DEENDAYAL PORT AUTHORITY
(Erstwhile: DEENDAYAL PORT TRUST)

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

www.deendayalport.gov.in

EG/WK/4751 (EC)/part (Comp 1)/ 97

Dated: 25/07/2024

To,
Shri T.C. Patel,
The Unit Head, Kachchh,
Gujarat Pollution Control Board,
Paryavaran Bhavan,
Sector 10A, Gandhinagar- 382 010.

Sub: "Development of 7 Integrated facilities (Stage I) within the existing Kandla Port Trust limit at District Kutch (Gujarat) by M/s Kandla Port Trust Limited" – **Pointwise Compliance of the conditions stipulated in NOC (CTE- 74334) issued by GPCB reg.**

Ref.:1) GPCB letter no.PC/CCA-KUTCH-1231/GPCB ID: 44000 dated 22/12/2015 and its further extension vide PC/CCA-Kutch-1231(2)/GPCB:44000 dated 27/04/2023 valid upto 15/11/2025.
2) Compliance Report (period up to May, 2017) submitted by KPT vide letter no. EG/WK/4751 (EC)/part (Compliance) Dated: 15/06/2017.
3) Compliance Report (period up to Nov, 2017) submitted by DPT vide letter no. EG/WK/4751 (EC)/part (Compliance)/611 Dated: 15/12/2017.
4) Compliance Report (period up to May, 2018) submitted by DPT vide letter no. EG/WK/4751 (EC)/part (Compliance)/314 Dated: 14(21)/06/2018.
5) Compliance Report (period up to March, 2019) submitted by DPT vide letter no. EG/WK/4751 (EC)/part (Compliance)/ Dated: 30(2)/03(04)/2019.
6) Compliance Report (period up to October, 2019) submitted by DPT vide letter no. EG/WK/4751 (EC)/part (Comp 1)/154 Dated: 14/11/2019.
7) Compliance Report (period up to November, 2020) submitted by DPT vide letter no. EG/WK/4751 (EC)/part (Comp 1)/Dated: 29/12/2020.
8) Compliance Report (period up to May, 2021) submitted by DPT vide letter no. EG/WK/4751 (EC)/part (Comp 1)/94 Dated: 07/10/2021.
9) Compliance Report (period up to May, 2022) submitted by DPA vide letter no. EG/WK/4751 (EC)/part (Comp 1)/223 Dated: 30/01/2023.
10) Compliance Report (period up to November, 2022) submitted by DPA vide letter no. EG/WK/4751 (EC)/part (Comp 1)/288 Dated: 20/04/2023.
11) Compliance Report (period up to May, 2023) submitted by DPA vide letter no. EG/WK/4751 (EC)/part (Comp 1)/360 Dated: 12/09/2023.
12) Compliance Report (period up to November, 2023) submitted by DPA vide letter no. EG/WK/4751 (EC)/part (Comp 1)/28 Dated: 20/2/2024.

Sir,

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

In this connection, it is to state that, vide above referred letter, Gujarat Pollution Control Board had granted Consent to Establish (CTE- 74334) with certain specific & general conditions and validity up to 15/11/2022 and also its further extension granted by letter dated 05/05/2023 with validity upto 15/11/2025 . In this regard, it is relevant to mention here that, DPA had already obtained Environmental & CRZ Clearance for 7 project activities from the MoEF&CC,GoI dated 19/12/2016, based on the recommendation of the Gujarat Coastal Zone Management Authority dated 1/7/2015.

.....Cont.....

Subsequently, DPA vide above referred letters had regularly submitted compliance report of the stipulated conditions to GPCB.

Now, please find enclosed herewith, compliance report of conditions stipulated in CTE Order (period up to May, 2024) along with necessary enclosures as **Annexure I,** for kind perusal & record please.

Further, as per the MoEF&CC, Notification S.O.5845 (E) dated 26.11.2018, stated that "**In the said notification, in paragraph 10, in sub-paragraph (ii), for the words "hard and soft copies" the words "soft copy" shall be substituted**". Accordingly, we are submitting herewith soft copy of the same via e-mail ID kut-uh-gpcb@gujarat.gov.in.

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

Thanking You.

Yours faithfully,

25/7/24

Dy .CE and EMC (I/c)

Deendayal Port Authority

Encl.: As above

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

/

Annexure 1

Point wise compliance of NOC

Annexure 1

CURRENT STATUS OF WORK (UPTO MAY 2024)

Subject: Development of 7 integrated facilities (Stage I) within existing Deendayal Authority at Kandla.

Name of Project	Status
1. Development of oil jetty to handle liquid cargo and ship bunkering terminal at old Kandla under PP mode (jetty: 300m x 15m, approach 450 m X 10 m, back up area 5.5 HA, capacity – 3.39 MMTPA, capital dredging 1,73,660 m^3 maintenance dredging 1,56,294 m^3 (Estimated cost: 276.53 Cr.).	The Concession Agreement was executed between DPA and M/s KOTPL on 16/11/2013 to implement the project on Built, Transfer & Operate (BOT- PPP) Basis by M/s KOTPL. The award of concession was issued on 11/12/2020 to M/s KOTPL by DPA. **The Project is under construction phase.**
2. Multipurpose Cargo Terminal at Tekra off Tuna on BOT basis (T shape jetty 600m X 80 m Capacity 18MMTPA, back up area 101 Ha capital dredging 1,26,57,175 m3 maintenance dredging 18,98,576. 25 m^3 Estimated cost: 1686.66 Cr.	The Board of DPA approved the Feasibility Report in its meeting on 19.02.2021. The MoPSW, GoI vide communication dated 21/10/2022 has conveyed approval granted by the Cabinet Committee on Economic Affairs to the project. The project is under bidding stage. **No construction activity has started yet.**
3. Up gradation of Barge handling capacity at Bundar basis at Kandla capacity 3.33 MMTA back-up area 5 Ha, Estimated cost: 109.59 Cr.	The up-gradation work was completed.
4. Construction of Rail over Bridge at NH 8 A near Nakti Bridge (crossing of NH 8 A Estimated cost: 32.17 Cr.	**Construction activity has not yet started.**
5. Mechanization of Dry Cargo handling capacity at Kandla Port (Berth 7 and 8 capacity 7.35 MMTPA estimated cost 80.61 Cr.	Mechanization work already completed.
6. Strengthening of Oil jetty 1 (Estimated cost: 7.5 Cr.	The strengthening work completed.
7. Modification and strengthening of Cargo berth No. 6 at Kandla Port Estimated cost: 11.5 Cr.	The modification & strengthening work completed.

Out of a total of 7 project activities, construction activities of 4 projects (i.e. Sr. No. 3, 5, 6 & 7 mentioned in the EC & CRZ Clearance) have already been completed. Whereas construction activity of the project at Sr. No. 2 & 4 have not yet started.

For the current compliance period up to May 2024, construction activity related to project No. 1 is ongoing. The compliance report submitted by the Concessionaire M/s KOTPL is attached herewith as Annexure A.

COMPLIANCE REPORT (for the period up to May, 2024)

Subject: Compliance of conditions stipulated by the Gujarat Pollution Control Board in NOC/CTE issued for the project "**Development 7 Integrated facilities (Stage I) within the existing Kandla Port Trust limit at District Kutch (Gujarat) ".**

Reference: NOC/CTE issued by the GPCB (CTE – 74334) vide no. PC/CCA-KUTCH-1231/GPCB ID 44000 dated 22/12/2015 (outward) with validity upto 15/11/2022. DPA had obtained CTE validity extension (CTE-125870) from GPCB vide Order dated 27/04/2023 with validity up to 15/11/2025

Sr. No.	Specific Condition	Compliance
1	Kandla Port Trust shall strictly adhere to all conditions of CRZ Clearance issued by the Forest & Environment Department vide order no. ENV-10-2014·25-E dated 01/07/2015.	a) It is assured that Deendayal Port Authority (Erstwhile Deendayal Port Trust) strictly adheres to all conditions of CRZ Clearance issued by the Forest & Environment Department vide order no. ENV-10-2014·25-E dated 01/07/2015. The current compliance report up to November 2023 for the conditions stipulated in CRZ recommendation report is attached as **Annexure B.** b) For Project at Sr. No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A**.
2	CTE is granted conditionally that Kandla Port Trust shall not install & commission the construction activity of the seven activities mentioned above without obtaining Environment Clearance from MoEF&CC, New Delhi.	DPA had already obtained Environmental & CRZ Clearance from the MoEF&CC, GoI, dated 19/12/2016. A copy had already been submitted to the GPCB, along with the compliance report submitted dated 15/6/2017. The construction activity was commissioned after obtaining Environment Clearance from MoEF&CC, New Delhi.
3	Kandla Port Trust shall strictly adhere to all conditions of the Terms Of Reference (TOR) (vide letter no. F. No, 11-82/2011-IA.III) by MoEF&CC, New Delhi.	Based on the EIA report prepared by the M/s Mantec Consultants Pvt. Ltd., as per TOR given by the MoEF&CC, GoI dated 4/5/2016; DPA had obtained EC & CRZ Clearance from the MoEF&CC, GoI dated 19/12/2016.
3.	**Conditions under Water Act 1974.**	
3.1	There shall be no industrial effluent generation from the loading and unloading activities at the Port and other ancillary operations.	N/A
3.2	The quantity of Domestic wastewater (sewage) shall not exceed 6.4 KL/Day	a) Point noted. b) For Project at Sr. No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A.**
3.3	The quantity of sewage shall conform to the following standards: Parameter – Permissible limit BOD (5 days at 20 *C) – Less than 20 mg/lit Suspended solids – Less than 30 mg/lit Residual chlorine – Minimum 0.5 mg/lit	a) For monitoring of environmental parameters, DPA has been appointing NABL Accredited laboratory and reports are being submitted from time to time to the GPCB, IRO, MoEF&CC, GoI, Gandhinagar. Recently, DPA appointed GEMI, Gandhinagar for regular monitoring of environmental parameters vide Work Order dated 15/02/2023. The work is in progress and the annual environmental monitoring report submitted by GEMI, Gandhinagar is attached herewith as **Annexure C**. b) For Project at Sr. No. 1 which is under construction, kindly refer the monitoring report submitted by the Concessionaire M/s KOTPL along with the compliance report attached herewith as **Annexure A**.
3.4	Sewage shall be disposed of through a septic tank /soak pit system.	a)For completed projects (modification/ strengthening/ up-gradation of existing facilities), Sewage is being treated in the STP of Kandla (1.5 MLD). The treated

<table>
<tr><td></td><td></td><td>sewages from STP of DPA are utilized for plantation / Gardening.

b) For Project at Sr.No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at Annexure A.</td></tr>
<tr><td>3.5</td><td>The unit shall install a flow meter at utilities for measuring category-wise (category as given in the water cess act – 1977 schedule II) consumption of water.</td><td>Point noted</td></tr>
<tr><td>4</td><td colspan="2">Conditions Under Air Act 1981.</td></tr>
<tr><td>4.1</td><td>There shall be no use of fuel; hence shall be no flue gas emission from storage handling activity and other ancillary operations.</td><td>Not applicable.</td></tr>
<tr><td>4.2</td><td>The applicant shall provide portholes, ladder, platform etc. at chimney (s) for monitoring the air emission and shall be open for inspection to and for use of Boards staff. The chimney(s) vents attached to various sources of emission shall be designed by numbers such as S-1, S-2, etc. and these shall be painted/ displayed to facilitate identification.</td><td>Not applicable</td></tr>
<tr><td>4.3</td><td>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 Emission Standards issued by the Ministry of Environment and Forest dated 16th November 2009.

<table>
<tr><th>Sr. No.</th><th>Pollutant</th><th>Time-weighted Average</th><th>Concentration in Ambient air in µg/M³</th></tr>
<tr><td>1</td><td>Sulphur Dioxide (SO2)</td><td>Annual

24 Hours</td><td>50

80</td></tr>
<tr><td>2</td><td>Nitrogen Dioxide (NO_2)</td><td>Annual 24 Hours</td><td>40

80</td></tr>
<tr><td>3</td><td>Particulate Matter (Size less than 10 µm) OR PM_{10}</td><td>Annual

24 Hours</td><td>60

100</td></tr>
<tr><td>4</td><td>Particulate Matter (Size less than 2.5 mm) OR $PM_{2.5}$</td><td>Annual

24 Hours</td><td>40

60</td></tr>
</table>
</td><td>a) For monitoring of environmental parameters, DPA has been appointing NABL Accredited laboratory and reports are being submitted from time to time to the GPCB, IRO, MoEF&CC, GoI, Gandhinagar. Recently, DPA appointed GEMI, Gandhinagar for regular monitoring of environmental parameters vide Work Order dated 15/02/2023. The work is in progress and the annaul environmental monitoring report submitted by GEMI, Gandhinagar is attached herewith as Annexure C.

b) For Project at Sr. No. 1 which is under construction, kindly refer the monitoring report submitted by the Concessionaire M/s KOTPL along with the compliance report attached herewith as Annexure A.</td></tr>
<tr><td>3.4</td><td>The concentration of Noise in ambient air within the premises of the industrial unit shall not exceed the following levels:

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

Between 10 P.M. and 6 A.M.: 70 dB(A)</td><td>a) For monitoring of environmental parameters, DPA has been appointing NABL Accredited laboratory and reports are being submitted from time to time to the GPCB, IRO, MoEF&CC, GoI, Gandhinagar. Recently, DPA appointed GEMI, Gandhinagar for regular monitoring of environmental parameters vide Work Order dated 15/02/2023. The work is in progress and the annual environmental monitoring report submitted by GEMI, Gandhinagar is attached herewith as Annexure C.</td></tr>
</table>

		b) For Project at Sr. No. 1 which is under construction, kindly refer the monitoring report submitted by the Concessionaire M/s KOTPL along with the compliance report attached herewith as **Annexure A**.
5	**Conditions Under Hazardous Waste**	
5.1	The applicant shall provide temporary storage facilities for each type of hazardous waste as per the hazardous waste (management, handling & transboundary movement) Rule, 2008, as amended from time to time.	a) DPA has appointed GPCB authorized vendors for the management and recycling of hazardous waste as per the Hazardous Waste Management Rule, 2008 and its subsequent amendments. Further, DPA has appointed GEMI, Gandhinagar for the work of "Preparation of Plan for Management of Plastic Wastes, Solid Waste, including C&D waste, E-waste, Hazardous waste, including Biomedical and Non-Hazardous Waste in the Deendayal Port Authority" vide Work Order dated 24/01/2023. The work is in progress. b) For Project at Sr. No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A.**
5.2	The applicant shall obtain membership of a common TSDF site for disposal of Hazardous waste as categorized in Hazardous Waste (Management, Handling & transboundary Movement) Rules, 2008, as amended from time to time.	Not applicable
6	**General Conditions**	
6.1	Any change in personnel, equipment or working conditions as mentioned in the consent form/order should immediately be intimated to this Board.	a) Point noted. b) For Project at Sr. No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A.**
6.2	The waste generator shall be totally responsible for (i.e. collection, storage, transportation and ultimate disposal) of the waste generated.	a) DPA has entered into 'Selling Agency' agreement with M/s. MSTC (Govt. of India Entreprise), Vadodara on 04/01/2022 for collection, transporting and disposal of scrap, surplus items, unserviceable equipment etc. Further, DPA has appointed GEMI, Gandhinagar for the work of "Preparation of Plan for Management of Plastic Wastes, Solid Waste, including C&D waste, E-waste, Hazardous waste, including Biomedical and Non-Hazardous Waste in the Deendayal Port Authority" vide Work Order dated 24/01/2023. The work is in progress. b) For Project at Sr. No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A.**
6.3	Records of waste generation, its management and annual returns shall be submitted to Gujarat Pollution Control Board in Form – 4 by 31st January of every year.	a) DPA regularly submitted annual return Hazardous waste in Form IV to the Gujarat Pollution Control Board. The annual return for the year 2022-23 is submitted along with the earlier compliance report submitted on 12/09/2023. b) For Project at Sr. No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A.**
6.4	In case of any accident the same shall be submitted in form – 5 to Gujarat Pollution Control Board.	a) Point Noted b) For Project at Sr. No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A.**
6.5	The applicant shall comply with the relevant	Not applicable

	provision of "Public liability insurance act – 91".	
6.6	Unit shall take all concrete measures to show the tangible result in waste generation reduction, avoidance, reuse and recycling. Action taken in this regard shall be submitted within 03 months and also along with form 4.	a) The waste generated has been disposed of by selling out to registered recyclers/reprocessors. DPA regularly submitted the annual return of hazardous waste in Form IV to the GPCB. b) For Project at Sr. No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A.**
6.7	Industry shall have to display on – line data outside the main factory gate with regard to the 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.	a) Point Noted. Further, DPA invited tender for 'Online Continuous Ambient Air Quality Monitoring (CAAQM) For the Period of Three Years at Deendayal Port Authority'. The same is under evaluation stage. b) For Project at Sr. No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A.**
6.8	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 is developed.	a) DPA entrusted work of green belt development in and around Port area to the Forest Department, Gujarat at a cost of Rs. 352 lakhs (Area 32 hectares). The work is completed. Further, DPA has appointed Gujarat Institute of Desert Ecology (GUIDE) for "Green belt development in Deendayal Port Authority and its Surrounding Areas, Charcoal site' (Phase-I)" vide Work Order No.EG/WK/4757/Part [Greenbelt GUIDEJ, dated 31st May, 2022. The final report submitted by GUIDE, Bhuj is submitted vide earlier compliance reports. Further DPA has accorded the work of "Green belt development in DPA and its surrounding area (Phase II) to Gujarat Institute of Desert Ecology (GUIDE), Bhuj for the plantation of 10000 saplings of suitable species vide work order dated 23/06/2023. The same is in process Moreover, DPA and BOT operator will carry out plantation as per the condition. b) For Project at Sr. No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A.**
6.9	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 & control of pollution) Cess Act-1977.	a) DPA regularly submitted the Environmental Statement in Form V. copy of same is submitted along with the compliance report submitted on 12/09/2023. b) For Project at Sr. No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A.**

/

Annexure A

Compliance submitted by KOTPL

Kandla Oil Terminal Private Limited

Registered Office: "NEELADRI", 3rd Floor, No. 9, Cenotaph Road, Alwarpet, Chennai - 600 018.
Tel: +91-44-4590 2222, 4590 2299, Fax: + 91-44-4590 2200, URL : www.imc.net.in CIN: U60200TN2013PTC092551

KRO/KOTPL/03062024

Jun. 3, 24

The Executive Engineer (Design)
Deendayal Port Authority
Administrative –Office
Gandhidham
Kutch 370 201

Dear Sir,

Sub. : Development of Oil Jetty to handle Liquid Bulk and Ship bunkering Terminal at Old Kandla ("Project").- Half Yearly EC & CRZ Compliance report

The half-yearly compliance reports for the KOTPL project for the period from December 2023 to May 2024 are enclosed herewith (EC, CRZ & CTE)

We would appreciate your acknowledgment of receipt of these documents.

Yours sincerely,

For Kandla Oil Terminal (P) Limited

(Authorized Signatory)

CC: Independent Engineer, IITM

Encls.:

1. EC Compliance report
2. CRZ Compliance report
3. CTE Compliance report
4. Monitoring Data sheet
5. Ambient Air (Six Months)
6. Noise Monitoring (Six Months)
7. Drinking Water Report (Six Months)

Subject: Point-wise Compliance Status Report for Environmental clearance for Developing Integrated Facility within the existing Kandla Port at Kandla, Dist: Kutch by M/s. Kandla Port Trust Limited – Reg.

Ref No: - Environmental Clearance vide Letter No- F. No. 11-82/2011-IA III dated 19.12.2016

Sr. No.	EC Conditions	Compliance Status
PART A – SPECIFIC CONDITIONS		
I	Construction activity shall be carried out strictly according to the provisions of CRZ Notification 2011 No. construction work other than those permitted in coastal Regulation Zone Notification Shall be carried out in Coastal Regulation Zone area	It is assured that no activity other than those permissible in the Coastal Regulation Notification shall be carried out in the CRZ area.
ii	The project proponent shall ensure that there shall be no damage to the existing mangrove patches near the site and also ensure the free flow of water to avoid damage to the mangroves.	It is assured that due care shall be taken to protect existing mangrove patches near the site and the free flow of water to avoid damage to the mangroves.
iii	The project proponent shall ensure that no creeks or rivers are blocked due to any activities at the project site, and free flow of water is maintained.	It is assured that no creeks or rivers shall be blocked due to any activities at the project site, and the free flow of water shall be maintained.
iv	The shoreline should not be disturbed due to dumping. Periodical study on shoreline changes shall be conducted, and mitigation carried out, if necessary. The details shall be submitted along with the six-monthly monitoring reports.	No shoreline is disturbed due to dumping.
v	The foreshore facilities shall be set up in the stable/low or medium eroding site as demarcated in the shoreline change map by NCSCM. Further, NCSCM shall be authorized to monitor the project during the construction and operation	Ongoing construction is in line with and strictly adhering to EC-CRZ conditions issued about this project.

KANDLA OIL TERMINAL PRIVATE LIMITED KANDLA 370210

Sr. No.	EC Conditions	Compliance Status
	phases so as to ensure that the foreshore facilities cause minimum or no impact to the geomorphological systems.	
vi	The PP should take measures to ensure that construction materials/debris (mortar, cementing material, etc.) do not fall into the water. Construction materials including labor camps should be located at an adequate distance from CRZ areas.	It is assured that the construction activities are being carried out, with due care, and that the construction material /debris does not fall into the water. Further, it is also assured that construction waste will be collected at a designated location before being sent to the disposal site.
vii	Dredged materials should be analyzed for the 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 the Regional office of the Ministry.	The project is under construction stage, and no dredging activity has been carried out to date.
viii	PP in consultation with GCZMA should prepare a regional strategic impact assessment report with a special focus on the region where the PP started construction without permission. The cost towards this study should be borne by the PP	Not Applicable
ix	A comprehensive and integrated conservation plan including a detailed bathymetry study and protection of creeks/mangrove area including buffer zone, mapping of coordinates, running length, HTL, and CRZ boundary should be put in the palace. The plan should take note of all the conditions of approvals granted to all the project proponents in this area, and the reported cases of the disappearance of mangroves near the project site. The preservation of the entire area to maintain the fragile ecological	DPA has appointed the Gujrat Institute of Desert Ecology, Bhuj, for the work.

KANDLA OIL TERMIN
KAN
3702

Sr. No.	EC Conditions	Compliance Status
	conditions should be a part of the plan in relation to the creek and mangrove conservation.	
x	The commitments made during the Public Hearing and recorded in the minutes shall comply with by letter and spirit. A hard copy of the action taken shall be submitted to the ministry.	Not Applicable
xi	All the conditions stipulated in the earlier clearance including the recommendations of the Environment Management Plan, and Disaster Management Plan shall be strictly complied with.	Noted
xii	Disposal sites for excavated material should be so designed that the revised land use after dumping and changes in the land use pattern does not interfere with the natural drainage.	It is assured that; construction waste will be collected at a designated location before sending to the disposal site. Also, the land use pattern will not interfere with the natural drainage.
xiii	PP shall install a continuous automatic ambient air quality monitoring system (24x7) for all relevant parameters at two locations to monitor the ambient air quality status of the project area. Data should be transferred online to CPCB and SPCB websites.	The Environmental Monitoring Reports following CPCB guidelines and as submitted by NABL accredited laboratory is enclosed as **Annexure**.
xiv	The groundwater shall not be tapped within the CRZ areas by the PP to meet the water requirement in any case.	Water requirements will be met through GWSSB or private tankers. No groundwater shall be tapped.
xv	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.	Noted, the project is under the construction stage.
xvi	All the operational areas will be connected with the network of liquid	Noted, the project is under the construction stage.

Sr. No.	EC Conditions	Compliance Status
	waste collection corridors comprising of stormwater, oily waste and sewage collection pipelines.	
xvii	Automatic /online monitoring system (24x7) monitoring devices) for water pollution in respect of flow measurement and relevant pollutants in the treatment system to be installed. The data to be made available to the respective SPCB and in the Company's website.	Noted
xviii	Marine ecology shall be monitored regularly also in terms of seaweeds, sea grasses, mudflats, sand dunes, fisheries, echinoderms, shrimps, turtles, corals, coastal vegetation, mangroves, and other marine biodiversity components as part of the management plan. Marine ecology shall be monitored regularly also in terms of all micro, macro, and mega floral and faunal components of marine biodiversity.	DPA appointed the Gujarat Institute of Desert Ecology, Bhuj for Regular Monitoring of Marine Ecology.
xix	Measures should be taken to contain, control, and recover the accidental spills of fuel and cargo handles.	Noted, the project is under the construction stage.
xx	All the mitigation measures submitted in the EIA report shall be prepared in a matrix format and the compliance for each mitigation plan shall be submitted to the RO, MoEF&CC along with half yearly compliance report.	Noted
xxi	Ships/barges shall not be allowed to release any oily bilge waste or ballast water in the sea. Any effluents from the Jetty which have leachable characteristics shall be segregated and recycled/disposed of as per SPCB	Noted, the project is under the construction stage.

KANDLA OIL TERMINAL PRIVATE LIMITED KANDLA 370210

Sr. No.	EC Conditions	Compliance Status
	guidelines.	
xxii	The location of DG sets and other emission-generating equipment shall be decided keeping in view the predominant wind direction so that emissions do not affect nearby residential areas. Installation and operation of DG sets shall comply with the guidelines of CPCB.	Not Applicable
xxiii	All the mechanized handling systems and other associated equipment such as hoppers, belt conveyors, stackers cum reclaimers shall have integrated dust suppression systems. Dust suppression systems shall be provided at all transfer points.	Not applicable, as this project is for the handling of liquid cargo.
xxiv	No product other than permitted under the CRZ notification, 2011 shall be stored in the CRZ area.	It is hereby assured that only products permitted under the CRZ Notification, 2011 shall be stored in the CRZ area.
xxv	It shall be ensured by the Project Proponent that the activities do not cause disturbance to the fishing activity, movements of fishing boats and destruction of mangroves during the construction and operation phase.	It is assured that, due care will be taken so that the activities do not cause disturbance to the fishing activity, movement of fishing boats and destruction to mangroves.
xxvi	As proposed, a green belt over an area of 36.8 ha shall be developed with at least 10-meter-wide green belt on all sides along the periphery of the project area, in the downward direction, and along roadsides etc. Selection of plant species shall be as per the CPCB guidelines in consultation with the DFO.	Noted.
xxvii	Mangrove plantation in an area of 100 ha. shall be carried out by KPT within 2 years in a time bound manner. Action taken report shall be submitted to the Regional Office of MoEF &CC.	Not Applicable
xxviii	Municipal solid wastes and hazardous	Noted.

KANDLA OIL TERMINAL PRIVATE LIMITED KANDLA 370210

Sr. No.	EC Conditions	Compliance Status
	wastes shall be managed as per the Municipal Solid Waste Rule, 2016 and Hazardous Waste Management Rule, 2016.	
xxix	The Project Proponent shall take up and earmark adequate funds for socio-economic development and welfare measures as proposed under the CSR program. This shall be taken up on priority.	Noted, the project is under the construction stage.
xxx	The project proponent shall set up a separate environmental management cell for the effective implementation of the stipulated environmental safeguards under the supervision of a Senior Executive.	An NABL-accredited laboratory with expert manpower has assigned the work of monitoring to comply and safeguard under the compliance conditions. The Environmental Monitoring Reports are enclosed herewith as **Annexure**.
xxxi	The funds earmarked for the environment management plan shall be included in the budget, and this shall not be diverted for any other purposes.	Noted
xxxii	The proponent shall abide by all the commitments and recommendations made in the EIA/EMP report and also during their presentation to the EAC.	Noted, the project is under the construction stage.
xxxiii	The company shall prepare an operating manual in respect of all activities. It shall cover all safety & environmental related issues and systems. Measures to be taken for protection. One set of the environmental manual shall be made available at the project site. Awareness shall be created at each level of management. All the schedules and results of environmental monitoring shall be available at the project site office.	Noted, the project is under the construction stage.
xxxiv	Corporate Social Responsibility.	
	a. The Company shall have a well-laid-down Environment Policy approved	Noted.

KANDLA OIL TERMINAL PRIVATE LIMITED KANDLA 370210

Sr. No.	EC Conditions	Compliance Status
	by the Board of Directors. b. The Environment Policy shall prescribe standard operating processes/procedures to bring into focus any infringements/deviations/ violations of the environmental or forest norms/ conditions. c. The hierarchical system or Administrative Order of the company to deal with environmental issues and for ensuring compliance with the environmental clearance conditions shall be furnished. d. To have proper checks and balances, the company shall have a well-laid-down system of reporting non-compliances/ violations of environmental norms to the board of Directors of the company and/or shareholders or stakeholders at large.	Noted. Noted. Noted
B. GENERAL CONDITIONS:		
(i)	The project authorities must strictly adhere to the stipulations made by the State Pollution Control Board (SPCB), State Government, and any other statutory authority.	The project authorities assure to strictly adhere to the stipulations
(ii)	Full support shall be extended to the officers of this Ministry/ Regional Office at Bhopal by the project proponent during the inspection of the project for monitoring purposes by furnishing full details and an action plan including action is taken reports in respect of mitigation measures and other environmental protection activities.	Full support shall be extended to the regulatory officers during the inspection and furnishing required project details.
(iii)	A six-Monthly monitoring report shall	Noted.

KANDLA OIL TERMINAL PRIVATE LIMITED KANDLA 370210

Sr. No.	EC Conditions	Compliance Status
	need to be submitted by the project proponents to the Regional Office of this Ministry at Bhopal regarding the implementation of the stipulated conditions.	
(iv)	Ministry of Environment, Forest and Climate Change or any other competent authority may stipulate any additional conditions or modify the existing ones, if necessary, in the interest of the environment and the same shall be complied with.	Noted.
(v)	The Ministry reserves the right to revoke this clearance if any of the conditions stipulated have not complied with the satisfaction of the Ministry.	Noted.
(vi)	In the event of a change in the project profile or change in the implementation agency, a fresh reference shall be made to the Ministry of Environment, Forest and Climate Change.	Noted.
(vii)	The project proponents shall inform the Regional Office as well as the Ministry, of the date of financial closure and final approval of the project by the concerned authorities and the date of start of land development work.	Noted.
(viii)	A copy of the clearance letter shall be marked to the concerned Panchayat/local NGO, if any, from whom any suggestion/ representation has been made or received while processing the proposal.	Complied.
(ix)	A copy of the environmental clearance letter shall also be displayed on the website of the concerned State Pollution Control Board. The EC letter shall also be displayed at the Regional Office, District Industries centre and	Complied.

KANDLA OIL TERMINAL PRIVATE LIMITED KANDLA 370210

Sr. No.	EC Conditions	Compliance Status
	Collector's Office/Tehsildar's office for 30 days.	
11	These stipulations would be enforced among others under the provisions of the Water (Prevention and Control of Pollution) Act 1974, the Air (Prevention and Control of Pollution) Act 1981, the Environment (Protection) Act 1986, the Public Liability (Insurance) Act, 1991 and EIA Notification 1994, including the amendments and rules made thereafter.	Noted. The Environmental Monitoring Reports are enclosed herewith as **Annexure**.
12	All other statutory clearances such as the approvals for storage of diesel from Chief Controller of Explosives, Fire Department, Civil Aviation Department, Forest Conservation Act, 1980 and Wildlife (Protection) Act, 1972 etc. shall be obtained, as applicable by project proponents from the respective competent authorities.	Noted, the project is under the construction stage. Due statutory clearances applicable, will be taken during the course of respective project stages as per the condition stipulated.
13	The project proponent shall advertise in at least two local Newspapers widely circulated in the region, one of which shall be in the vernacular language informing that the project has been accorded Environmental and CRZ Clearance and copies of clearance letters are available with the State Pollution Control Board and may also be seen on the website of the Ministry of Environment, Forest and Climate Change at http://www.envfor.nic.in. The advertisement should be made within Seven days from the date of receipt of the Clearance letter and a copy of the same should be forwarded to the Regional office of this Ministry at Bhopal.	Complied
14	This Clearance is subject to a final order	Noted.

KANDLA OIL TERMINAL PRIVATE LIMITED KANDLA 370210

Sr. No.	EC Conditions	Compliance Status
	of the Hon'ble Supreme Court of India in the matter of Goa Foundation Vs Union of India in Writ Petition (Civil) No. 460 of 2004 as may be applicable to this product.	
15	The status of compliance with the various stipulated environmental conditions and environmental safeguards will be uploaded by the project proponent on its website.	Noted.
16	Any appeal against this Clearance 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.	Noted.
17	A copy of the clearance letter shall be sent by the proponent to the concerned Panchayat, Zilla Parishad/Municipal Corporation, Urban Local Body and the Local NGO, if any, from whom suggestions/ representations, if any, were received while processing the proposal. The clearance letter shall also be put on the website of the company by the proponent.	Complied.
18	The proponent shall upload the status of compliance with the stipulated EC conditions, including results of monitored data on their website and shall update the same periodically. It shall simultaneously be sent to the Regional Office of MoEFCC, the respective Zonal Office of CPCB and the SPCB.	Noted.
19	The environmental statement for each financial year ending 31st March in Form-V as is mandated to be submitted by the project proponent to the concerned State Pollution Control Board	Noted.

KANDLA OIL TERMINAL PRIVATE LIMITED KANDLA 370210

Sr. No.	EC Conditions	Compliance Status
	as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently, shall also be put on the website of the company along with the status of compliance of EC conditions and shall also be sent to the respective Regional Offices of MoEFCC by e-mail.	

KANDLA OIL TERMINAL PRIVATE LIMITED * KANDLA 370210

Monitoring Report (Up to May 2024)

DATA SHEET

Sr. No.	Particulars	Reply
1.	Project type: River valley/ Mining/Industry/ thermal/nuclear/Other (specify)	Development of Oil Jetty to handle Liquid Bulk and Ship bunkering Terminal at Old Kandla
2.	Name of the project	Development of Oil Jetty to handle Liquid Bulk and Ship bunkering Terminal at Old Kandla
3.	Clearance Letter (s). OM no and date	MoEFCC File No. F.No.11-82/2011-IA-III Proposal No. IA/GJ/MIS/28772/2011 Dated 16th May 2016
4.	Location a) District (s) b) State (s)	Location: a) Kutch b) Gujarat
5.	Address for Correspondence a) address of Concerned Project Chief Engineer (with pin code & telephone/telex/fax numbers b) Address of Executive project Engineer/manager/ (with pin code fax numbers)	Regional Head (IMCL) Near IOCL foreshore Terminal, Kandla Gandhidham, Kutch 370 201 Dy. General Manager Near IOCL foreshore Terminal, Kandla Gandhidham, Kutch 370 201
6.	Salient features a) Of the Project b) Of the Environmental Management Plan	Jetty: 3.39 MMTPA Tank farm: About 1,37,000 KL & Allied Facilities
7.	Production Details during compliance period and (or) during the previous financial year	The project is under the construction stage.
8.	Breakup of the project area a) Submergence area: forest & non-forest b) Others	N/A
9.	Breakup of the project affected population with	Not Applicable

KANDLA OIL TERMINAL PRIVATE LIMITED KANDLA 370210

	enumeration of those living houses/dwelling units only agricultural land & landless laborer's/artisan a) SC. ST/Adivasis b) Others (please indicate whether these figures are based on any scientific and systematic survey carried out of only provisional figures, if a survey is carried out give details and years of survey).	
10.	Financial details a) Project cost as originally planned and subsequent revised estimates and the year of prices reference b) Allocation made for environmental management plans with item wise and year wise break-up c) Benefit cost ratio/Internal rate of Return and the year of assessment Whether (c) includes the cost of environmental management plans so far. d) Actual expenditure incurred on the project e) Actual expenditure incurred on the environmental management plans so far.	Estimated Project cost: Rs. 233.50 Cr Revised project cost: Rs. 343 Cr. (Estimated) Rs. 07Lacs Rs. 57. 34 Cr.(up to May 24) Rs.5 Lakhs
11.	Forest land requirement a) The status of approval for diversion of forest land for non-forestry use b) The status of clear felling c) The status of compensatory a forestation, if any	Nil N/A. N/A N/A

KANDLA OIL TERMINAL PRIVATE LIMITED * KANDLA 370210

	d) Comments on the viability & sustainability of compensatory a forestation programmed in the light of actual field experience so far	N/A
12.	The status of clear felling in non-forest areas (such as the submergence area of the reservoir, approach roads), if any, with quantitative information.	N/A
13.	Status of construction a) Date of commencement (Actual and/or planned) b) Date of completion (Actual and/or planned)	The project is under the construction stage. Award of concession: December 2020 Planned date of Completion: 31st December 2025.
14.	Reasons for the delay if the Project is yet to start	The project is under construction stage, and delayed because of the Pandemic & Local hindrances.
15.	Date of site visited a) The dates on which the project was monitored by the regional office on pervious occasion. if any b) The date site visit for this monitoring report	No
16.	Details of the correspondence with project authorities for obtaining action plans/information on status of compliance to safeguard other than the routine letters for logistic support for site visit. (The first monitoring report may contain the details of all the letters issued so far but the later reports may cover only the letters issued subsequently.)	Noted.

KANDLA OIL TERMINAL PRIVATE LIMITED • KANDLA 370210

Subject: Point-wise Compliance Status Report for CRZ clearance for Developing integrated facility within the existing Kandla Port at Kandla, Dist: Kutch by M/s. Kandla Port Trust Limited – Reg.

Ref No: - GCZMA CRZ recommendation vide Letter No – ENV-10-2014-25-E Cell dated 01.07.2015

S. No.	CRZ Conditions	Compliance Status
	SPECIFIC CONDITIONS	
1.	The provisions of the CRZ notification of 2011 shall be strictly adhered to by the KPT. No activity in contradiction to the provisions of the CRZ Notification shall be carried out by the KPT.	It is assured that no activity contradicting the Provisions of the CRZ Notification shall be carried out.
2.	The KPT shall have to ensure that there shall not be any damage to the existing mangrove area.	It is ensured that due care shall be taken to protect the existing mangrove area.
3.	The KPT shall prepare an emergency plan to protect existing mangroves in case of any eventuality/accident	Not Applicable
4.	The KPT 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 provisions are being made that mangrove areas get proper flushing water and free flow of water shall not be obstructed.
5.	The KPT shall have to abide by whatever decision taken by the GCZMA for violations of CRZ notification 2011	Decisions taken by the GCZMA for violations of CRZ Notification, 2011, will be abided by.
6.	There shall not be violations of the order dated 9-12-2013 passed by the National Green Tribunal, and accordingly, there shall be no mangrove destruction taking place in the KPT area.	It is assured that due care shall be taken to protect the existing mangrove area.
7.	No dredging, reclamation or any other project-related activities shall be carried out in the CRZ area categorized as CRZ I (i), 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.	Noted
8.	The KPT shall participate financially in installing and operating the Vessel Traffic Management System in the Gulf of Kachchh and shall also take the lead in preparing and operational sing the Regional Oil Spill Contingency plan in the Gulf of Kachchh.	Not Applicable
9.	The KPT shall strictly ensure that no creeks or	It is assured that no creeks or rivers shall be

KANDLA OIL TERMINAL PRIVATE LIMITED • KANDLA 370210

S. No.	CRZ Conditions	Compliance Status
	rivers are blocked due to any activity at Kandla.	blocked due to any activity at Kandla.
10.	Mangrove plantation in an area of 100 ha. shall be carried out by the KPT within 2 years in a time-bound manner on the Gujarat coastline either within or outside the Kandla Port Trust area, and a six-monthly compliance report along with the satellite images shall be submitted to the Ministry of Environment and Forests as well as to this Department without fail.	Not Applicable
11.	No activities other than those permitted by the competent authority under the CRZ Notification shall be carried out in the CRZ area.	It is assured that only activities permitted by the competent authority under the CRZ Notification shall be carried out in the CRZ area.
12.	No groundwater shall be tapped for any purpose during the proposed expansion/modernization activities.	Water requirements will be met through GWSSB or private tankers. No groundwater shall be tapped.
13.	All necessary permissions from different Government Departments/agencies shall be obtained by the KPT before commencing the expansion activities.	Noted
14.	No effluent or sewage shall be discharged into the sea/creek or in the CRZ area, and it shall be treated to conform to the norms prescribed by the Gujarat Pollution Control Board and would be reused/recycled within the plant premises.	No waste water generation during the construction phase
15.	All the recommendations and suggestions given by Mantec Consultants Pvt. Ltd. New Delhi in their Comprehensive Environment Impact Assessment report for conservation/protection and betterment of the environment shall be implemented strictly by the KPT.	Noted
16.	The construction and operational activities shall be carried out in such a way that there is no negative impact on mangroves and other coastal/marine habitats. The construction activities and dredging shall be carried out only under the constant supervision and guidelines of the Institute of National repute like NIOT.	It is assured that construction activities are being carried out under constant supervision.
17.	The KPT shall contribute financially to any common study or project that may be proposed by this Department for environmental management/conservation /improvement for the	Not applicable

KANDLA OIL TERMINAL PRIVATE LIMITED KANDLA 370210

Kandla Oil Terminal Private Limited
Registered Office: "NEELADRI", 3rd Floor, No. 9, Cenotaph Road, Alwarpet, Chennai - 600 018.
Tel: +91-44-4590 2222, 4590 2299, Fax: + 91-44-4590 2200, URL : www.imc.net.in CIN: U60200TN2013PTC092551

S. No.	CRZ Conditions	Compliance Status
	Gulf of Kutch.	
18.	The construction debris and/or any other type of waste shall not be disposed of into the sea, creek, or in CRZ areas. The debris shall be removed from the construction site immediately after the construction is over.	It is assured that the construction activities are being carried out, with due care, and that the construction material /debris does not fall into the water. Further, it is also assured that construction waste will be collected at a designated location before being sent to the disposal site.
19.	The construction camps shall be located outside the CRZ area, and the construction labour shall be provided with the necessary amenities, including sanitation, water supply and fuel, and it shall be ensured that the environmental conditions are not deteriorated by the construction labours.	No construction camps on the site. Only Local laborers are involved.
20.	The KPT shall regularly update their Local Oil Spill Contingency and Disaster Management plan in consonance with the National Oil Spill and Disaster Contingency Plan and shall submit the same to this Department after having it vetted through the Indian Coast Guard.	Project is in construction phase.
21.	The KPT shall bear the cost of the external agency that may be appointed by this Department for supervision/ monitoring of proposed activities and the environmental impacts of the proposed activities.	Not applicable
22.	The KPT shall take up massive greenbelt development activities in and around Kandla and also within the KPT limits.	Noted
23.	The KPT 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.	Not applicable
24.	A separate budget shall be earmarked for environmental management and socio-economic activities, and details thereof shall be furnished to this Department as well as MoEF,GOI. The details with respect to the expenditure from this budget head shall also be furnished.	Noted
25.	A separate environmental management cell with qualified personnel shall be created for environmental monitoring and management	An NABL-accredited laboratory with expert manpower has assigned the work of monitoring to comply and safeguard under

KANDLA OIL TERMINAL PRIVATE LIMITED * KANDLA 370210

S. No.	CRZ Conditions	Compliance Status
	during the construction and operational phases of the project.	the compliance conditions. The Environmental Monitoring Reports are enclosed herewith as **Annexure**.
26.	An environmental report indicating the changes, if any, with respect to the baseline environmental quality in the coastal and marine environment shall be submitted every year by the KPT to this Department as well as to the MoEF&CC, GOI.	Noted. The Environmental Monitoring Reports are enclosed herewith as **Annexure**.
27.	The KPT shall have to contribute financially to support the National Green Corps Scheme being implemented in Gujarat by the GEER Foundation, Gandhinagar, in consultation with the Forests and Environment Department	Not applicable
28.	A six-monthly report on compliance with the conditions mentioned in this letter shall have to be furnished by the KPT on a regular basis to this Department/ MoEF&CC, GOI	Noted
29.	Any other conditions that may be stipulated by this Department/ MoEF&CC, GOI from time to time for environmental protection/management purposes shall also have to be complied with by the KPT.	Noted.

KANDLA OIL TERMINAL PRIVATE LIMITED • KANDLA 370210

Kandla Oil Terminal Private Limited

Subject: Point-wise Compliance Status Report for Consent to Establish for Developing Integrated Facility within the existing Kandla Port at Kandla, Dist: Kutch by M/s. Kandla Port Trust Limited – Reg.

Ref No: - PC/CCA-KUTCH-1231/GPCB ID 44000 dated 22.12.2015 and Amendment of Consent to Establish dated 04.12.2017

<table>
<tr><th>Sr. No.</th><th>Condition</th><th>Compliance Status</th></tr>
<tr><td>2.</td><td>SPECIFIC CONDITIONS:</td><td></td></tr>
<tr><td></td><td>1. Kandla Port Trust shall strictly adhere to all conditions of CRZ Clearance issued by the Forest & Environment Department vide order no. ENV-10-2014-25-E dated 01/07/2015.</td><td>All conditions of CRZ Clearance issued vide order no. ENV-10-2014-25-E dated 01/07/2015 will be strictly adhered to. The current CRZ compliance report for May 2024 is attached.</td></tr>
<tr><td></td><td>2. CTE is granted conditionally that Kandla Port Trust shall not install & commission, including the construction activity of seven activities mentioned above, without obtaining environmental clearance from MoEF&CC, New Delhi.</td><td>The construction activity was commissioned after due agreement and as per Environment Clearance was issued in the year 2016 by MoEF&CC, New Delhi.</td></tr>
<tr><td></td><td>3. Kandla Port Trust shall strictly adhere to all conditions of the Terms of Reference (ToR) (vide letter no. F. No. 11-82/2011-IA.III) by MoEF&CC, New Delhi.</td><td>Noted</td></tr>
<tr><td>3.</td><td><u>CONDITION UNDER THE WATER ACT 1974:</u>
3.1 There shall be no industrial effluent generation from the loading and unloading activities at the port and other ancillary operations.

3.2 The quantity of Domestic wastewater (Sewage) shall not exceed 6.4 KL/Day.

3.3 The quality of the sewage shall conform to the following standards:

<table><tr><th>PARAMETERS</th><th>GPCB NORMS</th></tr><tr><td>BOD (5 days at 20 °C)</td><td>20 mg/L</td></tr></table></td><td>Not applicable

The project is under the construction stage

The project is under the construction stage</td></tr>
</table>

KANDLA OIL TERMINAL PRIVATE LIMITED * KANDLA

	following standards: **PARAMETERS** / **GPCB NORMS** BOD (5 days at 20 °C) — 20 mg/L Suspended solids — 30 mg/L Residual Chlorine — Minimum 0.5 mg/L 3.4 Sewage shall be disposed of through a septic tank/soak pit system. 3.5 The unit shall install meters at utilities for measuring category-wise (Category as given in Schedule II of "Water (Prevention & Control of Pollution) Cess Act-1977") consumption of water.	construction stage Noted Noted
4.	**CONDITION UNDER THE AIR ACT 1981:** 4.1 There shall be no use of fuel hence there shall be no flue and process gas emission from storage handling activity and other ancillary operations. 4.2 The applicant shall provide portholes, ladder, platform, etc at chimney(s) for monitoring the air emissions and the same shall be open for inspection. The chimney(s) vents attached to various sources of emission shall be designed by numbers such as S-1, S-2, etc. and these shall be painted/ displayed to facilitate identification. 4.3 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** / **Concentration in Ambient air in µg/m³**	Not Applicable Not Applicable Routine environment monitoring is being done through a NABL accredited laboratory, and the data is being submitted to all the concerned authorities along with compliance reports. The latest environmental monitoring reports are enclosed as **Annexure**.

