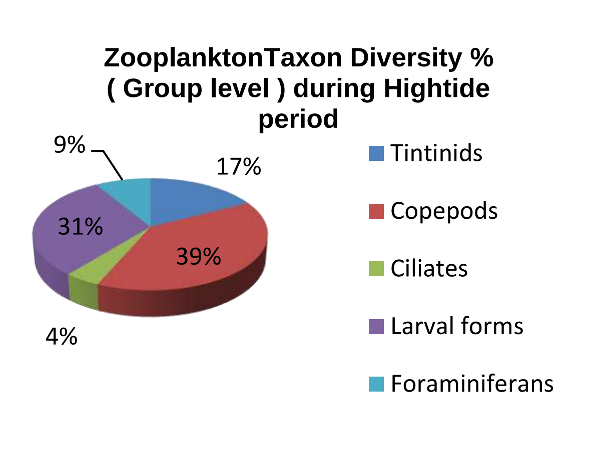
Table # 10 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS DURING SPRING TIDE IN SEPTEMBER,2021

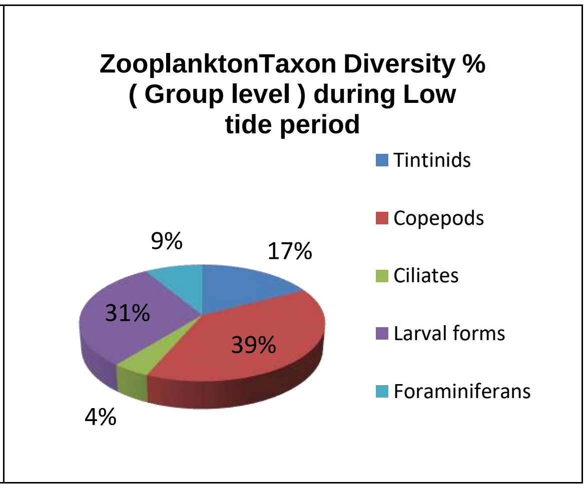
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	0-8	4/23	17.39
			Copepods	16-51	9/23	39.13
			Ciliates	0-1	1/23	4.35
			Larval forms	14-35	7/23	30.44
			Foraminiferans	0-3	2/23	8.69
			TOTAL ZOOPLANKTON NO/L	**32-86**	**23**	**23**
LOW TIDE	Sub surface	5	Tintinids	2-6	4/23	17.39
			Copepods	29-53	9/23	39.13
			Ciliates	0-1	1/23	4.35
			Larval forms	26-39	7/23	30.44
			Foraminiferans	1-4	2/23	8.69
			TOTAL ZOOPLANKTON NO/M3	**64-100**	**23**	**23**

Table # 11 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA, NEAR BY CREEKS DURING NEAP TIDE IN SEPTEMBER, 2021

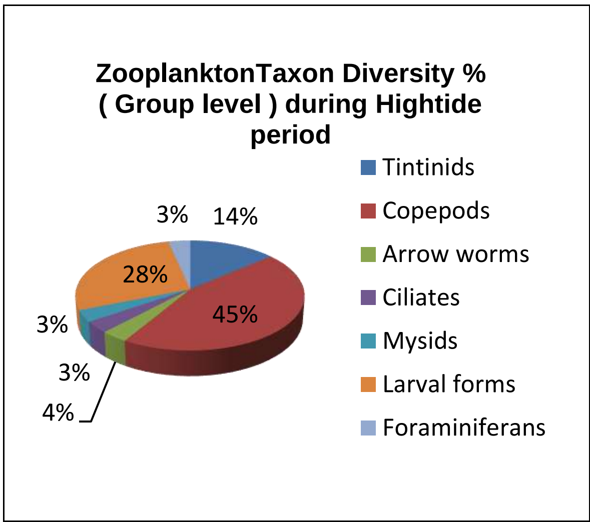
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	6	Tintinids	1-8	4/29	13.79
			Copepods	17-71	13/29	44.83
			Arrow worms	0-1	1/29	3.45
			Ciliates	1-7	1/29	3.45
			Mysids	0-4	1/29	3.45
			Larval forms	22-87	8/29	27.58
			Foraminiferans	0-2	1/29	3.45
			TOTAL ZOOPLANKTON	**43-173**	**29**	**-**
LOW TIDE	Sub surface	5	Tintinids	2-8	4/29	13.79
			Copepods	38-70	13/29	44.83
			Arrow worms	0-1	1/29	3.45
			Ciliates	3-7	1/29	3.45
			Mysids	1-4	1/29	3.45
			Larval forms	67-106	8/29	27.58
			Foraminiferans	**0-1**	1/29	3.45
			TOTAL ZOOPLANKTON NO/M3	**115-184**	**29**	**-**

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



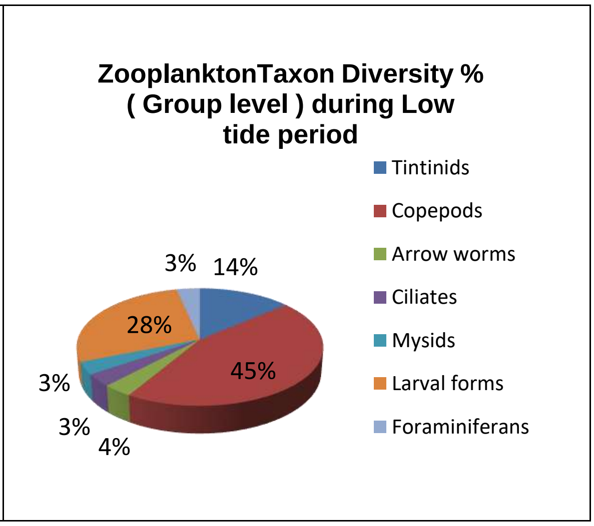


TABLE # 12 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURINGSPRING TIDE OF SEPTEMBER 2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALGAE	Cyanophyta	Cyanophyceae	Nostocales	Oscillatoriaceae	*Oscillatoria* sp.	B1	Occasional
					Arthrospira sp.	B2	Rare
			Stigonematales	Stigonemataceae	*Stigonema sp.*	B3	Rare
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Occasional
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D2	Abundant
			Triceratiales	Triceratiaceae	*Odontella sp*	D3	Frequent
					Triceratium sp.	D4	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D5	Dominant
			Hemiaulales	Bellerocheaceae	*Bellerochea* sp	D6	Rare
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D7	Rare
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp	D8	Occasional
			Lithodesmiales	Lithodesmiaceae	*Ditylum sp*	D9	Abundant
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma* sp	D10	Rare
					Navicula sp	D11	Rare
			Surirellales	*Surirellaceae*	*Surirella* sp	D12	Rare
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D13	Frequent
					Thalassionema sp.	D14	Rare
			Fragilariales	Fragilariaceae	*Asterionellopsis sp.*	D15	Rare
					Fragilaria sp	D16	Occasional
					*Synedra*sp	D17	Rare
			Tabellariales	Tabellariaceae	*Tabellaria* sp	D18	Rare

TABLE # 13 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AND NEARBY CREEKS DURING AND NEAP TIDE OF SEPTEMBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALGAE	Cyanophyta	Cyanophyceae	Nostocales	Oscillatoriaceae	*Oscillatoria* sp.	B1	Rare
					Arthrospira 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	Frequent
					Triceratium sp.	D4	Occasional
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D5	Dominant
			Hemiaulales	Bellerocheaceae	*Bellerochea* sp	D6	Occasional
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp	D7	Rare
			Lithodesmiales	Lithodesmiaceae	*Ditylum sp*	D8	Abundant
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma* sp	D9	Occasional
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D10	Abundant
					Thalassionema sp.	D11	Rare
			Fragilariales	Fragilariaceae	*Asterionellopsis sp.*	D12	Rare
					Fragilaria sp	D13	Occasional
					*Synedra*sp	D14	Frequent
			Tabellariales	Tabellariaceae	*Tabellaria* sp	D15	Rare

TABLE #14 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS IN DPT HARBOUR AREA, AND NEAR BY CREEKS DURING SPRING TIDE OF SEPTEMBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnus sp.*	T1	Rare
				Codonellidae	*Tintinnopsis gracilis*	T2	Occasional
					Tintinnopsis radix	T3	Rare
					Tintinnopsis tocantinensis	T4	Rare
COPEPODS	ATHROPODA	Crustacea Sub class copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Abundant
				Eucalanidae	*Pareucalanus sp.*	C2	Rare
				Clausocalanidae	*Clausocalanus sp.*	C3	Occasional
				Acartiidae	*Acartia sp.*	C4	Rare
				Temoridae	*Temora sp.*	C5	Occasional
			Cyclopoida	Oithonidae	*Oithona sp.*	C6	Frequent
			Harpacticoida	Ectinosomatidae	*Microsetella* sp.	C7	Frequent
				Euterpinidae	*Euterpina sp.*	C8	Rare
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C9	Rare
CILIATES	CILIOPHORA	Oligohymenophorea	Sessilida	Zoothamniidae	*Zoothamnium sp.*	CI1	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L2	Occasional
POLYCHAETE LARVAE	ANNELIDA	Polychaeta			Trochophore larvae	L3	Rare
BARNACLE LARVAE	ATHROPODA CRUSTACEA	Maxillopoda Thecostraca			Cirripede larvae	L4	Rare
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda,Streptoneura			Opisthobranchia larvae	L5	Occasional
CYPHONAUTES LARVAE	BRYOZOA				Cyphonautes larvae	L6	Rare
BRACHYURA LARVAE	ARTHROPODA (CRUSTACEA)	Malacostraca Decapoda			Brachyuran Zoea larvae	L7	Rare
FORAMINIFERA	FORAMINIFERA	Globothalamea	Rotaliida	Globigerinidae	*Globigerina* sp.	F1	Rare
				Rotalliidae	*Rotalia* sp.	F2	Rare

TABLE # 15 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS IN DPT HARBOUR AREA, AND NEAR BY CREEKS DURING NEAP TIDE OF SEPTEMBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnus sp.*	T1	Rare
				Codonellidae	*Tintinnopsis gracilis*	T2	Occasional
					Tintinnopsis radix	T3	Rare
					Tintinnopsis failakkaensis	T4	Rare
COPEPODS	ATHROPODA	Crustacea Sub class copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Frequent
					Parvocalanus sp.	C2	Rare
				Eucalanidae	*Pareucalanus sp.*	C3	Rare
					Subeucalanus sp.	C4	Rare
				Clausocalanidae	*Clausocalanus sp.*	C5	Occasional
				Centropagidae	*Centropages sp.*	C6	Rare
				Tortanidae	*Tortanus sp.*	C7	Rare
				Acartiidae	*Acartia sp.*	C8	Frequent
				Temoridae	*Temora sp.*	C9	Occasional
			Cyclopoida	Oithonidae	*Oithona sp.*	C10	Abundant
			Harpacticoida	Ectinosomatidae	*Microsetella* sp.	C11	Frequent
				Euterpinidae	*Euterpina sp.*	C12	Occasional
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C13	Rare
ARROW WORMS	CHAETOGNATHA	Sagittoidea	Aphragmophora	Sagittidae	*Sagitta sp.*	A1	Rare
CILIATES	CILIOPHORA	Oligohymenophorea	Sessilida	Zoothamniidae	*Zoothamnium sp.*	CI1	Occasional
MYSIDS	ATHROPODA CRUSTACEA	Malacostraca	Mysida, Decapoda	Penaeidae	*Penaeus sp.*	M1	Occasional
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BRACHYURA LARVAE	ARTHROPODA (CRUSTACEA)	Malacostraca Decapoda			Brachyuran Zoea larvae	L2	Abundant

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
BARNACLE LARVAE	ATHROPODA CRUSTACEA	Maxillopoda Thecostraca			Cirripede larvae	L3	Frequent
CYPHONAUTES LARVAE	BRYOZOA				Cyphonautes larvae	L4	Occasional
ECHINODERMATA LARVAE	ECHINODERMATA				Ophipluutes larvae/ Echinoplutes larvae	L5	Occasional
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L6	Occasional
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L7	Frequent
POLYCHAETE LARVAE	ANNELIDA	Polychaeta			Trochophore larvae	L8	Frequent
FORAMINIFERA	FORAMINIFERA	Globothalamea	Rotaliida	Rotalliidae	*Rotalia* sp.	F1	Rare

BENTHIC ORGANISMS:

Few Benthic organismswere observed in the collected sediments by using the Van-veen grabs during the sampling conducted during spring tide period and while no benthic organisms were observed during sampling conducted in Neap tide period from DPT harbour region and nearby creek except few dead shells.The meiobenthic organisms during spring tide were represented by Polychaetes,and Nematodes. The polychaetes were represented by *Scyphoproctus sp*. and *Branchiocapitelida* sps,during spring tide sampling. The meiobenthic organisms in the collected samples were varying from 0-80N/M ^{2}.

Table # 16 BENTHIC FAUNA IN THE SAMPLING LOCATIONS IN DPT HARBOUR AREA CREEKS DURING SPRING TIDE IN SEPTEMBER ,2021

Benthic fauna	ABUNDANCE IN NO/M ^{2} DIFFERENT SAMPLING STATIONS REPRESENTATION BY GROUP						
	DPT HARBOUR			CREEKS			
POLYCHAETES	KPT-1	KPT-2	KPT-3	KPT-4	KPT-5	KPT-6	
Family : Capitellidae **Scyphoproctus** *sp.*	40	0	0	0	0	NS	
Family : Capitellidae **Branchiocapitelida** *sp.*	0	20	0	0	0		
Total Polychates N/M^2	40	20	0	00	0	NS	
Un identified Nematode worms	40	20	0	10	0	NS	
TOTAL Benthic Fauna NUMBER/ M^2	80	40	0	10	0	-	

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 29.0 °C. The day-time maximum temperature was 36.2 °C. The mean night time temperature was 26.7 °C. The minimum mean night time temperature recorded was 29.4 °C.

Air Pressure

The mean absolute air pressure for the month of September was 1003.7 hpa, whereas the mean relative pressure was 1002.3 hpa. The maximum absolute air pressure recorded for the month of September was 1010.1 hpa.

Heat Index

The mean day-time heat index for the month of September was 33.5 ^{o}C. The maximum heat index recorded was 49^{o}C.

Solar Radiation

The mean Solar Radiation in September was 136.4 w/m^2. The maximum solar radiation recorded in the month of September was 808.9 w/m^2.

Humidity

The mean day-time humidity was 83.5 % for the month of September and mean night time humidity was 98.0%. Maximum humidity recorded during day-time was 90.3 % and maximum humidity recorded during night-time was 96.0%.

Wind Velocity and Wind Direction

The mean wind velocity for the entire month of September was 6.88 km/hour. Maximum wind velocity recorded was 43.2 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 September, 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.

SOURCE OF LITERATURE AND ADDITIONAL REFERENCE FOR ECOLOGICAL STUDY

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ENVIRONMENTAL MONITORING REPORT
FOR
DEENDAYAL PORT TRUST

REPORT NO.	:	DCPL/DPT/20-21/18
Month	:	October 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 October 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	06.10.2021	349	165	80	2.20	2.64	26.04	25.19	12.76	13.44
					3.96		24.14		12.25	
					1.76		25.41		15.32	
AL1 – 2	08.10.2021	474	229	103	4.40	3.22	15.24	19.27	12.51	13.02
					3.08		16.51		13.02	
					2.20		26.04		13.53	
AL1 – 3	13.10.2021	280	162	58	7.47	7.33	28.58	26.04	10.72	10.81
					8.79		31.12		12.51	
					5.71		18.42		9.19	
AL1 – 4	15.10.2021	404	227	95	3.08	2.49	16.51	15.24	13.79	14.89
					2.64		13.97		15.83	
					1.76		15.24		15.06	
AL1 – 5	20.10.2021	336	156	73	3.52	3.96	18.42	20.54	5.87	9.28
					4.84		20.96		10.72	
					3.52		22.23		11.23	
AL1 - 6	22.10.2021	453	267	85	2.64	3.52	15.88	15.67	10.72	6.47
					5.28		19.69		5.62	
					2.64		11.43		3.06	
AL1 - 7	27.10.2021	338	163	76	3.52	3.37	12.07	16.73	10.47	10.55
					3.96		20.96		11.49	
					2.64		17.15		9.70	
AL1 – 8	29.10.2021	275	152	88	2.64	3.08	24.14	25.19	12.51	9.02
					2.20		29.22		6.64	
					4.40		22.23		7.91	
Monthly Average		364	190	82		3.70		20.48		10.93
Standard Deviation		74	44	14		1.54		4.50		2.75

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	06.10.2021	1.12	BQL	1.89	492
AL1 – 2	08.10.2021	1.11	BQL	1.75	489
AL1 – 3	13.10.2021	1.32	BQL	1.82	499
AL1 – 4	15.10.2021	1.15	BQL	1.76	492
AL1 – 5	20.10.2021	1.13	BQL	1.84	493
AL1 - 6	22.10.2021	1.15	BQL	1.86	501
AL1 – 7	27.10.2021	1.21	BQL	1.88	488
AL1 – 8	29.10.2021	1.13	BQL	1.95	511
Monthly Average		**1.17**	**-**	**1.84**	**496**
Standard Deviation		**0.07**	**-**	**0.07**	**8**

* NMHC- Non- Methane Hydrocarbons

BQL- Below Quantification Limit (Quantification Limit – NMHC: 0.5 ppm)

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 364 µg/m³, The mean PM_{10} values were 190.0 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 82 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 3.70 µg/ m³, 20.48 µg/ m³ & 10.93 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 1.17 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.84 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	06.10.2021	380	162	82	4.40	5.28	33.66	33.66	8.93	9.96
					5.28		36.84		10.21	
					6.15		30.49		10.72	
AL2 – 2	08.10.2021	486	284	103	1.76	3.96	8.89	11.01	6.38	9.62
					4.84		9.53		10.98	
					5.28		14.61		11.49	
AL2 – 3	13.10.2021	451	300	89	7.47	9.52	32.39	24.35	3.57	6.30
					9.23		18.42		6.13	
					11.87		22.23		9.19	
AL2 – 4	15.10.2021	480	335	100	2.20	2.05	16.51	14.82	7.40	8.93
					2.64		14.61		10.47	
					1.32		13.34		8.93	
AL2 – 5	20.10.2021	464	190	76	2.64	2.49	20.33	19.48	9.19	7.32
					1.76		24.77		4.85	
					3.08		13.34		7.91	
AL2 – 6	22.10.2021	509	280	100	4.84	5.28	20.96	14.82	5.62	8.00
					7.03		10.16		7.91	
					3.96		13.34		10.47	
AL2 – 7	27.10.2021	448	215	71	1.76	1.76	22.87	19.48	9.19	10.04
					1.32		14.61		12.51	
					2.20		20.96		8.42	
AL2 – 8	29.10.2021	504	204	92	1.32	2.49	14.61	17.36	6.38	9.10
					2.20		22.87		9.96	
					3.96		14.61		10.98	
Monthly Average		465	246	89		4.10		19.37		8.66
Standard Deviation		41	61	12		2.59		7.01		1.34

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	06.10.2021	1.11	BQL	1.88	499
AL2 -2	08.10.2021	1.21	BQL	1.78	495
AL2 -3	13.10.2021	1.26	BQL	1.86	468
AL2 -4	15.10.2021	1.11	BQL	1.83	466
AL2 – 5	20.10.2021	1.22	BQL	1.89	458
AL2 – 6	22.10.2021	1.18	BQL	1.87	488
AL2 -7	27.10.2021	1.01	BQL	1.77	498
AL2 – 8	29.10.2021	1.14	BQL	1.82	501
Monthly Average		**1.16**	**-**	**1.84**	**484**
Standard Deviation		**0.08**	**-**	**0.05**	**17**

* NMHC- Non- Methane Hydrocarbons

BQL- Below Quantification Limit (Quantification 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 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 465 µg/m³ .The mean PM_{10} values were 246 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 mean concentration of SO_2, NO_x and NH3 were 4.10 µg/m³, 19.37 µg/m³ and 8.66 µg/m³ respectively.

The levels of Benzene, Hydrocarbons (HC) and CO were within the permissible limit at Oil Jetty. The mean Benzene concentration was 1.16 µg/m³ .Well below the permissible limit of 5.0 µg/m³. , HC's were below the detectable limit and Carbon Monoxide concentration was 1.84 mg/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

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	06.10.2021	355	161	79	4.84	3.37	12.70	23.08	14.30	12.00
					3.52		24.14		12.25	
					1.76		32.39		9.45	
AL3 – 2	08.10.2021	280	121	76	3.96	2.64	13.34	12.49	10.47	9.10
					1.32		9.53		11.49	
					2.64		14.61		5.36	
AL3 – 3	13.10.2021	420	282	98	3.08	3.52	13.97	19.48	7.91	5.87
					4.84		19.69		6.38	
					2.64		24.77		3.32	
AL3 – 4	15.10.2021	530	287	101	4.40	2.93	8.89	8.05	12.25	9.10
					2.64		8.26		9.19	
					1.76		6.99		5.87	
AL3 – 5	20.10.2021	401	239	98	5.28	3.66	18.42	23.50	8.93	9.19
					3.08		32.39		9.70	
					2.64		19.69		8.93	
AL3 – 6	22.10.2021	381	244	93	5.28	4.40	18.42	19.27	10.47	8.25
					1.76		14.61		8.93	
					6.15		24.77		5.36	
AL3 – 7	27.10.2021	466	194	90	4.84	2.93	19.69	17.36	11.23	10.81
					2.64		16.51		10.72	
					1.32		15.88		10.47	
AL3 – 8	29.10.2021	380	222	87	1.76	2.93	15.88	16.94	12.00	9.10
					4.40		15.24		9.70	
					2.64		19.69		5.62	
Monthly Average		402	219	90		3.30		17.52		9.18
Standard Deviation		74	58	9		0.56		5.20		1.79

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	06.10.2021	1.01	BQL	1.85	489
AL3 -2	08.10.2021	1.12	BQL	1.98	496
AL3 -3	13.10.2021	1.02	BQL	1.79	488
AL3 -4	15.10.2021	1.11	BQL	1.81	499
AL3 – 5	20.10.2021	1.06	BQL	1.88	480
AL3 – 6	22.10.2021	1.18	BQL	1.79	485
AL3 – 7	27.10.2021	1.26	BQL	1.96	472
AL3 – 8	29.10.2021	1.14	BQL	1.88	498
Monthly Average		**1.11**	**-**	**1.87**	**488**
Standard Deviation		**0.08**	**-**	**0.07**	**9**

* NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification 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 402 µg/m^3, The mean PM_{10} values were 219 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 90 µg/m^3). The average values of SO_2, NO_x and NH3 were 3.30 µg/m^3, 17.52 µg/m^3 and 9.18 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 1.11 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 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	06.10.2021	158	96	40	6.15	4.40	18.42	25.83	3.83	5.87
					3.96		25.41		7.40	
					3.08		33.66		6.38	
AL4 -2	08.10.2021	246	115	77	3.96	5.28	12.70	10.37	4.85	5.70
					5.28		9.53		5.11	
					6.59		8.89		7.15	
AL4 -3	13.10.2021	302	129	66	2.20	2.64	10.16	11.22	3.83	4.25
					3.08		12.70		4.85	
					2.64		10.80		4.08	
AL4 -4	15.10.2021	414	267	89	2.20	2.20	10.16	8.68	6.38	5.45
					2.64		9.53		4.60	
					1.76		6.35		5.36	
AL4 – 5	20.10.2021	268	128	90	2.64	2.64	14.61	14.61	4.85	6.64
					3.08		9.53		8.42	
					2.20		19.69		6.64	
AL4 – 6	22.10.2021	219	114	93	2.64	2.49	13.34	12.49	4.85	8.51
					3.08		9.53		9.19	
					1.76		14.61		11.49	
AL4 – 7	27.10.2021	274	132	84	2.64	3.08	17.78	15.88	6.38	6.55
					3.08		13.34		7.91	
					3.52		16.51		5.36	
AL4 – 8	29.10.2021	311	142	96	2.20	3.22	13.34	12.70	7.40	8.25
					3.52		13.97		8.42	
					3.96		10.80		8.93	
Monthly Average		274	140	79		3.24		13.97		6.40
Standard Deviation		75	53	18		1.06		5.30		1.43

NS: Not Specified

Table 4B : Results of Air Pollutant Concentration at Gopalpuri Hospital					
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
AL4 -1	06.10.2021	1.02	BQL	1.88	496
AL4 -2	08.10.2021	1.11	BQL	1.68	482
AL4 -3	13.10.2021	1.32	BQL	1.65	501
AL4 -4	15.10.2021	1.25	BQL	1.79	499
AL4 – 5	20.10.2021	1.52	BQL	1.65	501
AL4 – 6	22.10.2021	1.32	BQL	1.82	508
AL4 – 7	27.10.2021	1.23	BQL	1.7	487
AL4 – 8	29.10.2021	1.58	BQL	1.76	496
Monthly Average		**1.29**	**-**	**1.74**	**496**
Standard Deviation		**0.19**	**-**	**0.08**	**8**

* NMHC- Non- Methane Hydrocarbons

BQL- Below Quantification Limit (Quantification 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 TSPM values at Oil Jetty were 274 µg/m³, The mean PM_{10} values were 140 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean= 79 µg/m³). The average values of SO_2, NO_x and NH_3 were 3.24 µg/m³, 13.97 µg/m³ and 6.40 µg/m³ 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 1.29 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.74 mg/m³, well below the permissible limit of 4.0 mg/m³.

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	06.10.2021	266	122	92	4.40	5.71	44.46	49.33	15.32	14.04
					6.15		49.54		13.53	
					6.59		53.99		13.27	
AL5 – 2	08.10.2021	360	208	79	3.96	3.96	20.33	18.84	15.57	16.25
					2.64		22.23		17.61	
					5.28		13.97		15.57	
AL5 – 3	13.10.2021	647	226	110	10.11	8.65	22.23	22.87	7.91	7.32
					6.15		26.04		6.13	
					9.67		20.33		7.91	
AL5 – 4	15.10.2021	760	217	118	1.32	2.93	16.51	18.84	12.51	9.62
					3.52		19.69		8.42	
					3.96		20.33		7.91	
AL5 – 5	20.10.2021	597	244	110	4.84	4.25	19.69	20.75	10.72	11.32
					4.40		17.78		10.98	
					3.52		24.77		12.25	
AL5 – 6	22.10.2021	647	206	106	3.52	4.54	14.61	17.15	14.30	14.47
					3.96		15.88		15.06	
					6.15		20.96		14.04	
AL5 – 7	27.10.2021	614	249	107	4.40	4.25	13.34	16.51	9.96	9.36
					4.84		17.78		9.19	
					3.52		18.42		8.93	
AL5 – 8	29.10.2021	324	151	117	4.84	4.10	22.87	25.41	12.51	14.04
					3.96		27.95		14.30	
					3.52		25.41		15.32	
Monthly Average		527	203	105		4.80		23.71		12.05
Standard Deviation		182	44	13		1.73		10.76		3.11

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	06.10.2021	1.22	BQL	1.85	498
AL5 – 2	08.10.2021	1.32	BQL	1.86	488
AL5 – 3	13.10.2021	1.22	BQL	1.89	485
AL5 – 4	15.10.2021	1.16	BQL	1.84	501
AL5 – 5	20.10.2021	1.33	BQL	1.86	496
AL5 – 6	22.10.2021	1.24	BQL	1.9	500
AL5 – 7	27.10.2021	1.15	BQL	1.84	490
AL5 – 8	29.10.2021	1.18	BQL	1.98	498
Monthly Average		**1.23**	**-**	**1.88**	**495**
Standard Deviation		**0.07**	**-**	**0.05**	**6**

* NMHC- Non- Methane Hydrocarbons

BQL- Below Quantification Limit (Quantification 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 527µg/m³. The mean PM_{10} values were 203 µg/m³, which is well above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 105 µg/m³). The average values of SO_2, NO_x and NH_3 were 4.80 µg/m³, 23.71 µg/m³ and 12.05 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 1.88 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	06.10.2021	280	134	98	4.40	4.10	15.88	29.85	5.62	7.40
					6.15		33.66		7.66	
					1.76		40.02		8.93	
AL6 – 2	08.10.2021	293	130	92	1.76	3.22	13.34	12.49	13.53	11.49
					3.08		13.97		12.25	
					4.84		10.16		8.68	
AL6 – 3	13.10.2021	438	251	103	6.15	4.69	16.51	16.94	6.38	5.96
					5.71		20.96		4.08	
					2.20		13.34		7.40	
AL6 – 4	15.10.2021	466	153	100	2.20	1.76	5.08	6.78	5.62	6.47
					1.76		8.26		7.15	
					1.32		6.99		6.64	
AL6 – 5	20.10.2021	480	180	94	1.32	2.64	20.33	16.94	12.25	11.57
					2.64		13.97		11.49	
					3.96		16.51		10.98	
AL6 – 6	22.10.2021	310	123	88	4.84	3.22	32.39	27.31	9.96	12.76
					2.20		20.96		15.57	
					2.64		28.58		12.76	
AL6 – 7	27.10.2021	275	140	93	2.20	2.49	15.24	15.88	9.19	9.36
					1.76		16.51		8.42	
					3.52		15.88		10.47	
AL6 – 8	29.10.2021	352	191	98	2.20	2.93	15.88	15.03	10.72	10.30
					2.64		10.80		8.93	
					3.96		18.42		11.23	
Monthly Average		362	163	96		3.13		17.65		9.41
Standard Deviation		86	43	5		0.92		7.54		2.55

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	06.10.2021	1.03	BQL	1.79	510
AL6 – 2	08.10.2021	1.11	BQL	1.84	502
AL6 – 3	13.10.2021	1.14	BQL	1.72	511
AL6 – 4	15.10.2021	1.11	BQL	1.69	496
AL6 – 5	20.10.2021	1.18	BQL	1.88	499
AL6 – 6	22.10.2021	1.06	BQL	1.87	502
AL6 – 7	27.10.2021	1.10	BQL	1.74	506
AL6 – 8	29.10.2021	1.01	BQL	1.7	512
Monthly Average		**1.09**	**-**	**1.78**	**505**
Standard Deviation		**0.06**	**-**	**0.08**	**6**

* NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification Limit – NMHC: 0.5 ppm)
NS- Not Specified

The mean TSPM values at Tuna Port were 362 µg/m³, The mean PM_{10} values were 163 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 96 µg/m³). The average values of SO_2, NO_x and NH_3 were 3.13 µg/m³, 17.65 µg/m³ and 9.41 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 1.09 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.78 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	06.10.2021	115	73	30	4.40	3.52	19.69	18.63	6.89	6.21
					3.52		22.23		6.38	
					2.64		13.97		5.36	
AL7 -2	08.10.2021	111	62	34	3.96	2.78	16.51	16.94	8.42	8.42
					1.76		20.33		6.13	
					2.64		13.97		10.72	
AL7 -3	13.10.2021	198	107	52	3.08	3.08	16.51	16.51	4.60	5.45
					3.96		23.50		5.11	
					2.20		9.53		6.64	
AL7 -4	15.10.2021	146	72	50	3.96	4.40	15.24	12.91	7.91	7.06
					5.28		11.43		9.96	
					3.96		12.07		3.32	
AL7 -5	20.10.2021	171	85	44	3.08	2.64	8.89	9.32	6.89	7.23
					2.20		8.26		8.93	
					2.64		10.80		5.87	
AL7 -6	22.10.2021	178	88	71	3.08	4.54	14.61	12.49	8.42	8.17
					4.84		9.53		8.68	
					5.71		13.34		7.40	
AL7 -7	27.10.2021	160	80	52	3.08	3.81	6.35	11.22	10.98	8.25
					2.64		15.24		5.36	
					5.71		12.07		8.42	
AL7 -8	29.10.2021	177	89	56	2.20	3.52	9.53	10.16	8.42	5.96
					3.96		12.07		3.32	
					4.40		8.89		6.13	
Monthly Average		157	82	49		3.5		13.5		7.1
Standard Deviation		31	14	13		0.7		3.4		1.1

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	06.10.2021	1.10	BQL	1.71	466
AL7 – 2	08.10.2021	1.13	BQL	1.62	488
AL7 – 3	13.10.2021	1.06	BQL	1.66	479
AL7 – 4	15.10.2021	1.11	BQL	1.72	480
AL7 – 5	20.10.2021	1.16	BQL	1.59	486
AL7 – 6	22.10.2021	1.17	BQL	1.66	477
AL7 – 7	27.10.2021	1.04	BQL	1.79	468
AL7 – 8	29.10.2021	1.10	BQL	1.64	470
Monthly Average		**1.11**	**-**	**1.67**	**477**
Standard Deviation		**0.04**	**-**	**0.06**	**8**

*

*NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification Limit – NMHC: 0.5 ppm)
NS_ Not Specified

The mean TSPM values at Vadinar Port were 157 µg/m³. The mean PM_{10} values were 82 µg/m³, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 49 µg/m³). The average values of SO_2, NO_x and NH_3 were 3.5 µg/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 Vadinar Port. The mean Benzene concentration was 1.11 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.67 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	06.10.2021	221	113	82	2.64	3.22	8.89	12.28	7.40	5.79
					3.08		14.61		5.87	
					3.96		13.34		4.08	
AL8 -2	08.10.2021	218	126	73	4.40	5.42	27.95	18.21	4.08	6.81
					5.28		15.88		10.72	
					6.59		10.80		5.62	
AL8 -3	13.10.2021	197	104	72	3.08	3.22	10.16	17.57	5.87	9.02
					3.96		26.68		11.74	
					2.64		15.88		9.45	
AL8 -4	15.10.2021	227	111	75	2.20	3.37	20.96	15.24	8.42	6.30
					4.40		14.61		4.08	
					3.52		10.16		6.38	
AL8 -5	20.10.2021	185	88	54	4.40	3.52	15.24	16.73	8.42	6.98
					2.64		20.96		6.64	
					3.52		13.97		5.87	
AL8 -6	22.10.2021	248	121	94	3.96	3.81	8.89	10.37	5.36	5.19
					2.20		8.26		4.08	
					5.28		13.97		6.13	
AL8 -5	27.10.2021	210	138	62	3.08	3.66	13.97	13.76	15.06	10.64
					1.32		6.35		11.49	
					6.59		20.96		5.36	
AL8-6	29.10.2021	186	128	50	3.08	3.23	15.88	11.01	4.08	5.53
					2.20		8.89		5.87	
					4.40		8.26		6.64	
Monthly Average		211	116	70		3.7		14.4		7.0
Standard Deviation		22	16	15		0.7		3.0		1.9

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	06.10.2021	1.30	BQL	1.86	451
AL8-2	08.10.2021	1.09	BQL	1.79	450
AL8 -3	13.10.2021	1.20	BQL	1.71	462
AL8-4	15.10.2021	1.11	BQL	1.82	455
AL8 -5	20.10.2021	1.16	BQL	1.69	469
AL8-6	22.10.2021	1.06	BQL	1.77	470
AL8-7	27.10.2021	1.30	BQL	1.82	459
AL8-8	29.10.2021	1.10	BQL	1.74	466
Monthly Average		**1.17**	**-**	**1.78**	**460**
Standard Deviation		**0.09**	**-**	**0.06**	**8**

* NMHC- Non- Methane Hydrocarbons

BQL- Below Quantification Limit (Quantification 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 211 µg/m^3. The mean PM_{10} values were 116 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 70.0 µg/m^3). The average values of SO_2, NO_x and NH_3 were 3.7 µg/m^3, 14.4 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 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 1.78 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	7.3	7.4	7.3	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	970	1310	1250	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	1860	2560	2430	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/l	476.06	440.98	506.13	250.0	1000.0
9	Ca as Ca	mg/l	64.13	68.14	72.14	75.0	200.0
10	Mg as Mg	mg/l	63.18	70.47	65.61	30.0	100.0
11	Total Hardness	mg/l	420	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	0.32	0.35	0.17	1.0	1.5
14	Sulphate as SO4	mg/l	286.8	289.2	194.4	200.0	400
15	Nitrite as NO2	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate as NO3	mg/l	6.41	7.88	13.02	45.0	No Relaxation
17	Salinity	%	0.86	0.80	0.91	NS*	NS*
18	Sodium as Na	mg/l	199	193	258	NS*	NS*
19	Potassium as K	mg/l	3.24	3.68	3.51	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	7.7	7.4	7.2	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1340	980	1040	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	2600	1940	2040	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride as Cl	mg/l	526.17	496.10	481.07	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	65.61	70.47	30.0	100.0
11	Total Hardness	mg/l	440	430	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	0.46	0.50	0.52	1.0	1.5
14	Sulphate as SO4	mg/l	186	194.4	288	200.0	400
15	Nitrite as NO2	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate as NO3	mg/l	8.59	10.21	9.22	45.0	No Relaxation
17	Salinity	%	0.95	0.90	0.87	NS*	NS*
18	Sodium as Na	mg/l	215	209	231	NS*	NS*
19	Potassium as K	mg/l	4.23	3.88	4.21	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	7.4	7.8	7.5	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1190	1420	1160	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	1920	2870	2180	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	616.37	591.31	491.09	250.0	1000.0
9	Ca as Ca	mg/l	64.13	68.14	60.12	75.0	200.0
10	Mg as Mg	mg/l	68.04	58.32	65.61	30.0	100.0
11	Total Hardness	mg/l	440	410	420	200.0	600.0
12	Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.90	0.57	0.63	1.0	1.5
14	Sulphate	mg/l	217.2	205.2	289.2	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	13.52	9.93	12.74	45.0	No Relaxation
17	Salinity	%	1.11	1.07	0.89	NS*	NS*
18	Sodium as Na	mg/l	265	218	323	NS*	NS*
19	Potassium as K	mg/l	3.87	3.73	3.56	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	7.3	7.6	7.2	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1090	1460	940	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	2090	2850	1860	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	445.99	466.04	496.10	250.0	1000.0
9	Ca as Ca	mg/l	56.11	68.14	60.12	75.0	200.0
10	Mg as Mg	mg/l	75.33	72.90	80.19	30.0	100.0
11	Total Hardness	mg/l	450	470	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	0.87	0.68	0.92	1.0	1.5
14	Sulphate	mg/l	294	318	210	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	9.29	10.14	11.69	45.0	No Relaxation
17	Salinity	%	0.81	0.84	0.90	NS*	NS*
18	Sodium as Na	mg/l	101	221	402	NS*	NS*
19	Potassium as K	mg/l	4.08	4.01	3.99	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	7.4	7.4	7.3	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1020	1340	1100	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	2010	2660	2140	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	466.04	506.13	466.04	250.0	1000.0
9	Ca as Ca	mg/l	52.10	72.14	68.14	75.0	200.0
10	Mg as Mg	mg/l	77.76	55.89	63.18	30.0	100.0
11	Total Hardness	mg/l	450	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	0.60	0.81	1.08	1.0	1.5
14	Sulphate	mg/l	291.6	294	283.2	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	9.29	10.63	9.36	45.0	No Relaxation
17	Salinity	%	0.84	0.91	0.84	NS*	NS*
18	Sodium as Na	mg/l	275	300	130	NS*	NS*
19	Potassium as K	mg/l	3.49	3.50	3.56	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	7.4	7.38	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1120	1090	1080	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	2210	2190	2160	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	<2	NS*	NS*
8	Chloride	mg/l	576.28	521.16	520	250.0	1000.0
9	Ca as Ca	mg/l	72.14	76.15	78.56	75.0	200.0
10	Mg as Mg	mg/l	55.89	65.61	54.92	30.0	100.0
11	Total Hardness	mg/l	410	460	422	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	0.93	0.46	1.0	1.5
14	Sulphate	mg/l	265.2	238.8	180	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	9.86	7.88	8.2	45.0	No Relaxation
17	Salinity	%	1.04	0.94	0.98	NS*	NS*
18	Sodium as Na	mg/l	235	235	260	NS*	NS*
19	Potassium as K	mg/l	2.18	4.01	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	7.5	7.6	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1030	1010	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	2020	1960	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<2	<2	NS*	NS*
8	Chloride	mg/l	425.95	415.92	250.0	1000.0
9	Ca as Ca	mg/l	60.12	52.10	75.0	200.0
10	Mg as Mg	mg/l	75.33	94.26	30.0	100.0
11	Total Hardness	mg/l	460	440	200.0	600.0
12	Iron as Fe+3	mg/l	<0.01	<0.01	0.3	No Relaxation
13	Fluorides	mg/l	0.92	0.67	1.0	1.5
14	Sulphate	mg/l	22.44	22.20	200.0	400
15	Nitrite	mg/l	<0.01	<0.01	NS*	NS*
16	Nitrate	mg/l	7.39	9.99	45.0	No Relaxation
17	Salinity	%	0.90	0.92	NS*	NS*
18	Sodium as Na	mg/l	51.1	44.1	NS*	NS*
19	Potassium as K	mg/l	2.2	<2.0	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 900 -1500 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 October ranged from 1800-3000 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 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 400-650 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 50 - 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 50 – 99 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 400-480 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 20 – 350 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 6.41 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 0.5 to 1.4 %. There are no prescribed Indian standards for salinity in Drinking water**.**

Sodium and Potassium Salts

Sodium values in the samples collected ranged from 50 - 400 mg/l and Potassium salts ranged from 2.0 to 4.5 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	73.9	53.4
2	Nirman Building 1	62.3	51.0
3	Tuna Port	57.2	50.9
4	Main Gate North	67.0	61.8
5	West Gate I	70.5	65.1
6	Canteen Area	64.5	51.0
7	Main Road	68.4	51.5
8	ATM Building	80.4	57.3
9	Wharf Area /Jetty Area	72.9	68.1
10	Port & Custom Office	67.8	41.8
	Vadinar Port		
11	Entrance Gate of Vadinar Port	66.4	53.2
12	Nr. Port Colony, Vadinar	60.7	54.1
13	Nr. Vadinar Jetty	72.4	66.5

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 13 locations at Deendayal Port ranged from 57.0 dB(A) to 73.9 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 13 locations of Deendayal Port ranged from 41.8 dB to 68.4 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 October 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	-	8.62	8.10	8.75	8.33	8.10	8.22
3	Electrical Conductivity	µs/cm	16,200.0	26,820.0	16,252.0	17,520.0	560.0	480.0
4	Moisture	%	17.00	18.20	19.10	20.22	7.26	8.22
5	Total Organic Carbon	%	0.52	1.02	0.62	3.10	0.12	0.20
6	Alkalinity	mg/kg	60.06	80.44	140.20	80.44	60.06	80.44
7	Total Nitrogen	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
8	Chloride	mg/kg	1,620.0	5,380.0	1,820.0	2,078.0	62.0	77.0
9	Sulphate	mg/kg	230.0	198.0	120.0	118.0	16.0	20.0
10	Phosphorus	mg/kg	0.90	0.82	0.96	1.02	0.80	0.72
11	Potassium	mg/kg	396.0	810.0	366.0	460.0	120.0	160.0
12	Sodium	mg/kg	1,620.0	3,400.0	2,122.0	2,012.0	910.0	888.0
13	Calcium	mg/kg	230.32	722.20	252.00	470.42	110.00	82.00
14	Copper as Cu	mg/kg	17.40	38.80	21.20	35.10	16.6	17.0
15	Lead as Pb	mg/kg	6.40	7.90	29.10	7.60	4.8	2.0
16	Nickel as Ni	mg/kg	33.50	13.90	34.50	13.20	13.2	12.2
17	Zinc as Zn	mg/kg	55.90	91.90	77.9	81.90	28.00	36.22
18	Cadmium as Cd	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL

4.3 Discussion

- The data shows that value of pH ranges from 8.10 at IFFCO Plant to 8.75 at Khori Creek indicating that all soil samples are neutral to slight basic. Iffco Plant samples showed maximum conductivity of 26,820 µmhos/cm, while Tuna Port location showed minimum conductivity of 16,200 µmhos/cm. Conductivity at Vadinar Port was 560 and 480 µmhos/cm at Admin site and Vadinar Port colony respectively.
- Total organic Carbon ranged from 0.5 % to 3.1 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 0.7 to 1.0 mg/kg and 300.0 to 800 mg/kg respectively at Deendayal Port. The mean concentration of Phosphorous at Vadinar site was 0.76 mg/kg and mean concentration of Potassium at Vadinar site was 140 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	08.10.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.62	7.4
2	Total Suspended Solids	mg/l	99.2	64.7
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	424.2	98.0
5	BOD @ 27 °C	mg/l	141.0	23.0
6.	Fecal Coliform	MPN Index / 100 ml	-	79.0
Aeration Tank				
7.	MLSS	mg/l	6.0	
8.	MLVSS	%	93.0	

Table 19: Sewage Water Monitoring at Kandla STP (2nd Week)

Date of Sampling	12.10.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.6	7.2
2	Total Suspended Solids	mg/l	152.2	72.4
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	384	103.0
5	BOD @ 27 °C	mg/l	120.0	24.0
6.	Fecal Coliform	MPN Index / 100 ml	-	8.0
Aeration Tank				
7.	MLSS	mg/l	12.0	
8.	MLVSS	%	84.0	

Table 20: Sewage Water Monitoring at Kandla STP (3rd Week)

Date of Sampling	21.10.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.65	7.41
2	Total Suspended Solids	mg/l	223.4	99.8
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	181.8	101
5	BOD @ 27 °C	mg/l	68.0	24.0
6.	Fecal Coliform	MPN Index / 100 ml	-	11.0
Aeration Tank				
7.	MLSS	mg/l	9.0	
8.	MLVSS	%	87.0	

Table 21: Sewage Water Monitoring at Kandla STP (4th Week)

Date of Sampling	25.10.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.72	7.5
2	Total Suspended Solids	mg/l	284.6	113.6
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	212	101.0
5	BOD @ 27 °C	mg/l	98.0	26.0
6.	Fecal Coliform	MPN Index / 100 ml	-	3.6
Aeration Tank				
7.	MLSS	mg/l	14.0	
8	MLVSS	%	84.0	

- **Gopalpuri Colony STP**

Table 22: Sewage Water Monitoring at Gopalpuri STP (1st Week)

Date of Sampling	08.10.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.6	7.4
2	Total Suspended Solids	mg/l	195.6	84.0
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	304.0	104.0
5	BOD @ 27 °C	mg/l	120.0	26.0
6.	Fecal Coliform	MPN Index / 100 ml	-	49.0
Aeration Tank				
7.	MLSS	mg/l	10.0	
8	MLVSS	%	87.0	

Table 23: Sewage Water Monitoring at Gopalpuri STP (2nd Week)

Date of Sampling	12.10.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.7	7.5
2	Total Suspended Solids	mg/l	388	131.8
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	414.1	106.00
5	BOD @ 27 °C	mg/l	139.0	28.0
6.	Fecal Coliform	MPN Index / 100 ml	-	6.0
Aeration Tank				
7.	MLSS	mg/l	14.0	
8	MLVSS	%	90.0	

Table 24: Sewage Water Monitoring at Gopalpuri STP (3rd Week)

Date of Sampling	21.10.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.52	7.21
2	Total Suspended Solids	mg/l	354.2	103.3
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	161.6	90.9
5	BOD @ 27 °C	mg/l	80.0	26.0
6.	Fecal Coliform	MPN Index / 100 ml	-	46.0
Aeration Tank				
7.	MLSS	mg/l	14.0	
8	MLVSS	%	84.0	

Table 25: Sewage Water Monitoring at Gopalpuri STP (4th Week)

Date of Sampling	25.10.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.45	7.19
2	Total Suspended Solids	mg/l	345.8	105
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	232	106
5	BOD @ 27 °C	mg/l	82.0	28.0
6.	Fecal Coliform	MPN Index / 100 ml	-	32.0
Aeration Tank				
7.	MLSS	mg/l	10.0	
8.	MLVSS	%	89.0	

- **Vadinar STP**

Table 26: Sewage Water Monitoring at Vadinar STP (1st Week)

Date of Sampling	08.10.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.62	7.4
2	Total Suspended Solids	mg/l	99.2	64.7
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	88.0	60.0
5	BOD @ 27 °C	mg/l	32.0	16.0

Table 27: Sewage Water Monitoring at Vadinar STP (2nd Week)

Date of Sampling	12.10.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.7	7.5
2	Total Suspended Solids	mg/l	133.5	59.9
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	188.0	60.0
5	BOD @ 27 °C	mg/l	60.0	16.0

Table 28: Sewage Water Monitoring at Vadinar STP (3rd Week)

Date of Sampling	21.10.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.7	7.5
2	Total Suspended Solids	mg/l	105	38
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	161.6	70.7
5	BOD @ 27 °C	mg/l	62.0	20.0

Table 29: Sewage Water Monitoring at Vadinar STP (4th Week)

Date of Sampling	25.10.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.7	7.2
2	Total Suspended Solids	mg/l	105	58.8
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	202	80.8
5	BOD @ 27 °C	mg/l	60.0	20.0

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.

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 6th& 7th October-2021 in harbor regions of KPT and on 7th October-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 13th& 14th October 2021 in harbor regions of KPT. 14th October -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	7.14	7.16	7.42	7.36
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.5	32.0	32.6	32.0
5	Turbidity	NTU	38	29	36	31
6	Total Dissolved Solids	mg/l	42450	39030	42122.0	41187.0
7	Total Suspended Solids	mg/l	685	950	764.9	558.1
8	Total Solids	mg/l	43135	39980	42886.9	41745.1
9	DO	mg/l	4.1	4	4.3	4.2
10	COD	mg/l	78.0	80.0	80.0	78.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.75	0.64	0.65	0.53
13	Phosphate	mg/l	0.36	0.26	0.16	0.18
14	Sulphate	mg/l	3060	2892	2256	2532
15	Nitrate	mg/l	2.89	2.46	2.50	3.48
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	601.20	521.04	561.12	521.04
18	Magnesium	mg/l	1628.1	1603.8	0	0
19	Sodium	mg/l	9473.0	8438.0	9368	8523
20	Potassium	mg/l	362.1	314.0	360.8	302.8
21	Iron	mg/l	1.63	1.34	1.35	1.24
22	Chromium	mg/l	0.11	0.13	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	0.04	0.05	0.04	0.04
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.09	0.11	0.11	0.09
28	Zinc	mg/l	0.07	0.06	0.06	0.05

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	7.25	7.21	7.51	7.1
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.8	31.9	31.8	31.9
5	Turbidity	NTU	36	25	39	45
6	Total Dissolved Solids	mg/l	33930	47550	40323.0	40031.0
7	Total Suspended Solids	mg/l	658	769	569.8	528.6
8	Total Solids	mg/l	34588	48319	40892.8	40559.6
9	DO	mg/l	4.4	3.8	4.4	4.1
10	COD	mg/l	82.0	86.0	88.0	80.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.51	0.60	0.80	0.75
13	Phosphate	mg/l	0.23	0.26	0.18	0.19
14	Sulphate	mg/l	2784	3252	2388	2652
15	Nitrate	mg/l	3.03	3.59	2.89	4.04
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	561.12	641.28	480.96	561.12
18	Magnesium	mg/l	1555.2	1628.1	0	0
19	Sodium	mg/l	9670.0	9156.0	9686	9192
20	Potassium	mg/l	380.0	326.1	354.2	278.2
21	Iron	mg/l	1.90	1.73	1.68	1.33
22	Chromium	mg/l	0.13	0.11	0.11	0.15
23	Copper	mg/l	0.07	0.05	0.07	0.07
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.05	0.04	0.04	0.05
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.12	0.12	0.09	0.11
28	Zinc	mg/l	0.05	0.06	0.08	0.09

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	7.40	7.52	7.2	7.41
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.2	32.0	32.0	31.7
5	Turbidity	NTU	36	28	33	41
6	Total Dissolved Solids	mg/l	45010	41120	40162.0	42404.0
7	Total Suspended Solids	mg/l	586	838	492.9	627.8
8	Total Solids	mg/l	45596	41958	40654.9	43031.8
9	DO	mg/l	4.1	5	4.5	5.2
10	COD	mg/l	88.0	90.0	79.0	74.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.69	0.76	0.53	0.71
13	Phosphate	mg/l	0.27	0.37	0.16	0.19
14	Sulphate	mg/l	3300	1872	2688	2256
15	Nitrate	mg/l	3.87	4.36	2.96	2.59
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	601.20	681.36	521.04	480.96
18	Magnesium	mg/l	1676.7	1652.4	0	0
19	Sodium	mg/l	9421.0	8958.0	9328	8688
20	Potassium	mg/l	354.2	343.7	283.8	332.6
21	Iron	mg/l	1.56	1.88	1.93	1.57
22	Chromium	mg/l	0.14	0.14	0.14	0.11
23	Copper	mg/l	0.06	0.07	0.06	0.06
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.05	0.04	0.06	0.05
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.13	0.10	0.08	0.10
28	Zinc	mg/l	0.07	0.08	0.06	0.07

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	7.28	7.40	7.3	7.4
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.5	32.6	32.4	32.0
5	Turbidity	NTU	46	36	50	30
6	Total Dissolved Solids	mg/l	42910	48900	40963.0	41643.0
7	Total Suspended Solids	mg/l	660	562	711.1	509.7
8	Total Solids	mg/l	43570	49462	41674.1	42152.7
9	DO	mg/l	4.7	4.6	5.8	5.6
10	COD	mg/l	72.0	76.0	82.0	78.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.73	0.62	0.65	0.49
13	Phosphate	mg/l	0.28	0.24	0.22	0.19
14	Sulphate	mg/l	1500	3336	2412	2124
15	Nitrate	mg/l	1.76	2.89	2.78	2.02
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	521.04	601.20	440.88	601.2
18	Magnesium	mg/l	1676.7	1555.2	0	0
19	Sodium	mg/l	9979.0	9708.0	9808	9629
20	Potassium	mg/l	373.2	343.9	327.8	305.6
21	Iron	mg/l	1.73	1.67	1.02	1.68
22	Chromium	mg/l	0.15	0.17	0.09	0.09
23	Copper	mg/l	0.05	0.08	0.07	0.07
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.03	0.06	0.07	0.04
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.09	0.01	0.09	0.08
28	Zinc	mg/l	0.06	0.08	0.07	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	7.20	7.40	7.2	7.4
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.1	31.9	31.6	31.2
5	Turbidity	NTU	34	46	33	29
6	Total Dissolved Solids	mg/l	48700	49900	40306.0	38117.0
7	Total Suspended Solids	mg/l	867	848	441.1	513
8	Total Solids	mg/l	49567	50748	40747.1	38630.0
9	DO	mg/l	4.2	4.8	4.8	4.7
10	COD	mg/l	96.0	98.0	90.0	92.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.53	0.84	0.73	0.60
13	Phosphate	mg/l	0.25	0.24	0.20	0.17
14	Sulphate	mg/l	3504	3780	2772	2364
15	Nitrate	mg/l	3.24	3.59	2.74	4.60
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	521.04	601.20	480.96	521.04
18	Magnesium	mg/l	1652.4	1676.7	0	0
19	Sodium	mg/l	10156.0	10254.0	10268	10438
20	Potassium	mg/l	336.9	336.4	278.6	297.8
21	Iron	mg/l	1.54	1.83	1.55	1.50
22	Chromium	mg/l	0.12	0.11	0.14	0.16
23	Copper	mg/l	0.08	0.07	0.05	0.05
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.04	0.06	0.06	0.04
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.12	0.13	0.11	0.13
28	Zinc	mg/l	0.08	0.09	0.05	0.09

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	7.50	Sampling not possible during Low Tide	7.5	Sampling not possible during Low Tide
2	Color	-	Colorless		Colorless	
3	Odor	-	Odorless		Odorless	
4	Salinity	ppt	31.8		31.0	
5	Turbidity	NTU	34		34	
6	Total Dissolved Solids	mg/l	43730		40522.0	
7	Total Suspended Solids	mg/l	635		432.9	
8	Total Solids	mg/l	44365		40954.9	
9	DO	mg/l	4.6		5.2	
10	COD	mg/l	98.0		90.0	
11	BOD	mg/l	<2.0		<2.0	
12	Silica	mg/l	1.00		0.51	
13	Phosphate	mg/l	0.24		0.17	
14	Sulphate	mg/l	3576		2352	
15	Nitrate	mg/l	3.03		3.37	
16	Nitrite	mg/l	<0.05		<0.05	
17	Calcium	mg/l	561.12		601.2	
18	Magnesium	mg/l	1725.3		0	
19	Sodium	mg/l	10760.0		10536	
20	Potassium	mg/l	335.1		335.1	
21	Iron	mg/l	1.80		1.33	
22	Chromium	mg/l	0.16		0.10	
23	Copper	mg/l	0.07		0.06	
24	Arsenic	mg/l	<0.01		<0.01	
25	Cadmium	mg/l	0.03		0.05	
26	Mercury	mg/l	<0.001		<0.001	
27	Lead	mg/l	0.12		0.11	
28	Zinc	mg/l	0.09		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	7.50	7.80	7.54	7.45
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.0	32.0	32.1	31.9
5	Turbidity	NTU	46	36	46	42
6	Total Dissolved Solids	mg/l	47700	46610	37421.0	38258.0
7	Total Suspended Solids	mg/l	483	476	553.6	490
8	Total Solids	mg/l	48183	47086	37974.6	38748.0
9	DO	mg/l	4.3	4.5	4.6	4.8
10	COD	mg/l	86.0	88.0	88.0	86.0
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.85	0.93	0.71	0.89
13	Phosphate	mg/l	0.23	0.25	0.18	0.17
14	Sulphate	mg/l	2784	2556	2532	2448
15	Nitrate	mg/l	2.46	2.89	3.60	3.37
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	641.28	561.12	561.12	521.04
18	Magnesium	mg/l	1506.6	1579.5	0	0
19	Sodium	mg/l	10233.0	10490.0	10860.0	10880.0
20	Potassium	mg/l	331.3	363.9	336.0	333.0
21	Iron	mg/l	1.38	1.69	1.34	1.2
22	Chromium	mg/l	0.15	0.19	0.11	0.12
23	Copper	mg/l	0.06	0.08	0.06	0.06
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.04	0.04	0.06	0.05
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.11	0.11	0.09	0.09
28	Zinc	mg/l	0.06	0.08	0.06	0.05

Table 36 (a): Marine Water Quality Monitoring Parameters for locations Nr. Vadinar SPM

Sr. No.	Parameters	Unit	Nr.Vadinar SPM			
			22°30'56.15"N 69°42'12.07"E			
			Spring Tide		Neap Tide	
	Tide →		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.70	7.50	7.42	7.36
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.5	32.6	32.0	31.8
5	Turbidity	NTU	34	32	38	44
6	Total Dissolved Solids	mg/l	40230	39870	40119.0	40011.0
7	Total Suspended Solids	mg/l	470	447	496.1	457.4
8	Total Solids	mg/l	40700	40317	40615.1	40468.4
9	DO	mg/l	4.2	4.1	4.4	4.5
10	COD	mg/l	88.0	90	88.0	86
11	BOD	mg/l	<2.0	<2.0	<2.0	<2.0
12	Silica	mg/l	0.82	0.93	0.62	0.76
13	Phosphate	mg/l	0.24	0.25	0.17	0.17
14	Sulphate	mg/l	2688	2340	2352	2472
15	Nitrate	mg/l	2.68	2.82	3.27	3.60
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	601.20	641.28	0	0
18	Magnesium	mg/l	1579.5	1652.4	0	0
19	Sodium	mg/l	10575	10639	10936.0	10886.0
20	Potassium	mg/l	370.1	367.9	331	402
21	Iron	mg/l	1.57	1.81	1.07	1.63
22	Chromium	mg/l	0.17	0.18	0.09	0.11
23	Copper	mg/l	0.06	0.08	0.06	0.04
24	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
25	Cadmium	mg/l	0.04	0.05	0.04	0.06
26	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001
27	Lead	mg/l	0.13	0.12	0.08	0.08
28	Zinc	mg/l	0.06	0.07	0.07	0.08

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 - 4	KPT - 5	Jetty	SPM
1	Texture	-	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	mg/kg	1.10	1.08	1.01	1.02	0.98	2.03	0.81
3	Organic Carbon	mg/kg	0.65	0.52	0.60	0.56	0.56	1.08	0.47
4	Inorganic Phosphate	mg/kg	110.0	131.0	132.0	145.0	145.0	132.0	149.0
5	Moisture	%	18.96	19.65	21.0	22.10	23.5	17.7	27.00
6	Aluminium	mg/kg	ND	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	16.5	15.6	12.0	16.3	15.5	18.7	18.00
8	Phosphate	mg/kg	8.02	10.99	7.22	11.00	7.65	9.52	11.20
9	Sulphate	mg/kg	205.0	265.0	266.0	198.0	221.0	197.6	265.0
10	Nitrite	mg/kg	0.1	0.15	0.11	0.13	0.13	0.09	0.11
11	Nitrate	mg/kg	9.35	7.32	7.06	8.65	8.99	7.65	8.88
12	Calcium	mg/kg	325.0	306.0	396.0	388.0	324.0	324.0	378.0
13	Magnesium	mg/kg	195.0	185.0	243.0	244.0	188.0	175.0	210.0
14	Sodium	mg/kg	3745.0	3945.0	4660.0	2566.0	2899.0	2253.0	2854.0
15	Potassium	mg/kg	238.0	194.0	186.0	178.0	138.0	152.0	110.0
16	Chromium	mg/kg	8.1	48.3	30.7	40.3	23.3	36.4	6.6
17	Nickel	mg/kg	16.4	31.8	22.9	25.8	14	46.6	3.7
18	Copper	mg/kg	27.7	36.9	8.7	14.3	4.2	19.2	1.9
19	Zinc	mg/kg	32.40	40.50	35.10	36.20	21.20	21.30	5.00
20	Cadmium	mg/kg	ND	ND	ND	ND	ND	ND	ND
21	Lead	mg/kg	3.8	5.8	3.3	4.4	4.9	ND	1.2
22	Mercury	mg/kg	ND	ND	ND	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND	ND	ND	ND

*ND - Not Detected

Table 34B: Results of Analysis of Sediment of Kandla & Vadinar Port (Neap Tide)

Sr. No.	Parameters	Unit	KPT – 1	KPT - 2	KPT - 4	SPM
1	Texture	-	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	mg/kg	1.99	0.85	1.11	1.08
3	Organic Carbon	mg/kg	1.12	0.41	0.65	0.65
4	Inorganic Phosphate	mg/kg	120.0	130.0	148.0	152.0
5	Moisture	%	19.20	18.50	17.7	17.56
6	Aluminium	mg/kg	ND	ND	ND	ND
7	Silica	mg/kg	21.88	18.00	17.5	14.72
8	Phosphate	mg/kg	5.62	8	7.65	8.65
9	Sulphate	mg/kg	225.0	240.0	211.5	195.0
10	Nitrite	mg/kg	0.1	0.11	0.09	0.1
11	Nitrate	mg/kg	7.66	8.11	6.65	6.85
12	Calcium	mg/kg	321.0	310.0	345.0	265.0
13	Magnesium	mg/kg	205.0	197.0	202.0	169.0
14	Sodium	mg/kg	4120.0	3842.0	4465.0	3589.0
15	Potassium	mg/kg	201.0	147.0	154.0	154.00
16	Chromium	mg/kg	13.3	10.5	13	16.8
17	Nickel	mg/kg	8.8	6	8.2	10.5
18	Copper	mg/kg	4.3	2	2.2	5.5
19	Zinc	mg/kg	18.20	9.90	10.30	12.10
20	Cadmium	mg/kg	ND	ND	ND	ND
21	Lead	mg/kg	2.1	2.5	2.8	1.8
22	Mercury	mg/kg	ND	ND	ND	ND
23	Arsenic	mg/kg	ND	ND	ND	ND

*Grab samples could not be collected due high current at KPT – 3,KPT – 5 Location.
*ND - Not Detected

REPORT

ON

ECOLOGICAL MONITORING

OF MARINE ENVIRONMENT

IN

DPT HARBOUR AREA, NEAR BY CREEKS

AND

VADINAR JETTY AND SPM

FOR

DEENDAYAL PORT TRUST

OCTOBER, 2021

INTRODUCTION:

Sampling Stations:

The monitoring of marine environment for the study of biological and ecological Parameters was carried out on6th October, 2021 in harbour region of DPT at Kandla Creek, and on 7th October,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 13th October ,2021 in harbour region of DPT at Kandla Creek and on 14th October 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 KPT 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 Neap tide and spring 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 at Path Finder Creek during spring tide period and during neap tide. Sampling was conducted at only during Neap tide period nearSPM both during High tide period and low 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 Vadinar jetty SPM	3 in Kandla creek 2 in Nakti creek 1 in Khori creek 1 near Vadinar Jetty 1 near I st SPM
Total Number of locations	**8**

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 litre 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, and 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.

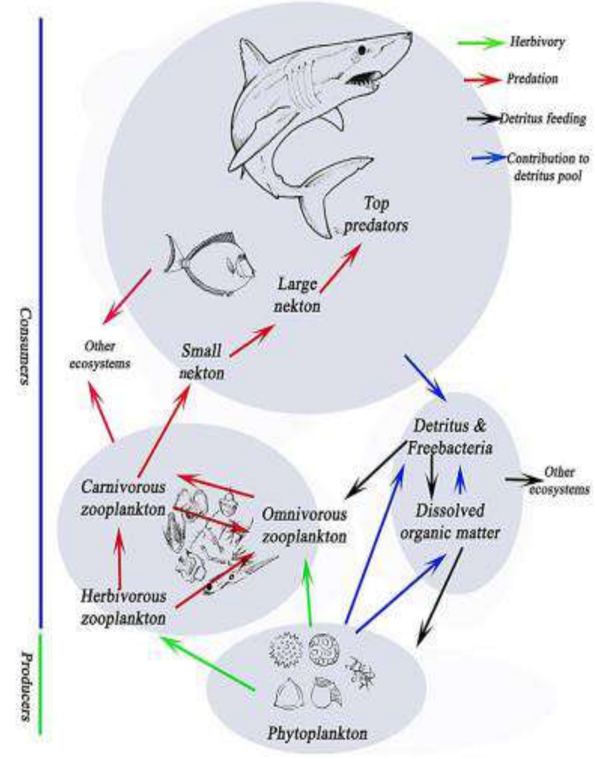
Zooplankton can be subdivided into holoplankton, i.e., permanent members of the plankton (e.g., Calanoid copepods), and meroplankton, i.e., temporary members in the plankton e.g., larvae of fish,

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**) reproduces 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 0.615 -1.459mg/m^3.in harbour region of DPT in Kandla Creek during sampling done in spring tide period of October, 2021. In the nearby creeks chlorophyll-a was varying from 0.153 -1.497mg/m^3.Pheophytin –a level was below detectable limit- the all the sampling stations during springtide except at KPT-I in the harbour region of DPT.

In the sub surface water chlorophyll-a was varying from 0.204 -0.749mg/m^3.in harbour region of DPT in Kandla Creek during sampling done in neap tide period of October , 2021 . In the nearby creeks chlorophyll-a was varying from 0.184-0.610 mg/m^3. Pheophytin –a level was below detectable limit- the all the sampling stations during neap tide in the harbour region of DPT.

In the sub surface water chlorophyll-a was varying from 0.527 -0.733 mg/m^3.in harbour region of DPT OOT in path finder Creek during sampling done in spring tide period of October, 2021. In the sub surface water chlorophyll-a was varying from 0.750 -1.175 mg/m^3.in harbour region of DPT OOT in path finder Creek during sampling done in Neap Tide period of October, 2021

TABLE #2 VARIATIONS IN CHLOROPHYLL –a PHEOPHYTIN- a AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA IN KANDLA CREEK ,NEAR BY CREEKS AND DPT OOT JETTY IN PATH FINDER CREEK AND SPM NEAR VADINAR DURING SPRING TIDE IN OCTOBER,2021

Sr.No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREAKANDLA CREEK					
1	KPT1	High tide	1.459	0.821	97.75
		Low tide	1.187	0.661	79.53
2	KPT 2	High tide	0.765	BQL	51.25
		Low tide	0.852	BQL	57.08
3	KPT 3	High tide	0.968	BQL	64.85
		Low tide	0.615	BQL	41.20
CREEKS					
4	KPT-4 Khori-I	High tide	1.056	BQL	70.75
		Low tide	1.497	BQL	100.2
5	KPT-5 Nakti-I	High tide	0.764	BQL	51.19
		Low tide	0.612	BQL	41.00
6	KPT-5 Nakti-II	High tide	0.153	BQL	10.24
PATHFINDER CREEK VADINAR					
7	VADINAR-I jetty	Low tide	0.527	BQL	35.31
8		High tide	0.733	BQL	49.11
9	SPM	High tide	No sample	--	--
10	SPM	Low tide	No sample	-	--

BDL: Below Quantification Limit.

TABLE #3 VARIATIONS IN CHLOROPHYLL –a PHEOPHYTIN- a AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA ,NEAR BY CREEKS AND DPT OOT JETTY IN PATH FINDER CREEK AND SPM NEAR VADINAR DURING NEAP TIDE IN OCTOBER,2021

Sr.No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin- a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREA KANDLA CREEK					
1	KPT1	High tide	0.307	BQL	20.57
		Low tide	0.529	BQL	35.44
2	KPT 2	High tide	0.749	BQL	50.18
		Low tide	0.614	BQL	41.14
3	KPT 3	High tide	0.204	BQL	13.67
		Low tide	0.542	BQL	36.31
CREEKS					
4	KPT-4 Khori-I	High tide	0.441	BQL	29.54
		Low tide	0.426	BQL	28.54
5	KPT-5 Nakti-I	High tide	0.610	BQL	40.87
		Low tide	0.441	BQL	29.55
6	KPT-5 Nakti-II	High tide	0.184	BQL	12.33
PATHFINDER CREEK VADINAR					
7	VADINAR-I jetty	Low tide	0.750	0.435	50.25
8		High tide	0.820	0.484	54.94
9	SPM	High tide	1.071	0.610	71.76
10	SPM	Low tide	1.175	0.680	78.73

BDL: Below Quantification 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 dinoflagellatesduring spring tide period.Diatoms were represented by 19genera. Blue green were represented by 3 genera and dinoflagellates were represented by two generaduring the sampling conducted in spring tide in OCTOBER,2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 46-209units/ L during high tide period and183-229 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 20genera Blue green algae were represented 3 genera and dinoflagellates with two genera during the sampling conducted in Neap tide in October,2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from88-170units/ L during high tide period and 120-157 units/ L during low tide of Neap Tide.

For the evaluation of the Phytoplankton population in DPT OOT jetty area in Path Finder creek sampling was conducted from one sampling locations ; jetty area during high tide period and low tide of spring tide. For the evaluation of the Phytoplankton population in DPT OOT jetty area in Path Finder creek in Vadinar sampling was conducted from 2 sampling locations ; jetty area and one near SPM during high tide period and low tide of Neap tide.

The phytoplankton community of the sub surface water in the path finder creeks was represented by only Diatoms spring tide period.Diatoms were represented by 9 genera during the sampling conducted in spring tide in October, 2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 131 units/ L during high tide period and 147 units/ L during low tide of Spring Tide.

The phytoplankton community of the sub surface water in the path finder creeks was represented by Diatoms, Blue green algae and Dinoflagellatesduring Neap tide period.Diatoms were represented by 10 genera Blue green algae were represented single genera and dinoflagellates by four genera during the sampling conducted in Neap tide in October, 2021. Phytoplankton of the sampling stations at sub surface path finder creek was varying from 203-427 units/ L during high tide period and 544-744 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 Kandla creek and nearby creeks sampling stations was varying from 2.059-3.212 with an average of 2.632during the sampling conducted in High tide period of spring tide.While Margalef's diversity index (Species Richness) S of phytoplankton communities in the Kandla creek region and nearby creeks was varying from2.687-3.144 with an average of 2.923 during the consecutive low tide period.

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations in Kandla creek and nearby creeks was varying from 1.582-3.384 with an average of 2.477 during the sampling conducted in High tide period of Neaptide. While Margalef's diversity index (Species Richness) S of phytoplankton communities in the Kandla creek region and nearby creeks was varying from1.582-3.040 with an average of 2.141 during consecutive low tide.

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was 1.641 during the sampling conducted in High tide period of spring tide at Path Finder Creek, Vadinar . While Margalef's diversity index (Species Richness) S of phytoplankton communities in the path finder creek was1.603 during the consecutive low tide period at Path Finder Creek, Vadinar .

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was varying from 1.981-2.064 during the sampling conducted in consecutive High tide period and low tide period of Neap Tide at jetty area of Path finder Creek. While Margalef's diversity index (Species Richness) S of phytoplankton communities near the SPM was varying from 2.259- 1.512 during the consecutive high tide and low tide period of Neap tide.

Shannon-Wiener's index:

Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.802- 0.935 (H'(log10)) between selected sampling stations with an average value of 0.860 during high tide period of spring tide at Kandla creek and nearby creeks. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.858-0.979 (H'(log10)) between selected sampling stations with an average value of 0.909 during consecutive lowtide at Kandla creek and nearby creeks. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.774 -0.934 (H'(log10)) between selected sampling stations with an average value of 0.868 during high tide period of neap tide at Kandla creek and nearby creeks. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.773 -0.927 (H'(log10)) between selected sampling stations with an average value of 0.842during consecutive low tideat Kandla creek and nearby creeks.

Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations in the stations was 0.684 during the sampling conducted in High tide period of spring tide at Path Finder Creek, Vadinar. Shannon-Wiener's Index (H)of phytoplankton communities in the path finder creek was 0.695 during the consecutive low tide period at Path Finder Creek, Vadinar .

Shannon-Wiener's Index (H) of phytoplankton communities in the stations was varying from 0.356-0.255 during the sampling conducted in consecutive High tide period and low tide period of Neap Tide at jetty area of Path finder Creek. While Shannon-Wiener's Index (H) of phytoplankton communities near the SPM was varying from 0.508-0.234 during the consecutive high tide and low tide period of Neap 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 0.809- 0.852 between selected sampling stations with an average of 0.827 during high tide period of spring tide. Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stationsin the Kandla Harbour region and nearby creeks, which was varying from 0.819- 0.865 between selected sampling stations with an average of 0.840during consecutive low tide .

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 0.809-0.853 with an average value of 0.835 between selected sampling stations during high tide period and varying from 0.809-0.852 with an average value of 0.831 between selected sampling stations during consecutive low tide period Low species diversity suggests a relatively few successful species in this habitat.

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 path finder Creek, which was 0-720 during high tide period and 0.751 during low tide period of spring tide at Jetty region . Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stations in the in path finder Creek, which was varying from 0.720-0.751 at jetty region of path finder creek during consecutive high tide and low tide period of Spring Tide and recorded below 9 at SPM during consecutive high tide and low tide period of Neap tide also , 0.329 - 0.499 during high tide and 0.218-0.201 during low tide

Table # 4PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA AT KANDLA CREEK AND ,NEAR BY CREEKS DURING SPRING TIDE IN OCTOBER,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	199	18/24	75	3.212	0.9355	0.8519
	2	209	12/24	50	2.059	0.8018	0.8091
	3	204	14/24	58.3	2.444	0.8451	0.8244
	4	204	17/24	70.83	3.009	0.9095	0.837
	5	199	14/24	58.3	2.456	0.8497	0.8167
	6	46	11/24	45.83	2.612	0.8208	0.8232
LOW TIDE	1	223	18/24	75	3.144	0.9797	0.8653
	2	214	17/24	70.83	2.982	0.9126	0.8446
	3	193	17/24	70.83	3.04	0.919	0.8416
	4	229	16/24	66.66	2.761	0.8806	0.8312
	5	183	15/24	62.5	2.687	0.858	0.8193

Table # 5 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA AT KANDLA CREEK AND ,NEAR BY CREEKS DURING NEAP TIDE IN OCTOBER,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	170	18/25	72	3.31	0.9214	0.8451
	2	133	14/25	56	2.658	0.8621	0.8308
	3	142	11/25	44	2.018	0.8693	0.847
	4	152	18/25	72	3.384	0.9173	0.8463
	5	128	12/25	48	2.267	0.8398	0.828
	6	88	14/25	56	2.904	0.9345	0.8406
LOW TIDE	1	143	11/25	44	2.015	0.8355	0.832
	2	149	13/25	52	2.398	0.8822	0.842
	3	139	16/25	64	3.04	0.9274	0.8526
	4	157	9/25	36	1.582	0.7937	0.8176
	5	120	9/25	36	1.671	0.7738	0.8094

Table # 6 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA AT KANDLA CREEK AND , NEAR BY CREEKS DURING SPRING TIDE IN OCTOBER, 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	39-204	19/24	79.2
			BLUE GREEN	3-8	3/24	12.5
			DINOFLAGELLATES	2-9	2/24	8.3
			TOTAL PHYTO PLANKTON	**46-209**	**24**	-
LOW TIDE	Sub surface	5	DIATOMS	176-222	19/24	79.2
			BLUE GREEN	3-8	3/24	12.5
			DINOFLAGELLATES	2-6	2/24	8.3
			TOTAL PHYTO PLANKTON	183-229	**24**	-

Table # 7 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA AT KANDLA CREEK AND , NEAR BY CREEKS DURING NEAP TIDE IN OCTOBER,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	81-164	20/25	80
			BLUE GREEN	1-6	3/25	12
			DINOFLAGELLATES	0-4	2/25	8
			TOTAL PHYTO PLANKTON	**88-170**		
LOW TIDE	Sub surface	5	DIATOMS	117-157	20/25	80
			BLUE GREEN	0-7	3/25	12
			DINOFLAGELLATES	0-4	2/25	8
			TOTAL PHYTO PLANKTON	**120-157**		

Table # 8 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT OOTAT PATH FINDER CREEK , VADINAR &NEAR BY SPM, DURING SPRING TIDE IN OCTOBER, 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	jetty	131	9/9	100	1.641	0.6874	0.7201
LOW TIDE	jetty	147	9/9	100	1.603	0.6956	0.7508

Table # 9 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT OOTAT PATH FINDER CREEK , VADINAR & NEAR BY SPM, DURING NEAP TIDE IN OCTOBER, 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	jetty	427	13/15	86.67	1.981	0.3559	0.3291
	SPM	203	13/15	86.67	2.259	0.5079	0.499
LOW TIDE	jetty	544	14/15	93.33	2.064	0.2555	0.2188
	SPM	744	11/15	73.33	1.512	0.2343	0.2011

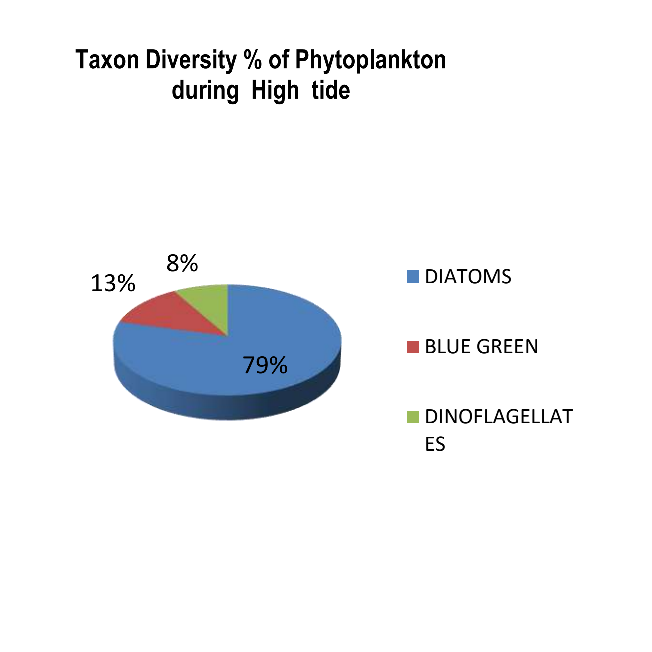
Table # 10 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT DPTOOT AT PATH FINDER CREEK , VADINAR & NEAR BY SPM, DURING SPRING TIDE IN OCTOBER, 2021

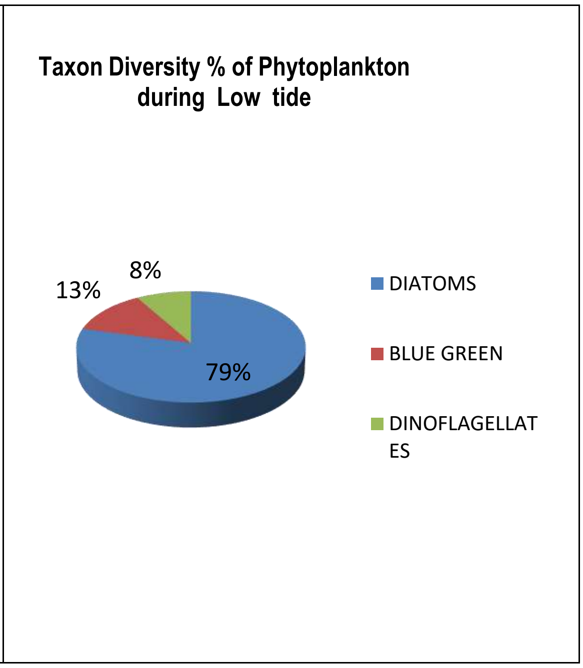
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	1	DIATOMS	131	9/9	100
			TOTAL PHYTO PLANKTON	**131**	**9**	
LOW TIDE	Sub surface	1	DIATOMS	147	9/9	100
			TOTAL PHYTO PLANKTON	147	**9**	

Table # 11 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT DPTOOT AT PATH FINDER CREEK , VADINAR & NEAR BY SPM, DURING NEAP TIDE IN OCTOBER, 2021

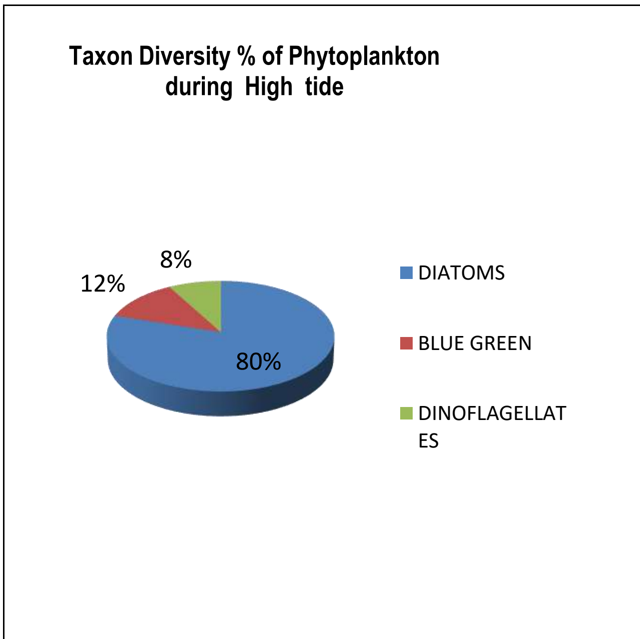
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	2	DIATOMS	189-424	10/15	66.5
			BLUE GREEN	1-4	1/15	7.5
			DINOFLAGELLATES	4-10	4/15	26.0
			TOTAL PHYTO PLANKTON	**203-427**		
LOW TIDE	Sub surface	2	DIATOMS	480-664		
			BLUE GREEN	2	10/15	66.5
			DINOFLAGELLATES	5-10	1/15	7.5
			TOTAL PHYTO PLANKTON	544-744	4/15	26.0

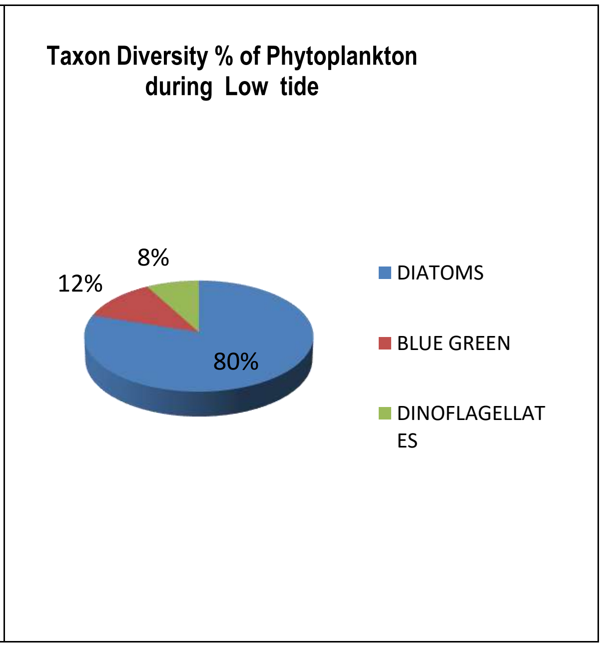
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide in Kandala creek and nearby creeks



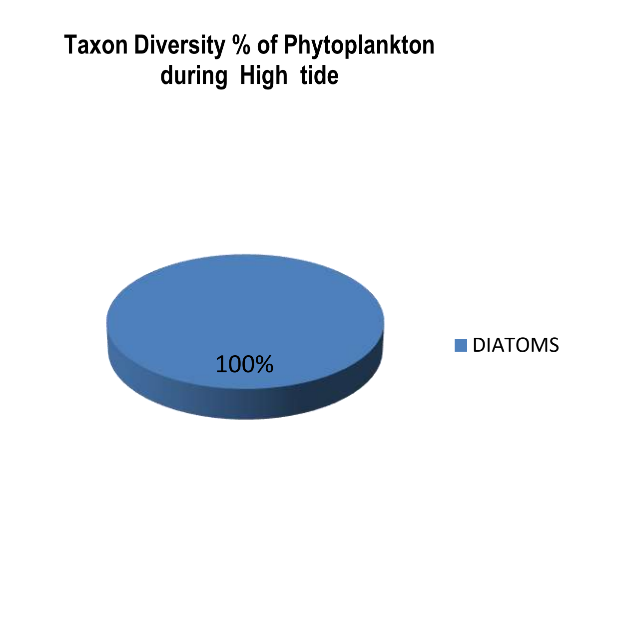


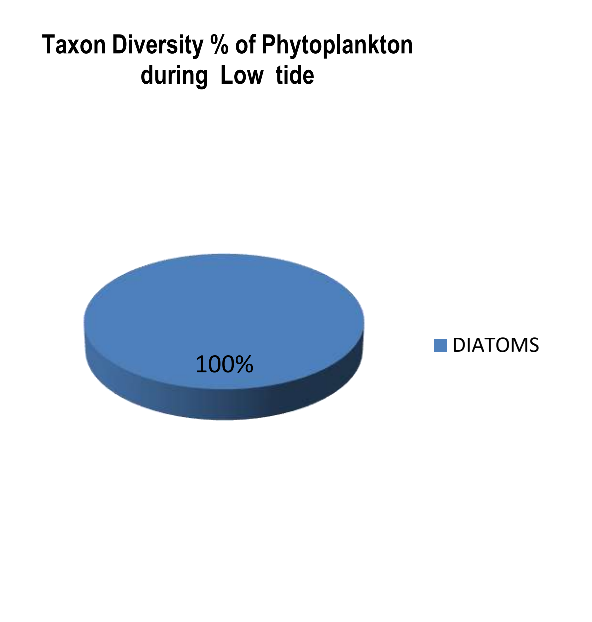
Taxon Diversity % of Phytoplankton during High tide and Low tide period during Neap tide inKandala creek and nearby creeks



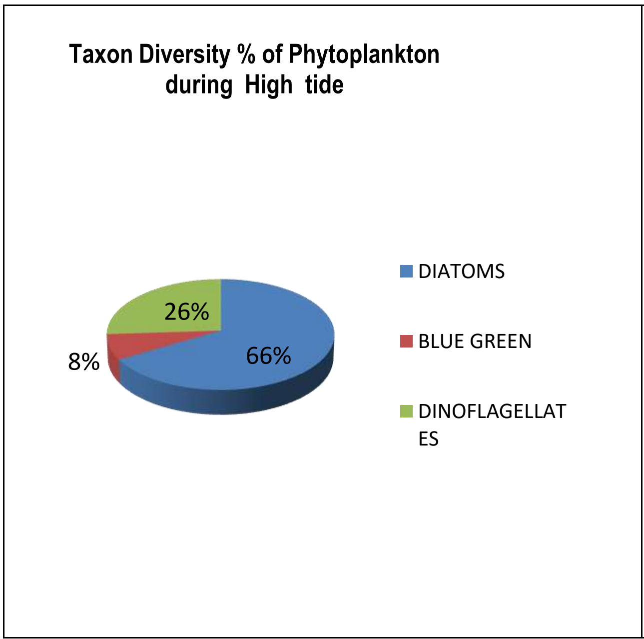


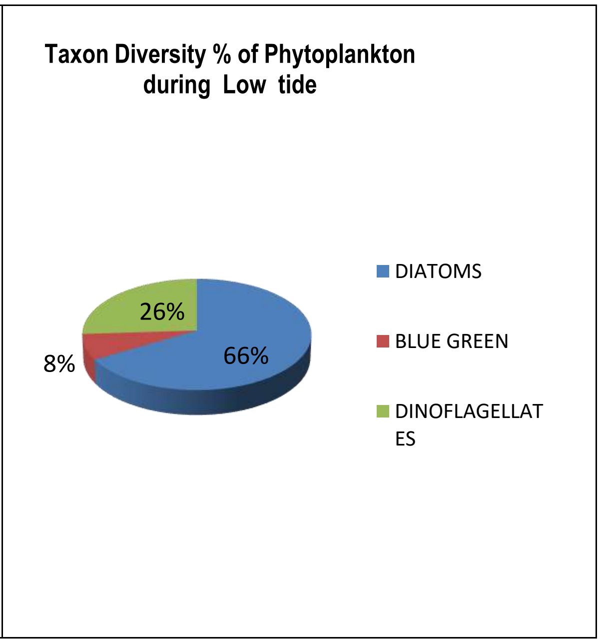
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide in Path Finder Creek, Vadinar





Taxon Diversity % of Phytoplankton during High tide and Low tide period during Neap tide in Path Finder Creek, Vadinar





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 October,2021. The Zooplankton community of the sub surface water in the harbour and nearby creeks during spring tide was represented by mainly 9 groups, and 7 larval forms; Tintinids, Copepods,Rotifers, Arrow worms, Mysids, Urochordates ,Ciliates ,Unidentified medusa and Foraminiferans.Larval forms represented from the group of Crustacea, Molluscansand Polychaetes. The Zooplankton community of the sub surface water in the harbour and nearby creeks during neap tide was represented by mainly 9groups, and Eight larval forms . The major zooplankton group was Tintinids, Copepods, Rotifers, Arrow worms ,Mysids, Urochordata, Ciliates , Medusa and Foraminiferans . Larval forms were represented from the group of Crustaceans ,Echinodermata, Bryozoans , Molluscansand Polychaetes,

Zooplankton of the sampling stations at sub surface layer in the DPT harbour area and nearby creek was varying from 33-132 x10^3 N/ m^3 during high tide and 81-107x10^3 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 47-167x10^3 N/ m^3 during high tide and9-112x10^3 N/ m^3during low tide of Neap Tide period.

For the evaluation of the Zoo plankton population in DPT OOT jetty area in Path Finder creek and SPM in Vadinar selected 2 sampling locations (1 in jetty area and one near SPM) Duringspring tide sampling plankton sample were collected only at Jetty area during consecutive high tide period and low tide period. During Neap tide sampling Plankton samples were collected from jetty area and SPM during consecutive high tide period and low tide period.
The Zooplankton community of the sub surface water in the path finder creek creeks during spring tide was represented by mainly two groups, Tintinids, Copepods, and larval forms of Crustacea and Molluscans. The Zooplankton community of the sub surface water in the path Finder creeks at Jetty region and SPM during neap tide was represented by mainly Five groups, Tintinids, Copepods, Arrow worms , Urochordata and ,Mysids .Larval forms were represented from the major group of Crustaceans , Molluscans , Echinodremataand Polychaetes,.

Zooplankton of the sampling stations at sub surface layer in the DPT OOTjetty area of path finder creek was 76 x10^3 N/ m^3 during high tide and 74 x10^3 N/ m^3 during low tide of Spring Tide period. Zooplankton of the sampling stations at sub surface layer in the DPT OOTjetty area in path finder creekwas recorded 54x10^3 N/ m^3during high tide and 73 x10^3 N/ m^3 during consecutive low tide period of Neap . Zooplankton of the sampling stations at sub surface layer in the DPT SPM area in path finder creek was recorded 78 x10^3 N/ m^3during high tide and 82 x10^3 N/ m^3 during consecutive low tide period 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 Zooplankton communities in the stations Kandla creek region and nearby creeks was varying from 3.146-4.804 with an average of 3.874during the sampling conducted in High tide period.Margalef's diversity index (Species Richness) S of Zooplankton communities varying from.2.842-4.280 with an average of 3.393 during the sampling conducted in low tide period during Spring tide.

Margalef's diversity index (Species Richness) S of Zooplankton communities in the Kandla creek region and nearby creeks sampling stations was varying from3.117- 6.839 with an average of 5.036 during the sampling conducted in high tide and varying from. 3.034 -4.570 with an average of 3.769 during the sampling conducted in low tide during Neap tide period

Margalef's diversity index (Species Richness) S of Zooplankton communities in the sampling stationnear jetty at Path Finder Creek, Vadinar during the sampling conducted in consecutive High tide period and low tide of spring tide was recorded as 1.847 and 1. 859 respectively..

Margalef's diversity index (Species Richness) S of Zooplankton communities in the two stations at Path finder creek was varying from 3.259-3.443 during the sampling conducted in High tide period of Neap tide. While Margalef's diversity index (Species Richness) S of Zooplankton communities in the two stations at Path finder creekwas varying from 2.797-4.085 during the consecutive low 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 -1.060 (H'(log10)) between selected sampling stations with an average value of 0.992 (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 0.844-0.965(H'(log10)) between selected sampling stations with an average value of 0.894 (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 0.834 -1.336 (H'(log10)) between selected sampling stations with an average value of 1.146 (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 0.949-1.139 (H'(log10)) between selected sampling stations with an average value of 1.043 (H'(log10)) during consecutive low tide period.

Shannon-Wiener’s Index (H) of Zooplankton communities in the sampling station near jetty at Path Finder Creek, Vadinar during the sampling conducted in consecutive High tide period and low tide of spring tide was recorded as 0.775 and 0.822 respectively..

Shannon-Wiener’s Index (H)of Zooplankton communities in the two stations at Path finder creek was varying from 0.991-0.927 during the sampling conducted in High tide period of Neap tide. While Shannon-Wiener’s Index (H)of Zooplankton communities in the two stations at Path finder creek was varying from 0.815-1.004 during the 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 0.848-0.881between selected sampling stations with an average of 0.865 during high tide period and was varying from 0.812- 0.845 with an average value of 0.827 between selected sampling stations during low tide

Simpson diversity index (1-D) of Zooplankton communities was blow 0.9 at all sampling stationsin the Kandla Harbour region and nearby creeks except few during high tide and low tide period, which was varying from 0.793- 0.937 between selected sampling stations with an average of 0.894 during high tide period and was varying from 0.861- 0.910 with an average value of 0.884 between selected sampling stations during consecutive low tide

This high species diversity suggests a relatively more number of successful species in this habitat during October ,2021 sampling.

Simpson diversity index (1-D) of Zooplankton communities in the sampling station near jetty at Path Finder Creek, Vadinar during the sampling conducted in consecutive High tide period and low tide of spring tide was recorded as 0.800 and 0.827 respectively..

Simpson diversity index (1-D) of Zooplankton communities in the two stations at Path finder creek was varying from 0.884 -0.838 during the sampling conducted in High tide period of Neap tide. While Shannon-Wiener's Index (H)of Zooplankton communities in the two stations at Path finder creek was varying from 0.816 -0.863 during the consecutive low tide period.

Table # 12 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA AT KANDLA CREEK AND NEAR BY CREEKS DURING SPRING TIDE IN OCTOBER,2021

Tide	Sampling Station	Abundance In N / m³	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	120 $x10^3$	24/32	75	4.804	1.06	0.8695
	2	105 $x10^3$	21/32	65.62	4.297	1.045	0.8753
	3	132 $x10^3$	18/32	56.25	3.482	0.9555	0.8523
	4	117 $x10^3$	18/32	56.25	3.57	1.032	0.8811
	5	123 $x10^3$	20/32	62.50	3.948	0.9513	0.8481
	6	33 $x10^3$	12/32	37.5	3.146	0.9125	0.8636
LOW TIDE	1	97 $x10^3$	14/32	43.75	2.842	0.8439	0.8174
	2	107 $x10^3$	21/32	65.63	4.28	0.9654	0.8455
	3	81 $x10^3$	15/32	46.87	3.186	0.9009	0.8315
	4	93 $x10^3$	16/32	50	3.309	0.8669	0.8125
	5	88 $x10^3$	16/32	50	3.35	0.8971	0.8325

Table # 13 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREAAT KANDLA CREEK AND NEAR BY CREEKS DURING NEAP TIDE IN OCTOBER,2021

Tide	Sampling Station	Abundance In No / m³	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	167 $x10^3$	36/37	97.30	6.839	1.336	0.9367
	2	124 $x10^3$	28/37	75.68	5.601	1.282	0.9373
	3	133 $x10^3$	24/37	64.86	4.703	1.163	0.9108
	4	144 $x10^3$	29/37	78.38	5.634	1.19	0.8993
	5	102 $x10^3$	21/37	56.75	4.324	1.075	0.8893
	6	47 $x10^3$	13/37	35.13	3.117	0.834	0.7928
LOW TIDE	1	112 $x10^3$	18/37	48.65	3.603	0.9973	0.8637
	2	90 $x10^3$	19/37	51.35	4	1.065	0.8974
	3	99 $x10^3$	22/37	59.46	4.57	1.139	0.9105
	4	107 $x10^3$	18/37	48.65	3.638	1.068	0.8889
	5	101 $x10^3$	15/37	40.54	3.034	0.9498	0.861

Table # 14 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREAATKANDLA CREEK AND ,NEAR BY CREEKS DURING SPRING TIDE IN OCTOBER,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	3-21	6/32	18.75
			Copepods	13-68	10/32	31.25
			Rotifers	0-4	1/32	3.13
			Arrow worms	0-2	1/32	3.13
			Mysids	0-2	2/32	6.25
			Urochordata	0-1	1/32	3.12
			Ciliates	1-7	1/32	3.12
			Medusa	0-1	1/32	3.12
			Larval forms	11-43	7/32	21.88
			Foraminiferans	0-1	2/32	6.25
			TOTAL ZOOPLANKTON N/ M^3	**33-132**	**32**	
LOW TIDE	Sub surface	5	Tintinids	4-15	6/32	18.75
			Copepods	45-59	10/32	31.25
			Rotifers	0-1	1/32	3.13
			Arrow worms	0-1	1/32	3.13
			Mysids	0-1	2/32	6.25
			Urochordata	0-1	1/32	3.12
			Ciliates	1-6	1/32	3.12
			Medusa	0	1/32	3.12
			Larval forms	22-33	7/32	21.88
			Foraminiferans	0-2	2/32	6.25
			TOTAL ZOOPLANKTON N/M^3	**81-107**	**32**	

Table # 15 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA IN KANDLA CREEK AND , NEAR BY CREEKS DURING NEAP TIDE IN OCTOBER, 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	2-26	6/37	16.22
			Copepods	18-76	11/37	29.73
			Rotifers	0-2	1/37	2.70
			Mysids	0-6	4/37	10.81
			Arrow worms	0-4	1/37	2.70
			Urochordata	0-4	1/37	2.70
			Ciliates	0-8	1/37	2.70
			Medusa	0-4	1/37	2.70
			Larval forms	20-46	9/37	24.32
			Foraminiferans	0-6	2/37	5.42
			TOTAL ZOOPLANKTON N/M^3	**47-165**		
LOW TIDE	Sub surface	5	Tintinids	13-22	6/37	16.22
			Copepods	42-47	11/37	29.73
			Rotifers	0	1/37	2.70
			Mysids	0-4	4/37	10.81
			Arrow worms	0-1	1/37	2.70
			Urochordata	0-2	1/37	2.70
			Ciliates	1-5	1/37	2.70
			Medusa	0	1/37	2.70
			Larval forms	21-40	9/37	24.32
			Foraminiferans	**0-5**	2/37	5.42
			TOTAL ZOOPLANKTON N/M^3	**89-112**		

Table # 16 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT OOT AREA AT PATH FINDER CREEK AND NEAR BY SPM DURING SPRING TIDE IN OCTOBER,2021

Tide	Sampling Station	Abundance In N / 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	Jetty	76 x10^3	9/9	100	1.847	0.7749	0.8004
LOW TIDE	Jetty	74 x10^3	9/9	100	1.859	0.8222	0.8278

Table # 17 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT OOT AREA AT PATH FINDER CREEK AND NEAR BY SPM DURING NEAP TIDE IN OCTOBER,2021

Tide	Sampling Station	Abundance In N / 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	Jetty	54 $x10^3$	14/23	60.87	3.259	0.9911	0.884
	SPM	78 $x10^3$	16/23	69.56	3.443	0.9276	0.8385
LOW TIDE	Jetty	73 $x10^3$	13/23	56.52	2.797	0.8156	0.8166
	SPM	82 $x10^3$	19/23	82.61	4.085	1.004	0.863

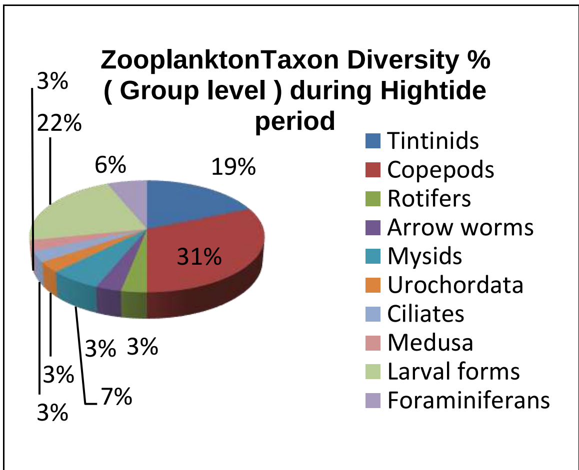
Table # 18 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT OOT AREAAT PATH FINDER CREEK AND NEAR BY SPM DURING SPRING TIDE IN OCTOBER,2021

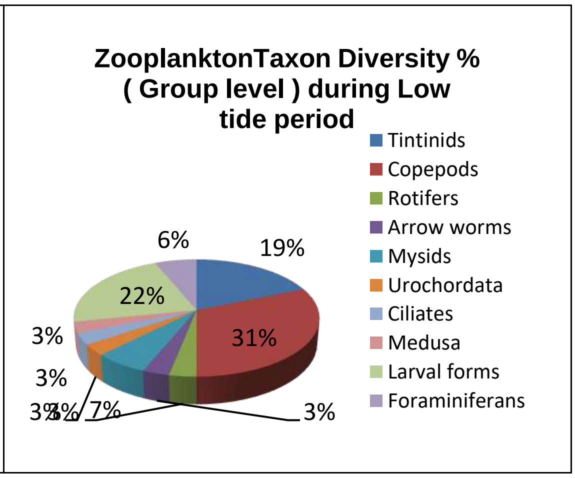
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton $x10^3$ Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	1	Tintinids	40	5/9	55.56
			Copepods	18	2/9	22.22
			Larval forms	18	2/9	22.22
			TOTAL ZOOPLANKTON NO/L	**76**	**9**	
LOW TIDE	Sub surface	1	Tintinids	38	5/9	55.56
			Copepods	16	2/9	22.22
			Larval forms	20	2/9	22.22
			TOTAL ZOOPLANKTON NO/M3	**74**	**9**	

Table # 19 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT OOT AREAAT PATH FINDER CREEK AND NEAR BY SPM DURING NEAP TIDE IN OCTOBER, 2021

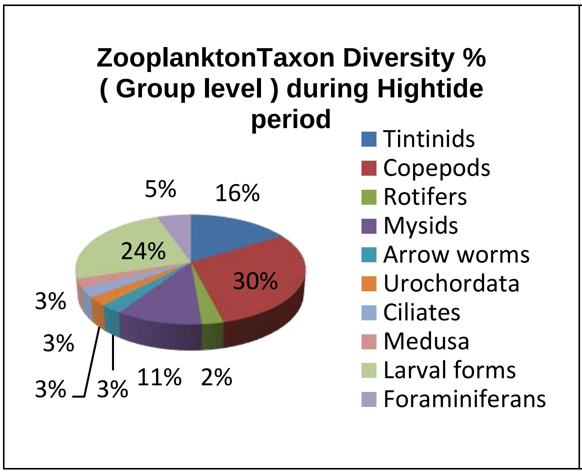
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	2	Tintinids	1-2	2/23	8.70
			Copepods	30-45	8/23	34.78
			Arrow worms	0-1	1/23	4.35
			Mysids	4-9	4/23	17.39
			Urochordata	2-4	1/23	4.35
			Larval forms	12-22	7/23	30.43
			TOTAL ZOOPLANKTON	**41-60**		
LOW TIDE	Sub surface	2	Tintinids	1-2	2/23	8.70
			Copepods	49-53	8/23	34.78
			Arrow worms	1	1/23	4.35
			Mysids	2-5	4/23	17.39
			Urochordata	1	1/23	4.35
			Larval forms	19-20	7/23	30.43
			TOTAL ZOOPLANKTON NO/M3	**73-82**		

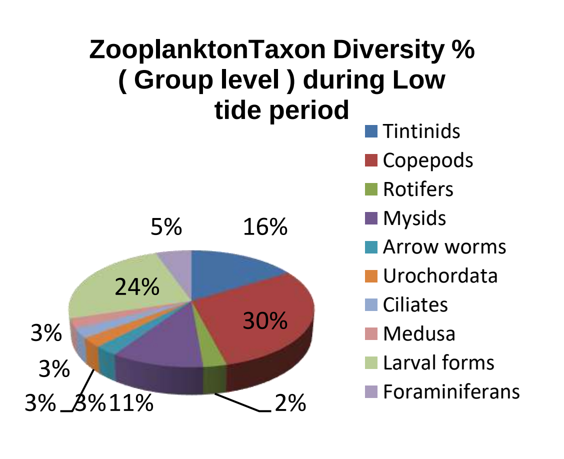
Taxon Diversity % of Zooplankton during High tide and Low tide period of Spring tide In Kandla Creek and nearby Creeks



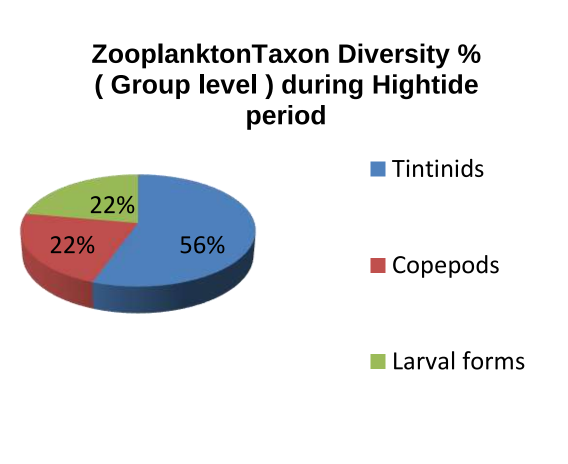


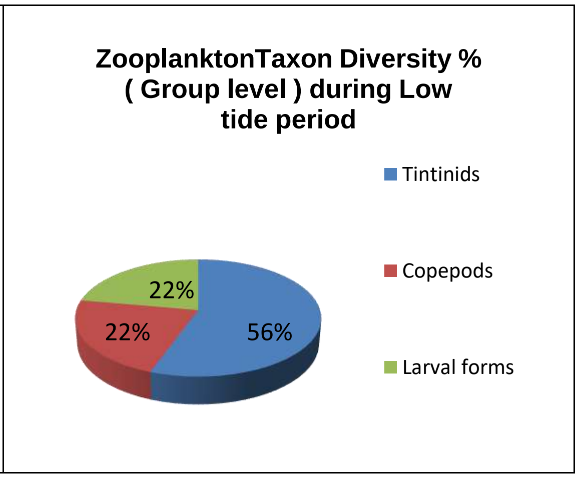
Taxon Diversity % of Zooplankton during High tide and Low tide period of Neap tide In Kandla Creek and nearby Creeks



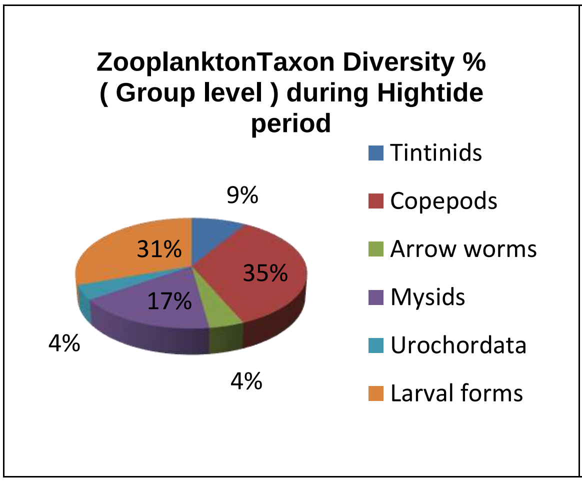


Taxon Diversity % of Zooplankton during High tide and Low tide period of Spring tide In Path Finder Creek and near Jetty





Taxon Diversity % of Zooplankton during High tide and Low tide period of Neap tide In Path Finder Creek near jetty and nearby SPM



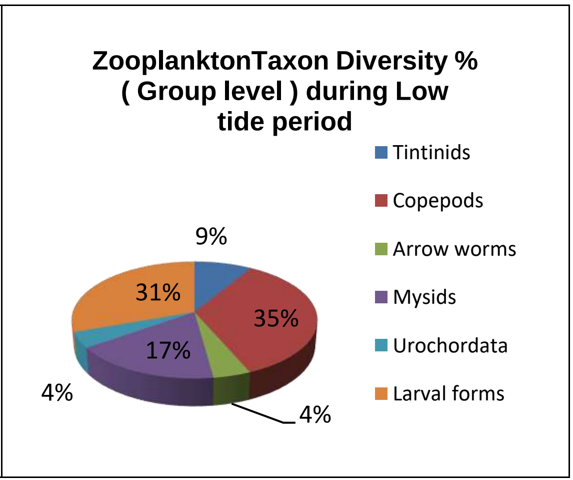


TABLE # 20SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS OF DPT HARBOUR AREA AT KANDLA CREEK AND NEARBY CREEKS DURINGSPRING TIDE OF OCTOBER 2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALGAE	Cyanophyta	Cyanophyceae	Nostocales	Oscillatoriaceae	*Oscillatoria* sp.	B1	Occasional
					Arthrospira sp.	B2	Rare
			Stigonematales	Stigonemataceae	*Stigonema sp.*	B3	Occasional
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Occasional
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D2	Dominant
			Triceratiales	Triceratiaceae	*Odontella*sp	D3	Occasional
					*Triceratium*sp.	D4	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D5	Abundant
			Hemiaulales	Bellerocheaceae	*Bellerochea*sp	D6	Rare
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D7	Rare
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros*sp	D8	Frequent
			Leptocylindrales	Leptocylindraceae	*Leptocylindrus*sp	D9	Occasional
			Lithodesmiales	Lithodesmiaceae	*Ditylum*sp	D10	Dominant
			Melosirales	Melosiraceae	*Melosira*sp	D11	Rare
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*sp	D12	Rare
			Surirellales	Surirellaceae	*Surirella*sp	D13	Rare
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D14	Abundant
					Thalassionema sp.	D15	Rare
			Fragilariales	Fragilariaceae	*Asterionellopsis sp.*	D16	Occasional
					*Fragilaria*sp	D17	Frequent
					*Synedra*sp	D18	Rare
			Tabellariales	Tabellariaceae	*Tabellaria*sp	D19	Rare
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium sp.*	DF1	Rare
			Gonyaulacales	Ceratiaceae	*Ceratiumfurca*	DF2	Occasional

TABLE # 21 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AT KANDLA CREEK AND NEARBY CREEKS DURING AND NEAP TIDE OF OCTOBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALGAE	Cyanophyta	Cyanophyceae	Nostocales	Oscillatoriaceae	*Oscillatoria* sp.	B1	Rare
					Arthrospira sp.	B2	Rare
			Stigonematales	Stigonemataceae	*Stigonema sp.*	B3	Rare
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniellasp*	D1	Occasional
					Thalassiosirasp	D2	Rare
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D3	Dominant
			Triceratiales	Triceratiaceae	*Odontellasp*	D4	Occasional
					*Triceratium*sp.	D5	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphiasp*	D6	Abundant
			Hemiaulales	Bellerocheaceae	*Bellerocheasp*	D7	Rare
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D8	Rare
			Chaetocerotales	Chaetocerotaceae	*Chaetocerossp*	D9	Frequent
			Leptocylindrales	Leptocylindraceae	*Leptocylindrussp*	D10	Occasional
			Lithodesmiales	Lithodesmiaceae	*Ditylumsp*	D11	Dominant
		Bacillariophyceae	Naviculales	Naviculaceae	*Naviculasp*	D12	Rare
				Pleurosigmataceae	*Gyrosigmasp*	D13	Rare
					Pleurosigmasp	D14	Rare
			Surirellales	Surirellaceae	*Surirellasp*	D15	Rare
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D16	Abundant
					Thalassionema sp.	D17	Rare
			Fragilariales	Fragilariaceae	*Fragilariasp*	D18	Frequent
					Synedrasp	D19	Rare
			Tabellariales	Tabellariaceae	*Tabellariasp*	D20	Rare
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium sp.*	DF1	Rare
			Gonyaulacales	Ceratiaceae	*Ceratiumfurca*	DF2	Occasional

TABLE # 22 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT OOT AREA AT PATH FINDER CREEK AND NEARBY SPM AT VADINAR DURING SPRING TIDE OF OCTOBER 2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D1	Occasional
			Triceratiales	Triceratiaceae	*Triceratium*sp.	D2	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D3	Rare
			Hemiaulales	Bellerocheaceae	*Bellerochea*sp	D4	Rare
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D5	Rare
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros*sp	D6	Dominant
			Lithodesmiales	Lithodesmiaceae	*Ditylum*sp	D7	Occasional
			Bacillariales	Bacillariaceae	*Pseudo-Nitzschia*sp	D8	Abundant
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D9	Frequent

TABLE # 23 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT OOT AREA AT PATH FINDER CREEK AND NEARBY SPM AT VADINAR DURING AND NEAP TIDE OF OCTOBER, 2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALGAE	Cyanophyta	Cyanophyceae	Nostocales	Oscillatoriaceae	*Oscillatoria* sp.	B1	Rare
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Occasional
				Lauderiaceae	*Lauderia*sp	D2	Rare
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D3	Abundant
			Hemiaulales	Bellerocheaceae	*Bellerochea*sp	D4	Occasional
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D5	Rare
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros*sp	D6	Dominant
			Lithodesmiales	Lithodesmiaceae	*Ditylum*sp	D7	Occasional
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*sp	D8	Rare
			Bacillariales	Bacillariaceae	*Pseudo-Nitzschia*sp	D9	Frequent
			Fragilariales	Fragilariaceae	*Synedra*sp	D10	Rare

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium sp.*	DF1	Rare
			Gonyaulacales	Ceratiaceae	*Ceratiumfurca*	DF2	Occasional
					Ceratiumfusus	DF3	Rare
					Ceratiumtripos	DF4	Rare

TABLE #24 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS OF DPT HARBOUR AREA AT KANDLA CREEK AND NEARBY CREEKSDURING SPRING TIDE OF OCTOBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Occasional
				Codonellidae	*Tintinnopsisdadayi*	T2	Rare
					Tintinnopsisgracilis	T3	Occasional
					Tintinnopsis radix	T4	Rare
					Tintinnopsisfailakkaensis	T5	Occasional
				Xystonellidae	*Favella* sp.	T6	Rare
COPEPODS	ATHROPODA	Crustacea Subclass: Copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Abundant
					Bestiolina sp.	C2	Rare
				Eucalanidae	*Subeucalanus sp.*	C3	Rare
				Clausocalanidae	*Clausocalanus sp.*	C4	Occasional
				Centropagidae	*Centropages sp.*	C5	Rare
				Acartiidae	*Acartia sp.*	C6	Rare
			Cyclopoida	Oithonidae	*Oithona sp.*	C7	Dominant
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C8	Rare
				Euterpinidae	*Euterpina sp.*	C9	Frequent
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C10	Rare
ROTIFERS	ROTIFERA	Rotifera Subclass: Eurotatoria	Superorder: Monogononta Order:Ploimida	Brachionidae	*Brachionusplicatilis*	R1	Rare
ARROW WORMS	CHAETOGNATHA	Sagittoidea	Aphragmophora	Sagittidae	*Sagitta sp.*	A1	Rare
MYSIDS	ATHROPODA CRUSTACEA	Malacostraca	Mysida, Decapoda	Penaeidae	*Metapenaeussp.*	M1	Rare
					Penaeussp.	M2	Rare

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
UROCHORDATA	CHORDATA SUB PHYLUM UROCHORDATA	Appendicularia		Oikopleuridae	*Oikopleura sp.*	U1	Rare
CILIATES	CILIOPHORA	Oligohymenophorea	Sessilida	Zoothamniidae	*Zoothamniumsp.*	CI1	Occasional
MEDUSA	PHYLUM CNIDARIA	Hydrozoa			Unidentified medusa	ME1	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BRACHYURA LARVAE	ARTHROPODA (CRUSTACEA)	Malacostraca Decapoda			Brachyuran Zoea larvae	L2	Rare
BARNACLE LARVAE	ATHROPODA CRUSTACEA	Maxillopoda Thecostraca			Cirripede larvae	L3	Rare
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L4	Rare
CHORDATA	VERTEBRATA	Pisces			Fish larvae	L5	Rare
POLYCHAETE LARVAE	ANNELIDA	Polychaeta			Trochophore larvae	L6	Occasional
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L7	Rare
FORAMINIFERA	FORAMINIFERA	Globothalamea	Rotaliida	Globigerinidae	*Globigerina* sp.	F1	Rare
				Rotalliidae	*Rotalia* sp.	F2	Rare

TABLE # 25 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING OF DPT HARBOUR AREA AT KANDLA CREEK AND NEARBY CREEKSDURING NEAP TIDE OF OCTOBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Frequent
				Codonellidae	*Tintinnopsisdadayi*	T2	Rare
					Tintinnopsisgracilis	T3	Rare
					Tintinnopsis radix	T4	Occasional
					Tintinnopsisfailakkaensis	T5	Rare
				Codonellopsidae	*Codonellopsis* sp.	T6	Rare
COPEPODS	ATHROPODA	Crustacea Subclass: Copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Abundant
				Eucalanidae	*Pareucalanus sp.*	C2	Rare
					Subeucalanus sp.	C3	Rare
				Clausocalanidae	*Clausocalanus sp.*	C4	Occasional
				Centropagidae	*Centropages sp.*	C5	Rare
				Temoridae	*Temora sp.*	C6	Rare
				Acartiidae	*Acartia sp.*	C7	Occasional
			Cyclopoida	Oithonidae	*Oithona sp.*	C8	Abundant
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C9	Occasional
				Euterpinidae	*Euterpina sp.*	C10	Frequent
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C11	Rare
ROTIFERS	ROTIFERA	Rotifera Subclass: Eurotatoria	Superorder: Monogononta Order:Ploimida	Brachionidae	*Brachionusplicatilis*	R1	Rare
ARROW WORMS	CHAETOGNATHA	Sagittoidea	Aphragmophora	Sagittidae	*Sagitta sp.*	A1	Rare
MYSIDS	ATHROPODA CRUSTACEA	Malacostraca	Mysida, Decapoda	Solenoceridae	*Solenocerasp.*	M1	Rare
				Penaeidae	*Metapenaeussp.*	M2	Rare
					Penaeussp.	M3	Rare
				Luciferidae	*Lucifer sp.*	M4	Rare
UROCHORDATA	CHORDATA SUB PHYLUM UROCHORDATA	Appendicularia		Oikopleuridae	*Oikopleura sp.*	U1	Rare
CILIATES	CILIOPHORA	Oligohymenophorea	Sessilida	Zoothamniidae	*Zoothamniumsp.*	CI1	Occasional

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
MEDUSA	PHYLUM CNIDARIA	Hydrozoa			Unidentified medusa	ME1	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BRACHYURA LARVAE	ARTHROPODA (CRUSTACEA)	Malacostraca Decapoda			Brachyuran Zoea larvae	L2	Occasional
BARNACLE LARVAE	ATHROPODA CRUSTACEA	Maxillopoda Thecostraca			Cirripede larvae	L3	Rare
CYPHONAUTES LARVAE	BRYOZOA				Cyphonautes larvae	L4	Occasional
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L5	Rare
ECHINODERMATA LARVAE	ECHINODERMATA				Ophipluutes larvae/ Echinoplutes larvae	L6	Rare
CHORDATA	VERTEBRATA	Pisces			Fish larvae	L7	Rare
POLYCHAETE LARVAE	ANNELIDA	Polychaeta			Trochophore larvae	L8	Occasional
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L9	Rare
FORAMINIFERA	FORAMINIFERA	Globothalamea	Rotaliida	Globigerinidae	*Globigerina* sp.	F1	Occasional
				Rotalliidae	*Rotalia* sp.	F2	Rare

TABLE # 26 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS OF DPT OOT AREA AT PATH FINDER CREEK AND NEARBY SPM AT VADINAR DURING SPRING TIDE OF OCTOBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Dominant
				Codonellidae	*Tintinnopsisgracilis*	T2	Occasional
					Tintinnopsis radix	T3	Occasional
					Tintinnopsistocantinensis	T4	Occasional
				Xystonellidae	*Favella* sp.	T5	Rare
COPEPODS	ATHROPODA	Crustacea Subclass: Copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Occasional
			Cyclopoida	Oithonidae	*Oithona sp.*	C2	Frequent
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Abundant
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L2	Rare

TABLE # 27 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS OF DPT OOT AREA AT PATH FINDER CREEK AND NEARBY SPM AT VADINAR DURING NEAP TIDE OF OCTOBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Rare
				Xystonellidae	*Favella* sp.	T2	Rare
COPEPODS	ATHROPODA	Crustacea Subclass: Copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Dominant
				Eucalanidae	*Pareucalanus sp.*	C2	Rare
					Subeucalanus sp.	C3	Rare
				Clausocalanidae	*Clausocalanus sp.*	C4	Occasional
				Tortanidae	*Tortanus sp.*	C5	Rare
			Cyclopoida	Oithonidae	*Oithona sp.*	C6	Abundant
			Harpacticoida	Euterpinidae	*Euterpina sp.*	C7	Frequent
			Poicilostomatatoida	Corycaeidae	*Corycaeus sp.*	C8	Rare

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
ARROW WORMS	CHAETOGNATHA	Sagittoidea	Aphragmophora	Sagittidae	*Sagitta sp.*	A1	Rare
MYSIDS	ATHROPODA CRUSTACEA	Malacostraca	Mysida, Decapoda	Solenoceridae	*Solenocerasp.*	M1	Rare
				Penaeidae	*Metapenaeussp.*	M2	Rare
					Penaeussp.	M3	Rare
				Luciferidae	*Lucifer sp.*	M4	Rare
UROCHORDATA	CHORDATA SUB PHYLUM UROCHORDATA	Appendicularia		Oikopleuridae	*Oikopleura sp.*	U1	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Frequent
BRACHYURA LARVAE	ARTHROPODA (CRUSTACEA)	Malacostraca Decapoda			Brachyuran Zoea larvae	L2	Rare
BARNACLE LARVAE	ATHROPODA CRUSTACEA	Maxillopoda Thecostraca			Cirripede larvae	L3	Rare
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L4	Rare
ECHINODERMATA LARVAE	ECHINODERMATA				Ophipluutes larvae/ Echinoplutes larvae	L5	Rare
POLYCHAETE LARVAE	ANNELIDA	Polychaeta			Trochophore larvae	L6	Occasional
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L7	Rare

BENTHIC ORGANISMS:

Few Benthic organismswere observed in the collected sediments by using the Van-veen grabs during the sampling conducted during spring tide period and while no Benthic organisms were observed during sampling conducted in Neap tide period from DPT harbour region and nearby creek except few dead shells.The meiobenthic organisms during spring tide were represented by Polychaetes,and Nematodes. The polychaetes were represented by *Scyphoproctus sp.* ,during spring tide sampling.The meiobenthic organisms in the collected samples were varying from 40-60N/M ^{2}during spring tide

Table # 28BENTHIC FAUNA IN THE SAMPLING LOCATIONS IN DPT HARBOUR AREA CREEKS DURING NEAP TIDE IN OCTOBER ,2021

Benthic fauna	ABUNDANCE IN NO/M ^{2} DIFFERENT SAMPLING STATIONS REPRESENTATION BY GROUP						
	DPT HARBOUR			CREEKS			
POLYCHAETES	KPT-1	KPT-2	KPT-3	KPT-4	KPT-5	KPT-6	
Family : Capitellidae **Scyphoproctus** *sp.*	20	40	20	20	20	NS	
Total Polychates N/M^2	20	40	20	20	20	NS	
Un identified Nematode worms	40	20	20	40	20	NS	
TOTAL Benthic Fauna NUMBER/ M^2	60	60	40	60	40	-	

NS : No sample

7. Meteorological Data

Automatic Weather station have been installed in Seva Sadan -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 30.3 °C. The day-time maximum temperature was 38.6 °C. The mean night time temperature was 26.5 °C. The minimum mean night time temperature recorded was 30.6 °C.

