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(An ISO 9001:2015 Certified Company)

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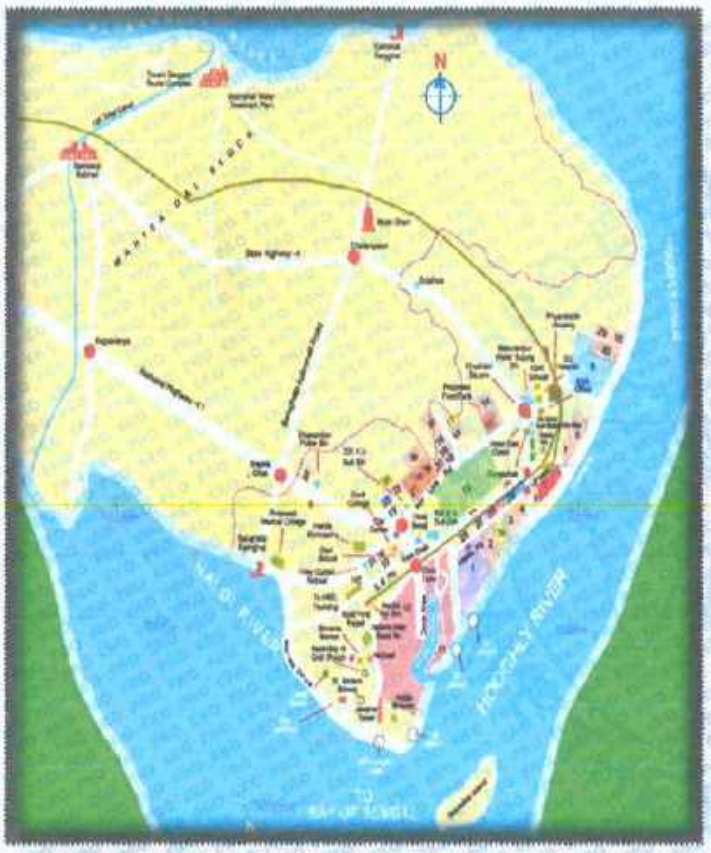
ENVIRONMENTAL MONITORING
SUMMER SEASON–APRIL-JUNE 2021

At KOLKATA PORT TRUST
HALDIA DOCK COMPLEX



Submitted To:

KOLKATA PORT TRUST

Haldia Dock Complex

Haldia Township, Haldia

Distt: PurbaMedinpur (West Bengal)

Prepared by:

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Pankaj Chauhan
(Technical Manager)

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Amit Saxena
(Quality Manager)

1. Summary

Kolkata Port Trust, Haldia Dock Complex has awarded the project titled "POST PROJECT MONITORING OF DIFFERENT ENVIRONMENTAL PARAMETERS UNDER HALDIA DOCK COMPLEX, HALDIA" to M/s. Eko Pro Engineers Private Limited, Ghaziabad vide work order No. I&CF/IZ&R/T/296/702 dated 10.10.2019.

The main objective of environmental Monitoring is to take the environmental observations, inside and outside the Dock complex.

A comprehensive environmental monitoring program has been planned to monitor data for the period of **April 2021 – June 2021**. The monitored data of Ambient Air Quality, Fugitive Emission, Ambient Noise Quality, Marine Water Quality, Sediment Quality and green belt study in an around Haldia Dock complex.

In this study, multiple and periodic sampling has been carried out for Ambient air Quality. The frequency of Air monitoring is followed twice a week for a season.

Ambient Noise monitoring is followed once in month i.e. April-2021 – June 2021. The observations of total twelve locations were taken.

Marine Water quality samples for Physico-Chemical Analysis and Biological Analysis are carried out once in season.

Marine Sediment Quality samples for physico-chemical analysis and biological analysis also being carried out once as the frequency for the same is once in a season.

Green Belt Survey also been conducted in the Dock premises once in season.

Eko Pro Engineers Private Limited mobilized sampling team for conducting the Water, Noise, sediment and Air monitoring in Haldia Dock Complex.

All the work was carried out by team and submitted the samples in lab.

We are very thankful to the official staff of Dock complex to support us and make this successfully happen. A big support of official staff we had at site to get the study and sample collection job done and gave us such type of opportunity.