KANDLA OIL TERMINAL PRIVATE LIMITED

	following standards: **PARAMETERS** / **GPCB NORMS** BOD (5 days at 20 °C) — 20 mg/L Suspended solids — 30 mg/L Residual Chlorine — Minimum 0.5 mg/L 3.4 Sewage shall be disposed of through a septic tank/soak pit system. 3.5 The unit shall install meters at utilities for measuring category-wise (Category as given in Schedule II of "Water (Prevention & Control of Pollution) Cess Act-1977") consumption of water.	construction stage Noted Noted
4.	**CONDITION UNDER THE AIR ACT 1981:** 4.1 There shall be no use of fuel hence there shall be no flue and process gas emission from storage handling activity and other ancillary operations. 4.2 The applicant shall provide portholes, ladder, platform, etc at chimney(s) for monitoring the air emissions and the same shall be open for inspection. The chimney(s) vents attached to various sources of emission shall be designed by numbers such as S-1, S-2, etc. and these shall be painted/ displayed to facilitate identification. 4.3 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** / **Concentration in Ambient air in µg/m³**	Not Applicable Not Applicable Routine environment monitoring is being done through a NABL accredited laboratory, and the data is being submitted to all the concerned authorities along with compliance reports. The latest environmental monitoring reports are enclosed as **Annexure**.

KANDLA OIL TERMINAL PRIVATE LIMITED KANDLA 370210

wastes generated.	
6.3 Records of waste generation, its management, and annual return shall be submitted to the Gujarat Pollution Control Board in Form- 4 by 31st January of every year.	Noted
6.4 In case of any accident, details of the same shall be submitted in Form- 5 to the Gujarat Pollution Control Board.	Noted
6.5 Applicant shall comply with the relevant provision of "Public Liability Insurance Act-91".	Noted
6.6 Unit shall take all concrete measures to show tangible results in waste generation reduction, avoidance, reuse, and recycling. Action taken in this regard shall be submitted within 03 months and also along with Form 4.	Noted, the project is under the construction stage
6.7 Industry shall have to display online data outside the main factory gate with regard to the 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.	Noted, the project is under the construction stage
6.8 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 is developed.	Noted.
6.9 The applicant shall have to submit the returns in the 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.	Noted, the project is under the construction stage

KANDLA OIL TERMINAL PRIVATE LIMITED * KANDLA 370210

A 2 Z ENVIROTECH LAB PVT. LTD.

A2Z

ENVIROTECH LAB PVT . LTD .

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 22/03/2024
Report No : A2ZELPL/AA/03/2024/02

Description of Sample:					
Date of Sampling	:	13/03/2024	**Type of Sampling**	:	
Date of Sample Received	:	14/03/2024	**Sample ID**	:	AA/032024/02
Sampling Location of Sampling Point	:	NEAR JETTY AREA	**Sample Particular**	:	AMBIENT AIR
Sample Collected / Submitted by	:	A2ZELPL Team Member	**Reference Method for Sampling**	:	-----
Sample Quantity /Total No.	:	2 Filter paper $1SO_2$ × 35 ml, $1NO_2$ × 35 ml.	**Date of Analysis Start**	:	15/03/2024
Details of Packing/Label/Seal	:	Satisfactory	**Date of Analysis Completion**	:	18/03/2024
Environment condition during the test	:	25 ± 3 °C	**Metrological conditions during monitoring**		Clear Sky
Instrument code	:	A2ZELPL/RDS/01 A2ZELPL/FDS/01	**Actual Duration of Monitoring (Hours)**		24

Test Results

Sr. No.	Parameters	Results	Unit	NAAQS LIMITS	Reference Method
1.	Particulate Matter PM_{10}	74.4	µg/m3	100 µg/m3	IS 5182 (Part 23)2006/ Reaffirmed 2017
2.	Particulate Matter $PM_{2.5}$	41.85	µg/m3	60 µg/m3	IS 5182 (Part 24)2019
3.	Sulfur Dioxide SO_2	19.48	µg/m3	80 µg/m3	IS 5182 (Part 2)2001/ Reaffirmed 2017
4.	Nitrogen Dioxide NO_2	28.61	µg/m3	80 µg/m3	IS 5182 (Part 6)2006/ Reaffirmed 2017

Rajat

Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items testedand for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

---------- **End of Report** ----------

A2Z ENVIROTECH LAB PVT . LTD .

TEST REPORT

Customer's Name and Address:
KOTPL
OPP.SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 22/03/2024
Report No : A2ZELPL/AA/03/2024/03

Description of Sample:					
Date of Sampling	:	13/03/2024	**Type of Sampling**	:	
Date of Sample Received	:	14/03/2024	**Sample ID**	:	AA/032024/03
Sampling Location of Sampling Point	:	NEAR TANK FARM AREA	**Sample Particular**	:	AMBIENT AIR
Sample Collected / Submitted by	:	A2ZELPL Team Member	**Reference Method for Sampling**	:	----
Sample Quantity /Total No.	:	2 Filter paper $1SO_2 \times 35$ ml, $1NO_2 \times 35$ ml.	**Date of Analysis Start**	:	15/03/2024
Details of Packing/Label/Seal	:	Satisfactory	**Date of Analysis Completion**	:	18/03/2024
Environment condition during the test	:	25 ± 3 °C	**Metrological conditions during monitoring**		Clear Sky
Instrument code	:	A2ZELPL/RDS/01 A2ZELPL/FDS/01	**Actual Duration of Monitoring (Hours)**		24

Test Results

Sr. No.	Parameters	Results	Unit	NAAQS LIMITS	Reference Method
1.	Particulate Matter PM_{10}	72.02	µg/m3	100 µg/m3	IS 5182 (Part 23)2006/ Reaffirmed 2017
2.	Particulate Matter $PM_{2.5}$	42.58	µg/m3	60 µg/m3	IS 5182 (Part 24)2019
3.	Sulfur Dioxide SO_2	26.45	µg/m3	80 µg/m3	IS 5182 (Part 2)2001/ Reaffirmed 2017
4.	Nitrogen Dioxide NO_2	34.10	µg/m3	80 µg/m3	IS 5182 (Part 6)2006/ Reaffirmed 2017

Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items testedand for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

End of Report

PLOT NO.340, SECTOR 1A,2ND FLOOR, SHIV HOUSE, NEAR OSLO CIRCLE, GANDHIDHAM-KACHCHH, GUJARAT-370001
NABL/TC-10331 | Gmail id: a2zenvirotechlab@gmail.com | AKBARKHAN JALORI 9898711906

ENVIROTECH LAB PVT . LTD .

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 16/03/2024
Report No : A2ZELPL/DW/03/2024/02

Description of Sample:					
Date of Sampling	:	13/03/2024	Type of Sampling	:	Drinking Water
Date of Sample Received	:	13/03/2024	Sample ID	:	DW/032024/02
Sampling Location of Sampling Point	:	Near office area	Sample Particular	:	Drinking Water
Sample Collected / Submitted by	:	A2ZELPL Team Member	Reference Method for Sampling	:	------
Sample Quantity /Total No.	:	2 Litre/1Nos.	Date of Analysis Start	:	14/03/2024
Details of Packing/Label/Seal	:	Satisfactory	Date of Analysis Completion	:	15/03/2024
Environment condition during the test	:	25 ± 3 °C			

Test Results

Sr. No.	Parameters	Results	STANDARD Limit	Unit	Reference Method
1.	pH @°C	7.25	6.5-8.5	-	APHA, 23rd Edition 2017/4500-H+ B
2.	Electrical Conductivity @°C	0.36	--	mS/cm	APHA, 23rd Edition 2017/2510-B
3.	Temperature	24.5	--	°C	APHA, 23rd Edition 2017/2550B
4.	Total dissolved solids	270	500	mg/L	APHA, 23rd Edition 2017/ 2540-C
5.	Total Suspended solids	90	50-150	mg/L	APHA, 23rd Edition 2017/ 2540-D
6.	Chloride as Cl	33.1	250	mg/L	APHA, 23rd Edition 2017/ 4500 Cl- B
7.	Total Hardness as $CaCO_3$	63	200	mg/L	APHA, 23rd Edition 2017/2340-C
8.	Calcium as Ca	19	75	mg/L	APHA, 23rd Edition 2017/3500-Ca-B
9.	Magnesium as Mg	5.1	30	mg/L	APHA, 23rd Edition 2017/Calculation Method 3500 -Mg B

Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items tested and for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

End of Report

A 2 Z ENVIROTECH LAB PVT.LTD.

A2Z ENVIROTECH LAB PVT . LTD .

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 14/03/2024
Report No : A2ZELPL/AN/032024/02

Description of Sample:					
Date of Sampling	:	13/03/2024	**Type of Sampling**	:	----------
Date of Sample Received	:	13/03/2024	**Sample ID**	:	AN/032024/02
Sampling Location of Sampling Point	:	----------	**Sample Particular**	:	NOISE
Sample Collected / Submitted by	:	A2ZELPL Team Member	**Reference Method for Sampling**	:	IS 9989-1991
Instrument calibration status	:	OK	**Date of Analysis Start**	:	-----
Metrological conditions during monitoring	:	CLEAR SKY	**Date of Analysis Completion**	:	-----
Instrument code	:	A2ZELPL/SLM/01	**Actual Duration of Monitoring (MINUTE)**		30

Test Results

Sr. No.	LOCATION	Results	CPCB Limit	Unit	Reference Method
1.	NEAR TANK FARM	69	75	dB	IS 9989-1991
2.	NEAR JEETY LANDFALL AREA	58	75	dB	IS 9989-1991
3.	TANK FARM RIGHT SIDE	62	75	dB	IS 9989-1991
4.	TANK FARM LEFT SIDE	53	75	dB	IS 9989-1991

Rajat
Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items tested and for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

---------- **End of Report** ----------

PLOT NO.340, SECTOR 1A,2ND FLOOR, SHIV HOUSE, NEAR OSLO CIRCLE, GANDHIDHAM-KACHCHH, GUJARAT-370001
NABL/TC-10331 | Gmail id: a2zenvirotechlab@gmail.com | AKBARKHAN JALORI 9898711900

A 2 Z ENVIROTECH LAB PVT. LTD.

A2Z ENVIROTECH LAB PVT . LTD .

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 11/05/2024
Report No : A2ZELPL/AA/05/2024/01

Description of Sample:					
Date of Sampling	:	06/05/2024	**Type of Sampling**	:	
Date of Sample Received	:	07/05/2024	**Sample ID**	:	AA/052024/01
Sampling Location of Sampling Point	:	NEAR JETTY AREA	**Sample Particular**	:	AMBIENT AIR
Sample Collected / Submitted by	:	A2ZELPL Team Member	**Reference Method for Sampling**	:	-----
Sample Quantity /Total No.	:	2 Filter paper $1SO_2 \times 35$ ml, $1NO_2 \times 35$ ml.	**Date of Analysis Start**	:	08/05/2024
Details of Packing/Label/Seal	:	Satisfactory	**Date of Analysis Completion**	:	10/05/2024
Environment condition during the test	:	25 ± 3 °C	**Metrological conditions during monitoring**		Clear Sky
Instrument code	:	A2ZELPL/RDS/01 A2ZELPL/FDS/01	**Actual Duration of Monitoring (Hours)**		24

Test Results

Sr. No.	Parameters	Results	Unit	NAAQS LIMITS	Reference Method
1.	Particulate Matter PM_{10}	78.6	µg/m3	100 µg/m3	IS 5182 (Part 23)2006/ Reaffirmed 2017
2.	Particulate Matter $PM_{2.5}$	47.68	µg/m3	60 µg/m3	IS 5182 (Part 24)2019
3.	Sulfur Dioxide SO_2	23.32	µg/m3	80 µg/m3	IS 5182 (Part 2)2001/ Reaffirmed 2017
4.	Nitrogen Dioxide NO_2	25.41	µg/m3	80 µg/m3	IS 5182 (Part 6)2006/ Reaffirmed 2017

Tested by
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items testedand for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written convent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

End of Report

PLOT NO.340, SECTOR 1A,2ND FLOOR, SHIV HOUSE, NEAR OSLO CIRCLE, GANDHIDHAM-KACHCHH, GUJARAT-370001
NABL/TC-10331 | Gmail id: a2zenvirotechlab@gmail.com | AKBARKHAN JALORI 9898711906

A 2 Z ENVIROTECH LAB PVT.LTD.

A2Z

ENVIROTECH LAB PVT . LTD .

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 11/05/2024
Report No : A2ZELPL/AA/05/2024/02

Description of Sample:					
Date of Sampling	:	06/05/2024	**Type of Sampling**	:	
Date of Sample Received	:	07/05/2024	**Sample ID**	:	AA/052024/02
Sampling Location of Sampling Point	:	NEAR TANK FARM AREA	**Sample Particular**	:	AMBIENT AIR
Sample Collected / Submitted by	:	A2ZELPL Team Member	**Reference Method for Sampling**	:	-----
Sample Quantity /Total No.	:	2 Filter paper $1SO_2$ × 35 ml, $1NO_2$ × 35 ml.	**Date of Analysis Start**	:	08/05/2024
Details of Packing/Label/Seal	:	Satisfactory	**Date of Analysis Completion**	:	10/05/2024
Environment condition during the test	:	25 ± 3 °C	**Metrological conditions during monitoring**		Clear Sky
Instrument code	:	A2ZELPL/RDS/01 A2ZELPL/FDS/01	**Actual Duration of Monitoring (Hours)**		24

Test Results

Sr. No.	Parameters	Results	Unit	NAAQS LIMITS	Reference Method
1.	Particulate Matter PM_{10}	75.2	µg/m3	100 µg/m3	IS 5182 (Part 23)2006/ Reaffirmed 2017
2.	Particulate Matter $PM_{2.5}$	49.52	µg/m3	60 µg/m3	IS 5182 (Part 24)2019
3.	Sulfur Dioxide SO_2	26.78	µg/m3	80 µg/m3	IS 5182 (Part 2)2001/ Reaffirmed 2017
4.	Nitrogen Dioxide NO_2	29.48	µg/m3	80 µg/m3	IS 5182 (Part 6)2006/ Reaffirmed 2017

Rajat
Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items testedand for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

---------- **End of Report** ----------

PLOT NO.340, SECTOR 1A,2nd FLOOR, SHIV HOUSE, NEAR OSLO CIRCLE, GANDHIDHAM-KACHCHH, GUJARAT-370001
NABL/TC-10331 | Gmail id: a2zenvirotechlab@gmail.com | AKBARKHAN JALORI 9898711906

A2Z ENVIROTECH LAB PVT . LTD .

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 09/05/2024
Report No : A2ZELPL/DW/05/2024/01

Description of Sample:					
Date of Sampling	:	06/05/2024	**Type of Sampling**	:	Drinking Water
Date of Sample Received	:	06/05/2024	**Sample ID**	:	DW/052024/01
Sampling Location of Sampling Point	:	Near office area	**Sample Particular**	:	Drinking Water
Sample Collected / Submitted by	:	A2ZELPL Team Member	**Reference Method for Sampling**	:	------
Sample Quantity /Total No.	:	2 Litre/1Nos.	**Date of Analysis Start**	:	07/05/2024
Details of Packing/Label/Seal	:	Satisfactory	**Date of Analysis Completion**	:	08/05/2024
Environment condition during the test	:	25 ± 3 °C			

Test Results

Sr. No.	Parameters	Results	STANDARD Limit	Unit	Reference Method
1.	pH @°C	7.45	6.5-8.5	-	APHA, 23rd Edition 2017/4500-H+ B
2.	Electrical Conductivity @°C	0.45	--	mS/cm	APHA, 23rd Edition 2017/2510-B
3.	Temperature	25.1	--	°C	APHA, 23rd Edition 2017/2550B
4.	Total dissolved solids	304	500	mg/L	APHA, 23rd Edition 2017/ 2540-C
5.	Total Suspended solids	99	50-150	mg/L	APHA, 23rd Edition 2017/ 2540-D
6.	Chloride as Cl	38.2	250	mg/L	APHA, 23rd Edition 2017/ 4500 Cl- B
7.	Total Hardness as $CaCO_3$	73	200	mg/L	APHA, 23rd Edition 2017/2340-C
8.	Calcium as Ca	27	75	mg/L	APHA, 23rd Edition 2017/3500-Ca-B
9.	Magnesium as Mg	6.4	30	mg/L	APHA, 23rd Edition 2017/Calculation Method 3500 -Mg B

Rajat
Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items tested and for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

End of Report

PLOT NO.340, SECTOR 1A,2ND FLOOR, SHIV HOUSE, NEAR OSLO CIRCLE, GANDHIDHAM-KACHCHH, GUJARAT-370001
NABL/TC-10331 | Gmail id: a2zenvirotechlab@gmail.com | AKBARKHAN JALORI 9898711906

A2Z ENVIROTECH LAB PVT . LTD .

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 07/05/2024
Report No : A2ZELPL/AN/052024/01

Description of Sample:					
Date of Sampling	:	06/05/2024	Type of Sampling	:	----------
Date of Sample Received	:	06/05/2024	Sample ID	:	AN/052024/01
Sampling Location of Sampling Point	:	----------	Sample Particular	:	NOISE
Sample Collected / Submitted by	:	A2ZELPL Team Member	Reference Method for Sampling	:	IS 9989-1991
Instrument calibration status	:	OK	Date of Analysis Start	:	-----
Metrological conditions during monitoring	:	CLEAR SKY	Date of Analysis Completion	:	-----
Instrument code	:	A2ZELPL/SLM/01	Actual Duration of Monitoring (MINUTE)		30

Test Results

Sr. No.	LOCATION	Results	CPCB Limit	Unit	Reference Method
1.	NEAR TANK FARM	73	75	dB	IS 9989-1991
2.	NEAR JEETY LANDFALL AREA	61	75	dB	IS 9989-1991
3.	TANK FARM RIGHT SIDE	67	75	dB	IS 9989-1991
4.	TANK FARM LEFT SIDE	53	75	dB	IS 9989-1991

Rajat
Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items tested and for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

---------- **End of Report** ----------

A 2 Z ENVIROTECH LAB PVT. LTD.

A2Z ENVIROTECH LAB PVT . LTD .

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 25/04/2024
Report No : A2ZELPL/AA/04/2024/01

Description of Sample:					
Date of Sampling	:	19/04/2024	Type of Sampling	:	
Date of Sample Received	:	20/04/2024	Sample ID	:	AA/042024/01
Sampling Location of Sampling Point	:	NEAR JETTY AREA	Sample Particular	:	AMBIENT AIR
Sample Collected / Submitted by	:	A2ZELPL Team Member	Reference Method for Sampling	:	----
Sample Quantity /Total No.	:	2 Filter paper $1SO_2$ × 35 ml, $1NO_2$ × 35 ml.	Date of Analysis Start	:	22/04/2024
Details of Packing/Label/Seal	:	Satisfactory	Date of Analysis Completion	:	24/04/2024
Environment condition during the test	:	25 ± 3 °C	Metrological conditions during monitoring		Clear Sky
Instrument code	:	A2ZELPL/RDS/01 A2ZELPL/FDS/01	Actual Duration of Monitoring (Hours)		24

Test Results

Sr. No.	Parameters	Results	Unit	NAAQS LIMITS	Reference Method
1.	Particulate Matter PM_{10}	86.06	µg/m3	100 µg/m3	IS 5182 (Part 23)2006/ Reaffirmed 2017
2.	Particulate Matter $PM_{2.5}$	44.10	µg/m3	60 µg/m3	IS 5182 (Part 24)2019
3.	Sulfur Dioxide SO_2	31.15	µg/m3	80 µg/m3	IS 5182 (Part 2)2001/ Reaffirmed 2017
4.	Nitrogen Dioxide NO_2	34.87	µg/m3	80 µg/m3	IS 5182 (Part 6)2006/ Reaffirmed 2017

Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items testedand for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

End of Report

PLOT NO.340, SECTOR 1A,2ND FLOOR, SHIV HOUSE, NEAR OSLO CIRCLE, GANDHIDHAM-KACHCHH, GUJARAT-370001
NABL/TC-10331 | Gmail id: a2zenvirotechlab@gmail.com | AKBARKHAN JALORI 9898711906

ENVIROTECH LAB PVT . LTD .

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 25/04/2024
Report No : A2ZELPL/AA/04/2024/02

Description of Sample:					
Date of Sampling	:	19/04/2024	**Type of Sampling**	:	
Date of Sample Received	:	20/04/2024	**Sample ID**	:	AA/042024/02
Sampling Location of Sampling Point	:	NEAR TANK FARM AREA	**Sample Particular**	:	AMBIENT AIR
Sample Collected / Submitted by	:	A2ZELPL Team Member	**Reference Method for Sampling**	:	----
Sample Quantity /Total No.	:	2 Filter paper $1SO_2 \times 35$ ml, $1NO_2 \times 35$ ml.	**Date of Analysis Start**	:	22/04/2024
Details of Packing/Label/Seal	:	Satisfactory	**Date of Analysis Completion**	:	24/04/2024
Environment condition during the test	:	25 ± 3 °C	**Metrological conditions during monitoring**		Clear Sky
Instrument code	:	A2ZELPL/RDS/01 A2ZELPL/FDS/01	**Actual Duration of Monitoring (Hours)**		24

Test Results

Sr. No.	Parameters	Results	Unit	NAAQS LIMITS	Reference Method
1.	Particulate Matter PM_{10}	80.70	µg/m3	100 µg/m3	IS 5182 (Part 23)2006/ Reaffirmed 2017
2.	Particulate Matter $PM_{2.5}$	41.45	µg/m3	60 µg/m3	IS 5182 (Part 24)2019
3.	Sulfur Dioxide SO_2	18.17	µg/m3	80 µg/m3	IS 5182 (Part 2)2001/ Reaffirmed 2017
4.	Nitrogen Dioxide NO_2	28.44	µg/m3	80 µg/m3	IS 5182 (Part 6)2006/ Reaffirmed 2017

Rajat
Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items testedand for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

---------- **End of Report** ----------

PLOT NO.340, SECTOR 1A,2ND FLOOR, SHIV HOUSE, NEAR OSLO CIRCLE, GANDHIDHAM-KACHCHH, GUJARAT-370001
NABL/TC-10331 | Gmail id: a2zenvirotechlab@gmail.com | AKBARKHAN JALORI 9898711906

ENVIROTECH LAB PVT . LTD .

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 22/04/2024
Report No : A2ZELPL/DW/04/2024/01

Description of Sample:					
Date of Sampling	:	19/04/2024	**Type of Sampling**	:	Drinking Water
Date of Sample Received	:	19/04/2024	**Sample ID**	:	DW/042024/01
Sampling Location of Sampling Point	:	Near office area	**Sample Particular**	:	Drinking Water
Sample Collected / Submitted by	:	A2ZELPL Team Member	**Reference Method for Sampling**	:	------
Sample Quantity /Total No.	:	2 Litre/1Nos.	**Date of Analysis Start**	:	20/04/2024
Details of Packing/Label/Seal	:	Satisfactory	**Date of Analysis Completion**	:	22/04/2024
Environment condition during the test	:	25 ± 3 °C			

Test Results

Sr. No.	Parameters	Results	STANDARD Limit	Unit	Reference Method
1.	pH @°C	7.29	6.5-8.5	-	APHA, 23rd Edition 2017/4500-H+ B
2.	Electrical Conductivity @°C	0.39	--	mS/cm	APHA, 23rd Edition 2017/2510-B
3.	Temperature	25	--	°C	APHA, 23rd Edition 2017/2550B
4.	Total dissolved solids	292	500	mg/L	APHA, 23rd Edition 2017/ 2540-C
5.	Total Suspended solids	95	50-150	mg/L	APHA, 23rd Edition 2017/ 2540-D
6.	Chloride as Cl	36.4	250	mg/L	APHA, 23rd Edition 2017/ 4500 Cl- B
7.	Total Hardness as $CaCO_3$	69	200	mg/L	APHA, 23rd Edition 2017/2340-C
8.	Calcium as Ca	23	75	mg/L	APHA, 23rd Edition 2017/3500-Ca-B
9.	Magnesium as Mg	5.9	30	mg/L	APHA, 23rd Edition 2017/Calculation Method 3500 -Mg B

Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items tested and for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

---------- **End of Report** ----------

PLOT NO.340, SECTOR 1A,2nd FLOOR, SHIV HOUSE, NEAR OSLO CIRCLE, GANDHIDHAM-KACHCHH, GUJARAT-370001
NABL/TC-10331 | Gmail id: a2zenvirotechlab@gmail.com | AKBARKHAN JALORI 9898711906

ENVIROTECH LAB PVT . LTD .

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 20/04/2024
Report No : A2ZELPL/AN/042024/01

Description of Sample:					
Date of Sampling	:	19/04/2024	**Type of Sampling**	:	----------
Date of Sample Received	:	19/04/2024	**Sample ID**	:	AN/042024/01
Sampling Location of Sampling Point	:	----------	**Sample Particular**	:	NOISE
Sample Collected / Submitted by	:	A2ZELPL Team Member	**Reference Method for Sampling**	:	IS 9989-1991
Instrument calibration status	:	OK	**Date of Analysis Start**	:	-----
Metrological conditions during monitoring	:	CLEAR SKY	**Date of Analysis Completion**	:	-----
Instrument code	:	A2ZELPL/SLM/01	**Actual Duration of Monitoring (MINUTE)**		30

Test Results

Sr. No.	LOCATION	Results	CPCB Limit	Unit	Reference Method
1.	NEAR TANK FARM	71	75	dB	IS 9989-1991
2.	NEAR JEETY LANDFALL AREA	60	75	dB	IS 9989-1991
3.	TANK FARM RIGHT SIDE	64	75	dB	IS 9989-1991
4.	TANK FARM LEFT SIDE	58	75	dB	IS 9989-1991

Rajat
Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items tested and for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

---------- **End of Report** ----------

PLOT NO.340, SECTOR 1A,2ND FLOOR, SHIV HOUSE, NEAR OSLO CIRCLE, GANDHIDHAM-KACHCHH, GUJARAT-370001
XABL/TC-10331 | Gmail id: a2zenvirotechlab@gmail.com | AKBARKHAN JALORI 9898711908

A 2 Z ENVIROTECH LAB PVT. LTD.

A2Z ENVIROTECH LAB PVT . LTD .

TC-10331

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 12/12/2023
Report No : A2ZELPL/AA/12/2023/04

Description of Sample:					
Date of Sampling	:	08/12/2023	**Type of Sampling**	:	
Date of Sample Received	:	09/12/2023	**Sample ID**	:	AA/122023/04
Sampling Location of Sampling Point	:	NEAR TANK FARM AREA	**Sample Particular**	:	AMBIENT AIR
Sample Collected / Submitted by	:	A2ZELPL Team Member	**Reference Method for Sampling**	:	-----
Sample Quantity /Total No.	:	2 Filter paper $1SO_2 \times 35$ ml, $1NO_2 \times 35$ ml.	**Date of Analysis Start**	:	09/12/2023
Details of Packing/Label/Seal	:	Satisfactory	**Date of Analysis Completion**	:	11/12/2023
Environment condition during the test	:	25 ± 3 °C	**Metrological conditions during monitoring**		Clear Sky
Instrument code	:	A2ZELPL/RDS/01 A2ZELPL/FDS/01	**Actual Duration of Monitoring (Hours)**		24

Test Results

Sr. No.	Parameters	Results	Unit	NAAQS LIMITS	Reference Method
1.	Particulate Matter PM_{10}	63.7	µg/m3	100 µg/m3	IS 5182 (Part 23)2006/ Reaffirmed 2017
2.	Particulate Matter $PM_{2.5}$	28.1	µg/m3	60 µg/m3	IS 5182 (Part 24)2019
3.	Sulfur Dioxide SO_2	21.96	µg/m3	80 µg/m3	IS 5182 (Part 2)2001/ Reaffirmed 2017
4.	Nitrogen Dioxide NO_2	34.82	µg/m3	80 µg/m3	IS 5182 (Part 6)2006/ Reaffirmed 2017

Rajat
Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items testedand for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

---------- **End of Report** ----------

A 2 Z ENVIROTECH LAB PVT. LTD.

ENVIROTECH LAB PVT . LTD .

TC-10331

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 12/12/2023
Report No : A2ZELPL/AA/12/2023/05

Description of Sample:					
Date of Sampling	:	08/12/2023	Type of Sampling	:	
Date of Sample Received	:	09/12/2023	Sample ID	:	AA/122023/05
Sampling Location of Sampling Point	:	NEAR JETTY AREA	Sample Particular	:	AMBIENT AIR
Sample Collected / Submitted by	:	A2ZELPL Team Member	Reference Method for Sampling	:	-----
Sample Quantity /Total No.	:	2 Filter paper $1SO_2 \times 35$ ml, $1NO_2 \times 35$ ml.	Date of Analysis Start	:	09/12/2023
Details of Packing/Label/Seal	:	Satisfactory	Date of Analysis Completion	:	11/12/2023
Environment condition during the test	:	25 ± 3 °C	Metrological conditions during monitoring		Clear Sky
Instrument code	:	A2ZELPL/RDS/01 A2ZELPL/FDS/01	Actual Duration of Monitoring (Hours)		24

Test Results

Sr. No.	Parameters	Results	Unit	NAAQS LIMITS	Reference Method
1.	Particulate Matter PM_{10}	66.2	µg/m3	100 µg/m3	IS 5182 (Part 23)2006/ Reaffirmed 2017
2.	Particulate Matter $PM_{2.5}$	30.8	µg/m3	60 µg/m3	IS 5182 (Part 24)2019
3.	Sulfur Dioxide SO_2	15.04	µg/m3	80 µg/m3	IS 5182 (Part 2)2001/ Reaffirmed 2017
4.	Nitrogen Dioxide NO_2	27.51	µg/m3	80 µg/m3	IS 5182 (Part 6)2006/ Reaffirmed 2017

Rajet
Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items testedand for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

End of Report

A 2 Z ENVIROTECH LAB PVT. LTD.

ENVIROTECH LAB PVT . LTD .

TC-10331

TEST REPORT

Format No. : 7.8 F-01
Date of Report : 09/01/2024
Report No : A2ZELPL/AA/01/2024/01

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Description of Sample:					
Date of Sampling	:	05/01/2024	Type of Sampling	:	
Date of Sample Received	:	06/01/2024	Sample ID	:	AA/012024/01
Sampling Location of Sampling Point	:	NEAR TANK FARM AREA	Sample Particular	:	AMBIENT AIR
Sample Collected / Submitted by	:	A2ZELPL Team Member	Reference Method for Sampling	:	-----
Sample Quantity /Total No.	:	2 Filter paper $1SO_2$ × 35 ml, $1NO_2$ × 35 ml.	Date of Analysis Start	:	06/01/2024
Details of Packing/Label/Seal	:	Satisfactory	Date of Analysis Completion	:	08/01/2024
Environment condition during the test	:	25 ± 3 °C	Metrological conditions during monitoring		Clear Sky
Instrument code	:	A2ZELPL/RDS/01 A2ZELPL/FDS/01	Actual Duration of Monitoring (Hours)		24

Test Results

Sr. No.	Parameters	Results	Unit	NAAQS LIMITS	Reference Method
1.	Particulate Matter PM_{10}	74.3	µg/m3	100 µg/m3	IS 5182 (Part 23)2006/ Reaffirmed 2017
2.	Particulate Matter $PM_{2.5}$	39.4	µg/m3	60 µg/m3	IS 5182 (Part 24)2019
3.	Sulfur Dioxide SO_2	20.86	µg/m3	80 µg/m3	IS 5182 (Part 2)2001/ Reaffirmed 2017
4.	Nitrogen Dioxide NO_2	26.29	µg/m3	80 µg/m3	IS 5182 (Part 6)2006/ Reaffirmed 2017

Rajat
Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items testedand for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

End of Report

ENVIROTECH LAB PVT . LTD .

TC-10331

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 09/01/2024
Report No : A2ZELPL/AA/01/2024/02

Description of Sample:					
Date of Sampling	:	05/01/2024	Type of Sampling	:	
Date of Sample Received	:	06/01/2024	Sample ID	:	AA/012024/02
Sampling Location of Sampling Point	:	NEAR JETTY AREA	Sample Particular	:	AMBIENT AIR
Sample Collected / Submitted by	:	A2ZELPL Team Member	Reference Method for Sampling	:	-----
Sample Quantity /Total No.	:	2 Filter paper $1SO_2$ × 35 ml, $1NO_2$ × 35 ml.	Date of Analysis Start	:	06/01/2024
Details of Packing/Label/Seal	:	Satisfactory	Date of Analysis Completion	:	08/01/2024
Environment condition during the test	:	25 ± 3 ° C	Metrological conditions during monitoring		Clear Sky
Instrument code	:	A2ZELPL/RDS/01 A2ZELPL/FDS/01	Actual Duration of Monitoring (Hours)		24

Test Results

Sr. No.	Parameters	Results	Unit	NAAQS LIMITS	Reference Method
1.	Particulate Matter PM_{10}	76.5	µg/m3	100 µg/m3	IS 5182 (Part 23)2006/ Reaffirmed 2017
2.	Particulate Matter $PM_{2.5}$	38.5	µg/m3	60 µg/m3	IS 5182 (Part 24)2019
3.	Sulfur Dioxide SO_2	19.89	µg/m3	80 µg/m3	IS 5182 (Part 2)2001/ Reaffirmed 2017
4.	Nitrogen Dioxide NO_2	30.74	µg/m3	80 µg/m3	IS 5182 (Part 6)2006/ Reaffirmed 2017

Rajat
Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items testedand for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

---------- **End of Report** ----------

A 2 Z ENVIROTECH LAB PVT. LTD.

ENVIROTECH LAB PVT . LTD .

TC-10331

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 10/02/2024
Report No : A2ZELPL/AA/02/2024/01

Description of Sample:					
Date of Sampling	:	05/02/2024	Type of Sampling	:	
Date of Sample Received	:	06/02/2024	Sample ID	:	AA/022024/01
Sampling Location of Sampling Point	:	NEAR JETTY AREA	Sample Particular	:	AMBIENT AIR
Sample Collected / Submitted by	:	A2ZELPL Team Member	Reference Method for Sampling	:	-----
Sample Quantity /Total No.	:	2 Filter paper $1SO_2 \times 35$ ml, $1NO_2 \times 35$ ml.	Date of Analysis Start	:	07/02/2024
Details of Packing/Label/Seal	:	Satisfactory	Date of Analysis Completion	:	09/02/2024
Environment condition during the test	:	25 ± 3 °C	Metrological conditions during monitoring		Clear Sky
Instrument code	:	A2ZELPL/RDS/01 A2ZELPL/FDS/01	Actual Duration of Monitoring (Hours)		24

Test Results

Sr. No.	Parameters	Results	Unit	NAAQS LIMITS	Reference Method
1.	Particulate Matter PM_{10}	78.8	µg/m3	100 µg/m3	IS 5182 (Part 23)2006/ Reaffirmed 2017
2.	Particulate Matter $PM_{2.5}$	44.5	µg/m3	60 µg/m3	IS 5182 (Part 24)2019
3.	Sulfur Dioxide SO_2	17.51	µg/m3	80 µg/m3	IS 5182 (Part 2)2001/ Reaffirmed 2017
4.	Nitrogen Dioxide NO_2	20.92	µg/m3	80 µg/m3	IS 5182 (Part 6)2006/ Reaffirmed 2017

Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items testedand for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

End of Report

A 2 Z ENVIROTECH LAB PVT. LTD.

ENVIROTECH LAB PVT . LTD .

TC-10331

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 10/02/2024
Report No : A2ZELPL/AA/02/2024/02

Description of Sample:					
Date of Sampling	:	05/02/2024	**Type of Sampling**	:	
Date of Sample Received	:	06/02/2024	**Sample ID**	:	AA/022024/02
Sampling Location of Sampling Point	:	NEAR TANK FARM AREA	**Sample Particular**	:	AMBIENT AIR
Sample Collected / Submitted by	:	A2ZELPL Team Member	**Reference Method for Sampling**	:	-----
Sample Quantity /Total No.	:	2 Filter paper $1SO_2$ × 35 ml, $1NO_2$ × 35 ml.	**Date of Analysis Start**	:	07/02/2024
Details of Packing/Label/Seal	:	Satisfactory	**Date of Analysis Completion**	:	09/02/2024
Environment condition during the test	:	25 ± 3 °C	**Metrological conditions during monitoring**		Clear Sky
Instrument code	:	A2ZELPL/RDS/01 A2ZELPL/FDS/01	**Actual Duration of Monitoring (Hours)**		24

Test Results

Sr. No.	Parameters	Results	Unit	NAAQS LIMITS	Reference Method
1.	Particulate Matter PM_{10}	76.5	µg/m3	100 µg/m3	IS 5182 (Part 23)2006/ Reaffirmed 2017
2.	Particulate Matter $PM_{2.5}$	40.3	µg/m3	60 µg/m3	IS 5182 (Part 24)2019
3.	Sulfur Dioxide SO_2	29.65	µg/m3	80 µg/m3	IS 5182 (Part 2)2001/ Reaffirmed 2017
4.	Nitrogen Dioxide NO_2	35.12	µg/m3	80 µg/m3	IS 5182 (Part 6)2006/ Reaffirmed 2017

Rajat
Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items testedand for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

---------- **End of Report** ----------

A 2 Z ENVIROTECH LAB PVT. LTD.

ENVIROTECH LAB PVT . LTD .

TC-10331

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 09/12/2023
Report No : A2ZELPL/AN/12/2023/03

Description of Sample:					
Date of Sampling	:	08/12/2023	Type of Sampling	:	----------
Date of Sample Received	:	08/12/2023	Sample ID	:	AN/122023/03
Sampling Location of Sampling Point	:	----------	Sample Particular	:	----
Sample Collected / Submitted by	:	A2ZELPL Team Member	Reference Method for Sampling	:	IS 9989-1991
Instrument calibration status	:	OK	Date of Analysis Start	:	-----
Metrological conditions during monitoring	:	CLEAR SKY	Date of Analysis Completion	:	-----
Instrument code	:	A2ZELPL/SLM/01	Actual Duration of Monitoring (MINUTE)		30

Test Results

Sr. No.	LOCATION	Results	CPCB Limit	Unit	Reference Method
1.	NEAR TANK FARM	67	75	dB	IS 9989-1991
2.	NEAR JEETY LANDFALL AREA	54	75	dB	IS 9989-1991
3.	TANK FARM RIGHT SIDE	62	75	dB	IS 9989-1991
4.	TANK FARM LEFT SIDE	56	75	dB	IS 9989-1991

Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items tested and for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

---------- **End of Report** ----------

ENVIROTECH LAB PVT . LTD .

TC-10331

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 06/01/2024
Report No : A2ZELPL/AN/012024/03

Description of Sample:					
Date of Sampling	:	05/01/2024	**Type of Sampling**	:	----------
Date of Sample Received	:	05/01/2024	**Sample ID**	:	AN/012024/03
Sampling Location of Sampling Point	:	----------	**Sample Particular**	:	----
Sample Collected / Submitted by	:	A2ZELPL Team Member	**Reference Method for Sampling**	:	IS 9989-1991
Instrument calibration status	:	OK	**Date of Analysis Start**	:	-----
Metrological conditions during monitoring	:	CLEAR SKY	**Date of Analysis Completion**	:	-----
Instrument code	:	A2ZELPL/SLM/01	**Actual Duration of Monitoring (MINUTE)**		30

Test Results

Sr. No.	LOCATION	Results	CPCB Limit	Unit	Reference Method
1.	NEAR TANK FARM	69	75	dB	IS 9989-1991
2.	NEAR JEETY LANDFALL AREA	57	75	dB	IS 9989-1991
3.	TANK FARM RIGHT SIDE	64	75	dB	IS 9989-1991
4.	TANK FARM LEFT SIDE	59	75	dB	IS 9989-1991

Rajat
Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items tested and for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

---------- **End of Report** ----------

A 2 Z ENVIROTECH LAB PVT. LTD.

A2Z ENVIROTECH LAB PVT . LTD .

TC-10331

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 06/02/2024
Report No : A2ZELPL/AN/022024/01

Description of Sample:					
Date of Sampling	:	05/02/2024	**Type of Sampling**	:	----------
Date of Sample Received	:	05/02/2024	**Sample ID**	:	AN/022024/01
Sampling Location of Sampling Point	:	----------	**Sample Particular**	:	NOISE
Sample Collected / Submitted by	:	A2ZELPL Team Member	**Reference Method for Sampling**	:	IS 9989-1991
Instrument calibration status	:	OK	**Date of Analysis Start**	:	-----
Metrological conditions during monitoring	:	CLEAR SKY	**Date of Analysis Completion**	:	-----
Instrument code	:	A2ZELPL/SLM/01	**Actual Duration of Monitoring (MINUTE)**		30

Test Results

Sr. No.	LOCATION	Results	CPCB Limit	Unit	Reference Method
1.	NEAR TANK FARM	67	75	dB	IS 9989-1991
2.	NEAR JEETY LANDFALL AREA	59	75	dB	IS 9989-1991
3.	TANK FARM RIGHT SIDE	61	75	dB	IS 9989-1991
4.	TANK FARM LEFT SIDE	55	75	dB	IS 9989-1991

Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items tested and for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

---------- **End of Report** ----------

A 2 Z ENVIROTECH LAB PVT. LTD.

ENVIROTECH LAB PVT . LTD .

TC-10331

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 12/12/2023
Report No : A2ZELPL/DW/12/2023/04

Description of Sample:					
Date of Sampling	:	08/12/2023	Type of Sampling	:	Drinking Water
Date of Sample Received	:	08/12/2023	Sample ID	:	DW/122023/04
Sampling Location of Sampling Point	:	Near office area	Sample Particular	:	Drinking Water
Sample Collected / Submitted by	:	A2ZELPL Team Member	Reference Method for Sampling	:	------
Sample Quantity /Total No.	:	2 Litre/1Nos.	Date of Analysis Start	:	09/12/2023
Details of Packing/Label/Seal	:	Satisfactory	Date of Analysis Completion	:	11/12/2023
Environment condition during the test	:	25 ± 3 °C			

Test Results

Sr. No.	Parameters	Results	STANDARD Limit	Unit	Reference Method
1.	pH @°C	7.20	6.5-8.5	-	APHA, 23rd Edition 2017/4500-H+ B
2.	Electrical Conductivity @°C	0.50	--	mS/cm	APHA, 23rd Edition 2017/2510-B
3.	Temperature	25.5	--	°C	APHA, 23rd Edition 2017/2550B
4.	Total dissolved solids	266	500	mg/L	APHA, 23rd Edition 2017/ 2540-C
5.	Total Suspended solids	58	50-150	mg/L	APHA, 23rd Edition 2017/ 2540-D
6.	Chloride as Cl	40	250	mg/L	APHA, 23rd Edition 2017/ 4500 Cl- B
7.	Total Hardness as $CaCO_3$	52	200	mg/L	APHA, 23rd Edition 2017/2340-C
8.	Calcium as Ca	18.8	75	mg/L	APHA, 23rd Edition 2017/3500-Ca-B
9.	Magnesium as Mg.	9.5	30	mg/L	APHA, 23rd Edition 2017/Calculation Method 3500 –Mg B

Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items tested and for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

---------- **End of Report** ----------

A 2 Z ENVIROTECH LAB PVT. LTD.

ENVIROTECH LAB PVT . LTD .

TC-10331

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 09/01/2024
Report No : A2ZELPL/DW/01/2024/01

Description of Sample:					
Date of Sampling	:	05/01/2024	Type of Sampling	:	Drinking Water
Date of Sample Received	:	05/01/2024	Sample ID	:	DW/012024/01
Sampling Location of Sampling Point	:	Near office area	Sample Particular	:	Drinking Water
Sample Collected / Submitted by	:	A2ZELPL Team Member	Reference Method for Sampling	:	------
Sample Quantity /Total No.	:	2 Litre/1Nos.	Date of Analysis Start	:	06/01/2024
Details of Packing/Label/Seal	:	Satisfactory	Date of Analysis Completion	:	08/01/2024
Environment condition during the test	:	25 ± 3 °C			

Test Results

Sr. No.	Parameters	Results	STANDARD Limit	Unit	Reference Method
1.	pH @°C	7.18	6.5-8.5	-	APHA, 23rd Edition 2017/4500-H+ B
2.	Electrical Conductivity @°C	0.64	--	mS/cm	APHA, 23rd Edition 2017/2510-B
3.	Temperature	25	--	°C	APHA, 23rd Edition 2017/2550B
4.	Total dissolved solids	251	500	mg/L	APHA, 23rd Edition 2017/ 2540-C
5.	Total Suspended solids	69	50-150	mg/L	APHA, 23rd Edition 2017/ 2540-D
6.	Chloride as Cl	36	250	mg/L	APHA, 23rd Edition 2017/ 4500 Cl B
7.	Total Hardness as $CaCO_3$	48	200	mg/L	APHA, 23rd Edition 2017/2340-C
8.	Calcium as Ca	20	75	mg/L	APHA, 23rd Edition 2017/3500-Ca-B
9.	Magnesium as Mg.	10.7	30	mg/L	APHA, 23rd Edition 2017/Calculation Method 3500 -Mg B

Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items tested and for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

---------- **End of Report** ----------

A 2 Z ENVIROTECH LAB PVT. LTD.

ENVIROTECH LAB PVT . LTD .