Air Pressure

The mean absolute air pressure for the month of October was 1009.9 hpa, whereas the mean relative pressure was 1009.3 hpa. The maximum absolute air pressure recorded for the month of October was 1016.5 hpa.

Heat Index

The mean day-time heat index for the month of October was 33.8 ^{o}C. The maximum heat index recorded was 55^{o}C.

Solar Radiation

The mean Solar Radiation in October was 252.2 w/m^2. The maximum solar radiation recorded in the month of October was 746.6 w/m^2.

Humidity

The mean day-time humidity was 60.0 % for the month of October and mean night time humidity was 72.4%. Maximum humidity recorded during day-time was 94.0 % and maximum humidity recorded during night-time was 93.0%.

Wind Velocity and Wind Direction

The mean wind velocity for the entire month of October was 4.6 km/hour. Maximum wind velocity recorded was 29.2 Km/hr . The wind direction was mostly S to N.

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 October, 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.

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ENVIRONMENTAL MONITORING REPORTFOR

DEENDAYAL PORT TRUST

REPORT	**:**	**DCPL/DPT/20-21/19**
Mont	**:**	**November**
Issue	**:**	**01**
Revision	**:**	**00**
Prepare	**:**	**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 November 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	01.11.21	326	193	86	3.52	3.96	22.23	21.60	9.70	10.21	
					4.84		19.69		9.96		
					3.52		22.87		10.98		
AL1 – 2	09.11.21	303	156	90	5.71	6.15	15.88	20.54	13.02	13.36	
					6.15		17.15		12.76		
					6.59		28.58		14.30		
AL1 – 3	12.11.21	402	191	96	7.47	6.74	28.58	27.31	11.49	11.49	
					7.03		32.39		13.27		
					5.71		20.96		9.70		
AL1 – 4	17.11.21	438	180	90	3.08	2.64	19.69	16.73	15.57	16.00	
					2.20		14.61		18.12		
					2.64		15.88		14.30		
AL1 – 5	19.11.21	530	156	88	4.40	4.40	20.96	20.54	5.62	9.19	
					5.28		18.42		11.49		
					3.52		22.23		10.47		
AL1 - 6	24.11.21	468	182	90	2.64	3.52	14.61	16.30	10.98	7.49	
					5.28		20.96		6.64		
					2.64		13.34		4.85		
AL1 - 7	26.11.21	597	274	92	3.52	2.93	14.61	17.78	14.30	10.89	
					3.08		19.69		9.96		
					2.20		19.05		8.42		
AL1 – 8	29.11.21	613	210	90	2.20	2.78	26.04	24.98	10.47	8.00	
					2.64		29.22		6.38		
					3.52		19.69		7.15		
Monthly Average		460	193	90		4.14		20.72		10.83	
Standard Deviation		116	38	3		1.55		3.90		2.82	

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	1.11.21	1.27	BQL	2.15	581
AL1 – 2	9.11.21	1.12	BQL	1.9	497
AL1 – 3	12.11.21	1.11	BQL	1.94	361
AL1 – 4	17.11.21	1.05	BQL	2.04	357
AL1 – 5	19.11.21	1.12	BQL	1.85	541
AL1 - 6	24.11.21	1.38	BQL	1.91	561
AL1 – 7	26.11.21	1.07	BQL	1.98	567
AL1 – 8	29.11.21	1.14	BQL	2.21	541
Monthly Average		**1.16**	**-**	**2.00**	**501**
Standard Deviation		**0.11**	**-**	**0.13**	**91**

* NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification Limit – NMHC: 0.5 ppm)
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 460 µg/m³, The mean PM_{10} values were 193.0 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean 90.0 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 4.14 µg/ m³, 20.72 µg/ m³ & 10.83 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 1.16 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 2.0 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	01.11.21	421	151	92	3.96	3.66	17.15	15.67	13.79	14.81
					4.40		13.34		15.06	
					2.64		16.51		15.57	
AL2 – 2	09.11.21	532	176	89	1.76	2.93	13.34	12.49	6.13	9.70
					2.64		11.43		11.23	
					4.40		12.70		11.74	
AL2 – 3	12.11.21	539	180	96	7.03	8.79	32.39	25.19	4.85	7.32
					9.23		20.96		7.91	
					10.11		22.23		9.19	
AL2 – 4	17.11.21	510	200	101	3.96	2.93	15.88	15.24	7.91	9.79
					2.20		16.51		11.49	
					2.64		13.34		9.96	
AL2 – 5	19.11.21	407	234	98	3.52	2.49	17.78	19.48	9.19	8.00
					2.20		24.77		5.87	
					1.76		15.88		8.93	
AL2 – 6	24.11.21	520	152	100	7.03	6.45	20.96	15.88	5.87	8.42
					8.35		11.43		8.93	
					3.96		15.24		10.47	
AL2 – 7	26.11.21	434	150	98	1.32	1.90	22.87	19.69	9.19	10.04
					1.76		15.24		13.02	
					2.64		20.96		7.91	
AL2 – 8	29.11.21	551	278	100	2.20	2.93	16.51	18.42	6.64	9.02
					2.64		22.87		9.45	
					3.96		15.88		10.98	
Monthly Average		489	190	97		4.01		17.76		9.64
Standard Deviation		59	46	4		2.37		3.86		2.29

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	1.11.21	1.12	BQL	2	618
AL2 -2	9.11.21	1.09	BQL	1.91	583
AL2 -3	12.11.21	1.07	BQL	2.08	509
AL2 -4	17.11.21	1.19	BQL	2.04	487
AL2 – 5	19.11.21	1.27	BQL	2.07	590
AL2 – 6	24.11.21	1.16	BQL	2.05	549
AL2 -7	26.11.21	1.17	BQL	1.99	578
AL2 – 8	29.11.21	1.09	BQL	1.98	624
Monthly Average		**1.15**	**-**	**2.02**	**567**
Standard Deviation		**0.07**	**-**	**0.06**	**49**

* NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification 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 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 489 µg/m^3 .The mean PM_{10} values were 190 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 97 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 4.01 µg/m^3, 17.76 µg/m^3 and 9.79 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 1.15 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 2.02 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	01.11.21	205	114	80	2.20	2.64	22.87	22.23	13.79	16.34
					2.64		30.49		16.85	
					3.08		13.34		18.38	
AL3 – 2	09.11.21	302	134	90	3.08	3.08	13.97	13.97	9.70	7.49
					2.64		11.43		7.40	
					3.52		16.51		5.36	
AL3 – 3	12.11.21	422	215	92	3.52	3.81	13.34	19.27	8.93	6.98
					4.84		19.69		7.40	
					3.08		24.77		4.60	
AL3 – 4	17.11.21	610	270	108	5.28	3.08	10.80	9.32	13.02	10.21
					2.64		10.16		10.47	
					1.32		6.99		7.15	
AL3 – 5	19.11.21	459	269	100	5.28	3.96	26.04	25.41	8.93	9.19
					3.96		33.66		9.96	
					2.64		16.51		8.68	
AL3 – 6	24.11.21	736	363	102	5.71	4.84	19.69	19.48	10.47	8.93
					2.64		14.61		9.70	
					6.15		24.14		6.64	
AL3 – 7	26.11.21	483	180	98	5.28	3.81	20.96	17.57	11.49	10.98
					3.96		15.24		10.98	
					2.20		16.51		10.47	
AL3 – 8	29.11.21	677	189	105	2.20	3.22	15.88	16.73	12.25	9.02
					4.84		14.61		8.93	
					2.64		19.69		5.87	
Monthly Average		487	217	97		3.55		18.00		9.89
Standard Deviation		182	81	9		0.69		4.93		2.91

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	1.11.21	1.07	BQL	2.07	577
AL3 -2	9.11.21	1.1	BQL	1.91	583
AL3 -3	12.11.21	1.19	BQL	1.8	510
AL3 -4	17.11.21	1.11	BQL	1.91	480
AL3 – 5	19.11.21	1	BQL	2.1	652
AL3 – 6	24.11.21	1.1	BQL	1.84	672
AL3 – 7	26.11.21	1.26	BQL	2.12	364
AL3 – 8	29.11.21	1.26	BQL	2.01	426
Monthly Average		**1.14**	-	**1.97**	**533**
Standard Deviation		**0.09**	-	**0.12**	**108**

* NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification 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 487 µg/m^3, The mean PM_{10} values were 217 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 97 µg/m^3). The average values of SO_2, NO_x and NH3 were 3.55 µg/m^3, 18.0 µg/m^3 and 9.89 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 1.14 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 1.97 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	01.11.21	145	81	36	3.52	2.78	8.26	12.91	9.19	8.93
					2.20		15.88		10.47	
					2.64		14.61		7.15	
AL4 -2	09.11.21	254	132	89	2.64	2.05	9.53	12.28	5.87	5.36
					1.32		13.34		5.36	
					2.20		13.97		4.85	
AL4 -3	12.11.21	309	136	92	2.20	2.78	10.16	9.95	3.83	5.02
					3.52		8.26		5.87	
					2.64		11.43		5.36	
AL4 -4	17.11.21	474	249	101	3.52	2.78	9.53	10.16	6.64	5.70
					2.64		11.43		4.60	
					2.20		9.53		5.87	
AL4 – 5	19.11.21	298	127	90	2.64	2.64	16.51	15.46	5.87	6.81
					3.52		10.16		8.42	
					1.76		19.69		6.13	
AL4 – 6	24.11.21	351	170	98	3.08	2.49	15.88	13.13	5.87	8.85
					2.64		10.16		9.19	
					1.76		13.34		11.49	
AL4 – 7	26.11.21	285	132	87	2.64	3.22	17.78	16.73	6.38	6.55
					3.96		16.51		7.91	
					3.08		15.88		5.36	
AL4 – 8	29.11.21	738	469	104	3.52	3.37	13.34	13.34	8.17	8.34
					3.96		14.61		8.93	
					2.64		12.07		7.91	
Monthly Average		357	187	87		2.77		12.99		6.95
Standard Deviation		180	124	21		0.41		2.33		1.58

NS: Not Specified

Table 4B : Results of Air Pollutant Concentration at Gopalpuri Hospital					
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**
AL4 -1	1.11.21	1.02	BQL	2.01	609
AL4 -2	9.11.21	1.15	BQL	2.04	509
AL4 -3	12.11.21	1.26	BQL	1.94	487
AL4 -4	17.11.21	1.09	BQL	1.73	450
AL4 – 5	19.11.21	1.08	BQL	1.88	544
AL4 – 6	24.11.21	1.2	BQL	2.13	580
AL4 – 7	26.11.21	1.18	BQL	1.91	559
AL4 – 8	29.11.21	1.14	BQL	2.2	505
Monthly Average		**1.14**	**-**	**1.98**	**530**
Standard Deviation		**0.08**	**-**	**0.15**	**52**

* NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification 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 TSPM values at Oil Jetty were 357 μg/m³, The mean PM_{10} values were 187 μg/m³, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean= 87 μg/m³). The average values of SO_2, NO_x and NH_3 were 2.77 μg/m³, 12.99 μg/m³ and 6.95 μg/m³ 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 1.14 μg/m³, well below the permissible limit of 5.0 μg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 1.98 mg/m³, well below the permissible limit of 4.0 mg/m³.

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	01.11.21	306	154	89	2.20	3.22	20.96	20.33	8.93	9.79	
					3.08		21.60		7.40		
					4.40		18.42		13.02		
AL5 – 2	09.11.21	590	288	106	9.67	6.15	19.69	19.69	15.83	16.34	
					4.84		23.50		17.61		
					3.96		15.88		15.57		
AL5 – 3	12.11.21	680	351	104	10.5 5	9.08	22.87	26.68	8.68	7.83	
					7.03		26.04		6.64		
					9.67		31.12		8.17		
AL5 – 4	17.11.21	712	355	108	2.20	2.49	19.69	20.96	13.53	10.21	
					1.76		20.96		9.19		
					3.52		22.23		7.91		
AL5 – 5	19.11.21	696	380	110	5.28	5.13	20.96	22.44	10.72	11.23	
					6.15		19.69		9.96		
					3.96		26.68		13.02		
AL5 – 6	24.11.21	622	352	101	3.52	4.40	14.61	17.57	15.83	14.64	
					3.96		18.42		15.06		
					5.71		19.69		13.02		
AL5 – 7	26.11.21	578	218	106	3.52	3.96	16.51	18.63	10.98	9.36	
					4.84		20.96		9.19		
					3.52		18.42		7.91		
AL5 – 8	29.11.21	596	241	108	5.28	3.37	22.23	26.25	10.98	12.76	
					2.64		27.31		13.02		
					2.20		29.22		14.30		
Monthly Average		598	292	104		4.73		21.57		11.52	
Standard Deviation		128	81	7		2.10		3.36		2.87	

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	1.11.21	1.1	BQL	1.97	593
AL5 – 2	9.11.21	1.28	BQL	1.56	582
AL5 – 3	12.11.21	1.07	BQL	2.1	453
AL5 – 4	17.11.21	1.02	BQL	1.98	494
AL5 – 5	19.11.21	1.17	BQL	2.07	544
AL5 – 6	24.11.21	1	BQL	1.91	571
AL5 – 7	26.11.21	1.23	BQL	1.78	636
AL5 – 8	29.11.21	1.20	BQL	2.07	511
Monthly Average		**1.13**	**-**	**1.93**	**548**
Standard Deviation		**0.10**	**-**	**0.18**	**59**

* NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification 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 598µg/m^3. The mean PM_{10} values were 292 µg/m^3, which is well above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 104 µg/m^3). The average values of SO_2, NO_x and NH_3 were 4.73 µg/m^3, 21.57 µg/m^3 and 11.52 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 1.13 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 1.93 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	01.11.21	214	97	61	3.52	2.64	20.96	14.82	14.04	12.08
					2.64		12.07		12.51	
					1.76		11.43		9.70	
AL6 – 2	09.11.21	314	149	102	1.76	1.90	10.16	10.59	6.38	7.15
					2.64		11.43		6.64	
					1.32		10.16		8.42	
AL6 – 3	12.11.21	425	208	104	4.84	4.25	16.51	17.57	6.64	6.55
					5.28		20.96		4.85	
					2.64		15.24		8.17	
AL6 – 4	17.11.21	504	280	110	2.20	2.34	5.08	7.20	6.13	7.06
					1.76		7.62		8.42	
					3.08		8.89		6.64	
AL6 – 5	19.11.21	432	242	106	2.64	2.20	22.87	18.21	13.02	11.74
					2.20		13.34		11.74	
					1.76		18.42		10.47	
AL6 – 6	24.11.21	315	149	96	5.28	3.66	30.49	26.89	9.96	12.76
					1.76		22.23		15.57	
					3.96		27.95		12.76	
AL6 – 7	26.11.21	326	140	98	2.20	2.93	13.34	15.03	9.19	9.53
					3.08		15.24		8.93	
					3.52		16.51		10.47	
AL6 – 8	29.11.21	569	298	104	2.20	2.93	15.88	15.88	10.72	10.30
					2.64		13.34		8.93	
					3.96		18.42		11.23	
Monthly Average		387	195	98		2.86		15.77		9.65
Standard Deviation		116	73	15		0.78		5.79		2.48

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	01.11.21	1.2	BQL	1.91	586
AL6 – 2	09.11.21	1.02	BQL	2.1	600
AL6 – 3	12.11.21	1.08	1.91	1.91	452
AL6 – 4	17.11.21	1.26	BQL	1.94	507
AL6 – 5	19.11.21	1.21	BQL	2.08	593
AL6 – 6	24.11.21	1.01	BQL	1.98	568
AL6 – 7	26.11.21	1.203	BQL	2.08	577
AL6 – 8	29.11.21	1.19	BQL	2.04	517
Monthly Average		**1.15**	**-**	**2.01**	**550**
Standard Deviation		**0.10**	**-**	**0.08**	**52**

* NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification Limit – NMHC: 0.5 ppm)
NS- Not Specified

The mean TSPM values at Tuna Port were 387 µg/m³, The mean PM_{10} values were 195 µg/m³, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 98 µg/m³). The average values of SO_2, NO_x and NH_3 were 2.86 µg/m³, 15.77 µg/m³ and 9.65 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 1.15 µg/m³, well below the permissible limit of 5.0 µg/m³. HC's were below the detectable limit and Carbon Monoxide concentration was 2.01 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	01.11.21	251	137	109	2.20	3.22	7.62	11.86	6.89	5.70
					3.96		13.34		6.13	
					3.52		14.61		4.08	
AL7 -2	09.11.21	215	115	84	5.71	6.30	26.04	17.36	4.60	6.98
					6.15		14.61		10.47	
					7.03		11.43		5.87	
AL7 -3	12.11.21	202	104	76	3.52	3.96	10.16	16.51	6.38	8.68
					4.84		26.04		10.72	
					3.52		13.34		8.93	
AL7 -4	17.11.21	200	103	84	2.64	3.96	19.69	14.40	7.91	6.13
					5.28		13.34		4.60	
					3.96		10.16		5.87	
AL7 -5	19.11.21	224	104	94	5.71	3.96	13.97	16.30	9.19	7.66
					3.52		19.69		7.15	
					2.64		15.24		6.64	
AL7 -6	24.11.21	238	118	77	4.40	4.40	10.16	10.59	5.87	5.96
					2.64		6.99		4.60	
					6.15		14.61		7.40	
AL7 -7	26.11.21	213	120	64	2.64	3.52	15.88	14.40	14.04	10.38
					2.20		7.62		10.72	
					5.71		19.69		6.38	
AL7 -8	29.11.21	207	115	84	5.71	3.22	10.16	13.34	8.17	7.66
					2.64		15.24		7.91	
					1.32		14.61		6.89	
Monthly Average		219	115	84		4		14		7
Standard Deviation		18	11	13		1		2		2

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	01.11.21	1.03	BQL	1.75	569
AL7 – 2	09.11.21	1.16	BQL	1.85	629
AL7 – 3	15.11.2021	1.35	BQL	1.78	501
AL7 – 4	18.11.2021	1.09	BQL	2	449
AL7 – 5	19.11.2021	1	BQL	1.89	458
AL7 – 6	22.11.2021	1.22	BQL	1.87	510
AL7 – 7	25.11.2021	1.08	BQL	1.99	541
AL7 – 8	29.11.2021	1.18	BQL	1.88	565
Monthly Average		**1.14**	**-**	**1.88**	**528**
Standard Deviation		**0.11**	**-**	**0.09**	**60**

*NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification Limit – NMHC: 0.5 ppm)
NS_ Not Specified

The mean TSPM values at Vadinar Port were 219 µg/m^3. The mean PM_{10} values were 115 µg/m^3, which is below the permissible limit. $PM_{2.5}$ values were also within the permissible limit (mean = 84 µg/m^3). The average values of SO_2, NO_x and NH_3 were 4.0 µg/m^3, 14.0 µg/m^3 and 7.0µg/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 1.14 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 1.88 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	01.11.21	204	83	73	4.84	3.22	20.96	18.63	6.38	5.96
					2.64		19.69		5.87	
					2.20		15.24		5.62	
AL8 -2	09.11.21	193	86	75	4.40	3.08	13.34	15.67	8.93	8.85
					2.64		20.33		6.64	
					2.20		13.34		10.98	
AL8 -3	12.11.21	241	126	107	2.64	2.49	15.88	16.09	4.85	5.96
					3.08		22.87		5.62	
					1.76		9.53		7.40	
AL8 -4	17.11.21	167	100	53	3.52	3.81	17.78	12.91	8.42	7.57
					4.84		10.16		10.47	
					3.08		10.80		3.83	
AL8 -5	19.11.21	183	151	72	2.20	2.49	10.16	10.59	5.36	6.55
					1.76		9.53		8.17	
					3.52		12.07		6.13	
AL8 -6	24.11.21	197	104	80	3.52	5.28	15.88	13.55	8.93	7.66
					5.71		10.16		7.91	
					6.59		14.61		6.13	
AL8 -5	26.11.21	226	111	88	3.52	3.37	10.16	11.43	11.74	8.85
					1.76		13.34		5.87	
					4.84		10.80		8.93	
AL8-6	29.11.21	226	104	106	2.64	2.78	10.16	13.13	9.19	7.40
					3.52		20.96		5.87	
					2.20		8.26		7.15	
Monthly Average		205	108	82		3		14		7
Standard Deviation		25	22	18		1		3		1

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	01.11.21	1.23	BDL	1.88	571
AL8-2	09.11.21	1.09	BDL	2.04	581
AL8 -3	15.11.2021	1.29	BDL	2.17	465
AL8-4	18.11.2021	1.05	BDL	1.82	452
AL8 -5	19.11.2021	1.01	BDL	1.92	482
AL8-6	22.11.2021	1.28	BDL	1.73	496
AL8-7	25.11.2021	1.15	BDL	1.85	524
AL8-8	29.11.2021	1.13	BDL	2.02	561
Monthly Average		**1.15**	**-**	**1.93**	**517**
Standard Deviation		**0.10**	**-**	**0.14**	**50**

* NMHC- Non- Methane Hydrocarbons
BQL- Below Quantification Limit (Quantification 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 205 µg/m^3. The mean PM_{10} values were 108 µg/m^3, which is above the permissible limit. $PM_{2.5}$ values were above the permissible limit (mean = 82.0 µg/m^3). The average values of SO_2, NO_x and NH_3 were 3.0 µg/m^3, 14.0 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 Admin Building, 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 1.93 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	7.3	7.4	7.2	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	990	1280	1310	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	1860	2430	2540	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	BQL	BQL	BQL	NS*	NS*
8	Chloride as Cl	mg/l	491.09	461.02	516.15	250.0	1000.0
9	Ca as Ca	mg/l	64.13	68.14	60.12	75.0	200.0
10	Mg as Mg	mg/l	63.18	70.47	68.04	30.0	100.0
11	Total Hardness	mg/l	420	460	430	200.0	600.0
12	Iron as Fe	mg/l	BQL	BQL	BQL	0.3	No Relaxation
13	Fluorides as F	mg/l	0.32	0.35	0.34	1.0	1.5
14	Sulphate as SO4	mg/l	286.8	289.2	283.2	200.0	400
15	Nitrite as NO2	mg/l	<0.1	<0.1	<0.1	NS*	NS*
16	Nitrate as NO3	mg/l	6.41	7.88	6.20	45.0	No Relaxation
17	Salinity	%	0.86	0.80	0.89	NS*	NS*
18	Sodium as Na	mg/l	202	225	277	NS*	NS*
19	Potassium as K	mg/l	5.08	3.26	5.26	NS*	NS*
20	Manganese	mg/l	BQL	BQL	BQL	0.1	0.3
21	Hexavalent Chromium	mg/l	BQL	BQL	BQL	NS*	NS*
22	Copper	mg/l	BQL	BQL	BQL	0.05	1.5
23	Cadmium	mg/l	BQL	BQL	BQL	0.003	0.003
24	Arsenic	mg/l	BQL	BQL	BQL	0.01	0.05
25	Mercury	mg/l	BQL	BQL	BQL	0.001	0.001
26	Lead	mg/l	BQL	BQL	BQL	0.01	0.01
27	Zinc	mg/l	BQL	BQL	BQL	5.0	15.0
28	Bacterial Count	CFU/100 ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified
BQL- Below Quantification Limit, (BOD-2.0 mg/l, Fe-0.009 mg/l, Mn- 0.01 mg/l, Cr^{+6}- 0.03 mg/l, Cu-0.004 mg/l, Cd-0.003 mg/l, As-0.003mg/l, Hg-0.001 mg/l, Pb-0.006mg/l, Zinc-0.021 mg/l).

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	7.5	7.3	7.2	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1410	1350	1420	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	2710	2560	2730	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	BQL	BQL	BQL	NS*	NS*
8	Chloride as Cl	mg/l	541.20	486.08	491.09	250.0	1000.0
9	Ca as Ca	mg/l	64.13	56.11	64.13	75.0	200.0
10	Mg as Mg	mg/l	68.04	68.04	72.90	30.0	100.0
11	Total Hardness	mg/l	440	420	460	200.0	600.0
12	Iron as Fe	mg/l	BQL	BQL	BQL	0.3	No Relaxation
13	Fluorides as F	mg/l	0.41	0.29	0.34	1.0	1.5
14	Sulphate as SO4	mg/l	291.6	204.0	194.4	200.0	400
15	Nitrite as NO2	mg/l	<0.1	<0.1	<0.1	NS*	NS*
16	Nitrate as NO3	mg/l	8.10	12.25	8.87	45.0	No Relaxation
17	Salinity	%	0.83	0.93	0.98	NS*	NS*
18	Sodium as Na	mg/l	201	195	279	NS*	NS*
19	Potassium as K	mg/l	4.28	4.08	4.69	NS*	NS*
20	Manganese	mg/l	BQL	BQL	BQL	0.1	0.3
21	Hexavalent Chromium	mg/l	BQL	BQL	BQL	NS*	NS*
22	Copper	mg/l	BQL	BQL	BQL	0.05	1.5
23	Cadmium	mg/l	BQL	BQL	BQL	0.003	0.003
24	Arsenic	mg/l	BQL	BQL	BQL	0.01	0.05
25	Mercury	mg/l	BQL	BQL	BQL	0.001	0.001
26	Lead	mg/l	BQL	BQL	BQL	0.01	0.01
27	Zinc	mg/l	BQL	BQL	BQL	5.0	15.0
28	Bacterial Count	CFU/100 ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

BQL- Below Quantification Limit, (BOD-2.0 mg/l, Fe-0.009 mg/l,Mn- 0.01 mg/l, Cr^{+6}- 0.03 mg/l, Cu-0.004 mg/l, Cd-0.003 mg/l, As-0.003mg/l, Hg-0.001 mg/l, Pb-0.006mg/l, Zinc-0.021 mg/l).

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 as per IS 10500 : 2012	Permissible Limits in the absence of Alternate Source as per IS 10500 : 2012
1	pH	pH Unit	7.4	7.7	7.5	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1360	1325	1430	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	2530	2480	2680	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	BQL	BQL	BQL	NS*	NS*
8	Chloride	mg/l	656.46	611.36	516.15	250.0	1000.0
9	Ca as Ca	mg/l	56.11	60.12	64.13	75.0	200.0
10	Mg as Mg	mg/l	75.33	65.61	72.90	30.0	100.0
11	Total Hardness	mg/l	450	420	460	200.0	600.0
12	Iron as Fe	mg/l	BQL	BQL	BQL	0.3	No Relaxation
13	Fluorides	mg/l	0.23	0.45	0.46	1.0	1.5
14	Sulphate	mg/l	198.0	290.4	230.4	200.0	400
15	Nitrite	mg/l	<0.1	<0.1	<0.1	NS*	NS*
16	Nitrate	mg/l	10.42	9.57	13.94	45.0	No Relaxation
17	Salinity	%	0.88	0.89	1.19	NS*	NS*
18	Sodium as Na	mg/l	303	248	327	NS*	NS*
19	Potassium as K	mg/l	4.30	5.61	8.26	NS*	NS*
20	Manganese	mg/l	BQL	BQL	BQL	0.1	0.3
21	Hexavalent Chromium	mg/l	BQL	BQL	BQL	NS*	NS*
22	Copper	mg/l	BQL	BQL	BQL	0.05	1.5
23	Cadmium	mg/l	BQL	BQL	BQL	0.003	0.003
24	Arsenic	mg/l	BQL	BQL	BQL	0.01	0.05
25	Mercury	mg/l	BQL	BQL	BQL	0.001	0.001
26	Lead	mg/l	BQL	BQL	BQL	0.01	0.01
27	Zinc	mg/l	BQL	BQL	BQL	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

BQL- Below Quantification Limit, (BOD-2.0 mg/l, Fe-0.009 mg/l,Mn- 0.01 mg/l, Cr^{+6}- 0.03 mg/l, Cu-0.004 mg/l, Cd-0.003 mg/l, As-0.003mg/l, Hg-0.001 mg/l, Pb-0.006mg/l, Zinc-0.021 mg/l).

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	7.6	7.3	7.2	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1310	1410	1430	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	2540	2690	2740	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	<0.1	<0.1	<0.1	NS*	NS*
8	Chloride	mg/l	481.07	531.18	516.15	250.0	1000.0
9	Ca as Ca	mg/l	72.14	76.15	64.13	75.0	200.0
10	Mg as Mg	mg/l	55.89	58.32	68.04	30.0	100.0
11	Total Hardness	mg/l	410	430	440	200.0	600.0
12	Iron as Fe	mg/l	BQL	BQL	BQL	0.3	No Relaxation
13	Fluorides	mg/l	0.48	0.85	0.52	1.0	1.5
14	Sulphate	mg/l	210.0	291.6	301.2	200.0	400
15	Nitrite	mg/l	<0.1	<0.1	<0.1	NS*	NS*
16	Nitrate	mg/l	10.28	13.24	9.79	45.0	No Relaxation
17	Salinity	%	1.10	0.93	0.87	NS*	NS*
18	Sodium as Na	mg/l	154	384	218	NS*	NS*
19	Potassium as K	mg/l	3.26	4.69	4.03	NS*	NS*
20	Manganese	mg/l	BQL	BQL	BQL	0.1	0.3
21	Hexavalent Chromium	mg/l	BQL	BQL	BQL	NS*	NS*
22	Copper	mg/l	BQL	BQL	BQL	0.05	1.5
23	Cadmium	mg/l	BQL	BQL	BQL	0.003	0.003
24	Arsenic	mg/l	BQL	BQL	BQL	0.01	0.05
25	Mercury	mg/l	BQL	BQL	BQL	0.001	0.001
26	Lead	mg/l	BQL	BQL	BQL	0.01	0.01
27	Zinc	mg/l	BQL	BQL	BQL	5.0	15.0
28	Bacterial Count	CFU/100 ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

BQL- Below Quantification Limit, (BOD-2.0 mg/l, Fe-0.009 mg/l,Mn- 0.01 mg/l, Cr^{+6}- 0.03 mg/l, Cu-0.004 mg/l, Cd-0.003 mg/l, As-0.003mg/l, Hg-0.001 mg/l, Pb-0.006mg/l, Zinc-0.021 mg/l).

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	7.4	7.6	7.5	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1400	1720	1090	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	2640	2730	2130	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	BQL	BQL	BQL	NS*	NS*
8	Chloride	mg/l	496.10	526.17	481.07	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	80.19	77.76	65.61	30.0	100.0
11	Total Hardness	mg/l	480	460	440	200.0	600.0
12	Iron as Fe	mg/l	BQL	BQL	BQL	0.3	No Relaxation
13	Fluorides	mg/l	0.60	0.81	0.63	1.0	1.5
14	Sulphate	mg/l	314.4	214.8	289.2	200.0	400
15	Nitrite	mg/l	<0.1	<0.1	<0.1	NS*	NS*
16	Nitrate	mg/l	10.91	12.39	10.00	45.0	No Relaxation
17	Salinity	%	0.96	0.93	0.90	NS*	NS*
18	Sodium as Na	mg/l	287	106	246	NS*	NS*
19	Potassium as K	mg/l	5.28	6.29	2.25	NS*	NS*
20	Manganese	mg/l	BQL	BQL	BQL	0.1	0.3
21	Hexavalent Chromium	mg/l	BQL	BQL	BQL	NS*	NS*
22	Copper	mg/l	BQL	BQL	BQL	0.05	1.5
23	Cadmium	mg/l	BQL	BQL	BQL	0.003	0.003
24	Arsenic	mg/l	BQL	BQL	BQL	0.01	0.05
25	Mercury	mg/l	BQL	BQL	BQL	0.001	0.001
26	Lead	mg/l	BQL	BQL	BQL	0.01	0.01
27	Zinc	mg/l	BQL	BQL	BQL	5.0	15.0
28	Bacterial Count	CFU/100 ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

BQL- Below Quantification Limit, (BOD-2.0 mg/l, Fe-0.009 mg/l,Mn- 0.01 mg/l, Cr^{+6}- 0.03 mg/l, Cu-0.004 mg/l, Cd-0.003 mg/l, As-0.003mg/l, Hg-0.001 mg/l, Pb-0.006mg/l, Zinc-0.021 mg/l).

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	7.6	7.3	7.42	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1020	1250	1150	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	1950	2380	2000	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	BQL	BQL	BQL	NS*	NS*
8	Chloride	mg/l	611.36	576.28	520	250.0	1000.0
9	Ca as Ca	mg/l	64.13	60.12	76.15	75.0	200.0
10	Mg as Mg	mg/l	55.89	72.90	55.89	30.0	100.0
11	Total Hardness	mg/l	390	450	420	200.0	600.0
12	Iron as Fe+3	mg/l	BQL	BQL	BQL	0.3	No Relaxation
13	Fluorides	mg/l	0.86	0.57	0.75	1.0	1.5
14	Sulphate	mg/l	301.2	285.6	274.8	200.0	400
15	Nitrite	mg/l	<0.1	<0.1	<0.1	NS*	NS*
16	Nitrate	mg/l	10.91	10.07	9.93	45.0	No Relaxation
17	Salinity	%	0.95	0.87	1.10	NS*	NS*
18	Sodium as Na	mg/l	235	235	248	NS*	NS*
19	Potassium as K	mg/l	3.98	5.54	4.8	NS*	NS*
20	Manganese	mg/l	BQL	BQL	BQL	0.1	0.3
21	Hexavalent Chromium	mg/l	BQL	BQL	BQL	NS*	NS*
22	Copper	mg/l	BQL	BQL	BQL	0.05	1.5
23	Cadmium	mg/l	BQL	BQL	BQL	0.003	0.003
24	Arsenic	mg/l	BQL	BQL	BQL	0.01	0.05
25	Mercury	mg/l	BQL	BQL	BQL	0.001	0.001
26	Lead	mg/l	BQL	BQL	BQL	0.01	0.01
27	Zinc	mg/l	BQL	BQL	BQL	5.0	15.0
28	Bacterial Count	CFU/100 ml	Absent	Absent	Absent	Absent	Absent

*NS: Not Specified

BQL- Below Quantification Limit, (BOD-2.0 mg/l, Fe-0.009 mg/l,Mn- 0.01 mg/l, Cr^{+6}- 0.03 mg/l, Cu-0.004 mg/l, Cd-0.003 mg/l, As-0.003mg/l, Hg-0.001 mg/l, Pb-0.006mg/l, Zinc-0.021 mg/l).

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	7.5	7.3	6.5 to 8.5	6.5 to 8.5
2	Total Dissolved Solids	mg/l	1060	1120	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	1960	2150	NS*	NS*
7	Biochemical Oxygen Demand	mg/l	BQL	BQL	NS*	NS*
8	Chloride	mg/l	486.08	521.16	250.0	1000.0
9	Ca as Ca	mg/l	68.14	60.12	75.0	200.0
10	Mg as Mg	mg/l	68.04	68.04	30.0	100.0
11	Total Hardness	mg/l	450	430	200.0	600.0
12	Iron as Fe+3	mg/l	BQL	BQL	0.3	No Relaxation
13	Fluorides	mg/l	0.86	0.69	1.0	1.5
14	Sulphate	mg/l	23.04	22.56	200.0	400
15	Nitrite	mg/l	<0.1	<0.1	NS*	NS*
16	Nitrate	mg/l	7.88	10.63	45.0	No Relaxation
17	Salinity	%	0.88	0.94	NS*	NS*
18	Sodium as Na	mg/l	52.8	40.2	NS*	NS*
19	Potassium as K	mg/l	3.3	2.1	NS*	NS*
20	Manganese	mg/l	BQL	BQL	0.1	0.3
21	Hexavalent Chromium	mg/l	BQL	BQL	NS*	NS*
22	Copper	mg/l	BQL	BQL	0.05	1.5
23	Cadmium	mg/l	BQL	BQL	0.003	0.003
24	Arsenic	mg/l	BQL	BQL	0.01	0.05
25	Mercury	mg/l	BQL	BQL	0.001	0.001
26	Lead	mg/l	BQL	BQL	0.01	0.01
27	Zinc	mg/l	BQL	BQL	5.0	15.0
28	Bacterial Count	CFU/100ml	Absent	Absent	Absent	Absent

*NS: Not Specified
BQL- Below Quantification Limit, (BOD-2.0 mg/l, Fe-0.009 mg/l,Mn- 0.01 mg/l, Cr^{+6}- 0.03 mg/l, Cu-0.004 mg/l, Cd-0.003 mg/l, As-0.003mg/l, Hg-0.001 mg/l, Pb-0.006mg/l, Zinc-0.021 mg/l).

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 7.1 to 7.7 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 900 -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 November ranged from 1800-3000 µs/cm. Electrical conductivity standards do not appear in BIS standards for drinking water.

BOD

BOD value in the studied area was found Below Quantification Limit (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 400-700 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 50 - 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 50-85 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 350-480 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 found Below Quantification Limit (0.009 mg/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 20 – 350 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 found Below Quantification Limit (0.1 mg/l). There are no specified standard values for Nitrites in Drinking water. The minimim Nitrate value in drinking water of KPT was 6.20 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 0.5 to 1.4 %. There are no prescribed Indian standards for salinity in Drinking water**.**

Sodium and Potassium Salts

Sodium values in the samples collected ranged from 40 - 400 mg/l and Potassium salts ranged from 2.0 to 8.5 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 Quantification 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	73.9	53.4
2	Nirman Building 1	62.3	51.0
3	Tuna Port	57.2	50.9
4	Main Gate North	67.0	61.8
5	West Gate I	70.5	65.1

6	Canteen Area	64.5	51.0
7	Main Road	68.4	51.5
8	ATM Building	74.4	57.3
9	Wharf Area /Jetty Area	72.9	68.1
10	Port & Custom Office	67.8	41.8
	Vadinar Port		
11	Entrance Gate of Vadinar Port	66.4	53.2
12	Nr. Port Colony, Vadinar	60.7	54.1
13	Nr. Vadinar Jetty	72.4	66.5

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 13 locations at Deendayal Port ranged from 57.2 dB(A) to 74.4 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 13 locations of Deendayal Port ranged from 41.8 dB to 68.4 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 November 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	-	8.42	7.92	8.44	8.23	7.79	8.43
3	Electrical Conductivity	µs/cm	14,070.0	16,210.0	13,680.0	9,240.0	387.0	314.0
4	Moisture	%	18.17	9.01	21.39	21.08	3.46	3.95
5	Total Organic Carbon	%	0.20	0.49	0.20	0.72	0.85	0.43
6	Alkalinity	mg/kg	80.08	120.12	60.06	100.10	60.06	80.08
7	Total Nitrogen	%	BQL	BQL	BQL	BQL	BQL	BQL
8	Chloride	mg/kg	1,956.8	4,112.2	1,800.9	514.7	21.7	113.4
9	Sulphate	mg/kg	212.0	279.0	93.3	165.1	44.7	27.7
10	Phosphorus	mg/kg	2.20	1.89	1.41	2.15	BQL	1.74
11	Potassium	mg/kg	539.0	327.4	409.2	667.6	70.4	62.0
12	Sodium	mg/kg	5,752.0	4,061.6	3,954.0	1,477.0	72.8	65.9
13	Calcium	mg/kg	200.40	488.98	252.00	470.42	436.87	256.51
14	Copper as Cu	mg/kg	14.90	29.50	9.80	27.60	88.4	48.4
15	Lead as Pb	mg/kg	5.80	6.40	3.50	8.20	BQL	4.2
16	Nickel as Ni	mg/kg	35.30	16.60	23.50	37.70	33.8	27.3
17	Zinc as Zn	mg/kg	40.60	104.80	25.4	55.20	66.00	30.50
18	Cadmium as Cd	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL

BQL- Below Quantification Limit, (TN:0.001%, Cd: 1.0mg/kg).

4.3 Discussion

The data shows that value of pH ranges from 7.92 at IFFCO Plant to 8.44 at Khori Creek indicating that all soil samples are neutral to slight basic. Iffco Plant samples showed maximum conductivity of 16,210.0 µmhos/cm, while Tuna Port location showed minimum conductivity of 14,070.0 µmhos/cm. Conductivity at Vadinar Port was 387 and 314 µmhos/cm at Admin site and Vadinar Port colony respectively.

Total organic Carbon ranged from 0.2 % to 0.72 at Deendayal Port. At Vadinar Port, organic carbon content ranged from 0.85 % to 0.43 %.

The concentration of Phosphorus and Potassium in the soil samples varies from 1.41 to 2.15 mg/kg and 327.0 to 670.0 mg/kg respectively at Deendayal Port. The mean concentration of Phosphorous at Vadinar site was 1.74 mg/kg and mean concentration of Potassium at Vadinar site was 132 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 below detection limit 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	02.11.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.82	7.46
2	Total Suspended Solids	mg/l	206	116.1
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	393.0	152.0
5	BOD @ 27 °C	mg/l	110.0	53.0
6.	Fecal Coliform	MPN Index / 100 ml	-	>1600.0
Aeration Tank				
7.	MLSS	mg/l	35.0	
8.	MLVSS	%	6.0	

Table 19: Sewage Water Monitoring at Kandla STP (2nd Week)

Date of Sampling	11.11.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.6	7.2
2	Total Suspended Solids	mg/l	152.2	72.4
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	384	103.0
5	BOD @ 27 °C	mg/l	120.0	24.0
6.	Fecal Coliform	MPN Index / 100 ml	-	9.2
Aeration Tank				
7.	MLSS	mg/l	7.0	
8.	MLVSS	%	90.0	

Table 20: Sewage Water Monitoring at Kandla STP (3rd Week)

Date of Sampling	17.11.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.35	7.14
2	Total Suspended Solids	mg/l	204	144
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	162	71
5	BOD @ 27 °C	mg/l	60.0	20.0
6.	Fecal Coliform	MPN Index / 100 ml	-	24.0
Aeration Tank				
7.	MLSS	mg/l	12.0	
8.	MLVSS	%	93.0	

Table 21: Sewage Water Monitoring at Kandla STP (4th Week)

Date of Sampling	22.11.2021

Sr. No.	Parameters	Unit	Results	
			KPT STP I/L	KPT STP O/L
1	pH	pH unit	7.82	7.46
2	Total Suspended Solids	mg/l	306	116
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	242	103.0
5	BOD @ 27 °C	mg/l	86.0	26.0
6.	Fecal Coliform	MPN Index / 100 ml	-	170.0
Aeration Tank				
7.	MLSS	mg/l	9.0	
8	MLVSS	%	98.0	

Gopalpuri Colony STP

Table 22: Sewage Water Monitoring at Gopalpuri STP (1st Week)

Date of Sampling	02.11.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.50	7.20
2	Total Suspended Solids	mg/l	210	120
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	414.0	142.0
5	BOD @ 27 °C	mg/l	122.0	53.0
6.	Fecal Coliform	MPN Index / 100 ml	-	>1600.0
Aeration Tank				
7.	MLSS	mg/l	86.0	
8	MLVSS	%	97.0	

Table 23: Sewage Water Monitoring at Gopalpuri STP (2nd Week)

Date of Sampling	11.11.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.46	7.2
2	Total Suspended Solids	mg/l	379.2	118
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	454	163.00
5	BOD @ 27 °C	mg/l	148.0	56.0
6.	Fecal Coliform	MPN Index / 100 ml	-	21.0
Aeration Tank				
7.	MLSS	mg/l	94.0	
8	MLVSS	%	92.0	

Table 24: Sewage Water Monitoring at Gopalpuri STP (3rd Week)

Date of Sampling	17.11.2021

Sr. No.	Parameters	Unit	Results	
			Gopalpuri STP I/L	Gopalpuri STP O/L
1	pH	pH unit	7.35	7.14
2	Total Suspended Solids	mg/l	204	144
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	162	71
5	BOD @ 27 °C	mg/l	60.0	20.0
6.	Fecal Coliform	MPN Index / 100 ml	-	24.0
Aeration Tank				
7.	MLSS	mg/l	12.0	
8	MLVSS	%	93.0	

Table 25: Sewage Water Monitoring at Gopalpuri STP (4th Week)

Date of Sampling	22.11.2021

Sr. No.	**Parameters**	**Unit**	**Results**	
			Gopalpuri STP I/L	**Gopalpuri STP O/L**
1	pH	pH unit	7.82	7.46
2	Total Suspended Solids	mg/l	306	116
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	242	103.0
5	BOD @ 27 °C	mg/l	86.0	26.0
6.	Fecal Coliform	MPN Index / 100 ml	-	170.0
Aeration Tank				
7.	MLSS	mg/l	9.0	
8.	MLVSS	%	98.0	

Vadinar STP

Table 26: Sewage Water Monitoring at Vadinar STP (1st Week)

Date of Sampling	02.11.2021

Sr. No.	**Parameters**	**Unit**	**Results**	
			Vadinar STP I/L	**Vadinar O/L**
1	pH	pH unit	7.62	7.41
2	Total Suspended Solids	mg/l	121	69
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	89.0	72.0
5	BOD @ 27 °C	mg/l	34.0	15.0

Table 27: Sewage Water Monitoring at Vadinar STP (2nd Week)

Date of Sampling	11.11.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.5	7.2
2	Total Suspended Solids	mg/l	109	31
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	173.0	62.0
5	BOD @ 27 °C	mg/l	48.0	20.0

Table 28: Sewage Water Monitoring at Vadinar STP (3rd Week)

Date of Sampling	17.11.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.7	7.5
2	Total Suspended Solids	mg/l	105	38
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	150	62
5	BOD @ 27 °C	mg/l	48.0	18.0

Table 29: Sewage Water Monitoring at Vadinar STP (4th Week)

Date of Sampling	25.10.2021

Sr. No.	Parameters	Unit	Results	
			Vadinar STP I/L	Vadinar O/L
1	pH	pH unit	7.5	7.3
2	Total Suspended Solids	mg/l	117	69
3	Residual Chlorine	mg/l	-	<0.5
4	COD	mg/l	192	101
5	BOD @ 27 °C	mg/l	60.0	24.0

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.

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 19^{th}& 20^{th} November-2021 in harbor regions of KPT and on 19^{th} November-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 26^{th}& 27^{th} November 2021 in harbor regions of KPT. 26^{th} November -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**

5.4 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	7.26	7.45	7.26
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.6	31.9	32.0	31.5
5	Turbidity	NTU	36	31	33	32
6	Total Dissolved Solids	mg/l	41592	42007	41300.0	41443.0

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
7	Total Suspended Solids	mg/l	655	870	754.2	571.1
8	Total Solids	mg/l	42247	42877	42054.2	42014.1
9	DO	mg/l	4	4.2	4.1	4.3
10	COD	mg/l	82.0	90.0	80.0	78.0
11	BOD	mg/l	BQL	BQL	BQL	BQL
12	Silica	mg/l	0.65	0.60	0.76	0.65
13	Phosphate	mg/l	0.35	0.24	0.16	0.18
14	Sulphate	mg/l	2772	2700	2184	2580
15	Nitrate	mg/l	2.89	2.46	2.45	3.44
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	561.12	480.96	480.96	521.04
18	Magnesium	mg/l	1725.3	1530.9	1676.7	1603.8
19	Sodium	mg/l	9038.0	8014.0	8629.0	9638.0
20	Potassium	mg/l	313.0	271.0	336.0	378.0
21	Iron	mg/l	1.42	1.30	1.32	1.10
22	Chromium	mg/l	0.12	0.11	0.13	0.12
23	Copper	mg/l	BQL	BQL	BQL	BQL
24	Arsenic	mg/l	BQL	BQL	BQL	BQL
25	Cadmium	mg/l	0.05	0.06	0.06	0.05
26	Mercury	mg/l	BQL	BQL	BQL	BQL
27	Lead	mg/l	0.07	0.09	0.06	0.08
28	Zinc	mg/l	BQL	BQL	BQL	BQL

BQL- Below Quantification Limit, (BOD-2.0 mg/l,Cu-0.1 mg/l, As-0.1mg/l, Hg-0.01 mg/l, Zinc-0.1 mg/l).

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	7.12	7.31	7.30	7.20
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.0	31.6	32.2	31.4
5	Turbidity	NTU	35	28	38	42
6	Total Dissolved Solids	mg/l	39062	40035	40245.0	36627.0
7	Total Suspended Solids	mg/l	784	773	528.3	504
8	Total Solids	mg/l	39845	40808	40773.3	37131.0
9	DO	mg/l	4.3	3.9	4.2	4
10	COD	mg/l	88.0	86.0	92.0	90.0
11	BOD	mg/l	BQL	BQL	BQL	BQL
12	Silica	mg/l	0.56	0.53	0.76	0.69
13	Phosphate	mg/l	0.24	0.26	0.19	0.20
14	Sulphate	mg/l	2580	3132	2340	2700
15	Nitrate	mg/l	3.03	3.31	2.80	3.98
16	Nitrite	mg/l	BQL	BQL	BQL	BQL
17	Calcium	mg/l	601.20	681.36	561.12	601.2
18	Magnesium	mg/l	1555.2	1652.4	1676.7	1628.1
19	Sodium	mg/l	9530.0	9278.0	9116.0	9368.0
20	Potassium	mg/l	349.0	336.0	272.0	302.0
21	Iron	mg/l	1.88	1.70	1.48	1.55
22	Chromium	mg/l	0.12	0.11	0.11	0.14
23	Copper	mg/l	BQL	BQL	BQL	BQL
24	Arsenic	mg/l	BQL	BQL	BQL	BQL
25	Cadmium	mg/l	0.04	0.05	0.06	0.04
26	Mercury	mg/l	BQL	BQL	BQL	BQL
27	Lead	mg/l	0.10	0.09	0.09	0.10
28	Zinc	mg/l	BQL	BQL	BQL	BQL

BQL- Below Quantification Limit, (BOD-2.0 mg/l,Nitrite: 0.05mg/lCu-0.1 mg/l, As-0.1mg/l, Hg-0.01 mg/l, Zinc-0.1 mg/l).

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	7.46	7.30	7.36
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.0	31.8	32.7	31.0
5	Turbidity	NTU	34	29	36	40
6	Total Dissolved Solids	mg/l	43205	41674	43606.0	40029.0
7	Total Suspended Solids	mg/l	590	863	500.2	604.3
8	Total Solids	mg/l	43795	42537	44106.2	40633.3
9	DO	mg/l	4	5.1	4.5	4.4
10	COD	mg/l	90.0	86.0	88.0	79.0
11	BOD	mg/l	BQL	BQL	BQL	BQL
12	Silica	mg/l	0.69	0.75	0.56	0.64
13	Phosphate	mg/l	0.28	0.34	0.17	0.20
14	Sulphate	mg/l	3240	2016	2676	2148
15	Nitrate	mg/l	3.87	4.58	2.95	2.62
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	641.28	601.20	480.96	521.04
18	Magnesium	mg/l	1628.1	1749.6	1749.6	1749.6
19	Sodium	mg/l	9425.0	8408.0	9423.0	8709.0
20	Potassium	mg/l	339.0	299.0	306.0	230.0
21	Iron	mg/l	1.41	1.78	1.76	1.56
22	Chromium	mg/l	0.11	0.13	0.13	0.12
23	Copper	mg/l	BQL	BQL	BQL	BQL
24	Arsenic	mg/l	BQL	BQL	BQL	BQL
25	Cadmium	mg/l	0.06	0.05	0.05	0.07
26	Mercury	mg/l	BQL	BQL	BQL	BQL
27	Lead	mg/l	0.08	0.09	0.09	0.07
28	Zinc	mg/l	BQL	BQL	BQL	BQL

BQL- Below Quantification Limit, (BOD-2.0 mg/l,Cu-0.1 mg/l, As-0.1mg/l, Hg-0.01 mg/l,Zinc-0.1 mg/l).

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	7.35	7.50	7.50	7.20
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.1	32.6	31.9	31.6
5	Turbidity	NTU	43	39	45	33
6	Total Dissolved Solids	mg/l	42399	39089	38986.0	39711.0
7	Total Suspended Solids	mg/l	743	577	681.8	530.3
8	Total Solids	mg/l	43142	39666	39667.8	40241.3
9	DO	mg/l	4.6	4.5	5.2	5.6
10	COD	mg/l	92.0	90.0	82.0	89.0
11	BOD	mg/l	BQL	BQL	BQL	BQL
12	Silica	mg/l	0.82	0.58	0.58	0.51
13	Phosphate	mg/l	0.28	0.25	0.22	0.20
14	Sulphate	mg/l	1620	3492	2388	2100
15	Nitrate	mg/l	1.97	3.03	2.71	2.06
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	561.12	641.28	561.12	440.88
18	Magnesium	mg/l	1579.5	1603.8	1603.8	1822.5
19	Sodium	mg/l	9423.0	9014.0	9526.0	9468.0
20	Potassium	mg/l	341.0	301.0	218.0	221.0
21	Iron	mg/l	1.62	1.33	1.74	1.21
22	Chromium	mg/l	0.16	0.12	0.14	0.16
23	Copper	mg/l	BQL	BQL	BQL	BQL
24	Arsenic	mg/l	BQL	BQL	BQL	BQL
25	Cadmium	mg/l	0.04	0.05	0.06	0.04
26	Mercury	mg/l	BQL	BQL	BQL	BQL
27	Lead	mg/l	0.08	0.06	0.09	0.08
28	Zinc	mg/l	BQL	BQL	BQL	BQL

BQL- Below Quantification Limit, (BOD-2.0 mg/l,Cu-0.1 mg/l, As-0.1mg/l, Hg-0.01 mg/l, Zinc-0.1 mg/l).

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	7.30	7.20	7.30	7.40
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.6	31.2	31.2	31.1
5	Turbidity	NTU	36	42	36	31
6	Total Dissolved Solids	mg/l	40770	38329	38644.0	38955.0
7	Total Suspended Solids	mg/l	766	853	494.2	474
8	Total Solids	mg/l	41536	39182	39138.2	39429.0
9	DO	mg/l	4.1	4.7	4.6	4.8
10	COD	mg/l	98.0	96.0	96.0	98.0
11	BOD	mg/l	BQL	BQL	BQL	BQL
12	Silica	mg/l	0.53	0.89	0.75	0.64
13	Phosphate	mg/l	0.24	0.24	0.21	0.18
14	Sulphate	mg/l	3456	3732	2820	2424
15	Nitrate	mg/l	2.75	3.38	2.77	4.31
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	561.12	521.04	480.96	561.12
18	Magnesium	mg/l	1676.7	1725.3	1773.9	1676.7
19	Sodium	mg/l	9839.0	10125.0	10118.0	10168.0
20	Potassium	mg/l	399.0	402.0	387.0	390.0
21	Iron	mg/l	1.20	1.13	1.45	1.10
22	Chromium	mg/l	0.11	0.13	0.14	0.14
23	Copper	mg/l	BQL	BQL	BQL	BQL
24	Arsenic	mg/l	BQL	BQL	BQL	BQL
25	Cadmium	mg/l	0.05	0.07	0.07	0.08

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
26	Mercury	mg/l	BQL	BQL	BQL	BQL
27	Lead	mg/l	0.07	0.09	0.10	0.09
28	Zinc	mg/l	BQL	BQL	BQL	BQL

BQL- Below Quantification Limit, (BOD-2.0 mg/l,Cu-0.1 mg/l, As-0.1mg/l, Hg-0.01 mg/l,Zinc-0.1 mg/l).

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	7.52	Sampling not possible during Low Tide	7.52	Sampling not possible during Low Tide
2	Color	-	Colorless		Colorless	
3	Odor	-	Odorless		Odorless	
4	Salinity	ppt	31.8		32.2	
5	Turbidity	NTU	35		35	
6	Total Dissolved Solids	mg/l	41695		42152.0	
7	Total Suspended Solids	mg/l	684		452	
8	Total Solids	mg/l	42379		42604.0	
9	DO	mg/l	4.8		5.1	
10	COD	mg/l	100.0		94.0	
11	BOD	mg/l	BQL		BQL	
12	Silica	mg/l	0.96		0.53	
13	Phosphate	mg/l	0.23		0.17	
14	Sulphate	mg/l	3780		2376	
15	Nitrate	mg/l	3.24		3.61	
16	Nitrite	mg/l	<0.05		<0.05	
17	Calcium	mg/l	480.96		601.2	

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
18	Magnesium	mg/l	1725.3		1628.1	
19	Sodium	mg/l	10308.0		10319.0	
20	Potassium	mg/l	409.0		364.0	
21	Iron	mg/l	1.20		1.35	
22	Chromium	mg/l	0.11		0.12	
23	Copper	mg/l	BQL		BQL	
24	Arsenic	mg/l	BQL		BQL	
25	Cadmium	mg/l	0.06		0.06	
26	Mercury	mg/l	BQL		BQL	
27	Lead	mg/l	0.08		0.11	
28	Zinc	mg/l	BQL		BQL	

BQL- Below Quantification Limit, (BOD-2.0 mg/l,Cu-0.1 mg/l, As-0.1mg/l, Hg-0.01 mg/l,Zinc-0.1 mg/l).

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	7.70	7.41	7.52
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	31.2	32.0	31.5	31.4
5	Turbidity	NTU	45	39	42	40
6	Total Dissolved Solids	mg/l	38510	42661	40025.0	40250.0
7	Total Suspended Solids	mg/l	585	523	548.9	505
8	Total Solids	mg/l	39095	43184	40573.9	40755.0
9	DO	mg/l	4.4	4.6	4.7	4.6

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
10	COD	mg/l	76.0	80.0	72.0	70.0
11	BOD	mg/l	BQL	BQL	BQL	BQL
12	Silica	mg/l	0.85	1.02	0.75	0.82
13	Phosphate	mg/l	0.22	0.25	0.18	0.17
14	Sulphate	mg/l	2580	2700	2592	2508
15	Nitrate	mg/l	2.75	3.59	3.67	3.39
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	601.20	521.04	641.28	480.96
18	Magnesium	mg/l	1603.8	1676.7	1652.4	1676.7
19	Sodium	mg/l	10968.0	10848.0	11126.0	10829.0
20	Potassium	mg/l	344.0	382.0	355.0	392.0
21	Iron	mg/l	1.06	1.70	1.12	1.42
22	Chromium	mg/l	0.12	0.13	0.14	0.13
23	Copper	mg/l	BQL	BQL	BQL	BQL
24	Arsenic	mg/l	BQL	BQL	BQL	BQL
25	Cadmium	mg/l	0.05	0.04	0.08	0.07
26	Mercury	mg/l	BQL	BQL	BQL	BQL
27	Lead	mg/l	0.10	0.08	0.10	0.09
28	Zinc	mg/l	BQL	BQL	BQL	BQL

BQL- Below Quantification Limit, (BOD-2.0 mg/l,Cu-0.1 mg/l, As-0.1mg/l, Hg-0.01 mg/l, Zinc-0.1 mg/l).

Table 36 (a): Marine Water Quality Monitoring Parameters for locations Nr. Vadinar SPM

Sr. No.	Parameters	Unit	Nr.Vadinar SPM			
			22°30'56.15"N 69°42'12.07"E			
			Spring Tide		Neap Tide	
	Tide		High Tide	Low Tide	High Tide	Low Tide
1	pH	pH unit	7.40	7.60	7.45	7.26

Sr. No.	Parameters	Unit	Nr.Vadinar SPM			
			22°30'56.15"N 69°42'12.07"E			
			Spring Tide		Neap Tide	
	Tide		High Tide	Low Tide	High Tide	Low Tide
2	Color	-	Colorless	Colorless	Colorless	Colorless
3	Odor	-	Odorless	Odorless	Odorless	Odorless
4	Salinity	ppt	32.2	32.1	32.0	31.8
5	Turbidity	NTU	33.0	34.0	36.0	33.0
6	Total Dissolved Solids	mg/l	41700.0	41987	40610.0	40925
7	Total Suspended Solids	mg/l	635.0	480	513.0	548
8	Total Solids	mg/l	43340.0	43924	41384.0	42000
9	DO	mg/l	4.3	4.1	4.5	4.3
10	COD	mg/l	90.0	92.0	78.0	70.0
11	BOD	mg/l	BQL	BQL	BQL	BQL
12	Silica	mg/l	0.92	0.96	0.6	0.78
13	Phosphate	mg/l	0.24	0.25	0.2	0.16
14	Sulphate	mg/l	2628.0	2364	2316.0	2556
15	Nitrate	mg/l	3.10	3.38	3.34	3.68
16	Nitrite	mg/l	<0.05	<0.05	<0.05	<0.05
17	Calcium	mg/l	481.0	561.12	521.0	561.12
18	Magnesium	mg/l	1652.4	2065.5	1676.7	1701
19	Sodium	mg/l	10318	10829	10418	10786
20	Potassium	mg/l	354	355	377	354
21	Iron	mg/l	1.60	1.80	1.27	1.90
22	Chromium	mg/l	0.14	0.14	0.13	0.12
23	Copper	mg/l	BQL	BQL	BQL	BQL
24	Arsenic	mg/l	BQL	BQL	BQL	BQL
25	Cadmium	mg/l	0.05	0.04	0.08	0.08
26	Mercury	mg/l	BQL	BQL	BQL	BQL
27	Lead	mg/l	0.09	0.08	0.11	0.09

Sr. No.	Parameters	Unit	Nr.Vadinar SPM			
			22°30'56.15"N 69°42'12.07"E			
			Spring Tide		Neap Tide	
	Tide		High Tide	Low Tide	High Tide	Low Tide
28	Zinc	mg/l	BQL	BQL	BQL	BQL

BQL- Below Quantification Limit, (BOD-2.0 mg/l,Cu-0.1 mg/l, As-0.1mg/l, Hg-0.01 mg/l,Zinc-0.1 mg/l).

5.4.1 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.

5.5Results

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 - 4	KPT - 5	Jetty	SPM
1	Texture	-	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	mg/kg	1.72	1.34	1.36	2.74	1.53	2.31	2.00
3	Organic Carbon	mg/kg	0.99	0.78	0.79	1.59	0.89	1.34	1.16
4	Inorganic Phosphate	mg/kg	112.0	121.0	116.0	124.0	128.0	122.0	133.0
5	Moisture	%	29.43	23.11	31.0	27.25	25.69	27.4	43.00
6	Aluminium	mg/kg	ND	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	11.2	10.5	12.3	11.4	10.5	13.2	13.00
8	Phosphate	mg/kg	2.57	2.73	9.48	6.12	11.84	5.96	6.68
9	Sulphate	mg/kg	283.0	257.0	411.0	182.0	338.0	209.0	494.7
10	Nitrite	mg/kg	0.12	0.11	0.12	0.12	0.11	0.1	0.11
11	Nitrate	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL
12	Calcium	mg/kg	364.7	152.3	505.0	76.2	325.0	225.0	177.0
13	Magnesium	mg/kg	260.0	241.0	158.0	175.0	308.0	58.3	228.4

14	Sodium	mg/kg	1819.0	2881.0	876.0	1858.0	4022.0	3159.0	8637.0
15	Potassium	mg/kg	119.0	166.0	102.0	113.0	263.0	283.0	1036.7
16	Chromium	mg/kg	60	46.6	51.2	43.2	58	46.40	65.00
17	Nickel	mg/kg	32.1	33.7	24.9	28	32.5	28.00	45.60
18	Copper	mg/kg	39.9	14.6	33	16.8	31.8	26.80	21.00
19	Zinc	mg/kg	81.90	52.70	60.80	42.70	68.70	64.30	65.90
20	Cadmium	mg/kg	2.0	BQL	BQL	BQL	BQL	BQL	BQL
21	Lead	mg/kg	18.50	5.4	9.0	5.70	11.4	10.90	5.20
22	Mercury	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL
23	Arsenic	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL

*ND - Not Detected, BQL: Below Quantification Limit (NO3:10.0mg/kg, Cd: 1.0mg/kg, Hg: 1.0mg/kg, As: 1.0mg/kg)

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	SPM
1	Texture	-	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Organic Matter	mg/kg	1.12	1.50	2.88	1.41	0.69	1.43	1.69
3	Organic Carbon	mg/kg	0.65	0.87	1.67	0.82	0.40	0.83	0.98
4	Inorganic Phosphate	mg/kg	118.0	126.0	120.0	130.0	128.0	112.0	130.0
5	Moisture	%	17.76	22.98	20.4	14.01	22.6	34.3	32.16
6	Aluminium	mg/kg	ND	ND	ND	ND	ND	ND	ND
7	Silica	mg/kg	12.0	11.3	10.5	11.3	9.8	11.4	12.60
8	Phosphate	mg/kg	17.14	2.91	7.83	0.49	2.54	15.65	2.20
9	Sulphate	mg/kg	255.0	427.0	290.0	440.0	390.0	564.0	595.0
10	Nitrite	mg/kg	0.1	0.11	0.1	0.11	0.12	0.1	0.11
11	Nitrate	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL
12	Calcium	mg/kg	180.0	188.0	172.0	180.0	176.0	116.0	140.0
13	Magnesium	mg/kg	38.9	102.1	82.6	150.7	58.3	158.0	179.8

Sr. No.	Parameters	Unit	KPT - 1	KPT - 2	KPT - 3	KPT - 4	KPT - 5	Jetty	SPM
14	Sodium	mg/kg	325.0	853.6	743.8	656.1	414.0	1895.0	1810.0
15	Potassium	mg/kg	25.7	72.3	52.3	52.3	40.0	248.0	307.0
16	Chromium	mg/kg	25.7	38.6	28.6	27.3	31.3	51.90	56.20
17	Nickel	mg/kg	18.0	29.2	20.1	18.4	17.8	32.40	72.70
18	Copper	mg/kg	12.30	20.30	6.70	9.40	7.90	22.20	41.10
19	Zinc	mg/kg	24.90	57.40	32.80	27.90	25.50	46.40	1511.00
20	Cadmium	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL
21	Lead	mg/kg	4.60	6.7	7.5	3.70	3.3	24.70	29.60
22	Mercury	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL
23	Arsenic	mg/kg	BQL	BQL	BQL	BQL	BQL	BQL	BQL

*ND - Not Detected, BQL: Below Quantification Limit (NO3:10.0mg/kg,Cd: 1.0mg/kg,Hg: 1.0mg/kg, As: 1.0mg/kg)

REPORT

ON

ECOLOGICAL MONITORING

OF MARINE ENVIRONMENT

IN

DPTHARBOURAREA, NEAR BY CREEKS

AND

VADINAR JETTY AND SPM

FOR

DEENDAYAL PORT TRUST

November, 2021

INTRODUCTION:

Sampling Stations:

The monitoring of marine environment for the study of biological and ecological Parameters was carried out on19thNovember, 2021 in harbour region of DPT at Kandla Creek, and on 20thNovember, 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 26thNovember, 2021 in harbour region of DPT at Kandla Creek and on27thNovember 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 KPT 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 Neap tide and spring 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 at Path Finder Creek during neap tide on 11/11/2021 and spring tide period on 26/11/2021 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	3 in Kandla creek
Nakti creek	2 in Nakti creek
Khori Creek	1 in Khori creek
Vadinar jetty	1 near Vadinar Jetty
SPM	1 near I stSPM
Total Number of locations	**8**

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 litre 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, and 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.

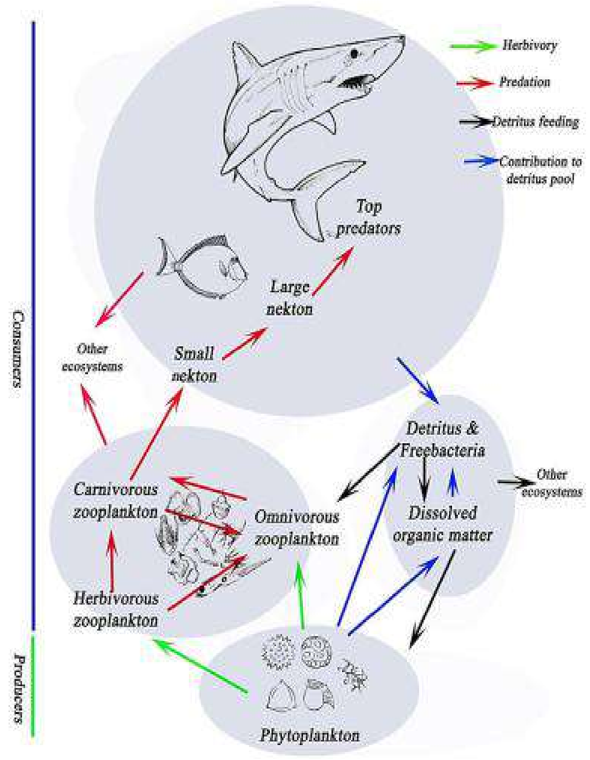
Based on the duration of planktonic life, zooplankton are categorised into Holoplankton (organisms which complete their entire lifecycle as plankton) and Meroplankton (organisms which are planktonic during the early part of their lives such as the larval stages of benthic and nektonic organisms). Tychoplankton 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:

$$D \quad \frac{n_i \; n_i \quad 1}{N \; N \quad 1}$$

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**) reproduces 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 0.559 -0.868 mg/m^3.in harbour region of DPT in Kandla Creek during sampling done in spring tide period of November, 2021. In the nearby creeks chlorophyll-a was varying from 0.246 -0.954 mg/m^3.Pheophytin –a level was below detectable limit- the all the sampling stations during springtide

In the sub surface water chlorophyll-a was varying from 0.535 -0.921mg/m^3.in harbour region of DPT in Kandla Creek during sampling done in neap tide period of November , 2021 . In the nearby creeks chlorophyll-a was varying from 0.425 –1.923 mg/m^3.·Pheophytin –a level was below detectable limit- the all the sampling stations except KPT-4 Khori-I during low tide and high tide and KPT-5 Nakti-I during High tide period.

In the sub surface water chlorophyll-a was varying from 0.393 -0.338 mg/m^3.in harbour region of DPT OOT in path finder Creek during sampling done in spring tide period ofNovember, 2021. In the sub surface water chlorophyll-a was varying from 1.356 -0.500 mg/m^3.in harbour region of DPT OOT in path finder Creek during sampling done in Neap Tide period of November, 2021

In the sub surface water chlorophyll-a was varying from 0.424 -0.290 mg/m^3.in SPM region of DPT OOT in path finder Creek during sampling done in spring tide period of November, 2021. In the sub surface water chlorophyll-a was varying from 0.703 -0.409 mg/m^3.in SPM region of DPT OOT in path finder Creek during sampling done in Neap Tide period of November, 2021

TABLE #2 VARIATIONS IN CHLOROPHYLL –a PHEOPHYTIN- a AND ALGAL BIOMASS FROM SAMPLING STATIONS IN DPT HARBOUR AREA IN KANDLA CREEK ,NEAR BY CREEKS AND DPT OOT JETTY IN PATH FINDER CREEK AND SPM NEAR VADINAR DURING SPRING TIDE IN NOVEMBER,2021

Sr. No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin-a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPT HARBOUR AREAKANDLA CREEK					
1	KPT1	High tide	0.748	BDL	50.15
		Low tide	0.559	BDL	37.45
2	KPT 2	High tide	0.677	BDL	45.36
		Low tide	0.764	BDL	51.19
3	KPT 3	High tide	0.835	BDL	55.94
		Low tide	0.868	BDL	58.16
CREEKS					
4	KPT-4 Khori-I	High tide	0.661	BDL	44.29
		Low tide	0.720	BDL	48.24
5	KPT-5 Nakti-I	High tide	0.848	BDL	56.82
		Low tide	0.954	BDL	63.92
6	KPT-5 Nakti-II	High tide	0.246	BDL	16.48
PATHFINDER CREEK VADINAR					
7	VADINAR-I jetty	Low tide	0.393	BDL	26.33
8		High tide	0.338	BDL	22.65
9	SPM	High tide	0.424	BDL	28.41
10	SPM	Low 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 AND DPT OOT JETTY IN PATH FINDER CREEK AND SPM NEAR VADINARDURING NEAP TIDE IN NOVEMBER,2021

Sr. No.	Station	Tide	Chlorophyll-a (mg/m^3)	Pheophytin-a (mg/m^3)	Algal Biomass (Chlorophyll method) mg/m^3
DPTHARBOUR AREAKANDLA CREEK					
1	KPT1	High tide	0.748	BDL	50.12
		Low tide	0.535	BDL	35.85
2	KPT 2	High tide	0.713	BDL	47.77
		Low tide	0.713	BDL	47.77
3	KPT 3	High tide	0.882	BDL	59.09
		Low tide	0.921	BDL	61.71
CREEKS					
4	KPT-4 Khori-I	High tide	1.669	0.484	111.82
		Low tide	1.178	0.380	78.93
5	KPT-5 Nakti-I	High tide	1.923	0.570	128.84
		Low tide	0.882	BDL	59.09
6	KPT-5 Nakti-II	High tide	0.425	BDL	28.47
PATHFINDER CREEK VADINAR					
7	VADINAR-I jetty	Low tide	1.356	0.415	90.85
8		High tide	0.500	BDL	33.50
9	SPM	High tide	0.703	BDL	47.10
10	SPM	Low tide	0.409	BDL	27.40

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 dinoflagellatesduring spring tide period.Diatoms were represented by 16genera. Blue green were represented by 2 genera and dinoflagellates were represented by two generaduring the sampling conducted in spring tide in November,2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from 43-198 units/ L during high tide period and133-220 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 20genera Blue green algae were represented 1genera and Dinoflagellates with two genera during the sampling conducted in Neap tide in November, 2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area and nearby creeks was varying from83-327 units/ L during high tide period and 108 -252 units/ L during low tide of Neap Tide.

For the evaluation of the Phytoplankton population in DPT OOT jetty area in Path Finder creek sampling was conducted from one sampling locations ; jetty area during high tide period and low tide of spring tide. For the evaluation of the Phytoplankton population in DPTOOT jetty area in Path Finder creek in Vadinar sampling was conducted from 2 sampling locations ; jetty area and one near SPM during high tide period and low tide of Neap tide.

The phytoplankton community of the sub surface water in the path finder creeks was represented by only Diatoms spring tide period. Diatoms were represented by 11 genera during the sampling conducted in spring tide in November, 2021. Phytoplankton of the sampling stations at sub surface layer in the harbour area was varying from 162 units/ L during high tide period and 178 units/ L during low tide of Spring Tide. Phytoplankton of the sampling stations at sub surface layer in the SPM area was varying from 154 units/ L during high tide period and 130 units/ L during low tide of Spring Tide.

The phytoplankton community of the sub surface water in the path finder creeks was represented by Diatoms,and Dinoflagellatesduring Neap tide period.Diatoms were represented by 15 generaand dinoflagellates by two genera during the sampling conducted in Neap tide in November, 2021. Phytoplankton of the sampling stations at sub surface path finder creek nearOOT Jetty was varying from 227 units/ L during high tide period and 182 -744 units/ L during low tide of Neap Tide. Phytoplankton of the sampling stations at sub surface path finder creek near SPM area was varying from 158 units/ L during high tide period and 158 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 Kandla creek and nearby creeks sampling stations was varying from 1.595-3.091 with an average of 2.396during the sampling conducted in High tide period of spring tide. While Margalef's diversity index (Species Richness) S of phytoplankton communities in the Kandla creek region and nearby creeks was varying from2.236 -2.863 with an average of 2.554 during the consecutive low tide period.

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations in Kandla creek and nearby creeks was varying from 2.339-2.984 with an average of 2.696 during the sampling conducted in High tide period of Neaptide. While Margalef's diversity index (Species Richness) S of phytoplankton communities in the Kandla creek region and nearby creeks was varying from2.450-2.713 with an average of 2.624 during consecutive low tide.

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was 1.769 at OOT jetty area and 1.588 at SPM area during the sampling conducted in High tide period of spring tide. While Margalef's diversity index (Species Richness) S of phytoplankton communities in the path finder creeknear OOT jetty was 1.737 and 1.644 at SPM during the consecutive low tide period.

Margalef's diversity index (Species Richness) S of phytoplankton communities in the stations was 2.561 at OOT jetty area and 2.370 at SPM area during the sampling conducted in High tide period of Neap tide. While Margalef's diversity index (Species Richness) S of phytoplankton communities in the path finder creek near OOT jetty was 2.114 and SPM area was 2.195 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 0.727-0.907 (H'(log10)) between selected sampling stations with an average value of 0.805 during high tide period of spring tide at Kandla creek and nearby creeks. Shannon-Wiener's Index (H) of phytoplankton communities in the sampling stations was in the range of 0.787 -0.895 (H'(log10)) between selected sampling stations with an average value of 0.853 during consecutive low tide at Kandla creek and nearby creeks. Shannon-Wiener’s Index (H) of phytoplankton communities in the sampling stations was in the range of 0.695 -0.931 (H'(log10)) between selected sampling stations with an average value of 0.823 during high tide period of neap tide at Kandla creek and nearby creeks. Shannon-Wiener’s Index (H) of phytoplankton communities in the sampling stations was in the range of 0.759-0.867 (H'(log10)) between selected sampling stations with an average value of 0.810 during consecutive low tide at Kandla creek and nearby creeks.

Shannon-Wiener’s Index (H) of phytoplankton communities in the stations was 0.798 atOOT jetty area and 0.7551 at SPM area during the sampling conducted in High tide period of spring tide. While Shannon-Wiener’s Index (H) of phytoplankton communities in the path finder creek near OOT jetty was 0.715 and 0.771 at SPM during the consecutive low tide period.

Shannon-Wiener’s Index (H) of phytoplankton communities in the stations was 0.787 at OOT jetty area and 0.7330 at SPM area during the sampling conducted in High tide period of Neap tide. While Shannon-Wiener’s Index (H) of phytoplankton communities in the path finder creek near OOT jetty was 0.729 and at SPM area was 0.712 during the 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 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 0.742- 0.830 between selected sampling stations with an average of 0.788 during high tide period of spring tide. Simpson diversity index (1-D) of phytoplankton communities was below 0.9 at all sampling stationsin the Kandla Harbour region and nearby creeks, which was varying from 0.786- 0.832

between selected sampling stations with an average of 0.809during consecutive low tide .

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 0.664-0.841 with an average value of 0.774 between selected sampling stations during high tide period and varying from 0.732-0.824 with an average value of 0.771 between selected sampling stations during consecutive low tide period Low species diversity suggests a relatively few successful species in this habitat.

Simpson diversity index (1-D) of phytoplankton communities in the stations was 0.813 atOOT jetty area and 0.779 at SPM area during the sampling conducted in High tide period of spring tide at Path finder creek . While Simpson diversity index (1-D) of phytoplankton communities in the path finder creek near OOT jetty was 0.753 and 0.794 at SPM during the consecutive low tide period in the path finder creek.

Simpson diversity index (1-D) of phytoplankton communities in the stations was 0.765 at OOT jetty area and 0.737 at SPM area during the sampling conducted in High tide period of Neap tide at Path finder Creek. While Simpson diversity index (1-D) of phytoplankton communities in the path finder creek near OOT jetty was 0.738 and at SPM area was 0.708 during the consecutive low tide period.

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.

Table # 4PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA AT KANDLA CREEK AND ,NEAR BY CREEKS DURING SPRING TIDE IN NOVEMBER,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	177	17/20	85	3.091	0.9004	0.8193
	2	152	16/20	80	2.986	0.9067	0.8305
	3	192	11/20	55	1.902	0.7268	0.7421
	4	167	13/20	65	2.345	0.7525	0.7454
	5	198	14/20	70	2.458	0.7886	0.7683
	6	43	7/20	35	1.595	0.7583	0.825
LOW TIDE	1	133	15/20	75	2.863	0.8948	0.8214
	2	153	15/20	75	2.783	0.893	0.832
	3	190	14/20	70	2.478	0.8679	0.8106
	4	137	12/20	60	2.236	0.8213	0.7966
	5	220	14/20	70	2.41	0.7872	0.786

Table # 5 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA AT KANDLA CREEK AND ,NEAR BY CREEKS DURING NEAP TIDE IN NOVEMBER,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	131	15/24	62.5	2.872	0.9308	0.8406
	2	120	13/24	54.16	2.507	0.8561	0.8136
	3	213	17/24	70.83	2.984	0.8315	0.7733
	4	259	14/24	58.33	2.339	0.7394	0.7223
	5	327	17/24	70.83	2.763	0.6955	0.6641
	6	83	13/24	54.16	2.716	0.8861	0.8316
LOW TIDE	1	108	13/24	54.16	2.563	0.791	0.7606
	2	134	13/24	54.16	2.45	0.8677	0.8239
	3	177	15/24	62.5	2.705	0.7892	0.7325
	4	252	16/24	66.66	2.713	0.7591	0.7444
	5	182	15/24	62.5	2.69	0.8458	0.7939

Table # 6 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA AT KANDLA CREEK AND , NEAR BY CREEKS DURING SPRING TIDE IN NOVEMBER, 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	41-197	16/20	80
			BLUE GREEN	0-4	2/20	10
			DINOFLAGELLATES	0-3	2/20	10
			TOTAL PHYTO PLANKTON	**43-198**	**20**	-
LOW TIDE	Sub surface	5	DIATOMS	129-216	16/20	80
			BLUE GREEN	0-4	2/20	10
			DINOFLAGELLATES	0-2	2/20	10
			TOTAL PHYTO PLANKTON	**133-220**	**20**	-

Table # 7 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA AT KANDLA CREEK AND , NEAR BY CREEKS DURING NEAP TIDE IN NOVEMBER,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	81-326	21/24	87.6
			BLUE GREEN	0-2	1/24	4.16
			DINOFLAGELLATES	0-2	2/24	8.33
			TOTAL PHYTO PLANKTON	**83-327**	**24**	
LOW TIDE	Sub surface	5	DIATOMS	108-251	21/24	87.6
			BLUE GREEN	0-2	1/24	4.16
			DINOFLAGELLATES	0-1	2/24	8.33
			TOTAL PHYTO PLANKTON	**108-252**	**24**	

Table # 8 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT OOTAT PATH FINDER CREEK , VADINAR &NEAR BY SPM, DURING SPRING TIDE IN NOVEMBER, 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	jetty	162	10/11	90.90	1.769	0.7989	0.8132
	SPM	178	10/11	90.90	1.737	0.7149	0.7536
LOW TIDE	jetty	154	9/11	81.82	1.588	0.7441	0.7796
	SPM	130	9/11	81.82	1.644	0.7712	0.7937

Table # 9 PHYTOPLANKTON VARIATIONS IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT OOTAT PATH FINDER CREEK , VADINAR & NEAR BY SPM, DURING NEAP TIDE IN NOVEMBER, 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	Jetty	227	15/17	88.24	2.581	0.7875	0.7647
	SPM	182	12/17	70.59	2.114	0.7288	0.7383
LOW TIDE	Jetty	158	13/17	76.47	2.37	0.733	0.7374
	SPM	150	12/17	70.59	2.195	0.7123	0.7087

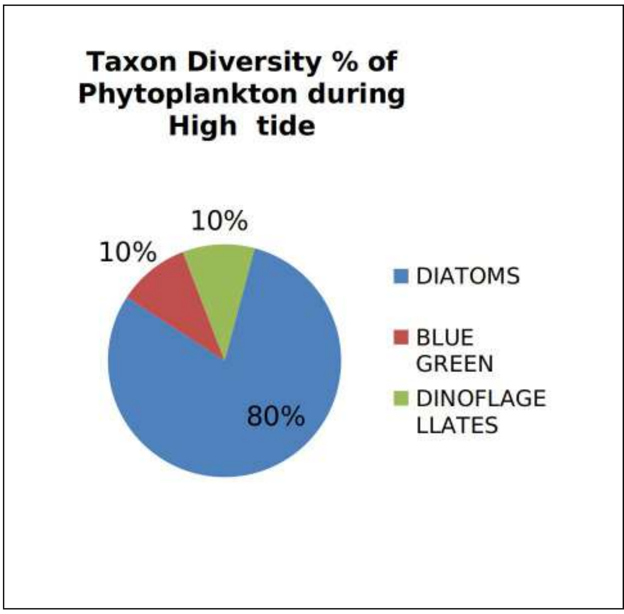
Table # 10 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT DPTOOT AT PATH FINDER CREEK , VADINAR & NEAR BY SPM, DURING SPRING TIDE IN NOVEMBER, 2021

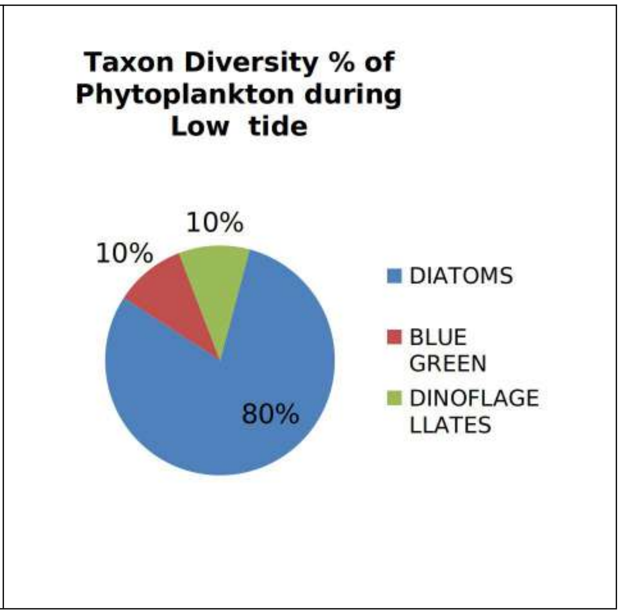
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	1	DIATOMS	162-178	11/11	100
			TOTAL PHYTO PLANKTON	162-178	**11**	
LOW TIDE	Sub surface	1	DIATOMS	130-154	11/11	100
			TOTAL PHYTO PLANKTON	130-154	**11**	

Table # 11 ABUNDANCE OF PHYTOPLANKTON SUBSURFACE SAMPLING STATIONS IN DPT DPTOOT AT PATH FINDER CREEK , VADINAR & NEAR BY SPM, DURING NEAP TIDE IN NOVEMBER, 2021

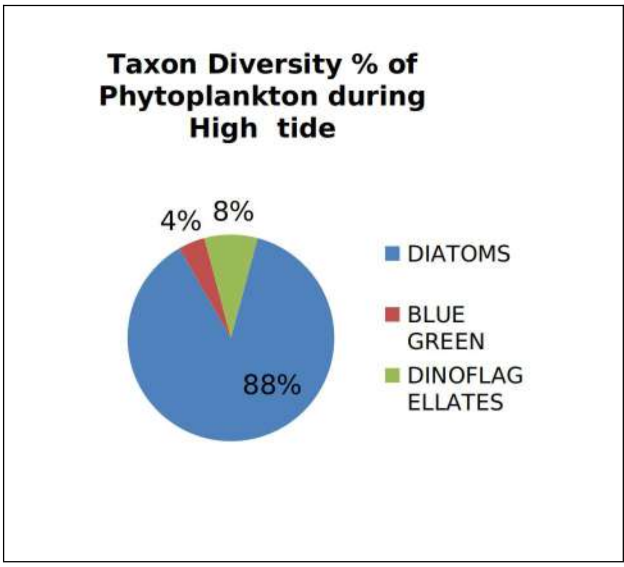
Tide	Surface	No of Sampling location	Group of phytoplankton	Phytoplankton Group range Units/L	Genera or species /total Phyto plankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	2	DIATOMS	182-226	15/17	88.24
			DINOFLAGELLATES	0-1	2/17	11.76
			TOTAL PHYTO PLANKTON	**182-227**	**17**	
LOW TIDE	Sub surface	2	DIATOMS	148-157	15/17	88.24
			DINOFLAGELLATES	0-1	2/17	11.76
			TOTAL PHYTO PLANKTON	148-158	**17**	

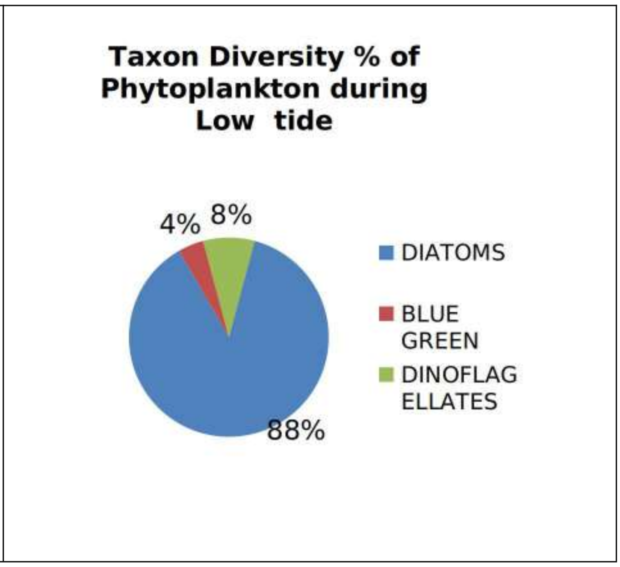
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide in Kandala creek and nearby creeks



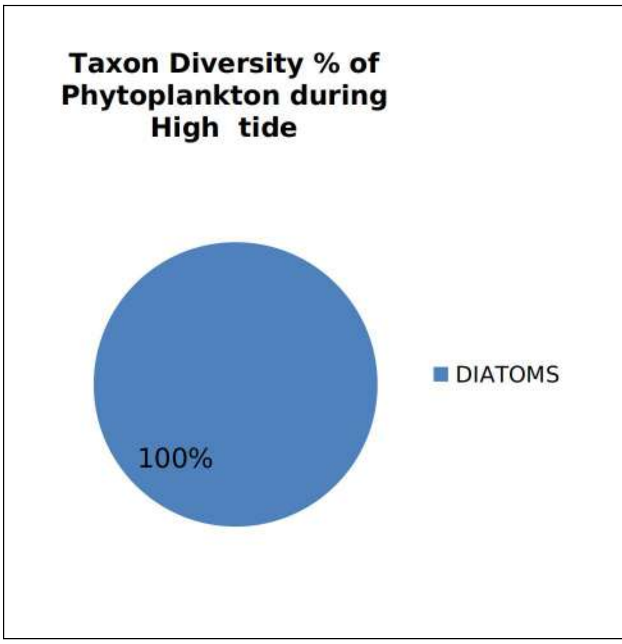


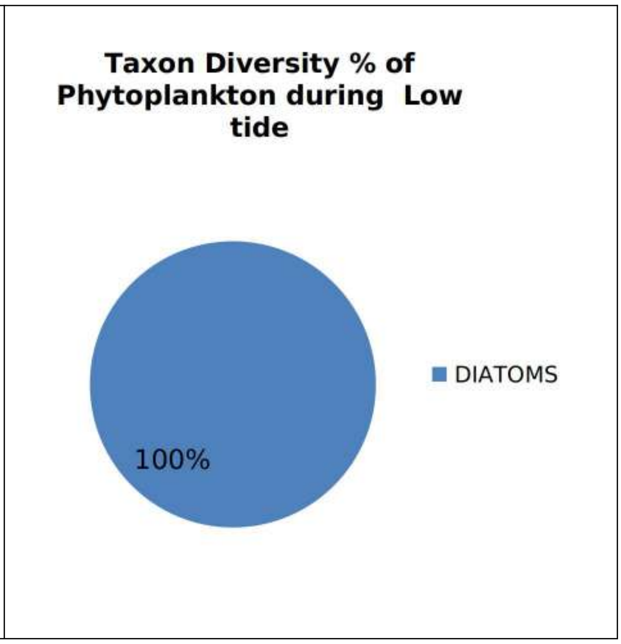
Taxon Diversity % of Phytoplankton during High tide and Low tide period during Neap tide in Kandala creek and nearby creeks



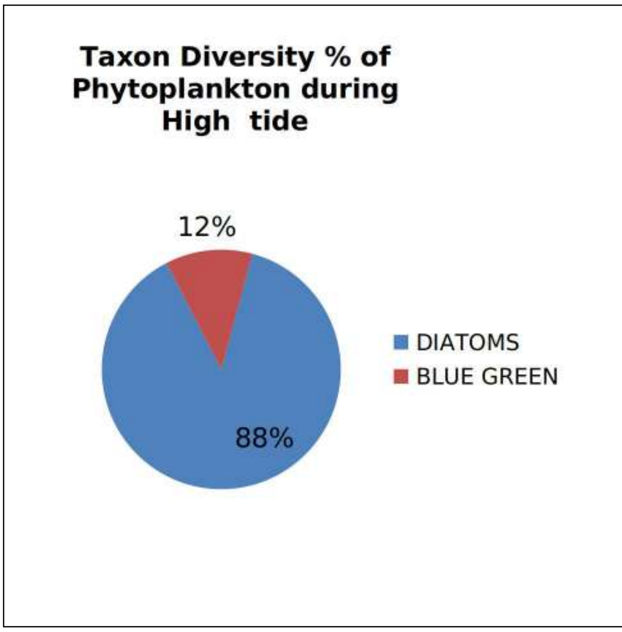


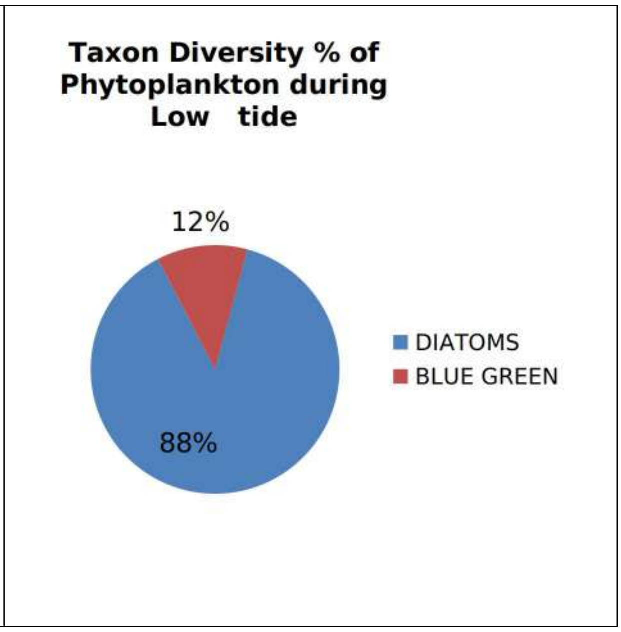
Taxon Diversity % of Phytoplankton during High tide and Low tide period during spring tide in Path Finder Creek, Vadinar





Taxon Diversity % of Phytoplankton during High tide and Low tide period during Neap tide in Path Finder Creek, Vadinar





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 November,2021. The Zooplankton community of the sub surface water in the harbour and nearby creeks during spring tide was represented by mainly 4 groups, and 5 larval forms; Tintinids, Copepods,Rotifers, Urochordatesand larval forms represented from the group of Crustacea, Molluscansand Polychaetes. The Zooplankton community of the sub surface water in the harbour and nearby creeks during neap tide was represented by mainly Six groups, Tintinids, Copepods, Arrow worms, Mysids, Urochordata, Ciliates and unidentified Cnidarian member and larval forms of Crustacea Molluscans and Echinodermata Larvae Polychaete Larvae..,

Zooplankton of the sampling stations at sub surface layer in the DPT harbour area and nearby creek was varying from 25-106x10^3 N/ m^3 during high tide and 58-85x10^3 N/ m^{3}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 40-143 x10^3 N/ m^3 during high tide and83-129x10^3 N/ m^{3}during low tide of Neap Tide period.

For the evaluation of the Zoo plankton population in DPT OOT jetty area in Path Finder creek and SPM in Vadinar selected 2 sampling locations (1 in jetty area and one near SPM) Duringspring tide sampling plankton sample were collected only at Jetty area during consecutive high tide period and low tide period. During Neap tide sampling Plankton samples were collected from jetty area and SPM during consecutive high tide period and low tide period.

The Zooplankton community of the sub surface water in the path finder creek creeks during spring tide was represented by mainly Titinids , Copepods and larval forms of Crusracens, Molluscs and Polychaetes .The Zooplankton community of the sub surface water in the path Finder creeks at Jetty region and SPM during neap tide was represented by mainly three groups, Tintinids, Copepods , Urochordates and , five Larval forms were represented from the major group of Crustaceans , Molluscans , and Polychaetes,.

Zooplankton of the sampling stations at sub surface layer in the DPT OOTjetty area of path finder creek was 87 x103 N/ m^3 during high tide and 117 x103 N/ m^3 during low tide of Spring Tide period. Zooplankton of the sampling stations at sub surface layer in the DPT SPM area of path finder creek was 85 x10^3 N/ m^3 during high tide and 109 x10^3 N/ m^3 during low tide of Spring Tide period. Zooplankton of the sampling stations at sub surface layer in the DPT OOT jetty area in path finder creekwas recorded 54x10^3 N/ m^{3}during high tide and 86x10^3 N/ m^3 during consecutive low tide period of Neap . Zooplankton of the sampling stations at sub surface layer in the DPT SPM area in path finder creek was recorded 72 x10^3 N/ m^3during high tide and 92 x10^3 N/ m^3 during consecutive low tide period 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 Zooplankton communities in the stations Kandla creek region and nearby creeks was varying from 1.733-2.796 with an average of 2.196 during the sampling conducted in High tide period. Margalef's diversity index (Species Richness) S of Zooplankton communities varying from.1.871-2.217 with an average of 2.026 during the sampling conducted in low tide period during Spring tide.

Margalef's diversity index (Species Richness) S of Zooplankton communities in the Kandla creek region and nearby creeks sampling stations was varying from2.771-3.983with an average of 3.445 during the sampling conducted in high tide and varying from2.635- 3.054 with an average of 3.049 during the sampling conducted in low tide during Neap tide period

Margalef's diversity index (Species Richness) S of Zooplankton communities in the sampling station near jetty at Path Finder Creek, Vadinar during the sampling conducted inconsecutive High tide period and low tide of spring tide was recorded as 1.769 and 1. 588 respectively..

Margalef's diversity index (Species Richness) S of Zooplankton communities near SPmat Path finder creek was varying from 2.256-2.572 during the sampling conducted in High tide period of Neap tide. While Margalef's diversity index (Species Richness) S of Zooplankton communities in the two stations at Path finder creek was varying from2.020- 1.769 during the consecutive low 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 0.725-0.945 (H'(log10)) between selected sampling stations with an average value of 0.811 (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 0.703-0.884 (H'(log10)) between selected sampling stations with an average value of 0.780 (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 0.782-1.119 (H'(log10)) between selected sampling stations with an average value of 1.000 (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 0.855-1.059 (H'(log10)) between selected sampling stations with an average value of 0.950(H'(log10)) during consecutive low tide period.

Shannon-Wiener’s Index (H) of Zooplankton communities in the sampling station near jetty at Path Finder Creek, Vadinar during the sampling conducted in consecutive High tide period and low tide of spring tide was recorded as 0.799 and 0.7441 respectively.. Shannon-Wiener’s Index (H) of Zooplankton communities in the sampling station near jetty at Path Finder Creek, Vadinar during the sampling conducted in consecutive High tide period and low tide of Neap tide was recorded as 0.742 and 0.709 respectively

Shannon-Wiener’s Index (H) of Zooplankton communities in the two stations at Path finder creek was varying from 0.715-0.798 during the sampling conducted in High tide period of Spring tide. While Shannon-Wiener’s Index (H)of Zooplankton communities in the two stations at Path finder creek was varying from -0.771-0.7441during the consecutive low tide period.

Shannon-Wiener’s Index (H) of Zooplankton communities in the two stations at Path finder creek was varying from 0.743-0.849 during the sampling conducted in High tide period of Neap tide. While Shannon-Wiener’s Index (H) of Zooplankton communities in the two stations at Path finder creek was varying from -0.641 - 0.709 during the 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 0.751-0.910between selected sampling stations with an average of 0.804 during high tide period and was varying from 0.722- 0.854 with an average value of 0.780 between selected sampling stations during low tide

Simpson diversity index (1-D) of Zooplankton communities was blow 0.9 at all sampling stationsin the Kandla Harbour region and nearby creeks except few during high tide and low tide period, which was varying from 0.766 - 0.912 between selected sampling stations with an average of 0.863 during high tide period and was varying from 0.795- 0.896with an average value of 0.843 between selected sampling stations during consecutive low tide

This low species diversity suggests a relatively few of successful species in this habitat during November, 2021 sampling.

Simpson diversity index (1-D) of Zooplankton communities in the sampling station near jetty at Path Finder Creek, Vadinar during the sampling conducted in consecutive High tide period and low tide of spring tide was recorded as 0.813and 0.779 respectively. Simpson diversity index (1-D) of Zooplankton communities in the sampling station near SPM at Path Finder Creek, Vadinar during the sampling conducted in consecutive High tide period and low tide of spring tide was recorded as 0.753 and 0.779 respectively.

Simpson diversity index (1-D) of Zooplankton communities in the sampling station near jetty at Path Finder Creek, Vadinar during the sampling conducted in consecutive High tide period and low tide of Neap tide was recorded as 0.778 - 0.729 respectively. Simpson diversity index (1-D) of Zooplankton communities in the sampling station near SPM at Path Finder Creek, Vadinar during the sampling conducted in consecutive High tide period and low tide of spring tide was recorded as 0.817 and 0.697 respectively.

Table # 12 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREA AT KANDLA CREEK AND NEAR BY CREEKS DURING SPRING TIDE IN NOVEMBER,2021

Tide	Sampling Station	Abundance In Nx10^3/ 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	75	10/16	62.5	2.085	0.7569	0.751
	2	82	11/16	68.75	2.269	0.8385	0.8154
	3	66	10/16	62.5	2.148	0.8294	0.8224
	4	106	11/16	68.75	2.144	0.7752	0.7641
	5	101	9/16	56.25	1.733	0.7251	0.7651
	6	25	10/16	62.5	2.796	0.9451	0.91
LOW TIDE	1	69	9/16	56.25	1.889	0.8145	0.809
	2	58	10/16	62.5	2.217	0.8838	0.8542
	3	72	9/16	56.25	1.871	0.7031	0.7218
	4	69	10/16	62.5	2.126	0.7896	0.7899
	5	85	10/16	62.5	2.026	0.7112	0.7272

Table # 13 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT HARBOUR AREAAT KANDLA CREEK AND NEAR BY CREEKS DURING NEAP TIDE IN NOVEMBER,

Tide	Sampling Station	Abundance In No x10^3/ 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	118	20/28	71.42	3.983	1.119	0.9122
	2	102	17/28	60.71	3.459	0.9987	0.875
	3	108	19/28	67.86	3.844	1.085	0.8974
	4	143	18/28	64.29	3.425	1.118	0.9087
	5	101	16/28	57.14	3.25	0.9028	0.8212
	6	40	11/28	39.29	2.711	0.7823	0.7667
LOW TIDE	1	83	13/28	46.43	2.716	0.8552	0.7949
	2	128	18/28	64.29	3.504	1.059	0.8958
	3	129	18/28	64.29	3.498	1.055	0.8815
	4	89	14/28	50	2.896	0.8648	0.7975
	5	95	13/28	46.43	2.635	0.9189	0.8434

2021

Table # 14 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREAATKANDLA CREEK AND ,NEAR BY CREEKS DURING SPRING TIDE IN NOVEMBER,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	3-13	3/16	18.75
			Copepods	11-40	6/16	37.5
			Rotifers	0-2	1/16	6.25
			Urochordata	1-4	1/16	6.25
			Larval forms	5-52	5/16	31.25
			TOTAL ZOOPLANKTON N/ M^3	**25-106**	**16**	
LOW TIDE	Sub surface	5	Tintinids	5-9	3/16	18.75
			Copepods	20-27	6/16	37.5
			Rotifers	0	1/16	6.25
			Urochordata	0-4	1/16	6.25
			Larval forms	30-53	5/16	31.25
			TOTAL ZOOPLANKTON N/M^3	**58-85**	**16**	

Table # 15 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT HARBOUR AREA IN KANDLA CREEK AND , NEAR BY CREEKS DURING NEAP TIDE IN NOVEMBER, 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	7-36	5/28	17.86
			Copepods	11-49	8/28	28.58
			Mysids	0-1	2/28	7.14
			Arrow worms	0-2	1/28	3.57
			Urochordata	0-2	1/28	3.57
			Ciliates	0-4	1/28	3.57
			Medusa	0-4	1/28	3.57
			Larval forms	20-58	7/28	25
			Foraminiferans	0-4	2/28	7.14
			TOTAL ZOOPLANKTON N/M^3	**40-143**	**28**	
LOW TIDE	Sub surface	5	Tintinids	10-32	5/28	17.86
			Copepods	17-54	8/28	28.58
			Mysids	0-2	2/28	7.14
			Arrow worms	0-1	1/28	3.57
			Urochordata	0-2	1/28	3.57
			Ciliates	0-1	1/28	3.57
			Medusa	0-1	1/28	3.57
			Larval forms	50-62	7/28	25

			Foraminiferans	**0-3**	2/28	7.14
			Total Zooplankton N/M3		**28**	

Table # 16 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT OOT AREA AT PATH FINDER CREEK AND NEAR BY SPM DURING SPRING TIDE IN NOVEMBER,2021

Tide	Sampling Station	Abundance In x10^{3}N / 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	Jetty	87	11/13	84.62	2.239	0.6821	0.6864
	SPM	85	12/13	92.31	2.476	0.7967	0.788
LOW TIDE	Jetty	117	10/13	76.92	1.89	0.7264	0.7265
	SPM	109	10/13	76.92	1.918	0.6599	0.6624

Table # 17 ZOOPLANKTON VARIATION IN ABUNDANCE AND DIVERSITY IN SUB SURFACE SAMPLING STATIONS IN DPT OOT AREA AT PATH FINDER CREEK AND NEAR BY SPM DURING NEAP TIDE IN NOVEMBER,2021

Tide	Sampling Station	Abundance In Nx10^3/ 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	Jetty	227	15/17	88.23	2.581	0.7875	0.7647
	SPM	182	12/17	70.59	2.114	0.7288	0.7383
LOW TIDE	Jetty	158	13/17	76.47	2.37	0.733	0.7374
	SPM	150	12/17	70.59	2.195	0.7123	0.7087

Table # 18 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT OOT AREAAT PATH FINDER CREEK AND NEAR BY SPM DURING SPRING TIDE IN NOVEMBER,2021

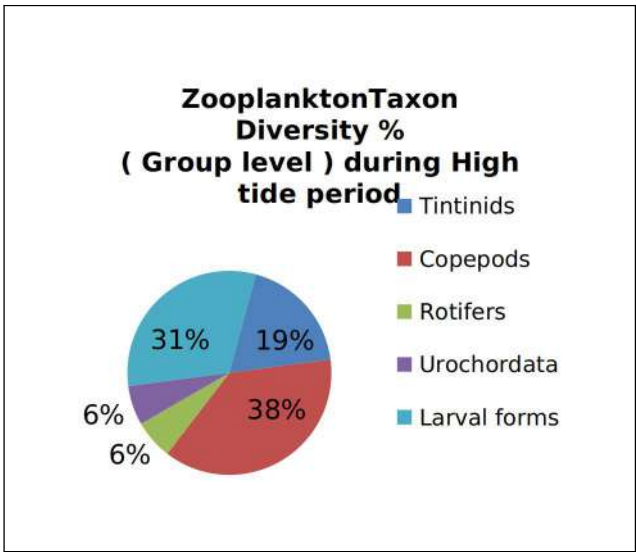
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	2	Tintinids	6-7	3/13	23.08
			Copepods	30-39	6/13	46.15
			Larval forms	39-51	4/13	30.77
			TOTAL ZOOPLANKTON NO/L	**85-87**	**13**	
LOW TIDE	Sub surface	2	Tintinids	15-16	3/13	23.08
			Copepods	30-35	6/13	46.15
			Larval forms	67-73	4/13	30.77

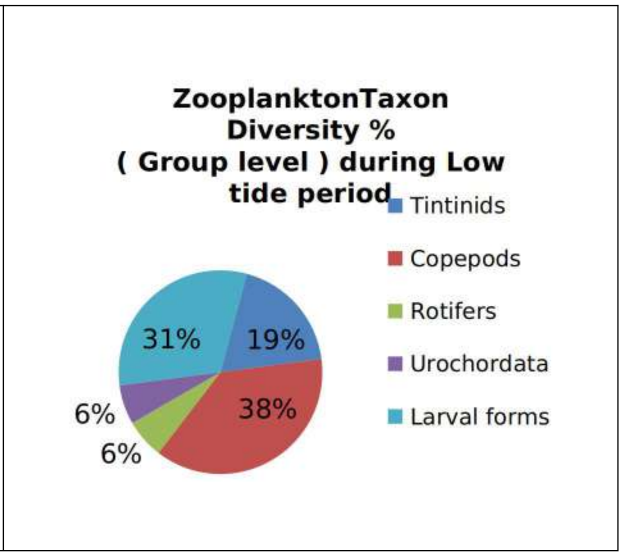
			TOTAL ZOOPLANKTON NO/M3	**109-117**	**13**	

Table # 19 ABUNDANCE OF ZOOPLANKTON IN SUBSURFACE SAMPLING STATIONS IN DPT OOT AREA AT PATH FINDER CREEK AND NEAR BY SPM DURING NEAP TIDE IN NOVEMBER, 2021

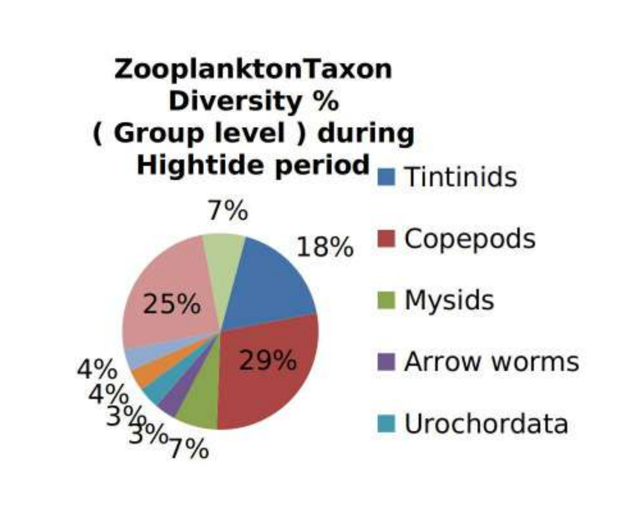
Tide	Surface	No of Sampling locations	Group of Zooplankton	Abundance of Zooplankton on x10^3 Group Range	Genera or species /total Zooplankton	Taxon Diversity % (Group level)
HIGH TIDE	Sub surface	2	Tintinids	6-9	4/17	23.53
			Copepods	25-31	7/17	41.18
			Urochordata	0-1	1/17	5.88
			Larval forms	23-41	5/17	29.41
			TOTAL ZOOPLANKTON	**48-63**	**17**	
LOW TIDE	Sub surface	2	Tintinids	9-10	4/16	25
			Copepods	43-47	7/16	43.75
			Urochordata	0	0	0
			Larval forms	43-47	5/16	31.25
			TOTAL ZOOPLANKTON NO/M3	**77-83**	**16**	

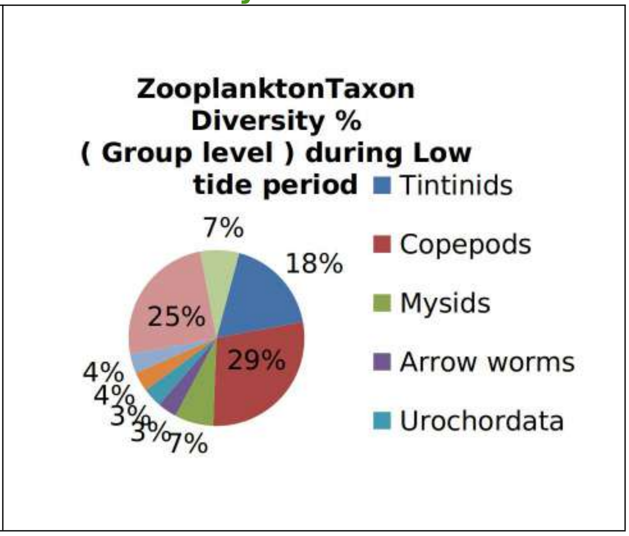
Taxon Diversity % of Zooplankton during High tide and Low tide period of Spring tide In Kandla Creek and near by Creeks



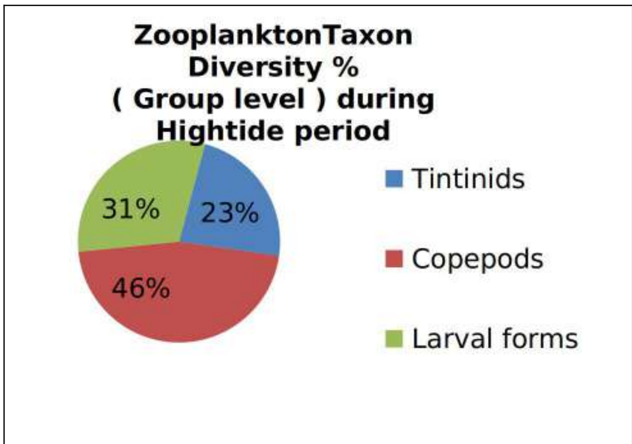


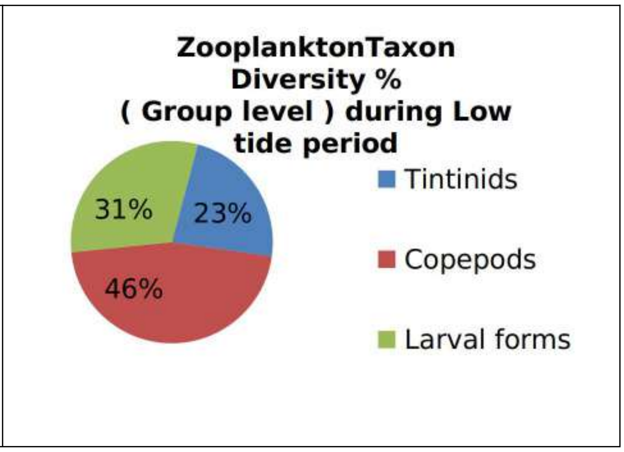
Taxon Diversity % of Zooplankton during High tide and Low tide period of Neap tide In Kandla Creek and nearby Creeks



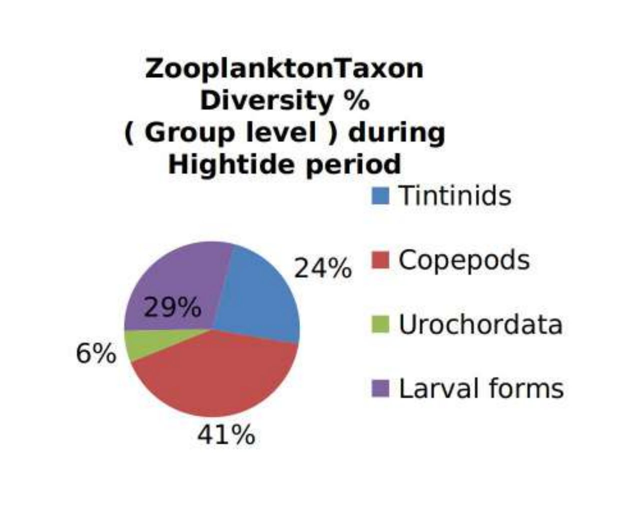


Taxon Diversity % of Zooplankton during High tide and Low tide period of Spring tide In Path Finder Creek and near Jetty





Taxon Diversity % of Zooplankton during High tide and Low tide period of Neap tide In Path Finder Creek near jetty and nearby SPM



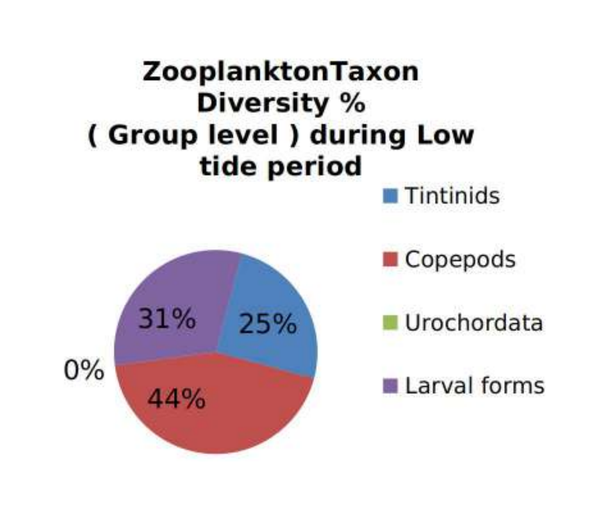


TABLE # 20SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS OF DPT HARBOUR AREA AT KANDLA CREEK AND NEARBY CREEKS DURINGSPRING TIDE OF NOVEMBER 2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALGAE	Cyanophyta	Cyanophyceae	Nostocales	Oscillatoriaceae	*Oscillatoria* sp.	B1	Rare
					Arthrospira sp.	B2	Rare
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Rare
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D2	Abundant
			Triceratiales	Triceratiaceae	*Odontella*sp	D3	Occasional
					*Triceratium*sp.	D4	Occasional
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D5	Dominant
			Hemiaulales	Bellerocheaceae	*Bellerochea*sp	D6	Rare
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D7	Occasional
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros*sp	D8	Occasional
			Leptocylindrales	Leptocylindraceae	*Leptocylindrussp*	D9	Occasional
			Lithodesmiales	Lithodesmiaceae	*Ditylumsp*	D10	Frequent
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*sp	D11	Occasional
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D12	Frequent
					Thalassionema sp.	D13	Rare
			Fragilariales	Fragilariaceae	*Fragilaria*sp	D14	Frequent
					*Synedra*sp	D15	Rare
			Tabellariales	Tabellariaceae	*Tabellaria*sp	D16	Rare
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium sp.*	DF1	Rare
			Gonyaulacales	Ceratiaceae	*Ceratiumfurca*	DF2	Rare

TABLE # 21 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT HARBOUR AREA AT KANDLA CREEK AND NEARBY CREEKS DURING AND NEAP TIDE OF NOVEMBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
BLUE GREEN ALGAE	Cyanophyta	Cyanophyceae	Nostocales	Oscillatoriaceae	*Oscillatoria* sp.	B1	Rare
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Occasional
					Thalassiosirasp	D2	Occasional
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D3	Frequent
			Triceratiales	Triceratiaceae	*Odontellasp*	D4	Rare
					*Triceratium*sp.	D5	Occasional
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D6	Dominant
			Hemiaulales	Bellerocheaceae	*Bellerochea*sp	D7	Rare
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D8	Occasional
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros*sp	D9	Rare
			Leptocylindrales	Leptocylindraceae	*Leptocylindrussp*	D10	Rare
			Lithodesmiales	Lithodesmiaceae	*Ditylumsp*	D11	Frequent
		Bacillariophyceae	Bacillariales	Bacillariaceae	*Bacillaria*sp.	D12	Occasional
					*Nitzschia*sp	D13	Rare
			Naviculales	Naviculaceae	*Naviculasp*	D14	Rare
				Pleurosigmataceae	*Pleurosigma*sp	D15	Rare
			Surirellales	Entomoneidaceae	*Entomoneissp*	D16	Rare
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D17	Abundant
					Thalassionema sp.	D18	Occasional
			Fragilariales	Fragilariaceae	*Fragilaria*sp	D19	Frequent
					*Synedra*sp	D20	Rare
			Tabellariales	Tabellariaceae	*Tabellaria*sp	D21	Rare
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Gonyaulacales	Ceratiaceae	*Ceratiumfurca*	DF1	Rare
					Ceratiumtripos	DF2	Rare

TABLE # 22 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT OOT AREA AT PATH FINDER CREEK AND NEARBY SPM AT VADINAR DURING SPRING TIDE OF NOVEMBER 2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D1	Dominant
			Triceratiales	Triceratiaceae	*Triceratium*sp.	D2	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D3	Abundant
			Hemiaulales	Bellerocheaceae	*Bellerochea*sp	D4	Rare
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D5	Occasional
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros*sp	D6	Frequent
			Lithodesmiales	Lithodesmiaceae	*Ditylum*sp	D7	Occasional
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*sp	D8	Rare
			Bacillariales	Bacillariaceae	*Bacillaria*sp.	D9	Rare
					*Pseudo-Nitzschia*sp	D10	Occasional
		Fragilariophyceae	Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D11	Frequent

TABLE # 23 SYSTEMATIC ACCOUNT OF PHYTOPLANKTON IN THE SAMPLING LOCATIONS IN OF DPT OOT AREA AT PATH FINDER CREEK AND NEARBY SPM AT VADINAR DURING AND NEAP TIDE OF NOVEMBER, 2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	Relative Abundance
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella*sp	D1	Occasional
					Thalassiosirasp	D2	Rare
			Coscinodiscales	Coscinodiscaceae	*Coscinodiscus sp.*	D3	Dominant
			Triceratiales	Triceratiaceae	*Triceratium*sp	D4	Rare
			Biddulphiales	Biddulphiaceae	*Biddulphia*sp	D5	Abundant
			Hemiaulales	Bellerocheaceae	*Bellerochea*sp	D6	Occasional
			Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia sp.*	D7	Occasional
			Chaetocerotales	Chaetocerotaceae	*Chaetoceros*sp	D8	Rare
			Lithodesmiales	Lithodesmiaceae	*Ditylumsp*	D9	Frequent
		Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*sp	D10	Rare
			Bacillariales	Bacillariaceae	*Bacillaria*sp.	D11	Occasional
					*Nitzschia*sp	D12	Rare
					*Pseudo-Nitzschia*sp	D13	Frequent
		Fragilariophyceae	Fragilariales	Fragilariaceae	*Synedra sp.*	D14	Rare
			Thalassionematales	Thalassionemataceae	*Thalassiothrix sp.*	D15	Occasional
DINO FLAGELLATES	Dinoflagellata / Dinozoa	Dinophyceae	Gonyaulacales	Ceratiaceae	*Ceratiumfusus*	DF1	Rare
					Ceratiumfurca	DF2	Rare

TABLE #24 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS OF DPT HARBOUR AREA AT KANDLA CREEK AND NEARBY CREEKSDURING SPRING TIDE OF NOVEMBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Rare
				Codonellidae	*Tintinnopsis radix*	T2	Rare
					Tintinnopsisfailakkaensis	T3	Occasional
COPEPODS	ATHROPODA	Crustacea Subclass: Copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Frequent
				Clausocalanidae	*Clausocalanus sp.*	C2	Rare
			Cyclopoida	Oithonidae	*Oithona sp.*	C3	Abundant
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C4	Rare
				Euterpinidae	*Euterpina sp.*	C5	Occasional
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C6	Rare
ROTIFERS	ROTIFERA	Rotifera Subclass: Eurotatoria	Superorder: Monogononta Order:Ploimida	Brachionidae	*Brachionusplicatilis*	R1	Rare
UROCHORDATA	CHORDATA SUB PHYLUM UROCHORDATA	Appendicularia		Oikopleuridae	*Oikopleura sp.*	U1	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BRACHYURA LARVAE	ARTHROPODA (CRUSTACEA)	Malacostraca Decapoda			Brachyuran Zoea larvae	L2	Occasional

MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L3	Rare
POLYCHAETE LARVAE	ANNELIDA	Polychaeta			Trochophore larvae	L4	Occasional
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L5	Rare

TABLE # 25 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING OF DPT HARBOUR AREA AT KANDLA CREEK AND NEARBY CREEKSDURING NEAP TIDE OF NOVEMBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Frequent
				Codonellidae	*Tintinnopsisgracilis*	T2	Occasional
					Tintinnopsis radix	T3	Frequent
					Tintinnopsisfailakkaensis	T4	Occasional
				Tintinnidae	*Amphorides sp.*	T5	Rare
COPEPODS	ATHROPODA	Crustacea Subclass: Copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Occasional
				Eucalanidae	*Pareucalanus sp.*	C2	Rare
				Clausocalanidae	*Clausocalanus sp.*	C3	Rare
				Centropagidae	*Centropages sp.*	C4	Rare
			Cyclopoida	Oithonidae	*Oithona sp.*	C5	Abundant
			Harpacticoida	Ectinosomatidae	*Microsetella*sp.	C6	Frequent
				Euterpinidae	*Euterpina sp.*	C7	Occasional
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C8	Rare
ARROW WORMS	CHAETOGNATHA	Sagittoidea	Aphragmophora	Sagittidae	*Sagitta sp.*	A1	Rare

MYSIDS	ATHROPODA CRUSTACEA	Malacostraca	Mysida, Decapoda	Solenoceridae	*Solenocerasp.*	M1	Rare
				Luciferidae	*Lucifer sp.*	M2	Rare
UROCHORDATA	CHORDATA SUB PHYLUM UROCHORDATA	Appendicularia		Oikopleuridae	*Oikopleura sp.*	U1	Rare
CILIATES	CILIOPHORA	Oligohymenophorea	Sessilida	Zoothamniidae	*Zoothamniumsp.*	CI1	Rare
MEDUSA	PHYLUM CNIDARIA	Hydrozoa			Unidentified medusa	ME 1	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BRACHYURA LARVAE	ARTHROPODA (CRUSTACEA)	Malacostraca Decapoda			Brachyuran Zoea larvae	L2	Frequent
GROUP	**PHYLUM**	**CLASS**	**ORDER**	**FAMILY**	**GENUS/SPECIES**	**#**	**RELATIVE ABUNDANCE**
BARNACLE LARVAE	ATHROPODA CRUSTACEA	Maxillopoda Thecostraca			Cirripede larvae	L3	Occasional
CYPHONAUTES LARVAE	BRYOZOA				Cyphonautes larvae	L4	Occasional
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L5	Rare
ECHINODERMATA LARVAE	ECHINODERMATA				Ophipluutes larvae/ Echinoplutes larvae	L6	Rare
POLYCHAETE LARVAE	ANNELIDA	Polychaeta			Trochophore larvae	L7	Occasional
FORAMINIFERA	FORAMINIFERA	Globothalamea	Rotaliida	Globigerinidae	*Globigerina* sp.	F1	Rare
				Rotalliidae	*Rotalia* sp.	F2	Rare

TABLE # 26 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS OF DPT OOT AREA AT PATH FINDER CREEK AND NEARBY SPM AT VADINAR DURING SPRING TIDE OF NOVEMBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Occasional
				Codonellidae	*Tintinnopsisgracilis*	T2	Rare
					Tintinnopsis radix	T3	Occasional
COPEPODS	ATHROPODA	Crustacea Subclass: Copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Frequent
				Clausocalanidae	*Clausocalanus sp.*	C2	Rare
			Cyclopoida	Oithonidae	*Oithona sp.*	C3	Abundant
			Harpacticoida	Euterpinidae	*Euterpina sp.*	C4	Rare
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C5	Rare
				Corycaeidae	*Corycaeus sp.*	C6	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L2	Occasional
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L3	Occasional
POLYCHAETE LARVAE	ANNELIDA	Polychaeta			Trochophore larvae	L4	Occasional

TABLE # 27 SYSTEMATIC ACCOUNT OF ZOOPLANKTON FROM THE SAMPLING LOCATIONS OF DPT OOT AREA AT PATH FINDER CREEK AND NEARBY SPM AT VADINAR DURING NEAP TIDE OF NOVEMBER,2021

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#	RELATIVE ABUNDANCE
TINTINIDS	PROTOZOA CILIOPHORA	Spirotrichea	Tintinnida	Tintinnidiidae	*Leprotintinnussp.*	T1	Occasional
				Codonellidae	*Tintinnopsisgracilis*	T2	Rare
					Tintinnopsis radix	T3	Occasional
				Codonellopsidae	*Codonellopsis* sp.	T4	Rare
COPEPODS	ATHROPODA	Crustacea Subclass: Copepoda	Calanoida	Paracalanidae	*Acrocalanus* sp.	C1	Abundant
				Eucalanidae	*Subeucalanus sp.*	C2	Rare
				Clausocalanidae	*Clausocalanus sp.*	C3	Occasional
			Cyclopoida	Oithonidae	*Oithona sp.*	C4	Frequent
			Harpacticoida	Euterpinidae	*Euterpina sp.*	C5	Rare
			Poicilostomatatoida	Oncaeidae	*Oncaea sp.*	C6	Rare
				Corycaeidae	*Corycaeus sp.*	C7	Rare
UROCHORDATA	CHORDATA SUB PHYLUM UROCHORDATA	Appendicularia		Oikopleuridae	*Oikopleura sp.*	U1	Rare
CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda			Nauplius larvae of Copepods	L1	Dominant
BRACHYURA LARVAE	ARTHROPODA (CRUSTACEA)	Malacostraca Decapoda			Brachyuran Zoea larvae	L2	Rare
MOLLUSCAN LARVAE	MOLLUSCA	Gastropoda Streptoneura			Opisthobranchia larvae	L3	Rare
POLYCHAETE LARVAE	ANNELIDA	Polychaeta			Trochophore larvae	L4	Occasional
BIVALVE LARVAE	MOLLUSCA	Pelecypoda			Veliger larvae of Bivalves	L5	Rare

BENTHIC ORGANISMS:

Few Benthic organismswere observed in the collected sediments by using the Van-veen grabs during the sampling conducted during spring tide period andNeap tide period from DPT harbour region and nearby creek.The meiobenthic organisms during spring tide were represented by Polychaetes,and Nematodes. The polychaetes were representedby *Scyphoproctus sp*. *Notomastus*sp,*Dasybranchus.* The meiobenthic organisms in the collected samples were varying from 50-180N/M ^{2}during spring tide and 60-130 N/M

Table # 28BENTHIC FAUNA IN THE SAMPLING LOCATIONS IN DPT HARBOUR AREA CREEKS DURING SPRING TIDE IN NOVEMBER ,2021

Benthic fauna	ABUNDANCE IN NO/M ^{2} DIFFERENT SAMPLING STATIONS REPRESENTATION BY GROUP						
	DPT HARBOUR			CREEKS			
POLYCHAETES	KPT-1	KPT-2	KPT-3	KPT-4	KPT-5	KPT-6	
Family : Capitellidae *c*	0	40	0	20	20	NS	
Family : Capitellidae *Notomastus* sp.	40	60	40	80	30	NS	
Total Polychates N/M^2	40	100	40	120	50		
Un identified Nematode worms	10	20	40	60	20	NS	
TOTAL Benthic Fauna NUMBER/ M^2	50	120	80	180	70	-	

NS : No sample

Table # 29 BENTHIC FAUNA IN THE SAMPLING LOCATIONS IN DPT HARBOUR AREA CREEKS DURING NEAP TIDE IN NOVEMBER ,2021

Benthic fauna	ABUNDANCE IN NO/M ^{2} DIFFERENT SAMPLING STATIONS REPRESENTATION BY GROUP						
	DPT HARBOUR			CREEKS			
POLYCHAETES	KPT-1	KPT-2	KPT-3	KPT-4	KPT-5	KPT-6	
Family : Capitellidae *Dasybranchus sp.*	10	20	10	10	20	NS	
Family : Capitellidae *Notomastus* sp.	50	60	20	40	20	NS	
Family : Glyceridae Glycera	10	20	10	0	0	NS	

Total Polychates N/M^2	70	100	40	50	40		
Un identified Nematode worms	20	30	30	30	20	NS	
TOTAL Benthic Fauna NUMBER/ M^2	90	130	70	80	60	-	

NS : No sample

Meteorological Data

Automatic Weather station have been installed in Seva Sadan -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 30.3 °C. The day-time maximum temperature was 38.6 °C. The mean night time temperature was 26.5 °C. The minimum mean night time temperature recorded was 30.6 °C.