The results and interpretation of study and monitoring is follows

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2. Ambient Air Quality

2.1 Selection of Monitoring Station

Ambient Air Quality Monitoring (AAQM) stations were set up at four locations with due consideration of meteorological conditions on synoptic basis, topography of the study area, representatives of regional background air quality for obtaining baseline and consultation with Haldia Dock Complex officials. The monitoring locations are given in **Table 2.1**

Table 2.1: Monitoring Station of Ambient Air Quality (AAQ)

S.NO.	STATION CODE	LOCATION	LATITUDE	LONGITUDE
1	AAQ-1	Near 3rd Jetty	22°01'01.07"N	88°04'06.56"E
2	AAQ-2	Top of Marine House	22°01'32.55"N	88°05'17.89"E
3	AAQ-3	Township maintenance office	22°01'21.80"N	88°03'43.83"E
4	AAQ-4	Chrinjibpur Office	22°03'08.55"N	88°05'48.64"E

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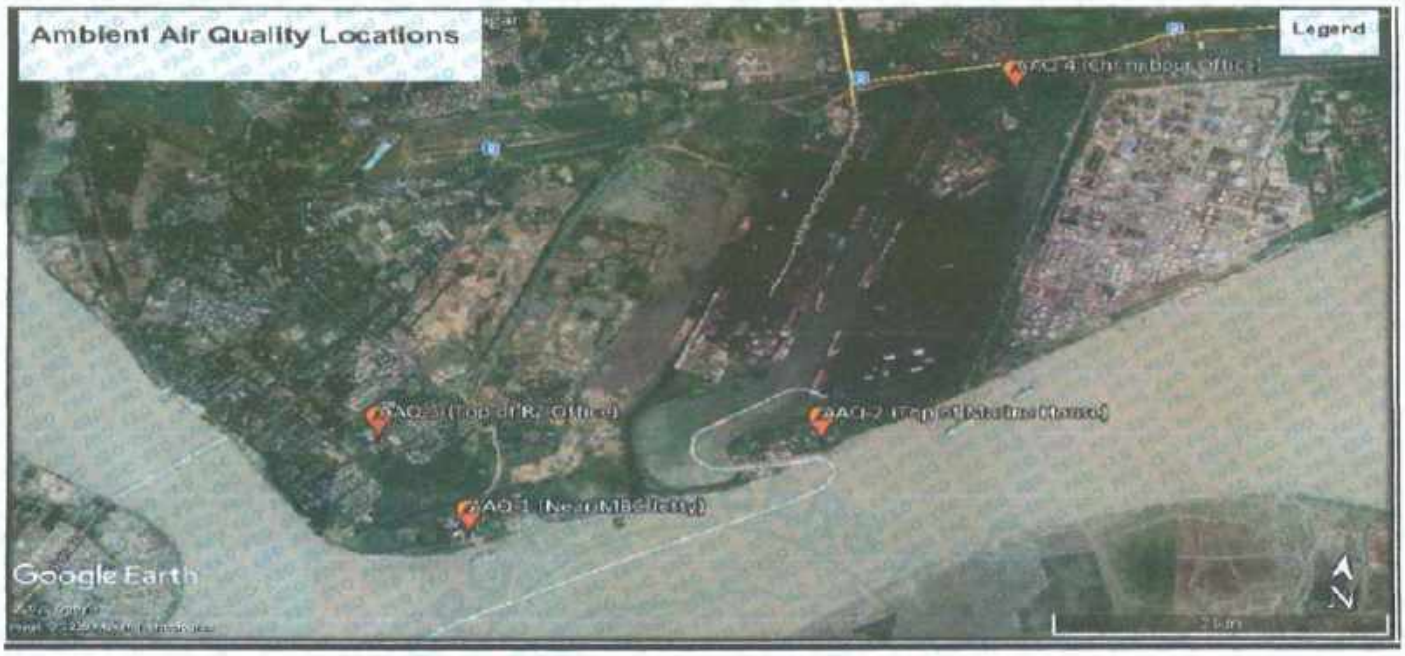

Figure 2.1 AAQ Location

2.2 Sampling Methodology and Parameter Selection

Ambient air quality monitoring has been carried out twice in each location during the study period (Winter Season-Jan21 to Mar21). The baseline data of ambient air has been generated for the following parameters as mentioned below.