TC-10331

TEST REPORT

Customer's Name and Address:
KOTPL
OPP,SHIRVA RAILAWAY CROSSING, NEAR LOC
FORESHORE TERMINALS NEW KANDLA -370210

Format No. : 7.8 F-01
Date of Report : 08/02/2024
Report No : A2ZELPL/DW/02/2024/01

Description of Sample:					
Date of Sampling	:	05/02/2024	Type of Sampling	:	Drinking Water
Date of Sample Received	:	05/02/2024	Sample ID	:	DW/022024/01
Sampling Location of Sampling Point	:	Near office area	Sample Particular	:	Drinking Water
Sample Collected / Submitted by	:	A2ZELPL Team Member	Reference Method for Sampling	:	------
Sample Quantity /Total No.	:	2 Litre/1Nos.	Date of Analysis Start	:	06/02/2024
Details of Packing/Label/Seal	:	Satisfactory	Date of Analysis Completion	:	07/02/2024
Environment condition during the test	:	25 ± 3 °C			

Test Results

Sr. No.	Parameters	Results	STANDARD Limit	Unit	Reference Method
1.	pH @°C	7.35	6.5-8.5	-	APHA, 23rd Edition 2017/4500-H+ B
2.	Electrical Conductivity @°C	0.75	--	mS/cm	APHA, 23rd Edition 2017/2510-B
3.	Temperature	25.3	--	°C	APHA, 23rd Edition 2017/2550B
4.	Total dissolved solids	236	500	mg/L	APHA, 23rd Edition 2017/ 2540-C
5.	Total Suspended solids	65	50-150	mg/L	APHA, 23rd Edition 2017/ 2540-D
6.	Chloride as Cl	42	250	mg/L	APHA, 23rd Edition 2017/ 4500 Cl- B
7.	Total Hardness as $CaCO_3$	56	200	mg/L	APHA, 23rd Edition 2017/2340-C
8.	Calcium as Ca	21.6	75	mg/L	APHA, 23rd Edition 2017/3500-Ca-B
9.	Magnesium as Mg	12.4	30	mg/L	APHA, 23rd Edition 2017/Calculation Method 3500 –Mg B

Tested By
(Sr. Analyst/Analyst)

Authorized Signatory
Akbarkhan P. Jalori
(Quality Manager)

This Report is issued under the following terms & Condition:

1. The results relate only to the items tested and for applicable parameter
2. This Test report shall not to be reproduced in full or part for any promotional or publicity and can't be used as evidence in court of law without the written consent of A 2 Z Envirotech Lab Private Limited
3. Reanalysis of the sample will be done if requested Within 15 days from the date of reporting of sample if the samples are not consumed during analysis.

---------- **End of Report** ----------

/

Annexure B

CRZ Compliance

Annexure 1

CURRENT STATUS OF WORK (up to May, 2024)

Subject: Development of 7 integrated facilities (Stage I) within existing Deendayal Authority at Kandla.

Name of Project	Status
1. Development of oil jetty to handle liquid cargo and ship bunkering terminal at old Kandla under PP mode (jetty: 300m x 15m, approach 450 m X 10 m, back up area 5.5 HA, capacity – 3.39 MMTPA, capital dredging 1,73,660 m^3 maintenance dredging 1,56,294 m^3 (Estimated cost: 276.53 Cr.)	The Concession Agreement was executed between DPA and M/s KOTPL on 16/11/2013 to implement the project on Built, Transfer & Operate (BOT- PPP) Basis by M/s KOTPL. The award of concession was issued on 11/12/2020 to M/s KOTPL by DPA. **The Project is under construction phase.**
2. Multipurpose Cargo Terminal at Tekra off Tuna on BOT basis (T shape jetty 600m X 80 m Capacity 18 MMTPA, back up area 101 Ha capital dredging 1,26,57,175 m^3 maintenance dredging 18,98,576. 25 m^3 Estimated cost: 1686.66 Cr.	The Board of DPA approved the Feasibility Report in its meeting on 19.02.2021. The MoPSW,GoI vide communication dated 21/10/2022 has conveyed approval granted by the Cabinet Committee on Economic Affairs to the project. The project is under bidding stage. **No construction activity has started yet.**
3. Up gradation of Barge handling capacity at Bundar basis at Kandla capacity 3.33 MMTA back-up area 5 Ha, Estimated cost: 109.59 Cr.	The up-gradation work was completed.
4. Construction of Rail over Bridge at NH 8 A near Nakti Bridge (crossing of NH 8 A Estimated cost: 32.17 Cr.	**Construction activity has not yet started.**
5. Mechanization of Dry Cargo handling capacity at Kandla Port (Berth 7 and 8 capacity 7.35 MMTPA estimated cost 80.61 Cr.	Mechanization work already completed.
6. Strengthening of Oil jetty 1 (Estimated cost: 7.5 Cr.	The strengthening work completed.
7. Modification and strengthening of Cargo berth No. 6 at Kandla Port Estimated cost: 11.5 Cr.	The modification & strengthening work completed.

Out of a total of 7 project activities, construction activities of 4 projects (i.e. Sr. No. 3, 5, 6 & 7 mentioned in the EC & CRZ Clearance) have already been completed. Whereas construction activity of the project at Sr. No. 2 & 4 have not yet started.

For the current compliance period up to May, 2024, construction activity related to project No. 1 is ongoing. The compliance report submitted by the Concessionaire M/s KOTPL is attached herewith as Annexure A.

COMPLIANCE REPORT (for the period up to May 2024)

Subject: Status of Compliance with the conditions stipulated By Gujarat State Coastal Zone Management Authority, Gandhinagar, in CRZ Recommendation Letter granted for "**Development of 7 integrated facilities (Stage I) within existing Deendayal Authority at Kandla**".

CRZ Recommendations: Letter No. ENV-I0-2014-25-E dated July 1, 2015, of Director (Environment) & Member Secretary, GCZMA, Forest & Environment Department, GoG.

**Note: Based on the recommendation of* the GCZMA, MoEF&CC, GoI *had accorded Environmental & CRZ Clearance vide letter dated 19/12/2016*

Sr. No.	Conditions in CRZ Recommendation Letter	Compliance
	Specific Conditions	
1	The provisions of the CRZ notification of 2011 and subsequent amendments issued from time to time shall be strictly adhered to by the KPT. No activity in contradiction to the Provisions of the CRZ Notification shall be carried out by the KPT.	a) For Project at Sr. No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A**. b) Further, w.r.t. project at Sr. No. 2 & 4 (construction not yet started), it is assured that no activity in contradiction to the Provisions of the CRZ Notification shall be carried out by DPA. c) Project at Sr no. 3,5,6 and 7 is already completed.
2	The KPT shall have to ensure that there shall not be any damage to the existing mangrove area.	a) For Project at Sr. No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A**. b) Further, w.r.t. project at sr.no. 2 & 4 (construction not yet started), it is assured that due care shall be taken to protect the existing mangrove area.
3	The KPT shall prepare an emergency plan to protect existing mangroves in case of any eventuality/accident.	DPA had already prepared report through Gujarat Institute of Desert Ecology, Bhuj on Study on present Status, Conservation and Management plan for Mangroves of Deendayal Port region.
4	The KPT shall have to make a provision that mangrove areas get proper flushing water and free flow of water shall not be obstructed.	a) For Project at Sr. No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A.** b) Further, w.r.t. project at sr.no. 2 & 4 (construction not yet started), it is assured that provisions shall be made that mangrove areas get proper flushing water and free flow of water shall not be obstructed.
5	The KPT shall have to abide by whatever decision is taken by the GCZMA for violations of CRZ Notification, 2011.	a) Point noted. DPA will abide by whatever decision is taken by the GCZMA for violations of CRZ Notification, 2011. b) For Project at Sr. No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A.**
6	There shall not be violations of the order dated 9/12/2013 passed by the National Green Tribunal; and accordingly, there shall be no mangrove destruction taking place in the KPT area.	a) Point Noted. It is hereby assured that due care shall be taken to protect the existing mangrove area. b) For Project at Sr.No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A.**
7	No dredging, reclamation or any other project-related activities shall be carried out in the CRZ area categorised as CRZ I (i), 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 activity.	a) It is hereby assured that DPA will undertake only such project activities (7 project activities) recommended by the GCZMA vide letter dated 1/7/2015 and EC & CRZ Clearance accorded by the MoEF&CC, GoI vide letter dated 19/12/2016. DPA issued a 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 Authority (Erstwhile Deendayal Port Trust) and continuous Monitoring Program covering all

		seasons on various aspects of the Coastal Environs for the period 2021-24. Final Report for the period 2020-21 has already been submitted along with compliance report submitted dated 07/10/2021 The final report for the year 2023-24 is attached herewith as **Annexure B.** In continuation of the same, DPA issued a work order to M/s GUIDE vide its letter no. EG/ WK/ 4751/ Part (Marine Ecology Monitoring) /72 dated 10/06/2024 for further period of 2024 – 27 (Work order attached as **Annexure C)** b) For Project at Sr.No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A.**
8	The KPT shall participate financially in installing and operating the Vessel Traffic Management System in the Gulf of Kachchh and shall also take the lead in preparing and operational sing and updating regularly after getting it vetted by the Indian Coast Guard.	Deendayal Port Authority had already contributed Rs. 41.25 crores, i.e. 25% of the total project cost of 165 crores for installing and operating the VTMS in the Gulf of Kachchh.
9	The KPT shall strictly ensure that no creeks or rivers are blocked due to any activity at Kandla.	a) For Project at Sr.No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A.** b) Further, w.r.t. project at sr.no. 2 & 4 (construction not yet started), it is assured that no creeks or rivers shall be blocked due to any activity at Kandla.
10	Mangrove plantation in an area of 100 ha. Shall be carried out by the KPT within 2 years in time bound manner on Gujarat coastline either within or outside the Kandla port Trust area, and a six-monthly compliance report along with the satellite images shall be submitted to the Ministry of Environment and Forest as well as to this Department without fail.	DPA has undertaken Mangrove Plantation in an area of 1600 Hectares since the year 2005. carried out through various agencies. The copy of the details has already been communicated with the earlier compliance reports submitted. In addition to the above, DPA appointed M/s GUIDE, Bhuj, for "Regular Monitoring of Mangrove Plantation carried out by DPA" (period 15/9/2017 to 14/9/2018 vide work order dated 1/9/2017 and 24/5/2021 to 23/5/2022 vide work order dated 3/5/2021). The final report submitted by M/s GUIDE, Bhuj, for the years 2017 to 2018 as well as for the year 2021 to 2022 has been submitted in the earlier compliance report submitted. Further, vide work order dated 10/06/224 DPA appointed M/s GUIDE, Bhuj, for "Regular Monitoring of Mangrove Plantation carried out by DPA" (Period 10/06/2024 to 09/06/2025) (A copy of work order is attached herewith as **Annexure D**)
11	No activities other than those permitted by the competent authority under the CRZ Notification shall be carried out in the CRZ area.	a) Point Noted. It is assured that only activities permitted by the competent authority under the CRZ Notification shall be carried out in the CRZ area. b) For Project at Sr. No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A**.
12	No groundwater shall be tapped for any purpose during the proposed expansion modernization activities.	a) For Project at Sr.No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A**. b) Further, w.r.t. Project at Sr. no.2 & 4 (construction not yet started), Water requirement will be met through procurement from GWSSB or private tankers. No ground water shall be tapped.

13	All necessary permissions from different Government Departments/agencies shall be obtained by the KPT before commencing the expansion activities.	DPA had already obtained the necessary Environmental & CRZ Clearance for 7 project activities (dated 19.12.2016). Further, Consent to Establish from GPCB had already been obtained from GPCB for 7 project activities. Moreover, DPA had obtained CTE validity extension (CTE-125870) from GPCB vide Order dated 27/04/2023 with validity up to 15/11/2025.
14	No effluent or sewage shall be discharged into sea/creek or in the CRZ area and it shall be treated to conform to the norms prescribed by the GPCB and would be reused /recycled within the plant premises.	a) For completed projects (modification/ strengthening/ up-gradation of existing facilities), Sewage is being treated in the STP of Kandla (1.5 MLD). The treated sewages from STP of DPA are utilized for plantation / Gardening. For monitoring of environmental parameters, DPA has been appointing NABL Accredited laboratory and reports are being submitted from time to time to the GPCB, IRO, MoEF&CC, GoI, Gandhinagar. Recently, DPA appointed GEMI, Gandhinagar for regular monitoring of environmental parameters vide Work Order dated 15/02/2023. The work is in progress and the annual environmental monitoring report submitted by GEMI, Gandhinagar is attached herewith as **Annexure E**. b) Further, w.r.t. Project at Sr.No.1, kindly refer to the Monitoring reports submitted by M/s KOTPL along with compliance report placed at **Annexure A**.
15	All the recommendations and suggestion given by the MANTEC Consultants Pvt. Ltd. in their Comprehensive Environment Impact Assessment report for conservation / protection and betterment of environment shall be implemented strictly by the KPT.	DPA has installed Mist Canon at the Port area to minimize the dust. DPA has undertaken the project of dust supersession sprinkling system for the 34 hectare coal storage yard Further, DPA has already installed continuous sprinkling system in coal stack yard in DPA (40 ha. area) to prevent dust pollution. Further, to control dust pollution in other area, regular sprinkling through tankers on roads and other staking yards is being done. Regular sweeping of spilled cargo from roads is done by parties on regular basis. For monitoring of environmental parameters, DPA has been appointing NABL Accredited laboratory and reports are being submitted from time to time to the GPCB, IRO, MoEF&CC, GoI, Gandhinagar. Recently, DPA appointed GEMI, Gandhinagar for regular monitoring of environmental parameters vide Work Order dated 15/02/2023. The work is in progress and the annual environmental monitoring report submitted by GEMI, Gandhinagar is attached herewith as **Annexure E**. For ship waste management, DPA issued Grant of License/Permission to carry out the work of collection and disposal of "Hazardous Waste/Sludge/ Waste Oil" and "Dry Solid Waste (Non- Hazardous)" from Vessels calling at Deendayal Port" through DPA contractors. Further, it is to state that, all ships are required to follow DG Shipping circulars regarding the reception facilities at Swachch Sagar portal. Further, DPA has appointed GEMI, Gandhinagar for the work of "Preparation of Plan for Management of Plastic Wastes, Solid Waste, including C&D waste, E-waste, Hazardous waste, including Biomedical and Non-Hazardous Waste in the Deendayal Port Authority" vide Work Order dated 24/01/2023. The work is in progress. DPA assigned work to M/s GUIDE, Bhuj, for regular monitoring of Marine Ecology since the year 2017 (From

		2017 – 2021), and final reports of the same submitted by GUIDE, Bhuj has already been communicated to the Regional Office, MoEF&CC, GoI, Gandhinagar as well as to the MoEF&CC, GoI, New Delhi along with compliance reports submitted. Further, DPA issued a 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 Authority (Erstwhile Deendayal Port Trust) and continuous Monitoring Program covering all seasons on various aspects of the Coastal Environs for the period 2021-24. Final Report for the period 2020-21 has already been submitted along with compliance report submitted dated 07/10/2021 The final report for the year 2023-24 is attached herewith as **Annexure B.** In continuation of the same, DPA issued a work order to M/s GUIDE vide its letter no. EG/ WK/ 4751/ Part (Marine Ecology Monitoring) /72 dated 10/06/2024 for further period of 2024 – 27 (Work order attached as **Annexure C)** As already informed, DPA entrusted work of green belt development in and around the Port area to the Forest Department, Gujarat at Rs. 352 lakhs (Area 32 hectares). The work is completed. Further, DPA has appointed the Gujarat Institute of Desert Ecology (GUIDE) for "Green belt development in Deendayal Port Authority and its Surrounding Areas, Charcoal site' (Phase-I)" vide Work Order No.EG/WK/4757/Part [Greenbelt GUIDE, dated 31st May 2022. The final report submitted by GUIDE, Bhuj is submitted by compliance report submitted on 12/09/2023. Further DPA has accorded the work of "Green belt development in DPA and its surrounding area (Phase II) to Gujarat Institute of Desert Ecology (GUIDE), Bhuj for the plantation of 10000 saplings of suitable species vide work order dated 23/06/2023. The same is in process For dredged material management, DPA assigned work to M/s GUIDE, Bhuj for analysis of dredged material since the year 2017 and the reports are being submitted from time to time along with compliance reports submitted. The final Report submitted by M/s GUIDE, Bhuj for the period 2022-2023 is attached herewith as **Annexure D.** Further, Dredged Material will be disposed of at designated location as identified by the CWPRS, Pune. For energy conservation measures, DPA is already generating 20 MW of Wind energy. In addition to it, DPA has commissioned a 45 kWP Solar Plant at Gandhidham. Further, it is relevant to mention that, two out of four Nos. of Harbour Mobile Crane (HMC) made electric operated. Balance 02 Nos. shall be made electric operated by 2023-2024. Four Nos. of Deisel operated RTGs converted to e-RTGs. Retrofitting of hydrogen fuel cell in Tug Kalinga and Pilot Boat Niharika to be done as a pilot project under the guidance of MoPSW. Also, 14 Nos. of EV cars to be hired in this year and 03 Nos. EV Bus to be procured by the year 2023-24.

		Further, for Oil Spill Management, DPA is already having Oil Spill Contingency Plan in place and Oil Response System as per the NOS-DCP guidelines.
16	The construction and operational activities shall be carried out in such a way that there is no negative impact on mangroves and other coastal /marine habitats. The construction activities and dredging shall be carried out only under the constant supervision and guidelines of the Institute of National repute like NIOT.	a) For Project at Sr. No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A.** b) For the remaining projects Sr. No 2 & 4 (construction not yet started), it is assured that construction activities and dredging shall be carried out only under the constant supervision and guidelines of the Institute of National repute like NIOT.
17	The KPT shall contribute financially for any common study or project that may be proposed by this Department for environmental management / conservation / improvement for the Gulf of Kutch.	Point noted.
18	The construction debris and / or any other of waste shall not be disposed of into the sea, creek or the CRZ areas. The debris shall be removed from the construction site immediately after the construction is over.	a) For Project at Sr.No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A**. b) Further, w.r.t. project at sr.no. 2 & 4 (construction not yet started), it is assured that construction debris and/ or any other of waste shall not be disposed of into the sea, creek or the CRZ areas, and the debris shall be removed from the construction site immediately after the construction is over.
19	The construction camps shall be located outside the CRZ area and the construction labour shall be provided with the necessary amenities, including sanitation, water supply and fuel and it shall be ensured that the environmental conditions are not deteriorated by the construction labours.	a) No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A**. b) Further, w.r.t. project at sr.no. 2 & 4 (construction not yet started), it is assured that, the construction camps shall be located outside the CRZ area, provision of the necessary amenities, including sanitation, water supply and fuel to the construction labour shall be made, and that the environmental conditions are not deteriorated by the construction labours.
20	The KPT shall regularly updates its Local Oil Spill Contingency and Disaster management Plan in accordance with the National Oil Spill and Disaster Contingency Plan and shall submit the same to the MoEF, GoI and this department after having it vetted through the Indian Coast Guard.	▪ Deendayal Port already has an updated Disaster Management Plan. ▪ Further, the Local Oil Spill Contingency Plan is already available with Deendayal Port Trust. ▪ DPA has also executed MOU with Oil Companies, i.e. IOCL, HPCL, BPCL etc., for combating the Oil Spill at Kandla
21	The KPT shall bear the cost of the external agency that may be appointed by this Department for supervision/monitoring of proposed activities and the environmental impacts of the proposed activities.	Point noted.
22	The KPT shall take up massive greenbelt development activities in and around Kandla and also within the KPT limits.	DPA has planted about one lakhs trees in roadside dividers, colony areas at Kandla and Gopalpuri, in the green belt area of Gandhidham & Adipur Township, Sewage Treatment Plants at Gopalpuri & Kandla and some green belt development plans initiated at different locations in Township areas. DPA entrusted work of green belt development in and around the Port area to the Forest Department, Gujarat, at the cost of Rs. 352 lakhs (Area 32 hectares). The plantation is completed. Further, DPA has appointed the Gujarat Institute of Desert Ecology (GUIDE) for "Green belt development in Deendayal

		Port Authority and its Surrounding Areas, Charcoal site' (Phase-I)" vide Work Order No.EG/WK/4757/Part [Greenbelt GUIDE, dated 31st May 2022. The final report submitted by GUIDE, Bhuj is submitted along with compliance report submitted on 12/09/2023. Further DPA has accorded the work of "Green belt development in DPA and its surrounding area (Phase II) to Gujarat Institute of Desert Ecology (GUIDE), Bhuj for the plantation of 10000 saplings of suitable species vide work order dated 23/06/2023. The same is in process
23	The KPT shall have to contribute financially for taking up the socio-economic upliftment activities in this region in construction with the Forest and Environment Department and the District Collector/District Development Officer.	The details of the fund earmarked under CSR activities and CSR activities undertaken by DPA to date & proposed activities are placed at **Annexure F**.
24	A separate budget shall be earmarked for environmental management and socioeconomic activities and details there of shall be furnished to this Department as well as the MoEF, GOI. The details with respect to the expenditure from this budget head shall also be furnished.	a) The allocation made under the "Environmental Services & Clearance of other related Expenditure" during BE 2023-24 is Rs. 657 Lakhs. b) The funds earmarked for EMP by the Concessionaire M/s KOTPL w.r.t. project at Sr.No. 1 are delineated in the compliance report submitted (**Annexure A**).
25	A separate environmental management cell with qualified personnel shall be created for environmental monitoring and management during the construction and operational phases of the project.	a) For Project at Sr.No. 1 which is under construction, kindly refer compliance submitted by M/s KOTPL (concessionaire of the project) placed at **Annexure A.** b) DPA is already having Environment Management cell. Further, DPA has also appointed expert agency for providing Environmental Experts from time to time. Recently, DPA appointed M/s Precitech Laboratories, Vapi for providing Environmental Experts vide work order dated 5/2/2021. In addition, it is relevant to submit here that, DPA has appointed Manager (Environment) on contractual basis for the period of 3 years and further extendable to 2 years (Copy of the details has already been communicated with the last compliance report submitted). For monitoring of environmental parameters, DPA has been appointing NABL Accredited laboratory and reports are being submitted from time to time to the GPCB, IRO, MoEF&CC, GoI, Gandhinagar. Recently, DPA appointed GEMI, Gandhinagar for regular monitoring of environmental parameters vide Work Order dated 15/02/2023. The work is in progress and the annual environmental monitoring report submitted by GEMI, Gandhinagar is attached herewith as **Annexure E**.
26	An Environmental report indicating the changes, if any, with respect to the baseline environmental quality in the coastal and marine environment shall be submitted every year by the KPT to this Department as well as to the MoEF&CC, GOI.	For monitoring of environmental parameters, DPA has been appointing NABL Accredited laboratory and reports are being submitted from time to time to the GPCB, IRO, MoEF&CC, GoI, Gandhinagar. Recently, DPA appointed GEMI, Gandhinagar for regular monitoring of environmental parameters vide Work Order dated 15/02/2023. The work is in progress and the annual environmental monitoring report submitted by GEMI, Gandhinagar is attached herewith as **Annexure E**.
27	The KPT shall have to contribute financially to support the National Green Corps Scheme being implemented in Gujarat by the GEER Foundation, Gandhinagar, in construction with Forests and Environment Department.	Point Noted.
28	A six-monthly report on compliance of the conditions mentioned in this letter shall have to be furnished by the KPT on	DPA has been submitting the six-monthly compliance report of the conditions stipulated in CRZ recommendation to GCZMA and IRO, MoEF&CC, GoI, Gandhinagar.

	regular basis to this department/MoEF, GOI.	
29	Any other condition that may be stipulated by this department from time to time for environmental protection/management purpose shall also have to be complied with by the KPT.	Point noted.

/

Annexure C

Annual monitoring report of GEMI

Environmental Monitoring Annual Report

prepared under

"Preparing and monitoring of environmental monitoring and management plan for Deendayal Port Authority at Kandla and Vadinar for a period of 3 years"

Monitoring Period: 15th April 2023 -15th April 2024

Document Ref No.: GEMI/DPA/782(2)(2)/2024-25/78

Submitted to:

Deendayal Port Authority (DPA), Kandla

Gujarat Environment Management Institute (GEMI)

(An Autonomous Institute of Government of Gujarat)

GEMI Bhavan, 246-247, GIDC Electronic Estate, Sector-25, Gandhinagar-382025

"AN ISO 9001:2015, ISO 14001:2015 AND ISO 45001:2018 Certified Institute"

About this Document

Gujarat Environment Management Institute (GEMI) has been assigned with the work of "Preparing and monitoring of Environmental monitoring and Management plan for Deendayal Port Authority (DPA) at Kandla and Vadinar for a period of 3 years" by DPA, Kandla. Under the said project the report titled *"Environment Monitoring Annual Report (Monitoring Period: April 2023 - April 2024)"* is prepared.

- **Name of the Report:** *Environment Monitoring Report (Monitoring Period April 2023-April 2024)*
- **Date of Issue:**
- **Version:** 1.0
- **Report Ref.:** GEMI/DPA/782(2)(2)/2024-25/78

Table of Contents

List of Tables

List of Maps

List of Figures

List of Graphs

List of Abbreviations

A	Acceptable Limits as per IS: 10500:2012
AAQ	Ambient Air Quality
AWS	Automatic Weather monitoring stations
BIS	Bureau of Indian Standards
BOD	Biochemical Oxygen Demand
BQL	Below Quantification Limit
CCA	Consolidated Consent & Authorization
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
DO	Dissolved Oxygen
DPA	Deendayal Port Authority
EC	Electrical Conductivity
EMMP	Environmental monitoring and Management Plan
EMP	Environment Management Plan
FPS	Fine Particulate Sampler
FY	Financial Year
GEMI	Gujarat Environment Management Institute
IFFCO	Indian Farmers Fertiliser Cooperative Limited
IMD	India Meteorological Department
IOCL	Indian Oil Corporation Limited
LNG	Liquefied Natural Gas
MGO	Marine Gas Oil
MMTPA	Million Metric Tonnes Per Annum
MoEF	Ministry of Environment & Forests
MoEF&CC	Ministry of Environment, Forest and Climate Change
NAAQS	National Ambient Air Quality Standards
NO_x	Nitrogen oxides
NTU	Nephelometric Turbidity Unit
OOT	Off Shore Oil Terminal
OSR	Oil Spill Response
P	Permissible Limits as per IS: 10500:2012
PAH	Poly Aromatic Hydrocarbons
PM	Particulate Matter
PTFE	Polytetrafluoroethylene
RCC	Reinforced Concrete Cement
RDS	Respirable Dust Sampler
SAR	Sodium Adsorption Ratio
SBM	Single Bouy Mooring
SO_x	Sulfur oxides
STP	Sewage Treatment Plant
TC	Total Coliforms
TDS	Total Dissolved Solids
TOC	Total organic Carbon
TSS	Total Suspended Solids
VOC	Volatile Organic Compounds

CHAPTER 1: INTRODUCTION

1.1 Introduction

Kandla Port, also known as the Deendayal Port is a seaport in Kachchh District near the city of Gandhidham in Gujarat state in western India. Located on the Gulf of Kachchh, it is one of major ports on the western coast, and is located at 256 nautical miles southeast of the Port of Karachi in Pakistan and over 430 nautical miles north-northwest of the Port of Mumbai (Bombay). It is the largest port of India by volume of cargo handled. Deendayal Port's journey began in 1931 with the construction of RCC Jetty by Maharao Khengarji. Kandla was constructed in the 1950s as the chief seaport serving western India, after the independence of India. On 31st March 2016, Deendayal Port created history by handling 100 MMT cargo in a year and became the first Major Port to achieve this milestone. Deendayal Port Authority (DPA), India's busiest major port in recent years, is gearing up to add substantial cargo handling capacity with private sector participation. DPA has created new record by handling 137 MMTPA (at Kandla and Vadinar) during the financial year 2022-23. The DPA had commissioned the Off-shore Oil Terminal facilities at Vadinar in the year 1978, for which M/s. Indian Oil Corporation Limited (IOCL) provided Single Bouy Mooring (SBM) system, with a capacity of 54 MMTPA. Further, significant Quantum of infrastructural upgradation has been carried out & excellent maritime infrastructure has been created at Vadinar for the 32 MMTPA Essar Oil Refinery in Jamnagar District.

1.2 Green Ports Initiative

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

The Green Port Initiatives include twelve initiatives such as preparation and monitoring plan, acquiring equipment required for monitoring environmental pollution, acquiring dust suppression system, setting up of sewage/waste water treatment plants/ garbage disposal plant, setting up Green Cover area, projects for energy generation from renewable energy sources, completion of shortfalls of Oil Spill Response (OSR) facilities (Tier-I), prohibition of disposal of almost all kind of garbage at sea, improving the quality of harbour wastes etc.

DPA had also appointed GEMI as an Advisor for "Making Deendayal Port a Green Port-Intended Sustainable Development under the Green Port Initiatives. DPA has also signed MoU with Gujarat Forest Department in August 2019 for Green Belt Development in an area of 31.942 Ha of land owned by DPA. The plantation is being carried out by the Social Forestry division of Kachchh.

1.3 Importance of Environmental monitoring and management plan (EMMP)

Port activities can cause deterioration of air and marine water quality in the surrounding areas due to multifarious activities. The pollution problems usually caused by port and harbour activities can be categorized as follows:

1. Air pollutant emissions due to ship emissions, loading and unloading activities, construction emission and emissions due to vehicular movement.

2. Coastal habitats may be destroyed and navigational channels silted due to causeway construction and land reclamation.
3. Deterioration of surface water quality may occur during both the construction and operation phases.
4. Harbour operations may produce sewage, bilge wastes, solid waste and leakage of harmful materials both from shore and ships.
5. Human and fish health may be affected by contamination of coastal water due to urban effluent discharge.
6. Oil pollution is one of the major environmental hazards resulting from port/harbour and shipping operations. This includes bilge oil released from commercial ships handling non-oil cargo as well as the more common threat from oil tankers.
7. Unregulated mariculture activities in the port and harbour areas may threaten navigation safety.

Hence, for the determination of levels of pollution, identification of pollution sources, control and disposal of waste from various point and non-point sources and for prediction of pollution levels for future, regular monitoring and assessment are required during the entire construction and operation phase of a major port. As per the Ministry of Environment, Forest and Climate Change **(MoEF&CC)**, The Environmental Management Plan (EMP) is required to ensure sustainable development in the area surrounding the project. Hence, it needs to be an all encompasses plan consist of all mitigation measures for each item wise activity to be undertaken during the construction, operation and the entire life cycle to minimize adverse environmental impacts resulting from the activities of the project. for formulation, implementation and monitoring of environmental protection measures during and after commissioning of projects. The plan should indicate the details of various measures are taken and proposed to be taken for appropriate management of the environment of Deendayal Port Authority.

It identifies the principles, approach, procedures and methods that will be used to control and minimize the environmental and social impacts of operational activities associated with the port. An EMP is a required part of environmental impact assessment of a new port project but could also be evolved for existing ports. It is useful not only during the construction and operational phases of the new port but also for operation of existing ports to ensure the effectiveness of the mitigation measures implemented and to further provide guidance as to the most appropriate way of dealing with any unforeseen impacts.

It is extremely essential that port and harbour projects should have an Environmental Monitoring and Management Plan (EMMP), which incorporates monitoring of Ambient Air, Drinking Water, Noise, Soil, Marine (water, sediment, ecology) quality along with the collection of online meteorological data throughout the duration of the project.

To ensure the effective implementation of the EMP and weigh the efficiency of the mitigation measures, it is essential to undertake environmental monitoring both during construction and operation period. In view of the above, Gujarat Environment Management Institute (GEMI) has been awarded with the work "**Preparing and Monitoring of Environmental Monitoring and Management Plan for Deendayal Port Authority at Kandla and Vadinar for a period of 3 years**" vide letter No. EG/WK/EMC/1023/2011/III/239 dated: 15/02/2023 by DPA.

This document presents the Environmental Monitoring Report (EMR) for Kandla and Vadinar for the environmental monitoring done during the period from 15th April 2023-15th April 2024.

1.4 Objectives and scope of the Study

In line with the work order, the key objective of the study is to carry out the Environmental Monitoring and preparation the Management Plan for Kandla and Vadinar for a period of 3 years". Under the project, Environmental monitoring refers to systematic monthly monitoring and assessment of ambient air, water (drinking and surface), soil, sediment, noise and ecology in order to monitor the performance and implementation of a project in compliance with Environmental quality standards and/or applicable Statutory norms.

The scope of work includes not limited to following:

1. To review the locations/stations of Ambient Air, Ambient Noise, drinking water, and Marine Water, Soil and Sediments monitoring within the impacted region in-and-around DPA establishment, in view of the developmental projects.
2. To assess the Ambient Air quality, quality at 6 stations at Kandla and 2 at Vadinar in terms of gases and particulate matter.
3. To assess the DG stack emissions (gases and particulate matter).
4. To assess Drinking water quality at twenty locations (18 at Kandla and 2 at Vadinar) in terms of Physical, Chemical and Biological parameters viz., Color, Odor, turbidity, conductivity, pH, Total Dissolved Solids, chlorides, Hardness, total iron, sulphate, NH_4, PO_4, and bacterial count on a monthly basis.
5. To assess the Marine water quality in terms of aquatic Flora and Fauna and Sediment quality in terms of benthic flora and fauna.
6. To assess Marine Water Quality and sediment in term of physical and chemical parameter.
7. To assess the trends of water quality in terms of Marine ecology by comparing the data collected over a specified time period.
8. Weekly sample collection and analysis of inlet & Outlet points of the Sewage Treatment Plant (STP) to check the water quality being discharged by DPA as per the CC&A.
9. Carrying out monthly Noise monitoring; twice a day at the representative stations for a period of 24 hours.
10. Meteorological parameters are very important from air pollution point of view, hence precise and continuous data collection is of utmost importance. Meteorological data on wind speed, wind direction, temperature, relative humidity, solar radiation and rainfall shall be collected from one permanent station at DPA, Kandla and one permanent station at Vadinar.
11. To suggest mitigation measures, based on the findings of this study and also check compliance with Environmental quality standards, Green Port Initiatives, MIV 2030, and any applicable Statutory Compliance.
12. To recommend Environment Management Plans based on Monitoring programme and findings of the study.

CHAPTER 2: METHODOLOGY

2.1 Study Area

Under the study, the locations specified by Deendayal Port Authority for the areas of Kandla and Vadinar would be monitored. The details of the study area as follows:

a. Kandla

Deendayal Port (Erstwhile Kandla Port) is one of the twelve major ports in India and is located on the West Coast of India, in the Gulf of Kutch at 23001'N and 70013'E in Gujarat. The Major Port Authorities Act 2021 is the governing statute for Administration of Major Ports, under which, Deendayal Port Trust (DPT) has become Deendayal Port Authority (DPA). At Kandla, DPA has sixteen (16) cargo berths for handling various types of Dry Bulk Cargo viz, fertilizer, food grains, Coal, sulphur, etc.

- **Climatic conditions of Kandla**

Kandla has a semi-desert climate. Temperature varies from 25°C to 44°C during summer and 10°C to 25°C during winter. The average annual temperature is 24.8 °C. The average rainfall is 410 mm, most of which occurs during the monsoon from the months of June-to-September.

b. Vadinar

Vadinar is a small coastal town located in Devbhumi Dwarka district of the Gujarat state in India located at coordinates 22° 27' 16.20" N - 069° 40' 30.01". DPA had commissioned the Off Shore Oil Terminal (OOT) facilities at Vadinar in the year 1978, for which M/s. Indian Oil Corporation Limited (IOCL) provided Single Bouy Mooring (SBM) system, with a capacity of 54 MMTPA. The OOT of the DPA contributes in a large way to the total earnings of this port. Vadinar is now notable due to the presence of two refineries-one promoted by Reliance Industries and Essar Oil Ltd.

DPA also handled 43.30 MMT at Vadinar (which includes transhipment), the containerized cargo crossed 4.50 lakh TEU, grossing a total of 100 MMT overall. Major commodities handled by the Deendayal Port are Crude Oil, Petroleum product, Coal, Salt, Edible Oil, Fertilizer, etc.

- **Climatic conditions of Vadinar**

Vadinar has a hot semi-arid climate. The summer season lasts from March-to-May and is extremely hot, humid, but dry. The climatic conditions in Vadinar are quite similar to that recorded in its district head quarter i.e., Jamnagar. The annual mean temperature is 26.7 °C. Rainy season with extremely erratic monsoonal rainfall that averages around 630 millimetres. The winter season is from October-to-February remains hot during the day but has negligible rainfall, low humidity and cool nights.

The Kandla and Vadinar port have been depicted in the **Map 1 & 2** as follows:

Map 1: Locations of Kandla and Vadinar Port

Map 2: Locations of Kandla Port

Map 3: Locations of Vadinar Port

2.2 Environmental Monitoring at Kandla and Vadinar

Regular monitoring of environmental parameters is of immense importance to assess the status of environment during project operation. With the knowledge of baseline conditions, the monitoring programme will serve as an indicator for identifying any deterioration in environmental conditions, thereby assist in recommending suitable mitigatory steps in time to safeguard the environment. Monitoring is as important as that of control of pollution since the efficiency of control measures can only be determined by a well-defined monitoring program. Environmental Monitoring is vital for monitoring the environmental status of the port for sustainable development. The list of main elements for which Environmental monitoring is to be carried out have been mentioned below:

- Meteorology
- Ambient Air
- DG Stack
- Noise
- Soil
- Drinking Water
- Sewage Treatment Plant
- Marine (Surface) water
- Marine Sediments
- Marine Ecology

GEMI has been entrusted by DPA to carry out the monitoring of the various aforementioned environmental aspects at the port, so as to verify effectiveness of prevailing Environment Management plan, if it confirms to the statutory and/or legal compliance; and identify any unexpected changes. Standard methods and procedures have been strictly adhered to in the course of this study. QA/QC procedures were strictly followed which covers all aspects of the study, and includes sample collection, handling, laboratory analyses, data coding, statistical analyses, interpretation and communication of results. The analysis was carried out in GEMI's NABL/MoEF accredited/recognized laboratory.

Methodology adopted for the study

Methodology is a strictly defined combination of practices, methods and processes to plan, develop and control a project along the continuous process of its implementation and successful completion. The aim of the project management methodology is to allow the control of whole process of management through effective decision-making and problem solving. The methodology adopted for the present study is shown in **Figure 1** as given below:

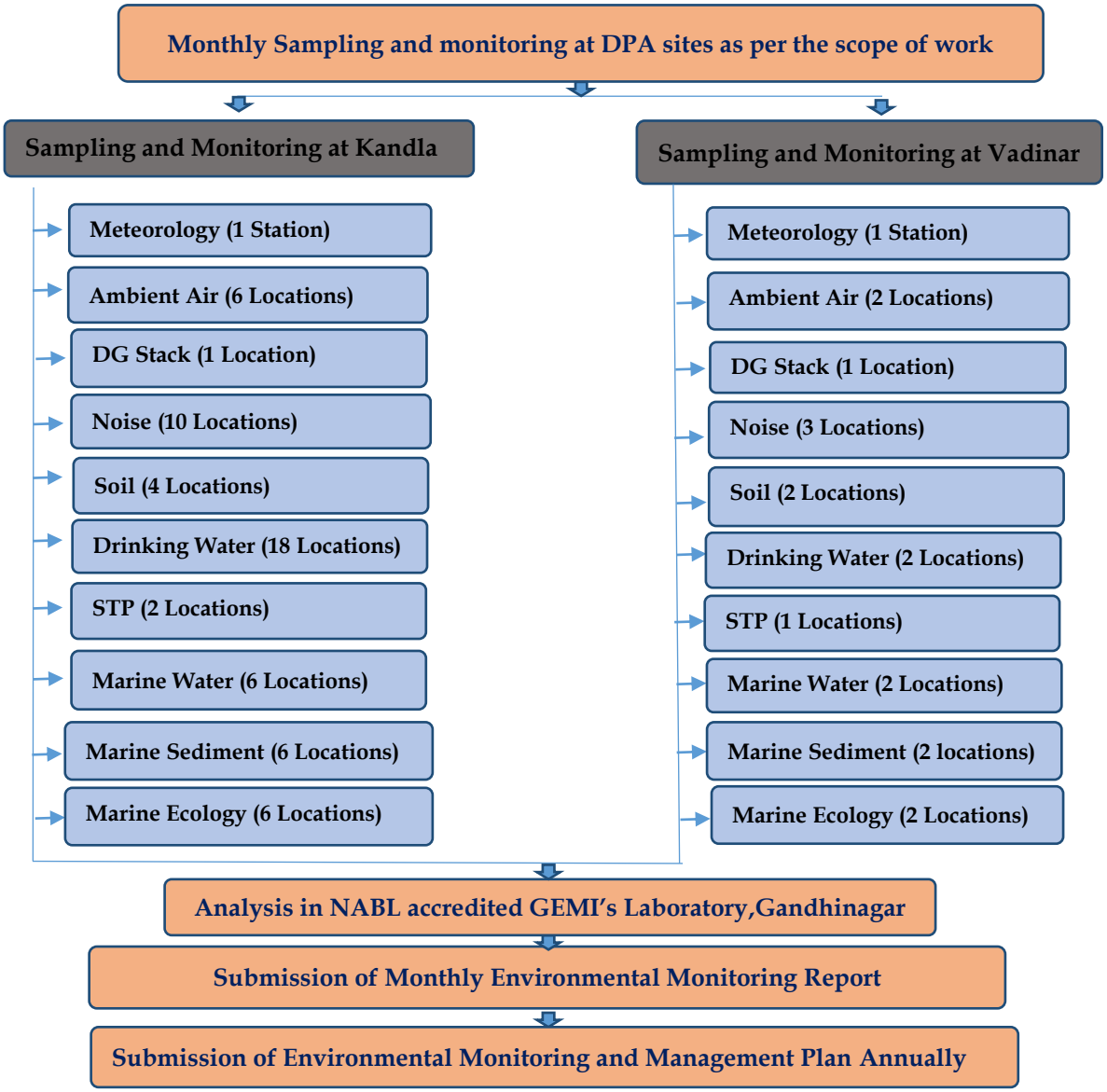


Figure 1: Methodology flow chart

The details of various sectors of Environment monitoring are described in subsequent chapters.

CHAPTER 3: METEOROLOGY MONITORING

3.1 Meteorology Monitoring

Meteorological conditions play a crucial role in dispersion of air pollutants as well as in environmental pollution studies particularly in pollutant transport irrespective of their entry into the environment. The wind speed and direction play a major role in dispersion of environment pollutants. In order to determine the prevailing micro-meteorological conditions at the project site an Automatic Weather Monitoring Stations (AWS) of Envirotech make (Model: WM280) were installed at both the sites of Kandla and Vadinar at 10 m above the ground. The details of the AWS installed have been mentioned in **Table 1** as follows:

Table 1: Details of Automatic Weather Station

Sr. No.	Site	Location Code	Location Name	Latitude Longitude
1.	Kandla	AWS-1	Environment Laboratory (DPA)	23.00996N 70.22175E
2.	Vadinar	AWS-2	Canteen Area	22.39994N 69.716608E

Methodology:

During the study, a continuous automatic weather monitoring station was installed at both the sites to record climatological parameters such as Wind speed, Wind Direction, Relative Humidity, Solar Radiation, Rainfall and Temperature to establish general meteorological regime of the study area. The methodology adopted for monitoring meteorological data shall be as per the standard norms laid down by Bureau of Indian Standards (BIS) and the India Meteorological Department (IMD). The details of Automatic Weather Monitoring Station have been mentioned in **Table 2**.

Table 2: Automatic Weather Monitoring Station details

Sr. No.	Details of Meteorological Data	Unit of Measurement	Instrument	Frequency
1.	Wind Direction	degree	Automatic Weather Monitoring Station (Envirotech WM280)	Hourly Average
2.	Wind Speed	Km/hr		
3.	Rainfall	mm/hr		
4.	Relative Humidity	% RH		
5.	Temperature	^{o}C		
6.	Solar Radiation	W/m^2		

Monitoring Frequency:

The Meteorological parameters were recorded at an interval of 1 hour in a day for the period of 15th April 2023 to 15th April 2024 and the average value for all the Meteorological parameters were summarized for the sampling period of at both the observatory site.

Figure 2: Photographs of Automatic Weather Monitoring Station at Kandla and Vadinar

3.2 Results and discussion

The summary of hourly climatological observations recorded at Kandla and Vadinar during the monitoring period of **April 2023 to April 2024,** with respect to significant parameters has been mentioned in **Table 3** as follows**:**

Table 3: Meteorological data for Kandla and Vadinar

Details of Micro-meteorological data at Kandla Observatory												
Monitoring Period	**Wind Speed (Km/h)**			**Temperature (°C)**			**Relative humidity (%)**			**Solar Radiation (W/m²)**	**Wind Direction (°)**	**Rainfall (mm)**
	Max.	**Min**	**Avg.**	**Max.**	**Min**	**Avg.**	**Max.**	**Min**	**Avg.**			
April-May 23	27.02	1.54	8.78	32.21	30.4	31.31	64.12	61.07	57.76	105.42	S.S.E	0.05
May-June 23	48.85	3.07	12.94	32.64	31.23	31.93	70.33	65.93	68.17	90.14	N & N.N.W	0.37
June- July 23	38.99	1.23	9.71	31.54	30.27	30.89	76.32	72.43	74.47	67.76	E.W.E & W.S.W	3.56
July-Aug 23	35.4	1.47	7.67	30.51	29.32	29.91	77.72	73.87	75.78	57.4	W.S.W	14.94
Aug-Sep 23	37.52	0.63	6.55	48.44	30.33	38.43	84.57	69.18	75.59	73.28	W.S.W	21.89
Sep- Oct 23	20.36	0.16	4.75	31.01	29.66	30.32	71.62	66.85	69.32	74.08	W.S.W	2.87
Oct- Nov 23	9.85	0.025	1.15	31.24	29.63	30.41	55.4	49.02	52.18	65.11	North	0.012
Nov- Dec 23	14.72	0	2.09	25.76	24.32	25.03	59.69	54.6	57.1	54.28	N.E	0.96
Dec- Jan 24	15.75	0	1.87	23.22	21.68	22.44	56.5	51.11	53.78	60.66	North	0
Jan- Feb 24	15.29	0.131	3.147	24.83	23.18	24	56	50.51	53.19	65.32	North	0
Feb- Mar 24	22.41	0.44	5.12	26.7	25.06	25.86	51.55	45.91	48.64	78.46	North	0.04
Mar- Apr 24	33.09	0.025	5.43	48.44	26.87	30.08	73.25	30.59	55.06	89.43	W.S.W	0

Details of Micro-meteorological data at Vadinar Observatory												
Monitoring Period	**Wind Speed (Km/h)**			**Temperature (°C)**			**Relative humidity (%)**			**Solar Radiation (W/m²)**	**Wind Direction (°)**	**Rainfall (mm)**
	Max.	**Min**	**Avg.**	**Max.**	**Min**	**Avg.**	**Mean**	**Max.**	**Min**			
April-May 23	26.33	7.78	13.24	28.74	28.04	28.17	73.47	70	71.08	110.76	W & South	0.02
May-June 23	34.08	7.63	16.76	29.96	29.22	29.34	71.77	69.03	69.83	102.95	S.S.E	0.19
June- July 23	12.31	1.62	5.19	29.51	28.86	28.94	77.68	75.42	75.95	78.26	South	0.27
July-Aug 23	31.69	5.39	13.12	28.62	27.99	28.06	79.51	77.31	77.77	60.86	South	0.22
Aug-Sep 23	28.07	5.2	12.96	27.75	27.18	27.22	75.13	72.87	73.42	88.14	South & S.W	0
Sep- Oct 23	21.82	4.64	9.59	28.12	27.5	27.56	77.12	74.66	75.32	87.51	South	0.06
Oct- Nov 23	13.8	1.77	4.17	27.89	27.1	27.28	63.61	59.58	61.15	81.61	N.E	0.18
Nov- Dec 23	19.37	3	4.84	24.79	24.11	24.24	64.12	60.47	61.79	70.68	S.S.E	0.03
Dec- Jan 24	16.76	1	4.18	22.94	22.14	22.34	63.13	59.25	60.71	73.37	South	0
Jan- Feb 24	10.62	1.99	3.94	23.24	22.92	22.7	65.66	64.19	64.9	87.29	South	0
Feb- Mar 24	16.92	5.36	8.55	24.16	23.6	23.82	62.34	60.91	61.51	101.99	N.N.W	0
Mar- Apr 24	29.61	0.31	11.63	29.8	24.96	26.5	82.36	57.41	71.08	114.77	N.N.W	0

3.3 Data Interpretation and Conclusion

1) Kandla:

a. The ambient temperature for the summer season varies in the range of **21.68** to **48.44** °C; in the monsoon season, the temperature varies between **29.32** and **33.38** °C; and in the winter season, the temperature varies between **21.68** and **31.24** °C. The yearly average temperature at Kandla is observed to be around **29.217** °C, with a standard deviation of 4.31.
b. The relative humidity for the summer season was recorded in the range of **30.59**% to **76.32**%; in the monsoon season, relative humidity was recorded in the range of **66.85**% to **84.57**%; and in the winter season, relative humidity was recorded in the range of **49.02** to **59.69**%; the yearly average humidity at Kandla was **61.75**% with a standard deviation of **10.635**.
c. The maximum rainfall at Kandla was observed at **21.89** mm for the monitoring period of August to September 2023; the yearly average rainfall was found to be **3.72** mm.
d. Wind speed and direction play a significant role in transporting pollutants and thus determining the air quality. In the summer season, wind blew from the North and North North West directions; in the monsoon season, wind blew from the West South West; and in the winter season, wind blew from the North direction.
e. The wind speed recorded ranges from **0.025** to **48.85** km/h in the summer season; in the monsoon season, the wind speed recorded ranges from **0.16** to **37.52** km/h; and in the winter season, the wind speed recorded ranges from **0** to **15.75** km/h. The yearly average wind speed at Kandla is **5.77** km/h, with a standard deviation of 3.55.
f. The **maximum** solar radiation at Kandla was observed at **105.42** W/m^2 during the monitoring period **April to May 2023**; the **minimum** solar radiation at Kandla was observed at 54.**28** W/m^2 for the monitoring period **November to December 2023; and** the yearly **average** solar radiation was found to be **73.445** W/m2 with a standard deviation of 15.19.