Air Pressure

The mean absolute air pressure for the month of November was 1009.9 hpa, whereas the mean relative pressure was 1009.3 hpa. The maximum absolute air pressure recorded for the month of November was 1016.5 hpa.

Heat Index

The mean day-time heat index for the month of November was 33.8 ^oC. The maximum heat index recorded was 55^oC.

Solar Radiation

The mean Solar Radiation in November was 252.2 w/m^2. The maximum solar radiation recorded in the month of November was 746.6 w/m^2.

Humidity

The mean day-time humidity was 60.0 % for the month of November and mean night time humidity was 72.4%. Maximum humidity recorded during day-time was 94.0 % and maximum humidity recorded during night-time was 93.0%.

Wind Velocity and Wind Direction

The mean wind velocity for the entire month of November was 4.6 km/hour. Maximum wind velocity recorded was 29.2 Km/hr . The wind direction was mostly S to N.

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.

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 November, 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.

SOURCE OF LITERATURE AND ADDITIONAL REFERENCE FOR ECOLOGICAL STUDY

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ANNEXURE H

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

EG/WK/4751/Part (EC- Shoreline study)/98 Dated: 12/10/2021

To,
The Director,
National Centre for Sustainable Coastal Management,
(Ministry of Environment, Forest & Climate Change),
Anna University Campus,
Chennai – 600025, Tamil Nadu, India.
Phone : 044-22200600/22200900 & Fax: 044- 22200700.

Sub : Shoreline Change Study for Deendayal Port Trust , Kandla, Kachchh District, Gujarat, to Study the Effect of Dumping, if any reg.

Ref.: 1) DPT request letter vide no. EG/WK/4751/Part (EC-Shoreline Study)/65 dated 16 (17)/8/2021.
2) Offer submitted by the NCSCM,Chennai vide no. NCSCM/CZM/Gujarat/21-0254/EDC dated 8/9/2021.

Sir,

Your offer for the subject work as per reference at (2) above amounting to Rs. 13,29,860.00 inclusive of 18% GST (Rupees Thirteen lakh twenty nine thousand eight hundred sixty only), has been accepted, with following terms & conditions:-

1. Scope of work : Shoreline Change study (during the period 2009-2021) for Deendayal Port Trust, Kandla, to study the effect of dumping, if any (three dumping locations), in compliance of stipulated conditions mentioned in the EC & CRZ Clearance granted by the MoEF&CC,GoI to the various projects of DPT (Ref.: specific condition no. iv of EC dated 19/12/2016, specific condition no. ix of EC dated 19/2/2020, specific condition no. xiv of EC dated 18/2/2020 & standard conditions, VI, subpara II of EC dated 20/11/2020).

2. Obligation of DPT :

- Dates of dumping and the quantities of material, at three dumping sites.
- Other secondary data available, as required for the studies.

3. Deliverables : Hard copies and pdf copies of Shoreline Change Maps on 1:10000 scale, for the entire shoreline covering all the 3 locations of dumping, depicting the erosion, accreditation and other categories as mentioned in the table 2 of Annexure 1 of the offer submitted by NCSCM,Chennai dated 8/9/2021.

........Cont..

4. Time Period : Total duration 6 months from: **1**. Date of advance payment to NCSCM, Chennai amounting to Rs.13,29,860.00 (inclusive of 18% GST) AND **2**. Date of providing information to NCSCM as per para 2 above.

5. The terms of payment : Advance payment of Rs.13,29,860.00 (including 18 % GST). Payment shall be made through RTGS/NEFT.

6. Kindly send the acknowledgement of this work order.

Thanking you.

Yours faithfully,

12/10/21

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

ANNEXURE I

KANDLA PORT TRUST

Conducting Various Studies for Oil Spill Contingency Plan for Kandla

Final Report

August, 2016

KITCO
the consultants

**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.

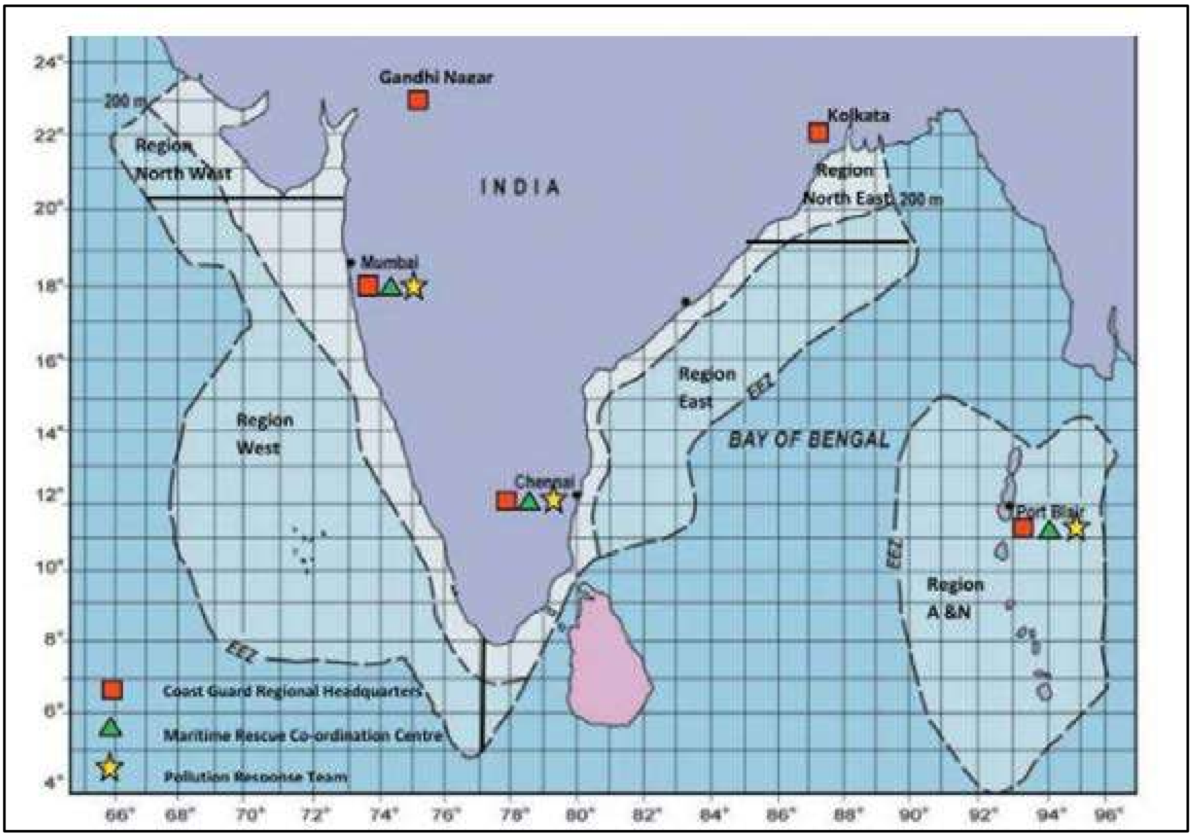


Figure 4.1. National pollution response areas

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:

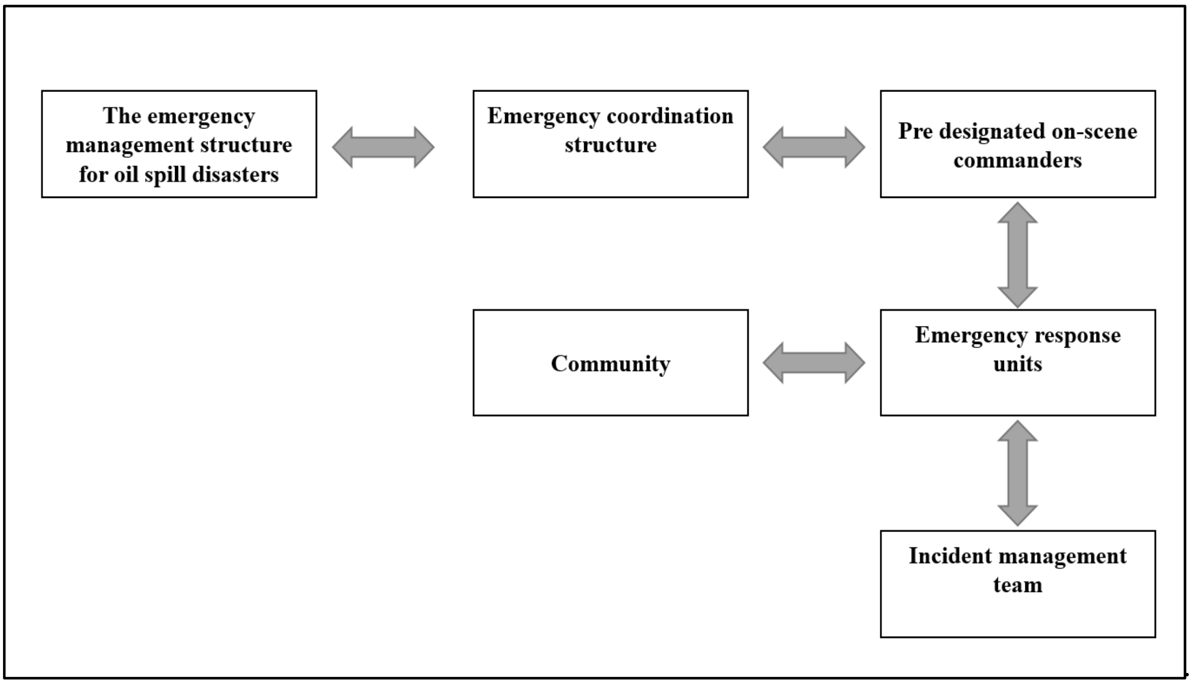


Figure 4.2. Organization structure for handling the oil spill disasters in India

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.

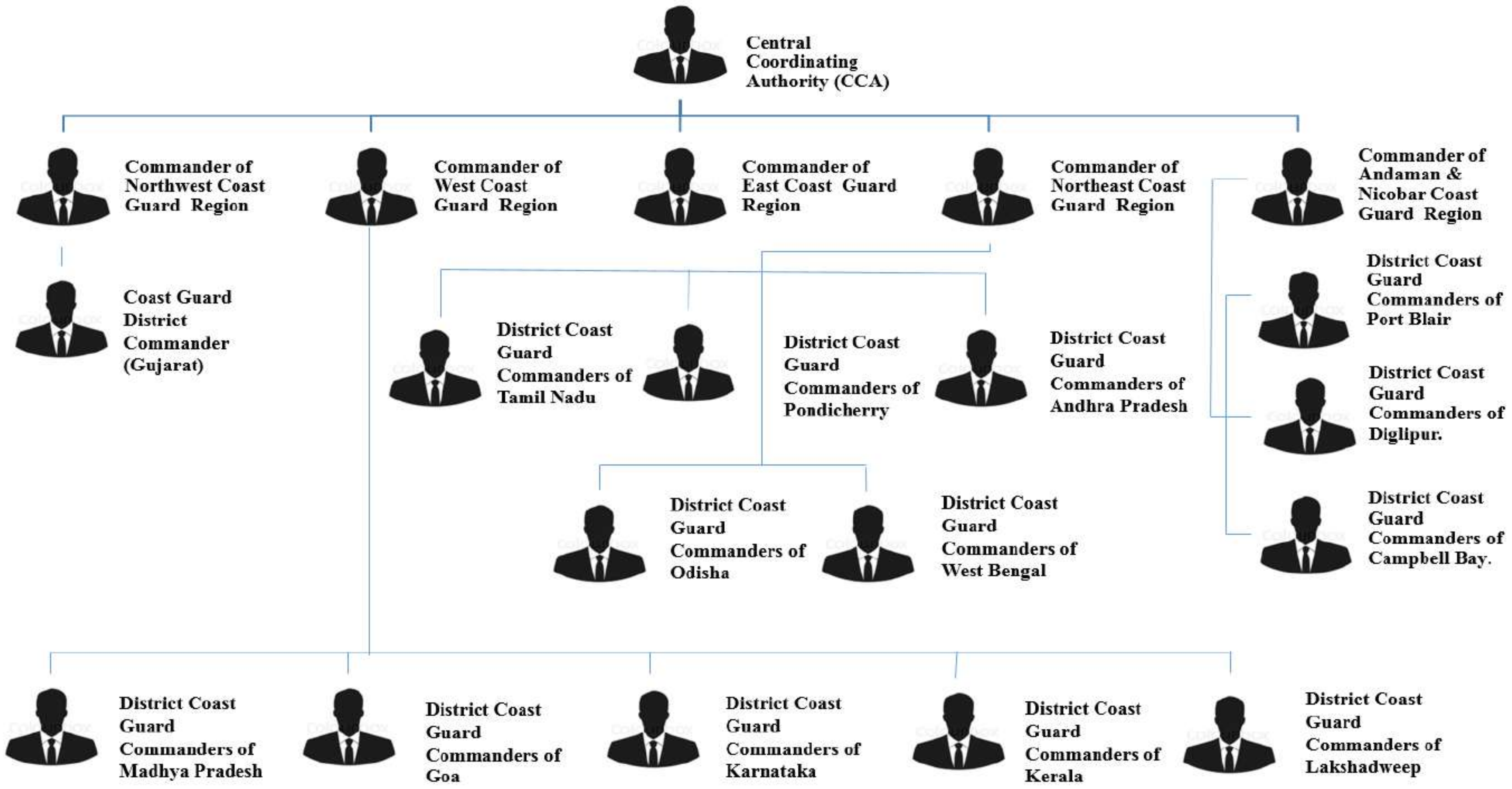


Figure 4.4. The Emergency Coordination Structure

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**

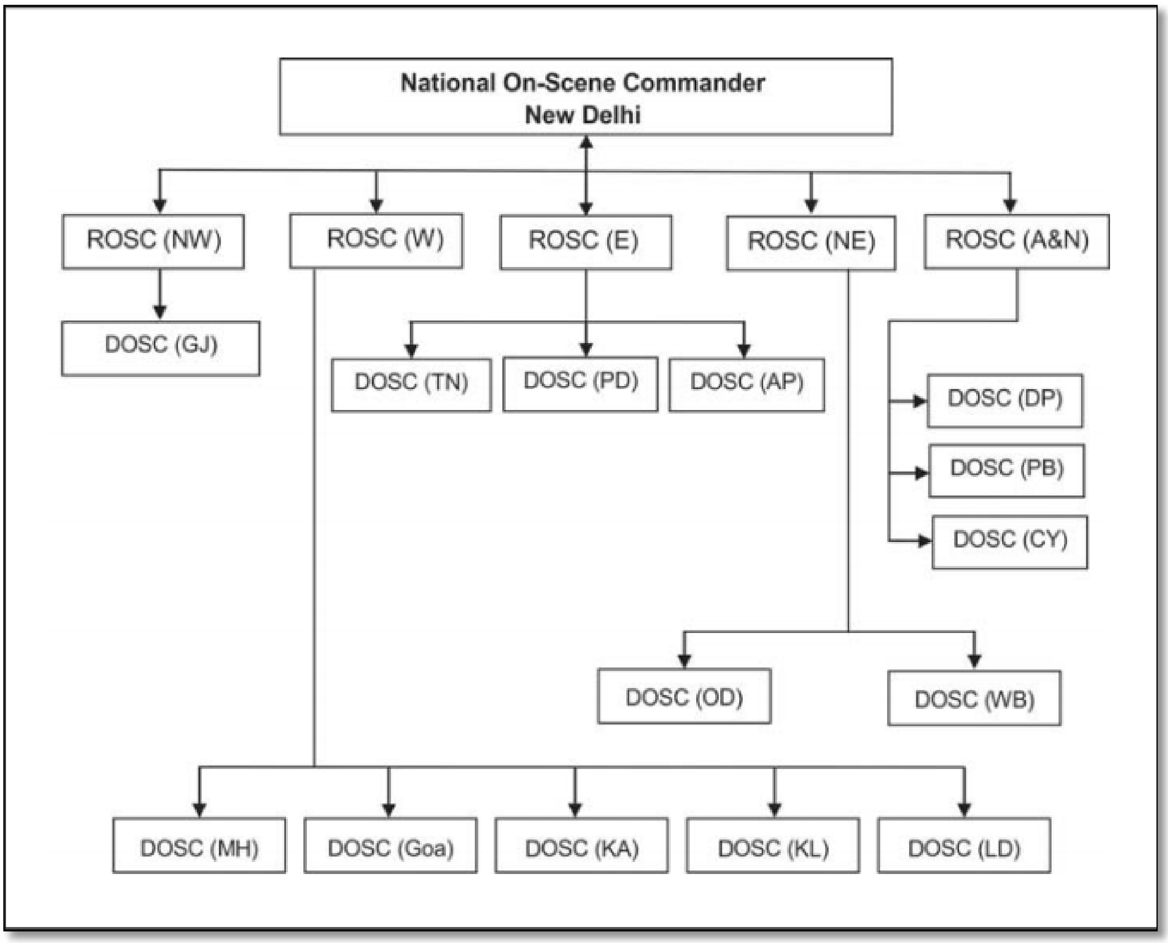


Figure 4.5. Hierarchical arrangement of On Scene Commander

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.

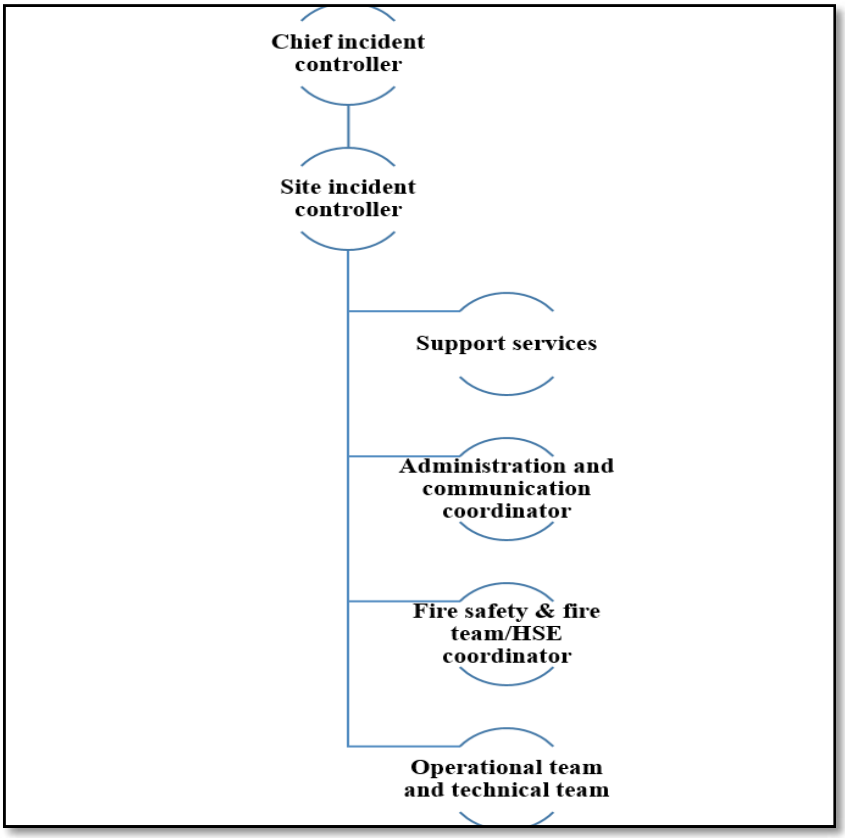


Figure 4.6. Composition of a typical Incident Management Team (IMT)

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

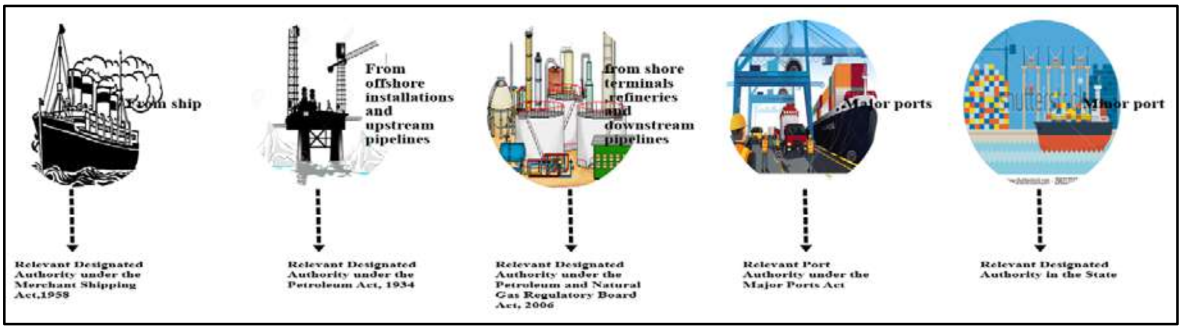
The Equipment Operator role has been broken down into areas of specific expertise. Equipment Operators may be competent in more than one area.

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.

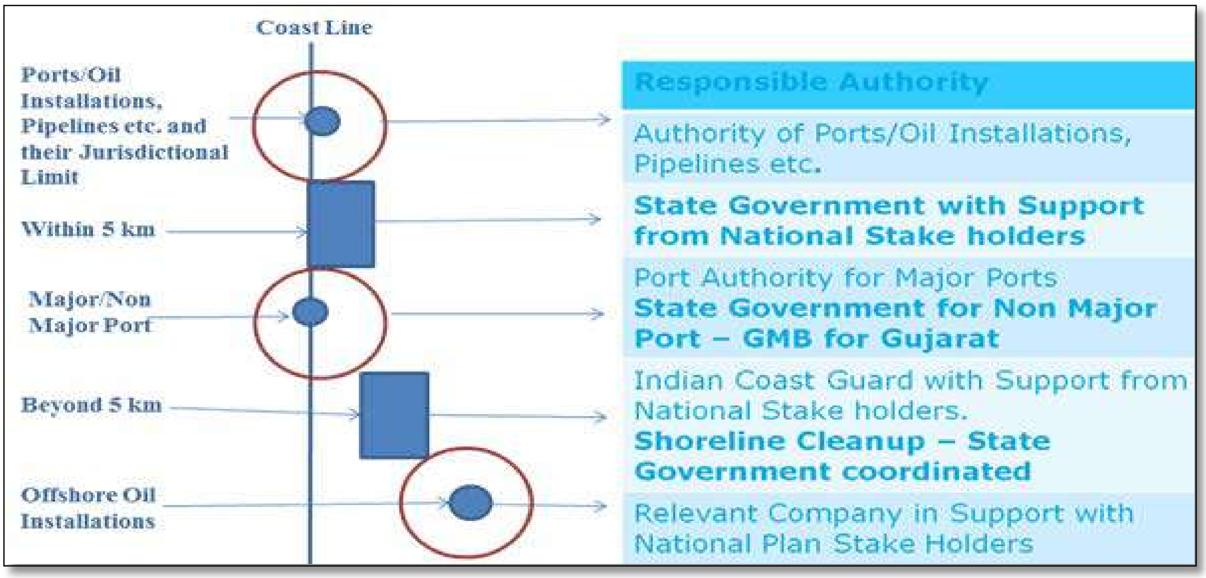
4.8. Responsibility for Responding to Oil Spills

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.**

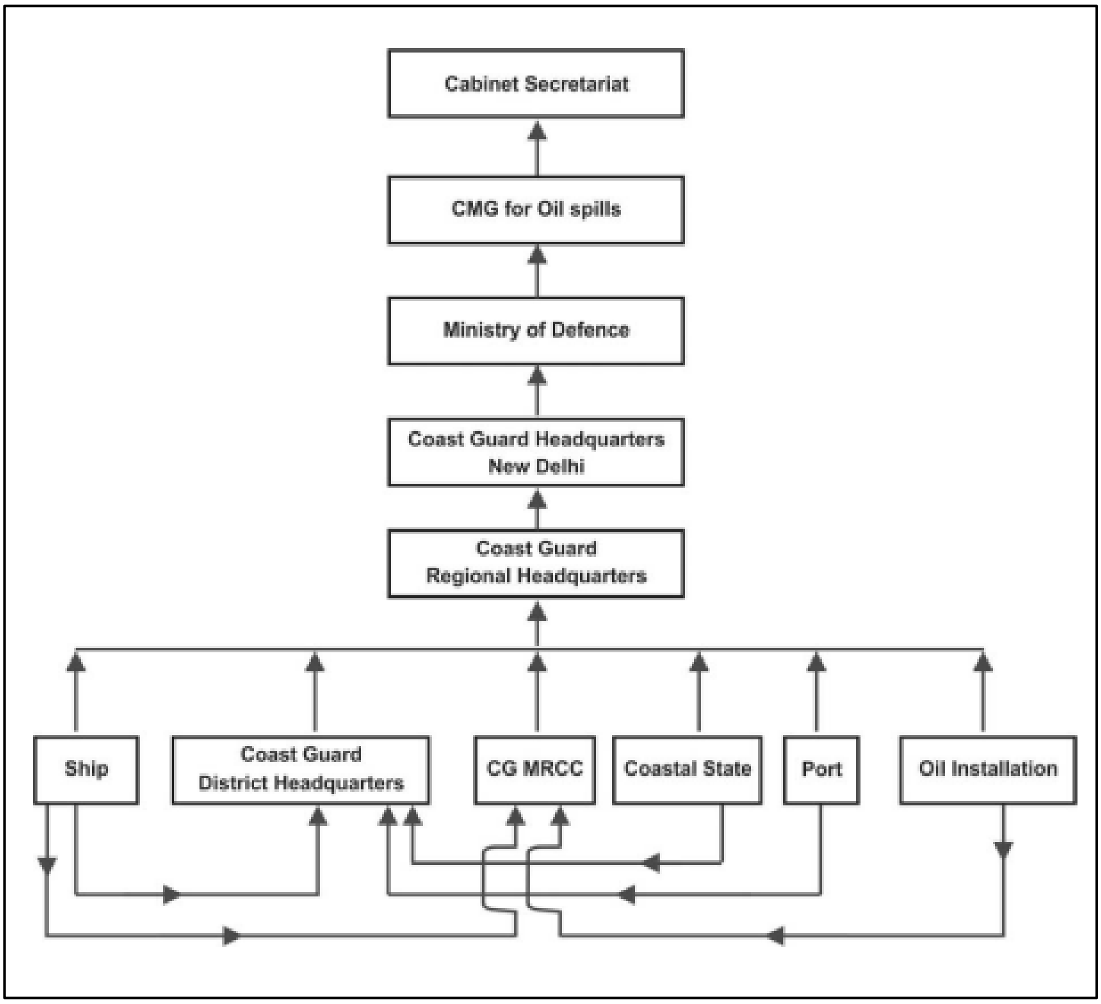


Figure 4.9. Flow Chart of the Information Flow from the Site of Incident to the Cabinet Secretariat

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.**

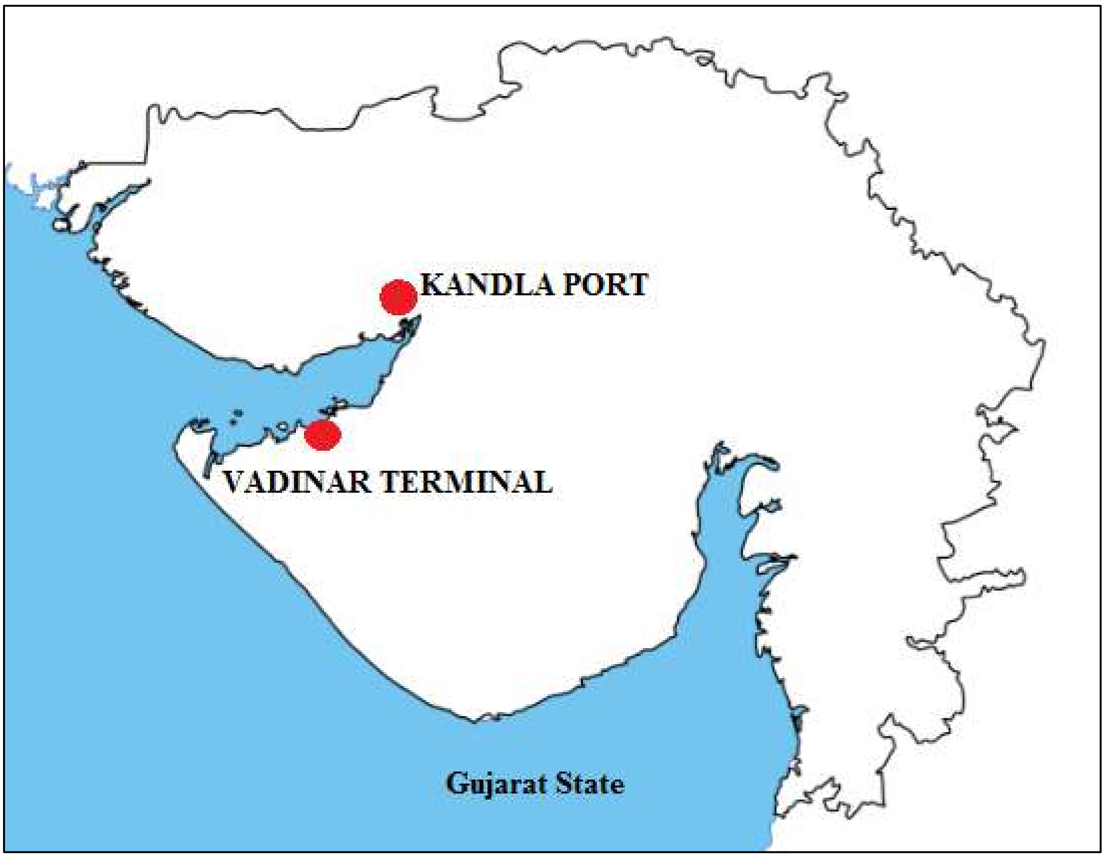


Figure 5.1 Location map of Kandla Port & Vadinar Terminal

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				

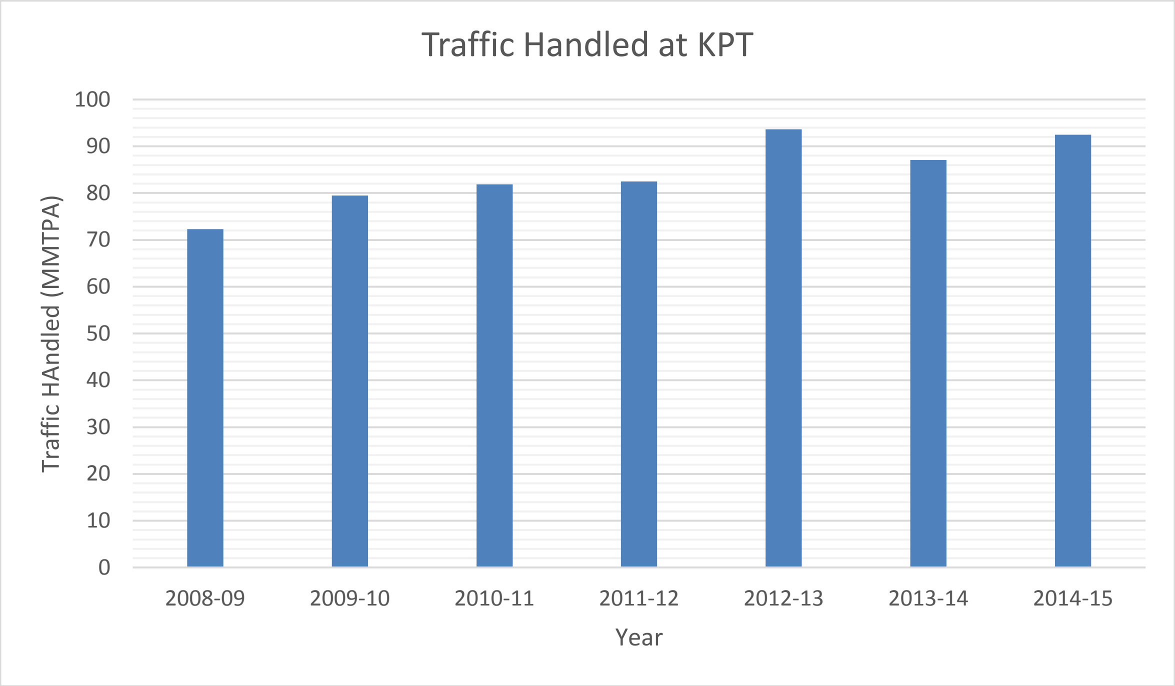
1	Edible Oil	2.10	1.66	(+) 27
2	Bauxite	3.39	0.86	(+) 294
3	Other Food	3.82	3.79	(+) 01

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.

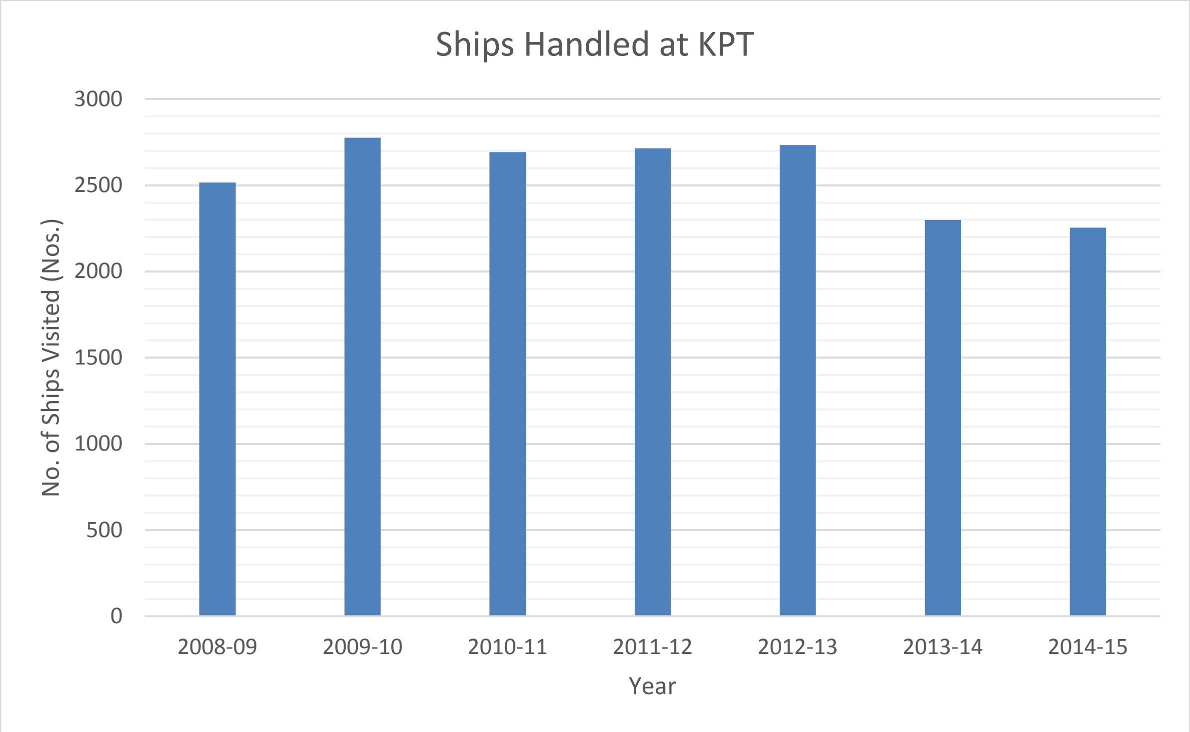


Source: http://www.kandlaport.gov.in/

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.



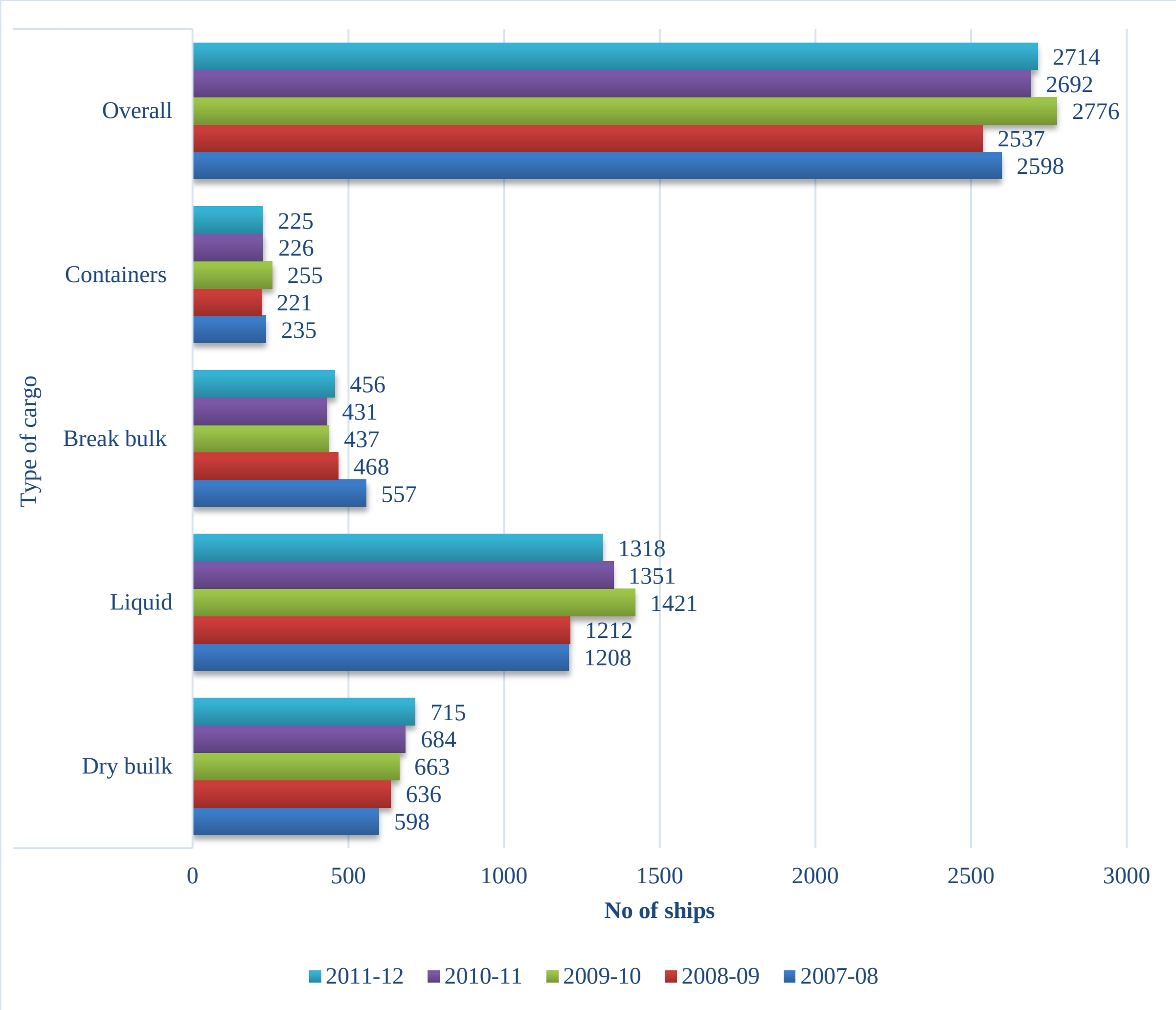
Source: http://www.kandlaport.gov.in/

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 .**

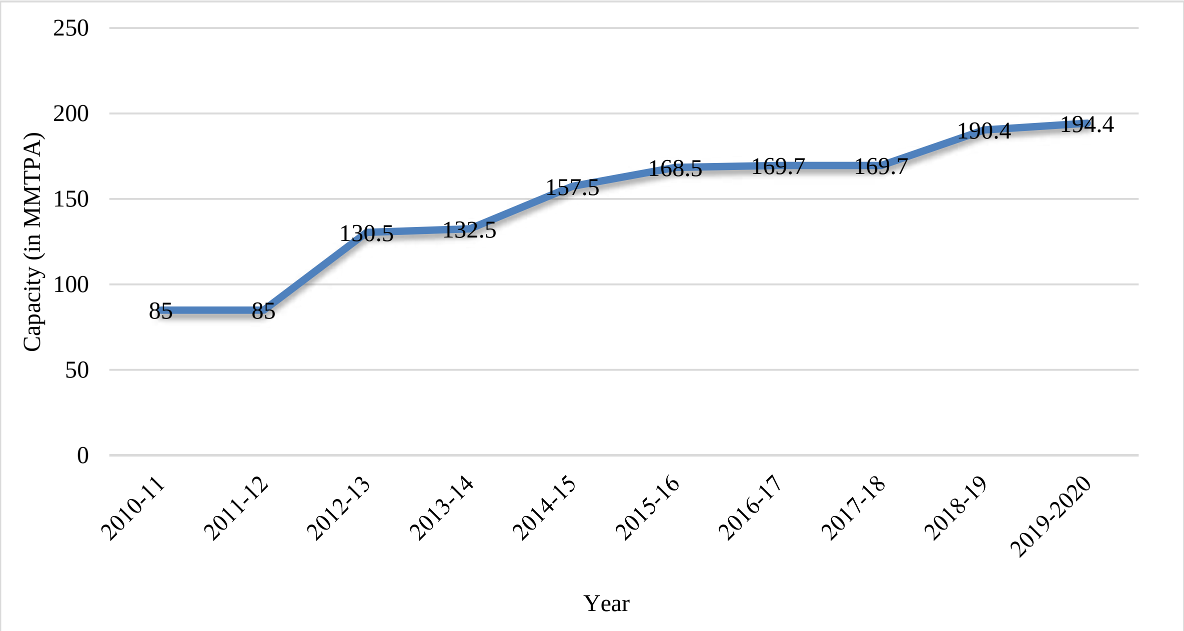


Source: http://www.kandlaport.gov.in/

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.

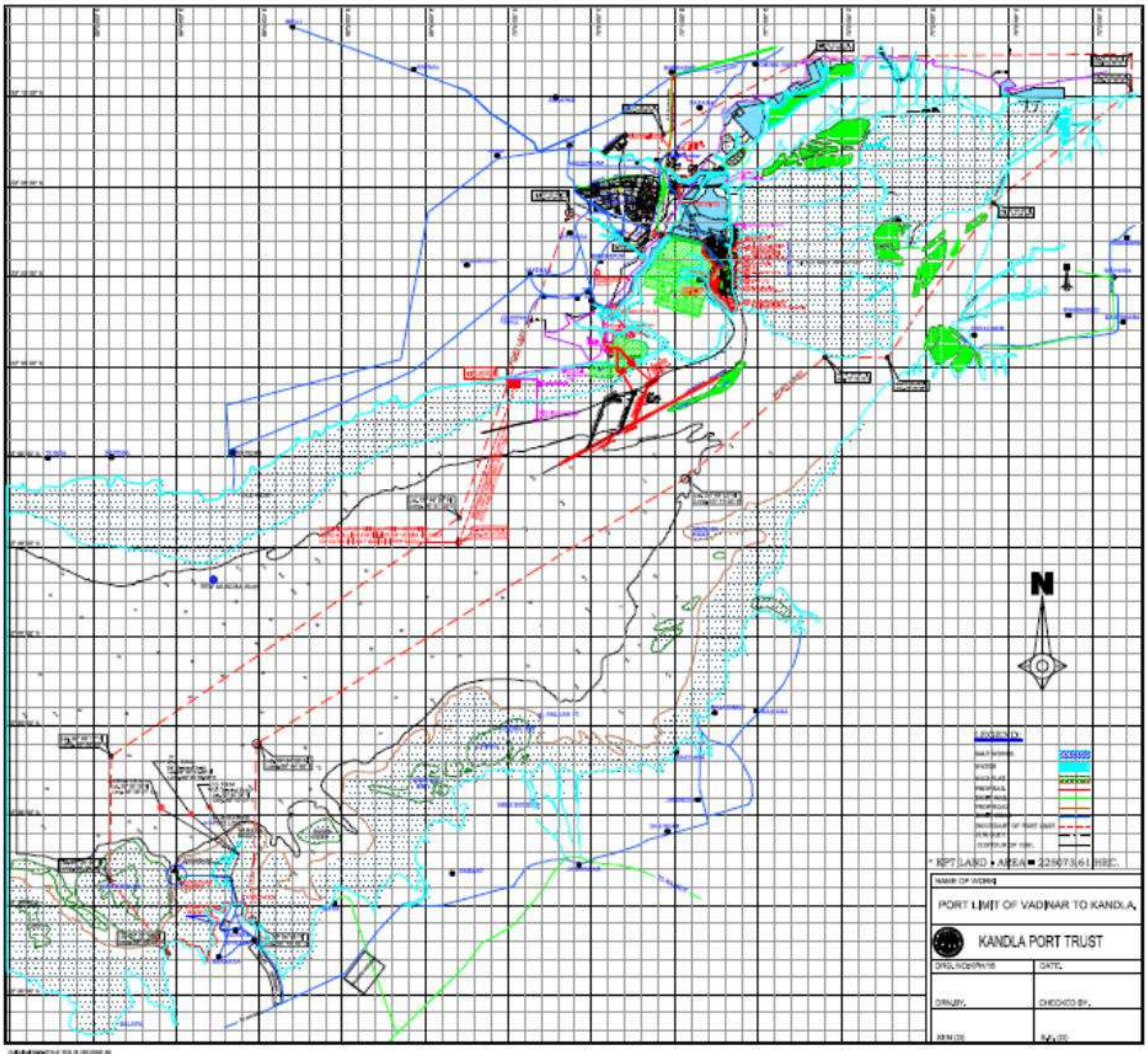


Figure 6.2. KPT Limit

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

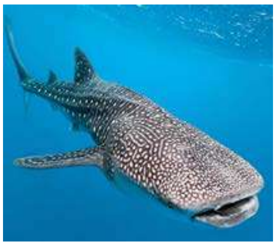
In the Gulf, the reptiles are mainly represented by marine turtles Chelonia mydas and Lepidochelys olivacea. They have been known to breed and spawn on the sandy beaches along the coast as well as on the Islands particularly along the southern Gulf between Okha and Okha Madhi and Vadinar-Sikka coast 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).

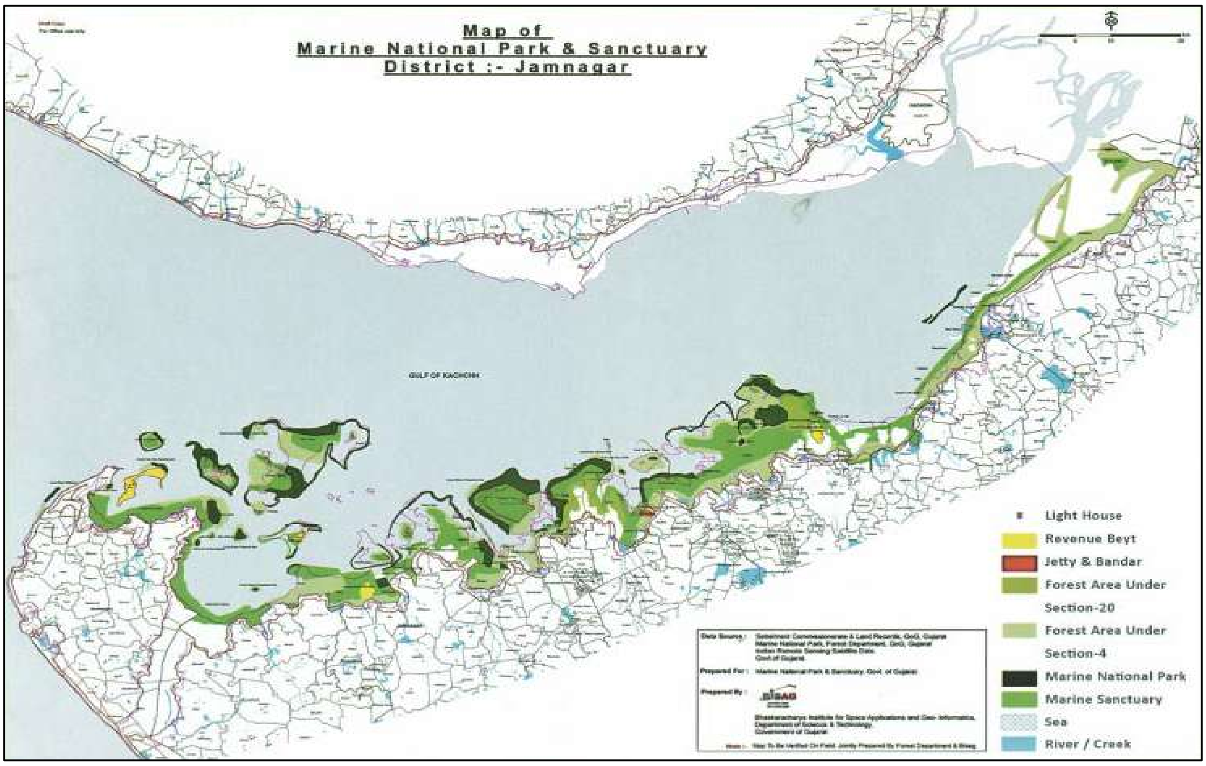


Figure 6.14. Marine National Park and Sanctuary

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	Align ment	Feature	Sedime nt	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	Maximu m 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 calcareou s 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.

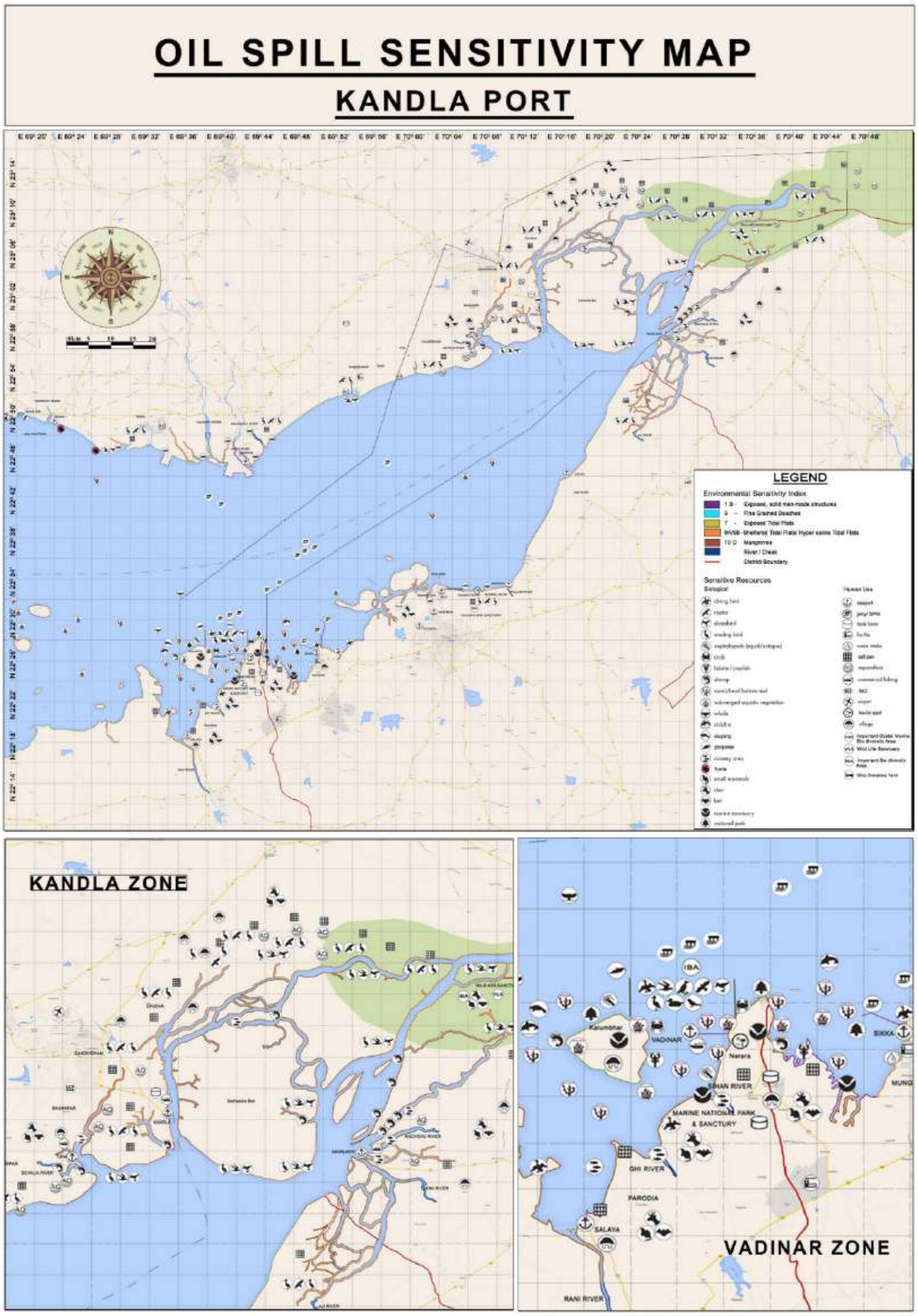


Figure 6.16. Oil Spill Sensitivity Map for Kandla Port

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'.

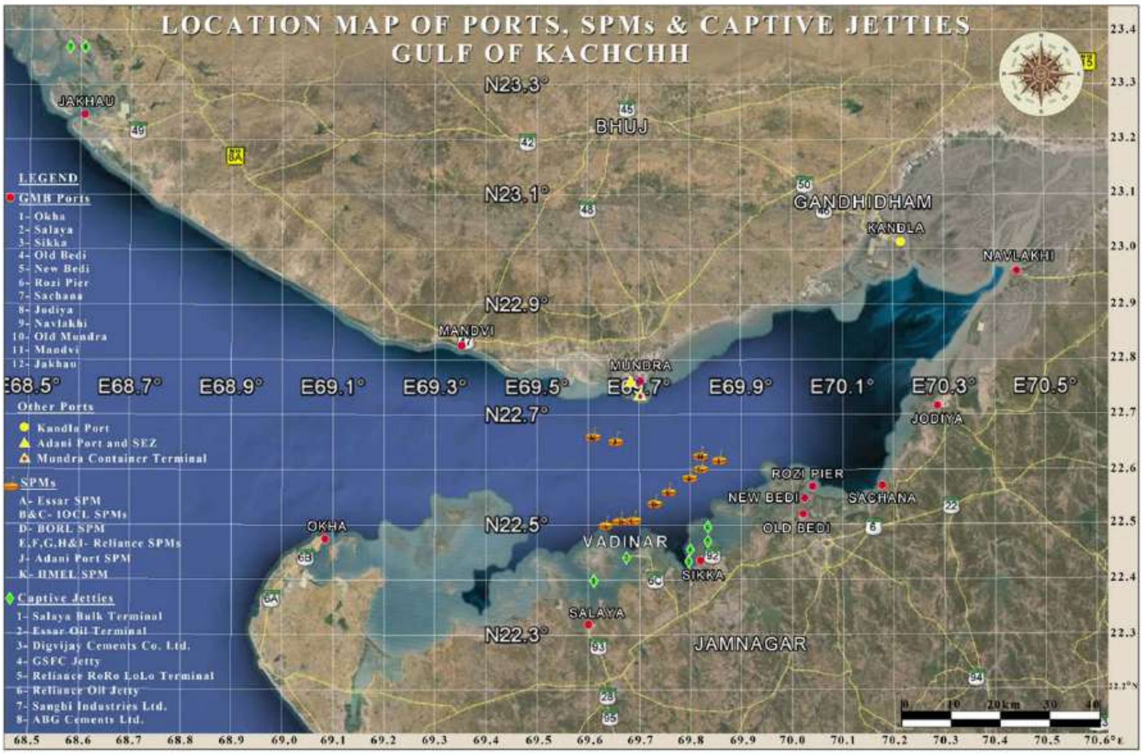


Figure 7.1. Location Port and allied facilities in Gulf of Kachchh

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*	*High*		*Y*	*Yes*		*VG*	*Very Good*	
		M	*Medium*		*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
Equipment	Skimmer (20 TPH)		4	4	2
Equipment	OSD Applicator (no.)		6	2	2
Equipment	Oil Spill Dispersant (litres)		10,000	5,000	3,000
Equipment	10 Tons Flex Barge (no.)		4	02	2
Equipment	Current Buster booms if tidal current >2 knots (meters)		400	400	
Equipment	Sorbent boom (meters)		500	200	
Equipment	Sorbent Pads (no.)		2000	1000	
Equipment	Shoreline cleanup Equipment	Mini Vacuum pumps	5		
Equipment	Shoreline cleanup Equipment	OSD Applicator	5		
Equipment	Shoreline cleanup Equipment	Fast tanks	5		
Vessel	Work Boats		2	1	1
Vessel	Tugs		2	1	
Man Power	IMO Level 1		10	6	2
Man Power	IMO Level 2		4	2	
Man Power	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.**

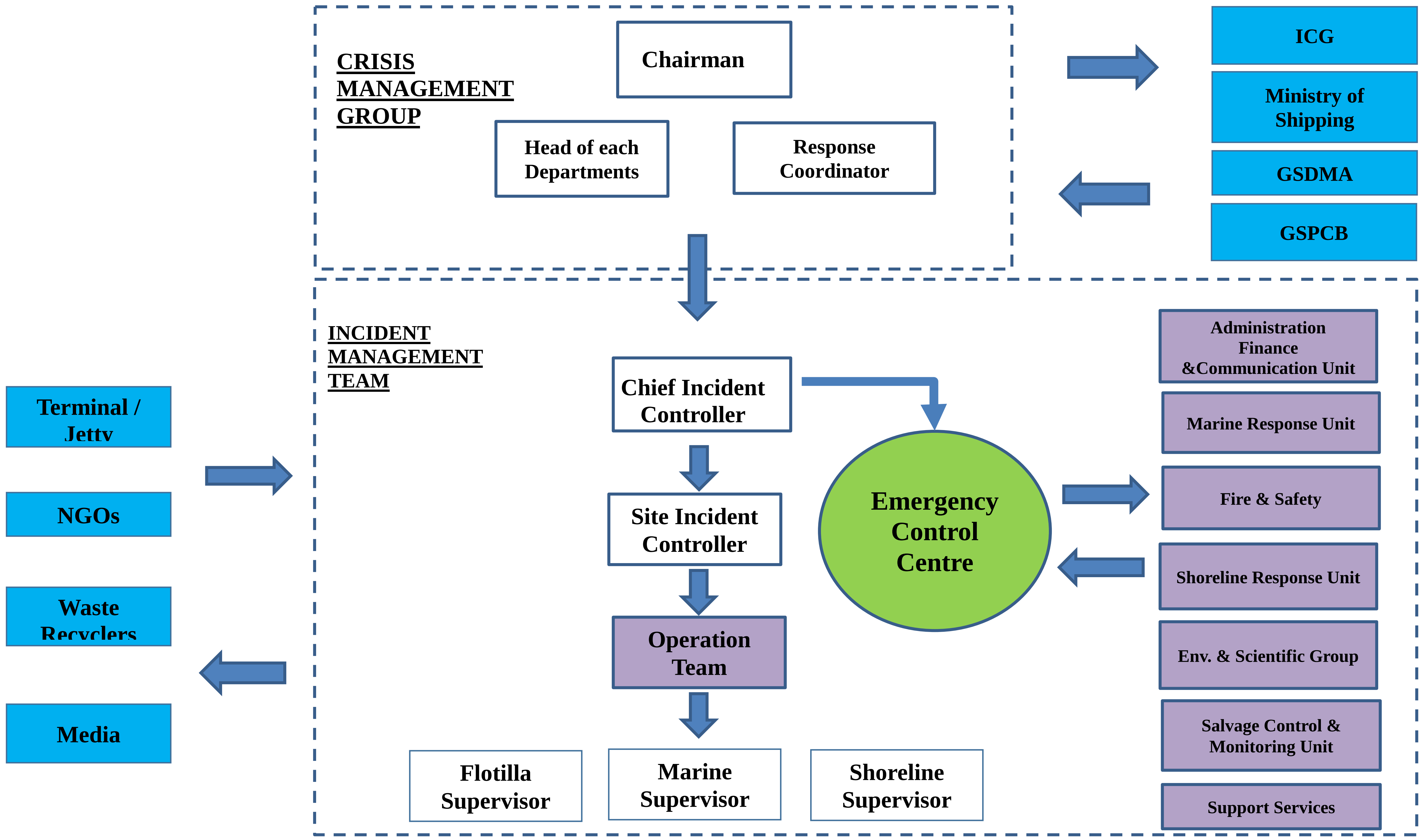


Figure 8.1. Oil Spill Response Organization Chart

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 colspan="2">Sample Container</th><th colspan="2">Quantity of Sample</th></tr>
<tr><td rowspan="3">1</td><td rowspan="3">Oil</td><td colspan="2" 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="3">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="3">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.

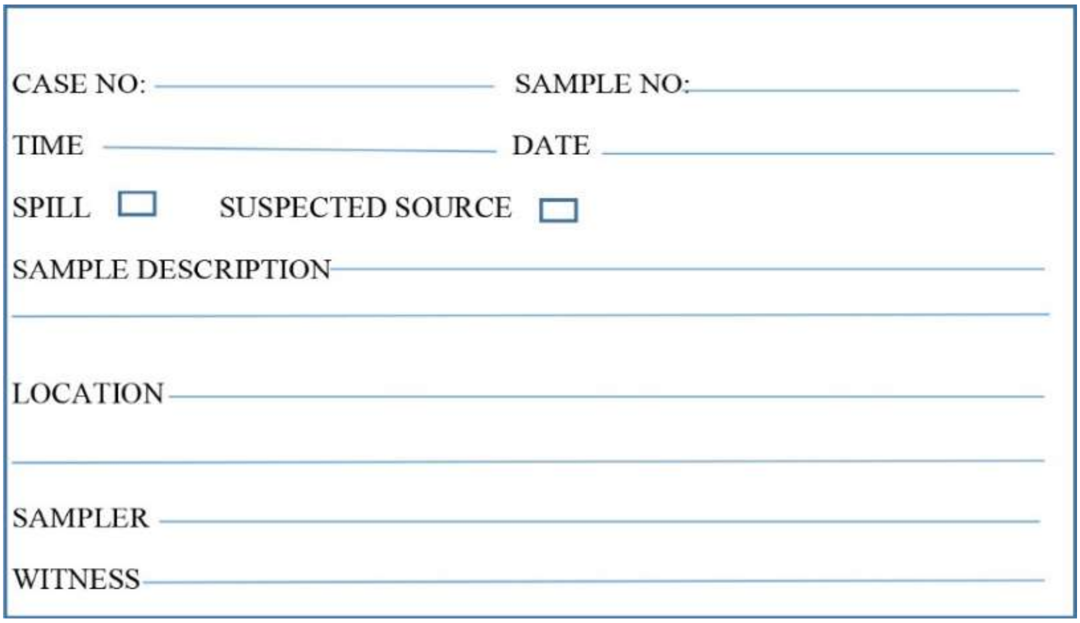

CASE NO: SAMPLE NO:
TIME DATE
SPILL SUSPECTED SOURCE
SAMPLE DESCRIPTION
LOCATION
SAMPLER
WITNESS

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

<table>
<tr><th colspan="6">Chain of Custody Record</th></tr>
<tr><td colspan="6">Organization's name</td></tr>
<tr><td colspan="6">Address:</td></tr>
<tr><td>Spill</td><td>Source</td><td>Sample no</td><td colspan="3">Description of samples for case no:</td></tr>
<tr><td></td><td></td><td></td><td colspan="3"></td></tr>
<tr><td colspan="3">Person Assuming Responsibility for Samples</td><td colspan="3">Time/ Date</td></tr>
<tr><td>Sample number</td><td>Relinquished by:</td><td>Time/ date</td><td>Received by</td><td>Time/ date</td><td>Reason for change of custody</td></tr>
<tr><td>Sample number</td><td>Relinquished by:</td><td>Time/ date</td><td>Received by</td><td>Time/ date</td><td>Reason for change of custody</td></tr>
<tr><td>Sample number</td><td>Relinquished by:</td><td>Time/ date</td><td>Received by</td><td>Time/ date</td><td>Reason for change of custody</td></tr>
<tr><td colspan="6">Page of _</td></tr>
</table>

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.**

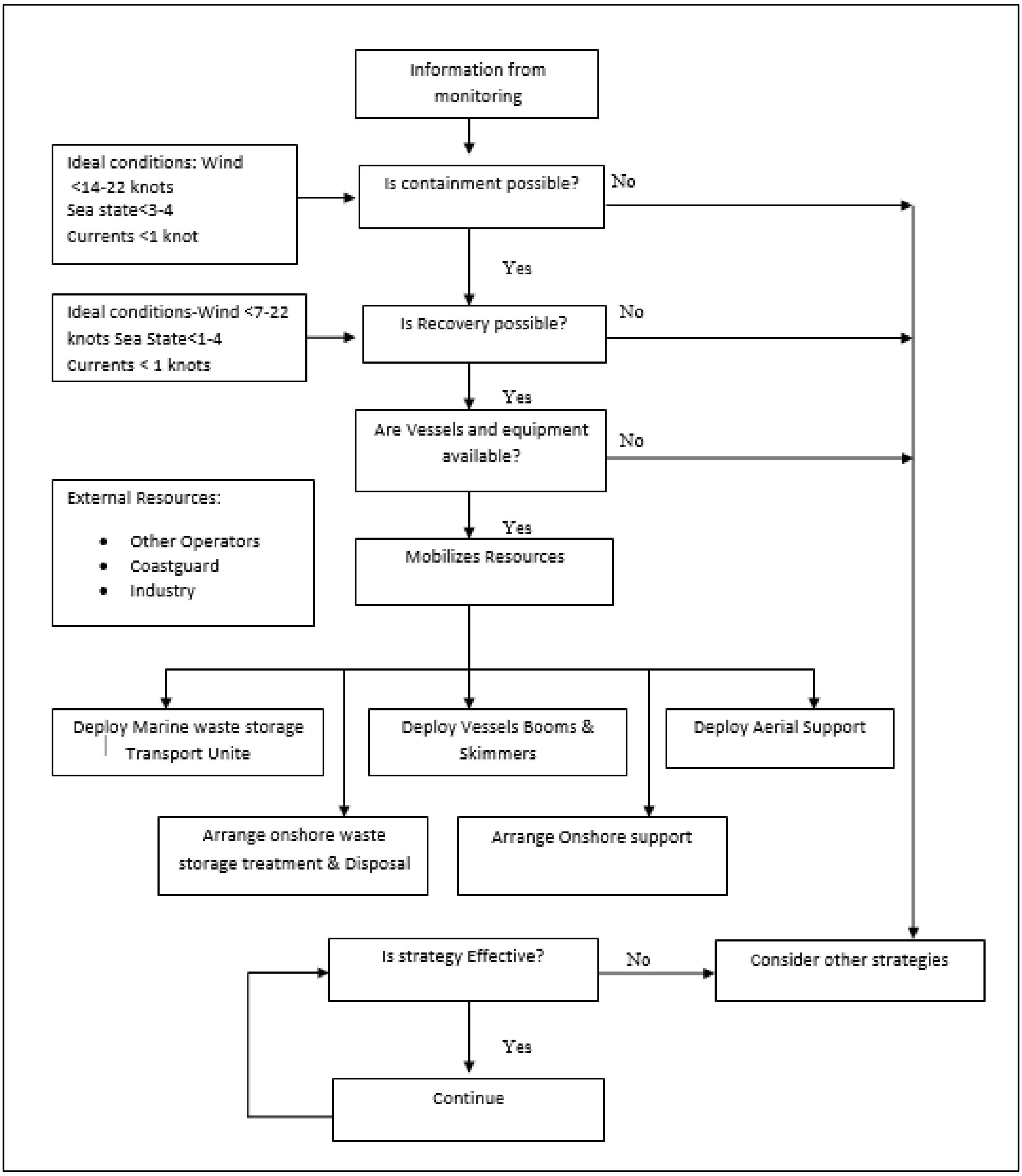


Figure 10.1. Oil Spill Response Planning Chart

(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**.

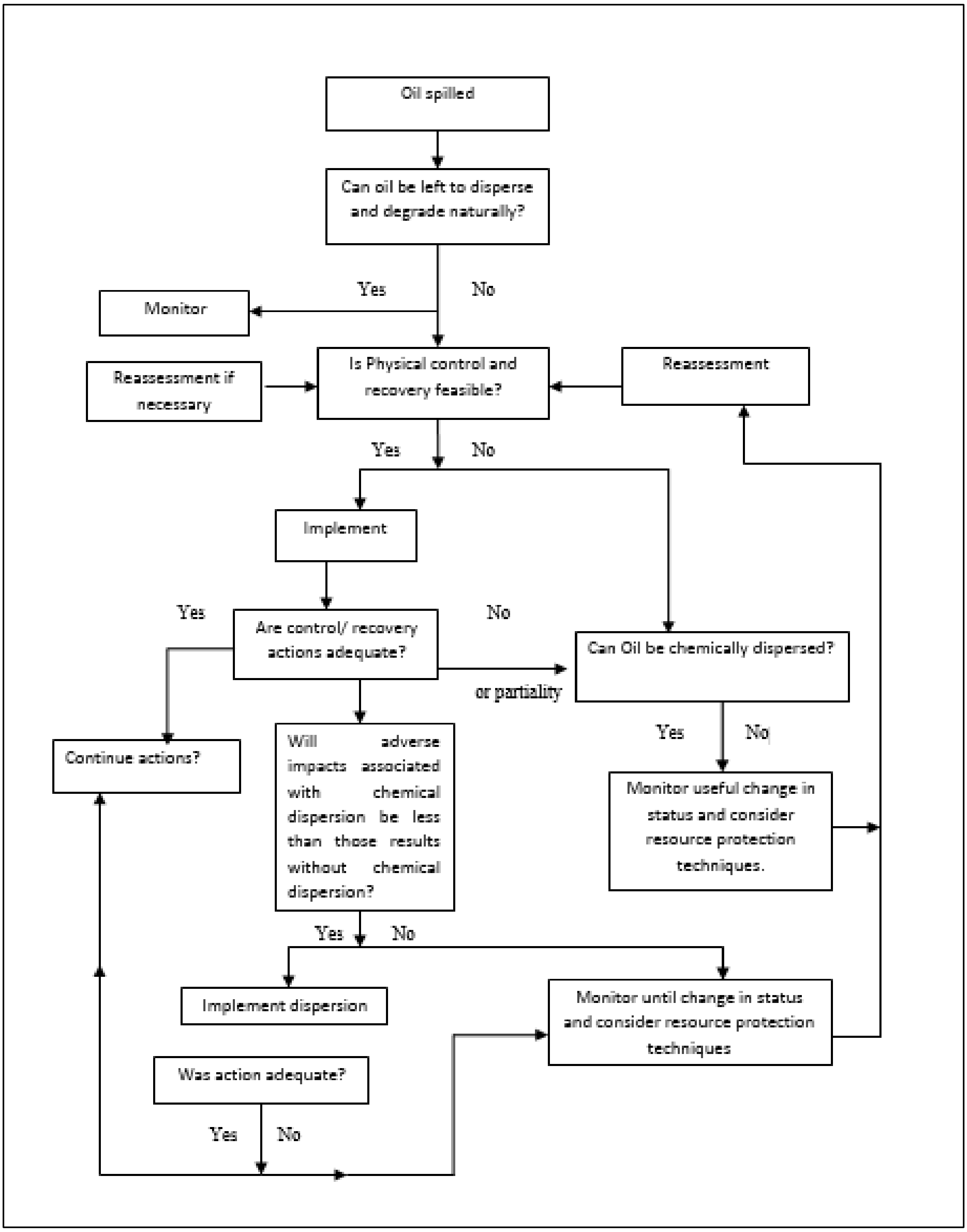


Figure 10.2. Dispersant Decision Tree

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	Name	Designation	Contact Particulars	
C-¯Ase Of Spill	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.

15

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

<table>
<tr><th rowspan="2"></th><th rowspan="2" colspan="2">Description</th><th colspan="4">Risk category</th></tr>
<tr><th>SUPER A</th><th>A</th><th>B</th><th>C</th></tr>
<tr><td rowspan="11">Equipment</td><td colspan="2">Inflatable Boom in metres</td><td>2000</td><td>1000</td><td>600</td><td>600</td></tr>
<tr><td colspan="2">Skimmer (20TPH)</td><td>4</td><td>4</td><td>2</td><td>2</td></tr>
<tr><td colspan="2">OSD Applicator (no.)</td><td>6</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td colspan="2">Oil Spill Dispersant (litres)</td><td>10,000</td><td>5,000</td><td>3,000</td><td>3,000</td></tr>
<tr><td colspan="2">Flex Barge 10 tons (no.)</td><td>4</td><td>2</td><td></td><td></td></tr>
<tr><td colspan="2">Current Buster booms atports where tidal current is>2 Kn (no.)</td><td>2</td><td>2</td><td></td><td></td></tr>
<tr><td colspan="2">Sorbent boom pack (meters)</td><td>500</td><td>200</td><td></td><td></td></tr>
<tr><td colspan="2">Sorbent Pads (no.)</td><td>2000</td><td>1000</td><td></td><td></td></tr>
<tr><td rowspan="3">Shoreline Cleanup Equipment</td><td>Mini Vacuumpumps</td><td>5</td><td></td><td></td><td></td></tr>
<tr><td>OSD Applicator</td><td>5</td><td></td><td></td><td></td></tr>
<tr><td>Fast tanks</td><td>5</td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Vessel</td><td colspan="2">Work Boats</td><td>2</td><td>1</td><td></td><td>1</td></tr>
<tr><td colspan="2">MSV/OSV/Tugs</td><td>2</td><td>1</td><td>1</td><td></td></tr>
<tr><td rowspan="3">Man Power</td><td colspan="2">IMO Level 1</td><td>10</td><td>6</td><td>2</td><td>2</td></tr>
<tr><td colspan="2">IMO Level 2</td><td>4</td><td>2</td><td></td><td></td></tr>
<tr><td colspan="2">OTHER</td><td>10</td><td>10</td><td>5</td><td>5</td></tr>
</table>

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 (POLWARN)	1.	Date and time
	2.	Position
	3.	Incident
	4.	Outflow
	5.	Acknowledge
Part II (POLINF)	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
	48.	Forecast
	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
Part III (POLFAC)	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
	86.	Change of command
	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	

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.
29/06/2016
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 Soild 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 Soild 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 annapetrochemempvtltd@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	srpimp05@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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Thiruvananthapuram :-
KITCO Ltd.,
House No 42,TC4/1687, Belhaven Garden, Kowdiar P.O.,
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e-mail: kitcotvm@gmail.com

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

TAB
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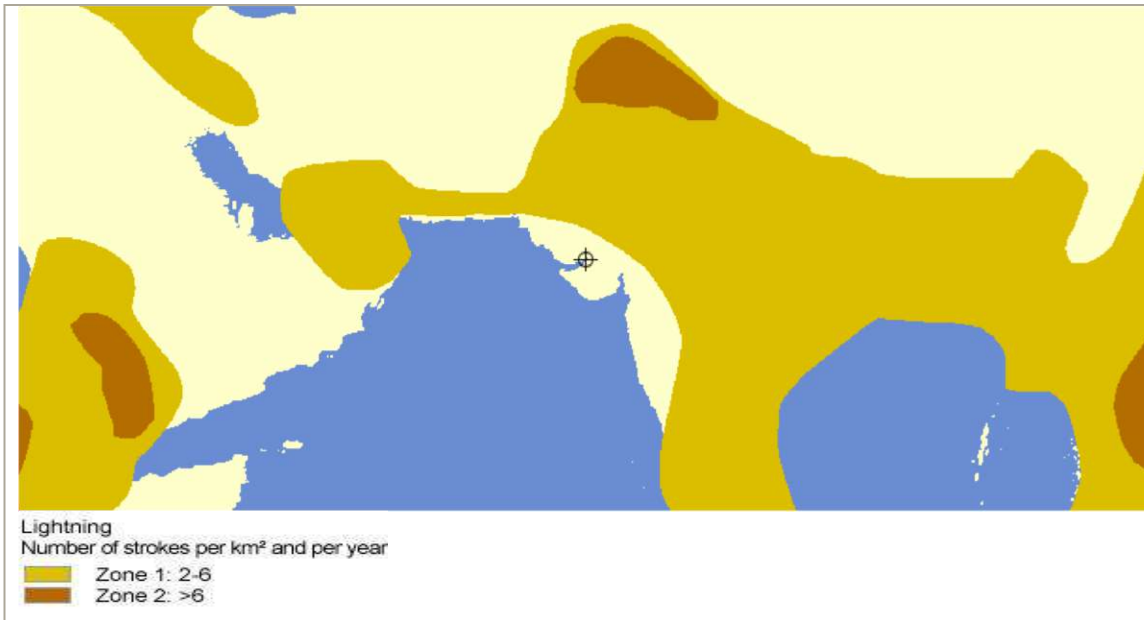
OF CONTENTS

Contents

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.



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

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.

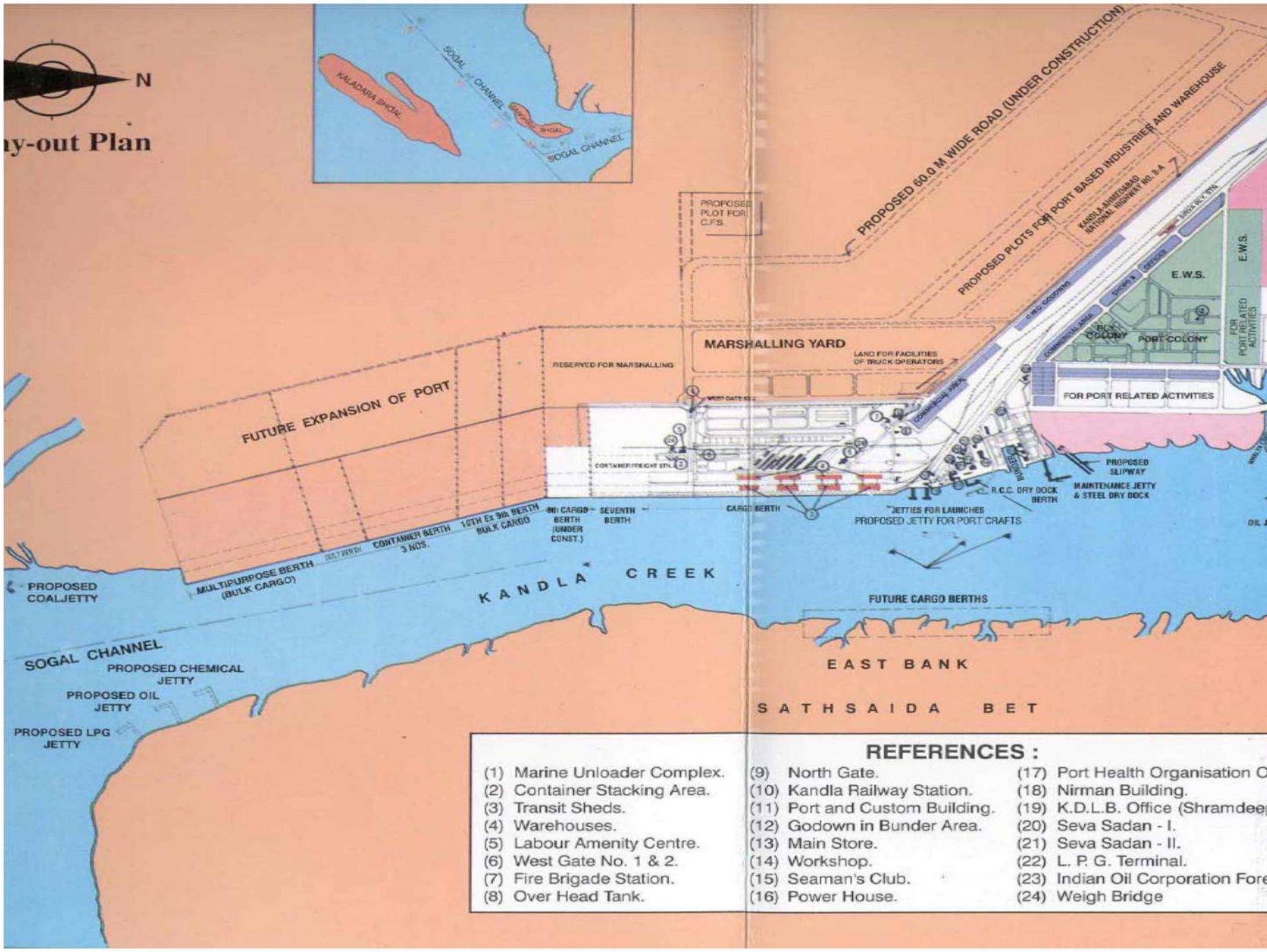
3.5 Port Location

- 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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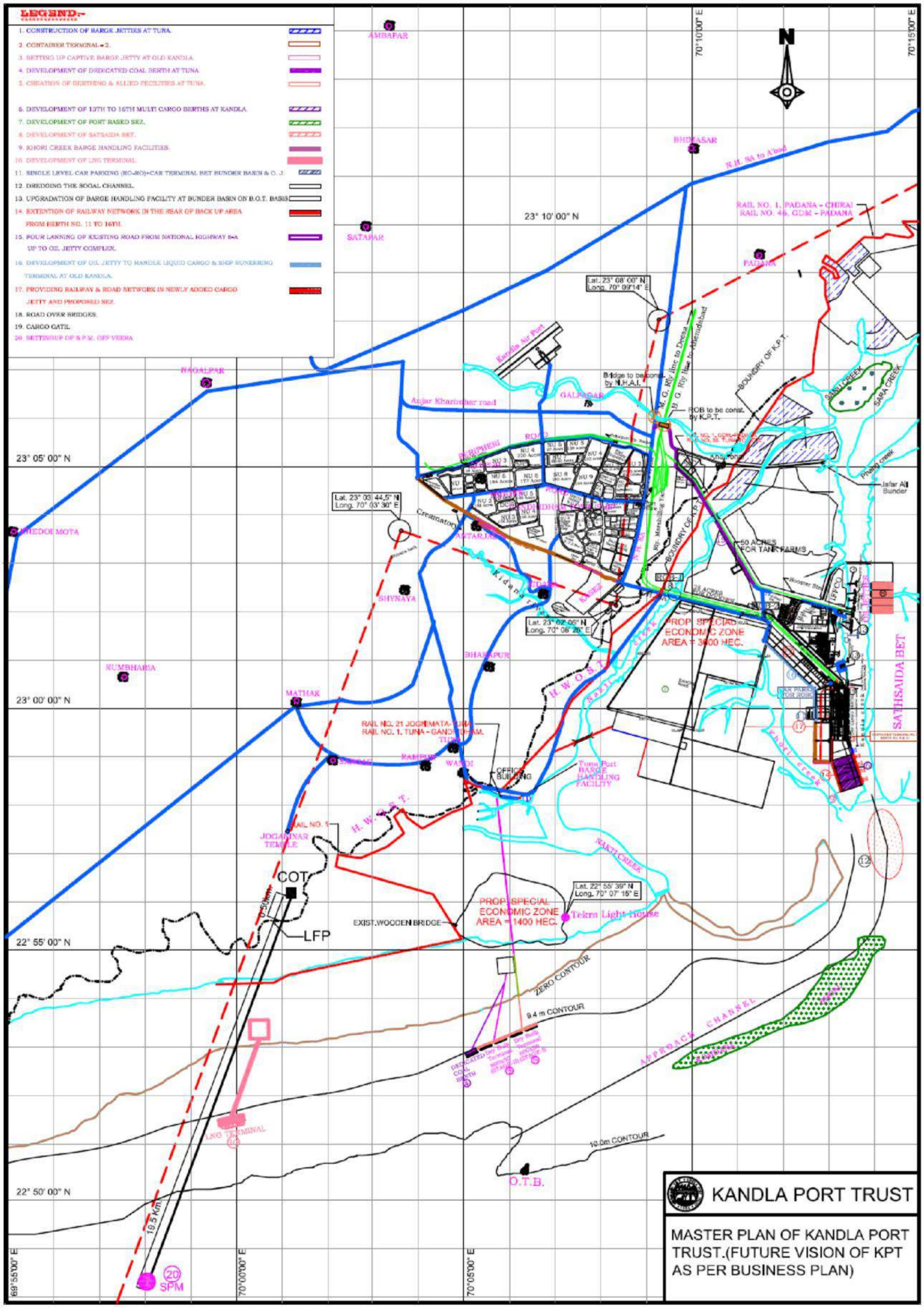
3.6 Future Vision of KPT as per Business Plan



LEGEND:-
1. CONSTRUCTION OF BARGE JETTIES AT TUNA.
2. CONTAINER TERMINAL - 2.
3. SETTING UP CAPTIVE BARGE JETTY AT OLD KANDLA.
4. DEVELOPMENT OF DEDICATED COAL BERTH AT TUNA.
5. CREATION OF BERTHING & ALLIED FECILITIES AT TUNA.
6. DEVELOPMENT OF 13TH TO 16TH MULTI CARGO BERTHS AT KANDLA.
7. DEVELOPMENT OF PORT BASED SEZ.
8. DEVELOPMENT OF SATSAIDA BET.
9. KHORI CREEK BARGE HANDLING FACILITIES.
10. DEVELOPMENT OF LNG TERMINAL.
11. SINGLE LEVEL CAR PARKING (RO-RO)+CAR TERMINAL BET BUNDER BASIN & O. J.
12. DREDGING THE SOGAL CHANNEL.
13. UPGRADATION OF BARGE HANDLING FACILITY AT BUNDER BASIN ON B.O.T. BASIS
14. EXTENTION OF RAILWAY NETWORK IN THE REAR OF BACK UP AREA FROM BERTH NO. 11 TO 16TH.
15. FOUR LANNING OF EXISTING ROAD FROM NATIONAL HIGHWAY 8-A UP TO OIL JETTY COMPLEX.
16. DEVELOPMENT OF OIL JETTY TO HANDLE LIQUID CARGO & SHIP BUNKERING TERMINAL AT OLD KANDLA.
17. PROVIDING RAILWAY & ROAD NETWORK IN NEWLY ADDED CARGO JETTY AND PROPOSED SEZ.
18. ROAD OVER BRIDGES.
19. CARGO GATE.
20. SETTINGUP OF S.P.M. OFF VEERA
N
70°10'00" E
70°15'00" E
70°05'00" E
70°00'00" E
69°55'00" E
23° 10' 00" N
23° 05' 00" N
23° 00' 00" N
22° 55' 00" N
22° 50' 00" N
AMBAPAR
BHIMASAR
N.H. 8A to A'bad
SATAPAR
PADANA
RAIL NO. 1, PADANA - CHIRAI
RAIL NO. 46, GDM - PADANA
Lat. 23° 08' 00" N
Long. 70° 09'14" E
NAGALPAR
Kandla Air Port
Anjar Kharirohar road
GALPADAR
Bridge to be const. by N.H.A.I.
ROB to be const. by K.P.T.
BOUNDRY OF K.P.T.
SANI CREEK
SARA CREEK
Phang creek
Jafar Ali Bunder
Lat. 23° 03' 44.5" N
Long. 70° 03' 36" E
Creamatorium
KHEDOI MOTA
SHYNAYA
50 ACRES FOR TANK FARMS
Lat. 23° 02' 06" N
Long. 70° 06' 26" E
PROP. SPECIAL ECONOMIC ZONE AREA = 3600 HEC.
BHARAPUR
KUMBHARIA
SATHSAIDA BET
MATHAK
RAIL NO. 21 JOGNIMATA-TUNA
RAIL NO. 1, TUNA - GANDHIDHAM.
TUNA
RAMPUR
WANDI
OFFICE BUILDING
Tuna Port BARGE HANDLING FACILITY
H. W. O. S. T.
RAIL NO. 1
JOGANINAR TEMPLE
COT
LFP
EXIST. WOODEN BRIDGE
PROP. SPECIAL ECONOMIC ZONE AREA = 1400 HEC.
Lat. 22° 55' 39" N
Long. 70° 07' 15" E
Tekra Light House
NAKTI CREEK
ZERO CONTOUR
9.4 m CONTOUR
APPROACH CHANNEL
DEDICATED COAL BERTH
LNG TERMINAL
10.0m CONTOUR
O.T.B.
19.5 Km
SPM
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.

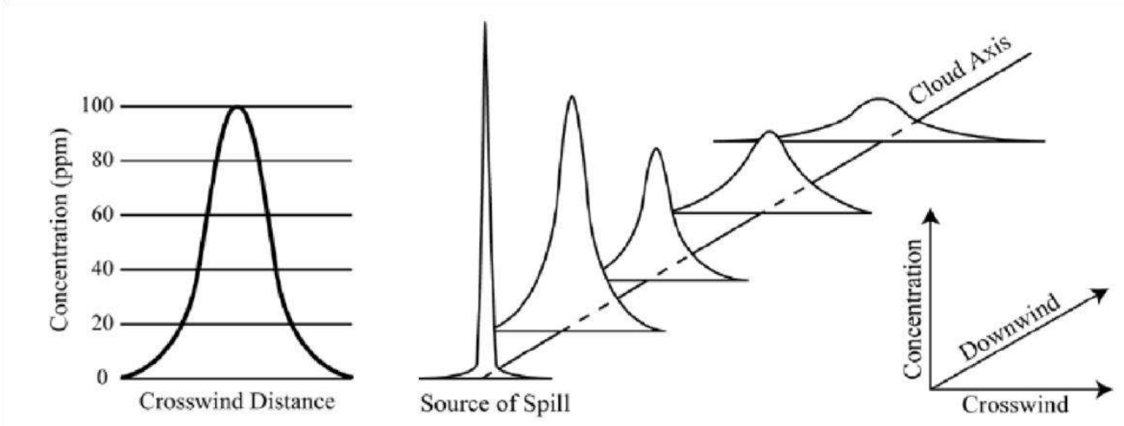
ALOHA can model the dispersion of a cloud of pollutant gas in the atmosphere and display a diagram that shows an overhead view of the regions, or threat zones, in which it predicts that key hazard levels (LOCs) will be exceeded. This diagram is called a threat zone plot. To obtain a threat zone estimate, 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.

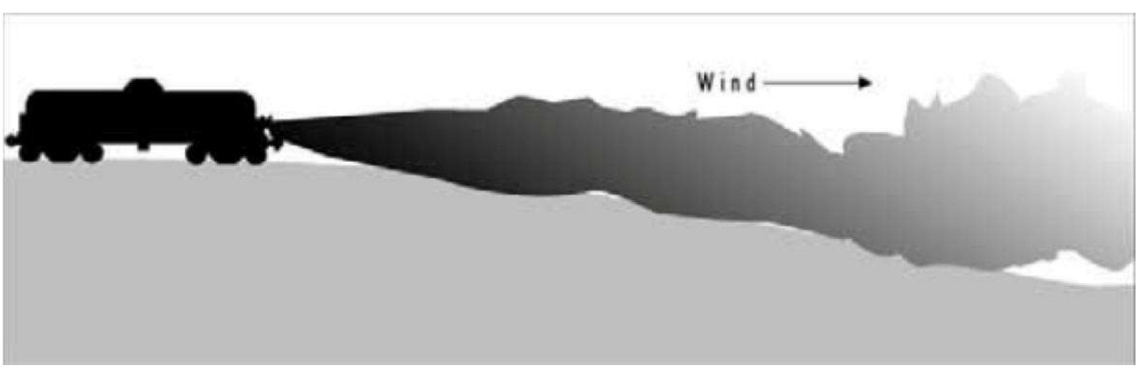
Gaussian distribution (left) & Gaussian Spread (right)



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 2nd 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.

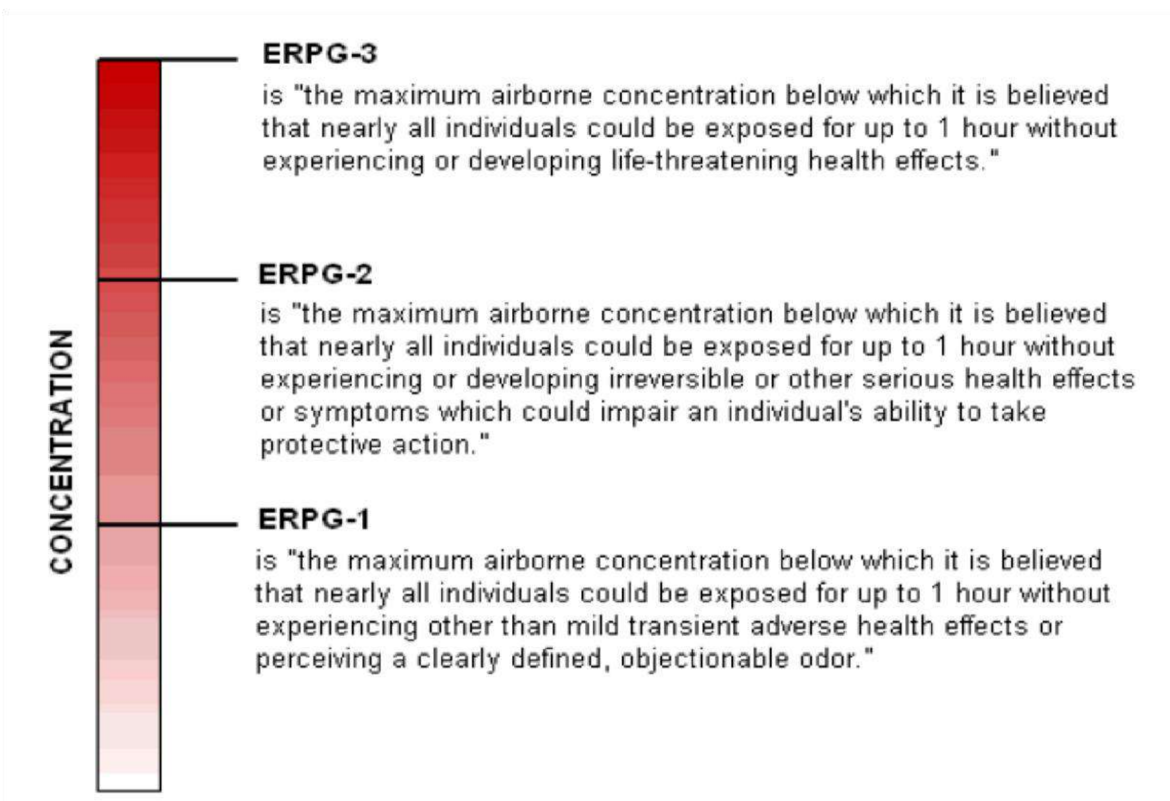
* These are peak pressures formed in excess of normal atmospheric pressure by blast and shock waves.

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.

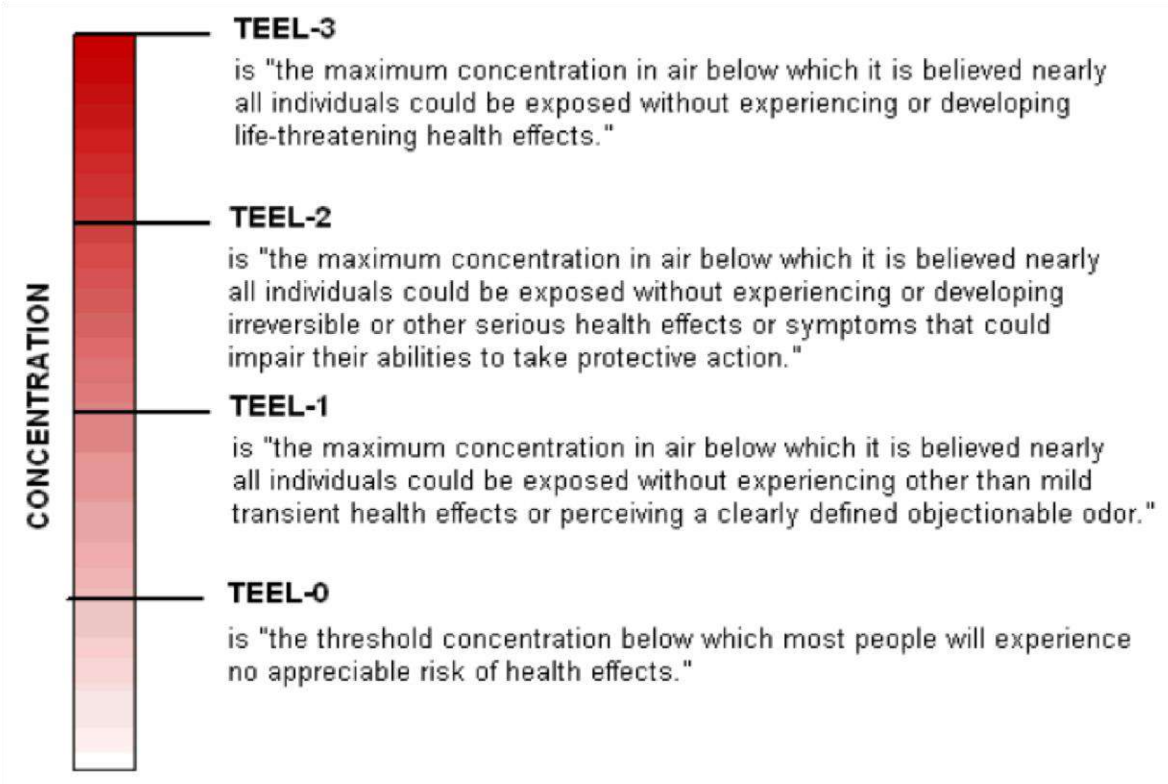
The guidelines are focused on one period of time: 1 hour. Exposure in the field may be longer or shorter. However, the ERPG committee strongly advises against trying to extrapolate ERPG values to longer periods of time.

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	10.0kW/m^2	5.0kW/m^2	2.0kW/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	10.0kW/m^2	5.0kW/m^2	2.0kW/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

Jetty 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.

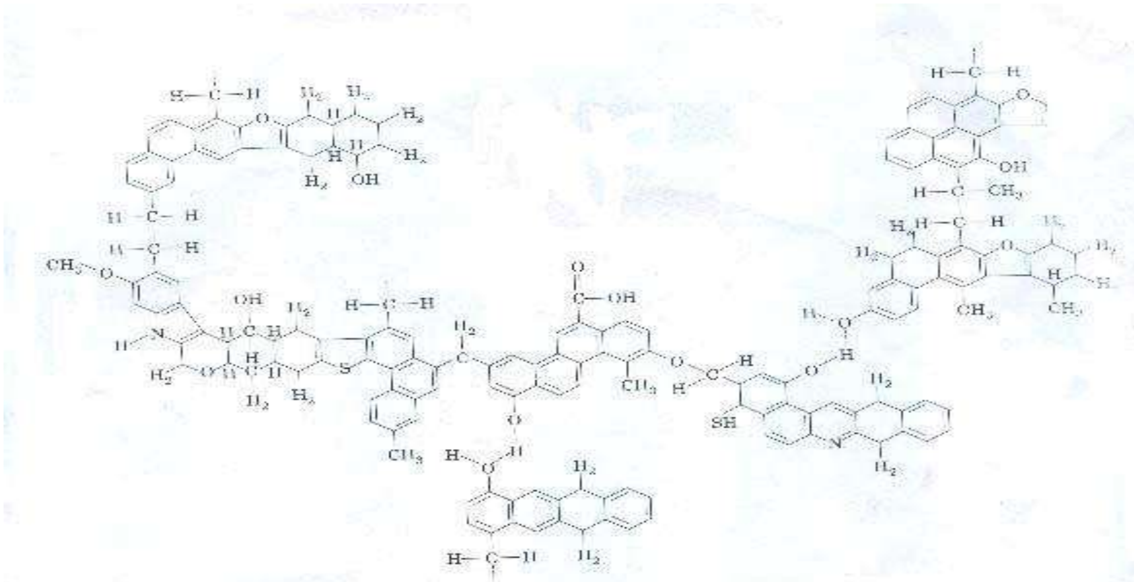
4.8 Coal Storage at Open Yard

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	=	5.6×10^{-8} KW/m^2K^4

$FQ\ 4\Pi K$ 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 = $10m^2$

$Q = 5.6 \times 10^{-8} \times 0.9 \times 10\ (1173^4 - 300^4)$

Q = 950 kW

For Heat radiation 4 kW/m^2 impact distance D

$D = \sqrt{(950\times0.15)/(4\times3.14\times 4)} = 1.68 = 1.7m$

For Heat radiation 12.5 kW/m^2 impact distance D

$D = \sqrt{(950\times0.15)/(4\times3.14\times12.5)} = 0.9527 = 1\ m$

For Heat radiation 37.5 kW/m^2 impact distance D

$D = \sqrt{(950\times0.15)/(4\times3.14\times37.5)} = 0.55m$

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

$D = \sqrt{(9500\times0.15)/(4\times3.14\times4)} = 5.32\ m$

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

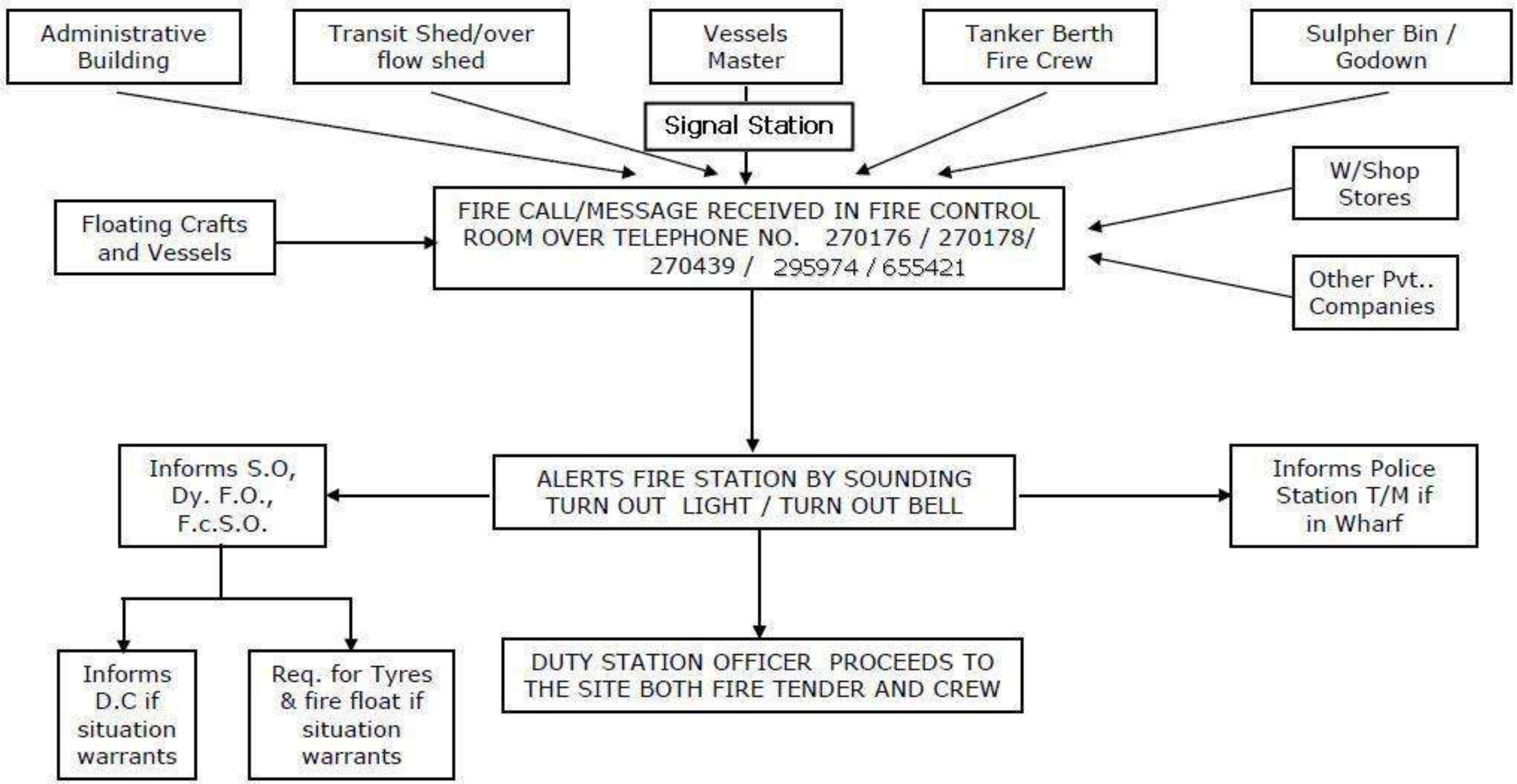
37.5 kW/m^2	0.5 m	1.74 m

Assuming that $100m^2$ surface area of the coal stack is smouldering no person should approach the stock within 6 m distance.

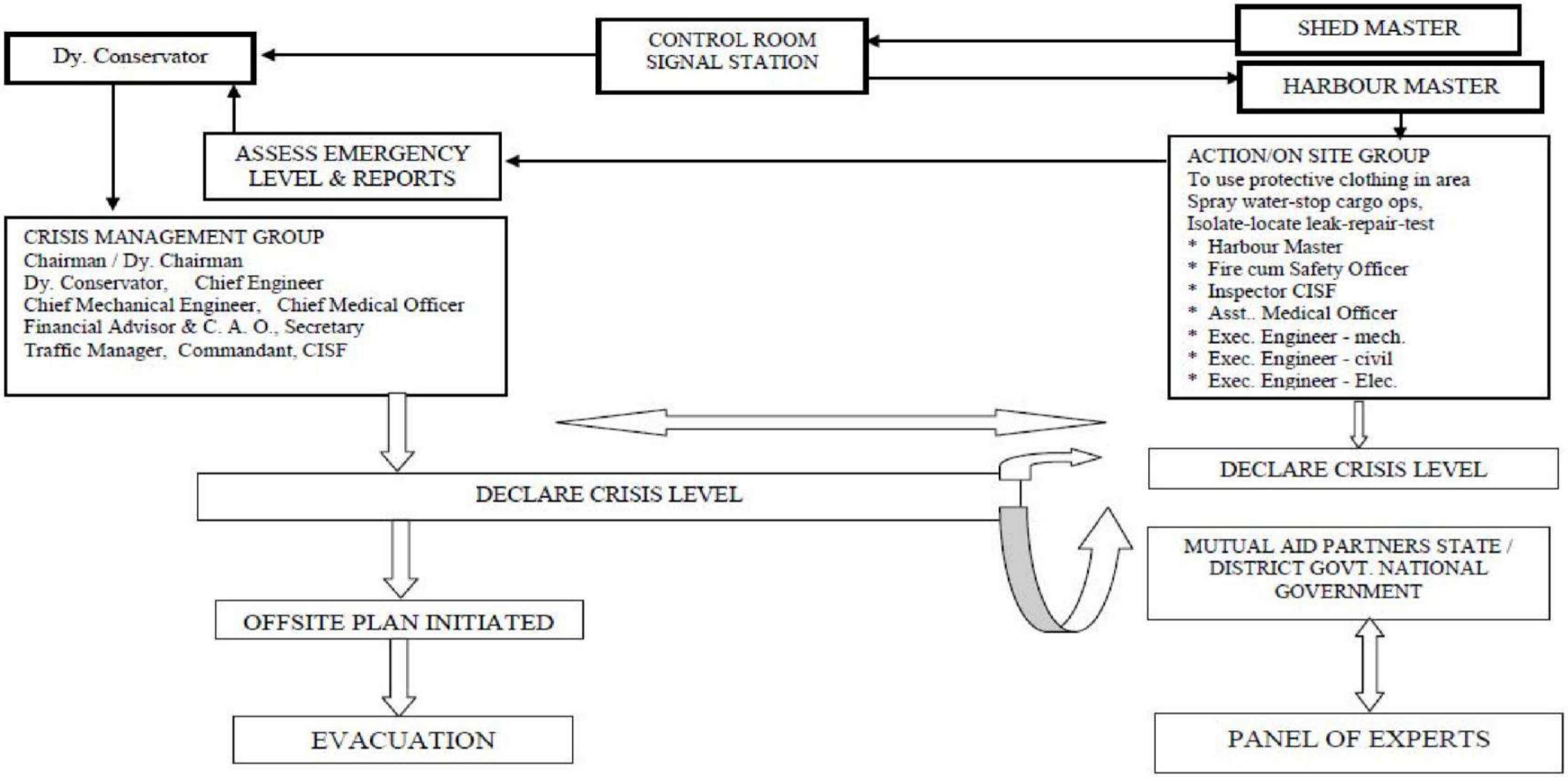
All fire fighting should be done from more than 5.3 m away from the affected coal stack unless the fire fighter is fully clothed with fire protective clothing and respiratory protection

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

Comments:

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

Comments

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

Comments:

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.