- SPM
- PM_{10}
- $PM_{2.5}$
- Sulphur-dioxide (SO_2)
- Oxides of Nitrogen (NO_x)
- Carbon monoxide (CO)

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It was ensured that the equipment was placed at a height of at least 3 to 4 m above the ground level at each monitoring station, for negating the effects of wind-blown ground dust. The distance of the sampler from any air flow obstacle i.e. buildings, walls, was more than two times the height of the obstacle. The equipment was placed at open space free from trees and vegetation which otherwise act as a sink of pollutants resulting in lower levels in monitoring results. Monitoring has been carried out as per the latest CPCB and MoEF guidelines and notifications.

2.3 Sampling and Analysis Technique

With a view to collecting the samples, Envirotech Make Calibrated Respirable Dust Samplers (SL No.-1902-701) along with Gaseous attachment and Fine Particulate Matter (FPS-Instrument SL No.1903-103) have been used. The RDS is capable of drawing air at a flow rate of 0.95 to 1.3 m^3/min with very little pressure drop for RDS and FPS is designed to operate at an air flow rate of 1m^3/hr. Filter papers (MGF 2000 and PTFE (46.2 dia)) were used for the collection of particulate matters and heavy metals. SO_2&NOx were collected by drawing air at a flow-rate of 0.5 liters per minute (lpm) through an absorbing solution for the duration of 24 hrs. Ammonia and ozone were collected drawing air flow rate of 1 liter per minute (lpm) for the duration of 1 hour. Sampling and analysis methodology adopted is given in Table 2.2 and National Ambient Air Quality Standards is given in Table 2.3.

Table 2.1: Sampling & Analysis Methodology

Sl. No.	Parameter	Methodology
1	Suspended Particulate Matter (SPM) ($\mu g/m^3$)	Respirable Dust Sampler (Gravimetric method)
2	Particulate Matter 10 (PM 10) ($\mu g/m^3$)	Respirable Dust Sampler (Gravimetric method)
3	Particulate Matter 2.5 (PM 2.5) ($\mu g/m^3$)	APM 550 Fine Particulate Sampler (Gravimetric method)
4	Sulphur Dioxide SO_2 ($\mu g/m^3$)	West and Gaeke Method
5	Oxides of Nitrogen ($\mu g/m^3$)	IS 5182, Part 6, Jacob & Hochheiser modified
6	Carbon monoxide (mg/m^3)	IS 5182, Part 10, Non-dispersive Infrared Absorption method

2.4 Duration of Sampling

The duration of sampling of fine particulate matter ($PM_{2.5}$), Respirable particulate matter (PM_{10}), SO_2 and NOx was each twenty four hourly continuous sampling per day and CO was sampled for eight hours

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continuous monitoring. The monitoring was conducted for two days in a week for one month in each quarter. The monitoring parameters and frequency of sampling are describe in tabular below.

Table- 2.3 Monitored Parameters and Frequency of Sampling

Parameters	Sampling Frequency
Fine Particulate Matter ($PM_{2.5}$)	24 hourly sample twice a week for one months
Respirable Particulate Matter (PM_{10})	24 hourly sample twice a week for one months
Sulphur dioxide (SO_2)	24 hourly sample twice a week for one months
Nitrogen dioxide (NO_2)	24 hourly sample twice a week for one months
Carbon Monoxide (CO)	8 hourly samples twice a week for one months

Table 2.4: National Ambient Air Quality Standards

Pollutant	Concentration in µg/m³ except for CO in mg/m³		
	Time	Industrial, Residential, Rural & other areas	Ecologically Sensitive area (Notified by Central Govt.)
Sulphur Dioxide (µg/m³)	Annual Avg.* 24 hours**	50 80	20 80
Nitrogen Dioxide (µg/m³)	Annual Avg. 24 hours	40 80	30 80
Carbon monoxide (mg/m³)	8 hours 1 hour	2 4	2 4
PM10 (µg/m³)	Annual Avg. 24 hours	60 100	60 100
PM2.5 (µg/m³)	Annual Avg. 24 hours	40 60	40 60
Ozone O_3 (µg/m³)	8 hourly 1 hourly	100 180	100 180
Lead Pb (µg/m³)	Annual Avg. 24 hours	0.50 1	0.50 1
Ammonia NH_3 (µg/m³)	Annual Avg. 24 hours	100 400	100 400
Arsenic As (µg/m³)	Annual Avg.	06	06
Nickel Ni (ng/m³)	Annual Avg.	20	20