2) Vadinar:

a. The ambient temperature for the summer season varies between **23.6** and **29.96** °C; in the monsoon season, it varies between **27.18** and **28.62** °C; and in the winter season, it varies between **22.14** and **27.89** °C. The yearly average temperature at Vadinar is **2.347** °C with standard deviation of **2.4**.
b. The relative humidity for the summer season was recorded in the range of **57.41**% to **82.36**%; in the monsoon season, relative humidity was recorded in the range of **72.87**% to **79.51**%; and in the winter season, relative humidity was recorded in the range of **59.25**% to **65.66**%; the yearly average humidity at Vadinar was **68.7**% with a standard deviation of 6.38.
c. The **maximum** rainfall at Vadinar was observed at **0.27** mm for the monitoring period from **June to July 2023**; the yearly **average** rainfall was found to be **0.08** mm.
d. In Summer Season wind blew from South Direction, in Monsoon season wind blew from South and in Winter Season wind blew from South and South West direction. The recorded wind speed ranges from **0.31** to **34.08** km/hr in the summer season, **4.64** to **31.69** km/hr, and in the monsoon season, the recorded wind speed ranges from **1** to **19.37** km/hr. The yearly average wind speed at Vadinar is 9.014 km/h with a standard deviation of **4.49**.

e. The maximum solar radiation at Vadinar was observed at **114.77** W/m2 for the monitoring period April to May 2024; the minimum solar radiation at Vadinar was observed at **60.86** W/m2 for the monitoring period July to August 2023; and the yearly average solar radiation was found to be **88.182** W/m2.

CHAPTER 4: AMBIENT AIR QUALITY MONITORING

4.1 Ambient Air Quality

It is necessary to monitor the ambient air quality of the study area, in order to determine the impact of the shipping activities and port operations on the ambient air quality. The prime objective of ambient air quality monitoring is to assess the present air quality and its conformity to National Ambient Air Quality Standards i.e. NAAQS, 2009(1).

Methodology

The study area represents the area occupied by DPA and its associated Port area. The sources of air pollution in the region are mainly vehicular traffic, fuel burning, loading & unloading of dry cargo, fugitive emissions from storage area and dust arising from unpaved village roads. Considering the below factors, under the study, as per the scope specified by DPA eight locations wherein, 6 stations at Kandla and 2 at Vadinar have been finalized within the study area

- Meteorological conditions;
- Topography of the study area;
- Direction of wind;
- Representation of the region for establishing current air quality status
- Representation with respect to likely impact areas.

The description of various air quality stations monitored at Kandla and Vadinar have been specified in **Table 4**.

Table 4: Details of Ambient Air monitoring locations

Sr. No.	Location Code		Location Name	Latitude Longitude	Significance
1.	Kandla	A-1	Oil Jetty No. 1	23.029361N 70.22003E	Liquid containers and emission from ship
2.		A-2	Oil Jetty No. 7	23.043538N 70.218617E	
3.		A-3	Kandla Port Colony	23.019797N 70.213536E	Vehicular activity and dust emission
4.		A-4	Marine Bhavan	23.007653N 70.222197E	Construction and vehicular activity, road dust emission,
5.		A-5	Coal Storage Area	23.000190N 70.219757E	Coal Dust, Vehicular activity
6.		A-6	Gopalpuri Hospital	23.081506N 70.135258E	Residential area, dust emission, vehicular activity
7.	Vadinar	A-7	Admin Building	22.441806N 69.677056E	Vehicular activity
8.		A-8	Vadinar Colony	22.401939N 69.716306E	Residential Area, burning waste, vehicular activity

The monitoring locations at Kandla and Vadinar have been depicted in map in **Map 4 and 5** respectively.

Ambient Air monitoring photos

Kandla

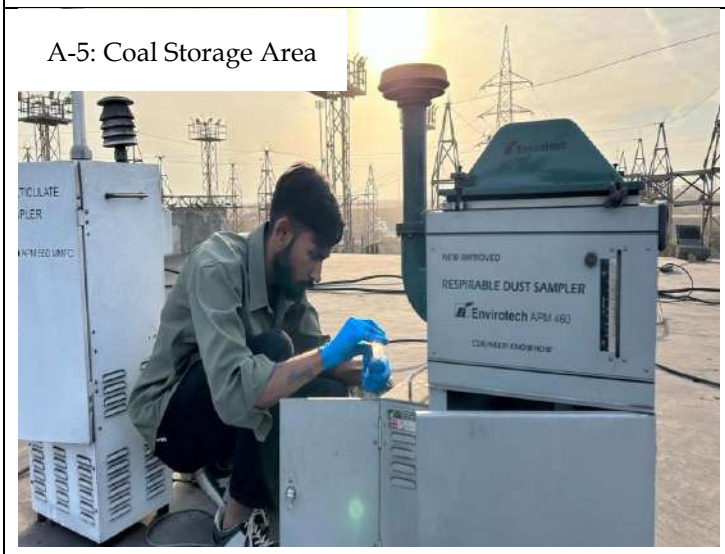
A-1: Oil Jetty No. 1

A-2: Oil Jetty No. 7

A-3: Kandla Port Colony

A-4: Marine Bhavan

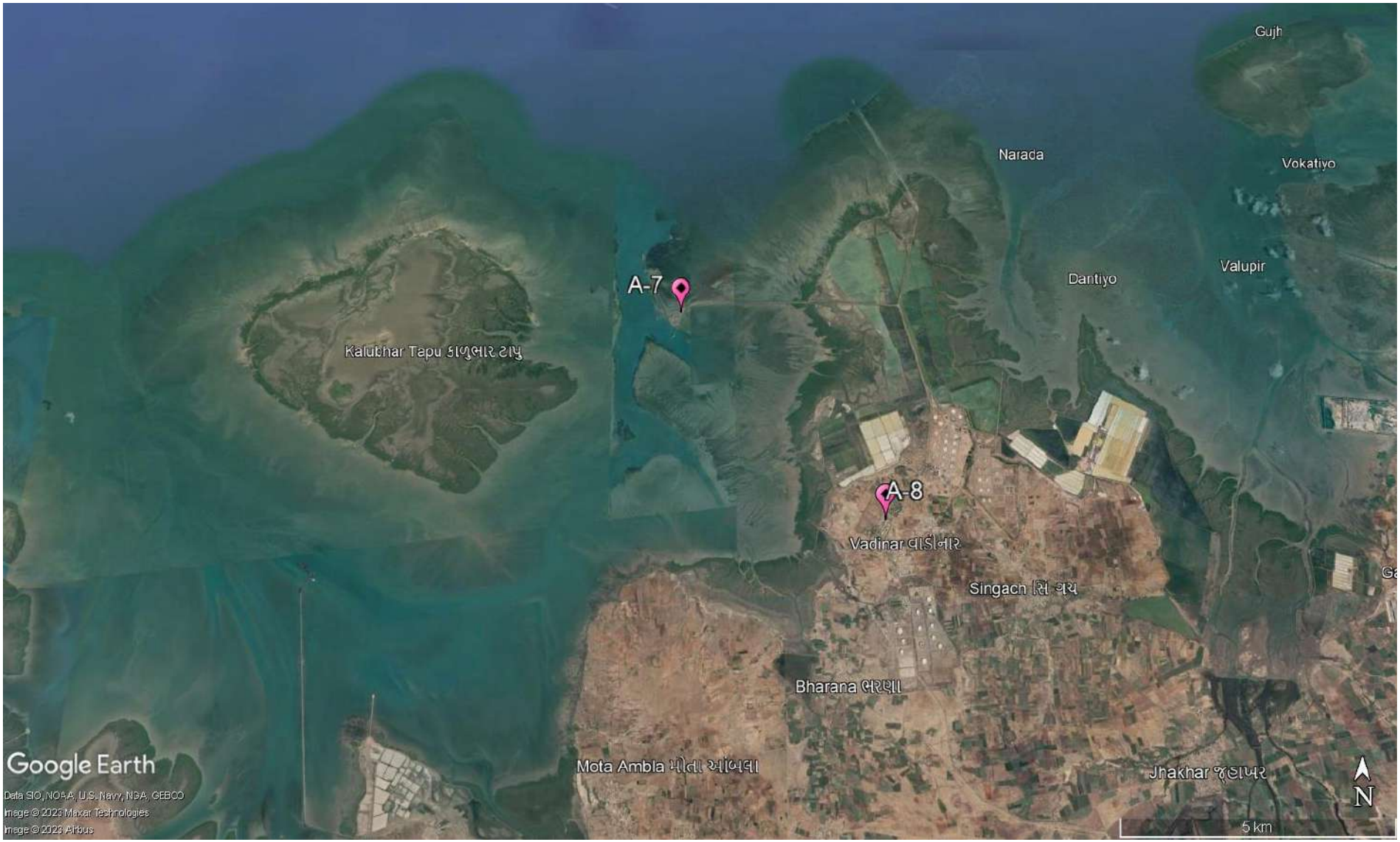
A-5: Coal Storage Area



A-6: Gopalpuri Hospital

Vadinar	
A-7: Admin Building 	A-8: Vadinar Colony 

Map 4: Ambient Air Monitoring locations at Kandla



Map 5: Ambient Air Monitoring locations at Vadinar

Monitoring Frequency

The sampling for Particulate matter, i.e., PM_{10} and $PM_{2.5}$, and gaseous components like SO_x, NO_x, and CO, as well as the total VOCs, was monitored twice a week for a period of 24 hours a day. Whereas, the sampling for the components of PAH, benzene, and non-methane VOCs was conducted on a monthly basis. The monitoring period for this study is from April 15, 2023, to April 15, 2024. During this period, 95 air samples were taken from six locations in Kandla, and 97 samples were taken from two locations in Vadinar.

Sampling and Analysis

The Sampling of the Ambient Air Quality parameters and analysis is conducted as per the CPCB guidelines of National Ambient Air Quality Monitoring. The sampling was performed at a height of 3.5 m (approximately) from the ground level. For the sampling of PM_{10}, calibrated 'Respirable Dust Samplers' were used, where Whatman GF/A microfiber filter paper of size 8"x 10" were utilized, where the Gaseous attachment of the make Envirotech instrument was attached with Respirable Dust Sampler for the measurement of SO_x and NO_x. The Fine Particulate Sampler for collection of $PM_{2.5}$ was utilized for the particulate matter of size <2.5 microns. A known volume of ambient air is passed through the cyclone to the initially pre-processed filter paper. The centrifugal force in cyclone acts on particulate matter to separate them into two parts and collected as following:

- Particles <10 µ size (Respirable): GF/A Filter Paper
- Particles <2.5 µ size (Respirable): Polytetrafluoroethylene (PTFE)

Sampling and analysis of ambient SO_2 was performed by adopting the 'Improved West and Gaeke Method'. The ambient air, drawn through the draft created by the RDS, is passed through an impinger, containing a known volume of absorbing solution of Sodium tetrachloromercurate, at a pre-determined measured flow rate of 1 liter/minute (L/min). Similarly, NO_x was performed by adopting the 'Jacob Hochheister Modified' (Na arsenite) method. The impinger contains known volume of absorbing solution of Sodium Arsenite and Sodium Hydroxide.

Data has been compiled for PM_{10}, $PM_{2.5}$, SO_x and NO_x samples of 24-hour carried out twice a week. In case of CO, one hourly sample were taken on selected monitoring days using the sensor-based CO Meter. For the parameters Benzene, Methane & Non-methane and Volatile Organic Carbons (VOCs), the Low Volume Sampler is used, where the charcoal tubes are used as sampling media. The sampling in the Low Volume Sampler (LVS) is carried out as per IS 5182 (Part 11): 2006 RA: 2017, where the ambient air flow rate is maintained at 200 cc/min, the volume of air that passes through the LVS during two hours monitoring is approx. 24 L.

The sampling of PAHs is carried out as per IS: 5182 (Part 12): 2004. Where, the EPM 2000 Filter papers are utilized in the Respirable Dust Sampler (RDS). For the parameters, Benzene, PAH & Non-methane VOC's, monthly monitoring is carried out. The details of the parameters with their frequency monitored are mentioned in **Table 5:**

Table 5: Parameters for Ambient Air Quality Monitoring

Sr. No.	Parameters	Units	Reference method	Instrument	Frequency
1.	PM_{10}	µg/m³	IS 5182 (Part 23): 2006	Respirable Dust Sampler (RDS) conforming to IS:5182 (Part-23): 2006	Twice in a week
2.	$PM_{2.5}$	µg/m³	IS:5182 (Part:24):2019	Fine Particulate Sampler (FPS) conforming to IS:5182 (Part-24): 2019	
3.	Sulphur Dioxide (SO_x)	µg/m³	IS 5182 (Part:2): 2001	Gaseous Attachment conforming to IS:5182 Part-2	
4.	Oxides of Nitrogen (NO_x)	µg/m³	IS:5182 (Part-6): 2006	Gaseous Attachment conforming to IS:5182 Part-6	
5.	Carbon Monoxide (CO)	mg/m³	GEMI/SOP/AAQM/11; Issue no 01, Date 17.01.2019: 2019	Sensor based Instrument	
6.	VOC	µg/m³	IS 5182 (Part 17): 2004	Low Flow Air Sampler	
8.	PAH	µg/m³	IS: 5182 (Part 12): 2004	Respirable Dust Sampler (RDS) conforming to IS:5182 (Part-12): 2004	Monthly
7.	Benzene	µg/m³	IS 5182 (Part 11): 2006 RA: 2017	Low Flow Air Sampler	
9.	Non-methane VOC	µg/m³	IS 5182 (Part 11): 2006	Low Volume Sampler	

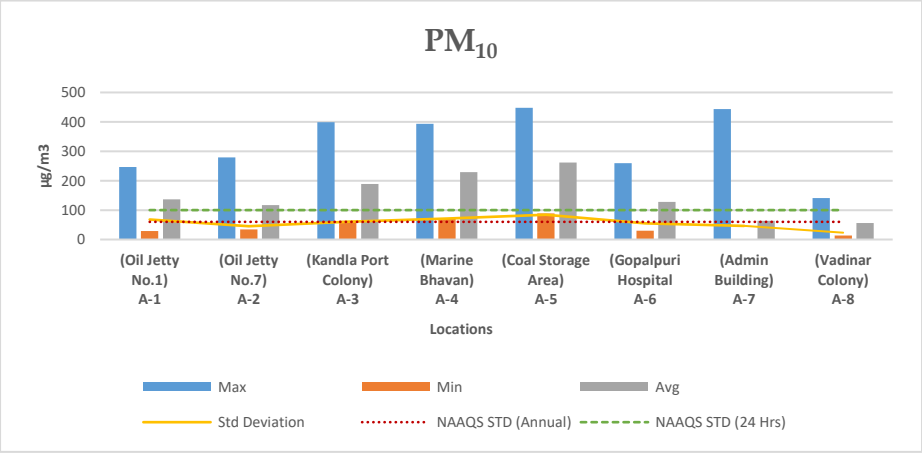
4.2 Result and Discussion

The summarized results of ambient air quality monitoring for the study period are presented in **Table-6 to 9** along with the graphical representation from **Graph 1 to Graph 6.** Various parameters monitored during the study have been presented by their maximum, minimum, average and Standard deviation**.**

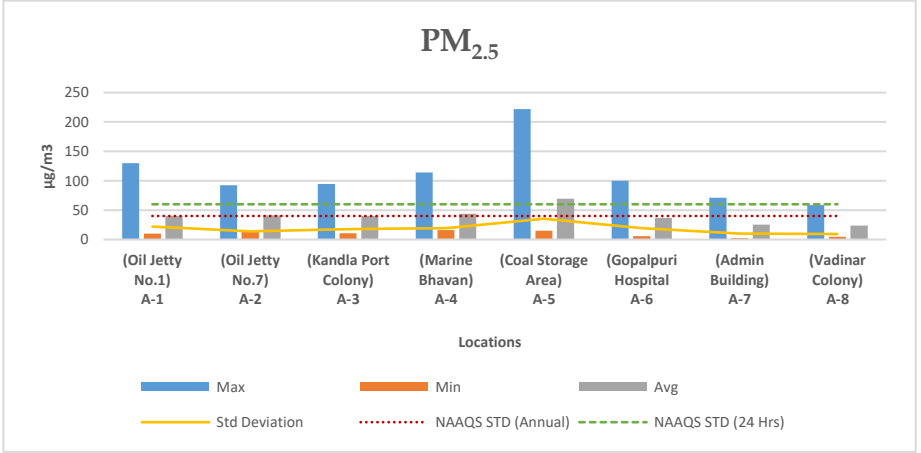
Table 6: Summarized results of PM_{10}, $PM_{2.5}$, SO_2, NO_x, VOC and CO for Ambient Air quality monitoring

Parameters / Locations	NAAQS by CPCB		(Oil Jetty No.1) A-1	(Oil Jetty No.7) A-2	(Kandla Port Colony) A-3	(Marine Bhavan) A-4	(Coal Storage Area) A-5	(Gopalpuri Hospital A-6	(Admin Building) A-7	(Vadinar Colony) A-8
PM_{10} (µg/m3)	24 Hours -100 Annual -60	Max	247.03	279.33	399.25	393.74	448.12	259.88	443.2	140.7
		Min	28.68	34.39	63.28	71.77	89.21	30.3	1.45	13.89
		Avg	136.50	116.67	188.36	229.41	262.04	127.95	63.49	56.54
		Std Deviation	68.203	44.97	60.56	71.74	84.18	55.43	46.36	23.15
$PM_{2.5}$ (µg/m3)	24 Hours -60 Annual -40	Max	129.77	92.24	94.51	114.34	221.9	99.82	71.18	58.73
		Min	10.03	12.85	10.84	15.97	14.85	5.51	2.36	4.7
		Avg	40.27	41.2	40.26	43.70	69.70	36.95	25.11	23.73
		Std Deviation	22.049	13.87	17.52	19.15	35.36	19.04	10.06	9.33
SO_2 (µg/m3)	24 Hours -80 Annual -50	Max	51.87	151.58	79.24	55.04	283	49.89	59.69	69.81
		Min	0.65	1.18	1.1	1.19	1.1	1.12	0.52	1.4
		Avg	11.076	20.01	14.63	11.82	16.82	11.56	12.59	13.69
		Std Deviation	12.142	28.41	17.15	12.25	30.85	12.08	13.35	14.90
NO_X (µg/m3)	24 Hours -80 Annual -40	Max	54.33	52.54	80.67	55.39	80.94	79.88	52.76	33.79
		Min	2.29	1.11	2.36	1.29	1.97	1.01	2.89	0.9
		Avg	14.75	14.58	22.91	20.52	28.12	15.24	12.84	9.70
		Std Deviation	11.68	9.85	14.98	10.53	17.98	13.59	8.62	5.73
VOC (µg/m3)	-	Max	4.85	5.67	17.43	4.41	3.97	4.12	4.52	6.62
		Min	0.01	0.01	0.01	0.02	0.04	0.01	0.01	0.01
		Avg	1.20	1.226	1.52	0.98	0.94	0.96	0.96	0.95
		Std Deviation	1.155	1.298	2.275	0.99	0.94	0.99	0.93	1.12
CO (mg/m3)	8 Hours -2 1 Hour -4	Max	0.98	4.21	2.91	3.16	3.21	2.18	3.14	2.74
		Min	0.08	0.09	0.14	0.39	0.36	0.32	0.03	0.45
		Avg	0.73	0.848	0.89	0.95	1.13	0.74	0.78	0.94
		Std Deviation	0.194	0.557	0.41	0.39	0.53	0.32	0.46	0.36

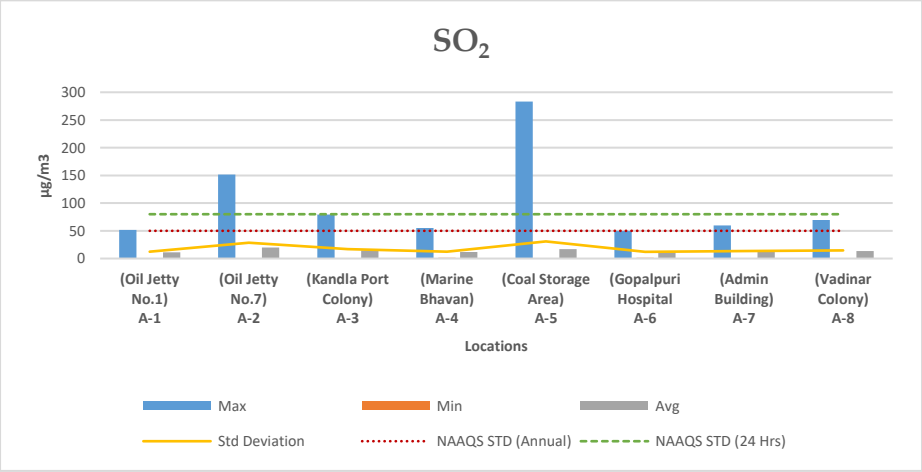
Graphs 1-6 shows spatial trend of ambient air parameter at all the eight-monitoring location (six at Kandla and 2 at Vadinar



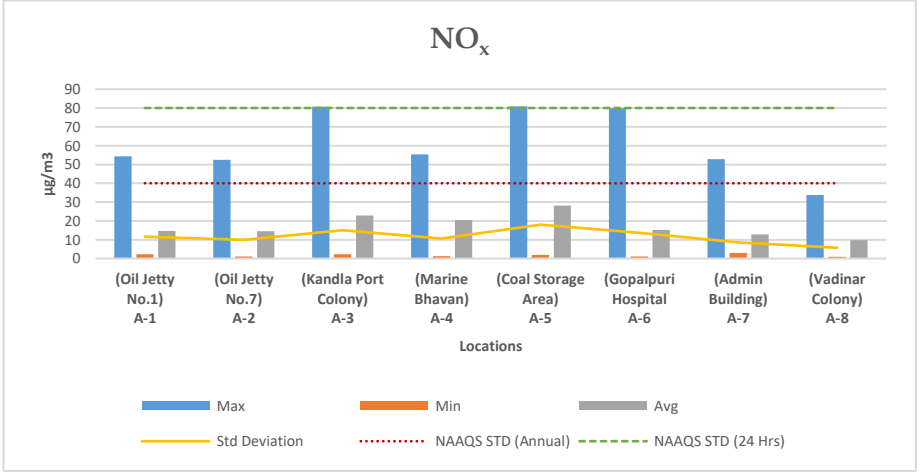
Graph 1 Spatial trend in Ambient PM_{10} Concentration



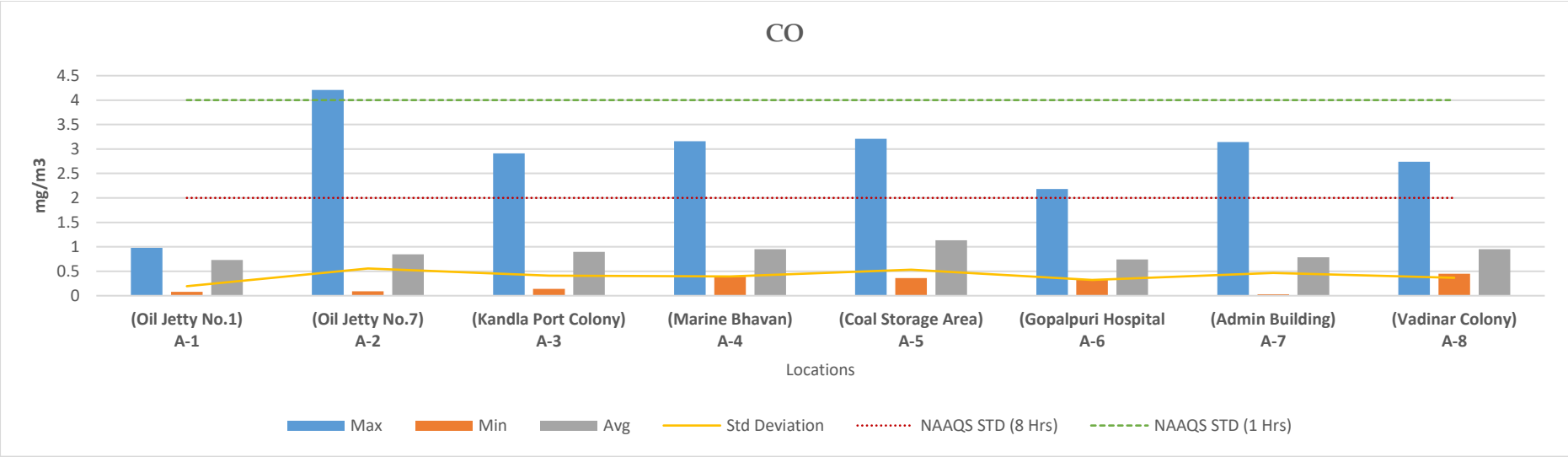
Graph 2 Spatial trend in Ambient $PM_{2.5}$ Concentration



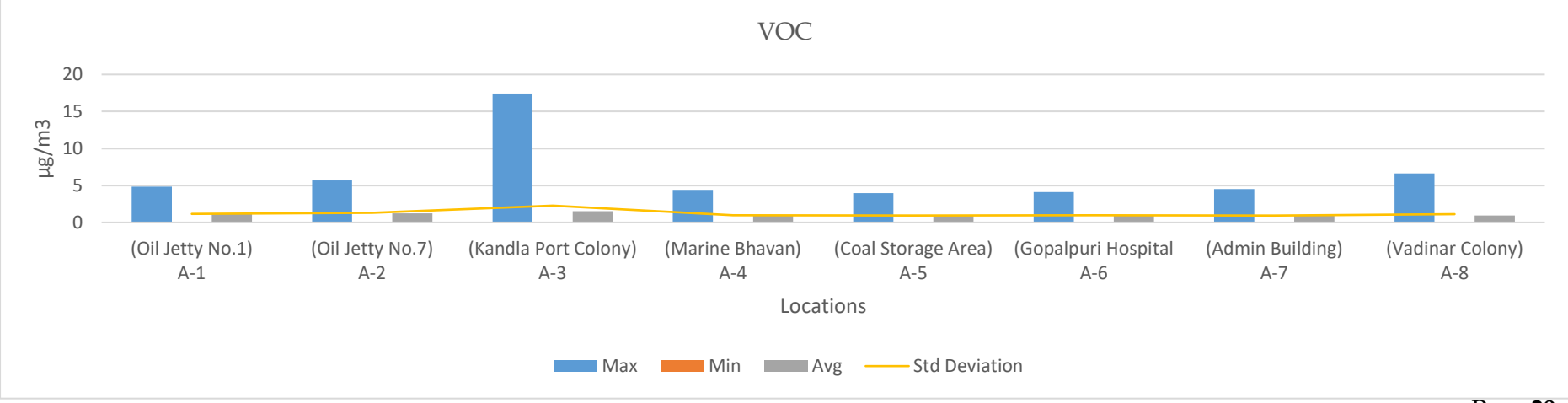
Graph 3 Spatial trend in Ambient SOx Concentration



Graph 4 Spatial trend in Ambient NOx Concentration



Graph 5 Spatial trend in Ambient CO Concentration



Graph 6 Spatial trend in Ambient Total VOCs

Table 7: Summarized results of Benzene for Ambient Air quality monitoring

Parameters / Locations	NAAQS by CPCB		(Oil Jetty No.1) A-1	(Oil Jetty No.7) A-2	(Kandla Port Colony) A-3	(Marine Bhavan) A-4	(Coal Storage Area) A-5	(Gopalpuri Hospital A-6	(Admin Building) A-7	(Vadinar Colony) A-8
Benzene (µg/m3)	Annual - 5	Max	3.8	1.84	1.43	1.95	1.11	1.97	1.03	0.95
		Min	0.03	0.02	0.02	0.02	0.03	0.02	0.02	0.01
		Avg	0.83	0.46	0.42	0.32	0.41	0.49	0.33	0.229

Table 8: Summarized results of Polycyclic Aromatic Hydrocarbons

Parameters / Locations		(Oil Jetty No.1) A-1	(Oil Jetty No.7) A-2	(Kandla Port Colony) A-3	(Marine Bhavan) A-4	(Coal Storage Area) A-5	(Gopalpuri Hospital A-6	(Admin Building) A-7	(Vadinar Colony) A-8
Napthalene (µg/m3)	Max	1.57	17.31	5.24	5.55	7.8	39.82	1.98	1.84
	Min	0.02	0.21	0.04	0.14	0.37	0.02	0.1	0.13
	Avg	0.40	3.29	0.58	1.05	2.01	4.96	0.45	0.42
Acenaphthylene (µg/m3)	Max	0.8	0.67	0.54	0.95	0.53	0.86	0.84	0.65
	Min	0.01	0.01	0.01	0.02	0.007	0.02	0.005	0.005
	Avg	0.15	0.20	0.17	0.31	0.15	0.18	0.19	0.17
Fluorene (µg/m3)	Max	0.39	0.39	22.99	178.72	10.88	27.22	7.57	11.64
	Min	0.01	0.05	0.04	0.11	0.01	0.06	0.01	0.01
	Avg	0.14	0.19	3.435	19.99	1.25	3.52	0.82	1.18
Anthracene (µg/m3)	Max	0.87	0.91	1.25	5.05	2.02	3.78	0.85	0.57
	Min	0.09	0.09	0.07	0.09	0.03	0.01	0.02	0.02
	Avg	0.3	0.42	0.40	0.94	0.94	0.69	0.23	0.19
Phenanthrene (µg/m3)	Max	0.9	0.82	0.84	0.91	1	0.99	0.82	0.74
	Min	0.01	0.009	0.01	0.01	0.01	0.01	0.07	0.06
	Avg	0.23	0.20	0.15	0.22	0.33	0.20	0.25	0.22
Fluoranthene (µg/m3)	Max	2.65	0.84	1.59	19.54	4.16	20.36	0.68	1.71
	Min	0.06	0.15	0.2	0.24	0.2	0.01	0.01	0.01
	Avg	0.43	0.36	0.74	3.61	1	2.12	0.24	0.30
Pyrene (µg/m3)	Max	3.52	1.13	2.4	42.23	40.25	51.22	0.87	0.74
	Min	0.01	0.14	0.23	0.15	0.02	0.01	0.01	0.01
	Avg	0.54	0.48	0.90	7.46	4.37	7.98	0.16	0.14
Chrycene (µg/m3)	Max	4.59	1.03	3.01	6.27	5.51	5.82	0.61	0.79

	Min	0.08	0.15	0.44	0.42	0.08	0.06	0.05	0.05
	Avg	0.78	0.51	1.01	1.50	1.47	1.22	0.19	0.22
Banz(a)anthracene (µg/m3)	Max	5.64	2.84	3.7	15.42	6.57	16.73	1.01	0.97
	Min	0.17	0.17	0.04	0.14	0.05	0.06	0.01	0.01
	Avg	0.89	0.65	0.88	2.66	1.44	2.93	0.25	0.31
Benzo[k]fluoranthene (µg/m3)	Max	7.67	1.99	5.98	4.81	4.06	6.89	0.84	0.69
	Min	0.15	0.38	0.14	0.48	0.05	0.06	0.03	0.03
	Avg	1.32	0.99	1.34	1.21	0.89	1.76	0.35	0.21
Benzo[b]fluoranthene (µg/m3)	Max	7.89	1.93	6.15	5.12	4.73	7.29	0.59	0.71
	Min	0.12	0.04	0.21	0.17	0.07	0.01	0.06	0.01
	Avg	1.09	0.62	1.053	1.43	1.06	1.65	0.17	0.20
Benzopyrene (µg/m3)	Max	10.9	2.79	8.42	7.25	8.91	9.19	0.96	0.69
	Min	0.24	0.08	0.39	0.39	0.01	0.04	0.01	0.01
	Avg	1.64	0.87	1.66	1.75	1.58	1.31	0.30	0.27
Indeno [1,2,3-cd] fluoranthene (µg/m3)	Max	2.39	6.67	0.95	2.46	1.68	4.61	0.52	0.98
	Min	0.13	0.07	0.42	0.26	0.11	0.09	0.07	0.06
	Avg	0.71	1.02	0.57	0.72	0.70	1.25	0.22	0.42
Dibenz(ah)anthracene (µg/m3)	Max	1.82	1.2	0.91	1.25	2.24	0.99	1.34	2.48
	Min	0.11	0.08	0.16	0.1	0.07	0.04	0.08	0.05
	Avg	0.47	0.32	0.35	0.46	0.54	0.24	0.31	0.4
Benzo[ghi]perylene (µg/m3)	Max	16.3	9.7	27.2	13.6	9.4	12.2	8	2.3
	Min	0.1	0.07	0.04	0.06	0.06	0.17	0.07	0.13
	Avg	2.049	2.63	2.95	2.55	1.61	2.13	0.83	0.47
Acenaphthene (µg/m3)	Max	0.69	0.45	15.1	119.08	2.54	11.8	0.67	2
	Min	0.01	0.05	0.04	0.11	0.01	0.06	0.01	0.01
	Avg	0.14	0.22	2.63	11.34	0.369	1.55	0.14	0.33

Table 9: Summarized results of Non-methane VOC

Parameters \ Locations		(Oil Jetty No.1) A-1	(Oil Jetty No.7) A-2	(Kandla Port Colony) A-3	(Marine Bhavan) A-4	(Coal Storage Area) A-5	(Gopalpuri Hospital A-6	(Admin Building) A-7	(Vadinar Colony) A-8
Non- Methane VOC (µg/m3)	Max	2.11	2.67	3.54	1.35	1.8	2.01	2.15	1.67
	Min	0.12	0.09	0.1	0.08	0.13	0.11	0.07	0.1
	Avg	0.73	0.79	0.87	0.79	1.09	0.93	0.91	0.74s

4.3 Data Interpretation and Conclusion

The results were compared with the National Ambient Air Quality Standards (NAAQS), 2009 of Central Pollution Control Board (CPCB).

1) Kandla:

Particulate matter:

- The concentration of PM_{10} varies very widely and is reported in the range of **28.68** to **448.12** µg/m3, with a yearly average value of **176.83** with standard deviation **64.185** µg/m^3. As shown in Graph 1, the highest concentration (value) of PM_{10} is reported at location A-5 (coal storage area) during the winter. It can be seen that PM_{10} exceeds the NAAQS annual limit, i.e., 60 µg/m^3, in all locations. It can be seen that location A-5 (coal storage area) had the maximum percentage exceedance, and location A-1 (oil jetty No. 1) had the minimum percentage exceedance while comparing with the NAAQS 24-hour limit, i.e., 100 µg/m^3.
- The concentration of PM2.5 varies in the range of 5.51 to 221.9 µg/m^3, with a yearly average value of 45.35 with standard deviation 21.16 µg/m^3. As shown in Graph 2, the highest concentration of $PM_{2.5}$ is at location A-5 (the coal storage area) in winter. It can be seen that $PM_{2.5}$ exceeds the NAAQS annual limit, i.e., 40 µg/m3, on five locations, and location A-6, i.e., Gopalpuri hospital, falls within the NAAQS annual limit. It can be seen that location A-5 (coal storage area) had the maximum percentage exceedance, and location A-6 (Gopalpuri hospital) had the minimum percentage exceedance while comparing with the NAAQS 24-hour limit, i.e., 60 µg/m^3.
- The highest concentration of Particulate matter at locations **A–5, (the coal storage area)**, could be attributed to the presence of heavy vehicular traffic in upwind areas, which have a higher impact, causing the dispersion of emitted particulate matter in the ambient air. Ther activities observed in the surrounding such as The unloading of coal directly into the truck using grabs, construction in the vicinity causes the dust to disperse in the air as well as coal dust to fall and settle on the ground. This settled coal dust again mixes with the air while trucks travel through it. Also, the coal-loaded trucks are generally not always covered with tarpaulin sheets, and this might result in increased suspension of coal from trucks or dumpers during their transit from vessel to yard or storage site. This might increase the PM in and around the coal storage area and Marine Bhavan.

Gaseous Pollutants:

- The concentration of SOx varies from **0.52** to **283** µg/m^3, with a yearly average concentration of **14.029** with standard deviation **18.85** µg/m^3. As shown in Graph 3, the highest concentration of SOx is at location **A-5 (the coal storage area)** in winter. It can be seen that at all locations, SOx are within the NAAQS annual limit, i.e., 50 µg/m^3. It can be seen that location A-2 **(Oil Jetty No. 7)** had the maximum percentage exceedance, i.e., **7.36**%, which is about 7 days out of 95 days of monitoring, and the other five locations comply with the standards (compliance more than 98% times) while comparing with the NAAQS 24-hour limit, i.e., 80 µg/m^3. The concentration of NOx varies from **1.01** to **80.94** µg/m3, with a yearly average concentration of **19.35** with standard deviation **13.10**

µg/m3. As shown in Graph 4, the highest concentration of NOx is at location A-5 (the coal storage area) in winter. It can be seen that on all locations's NOx within the NAAQS annual limit, i.e., 40 µg/m^3, it can be seen that all locations comply with the standards (complied more than 98% times) while comparing with the NAAQS 24-hour limit, i.e., 80 µg/m^3.

- The concentration of CO varies from **0.08** to **4.21** mg/m^3, with a yearly average concentration of **0.884** with standard deviation **0.40** mg/m^3. As shown in Graph 5, the highest concentration of CO is at location A-2 (Oil Jetty No. 7) in winter. It can be seen that at all locations, they're complying (more than 98% of the time) with the NAAQS 1 hour limit, i.e., 4 mg/m^3. Location A-5 (the coal storage area) had the maximum percentage exceedance, i.e., **7.36**%, which is about 7 days out of 95 days of monitoring, and other locations such as Location A-2 (Oil Jetty No. 7), Location A-3 (Kandla Port Colony), Location A-4 (Marine Bhavan), and Location A-6 (Gopalpuri Hospital) had percentage exceedances of **5.26, 5.26, 2.85**, and **2.85**, respectively. And location A-1 (oil jetty no. 1) comply with the standards (compliance more than 98% times) while comparing with the NAAQS 8-hour limit, i.e., 2 mg/m3.
- The concentration of total VOC levels was recorded in the range of **0.01** to **17.43** µg/m3, with a yearly average value of **1.14** with standard deviation 1.21 µg/m3 at Kandla. As shown in graph 6, the highest concentration of VOCs is at location **A-3, (Kandla port colony)**; this is the only spike observed in the whole monitoring period for VOCs at this location. The main source of VOCs in the ambient air may be attributed to the burning of gasoline and natural gas in vehicle exhaust, burning fossil fuels, and garbage that releases VOCs into the atmosphere. During the monitoring period, the wind flows in the south direction at Kandla, and hence the wind direction and speed also contribute to increased dispersion of pollutants from the upward areas towards the downward areas.

  Polycyclic Aromatic Hydrocarbons (PAHs): are ubiquitous pollutants in urban atmospheres. Anthropogenic sources of total PAHs in ambient air emissions are greater than those that come from natural events. These locations are commercial areas where Vehicular activity and dust emission is common. PAHs are a class of chemicals that occur naturally in coal, crude oil, and gasoline. The higher concentration which results from burning coal, oil, gas, road dust, etc. Other outdoor sources of PAHs may be the industrial plants in-and-around the DPA premises.
- The concentration of Benzene levels was recorded in the range of **0.02** to **3.8** µg/m^3, with a yearly average value of **0.84** with standard deviation **0.64** µg/m^3. The highest concentration of Benzene is at location **A-1, (Oil Jetty No. 1)** in summer. It can be seen that at all locations, Benzene within the NAAQS annual limit, i.e., 5 µg/m3.
- The ambient air monitoring location of Kandla recorded the non-methane VOC (NM-VOC) concentration in the range of **0.08** to **3.54** µg/m3, with a yearly average value of **0.86** µg/m3 at Kandla. The highest concentration is at location **A-3, (Kandla Port Colony** in Winter.

2) Vadinar:

Particulate matter: The concentration of PM10 at Vadinar varies in the range of **1.45 to 443.2** µg/m^3, with a yearly average value of **63.49** with a standard deviation of **34.76** µg/m3. As shown in Graph 1, the highest concentration of PM_{10} is at location A-7 (Admin Building Vadinar) in the winter. It can be seen that at location A-7 (Admin Building Vadinar), PM_{10} exceeds the NAAQS annual limit, i.e., 60 µg/m^3, and at location A-8 (Vadinar Colony), it falls within the annual standards. It can be seen that locations A-7 (Admin Building Vadinar) and A-8 (Vadinar Colony) had a 5.15% percentage exceedance while comparing with the NAAQS 24-hour limit, i.e., 100 µg/m^3.

- The concentration of $PM_{2.5}$ varies in the range of **2.36** to **71.18** µg/m^3, with a yearly average value of **24.42** with a standard deviation **of 9.69** µg/m^3. As shown in Graph 2, the highest concentration of $PM_{2.5}$ is at location **A-7 (Admin Building Vadinar)** in winter. It can be seen that in all two locations, $PM_{2.5}$ is within the NAAQS annual limit, i.e., 40 µg/m^3. it can be seen that on both locations, **A-7 (building Vadinar)** and **A-8 (Vadinar Colony)** comply with the standards (complimented more than 98% times) while comparing with the NAAQS 24-hour limit, i.e., 60 µg/m^3.

Gaseous Pollutants:

- The concentration of SOx varies from **0.52** to **69.91** µg/m3, with a yearly average concentration of 13.146 with a standard deviation of 14.14 µg/m3. As shown in Graph 3, the highest concentration of SOx is at location A-8 (Vadinar Colony) in the winter. It can be seen that in all locations, SOx are within the NAAQS annual limit, i.e., 50 µg/m^3. It can be seen that both locations comply with the standards (compliance more than 98% times) while comparing with the NAAQS 24-hour limit, i.e., 80 µg/m^3.
- The concentration of NOx varies from **0.9** to **52.76** µg/m^3, with a yearly average concentration of **11.28** with a standard deviation of **7.17** µg/m^3. As shown in Graph 4, the highest concentration of NOx is at location A-7 (Admin Building Vadinar) in the winter. It can be seen that in all locations, NOx is within the NAAQS annual limit, i.e., 40 µg/m^3. It can be seen that all locations comply with the standards (compliance more than 98% of the time) while comparing with the NAAQS 24-hour limit, i.e., 80 µg/m^3.
- The concentration of CO varies from **0.03** to **3.14** mg/m3, with a yearly average concentration of **0.87** with a standard deviation **0.41** mg/m^3. As shown in Graph 5, the highest concentration of CO is at location **A-7, (Admin Building Vadinar)** in winter. it can be seen that at all locations they are complying (Complied more than 98% times) with the NAAQS 1 hour limit, i.e., 4 mg/m^3. Both **locations A-7, (Admin building Vadinar)** and **A-8,(Vadinar Colony)** had **5.16**% exceedance, which is about 5 days out of 97 days of monitoring, while comparing with the NAAQS 8-hour limit, i.e., 2 mg/m3.
- The concentration of **Total VOCs** levels was recorded in a range of **0 to 6.62** µg/m^3 with a yearly average value of **0.96** with a standard deviation of **1.051** µg/m^3 at Vadinar. As shown in graph 6, the **highest** concentration of **VOCs** is at

location A-8, (Vadinar Colony), this is the only spike observed in the whole monitoring period for VOCs at this location.

Polycyclic Aromatic Hydrocarbons (PAHs):

- The concentration of **Benzene** levels was recorded in a range of **0.01 to 1.03** µg/m^3, with a yearly average value of **0.28** with a standard deviation of 0.36 µg/m^3. the **highest** concentration of Benzene is at **location A-7, (Admin building Vadinar)** in Winter. It can be seen that in all locations **Benzene** within the NAAQS annual limit, i.e., 5 µg/m^3.
- **Non-methane VOC** (NM-VOC) concentration at Vadinar was observed in the range of **0.07 to 2.15** µg/m^3 with a yearly average value of **0.82** with a standard deviation **0.085** µg/m^3. the **highest** concentration is at **A-7, (Admin building Vadinar)** in Winter.

With reference to the Ambient Air Quality monitoring conducted under the study, it may be concluded that the particulate matter PM_{10}, were reported in higher concentration and apparently exceeds the NAAQS particularly at locations of Kandla., whereas $PM_{2.5}$ complies with the NAAQS at majority of the locations. For both the ambient air monitoring parameters (PM_{10} and $PM_{2.5}$), the major exceedance was observed at location A-5 i.e. Coal Storage Area. The gaseous pollutants (NO_x, SO_x, CO, VOCs etc.) falls within the permissible limit. The probable reasons contributing to these emissions of pollutants into the atmosphere in-and-around the port area are summarized as follows: -

1. **Port Machinery:** Port activities involve the use of various machinery and equipment, including cranes, for lifts, tugboats, and cargo handling equipment. These machines often rely on diesel engines, which can emit pollutants such as NO_x, Particulate matter, and CO. Older or poorly maintained equipment tends to generate higher emissions.
2. **Port Vehicles:** Trucks and other vehicles operating within port and port area contributes to air pollution. Similar to port machinery, diesel-powered vehicles can emit NO_x, PM, CO, and other pollutants such as PAH, VOCs etc. Vehicle traffic and congestion in and around port areas can exacerbate the air quality issues.
3. **Coal Handling:** Resuspension of dust occurs due to the transportation of coal and the handling of coal.
4. **Construction Activities:** Another reason for the high particulate matter content in this area is due to high construction activities in the surrounding area.