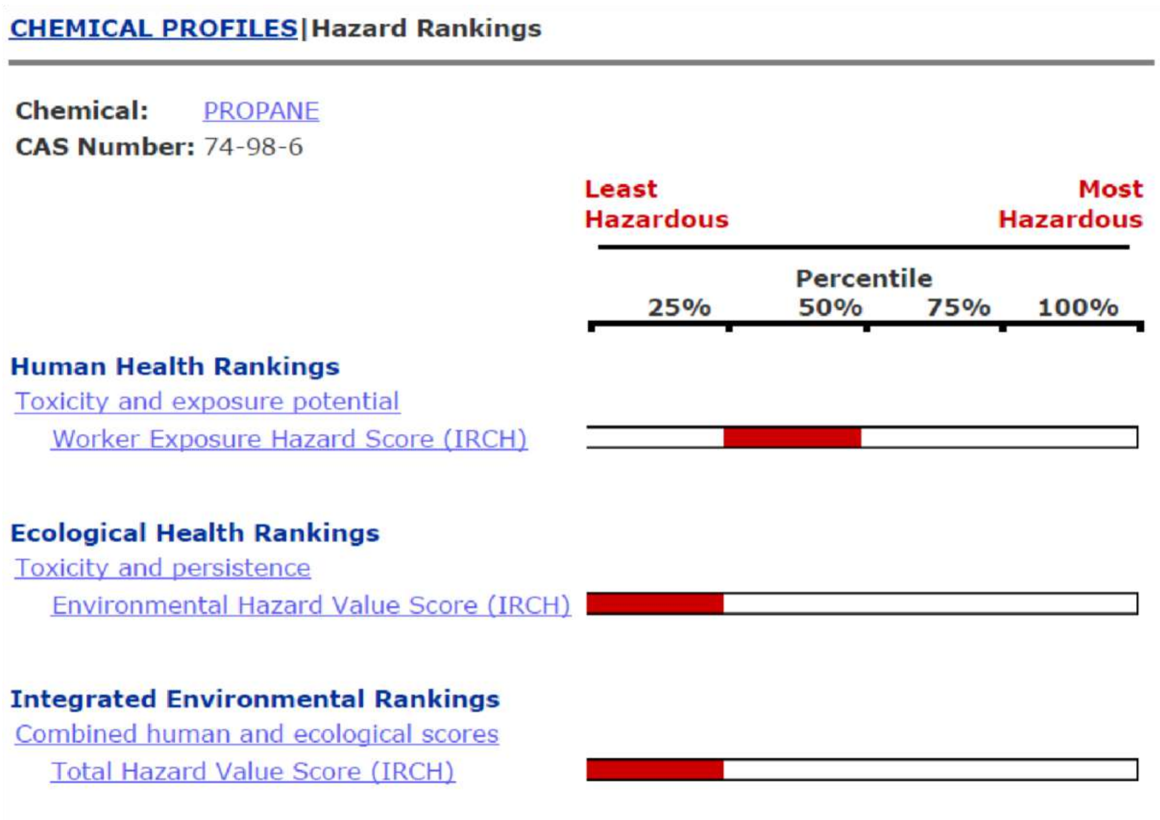
5.2.17.1 Dispersion Distance for Acrylonitrile

Sr. No.	Concentration of interest ppm	Dispersion Distance in meters	
		5.0m/s;C	2.0m/s; D
1.	400	574	1508

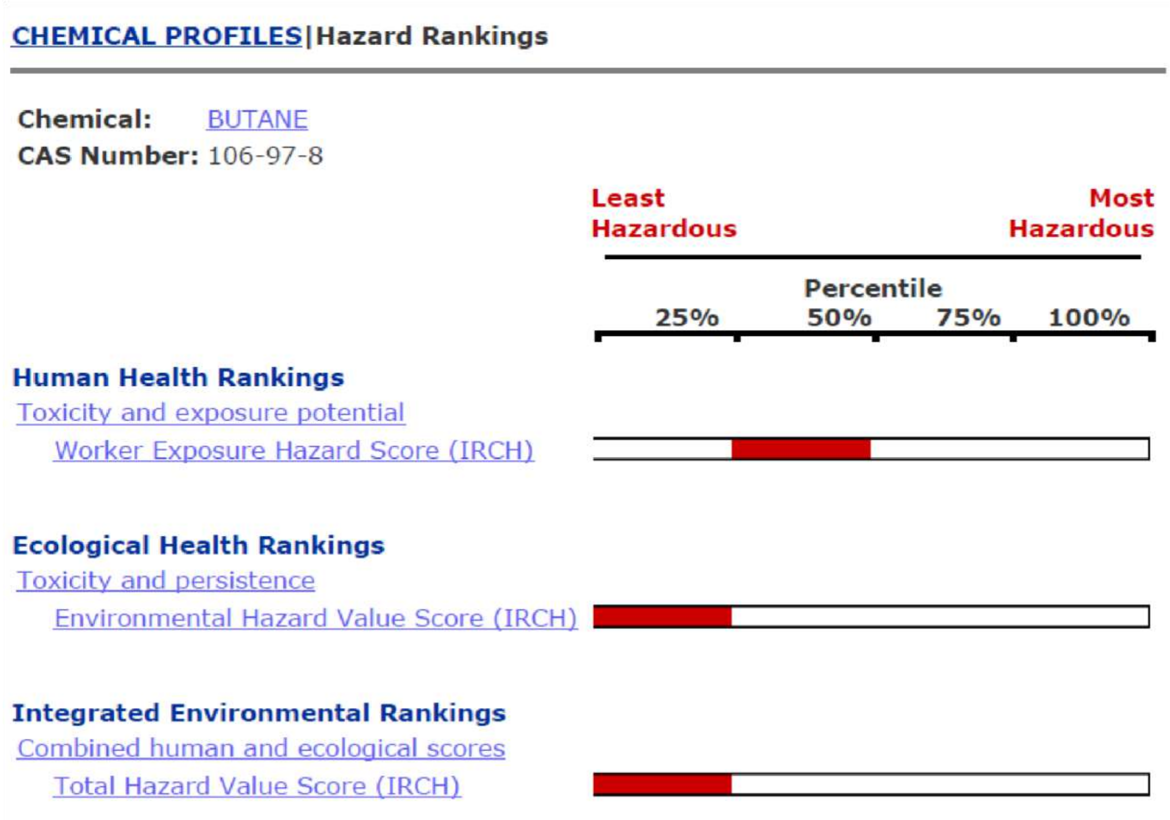
6 TOXIC HAZARD RANKING FOR HAZARDOUS CHEMICALS HANDLED AT PORT PREMISES

6.1 Hazard Ranking

6.1.1 Propane



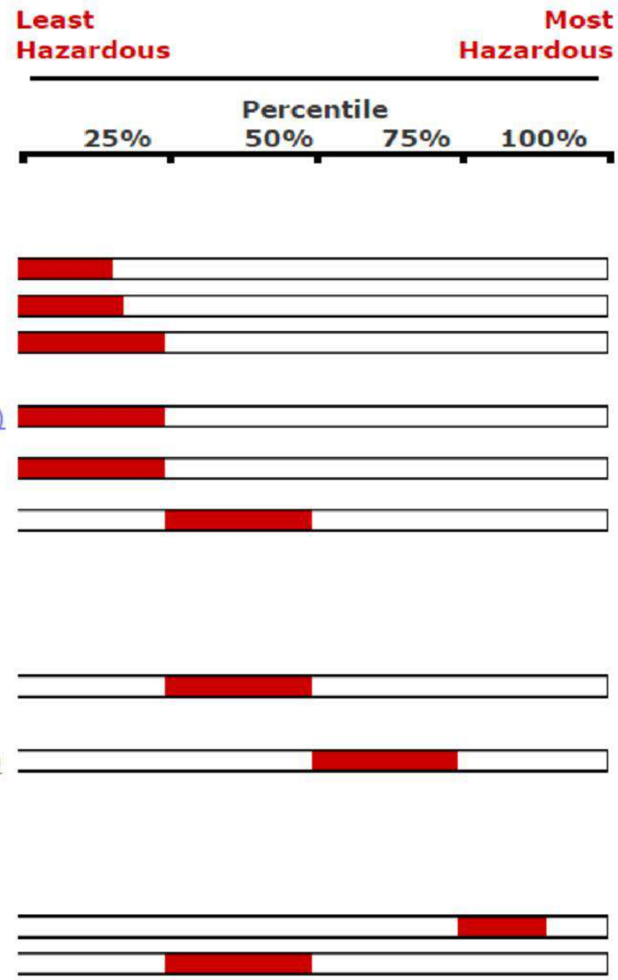
6.1.2 Butane



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

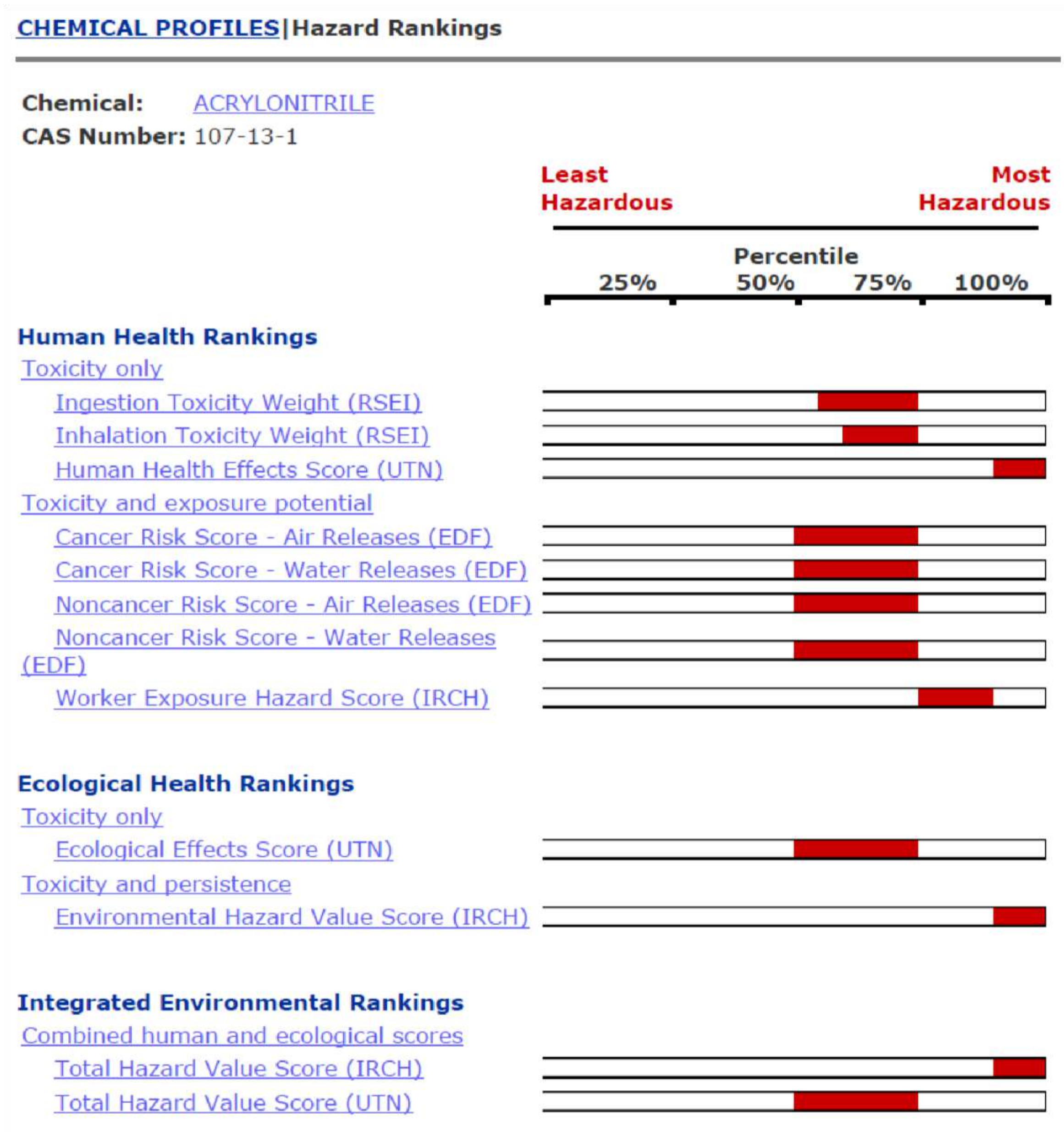
- Environmental Hazard Value Score (IRCH)

Integrated Environmental Rankings

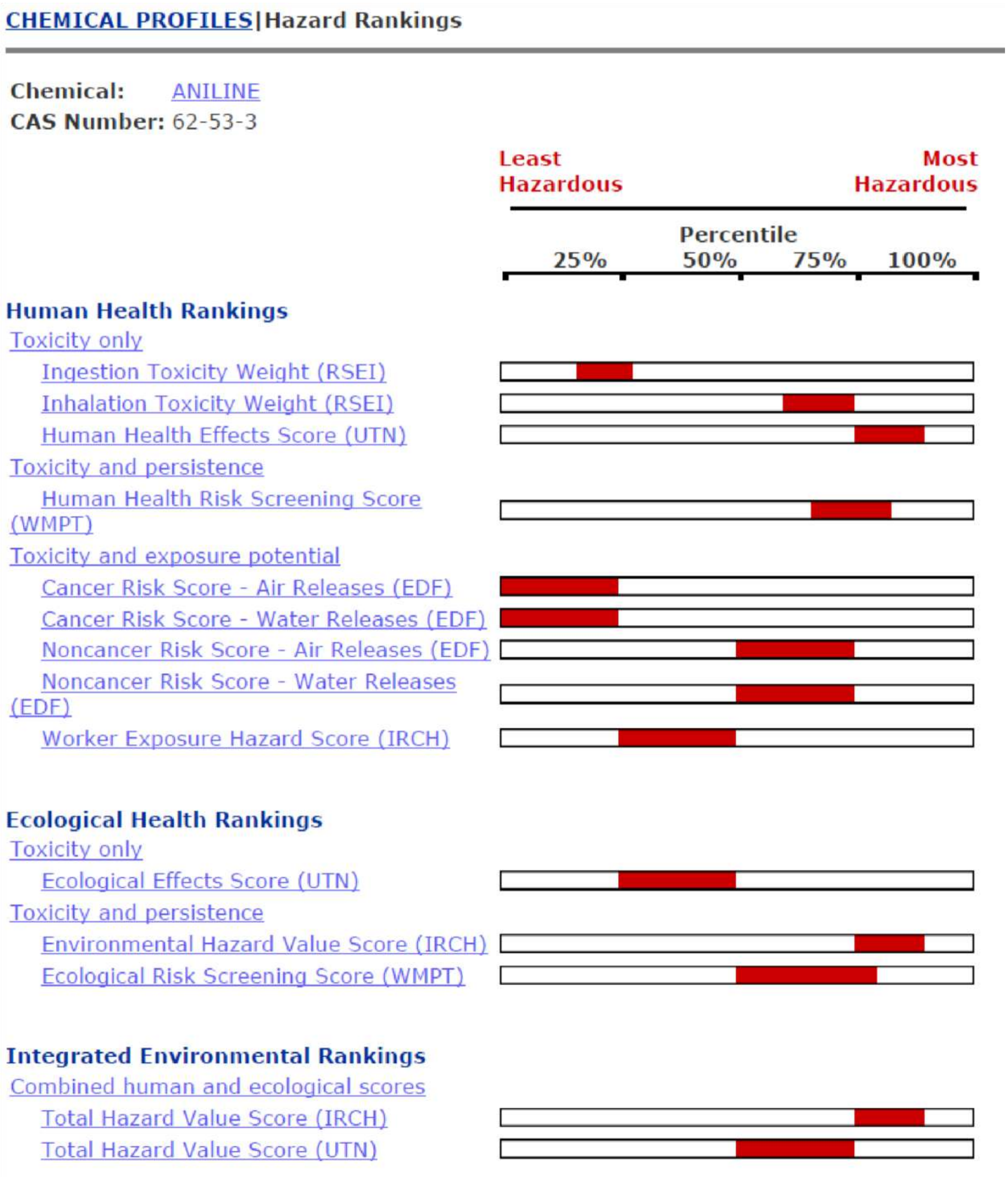
Combined human and ecological scores

- Total Hazard Value Score (IRCH)
- Total Hazard Value Score (UTN)

6.1.4 Acrylonitrile

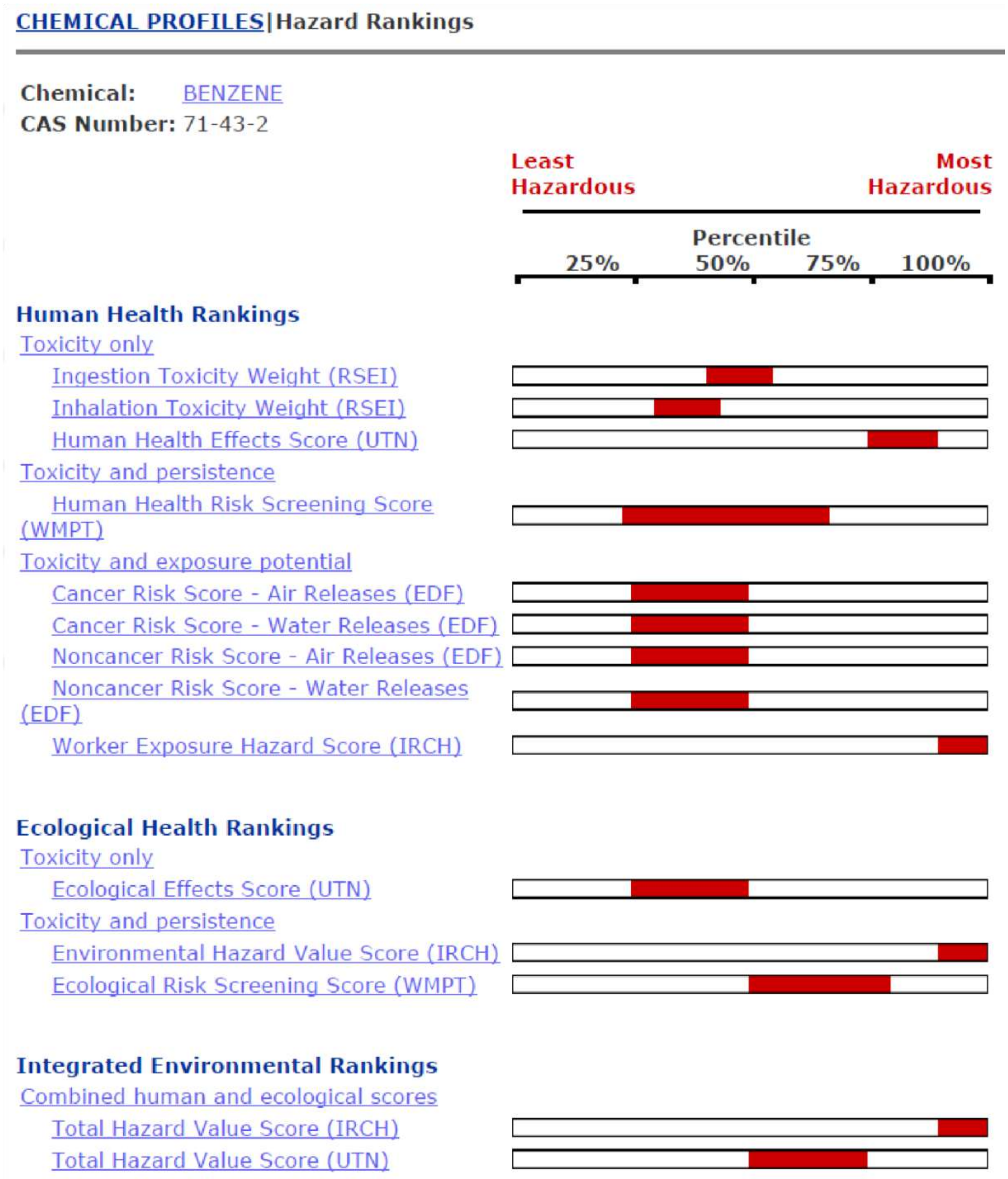


6.1.5 Aniline

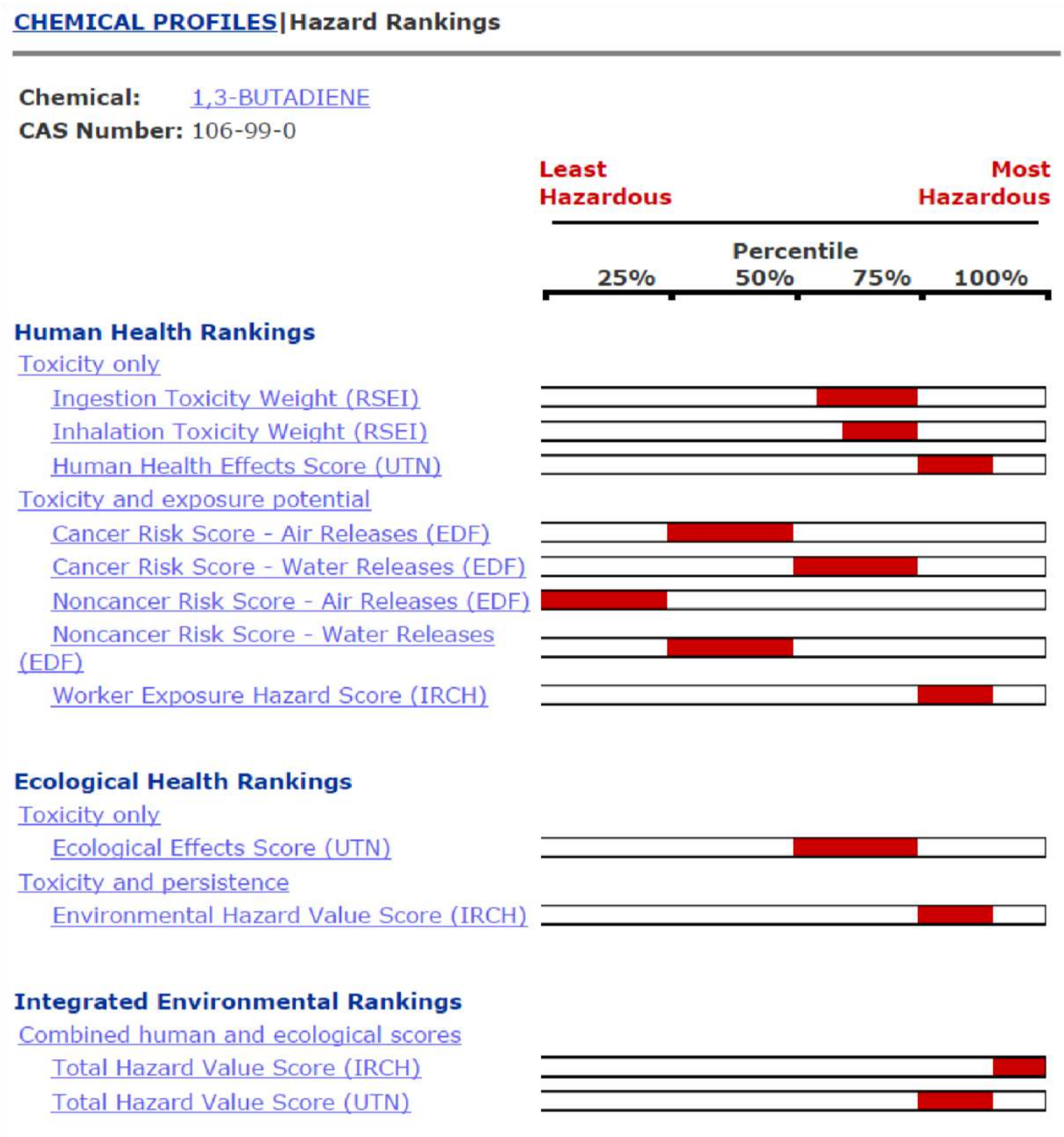


CHEMICAL PROFILES|Hazard Rankings
Chemical: ANILINE
CAS Number: 62-53-3
Least Hazardous
Most Hazardous
Percentile
25%
50%
75%
100%
Human Health Rankings
Toxicity only
Ingestion Toxicity Weight (RSEI)
Inhalation Toxicity Weight (RSEI)
Human Health Effects Score (UTN)
Toxicity and persistence
Human Health 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



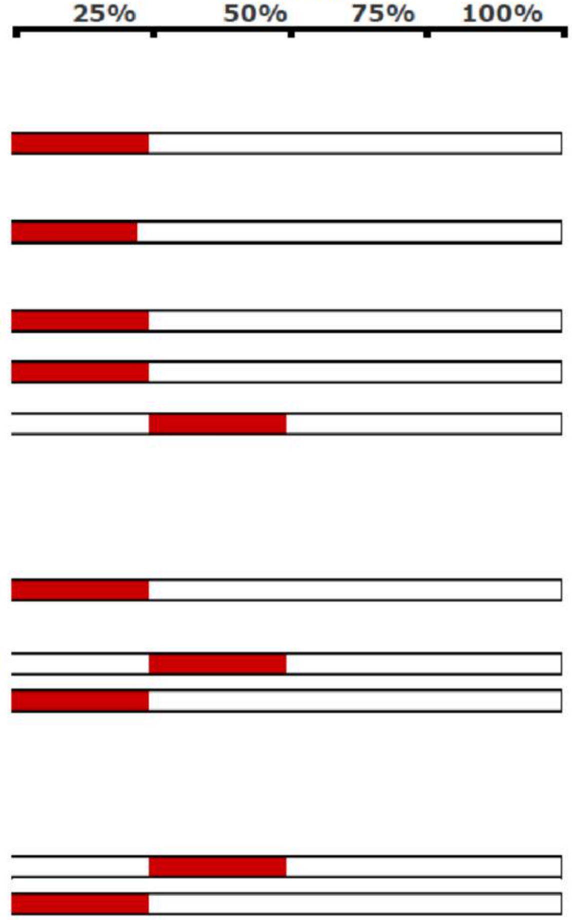
6.1.8 Acetone

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

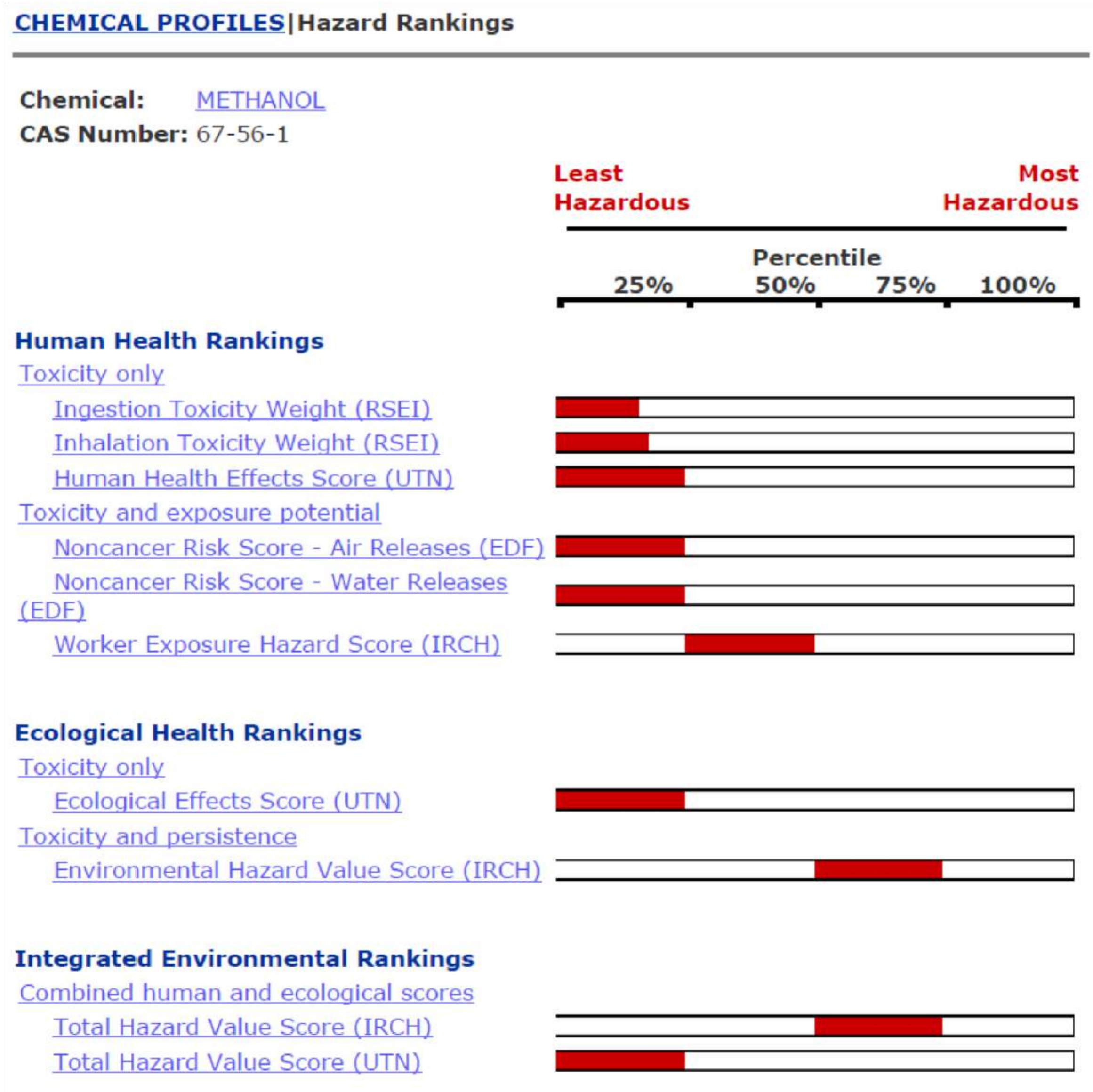
Toxicity only
- Ecological Effects Score (UTN)

Toxicity and persistence
- Environmental Hazard Value Score (IRCH)
- Ecological Risk Screening Score (WMPT)

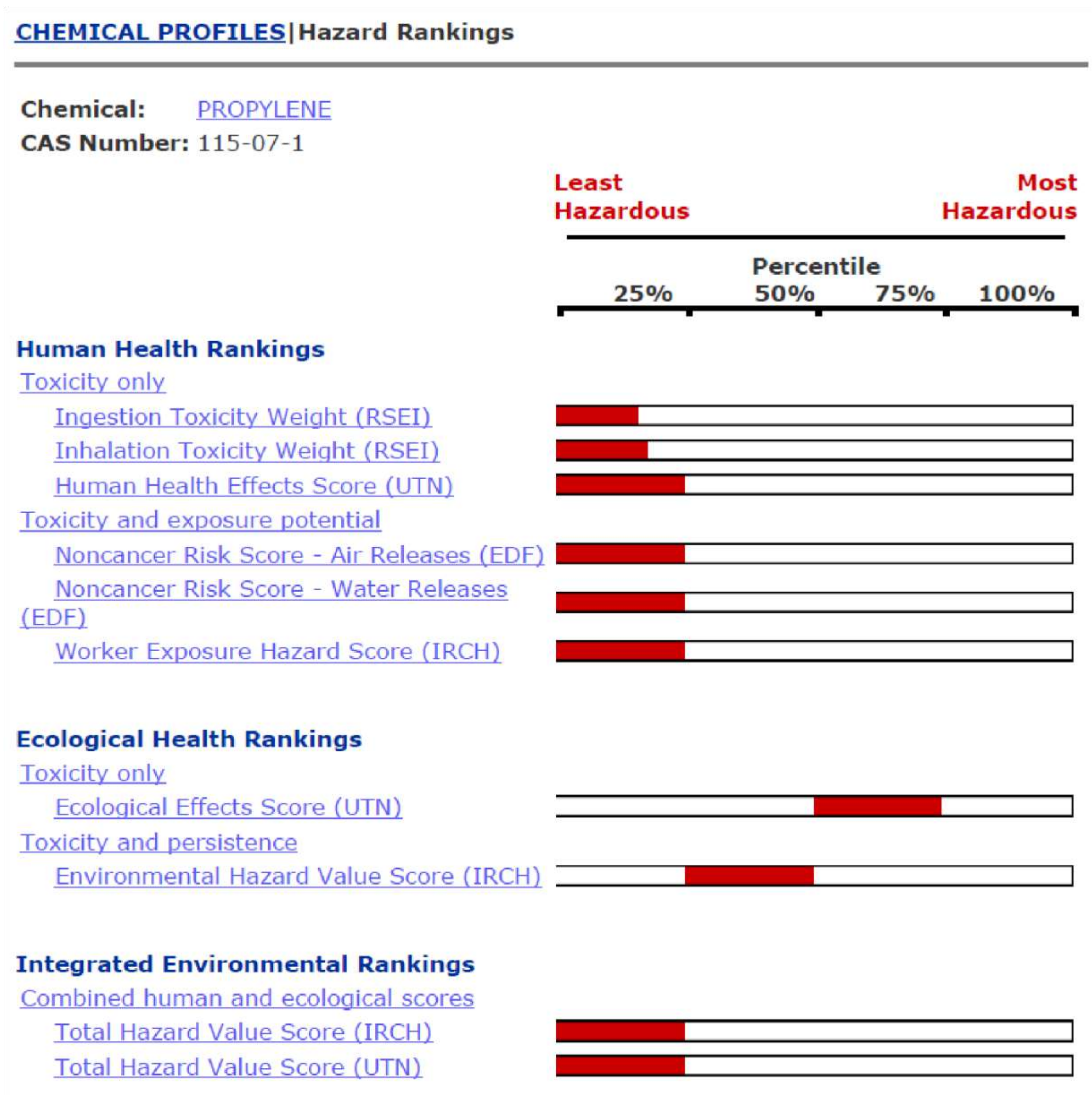
Integrated Environmental Rankings

Combined human and ecological scores
- Total Hazard Value Score (IRCH)
- Total Hazard Value Score (UTN)

6.1.9 Methanol



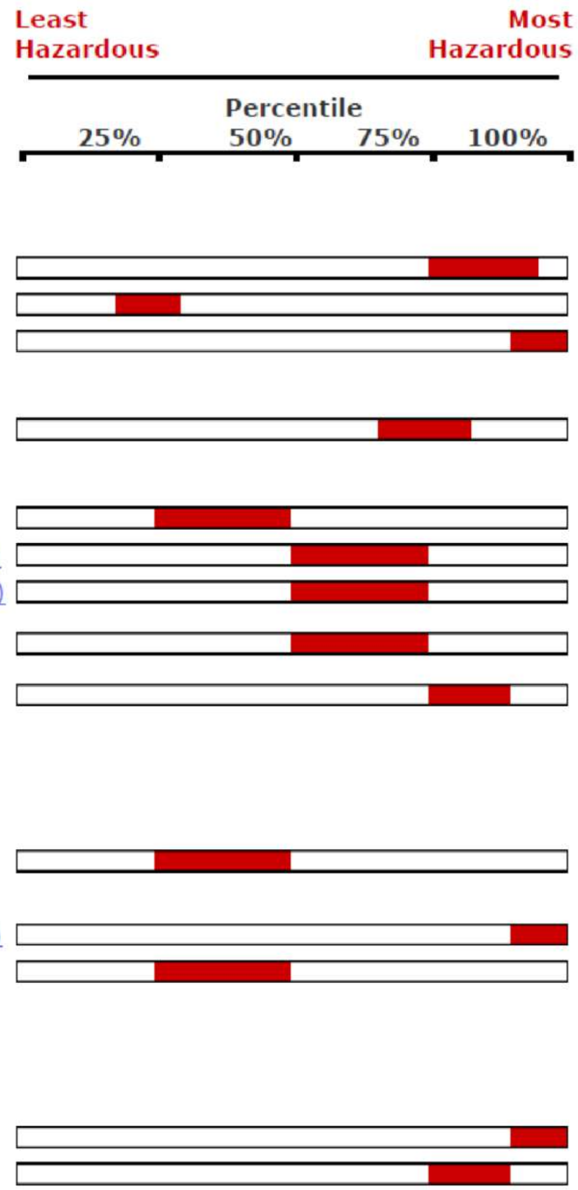
6.1.10 Propylene



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

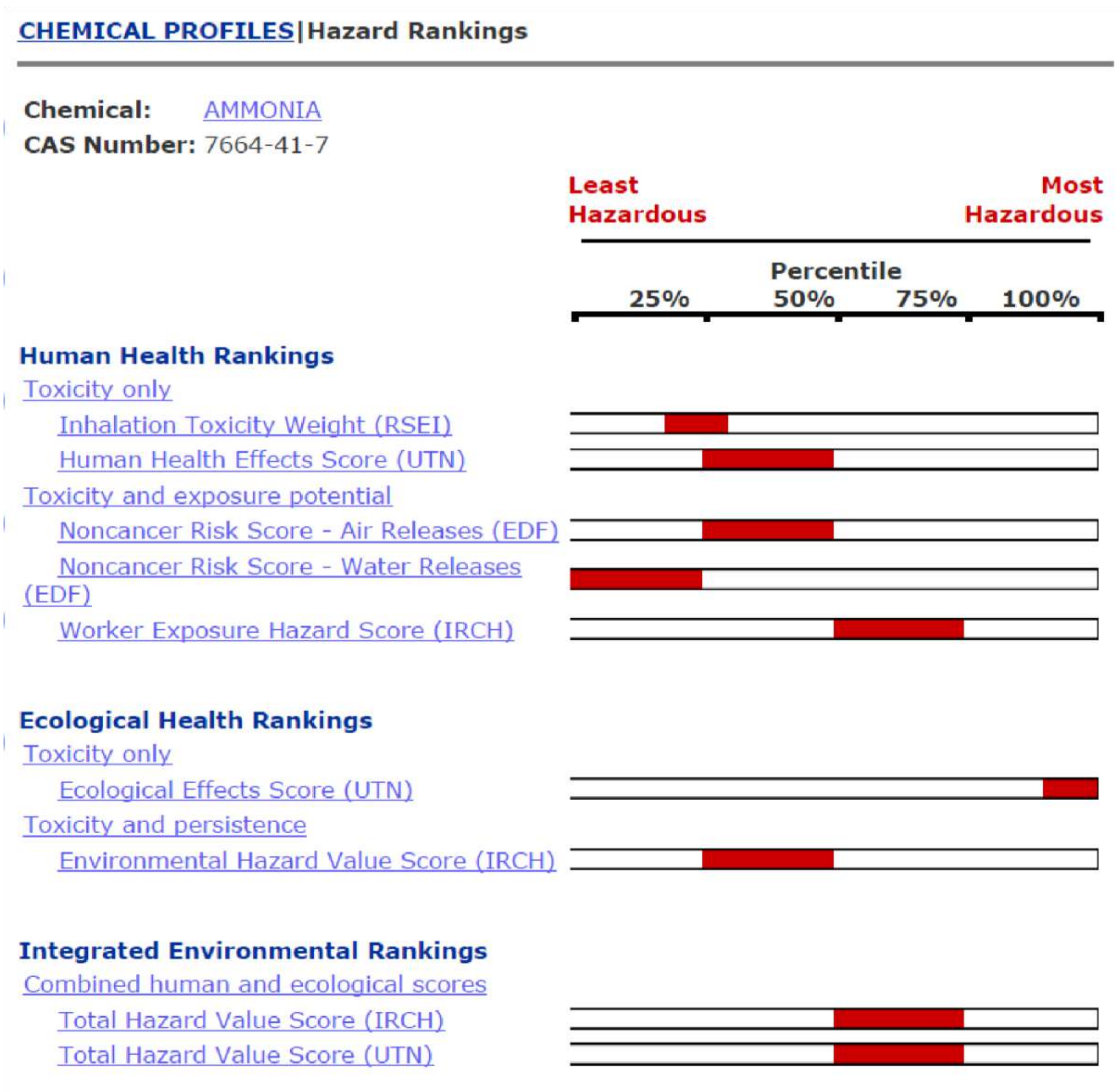
- Environmental Hazard Value Score (IRCH)
- Ecological Risk Screening Score (WMPT)

Integrated Environmental Rankings

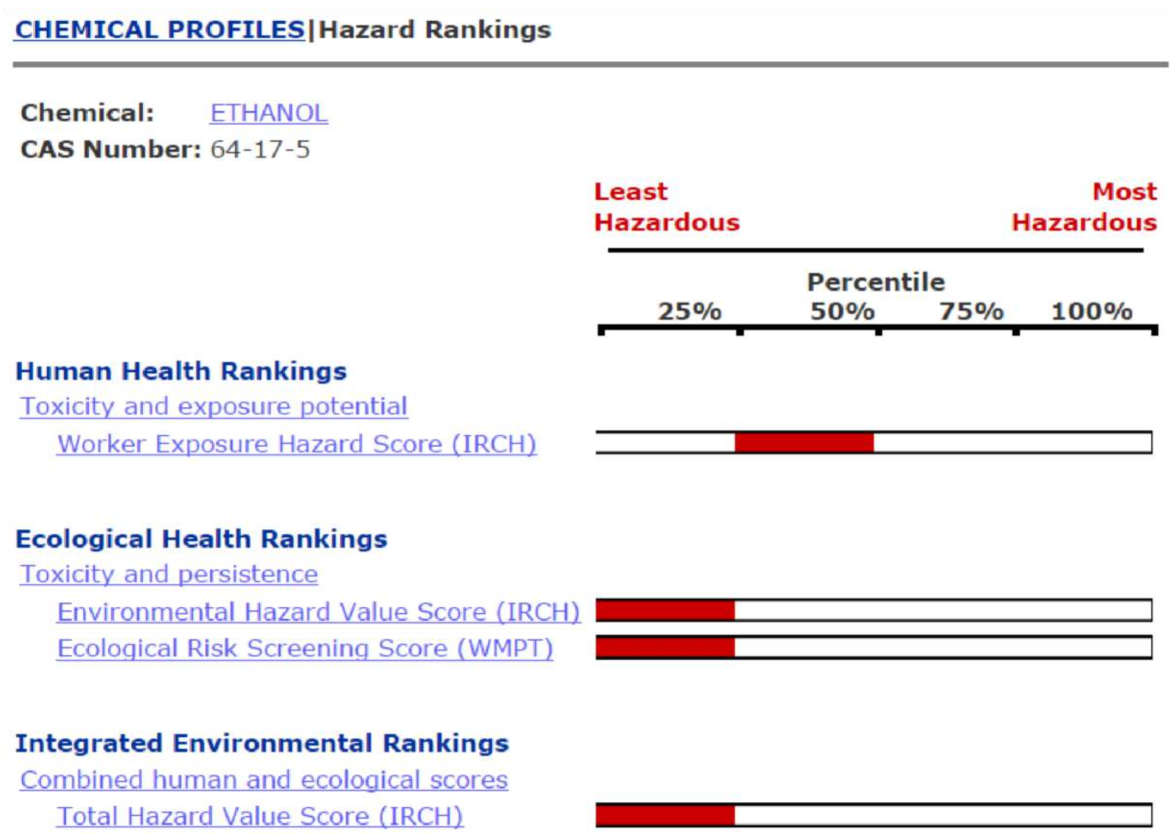
Combined human and ecological scores

- Total Hazard Value Score (IRCH)
- Total Hazard Value Score (UTN)

6.1.12 Ammonia



6.1.13 Ethanol

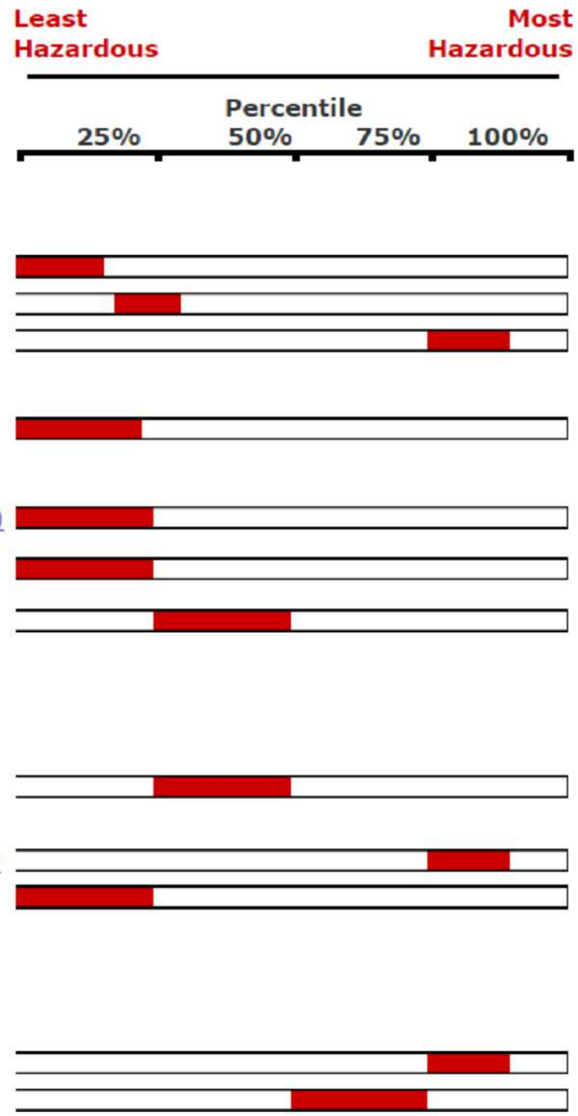


6.1.14 Phenol

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

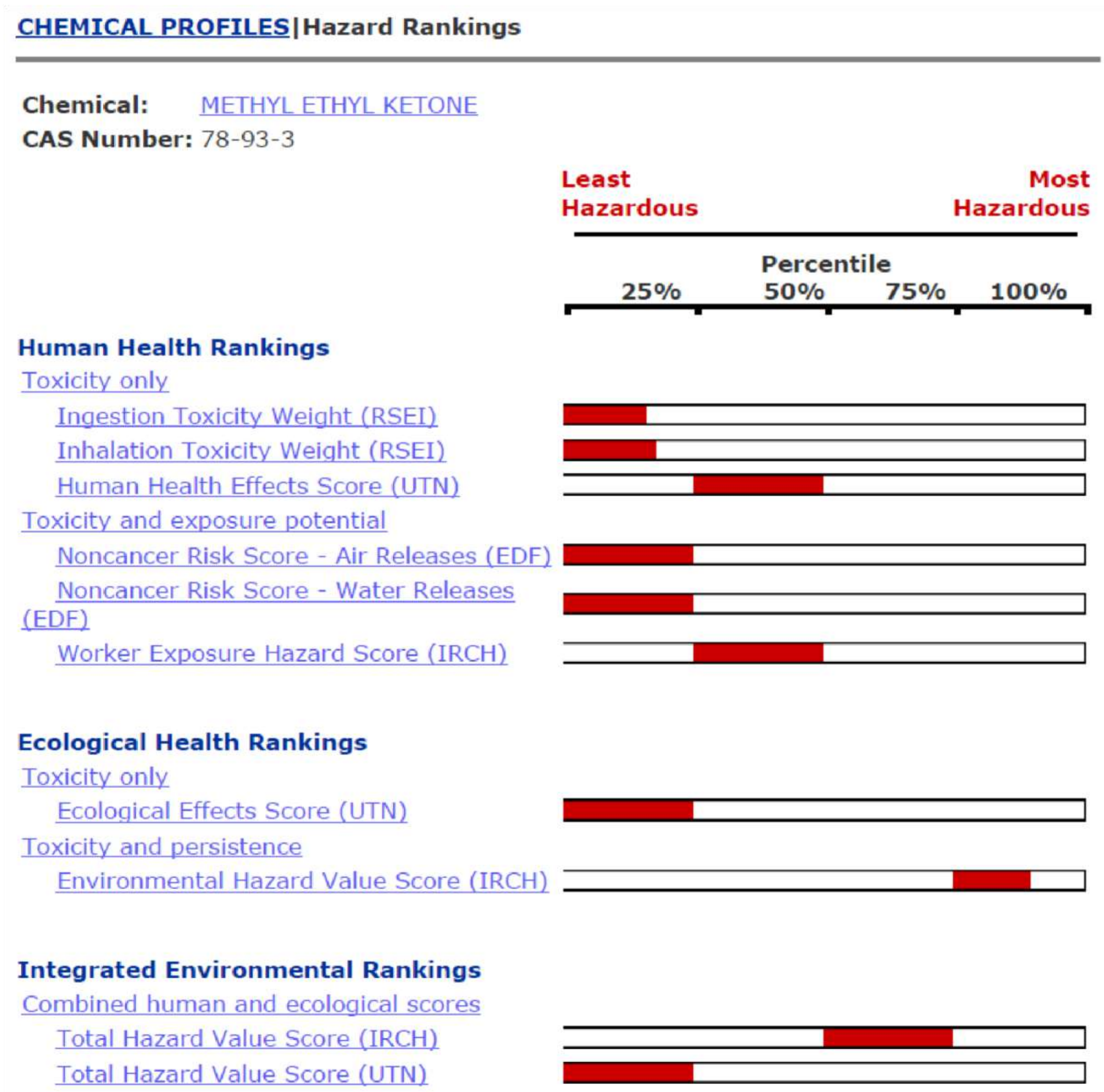
- Environmental Hazard Value Score (IRCH)
- Ecological Risk Screening Score (WMPT)

Integrated Environmental Rankings

Combined human and ecological scores

- Total Hazard Value Score (IRCH)
- Total Hazard Value Score (UTN)

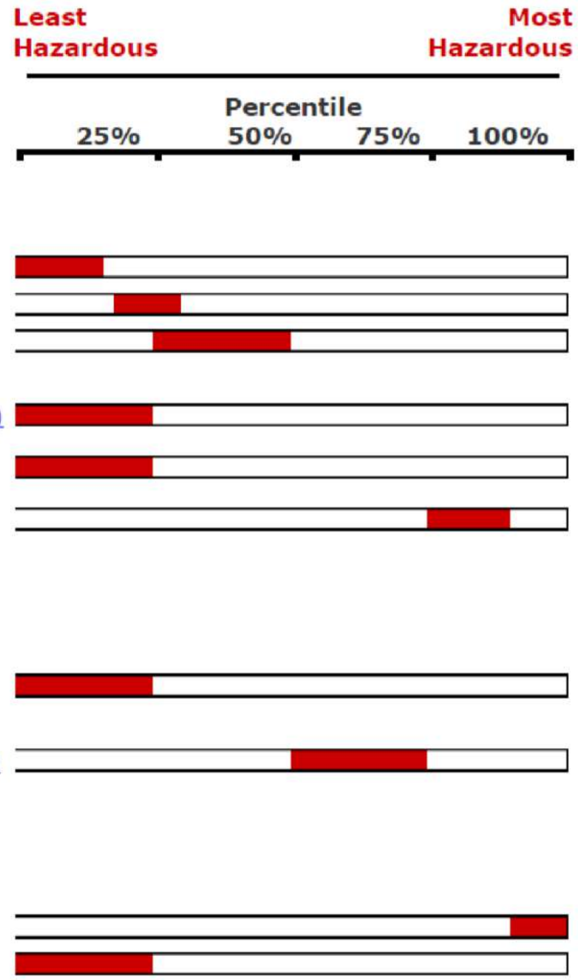
6.1.15 Methyl Ethyl Ketone



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

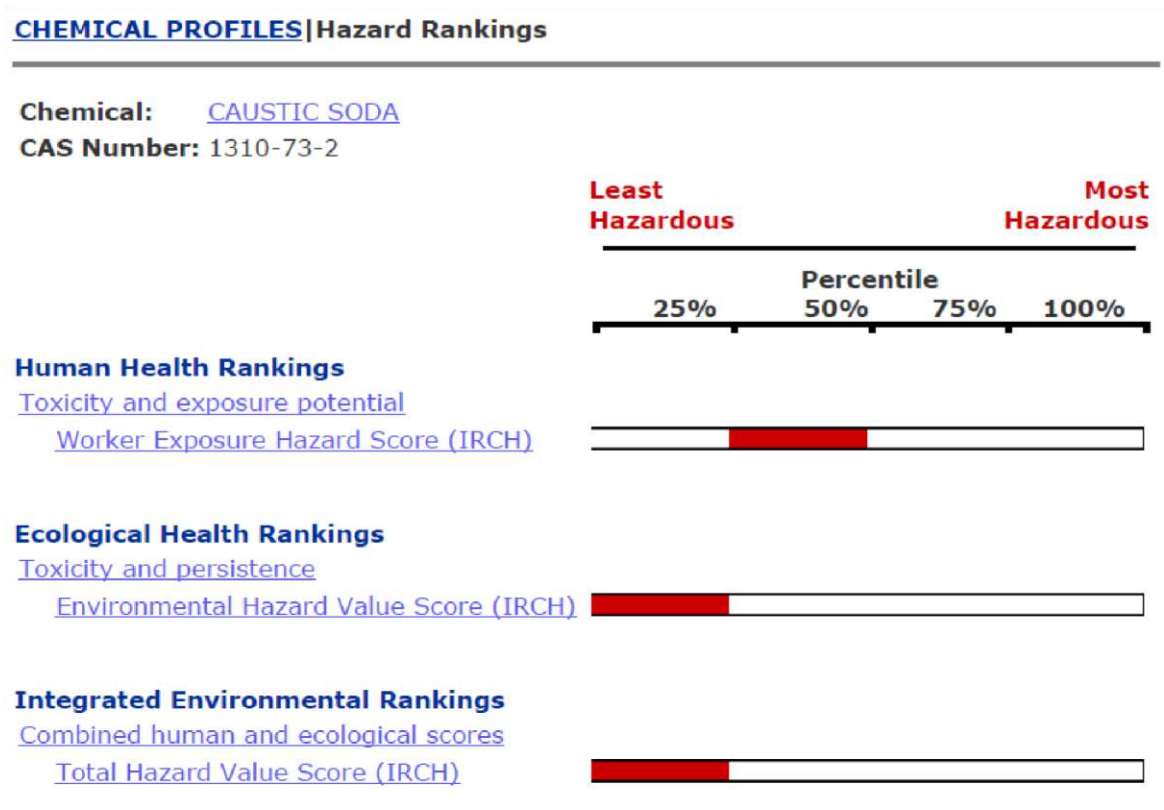
- Environmental Hazard Value Score (IRCH)

Integrated Environmental Rankings

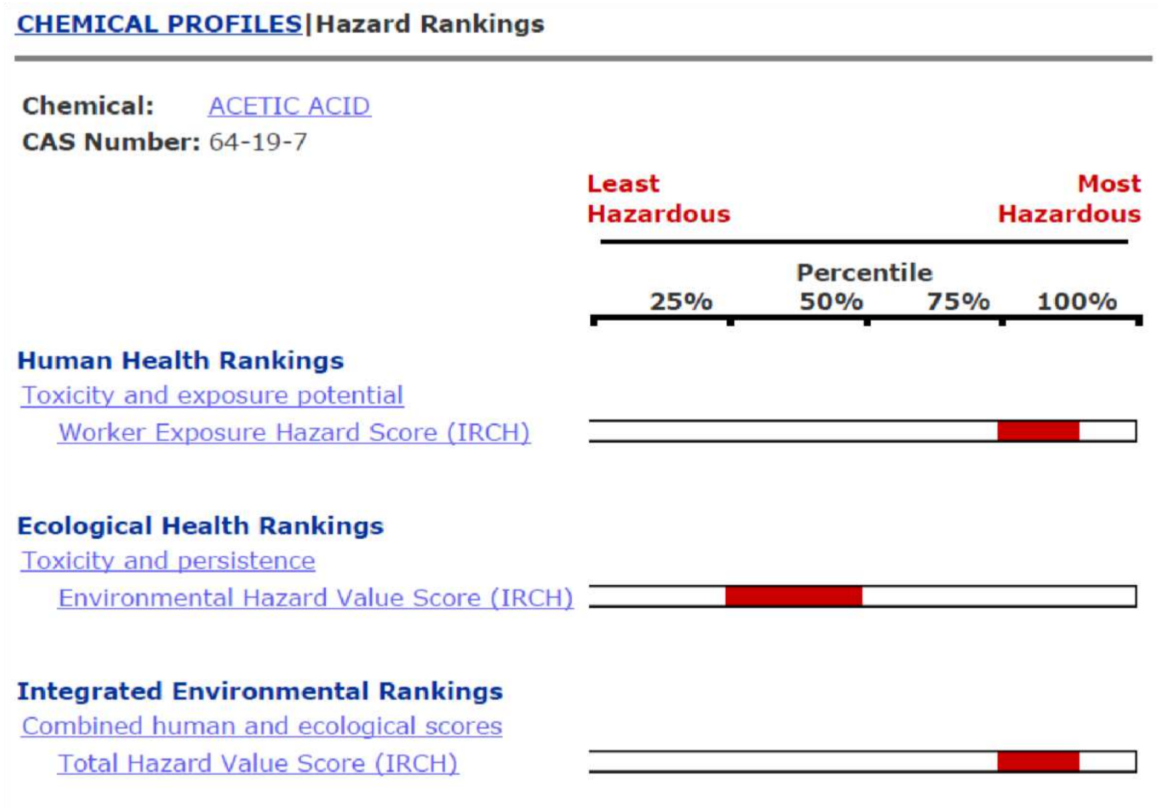
Combined human and ecological scores

- Total Hazard Value Score (IRCH)
- Total Hazard Value Score (UTN)

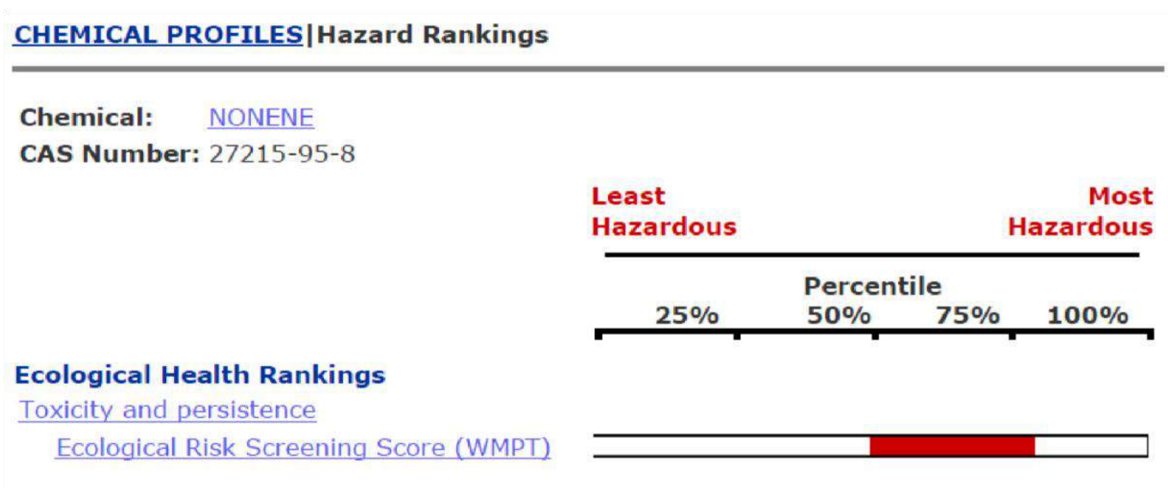
6.1.17 Caustic Soda



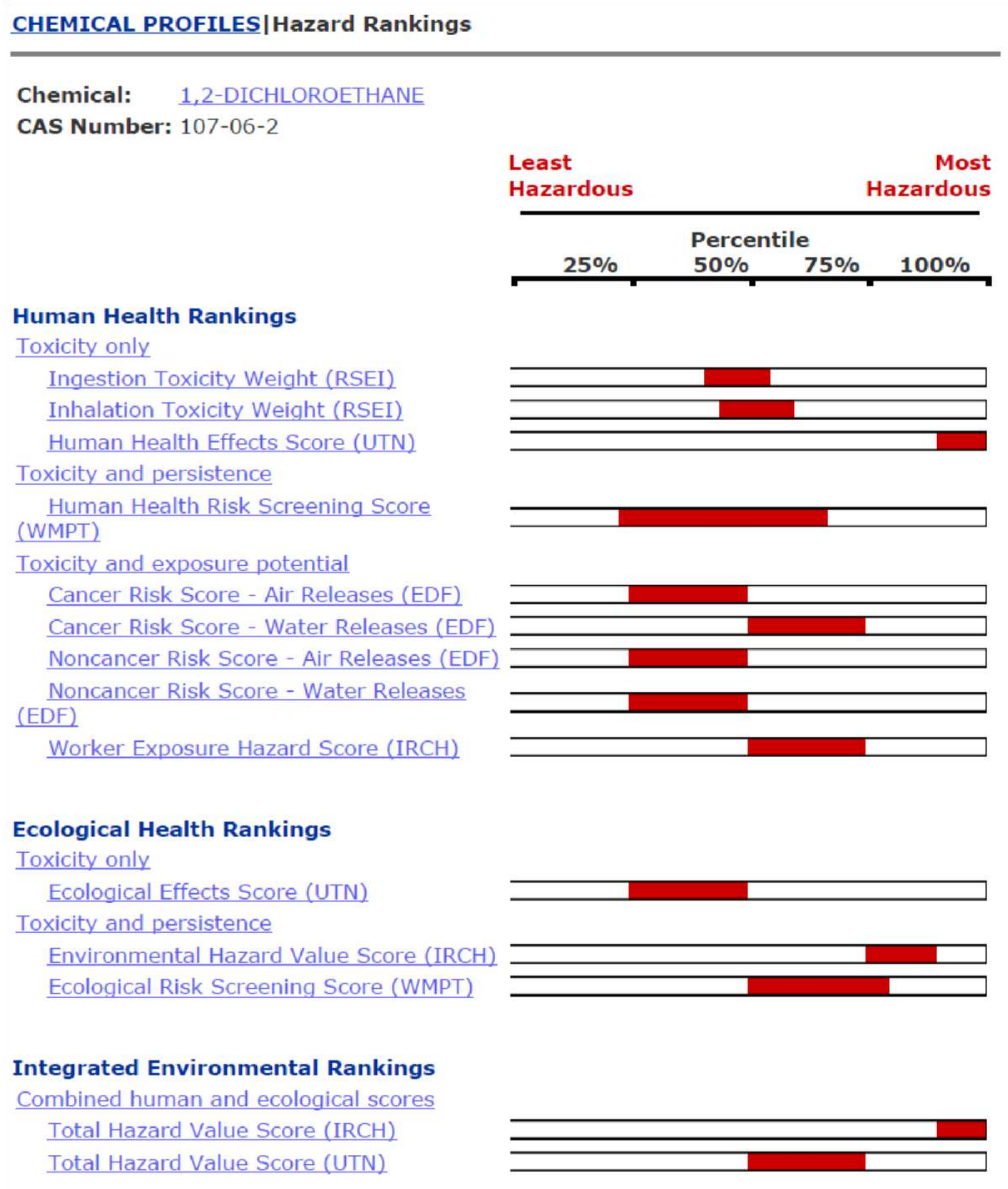
6.1.18 Acetic Acid


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

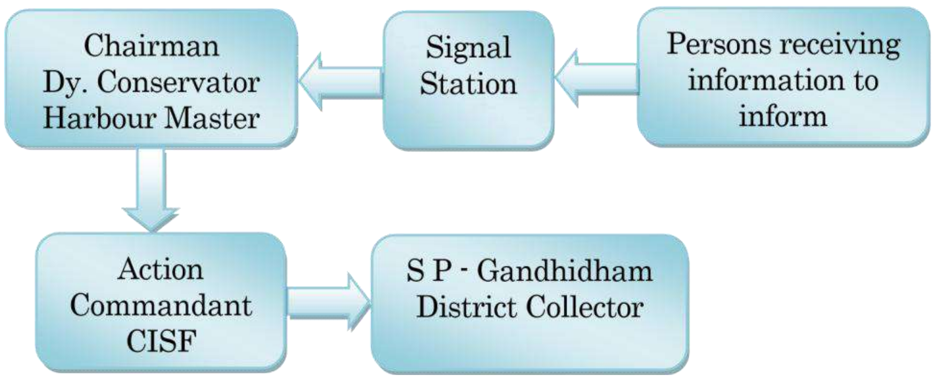
S. No	Designation	Present incumbent	Contact Telephone Numbers

			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.

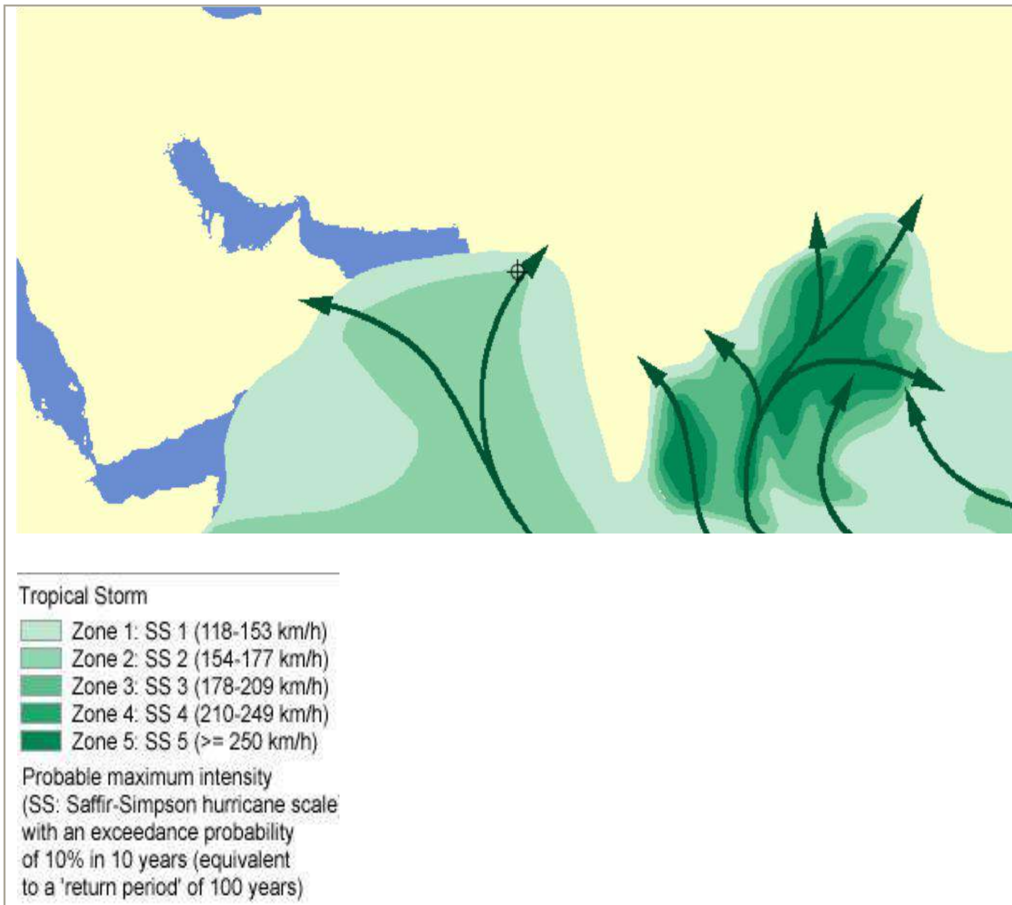
9 SEVERE WEATHER SITUATION

9.1 Act of God Perils (Cyclones Tsunami

9.1.1 Storms / Cyclone

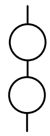
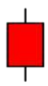
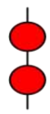
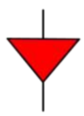
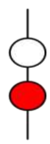
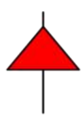
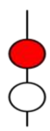
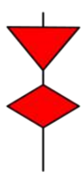
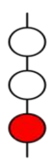
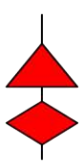
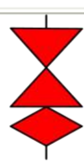
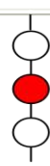
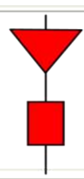
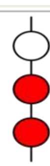
Even though Kandla is within the cyclone area of storms originating in the Arabian Sea and those that enter across the Indian Peninsula from the Bay of Bengal, cyclones are not as severe or frequent as in the Bay of Bengal. Historically, there has been major cyclone in the region in the year 1998.

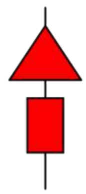
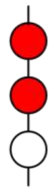
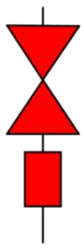
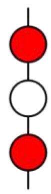
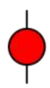
Hence the exposure to this peril is High.



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 communicat ion	Failure of Communication with Meteorological head quarters has broken down and the local officer considers that there is danger of bad weather.

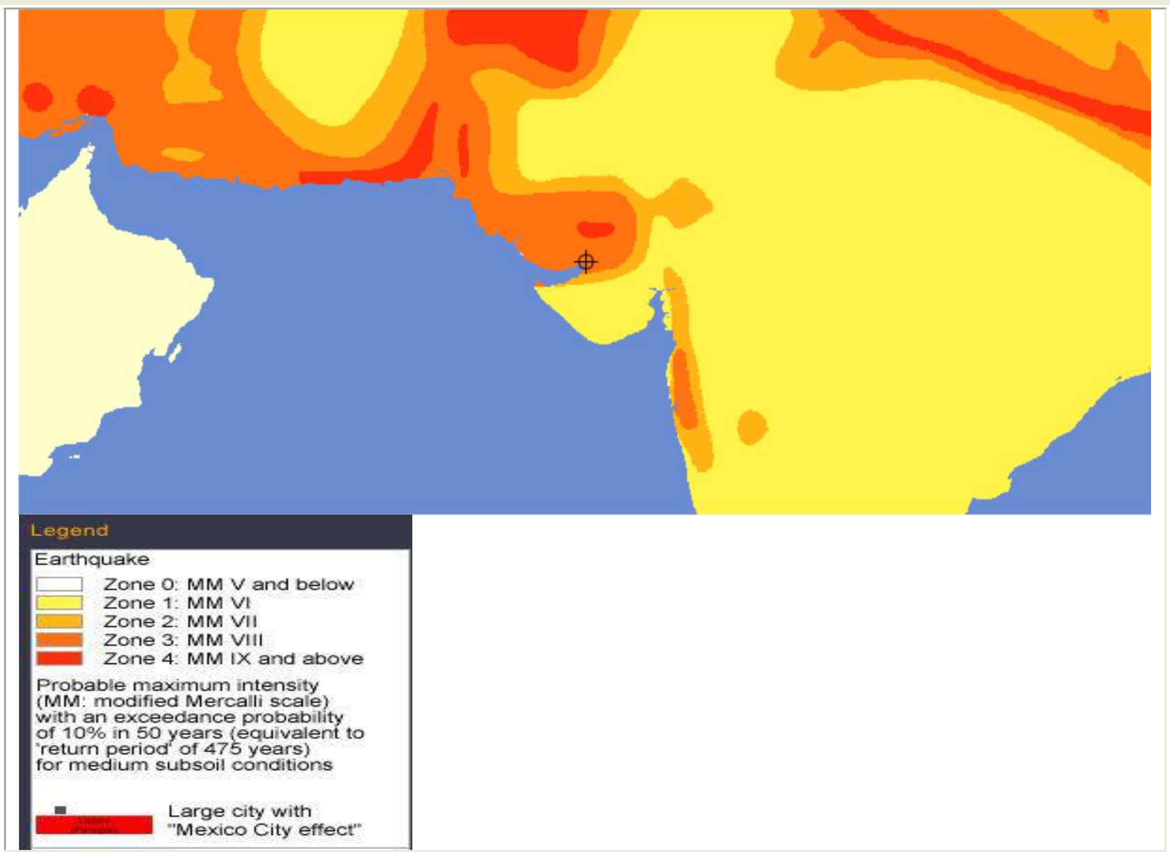
Red Light,

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.

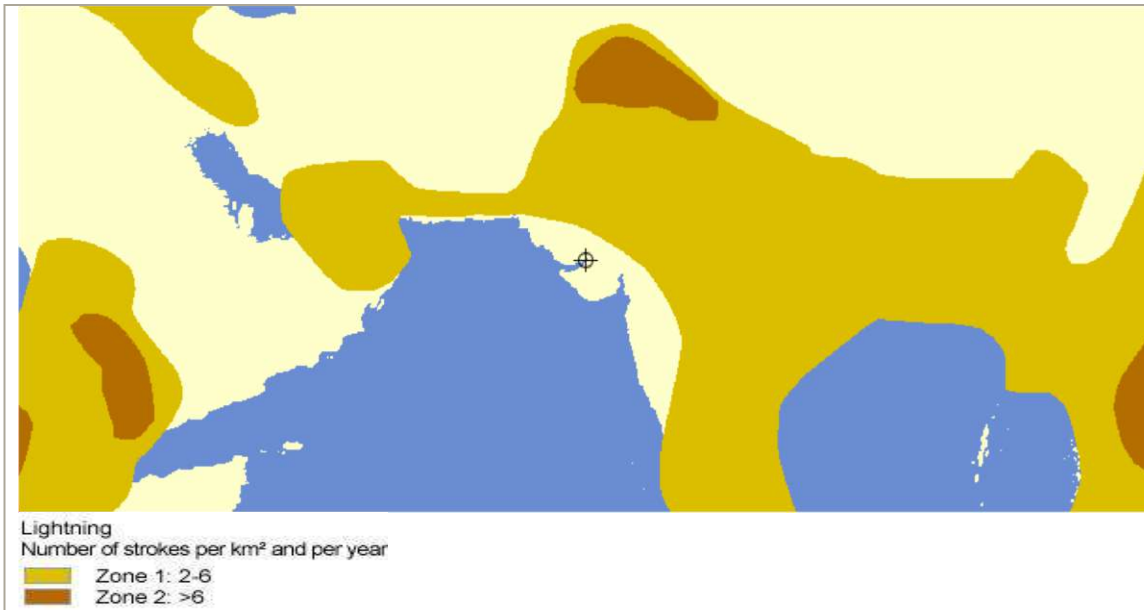
Thus taking the dynamic seismic scenario in to consideration risk exposure can be considered as High.



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.

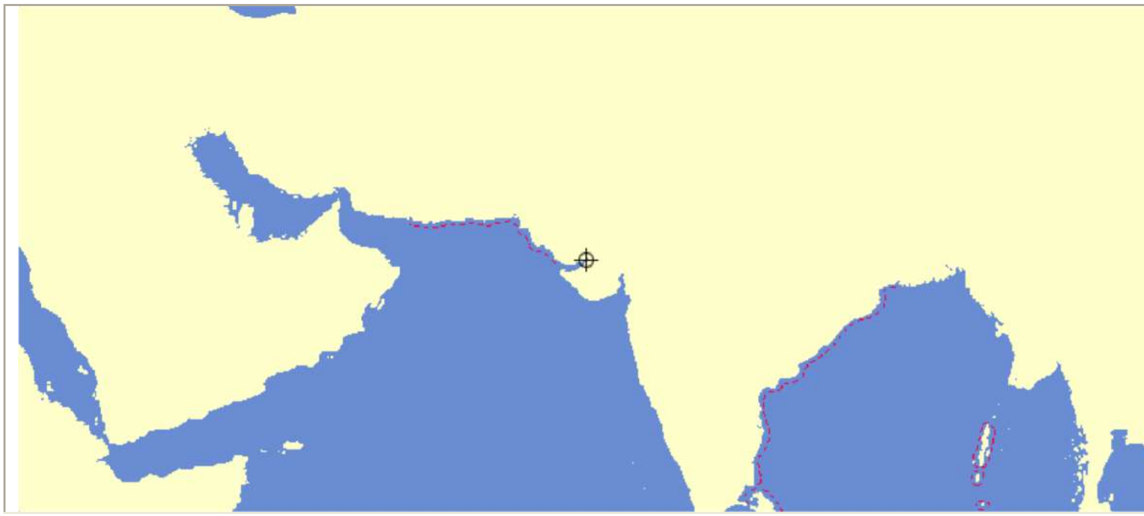
Thus risk exposure can be considered as moderate.



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.

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 F Chaturani Plot No.13, Sector 1, Gandhidham	Mr. Romesh / Ashwin Mr. Dayalbha 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

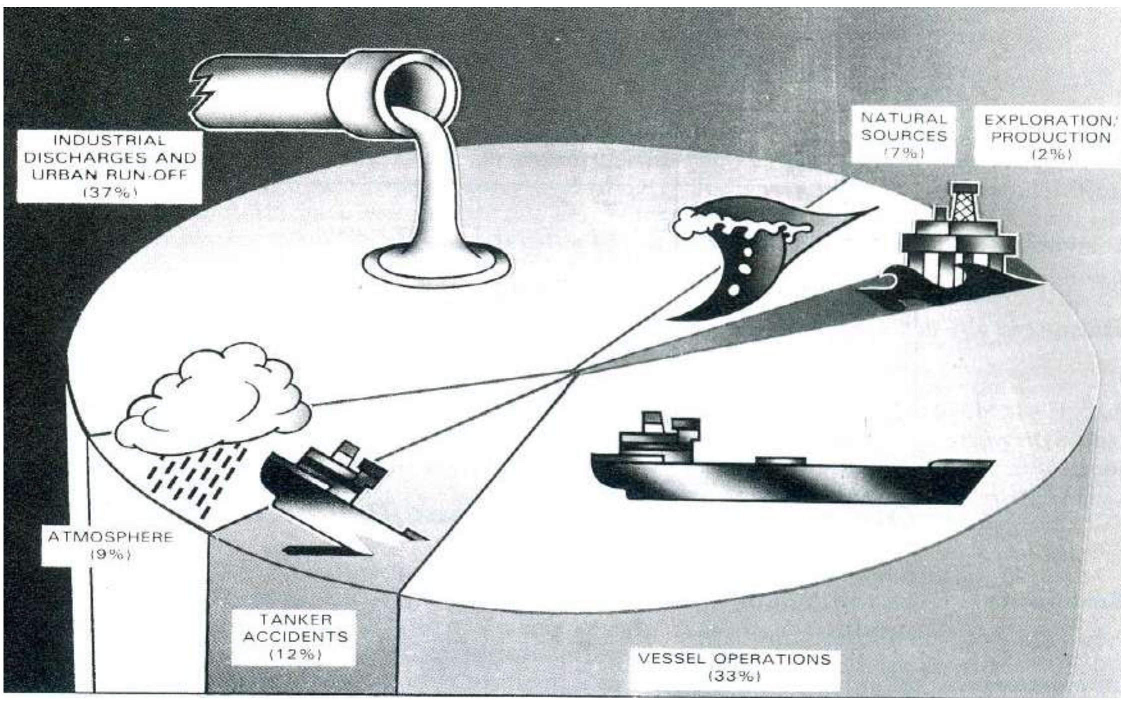
Periodical Meetings will be conducted with the Executive Engineer’s/ DSOs/Staff Member to assess the progress made during the day and to instruct further course of action in the matter.

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%)

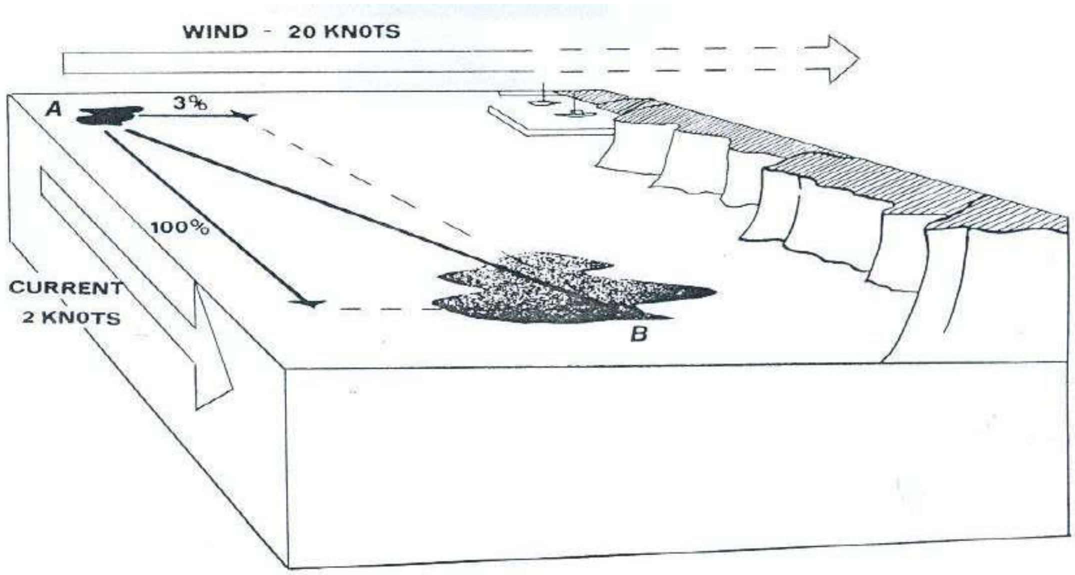
12.2 Forecasting Slick Movement

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.

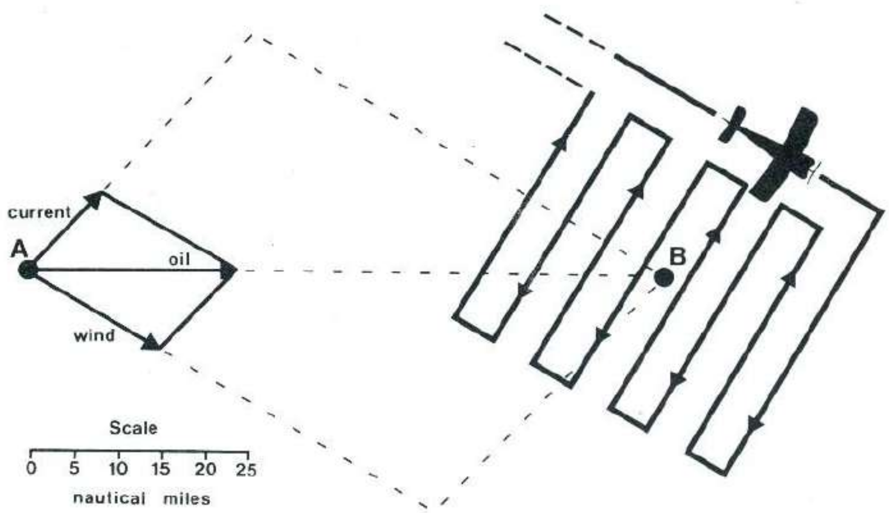
12.3 Aerial Surveillance at Sea

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

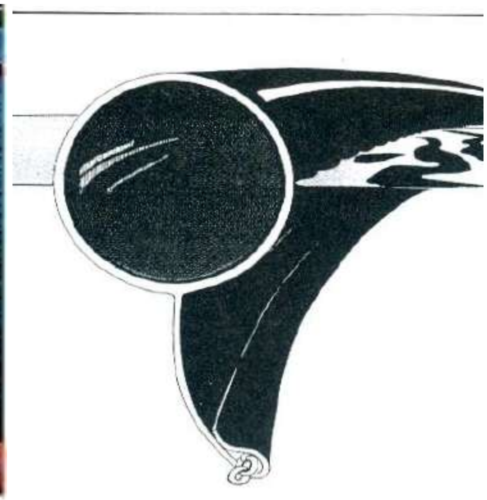
Designs vary considerably but all normally incorporate the following features:

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:

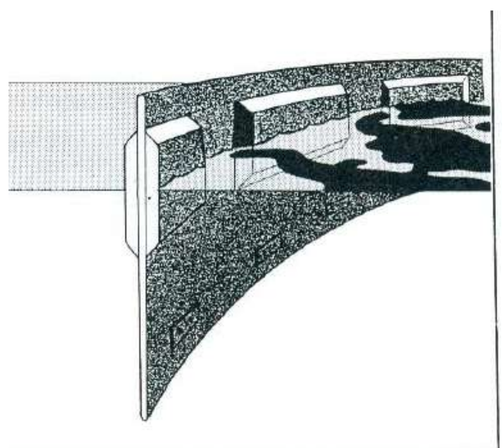
12.7.1 Curtain Booms

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.

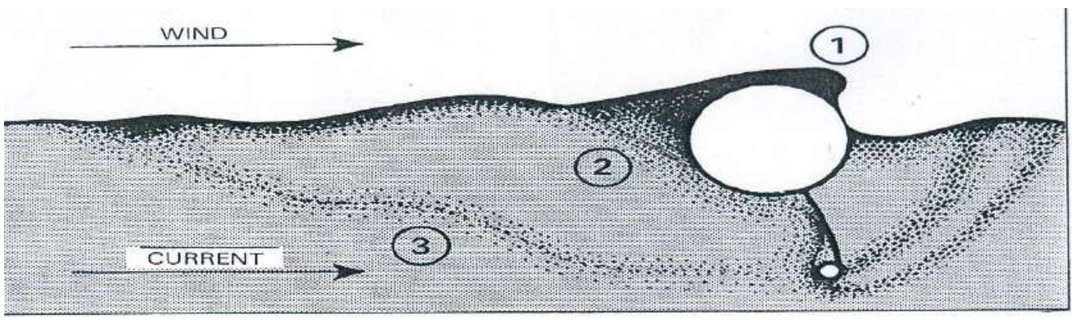
12.7.2.1 Common features

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

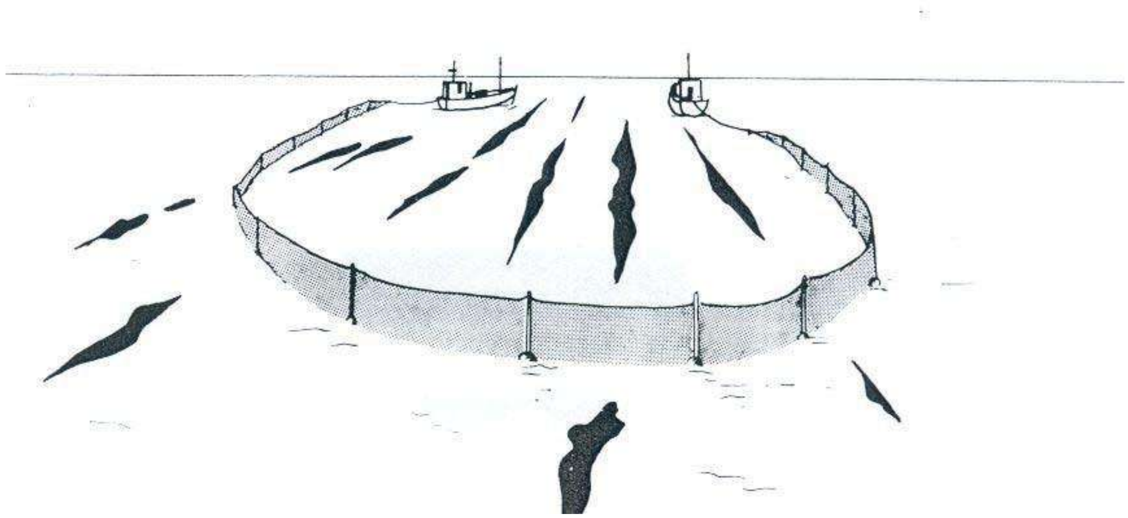
The use of nets to recover solid tar balls is an obvious application and the extension of their use to contain viscous oils theoretically presents a number of advantages over the use of conventional booms. In particular, the open structure should offer less resistance to water movement so that light 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

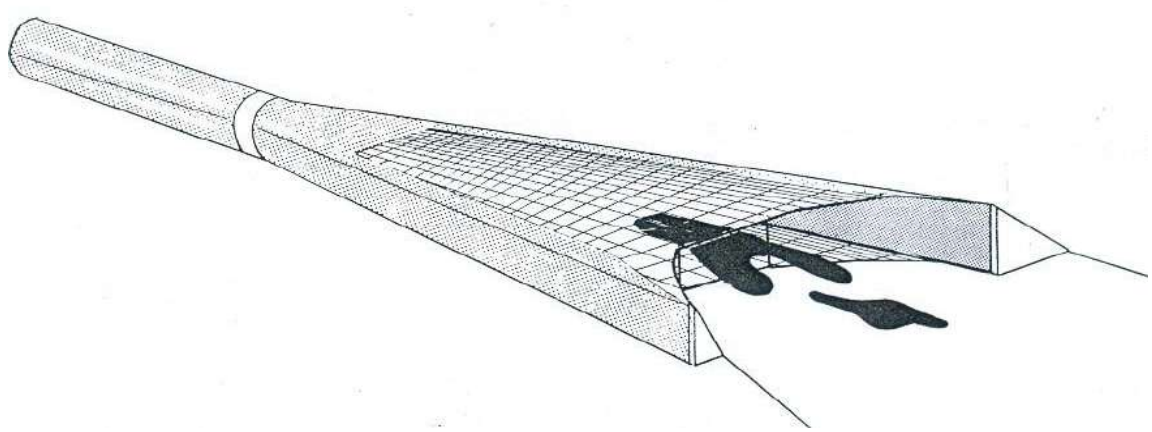
Two basic designs of net have so far been developed which draw on experience from the fishing industry a long double net based on the purse seine method of fishing which can be used to corral or collect floating oil or which can be moored to protect sensitive areas; and a trawl net with a detachable ‘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.

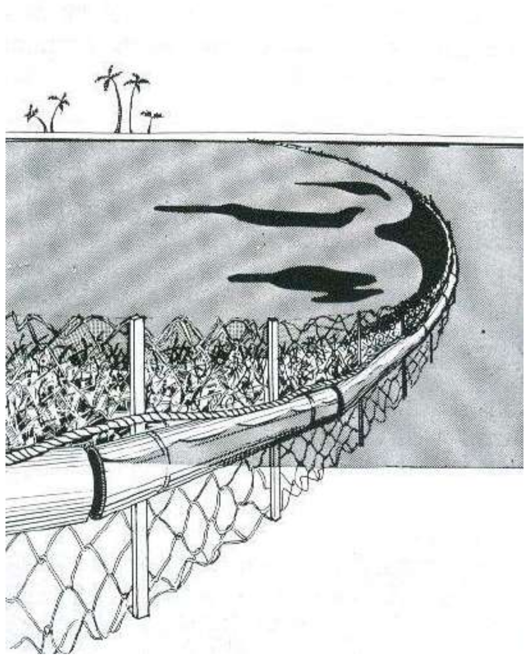


Oil trawl for collecting floating solid oil into a detachable cod-end.

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.

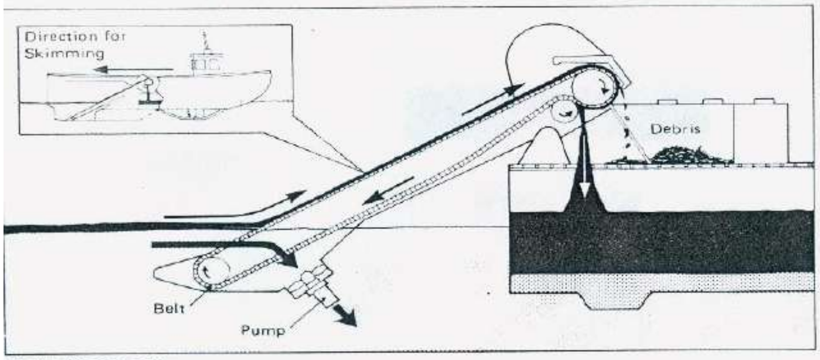
12.9.1.1 Recovery

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.

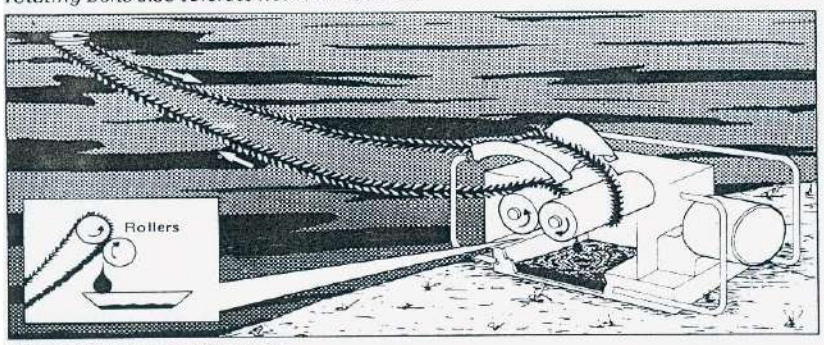
12.10 Skimmers

ADHESION DEVICES

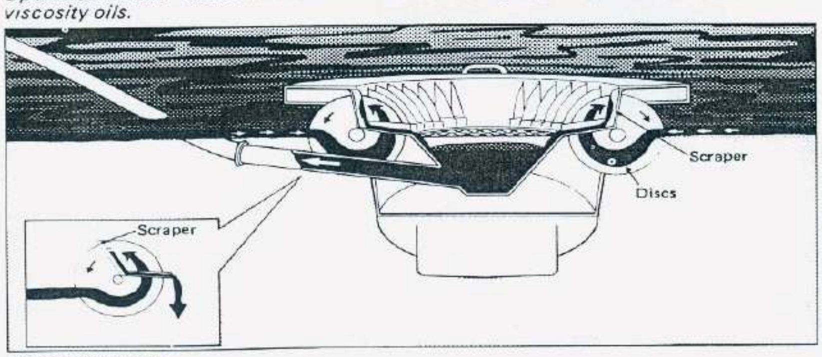
SUCTION DEVICES



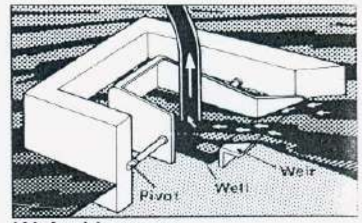
Belt skimmers
A belt conveys the oil from the water surface by adhesion. Upward rotating belts carry the oil to their top limit where it is scraped or squeezed off into a storage tank. Conversely, downward rotating belts first submerge the oil which then surfaces behind the belt, due to its buoyancy, into a defined area within the vessel. Operational limit – for upward rotating belts 0.5 knots, sea state 1; for downward rotating belts 2 knots, sea state 2. Preference – medium viscosity oils but upward rotating belts also tolerate heavier material.



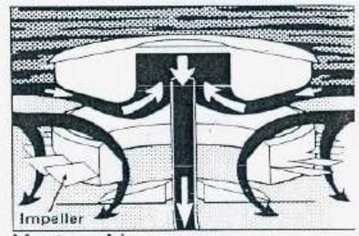
Oleophilic rope skimmers
A central tension core rope, through which is interwoven oleophilic strands forming a long continuous mop. The floating mop is pulled by powered rollers around a return pulley. The rollers squeeze the oil into a storage tank. Operational limit – sea state 3. Sensitive to increasing viscosity. Preference medium viscosity oils.



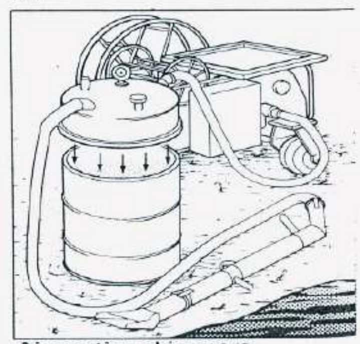
Disc skimmers
Discs rotate through the oil/water interface. Oil adheres to the disc surface, is removed by scraper to a central collection point and is pumped to storage. Operational limit – sea state 2. Sensitive to emulsified oils, waves, debris. Preference – medium viscosity oils.



Weir skimmers
Oil flows over a self-levelling weir into the well of the skimmer and is pumped to storage. Operational limit – sea state 1. Sensitive to higher viscosity oils, emulsified oils, waves and debris. Preference – free-flowing oils.



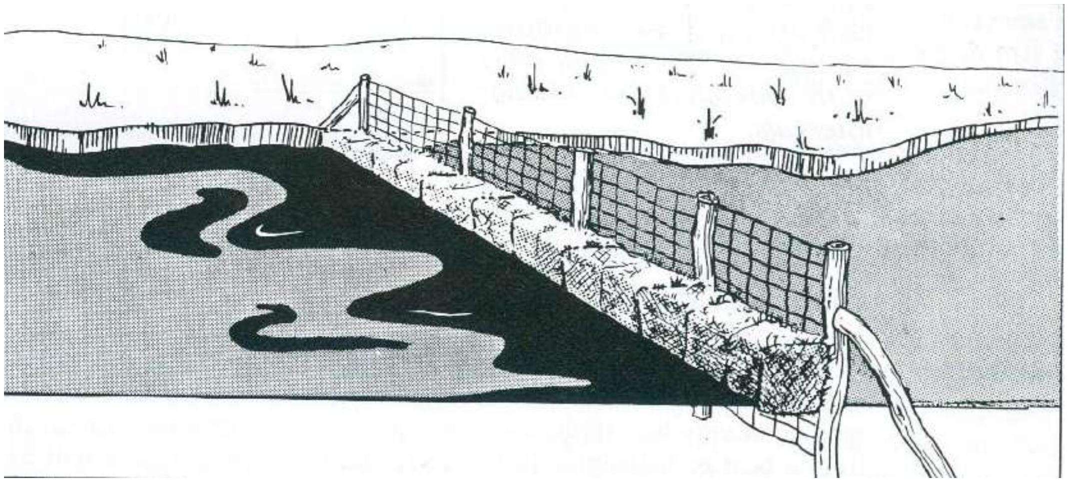
Vortex skimmers
A vortex induced by an impeller causes the oil to concentrate at the centre of the vortex due to centrifugal effects. The collected oil is pumped from the top and the free water released from the bottom. Operational limit – sea state 2 and 0.5 kt water movement. Sensitive to debris. Preference – free-flowing oils.



Air suction skimmers
Vacuum system or an air conveyor attached to a hose which may be fitted with specially designed skimmer heads. The pumping of more viscous materials is possible by increasing the water content. Operational limit – sea state 3. Vacuum systems more sensitive to debris. Preference – light to medium viscosity oils but air conveyors can tolerate high viscosity oils.

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.,	Mr. AK. Khanna Sr. Term. Manager	233274 (O) 229002 (R)	9427216637
	Main Terminal, GIM	Mr. KS Rao, Sr.TM	270394 (O)	9426416108

	Foreshore Terminal, Kandla		270628 (O) 270477 (O) 233359 ®	
	KBPL	Mr. PS Negi Plant Manager	270978 (O) 236944 ®	9426725342
	LPG Import Plant			

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.

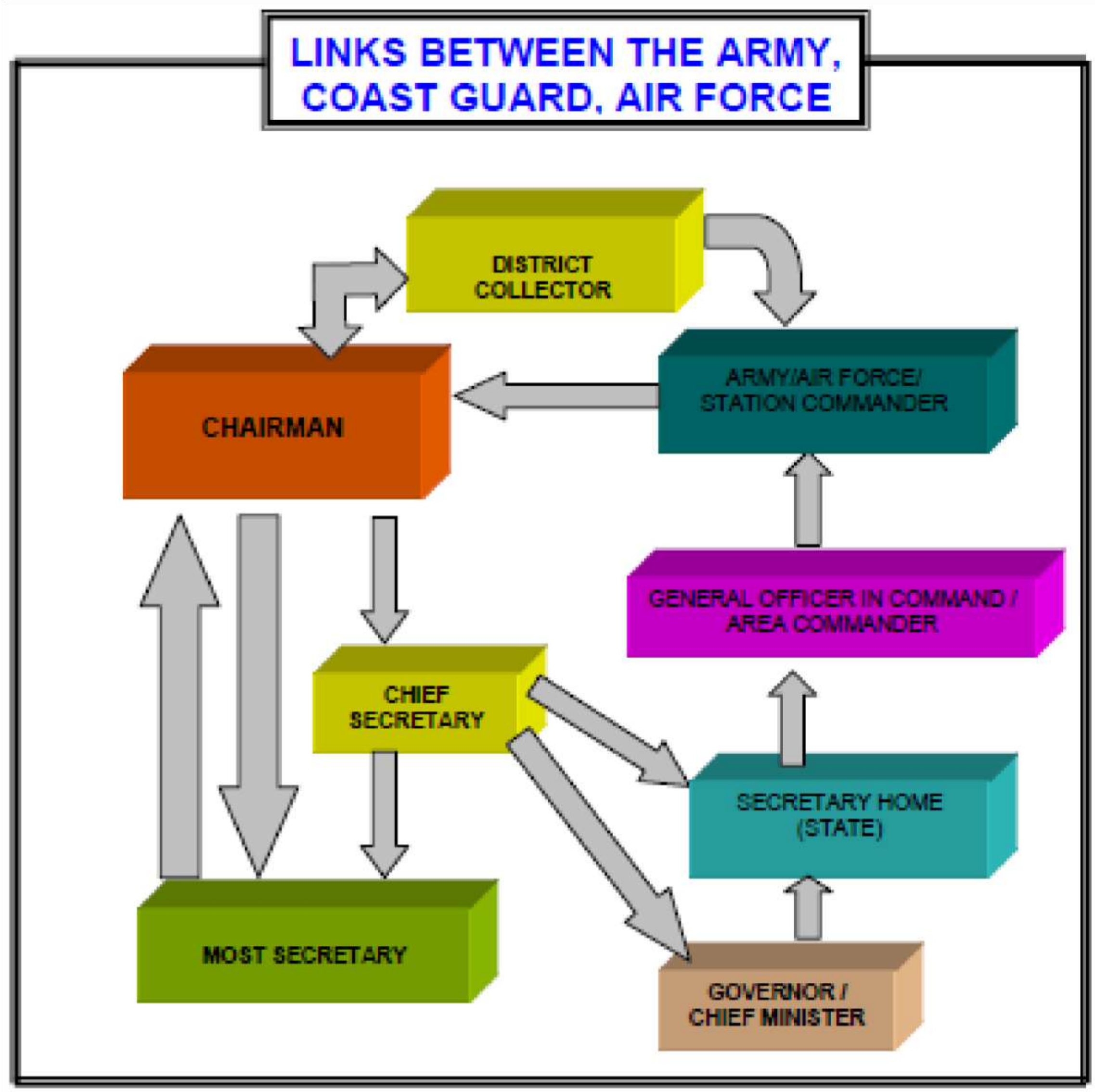
The Chairman / Deputy Chairman would be the coordinating officials for liaisoning with the Station Commander (army, navy as well as air force) after consulting the District Administration.

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

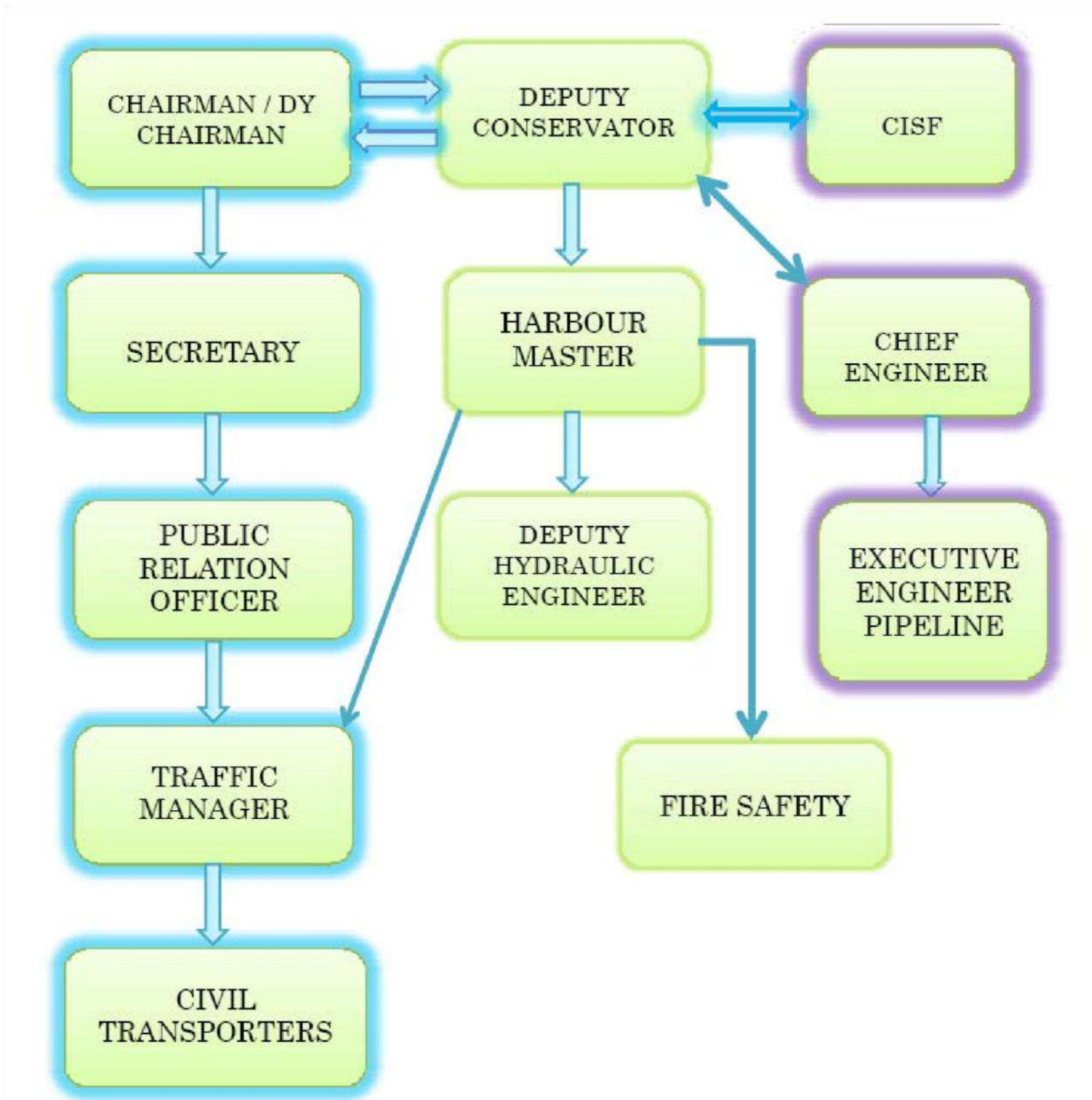
③ Administrative function

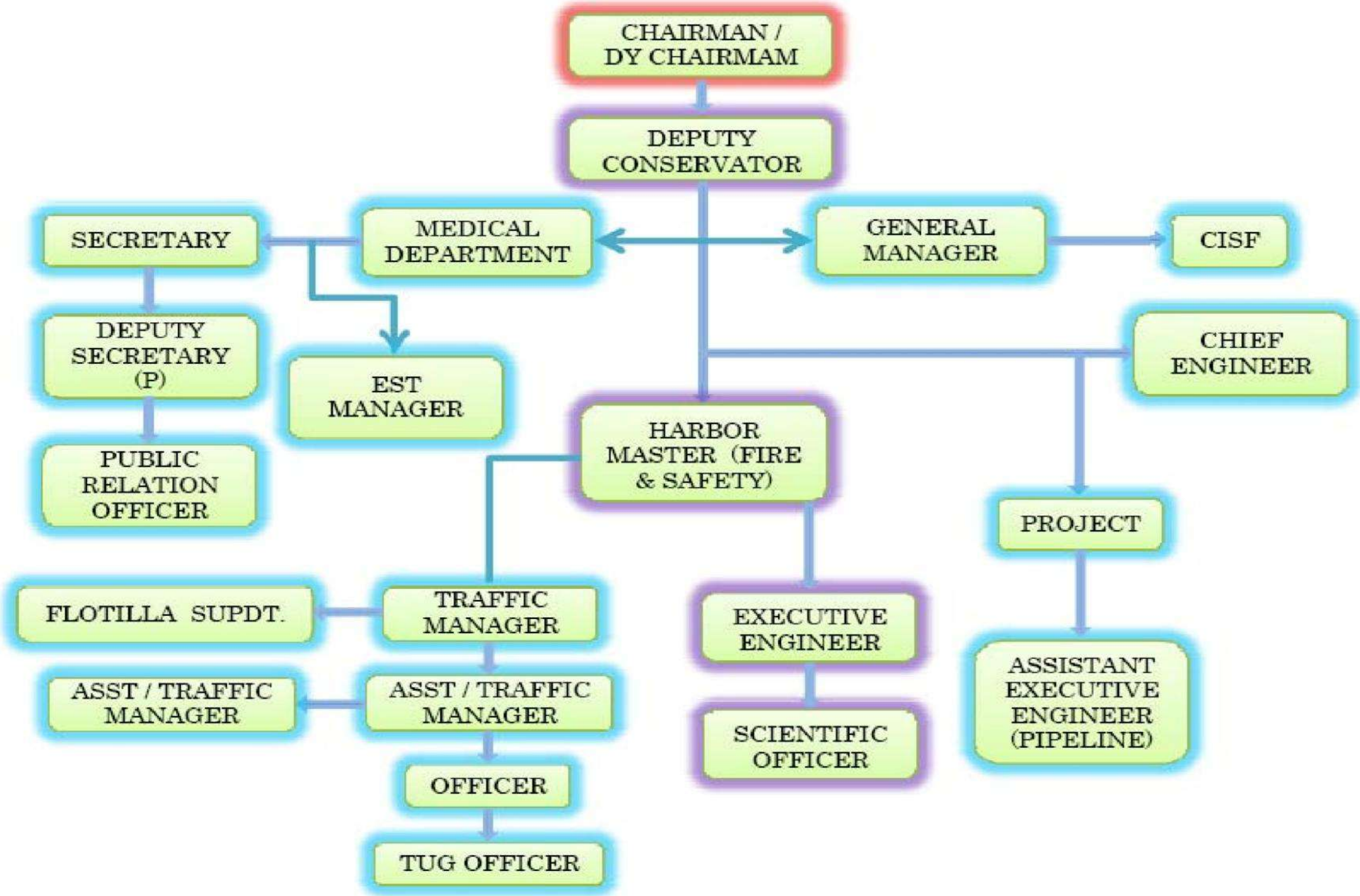
EMERGENCY NOTIFICATION SHEET	
1.	Plant / Location Name ______________________________ Unit ______________________________ Address of Plant / Site ______________________________
2.	Date ____________________ Time of Call ______________
3.	Caller's Name ______________________________ Caller's Position ______________________________ 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&Admn 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.