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Pollutant	Concentration in µg/m³ except for CO in mg/m³		
	Time	Industrial, Residential, Rural & other areas	Ecologically Sensitive area (Notified by Central Govt.)
Pyro Benzene (BaP) (ng/m³)	Annual Avg.	1	1

Source: Gazette of India Notification, dated 16th Nov, 2009
** Annual Arithmetic Mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals*
*** 24 hourly or 8 hourly or 01 hourly monitored values, as applicable shall be complied with 98% of the time in a year. 2% of the time they may exceed the limits but not on two consecutive days of monitoring*

2.5 Analytical Result

Table 2.5: Ambient Air Quality-1 (Near 3rd Jetty)

S.No.	Parameters	AAQ – 1 Near 3rd Jetty							
		1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	7th Round	8th Round
		05.05.21	06.05.21	10.05.21	11.05.21	14.06.21	15.06.21	21.06.21	22.06.21
i	PM_{10} (µg/m³)	88.4	92.7	79.1	85.6	91.7	81.2	84.8	81.5
ii	$PM_{2.5}$ (µg/m³)	48.5	51.7	42.6	46.1	48.4	47.1	49.4	51.2
iii	SO_2 (µg/m³)	6.9	7.5	7.2	6.7	7.2	6.8	7.9	7.4
iv	NO_2 (µg/m³)	27.9	30.2	32.4	36.8	37.5	32.1	34.6	39.1
v	CO (mg/m³)	0.799	0.965	0.876	0.822	0.966	0.912	0.865	0.892

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Table 2.6: Ambient Air Quality-2 (Top of Marine House)

S.No.	Parameters	AAQ – 2 Top of Marine House							
		1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	7th Round	8th Round
		12.05. 21	13.05.21	11.06.21	12.06.21	23.06.21	24.06.21	28.06.21	29.06.21
i	$PM_{10}(\mu g/m^3)$	90.4	95.6	93.8	89.2	86.5	82.1	90.6	88.5
ii	$PM_{2.5}(\mu g/m^3)$	46.9	52.1	50.5	54.7	50.2	49.4	53.1	51.9
iii	$SO_2(\mu g/m^3)$	7.1	7.8	7.4	7.7	8.2	8.8	7.9	8.1
iv	$NO_2(\mu g/m^3)$	35.1	36.8	32.5	37.9	38.1	35.8	39.1	36.4
v	$CO(mg/m^3)$	0.598	0.545	0.611	0.782	0.689	0.572	0.609	0.677

Table 2.7: Ambient Air Quality-3 (Township Maintenance Office)

S. No.	Parameters	AAQ – 3 Top of RZ Office							
		1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	7th Round	8th Round
		05.05.21	06.05.21	10.05.21	11.05.21	14.06.21	15.06.21	21.06.21	22.06.21
i	PM_{10} ($\mu g/m^3$)	87.4	81.7	78.2	84.1	86.3	76.1	93.4	90.1
ii	$PM_{2.5}(\mu g/m^3)$	40.9	41.6	43.1	44.5	41.2	46.7	50.2	48.4
iii	$SO_2(\mu g/m^3)$	6.5	7.4	6.9	7.2	6.6	6.9	5.6	6.4
iv	$NO_2(\mu g/m^3)$	31.7	34.5	36.7	37.1	35.4	33.7	36.4	38.1
v	$CO(mg/m^3)$	0.588	0.658	0.612	0.699	0.705	0.589	0.692	0.614