4.4 Remedial Measures:

Efficient mitigation strategies need to be implementation for substantial environmental and health co-benefits. To improve air quality, DPA has implemented a number of precautionary measures, such as maintaining Green zone, initiated Inter-Terminal Transfer of tractor-trailers, Centralized Parking Plaza, providing shore power supply to tugs and port crafts, the use of LED lights at DPA area helps in lower energy consumption and decreases the carbon foot prints in the environment, time to time cleaning of paved and unpaved roads, use of tarpaulin sheets to cover dumpers at project sites etc. are helping to achieve the cleaner and green future at port. To address air pollution from port shipping activities, various measures that can be implemented are as follows:

- Practice should be initiated for using mask as preventative measure, to avoid Inhalation of dust particle-Mask advised in sensitive areas. Covering vehicles with tarpaulin during transportation will help to reduce the suspension of pollutants in air.
- Ensuring maintenance of engines and machinery to comply with emission standards.
- Frequent water sprinkling on roads to reduce dust suspension due to vehicular movement, this can be use during transporting coal to avoid suspension of coal dust.
- Use of proper transport methods, such as a conveyor belt, for excavated material and screens around the construction site.
- End to End pavement of roads in construction site could considerably reduce dust emission. Prohibition of use of heavy diesel oil as fuel could be possibly reduce pollutants. Encouraging use of low-sulfur fuels (viz. Marine Gas Oil (MGO)/Liquefied Natural Gas (LNG), can significantly reduce sulfur and PM emissions from ships.
- Retrofitting ships with exhaust gas cleaning systems can help reduce sulfur emissions. Engine upgrades, such as optimizing fuel combustion and improving engine efficiency, can reduce overall emissions.
- Investing in infrastructure for cold ironing allows ships to connect to the electrical grid while docked, reducing the need for auxiliary engines and associated emissions.
- Implementing efficient cargo-handling processes, optimizing logistics to reduce congestion and idling times, and encouraging use of cleaner port machinery and vehicles can all contribute to reducing air pollution in port areas.
- 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.
- 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.
- Periodic vacuum-sweeping mechanisms shall be adopted.

CHAPTER 5: DG STACK MONITORING

5.1 DG Stack Monitoring

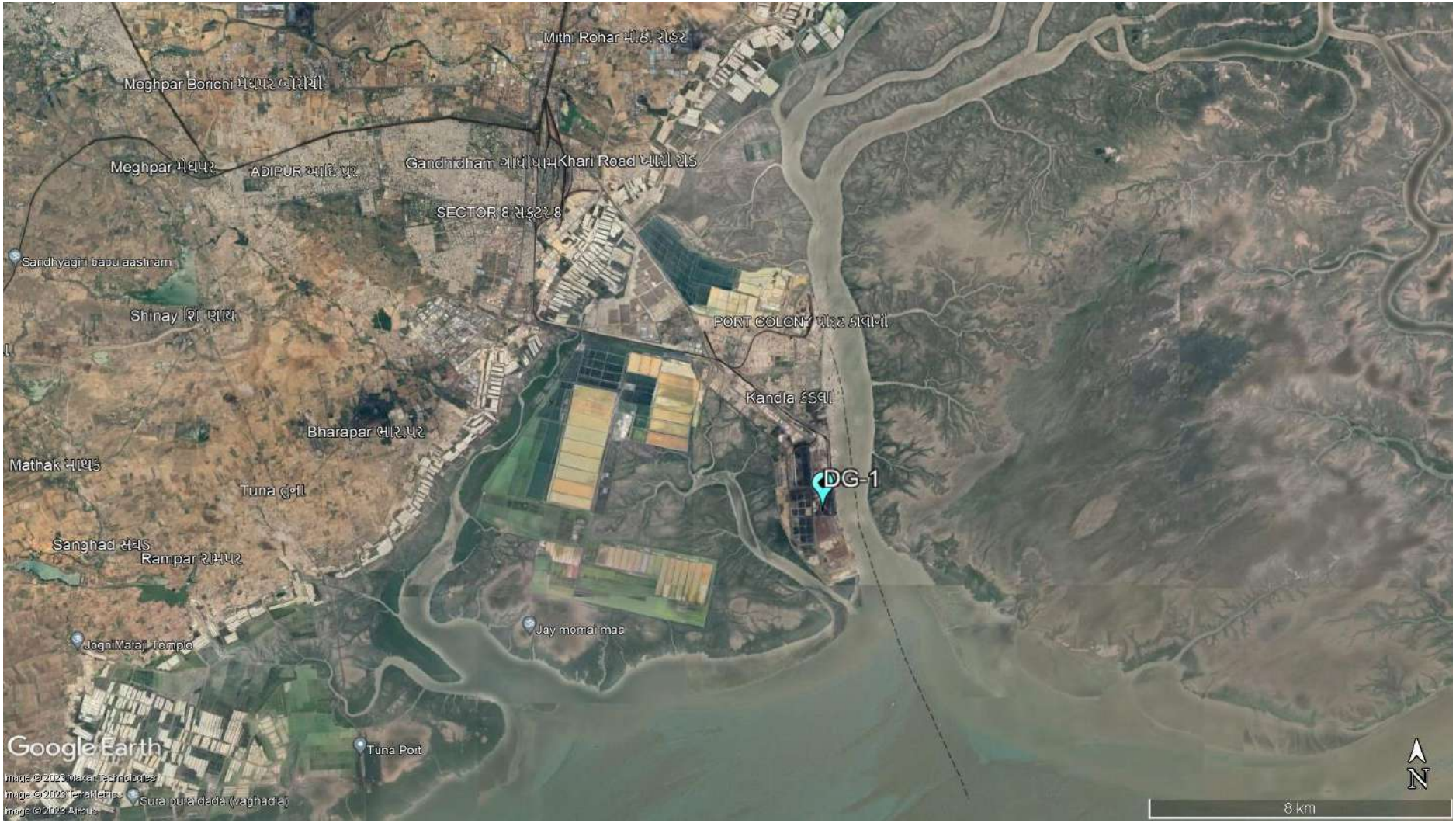
A diesel generator is a mechanical-electrical machine that produces electrical energy (electricity) from diesel fuel. They are used by the residential, commercial, charitable and governmental sectors to provide power in the event of interruption to the main power, or as the main power source. Diesel generating (DG) sets are generally used in places without connection to a power grid, or as an emergency power supply if the grid fails. These DG sets utilize diesel as fuel and generate and emit the air pollutants such as Suspended Particulate Matter, SO_2, NO_x, CO, etc. from the stack during its functioning. The purpose of stack sampling is to determine emission levels from plant processes to ensure they are in compliance with any emission limits set by regulatory authorities to prevent macro environmental pollution. The stack is nothing but chimney which is used to disperse the hot air at a great height, emissions & particulate matters that are emitted. Hence, monitoring of these stacks attached to DG Sets is necessary in order to quantify the emissions generated from it.

As defined in scope by DPA, the monitoring of DG Stack shall be carried out at two locations, one at Kandla and one at Vadinar. The details of the DG Sets at Kandla and Vadinar have been mentioned in Table 10 as follows:

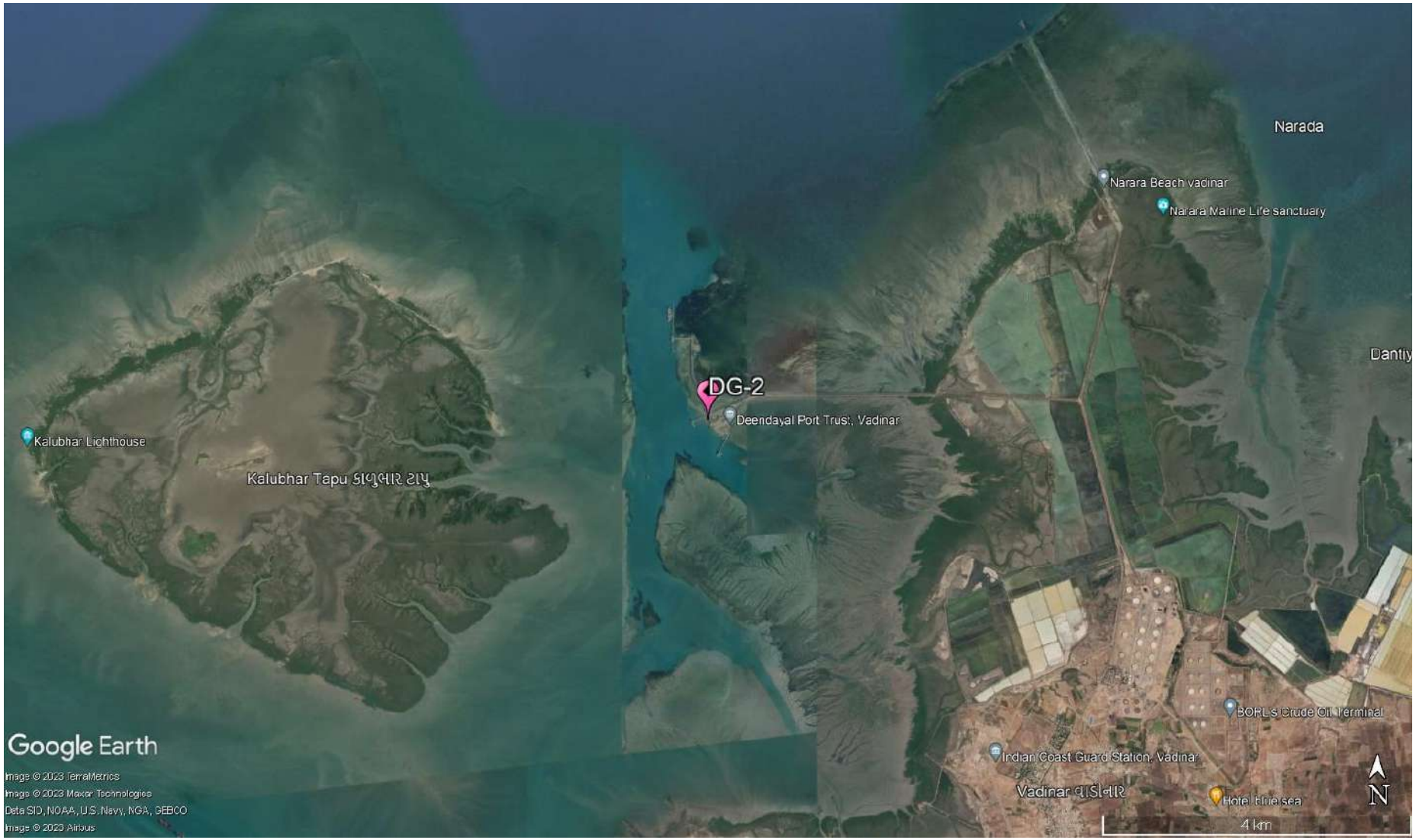
Table 10: Details of DG Stack monitoring locations

Sr. No.	Location Code	Location Name	Latitude/ Longitude
1.	DG-1	Kandla	22.98916N 70.22083E
2.	DG-2	Vadinar	22.44155N 69.67419E

The map depicting the locations of DG Stack Monitoring to be monitored in Kandla and Vadinar have been mentioned in **Map 6 and 7** as follows:



Map 6: DG Stack monitoring Locations at Kandla



Map 7: DG Stack monitoring Locations at Vadinar

Methodology:

Under the study, the list of parameters to be monitored under the projects for DG Stack Monitoring has been mentioned in **Table 11** as follows:

Table 11: DG stack parameters

Sr. No.	Parameter	Unit	Instrument
1.	Suspended Particulate Matter	**mg/Nm³**	**Stack Monitoring Kit**
2.	Sulphur Dioxide (SO_2)	PPM	**Sensor based Flue Gas Analyzer (Make: TESTO, Model 350)**
3.	Oxides of Nitrogen (NO_x)	PPM	
4.	Carbon Monoxide	%	
5.	Carbon Dioxide	%	

The methodology for monitoring of DG Stack has been mentioned as follows:

The monitoring of DG Stack is carried out as per the IS:11255 and USEPA Method. The Stack monitoring kit is used for collecting representative samples from the stack to determine the total amount of pollutants emitted into the atmosphere in a given time. Source sampling is carried out from ventilation stack to determine the emission rates/or characteristics of pollutants. Sample collected must be such that it truly represents the conditions prevailing inside the stack. Whereas the parameters Sulphur Dioxide, Oxides of Nitrogen (NO_x), Carbon Monoxide and Carbon Dioxide, the monitoring is carried out by using the sensor-based Flue Gas Analyzer.

Monitoring Frequency

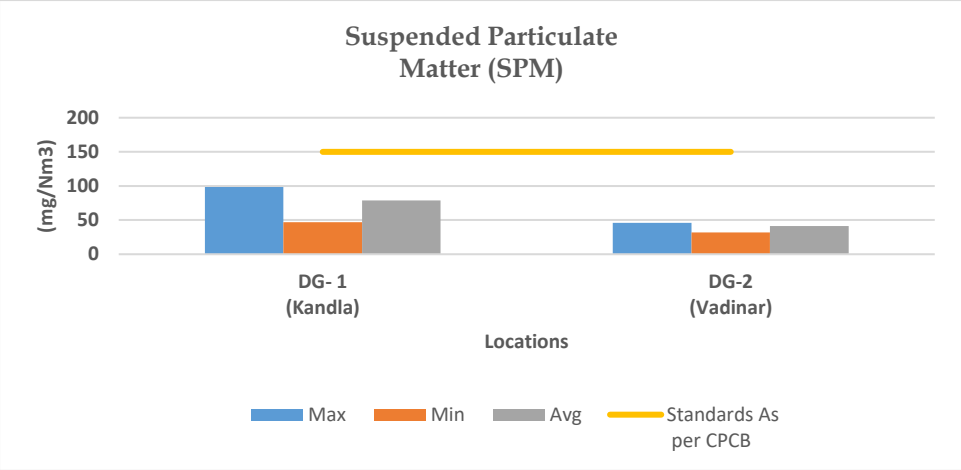
Monitoring is required to be carried out once a month for both the locations of Kandla and Vadinar for a period of 15th April 2023 to 15th April 2024.

5.2 Result and Discussion

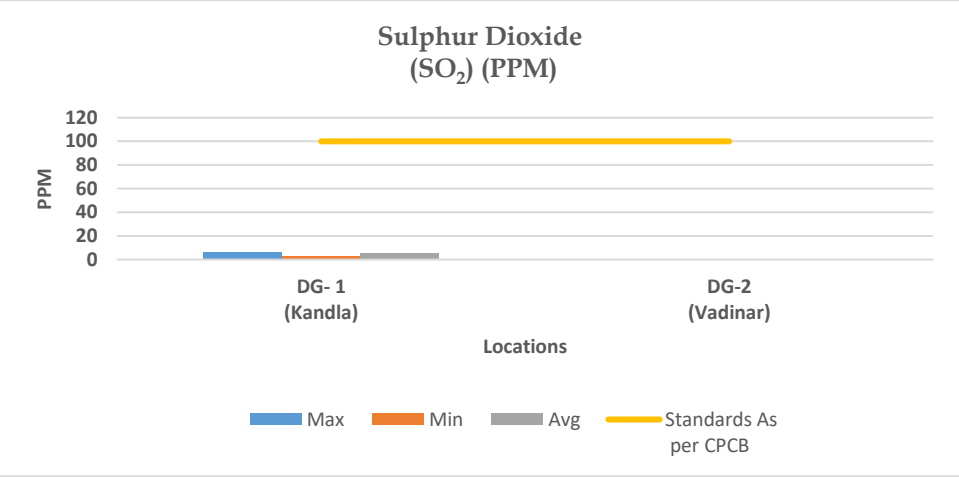
The sampling and monitoring of DG stack emission was carried out for monitoring period at Kandla and Vadinar and its comparison with CPCB or Indian standards for Industrial Stack Monitoring the flue gas emission from DG set has given in **Table 12.**

Table 12: DG monitoring data

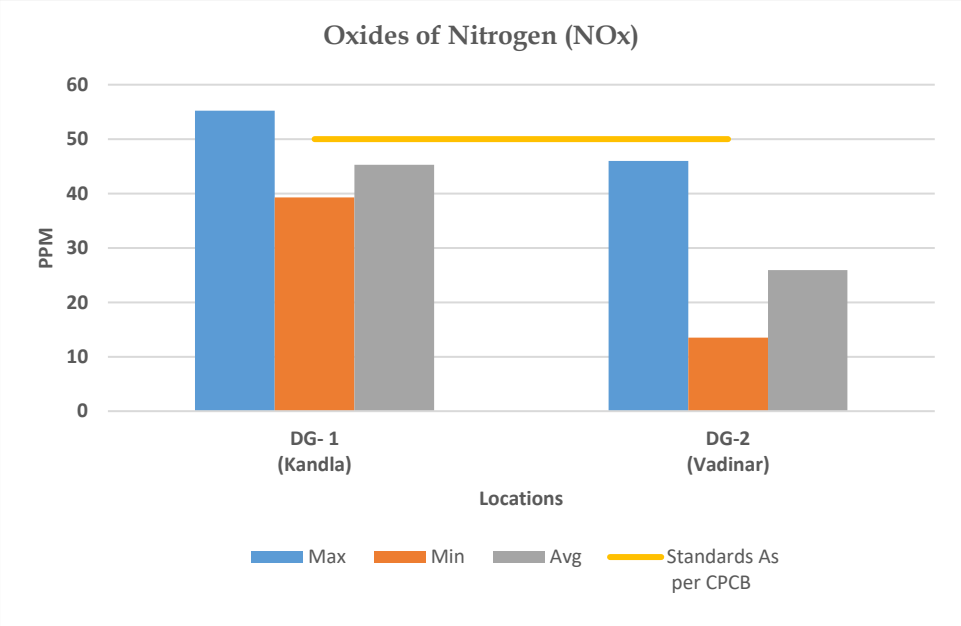
Sr. No.	Stack Monitoring Parameters for DG Sets		DG- 1 (Kandla)	DG-2 (Vadinar)	Stack Monitoring Limits /Standards As per CPCB
1.	**Suspended Particulate Matter (SPM) (mg/Nm³)**	**Max**	98.47	45.32	**150**
		Min	46.82	31.85	
		Avg.	78.96	41.33	
2.	**Sulphur Dioxide (SO2) (PPM)**	**Max**	6.45	N.D.	**100**
		Min	3.25	N.D.	
		Avg.	4.95	N.D.	
3.	**Oxides of Nitrogen (NO_x) (PPM)**	**Max**	55.2	46	**50**
		Min	39.27	13.52	
		Avg.	45.31	25.92	
4.	**Carbon Monoxide (CO) (%)**	**Max**	0.34	0.016	**1**
		Min	0.007	0.002	
		Avg.	0.16	0.01	
5.	**Carbon Dioxide (CO_2) (%)**	**Max**	3.09	1.42	**-**
		Min	1.21	1.03	
		Avg.	1.92	1.19	



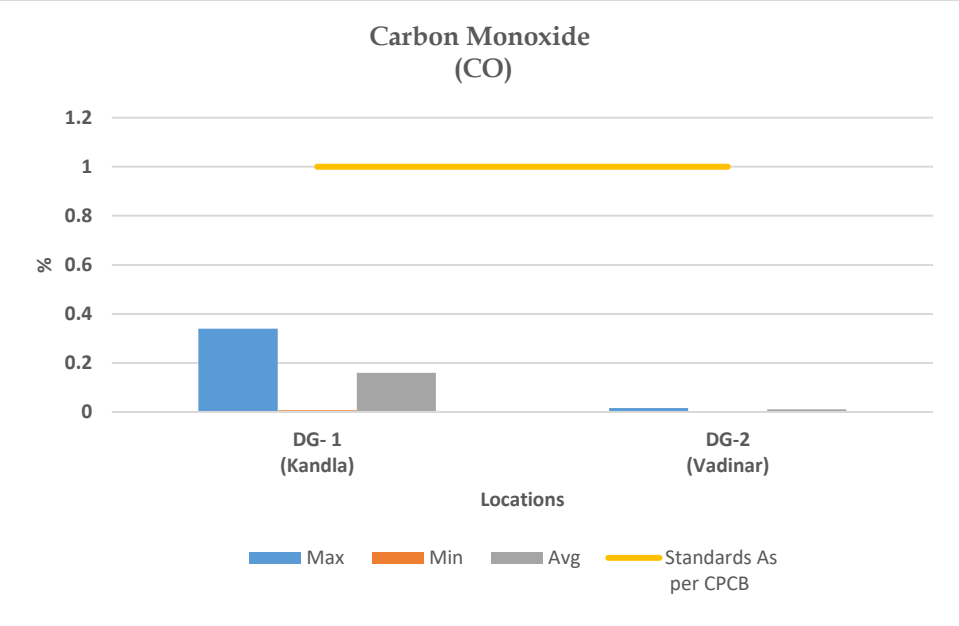
Graph 7 Spatial trend in SPM Concentration



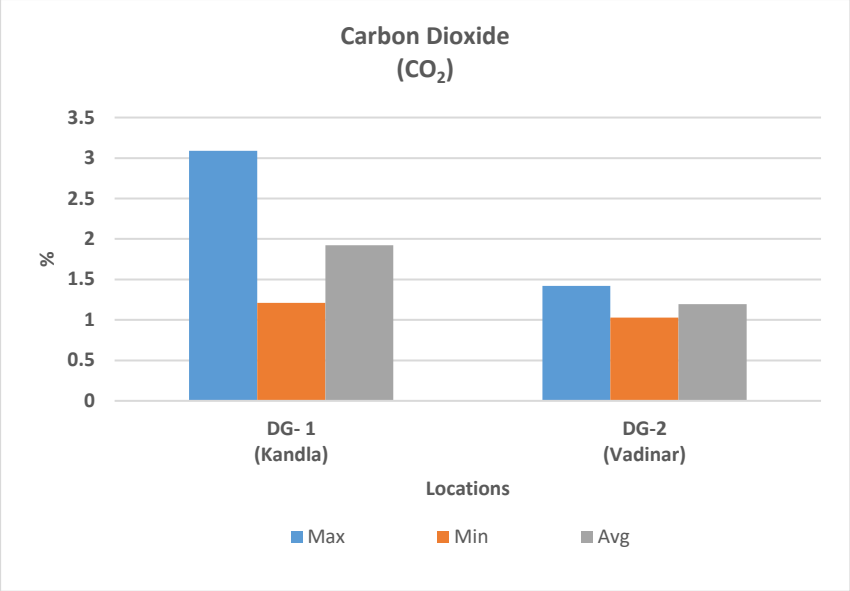
Graph 8 Spatial trend in SO_x Concentration



Graph 9 Spatial trend in NOx Concentration



Graph 10 Spatial trend in CO Concentration



Graph 11 Spatial trend in CO_2 Concentration

5.3 Data Interpretation and Conclusion

1) Kandla:

The Suspended Particulate Matter (SPM) varies in the range of **46.82** to **98.47** mg/m^3. The yearly average SPM of D.G stack-1 is **78.96** mg/m^3. The maximum concentration for SPM was observed in the monitoring period of October to November 2023. The Sulphur dioxide (SO_x) varies in the range of **3.25** to **6.45** PPM. The yearly average SO_x of D.G stack-1 is **4.95** PPM. The maximum concentration of SO_x observed in the monitoring period of October to November 2023.

The NO_x varies in the range of **39.27** to **55.2** PPM. The yearly average of NO_x of D.G stack-1 at Kandla is **45.31** PPM. The maximum concentration of NO_x observed in the monitoring period of July to August 2023.

The CO at Kandla varies in the range of **0.007** to **0.34** %. The yearly average of CO of D.G stack-1 at Kandla is **0.16** % The maximum concentration of CO observed in the monitoring period of March to April 2024.

The CO_2 at Kandla varies in the range of **1.21** to **3.09** %. The yearly average of CO_2 of D.G stack-1 at Kandla is **1.92** % The maximum concentration of CO_2 observed in the monitoring period of March to April 2024.

The results of all the above parameters of DG stack-1 at Kandla emission are compared with the permissible limits mentioned in the consent issued by GPCB, and have been found within the prescribed limit for all the monitored parameters.

2) Vadinar:

The Suspended Particulate Matter (SPM) in the range of **31.85** to **45.32** mg/m^3. The yearly average SPM of D.G stack-2 at Vadinar is **41.33** mg/m^3. The maximum concentration of SPM was observed in the monitoring period of March to April 2024. There is no Sulphur dioxide (SO_x) concentration detected at Vadinar.

The NO_x at Vadinar varies in the range of **13.52** to **46** PPM. The yearly average of NO_x of D.G stack-2 at Vadinar is **25.928** PPM. The maximum concentration of NO_x observed in the monitoring period of June to July 2023.

The CO at Vadinar varies in the range of **0.002** to **0.016** %. The yearly average of CO of D.G stack-2 at Vadinar is **0.0106** % The maximum concentration of CO observed in the monitoring period of October to November 2023.

The CO_2 at Vadinar varies in the range of **1.03 to 1.42** %. The yearly average in CO_2 of D.G stack-2 at Vadinar is **1.92** % The maximum concentration of CO_2 observed in the monitoring period of June to July 2024.

The results of all the above parameters of DG stack-2 at Vadinar emission are compared with the permissible limits mentioned in the consent issued by GPCB, and have been found within the prescribed limit for all the monitored parameters.

CHAPTER 6: NOISE MONITORING

6.1 Noise Monitoring

Noise can be defined as an unwanted sound, and it is therefore, necessary to measure both the quality as well as the quantity of environmental noise in and around the study area. Noise produced during operation stage and the subsequent activities may affect surrounding environment impacting the fauna and as well as the human population. Under the scope, the noise monitoring is required to be carried out at 10 locations in Kandla and 3 locations in Vadinar. The sampling locations for noise are not only confined to commercial areas of DPA but also the residential areas of DPA.

The details of the noise monitoring stations are mentioned in **Table 13** and locations have been depicted in the **Map 8 and 9** as follow:

Table 13: Details of noise monitoring locations

Sr. No.	Location Code		Location Name	Latitude/ Longitude
1.	Kandla	N-1	Oil Jetty 7	23.043527N 70.218456E
2.		N-2	West Gate No.1	23.006771N 70.217340E
3.		N-3	Canteen Area	23.003707N 70.221331E
4.		N-4	Main Gate	23.007980N 70.222525E
5.		N-5	Main Road	23.005194N 70.219944E
6.		N-6	Marin Bhavan	23.007618N 70.222087E
7.		N-7	Port & Custom Building	23.009033N 70.222047E
8.		N-8	Nirman Building	23.009642N 70.220623E
9.		N-9	ATM Building	23.009985N 70.221715E
10.		N-10	Wharf Area/ Jetty	22.997833N 70.223042E
11.	Vadinar	N-11	Near Main Gate	22.441544N 69.674495E
12.		N-12	Near Vadinar Jetty	22.441002N 69.673147E
13.		N-13	Port Colony Vadinar	22.399948N 69.716608E

Map 8: Locations for Noise Monitoring at Kandla

Map 9: Locations for Noise Monitoring at Vadinar

Methodology:

The intensity of sound energy in the environment is measured in a logarithmic scale and is expressed in a decibel (dB(A)) scale. The ordinary sound level meter measures the sound energy that reaches the microphone by converting it into electrical energy and then measures the magnitude in dB(A). Whereas, in a sophisticated type of sound level meter, an additional circuit (filters) is provided, which modifies the received signal in such a way that it replicates the sound signal as received by the human ear and the magnitude of sound level in this scale is denoted as dB(A). The sound levels are expressed in dB(A) scale for the purpose of comparison of noise levels, which is universally accepted. Noise levels were measured using an integrated sound level meter of the make Envirotech Sound Level Meter (Class-I) (model No. SLM-109). It has an indicating mode of Lp and Leq. Keeping the mode in Lp for few minutes and setting the corresponding range and the weighting network in "A" weighting set the sound level meter was run for one-hour time and Leq was measured at all locations.

Monitoring Frequency

Monitoring was carried out at each noise monitoring station for Leq. noise level (Day and Night), which was recorded for 24 hours continuously at a monthly frequency with the help of Sound/Noise Level Meter (Class-1). The details of the noise monitoring have been mentioned in **Table 14**.

Table 14: Details of the Noise Monitoring

Sr. No.	Parameters	Units	Reference Method	Instrument
1.	Leq (Day)	dB(A)	IS 9989: 2014	Noise Level Meter (Class-I) model No. SLM-109
2.	Leq (Night)	dB(A)		

Standard for Noise

Ministry of Environment & Forests (MoEF) has notified the noise standards vide the Gazette notification dated February 14, 2000 for different zones under the Environment Protection Act (1986). The day time noise levels have been monitored from 6.00 AM to 10.00 PM and night noise levels were measure from 10.00 PM to 6.00 AM at all the thirteen locations (10 at Kandla and 3 at Vadinar) monthly. The specified standards are as mentioned in **Table 15** as follows:

Table 15: Ambient Air Quality norms in respect of Noise[2]

Area Code	Category of Area	Noise dB(A) Leq	
		Daytime	Night time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

6.2 Result and Discussion

The details of the Noise monitoring conducted during the monitoring period April 2023 to April 2024 have been summarized in the **Table 16** as below:

Table 16: The Results of Ambient Noise Quality

Sr. No.	Station Code	Station Name	Category of Area	Standard	Day Time in dB(A)			Standard	Night Time in dB(A)		
					Max.	Min.	Avg.		Max.	Min.	Avg.
1	N-1	Oil Jetty 7	A	75	65.7	36.5	47.75	70	57.5	33	41.801
2	N-2	West Gate No.1	A	75	68.4	36.5	54.35	70	54.2	36.1	47.02
3	N-3	Canteen Area	B	65	66.2	38	52.61	55	52.1	33	43.46
4	N-4	Main Gate	A	75	61.4	35.3	50.69	70	50.8	36.1	43.33
5	N-5	Main Road	A	75	66.1	33.5	51.67	70	55.5	33.6	43.7
6	N-6	Marin Bhavan	B	65	62.3	38.9	52.52	55	52.3	31.9	43.23
7	N-7	Port & Custom Building	B	65	66.3	37.6	50.89	55	54.3	33.9	38.91
8	N-8	Nirman Building	B	65	60.8	40.9	51	55	58.9	35.2	43.02
9	N-9	ATM Building	B	65	65.1	35.1	49.7	55	53.4	34.1	39.25
10	N-10	Wharf Area/ Jetty	A	75	74.5	36.9	52.9	70	52.7	36	42.3
11	N-11	Near Main Gate	A	75	72.3	34	62.51	70	71.2	34.3	55.71
12	N-12	Near Vadinar Jetty	A	75	76.3	39.2	64.98	70	68.5	34.7	56.38
13	N-13	Port Colony Vadinar	C	55	77.5	37.7	50.05	45	65.9	36.2	49.5

6.3 Data Interpretation and Conclusion

1) **Kandla:** The noise level was compared with the standard limits specified in NAAQS by CPCB. During the Day Time, the average noise level at all 10 locations at Kandla ranged from **33.5** dB(A) to **74.5** dB(A) while, during Night Time the average Noise Level ranged from **31.9** dB(A) to **58.9** dB(A), of which six locations out of ten locations, noise level were within the permissible limits for the industrial, commercial area and residential zone for Day time and night time.
   Other Four locations such as i.e., **N-3 (Canteen Area)**, **N-7 (Port & Custom Building), N-8 (Nirman Building)** and **N-9 (ATM building)** which are Commercial areas, slightly exceed the standard limits prescribed by NAAQS by CPCB, in the monitoring period of **April to May 2023 and May to June 2023**.

2) **Vadinar:** The noise level was compared with the standard limits specified in NAAQS by CPCB. During the Day Time, the average noise level at all 3 locations at Vadinar ranged from **34** dB(A) to **77.5** dB(A) while, during Night Time the average Noise Level ranged from **34.3** dB(A) to **71.2** dB(A) at Vadinar, on location **N-11 (Near main gate)** noise level was within the permissible limits for the industrial zone for Day time and night time.
   On locations of Vadinar such as i.e., **N-12 (Near Vadinar jetty)**, which are considered as industrial area slightly exceed the standard limits prescribed by NAAQS by CPCB, in the monitoring period **of June to July 2023**. And on location **N-13 (Port Colony Vadinar)**, most frequently exceed the permissible limit during the day time as well as night time.

6.4 Remedial Measures

The noise levels detected at the locations of Kandla and Vadinar, are found within the prescribed norms. The noise can further be considerably reduced by adoption of low noise equipment or installation of sound insulation fences. Green belt of plants can be a good barrier. If noise exceeds the applicable norms, then the working hours may be altered as a possible means to mitigate the nuisances of construction activities.

CHAPTER 7: SOIL MONITORING

7.1 Soil Quality Monitoring:

The purpose of soil quality monitoring is to track changes in the features and characteristics of the soil, especially the chemical properties of soil occurring at specific time intervals under the influence of human activity. Soil quality assessment helps to determine the status of soil functions and environmental risks associated with various practices prevalent at the location.

As defined in scope by Deendayal Port Authority (DPA), Soil Quality Monitoring shall be carried out at Six locations, four at Kandla and two at Vadinar. The details of the soil monitoring locations within the Port area of DPA are mentioned in **Table 17:**

Table 17: Details of the Soil quality monitoring

Sr. No.	Location Code		Location Name	Latitude Longitude
1.	Kandla	S-1	Oil Jetty 7	23.043527N 70.218456E
2.		S-2	IFFCO Plant	23.040962N 70.216570E
3.		S-3	Khori Creek	22.970382N 70.223057E
4.		S-4	Nakti Creek	23.033476N 70.158461E
5.	Vadinar	S-5	Near SPM	22.400026N 69.714308E
6.		S-6	Near Vadinar Jetty	22.440759N 69.675210E

Methodology

As per the defined scope by Deendayal Port Authority (DPA), the sampling and analysis of Soil quality has been carried out on monthly basis.

The samples of soil collected from the locations of Kandla and Vadinar and analyzed for the various physico-chemical parameter. Collection and analysis of these samples was carried out as per established standard methods and procedures. The samples were analyzed for selected parameters to get the present soil quality status and environmental risks associated with various practices prevalent at the location. GEMI has framed its own guidelines for collection of soil samples titled as ***'Soil Sampling Manual'***. Soil samples were collected from 30 cm depth below the surface using scrapper, filled in polythene bags, labelled on-site with specific location code and name and sent to GEMI's laboratory, Gandhinagar for further detailed analysis. The samples collected from all locations are homogeneous representative of each location. The list of parameters to be monitored under the projects for the Soil Quality Monitoring been mentioned in **Table 18** as follows:

Monitoring Frequency

Monitoring is required to be carried out once a month for both the locations of Kandla and Vadinar. The monitoring was done from April 15th 2023, to April 15th, 2024

Table 18: Soil parameters

Sr. No.	Parameters	Units	Reference method	Instruments
1.	TOC	%	Methods Manual Soil Testing in India January, 2011, 09. Volumetric method (Walkley and Black, 1934)	Titration Apparatus
2.	Organic Carbon	%		
3.	Inorganic Phosphate	Kg/Hectare	Practical Manual Chemical Analysis of Soil and Plant Samples, ICAR-Indian Institute of Pulses Research 2017 Determination of Available Phosphorus in Soil	UV-Visible Spectrophotometer
4.	Texture	-	Methods Manual Soil Testing in India January 2011,01	Hydrometer
5.	pH	-	IS 2720 (Part 26): 1987	pH Meter
6.	Conductivity	µS/cm	IS 14767: 2000	Conductivity Meter
7.	Particle size distribution & Silt content	-	Methods Manual Soil Testing in India January 2011	Sieves Apparatus
8.	SAR	meq/L	Procedures for Soil Analysis, International Soil Reference and Information Centre, 6th Edition 2002 13-5.5.3 Sodium Absorption Ratio (SAR), Soluble cations	Flame Photometer
9.	Water Holding Capacity	%	NCERT, Chapter 9, 2022-23 and Water Resources Department Laboratory Testing Procedure for Soil & Water Sample Analysis	Muffle Furnace
10.	Aluminium	mg/Kg	EPA Method 3051A	ICP-OES
11.	Chromium	mg/Kg		
12.	Nickel	mg/Kg		
13.	Copper	mg/Kg	Methods Manual Soil Testing in India January, 2011, 17a	
14.	Zinc	mg/Kg	Methods Manual Soil Testing in India January, 2011, 17a	
15.	Cadmium	mg/Kg	EPA Method 3051A	
16.	Lead	mg/Kg		
17.	Arsenic	mg/Kg		
18.	Mercury	mg/Kg		

The map depicting the locations of Soil Quality Monitoring to be monitored in Kandla and Vadinar have been mentioned in **Map 10 and 11** as follows:

Map 10: Soil Quality Monitoring Locations at Kandla

Map 11: Soil Quality Monitoring Locations at Vadinar

7.2 Result and Discussion

The analysis results of physical analysis of the soil samples collected during environmental monitoring period during 15th April 2023 to 15th April 2024 mentioned in **Table 19** are shown below:

Table 19: Soil Quality for the Monitoring period

Sr. No	Parameters / Location		Kandla				Vadinar	
			S-1 (Oil Jetty 7)	S-2 IFFCO Plant)	S-3 (Khori Creek)	S-4 (Nakti Creek)	S-5 (Near SPM)	S-6 (Near Vadinar Jetty)
1	pH	Max	9.53	8.8	8.88	9.48	8.69	9.36
		Min	7.3	6.48	6.52	7.86	7.19	8.16
		Avg.	8.24	8.20	7.96	8.52	8.14	8.55
2	Conductivity (µS/cm)	Max	71500	36500	75700	17850	501	625
		Min	587	526	586	204	63	127
		Avg	26881.17	11442	20646.33	5470	177.13	281.54
3	Inorganic Phosphate (Kg/ha)	Max	13.32	619.89	20.31	15.87	5.64	8.67
		Min	0.39	0.43	1.24	0.32	0.35	0.26
		Avg	4.21	57.15	5.64	4.71	2.39	2.25
4	Organic Carbon (%)	Max	2.83	2.54	3.83	3.35	0.85	2.48
		Min	0.03	0.08	0.14	0.27	0.06	0.14
		Avg	0.91	0.79	1.06	0.92	0.33	0.59
5	Organic Matter (%)	Max	4.88	4.38	6.6	5.78	1.47	4.28
		Min	0.06	0.14	0.24	0.32	0.09	0.241
		Avg	1.57	1.36	1.82	1.48	0.57	1.01
6	SAR (meq/L)	Max	41.45	22.91	31.51	10.01	0.25	0.45
		Min	0.81	0.36	0.5	0.36	0.05	0.09
		Avg	13.24	6.56	11.71	2.57	0.10	0.17
7	Aluminium (mg/Kg)	Max	8643.04	9065.97	10298.7	9286.91	15921.7	14806.19
		Min	812.75	830.95	840.71	916.4	735.77	754.58
		Avg	2223.8	2322.3	2517.4	2470.4	2848.2	2762.2
8	Chromium (mg/Kg)	Max	92.23	90.7	86.18	87.07	106	91.88
		Min	28.213	28.91	31.57	24.7	71.68	60.93
		Avg	52.28	58.79	59.005	53.30	82.46	70.91
9	Nickel (mg/Kg)	Max	33.32	36.66	38.1	45.41	41.425	42.68
		Min	13.17	11.82	11.91	10.43	27.14	25.52
		Avg	19.17	19.22	22.72	21.72	33.29	32.353
10	Copper (mg/Kg)	Max	92.51	88.31	150.7	192.72	123.18	104.64
		Min	12.42	14.71	14.74	12.8	81.14	60.57
		Avg	49.94	61.10	84.93	56.708	103.06	82.37
11	Zinc (mg/Kg)	Max	210.35	1755.44	188.29	142.71	88.14	97.36
		Min	16.46	42.93	29.9	23.57	37.03	15.33
		Avg	73.75	283.57	99.49	81.77	62.53	49.70
12	Cadmium (mg/Kg)	Max	0.397	23.47	0.59	0	3	0
		Min	0.397	0.5	0.59	0	3	0
		Avg	0.397	6.608	0.59	0	3	0
13	Lead (mg/Kg)	Max	50.28	277.82	47.87	26.48	1.58	21.07
		Min	3.79	2.58	1.29	2.26	0.59	0.89
		Avg	12.09	32.75	15.59	8.88	1.08	6.66

Sr. No	Parameters / Location		Kandla				Vadinar	
			S-1 (Oil Jetty 7)	S-2 IFFCO Plant)	S-3 (Khori Creek)	S-4 (Nakti Creek)	S-5 (Near SPM)	S-6 (Near Vadinar Jetty)
14	Arsenic (mg/Kg)	Max	4.87	8.4	5.28	6.62	0.4	5.05
		Min	0.1	0.29	0.88	0.3	0.099	0.59
		Avg	2.38	3.04	2.97	2.26	0.22	2.82
15	Mercury (mg/Kg)	Max	0	0	0	0	0	0
		Min	0	0	0	0	0	0
		Avg	0	0	0	0	0	0
16	Water Holding Capacity (%)	Max	54	77.92	61.99	75.84	60	66
		Min	35.8	34	23.74	15.9	39.85	44
		Avg	42.66	46.48	43.95	48.34	47.70	60.01
17	Sand (%)	Max	77.61	77.7	85.46	82.36	62.4	78.46
		Min	44.4	46.57	48.27	13.39	42.26	42.25
		Avg	59.26	65.74	62.96	65.03	51.61	60.59
18	Silt (%)	Max	53.28	47.28	41.25	57.98	49.27	53.27
		Min	9.77	9.28	9.93	9.28	12.24	12
		Avg	30.41	26.40	28.84	24.13	34.72	29.17
19	Clay (%)	Max	19.53	14.32	22.35	28.63	35.92	21.02
		Min	2.32	0.63	0.64	0.48	1.75	1.74
		Avg	10.29	7.86	8.19	10.83	13.66	10.23
20	Texture		Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Loam	Sandy Loam

7.3 Data Interpretation and Conclusion

Soil samples were collected from 6 locations (4 at Kandla and 2 at Vadinar) and further analysed for its physical & chemical characteristics. Each of the parameters have been given an interpretation based on the observations as follows:

1) Kandla:

- The value of **pH** ranges from **6.48** to **9.53**, with the highest at location **S-1 (Oil Jetty 7)** and the lowest at **location S-2 (IFFCO plant),** while the average pH for Kandla was observed to be **8.23**. The pH in Kandla varies from **Slightly alkaline to strongly alkaline**

- At all monitoring locations, the value of **Electrical Conductivity** ranges from **204 to 75,700** µs/cm, with the highest at **location S-3 (Khori Creek**) and the lowest at **S-4 (Nakti Creek).** The average Electrical Conductivity is **16,109.87** µs/cm.

- The concentration of inorganic phosphate varied from **0.32** to **619.89** kg/ha, with an average of **17.93** kg/ha. The highest concentration of inorganic phosphate was found at **S-2 (IFFCO plant)** and the lowest concentration was found at **S-4 (Nakti Creek)**. The availability of phosphorus in the soil solution is influenced by several factors, such as organic matter, clay content, pH, temperature, and more.

- The concentration of **Total Organic Carbon** ranges from **0.03% to 3.86%,** with an average TOC of **0.92%** detected. The highest concentration was found at **location S-3 (Khori Creek),** and the minimum concentration was found **at S-1 (Oil Jetty 7).**
- The **Sodium Adsorption Ratio** ranges from **0.36** to **41.45** meq/L, with an average value of **8.25** meq/L at Kandla. The highest concentration of SAR is found at **S-1 (Oil Jetty 7)** and the lowest concentration at **S-4 (Nakti Creek)**.
- The **Water Holding Capacity (WHC)** in the soil samples of Kandla varies from **15.9% to 77.92%**, with an average of **45.36%**. The highest concentration of WHC was observed at **S-2 (IFFCO plant)** and the lowest concentration at **S-4 (Nakti Creek)**.
- The Soil Texture was observed as "**Sandy loam**" to "**loamy sand**" at all the monitoring locations in Kandla.

Heavy Metals

- During the sampling period, the concentration of **Aluminium** varied from **812.75** to **10,298.7** mg/kg. The average **Aluminium** concentration was observed to be **2,383.475** mg/kg at the Kandla monitoring station. The **highest concentration** was observed at **S-3 (Khori Creek)**, and the **lowest concentration** was observed at **S-1 (Oil Jetty 7)**.
- The concentration of **Chromium** varied from **24.7 to 92.23** mg/kg, with an average value of **55.848** mg/kg observed at the Kandla monitoring station. The highest concentration was observed at **S-1 (Oil Jetty 7)**, and the lowest concentration was observed at **S-4 (Nakti Creek)**.
- The concentration of **Nickel** varied from **10.43** to **45.41** mg/kg at Kandla, with an average value of **20.71** mg/kg at the Kandla monitoring station. The highest concentration was observed at **S-4 (Nakti Creek)**, while the lowest concentration was also observed at **S-4 (Nakti Creek)**.
- The concentration of **Zinc** varied from **16.46** to **1755.4** mg/kg at Kandla, with an average value of **134.64** mg/kg at the Kandla monitoring station. The highest concentration was observed at **S-2 (IFFCO plant)**, which was the only spike observed during the entire monitoring period at Kandla. The lowest concentration was observed at **S-1 (Oil Jetty 7)**.
- The concentration of **Copper** varied from **12.42** to **192.72** mg/kg, with an average value of **13.667** mg/kg observed at the Kandla monitoring station. The highest concentration was observed at **S-4 (Nakti Creek)** and the lowest concentration was observed at **S-1 (Oil Jetty 7)**.
- The concentration of Lead varied from **1.29 to 277.82** mg/kg, with an average value of **17.33** mg/kg. The highest concentration was observed at **S-2 (IFFCO plant)**; this was the only spike observed during the entire monitoring period, while the lowest concentration was observed at **S-3 (Khori creek)**.
- The concentration of A**rsenic** varied from **0.1 to 8.4** mg/kg, with an average value of **2.67** mg/kg. The highest concentration was observed at **S-1 (Oil Jetty 7)**, and the lowest concentration was observed at **S-3 (Khori Creek)**.
- The concentration of **Cadmium** varied from **0** to **23.47** mg/kg, with an average value of **1.89** mg/kg. The highest concentration was observed at **S-2 (IFFCO plant)**. During the monitoring period, it was observed that cadmium was mostly found **Below**

Quantification Limit (BQL) at all locations, with only one spike observed at **S-2 (IFFCO plant)** throughout the entire monitoring period.