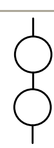
19.16.7 Important Telephone Nos of IMD http://www.imdahm.gov.in/index.html

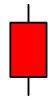
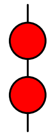
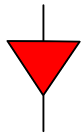
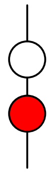
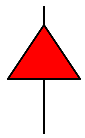
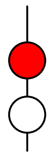
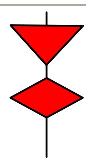
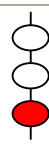
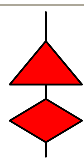
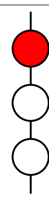
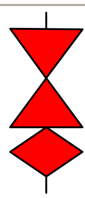
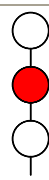
19.16.8 List of Vehicle Hire / Transport Travel Contractors at Jamnagar

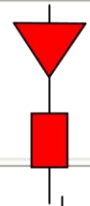
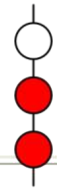
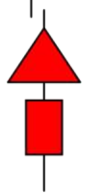
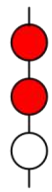
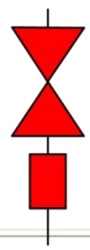
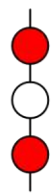
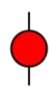
Sr.No	Name and address of Transport / traveler	Telephone
1	Pavan Travels, Pancheshwar tower, Jamnagar	2552002
2	Patel Travels, Pancheshwar tower. Jamnagar	2552419 /

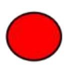
		2660243
3	Ashwamegh Travels, Jamnagar	2670613
4	Sheenath Travels, Jamnagar	2663315 / 2662215
5	Royal Travels, Opp. Town Hall, Jamnagar	2553333 / 2553636
6	Pruthvi Travels, Sikka Patia, SIKKA (Jamnagar.)	244466
7	Shree Divya Travels, Jamnagar	2677601
8	Payal Travels, Jamnagar	2551514 / 2551415
9	Gujarat 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

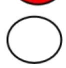
19.16.9 Chart of Weather Warnings

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: 20° 30’ 34 “ N LONG: 69° 42’ 04 “ E	LAT: 22 ° 30’ 14.36 “ N LONG: 69° 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 Fightng 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**	

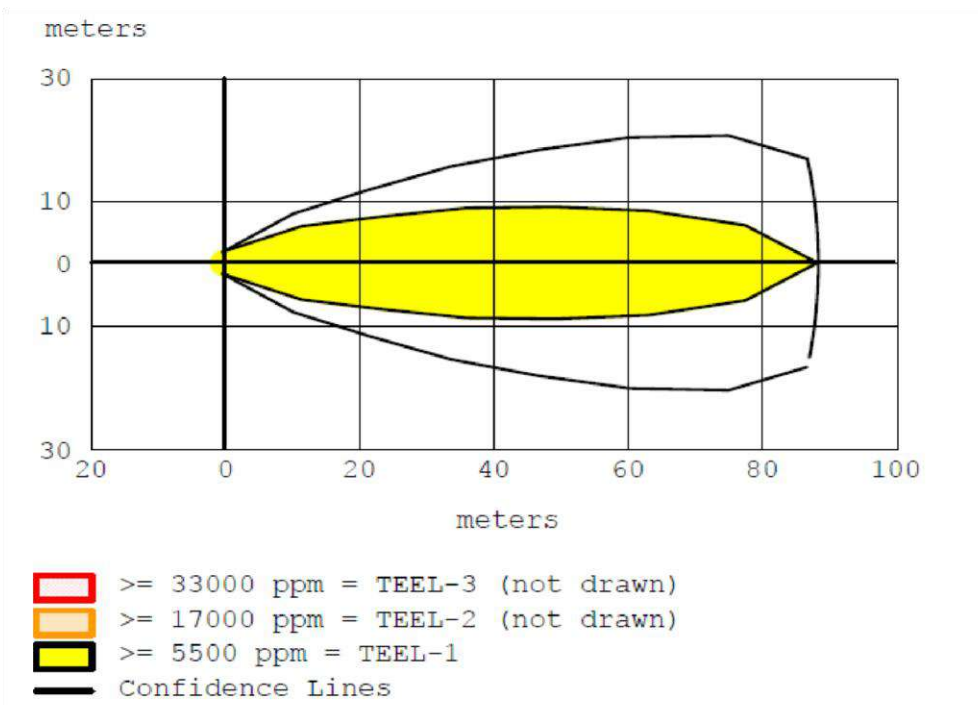
	CO_2 Type	33 Nos.
	2.0 Kg	13 Nos.
	3.2Kg	Nil
	4.5 Kg.	15 Nos.
	6.8 Kg.	05 Nos.
	DCP Type	27 Nos.
	5 Kg	01 No
	10 Kg	20 Nos.
	75 Kg	06 Nos.
5	**Fixed Fire Fighitng Facilities**	
	Fire Water Mains (size) and date of Pressure Testing	8" Dia tested on July'10
	Fire water pond/tank (no. and capacity)	2 nos 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

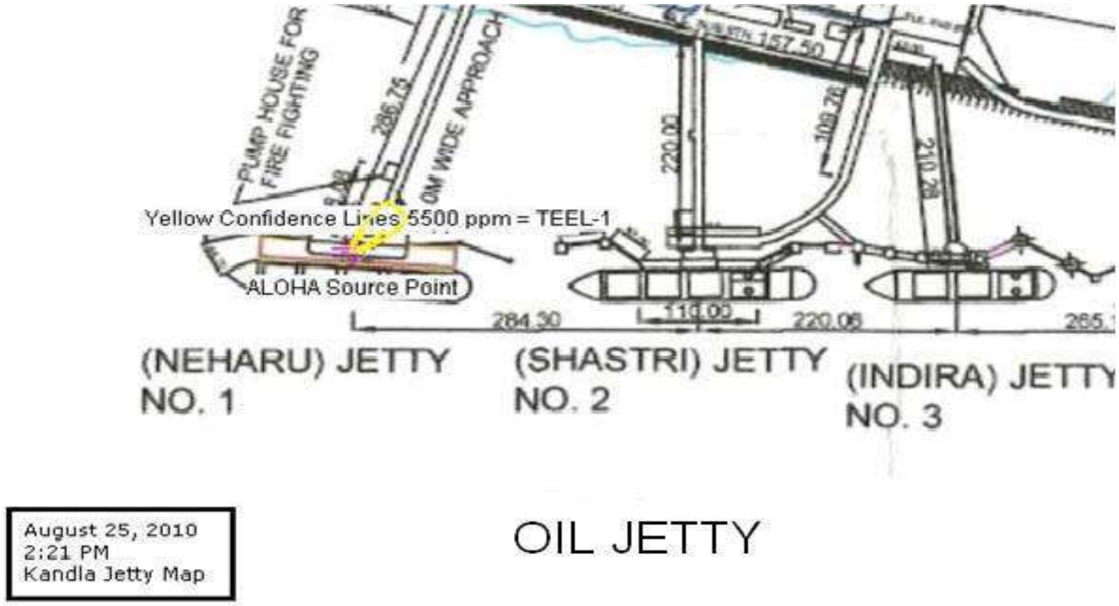
20.1 Graphs & Contours of various MCLS worked out at Jetty (Refer Chapter 4.7)

20.1.1 Jetty One – LPG

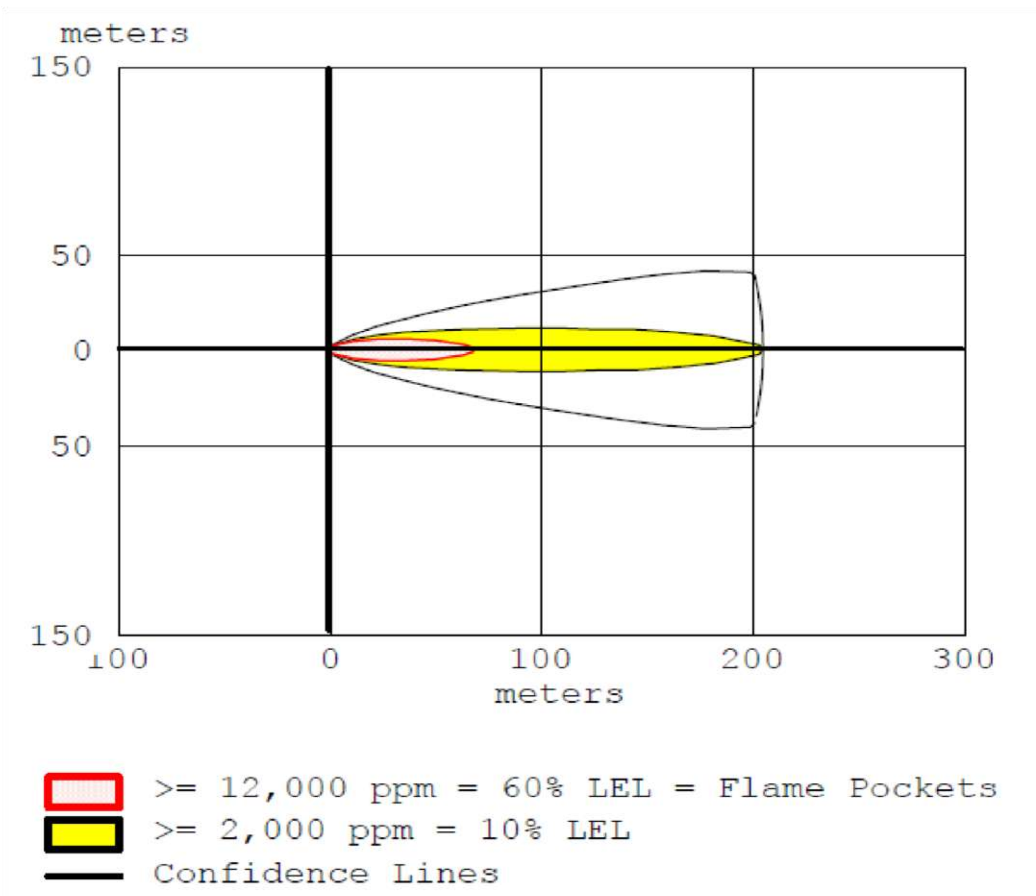
20.1.1.1 Instantaneous Release – Toxic Threat Zone (Graph)



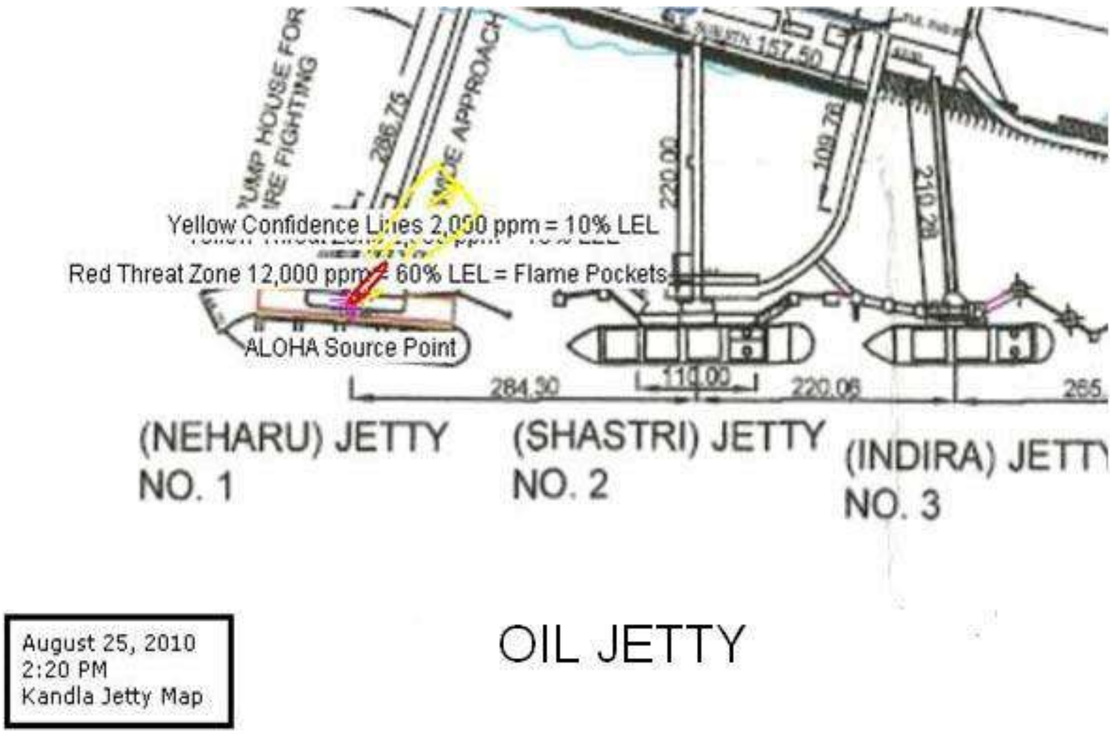
20.1.1.2 Instantaneous Release – Toxic Threat Zone (Contour)



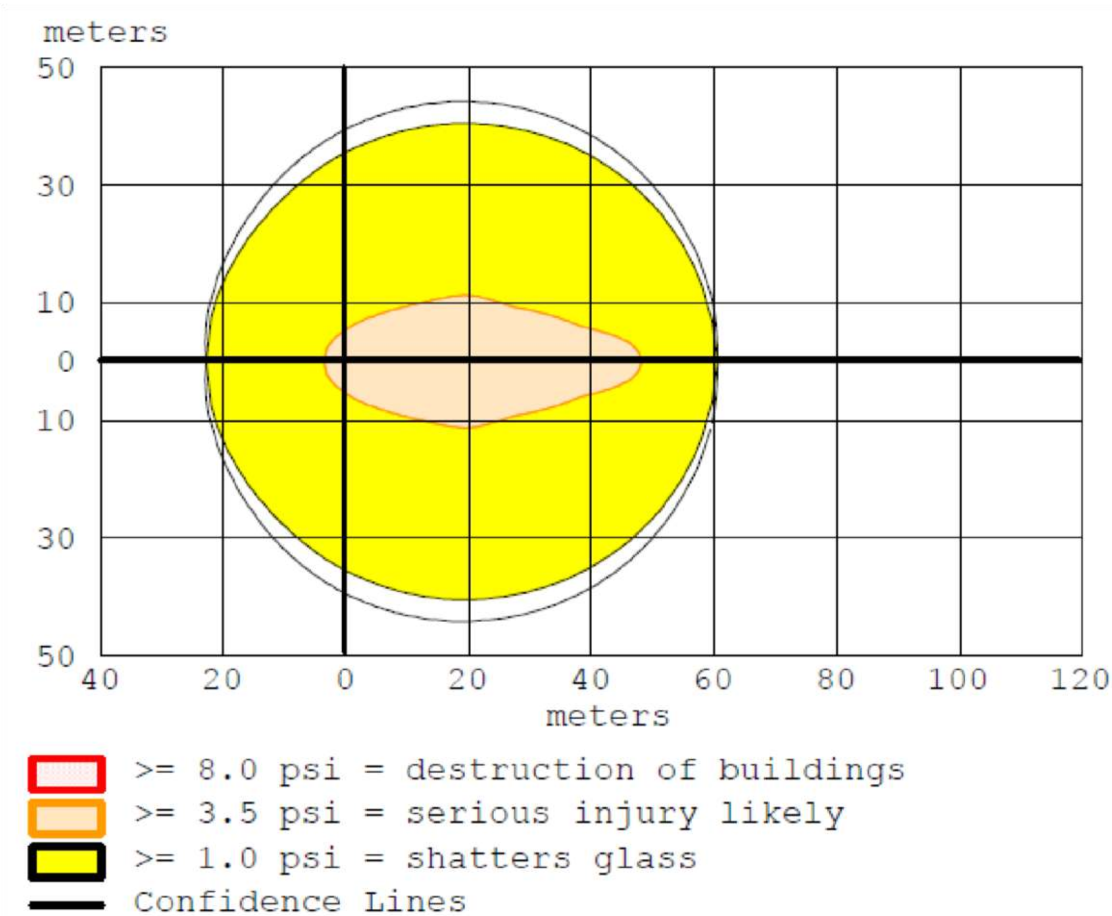
20.1.1.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



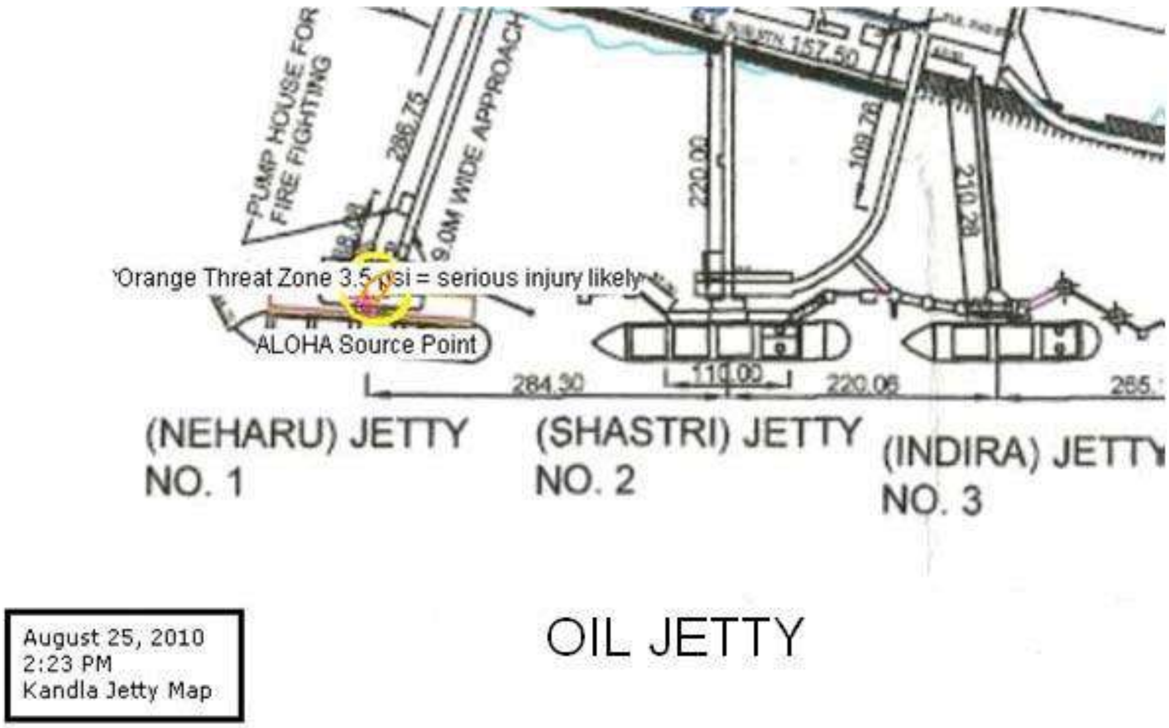
20.1.1.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



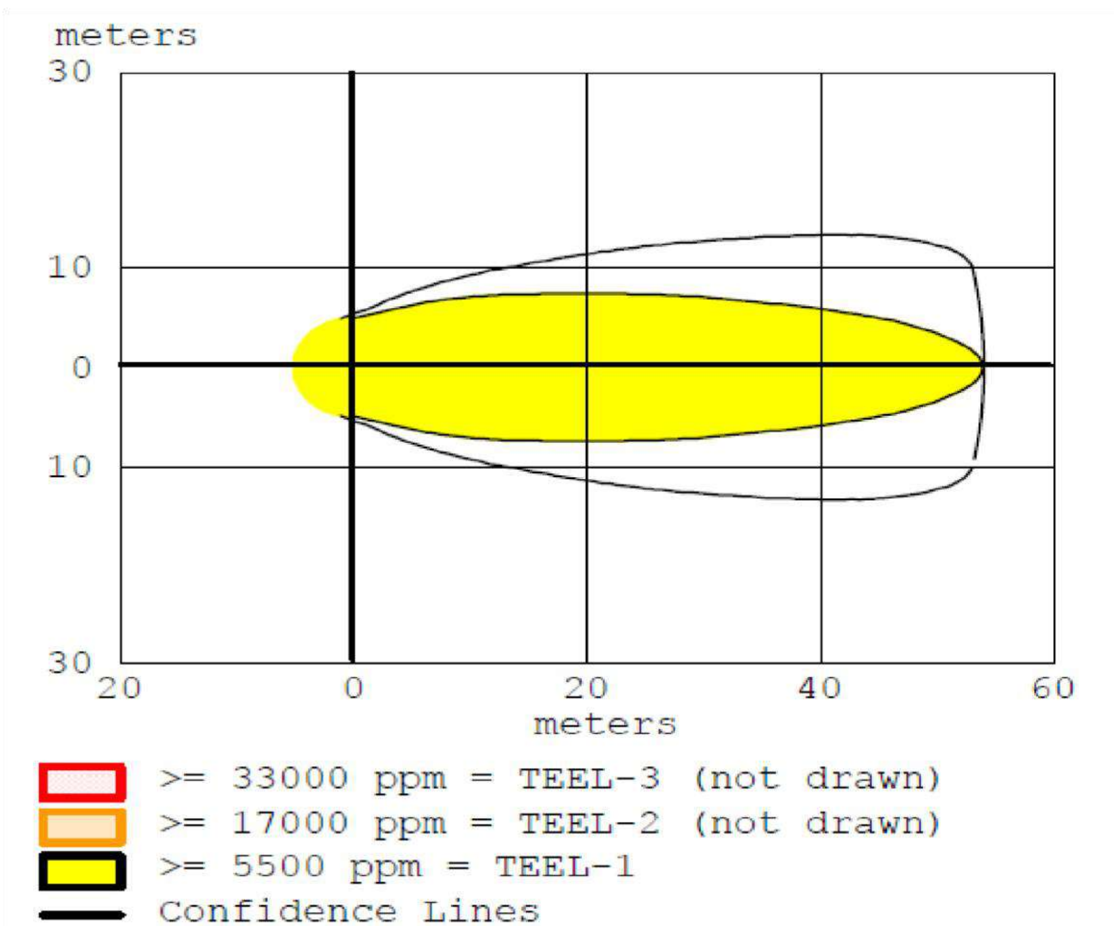
20.1.1.5 Instantaneous Release – Overpressure (Graph)



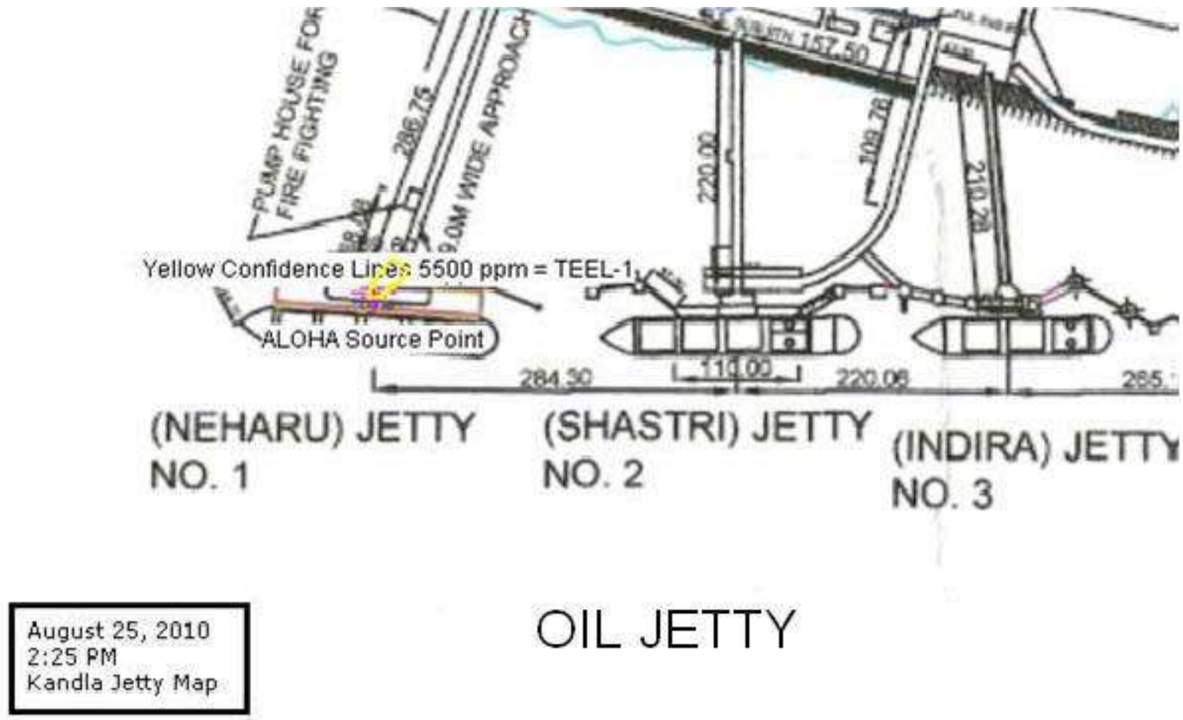
20.1.1.6 Instantaneous Release – Overpressure (Contour)



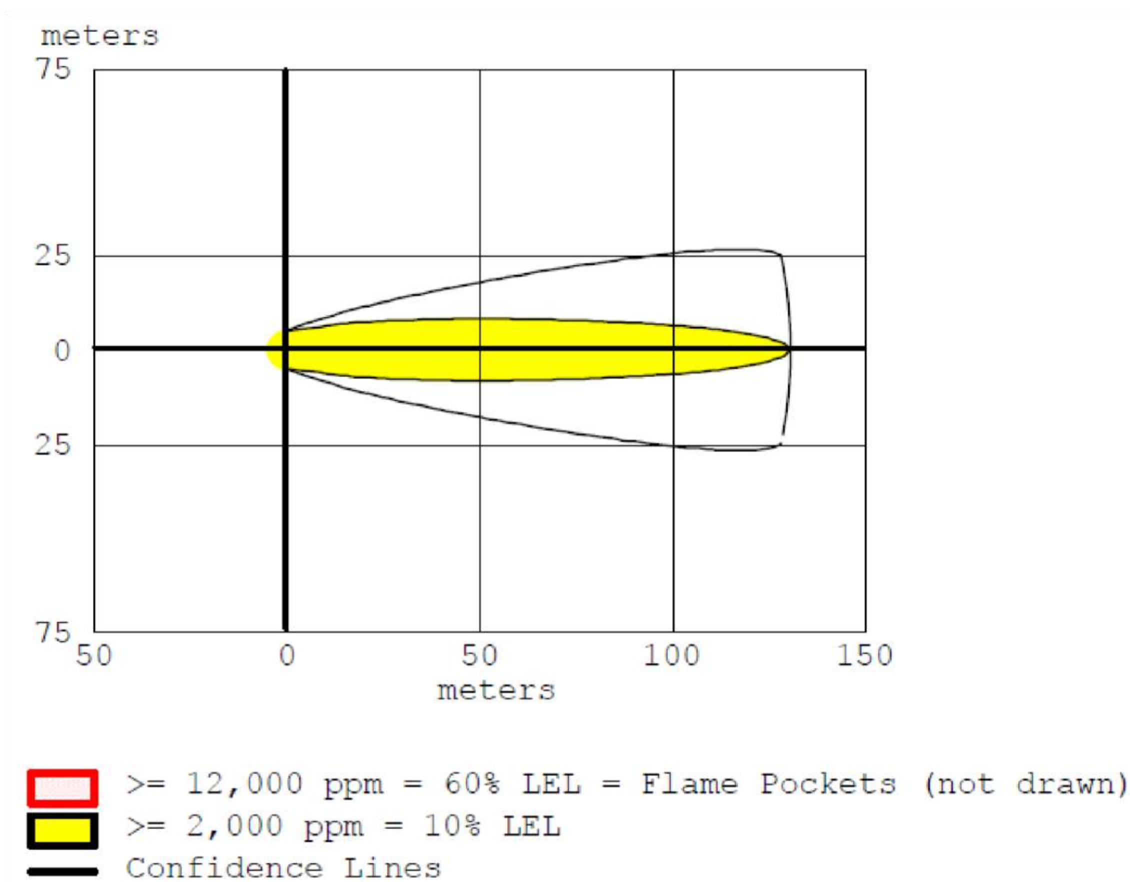
20.1.1.7 Evaporating Puddle – Toxic Threat Zone (Graph)



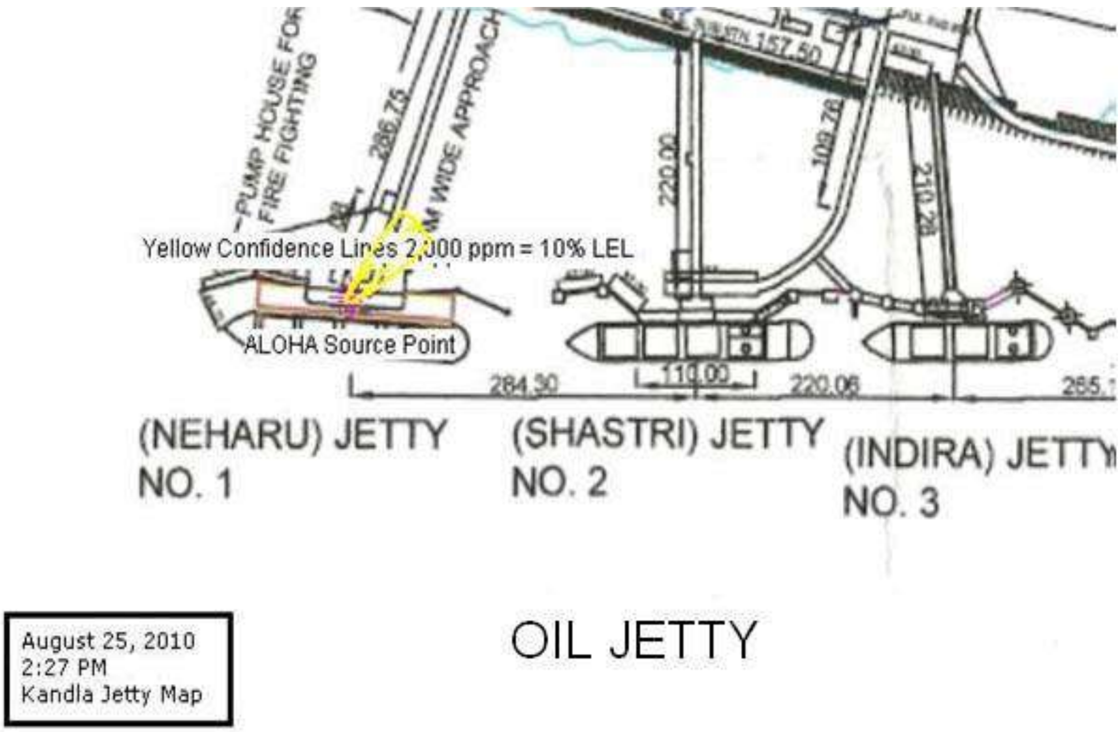
20.1.1.8 Evaporating Puddle – Toxic Threat Zone (Contour)



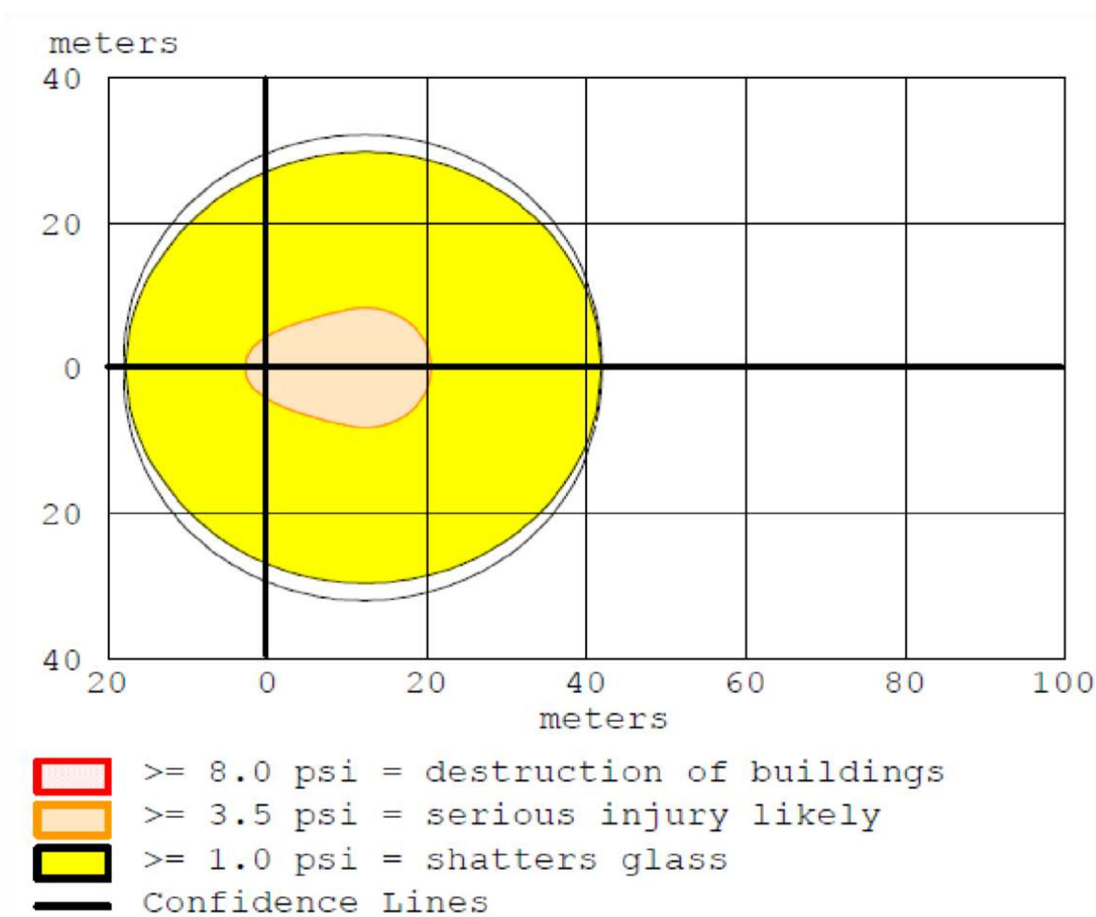
20.1.1.9 Evaporating Puddle – Flammable Area of Vapor Cloud (Graph)



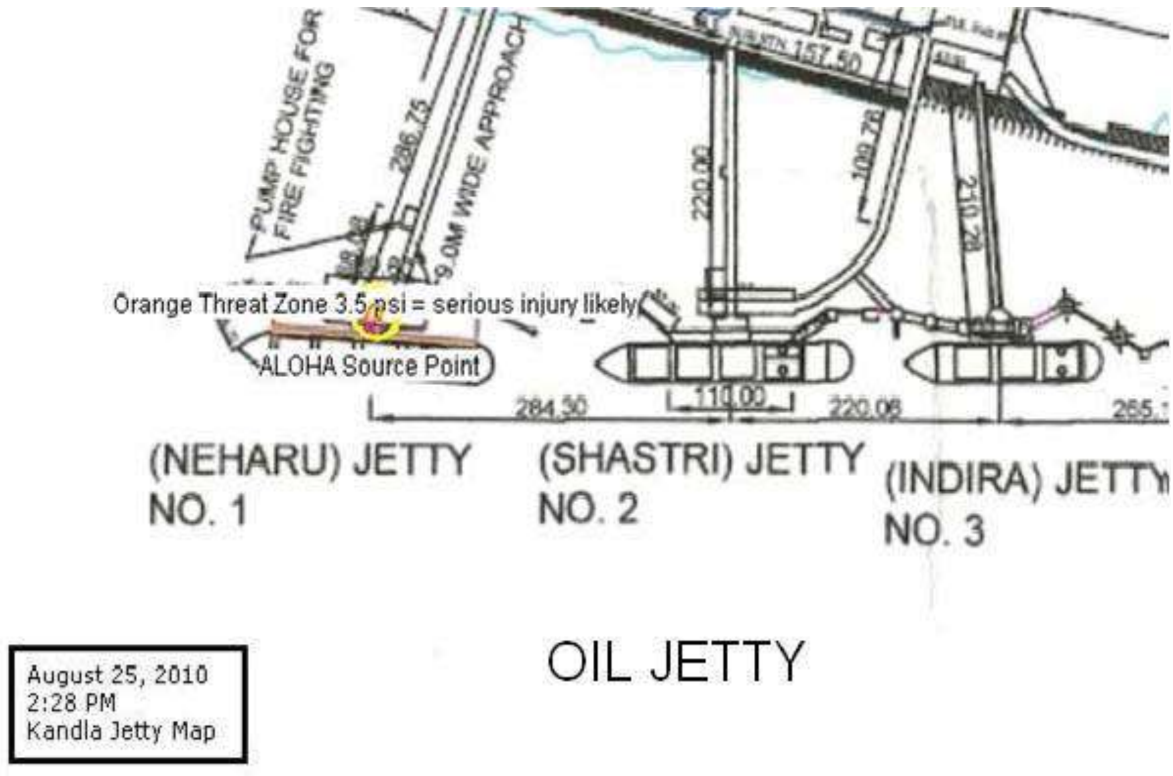
20.1.1.10 Evaporating Puddle – Flammable Area of Vapor Cloud (Contour)



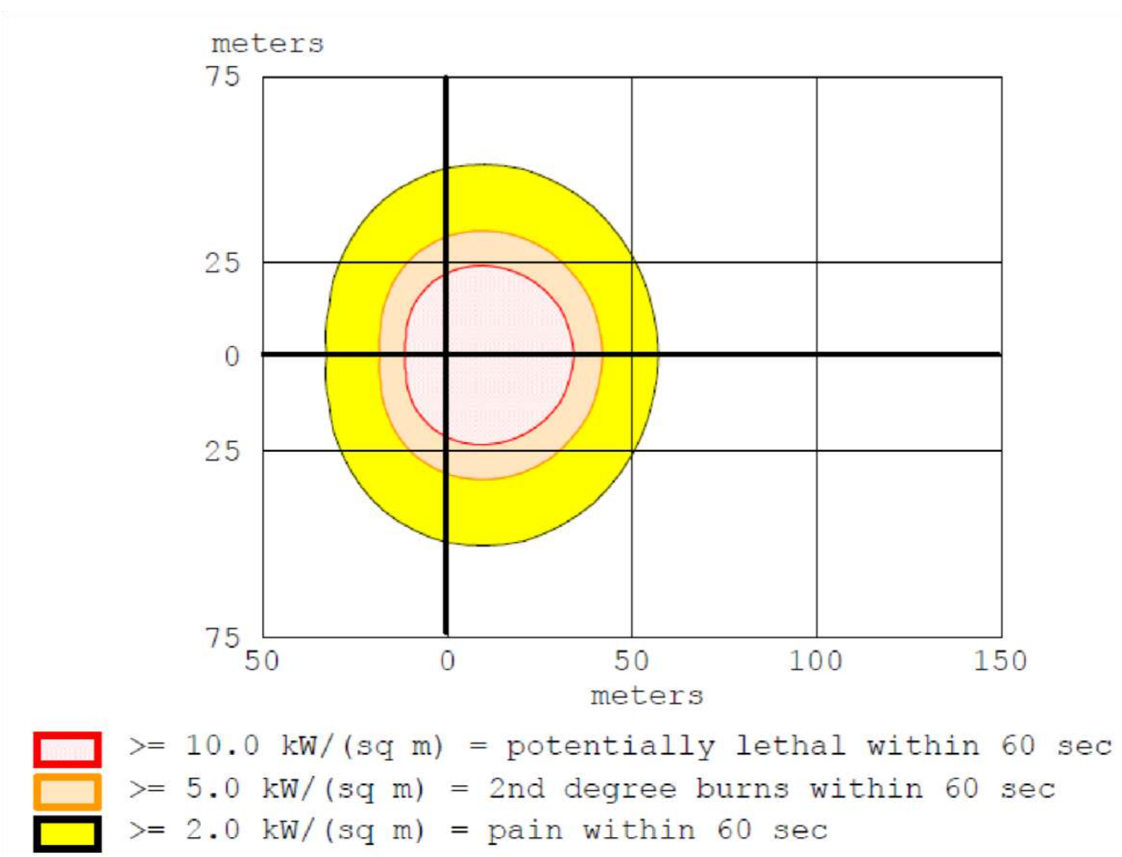
20.1.1.11 Evaporating Puddle – Overpressure (Graph)



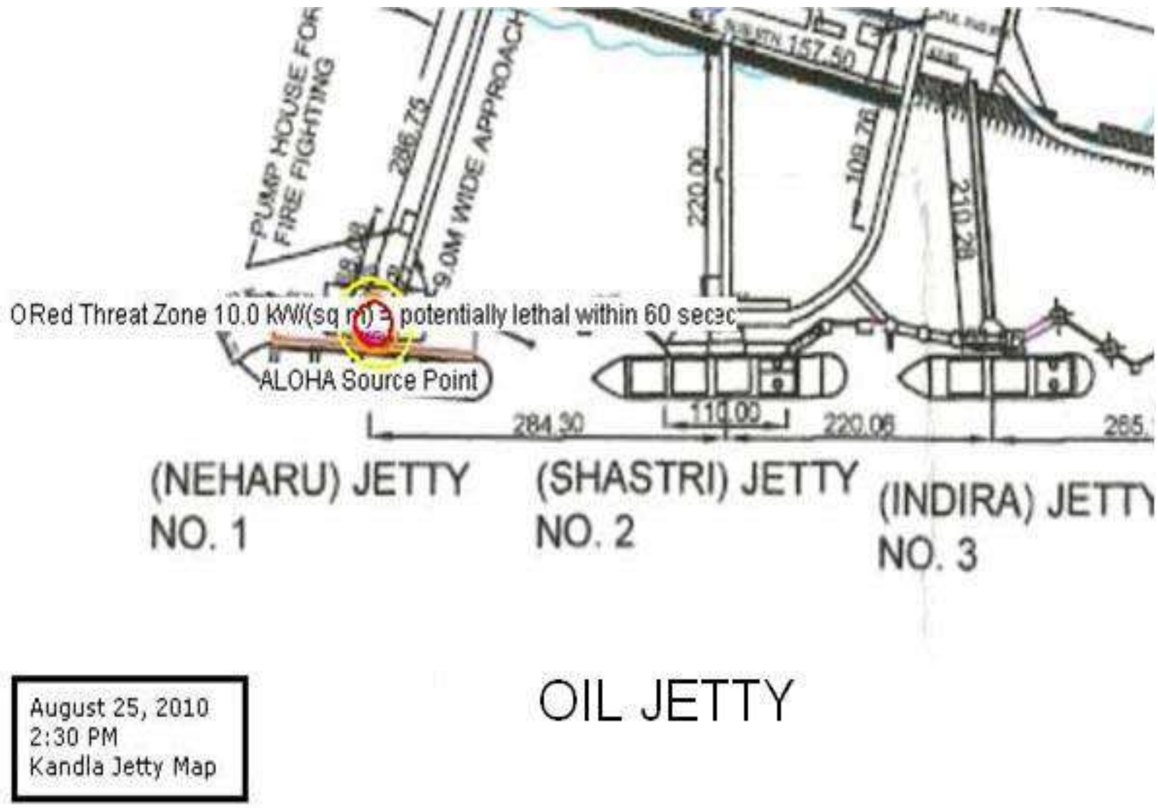
20.1.1.12 Evaporating Puddle – Overpressure (Contour)



20.1.1.13 Burning Puddle – Thermal Radiation (Graph)

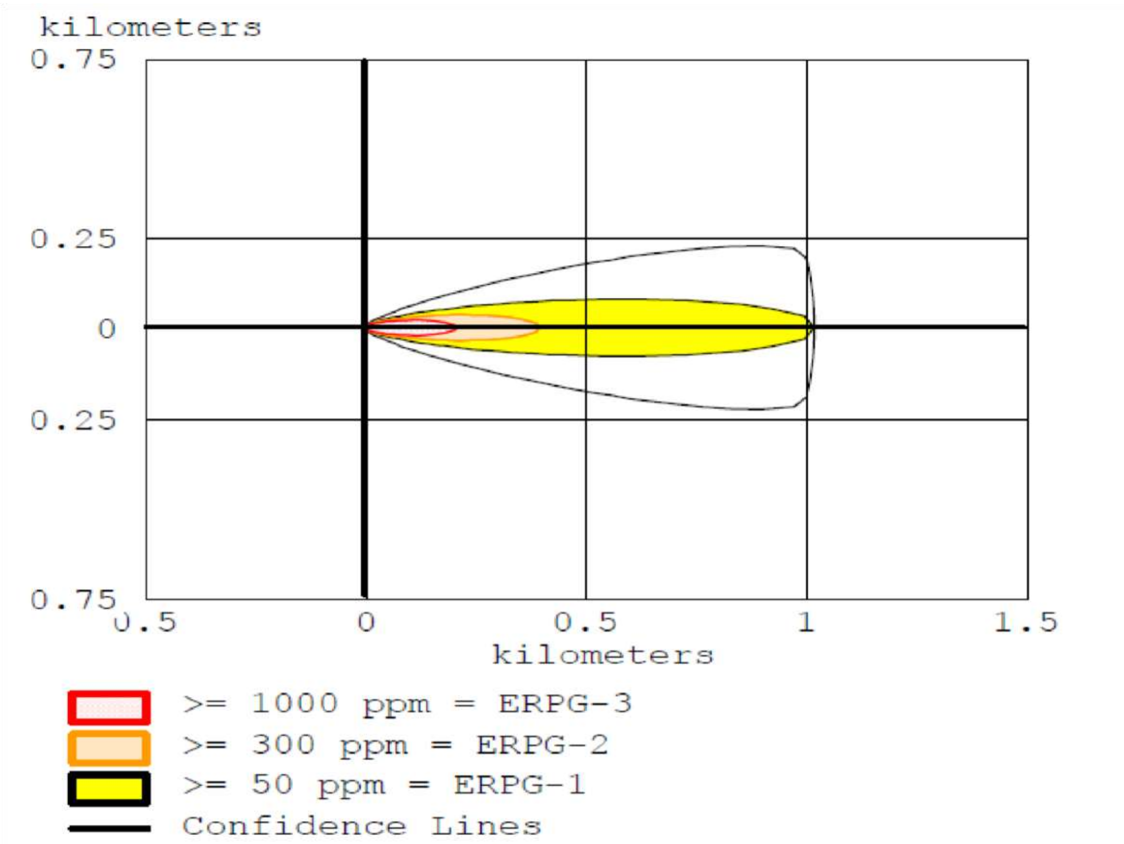


20.1.1.14 Burning Puddle – Thermal Radiation (Contour)

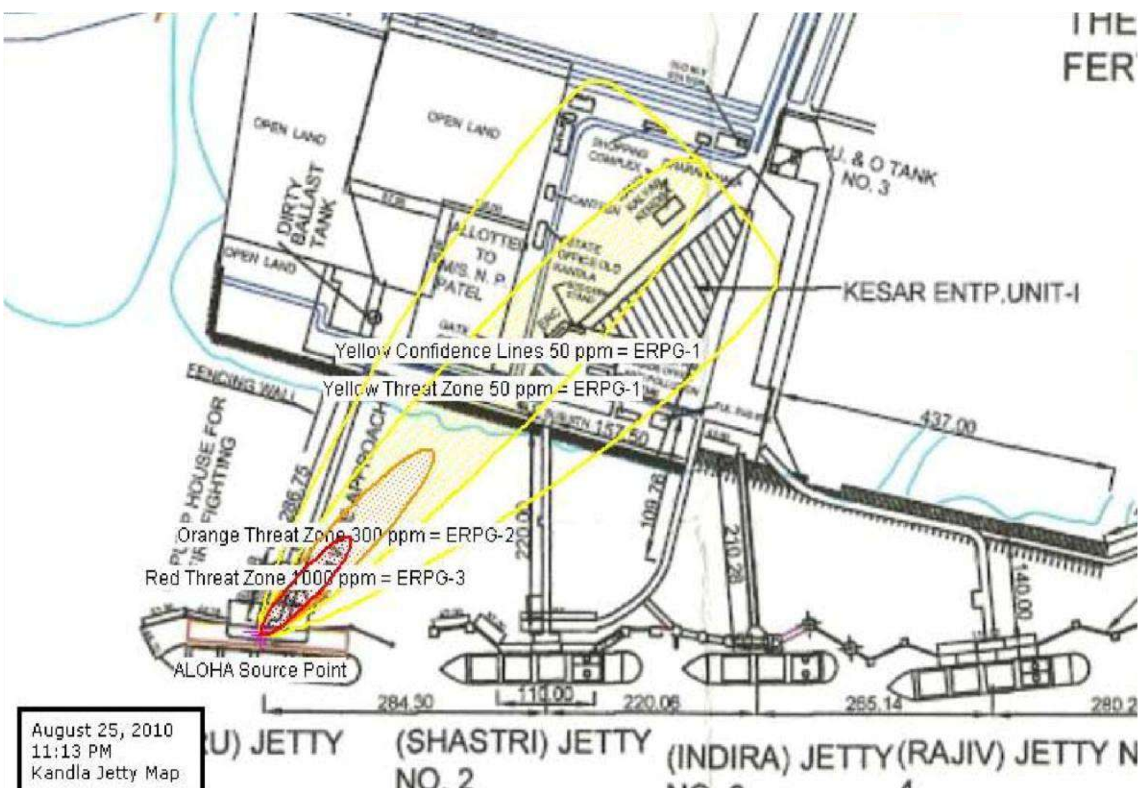


20.1.2 Jetty One – Toluene

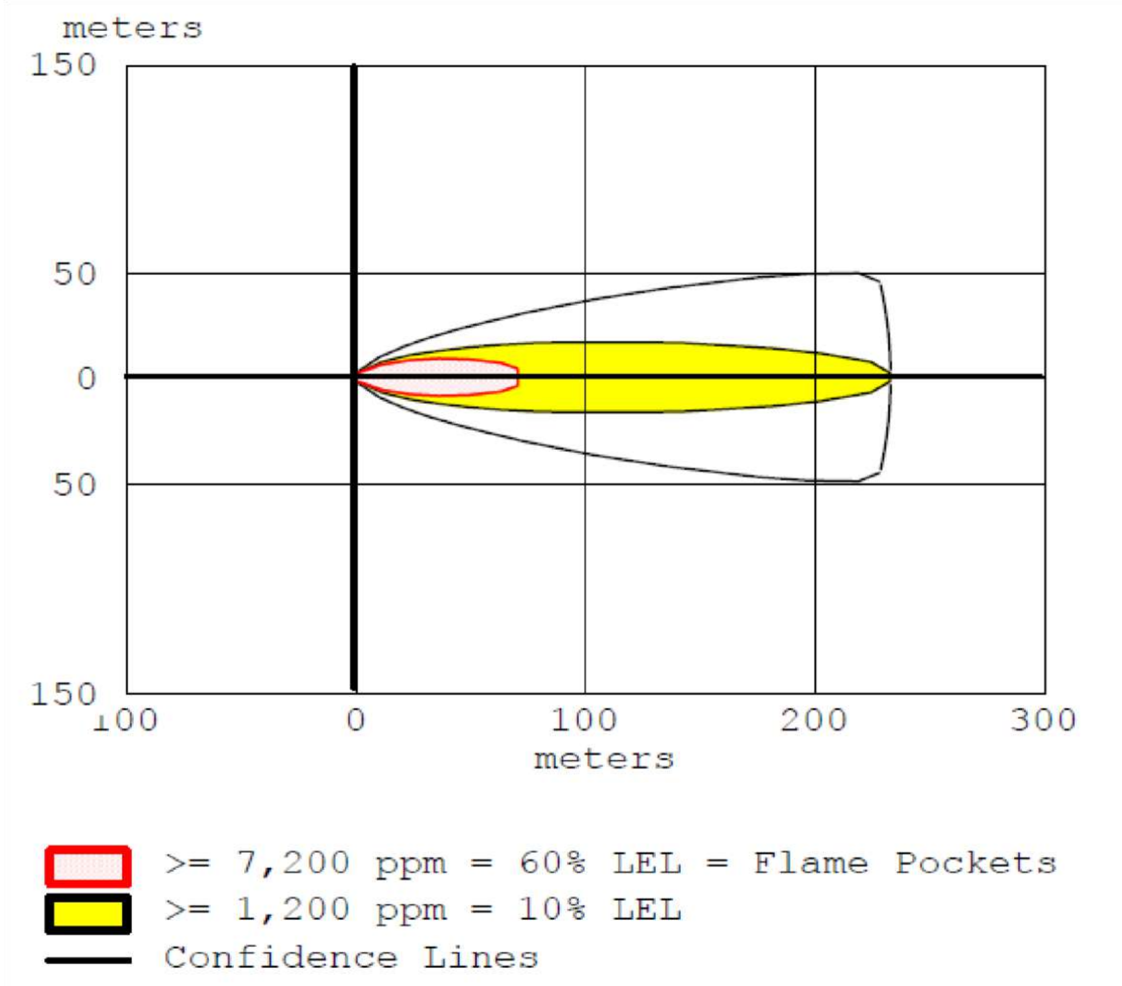
20.1.2.1 Instantaneous Release – Toxic Threat Zone (Graph)



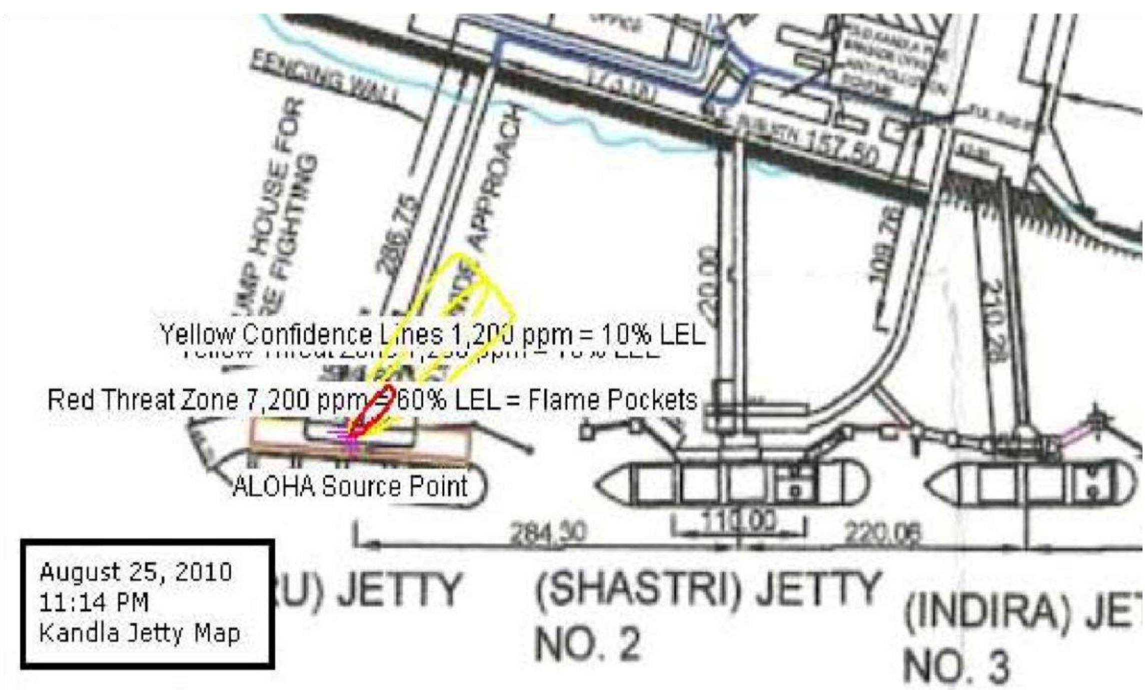
20.1.2.2 Instantaneous Release – Toxic Threat Zone (Contour)



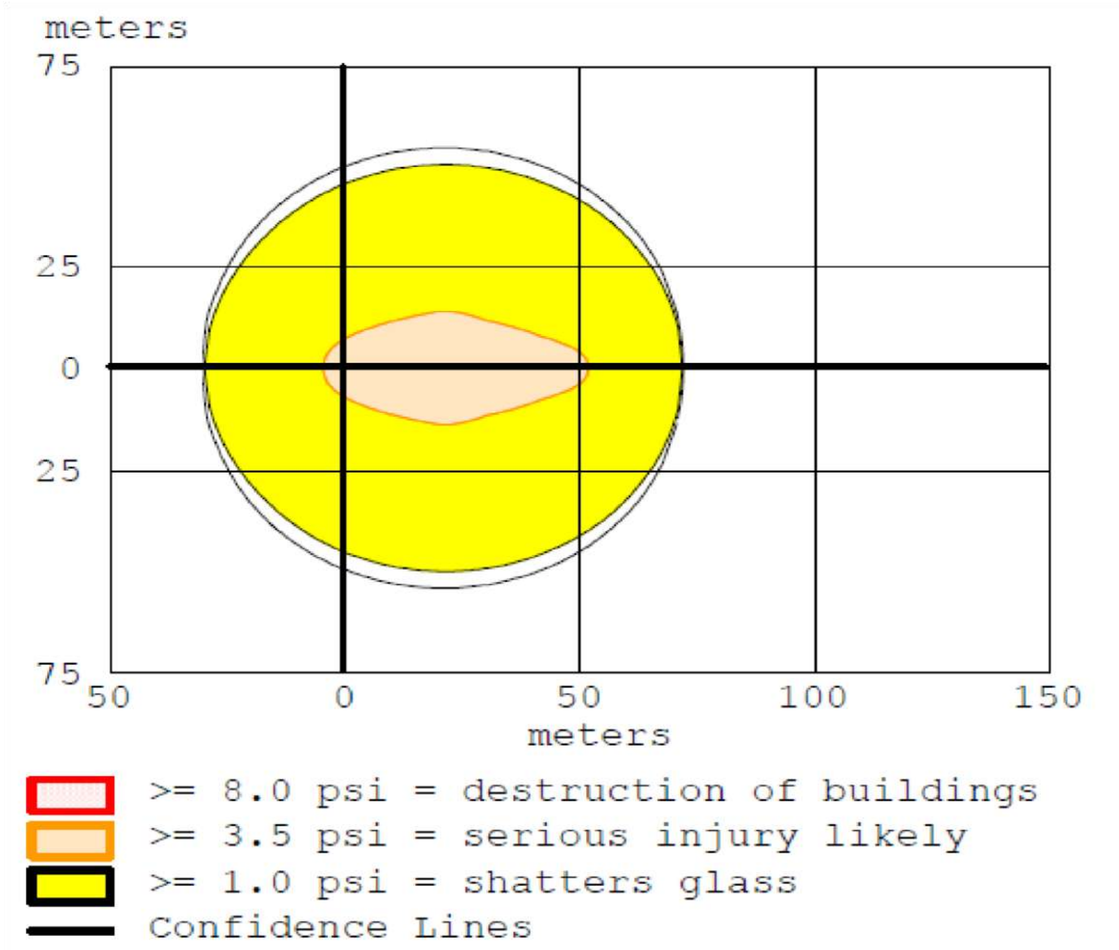
20.1.2.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



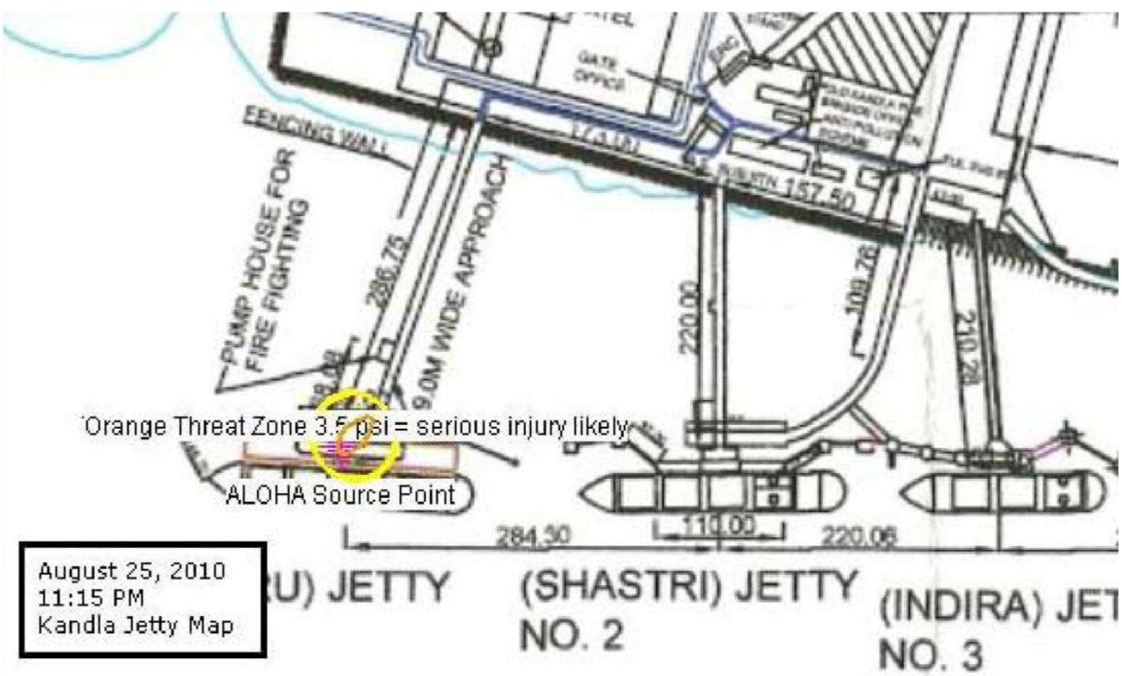
20.1.2.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



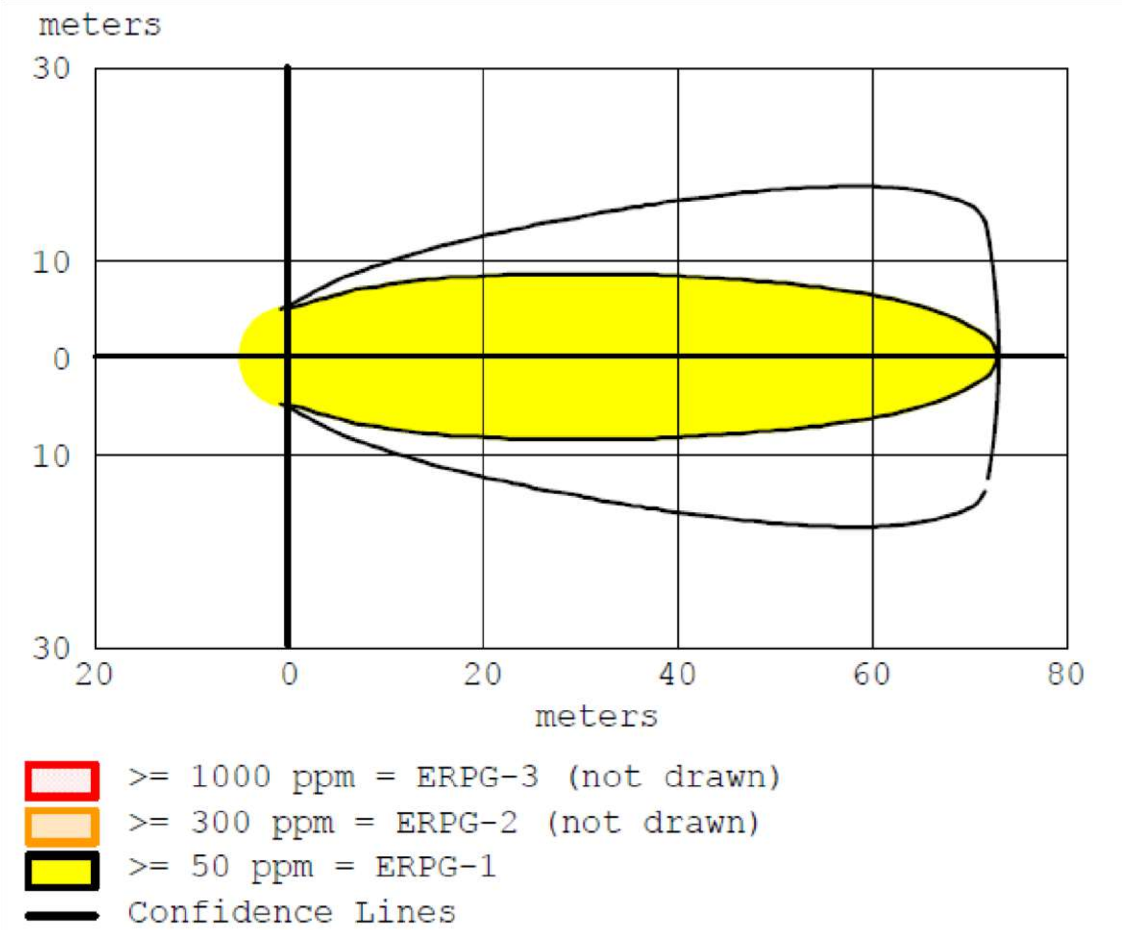
20.1.2.5 Instantaneous Release – Overpressure (Graph)



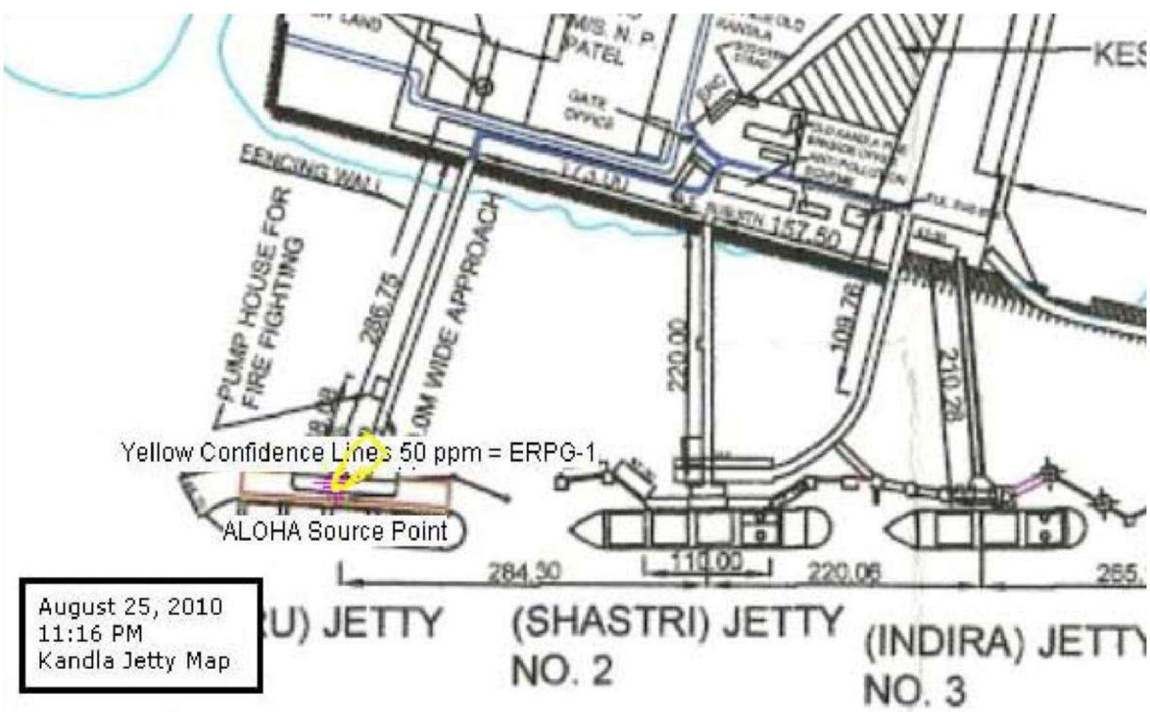
20.1.2.6 Instantaneous Release – Overpressure (Contour)



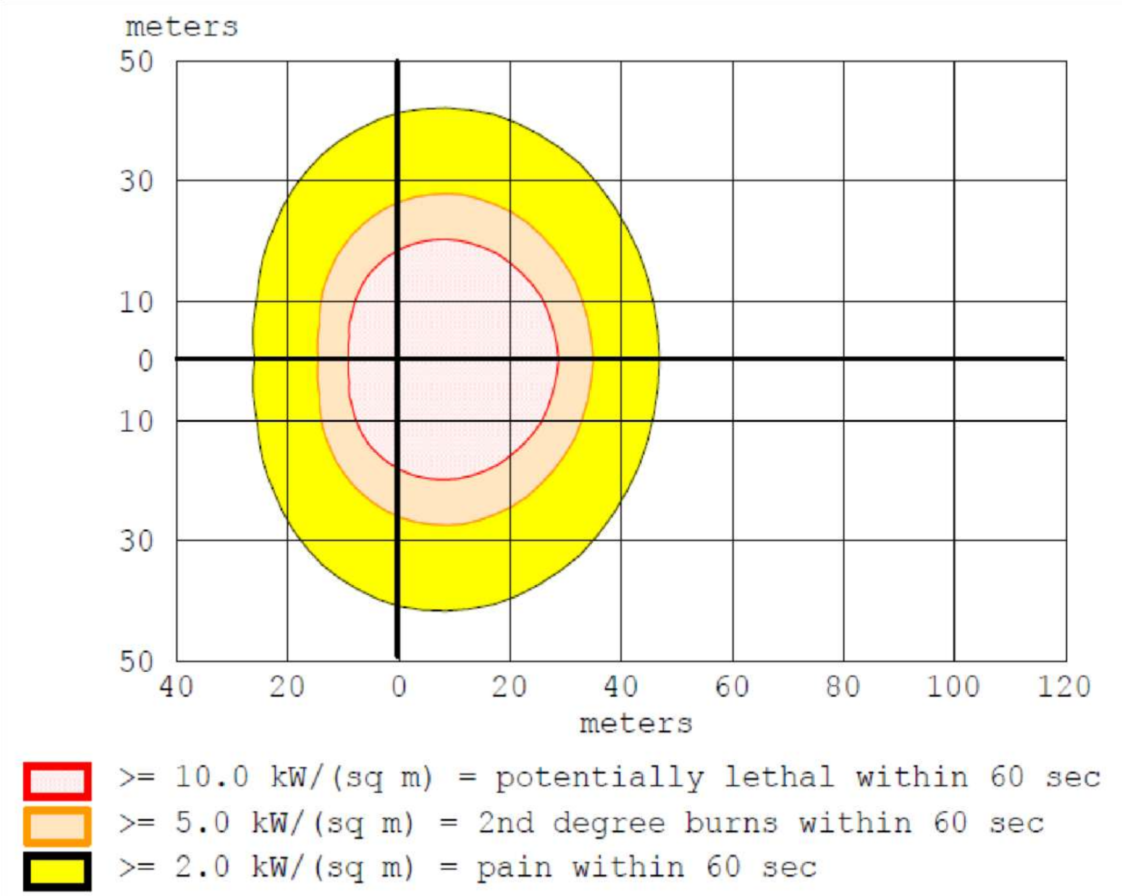
20.1.2.7 Evaporating Puddle – Toxic Threat Zone (Graph)



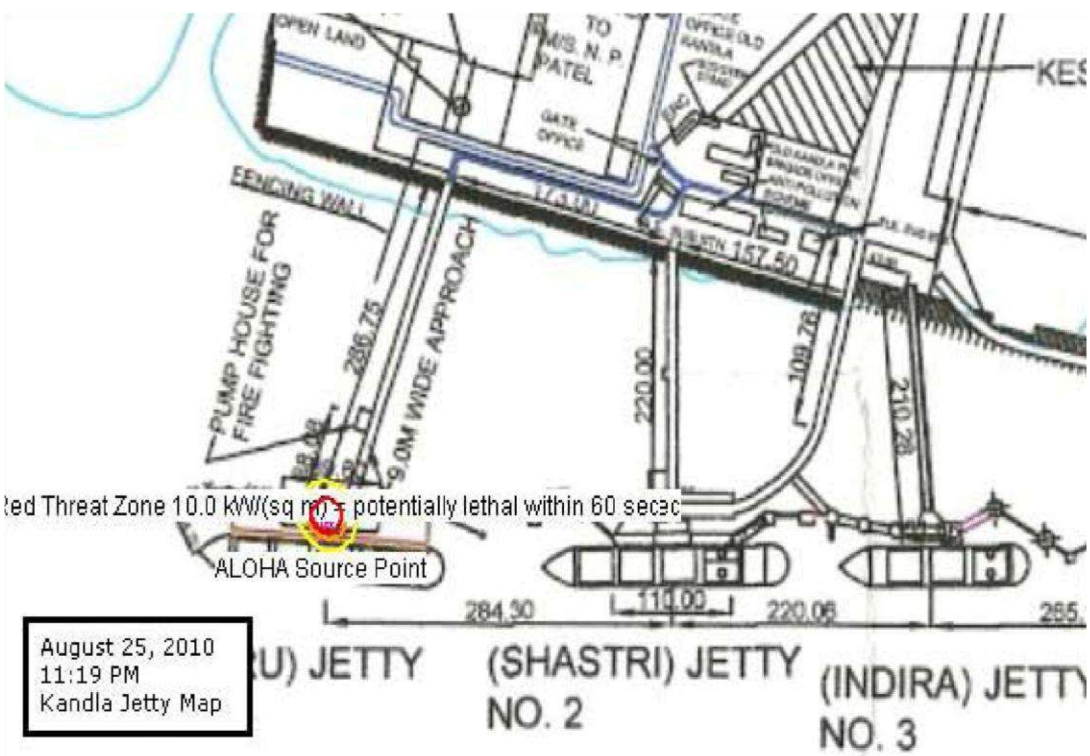
20.1.2.8 Evaporating Puddle – Toxic Threat Zone (Contour)



20.1.2.9 Burning Puddle – Thermal Radiation (Graph)

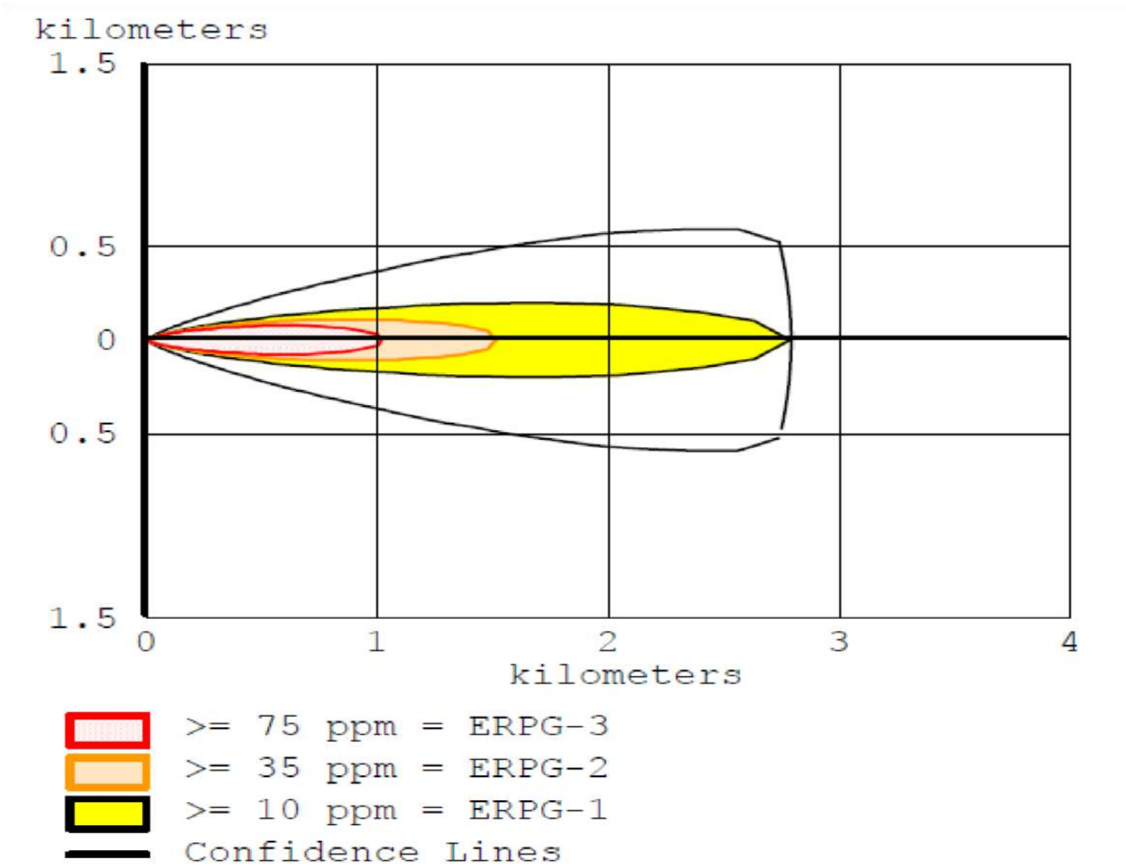


20.1.2.10 Burning Puddle – Thermal Radiation (Contour)

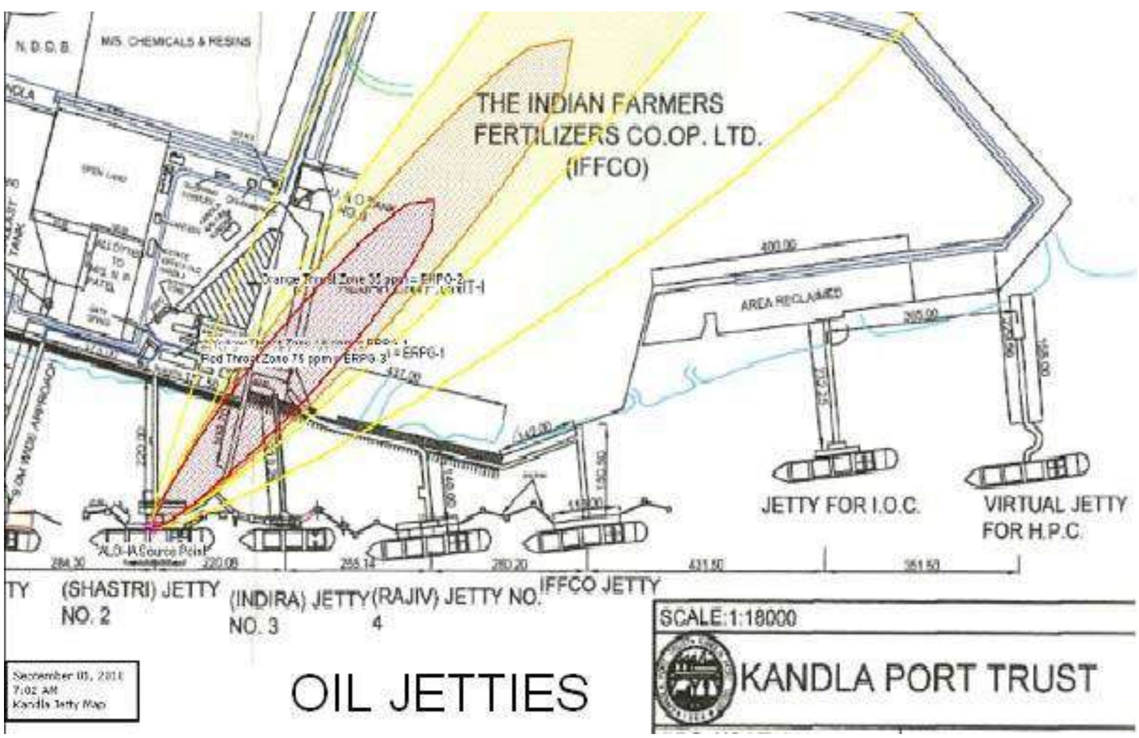


20.1.3 Jetty Two – Acrylonitrile

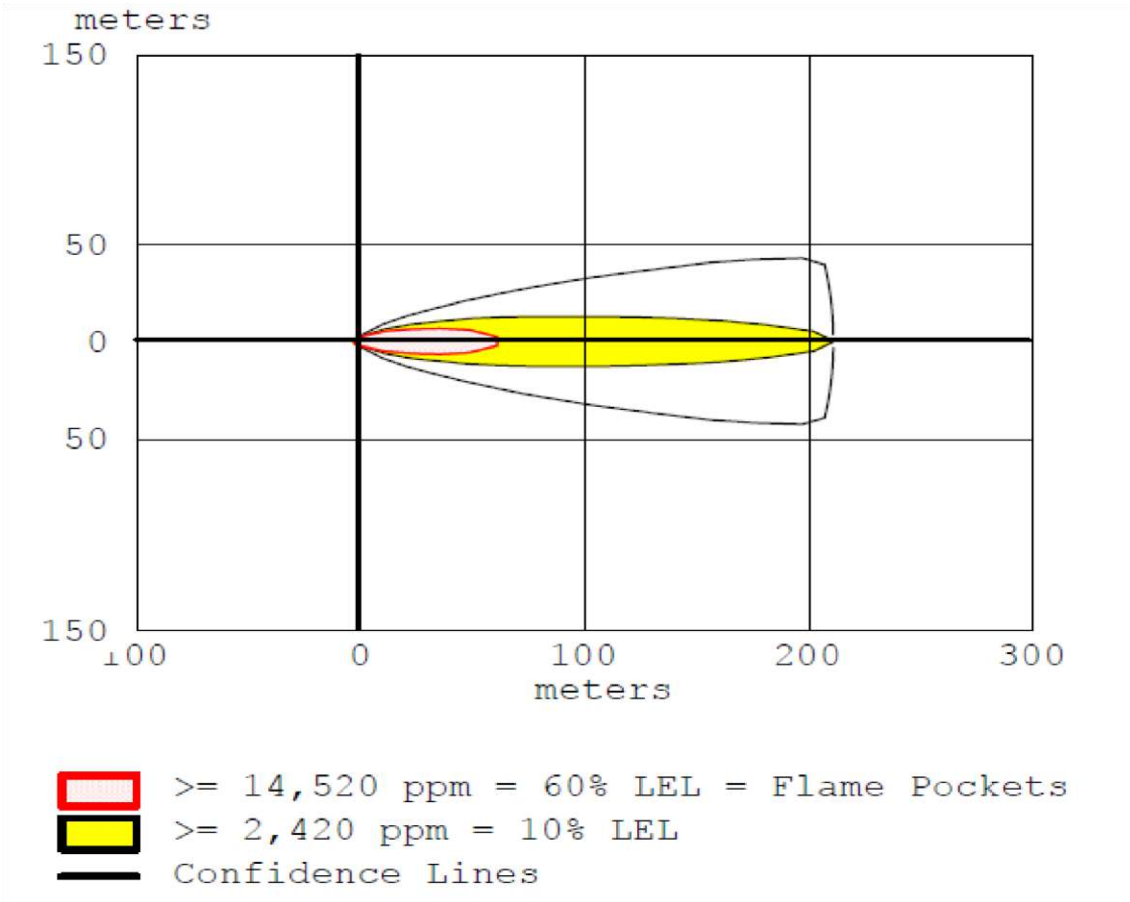
20.1.3.1 Instantaneous Release – Toxic Threat Zone (Graph)



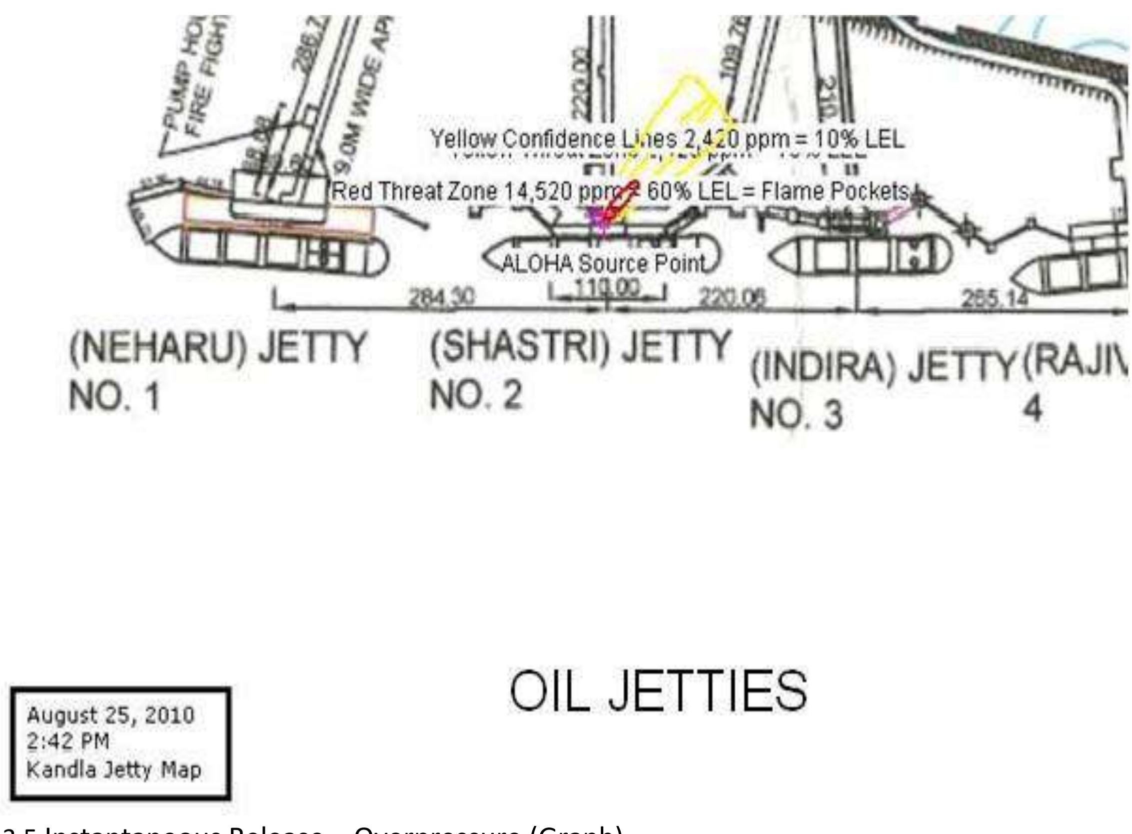
20.1.3.2 Instantaneous Release – Toxic Threat Zone (Contour)



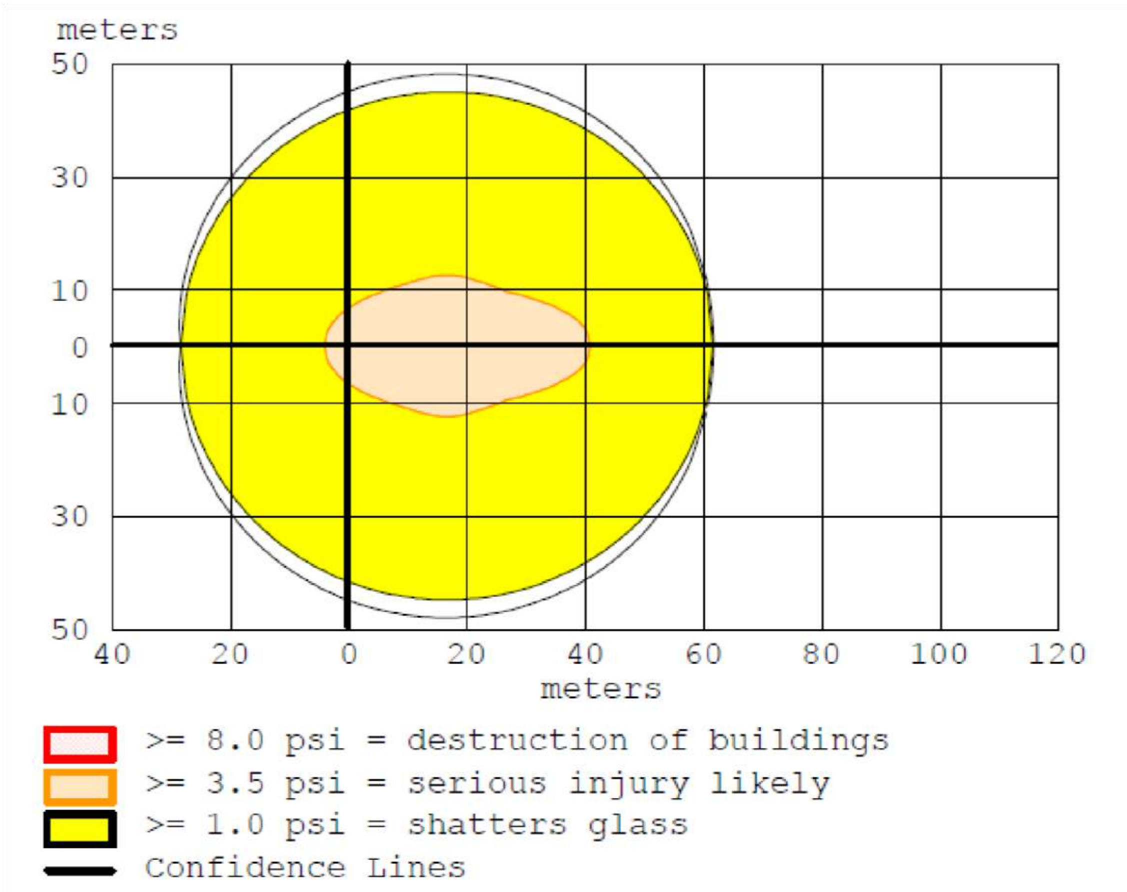
20.1.3.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



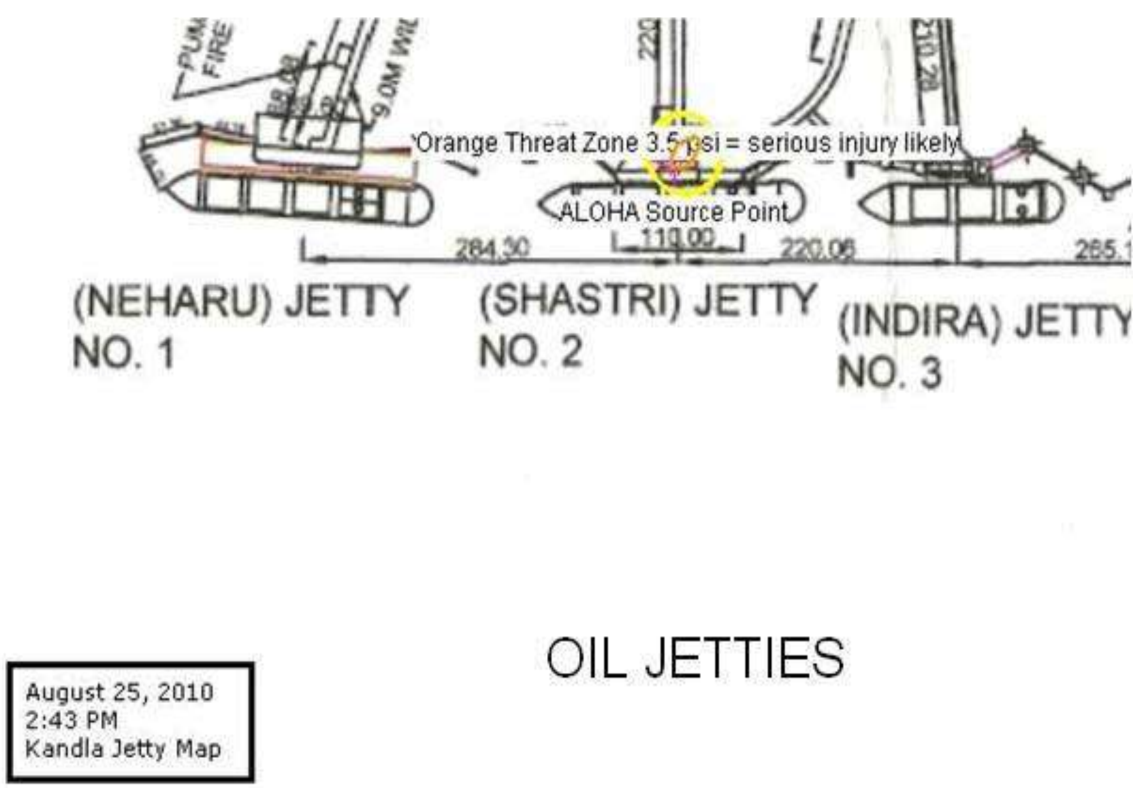
20.1.3.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



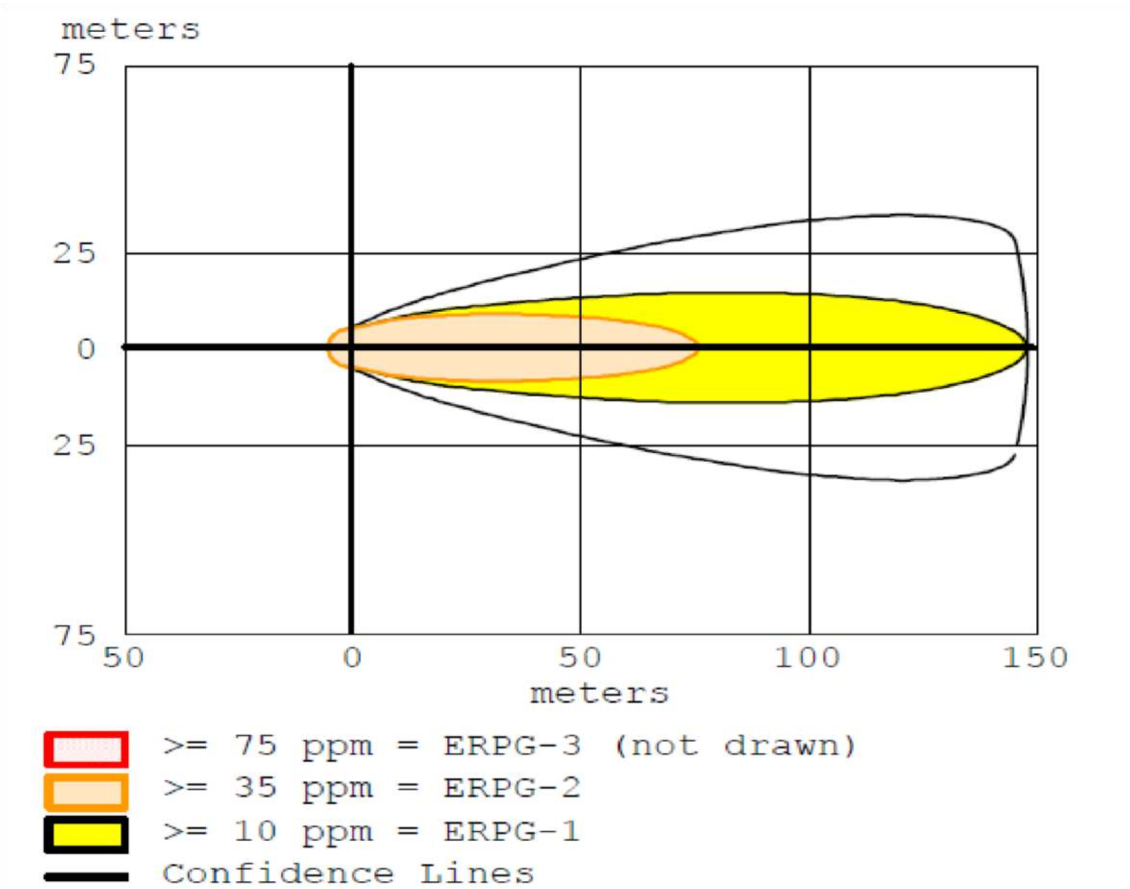
20.1.3.5 Instantaneous Release – Overpressure (Graph)



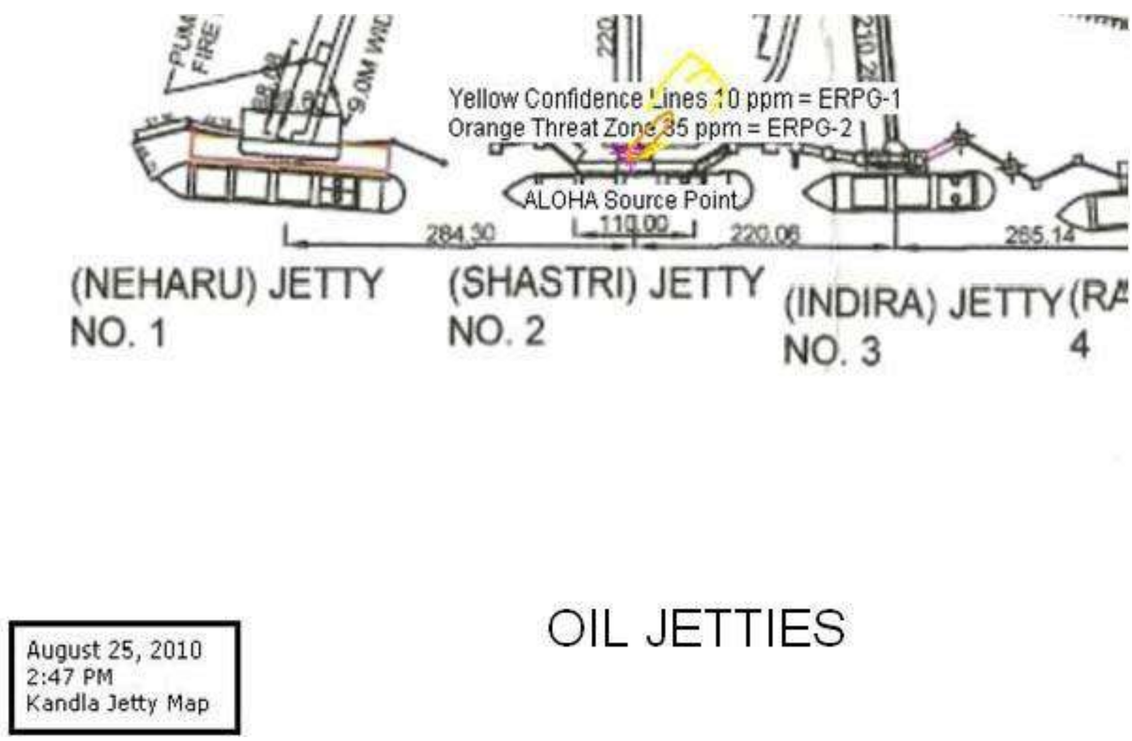
20.1.3.6 Instantaneous Release – Overpressure (Contour)



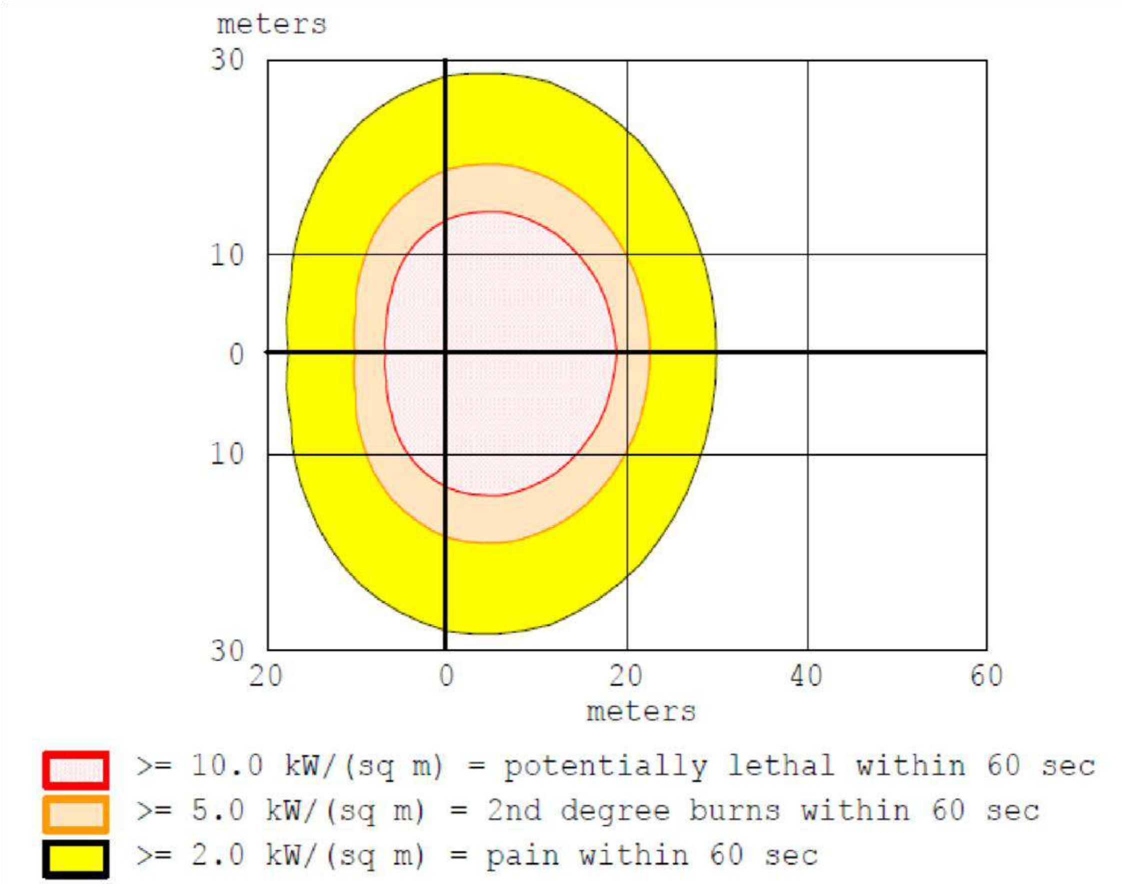
20.1.3.7 Evaporating Puddle – Toxic Threat Zone (Graph)



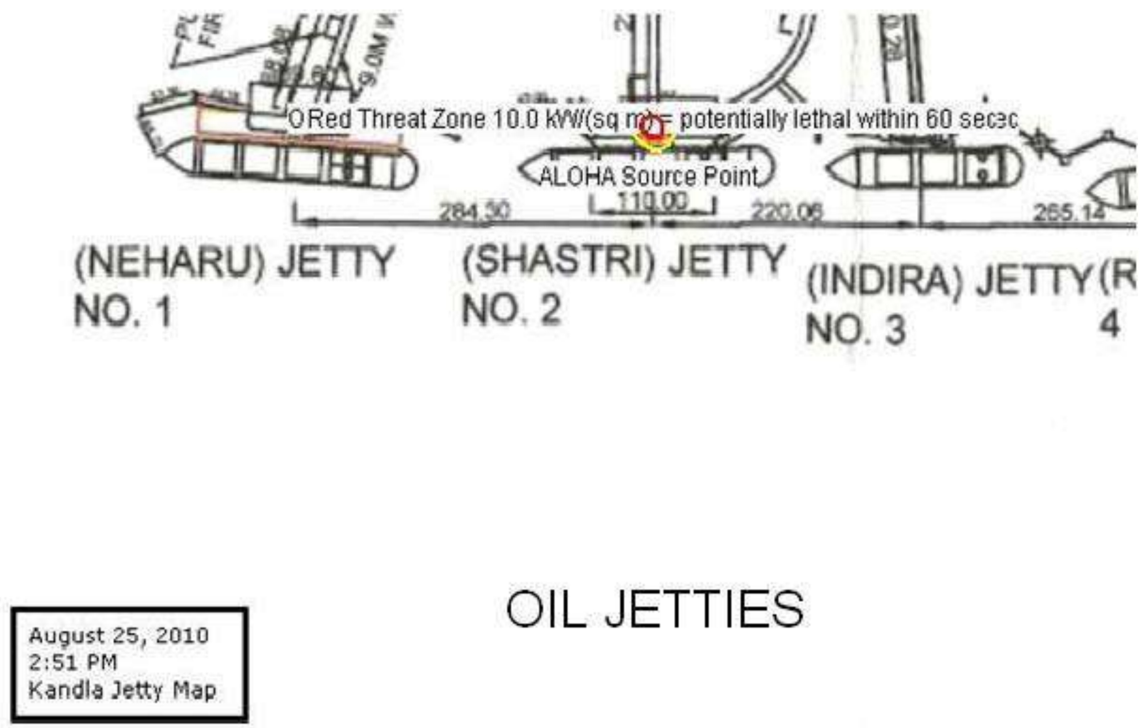
20.1.3.8 Evaporating Puddle – Toxic Threat Zone (Contour)



20.1.3.9 Burning Puddle – Thermal Radiation (Graph)

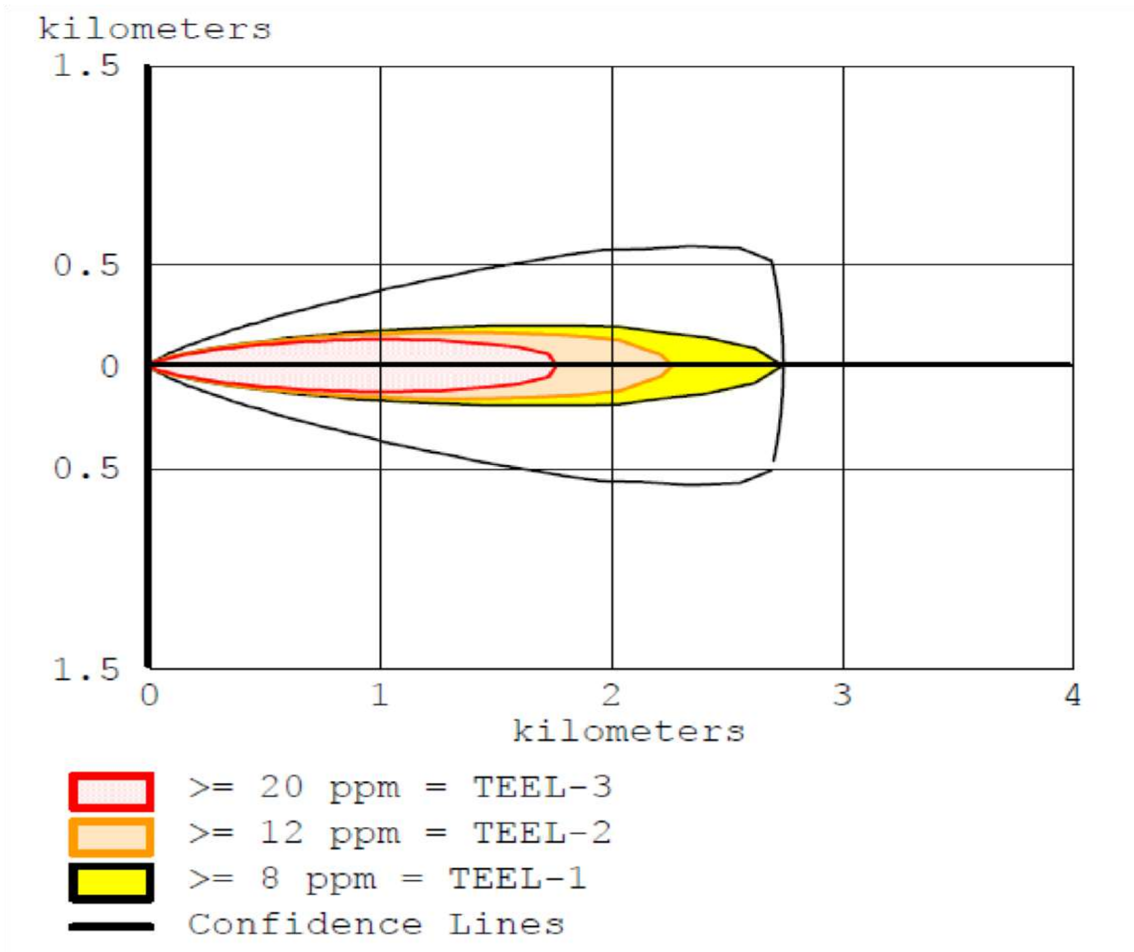


20.1.3.10 Burning Puddle – Thermal Radiation (Contour)

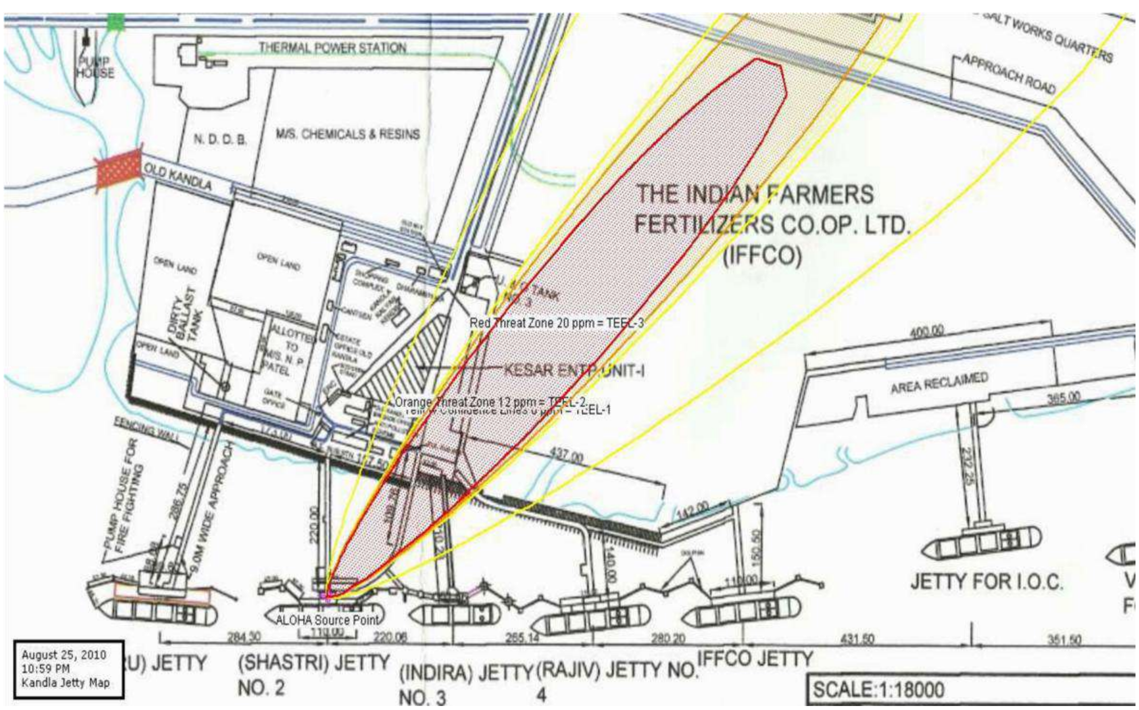


20.1.4 Jetty Two – Aniline

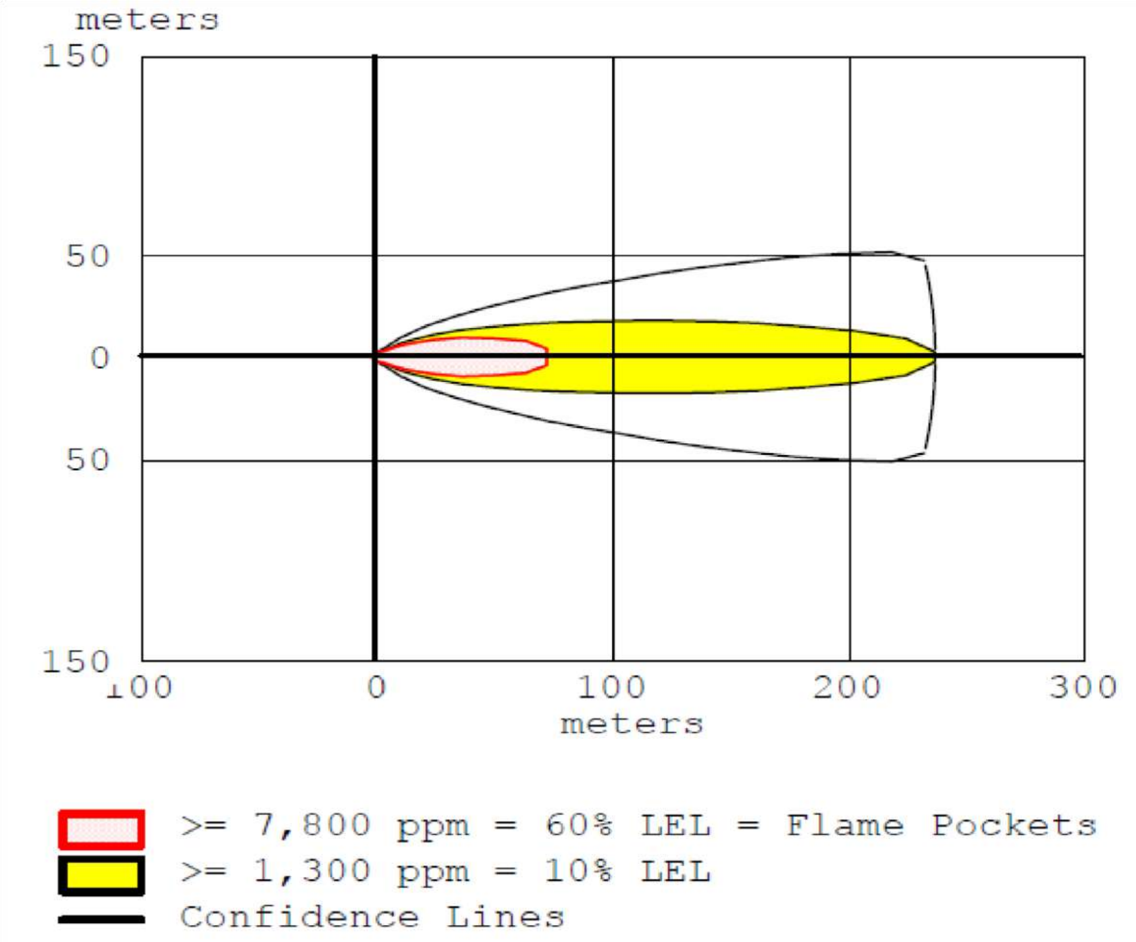
20.1.4.1 Instantaneous Release – Toxic Threat Zone (Graph)



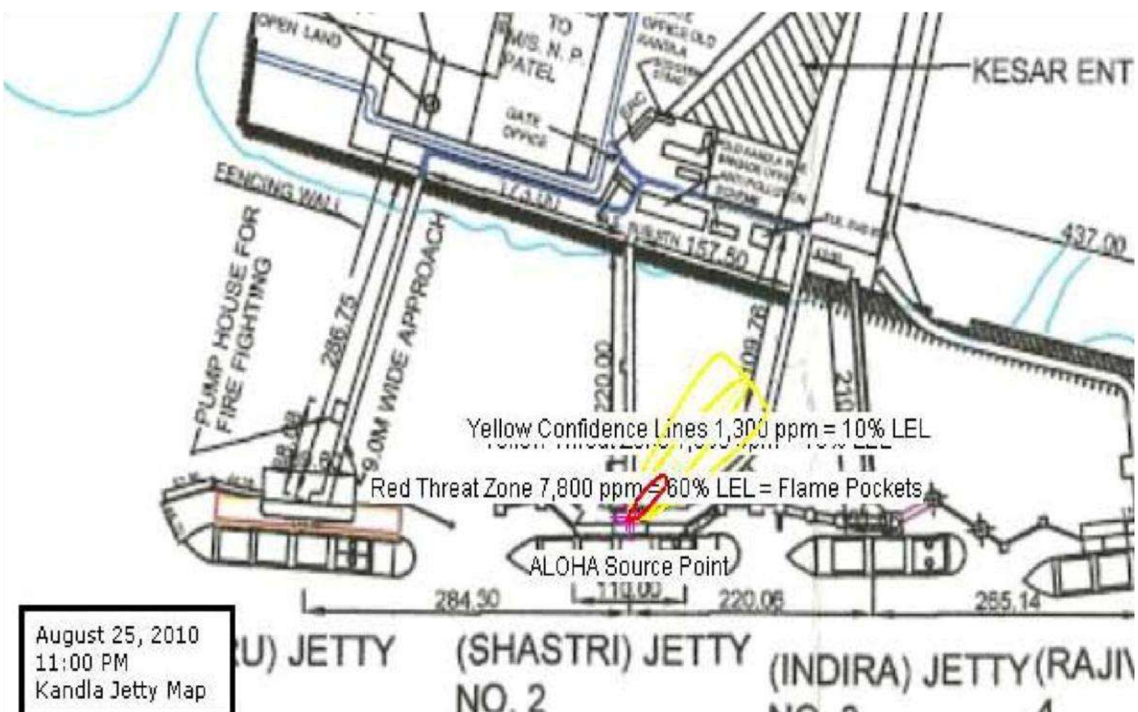
20.1.4.2 Instantaneous Release – Toxic Threat Zone (Contour)



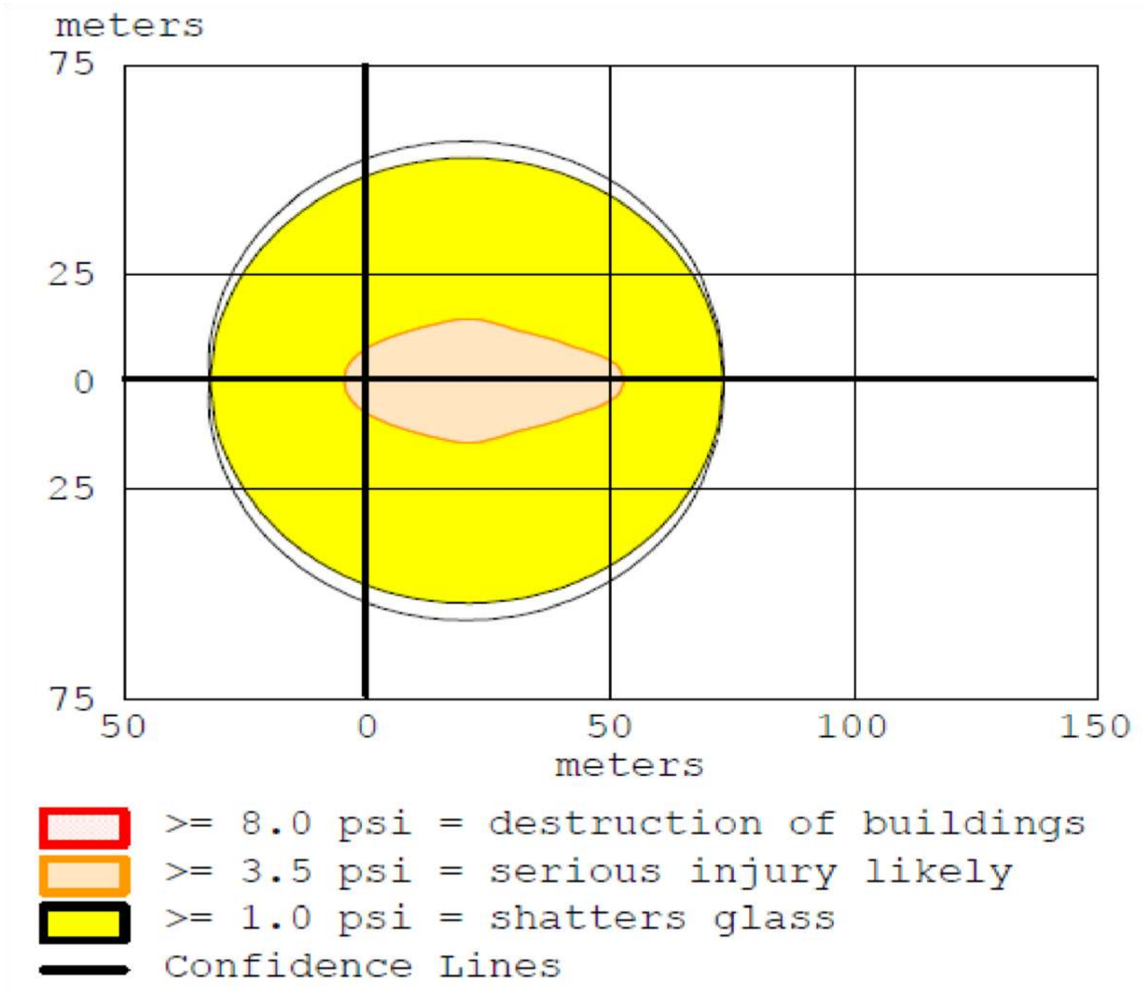
20.1.4.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



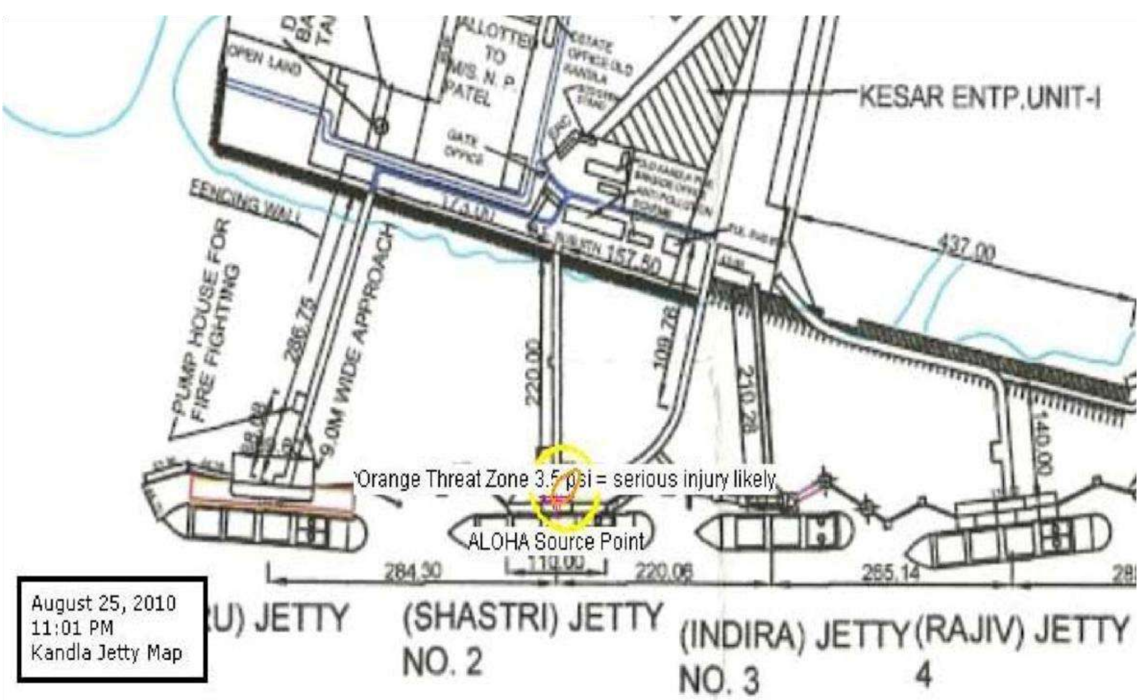
20.1.4.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



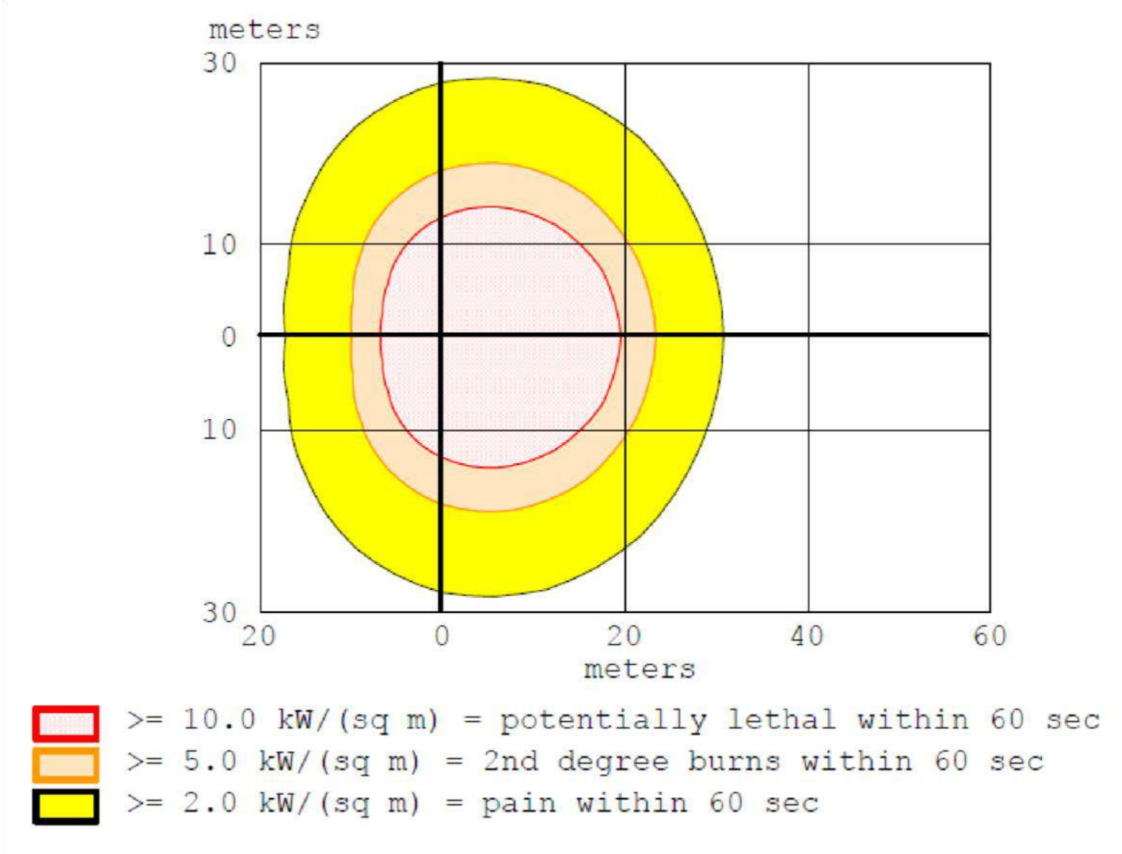
20.1.4.5 Instantaneous Release – Overpressure (Graph)



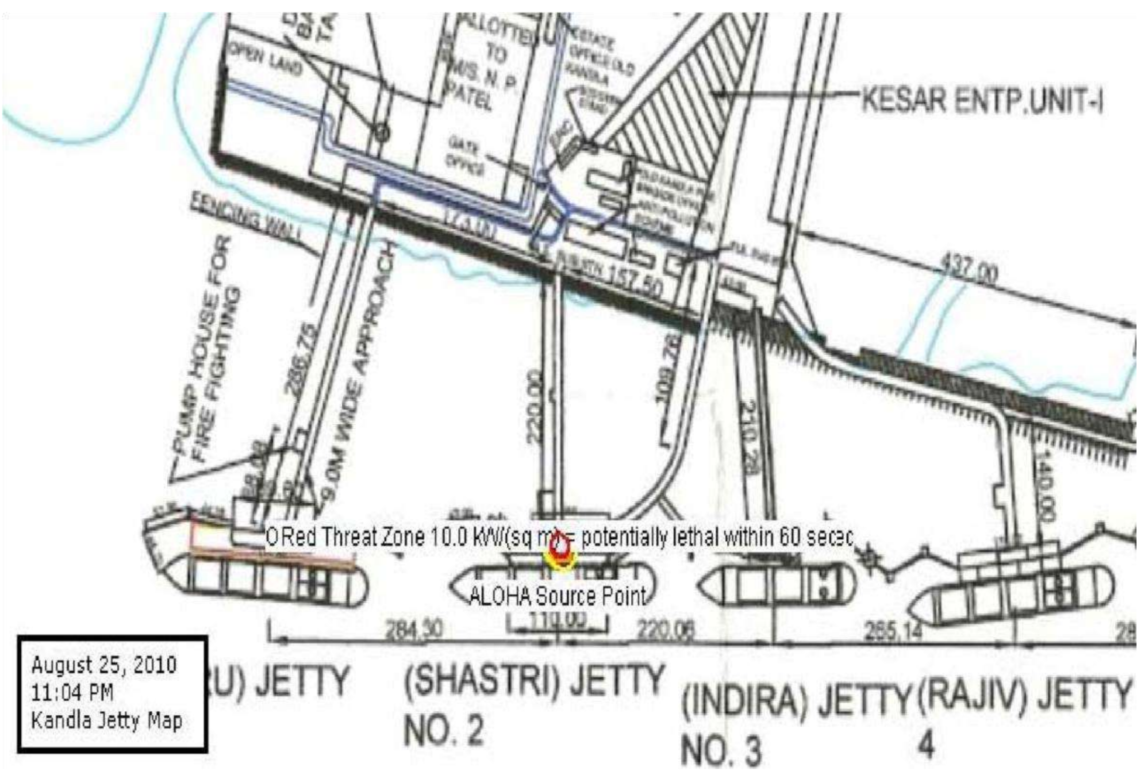
20.1.4.6 Instantaneous Release – Overpressure (Contour)



20.1.4.7 Burning Puddle – Thermal Radiation (Graph)

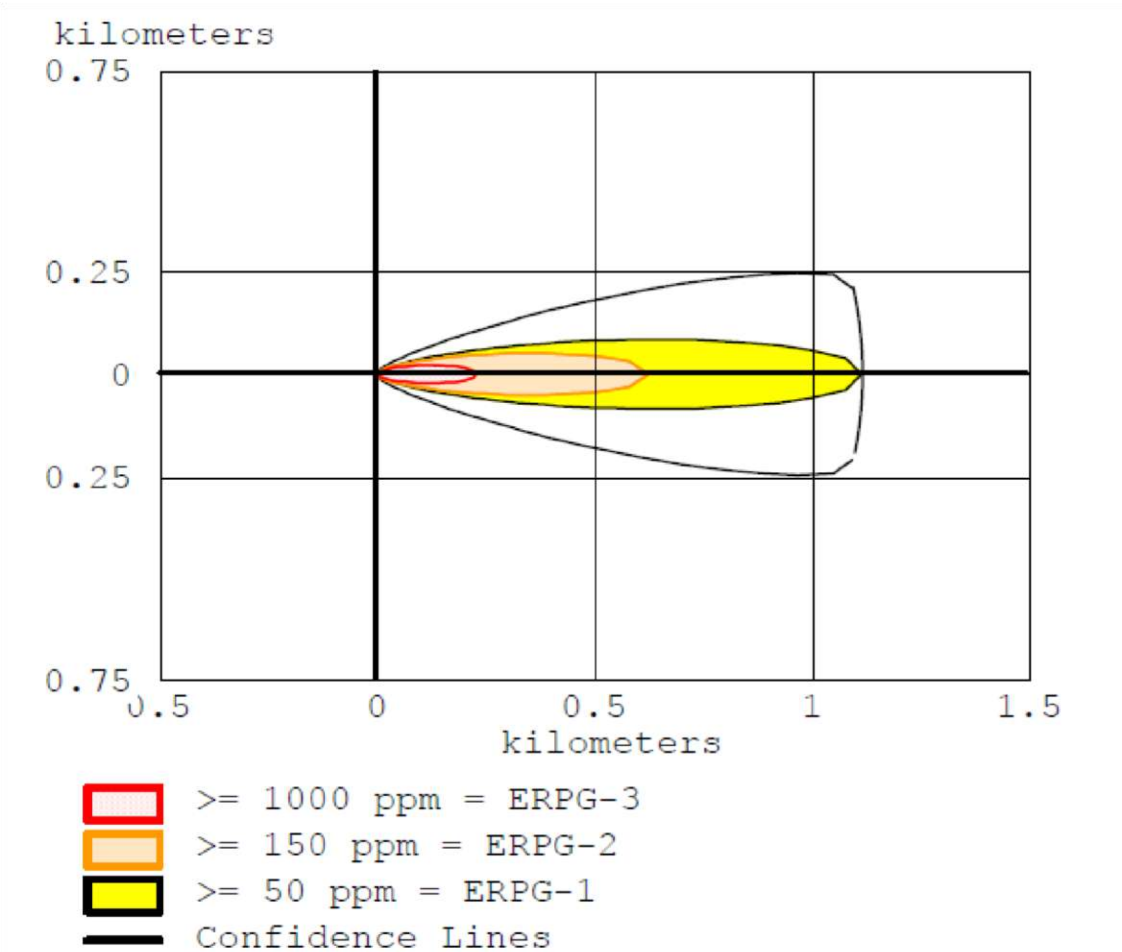


20.1.4.8 Burning Puddle – Thermal Radiation (Contour)

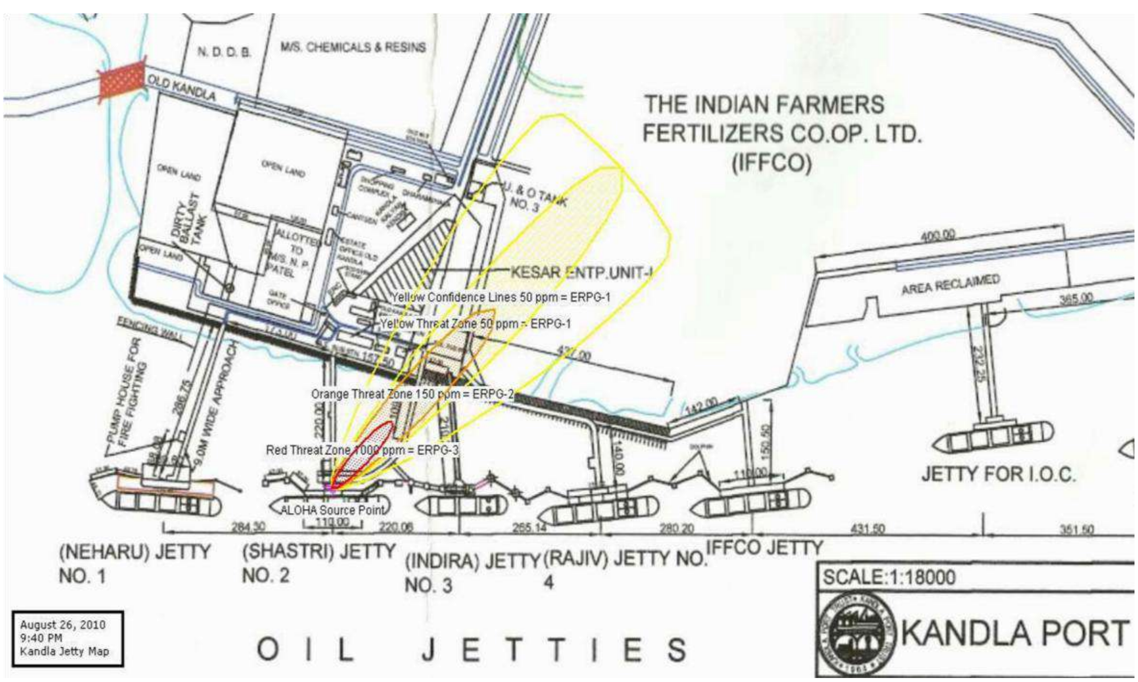


20.1.5 Jetty Two – Benzene

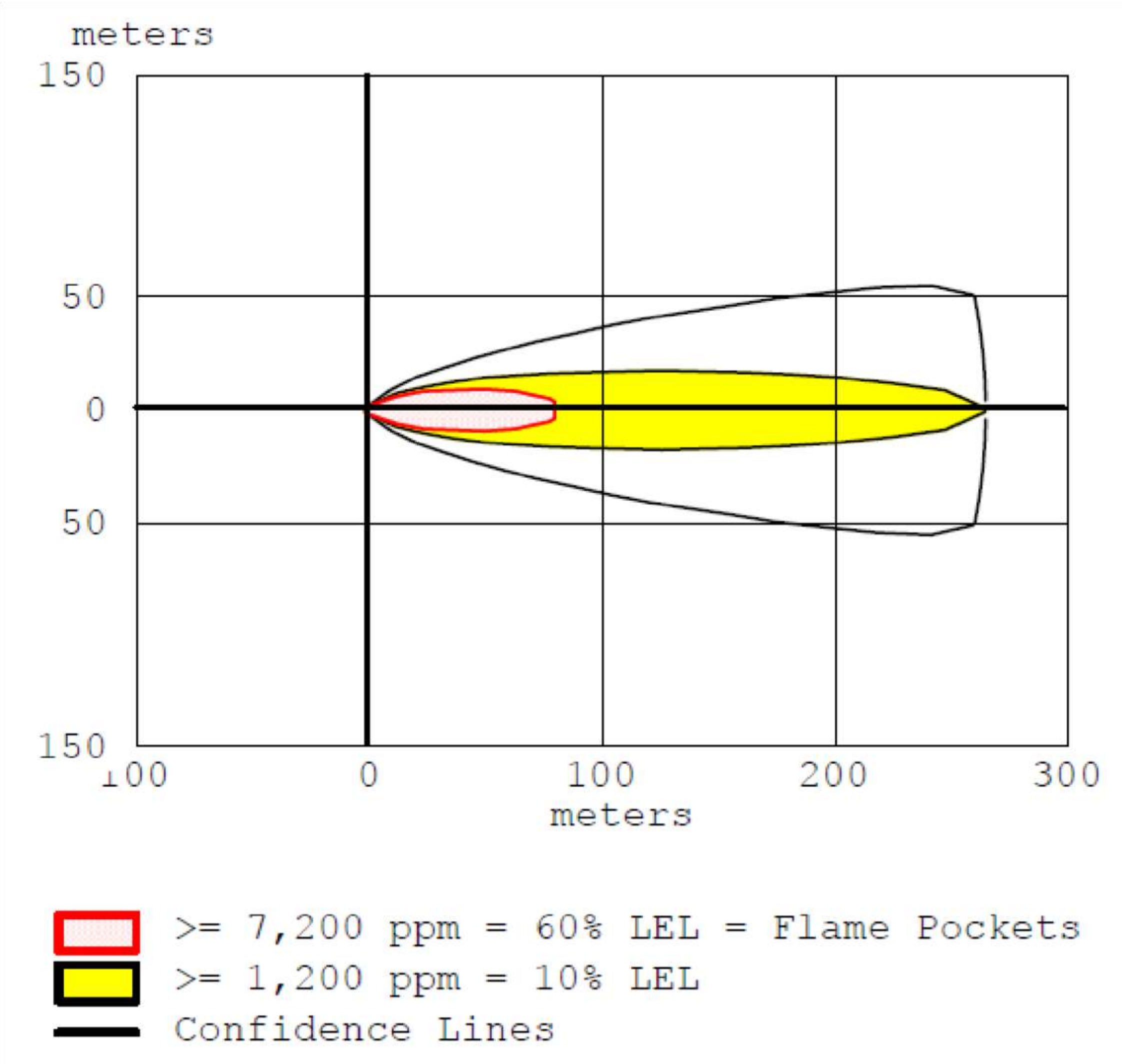
20.1.5.1 Instantaneous Release – Toxic Threat Zone (Graph)



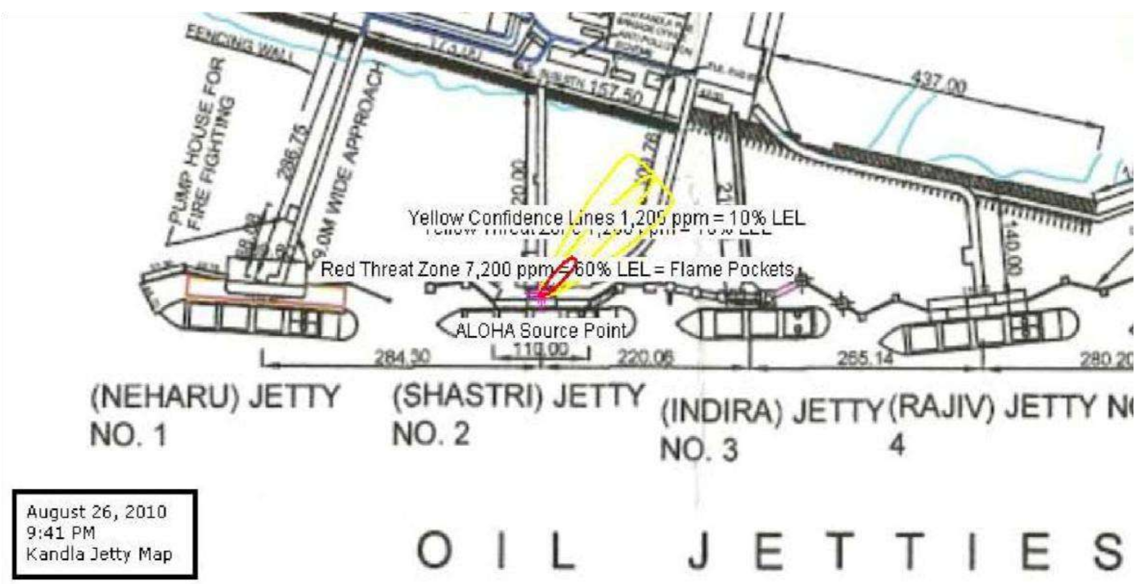
20.1.5.2 Instantaneous Release – Toxic Threat Zone (Contour)