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S. No.	Parameters	AAQ – 4 Chrinjibpur Office							
		1st Round	2nd Round	3rd Round	4th Round	5th Round	6th Round	7th Round	8th Round
		12.05. 21	13.05.21	11.06.21	12.06.21	23.06.21	24.06.21	28.06.21	29.06.21
i	PM_{10} ($\mu g/m^3$)	90.1	85.4	81.9	76.1	89.6	79.4	85.2	82.1
ii	$PM_{2.5}$ ($\mu g/m^3$)	46.2	50.9	53.1	47.6	49.8	40.9	43.4	50.1
iii	SO_2 ($\mu g/m^3$)	9.2	8.9	8.8	9.7	8.5	8.9	7.2	7.5
iv	NO_2 ($\mu g/m^3$)	31.5	34.8	32.1	36.2	35.1	37.4	35.6	34.2
v	CO (mg/m^3)	0.695	0.789	0.955	0.812	0.865	0.702	0.945	0.881

Table 2.8: Ambient Air Quality-4 (Chrinjibpur Office)

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2.6 Interpretation

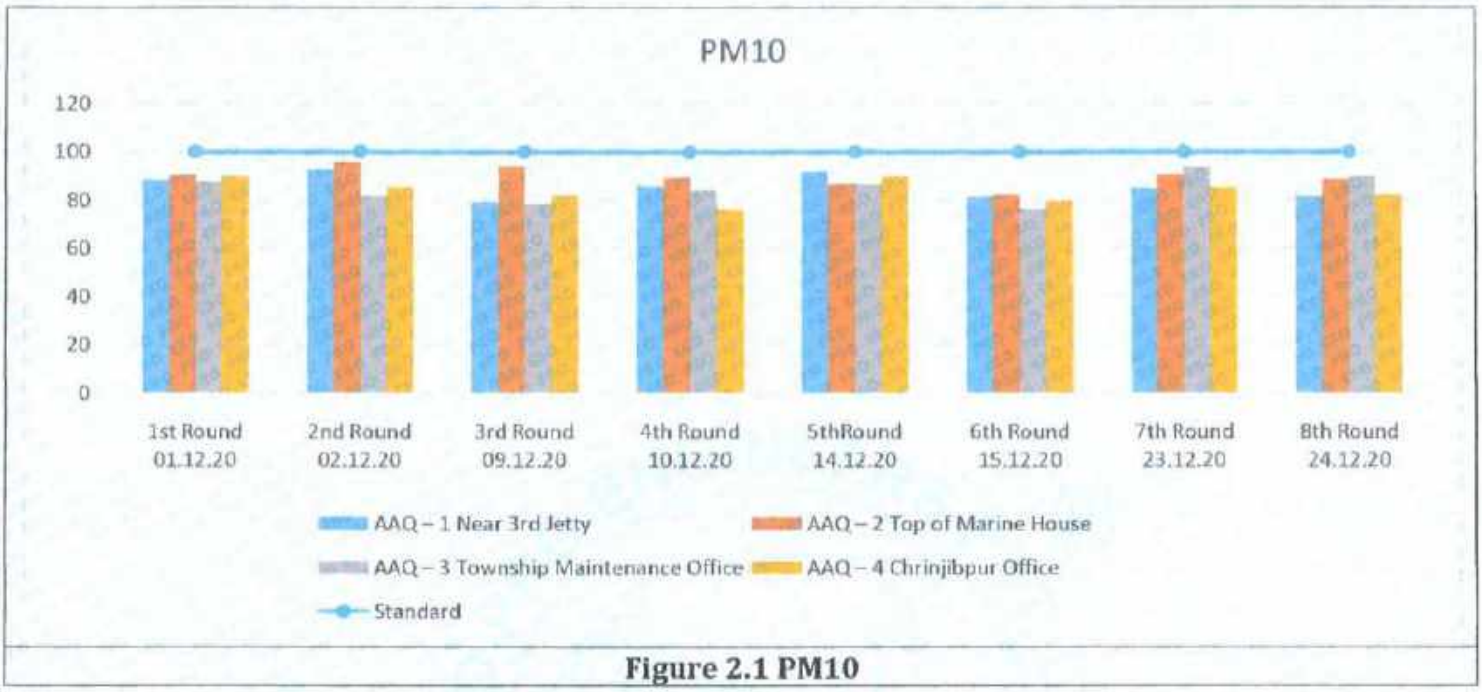

Figure 2.1 PM10

The PM_{10} concentration varies between 77.4 µg/m³ to 94.8 µg/m³ during the study period in winter season. The results were compared with the National Ambient Air Quality Standards 2009. The values were found within the permissible limit. The various sources of air pollution are observed in the study area i.e. industrial, traffic, urban and rural activities.