- During the monitoring period, it was observed that the concentration of **Mercury** was mostly found **below the quantification limit (BQL)** at all locations.

2) Vadinar:

- The value of **pH** ranges from **7.675** to **9.36**, with the highest at location **S-6 (Near Vadinar jetty)** and the lowest at **location S-5 (Near SPM),** while the average pH for Vadinar was observed to be **8.34**. pH of Soil at Vadinar was found to be **moderately alkaline**.
- At all monitoring locations in Vadinar, the value of **Electrical Conductivity** ranges from **63 to 625** µs/cm, with the highest at **S-6 (Near Vadinar jetty)** and the lowest at **location S-5 (Near SPM).** The average Electrical Conductivity is **229.33** µs/cm.
- The concentration of **inorganic phosphate** varied from **0.26** to **8.67** kg/ha, with an average of **2.32** kg/ha. The highest concentration of inorganic phosphate was found at **S-6 (Near Vadinar jetty)** and the lowest concentration was found at **location S-5 (Near SPM)**.
- The concentration of **Total Organic Carbon** ranges from **0.06% to 2.48%,** with an average TOC of **0.46%** detected at Vadinar. The highest concentration was found at **S-6 (Near Vadinar jetty),** and the minimum concentration was found **at S-5 (Near SPM).**
- The **Sodium Adsorption Ratio** ranges from **0.05** to **0.45** meq/L, with an average value of **0.143** meq/L at Vadinar. The highest concentration of SAR is found at **6 (Near Vadinar jetty)** and the lowest concentration at **S-5 (Near SPM)**.
- The **Water Holding Capacity (WHC)** in the soil samples of Vadinar varies from **39.85% to 66%**, with an average of **53.85%**. The highest concentration of WHC was observed at **S-6 (Near Vadinar jetty)** and the lowest concentration at **S-5 (Near SPM)**.
- The soil texture of Vadinar varies from "loam" to "slit loam".

Heavy Metals

- During the sampling period, the concentration of **Aluminium** varied from **735.77** to **15921.72** mg/kg. The average **Aluminium** concentration was observed to be **2,805.2** mg/kg at the Vadinar monitoring station. The **highest concentration** was observed at **S-5 (Near SPM)**, and the **lowest concentration** was observed at **S-5 (Near SPM) but during different months**.
- The concentration of **Chromium** varied from **60.93 to 106** mg/kg, with an average value of **76.69** mg/kg observed at the Vadinar monitoring station. The highest concentration was observed at **S-5 (Near SPM)**, and the lowest concentration was observed at **S-6 (Near Vadinar jetty)**.
- The concentration of **Nickel** varied from **25.62** to **42.68** mg/kg, with an average value of **32.825** mg/kg at the Vadinar monitoring station. The highest concentration was observed at **S-6 (Near Vadinar jetty)**, and the lowest concentration was also observed at **S-6 (Near Vadinar jetty)** but during different months.

- The concentration of **Zinc** varied from **15.33** to **97.36** mg/kg, with an average value of **56.118** mg/kg at the Vadinar monitoring station. The highest concentration was observed at **S-6 (Near Vadinar jetty)**, and the lowest concentration was also observed at **S-6 (Near Vadinar jetty)** but during different months.
- The concentration of **Copper** varied from **60.57** to **123.18** mg/kg, with an average value of **92.71** mg/kg observed at the Vadinar monitoring station. The highest concentration was observed at **S-5 (Near SPM)** and the lowest concentration was observed at **S-6 (Near Vadinar jetty)**.
- The concentration of **Lead** varied from **0.59 to 21.07** mg/kg, with an average value of **3.875** mg/kg. The highest concentration was observed at **S-6 (Near Vadinar jetty)**; this was the only spike observed during the entire monitoring period at Kandla, while the lowest concentration was observed at **S-5 (Near SPM)**.
- The concentration of A**rsenic** varied from **0.099 to 0.59** mg/kg, with an average value of **5.05** mg/kg. The highest concentration was observed at **S-6 (Near Vadinar jetty)**, and the lowest concentration was observed at **S-5 (Near SPM)**.
- The concentration of **Cadmium** varied from **0** to **3** mg/kg, with an average value of **3** mg/kg. The highest concentration was observed at **S-5 (Near SPM)**. During the monitoring period, it was observed that cadmium was mostly found **Below Quantification Limit (BQL)** at all locations.
- During the monitoring period, it was observed that the concentration of **Mercury** was mostly found **below the quantification limit (BQL)** at all locations.

CHAPTER 8: DRINKING WATER MONITORING

8.1 Drinking Water Monitoring

It is necessary to check with the drinking water sources regularly so as to know whether water quality conforms to the prescribed standards for drinking. Monitoring the drinking water quality is essential to protect human health and the environment. With reference to the scope specified by DPA, a total of 20 locations (18 at Kandla and 2 at Vadinar) were monitored to assess the Drinking Water quality.

The details of the drinking water sampling stations have been mentioned in **Table 20** and the locations have been depicted through Google map in **Map 12 and 13.**

Table 20: Details of Drinking Water Sampling Locations

Sr. No.	Location Code		Location Name	Latitude/ Longitude
1.	Kandla	DW-1	Oil Jetty 7	23.043527N 70.218456E
2.		DW-2	Port & Custom Building	23.009033N 70.222047E
3.		DW-3	North Gate	23.007938N 70.222411E
4.		DW-4	Workshop	23.009372N 70.222236E
5.		DW-5	Canteen Area	23.003707N 70.221331E
6.		DW-6	West Gate 1	23.006771N 70.217340E
7.		DW-7	Sewa Sadan -3	23.009779N 70.221838E
8.		DW-8	Nirman Building	23.009642N 70.220623E
9.		DW-9	Custom Building	23.018930N 70.214478E
10.		DW-10	Port Colony Kandla	23.019392N 70.212619E
11.		DW-11	Wharf Area/ Jetty	22.997833N 70.223042E
12.		DW-12	Hospital Kandla	23.018061N 70.212328E
13.		DW-13	A.O. Building	23.061914N 70.144861E
14.		DW-14	School Gopalpuri	23.083619N 70.132061E
15.		DW-15	Guest House	23.078830N 70.131008E
16.		DW-16	E- Type Quarter	23.083306N 70.132422E
17.		DW-17	F- Type Quarter	23.077347N 70.135731E
18.		DW-18	Hospital Gopalpuri	23.081850N 70.135347E
19.	Vadinar	DW-19	Near Vadinar Jetty	22.440759N 69.675210E
20.		DW-20	Near Port Colony	22.401619N 69.716822E

Map 12: Drinking Water Monitoring Locations at Kandla

Map 13: Drinking Water Monitoring Locations at Vadinar

Methodology

The water samples were collected from the finalized sampling locations and analyzed for physico-chemical and microbiological parameter, for which the analysis was carried out as per APHA, 23rd Edition and Indian Standard method in GEMI's NABL Accredited Laboratory, Gandhinagar. GEMI has followed the CPCB guideline as well as framed its own guidelines for the collection of water/wastewater samples, under the provision of Water (Preservation and Control of Pollution) Act 1974, titled as '**Sampling Protocol for Water & Wastewater'**; approved by the Government of Gujarat vide letter no. ENV-102013-299-E dated 24-04-2014. The samples under the study were collected and preserved as per the said Protocol. The parameters finalized to assess the drinking water quality have been mentioned in **Table 21** as follows:

Table 21: List of parameters for Drinking Water Quality monitoring[3]

Sr. No.	Parameters	Units	Reference method	Instrument
1.	pH	-	APHA, 23rd Edition (Section-4500-H^+B):2017	pH Meter
2.	Colour	Hazen	APHA, 23rd Edition, 2120 B:2017	Color Comparator
3.	EC	µS/cm	APHA, 23rd Edition (Section-2510 B):2017	Conductivity Meter
4.	Turbidity	NTU	APHA, 23rd Edition (Section -2130 B):2017	Nephlo Turbidity Meter
5.	TDS	mg/L	APHA, 23rd Edition (Section-2540 C):2017	Vaccum Pump with filtration assembly and Oven
6.	TSS	mg/L	APHA, 23rd Edition, 2540 D: 2017	
7.	Chloride	mg/L	APHA, 23rd Edition (Section-4500-Cl-B):2017	Titration Apparatus
8.	Total Hardness	mg/L	APHA, 23rd Edition (Section-2340 C):2017	
9.	Ca Hardness	mg/L	APHA, 23rd Edition (Section-3500-Ca B):2017	
10.	Mg Hardness	mg/L	APHA, 23rd Edition (Section-3500-Mg B):2017	
11.	Free Residual Chlorine	mg/L	APHA 23rd Edition, 4500	
12.	Fluoride	mg/L	APHA, 23rd Edition (Section-4500-F-D):2017	UV- Visible Spectrophotometer
13.	Sulphate	mg/L	APHA, 23rd Edition (Section 4500-SO4-2-E):2017	
14.	Sodium	mg/L	APHA, 23rd Edition (Section-3500-Na-B):2017	Flame Photometer
15.	Potassium	mg/L	APHA,23rd Edition, 3500 K-B: 2017	
16.	Salinity	mg/L	APHA, 23rd Edition (section 2520 B, E.C. Method)	Salinity /TDS Meter
17.	Nitrate	mg/L	APHA, 23rd Edition, 4500 NO3- B: 2017	UV- Visible Spectrophotometer
18.	Nitrite	mg/L	APHA, 23rd Edition, 4500 NO2-B: 2017	
19.	Hexavalent Chromium	mg/L	APHA, 23rd Edition, 3500 Cr B: 2017	
20.	Manganese	mg/L	APHA,23rd Edition, ICP Method 3120 B: 2017	ICP-OES

Sr. No.	Parameters	Units	Reference method	Instrument
21.	Mercury	mg/L	EPA 200.7	
22.	Lead	mg/L	APHA ICP 23rd Edition (Section-3120 B):2017	
23.	Cadmium	mg/L	APHA ICP 23rd Edition (Section-3120 B):2017	
24.	Iron	mg/L	APHA ICP 23rd Edition (Section-3120 B):2017	
25.	Total Chromium	mg/L	APHA ICP 23rd Edition (Section-3120 B):2017	
26.	Copper	mg/L	APHA,23rd Edition, ICP Method 3120 B: 2017	ICP-OES
27.	Zinc	mg/L	APHA ICP 23rd Edition (Section-3120 B):2017	
28.	Arsenic	mg/L	APHA ICP 23rd Edition (Section-3120 B):2017	
29.	Total Coliforms	MPN/ 100ml	IS 15185: 2016	LAF/ Incubator

Monitoring Frequency

Monitoring is required to be carried out once a month for both the locations of Kandla and Vadinar. Sample Collected from this location during the monitoring period 15th April 2023 to15thApril2024.

8.2 Result and Discussion

The drinking water quality of the locations at Kandla and Vadinar and its comparison with the to the stipulated standard (Drinking Water Specifications i.e., IS: 10500:2012) [4] have been summarized in **Table 22A, 22B, 22C** as follows:

Table 22A: Drinking Water Quality for the Monitoring period

Parameters	Standard values as per IS-		DW-1 (Oil Jetty 7)			DW-2 (Port & Custom Building)			DW-3 (North Gate)			DW-4 (Workshop)			DW-5 (Canteen Area)			DW-6 (West Gate 1)			DW-7 (Sewa Sadan -3)		
	A	P	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg
pH	6.5-8.5		7.9	6.6	7.4	8.4	6.8	7.3	8.0	6.8	7.3	8.1	7.1	7.4	8.2	7.3	7.7	8.4	7.2	7.7	8.2	7.2	7.5
Colour (Hazen)	5	15	5.0	1.0	1.7	5.0	1.0	1.3	5.0	1.0	1.3	5.0	1.0	1.3	5.0	1.0	3.3	5.0	1.0	1.7	5.0	1.0	1.3
EC (µS/ cm)			370	19.4	195.6	600.	36.0	153.8	1653	27.0	259.7	401	12.8	85.6	2200	42.0	1056	1470	28.0	336.3	150	22	57.8
Salinity (PSU)			1.0	0.0	0.2	0.3	0.0	0.1	0.8	0.0	0.1	0.2	0.0	0.0	1.1	0.0	0.5	0.7	0.0	0.2	0.1	0	0.0
Turbidity (NTU)	1	5	1.2	1.1	1.1	2.0	1.5	1.8	1.9	0.7	1.2	3.7	0.9	2.3	3.1	0.9	1.9	1.5	1.0	1.2	5.9	1.1	3.5
Chloride (mg/L)	250	1000	81	5.8	41.6	92	7.5	34.1	354.9	8.0	56.9	110	3	22.9	437.4	10.3	192.0	329.9	9.0	78	42.5	6.5	15.7
Total Hardness (mg/L)	200	600	42	3	13.3	148	3	24.8	320	2.0	33.4	20.0	2	7.5	310	10	181	230	5.0	53.2	10	2	4.1
Ca Hardness (mg/L)			27	2	6.3	92	2	13.9	200	1.0	20.3	8.0	1	3.3	210.0	5	103.9	120.0	2.5	28.9	5.0	1	2.2
Mg Hardness (mg/L)			15	1	6.8	56	1	10.1	120	1.0	13.1	12	1	3.9	120.0	5	76.6	110.0	2.0	24.4	5.0	1	2
Free Residual Chlorine (mg/L)	0.2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TDS (mg/L)	500	2000	184	10	101.7	306	20	81.8	840	14	132.7	204	8.0	44.7	928	22	452.4	752	20.0	171.6	78	14	30.8
TSS (mg/L)			0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	0	0	0	0	0	0
Fluoride (mg/L)	1	1.5	0.4	0.4	0.4	0.5	0.4	0.5	0.7	0.3	0.4	0.0	0.0	0.0	0.9	0.3	0.5	0.9	0.7	0.8	0.4	0.4	0.4
Sulphate (mg/L)	200	400	15.7	15.7	15.7	35.7	35.7	35.7	73.9	73.9	73.9	0.0	0.0	0.0	113.3	2.2	64.0	97.3	2	55.3	0	0	0

Parameters	Standard values as per IS-		DW-1 (Oil Jetty 7)			DW-2 (Port & Custom Building)			DW-3 (North Gate)			DW-4 (Workshop)			DW-5 (Canteen Area)			DW-6 (West Gate 1)			DW-7 (Sewa Sadan -3)		
	A	P	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg
Nitrate (mg/L)	45		26	3.7	12.5	4.2	0.5	1.8	7.5	1.3	4.6	2.4	2.4	2.4	8.8	3.4	5.8	5.7	1.3	2.8	2.1	2.1	2.1
Nitrite (mg/L)			0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0.2	0.2	0.2	0	0	0
Sodium (mg/L)			86	5	34.5	38.5	7	21.2	178.6	9.7	38.0	42.6	5.7	18.0	319.6	12.0	118.4	197.5	8.8	44.1	15.1	5.5	9.6
Potassium (mg/L)			0	0	0	0	0	0	0	0	0	0	0	0	5.8	5.8	5.8	0	0	0	0	0	0
Hexavalent Chromium (mg/L)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odour (TON)	Agreeable			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Arsenic (mg/L)	0.01	0.05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium (mg/L)	0.003		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Copper (mg/L)	0.05	1.5	17.3	0	5.8	8.4	0.0	2.8	6.2	0.0	3.1	11.1	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Iron (mg/L)	0.3		0.6	0	0.3	0.2	0.2	0.2	0.2	0.0	0.1	0.2	0.2	0.2	0.2	0.0	0.1	0.2	0.0	0.1	0.1	0.1	0.1
Lead (mg/L)	0.01		3.1	0	0.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese (mg/L)	0.1	0.3	0.1	0	0.1	0	0	0	0.5	0.5	0.5	0.1	0.1	0.1	0	0	0	0.5	0	0.2	0	0	0
Mercury (mg/L)	0.001		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Chromium (mg/L)	0.05		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc (mg/L)	5	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Coliform* (MPN/ 100ml)	Shall not be detected		630.0	5.0	118.0	12500.0	5.0	1629.3	250.0	10.0	100.7	50.0	5.0	24.0	144500	5.0	17137	4350	5.0	1407	23500	2.0	3963.3

Table 22B: Drinking Water Quality for the Monitoring period

Parameters	Standard values as per IS		DW-8 (Nirman Building)			DW-9 (Custom Building)			DW-10 (Port Colony Kandla)			DW-11 (Wharf Area/ Jetty)			DW-12 (Hospital Kandla)			DW-13 (A.O. Building)			DW-14 (School Gopalpuri)		
	A	P	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg
pH	6.5-8.5		8	7	7.5	8	6.2	7.3	7.9	6.82	7.31	8.3	6.85	7.71	7.75	6.62	7.224	8.5	7.2	7.61	8.2	7.08	7.56
Colour (Hazen)	5	15	5.0	1.0	2.3	5.0	1.0	2.0	5.0	1	2	10	1	3.083	5	1	1.67	5	1	1.33	10	1	3.28
EC (µS/ cm)			2000	40.0	403.8	2900.0	48.0	492.9	3100	105.4	554.9	2460	55	980.1	269	47	141.2	1412	23.2	187.2	1467	43.3	412.15
Salinity (PSU)			1.0	0.0	0.2	1.5	0.0	0.2	1.6	0.05	0.283	1.2	0.02	0.42	0.13	0.03	0.072	0.71	0.02	0.151	0.73	0.03	0.22
Turbidity (NTU)	1	5	3.6	1.1	1.8	4.7	1.0	2.8	2.2	0.95	1.575	3.79	1	2.09	2	1.02	1.57	9.9	0.9	3.67	13.9	0.5	5.48
Chloride (mg/L)	250	1000	499.9	10.0	93.1	689.8	12.5	108.7	504.8	21.99	75.52	404.8	13.54	173.9	67.98	12.5	31.79	307.4	7.5	44.28	332.4	11.5	93.83
Total Hardness (mg/L)	200	600	280.0	4.0	61.8	480	6.0	80.2	340.0	3	62.83	320	15	176.4	30	3	17.84	240	1.5	70.3	270	2	82.64
Ca Hardness (mg/L)			140.0	2.0	31.8	240	3.0	38.7	190.0	2	33.5	170	5	91.30	17	2	9.67	120	1	31.12	140	1.5	42.96
Mg Hardness (mg/L)			140.0	2.0	30.1	190	3.0	37.5	150.0	1	29.32	150	10	84.76	14	1	8.167	120	0.5	33.15	130	2	43.6
Free Residual Chlorine (mg/L)	0.2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TDS (mg/L)	500	2000	1012	22.0	205.2	1522	24.0	255.8	1064	54	165.4	872	29	403.8	138	24	73.17	718	14	101.9	742	22	218
TSS (mg/L)			2.0	2.0	2.0	12.0	2.0	7.0	2.0	2	2	2	2	2	0	0	0	0	0	0	12	8	10
Fluoride (mg/L)	1	1.5	0.0	0.0	0.0	1.5	0.6	1.1	0.5	0.416	0.433	1.06	0.367	0.57	1.108	1.108	1.108	0	0	0	0.35	0.15	0.25
Sulphate (mg/L)	200	400	100.8	45.5	73.2	142.0	41.5	80.0	115.6	3.17	59.39	134.7	1.97	59.51	0	0	0	108.7	108.77	108.7	113.4	11.55	56.304
Nitrate (mg/L)	45		4.5	1.1	2.6	5.6	2.4	3.8	7.5	1.04	3.68	8.49	3.78	5.929	2.023	1.42	1.752	3.392	1.524	2.585	4.48	1.382	2.38

Parameters	Standard values as per IS		DW-8 (Nirman Building)			DW-9 (Custom Building)			DW-10 (Port Colony Kandla)			DW-11 (Wharf Area/ Jetty)			DW-12 (Hospital Kandla)			DW-13 (A.O. Building)			DW-14 (School Gopalpuri)		
	A	P	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg
Nitrite (mg/L)			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0.201	0.11	0.147	0	0	0	0	0	0	0	0	0
Sodium (mg/L)			109.5	9.2	39.4	396.2	8.0	75.4	105.8	11.98	37.65	356.5	12.8	106.5	31.35	11.59	20.22	83.91	8.66	21.44	173.5	6.24	46.666
Potassium (mg/L)			0	0	0	13.6	13.6	13.6	7.0	2.6	4.8	0	0	0	0	0	0	0	0	0	0	0	0
Hexavalent Chromium (mg/L)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odour (TON)	Agreeable			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Arsenic (mg/L)	0.01	0.05	0	0	0	0	0	0	0	0.007	0.007	0.005	0.0039	0.004	0	0	0	0	0	0	0.015	0.015	0.015
Cadmium (mg/L)	0.003		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.005	0.005	0.005	0.006	0.006	0.006
Copper (mg/L)	0.05	1.5	6.8	0	3.4	0	0	0	10.2	0.005	2.049	0	0	0	9.257	0.005	3.57	0.008	0.0079	0.008	0	0	0
Iron (mg/L)	0.3		0.1	0.1	0.1	0	0	0	0.3	0.0001	0.16	0.17	0.0001	0.092	0	0	0	0.13	0.13	0.13	0.0001	0.0001	0.0001
Lead (mg/L)	0.01		0.2	0	0.1	0	0	0	0	0.0033	0.003	0.004	0.0038	0.004	0.0028	0.003	0.003	0.002	0.002	0.002	4.27	4.27	4.27
Manganese (mg/L)	0.1	0.3	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0.05	0.05	0.05	0	0	0
Mercury (mg/L)	0.001		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Chromium (mg/L)	0.05		0	0	0	0	0	0	0	0	0	0	0	0	0.0122	0.012	0.012	0.006	0.006	0.006	0	0	0
Zinc (mg/L)	5	15	0	0	0	0.6	0.6	0.6	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Coliform* (MPN/ 100ml)	Shall not be detected		240.0	2.0	114.7	12050	4.0	1826	37080	35	5374	25550	5	3329	140	4	47.2	685	20	166.7	4900	15	636.4

Table 22C: Drinking Water Quality for the Monitoring period

Parameters	Standard values as per IS		DW-15 (Guest House)			DW-16 (E- Type Quarter)			DW-17 (F- Type Quarter)			DW-18 (Hospital Gopalpuri)			DW-19 (Near Vadinar Jetty)			DW-20 (Near Port Colony)		
	A	P	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg
pH	6.5-8.5		7.99	6.87	7.35	7.68	6.93	7.28	8.19	6.78	7.46	8.27	7.12	7.6	8.38	7.21	7.685	8.07	7.05	7.435
Colour (Hazen)	5	15	5	1	1.67	5	1	1.67	5	1	1.67	10	1	3.5	5	1	2.333	20	1	6
EC (µS/ cm)			264	34.3	120.22	746	17.79	116.84	1337	15.93	298.6	7930	30.2	1037	537	30	199.7	1736	88.4	427.7
Salinity (PSU)			0.7	0.02	0.113	0.38	0.02	0.06	0.67	0.02	0.16	4.39	0.02	0.55	0.26	0.02	0.100	0.87	0.05	0.235
Turbidity (NTU)	1	5	2.29	0.63	1.27	2.8	0.52	1.50	1.97	1.1	1.66	3.98	0.7	2.03	1.5	1.2	1.35	5.3	0.7	3.25
Chloride (mg/L)	250	1000	60.98	10.5	26.98	124.96	4	24.58	287.41	4	61.99	163.9	9	75.28	66.98	9	27.20	407.37	13	73.15
Total Hardness (mg/L)	200	600	20	2	11.97	180	1.5	22.86	230	2	52.6	195	4	96.25	160	2	44.58	240	20	88.5
Ca Hardness (mg/L)			10	1.5	6.25	80	1	10.77	120	1	28.5	102	2	49.43	80	1.5	21.54	140	10	44.08
Mg Hardness (mg/L)			12.5	1	6.136	100	0.5	13.25	110	1	24.1	100	1	46.79	80	1	25.09	100	8	44.41
Free Residual Chlorine (mg/L)	0.2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TDS (mg/L)	500	2000	138	18	62.75	382	10	60.5	682	8	157.5	448	16	198.8	272	15	100.9	882	46	218.5
TSS (mg/L)			0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	12	4	8
Fluoride (mg/L)	1	1.5	0.34	0.34	0.34	0	0	0	0.5	0.37	0.43	0.51	0.38	0.44	0.35	0.35	0.35	1.06	1.06	1.06
Sulphate (mg/L)	200	400	10.62	10.3	10.46	34.35	34.35	34.35	104.64	8.37	41.20	59.94	1.81	40.82	42.2	13.07	31.87	102.92	25.4	48.22
Nitrate (mg/L)	45		5.63	1.12	2.53	1.97	1.97	1.97	6.06	1.19	3.20	16.51	1.17	5.1	15.79	1.82	5.55	18.54	1.06	6.45
Nitrite (mg/L)			0	0	0	0	0	0	0	0	0	0.20	0.11	0.16	0	0	0	1.89	1.89	1.89

Parameters	Standard values as per IS		DW-15 (Guest House)			DW-16 (E- Type Quarter)			DW-17 (F- Type Quarter)			DW-18 (Hospital Gopalpuri)			DW-19 (Near Vadinar Jetty)			DW-20 (Near Port Colony)		
	A	P	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg
Sodium (mg/L)			40.46	14.3	19.38	74.46	7.06	24.85	82.61	5.75	35.30	185.2	7.08	55.81	58.37	6.08	20.49	204.04	7.18	46.23
Potassium (mg/L)			0	0	0	0	0	0	0	0	0	3.2	3.2	3.2	0	0	0	5.85	5.85	5.85
Hexavalent Chromium (mg/L)			0	0	0	0	0	0	0	0	0	0	0	0	0.041	0.041	0.041	0.01	0.01	0.01
Odour (TON)	Agreeable			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Arsenic (mg/L)	0.01	0.05	0.007	0.007	0.007	0	0	0	0.008	0.008	0.008	0.015	0.01	0.012	0.08	0.08	0.08	0	0	0
Cadmium (mg/L)	0.003		0.007	0.007	0.007	0.006	0.006	0.006	0.007	0.007	0.007	0.008	0.008	0.008	0	0	0	0	0	0
Copper (mg/L)	0.05	1.5	7.24	0.006	2.42	0	0	0	0.012	0.012	0.012	7.3	0.006	3.65	16.25	0.006	7.99	15.403	0.01	3.09
Iron (mg/L)	0.3		0.25	0.0002	0.13	0	0	0	0.52	0.0001	0.213	0.11	0.0003	0.055	1.47	1.47	1.47	0	0	0
Lead (mg/L)	0.01		2.21	0.002	1.10	0	0	0	0	0	0	0	0	0	10.53	0.003	5.26	0.002	0.002	0.002
Manganese (mg/L)	0.1	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.	0.13	0	0.08
Mercury (mg/L)	0.001		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Chromium (mg/L)	0.05		0	0	0	0	0	0	0	0	0	0.006	0.006	0.006	0	0	0	0	0	0
Zinc (mg/L)	5	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Coliform* (MPN/ 100ml)	Shall not be detected		200	5	57.75	7650	5	1669	57000	9	6635	310	5	131	2850	120	1485	130000	10	16647

A: Acceptable, P:Permissible, BQL: Below Quantification limit Turbidity (QL=0.5 NTU), Free Residual Chlorine (QL=2 mg/L), Total Suspended Solids (QL=2 mg/L), Fluoride (QL=0.3 mg/L), Sulphate (QL=10 mg/L), Nitrate as NO_3 (QL=1 mg/L), Nitrite as NO_2 (QL=0.1mg/L), Sodium as Na (QL=5mg/L), Potassium as K (QL=5mg/L), Hexavalent Chromium (QL=0.01 mg/L), Arsenic (QL=0.005 mg/L), Cadmium (QL=0.002 mg/L), Copper (QL=0.005 mg/L), Iron (QL=0.1mg/L), Lead (QL=0.002 mg/L), Manganese (QL=0.04 mg/L), Mercury (QL=0.0005 mg/L), Total Chromium (QL=0.005 mg/L), Zinc (QL=0.5 mg/L), Total Coliforms (QL=1 MPN/ 100ml)

Note: For Total Coliform, one MPN is equivalent to one CFU. The use of either method; MPN or CFU for the detection of bacteria are considered valid measurements for bacteria limits.

8.3 Data Interpretation and Conclusion

Drinking water samples were taken from 20 locations (18 at Kandla and 2 at Vadinar), and their physical and chemical properties were analyzed. The analysis's results were compared with standard values as prescribed in IS 10500:2012 Drinking Water Specification.

Physico-Chemical Parameters:

- **pH:** The pH values of drinking water samples in Kandla were reported to be in the range of **6.24 to 8.5**, with an average pH of **7.5**. In Vadinar, its values ranged from **7.05 to 8.38**, with an average pH of **7.36**. Notably, the pH levels at both project sites fall within the acceptable range of 6.5 to 8.5, as specified under IS:10500:2012.
- **Colour:** The colour varies from 1 to 10 at the monitoring locations in Kandla. Locations DW-11, DW-14 and DW-10 showed the value of 10 Hazen at Kandla. At Vadinar, the color was observed within the range of 1 to 20 Hazen. the Colour levels at both project sites fall within the acceptable range of 1 to 15, as specified under IS:10500:2012, except of one location DW-20 within the monitoring period of April to May 2023
- **Electrical Conductivity (EC):** It is a measure of the ability of a solution to conduct electric current, and it is often used as an indicator of the concentration of dissolved solids in water. During the monitoring period, the EC values for samples collected in Kandla were observed to range from **12.83 to 7930 µS/cm**, with an average value of **708.65** µS/cm. In Vadinar, the EC values showed variation from **30 to 1736 µS/cm**, with an average value of **503.14** µS/cm. It's important to regularly monitor EC levels in drinking water as it can provide valuable information about water quality and presence of dissolved substances.
- **Salinity:** Salinity at Kandla varies from **0.02 to 4.39 PSU** with an average of **0.396** PSU, while at Vadinar, salinity was observed within the range of **0.02** to **0.87 PSU**.
- **Turbidity**: The Turbidity values of drinking water samples in Kandla were reported to be in the range of **0.5 to 13.9 NTU**, with an average of **2.32**. In Vadinar, its values ranged from **0 to 5.3**, with an average **2.21**. Notably, the Turbidity levels at both project sites fall within the acceptable range of 1 to 5 NTU, as specified under IS:10500:2012, except DW-7, in the monitoring period of July to August 2023, DW-13 in the monitoring period of May to June 2023 and DW-14 in the monitoring period of September to October and October to November 2023. On all this location most of the time Turbidity observed Below Quantification Limit
- **Chlorides:** The chloride concentrations in Kandla varied from **3 to 689.78 mg/L**, with an average value of **116.85** mg/L. At Vadinar the chloride concentration was observed within the range of **9** mg/L to **407.37** mg/L, with an average value of **99.45** mg/L. Thus, the chloride levels at both project sites fall within the Permissible limit of 1000 mg/L, as specified under IS:10500:2012.
- **Total Hardness (TH):** The concentration of Total Hardness varies from **1.5 to 480 mg/L**, with an average concentration of **88.68** mg/L. While at Vadinar, the observed values were within range of **2 to 240** mg/L. at both study areas Total Hardness found

to be within the Permissible limit norm of 600 mg/L as specified by IS:10500:2012 and is not harmful for local inhabitants.

- **Total Dissolved Solids (TDS):** Monitoring TDS is crucial because it provides an indication of overall quality of the water. During the monitoring period, the TDS concentrations in Kandla were observed to vary in a wide range i.e., between **8** to **1522** mg/L, with an average concentration of **264.4** mg/L. which is within the permissible limit. while in Vadinar, it ranged from **6** to **882** mg/L, with an average of **255.75** mg/L. It is important to note that the TDS concentrations in both Kandla and Vadinar fall well within the Permissible limit of 2000 mg/L.
- **Fluoride:** The concentration Fluoride varies from **0** to **1.477** mg/L, with an average concentration of **0.44** mg/L. While at Vadinar Fluoride concentration was varies within range of **0** to **1.06** mg/L**,** with an average concentration of **0.708** mg/L**.** The Fluoride concentration was found to be **BQL** in majority of the monitoring location at Kandla and Vadinar. at both study areas Fluoride found to be within the Permissible limit norm of 1.5 mg/L as specified by IS:10500:2012
- **Sulphate:** The concentration Sulphate varies from **0** to **141.99** mg/L, with an average concentration of **45.67** mg/L. While at Vadinar Sulphate concentration was varies within range of **13.07** to **102.92** mg/L**,** with an average concentration of **43.94** mg/L**.** During monitoring period in Kandla and Vadinar, the sulphate concentrations were found to be within the acceptable limits i.e., 200 mg/L as per the specified norms.
- **Nitrate:** The concentration Nitrate varies from **0** to **25.96** mg/L, with an average concentration of **4.08** mg/L. While at Vadinar Nitrate concentration was varies within range of **0** to **18.54** mg/L**,** with an average concentration of **8.20** mg/L**.** The Nitrate concentration was found to be **BQL** in majority of the monitoring location at Kandla and Vadinar. at both study areas Nitrate found to be within the Acceptable limit norm of 45 mg/L as specified by IS: 10500:2012.
- **Nitrite:** The concentration Nitrite varies from **0** to **0.2** mg/L. While at Vadinar Nitrite concentration was varies within range of **0** to **1.89** mg/L**,** with an average concentration of **0.945** mg/L**.** The Nitrite concentration was found to be **BQL** in majority of the monitoring location at Kandla and Vadinar.
- **Sodium:** During the monitoring period, at Kandla variation in the concentration of Sodium was observed to be in the range of **5.01 to 396.2 mg/L**, with the average concentration of **63.71** mg/L. While at Vadinar, the concentration recorded between **6.08** to **204.4** mg/L, with the average concentration of **57.067** mg/L.
- **Odour:** Odour values recorded 1 TON at all monitoring locations of Kandla and Vadinar.

Metals:

- **Arsenic:** The Arsenic concentrations in Kandla varied from **0 to 0.042 mg/L**. At Vadinar the Arsenic concentration was observed within the range of **0** mg/L to **0.08** mg/L. Thus, the Arsenic levels at both project sites fall within the Permissible limit of 0.05 mg/L, as specified under IS:10500:2012, except on one location at Vadinar DW-19 where Arsenic Concentration found 0.08 mg/L in the monitoring period of November to December 2023. In Kandla and Vadinar, the Arsenic concentrations were recorded

BQL for majority of the locations except the locations DW-2, DW-12, and DW-18 in Kandla and DW-20 In Vadinar.

- **Copper:** The Copper concentrations in Kandla varied from **0 to 17.3 mg/L**. At Vadinar the Copper concentration was observed within the range of **0** mg/L to **16.25** mg/L. Thus, the Copper levels at both project sites fall within the Permissible limit of 1.5 mg/L, as specified under IS:10500:2012, except for locations DW-1, DW-2, DW-4, DW-8, DW-10, DW-12, DW-15, DW-18 in Kandla and on both Locations DW-19 and DW-20 of Vadinar for some samples taken during whole monitoring period. The Copper concentrations were recorded BQL for majority of the locations in Kandla and Vadinar.
- **Iron:** The Iron concentrations in Kandla varied from **0 to 0.64 mg/L**, with an average concentration of **0.10** mg/L. At Vadinar the Iron concentration was observed within the range of **0** mg/L to **1.478** mg/L. Thus, the Iron levels at both project sites fall within the Acceptable limit of 0.3 mg/L, as specified under IS:10500:2012, except for locations DW-1, DW-10, and DW-17 in Kandla and on Location DW-19 of Vadinar for some samples taken during the whole monitoring period. The Iron concentrations were recorded by BQL for the majority of the locations in Kandla and Vadinar.
- **Lead:** The Lead concentrations in Kandla varied from **0 to 4.279 mg/L**, with an average concentration of **0.37** mg/L. While at Vadinar the Lead concentration was observed within the range of **0** mg/L to **10.53** mg/L, with an average concentration of **2.6344**. Thus, the Lead levels at both project sites fall within the Acceptable limit of 0.01 mg/L, as specified under IS:10500:2012, except for locations DW-1, DW-8, DW-14 and DW-15 in Kandla and on Location DW-19 of Vadinar for some samples taken during the whole monitoring period. The Lead concentrations were recorded in BQL for the majority of the locations in Kandla and Vadinar.
- **Manganese:** The Manganese concentrations in Kandla varied from **0 to 0.51 mg/L**, with an average concentration of **0.1** mg/L. While at Vadinar, the Manganese concentration was observed within the range of **0** mg/L to **0.13** mg/L. Thus, the Manganese levels at both project sites fall within the Acceptable limit of 0.3 mg/L, as specified under IS:10500:2012, except for locations DW-3, and DW-6 in Kandla and on Location DW-20 of Vadinar for some samples taken during the whole monitoring period. The Manganese concentrations were recorded BQL for the majority of the locations in Kandla and Vadinar.
- The concentrations of parameters such as **Free Residual Chlorine, Total Suspended Solid, Potassium Hexavalent Chromium** and **the metals (Cadmium, Mercury, Total Chromium and Zinc)** were observed to fall within the Permissible limit at both project sites. Observed "Below the Quantification Limit (BQL)" at majority of the locations during the monitoring period.
- Bacteriological Analysis of the drinking water reveals that **Total Coliforms (TC)** were detected in the range of **0** to **144500** MPN/100ml, with the average of **6964.8** MPN/100ml. While at Vadinar the observed within the range of **0** MPN/100ml to **1,30,000** MPN/100ml, with the average concentration of **25,185** MPN/100ml. And for the rest of the monitoring locations of Kandla and Vadinar were detected "Below the Quantification Limit (BQL)". Reporting such concentration of Coliforms indicates

certain external influx may contaminate the source. Hence, it should be checked at every distribution point. The higher concentration of total coliforms were observed on locations DW-2, DW-5, DW-7, DW-10, DW-11, and DW-17 in Kandla and DW-20 location in Vadinar.

8.4 Remedial Measures

Appropriate water treatment processes should be administered to eradicate coliform bacteria. The methods of disinfection such as **chlorination, ultraviolet (UV), or ozone** etc, apart from that, filtration systems can also be implemented to remove bacteria, sediment, and other impurities.

The following steps can be implemented to ensure that the water being supplied is safe for consumption:

- Regular monitoring should be carried out to assess the quality of drinking water at various stages, including the source, purification plants, distribution network, and consumer endpoints would help in early detection of coliform bacteria or other contaminants in the drinking water.
- It is necessary to carry out a system assessment to determine whether the drinking-water supply chain (up to the point of consumption) as a whole can deliver water of a quality that meets identified targets. This also includes the assessment of design criteria of the treatment systems employed.
- Identifying control measures in a drinking-water system that will collectively control identified risks and ensure that the health-based targets are met. For each control measure identified, an appropriate means of operational monitoring should be defined that will ensure that any deviation from required performance (water quality) is rapidly detected in a timely manner.
- Management and communication plan should be formulated describing actions to be taken during normal operation as well as during incident conditions (such as drinking water contamination) and documenting the same.

CHAPTER 9: SEWAGE TREATMENT PLANT MONITORING

9.1 Sewage Treatment Plant (STP) Monitoring:

The principal objective of STP is to remove contaminants from sewage to produce an effluent that is suitable to discharge to the surrounding environment or an intended reuse application, thereby preventing water pollution from raw sewage discharges. As defined in the scope by Deendayal Port Authority (DPA), Kandla, the STP Monitoring is to be carried out weekly at three locations, one at Kandla, one at Gopalpuri and one STP at Vadinar. The samples from the inlet and outlet of the STP have been collected weekly. The details of the locations of STP to be monitored for Kandla and Vadinar have been mentioned in **Table 23** as follows:

Frequency of monitoring: weekly

Table 22A: Details of the monitoring locations of STP

Sr. No.	Location Code		Location Name	Latitude Longitude
1.	Kandla	STP-1	STP Kandla	23.021017N 70.215594E
2.		STP-2	STP Gopalpuri	23.077783N 70.136759E
3.	Vadinar	STP-3	STP at Vadinar	22.406289N 69.714689E

The Consolidated Consent and Authorization (CC&A) issued by the GPCB were referred for the details of the STP for Kandla and Gopalpuri. The CC&A of Kandla and Gopalpuri entails that the treated domestic sewage should conform to the norms specified in **Table 24**. The treated effluent conforming to the norms shall be discharged on the land within the premises strictly for the gardening and plantation purpose. Whereas, no sewage shall be disposed outside the premises in any manner.

Table 23Bs: Discharge norms (as per CC&A of Kandla STP)

Sr. No.	Parameters	Prescribed limits
1.	pH	6.5-8.5
2.	BOD (3 days at 27°C)	30 mg/L
3.	Suspended Solids	100 mg/L
4.	Fecal Coliform	< 1000 MPN/100 ml

The detailed process flow diagram of the Kandla and Gopalpuri STP have been mentioned in **Figure 3 and 4** as follows:

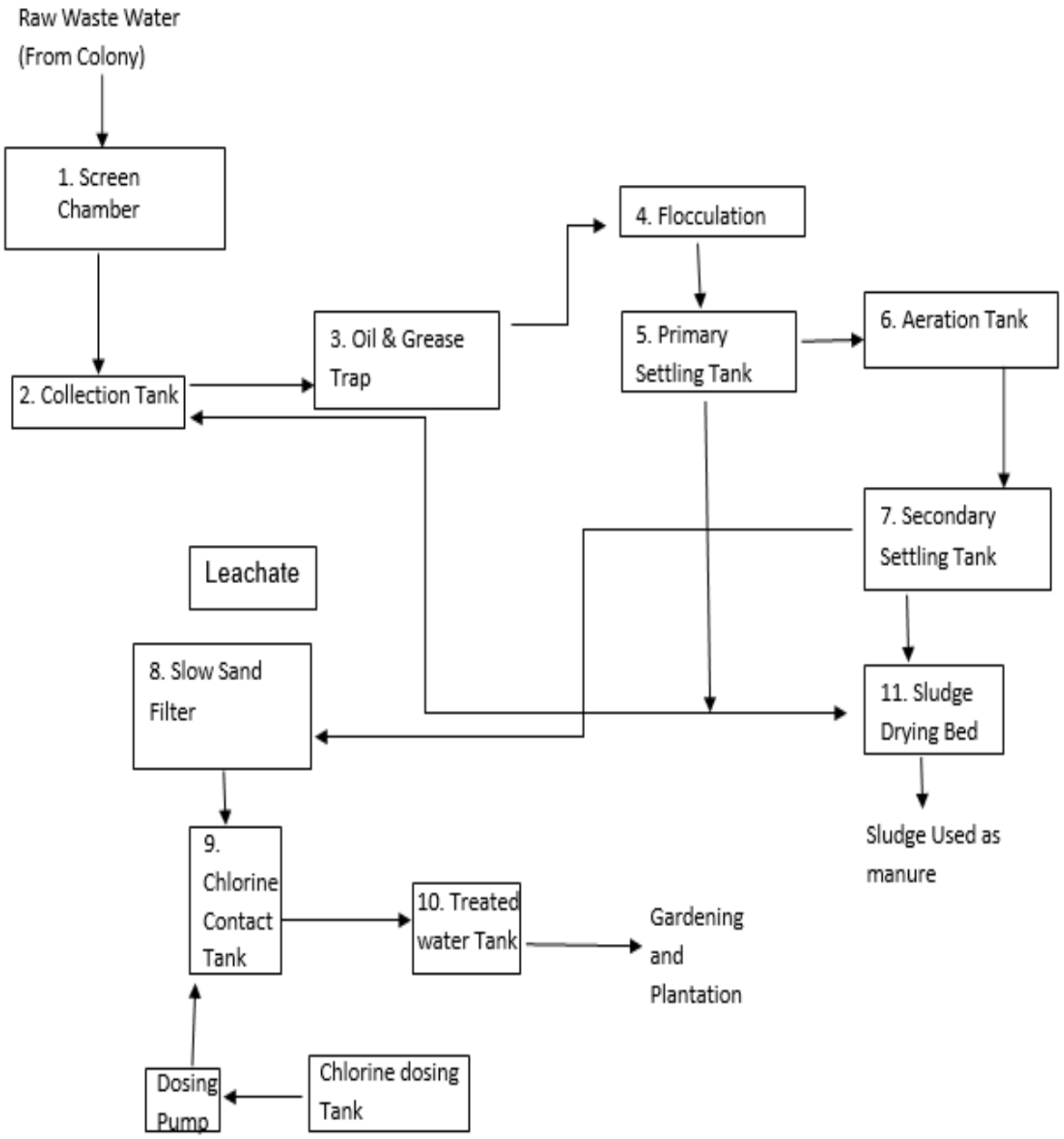


Figure 3: Process flow diagram of STP at Kandla

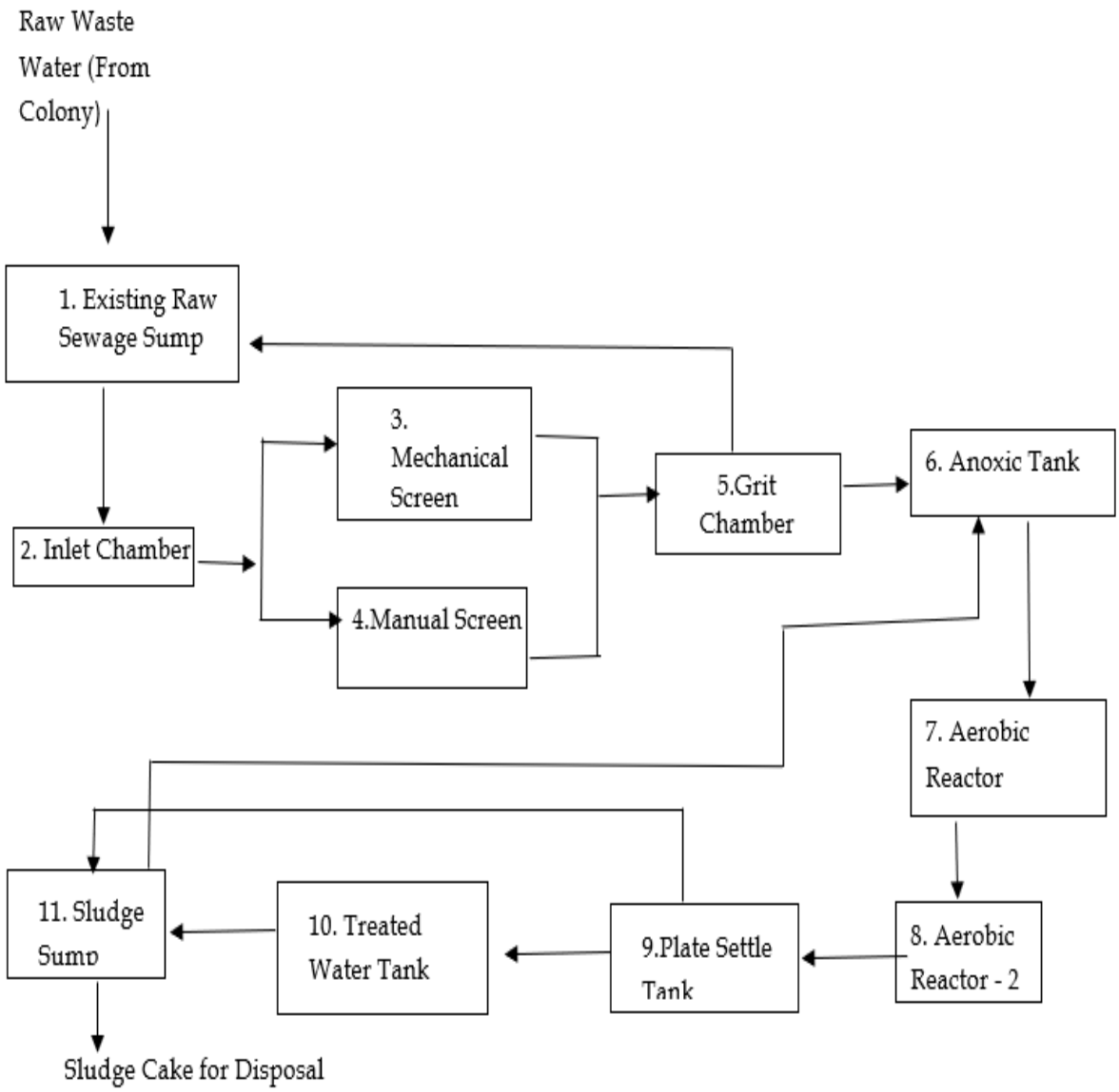


Figure 4: Process flow diagram of STP at Gopalpuri, Kandla

STP at Vadinar

The STP at Vadinar has been built with a treatment capacity of 450 KLD/day. The Consolidated Consent and Authorization (CC&A) issued by the GPCB has been referred for the details of the said STP. The CC&A of the Vadinar STP suggests that the domestic effluent generated shall be treated as per the norms specified in **Table 25**. The treated effluent conforming to the norms shall be discharged on the land within the premises strictly for the gardening and plantation purpose. Whereas, no sewage shall be disposed outside the premises in any manner.