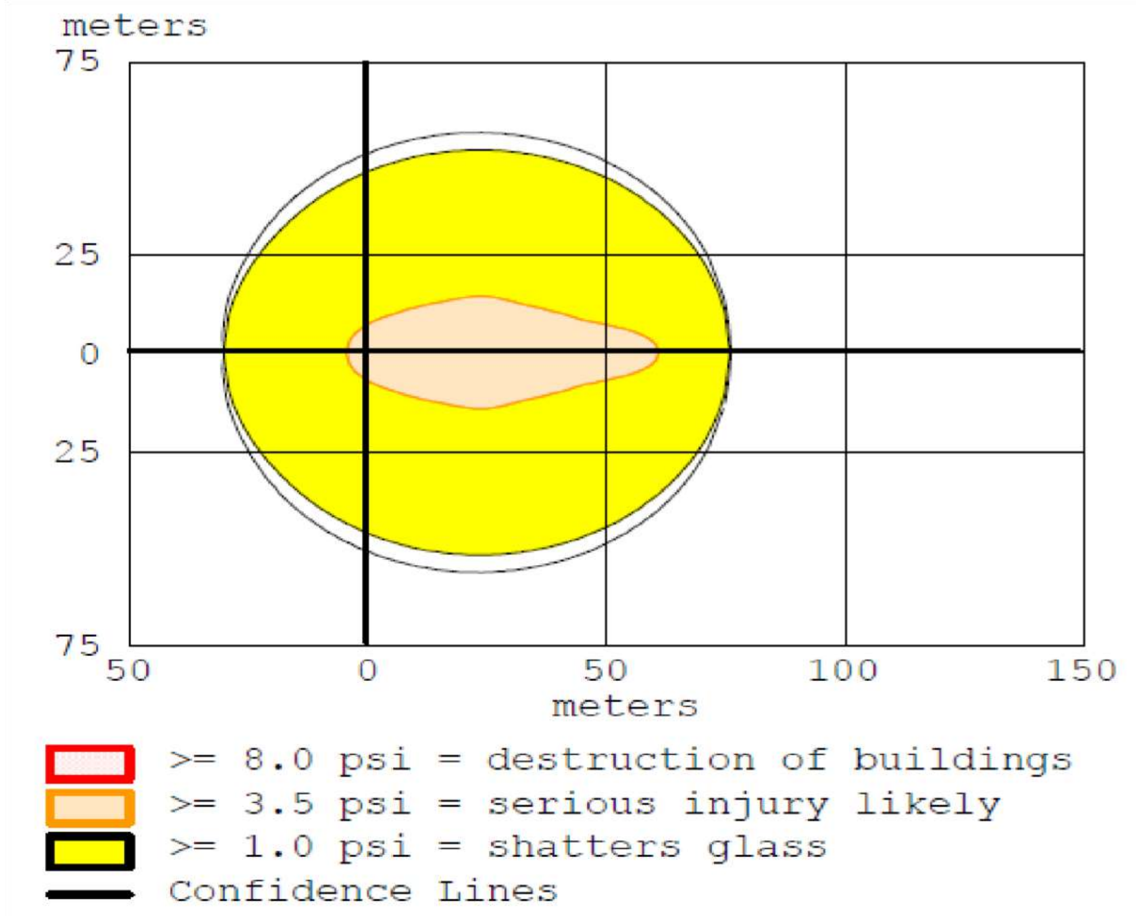
20.1.5.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



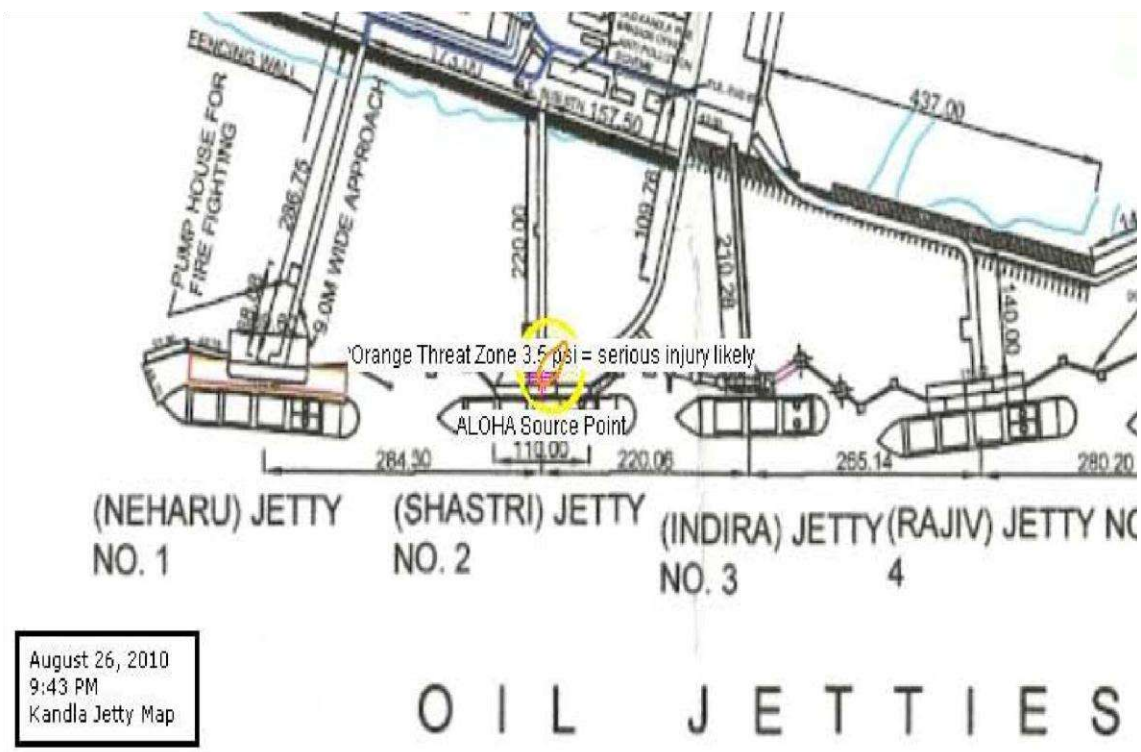
20.1.5.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



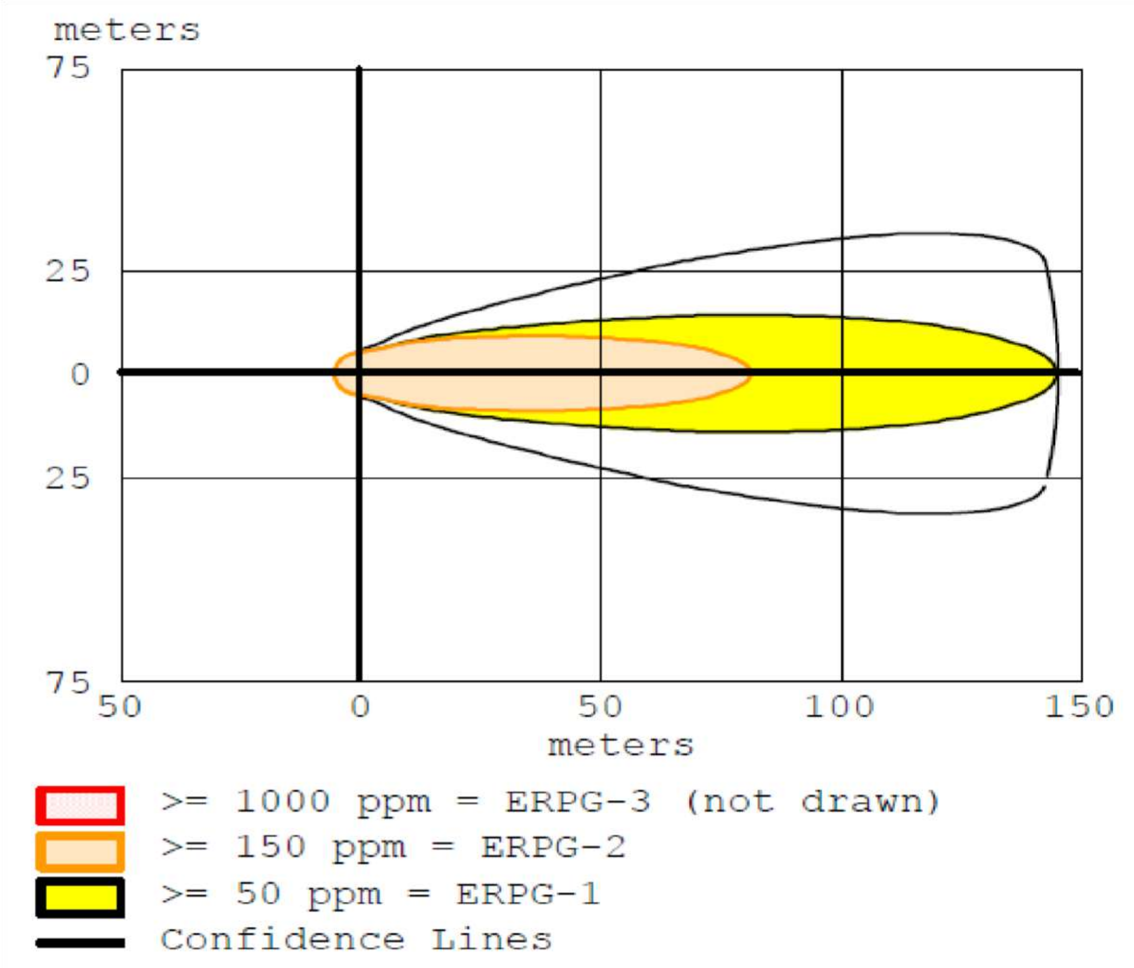
20.1.5.5 Instantaneous Release – Overpressure (Graph)



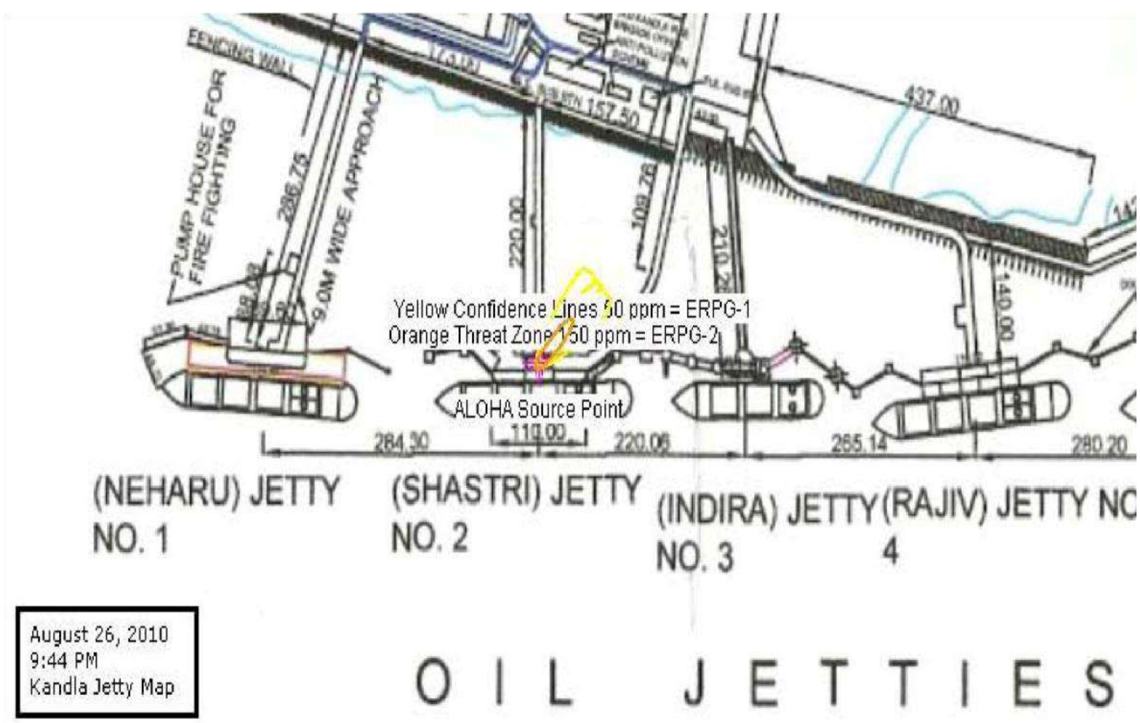
20.1.5.6 Instantaneous Release – Overpressure (Contour)



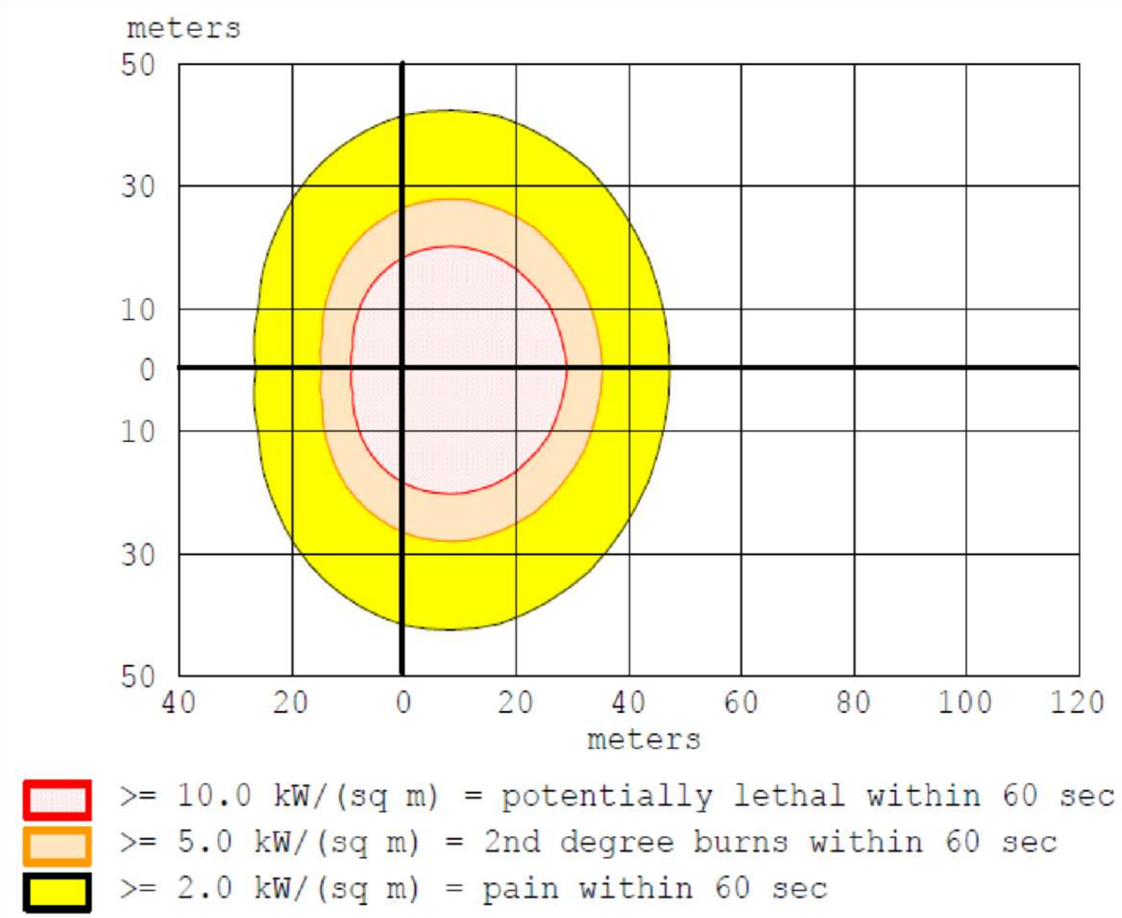
20.1.5.7 Evaporating Puddle – Toxic Threat Zone (Graph)



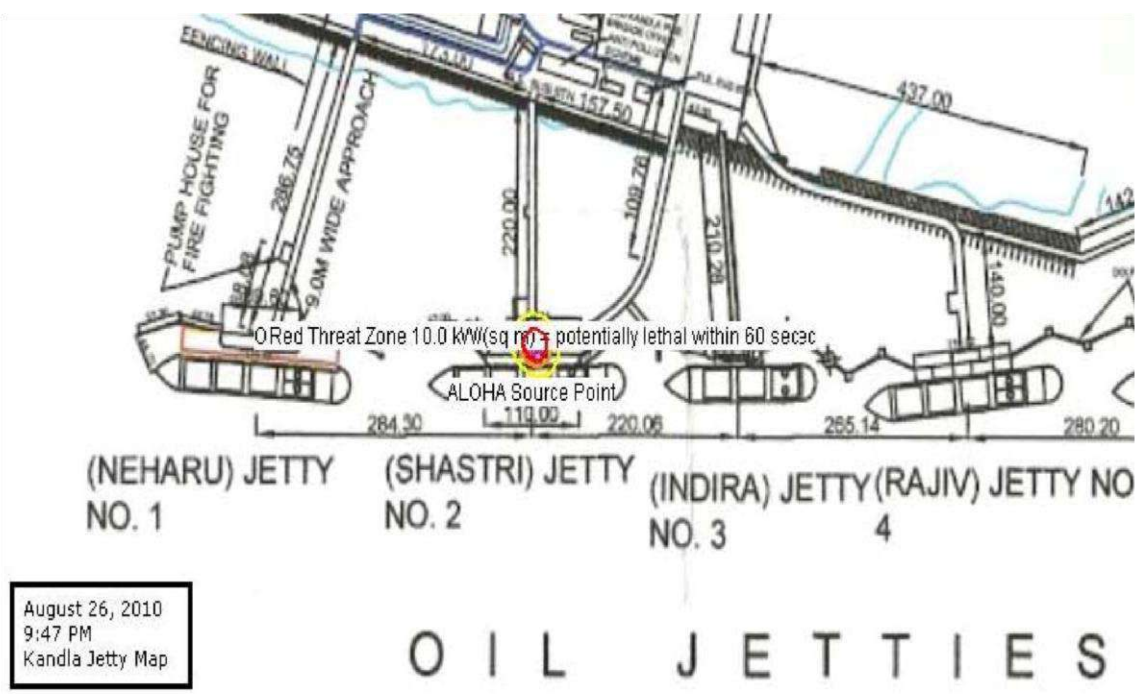
20.1.5.8 Evaporating Puddle – Toxic Threat Zone (Contour)



20.1.5.9 Burning Puddle – Thermal Radiation (Graph)

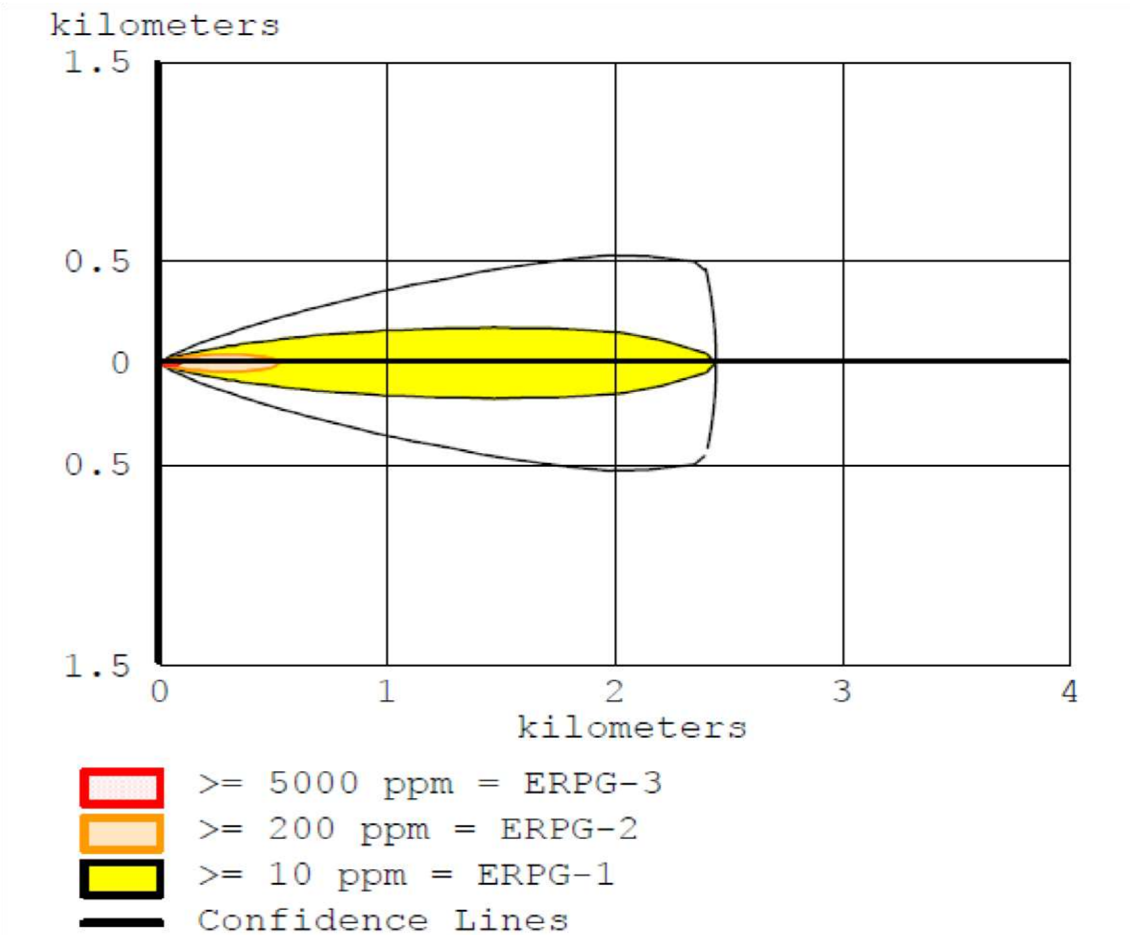


20.1.5.10 Burning Puddle – Thermal Radiation (Contour)

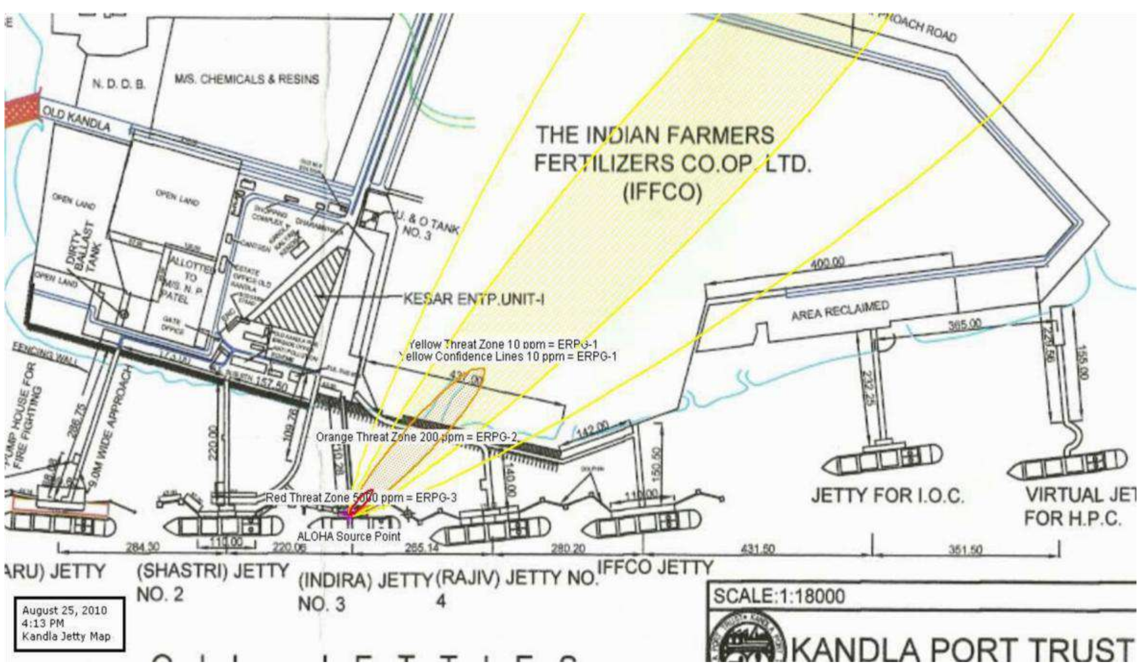


20.1.6 Jetty Three – 1:3, Butadiene

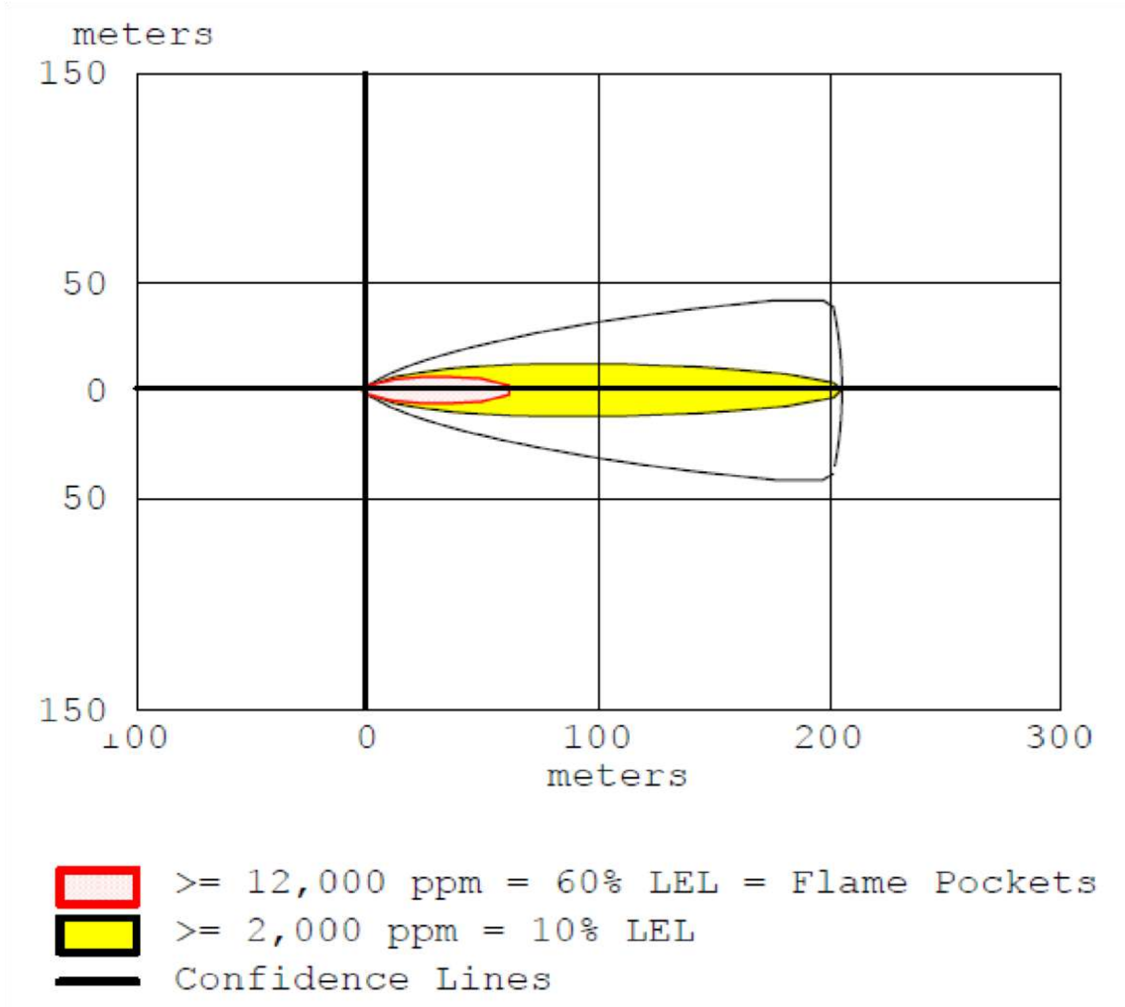
20.1.6.1 Instantaneous Release – Toxic Threat Zone (Graph)



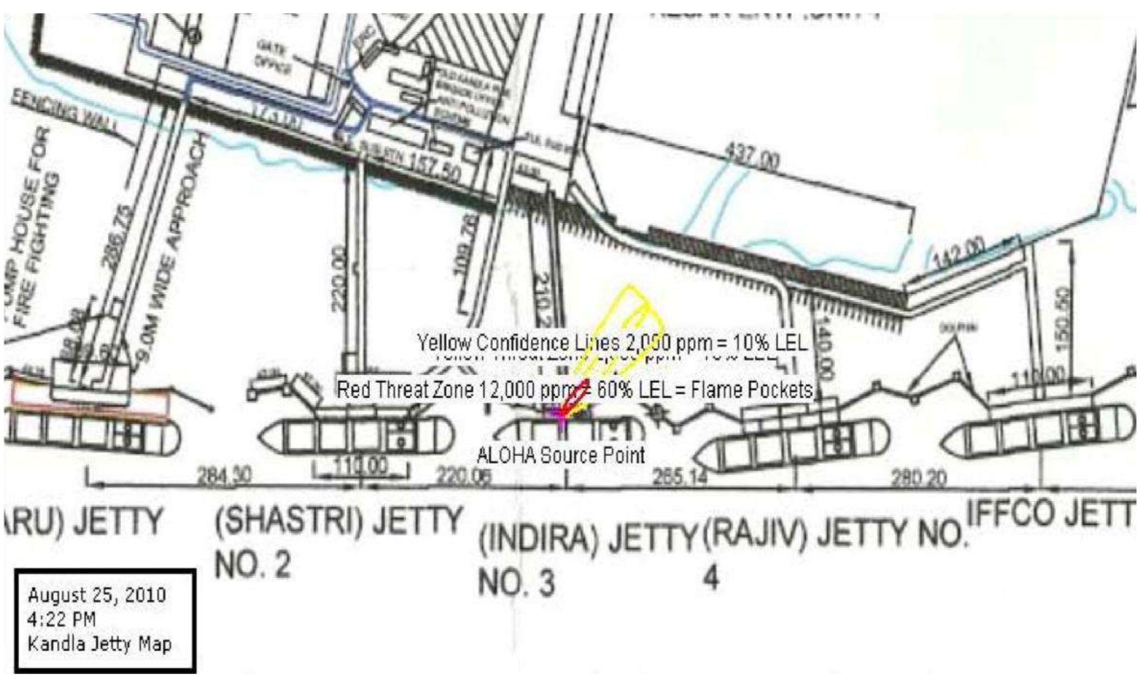
20.1.6.2 Instantaneous Release – Toxic Threat Zone (Contour)



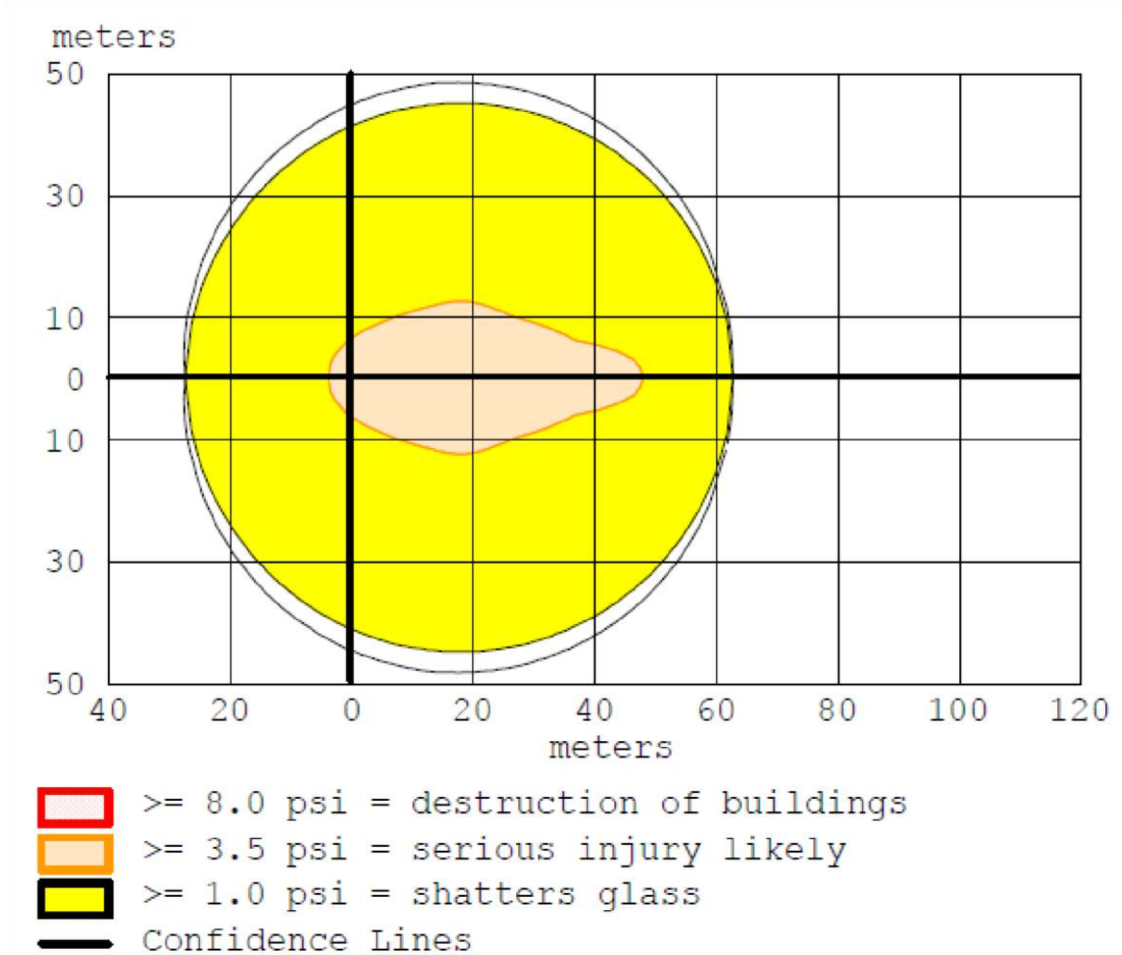
20.1.6.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



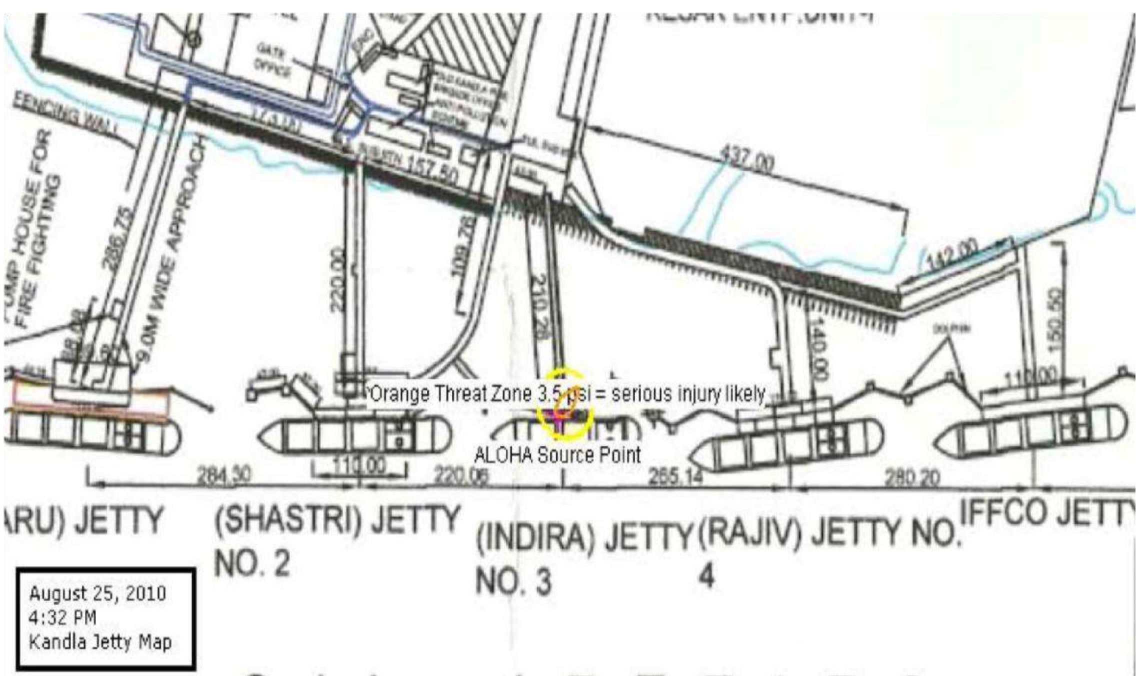
20.1.6.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



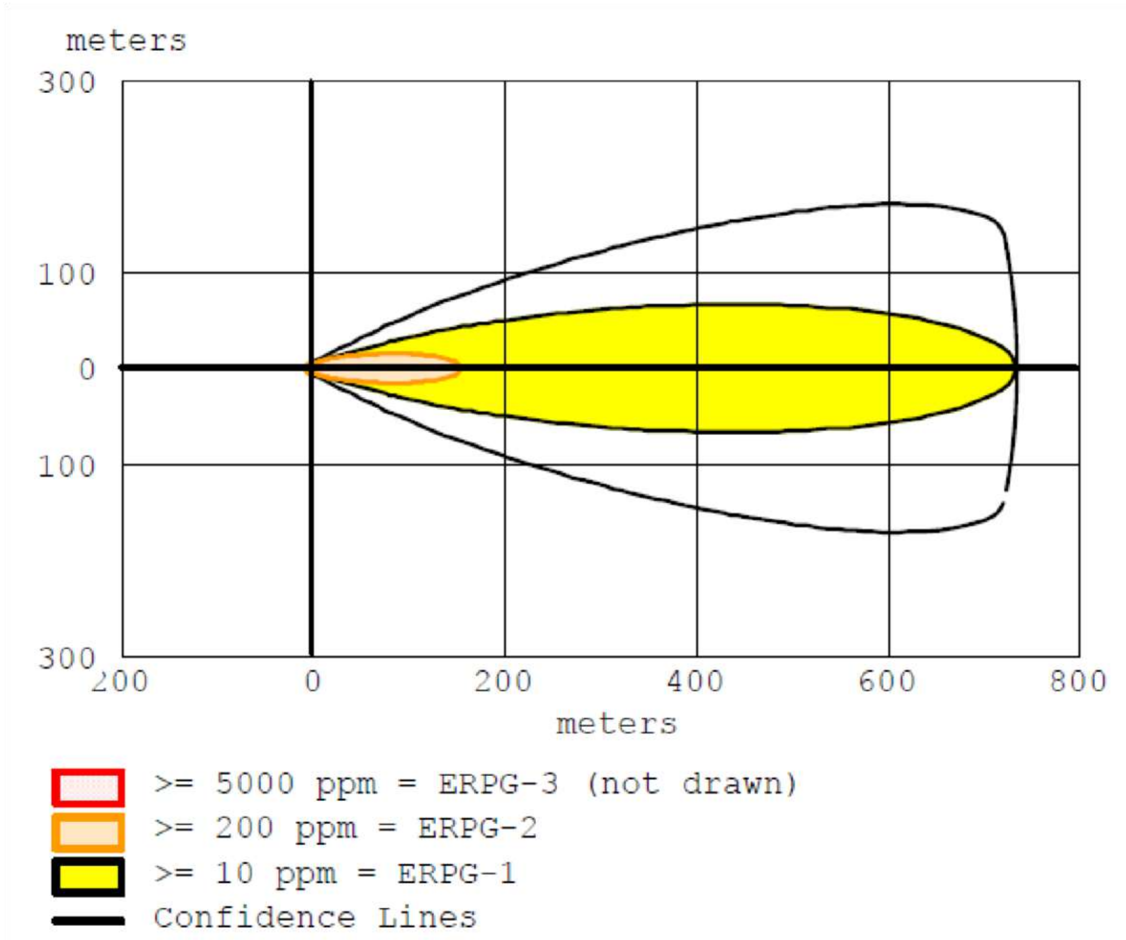
20.1.6.5 Instantaneous Release – Overpressure (Graph)



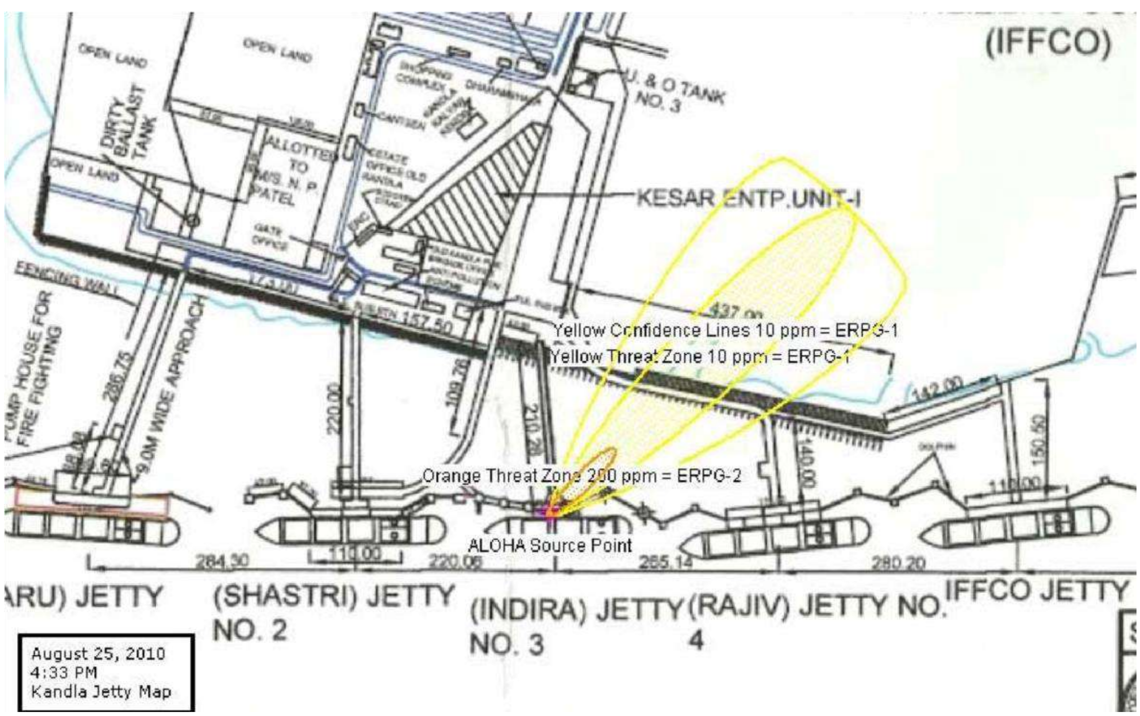
20.1.6.6 Instantaneous Release – Overpressure (Contour)



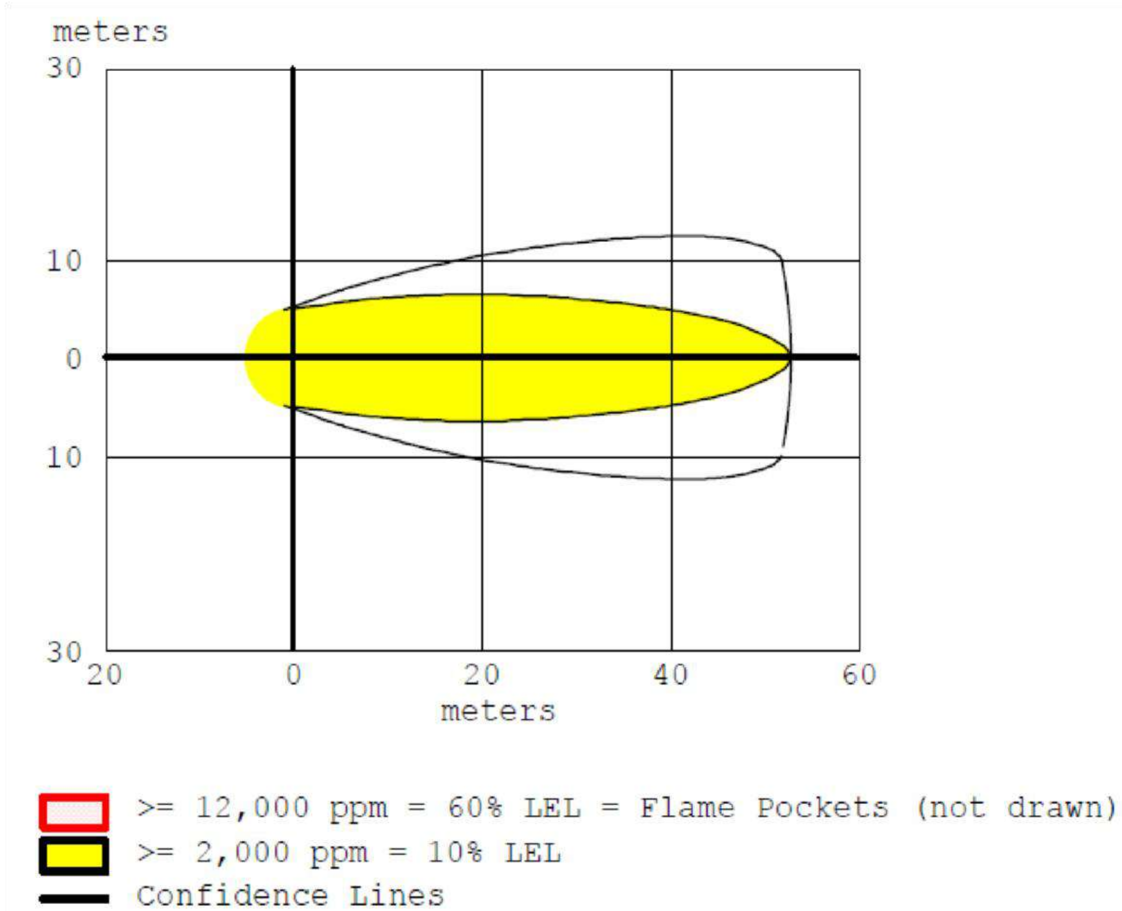
20.1.6.7 Evaporating Puddle – Toxic Threat Zone (Graph)



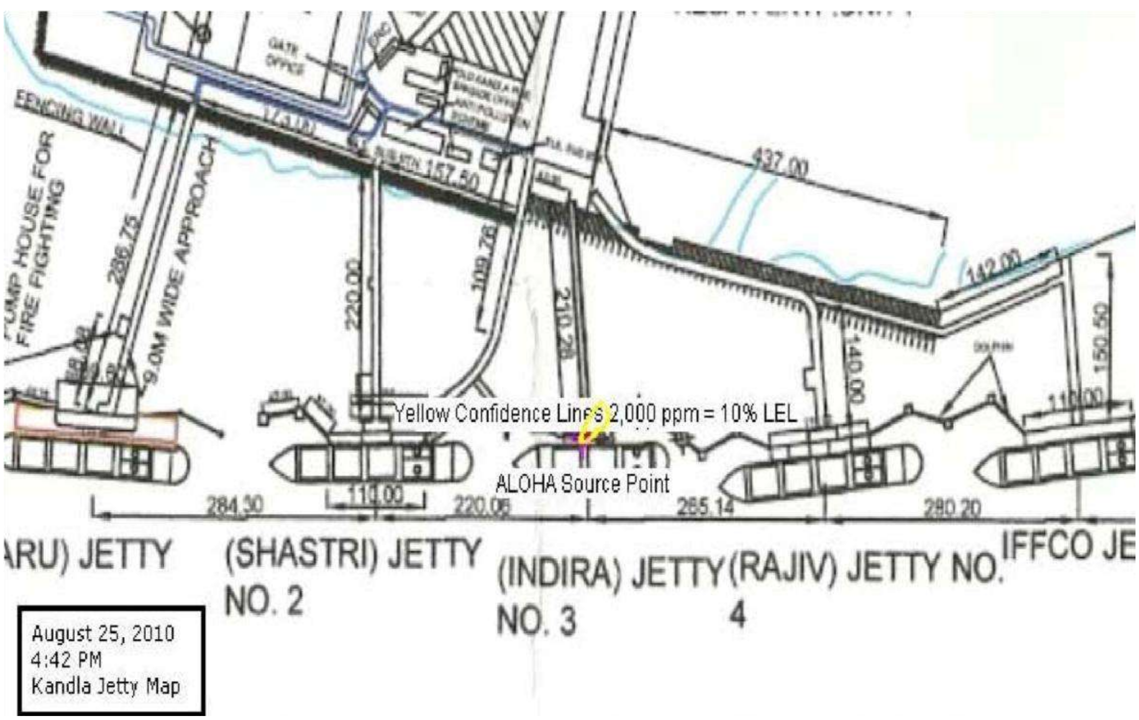
20.1.6.8 Evaporating Puddle – Toxic Threat Zone (Contour)



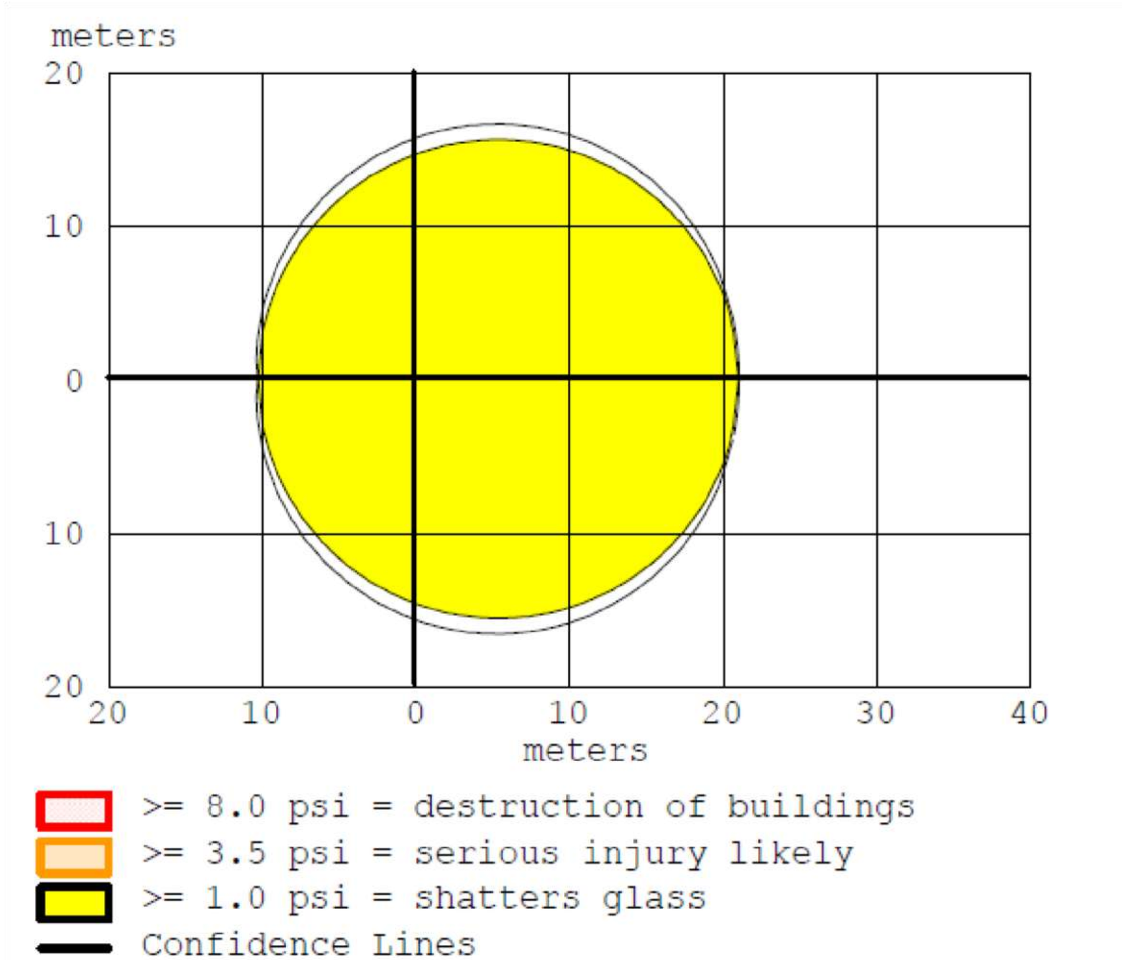
20.1.6.9 Evaporating Puddle – Flammable Area of Vapor Cloud (Graph)



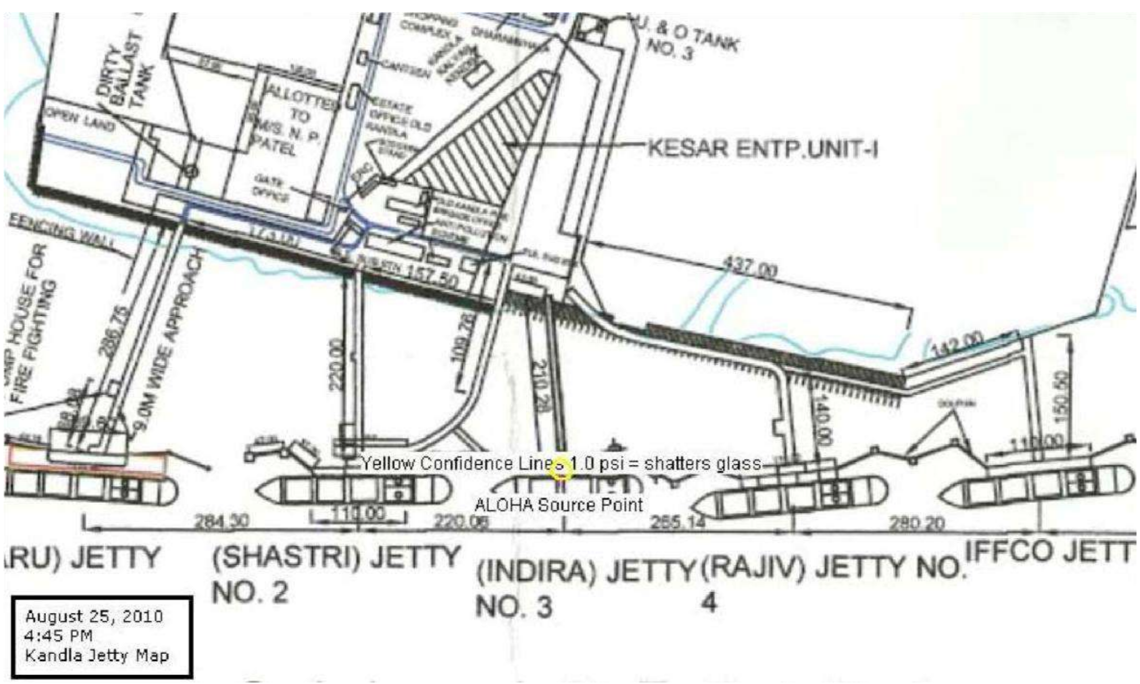
20.1.6.10 Evaporating Puddle – Flammable Area of Vapor Cloud (Contour)



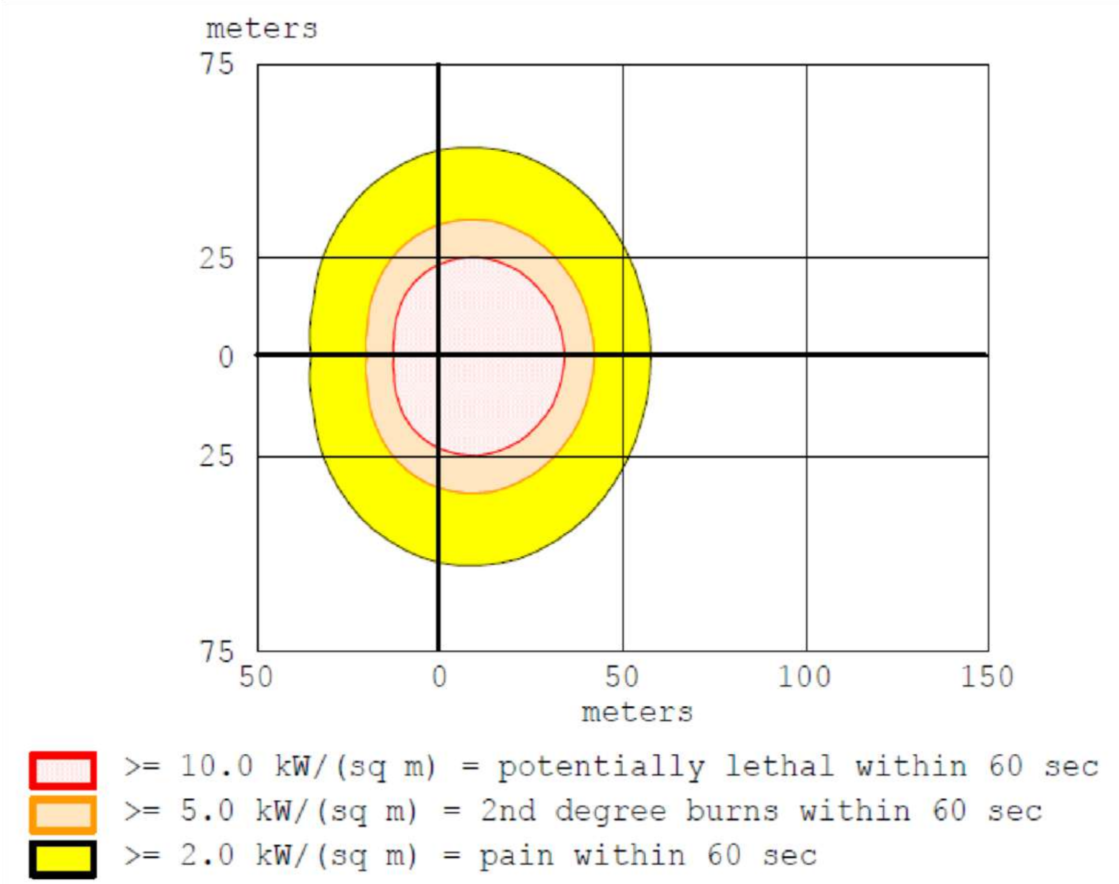
20.1.6.11 Evaporating Puddle – Overpressure (Graph)



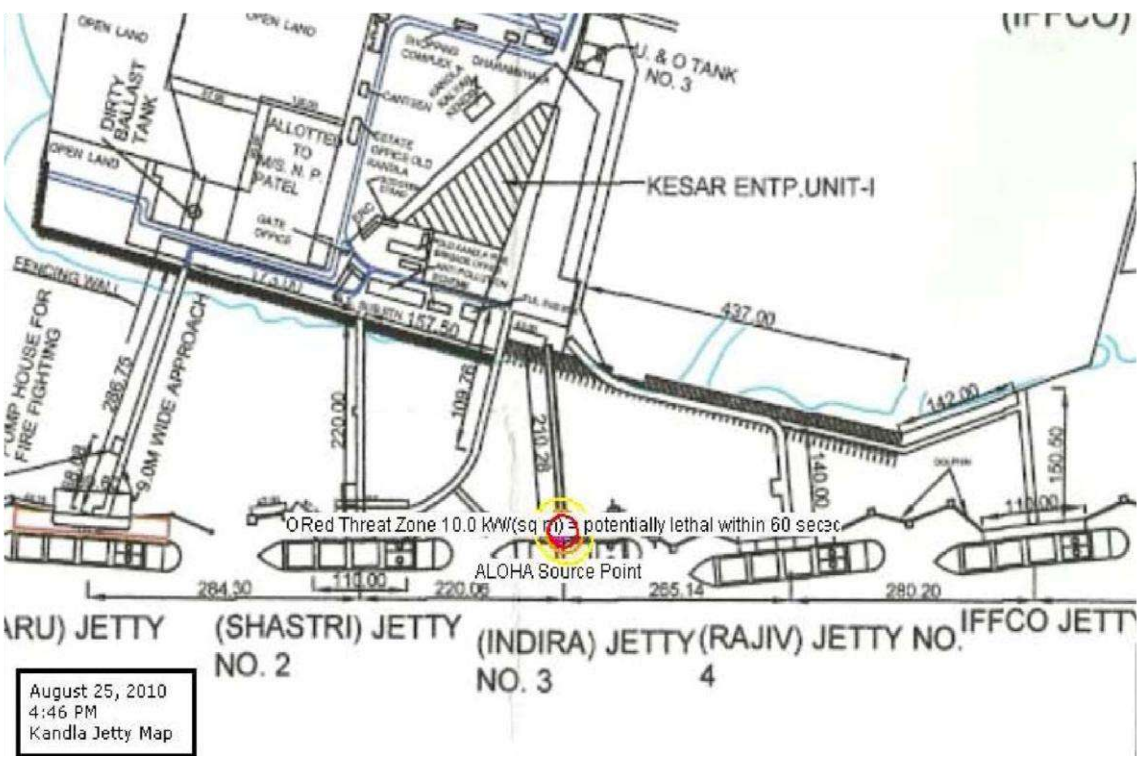
20.1.6.12 Evaporating Puddle – Overpressure (Contour)



20.1.6.13 Burning Puddle – Thermal Radiation (Graph)

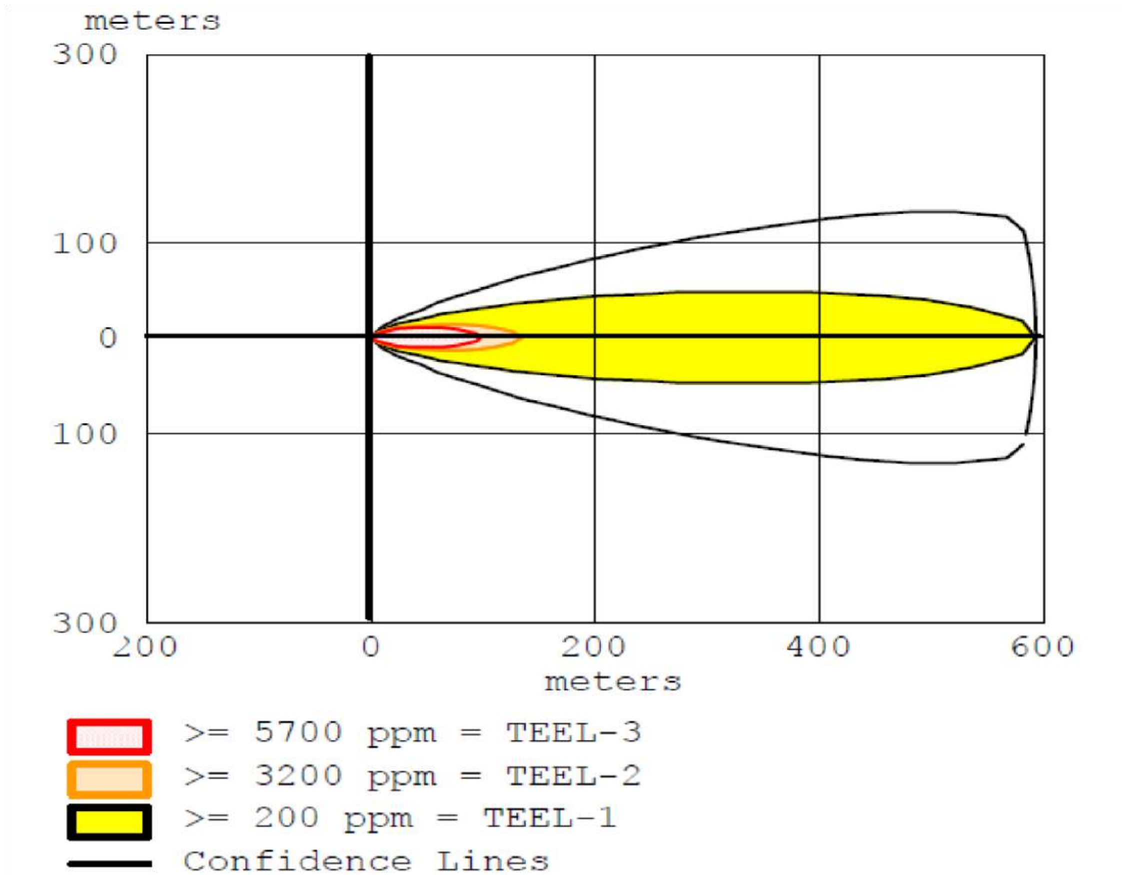


20.1.6.14 Burning Puddle – Thermal Radiation (Contour)

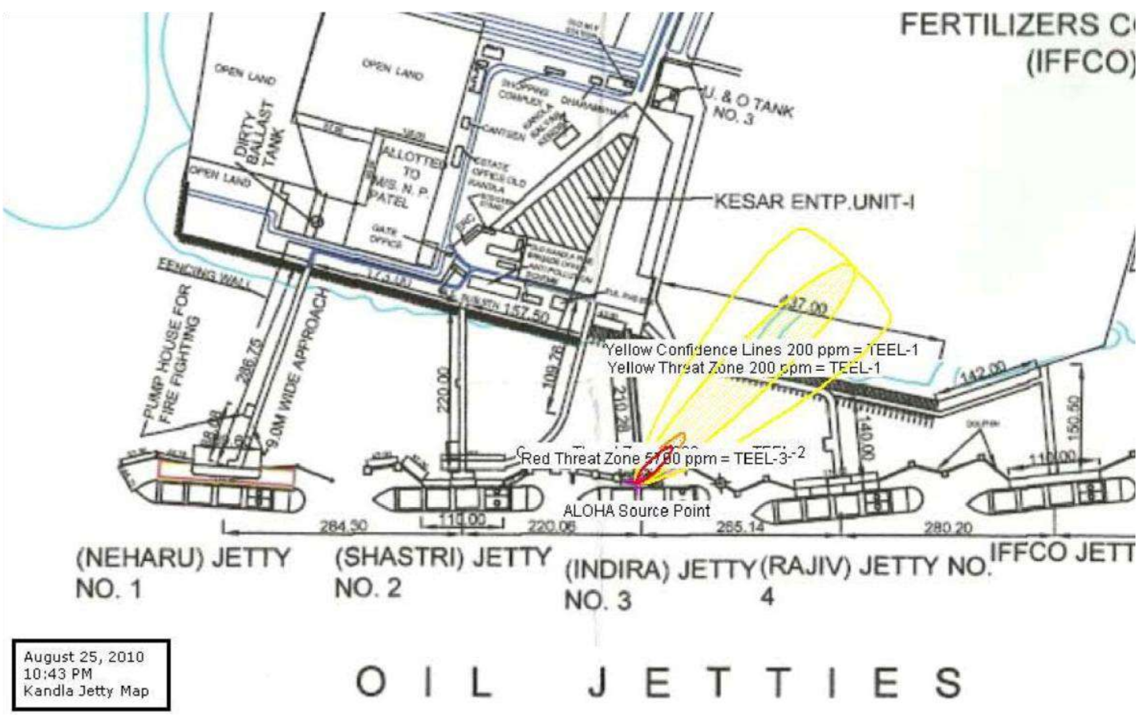


20.1.7 Jetty Three – Acetone

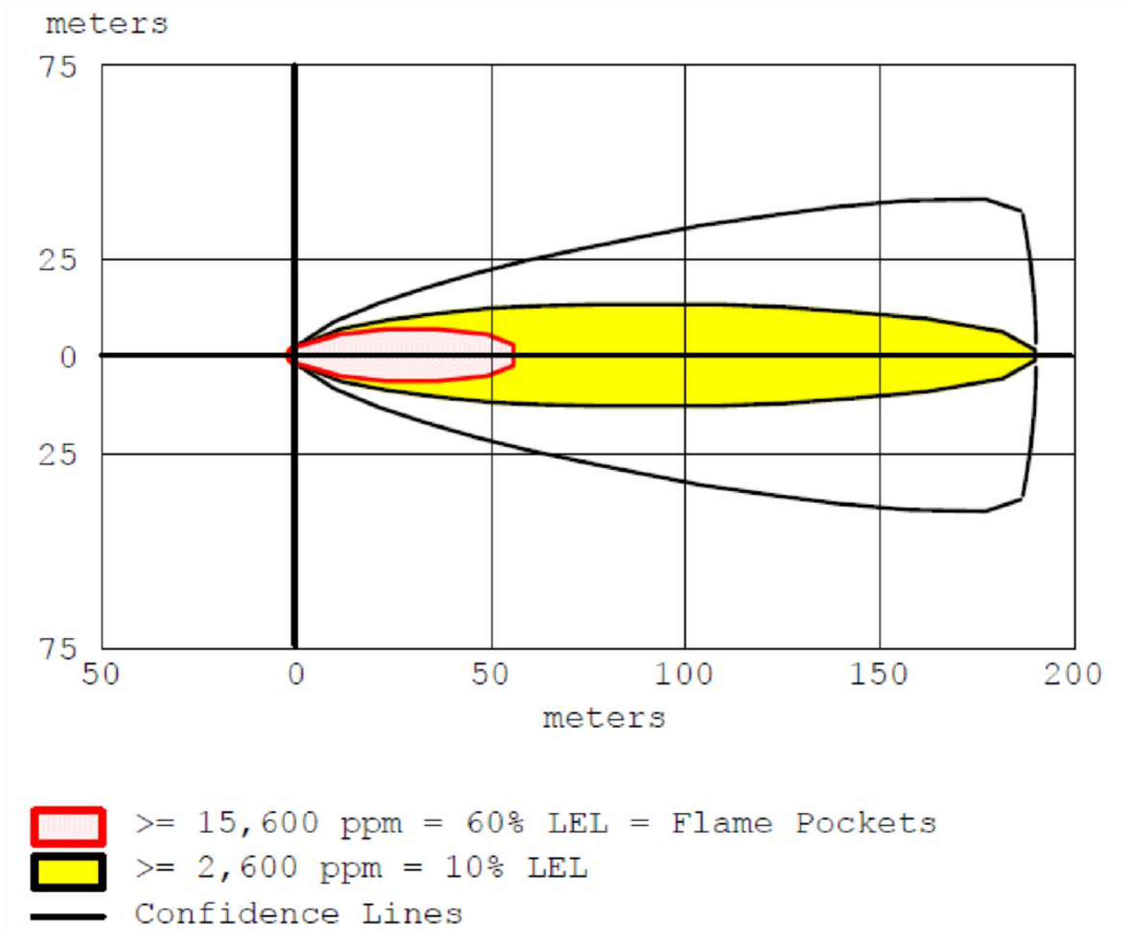
20.1.7.1 Instantaneous Release – Toxic Threat Zone (Graph)



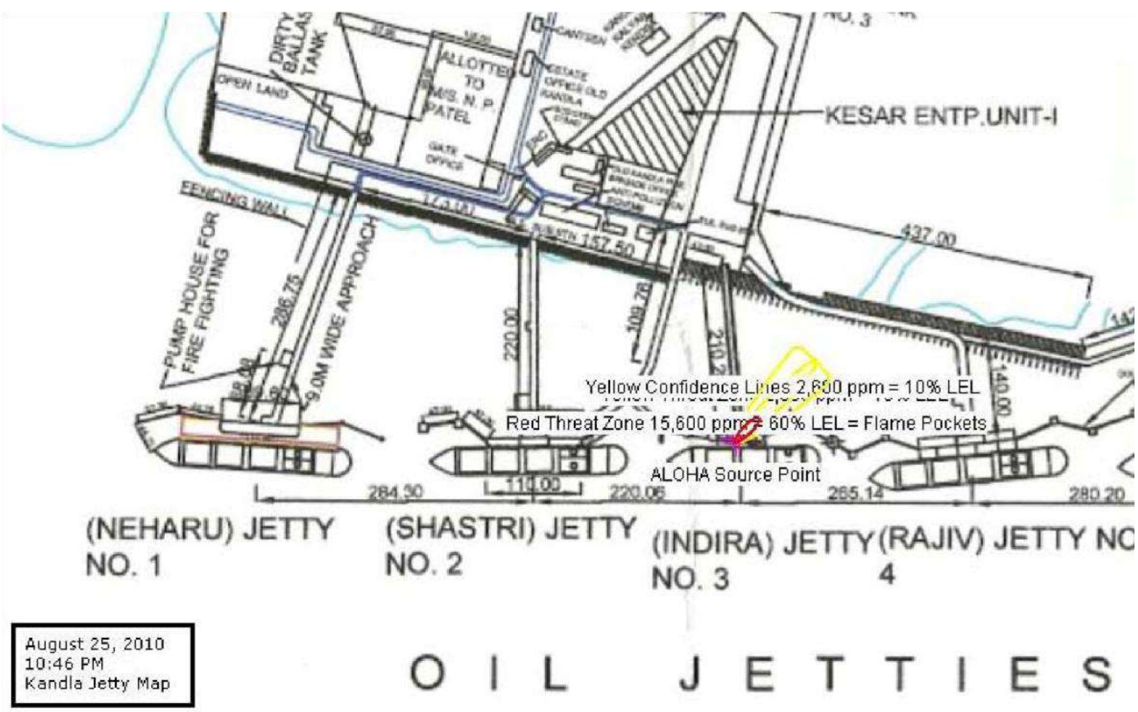
20.1.7.2 Instantaneous Release – Toxic Threat Zone (Contour)



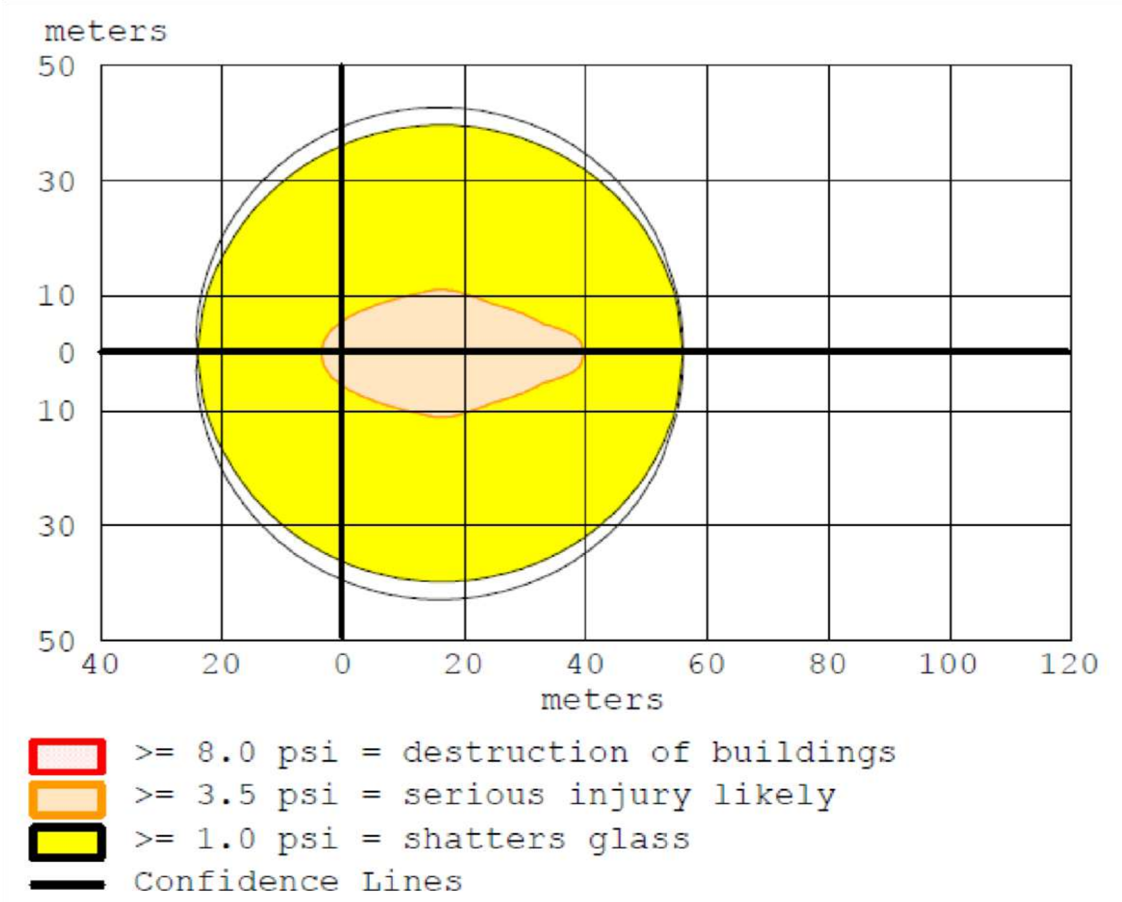
20.1.7.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



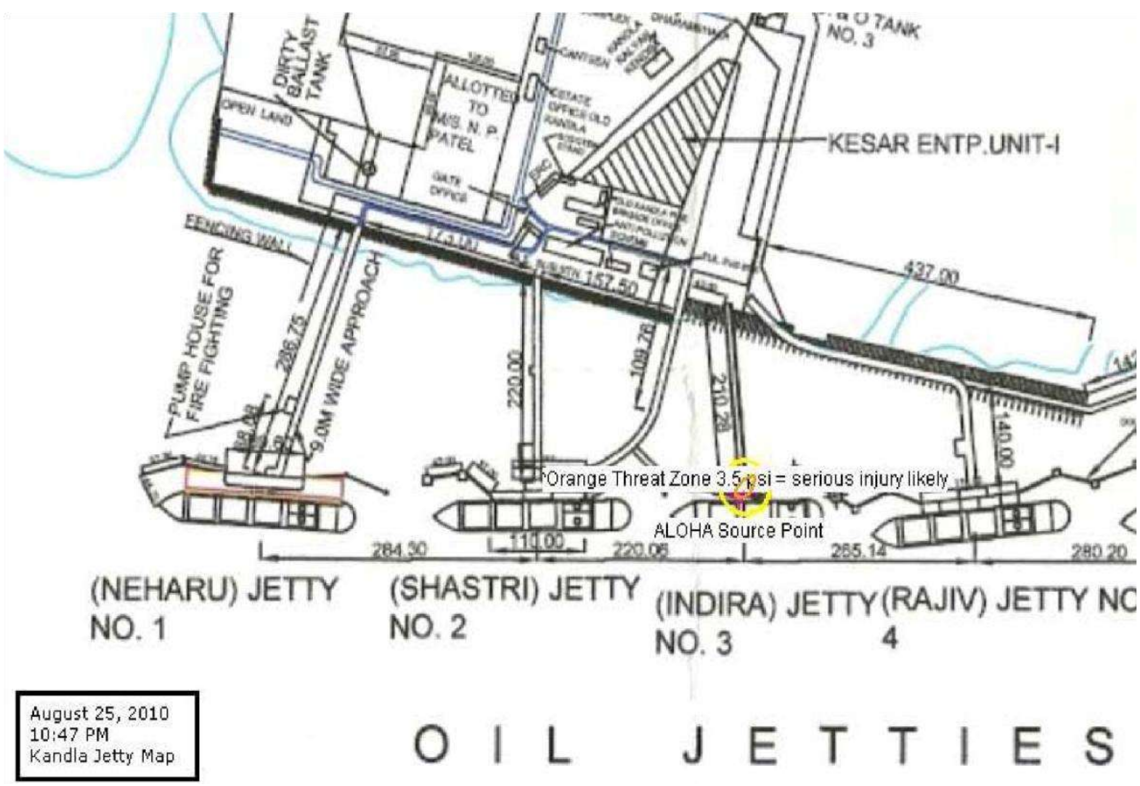
20.1.7.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



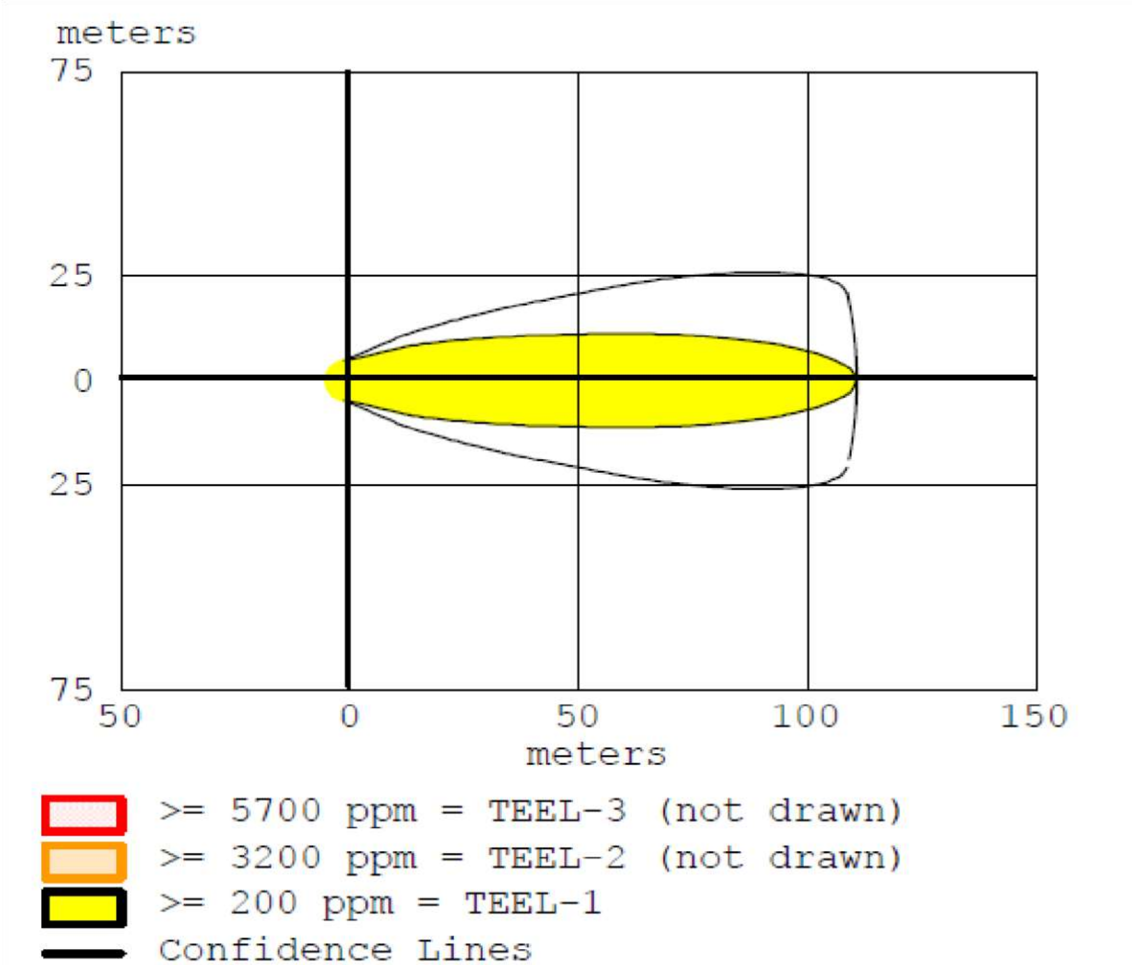
20.1.7.5 Instantaneous Release – Overpressure (Graph)



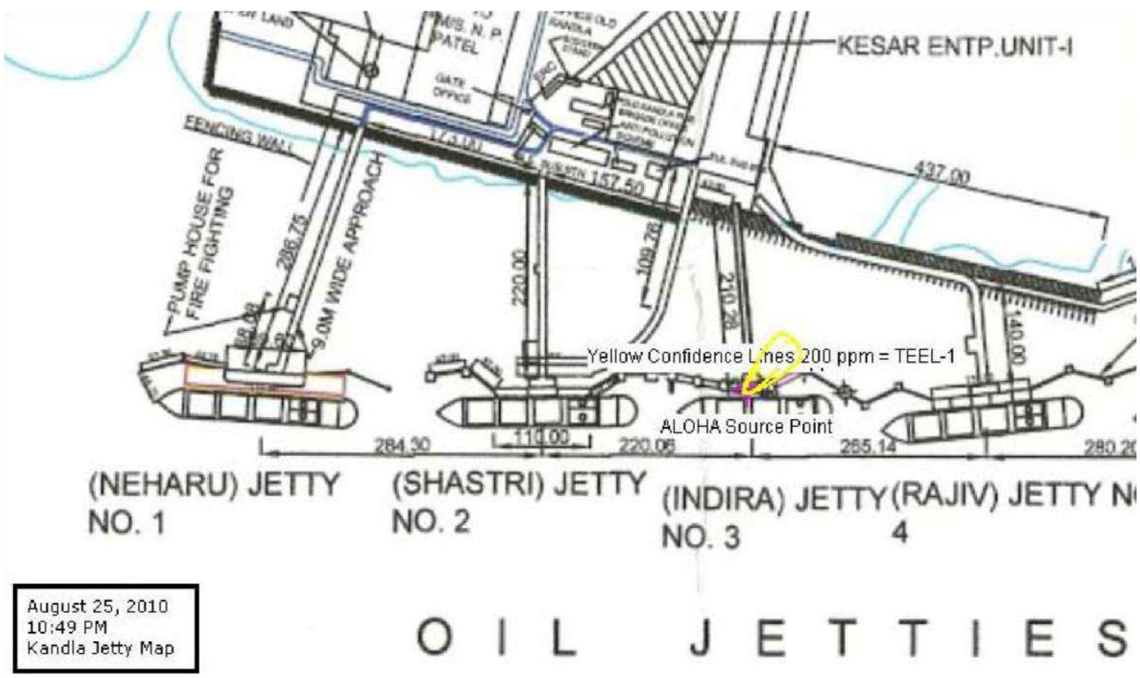
20.1.7.6 Instantaneous Release – Overpressure (Contour)



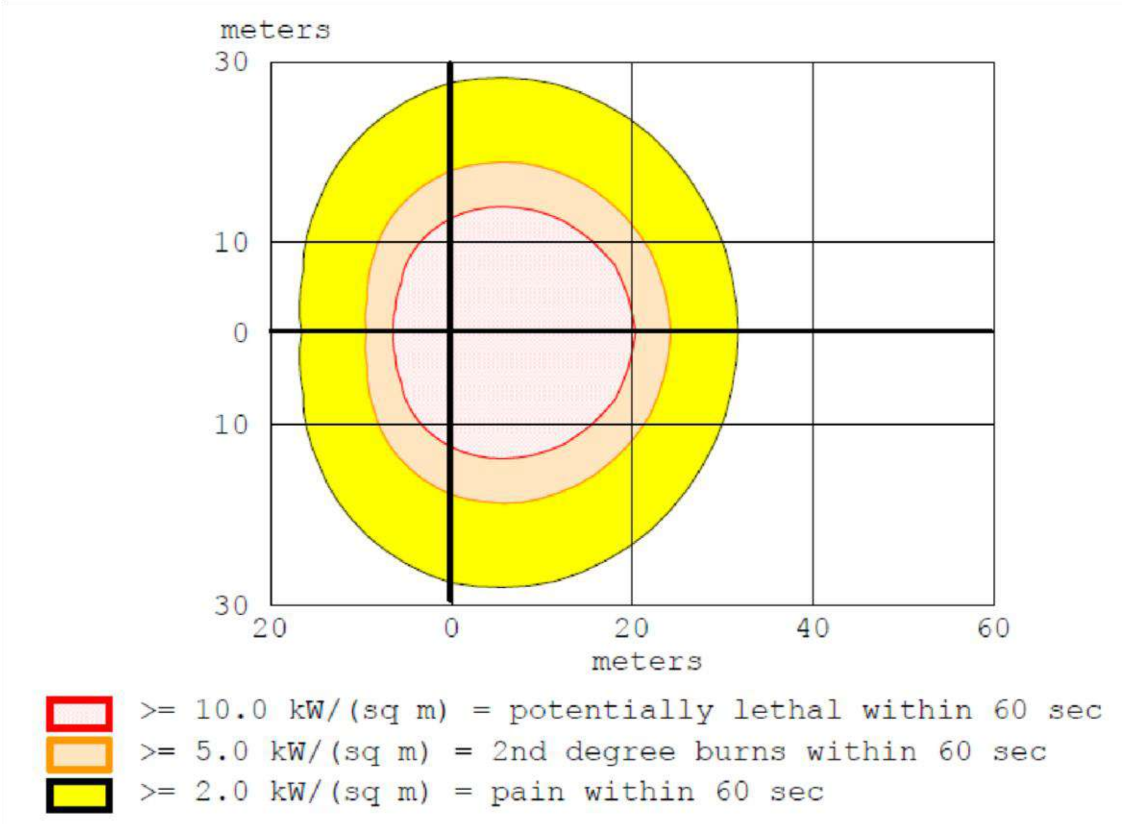
20.1.7.7 Evaporating Puddle – Toxic Threat Zone (Graph)



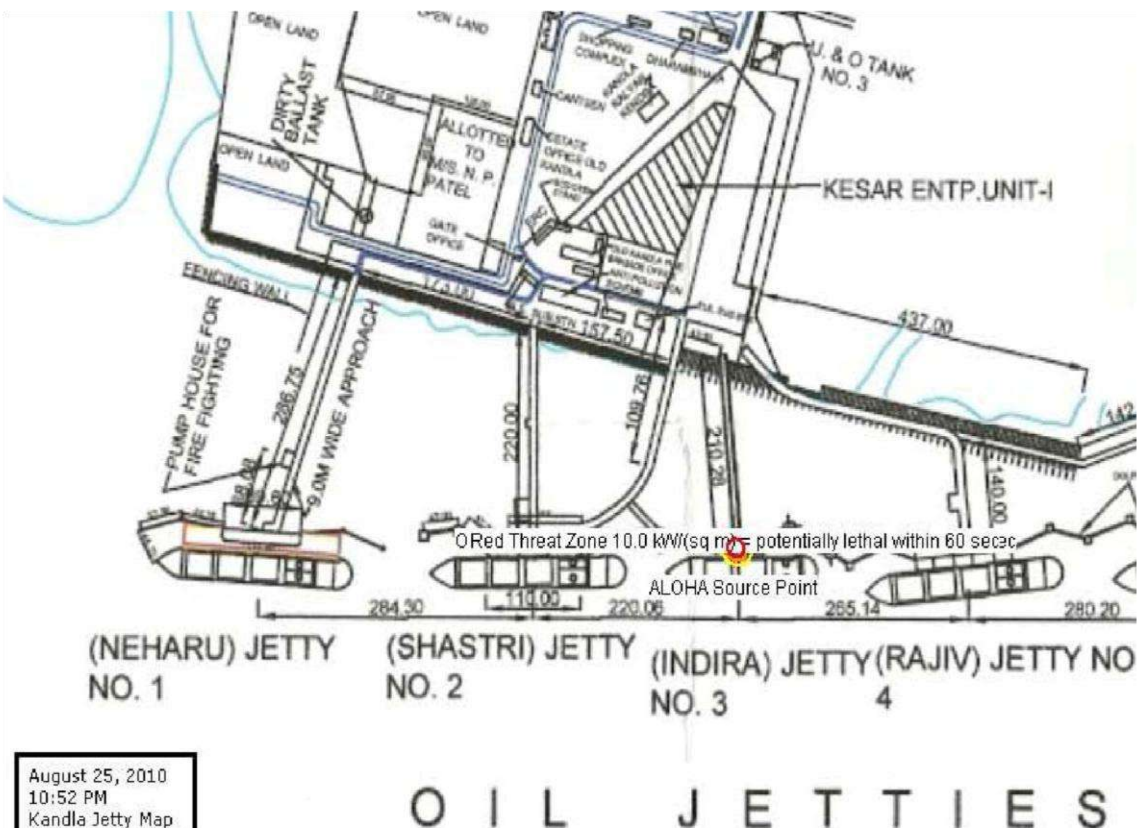
20.1.7.8 Evaporating Puddle – Toxic Threat Zone (Contour)



20.1.7.9 Burning Puddle – Thermal Radiation (Graph)

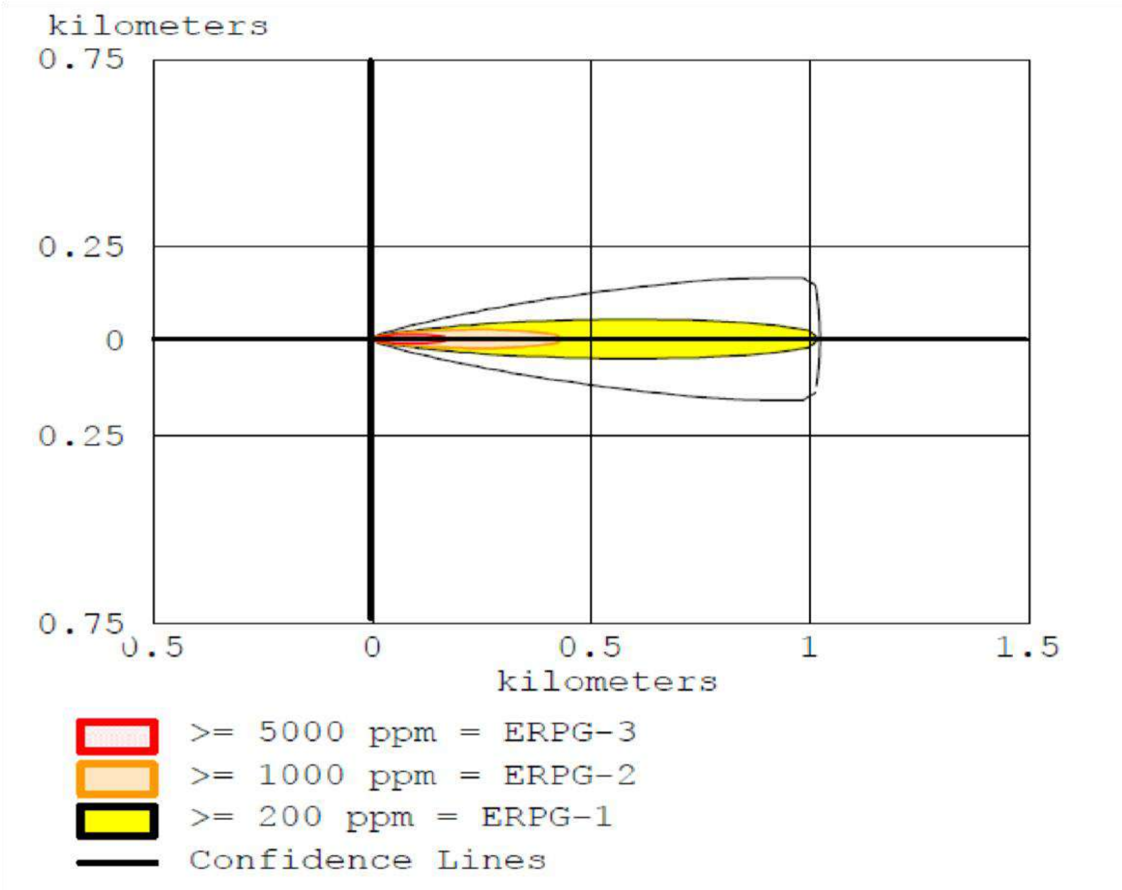


20.1.7.10 Burning Puddle – Thermal Radiation (Contour)

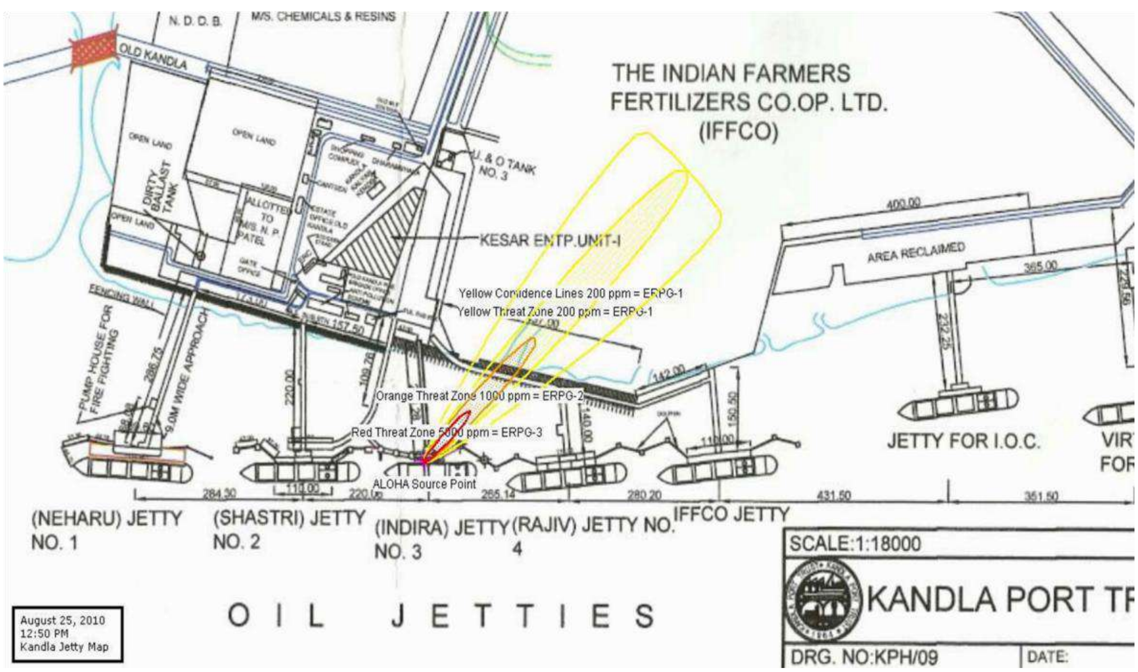


20.1.8 Jetty Three – Methanol

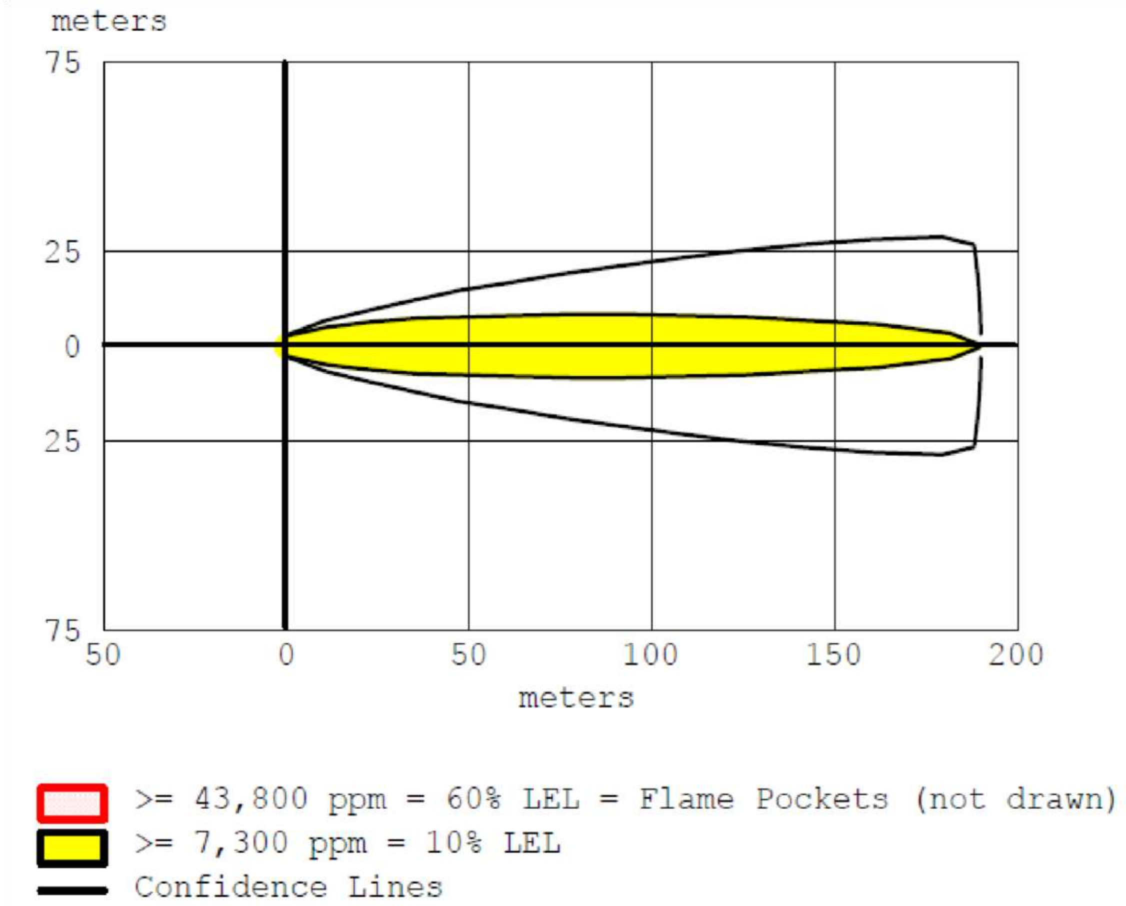
20.1.8.1 Instantaneous Release – Toxic Threat Zone (Graph)



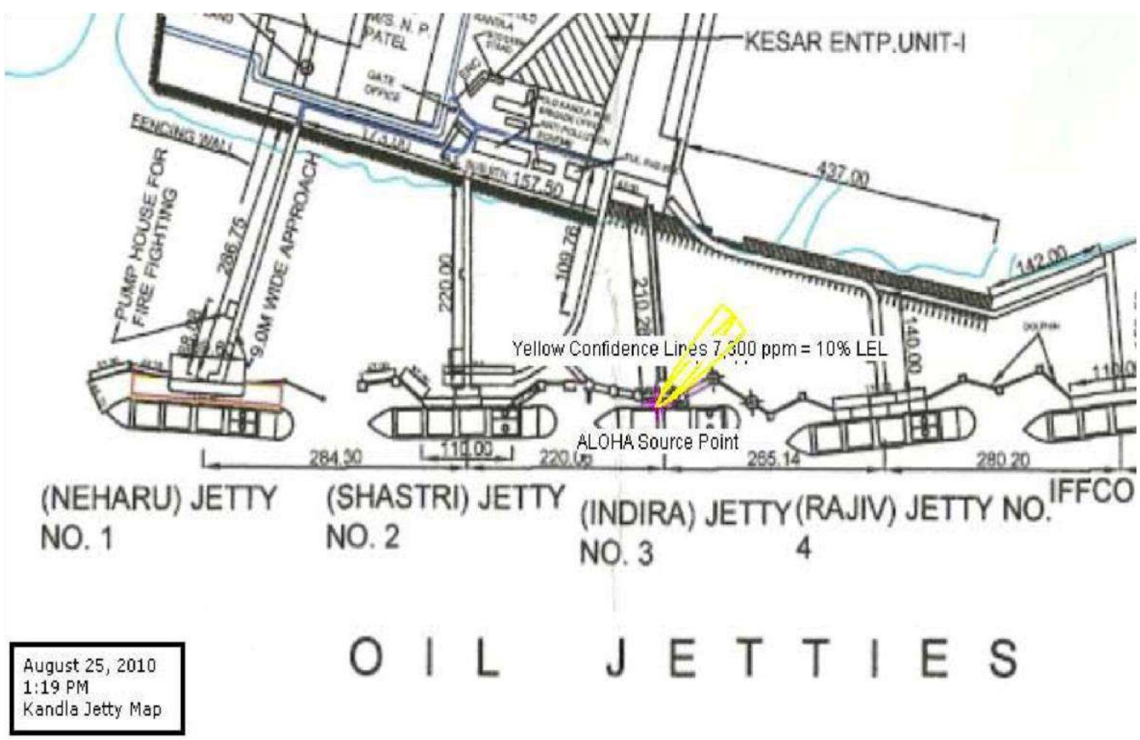
20.1.8.2 Instantaneous Release – Toxic Threat Zone (Contour)



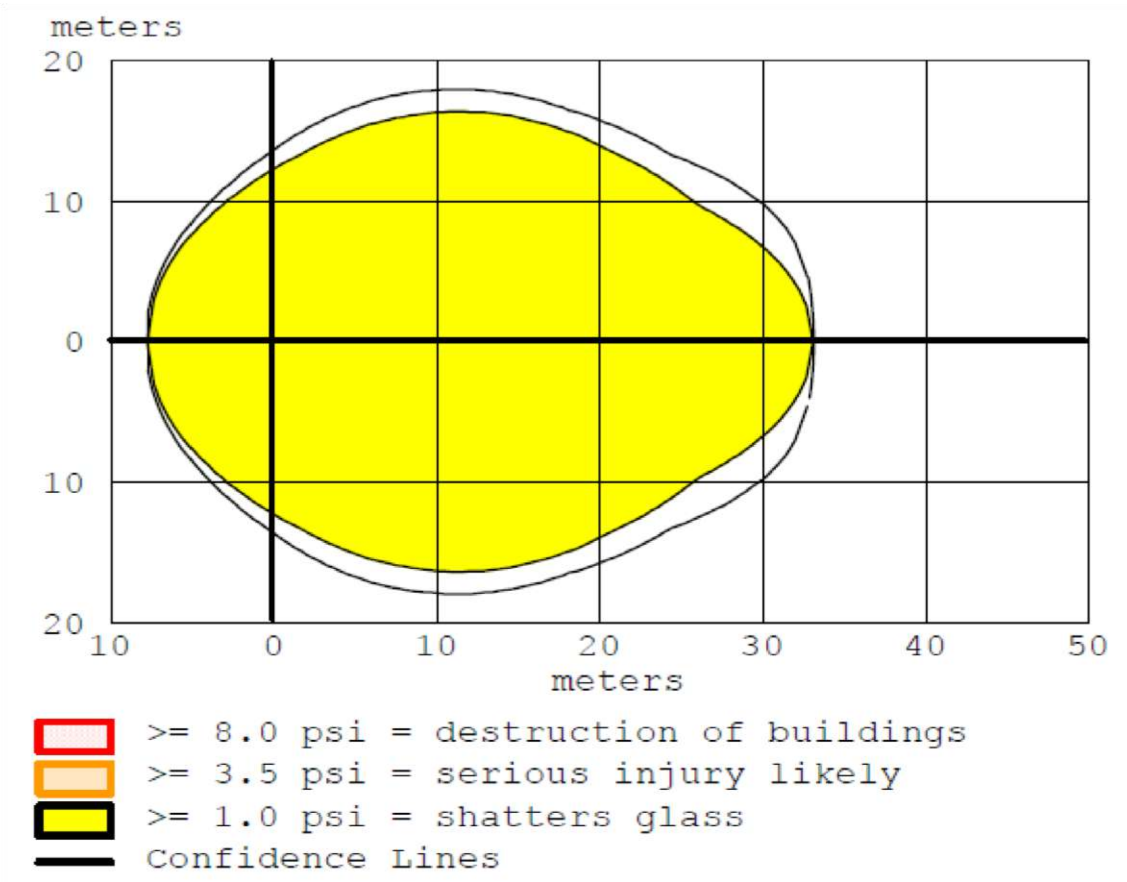
20.1.8.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



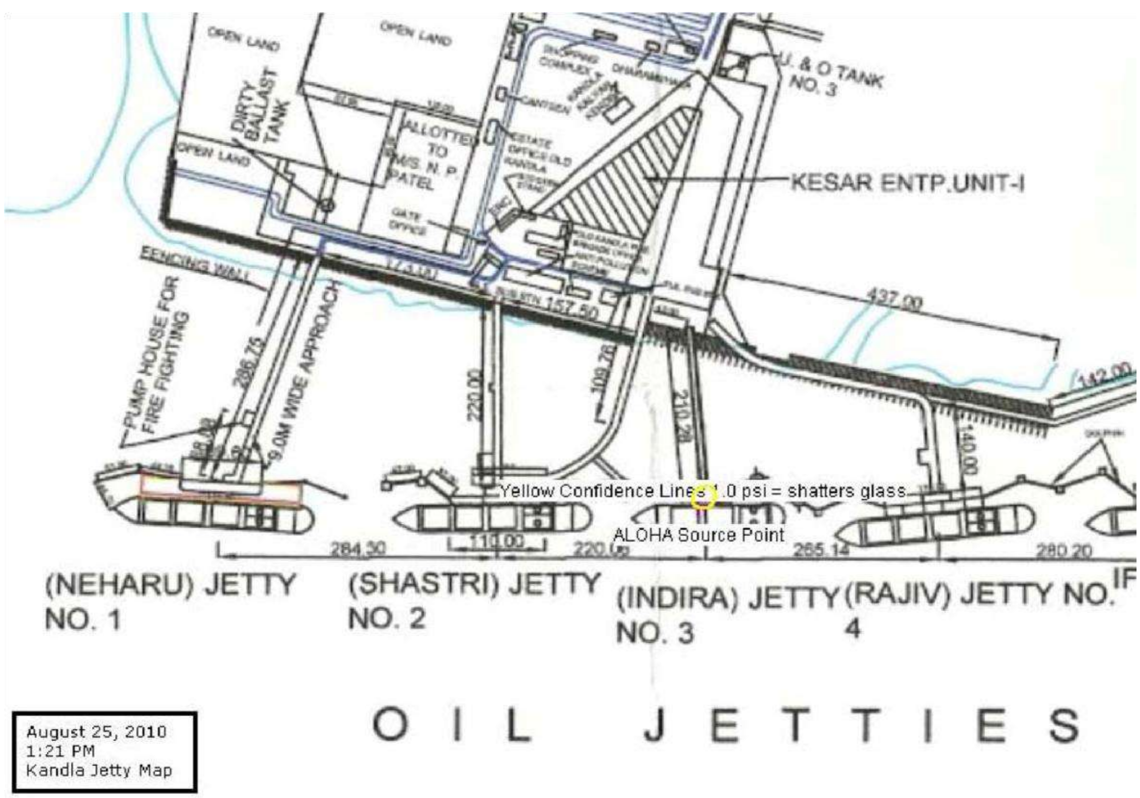
20.1.8.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



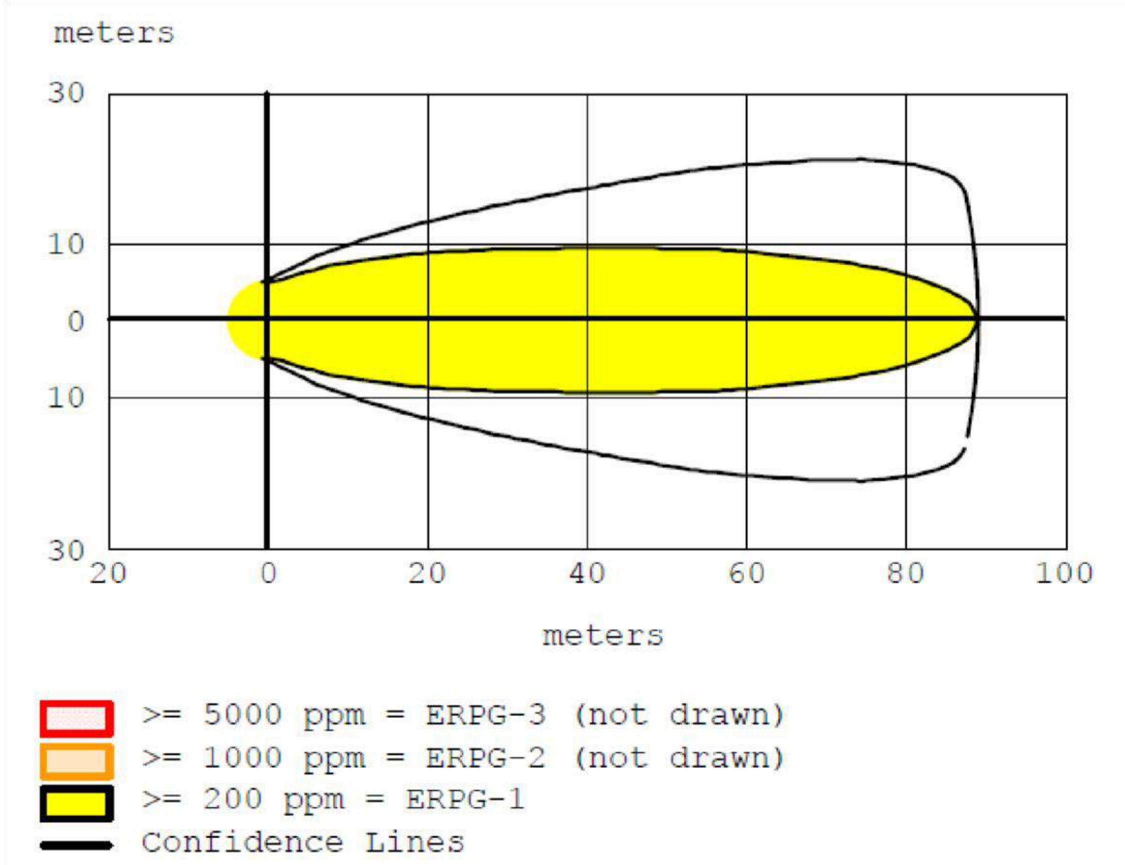
20.1.8.5 Instantaneous Release – Overpressure (Graph)



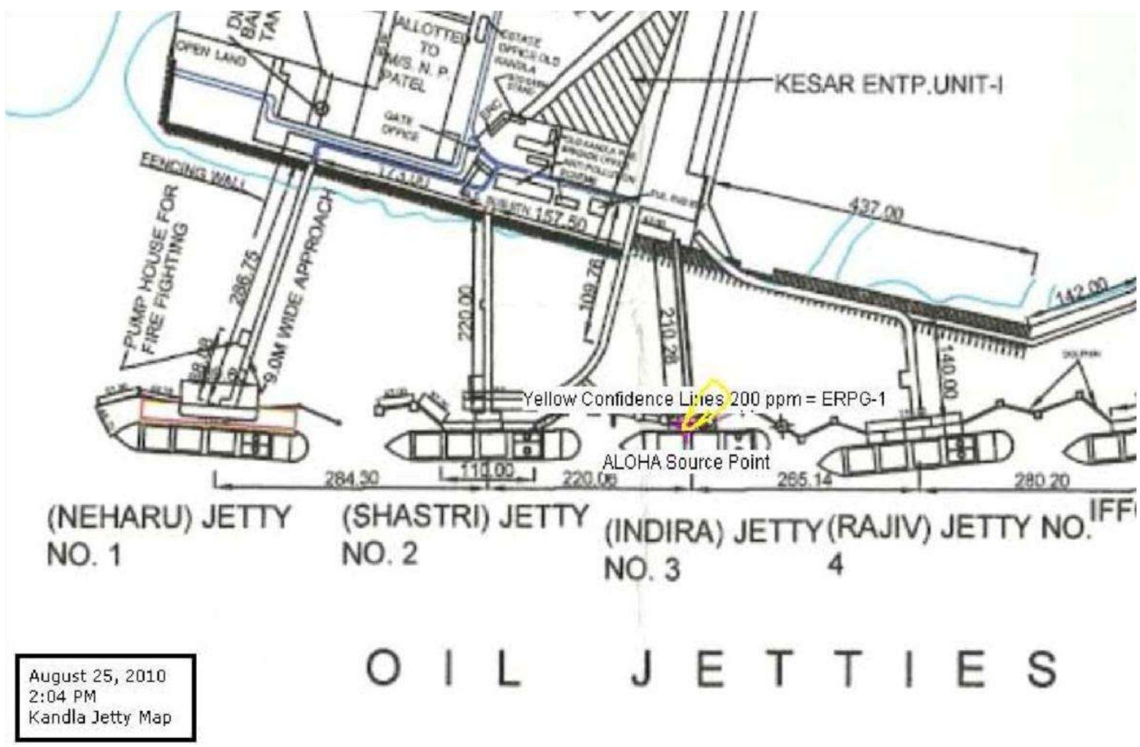
20.1.8.6 Instantaneous Release – Overpressure (Contour)



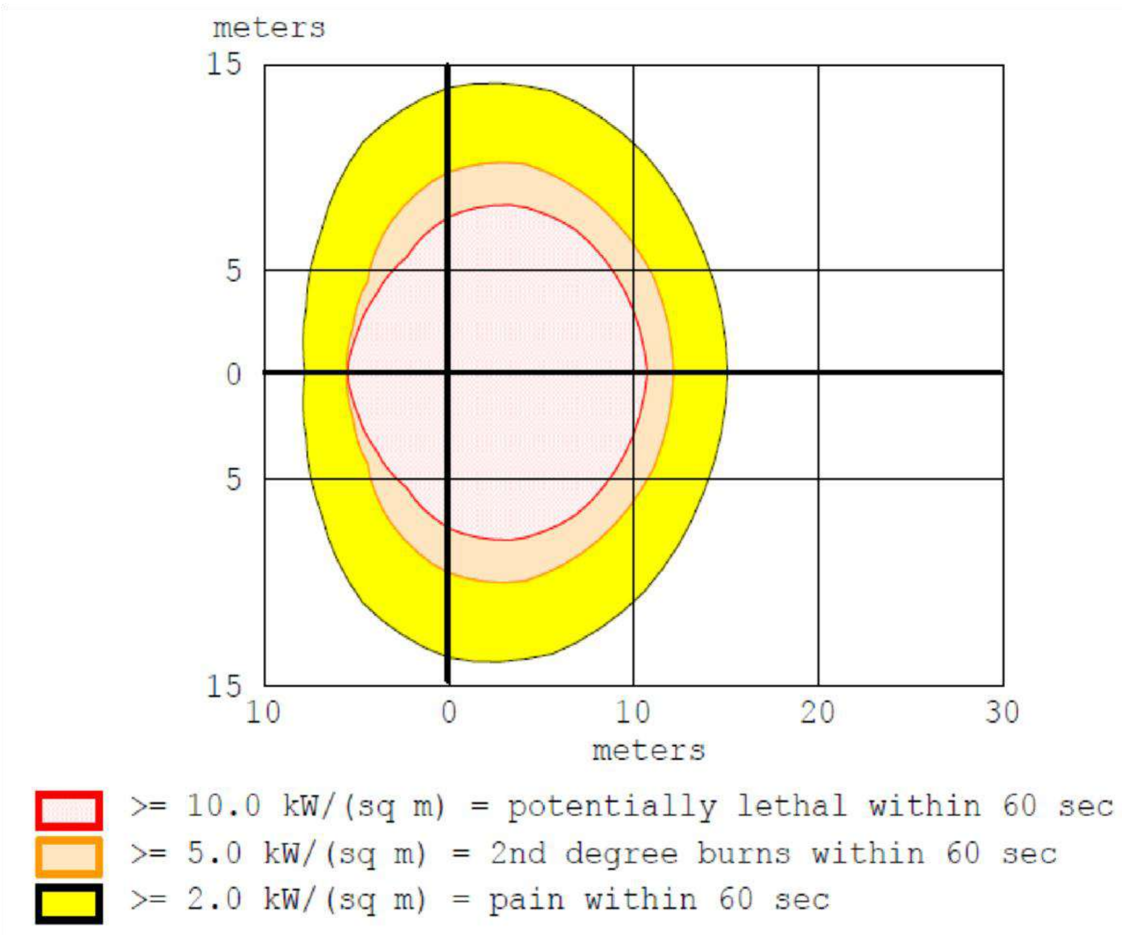
20.1.8.7 Evaporating Puddle – Toxic Threat Zone (Graph)



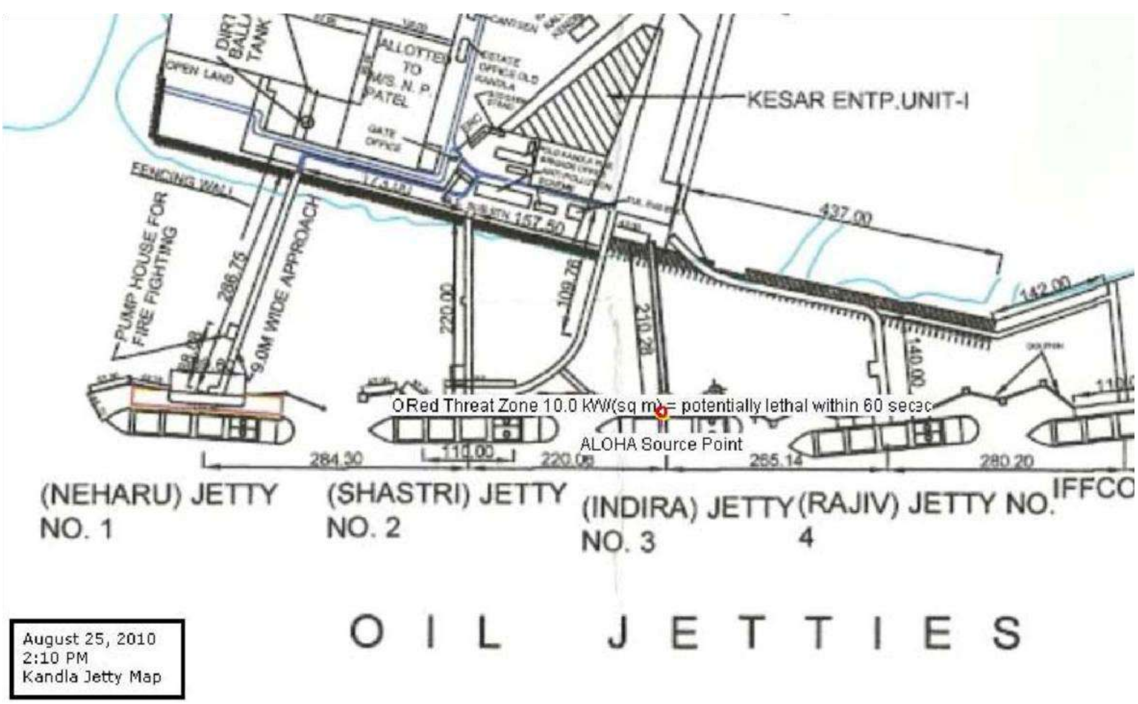
20.1.8.8 Evaporating Puddle – Toxic Threat Zone (Contour)