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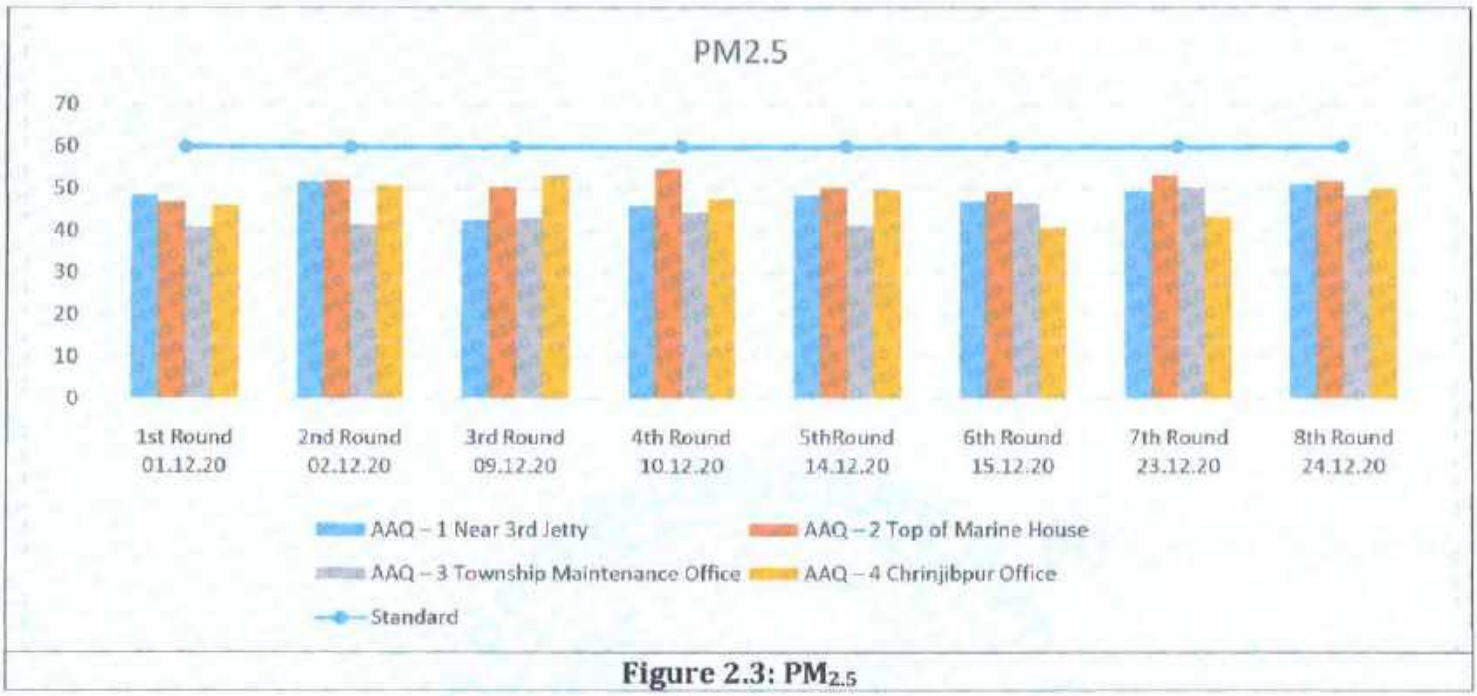

Figure 2.3: $PM_{2.5}$

The $PM_{2.5}$ concentration varies between 41.2 µg/m³to 53.4 µg/m³ in winter season. However, the levels for $PM_{2.5}$ were found to be below the National Ambient Air Quality Standards (< 60µg/m³) of NAAQS: 2012. Populations subjected to long-term exposure to particulate matter has a significantly higher cardiovascular incident and mortality rate. Short-term acute exposures subtly increase the rate of cardiovascular events within days of a pollution spike.