Table 24: Norms of treated effluent as per CC&A of Vadinar STP

Sr. No.	Parameters	Prescribed limits
1.	pH	5.5-9

Sr. No.	Parameters	Prescribed limits
2.	BOD (3 days at 27°C)	10 mg/L
3.	Suspended Solids	20 mg/L
4.	Fecal Coliform	Desirable 100 MPN/100 ml Permissible 230 MPN/100 ml
5.	COD	50 mg/L

The detailed process flow diagram of the Vadinar STP have been mentioned in **Figure 5** as follows:

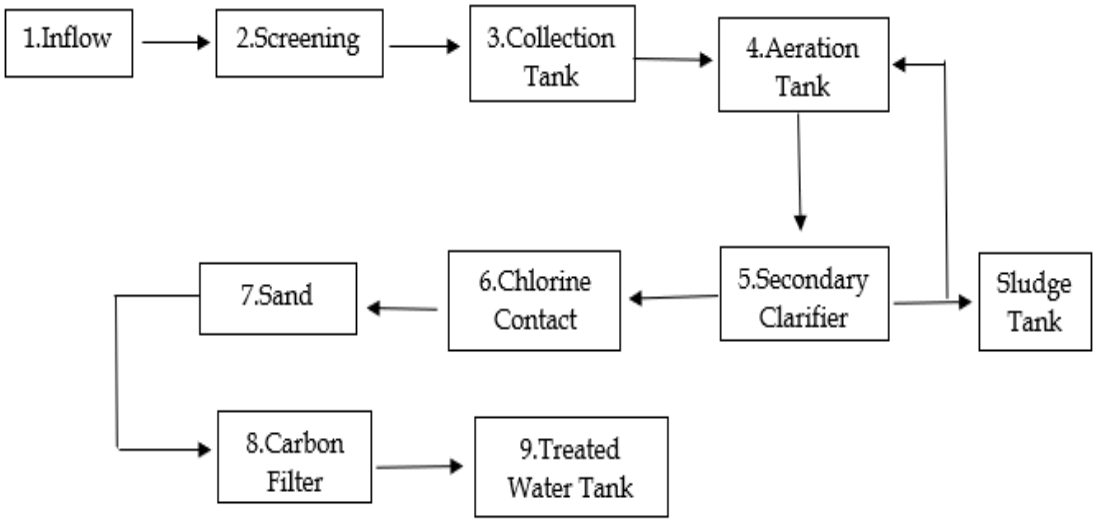
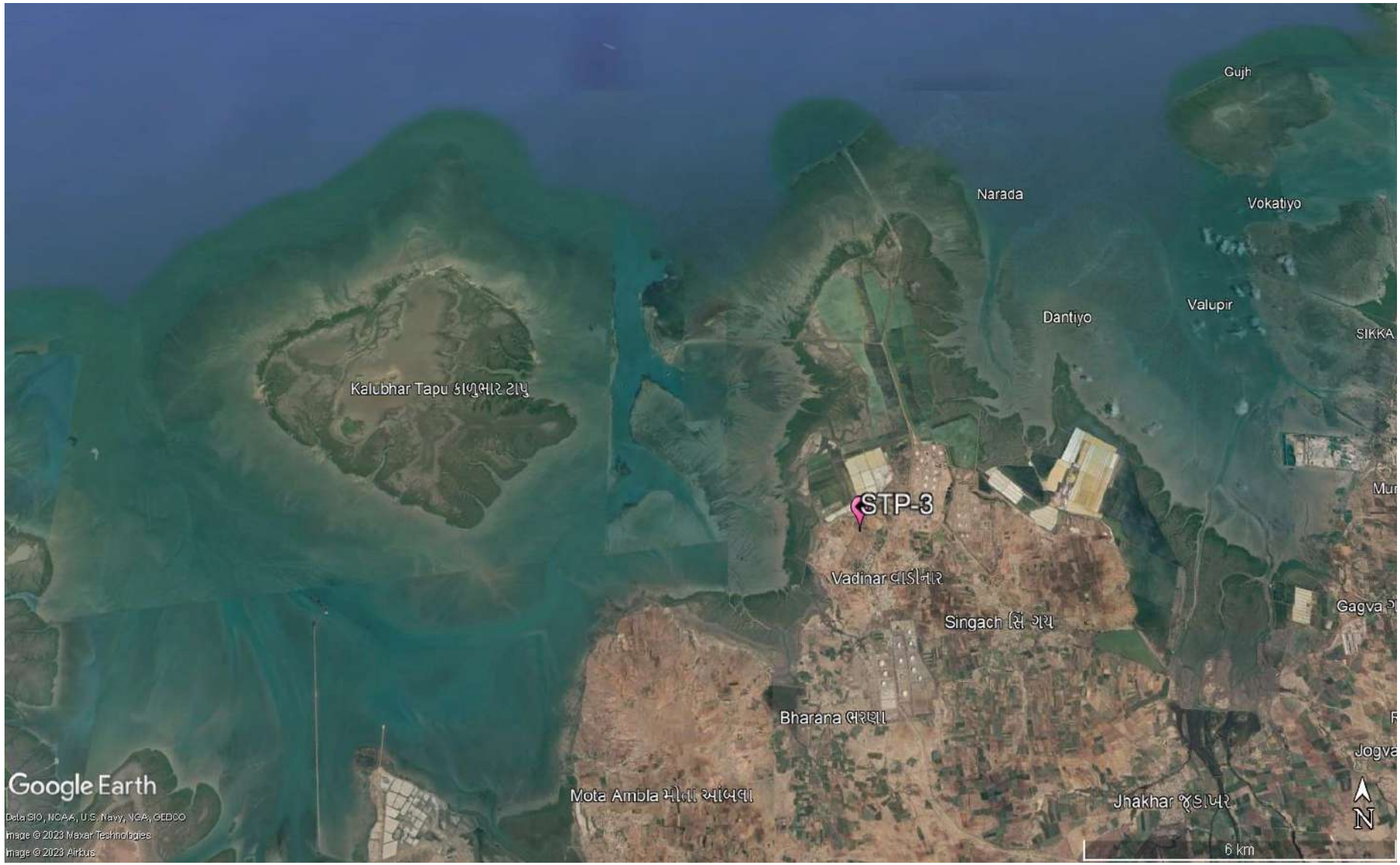


Figure 5: Process flowchart for the STP at Vadinar

The map depicting the locations of STP to be monitored in Kandla and Vadinar have been shown in **Map 14 and 15** as follows:

Map 14: STP Monitoring Locations at Kandla



Map 15: STP Monitoring Locations at Vadinar

Methodology

As per the defined scope by DPA, the sampling and analysis of water samples from the inlet and outlet of the STP's of Kandla and Vadinar are carried out once a week, i.e., four times a month.

The water samples were collected from inlet and the outlet of the STP's and analyzed for physico-chemical and microbiological parameter. Collection and analysis of these samples was carried out as per established standard methods and procedures for the examination of water. The samples were analyzed for selected parameters to establish the existing water quality of the inlet and outlet points of the STP. GEMI has framed its own guidelines for collection of water/wastewater samples titled as 'Sampling Protocol for Water & Wastewater'; which has been approved by the Government of Gujarat vide letter no. ENV-102013-299-E dated 24-04-2014 under the provision of Water (Preservation and Control of Pollution) Act 1974. The sample collection and preservation are done as per the said Protocol. Under the project, the list of parameters to be monitored for the STP have been mentioned in **Table 26** as follows:

Monitoring Frequency

Monitoring is required to be carried out once a week for monitoring location of Kandla and Vadinar i.e., two STP station at Kandla and one STP station at Vadinar. Sample Collected from this location during the monitoring period 15th April 2023 to 15th April 2024.

Table 25: List of parameters monitored for STP's at Kandla and Vadinar

Sr. No.	Parameters	Units	Reference method	Instruments
1.	pH	-	APHA, 23rd edition, 4500- H^+ B, 2017	pH Meter
2.	TDS	mg/L	APHA, 23rd Edition, 2540 C: 2017	Vacuum Pump with filtration assembly and Oven
3.	TSS	mg/L		
4.	DO	mg/L	APHA, 23rd Edition, 4500 C: 2017	Titration Apparatus
5.	COD	mg/L	APHA, 23rd Edition, 5220 B: 2017	Titration Apparatus plus Digester
6.	BOD	mg/L	IS-3025, Part 44, 1993	BOD Incubator plus Titration Apparatus
7.	SAR	meq/L	IS 11624: 2019	Flame Photometer
8.	Total Coliforms	MPN/100ml	IS 1622: 2019	LAF/ Incubator

9.2 Result and Discussion

Analytical results of the STP samples collected from the inlet and the outlet of the STP's of Kandla and Vadinar have been summarized in **Table 27**. Further it was compared with the standard norms specified in the CC&A of the respective STPs.

Table 26: Water Quality of inlet and outlet of STP of Kandla

Sr No.	Parameter	Units	Kandla						Vadinar			
			GPCB Norms (Kandla)	STP-1			STP-2			GPCB Norms (Vadinar)	STP-3		
				Inlet	Outlet		Inlet	Outlet			Inlet	Outlet	
				Avg	Avg	Max	Avg	Avg	Max		Avg	Avg	Max
1.	pH	-	**6.5-8.5**	7.17	7.302	7.65	6.99	7.48	8.88	**5.5-9**	7.19	7.41	8.46
2.	TDS	mg/L	-	3065.7	2069.28	6228	1099.40	1003.3	1814	-	471.61	402.67	482
3.	TSS	mg/L	**100**	183.4	20.97	88	115.17	16.45	46	**20**	38.78	8.42	36
4.	COD	mg/L	-	184.7	32.57	133.1	213.54	25.98	88.4	**50**	138.27	16.18	40.2
5.	DO	mg/L	-	145.91	37.780	277.09	162.29	21.98	76.92	-	115.12	18.69	54.5
6.	BOD	mg/L	**30**	56.82	11.937	52.4	61.75	8.40	18.45	**10**	44.62	6.053	11
7.	SAR	meq/L	-	12.06	9.318	21.04	5.75	5.43	13.1	-	2.71	2.12	3.2
8.	Total Coliforms	MPN/ 100ml	**<1000**	1565.95	1530.66	1600	1537.02	1500.51	1600	**100-230**	1551	1492.3	1600

BQL: Below Quantification limit; Total Suspended Solids (QL=2), Dissolved Oxygen (QL=0.5), Biochemical Oxygen Demand (QL=3 mg/L)

9.3 Data Interpretation and Conclusion

For physicochemical analysis, the treated sewage water was gathered from the Kandla STP, Gopalpuri STP, and Vadinar STP and the analytical results were compared with the standards mentioned in the Consolidated Consent and Authorization (CC&A) by GPCB.

- The average pH at the inlet of STP-1, STP-2, and STP-3 is, respectively, **7.17, 6.99, and 7.19**. After treatment, the treated effluent from STPs at Kandla (STP-1 and STP-2) and Vadinar (STP-3) had a maximum pH of **7.65, 8.88, and 8.46** and an average pH of **7.302, 7.48, and 7.41**, respectively. Which conform to their respective stipulated norms of 6.5–8.5 at Kandla and 5.5–9 at Vadinar, respectively.
- The average TDS concentrations at the inlet of STP-1, STP-2, and STP-3 are, respectively, **3065.8, 1099.4, and 471.33** mg/L. After treatment, the treated effluent from STPs at Kandla (STP-1 and STP-2) and Vadinar (STP-3) had a maximum TDS concentration of **6228, 1814, and 482** mg/L, and an average TDS concentration of **2069.3, 1003.3, and 402.67** mg/L, respectively.
- The average TSS at the inlet of STP-1, STP-2, and STP-3 is respectively **183.43, 115.17, and 38.78** mg/L. After treatment, the treated effluent from STPs at Kandla (STP-1 and STP-2) and Vadinar (STP-3) had a maximum TSS of **88, 46**, and **36** mg/L, and an average TSS of **20.974, 16.452, and 8.41** mg/L, respectively. Which conform to their respective stipulated norms of 100 mg/L at Kandla and 20 mg/L at Vadinar, respectively, as mentioned in their respective CCA, except in STP-3 at Vadinar, which exceeds norms in the 3rd and 4th weeks of April 2023.
- The average COD at the inlet of STP-1, STP-2, and STP-3 is respectively **184.7, 213.54, and 138.27** mg/L. After treatment, the treated effluent from STPs at Kandla (STP-1 and STP-2) and Vadinar (STP-3) had maximum COD concentrations of **133.1, 88.4, and 40.2** mg/L, and average COD concentrations of **32.576, 25.97, and 16.18** mg/L, respectively. There are no discharge norms for the COD parameter in STP-1 and STP-2 at Kandla, and they conform to their respective stipulated norms of 50 mg/L at Vadinar as mentioned in their respective CCA.
- The average DO concentrations at the inlet of STP-1, STP-2, and STP-3 are, respectively, **145.91, 162.29, and 115.12** mg/L. After treatment, the treated effluent from STPs at Kandla (STP-1 and STP-2) and Vadinar (STP-3) had a maximum DO concentration of **277.09, 76.92, and 54.5** mg/L, and an average DO concentration of **37.78, 21.98, and 18.68,** mg/L respectively.
- The average BOD at the inlet of STP-1, STP-2, and STP-3 is respectively **56.82, 61.76, and 44.62** mg/L. After treatment, the treated effluent from STPs at Kandla (STP-1 and STP-2) and Vadinar (STP-3) had a maximum BOD of **52.4, 18.45, and 11** mg/L, and an average BOD of **11.93, 8.40, and 6.05** mg/L, respectively. Which conform to their respective stipulated norms of 30 mg/L at Kandla and 10 mg/L at Vadinar, respectively, as mentioned in their respective CCA, except in STP-3 at Vadinar, which exceeds norms in the 3rd and 4th weeks of April 2023.
- The average SAR concentrations at the inlet of STP-1, STP-2 and STP-3 are respectively **12.068**, **5.75** and **2.71** meq/L**.** After treatment, the treated effluent from

STPs at Kandla (STP-1 and STP-2) and Vadinar (STP-3) having maximum SAR concentration **21.04**, **13.1** and **3.2** meq/L, and having Average SAR concentration **9.31**, **5.46** and **2.12** meq/L respectively.

- The **Total Coliforms** was observed to exceed the norms at the locations of the STP-1 & STP-2 for the treated effluent at Kandla and STP-3 at Vadinar.

During the monitoring period, only Total Coliforms were observed to be exceeding the limits at STPs of Kandla and Vadinar while rest of the treated sewage parameters for STP outlet were within norms as specified under the CCA at both the monitoring sites. Regular monitoring of the STP performance should be conducted on regular basis to ensure adequate treatment as per the norms.

9.4 Remedial Measures:

- The quantum of raw sewage (influent) entering the STP should be monitored by installation of the flow meter. If the quantity of the sewage exceeds the treatment capacity of the treatment plant, then provision of additional capacity of collection sump should be provided.
- The adequacy and efficacy of the stages of Sewage treatment units shall be conducted.
- The results show the presence of total coliforms; hence the method of disinfection (Chlorination) sodium or calcium Hypochlorite can be used.
- Effectiveness of any technology depends on factors such as the specific pollutants in the wastewater, plant size, local regulations, and available resources. There are several processes that may be implemented such as - Advanced oxidation process involve using strong oxidants to break down complex organic compounds. Methods like Fenton's reagent (hydrogen peroxide and iron catalyst) and UV/H_2O_2 treatment can help in reducing COD through oxidation.
- Electrochemical processes like Electrocoagulation (EC) and Electrooxidation (EO) that involve the application of an electric current to facilitate the removal of pollutants through coagulation, flocculation, and oxidation. These methods can be useful for treating sewage containing various pollutants.

CHAPTER 10: MARINE WATER QUALITY MONITORING

10.1 Marine Water

Deendayal Port is one of the largest ports of the country and thus, is engaged in wide variety of activities such as movement of large vessels, oil tankers and its allied small and medium vessels and handling of dry cargo several such activities whose waste if spills in water, can cause harmful effects to marine water quality.

Major water quality concerns at ports include wastewater and leakage of toxic substances from ships, stormwater runoff, etc. This discharge of wastewater, combined with other ship wastes which includes sewage and wastewater from other on-board uses, is a serious threat to the water quality as well as to the marine life. As defined in the scope by DPA, the Marine Water sampling and analysis has to be carried out at a total of eight locations, six at Kandla and two at Vadinar. The marine water sampling has been carried out with the help of Niskin Sampler with a capacity of 5L. The Niskin Sampler is a device used to take water samples at a desired depth without the danger of mixing with water from other depths. Details of the locations to be monitored have been mentioned in **Table 29:**

Table 27: Details of the sampling locations for Marine water

Sr. No.	Location Code		Location Name	Latitude Longitude
1.	Kandla	MW-1	Near Passenger Jetty One	23.017729N 70.224306E
2.		MW-2	Kandla Creek (nr KPT Colony)	23.001313N 70.226263E
3.		MW-3	Near Coal Berth	22.987752N70.227923E
4.		MW-4	Khori Creek	22.977544N 70.207831E
5.		MW-5	Nakti Creek (nr Tuna Port)	22.962588N 70.116863E
6.		MW-6	Nakti Creek (nr NH-8A)	23.033113N 70.158528E
7.	Vadinar	MW-7	Near SPM	22.500391N 69.688089E
8.		MW-8	Near Vadinar Jetty	22.440538N 69.667941E

The map depicting the locations of Marine Water to be sampled and analysed for Kandla and Vadinar have been mentioned in **Map 16 and 17** as follows:

Map 16: Marine Water Monitoring Locations at Kandla

Map 17: Marine Water Monitoring Locations at Vadinar

Methodology

The methodology adopted for the sampling and monitoring of Marine Water was carried out as per the '**Sampling Protocol for Water & Wastewater'** developed by GEMI. The water samples collected through the Niskin Sampler are collected in a clean bucket to reduce the heterogeneity. The list of parameters to be monitored under the project for the Marine Water quality have been mentioned in **Table 30** along with the analysis method and instrument.

Monitoring Frequency

As defined in the scope by DPA, the sampling and analysis of Marine Water has to be carried out once in a month at the eight locations (i.e., six at Kandla and two at Vadinar). For the period 15th April 2023 to 15th April 2024.

Table 28: List of parameters monitored for Marine Water

Sr. No	Parameters	Units	Reference method	Instrument
1.	Electrical Conductivity	µS/cm	APHA, 23rd Edition (Section-2510 B):2017	Conductivity Meter
2.	Dissolved Oxygen (DO)	mg/L	APHA, 23rd Edition, 4500 O C, 2017	Titration Apparatus
3.	pH	-	APHA, 23rd Edition (Section-4500-H+B):2017	pH meter
4.	Color	Hazen	APHA, 23rd Edition, 2120 B: 2017	Color comparator
5.	Odour	-	IS 3025 Part 5: 2018	Heating mantle & odour bottle
6.	Turbidity	NTU	IS 3025 Part 10: 1984	Nephlo Turbidity Meter
7.	Total Dissolved Solids (TDS)	mg/L	APHA, 23rd Edition (Section-2540 C):2017	Vaccum Pump with Filtration Assembly and Oven
8.	Total Suspended Solids (TSS)	mg/L	APHA, 23rd Edition, 2540 D: 2017	
9.	Particulate Organic Carbon	mg/L	APHA, 23rd Edition, 2540 D and E	TOC analyser
10.	Chemical Oxygen Demand (COD)	mg/L	IS-3025, Part- 58: 2006	Titration Apparatus plus Digester
11.	Biochemical Oxygen Demand (BOD)	mg/L	IS-3025, Part 44,1993,	BOD Incubator plus Titration apparatus
12.	Silica	mg/L	APHA, 23rd Edition, 4500 C, 2017	UV- Visible Spectrophotometer
13.	Phosphate	mg/L	APHA, 23rd Edition, 4500 P-D: 2017	
14.	Sulphate	mg/L	APHA, 23rd Edition, 4500 SO4-2 E: 2017	
15.	Nitrate	mg/L	APHA, 23rd Edition, 4500 NO3-B: 2017	
16.	Nitrite	mg/L	APHA, 23rd Edition, 4500 NO2- B: 2017	
17.	Sodium	mg/L	APHA, 23rd Edition, 3500 Na-B: 2017	Flame photometer

Sr. No	Parameters	Units	Reference method	Instrument
18.	Potassium	mg/L	APHA, 23rd Edition, 3500 K-B: 2017	
19.	Manganese	µg/L	APHA, 23rd Edition, ICP Method 3120 B: 2017	ICP-OES
20.	Iron	mg/L	APHA, 23rd Edition, ICP Method 3120 B: 2017	
21.	Total Chromium	µg/L	APHA, 23rd Edition, 3500 Cr B: 2017	
22.	Hexavalent Chromium	µg/L		UV- Visible Spectrophotometer
23.	Copper	µg/L	APHA, 23rd Edition, ICP Method 3120 B: 2017	ICP-OES
24.	Cadmium	µg/L		
25.	Arsenic	µg/L		
26.	Lead	µg/L		
27.	Zinc	mg/L		
28.	Mercury	µg/L	EPA 200.7	
29.	Floating Material (Oil grease scum, petroleum products)	mg/L	APHA, 23rd Edition, 5520 C: 2017	Soxhlet Assembly
30.	Total Coliforms (MPN)	MPN/ 100ml	IS 1622: 2019	LAF/ Incubator

10.2 Result and Discussion

The quality of the Marine water samples collected from the locations of Kandla and Vadinar during the monitoring period has been summarized in the **Table 31**. The said water quality has been represented in comparison with the standard values as stipulated by CPCB for Class SW-IV Waters.

Table 29: Results of Analysis of Marine Water Sample for the sampling period

Parameters	Primary Water Quality Criteria for Class SW-IV Waters	Kandla																			Vadinar					
		MW-1			MW-2			MW-3			MW-4			MW-5			MW-6			MW-7			MW-8		
		Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Density (kg/m³)	-	1.02	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.021	1.02	1.02	1.02	1.02	1.02	1.02
pH	6.5-9.0	6.12	8.32	7.89	7.04	8.36	7.99	7.83	8.33	8.11	7.69	8.31	8.05	7.19	8.48	8.03	6.01	8.31	7.94	7.98	8.2	8.11	7.07	8.22	8.06
Colour (Hazen)	No Noticeable	1	10	5.41	1	20	7.83	1	15	7.16	5	20	9	5	15	7.41	5	20	8.27	1	10	5.66	1	10	5.08
EC (µS/ cm)	-	49700	63600	54282.5	49800	61700	54490.91	50200	60600	53767.75	50400	75300	55689.91	50100	65100	55115.58	15950	61528	50873.17	52200	56900	54239.2	52.119	57500	50312.6
Turbidity (NTU)	-	56.4	310	188.26	33.9	314	206.76	61.8	317	203.81	69	300	216.66	94.5	379	202.5	70.1	346	209.23	3.15	12.5	5.36	3.42	13.8	6.39
TDS (mg/L)	-	24800	44466	36356.3	24900	41922	36679.5	25100	41624	35690.92	25200	64721	38189.5	25000	47159	36938.58	9970	41436	32927.91	25784	38620	35400.16	26882	41790	35965.75
TSS (mg/L)	-	44	436	342.42	26	563	374.58	52	478	340.75	58	924	402.33	80	682	427.66	58	852	387.72	78	341	255.08	151	346	282.33
COD (mg/L)	-	29.2	79.37	49.62	11.98	79.37	47.81	25.41	81	47.68	22.65	81	52.12	31.56	79.37	53.76	22.97	88.8	49.34	21.28	75	50.98	17.92	75	47.63
DO (mg/L)	3.0 mg/L	4.7	6.4	5.76	5.3	6.4	6.07	4.5	6.7	5.87	3.4	6.5	5.85	5	6.6	6.07	5.6	8.4	6.49	4.3	7.6	6.25	4.4	7.9	6.48
BOD (mg/L)	5.0 mg/L	5.24	8.54	7.56	8.4	8.9	8.57	3.74	8.45	6.81	5	8.78	7.755	9.32	9.87	9.57	3.6	11.1	8.64	3.91	7.5	6.51	4.2	7.16	6.16
Oil & Grease (mg/L)	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sulphate (mg/L)	-	2056	2937.5	2529.7	2156.32	2897.7	2544.18	2083.7	2925.2	2530.85	2239	3704.9	2879.88	2334.9	2916.8	2652.42	632.62	3612.8	2561.07	1846.3	3225.8	2472.195	2039.9	3236.8	2664.27
Nitrate (mg/L)	-	1.89	5.40	4.28	1.12	5.16	3.75	3.21	5.68	4.17	3.41	5.85	4.64	3.17	6.92	4.21	3.06	6.84	4.06	2.225	5.17	3.56	1.759	5.1	3.39
Nitrite (mg/L)	-	0.12	0.12	0.12	0	0	0	0	0	0	0	0	0	0.11	0.11	0.11	0.13	0.16	0.14	0	0	0	0	0	0!
Phosphate (mg/L)		0.25	1.59	0.82	0.09	1.34	0.69	0.57	1.46	0.96	0.61	2.01	0.92	0.29	1.34	0.76	0.54	1.61	0.81	0.64	0.94	0.79	1.43	1.43	1.43
Silica (mg/L)	-	0.29	3.24	2.12	0.22	4.04	2.24	0.2	3.73	2.19	1.12	3.69	2.54	1.26	4	2.64	0.33	3.74	1.92	0.11	0.96	0.56	0.09	1.86	0.76
Sodium (mg/L)	-	7686	10625	9475.57	7811	10341	9242.42	7763	10308	9347.33	9101	10323	9724.14	8789	10278	9403.67	2086	10722	8042.71	2149.6	9485	6743.97	2349.4	9542	7244.66
Potassium (mg/L)	-	68.35	451.9	318.57	69.27	446.5	303.94	68.57	421	290.60	71.73	543.96	342.71	69.63	423.34	324.92	68.34	442.63	272.9	10.86	421.7	259.6	76.31	518	327.43
Hexavalent Chromium (mg/L)	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	321	321	321	333	333	333
Odour	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Arsenic (mg/L)	-	5.13	5.13	5.13	5.25	5.25	5.25	5.4	5.4	5.4	0	0	0	0	0	0	9.44	12.94	11.19	0.11	1	0.41	0.08	1	0.38
Cadmium (mg/L)	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Copper (mg/L)	-	5.1	6.99	5.8175	0.006	10.9	5.79	0.005	7.7	3.85	5.34	12.01	8.224	0.0067	7.6	5.13	8.07	10.2	9.49	3.4	3.4	3.4	0	0	0
Iron (mg/L)	-	0.69	4.11	1.38	0.21	4.07	1.76	0.37	3.92	1.79	1.02	7.93	2.49	0.98	5.45	2.09	0.43	5.3	2.005	0.01	0.25	0.145	0.08	0.66	0.21
Lead (mg/L)	-	0.002	3.44	2.067	0.0029	3.44	2.29	0.0026	3.06	1.98	0.002	9.68	4.32	0.002	4.65	2.39	0.0029	3.65	2.47	0.0023	2.26	1.035	0.002	2.75	0.96
Manganese (mg/L)	-	0.082	129.91	71.47	0.12	159.78	83.88	0.1085	125.66	74.0	0.096	294.91	93.56	0.074	213.14	74.7	0.11	156.41	80.27	2.39	113.93	39.62	1.97	98.8	34.64
Total Chromium (mg/L)	-	0	0	0	5.62	7.8	6.71	5.67	5.67	5.67	5.14	15.99	12.28	5.11	9.65	7.207	0	0	0	0	0	0	45.75	45.75	45.75
Zinc (mg/L)	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mercury (mg/L)	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Particulate Organic	-	0.51	900	76.22	0.51	35	3.98	0.42	10	1.94	0.58	55	6.03	0.92	30	3.89	0.85	44	5.01	0.47	4.67	1.62	0.32	4.76	1.51

Parameters	Primary	Kandla																		Vadinar					
Carbon (mg/L)																									
Total Coliform* (MPN/ 100ml)	500/100 ml	0.32	1600	159.61	0.16	120	29.76	0.56	108	31.55	0.25	47	14.02	0.35	170	37.19	0.29	50	21.86	0.36	240	39.76	0.39	240	35.28
Floating Material (Oil grease scum, petroleum products) (mg/L)	10 mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	23	23

10.3 Data Interpretation and Conclusion

The Marine water quality of Deendayal Port Harbor waters at Kandla and Vadinar has been monitored for various physico-chemical and biological parameters during the monitoring 2023 at high tide. The detailed interpretation of the parameters in comparison to the Class SW-IV for Harbour Waters is as follows:

- **Density** at Kandla was observed in the range of **1.02 to 1.03 kg/m³**, with the average of **1.022 kg/m³.** Whereas for the location of Vadinar, it was observed in the range of **1.021 to 1.026 kg/m³**, with the average of **1.022 kg/m³**.
- **pH** at Kandla was observed in the range of **6.01 to 8.48**, with the average pH as **7.78**. Whereas for the locations of Vadinar, it was observed in the range of be **7.07** to **8.22**, with the average pH as **7.94**. For the monitoring location of both the study areas, pH was found to comply with the norms of 6.5-8.5.
- **Color** range varied from **1 to 20 Hazen** at all the monitoring locations in Kandla, and for Vadinar, it varied from **1 to 10 Hazen**.
- **Electrical conductivity (EC)** was observed in the range of **15,950 to 75,300 µS/cm**, with the average EC as **54,344.32** µS/cm for the locations of Kandla, whereas for the locations of Vadinar, it was observed in the range of **52,199 to 57,500 µS/cm**, with the average EC as **45,200.67** µS/cm.
- For all monitoring locations of Kandla the value of **Turbidity** was observed in the range of **33.9 to 379 NTU**, with average value of **198.83** NTU. For Vadinar it ranges from **3.15 to 13.8 NTU**, with average of **7.43** NTU. Materials that cause water to be turbid include clay, silt, finely divided organic and inorganic matter, soluble coloured organic compounds, plankton and microscopic organisms. Turbidity affects the amount of light penetrating to the plants for photosynthesis.
- For the monitoring locations at Kandla the value of **Total Dissolved Solids (TDS)** ranged from **9,970 to 64,721 mg/L**, with an average value of **35,171** mg/L. Similarly, at Vadinar, the TDS values ranged from **25,784 to 41,790 mg/L**, with an average value of **34,073** mg/L.

- **TSS** values in the studied area varied between **26 to 924 mg/L** at Kandla and **78 to 346 mg/L** at Vadinar, with the average value of **362.69** mg/L and **242.23** mg/L respectively for Kandla and Vadinar.
- **COD** varied between **11.98 to 88.8 mg/L** at Kandla and **17.92 to 75 mg/L** at Vadinar, with the average value as **51.83** mg/L and **47.86** mg/L respectively for Kandla and Vadinar.
- **DO** level in the studied area varied between **3.4 to 8.4 mg/L** at Kandla and **4.3 to 7.9 mg/L** at Vadinar, with the average value of **5.86** mg/L and **6.15** mg/L respectively for Kandla and Vadinar. Which represents that the marine water is suitable for marine life.
- **BOD** observed was observed in the range of **3.6 to 11.1 mg/L**, with average of **7.76** mg/L for the location of Kandla and for the locations of Vadinar, it was observed in the range of **3.91 to 7.5 mg/L**, with an average value of **5.9** mg/L.
- **Sulphate** concentration in the studied area varied between **632.92 to 3704.9 mg/L** at Kandla and **1846.3 to 3236.8 mg/L** at Vadinar. The average value observed at Kandla was **2566.45** mg/L, whereas **2580.87** mg/L was the average value of Vadinar. Sulphate is naturally formed in inland waters by mineral weathering or the decomposition and combustion of organic matter.
- **Nitrate** in the study area was observed in the range of **1.12 to 6.92 mg/L**, with the average of **4.26** mg/L. Whereas for the Vadinar the concentration of Nitrate was observed in the range of **1.759 to 5.17** mg/L, with the average **3.53** mg/L.
- **Nitrite** in the study area was observed in the range of **0 to 0.16 mg/L**, with the average of **0.625** mg/L. Whereas for the Vadinar the concentration of Nitrite was observed Below Quantification Limit During whole monitoring period.
- **Phosphate** in the study area was observed in the range of **0.09 to 2.01 mg/L**, with the average of **0.92** mg/L. Whereas for the Vadinar the concentration of Phosphate was observed in the range of **0.64 to 1.43** mg/L, with the average **1.11** mg/L.
- **Silica** in the study area was observed in the range of **0.2 to 4.04 mg/L**, with the average of **2.19** mg/L. Whereas for the Vadinar the concentration of silica was observed in the range of **0.09 to 1.86** mg/L, with the average **0.724** mg/L.
- In the study area of Kandla the concentration of **Potassium** varied between **68.34 to 543.68 mg/L** and **10.86 to 518 mg/L** at Vadinar, with the average value as **277.71** mg/L and **268.99** mg/L respectively for Kandla and Vadinar.
- **Sodium** in the study area varied between **2,086 to 10,722 mg/L**, with average of **8948.26** mg/L, at Kandla whereas at Vadinar its value recorded within range of **2149.6 to 9542 mg/L,** with the average of **6252.43** mg/L.
- **Odour** was observed 1 for all locations of Kandla and Vadinar.
- **Arsenic** concentration observed to be BQL for majority of location for Kandla and Vadinar except locations MW-1, MW-2, MW-3, MW-6, MA-7 and MW-8 for some instant of time during whole monitoring period.
- **Copper** in the study area varied between **0.005 to 12.01 mg/L**, with average of **6.23** mg/L, at Kandla whereas at Vadinar its value recorded within range of **0 to 3.4 mg/L,**

with the average of **2.04** mg/L, on both project sites during monitoring majority of time Copper found Below Quantification Limit.

- **Iron** in the studied area varied between **0.21 to 7.93 mg/L**, with the average of **2.55** mg/L, at Kandla, and for Vadinar value were recorded within range of **0.01** to **0.66** mg/L, with average value of **0.22** mg/L.
- **Lead** concentration varied **0.002 to 9.68 mg/L**, with an average of **2.41** mg/L at Kandla. At Vadinar location within range of **0.002** to **2.753** mg/L with an average **1.17** mg/L
- **Manganese** in the studied area varied between **0.0748 to 294.91 mg/L**, with the average of **86.57** mg/L, at Kandla and for Vadinar, recorded value were observed within the range of **1.97** to **113.93 mg/L**, with the average of **48.56** mg/L.
- **Total Chromium** in the study area varied between **0 to 15.99 mg/L**, with average of **5.13** mg/L, at Kandla whereas at Vadinar its value recorded **45.76** mg/L at MW-8 in the monitoring period of January to February 2024**,** While on both project sites during monitoring majority of time Total Chromium found Below Quantification Limit
- **Particulate Organic Carbon** in the study area was observed in the range of **0.42 to 900**, with the average value of **65.27**. the maximum spike of 900 is only observed once in the period of April to May 2023 during whole monitoring period. Whereas for the Vadinar, the value observed was Within the range of **0.32** to **4.76**, with the average of **2.22**.
- **Oil & Grease, Nitrite, Phosphate, Hexavalent Chromium, Arsenic, Cadmium, Total Chromium, Zinc, Mercury and Floating Material (Oil grease scum, petroleum products)** were observed to have concentrations **"Below the Quantification Limits (BQL)"** for most of the locations of Kandla and Vadinar, majority of time during whole monitoring period.
- **Total Coliforms** were detected complying with the specified norm of 500 MPN/100ml for all the locations of Kandla and Vadinar, except on location MW-1 in the month of May to June 2023.

During the Monitoring period, marine water samples were analysed and found in line with Primary Water Quality criteria for class-IV Waters (For Harbour Waters).

However, as a safeguard towards marine water pollution prevention, appropriate regulations on ship discharges and provision of reception facilities are indispensable for proper control of emissions and effluent from ships. Detection of spills is also important for regulating ship discharges. Since accidental spills are unavoidable, recovery vessels, oil fences, and treatment chemicals should be prepared with a view to minimizing dispersal. Proper contingency plans and a prompt reporting system are keys to prevention of oil dispersal. Periodical clean-up of floating wastes is also necessary for preservation of port water quality.

CHAPTER 11: MARINE SEDIMENT QUALITY MONITORING

11.1 Marine Sediment Monitoring

Marine sediment, or ocean sediment, or seafloor sediment, are deposits of insoluble particles that have accumulated on the seafloor. These particles have their origins in soil and rocks and have been transported from the land to the sea, mainly by rivers but also by dust carried by wind. The unconsolidated materials derived from pre-existing rocks or similar other sources by the process of denudation are deposited in water medium are known as sediment. For a system, like a port, where large varieties of raw materials and finished products are handled, expected sediment contamination is obvious.

The materials or part of materials spilled over the water during loading and unloading operations lead to the deposition in the harbour water along with sediment and thus collected as harbour sediment sample. These materials, serve as receptor of many trace elements, which are prone to environment impact. In this connection it is pertinent to study the concentration and distribution of environmentally sensitive elements in the harbour sediment. However, human activities result in accumulation of toxic substances such as heavy metals in marine sediments. Heavy metals are well-known environmental pollutants due to their toxicity, persistence in the environment, and bioaccumulation. Metals affect the ecosystem because they are not removed from water by self-purification, but accumulate in sediments and enter the food chain.

Methodology

As defined in the scope by DPA, the Marine Sediment sampling is required to be carried out once in a month at total eight locations, i.e., six at Kandla and two at Vadinar. The sampling of the Marine Sediment is carried out using the Van Veen Grab Sampler (make Holy Scientific Instruments Pvt. Ltd). The Van Veen Grab sampler is an instrument to sample (disturbed) sediment up to a depth of 20-30 cm into the sea bed. While letting the instrument down on the seafloor, sediment can be extracted. The details of locations of Marine Sediment to be monitored under the study are mentioned in **Table 32** as follows:

Table 30: Details of the sampling locations for Marine Sediment

Sr. No	Location Code		Location Name	Latitude Longitude
1.	Kandla	MS-1	Near Passenger Jetty One	23.017729N 70.224306E
2.		MS-2	Kandla Creek	23.001313N 70.226263E
3.		MS-3	Near Coal Berth	22.987752N 70.227923E
4.		MS-4	Khori Creek	22.977544N 70.207831E
5.		MS-5	Nakti Creek (near Tuna Port)	22.962588N 70.116863E
6.		MS-6	Nakti Creek (near NH-8A)	23.033113N 70.158528E
7.	Vadinar	MS-7	Near SPM	22.500391N 69.688089E
8.		MS-8	Near Vadinar Jetty	22.440538N 69.667941E

The map depicting the locations of Marine Sediment sampling at Kandla and Vadinar have been mentioned in **Map 18 and 19** as follows:

Map 18: Marine Sediment Monitoring Location at Kandla

Map 19: Marine Sediment Monitoring Locations at Vadinar

The list of parameters to be monitored under the projects for the Marine Sediment sampling been mentioned in **Table 33** as follows:

Table 31: List of parameters to be monitored for Sediments at Kandla and Vadinar

Sr. No.	Parameters	Units	Reference method	Instruments
1.	Texture		Methods Manual Soil Testing in India January 2011,01	Hydrometer
2.	Organic Matter	%	Methods Manual Soil Testing in India January, 2011, 09. Volumetric method (Walkley and Black, 1934)	Titration apparatus
3.	Inorganic Phosphates	mg/Kg	Practical Manual Chemical Analysis of Soil and Plant Samples, ICAR-Indian Institute of Pulses Research 2017	UV- Visible Spectrophotometer
4.	Silica	mg/Kg	EPA METHOD 6010 C & IS: 3025 (Part 35) – 1888, part B	
5.	Phosphate	mg/Kg	EPA Method 365.1	
6.	Sulphate as SO^{4-}	mg/Kg	IS: 2720 (Part 27) - 1977	
7.	Nitrite	mg/Kg	ISO 14256:2005	
8.	Nitrate	mg/Kg	Methods Manual Soil Testing in India January, 2011, 12	
9.	Calcium as Ca	mg/Kg	Methods Manual Soil Testing in India January 2011, 16.	Titration Apparatus
10.	Magnesium as Mg	mg/Kg	Method Manual Soil Testing in India January 2011	
11.	Sodium	mg/Kg	EPA Method 3051A	Flame Photometer
12.	Potassium	mg/Kg	Methods Manual Soil Testing in India January, 2011	
13.	Aluminium	mg/Kg	EPA Method 3051A	ICP-OES
14.	Chromium	mg/Kg		
15.	Nickel	mg/Kg		
16.	Zinc	mg/Kg		
17.	Cadmium	mg/Kg		
18.	Lead	mg/Kg		
19.	Arsenic	mg/Kg		
20.	Mercury	mg/Kg		

11.2 Result and Discussion

The quality of Marine Sediment samples collected from the locations of Kandla and Vadinar during the monitoring period of April 2023 to April 2024 has been summarized in the **Table 34.**

Table 32: Summarized result of Marine Sediment Quality

Parameters	Kandla																		Vadinar					
	MS-1			MS-2			MS-3			MS-4			MS-5			MS-6			MS-7			MS-8		
	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg
Inorganic Phosphate (kg/ ha)	16.85	0.86	6.6042	14.37	0.67	8.81	41.2	0.8	16.98	19.44	0.81	9.532	45.1	0.72	14.48	34.6	0.66	15.24	14.5	1.24	5.65	18.51	0.82	5.7325
Phosphate (mg/Kg)	3247.8	290.8	1280.63	2514.7	258.3	1304	3736	226.6	1515	3871	353.7	1287	3741	306.8	1442	14076	578.3	2793.9	3002	152.5	770.24	3477.29	167.93	940.70
Organic Matter (%)	1.42	0.21	0.7875	2.17	0.29	1.13	1.01	0.17	0.593	2.1	0.33	0.975	1.24	0.67	0.911	2.06	0.21	0.915	2.29	0.15	1.04	1.65	0.17	0.89
Sulphate as SO^{4-} (mg/Kg)	905.25	110.2	366.8	1022.25	98.2	370.03	571.64	95.33	275.09	650.25	97.45	268.51	768	87.28	294.27	732	96.38	249.1	296	74.07	126.31	213.4	80.06	132.03
Calcium as Ca (mg/Kg)	13800	1612	3464.3	5800	1259	2836	4200	962	2163	4200	1102	2669	10500	1089	3102	3800	1047	2274.6	3700	2200	2930.9	3974.2	2100	2805.45
Magnesium as Mg (mg/Kg)	1952	1225	1538.53	3050	826.46	1810.84	2136	764	1592.59	3172	866.94	1810.6	2440	1032	1622.80	2745	906.98	1581.95	1952	854	1385.18	14640	1167	2920.83
Silica (g/Kg)	671.25	261.3	479.11	612.51	289.4	481.7	571.5	329.1	444.8	555.2	245.7	392.1	597.1	179.2	418.6	580.4	245.3	436.12	529.8	220.9	377.71	546.08	264.92	426.66
Nitrite (mg/Kg)	0.75	0.12	0.41	0.92	0.13	0.50	0.81	0.08	0.41	0.91	0.01	0.43	0.71	0.11	0.375	0.89	0.07	0.489	0.22	0.07	0.159	0.37	0.04	0.23
Nitrate (mg/Kg)	22.34	5.86	16.58	37.12	7.59	18.29	36.47	4.51	15.50	25.94	4.31	13.99	10.34	5.24	13.17	20.38	6.34	14.52	25.33	9.54	15.36	25.21	4.75	10.52
Sodium (mg/Kg)	7860	3194	4512.43	14688	2453	5318	8612	2072	4550	18308	2612	6435	10520	2063	4665	14076	2072	5639.6	11944	3971	7904.6	13660	2719.42	9536.63
Potassium (mg/Kg)	2610.7	241	1525.98	11580	276	2320	3479	260.7	2126	4208	294	2424	3152	205	1790	3479	236.9	2233.4	3372	699	1876.1	4377	1028	2025.66
Aluminium (mg/Kg)	8371.7	2116	3827.74	10641	1237.1	4465.9	10363.1	1278.5	4370.2	12008.4	1971.2	5025.2	10361.1	1264.58	3891.23	12314.1	1273.22	4384.20	14179.7	358.3	4028.56	19356.55	479.16	4883.52
Mercury (mg/Kg)	4.71	4.71	4.71	10.74	10.74	10.74	41.29	41.29	41.29	6.44	6.44	6.44	15.21	15.21	15.21	34.69	34.69	34.69	0	0	0	0	0	0
Texture	Sandy loam	Sandy loam	Silt loam	Sandy loam	Silt loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Loam	Loam	Loam

11.3 Data Interpretation and Conclusion

The Marine sediment quality at Kandla and Vadinar has been monitored for various physico-chemical parameters during the monitoring April 2023 to April 2024. The detailed interpretation of the parameters is given below:

- **Inorganic Phosphate** for the sampling period was observed in range of **0.66 to 45.12** Kg/ha for Kandla. Whereas for Vadinar the value observed Within range of **0.82** to **18.51** Kg/ha. For Kandla and Vadinar the average value of Inorganic Phosphate was observed **13.77** and **7.74** Kg/ha respectively.
- The concentration of **Phosphate** was observed in range of **226.6 to 3871.15 mg/Kg** for Kandla and for Vadinar the value observed within the range of **152.53** to **3477.29** mg/Kg. For Kandla and Vadinar the average concentration of Phosphate was observed **1616.78** and **1418.5** mg/Kg respectively.
- The **Organic Matter** for the sampling period was observed in the range of **0.17 to 2.17** % for Kandla with the average value of **0.95**% and for Vadinar the value recorded Within range of **0.15 to 2.29**%, with average concentration as **1.03** %**.**
- The concentration of **Sulphate** was observed in the range of **87.28 to 1022 mg/Kg** for Kandla and for Vadinar the value observed Within range of **74.07** to **296** mg/Kg. For Kandla and Vadinar the average value of Sulphate was observed **392.10** and **153.64** mg/Kg respectively.
- The value of **Calcium** was observed in the range of **962 to 13800 mg/Kg** for Kandla and for Vadinar the value observed within the range of **2100** to **3974.5** mg/Kg. The average value of Calcium for the monitoring period was observed **3660.21** mg/Kg and **2951.76** mg/Kg at Kandla and Vadinar, respectively.
- The value of **Magnesium** for the sampling period was observed in the range of **764 to 3172 mg/Kg** for Kandla and for Vadinar the value observed Within the range of **854** to **1952** mg/Kg. For Kandla and Vadinar the average value of Magnesium was observed **1726**.35 mg/Kg and **1440.69** mg/Kg respectively.
- For the sampling period **Silica** was observed in the range of **179.25 to 671.25 mg/Kg** for Kandla with average value **432.83** mg/Kg and for Vadinar the value observed within the range of **220.98** and **546.5** mg/Kg with average **394.35** mg/Kg.
- The value of **Nitrate** was observed in the range of **4.31 to 37.12 mg/Kg** for Kandla with average value **15.47** mg/Kg and for Vadinar the value observed within the range of **4.75** to **25.33** mg/Kg. with average **15.12** mg/Kg.
- The value of **Nitrite** was observed in the range of **0.01 to 0.92 mg/Kg** for Kandla with average value **0.45** mg/Kg and for Vadinar the value observed to be within the range of **0.04** to **0.37** mg/Kg, with average **0.1828** mg/Kg.
- The value of **Sodium** was observed in the range of **2063.3 to 18308 mg/Kg** for Kandla with average value **6647.43** mg/Kg and for Vadinar the value observed within the range of **2719.42** and **13660** mg/Kg, with average **8289** mg/Kg.
- The value of **Potassium** was observed in the range of **205.08 to 11580 mg/Kg** for Kandla with average value **2357.95** mg/Kg and for Vadinar the value observed within range of **699.09** to **4377** mg/Kg, with average **2229.65** mg/Kg.