20.1.8.9 Burning Puddle – Thermal Radiation (Graph)

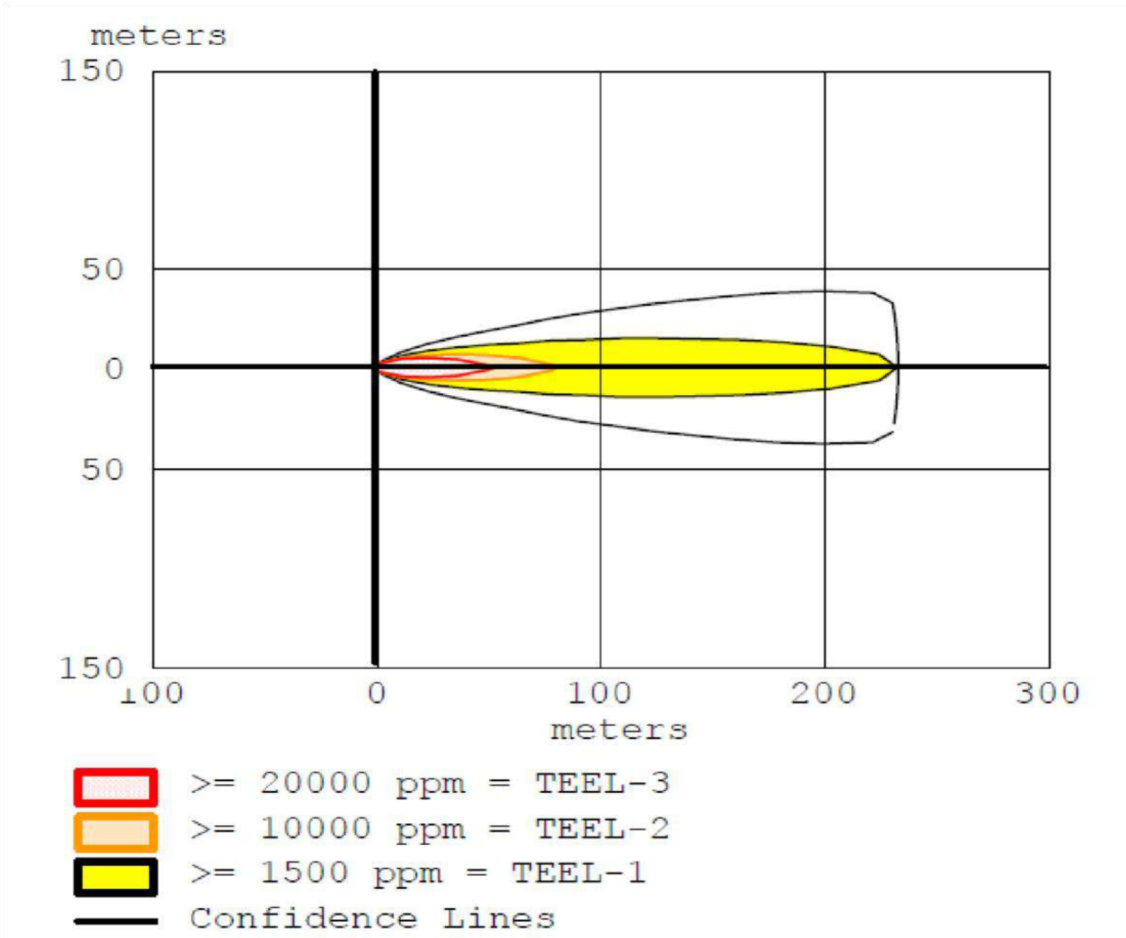


20.1.8.10 Burning Puddle – Thermal Radiation (Contour)

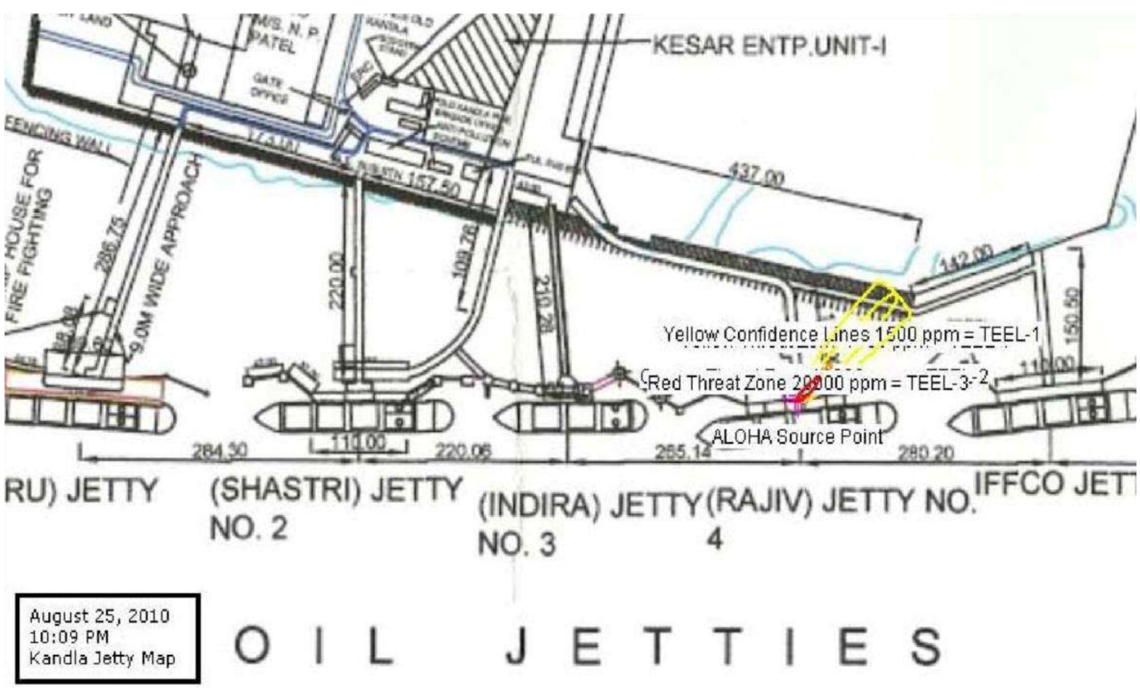


20.1.9 Jetty Four – Propylene

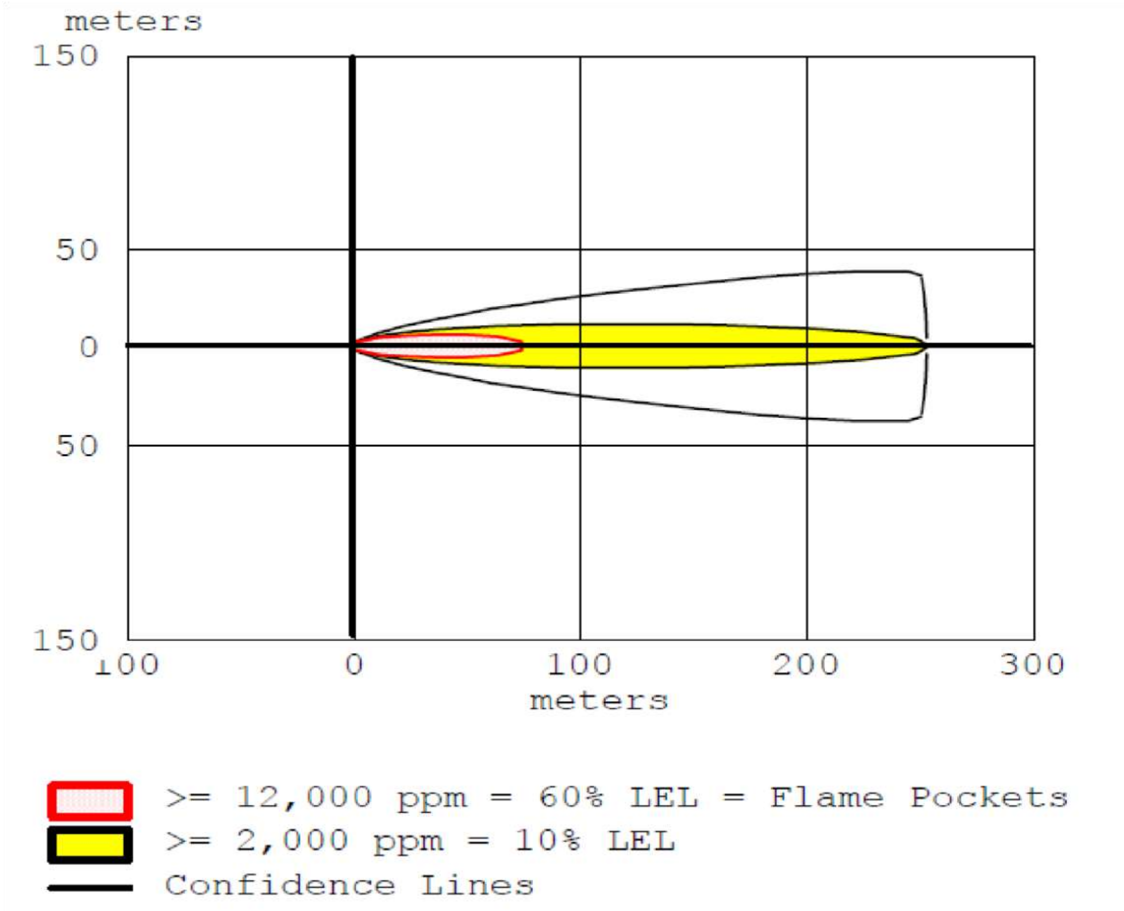
20.1.9.1 Instantaneous Release – Toxic Threat Zone (Graph)



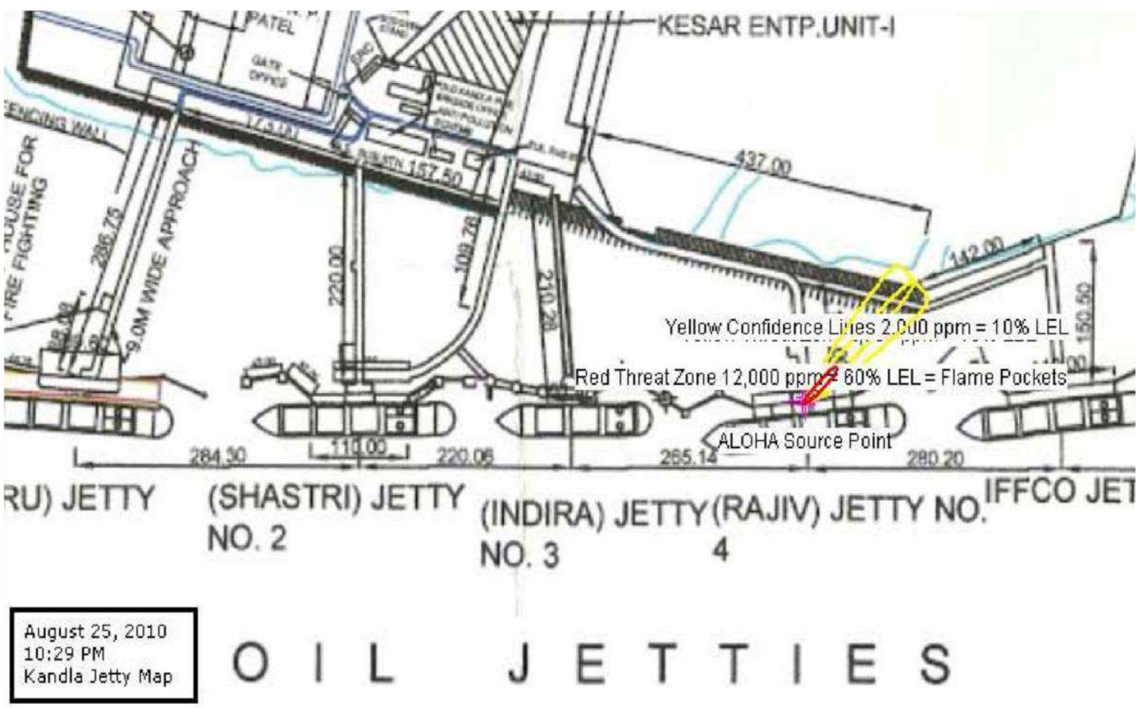
20.1.9.2 Instantaneous Release – Toxic Threat Zone (Contour)



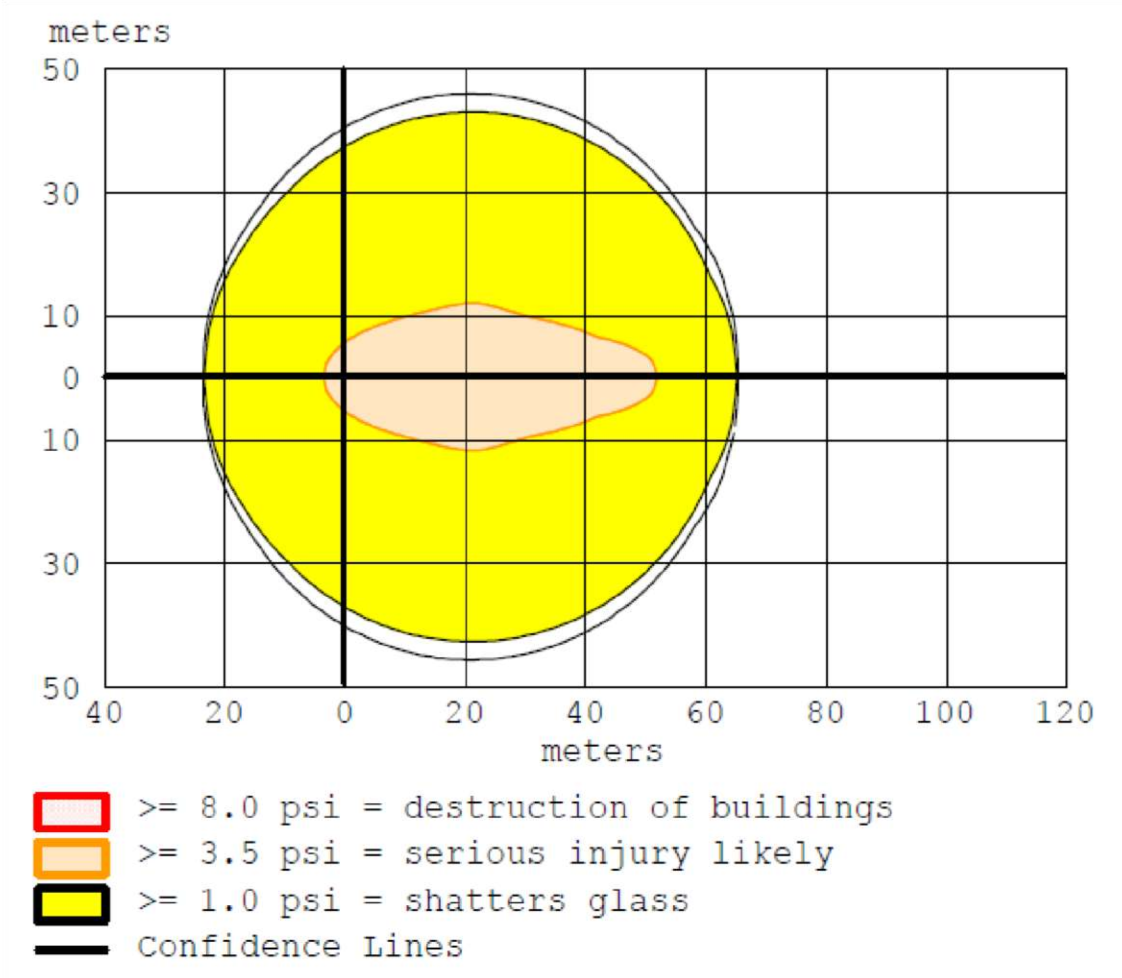
20.1.9.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



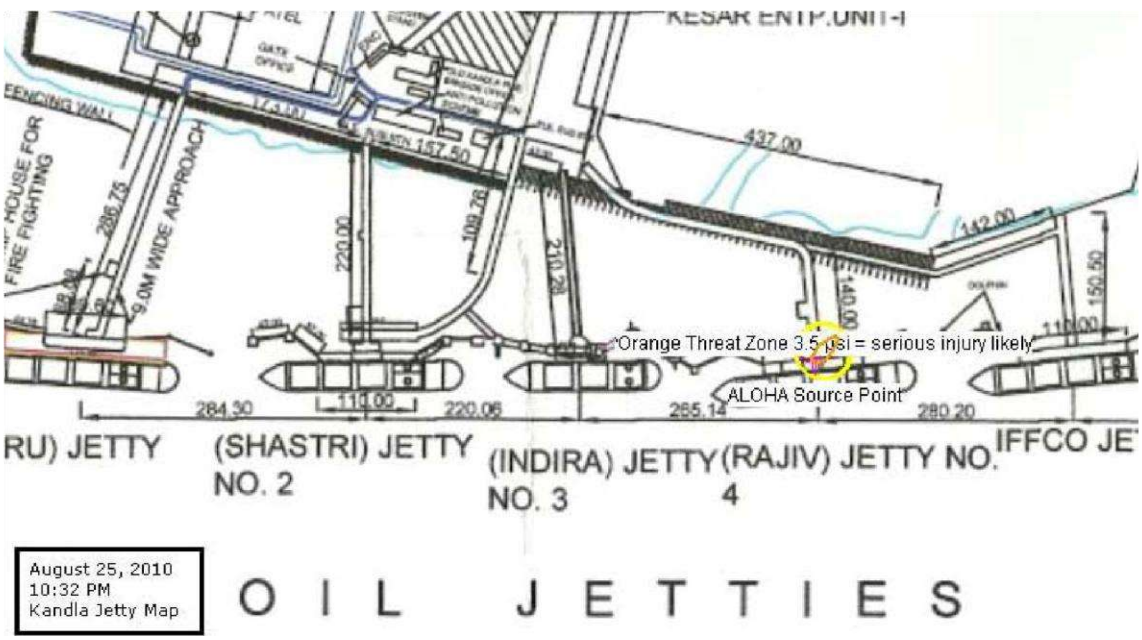
20.1.9.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



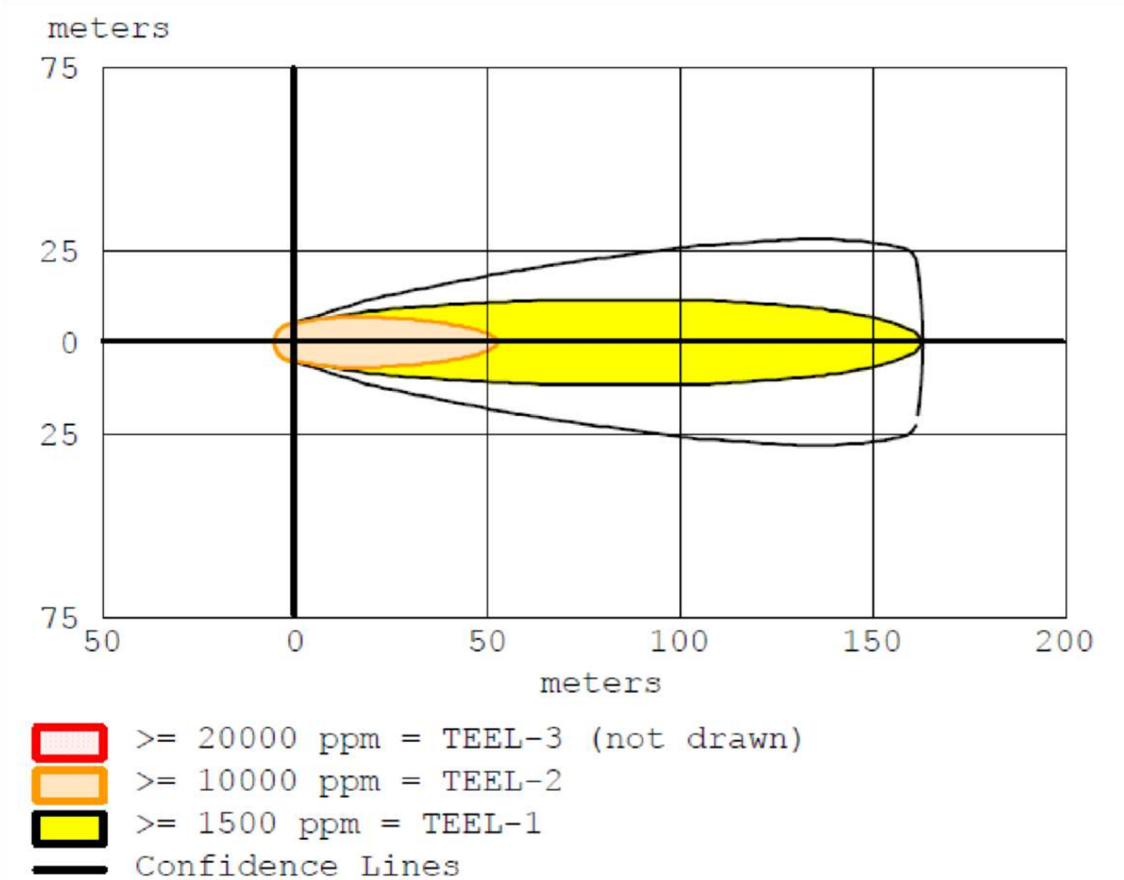
20.1.9.5 Instantaneous Release – Overpressure (Graph)



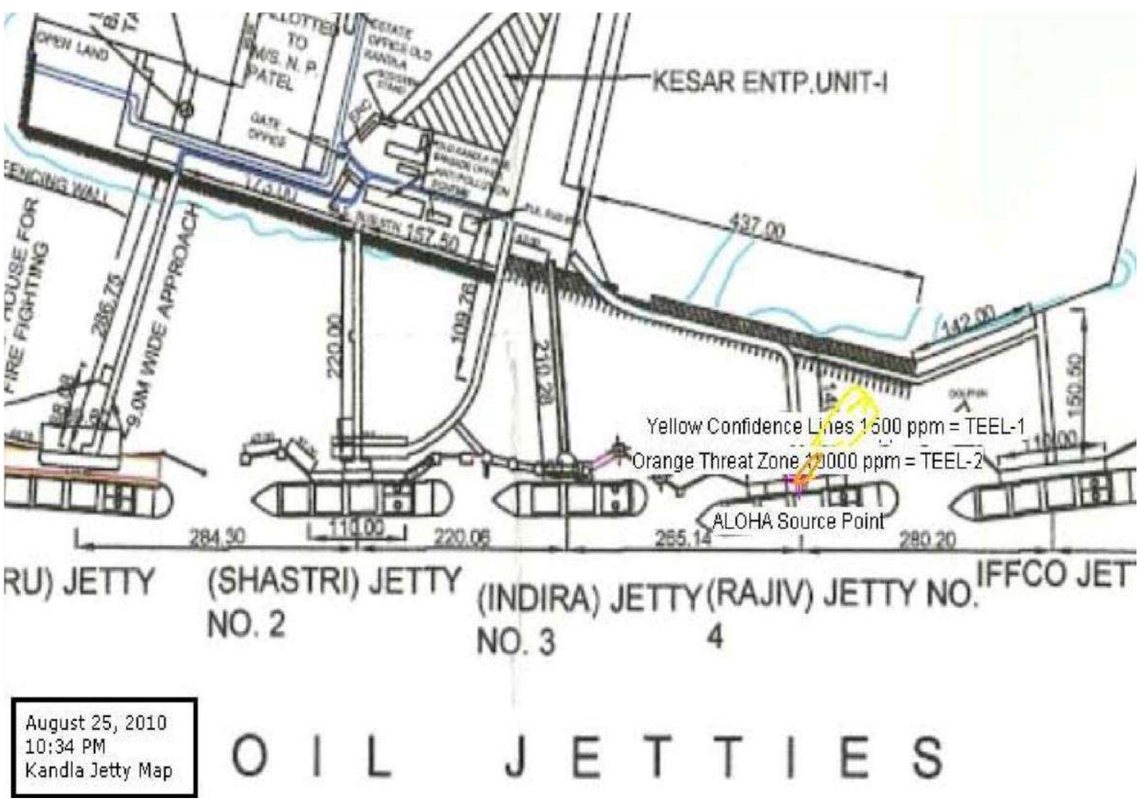
20.1.9.6 Instantaneous Release – Overpressure (Contour)



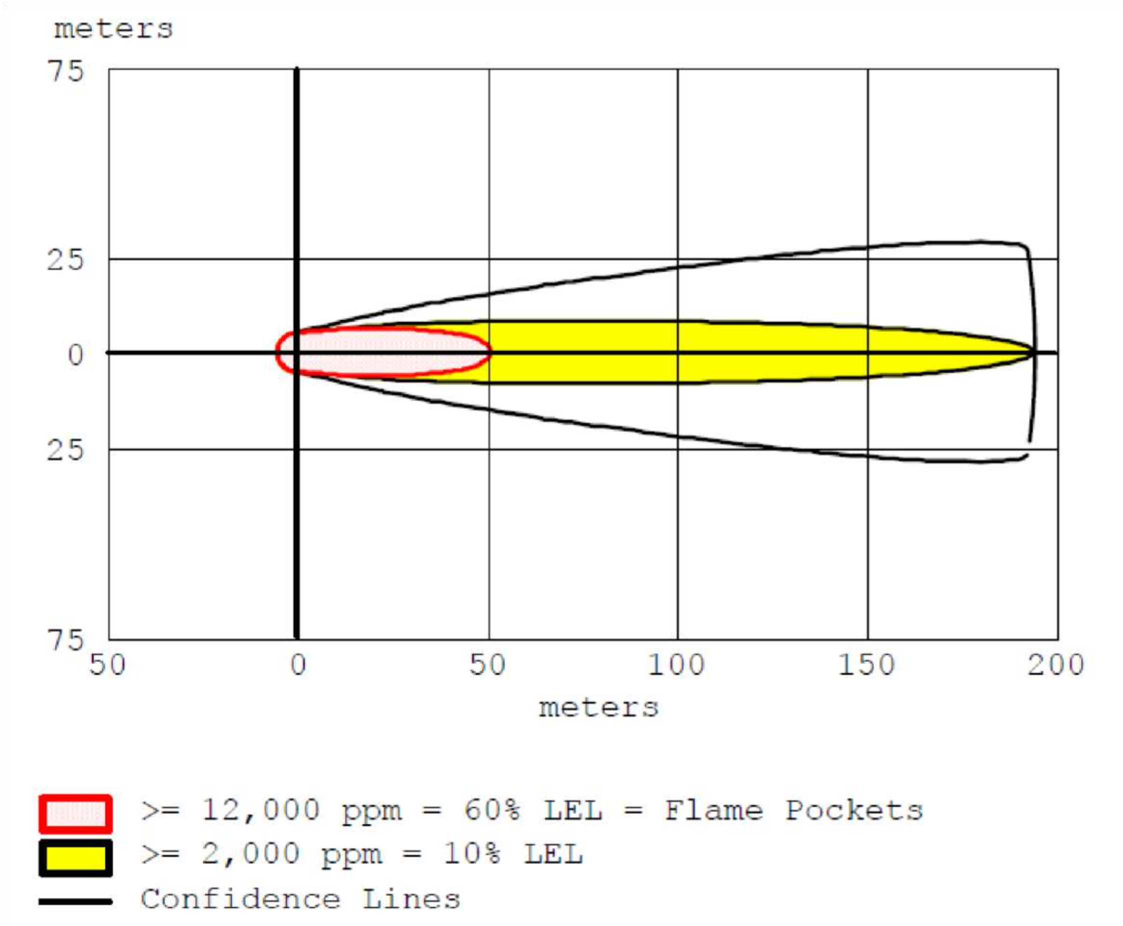
20.1.9.7 Evaporating Puddle – Toxic Threat Zone (Graph)



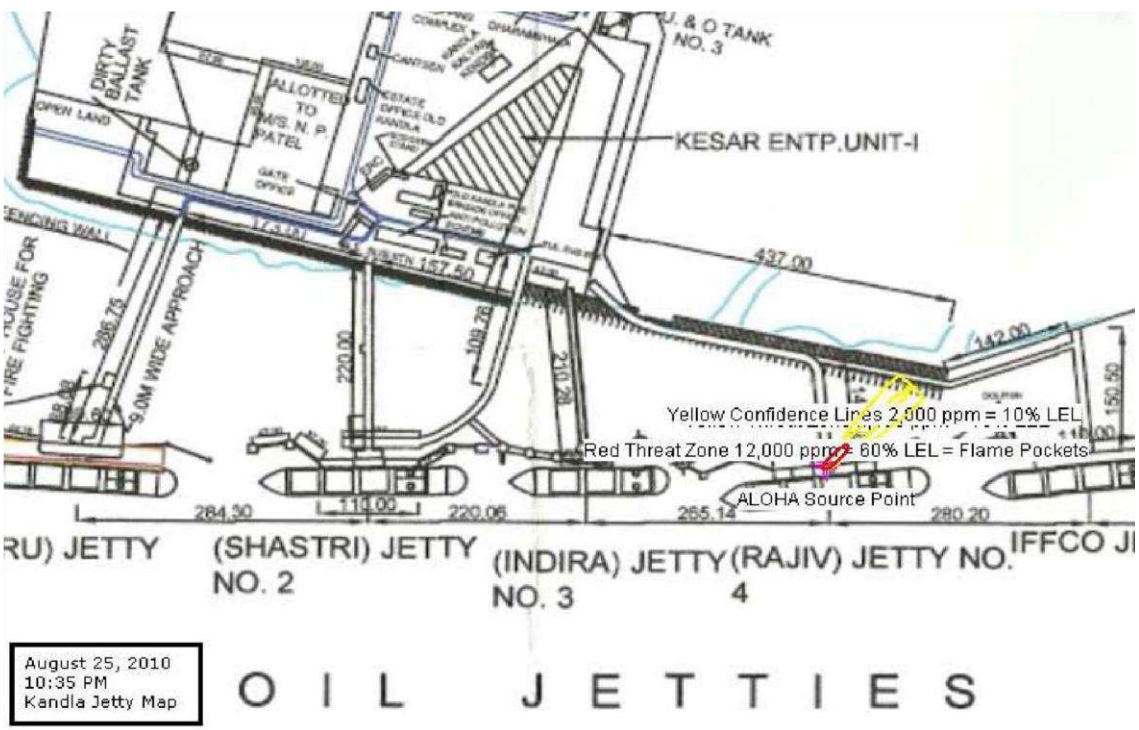
20.1.9.8 Evaporating Puddle – Toxic Threat Zone (Contour)



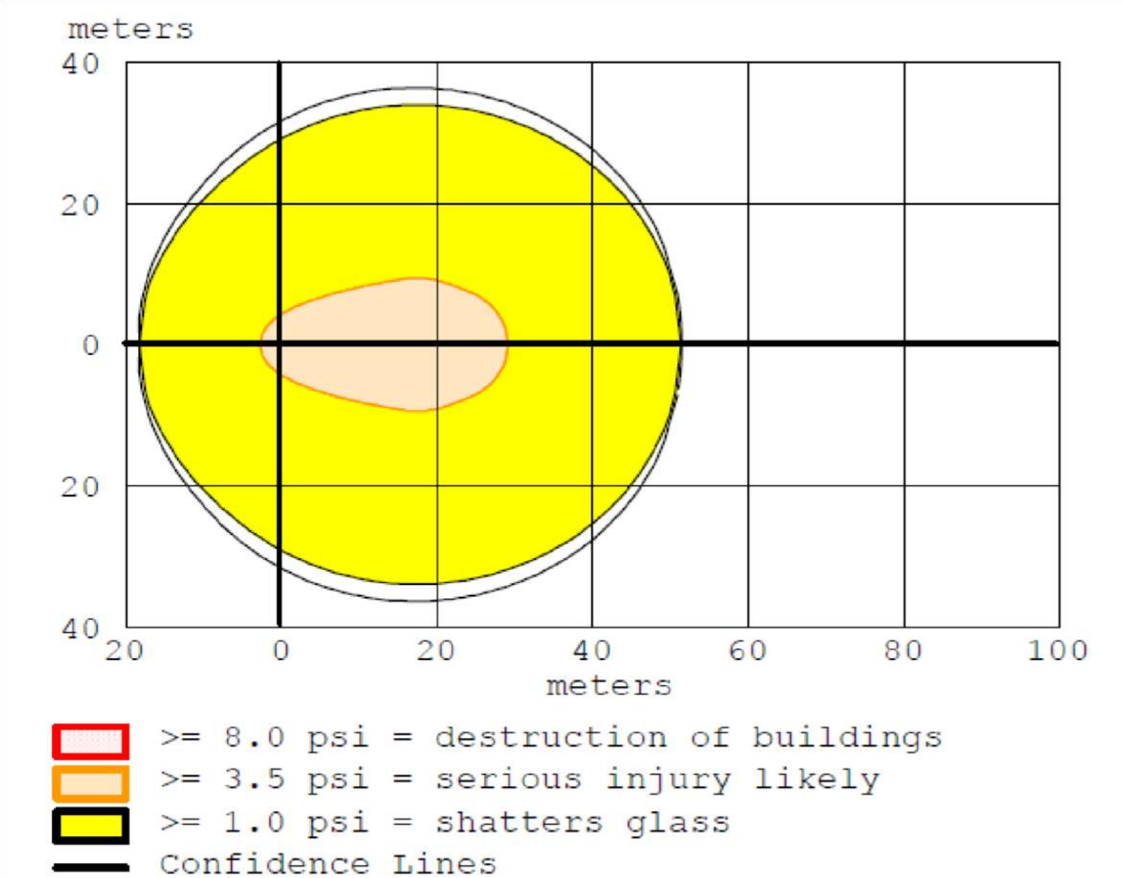
20.1.9.9 Evaporating Puddle – Flammable Area of Vapor Cloud (Graph)



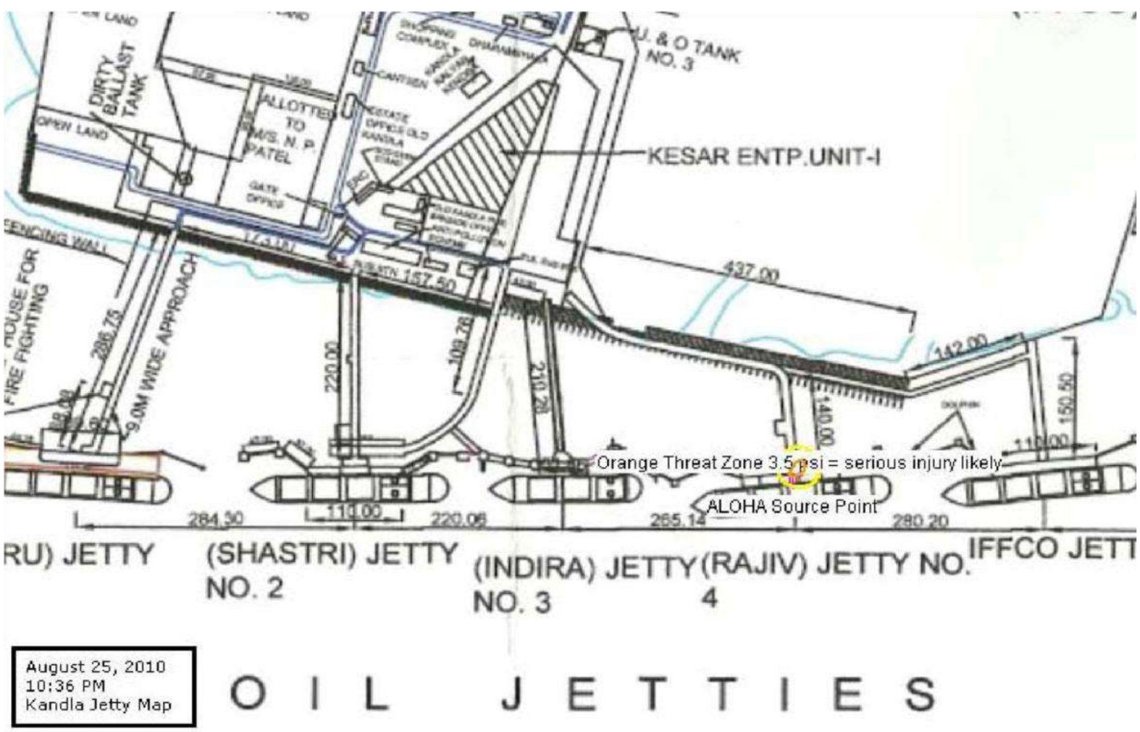
20.1.9.10 Evaporating Puddle – Flammable Area of Vapor Cloud (Contour)



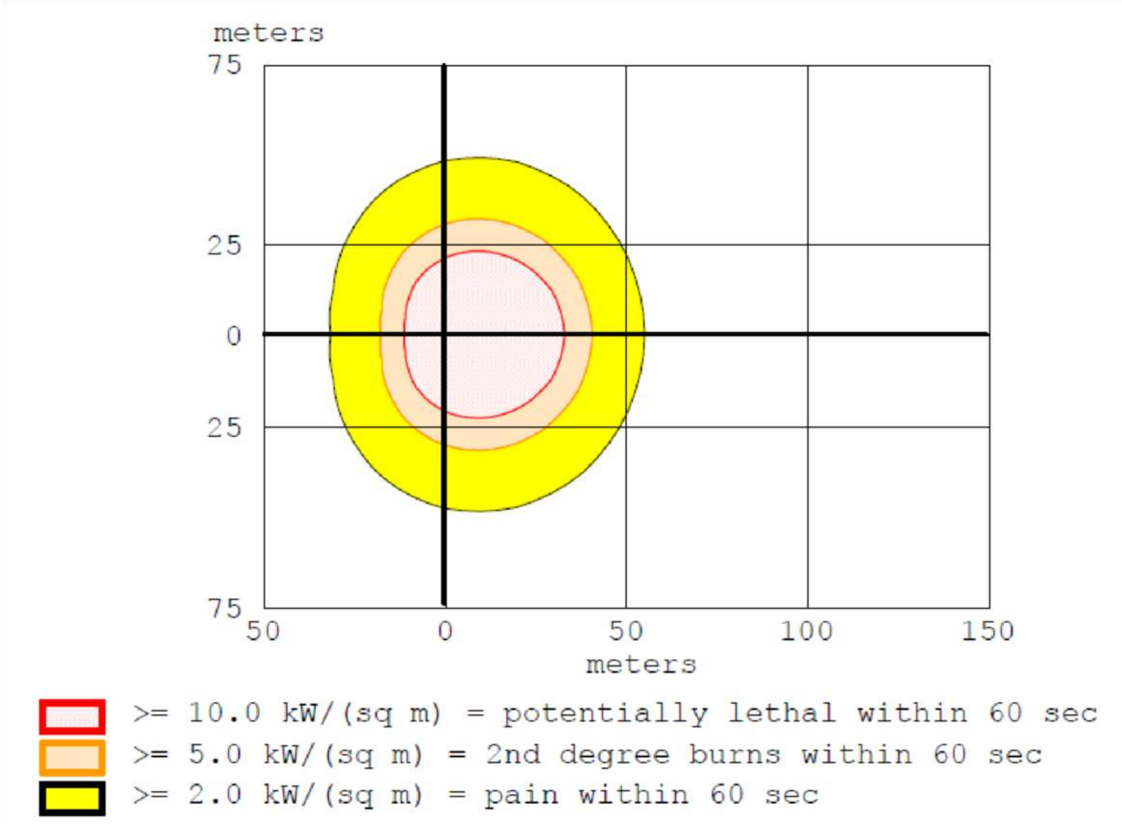
20.1.9.11 Evaporating Puddle – Overpressure (Graph)



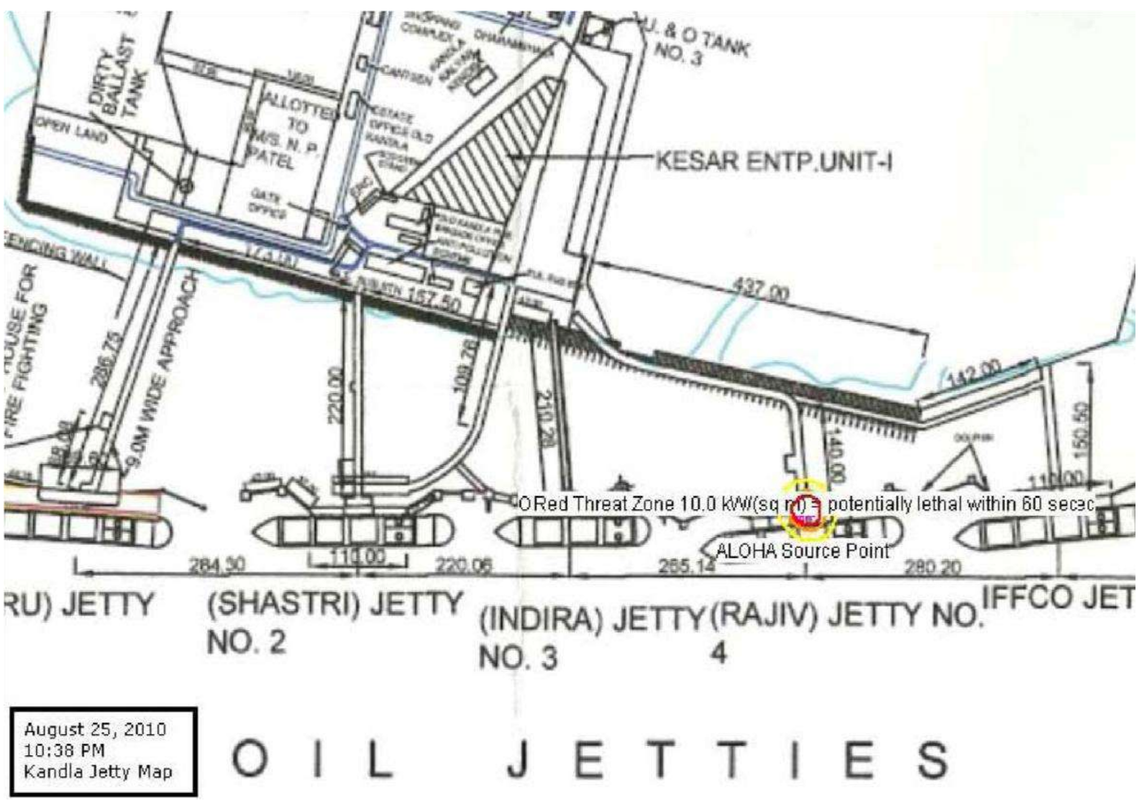
20.1.9.12 Evaporating Puddle – Overpressure (Contour)



20.1.9.13 Burning Puddle – Thermal Radiation (Graph)

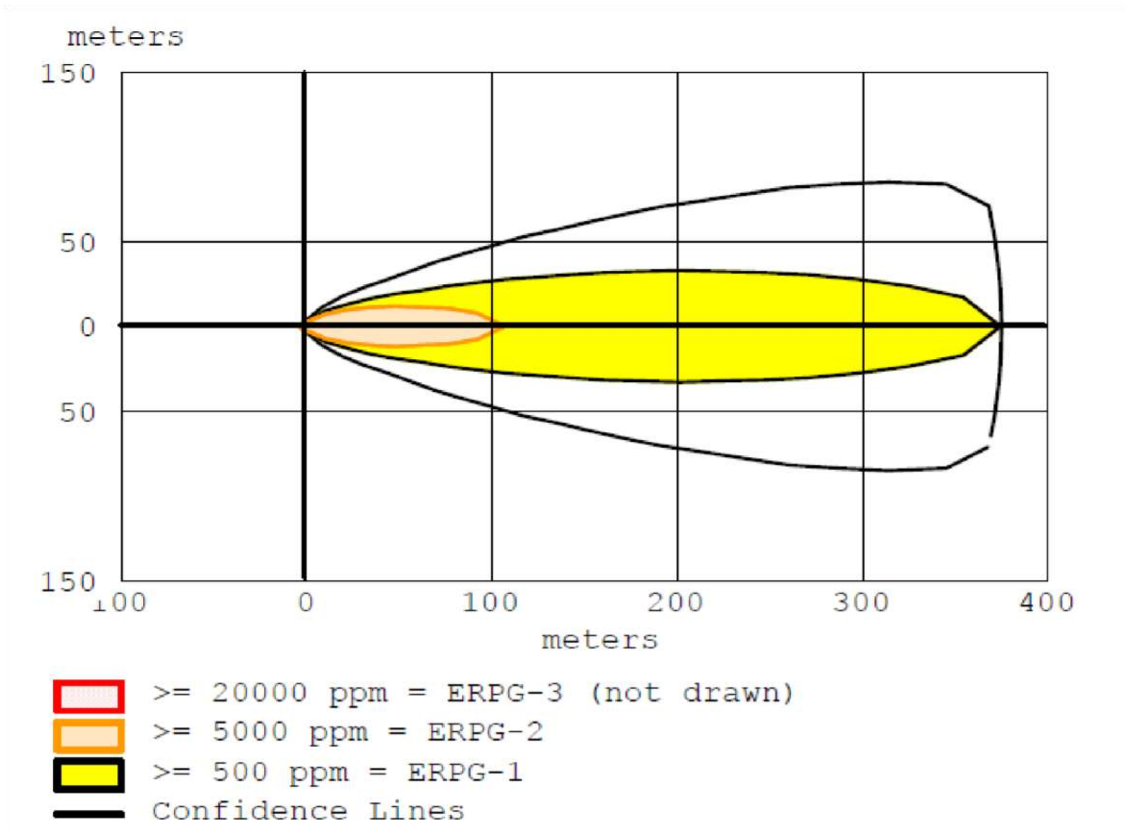


20.1.9.14 Burning Puddle – Thermal Radiation (Contour)

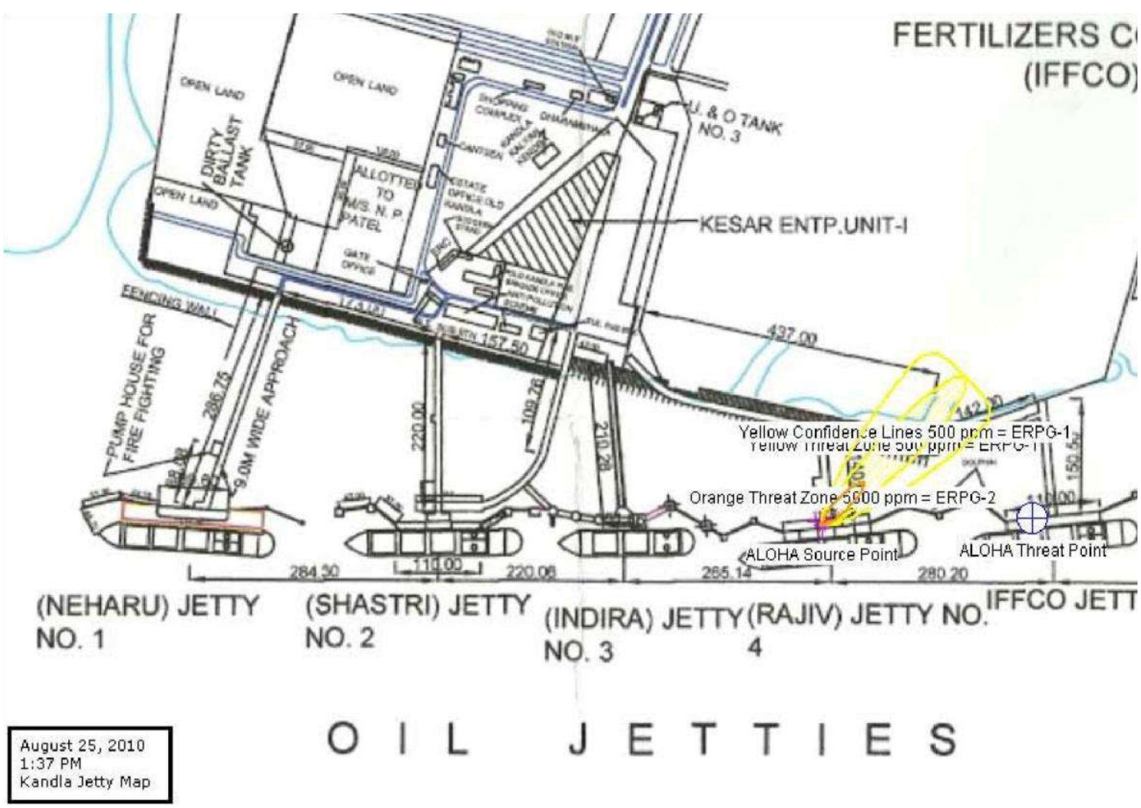


20.1.10 Jetty Four – Vinyl Chloride

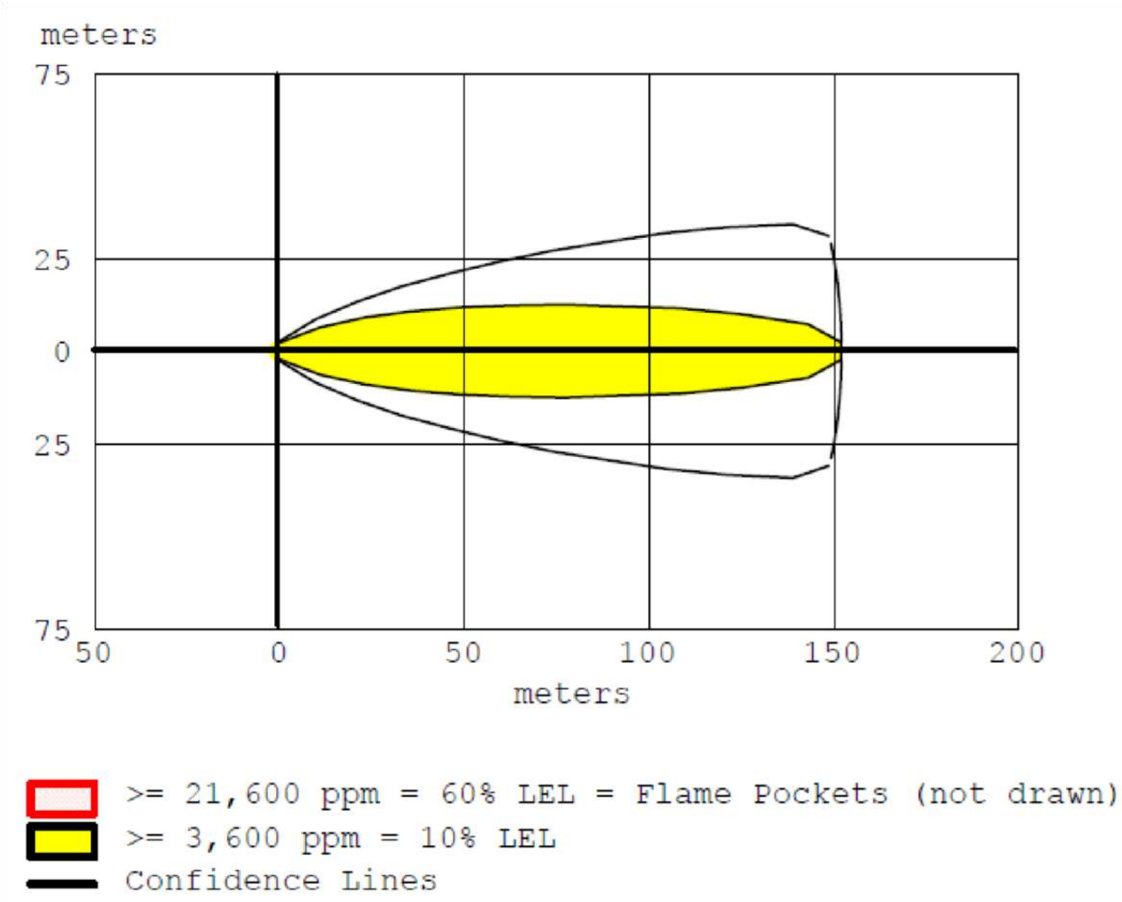
20.1.10.1 Instantaneous Release – Toxic Threat Zone (Graph)



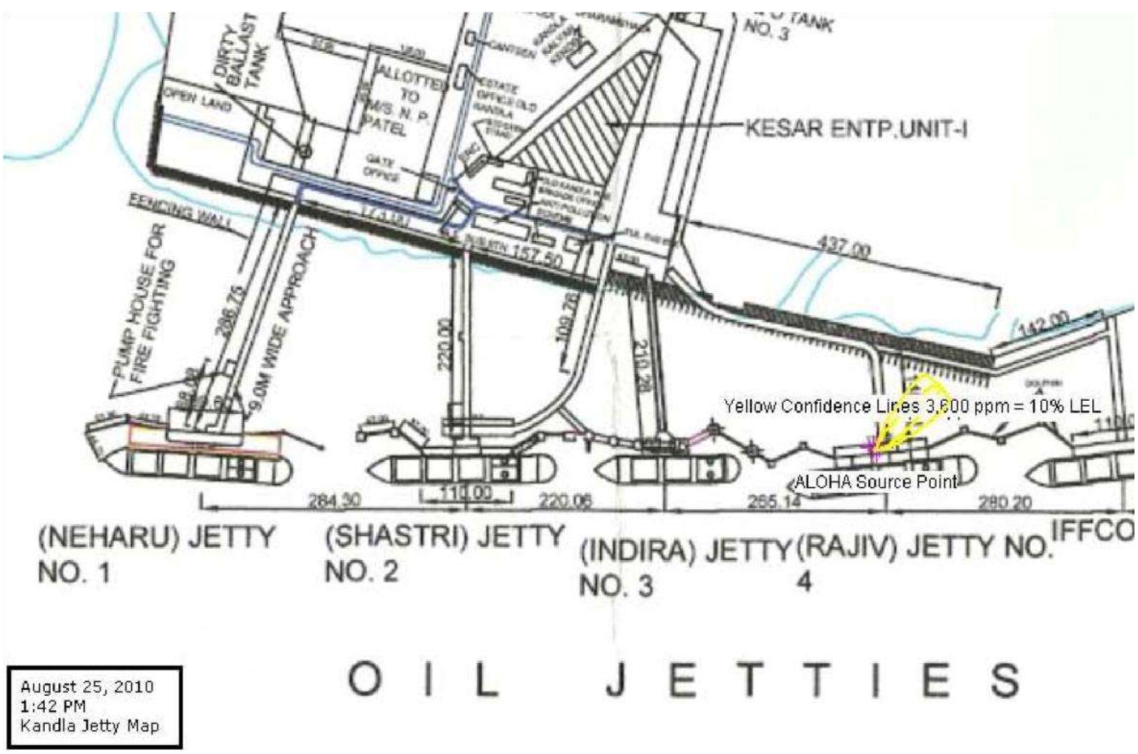
20.1.10.2 Instantaneous Release – Toxic Threat Zone (Contour)



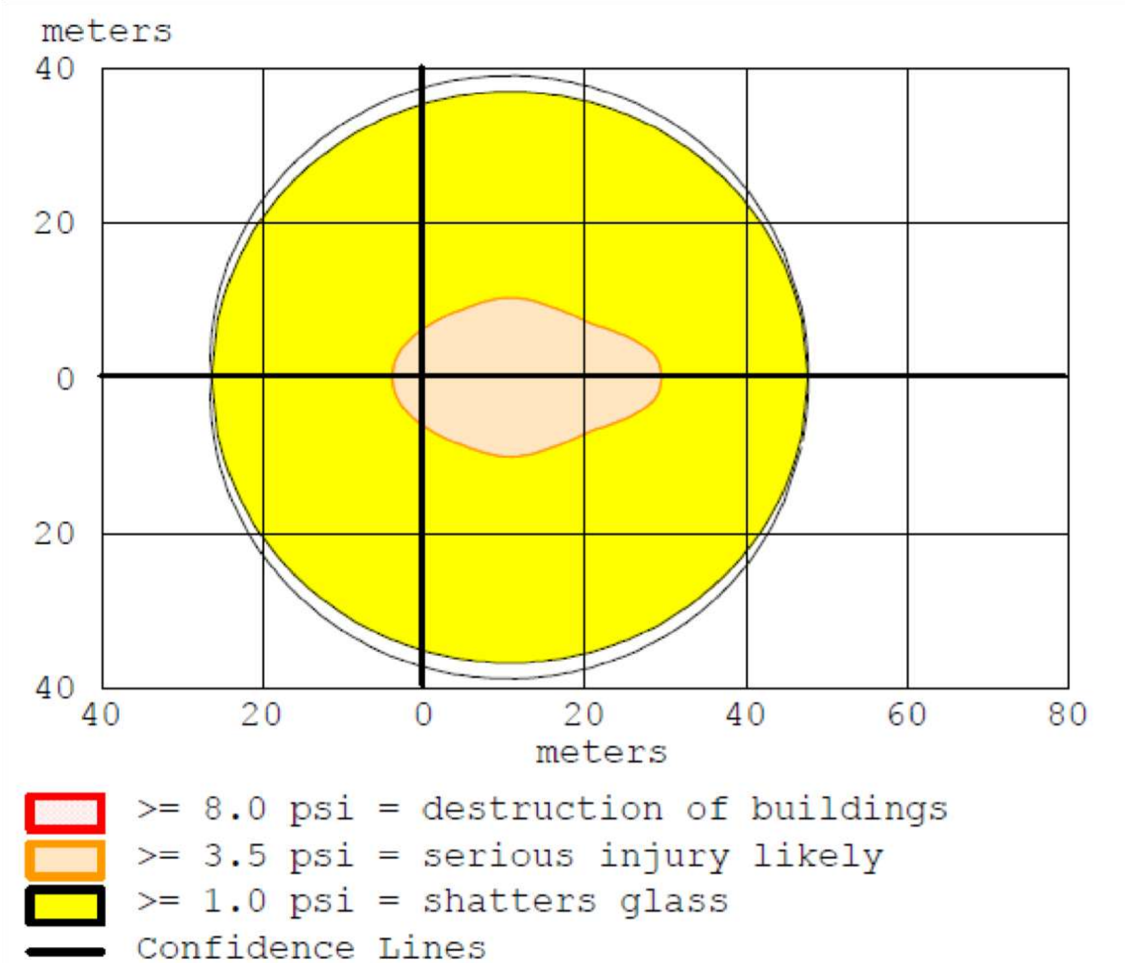
20.1.10.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



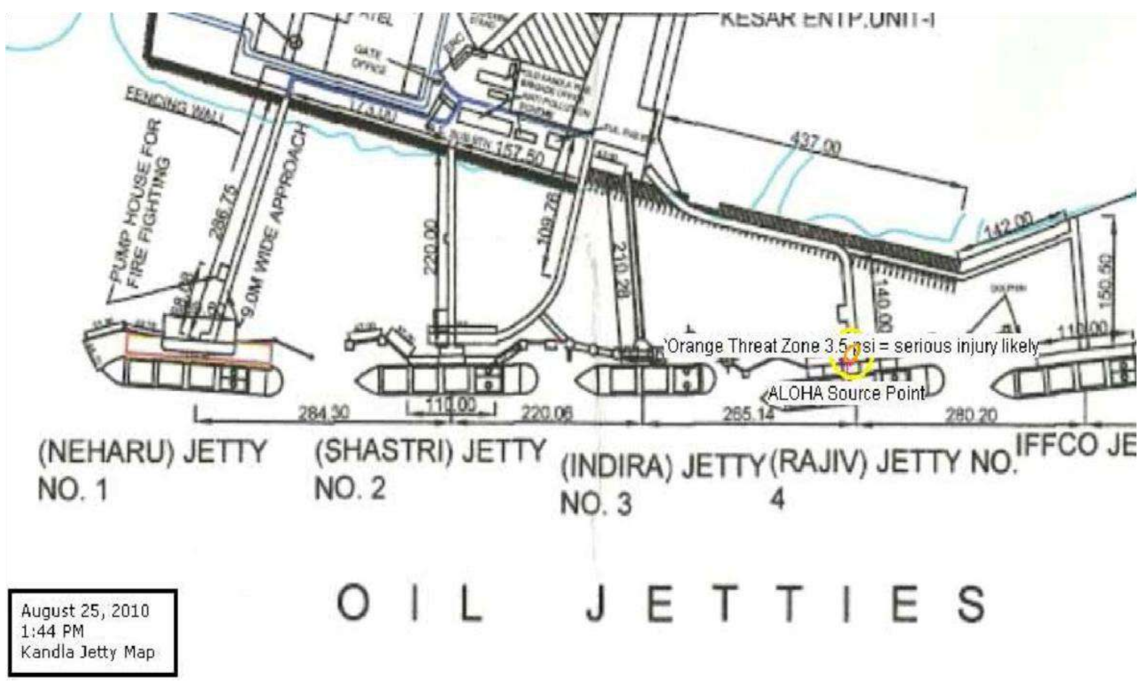
20.1.10.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



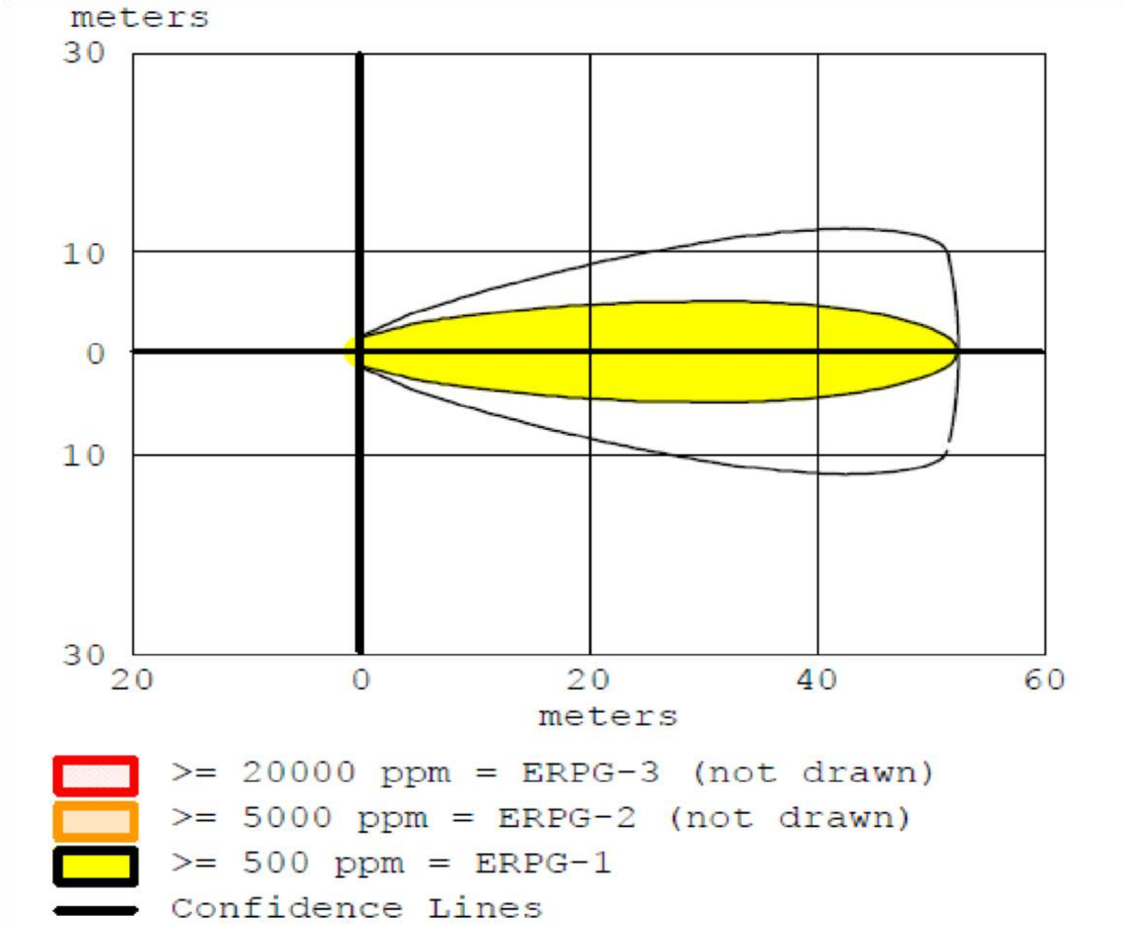
20.1.10.5 Instantaneous Release – Overpressure (Graph)



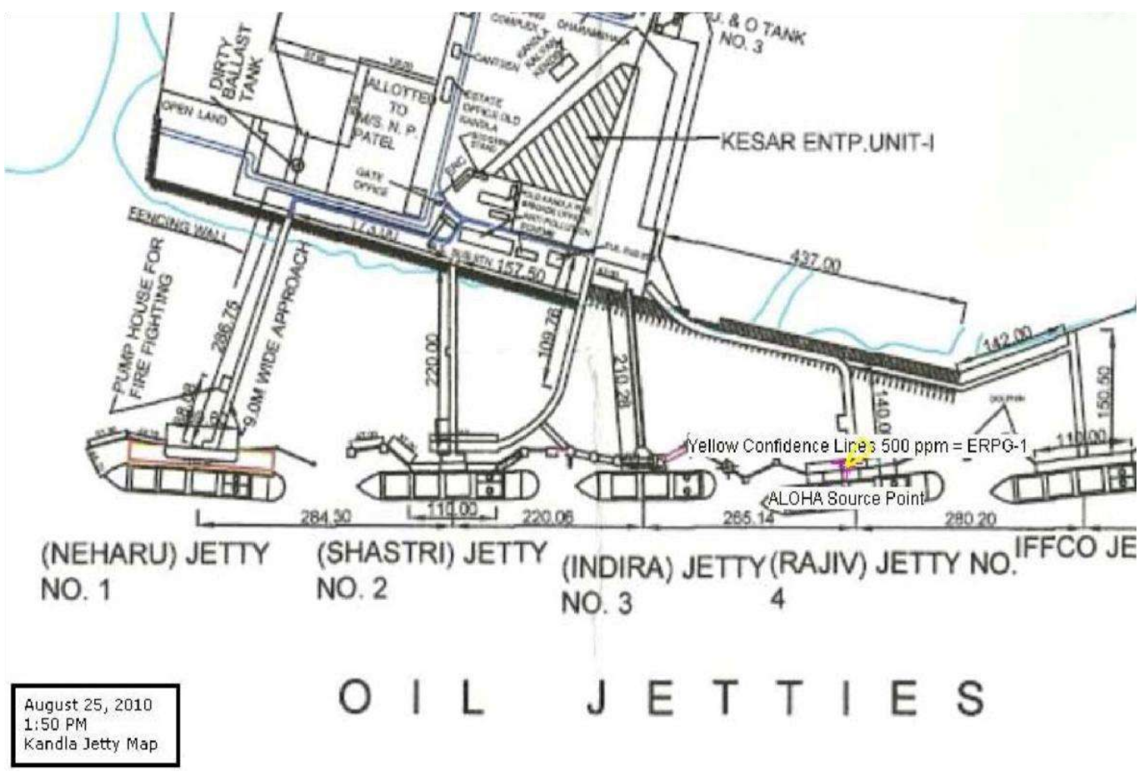
20.1.10.6 Instantaneous Release – Overpressure (Contour)



20.1.10.7 Evaporating Puddle – Toxic Threat Zone (Graph)

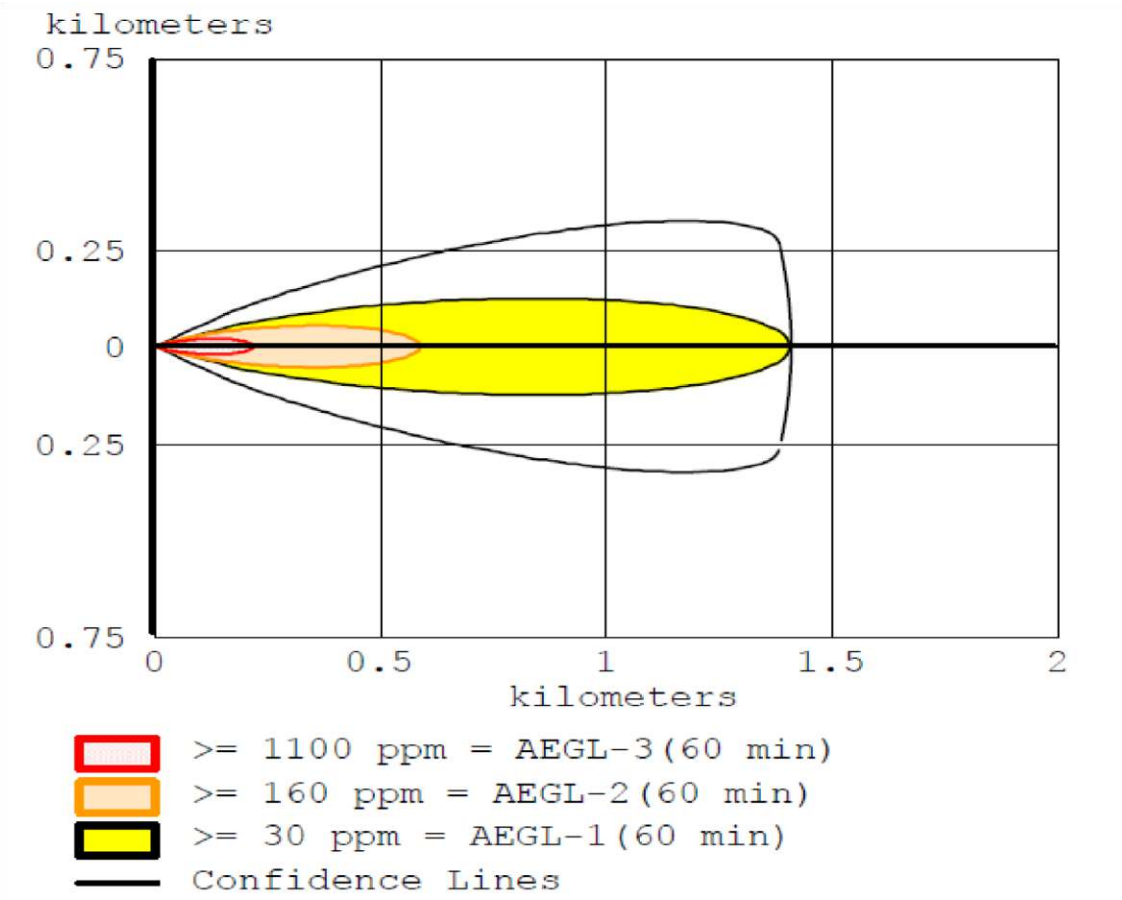


20.1.10.8 Evaporating Puddle – Toxic Threat Zone (Contour)

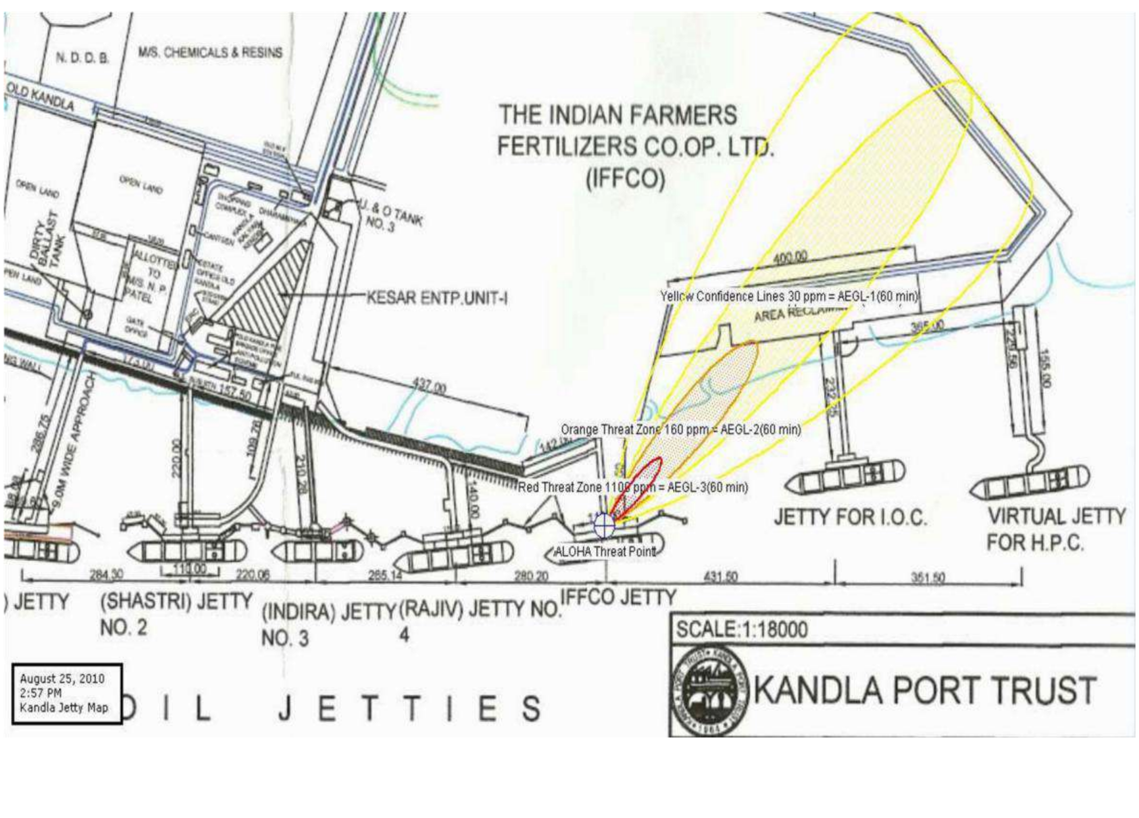


20.1.11 Jetty Five – Ammonia

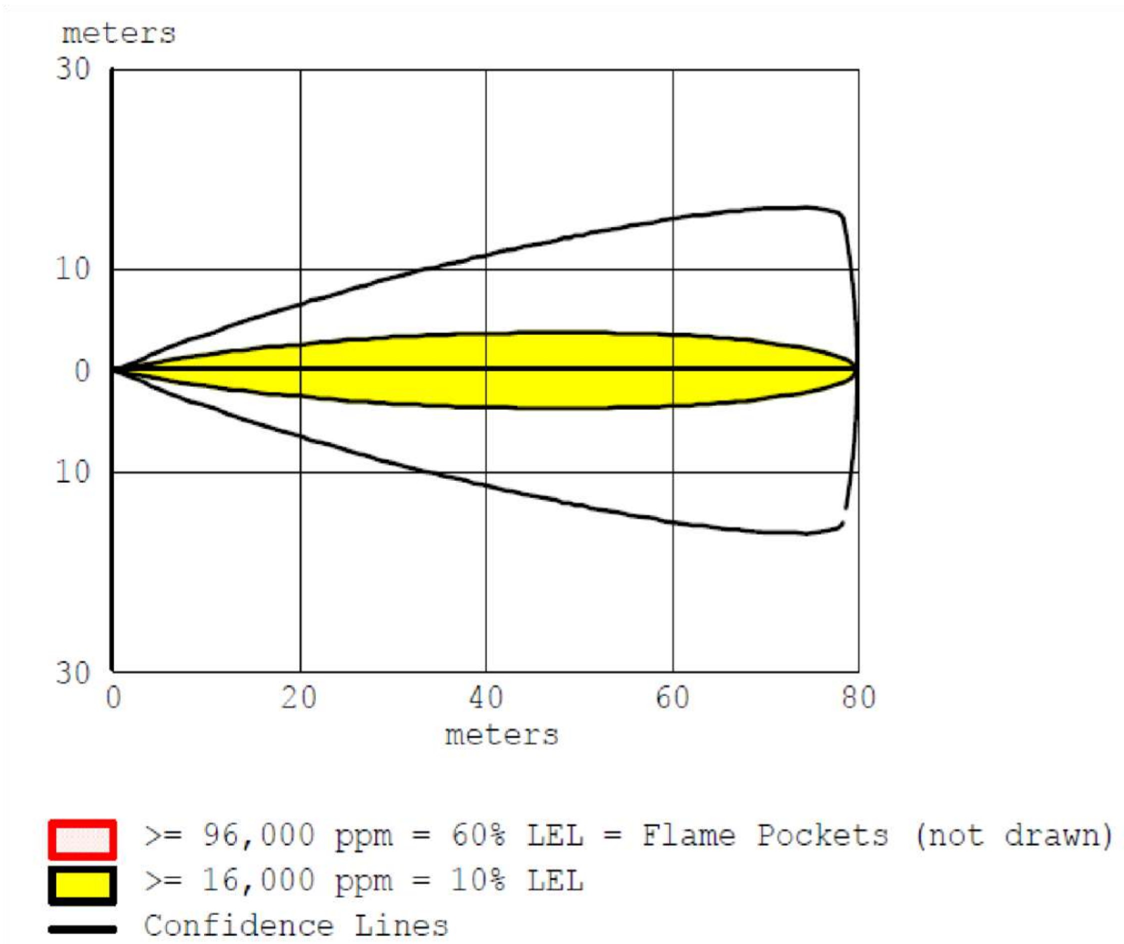
20.1.11.1 Instantaneous Release – Toxic Threat Zone (Graph)



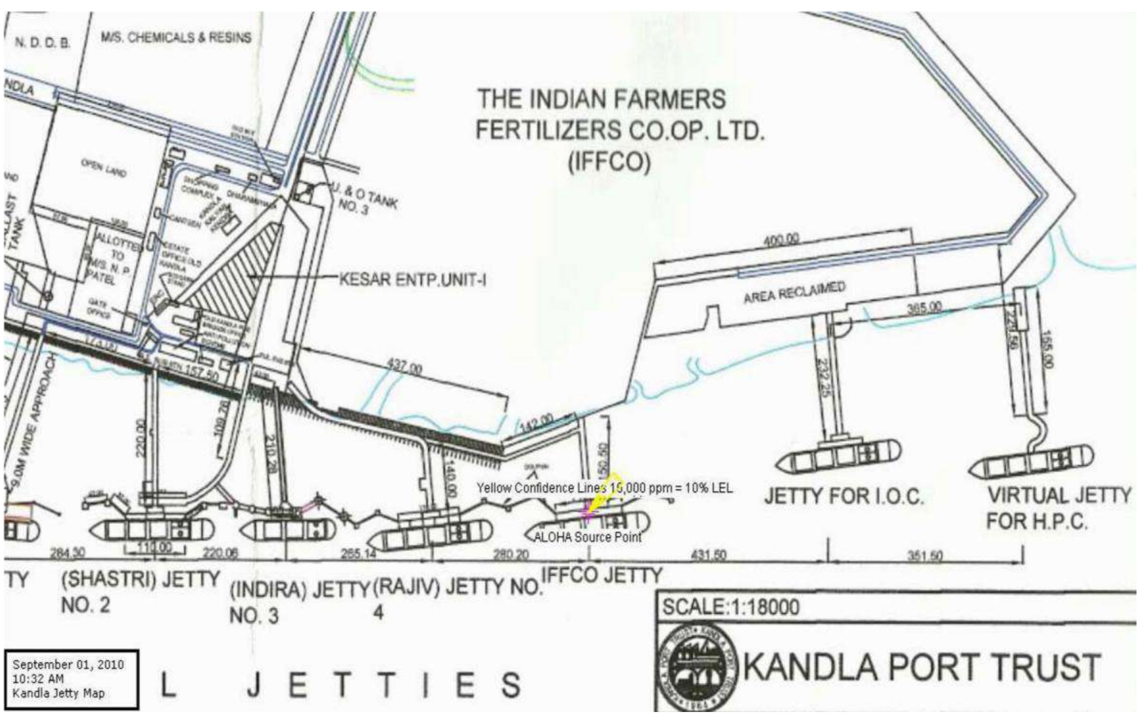
20.1.11.2 Instantaneous Release – Toxic Threat Zone (Contour)



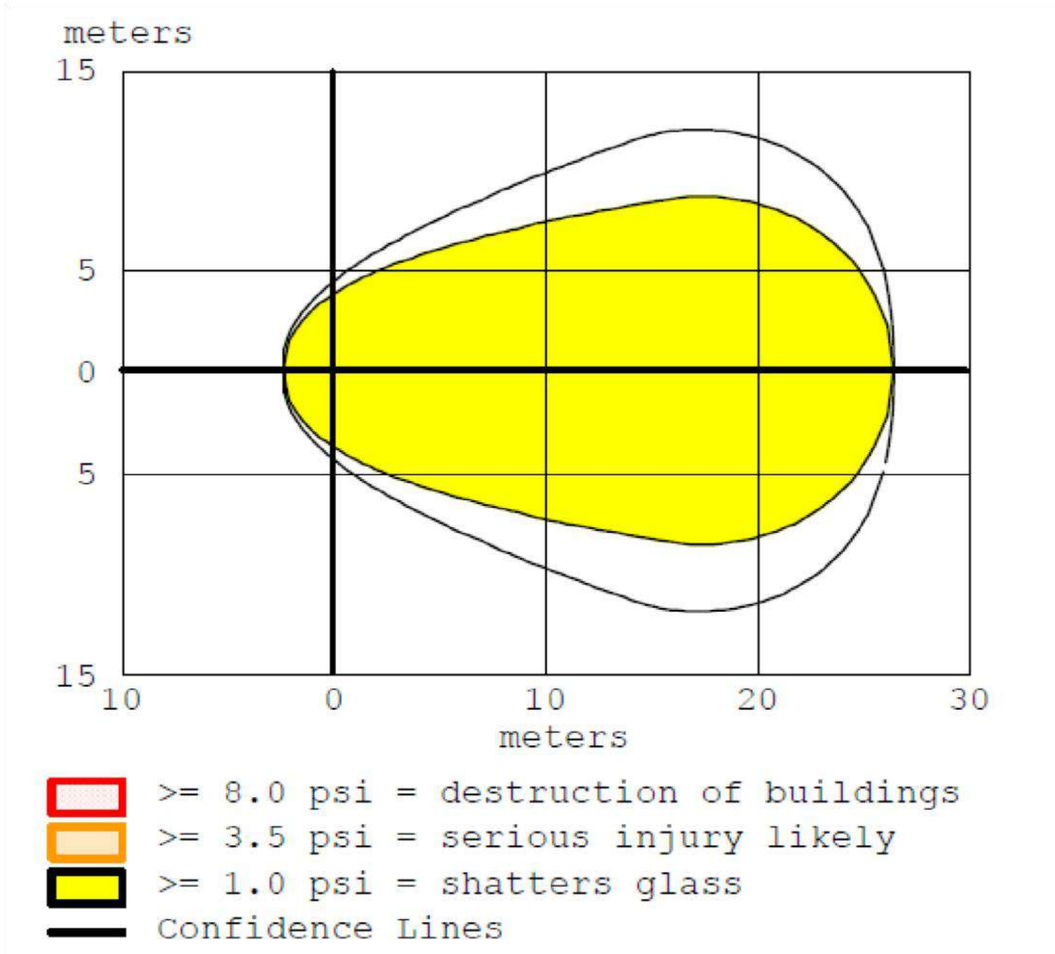
20.1.11.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



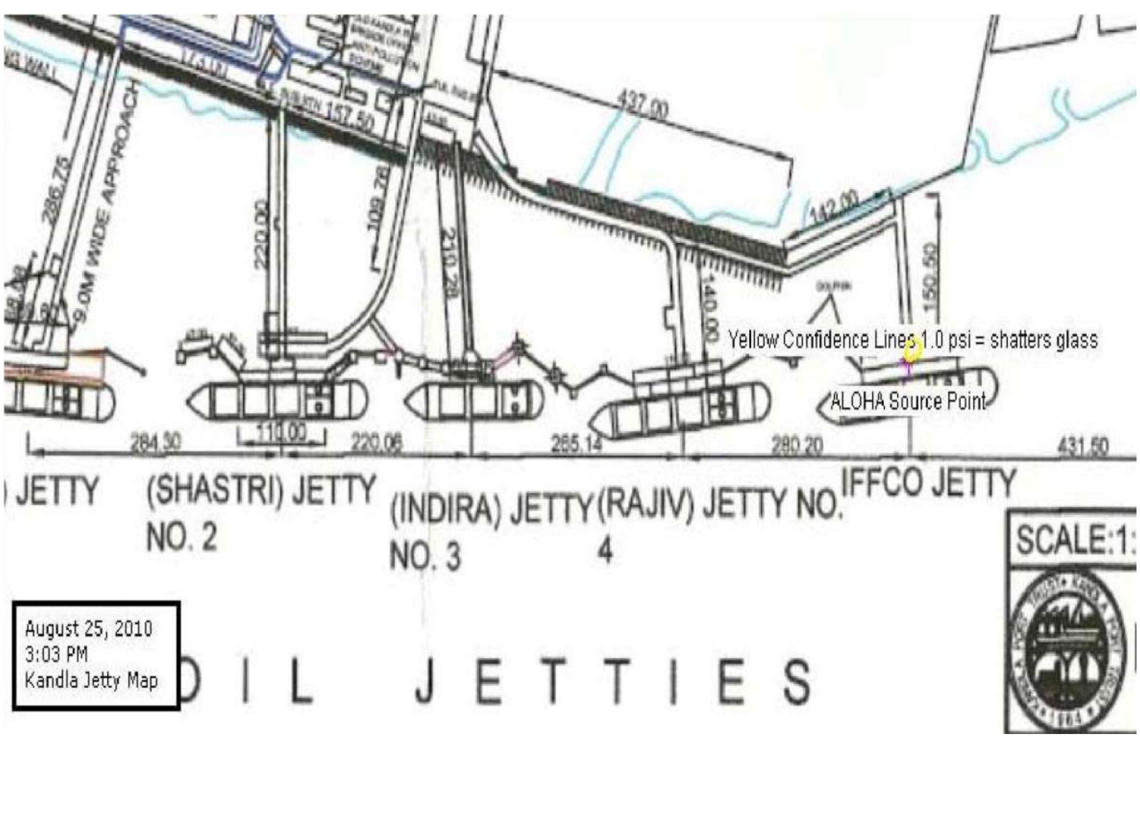
20.1.11.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



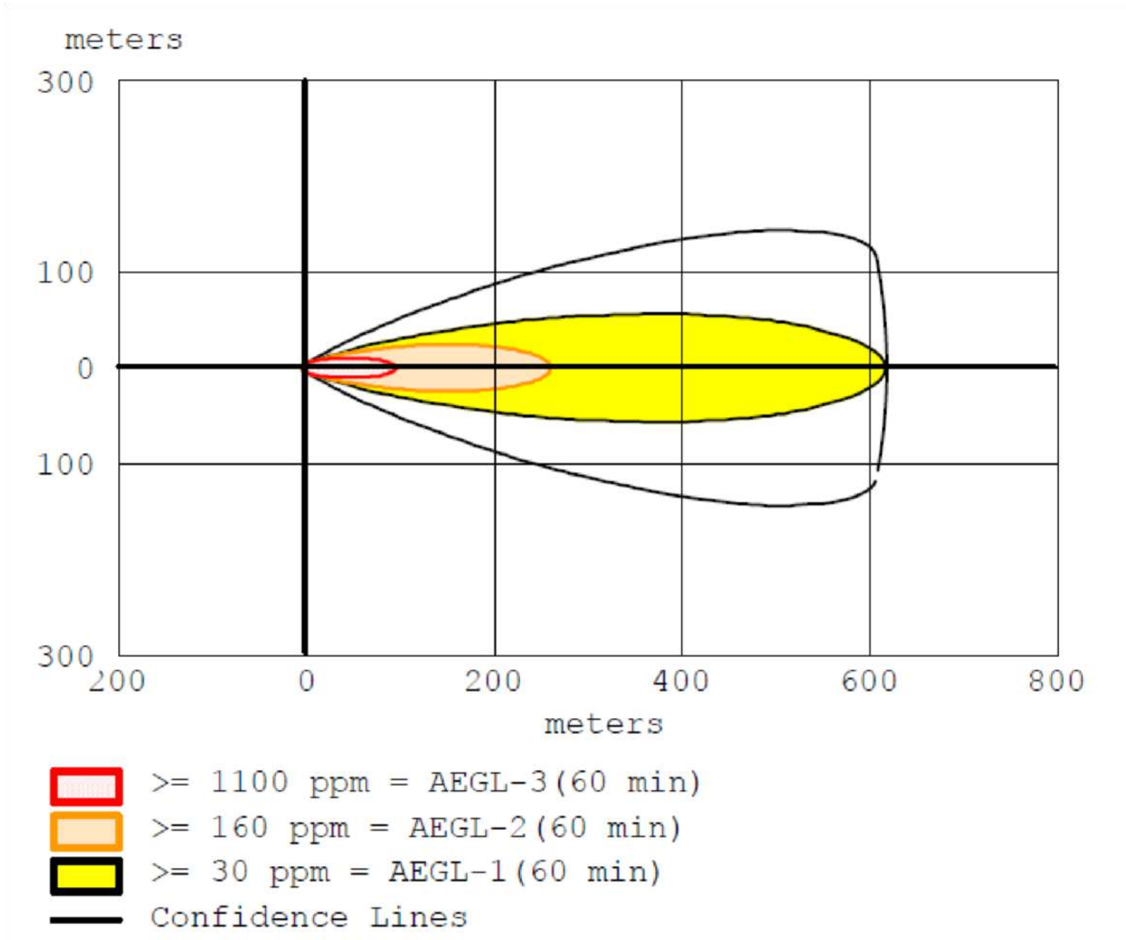
20.1.11.5 Instantaneous Release – Overpressure (Graph)



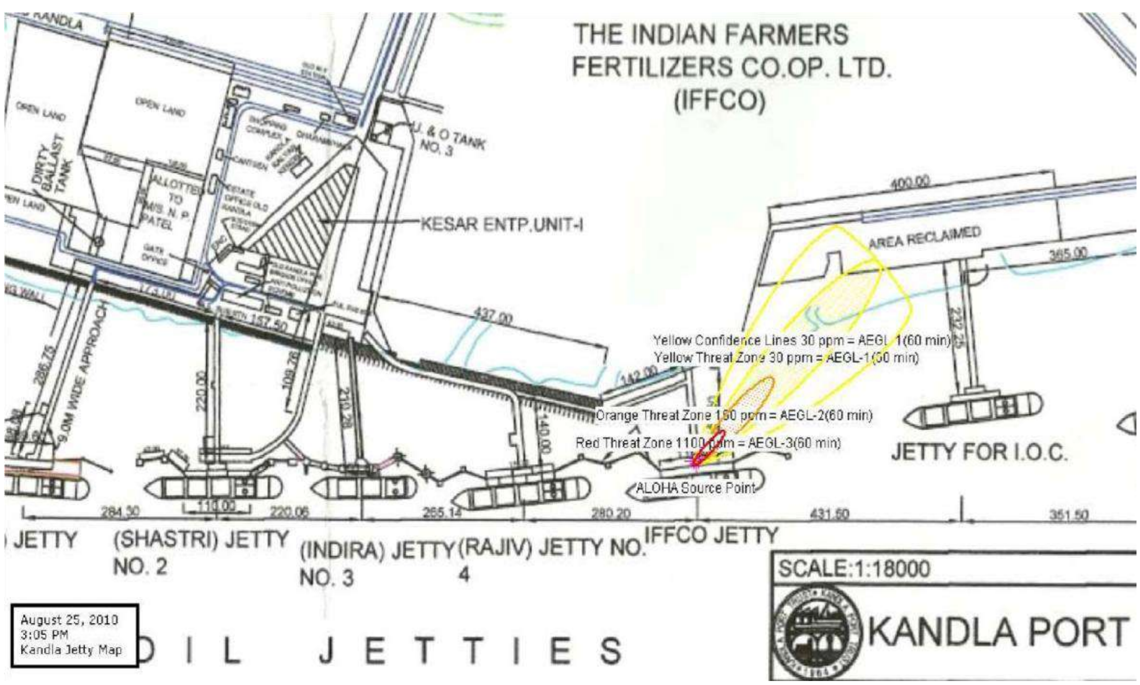
20.1.11.6 Instantaneous Release – Overpressure (Contour)



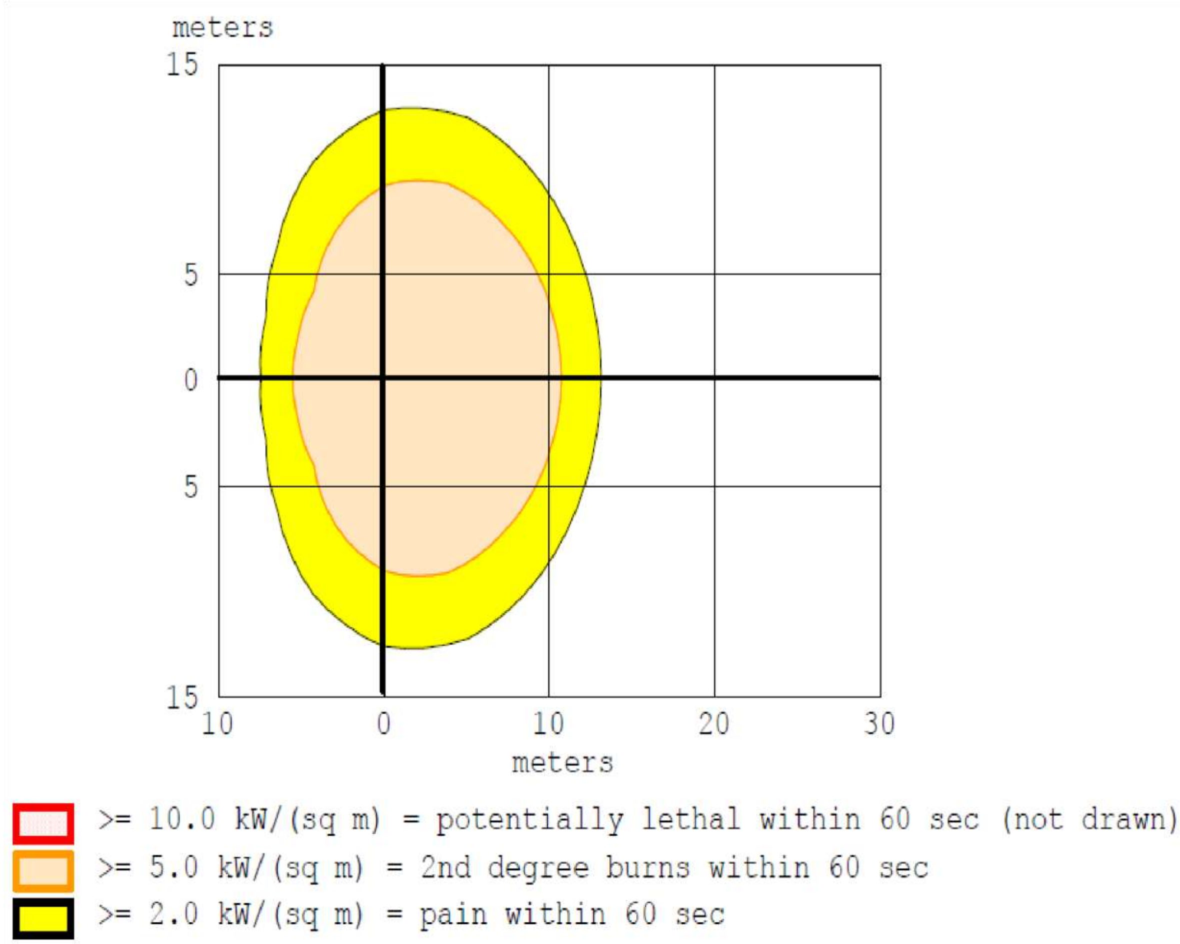
20.1.11.7 Evaporating Puddle – Toxic Threat Zone (Graph)



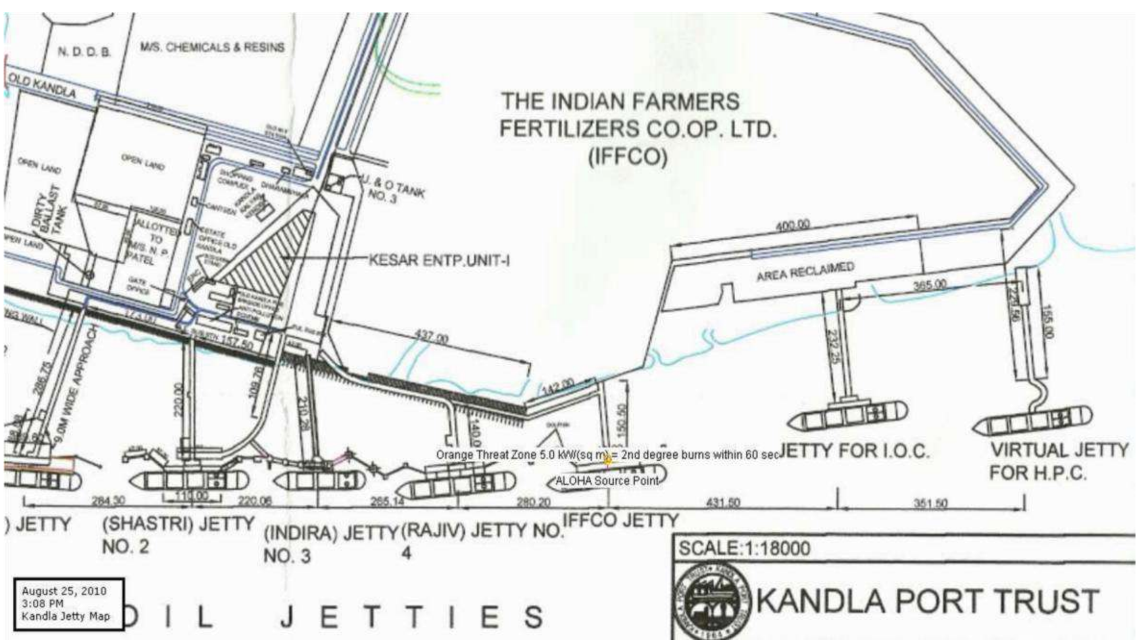
20.1.11.8 Evaporating Puddle – Toxic Threat Zone (Contour)



20.1.11.9 Burning Puddle – Thermal Radiation (Graph)

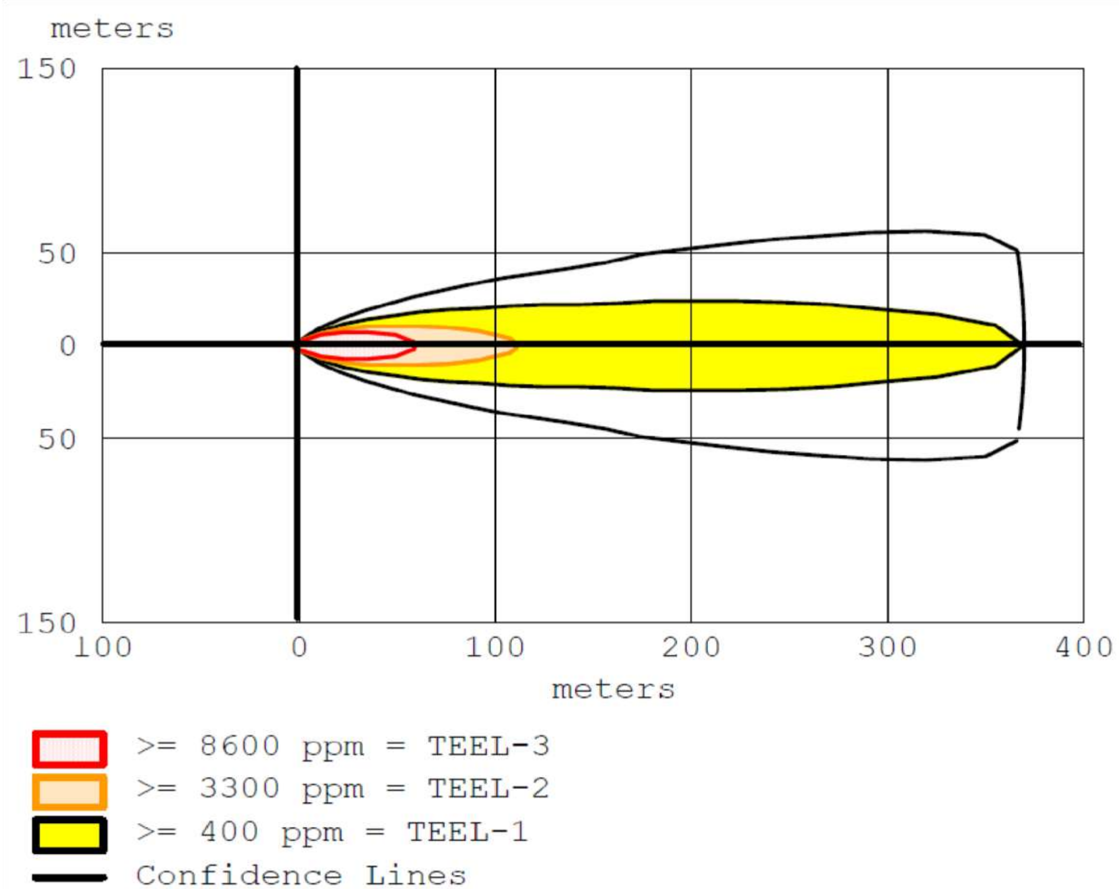


20.1.11.10 Burning Puddle – Thermal Radiation (Contour)

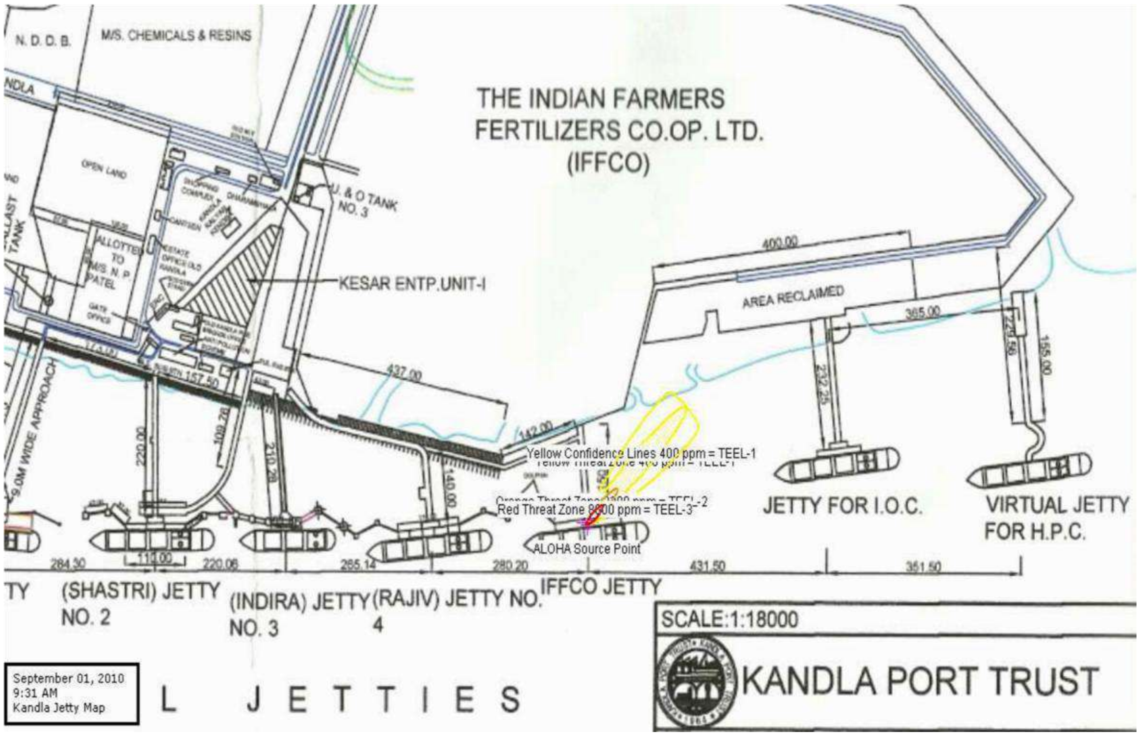


20.1.12 Jetty Five – HSD

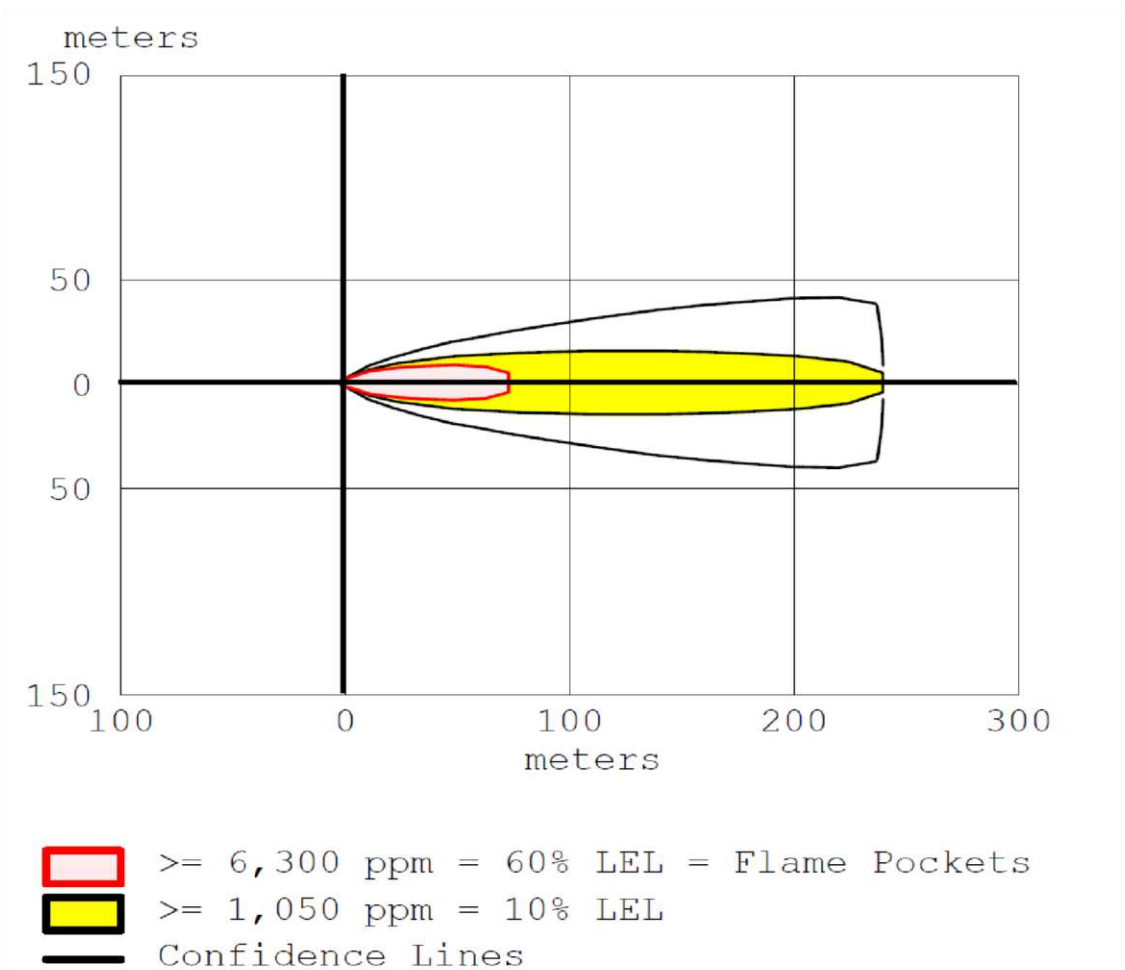
20.1.12.1 Instantaneous Release – Toxic Threat Zone (Graph)



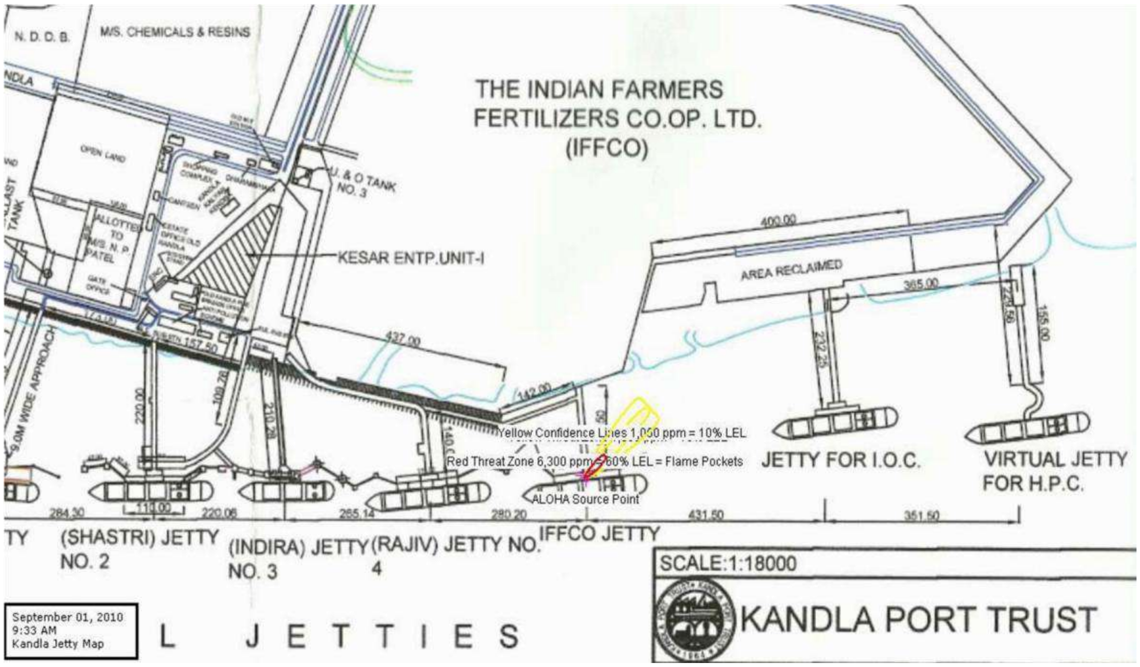
20.1.12.2 Instantaneous Release – Toxic Threat Zone (Contour)



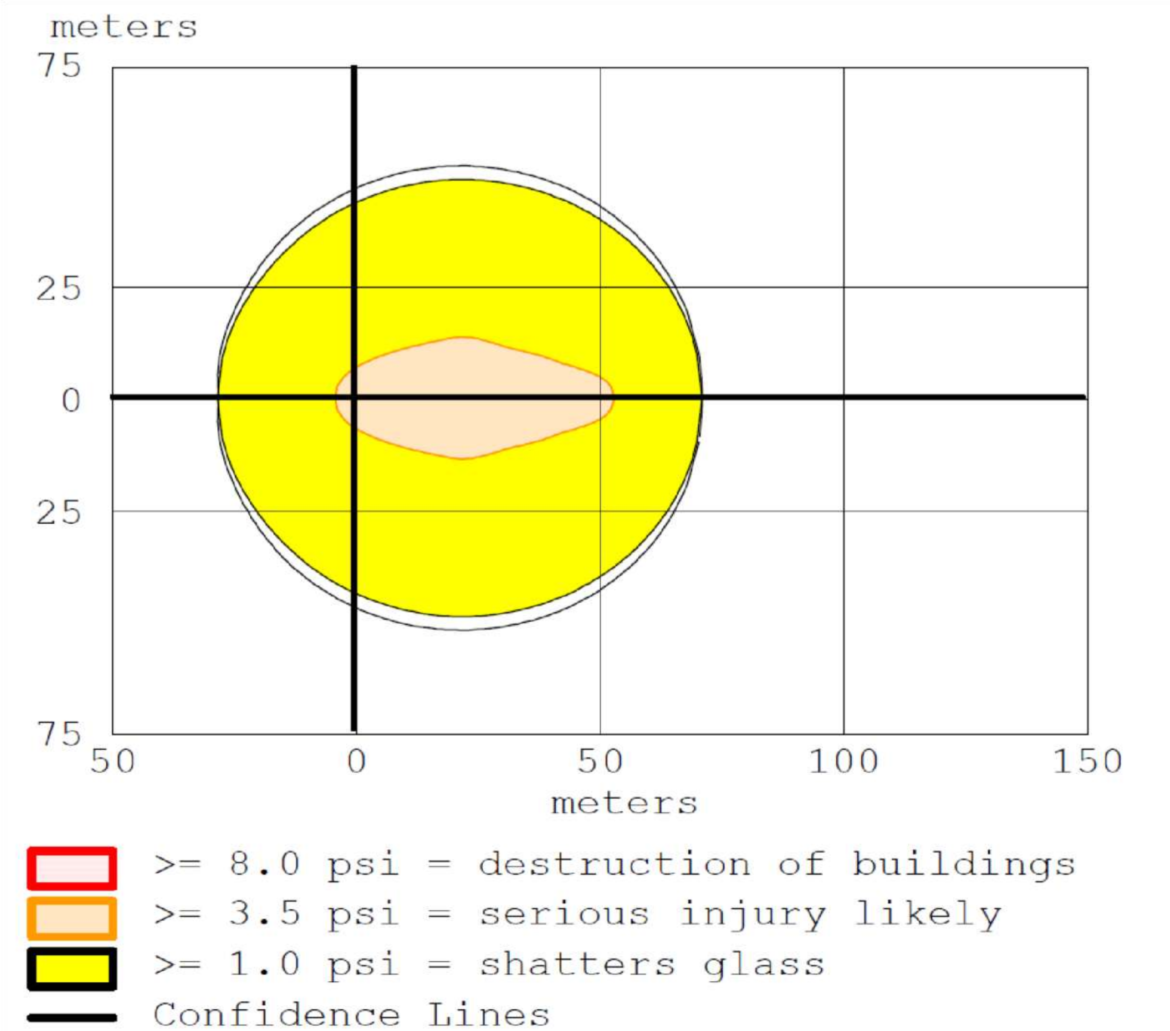
20.1.12.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



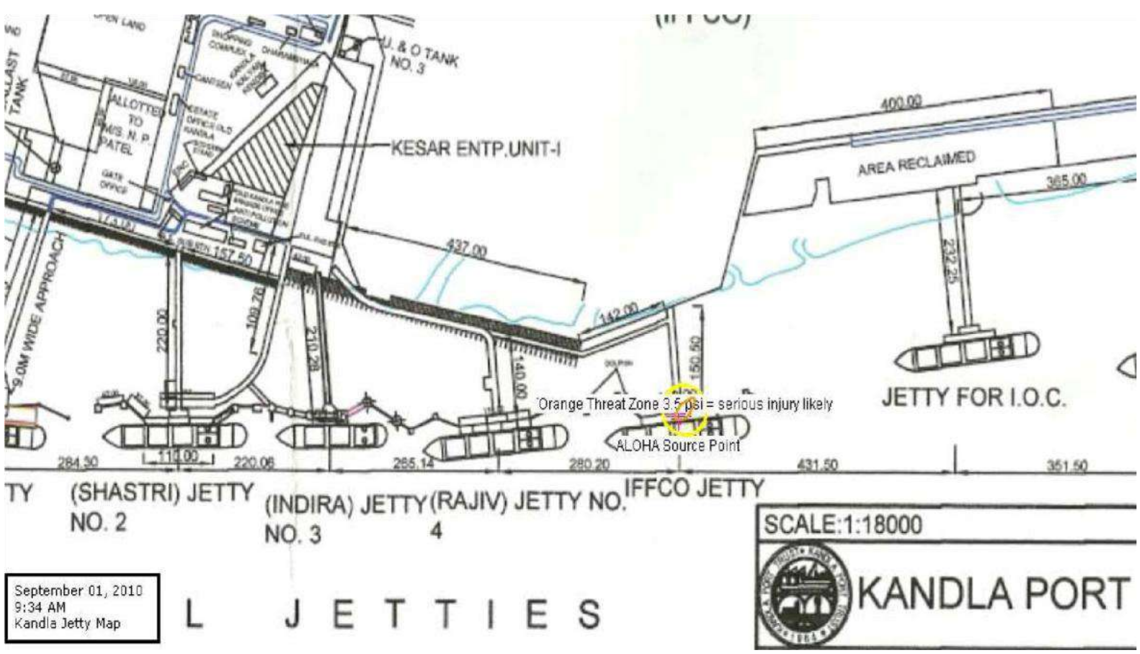
20.1.12.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



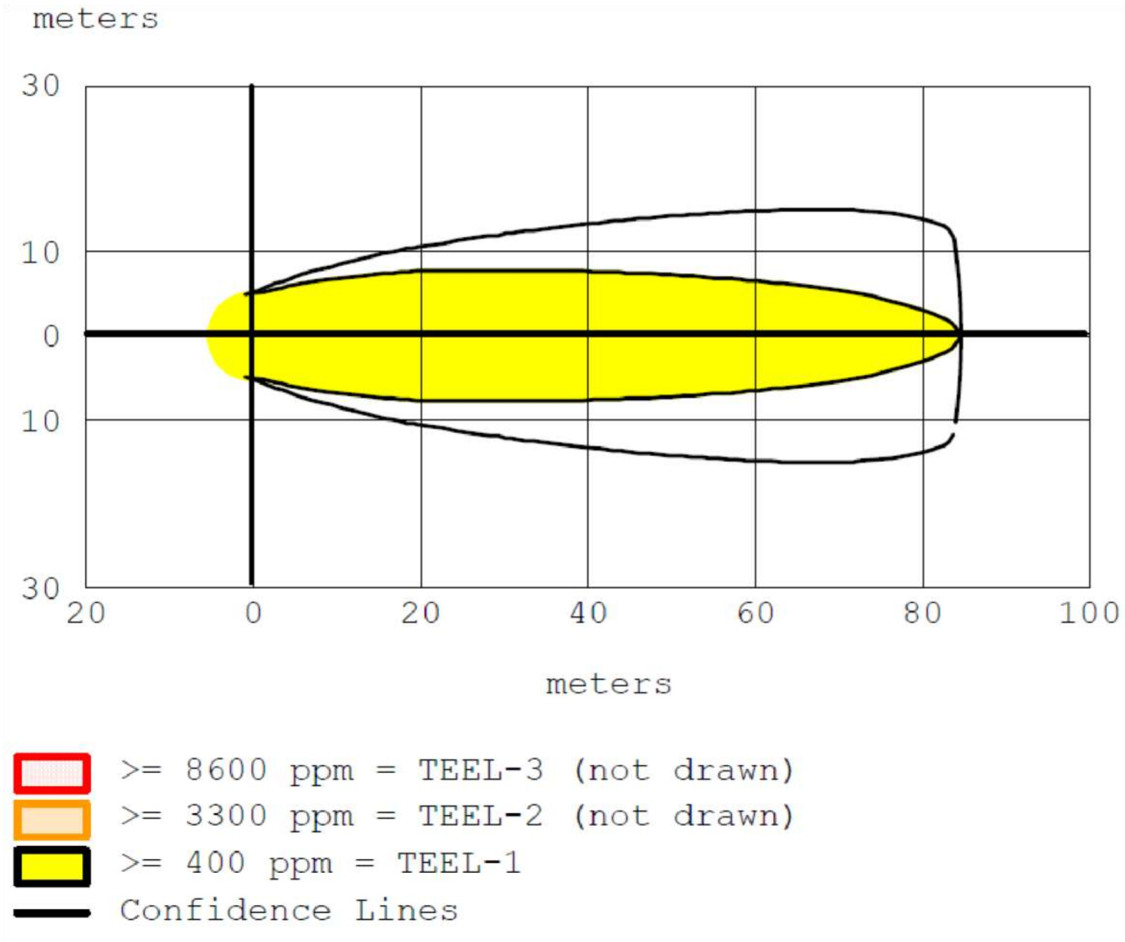
20.1.12.5 Instantaneous Release – Overpressure (Graph)



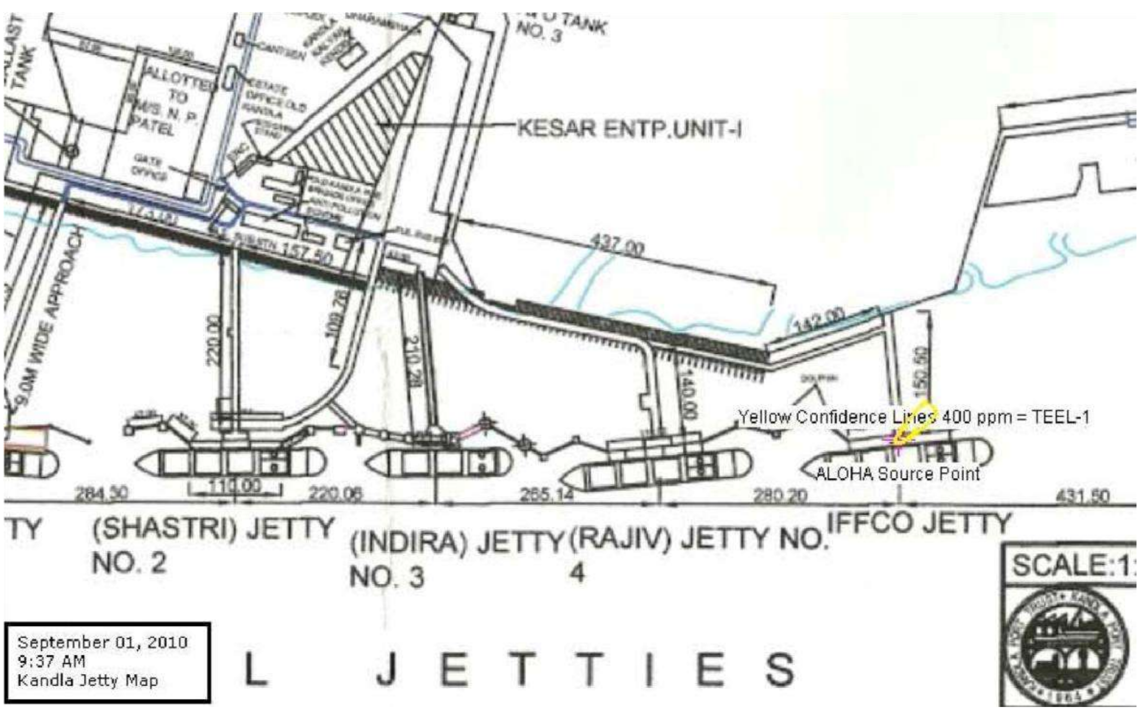
20.1.12.6 Instantaneous Release – Overpressure (Contour)



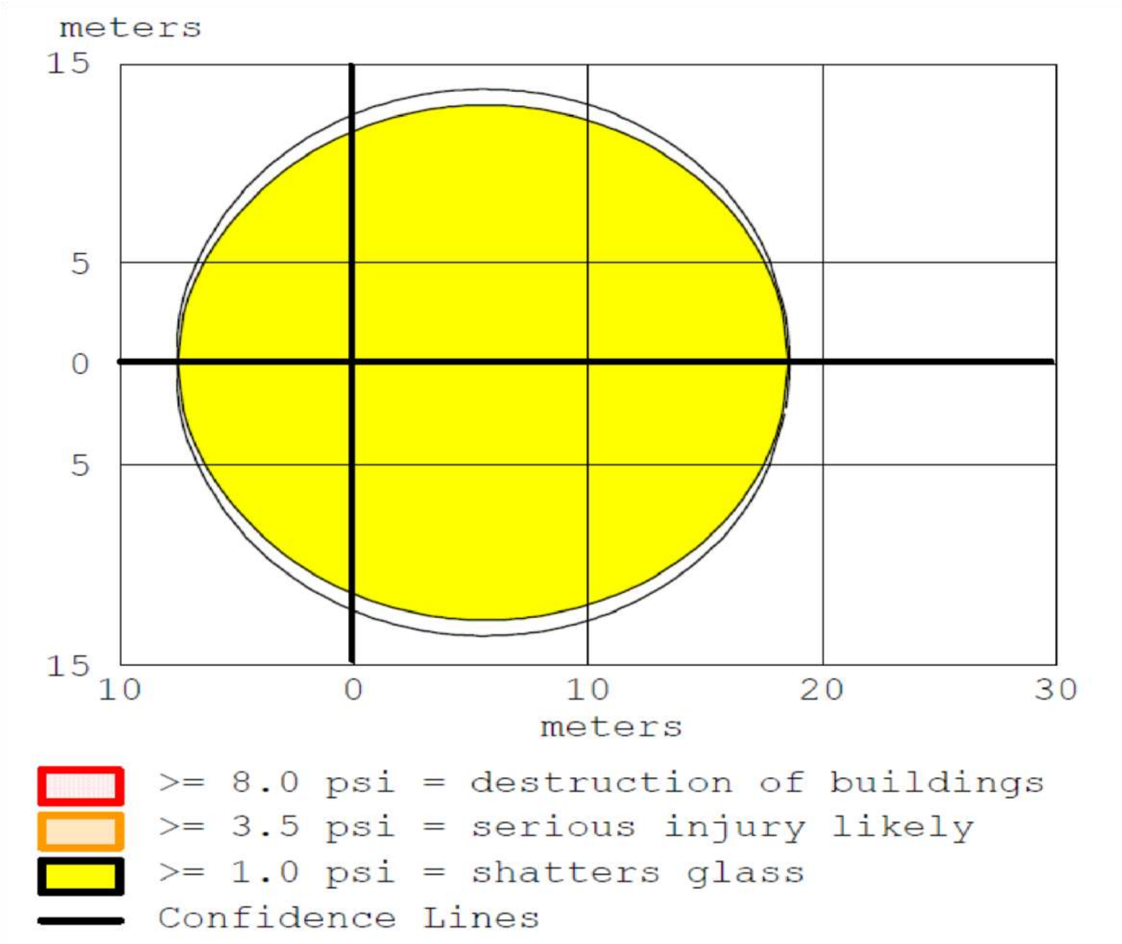
20.1.12.7 Evaporating Puddle – Toxic Threat Zone (Graph)