- The value of **Aluminium**, was observed in the range of **1237.13 to 12314.13 mg/Kg** for Kandla with average value **5509.23** mg/Kg and for Vadinar the value observed within the range of **358.3** to **19356** mg/Kg, with average **7214.30** mg/Kg.
- The value of **Mercury**, was observed in the range of **4.71 to 41.29 mg/Kg** for Kandla with average value **18.84** mg/Kg and for Vadinar the value of **Mercury** was observed "Below the Quantification Limit" at both two locations. During monitoring period majority of time Mercury was observed Below Quantification limit.
- Texture was observed to be "**Sandy Loam**" at location MS-1, MS-2, MS-4 and MS-6 "**Silt loam"** at location MS-3 & MS-5 in Kandla. "**Sandy Loam**" at location MS-7 & "**Silt loam"** at location MS-8 in Vadinar during sampling period.

Heavy Metals

The sediment quality of Kandla and Vadinar has been compared with respect to the Average Standard guideline applicable for heavy metals in marine sediment specified by EPA have been mentioned in **Table 35.**

Table 33: Standard Guidelines applicable for heavy metals in sediments

Sr. No.	Metals	Sediment quality (mg/kg)			Source
		Not polluted	Moderately polluted	Heavily polluted	
1.	As	<3	3-8	>8	EPA
2.	Cu	<25	25-50	>50	
3.	Cr	<25	25-75	>75	
4.	Ni	<20	20-50	>50	
5.	Pb	<40	40-60	>60	
6.	Zn	<90	90-200	>200	
7.	Cd	-	<6	>6	
ND = Not Detected					

(Source: G Perin et al. 1997)

Table 34: Comparison of Heavy metals with Standard value in Marine Sediment

Parameters	Kandla																		Vadinar					
	MS-1			MS-2			MS-3			MS-4			MS-5			MS-6			MS-7			MS-8		
	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg
Arsenic (mg/Kg)	5.13	1.09	3.527	4.43	2.11	3.264	6.17	2.06	3.92	5.86	1.28	3.75	5.2	1.75	3.458	5.78	1.98	3.67	5.36	2.04	2.84	5.17	2.5	3.69
Copper (mg/Kg)	5.6	2.13	3.282	11.4	2.14	5.013	8.1	2.08	4.49	9.8	3.48	5.71	12	2.14	5.97	8.9	2.98	4.97	6.13	2.19	4.567	412	2.1	39.05
Chromium (mg/Kg)	64.1	42.12	53.94	67.45	32.74	47.04	73.02	32.41	48.31	83.23	41.08	55.17	59.95	41.87	51.50	104.2	36.71	59.71	59.27	23.18	44.01	104.1	29.7	61.12
Nickel (mg/Kg)	51.4	16.8	31.76	38.9	10.21	23.87	36.41	4.54	22.77	40.87	7.61	27.45	31.86	21.72	25.881	50.78	4.54	25.058	36.21	12.23	22.84	43.66	12.47	29.282
Lead (mg/Kg)	7.05	1.25	5.3	7.45	4.21	5.76	28.73	2.36	6.683	8.25	3.46	5.9	14.22	1.21	6.055	5.01	2.81	7.88	7.94	2.85	4.90	10.58	2.97	5.65
Zinc (mg/Kg)	63.2	35.88	54.63	65.69	32.11	50.455	301.32	23.63	69.545	82.9	18.15	50.86	159.42	19.54	60.65	157.82	23.63	57.7	52.13	11.47	34.6	104.87	13.65	53.8595
Cadmium (mg/Kg)	1.08	0.88	0.98	0.6	0.6	0.6	1.25	0.87	1.1	1.12	0.78	1.022	1.08	0.91	0.995	7.53	0.15	2.302	0	0	0	0	0	0

- **Arsenic** was observed in the range of **1.09 to 6.17 mg/Kg** for Kandla with average value **3.58** mg/Kg and for Vadinar the value observed within range of **2.04** to **5.36** mg/Kg, with average of **3.6** mg/Kg. during monitoring period majority of time arsenic concentration found within moderately polluted class on both study area.
- **Copper** was observed in the range of **2.08 to 12 mg/Kg** for Kandla with average value **5.6** mg/Kg and for Vadinar the value observed within the range of be **2.1** to **8.33** mg/Kg, with average **4.72** mg/Kg. With reference to the guidelines mentioned in table 35, the sediment quality with respect to copper falls in non-polluted class.
- **Chromium** was observed in the range of **32.41 to 104.24 mg/Kg** for Kandla with average value **55.25** mg/Kg and for Vadinar the value observed within the range of **23.18** to **104.16** mg/Kg, with average **53.57** mg/Kg. With reference to the guidelines mentioned in table 35, the sediment quality with respect to chromium falls majority of time in moderately polluted and for some instance it location MS-4, MS-6, and MS-8 fall in Heavily polluted class.
- **Nickel** was observed in the range of **4.54 to 51.47 mg/Kg** for Kandla with average value **26.25** mg/Kg and for Vadinar the value observed within range of **12.23** to **43.66** mg/Kg, with average **26.115** mg/Kg. With reference to the guidelines mentioned in table 35, the sediment quality with respect to nickel falls in moderately polluted class and for some instance it location MS-1, and MS-6 fall in heavily polluted class.

- **Lead** was observed in the range of **1.21 to 28.73 mg/Kg** for Kandla with average value **5.63** mg/Kg and for Vadinar the value observed within the range of **2.85** and **10.58** mg/Kg, with average **5.81** mg/Kg. With reference to the guidelines mentioned in table 35, the sediment quality with respect to lead falls in not polluted class.
- **Zinc** was observed in the range of **18.15 to 301.32 mg/Kg** for Kandla with average value **73.73** mg/Kg and for Vadinar the value observed within the range of **11.47** to **104.87** mg/Kg, with average **46.997** mg/Kg. With reference to the guidelines mentioned in table 35, the sediment quality with respect to zinc falls in non-polluted class and for some instance its location MS-1, MS-3, MS-6 and MS-8 fall in Moderately polluted class.
- **Cadmium** was observed in the range of **0.15 to 7.53 mg/Kg** for Kandla with average value **1.325** mg/Kg**.** During the monitoring period majority of time **Cadmium** found BQL, which falls in non-polluted. While exception on one location MS-6 fall within moderately polluted for the duration of July to August 2023. **Cadmium** was observed BQL for all locations at Vadinar during sampling period. With reference to the guidelines mentioned in table 35, the sediment quality with respect to cadmium falls in non-polluted class.

Analysis of the sediments indicates moderate pollution. However, it may be noted that, the sediments are highly dynamic being constantly deposited and carried away by water currents. Hence maintaining the quality of sediments is necessary as it plays a significant role in regulating the quality of the marine water and the marine ecology.

The presence of anthropic activity in the coastal areas has an effect upon the marine water and sediment. One of the primary risks associated with contaminated sediments is bioaccumulation in benthic organisms, which is a route of entry into the food chain. Generally adopted sediment remediation approaches include dredging, capping of contaminated areas, and monitored natural recovery (MNR). Dredging can remove contaminated sediments, but it requires large areas of land for sediment disposal. It is expensive and may cause secondary contamination of the water column during re-suspension. MNR relies on ongoing naturally occurring processes to decrease the bioavailability or toxicity of contaminants in sediment. These processes may include physical, biological, and chemical mechanisms that act together to reduce the environmental risks posed by contaminated sediments. MNR require longer monitoring time and can be even more expensive than for dredging and capping. Capping consists of in situ covering of clean or suitable isolating material over contaminated sediments layer to limit leaching of contaminants, and to minimize their re-suspension and transport. Hence appropriate remedial measures for the polluted sediment sites may be implemented, to reduce the concentration of the heavy metals.

CHAPTER 12: MARINE ECOLOGY MONITORING

12.1 Marine Ecological Monitoring

The monitoring of the biological and ecological parameters is important in order to assess the marine environment. 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. Deendayal Port and its surroundings have mangroves, mudflats and creek systems as major ecological entities.

As defined in the scope by DPA, the Marine Ecological Monitoring is required to be carried out once a month specifically at eight locations, six at Kandla and two at Vadinar. The sampling of the Benthic Invertebrates has been carried out with the help of D-frame nets, whereas the sampling of zooplankton and phytoplankton has been carried out with the help of Plankton Nets (60 micron and 20 micron). The details of the locations of Marine Ecological Monitoring have been mentioned in **Table 37** as follows:

Table 35: Details of the sampling locations for Marine Ecological

Sr. No.	Location Code		Location Name	Latitude Longitude
1.	Kandla	ME-1	Near Passenger Jetty One	23.017729N 70.224306E
2.		ME-2	Kandla Creek (near KPT Colony)	23.001313N 70.226263E
3.		ME-3	Near Coal Berth	22.987752N 70.227923E
4.		ME-4	Khori Creek	22.977544N 70.207831E
5.		ME-5	Nakti Creek (near Tuna Port)	22.962588N 70.116863E
6.		ME-6	Nakti Creek (near NH - 8A)	23.033113N 70.158528E
7.	Vadinar	ME-7	Near SPM	22.500391N 69.688089E
8.		ME-8	Near Vadinar Jetty	22.440538N 69.667941E

The map depicting the locations of Marine Ecological monitoring in Kandla and Vadinar have been mentioned in **Map 20 and 21** as follows:

Map 20 Marine Ecological Monitoring: Locations at Kandla

Map 21: Marine Ecological Monitoring Locations at Vadinar

The various parameters to be monitored under the study for Marine Ecological Monitoring are mentioned in **Table 38** as follows:

Table 36: List of parameters to be monitored for Marine Ecological Monitoring

Sr. No.	Parameters
1.	Productivity (Net and Gross)
2.	Chlorophyll-a
3.	Pheophytin
4.	Biomass
5.	Relative Abundance, species composition and diversity of phytoplankton
6.	Relative Abundance, species composition and diversity of zooplankton
7.	Relative Abundance, species composition and diversity of benthic invertebrates (Meio, Micro and macro benthos)
8.	Particulate Oxidisable Organic Carbon
9.	Secchi Depth

Methodology

- **Processing for chlorophyll estimation:**
  Samples for 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.

- **Phytoplankton Estimation**
  Phytoplankton are 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*). Phytoplankton also include numerous and diverse collection of extremely small, motile algae which are termed micro

flagellates (naked flagellates) as well as Cyanophytes (Bluegreen 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 Estimation**

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. 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.

- **Diversity Index**

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.

1. **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. Shannon-Wiener's index (H) reproduces community parameters to a single number by using an equation are as follow:

$$H' = \sum p_i * \ln(p_i)$$

Where, ∑ = Summation symbol,

pi = Relative abundance of the species,

ln = Natural logarithm

More diverse ecosystems are considered healthier and more resilient. Higher diversity ecosystems typically exhibit better stability and greater tolerance to fluctuations. e.g., The Shannon diversity index values between 2.19 and 2.56 indicate relatively high diversity within the community compared to communities with lower values. It suggests that the community likely consists of a variety of species, and the species are distributed somewhat evenly in terms of their abundance.

2. Simpson's index:

A reasonably high level of dominance by one or a small number of species is indicated by the range of **0.89 to 0.91**. The general health and stability of the ecosystem may be impacted by this dominance. Community disturbances or modifications that affect the dominant species may be more likely to have an impact. The dominating species determined by the Simpson's index can have big consequences on how the community is organised and how ecological interactions take place.

The formula for calculating D is presented as:

$$D = 1 - \sum (p_i \hat{} 2)$$

Where, ∑ = Summation symbol, pi = Relative abundance of the species

3. Margalef's diversity index:

The number of species is significantly related to the port's vegetation cover surface, depth, and photosynthetic zone. The habitat heterogeneity is a result of these three elements. Species richness is related to the number of distinct species present in the analysed area. Margalef's index has a lower correlation with sample size. Small species losses in the community over time are likely to result in inconsistent changes.

Margalef's index D_{Mg}, which is also a measure of species richness and is based on the presumed linear relation between the number of species and the logarithm of the number of individuals. It is given by the formula:

$$D_{Mg} = \frac{S-1}{lnN}$$

Where, N = total number of individuals collected

S = No. of taxa or species or genera

4. Berger-Parker index:

This is a useful tool for tracking the biodiversity of deteriorated ecosystems. Environmental factors have a considerable impact on this index, which accounts for the

dominance of the most abundant species over the total abundance of all species in the assemblage. The preservation of their biodiversity and the identification of the fundamental elements influencing community patterns are thus critical for management and conservation. Successful colonising species will dominate the assemblage, causing the Berger-Parker index to rise, corresponding to well-documented successional processes. The environmental and ecological features of the system after disturbance may therefore simply but significantly determine the identity of the opportunistic and colonising species through niche selection processes.

The Berger-Parker index is a biodiversity metric that focuses on the dominance or relative abundance of a single species within a community. It provides a measure of the most abundant species compared to the total abundance of all species present in the community. Mathematically, it can be represented as follows:

$$d = \frac{N_{max}}{\mathrm{N}_i}$$

Where, N_{max} = Max no of individuals of particular genera or species

$\sum N_i$ = Total no of individuals obtained.

The resulting value of the Berger-Parker index ranges between 0 and 1. A higher index value indicates a greater dominance of a single species within the community. Conversely, a lower index value suggests a more even distribution of abundance among different species, indicating higher species diversity. The range of the Berger-Parker index can be interpreted as when the index value is close to 0, it signifies a high diversity with a more even distribution of abundances among different species. In such cases, no single species dominates the community, and there is a balanced representation of various species.

5. Evenness index–

Evenness index determines the homogeneity (and heterogeneity) of the species' abundance. Intermediate values between 0 and 1 represent varying degrees of evenness or unevenness in the distribution of individuals among species. Value of species evenness represents the degree of redundancy and resilience in an ecosystem. High species evenness = All species of a community can perform similar ecological activities or functions= even utilization of available ecological niches = food web more stable = ecosystem is robust (resistant to disturbances or environmental changes). Intermediate values between 0 and 1 represent variable degrees of evenness or unevenness.

$$EI = \frac{H}{\ln(S)}$$

Where, H= Shannon value

ln(S) = the natural logarithm of the number of different species in the community

Relative Abundance: The species abundance distribution (SAD) from disturbed ecosystems follows even/ uneven pattern. E.g., If relative abundance is 0.15, then the found species are neither highly dominant nor rare.

$$RA = \frac{No.of\ Individuals\ of\ Sp.}{Total\ no.of\ Individual} * 100\%$$

The basic idea of 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. Biodiversity is commonly expressed through indices based on species richness and species abundances. 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.

Monitoring Frequency:

Monitoring is required to be carried out once a month for both the locations of Kandla and Vadinar. Sample Collected from this location during the monitoring period 15th April 2023 to 15th April 2024.

12.2 Result and Discussion

The details of Marine Ecological Monitoring conducted for the locations of Kandla and Vadinar during the monitoring period has been summarized in the **Table 39.**

Table 37: Values of Biomass, Net Primary Productivity (NPP), Gross Primary Productivity (GPP), Pheophytin and Chlorophyll for Kandla and Vadinar

Sr. No.	Parameters	Kandla						Vadinar	
		ME-1 (Near Passenger Jetty One)	ME-2 (Kandla Creek)	ME-3 (Near Coal Berth)	ME-4 (Khori Creek)	ME-5 (Nakti Creek-near Tuna Port)	ME-6 (Nakti Creek near NH - 8A)	ME-7 (Near SPM)	ME-8 (Near Vadinar Jetty)
		Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.
1.	Biomass	115.3	115.64	95.73	141.73	101.6	120.45	78	110.64
2.	Net Primary Productivity	2.91	3.77	3.08	2.99	5.47	2.49	4.16	2.64
3.	Gross Primary Productivity	2.95	3.04	3.73	3.26	2.44	2.85	3.67	3.09
4.	Pheophytin	1.10	1.28	0.80	1.35	0.82	5.81	2.66	2.43
5.	Chlorophyll-a	2.40	1.61	1.72	1.72	2.04	12.43	2.37	3.24
6.	Particulate Oxidisable Organic Carbon	1.34	1.12	1.18	1.51	1.45	1.40	1.26	1.20
7.	Secchi Depth	0.61	0.63	0.56	0.60	0.56	0.62	3.93	2.61

- **Biomass:**

  With reference to the **Table 39**, the concentration of average **Biomass** reported during monitoring period, from location ME- to ME-6 in range between **95.73-141.73 mg/L** where lowest biomass presents in ME-3 (Near Coal Berth) and highest biomass present in ME-4 (Khori Creek) during sampling period. In Vadinar, the value of biomass was observed **78** mg/L at ME-7 (Near SPM) and **110.64** mg/L in ME-8 (Near Vadinar Jetty) monitoring station.

- **Productivity (Net and Gross)**

  Gross primary productivity (GPP) is the rate at which organic matter is synthesised by producers per unit area and time (GPP). The amount of carbon fixed during photosynthesis by all producers in an ecosystem is referred to as gross primary productivity. During the Monitoring Period, the monitoring location of Kandla reported

GPP value in range between **2.44 to 3.73 mg/L/48 Hr** where the highest value recorded for ME-3 (Near Coal Bearth) and lowest recorded at ME-5 (Nakti creek-near tuna port). In Vadinar, the value of **GPP** was observed **3.67** at ME-7 (Near SPM) and **3.09** mg/L/48 Hr at ME-8 (Near Vadinar Jetty) monitoring station.

Net primary productivity, is the amount of fixed carbon that is not consumed by plants, and it is this remaining fixed carbon that is made available to various consumers in the ecosystem. During the monitoring period of 2023 to 2024 the Net primary productivity of the monitoring location at Kandla from (ME-1 to ME-6) has been estimated to be between **2.49 to 5.47 mg/L/48 Hr**. While in Vadinar, the value of **NPP** was observed **4.16** at ME-7 (Near SPM) and **2.64** mg/L/48 Hr at ME-8 (Near Vadinar Jetty) monitoring station.

- **Pheophytin**

  The level of Pheophytin was detected in the range from **0.8 to 5.81 mg/m^3** where the highest value observed at ME-6 (Nakti Creek (Near NH-8A)) and the lowest value observed at ME-3(Near Coral Breth), While in Vadinar, the value of Pheophytin was observed **2.66** mg/m^3 at ME-7 and **2.43** mg/m^3 at ME-8 monitoring station.

- **Chlorophyll-a**

  In the sub surface water, the value of Chlorophyll-a reported in range from **1.61 to 12.43 mg/m^3**. The highest value observed at ME-6 (Nakti Creek (Near NH-8A)), while the lowest value observed at ME-2 (Kandla Creek). In Vadinar, the value of chlorophyll-a was observed **2.37** mg/m^3 at ME-7 (Near SPM) and **3.24** mg/m^3 in ME-8 (Near Vadinar Jetty) monitoring station.

- **Particulate Oxidisable Organic Carbon**

  During the sampling period, the particulate oxidisable organic carbon falls within the range of **1.12 to 1.51 mg/L** from monitoring location ME-1 to ME-6 at Kandla, whereas for Vadinar, the value of POC observed **1.26** mg/L at ME-7 (Near SPM) and **1.20** mg/L in ME-8 (Near Vadinar Jetty) monitoring station.

- **Secchi Depth**

  In monitoring station of Kandla (ME-1 to ME-6) the level of Secchi Depth was observed between **0.56 to 0.63 ft** whereas at Vadinar, the value recorded at ME-7 i.e. Near SPM is **3.93** ft and in Near Vadinar Jetty is **2.61** ft.

Ecological Diversity

Phytoplankton: For the evaluation of the Phytoplankton population in DPA Kandla and Vadinar within the immediate surroundings of the port, sampling was conducted during the study period. Total 8 sampling locations were studied i.es. sampling locations (6 from Kandla and two from Vadinar).

The details of variation in abundance and diversity in phytoplankton communities is mentioned in **Table 40**.

Table 38: Phytoplankton variations in abundance and diversity in sub surface sampling stations

Genera	ME-1 (Near Passenger Jetty One)	ME-2 (Kandla Creek)	ME-3 (Near Coal Berth)	ME-4 (Khori Creek)	ME-5 (Nakti Creek-near Tuna Port)	ME-6 (Nakti Creek near NH - 8A)	ME-7 (Near SPM)	ME-8 (Near Vadinar Jetty)
	Avg	Avg	Avg	Avg	Avg	Avg	Avg	Avg
Bacillaria sp.	360.55	391.28	387.28	404.75	374.33	521.333	390.12	347.6
Biddulphia sp.	492.66	340	184	542	315.25	434.5	402.8	274
Chaetoceros sp.	279.66	379.28	442.8	258.85	627.6	322.25	462.85	394.7
Chlamydomonas sp.	286.57	312.33	294	329.33	478	456	325.25	503
Cyclotella sp.	367.14	443.5	473.33	418.57	454	609	303.5	378.57
Coscinodiscus sp.	455.4	412.83	464.2	206	330.42	376.6	370.4	244
Ditylum sp	342.14	322.16	186.83	241.75	225	205.83	227.6	294.8
Fragilaria sp.	395	381.57	384.14	300.5	355	0	350.25	360.33
Bacteriastrum sp.	178.5	96	260.5	166.6	111.66	252.75	162	252.75
Pleurosigma sp.	236.66	236	233	565	276	675	352.5	219
Navicula sp.	366.28	488.5	525	393.16	420	332.71	375.25	856.87
Nitzschia sp.	309.12	272.57	349	295.5	366.57	284.77	418.71	435.75
Synedra sp.	479	328	218.66	322.83	144.5	541	192.75	327.42
Skeletonema sp.	270.66	566.66	433.33	0	488.66	536.66	521.25	495.66
Oscillatoria sp.	341	351.66	281.8	251	493.8	423.5	144	306.2
Thallassiosira	147	134.83	116	132.5	170	224.66	235.33	161.33
Gomphonema sp.	550	495.75	426.66	360	600	310	564.66	500
Planktothrix sp.	140.5	302	308.75	750	0	685	400	667.5
Gyrosigma sp.	410	560	650	0	0	500	0	0
Actinestrum sp.	0	0	0	550	0	685	700	500
Cymbella	500	500	0	650	0	800	750	0
Limnothrix sp.	0	700	0	485	0	630	0	0
Scendesmus sp.	0	0	0	8	0	20	0	4
Mougeotia sp.	0	0	0	0	0	850	0	0
Chlorella sp.	0	0	0	2918.1	3073.1	3704.3	3357.1	3576.8
Density-Units/L	3107.1	3525	3177.3	8.7	8.2	8.9	9.5	8.9
No. of genera	9.2	9.9	8.9	750	0	685	400	667.5

The phytoplankton community of the sub surface water in the Kandla and Vadinar was represented by, Diatoms, green algae and filamentous Cynobacteria. Diatoms were

represented by 15 genera; green algae were represented by 1 genera and filamentous Cynobacteria were represented by 1 genera during the sampling period.

The density of phytoplankton of the sampling stations from ME-1 to ME-6 (Kandla) varying from **2918** to **3704.3** units/L, while for Vadinar its density of phytoplankton observed **3357.1** units/L at ME-7 and **3576.6** units/L at ME-8. During the sampling, all communities were contributing in phytoplankton on both location of Kandla & Vadinar except Gyrosigma sp, Actinestrum sp, cymbella, Limnothrix sp, Scendesmus sp, Mougeotia sp and cholera sp.

The details of Species richness Index and Diversity Index in Phytoplankton is mentioned in **Table 41**.

Table 39: Species richness Index and Diversity Index in Phytoplankton

Indices	ME-1 (Near Passenger Jetty One)	ME-2 (Kandla Creek)	ME-3 (Near Coal Berth)	ME-4 (Khori Creek)	ME-5 (Nakti Creek-near Tuna Port)	ME-6 (Nakti Creek near NH - 8A)	ME-7 (Near SPM)	ME-8 (Near Vadinar Jetty)
	Avg	Avg	Avg	Avg	Avg	Avg	Avg	Avg
Taxa S	10.73	10.27	11.36	10.45	12.55	10.64	10.00	11.09
Individuals	5234.36	5688.36	6072.09	5832.45	6546.91	5605.09	5615.09	6223.27
Shannon diversity	2.05	1.89	1.93	1.86	1.78	1.85	1.96	1.58
Simpson 1-D	0.86	0.87	0.85	0.83	0.84	0.84	0.86	0.81
Species Evenness	0.94	0.84	0.92	0.88	0.86	0.86	0.90	0.73
Margalef richness	1.05	1.10	0.98	0.98	0.93	0.97	1.05	0.98
Berger-Parker	0.20	0.20	0.23	0.24	0.24	0.24	0.23	0.29
Relative abundance	0.41	0.44	0.37	0.43	0.38	0.40	0.40	0.41

- **Shannon- Wiener's Index (H):** During monitoring period 2023 to 2024, Average Shanon- Wierner's index of phytoplankton communities was in the range of **1.78 to 2.5** between selected sampling stations from ME-1 to ME-6. While for Vadinar, Average Shannon Wiener's index of phytoplankton communities recorded to be **1.96** at ME-7 and **1.58** at ME-8. The apportionment of the numbers of individuals among the species observed higher stability at all monitoring location of Kandla and Vadinar.
- **Simpson diversity index (1-D):** During the monitoring period **2023 to 2024,** average Simpson diversity index (1-D) of phytoplankton communities was ranged between **0.83 to 0.87** at all sampling stations in the Kandla creek and nearby creeks. Similarly, for Vadinar average Simpson diversity index (1-D) of phytoplankton communities was **0.86** at ME-7 and **0.81** at ME-8.
- **Margalef's diversity index** (Species Richness): During the monitoring period **2023 to 2024,** average margalef's diversity index of phytoplankton communities in Kandla and nearby creeks sampling stations was varying from **0.93 to 1.10.** While for Vadinar, average Margalef's diversity index (Species Richness) of phytoplankton communities observed **1.05** at ME-7 and **0.98** at ME-8.

- **Berger-Parker Index (d):** During the monitoring period **2023 to 2024,** average Berger-Parker Index (d) of phytoplankton communities was in the range of **0.93 to 1.10** between selected sampling stations from ME-1 to ME-6. at Kandla creek and nearby creeks.

Average Berger-Parker Index (d) of phytoplankton communities in the sampling stations of Vadinar, was in the range of **0.98** to **1.05.** All the monitoring station signifies a low diversity with an even distribution among the different species.

- The Average **Species Evenness** is observed in the range of **0.84 to 0.94** for all the six-monitoring station of Kandla and for the Vadinar the average species evenness is observed in the range of **0.73** to **0.90**.

- During the sampling period, average **Relative Abundance** of phytoplankton communities was in range of **0.37 to 0.44** between selected sampling stations from ME-1 to ME-6 at Kandla creek and nearby creeks. Whereas for Vadinar the Average relative Abundance value **0.40** at ME-7 and **0.41** at ME-8. thus it is concluded that the studied species can be stated as neither highly dominant nor rare.

The details of variation in abundance and diversity in zooplankton communities is mentioned in **Table 42**.

Table 40: Zooplankton variations in abundance and diversity in sub surface sampling stations

Genera	ME-1 (Near Passenger Jetty One)	ME-2 (Kandla Creek)	ME-3 (Near Coal Berth)	ME-4 (Khori Creek)	ME-5 (Nakti Creek-near Tuna Port)	ME-6 (Nakti Creek near NH - 8A)	ME-7 (Near SPM)	ME-8 (Near Vadinar Jetty)
	Avg	Avg	Avg	Avg	Avg	Avg	Avg	Avg
Acartia sp.	1.78	1.67	1.38	2.00	2.22	1.29	2.71	1.44
Acrocalanus	1.50	1.86	2.40	2.29	2.00	1.86	2.00	3.29
Amoeba	3.00	1.57	3.22	3.33	3.44	1.57	2.88	2.14
Brachionus sp.	2.67	2.25	2.00	1.88	2.40	3.11	3.50	1.67
Calanus sp.	2.14	2.60	2.75	1.83	2.33	2.43	1.86	3.00
Cladocera sp.	2.25	2.38	4.67	2.14	2.63	1.44	2.38	2.38
Cyclopoid sp.	4.50	3.88	4.13	4.13	2.50	2.10	3.33	2.00
Copepod larvae	1.67	3.00	2.33	2.75	2.00	3.75	1.67	2.25
Diaptomus sp.	4.88	1.83	4.17	2.25	3.50	1.67	3.00	2.86
Eucalanus sp.	3.33	1.83	2.25	3.67	2.80	5.40	2.88	3.71
Mysis sp.	3.20	9.00	7.50	4.86	1.20	6.00	5.13	8.00
Oithona sp.	1	2	4	2	1	3.5	3.33	9
Paracalanus sp.	7.71	6.67	4.00	7.88	11.50	7.90	8.56	9.75
Density Unit/L	24.45	24.91	25.82	26.00	22.91	26.45	27.64	27.36
No. of genera	7.73	7.64	7.64	7.91	7.09	8.36	7.82	7.73

A total of 13 groups/taxa of zooplankton were recorded in Kandla and Vadinar during the study period which mainly constituted by *diaptomus*, *copepods*, *brachionus*, *cladocera*, fish and shrimp larval forms. *Amoeba* and *Cyclopoida* had the largest representation at all stations from (ME-1 to ME-8). The average density of Zooplankton of the sampling stations from ME-1 to ME-6 (Kandla) varying from **22.91** to **26.45** units/L, while for Vadinar its average density of zooplankton observed **27.64** units/L at ME-7 and **27.36** units/L at ME-8. During

the sampling, all communities were contributing in zooplankton except Oithana sp. in Kandla and Vadinar.

The details of Species richness Index and Diversity Index in Zooplankton communities is mentioned in **Table 43**.

Table 41: Species richness Index and Diversity Index in Zooplankton

Indices	ME-1 (Near Passenger Jetty One)	ME-2 (Kandla Creek)	ME-3 (Near Coal Berth)	ME-4 (Khori Creek)	ME-5 (Nakti Creek-near Tuna Port)	ME-6 (Nakti Creek near NH - 8A)	ME-7 (Near SPM)	ME-8 (Near Vadinar Jetty)
	Avg	Avg	Avg	Avg	Avg	Avg	Avg	Avg
Taxa S	7.73	7.64	7.64	7.91	7.09	8.36	7.82	7.73
Individuals	24.45	24.91	25.82	26.00	22.91	26.45	27.64	27.36
Shannon diversity	1.75	1.70	1.80	1.74	1.62	1.66	1.71	1.69
Simpson (1-D)	0.83	0.84	0.83	0.83	0.82	0.82	0.84	0.81
Species Evenness	0.87	0.85	0.90	0.86	0.85	0.79	0.85	0.84
Margalef	2.14	2.19	2.07	2.21	2.06	2.34	2.20	2.17
Berger-Parker	0.34	0.32	0.32	0.34	0.35	0.37	0.31	0.35
Relative abundance	34.93	40.08	31.95	37.76	39.98	38.18	39.18	37.27

- **Shannon- Wiener's Index (H):** During monitoring period 2023 to 2024, Average Shanon- Wierner's index of zooplankton communities was in the range of **1.62 to 1.80** between selected sampling stations from ME-1 to ME-6, at Kandla creek and its nearby creeks. While for Vadinar, average Shannon Wiener's index of zooplankton communities recorded to be **1.71** at ME-7 and **1.69** at ME-8. The apportionment of the numbers of individuals among the species observed higher stability at all monitoring location of Kandla and Near SPM (Vadinar).
- **Simpson diversity index (1-D):** During the monitoring period **2023 to 2024,** average Simpson diversity index (1-D) of zooplankton communities was ranged between **0.82 to 0.84** at all sampling stations in the Kandla creek and nearby creeks, for Vadinar average Simpson diversity index (1-D) of zooplankton communities was **0.84** at ME-7 and **0.81** at ME-8.
- **Margalef's diversity index** (Species Richness): During the monitoring period **2023 to 2024,** average margalef's diversity index of zooplankton communities in Kandla and nearby creeks sampling stations was varying from **2.06 to 2.34,** during the sampling period. While for Vadinar, average Margalef's diversity index (Species Richness) of zooplankton communities observed **2.2** at ME-7 and **2.17** at ME-8.

- **Berger-Parker Index (d):** During the monitoring period **2023 to 2024,** average Berger-Parker Index (d) of zooplankton communities was in the range of **0.32 to 0.37** between selected sampling stations from ME-1 to ME-6, at Kandla creek and nearby creeks. Average Berger-Parker Index (d) of zooplankton communities in the sampling stations of Vadinar, was in the range of **0.31** to **0.35.** All the monitoring station signifies a low diversity with an even distribution among the different species.

- The average **Species Evenness** is observed in the range of **0.79 to 0.90** for all the six-monitoring station of Kandla whereas, for the Vadinar the average species evenness was observed in the range of **0.85** to **0.84**, during the monitoring period.

- During the sampling period, **average Relative Abundance** of zooplankton communities was in range of **31.95** to **40.08** between selected sampling stations from ME-1 to ME-6. at Kandla creek and nearby creeks. Whereas for Vadinar the average relative abundance value **39.18** at ME-7 and **37.27** at ME-8, thus it can be concluded that the studied species is stated as neither highly dominant nor rare.

The details of variation in abundance and diversity in **Benthic organism** is mentioned in **Table 44.**

Table 42: Benthic Fauna variations in abundance and diversity in sub surface sampling

Genera	ME-1 (Near Passenger Jetty One)	ME-2 (Kandla Creek)	ME-3 (Near Coal Berth)	ME-4 (Khori Creek)	ME-5 (Nakti Creek-near Tuna Port)	ME-6 (Nakti Creek near NH - 8A)	ME-7 (Near SPM)	ME-8 (Near Vadinar Jetty)
	Avg	Avg	Avg	Avg	Avg	Avg	Avg	Avg
Thiaridae	2.20	1.40	2.00	2.00	1.5	2.17	1.25	2.67
Mollusca sp.	2.22	1.33	2.00	1.67	2.5	1.75	2.00	2.50
Odonata sp.	2.50	1.00	1.86	2.33	1.4	2.43	2.20	2.60
Lymnidae	1.67	2.67	5.00	1.75	1.6	1.67	2.40	1.33
Planorbidae	1.00	1.33	1.67	1.00	2.0	2.00	1.50	1.00
Atydae	1.50	2.00	1.50	1.67	1.0	1.60	1.67	1.71
Gammaridae	1.50	2.17	1.25	1.50	1.3	1.50	1.83	2.83
Portunidae	1.00	1.00	1.00	1.00	0	1.00	1.00	1.00
Turbinidae	1.67	1.00	2.33	1.00	1.0	1.33	1.50	1.33
Palaemonidae	1.25	1.00	2.20	2.50	2.4	1.00	1.33	1.67
Diapatra sp.	1.67	2.00	2.50	3.67	2.0	3.50	1.33	2.33
Coleoptera sp.	2.00	1.50	3.00	2.50	0	1.00	2.67	2.00
Crustacea sp.	3.00	1.00	2.33	3.00	2.5	2.50	1.50	1.00
Hemiptera sp.	2.33	3.33	0	2.00	1.7	1.50	2.50	1.50
Tricoptera sp.	1.33	4.00	2.33	4.00	2.5	4.50	1.50	1.00
Hydrobidae	1.00	2.50	1.00	2.00	1.0	2.50	0	2.50
Viviparidae	3.00	1.00	0	1.00	2.0	1.50	3.00	3.00
Neridae	1.50	1.00	1.50	0	4.0	2.00	1.00	2.00
Density-m^3	10.18	8.82	9.64	10.09	8.5	9.73	9.73	9.55
No of genera	5.45	4.82	4.82	5.00	4.8	4.91	4.91	4.73

Few Benthic organisms were observed in the collected sample by using the Van-Veen grabs during the sampling conducted for DPA Kandla and Vadinar. Majority of the species were found under the Macro-benthic organisms during the sampling period were represented by *Atyde, Palaemonidae, Mollusca sp.*, etc. The average density of benthic fauna was varying from **8.55** to **10.18** m^3.

The details of Species richness Index and Diversity Index in Benthic Organisms is mentioned in **Table 45.**

Table 43: Species richness Index and Diversity Index in Benthic Organisms

Indices	ME-1 (Near Passenger Jetty One)	ME-2 (Kandla Creek)	ME-3 (Near Coal Berth)	ME-4 (Khori Creek)	ME-5 (Nakti Creek- near Tuna Port)	ME-6 (Nakti Creek near NH - 8A)	ME-7 (Near SPM)	ME-8 (Near Vadinar Jetty)
	Avg.	Avg	Avg	Avg	Avg	Avg	Avg	Avg
Taxa S	5.36	4.82	4.82	5.00	4.82	4.91	4.82	4.73
Individuals	10.18	8.82	9.64	10.09	8.55	9.73	8.91	9.55
Shannon diversity	1.48	1.35	1.38	1.40	1.35	1.39	1.29	1.35
Simpson 1-D	0.86	0.84	0.86	0.86	0.86	0.86	0.87	0.83
Species Evenness	0.88	0.87	0.88	0.89	0.87	0.89	0.82	0.88
Margalef	1.92	1.78	1.73	1.81	1.83	1.78	1.79	1.68
Berger-Parker	0.33	0.37	0.33	0.34	0.37	0.34	0.37	0.36
Relative abundance	55.92	57.66	53.67	56.55	60.63	56.18	57.46	51.58

- **Shannon- Wiener's Index (H):** During monitoring period 2023 to 2024, Average Shanon- Wierner's index of benthic organism was in the range of **1.35 to 1.48** between selected sampling stations from ME-1 to ME-6, at Kandla creek and its nearby creeks. While for Vadinar, average Shannon Wiener's index of benthic organism recorded to be **1.29** at ME-7 and **1.35** at ME-8. The apportionment of the numbers of individuals among the species observed higher stability at all monitoring location of Kandla and Vadinar.

- **Simpson diversity index (1-D):** During the monitoring period **2023 to 2024,** average Simpson diversity index (1-D) of benthic organism was ranged between **0.84 to 0.86** at all sampling stations in the Kandla creek and nearby creeks, Similarly, for Vadinar average Simpson diversity index (1-D) of benthic organism was **0.87** at ME-7 and **0.83** at ME-8.

- **Margalef's diversity index** (Species Richness): During the monitoring period **2023 to 2024,** average margalef's diversity index of benthic organism in Kandla and nearby creeks sampling stations was varying from **1.73 to 1.92**. While for Vadinar, average Margalef's diversity index (Species Richness) of benthic organism observed to be **1.79** at ME-7 and **1.68** at ME-8.

- **Berger-Parker Index (d):** During the monitoring period **2023 to 2024,** average Berger-Parker Index (d) of benthic organism was in the range of **0.33 to 0.37** between selected sampling stations from ME-1 to ME-6, at Kandla creek and nearby creeks. average Berger-Parker Index (d) of benthic organism in the sampling stations of Vadinar, was in the range of **0.36** to **0.37**. All the monitoring station signifies a low diversity with an even distribution among the different species.

- The average **Species Evenness** is observed in the range of **0.87 to 0.89** for all the six-monitoring station of Kandla and for the Vadinar the species evenness is observed in the range of **0.82** to **0.88.**

- During the sampling period, **average Relative Abundance** of Benthic organisms was in range of **53.67 to 60.63** between selected sampling stations from ME-1 to ME-6 at Kandla creek and nearby creeks. Whereas for Vadinar the Average relative abundance value **57.46** at ME-7 and **51.58** at ME-8, thus it is concluded that the studied species can be stated as neither highly dominant nor rare.

CHAPTER 13: SUMMARY AND CONCLUSION

13.1 Summary and Conclusion

The report, prepared by the Gujarat Environment Management Institute (GEMI), details the environmental monitoring and management plan for the Deendayal Port Authority (DPA) at Kandla and Vadinar. The monitoring covers the period from April 2023 to April 2024.

The primary objective is to systematically assess and monitor environmental parameters including ambient air, water (drinking and surface), soil, sediment, noise, and ecology to ensure compliance with environmental standards and statutory norms.

Methodology

Environmental monitoring was conducted using standard operating procedures, protocols, and guidelines to ensure accurate data collection. Various parameters were measured, including air quality, water quality, soil characteristics, noise levels, and meteorological data.

Based on the results obtained for both study areas, Kandla and Vadinar, during the monitoring period from April 2023 to April 2024, the following observations are concluded.

- **Ambient Air Quality Monitoring**
  Particulate matter (PM_{10} and $PM_{2.5}$) levels exceeded the national ambient air quality standards (NAAQS) at most monitoring locations, especially at the coal storage area. The high particulate matter levels were attributed to heavy vehicular traffic, loading/unloading of cargo, and dust from unpaved roads. For Gaseous monitoring, sulfur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOCs), and carbon monoxide (CO) were generally within the NAAQS limits.

- **DG Stack Monitoring**
  Monitoring of the diesel generator (DG) stacks was conducted at one location each in Kandla and Vadinar. Parameters like suspended particulate matter, SO_2, NO_x, CO, and CO_2 were measured and found to be within the prescribed emission limits.

- **Drinking Water Quality Monitoring**
  Drinking water samples were collected from 20 locations across Kandla and Vadinar. Most water quality parameters like pH, color, turbidity, chloride, and total hardness were within the drinking water standards (IS 10500:2012). A few locations showed slightly elevated levels of electrical conductivity, salinity, and total dissolved solids, likely due to the coastal location.

- **Marine Water and Sediment Quality Monitoring**
  Marine water and sediment samples were collected from 6 locations in Kandla and 2 locations in Vadinar. The water quality parameters like pH, salinity, dissolved oxygen, and nutrients were within the acceptable limits for coastal waters. The sediment quality in terms of heavy metals and organic contaminants was also found to be within the prescribed standards.

- **Marine Ecology Monitoring**
  Monitoring of marine Ecology was conducted at 6 locations in Kandla and 2 locations in Vadinar. The study did not find any significant adverse impacts on the marine ecosystem due to port operations.

Overall, the report concludes that the environmental monitoring conducted by the DPA during the period of April 2023 to April 2024 indicates compliance with the applicable environmental regulations, with some exceptions related to particulate matter levels in the ambient air.

Annexure 1: Photographs of the Environmental Monitoring conducted at Kandla

STP Monitoring

Noise Monitoring

Soil Monitoring

Marine Monitoring

Air Monitoring

Drinking Water Monitoring

Annexure 2: Photographs of the Environmental Monitoring conducted at Vadinar

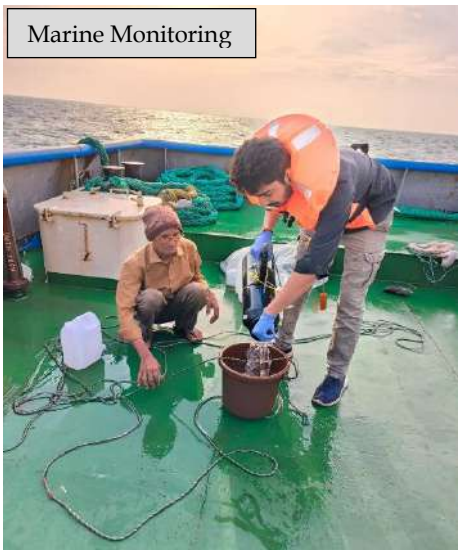
Air Monitoring

Noise Monitoring

STP Monitoring

Drinking water Monitoring

Marine Monitoring



Soil Monitoring

Source: GEMI

CHAPTER 14: REFERENCES

References:

(1) National ambient air quality standards central pollution control board, 2009

(2) Ambient Air Quality Standards in respect of Noise,2000.

(3) American Public Health Association 23rd Addition, Standard Methods for Water and Waste water analysis, 2017.s

(4) Indian Standard DRINKING WATER — SPECIFICATION (Second Revision), 2012.

Gujarat Environment Management Institute (GEMI)

(An Autonomous Institute of Government of Gujarat)

'An ISO 9001:2015, ISO 14001:2015 & ISO 45001:2018 Certified Institute

Head Office

Plot No. B 246 & 247, G.I.D.C. Electronic Estate,

Sector-25, Gandhinagar-382024

Laboratory

Plot No. B-64, G.I.D.C. Electronic Estate,

Opp. I.P.R., Sector-25, Gandhinagar-382025

Tel: (+91) 79-23240964 (O), T: (+91) 79-23287758 (Lab), F: (+91) 79-23240965

E-mail: info-gemi@gujarat.gov.in | Website: www.gemi.gujarat.gov.in

"We Provide Environmental Solutions"