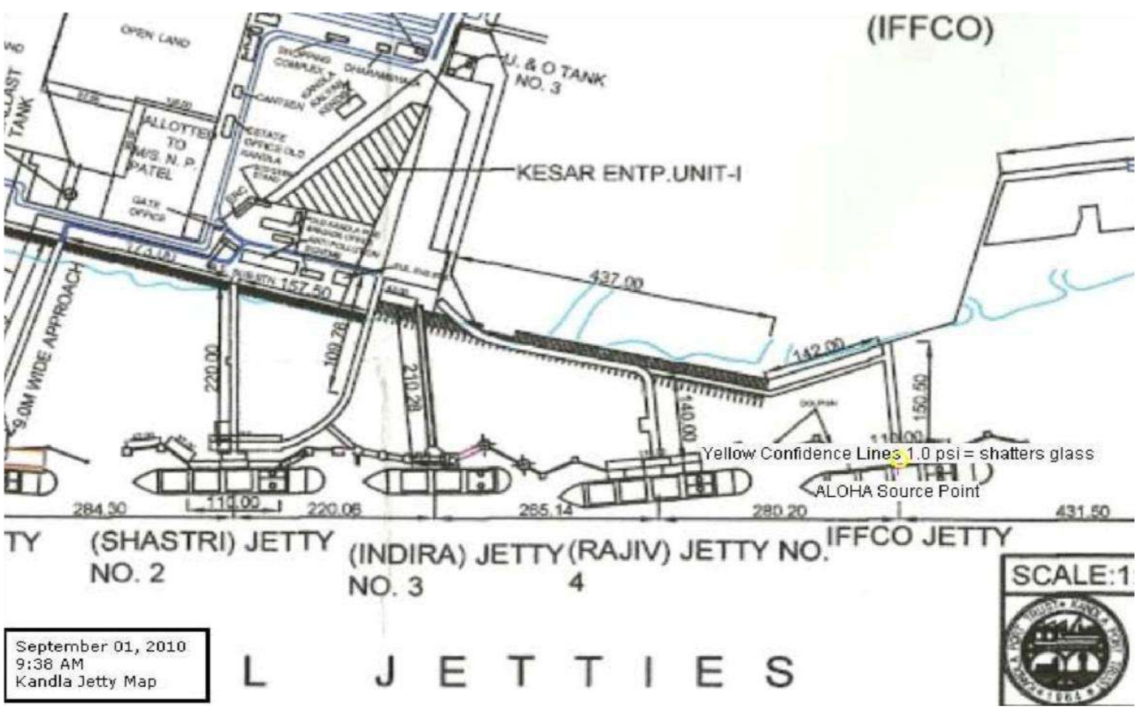
20.1.12.8 Evaporating Puddle – Toxic Threat Zone (Contour)



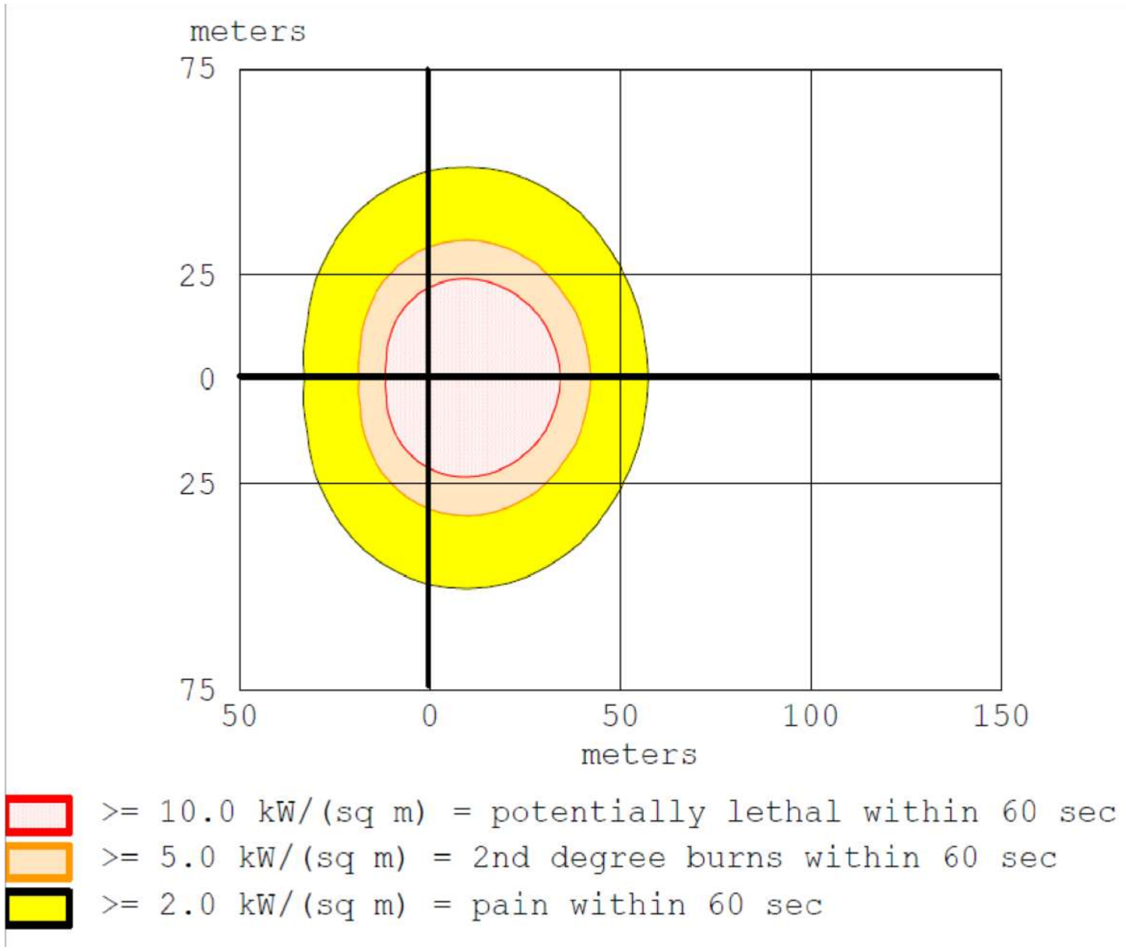
20.1.12.9 Evaporating Puddle – Overpressure (Graph)



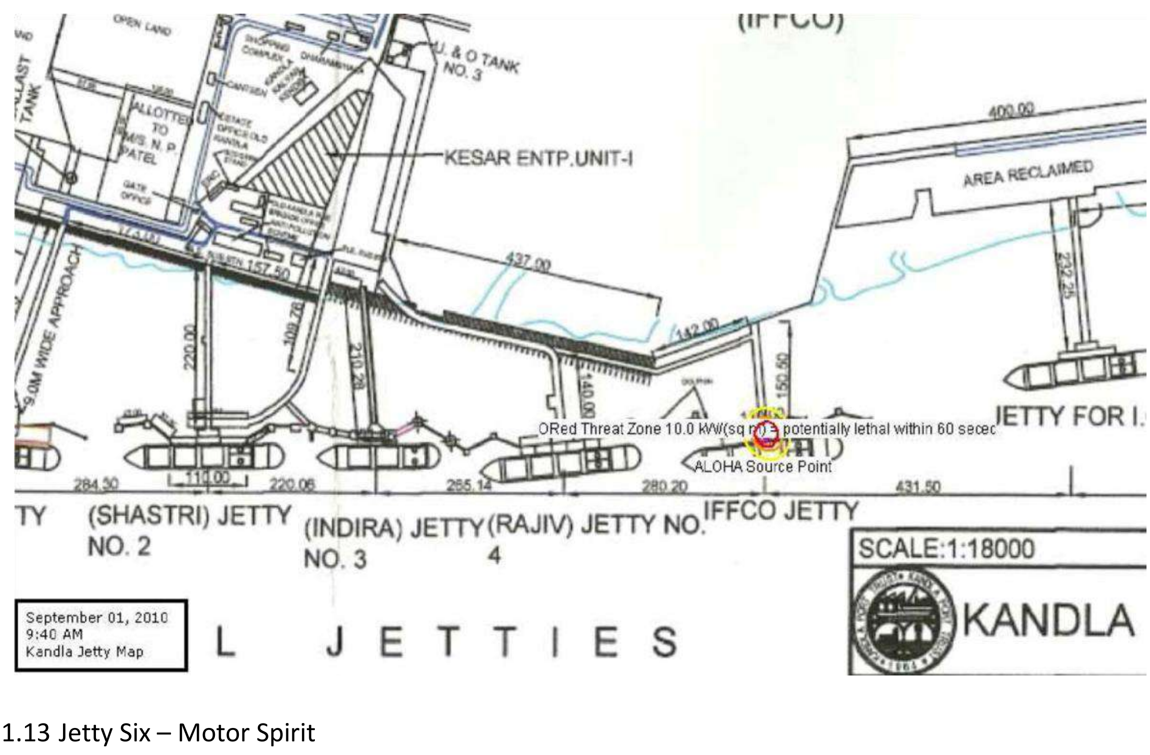
20.1.12.10 Evaporating Puddle – Overpressure (Contour)



20.1.12.11 Burning Puddle – Thermal Radiation (Graph)

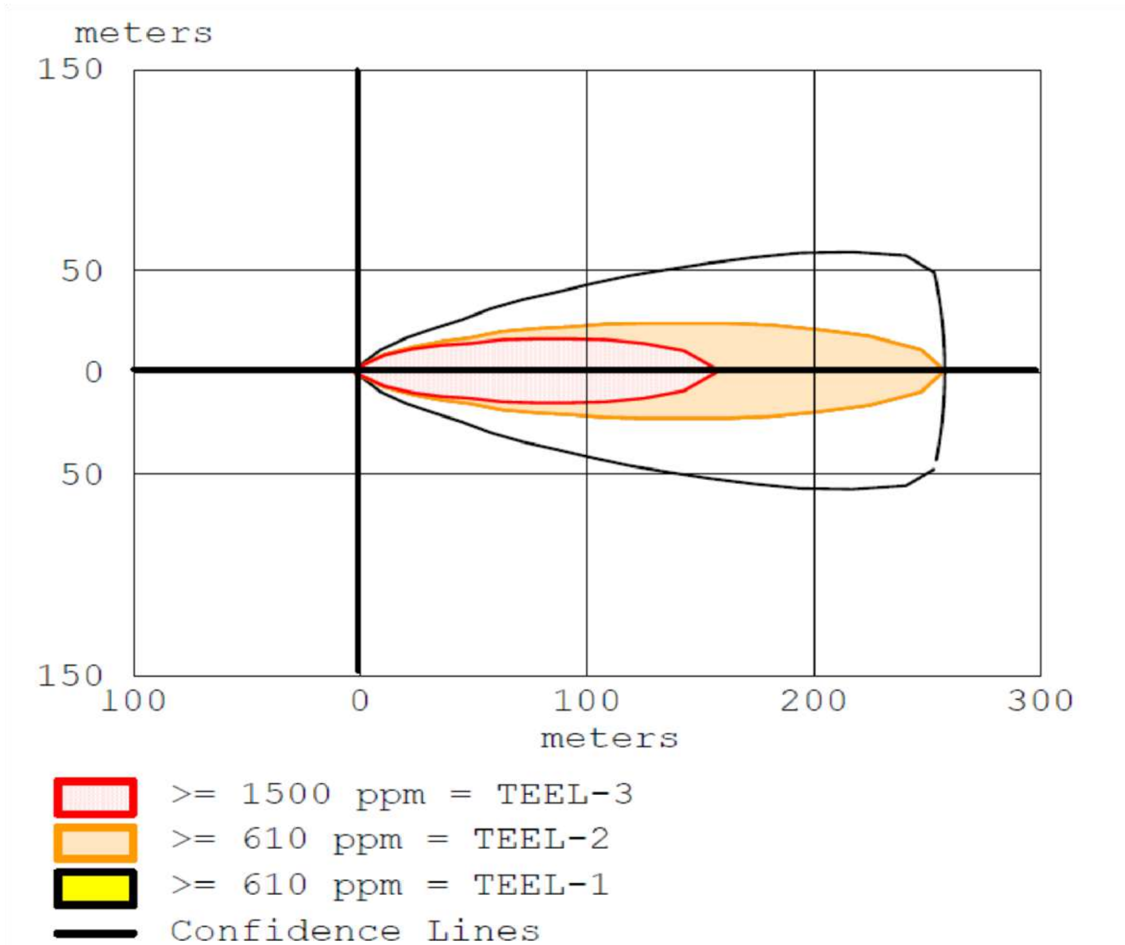


20.1.12.12 Burning Puddle – Thermal Radiation (Contour)

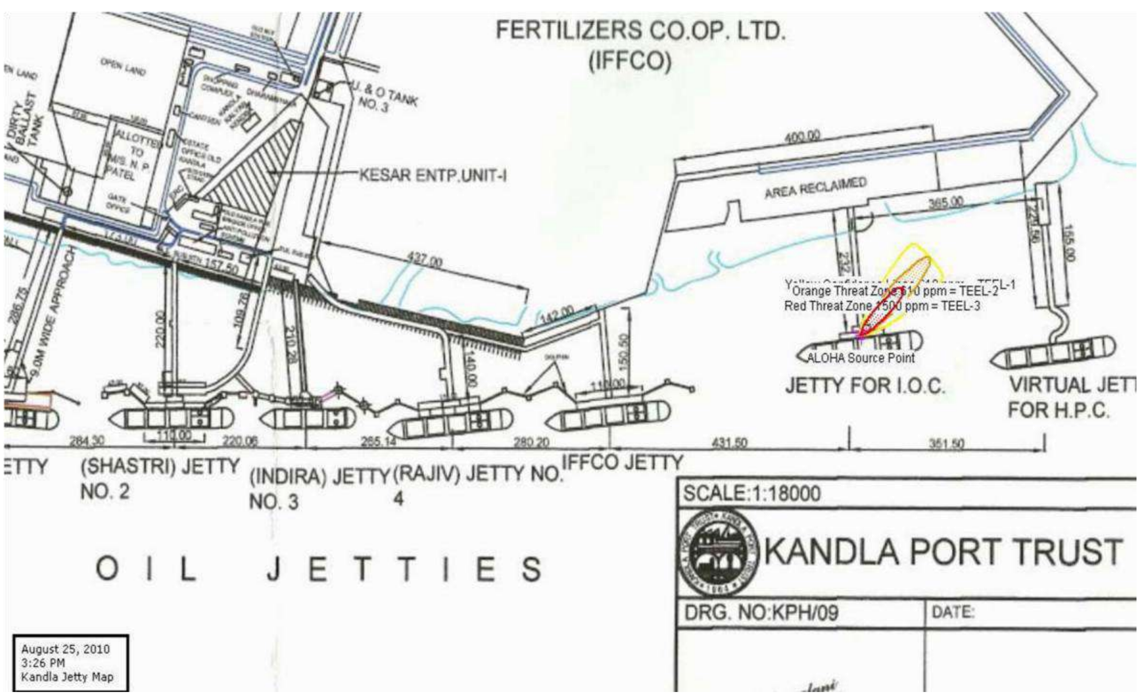


20.1.13 Jetty Six – Motor Spirit

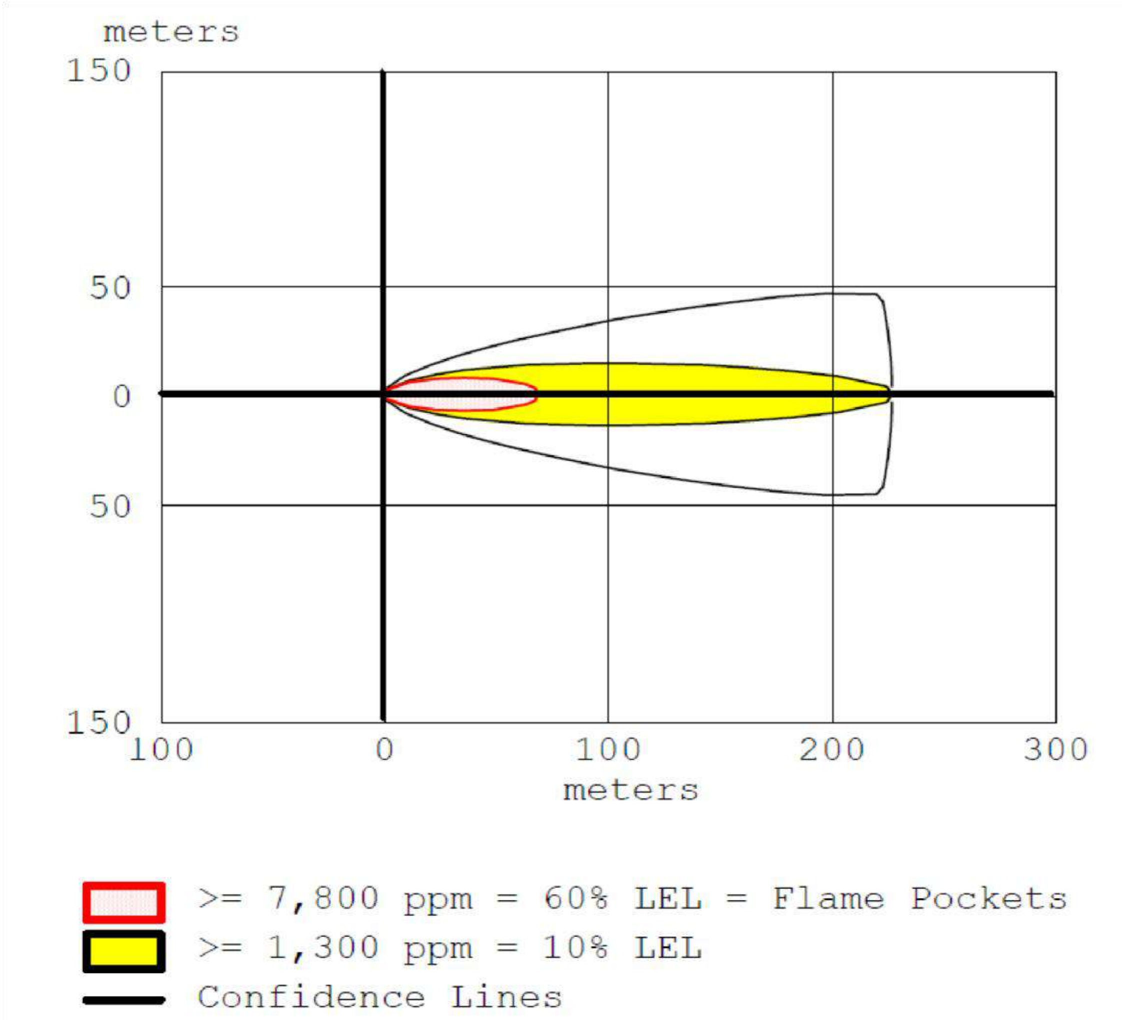
20.1.13.1 Instantaneous Release – Toxic Threat Zone (Graph)



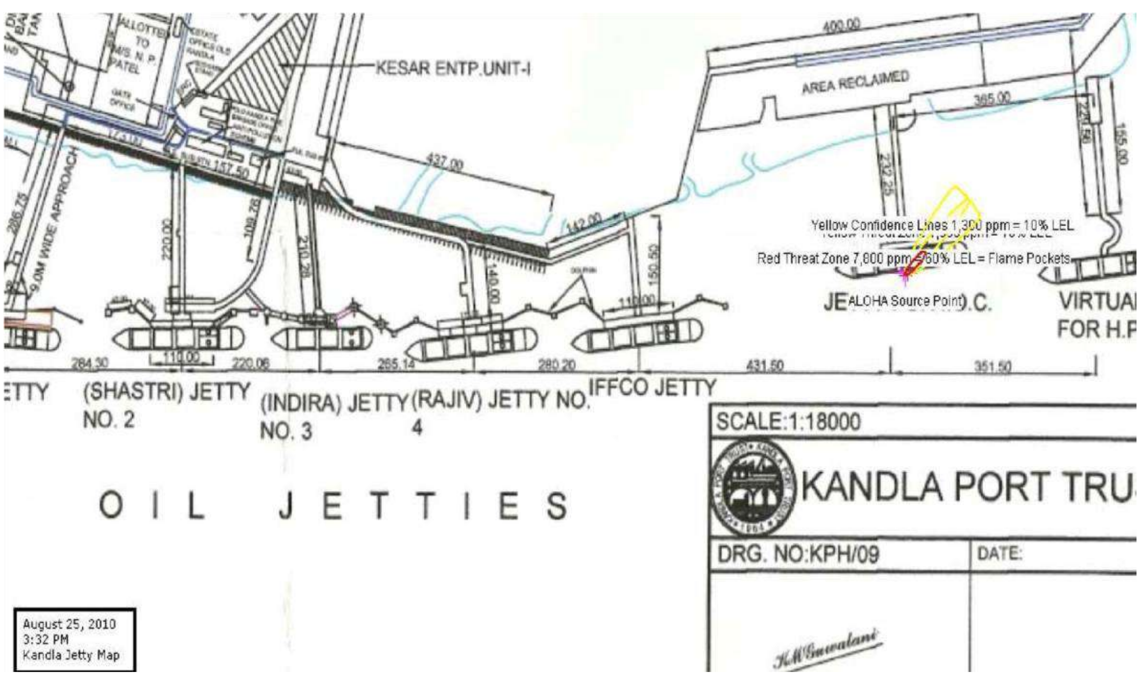
20.1.13.2 Instantaneous Release – Toxic Threat Zone (Contour)



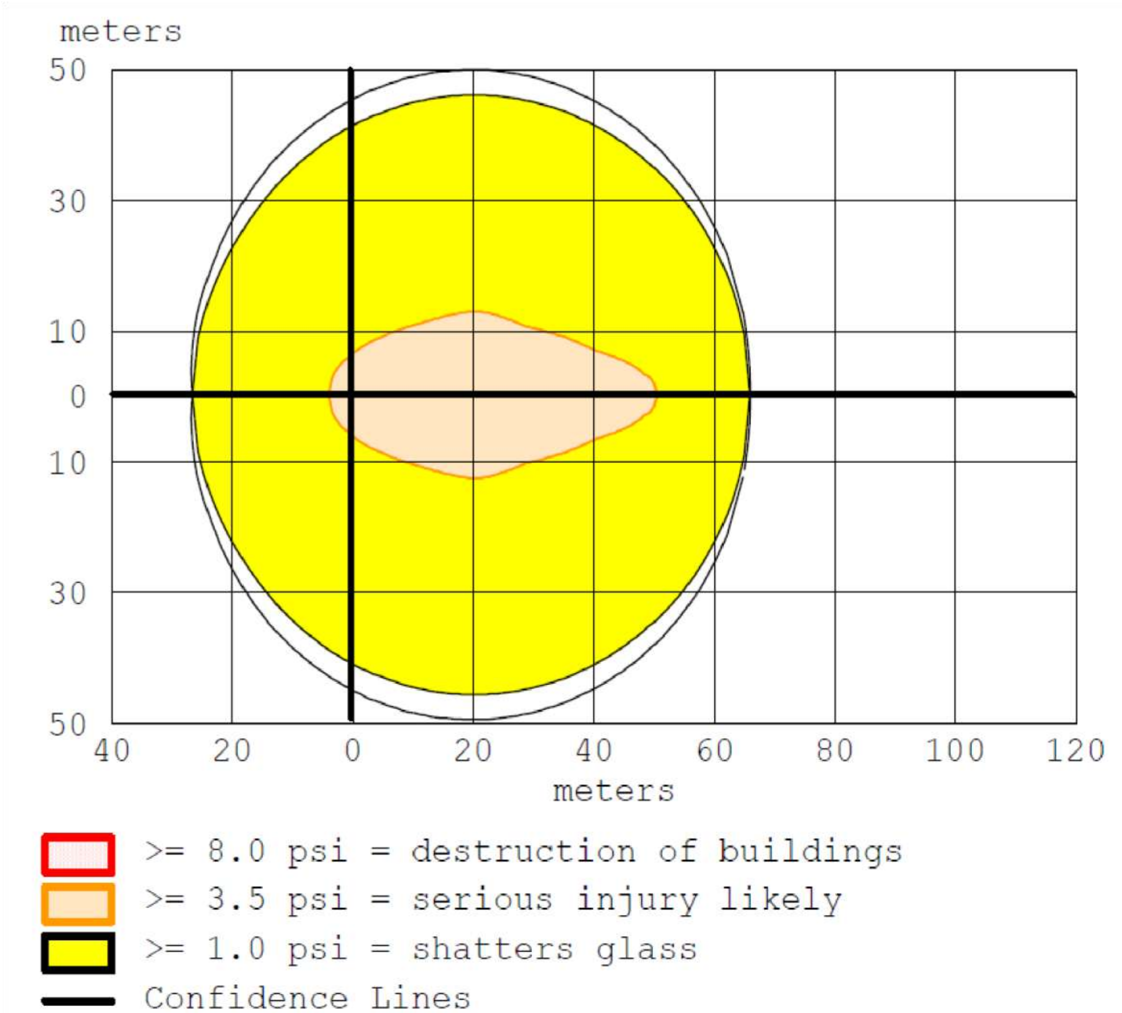
20.1.13.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



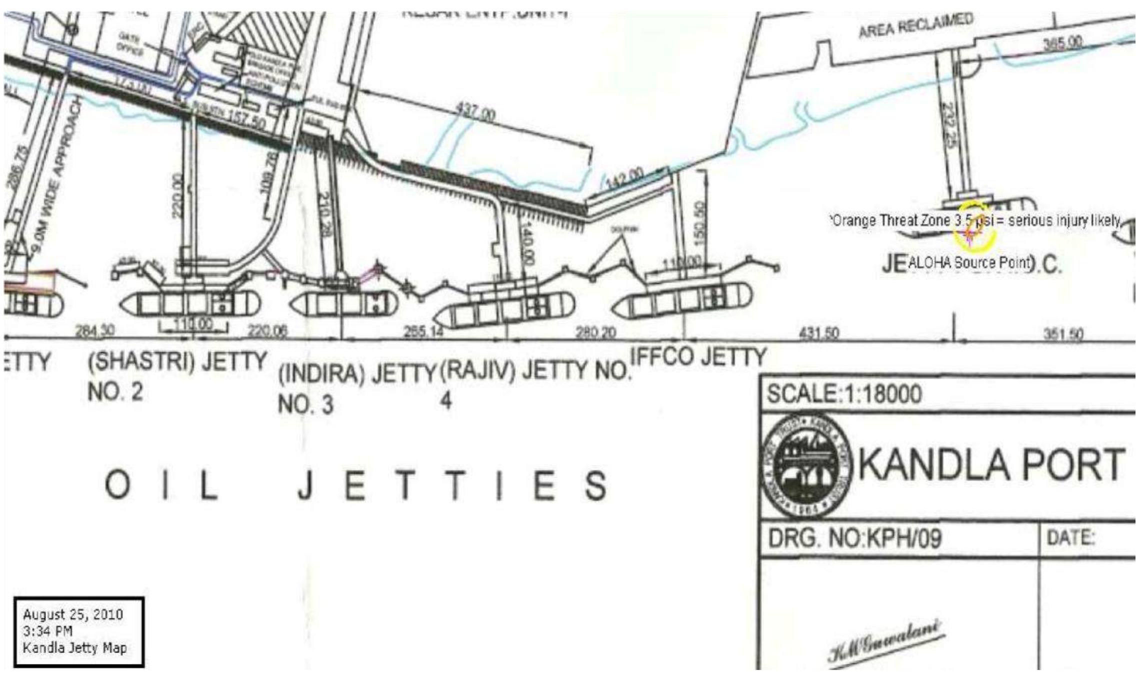
20.1.13.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



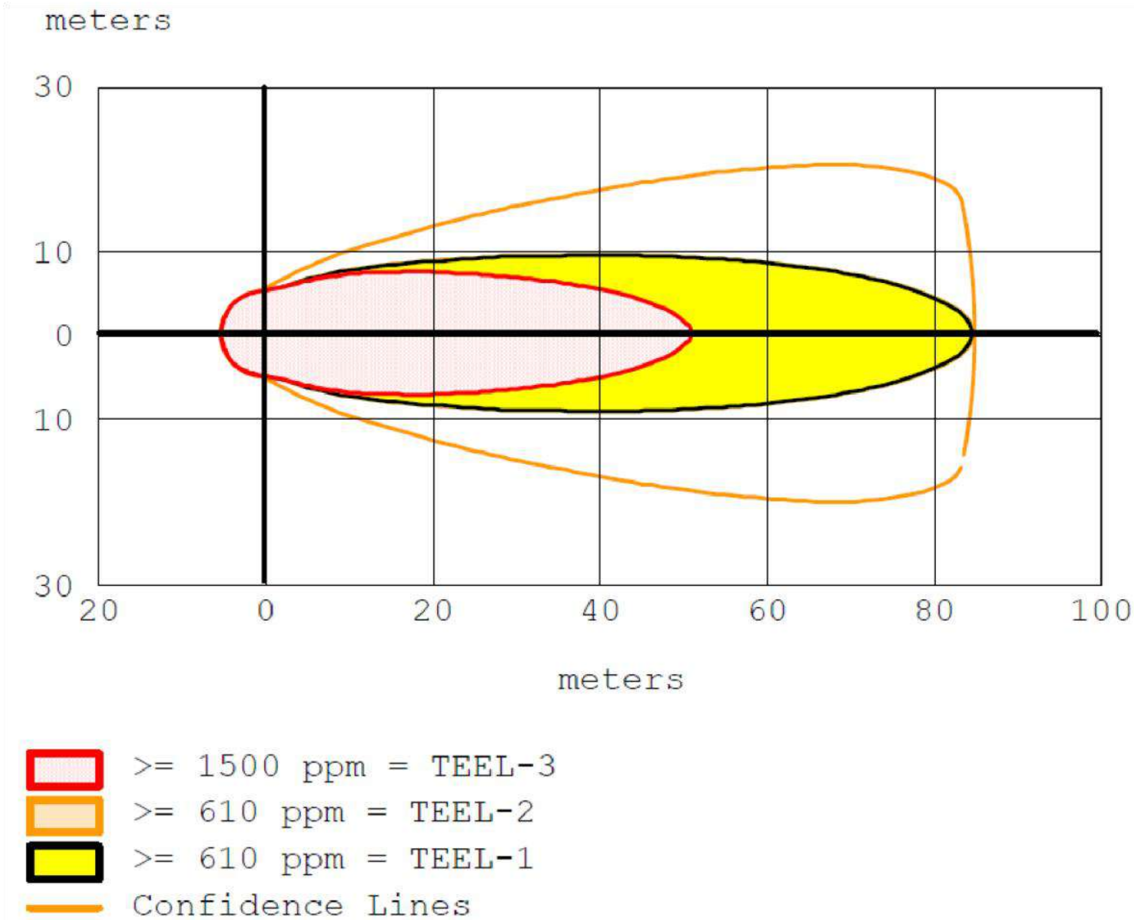
20.1.13.5 Instantaneous Release – Overpressure (Graph)



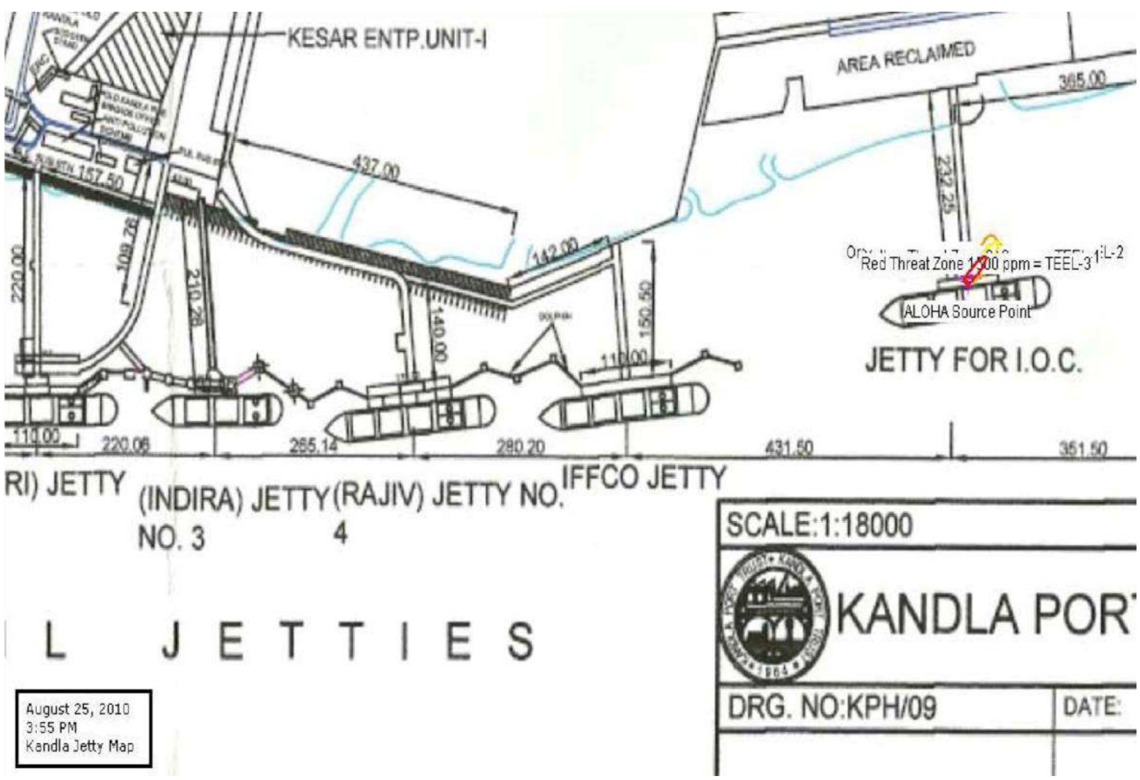
20.1.13.6 Instantaneous Release – Overpressure (Contour)



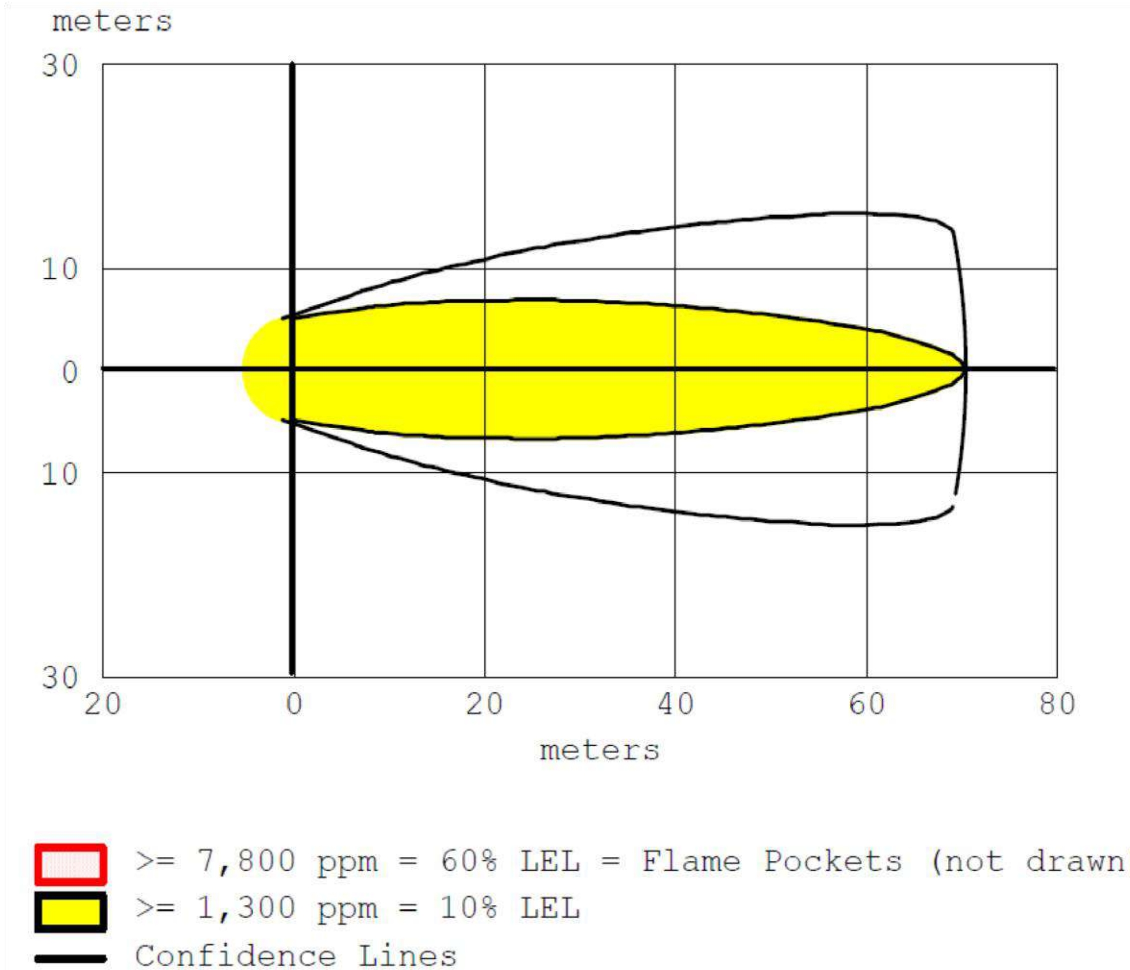
20.1.13.7 Evaporating Puddle – Toxic Threat Zone (Graph)



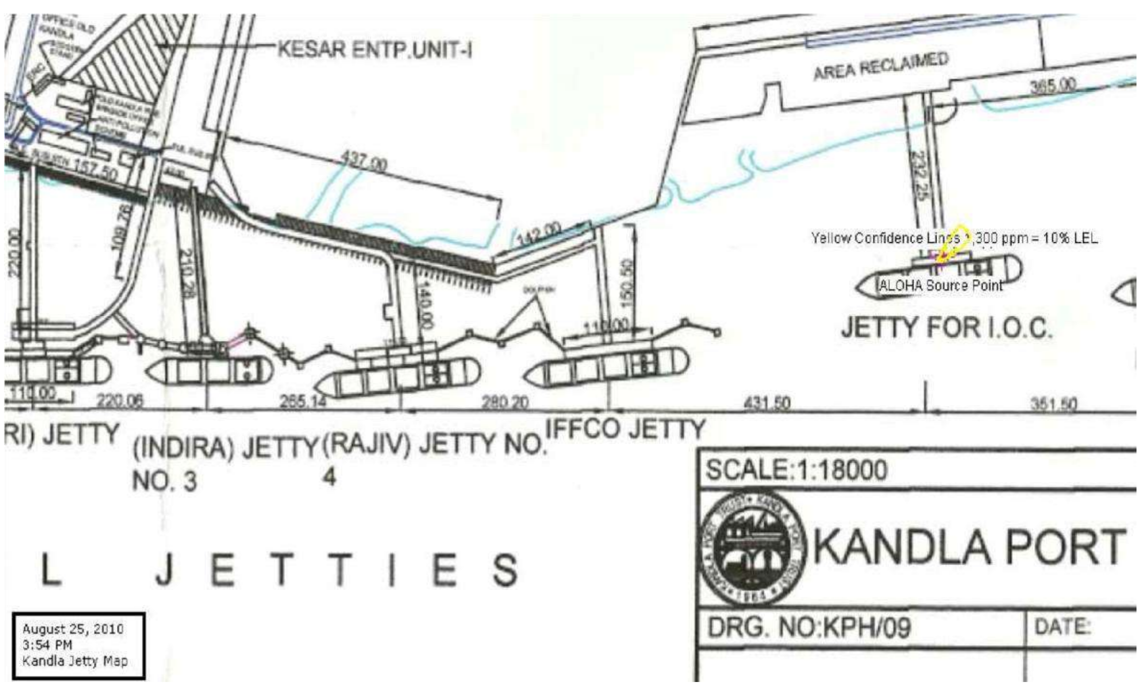
20.1.13.8 Evaporating Puddle – Toxic Threat Zone (Contour)



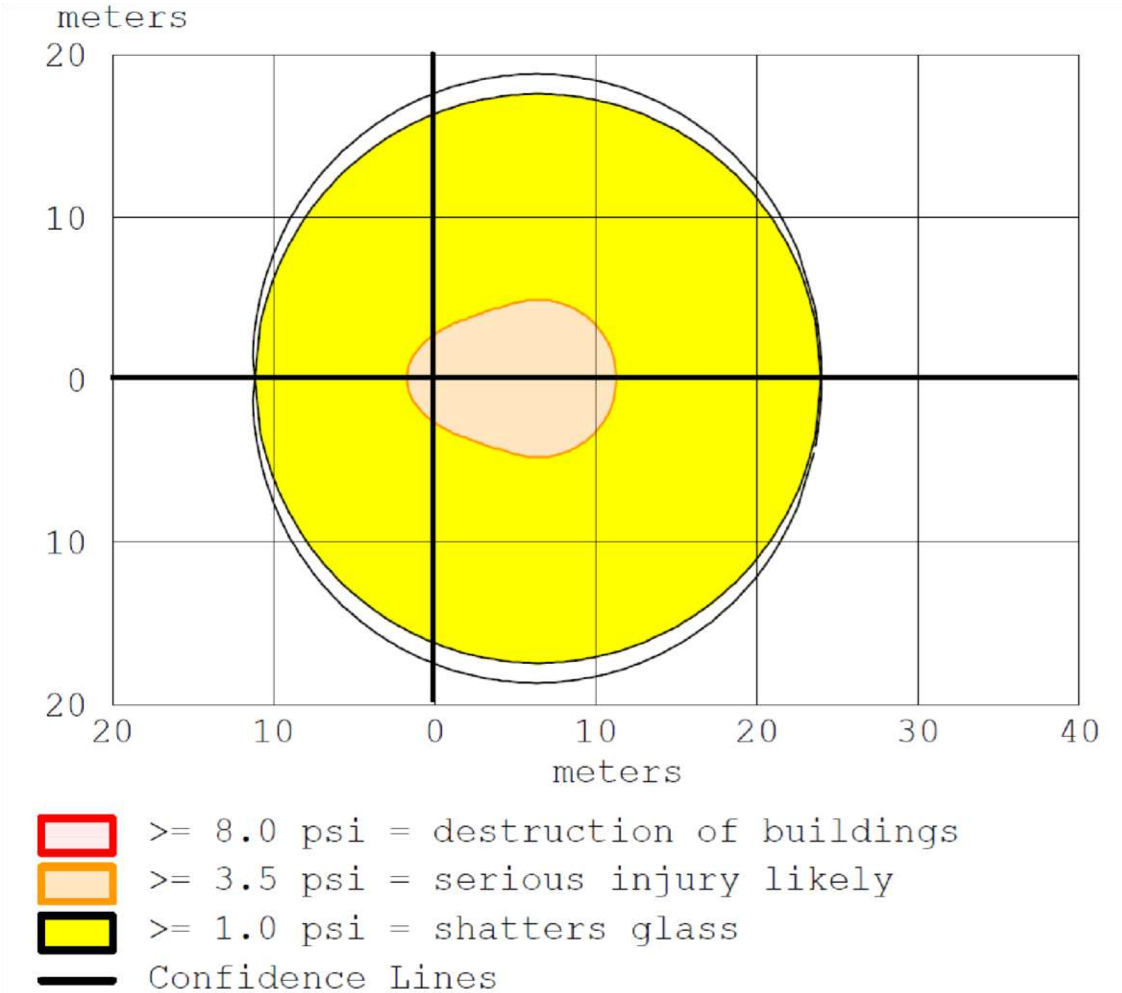
20.1.13.9 Evaporating Puddle – Flammable Area of Vapor Cloud (Graph)



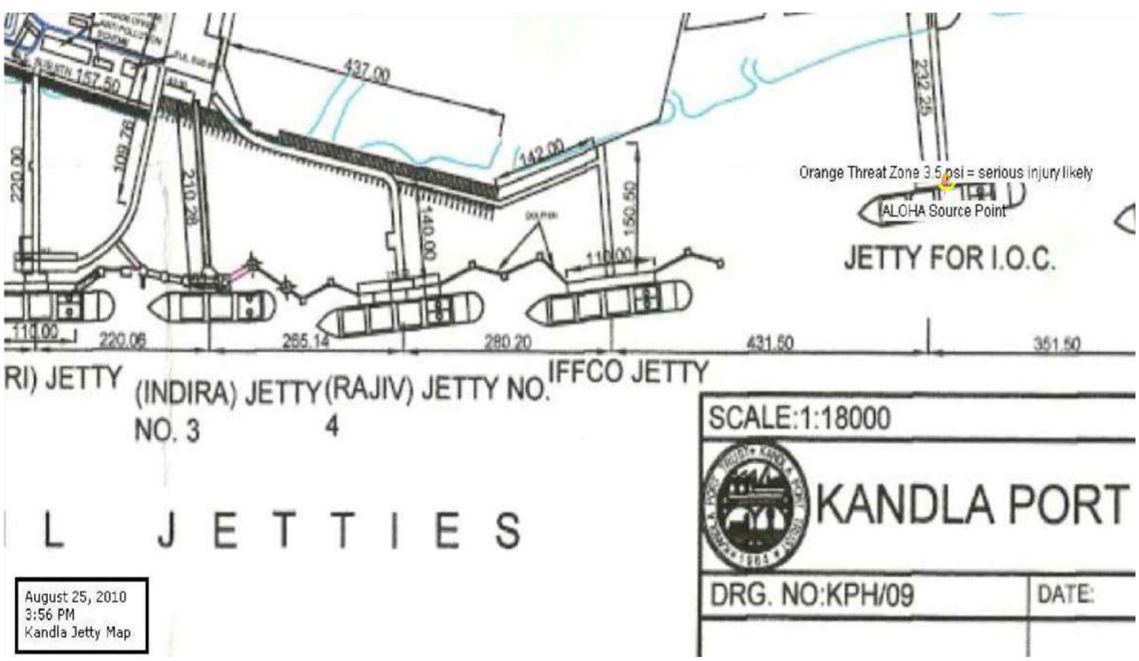
20.1.13.10 Evaporating Puddle – Flammable Area of Vapor Cloud (Contour)



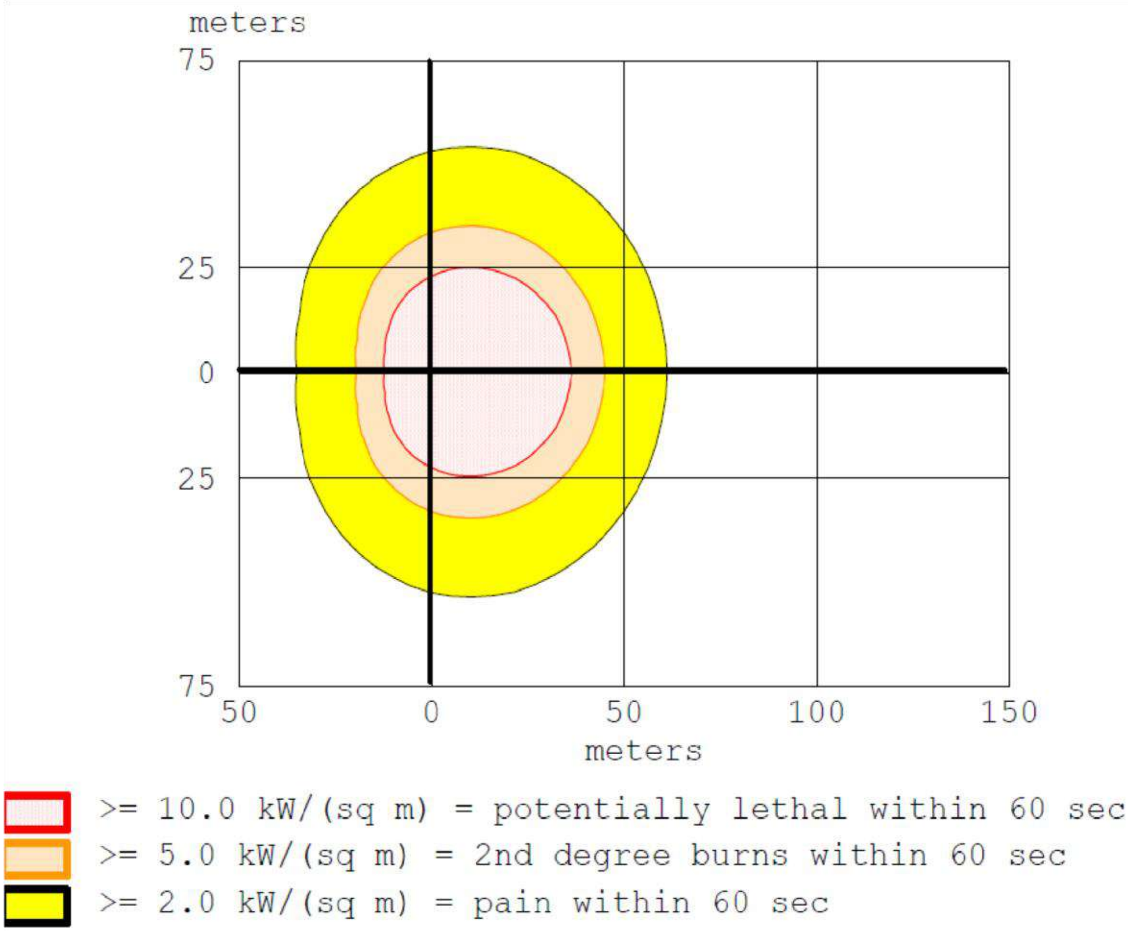
20.1.13.11 Evaporating Puddle – Overpressure (Graph)



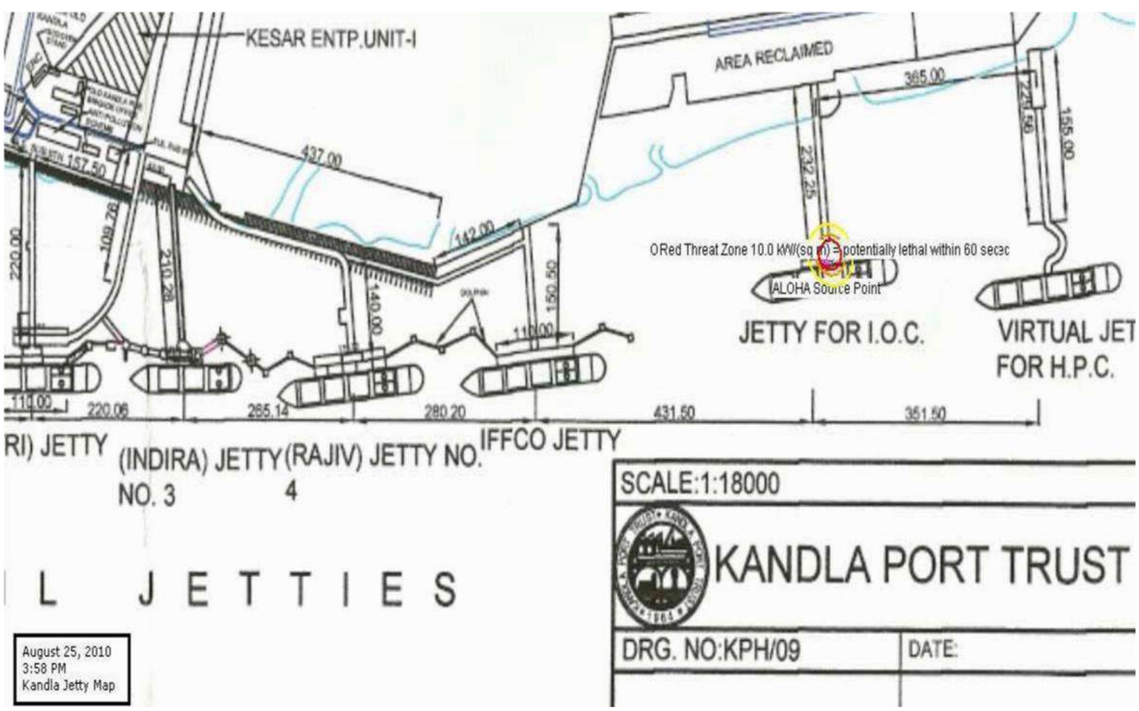
20.1.13.12 Evaporating Puddle – Overpressure (Contour)



20.1.13.13 Burning Puddle – Thermal Radiation (Graph)

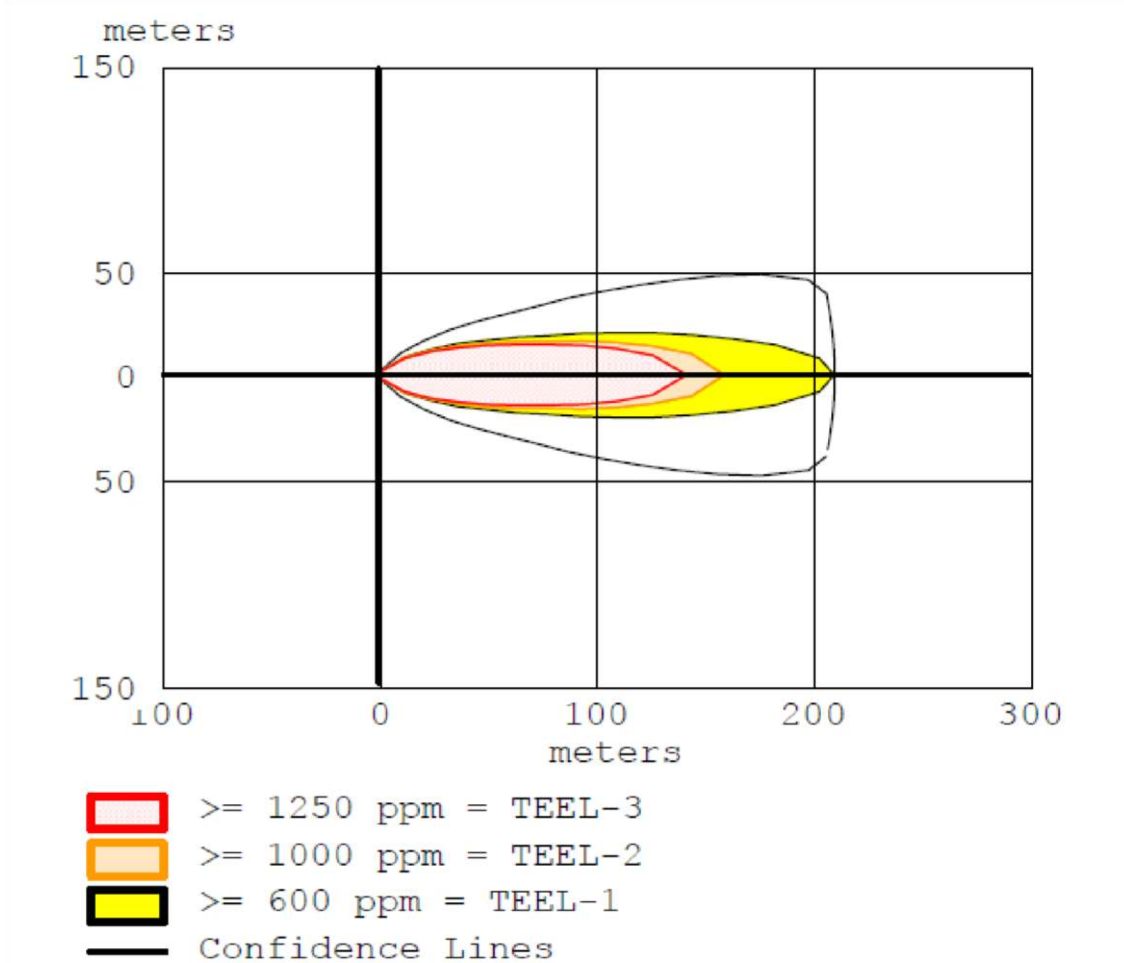


20.1.13.14 Burning Puddle – Thermal Radiation (Contour)

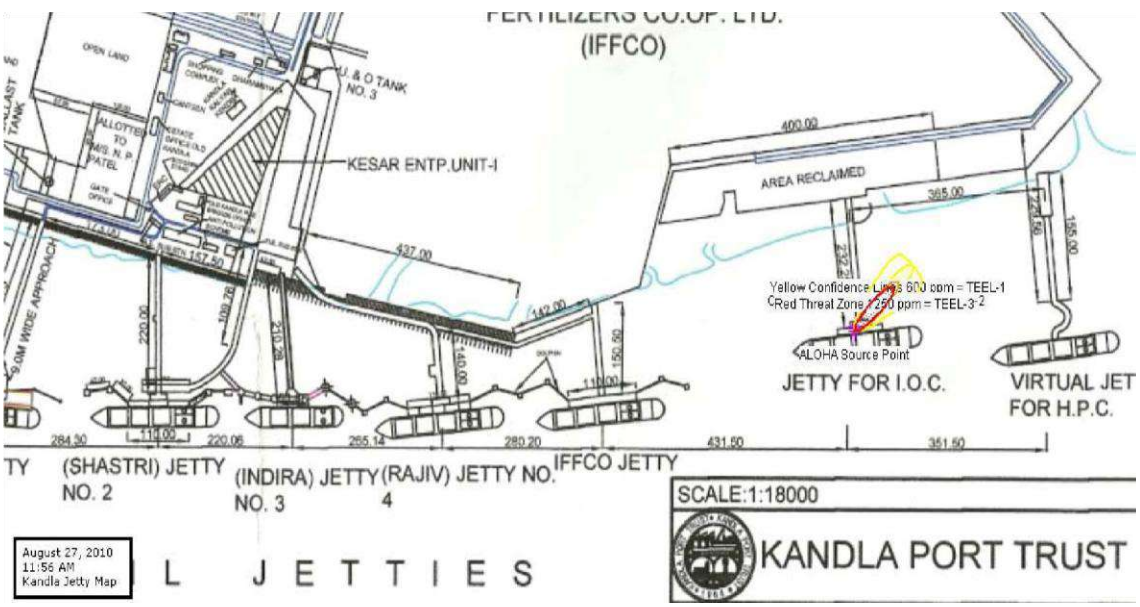


20.1.14 Jetty Six – Motor Spirit

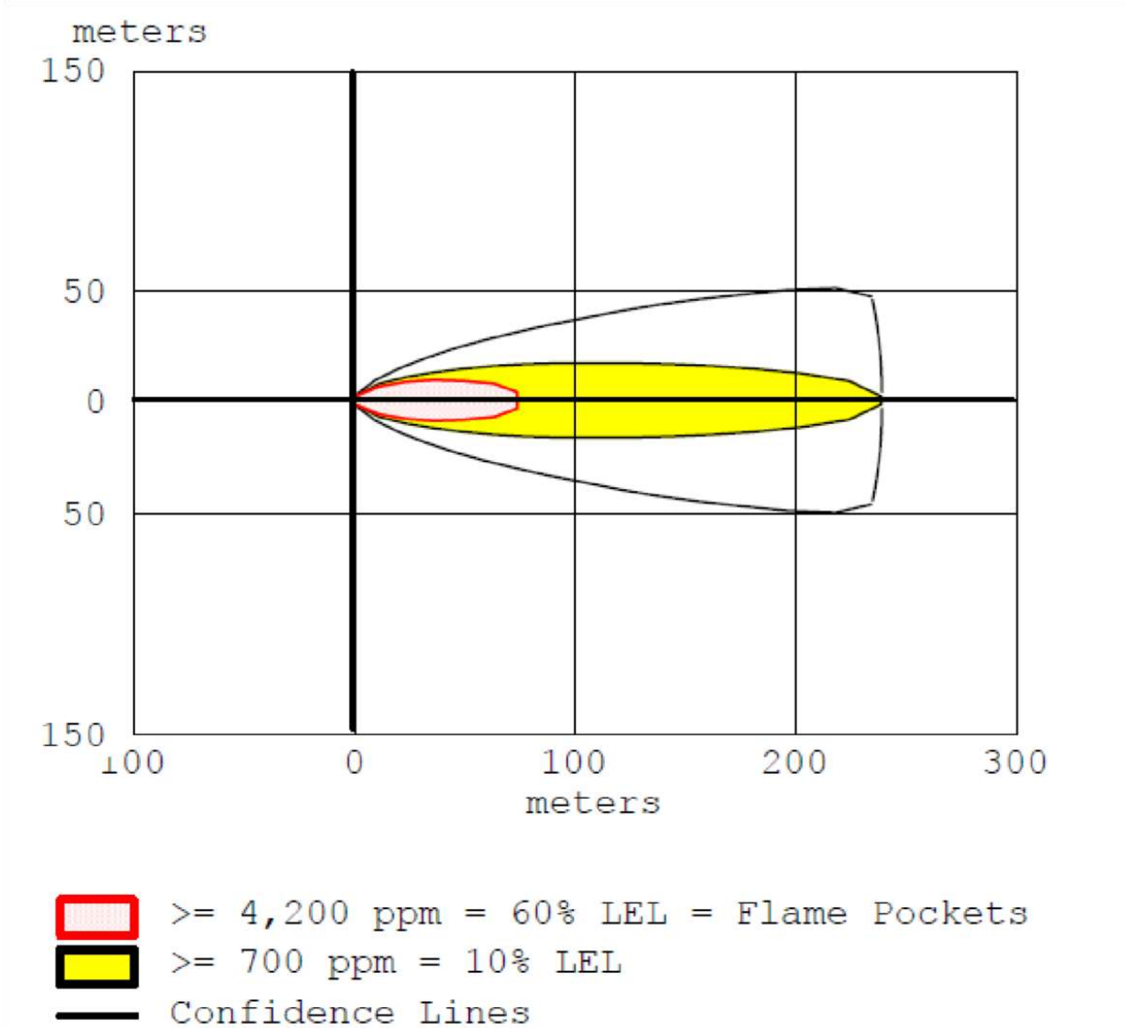
20.1.14.1 Instantaneous Release – Toxic Threat Zone (Graph)



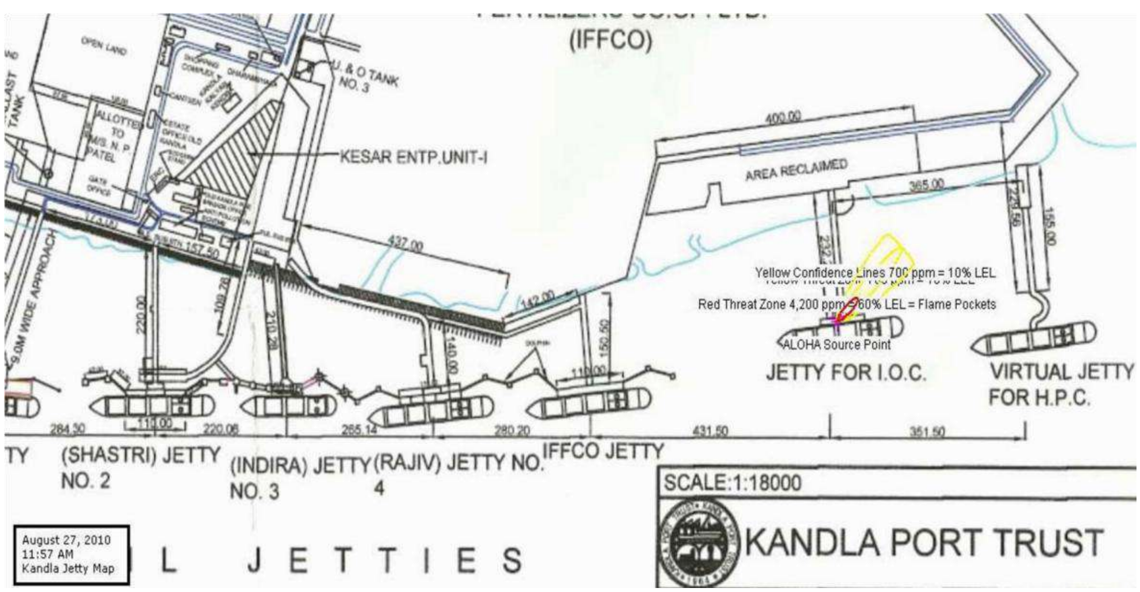
20.1.14.2 Instantaneous Release – Toxic Threat Zone (Contour)



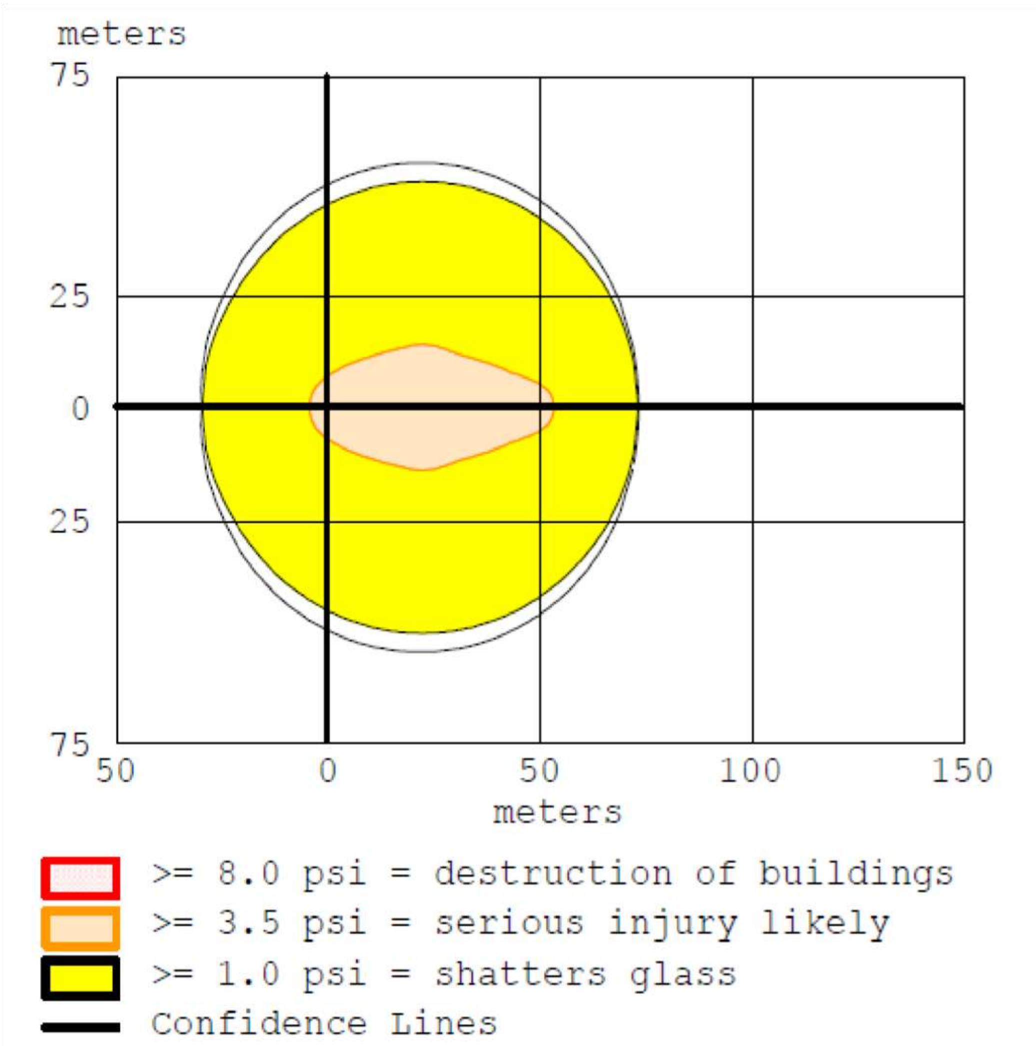
20.1.14.3 Instantaneous Release – Flammable Area of Vapor Cloud (Graph)



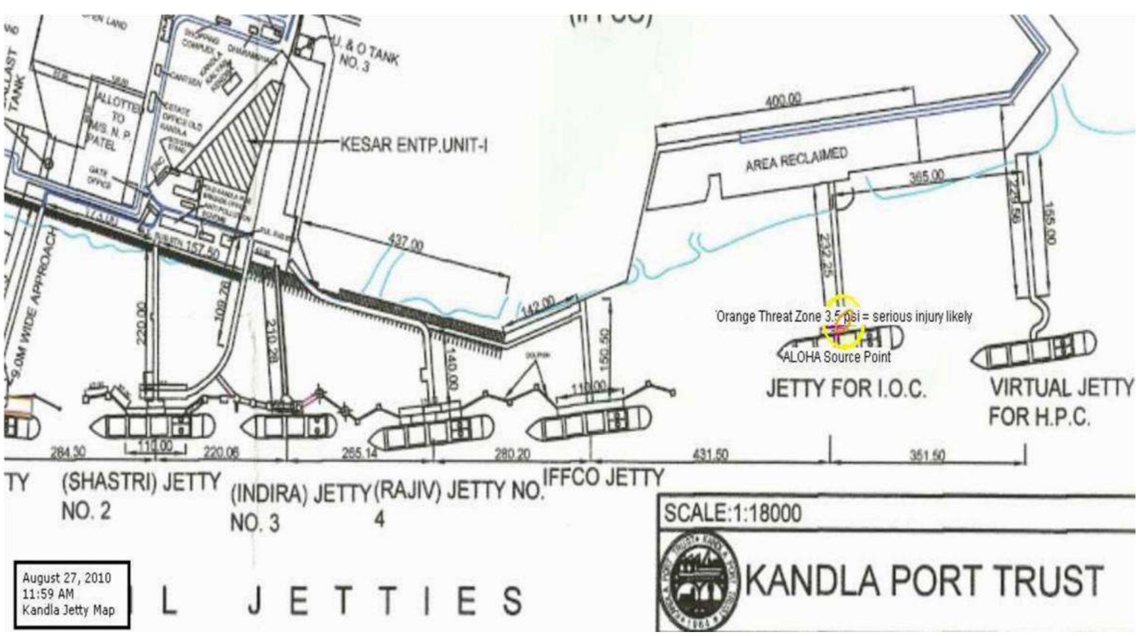
20.1.14.4 Instantaneous Release – Flammable Area of Vapor Cloud (Contour)



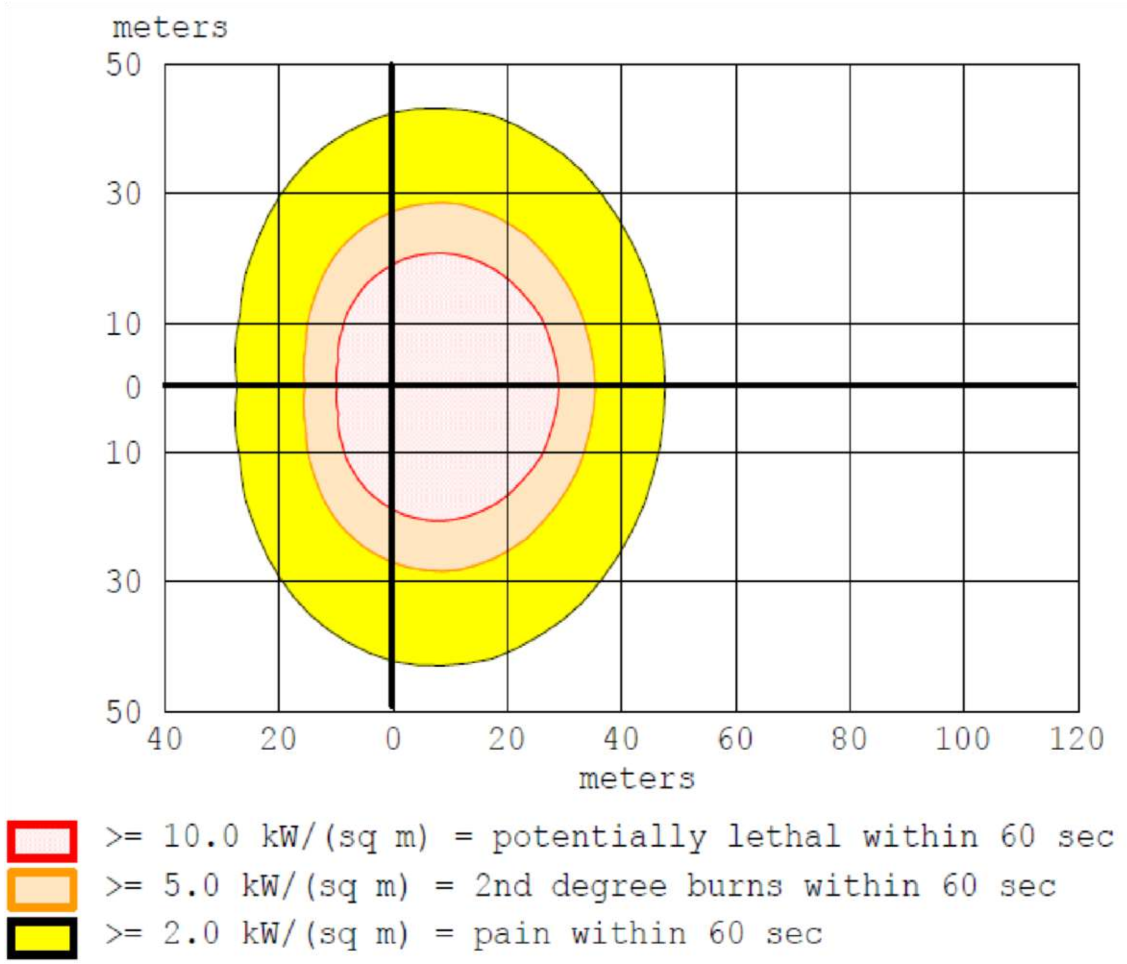
20.1.14.5 Instantaneous Release – Overpressure (Graph)



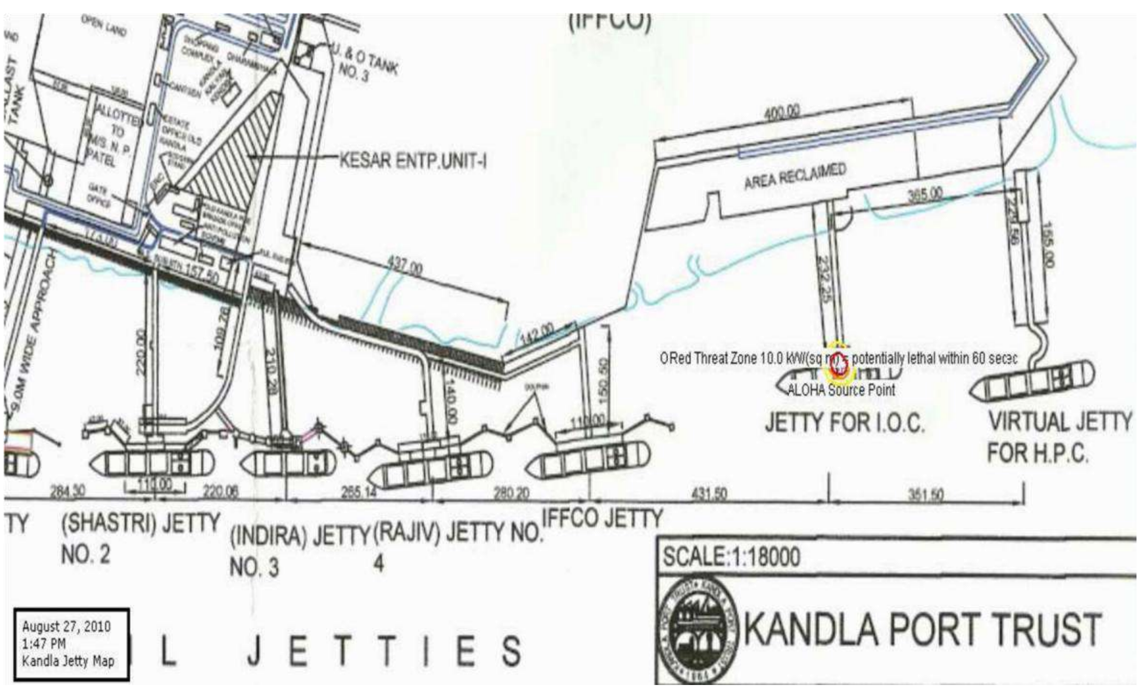
20.1.14.6 Instantaneous Release – Overpressure (Contour)



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 , Sector-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 Trust, Samiti 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 compounde r residi ng 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	Gandhid ham	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 Mangubhai C. Patel** 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	Telephone Nos. 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 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.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 J

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)/ 12 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: 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 of "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 Trust" (Part VIII Marine Ecology, Specific Condition·iii) reg.

Ref.: 1) DPT request vide email dated 10/4/2021.
2) M/s GUIDE, Bhuj letter no. GUIDE/DPT/Offer/Mgmt Plan/17/2021-22 dated 16/4/2021.

Sir,

Your offer for the subject work submitted vide above referred letter dated 16/4/2021 amounting to Rs. 11,00,000.00 + 18% GST (Rupees Eleven Lakhs only plus eighteen percent GST) including all terms & conditions mentioned in the offer letter, has been accepted.

2. The terms of payment :

1) 20% of the project budget should be paid within 15 days from the date of submission of Inception report by GUIDE .
2) 40% of the project budget should be paid within 15 days from the date of submission of Draft report by GUIDE.
3) 40% of the project budget should be paid within 15 days from the date of submission of Final report by GUIDE.

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

3. Scope of work :

Preparation of detailed Marine Biodiversity Management Plan for the impact of the project activities on the intertidal biotopes, corals and coral communities, Molluscs, sea grasses, sea weeds, sub-tidal habitats, fishes, other marine and aquatic micro, macro and mega flora and fauna including benthos, plankton, turtles, birds, etc. and also the productivity. The data collection and impact assessment shall be as per standards survey methods and include Underwater Photography.

Ref.; EC & CRZ Clearance granted by the MoEF&CC,GoI dated 20/11/2020 – Creation of water front facilities (OJ 8 to 11) ... - **Para VIII Marine Ecology, Specific condition iii.**

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 : One year (Frequency One time).

6. Kindly send the acknowledgement of this work order & start the work w.e.f. 24/5/2021.

Thanking you.

Yours faithfully,

23/5/21

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

ANNEXURE K

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)/ 12 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: 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 of "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 Trust" (Part VIII Marine Ecology, Specific Condition·iii) reg.

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3) 40% of the project budget should be paid within 15 days from the date of submission of Final report by GUIDE.

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

3. Scope of work :

Preparation of detailed Marine Biodiversity Management Plan for the impact of the project activities on the intertidal biotopes, corals and coral communities, Molluscs, sea grasses, sea weeds, sub-tidal habitats, fishes, other marine and aquatic micro, macro and mega flora and fauna including benthos, plankton, turtles, birds, etc. and also the productivity. The data collection and impact assessment shall be as per standards survey methods and include Underwater Photography.

Ref.; EC & CRZ Clearance granted by the MoEF&CC,GoI dated 20/11/2020 - Creation of water front facilities (OJ 8 to 11) ... - **Para VIII Marine Ecology, Specific condition iii.**

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 : One year (Frequency One time).

6. Kindly send the acknowledgement of this work order & start the work w.e.f. 24/5/2021.

Thanking you.

Yours faithfully,

23/5/21

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

ANNEXURE L

DEENDAYAL PORT TRUST
QHSE Policy
(Quality, Health, Safety & Environment Policy)

The Deendayal Port Trust, India's NO.1 Major Port strongly believes that Health, Safety, Environment & Quality is an integral part of our working culture and are core value for us.

We are strongly committed to maintain safe and healthy working environment for DPT employees, Port users, Customers & other stakeholders in por[illegible] with the best quality of service as a port.

To achieve this target, DPT has set the following strategic o[illegible]

- * Minimize the adverse Environmental Impacts for sustainab[illegible] port
- * No Occupational injuries or Diseases
- * No damage to property due to Fire and Explosion
- * Ensure quality services

To achieve these objectives, the Deendayal Port is highly committed to follow the below actions :

- * Comply with applicable laws and regulations related to port.
- * Seek opportunities, beyond compliance requirements to prevent occupational injuries and diseases, reducing the risk to the environment and safety.
- * Ensure protection of environment, protect biodiversity, ecosystem and mitigate the climate changes issues, with special focus on coastal environment. Adopt latest technology and training for protection of environment. Implement appropriate environmental monitoring programs to ensure that activities are not impacting negatively on environment.
- * Conserve the natural resources and energy by adopting green energy initiatives, efficiency improvement and reduction & recycling of wastes.
- * Ensure active participation and consultation of all stake holders for continual improvement to achieve QHSE objectives.
- * To adopt best national and international practices, innovative ideas and technologies to sustain the No.1 major port position by best performance and customer satisfaction.

Place: KANDLA

Date: 11-03-2021

Shri S. K. Mehta, IFS

Chairman-Deendayal Port Trust

ANNEXURE M

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.

.........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 N

DEENDAYAL PORT TRUST

(Erstwhile : Kandla Port Trust)

NIT NO. 06/CE

The Ministry of Environment, Forests & Climate Change, Government of India has accorded Environmental and CRZ Clearance for the Deendayal Port Trust 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, Kachchh (Gujarat) by M/s. Deendayal Port Trust (formely known as Kandla Port Trust)" vide F. No. 10-1/2017-IA-III dated 20.11.2020 and copy of the clearance letter is available in the website of DPT at www.deendayalport.gov.in and may also be seen on the Website of the Ministry of Environment, Forests & Climate Change at http://www.moef.gov.in

Cheif Engineer
Deendayal Port Trust

Delivering Maritime Excellence

NOTICES

NOTICE TO CONSIGNEES

HAMBURG SÜD

M.V.MAERSK BENTONVILLE 046I

IGM No. 2268132 dated 24.11.2020 Vessel Exch. Rate USD 1 = INR 75.33

The above vessel has arrived at MUNDRA on 26.11.2020 with following ICD/Transshipment/Local import cargo. Consignees are requested to kindly note the item nos filed against their bill of lading.

EX.VESSEL : MAERSK BENTONVILLE V. 046N

ITEM NO.	B/L NO.	DESTINATION
83	SUDU10001A8M3010	MUNDRA
84	SUDU10999A8M3059	MUNDRA
85	SUDU10999A8NL042	MUNDRA
86	SUDU60ITJ028445X	MUNDRA
87	SUDU60ITJ029348X	MUNDRA
88	SUDU60ITJ030160X	MUNDRA
89	SUDU70711ACYL013	MUNDRA
90	SUDU70711ACYL014	MUNDRA
91	SUDU70711ACYL018	MUNDRA
92	SUDU70711ACYL019	MUNDRA
93	SUDUA0FRA003821A	MUNDRA
94	SUDUA0HAM019204A	MUNDRA
95	SUDUA0HAM020456A	MUNDRA
96	SUDUA0HAM020463A	MUNDRA
97	EM20ITJ00757	MUNDRA
98	EM20ITJ00885	MUNDRA
99	DMCQHAM0053135	MUNDRA
100	SUDUA0DUS003965A	ICD JAIPUR(KANAKPURA)
102	SUDUC0ANR017417X	ICD KHODIYAR
103	SUDUC0ANR017863X	ICD KHODIYAR
104	SUDUA0FRA003819A	ICD LUDHIANA
107	SUDU50650A6UG166	ICD SAHNEWAL
108	SUDUA0DUS003972A	ICD SAHNEWAL

Consignees are requested to obtain the Delivery Orders on presentation of duly endorsed Original Bills of Lading and on payment of applicable charges within the free time to avoid detention charges being levied. Consignees are requested to note that all local clearance FCL containers will be moved enbloc from the terminal to the nominated SEABIRD CFS - MUNDRA (LDD) from where the delivery will be effected. Separate IGM will be lodged with respective ICD's, Mundra Customs for ICD's and Mundra Port Delivery. Carrier or its agents will not be responsible for any delay in CY-CFS movement due to port congestion. Consignees are also requested to note that carrier and / or their agents are not bound to send individual Cargo Arrival Notice (CAN) regarding the arrival of the vessel or goods. Incase of Perishable goods, if not cleared within 72 hours the cargo may be listed for auction at the sole discretion of the Customs Authorities, with all costs, risks and responsibility on the consignee. As per Indian Customs Regulations any / all containers / lying uncleared for more than 30 days are listed for the auction under Sec. 48 of Indian Customs Act 1962 under notice to Consignee by the Custodian, as per address stated in their respective Bill of Lading. The same will be auctioned or de-stuffed without any further information / notice to the consignee. However the Line reserves their right to recover / claim all cost or charges on such shipments from the consignee. Our surveyor at the CFS is M/s. Pinnacle Marine Services Pvt.Ltd, Add : Pota Cabin Rangoli Parking, Adani Port, Mundra-370 421, Kutch, Gujarat. **All import payments are to be made via RTGS/NEFT/IMPS in favour of M/s. Hamburg Sud India Private Limited.** Consignees are requested to send their Delivery Order request through Odex for all import shipments delivered at Mundra during the counter timings 9:30 am – 4:00 pm. OB/L can be submitted at Maersk CMS counter-Gandhidham timing 10.00 am to 3.30 pm. Please note IGM details can also be checked at our website : **www.hamburgsud-line.com**

Hamburg Sud India Private Limited

P.D. Plaza, 1st Floor, Plot No. 3, Sector 9/A Tagore Road,Gandhidham (Kutch), Gujarat – 370201

Phone : +91 9099 996 468 **CIN :** U74900MH2010FTC199423

ANNEXURE O

સૌરાષ્ટ્રના સમાચાર

ભુજમાં જુગાર સંચાલકોએ વેપારી પિતા-પુત્ર ઉપર હુમલો કર્યો

ગાંધીધામ : ભુજ શહેરના મોબાઈલ હબ ગણાતા એવા જનતા ઘર હોટેલની પાછળ લાંબા સમયથી ચાલતા ચકલા પોપટના જુગાર પર સ્થાનિક પોલીસની મીઠી નજરને કારણે લોહી રેડાયું હતું. કોમ્પ્લેક્ષમાં પેઢી ધરાવતા પિતા-પુત્ર પર જુગારના ગોરખ ધંધાર્થીઓએ હુમલો કરતા ચકચાર મચી ગઇ છે. પોલીસ સુત્રોમાંથી મળતી વિગતો મુજબ, જનતાઘર નીચે પેઢી ચલાવતા સામાજીક અગ્રણી એ. વાય. આકબાની અને તેના પુત્ર પર ચકલા પોપટના સંચાલકોએ હુમલો કર્યો હતો. લાંબા સમયથી ચાલતા આ જુગાર ધામને કારણે નીતનવા લોકો અહીં આવે છે જેથી સામાન્ય માણસ અને મહિલાઓને આ વિસ્તારમાં પસાર થવામાં મુંઝવણ ઉદભવે છે જેથી સામાજીક અગ્રણીએ વાંધો ઉઠાવ્યો હતો. જુગારના સંચાલકોએ મનદુઃખ રાખી ભરબપોરે આકબાની સાથે ઝપાઝપી કરીને મુંઢ માર માર્યો હતો તો તેમના પુત્ર તૌશીફ આકબાનીને પથ્થર અને લાકડીથી માર મારતા લોહી રેડાયું હતું જેથી સારવાર માટે ખાનગી હોસ્પિટલમાં ખસેડાયો હતો. આ અંગે એ-ડિવિઝન પોલીસ મથકે ફરિયાદ નોંધાતા પોલીસે ભોલુ કુંભાર અને આરીફ ઘાંચીની મોડી રાત્રે અટકાયત કરી આગળની કાર્યવાહી હાથ ધરી હતી.

ભુજમાં ખિલખિલાટની વેન જજની કાર સાથે અથડાઇ

ગાંધીધામ : ભુજના જ્યુબિલી ગ્રાઉન્ડ નજીક રાજય સરકારની ખિલખિલાટ વાહનના ચાલકે બેદરકારી પુર્વક વાહન હંકારી અધિક સેશન્સ જજની કારને ટક્કર મારી નુકસાન પહોંચાડતા કમાન્ડોએ વાહન ચાલક સામે ફોજદારી નોંધાવી હતી. ભુજના અધિક સેશન્સ જજ ચિરાગકુમાર એમ. પવારના કમાન્ડો અને એએસઆઇ ગોપાલભાઈ ફફલે ખિલખિલાટ વાહનના ચાલક અનિલ હરીગીરી ગોસ્વામી (રહે. ગણેશનગર, ભુજ)વાળા સામે બી-ડિવિઝન પોલીસ મથકે ફોજદારી નોંધાવી હતી. સોમવારે બપોરે અઢી વાગ્યે જ્યુબિલી સર્કલ નજીક સેશન્સ જજની મારૂતી સ્વિફટને ખિલખિલાટ ઈકો વાહનના ચાલકે ટક્કર મારી ૩૦ હજારનું નુકસાન પહોંચાડયું હતું.

ભુજના મમુઆરા પાસે ટ્રક-બાઈક ટકરાતાં ત્રણ યુવાનના મોત

ગાંધીધામ : પશ્ચિમ કચ્છમાં બાઇક અકસ્માતમાં સતત બીજા દિવસે વધુ ત્રણ નવ યુવાનોના જીવ ગયા હતા. મમુઆરા ફાટક પાસે સાંજે ટ્રક અને બાઇક વચ્ચે થયેલા ગંભીર અકસ્માતમાં ધાણેટી કંપનીમાં રહેતા પરપ્રાંતીય યુવાનોને કાળ આંબી ગયો હતો. પદ્ધર પોલીસે આગળની તજવીજ હાથ ધરી હતી. સુત્રોમાંથી જાણવા મળતી વિગતો મુજબ, મમુઆરાથી ધાણેટી તરફ જીજે ૧૨ સીજે ૦૮૦૫ નંબરની બાઈકથી જઈ રહેલા સાગો ઉર્ફે સાગર જોતીયા ડામોર (ઉ.વ. ૨૫, રહે. જુલવાડીયા, તા. જાંબવા), કાલીયાભાઈ નારસીંગ ડામોર (ઉ.વ.૨૫, રહે. જુલવાડીયા, તા. જાંબવા) અને શંકરભાઈ કરશનભાઈ નીનામા ઉ.વ.૨૩ રહે. ઢેબર, તા. કલ્યાણપુર) હાલે ત્રણેય રહે. નાડાપા) વાળા કંપનીમાં જઈ રહ્યા હતા. ત્યારે મમુઆરા પાટીયા પાસે સામેથી આવતી ટ્રક નંબર જીજે ૧૨ એડબલ્યુ ૬૭૭૯ સાથે ટક્કર થઇ હતી, ત્રણેય યુવાનોને ગંભીર પ્રકારની ઈજાઓ પહોંચતા ત્રણેયના મોત નિપજયા હતા. એક જ બાઇક પર ત્રિપલ સવારી જઈ રહેલા પરપ્રાંતિય યુવાનો માટે આ ટ્રક કાળનો કોળીયો બની હતી. પદ્ધર પોલીસે નોંધ લઈ આગળની તજવીજ હાથ ધરી હતી.

માંડવીમાં એકતરફી પ્રેમમાં પાગલ યુવતીએ પરિણીતાને છરી ઝીંકી

ગાંધીધામ : માંડવી તાલુકાના મેરાઉ ગામે એકતરફી પ્રેમમાં પાગલ યુવતીએ અન્ય એક યુવતીને તેના પ્રેમી સાથે લગ્ન કરવાની ના પાડી હોવા છતાંય લગ્ન કરી લેતા યુવતીએ પરિણિતાને છરી ભોંકી દીધી હતી. બનાવને પગલે માંડવી પોલીસ મથકે ગુનો નોંધાવાયો હતો. પોલીસ સુત્રોમાંથી મળતી વિગતો મુજબ, રસીલાબેન કાંતીભાઈ કાનજીભાઈ માતંગ (ઉ.વ.૨૩, રહે. મેરાઉ તા. માંડવી)એ ફરીયાદ નોંધાવી હતી કે, પાડોશમાં રહેતી કૌશલ્યાબેન જગદીશ પુનશી કન્નર (રહે. મેરાઉ)વાળી તેના પતિ કાંતી સાથે એકતરફી પ્રેમમાં પાગલ હતી. કૌશલ્યાએ કહ્યું કે, તને કાંતી સાથે લગ્ન કરવાની ના પાડી છતાંય તે લગ્ન શા માટે કર્યા, પોતે કાંતીના પ્રેમમાં પાગલ છે તેમ કહી બોલાચાલી કરી છરીના ઘા ઝીંકી દીધા હતા. ફરિયાદીના લગ્ન આઠેક માસ અગાઉ થઇ ચુક્યા છે. રવિવારે બપોરના અરસામાં આરોપણ મહિલા ઘરે જઈ ફરિયાદીને ઘા ઝીંકી જાનથી મારી નાખવાની ધમકી આપતા માંડવી પોલીસ મથકે મહિલા વિરૂદ્ધ ફોજદારી નોંધાવાઈ હતી.

મુન્દ્રા સીએફએસમાં કલમારમાંથી કન્ટેનર પટકાતાં યુવાન ચગદાયો

ગાંધીધામ : મુન્દ્રા સ્થિત સીએફએસમાં કલમારમાંથી કન્ટેનર નીચે પડતા યુવાન ચગદાઇ ગયો હતો અને ઘટના સ્થળે જ કરૂણ મોત નિપજયું હતું. મૃતક યુવાનના ભાઈ ભાવેશ ભવાનજી સિંઘલ (ઉ.વ.૨૭ રહે મૂળ કોઠારા-અબડાસા હાલે નદીવાળા નાકે-મુન્દ્રા)ની ફરીયાદને ટાંકીને પ્રાપ્ત અહેવાલ મુજબ ઉપરોકત બનાવ સ્થાનિકેના ઓલકાર્ગો સીએફએસ (કન્ટેનર ફ્રેઈટ સ્ટેશન)મધ્યે ગત રાત્રે ૧૦.૩૦ વાગ્યાના અરસામાં બન્યો હતો. જેમાં સીએફએસમાં કન્ટેનરની હેરફેર કરતા કલમાર નંબર એનએલ ૦૧ કે ૭૯૮૫ના ચાલકે બેદરકારી પૂર્વક કન્ટેનર ઉંચકતા કન્ટેનર કલમારમાંથી છટકી જેએસ રામદાસ સીએચએ પેઢીમાં ફરજ બજાવતા કુલદીપ ભવાનજી સિંઘલ(રહે મૂળ કોઠારા-હાલે નદીવાળા નાકે-મુન્દ્ર પર ખાબકતા તે નીચે ચગદાઈ જવાથી તેને ગંભીર ઈજાઓ થવા પામી હતી બનાવને પગલે કુલદીપને તાત્કાલીક અદાણી કંપનીની એમ્બ્યુલન્સમાં સારવાર અર્થે સીએચસીમાં ખસેડાતા ત્યાં ફરજ પરના તબીબે તેને મૃત ઘોષિત કર્યો હતો.ઘટનાને લઈ મુન્દ્રા પોલીસે કલમાર ચાલક વિરૂદ્ધ બેદરકારી પૂર્વક વાહન ચલાવી અકસ્માત કર્યાનો ગુનો દર્જ કરી આગળની કાયદાકીય કાર્યવાહી હાથ ધરાઈ હતી.

નખત્રાણાના રતડિયામાં બે ટ્રક અથડાતાં મજૂરોને ઈજા

ગાંધીધામ : નખત્રાણા તાલુકાના રતડીયા-વિગોડીની વચ્ચે મધરાત્રે બે ટ્રકો ભટકાઈ હતી. અકસ્માતમાં બંને ટ્રકની કેબીનનો બુકડો બોલી ગયો હતો. જીજે ૧૨ એટી ૭૬૬૯ નંબરની ટ્રક રવાપર બાજુથી મગફળી ભરી આવી રહી હતી ત્યારે નખત્રાણા સાઈડથી આવી રહેલી જીજે ૧૨ એટી ૬૨૪૫ નંબર ટ્રક સામસામે ભટકાઈ હતી. બંને ડ્રાઈવર સાઈડનો બુકડો બોલી ગયો હતો અને ડ્રાઈવરોને ઈજાઓ પહોંચી હતી. મગફળી ભરીને જતી ટ્રકનો અકસ્માત થતા તેમાં સવાર મજુરોને પણ ઈજાઓ પહોંચી હોવાનું જાણવા મળ્યું છે. સવારે છ વાગ્યે પવનચક્કીના મોટા પાખડા લઈને જતા ટ્રેઈલરો રોડની સાઈડે હતા અને બીજીબાજુ આ અકસ્માત થતા થોડા સમય માટે ટ્રાફિક જામ થયો હતો.

પ્રભાસપાટણમાં અજાણ્યા શખસે માર મારતા યુવાન ગંભીર

પ્રભાસપાટણ : પ્રભાસ પાટણમાં સાઈન કોલોની વિસ્તારમાં રહેતા યુવાનને કોઈ અજાણ્યા શખ્સે કોઈ કારણોસર ગળાના ભાગે તીક્ષ્ણ હથીયારનો ઘા મારતા વેરાવળની ખાનગી હોસ્પીટલમાં સારવારમાં ખસેડેલ છે. આ બનાવની પોલીસમાંથી પ્રાપ્ત વિગત મુજબ પ્રભાસ પાટણમાં સાઈન કોલોની વિસ્તારમાં આવેલ નુરાની મસ્જીદ પાસે રહેતો મુસ્તકીમ હારૂનભાઈ કાલવણીયા ઉ.વ.૨૦ નામનો યુવાન બરોડા ખાતે અભ્યાસ કરતો હોય અને હાલ કોરોનાના હીસાબે પ્રભાસ પાટણ આવેલ હોય ત્યારે સવારના સમયે તેના ઘરેથી મસ્જીદ તરફ જઈ રહેલ તે વખતે કોઈ અજાણ્યા છોકરા જેવા શખ્સે આવી તું મુસ્તકીમ છો ? તેમ કહેતા હા પાડેલ અને શું કામ છે તેમ પુછતા કાઈ જવાબ આપેલ નહીં અને તેની પાસે રહેલ ધારદાર હથીયારથી ગળાના ભાગે મારતા વેરાવળની ખાનગી હોસ્પીટલમાં સારવારમાં ખસેડેલ છે. આ બનાવ અંગે પોલીસે અજાણ્યા છોકરા જેવા શખ્સ સામે કલમ ૩૨૬ મુજબ ગુન્હો નોંધી વધુ તપાસ પી.આઈ. રાઠવાએ હાથ ધરેલ છે.

વેરાવળના ગુણવંતપુર ગામે સાસરીયાના ત્રાસની ફરિયાદ

વેરાવળ તાલુકાના ગુણંવતપુર ગામે રહેતી કીરણબેન નિલેશભાઈ જોરા ઉ.વ.૨૪ ને તેના પતિ નિલેશભાઈ, સસરા કાનાભાઈ, સાસુ હીરૂબેન દ્વારા તને ઘરકામ આવડતું નથી તેમ કહી ચારીત્ર્ય ઉપર શંકા કુશંકા કરી માર મારી જાનથી મારી નાખવાની ધમકી આપેલ હોવાની ફરીયાદ જીલ્લા મહિલા પોલીસમાં નોંધાવતા પોલીસે ૪૯૮ (ક) સહીતની કલમો હેઠળ ગુન્હો નોંધી વધુ તપાસ પી.એસ.આઈ. રીનાબેન સુવાએ હાથ ધરેલ છે.

રાજુલા માર્કેટિંગ યાર્ડમાં વેપારી અને તેલીબિયા પેનલના ૬ સભ્યો બિનહરીફ

હવે ૪ ડિસેમ્બરે ખેડૂત વિભાગની ૧૦ બેઠકોની ચૂંટણીનું મતદાનઃ ૨૧ ઉમેદવારો મેદાનમાં

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રાજુલા

આજરોજ રાજુલા માર્કેટિંગ યાર્ડ ખાતે યોજાનાર ચૂંટણીમાં વેપારી અને તેલીબિયાની વેપારી પેનલ બિનહરીફ થયેલ છે. જ્યારે હવે ખેડૂત વિભાગના ૧૦ સભ્યોની ચૂંટણી તા.૪-૧૨ના રોજ યોજાનાર છે. આ અંગે જાણવા મળતી વિગત મુજબ ગઈકાલે માર્કેટિંગ યાર્ડની ચૂંટણીમાં ફોર્મ પરત ખેંચવાની છેલ્લી તારીખ હતી જેમાં સહકારી ક્ષેત્રના ભિષ્મપિતામહ એવા દિલીપભાઈ સંઘાણી અને જિલ્લા ભાજપના પ્રમુખ કૌશિકભાઈ વેપરિયાની આગેવાની તથા સમજાવટથી અન્ય છ ફોર્મ પરત ખેંચાઈ જતાં તેલીબિયા અને વેપારી પેનલ બિનહરીફ થઈ છે. હવે તા.૧૪-૧૨ના રોજ ખેડૂત પેનલના ૧૦ સભ્યોની ચૂંટણીનું મતદાન યોજાશે તેમાં ૨૧ ઉમેદવારો મેદાનમાં છે. આગામી સમયમાં જોઈએ શું પરિણામ આવે છે.

સંઘાણી-વેકરિયાના પ્રયાસોને સફળતા

ગુજરાત ભાજપના આગેવાન અને સહકારી ક્ષેત્રના ભિષ્મપિતામહ ગણાતા એવા દિલીપભાઈ સંઘાણી, જિલ્લા ભાજપ પ્રમુખ વેકરિયા, ગુજરાત સરકારના પૂર્વ સંસદીય સચિવ અને રાજુલા, જાફરાબાદ, ખાંભાના પૂર્વ ધારાસભ્ય હિરાભાઈ સોલંકી, રાજુલા યાર્ડ અને સહકારી સંઘના ચેરમેન જીજ્ઞેશભાઈ પટેલ, જિલ્લા ભાજપના મહામંત્રી રવુભાઈ ખુમાણ તેમજ શહેર અને તાલુકા ભાજપ પ્રમુખ અને તેની ટીમ કાર્યકરોના અથાગ પ્રયત્નોને કારણે વેપારી વિભાગ અને તેલીબિયા વિભાગની ૬ બેઠકો બિનહરીફ કરવામાં સફળતા સાંપડી છે.

અંજારથી નીકળેલા ૫૬૦ એલઈડી ટીવીમાંથી ૨૩ ચોરાયા

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ગાંધીધામ

અંજારના ગળપાદર હાઈવે પર સ્થિત જીનસ કંપનીમાંથી ૫૬૦ એલઈડી ટીવીને કન્ટેનરમાં ભરીને મહારાષ્ટ્રના ભીવંડી મોકલવાનું નક્કી થયા બાદ નિયત સ્થળે તપાસ કરતા ૨૩ એલઈડી ઓછી આવી હોવાનું સામે આવતા મામલો સામે આવ્યો હતો. જે અંગે સતત થઈ રહેલા સમાધાનના પ્રયાસો અને દાવા છતાં કાંઈ ફળીભૂત ન થતા અંતે ટ્રાન્સપોર્ટરે જવાબદારી આપી હતી તે સર્વિસ ધારક અને ડ્રાઈવર વિરૂદ્ધ ફરિયાદ નોંધાવી હતી.

અંજાર પોલીસ મથકે સુધીરભાઈ ચૌધરીએ ટ્રક નં. ડીએન ૦૯ આર ૯૩૭૬ના ડ્રાઈવર બજરંગ શીશપાલ અને ગુરુ કન્ટેનર સર્વિસના અલદીપ પુનીયા (રહે.હમીનપુર, ઝુઝનુ, રાજસ્થાન) વિરૂદ્ધ ગુનો નોંધાવતા જણાવ્યું હતું કે જીનસમાંથી તેમને મળેલા આ ઓર્ડર અનુસાર તેમણે આરોપીને ટ્રકની જરૂરિયાત હોવા અંગે કહ્યું હતું. ત્યારબાદ નિયત સમય અનુસાર તા.૦૬/૧૧ના કુલ ૮૨,૯૬,૦૦૯ની કિંમતના થતા ૫૬૦ એલઈડી ટીવી લોડ કરીને મહારાષ્ટ્રના ભીવંડીના વીયુ ટેકનોલોજી પ્રા. લીમીટેડમાં જવા રવાના થયા હતા.

પરંતુ તા.૦૮/૧૧ના સવારે ડ્રાઈવરનો ફરિયાદી પર ફોન આવ્યો હતો કે કન્ટેનરનું શીલ તુટેલુ છે અને ૨૩ ટીવી ઓછા હોવાનું માલુમ પડે છે. જે અંગે જવાબદેહ ટ્રાન્સપોર્ટ દ્વારા સતત સમાધાનના દાવાઓ કર્યા બાદ પણ કાંઈ ન થતા અંતે ૨૩ ટીવીના ૩,૪૦,૭૨૮નો વિશ્વાસઘાત કર્યાની ફરિયાદ બન્ને આરોપી વિરૂદ્ધ નોંધાઈ હતી.

સાવરકુંડલાના યુવા પત્રકાર સોહિલ શેખનો જન્મદિવસ

સાવરકુંડલા યુવા પત્રકાર અને માનવતા ગ્રુપના ઉપપ્રમુખ સોહિલ શેખ પત્રકારિત્વ, સામાજિક, સેવાકીય અને રાજકીય ક્ષેત્રમાં સંકળાયેલા છે. જીવનના ૨૮ વર્ષ પૂર્ણ કરી ૨૯માં વર્ષમાં મંગલ પ્રવેશ કરનાર સોહિલ શેખને લોકોની સેવા અને સમસ્યા ઉકેલવાનો પોતાનો અંગત શોખ છે, યુવા સિપાહી સમાજના ઉપપ્રમુખ તરીકે પણ સમાજના નાના મોટા પ્રશ્નો ઉકેલવા લોકોની સેવા માટે જીવન સમર્પિત કરી દીધું હોવાથી ખાસ્સી લોકપ્રિયતા ધરાવે છે. સ્વભાવે ખૂબજ મિલનસાર અને આત્મિય ભાવથી તેમનો લોકસંપર્ક પણ બહોળો છે. સોહિલ શેખના જન્મદિવસ નિમિતે વિવિધ ક્ષેત્રના અગ્રણીઓ તેમના સગા સંબંધી મિત્રો વર્તુળોએ તેમના મોબાઈલ નંબર ૮૭૯૮૮ ૫૦૩૧૩ પર શુભેચ્છાઓનો ધોધ વરસાવ્યો છે.

જૂનાગઢઃ મરણોત્તરમાં ૫૦, લગ્નમાં ૧૦૦ વ્યક્તિની હાજરીની યાદી મંજૂર કરાવવી જરૂરી

સંક્રમણ વધી જતાં જિલ્લા કલેકટરની ઘોષણા

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જૂનાગઢ

કોરોનાની મહામારીને ધ્યાને લઈને જૂનાગઢ જિલ્લા કલેક્ટર ડો.સૌરભ પારધી દ્વારા દિશા નિર્દેશો જાહેર કરવામાં આવ્યા છે. જેમાં જિલ્લામાં લગ્ન પ્રસંગ કે મૃત્યની વિધીમાં મર્યાદીત લોકોની યાદી મામલતદાર કચેરી અને પોલીસ સ્ટેશન ખાતે મોકલવાની રહેશે

કોરોનાનું સંક્રમણ નિયંત્રણમાં રાખવાના હેતુસર રાજ્ય સરકાર દ્વારા નિયત થયેલ મર્યાદામાં કાર્યક્રમો યોજવા મંજુરી આપવામાં આવેલ છે. જેમાં લગ્ન/સત્કાર સમારંભ જેવી અન્ય ઉજવણીઓના કિસ્સામાં ખુલ્લા સ્થળોએ/બંધ સ્થળોએ, સ્થળની ક્ષમતાના ૫૦ ટકાથી વધુ નહીં પરંતુ

મહત્તમ ૧૦૦ વ્યકિત મર્યાદામાં સમારોહ, પ્રસંગના આયોજનને મંજુરી આપવાનું રાજ્ય સરકારે નક્કી કર્યુ છે તેમજ મૃત્યુના કિસ્સામાં અંતિમ ક્રિયા, ધાર્મિક વિધીના કિસ્સામાં મહત્તમ ૫૦ વ્યક્તિઓની મર્યાદામાં મંજુરી આપવાનું રાજ્ય સરકારે નક્કી કર્યું છે.

નિયત મર્યાદાથી વ્યક્તિઓની સંખ્યા વધે નહી તે માટે પ્રસંગ આયોજકે આવા કાર્યક્રમો/પ્રસંગોની જાણ નિયત પ્રફોર્મમાં અગાઉથી જ લાગુ પોલીસ સ્ટેશનને તથા લાગુ મામલતદાર કચેરીને જાણ કરવાની રહેશે. નિયત પ્રફોર્મ અલગથી મામલતદાર કચેરી તથા પોલીસ સ્ટેશન ખાતે મોકલવામાં આવેલ છે. જે મામલતદાર અને પોલીસ સ્ટેશન ખાતેથી મેળવી શકાશે.

નિયત મર્યાદામાં પ્રસંગ યોજાય તથા સોશ્યલ ડિસ્ટન્સીંગ, સેનીટાઈઝેશન તથા કોવિડ-૧૯ અંતર્ગત સરકારની વખતો વખતની અન્ય તમામ સૂચનાઓનું પાલન થાય તે અંગે ખાસ તકેદારી રાખવાની રહેશે. જિલ્લા કલેક્ટરની અખબારી યાદીમાં જણાવ્યું છે.

ગીર સોમનાથ જિલ્લામાં ૬ તબક્કામાં કોરોનાની તપાસ

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ગીર સોમનાથ

કોરોના વાયરસના સંક્રમણને અટકાવવા ગીર સોમનાથ જિલ્લા આરોગ્ય તંત્ર કટીબધ્ધ છે. જિલ્લામાં કોરોના વાયરસનું સંક્રમણ ન ફેલાય તે માટે ધનવંતરી આરોગ્ય રથના ૬ તબક્કામા લોકોને ઘર સુધી આરોગ્યની તપાસ કરવામાં આવી રહી છે. આરોગ્ય વિભાગની સાથે આયુર્વેદ શાખા દ્વારા જરૂરી દવા આપવામાં આવી રહી છે.

ગીર સોમનાથ જિલ્લાના વેરાવળ, સુત્રાપાડા, તાલાળા, કોડીનાર, ઉના અને ગીરગઢડા સહિત છ તાલુકામાં ૩૪ ધનવંતરી આરોગ્ય રથના માધ્યમથી લોકોના ઘર સુધી આરોગ્યની સવલત પુરી પાડવામાં આવી રહી છે. જેમાં પૈકી જિલ્લાના ૬૧૦૦ વિસ્તારના લોકોને આવરી લેવાની સાથે ૪૫૪૯૨૪ ઓ.પી.ડી. થયેલ છે. જિલ્લાના મોટાભાગના વિસ્તારમાં ધનવંતરી આરોગ્ય રથના માધ્યમથી તબીબ સહિત ૪ વ્યક્તિની ટીમ દ્વારા તાવ, ઉધરસ, શરદીના દર્દીઓને નિશુલ્ક આરોગ્યની સારવાર આપવામાં આવી હતી.

ધાંગધ્રાઃ દર્દીઓને ફળ વિતરણ અને ગરીબોને જમાડી જન્મદિનની ઉજવણી

સુરેન્દ્રનગર : ધ્રાંગધ્રા ખાતે પ્રદેશ ભાજપના ઉપપ્રમુખ આઈ.કે.જાડેજાએ તેમના જન્દીન નિમિતે સવારે સરકારી દવાખાને કાર્યકરો સાથે મુલાકાત લઈ દર્દીઓને ફળ વિતરત કર્યા હતા. જ્યારે સુરજ પાર્વતી ભોજનાલયમાં ગરીબ અને જરૂરીયાત મંદ લોકોને ભોજન કરાવવામાં આવ્યુ હતુ. ત્યારબાદ માસ્કનું વિતરણ કરાયુ હતુ. આ સેવાકાર્યમાં કિરીટસિંહ જાડેજા, મહામંત્રી સંજયભાઈ સહિત આગેવાનો અને કાર્યકરો ઉપસ્થિત રહ્યા હતા.

વેરાવળમાં ધારાસભ્ય જીજ્ઞેશ મેવાણીની અધ્યક્ષતામાં સંવાદ કાર્યક્રમ યોજાયો

આજકાલ પ્રતિનિધિ
વેરાવળ

વેરાવળ લોહાણા મહાજન વંડી ખાતે રાષ્ટ્રીય દલિત અધિકાર મંચના સંયોજક અને વડગામ ના યુવા ધારાસભ્ય જીગ્નેશભાઈ મેવાણી ની અધ્યક્ષતામાં આર્થિક સામાજીક તેમજ શૈક્ષણિક રીતે જરૂરત મંદ યુવાનોને મજબૂત કરવાના હેતુથી યુવા સંવાદ કાર્યક્રમ રાખવામાં આવેલ હતો. આ પ્રોગ્રામનું આયોજન સામાજિક કાર્યકર અફઝલ સર પંજા એ કરેલ હતું.

આ કાર્યક્રમમાં પોતાના તેજાબી વાણી દ્વારા જીગ્નેશભાઈ મેવાણી એ યુવાનો ને પોતાના સાહસ, મનોબળ અને મહેનત દ્વારા આગળ આવી પોતાનું સમાજનું દેશના દરેક કચડાયેલા લોકોનું તેમજ રાષ્ટ્રનું નવનિર્માણ કરવા હાકલ કરેલ હાલમાં કેન્દ્ર માં રહેલ ભાજપ ની મોદી સરકાર ઉપર પ્રહારો કરતા તેમણે એસ.ટી , ઓ.બી.સી, માયનોરિટી તેમજ સમાજના કચડાયેલા લોકોને આગળ આવી અને જેવી રીતે આઝાદીની લડતમાં એકતા અને ભાઈચારા સાથે અંગ્રેજોની સામે લડત લડી દેશને અંગ્રેજોની ચુંગાલમાંથી આઝાદ કરાવેલ તેવી જ રીતે હાલની આ ભ્રષ્ટાચારી કોમવાદી તેમજ દેશદ્રોહી સરકાર સામે લડી દેશ ને આ ભ્રષ્ટાચારી

અને તાનાશાહી લોકોથી બચાવવા અને આવા લોકોને રસ્તો દેખાડવા સ્વ દેશવાસીઓને રસ્તા ઉપર ઉતરી જવા માટે આહવાન કરેલ અને આ કાર્યક્રમમાં ગીર સોમનાથ જિલ્લા કોંગ્રેસ માયનોરિટી ડીપાર્ટમેન્ટ ના ચેરમેન ફારૂક મલિક પેરેડાઇઝ, પ્રવીણભાઈ ગઢિયા, મહેશભાઈ મકવાણા, નરેશભાઈ ચાવડા, રફીકભાઈ મોલાના, સફીભાઈ મોલાના, હનીફ બાગડા, મુકેશભાઈ ચૌહાણ, રામજી ભાઈ ચાવડા, બશીરભાઈ સુમરા, અમઝદભાઈ પંજા, અમીનભાઈ પંજા, જાવીદ મુગલ, ઈકબાલભાઈ સફર, સલીમભાઈ સોડા, સલીમભાઈ કટોરી, મુસ્તકીમ વાઝા, તેમજ વિશાળ સંખ્યામાં લોકો ઉપસ્થિત રહેલ હતા.

વેરાવળમાં કોરોના વાયરસના ટેસ્ટ સેન્ટર કાર્યરત

આજકાલ પ્રતિનિધિ-ગીર સોમનાથ

ગીર સોમનાથ જિલ્લામાં કોરોના વાયરસના સંક્રમણને અટકાવવા આરોગ્ય શાખા ગીર સોમનાથ દ્વારા વેરાવળમાં કોરોના વાયરસના ટેસ્ટ સેન્ટર કાર્યરત કરવામાં આવેલ છે. શંકાસ્પદ દર્દીઓને જે તે નજીકના ટેસ્ટ સેન્ટર પર ટેસ્ટ કરાવવા આવશ્યક છે. વેરાવળ બસ સ્ટેશને સવારે ૧૦.૩૦ થી બપોરે ૨ કલાક સુધી ત્યારબાદ બપોરે ૪ થી ૬ કલાક, કાશી વિશ્વનાથ મંદીર ખાતે, જૈન દેરાસર મંદિર ખાતે, હરસિધ્ધી અર્બન સેન્ટર ખાતે, બંદર રોડ અર્બન સેન્ટર ખાતે અને ભીડીયા અર્બન સેન્ટર ખાતે સવારે ૧૧ થી બપોરે ૩ કલાક સુધી કોરોના વાયરસના શંકાસ્પદ દર્દીઓના ટેસ્ટ કરવામાં આવશે. ઉપરાંત સી.એચ.સી.પ્રભાસ-પાટણ અને સિવિલ હોસ્પિટલ વેરાવળ ખાતે પણ ટેસ્ટ સેન્ટર કાર્યરત છે.

સોમનાથમાં વિકાસ પરિષદ દ્વારા રંગોળી સ્પર્ધા યોજાઇ

આજકાલ પ્રતિનિધિ
વેરાવળ

ભારત વિકાસ પરિષદની સોમનાથ શાખા દ્વારા નાન ગંગા સરસ્વતી વિદ્યાલય ખાતે બહેનો માટે રંગોળી હરીફાઈનું આયોજન કરવામાં આવેલ હતું.

આ સ્પર્ધા બે વિભાગમાં યોજાયેલ જેમાં ચિરોડી કલર અને કઠોળ અને ચિરોડી કલર વિભાગમાં ૨૦ અને કઠોળ વિભાગમાં ૩ સ્પર્ધકોએ ભાગ લીધેલ હતો. ચીરોડી વિભાગમાં પ્રથમ ક્રમે નીતાબેન દંદવાની, બીજા ક્રમે પૂજાબેન ત્રિવેદી તથા ભાવિકાબેન મહેતા (સંયુક્ત), ત્રીજા ક્રમે રીનાબેન પ્રસાદ અને કુમારી દ્રષ્ટિ ઘોડાસરાં (સંયુકત) તેમજ કઠોળ વિભાગમા

પ્રથમ ક્રમે કુમારી તેજલ વડોદરિયા વિજેતા બનેલ હતા.

ભારત વિકાસ પરિષદ સોમનાથ શાખાના મહિલા સંયોજીકા સંગીતાબેન ભટ્ટના માર્ગદર્શન હેઠળ સ્પર્ધા સંયોજીકા કાશ્મીરાબેન આનાંદપરાં અને સ્પર્ધા સહ સંયોજીકા ભારતીબેન તન્ના સહીતનાએ જહેમત ઉઠાવી કાર્યક્રમને સફળ બનાવેલ હોવાનું એક યાદીમાં જણાવેલ છે.

મોરબી જિલ્લામાં કોરોનાના નવા ૧૬ કેસઃ ૧૧ દર્દી સ્વસ્થ થતા રજા અપાઈ

આજકાલ પ્રતિનિધિ
મોરબી

મોરબી જિલ્લામાં કોરોનાના કેસો સતત વધી રહ્યા છે જેમાં આજે નવા ૧૬ કેસો નોંધાયા છે. જ્યારે વધુ ૧૧ દર્દીઓ સ્વસ્થ થયા છે.

આજના નવા કેસોમાં મોરબી તાલુકાના ૧૪ કેસોમાં ૭ ગ્રામ્ય અને ૭ શહેરી વિસ્તારમાં, હળવદનો ૧ કેસ ગ્રામ્ય પંથકમાં અને માળિયાનો ૧ કેસ ગ્રામ્ય પંથકમાં મળીને કુલ ૧૬ કેસ નોંધાયા છે. તો વધુ ૧૧ દર્દીઓ સ્વસ્થ થયા છે. નવા કેસો સાથે જિલ્લામાં કુલ કેસનો આંક ૨૫૬૩ થયો છે જેમાં ૧૫૫ એક્ટિવ કેસ છે. અત્યાર સુધીમાં કુલ ૨૨૫૯ દર્દીઓ સ્વસ્થ થયા છે.

ANNEXURE P

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/5202 (D)/Part (CRZ 2)

Date: 23/11/2020

To,
Shri C. P. Hirvaniya, Mamlatdar
Mamlatdar Office, Sector 1A,
Gandhidham- Kachchh.
Gujarat 370201.
Email : mam-gandhidham@gujarat.gov.in

R.D.Vyas, Taluka Development officer,
Gandhidham Taluka Panchyat
Gandhidham.(Email : tdo.gandhidham@gmail.com).

Chief Officer, Gandhidham Municipality
Plot no-35, Sector-9,
Gandhidham-kachchh (Email:np_gandhidham@yahoo.co.in)

Shri K B Chaudhary,
Regional Officer, GPCB (East Kachchh).
A.O.Buidling, Deendayal Port Trust, Gandhidham.

Sub: Creation of water front facilities (Oil Jetties 8, 9, 10 & 11) and development of land (1432 acres) for associated facilities for storage at Old Kandla, Gandhidham, Kutch, Gujarat by M/s Deendayal Port Trust – **Environmental & CRZ Clearance accorded by the MoEF&CC,GoI – Request to display copy of the same reg.**

Ref. : EC & CRZ Clearance accorded by the MoEF&CC,GoI vide F.No. F.No. 10-1/2017-IA-III dated 20/11/2020.

Sir,

Kindly refer to the above cited reference for the subject mentioned above.

In this regard, it is to inform that, the Ministry of Environment, Forest & Climate Change, Government of India vide above mentioned reference dated 20/11/2020 has accorded EC & CRZ Clearance to the subject proposal of the Deendayal Port Trust.

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

In the said EC & CRZ Clearance letter dated 20/11/2020, under Miscellaneous Condition (ii), it is mentioned that, ***"The copies of the environmental clearance shall be submitted by the project proponent to the Heads of local bodies, Panchayats and Municipal Bodies in addition to the relevant offices of the Government who in turn has to display the same for 30 days from the date of receipt".***

Accordingly, kindly find attached herewith a copy of the EC & CRZ Clearance accorded by the MoEF&CC,GoI dated 20/11/2020 is attached herewith as **Annexure A** for ready reference & taking further necessary action for display of the same as required under the above condition.

Thanking you.

Yours faithfully,

Encl. : As above

26/11

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

ANNEXURE R

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

EG/WK/5202 (D)/Part (CRZ 2)/146

Dated: 10/2/2021
11/02/2021

The Deputy Director General 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

Sub: 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 Trust – **Submission of detail w.r.t. Para B Standard Conditions - Point XI Miscellaneous (vii) of EC & CRZ Clearance accorded by the MoEF&CC,GoI reg.**

Ref.: Environmental & CRZ Clearance accorded by the Ministry of Environment, Forests & Climate Change, GoI vide F. no. 10-1/2017-IA-III dated 20/11/2020.

Sir,

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

In this connection, it is to state that, the MoEF & CC, GoI had accorded Environmental & CRZ Clearance for the subject proposal vide above referred letter dated 20/11/2020 **(Copy enclosed at Annexure A)**.

In this regard, it is to state that, in the above referred EC & CRZ Clearance, the MoEF &CC, GoI under Para B - Standard Conditions- Point No. XI : Miscellaneous (vii) had directed that ***"The project proponent shall inform the Regional Office as well as the Ministry, the date of financial closure and final approval of the project by the concerned authorities, commencing the land development work and start of production operation by the project".***

Accordingly, w.r.t. project of Oil Jetty No. 8 (Jetty & allied facilities), the requisite details are mentioned as under:

1) Date of Financial Closure : Through Internal Resources of Deendayal Port Trust.
2) Final approval of the project : Board of DPT accorded approval dated 11/1/2019.

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

Now, after receipt of EC & CRZ Clearance dated 20/11/2020 from the MoEF&CC,GoI, out of total four Oil jetties, Deendayal Port Trust has issued work order to M/s Kargwal KM Joint Venture, Mumbai vide letter no. CN/WK/1571/Work/243 dated 3/2/2021 **(Copy – Annexure B)** for ***"Construction of Oil Jetty No. 8 at Kandla"*** and accordingly they may start the project implementation work. However, for balance Oil Jetties no. 9, 10 & 11 to be implemented on BOT/PPP Mode (under approval stage) and for development of Land (under approval stage), the requisite details will be communicated in due course.

This is for kind information please.

Yours faithfully,

10/02/2021

Encl. : As above. O/c

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

Copy to:

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

Copy also to : 1) TPA to CE
2) SE (Project)