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Figure 2.4: SO2

The SO_2 concentration varies between 5.8 µg/m³to 9.9 µg/m³ during the study period in winter season, which is far below that national ambient air quality standard (< 80µg/m3) of NAAQS: 2012. The source of SO_2 in the study area is mainly from burning fuels containing sulfur. Other anthropogenic sources are emissions from domestic burning and vehicles Exposure to sulfur dioxide in the ambient air has been associated with reduced lung function, increased incidence of respiratory symptoms and diseases, irritation of the eyes, nose, and throat.

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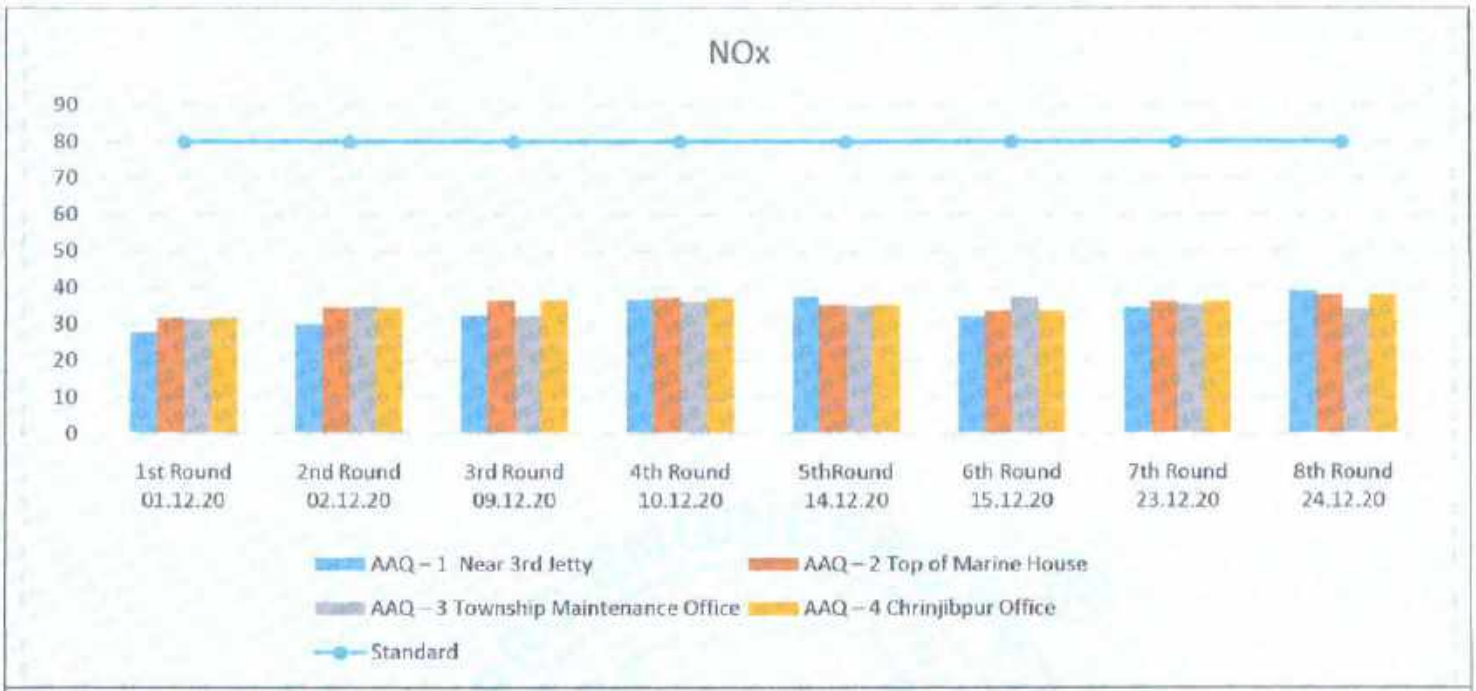

Figure 2.5: NO_x

The NO_2 concentration varies between 29.1 µg/m³to 38.6 µg/m³ in winter season. The values of Nitrogen dioxide were found well below the NAAQ standard. The primary sources of NO_2 are motor vehicles, electric utilities, and other industrial and residential sources that burn fuels. NO_2 is one of the main ingredients involved in the formation of ground level ozone, which can trigger serious respiratory problems.

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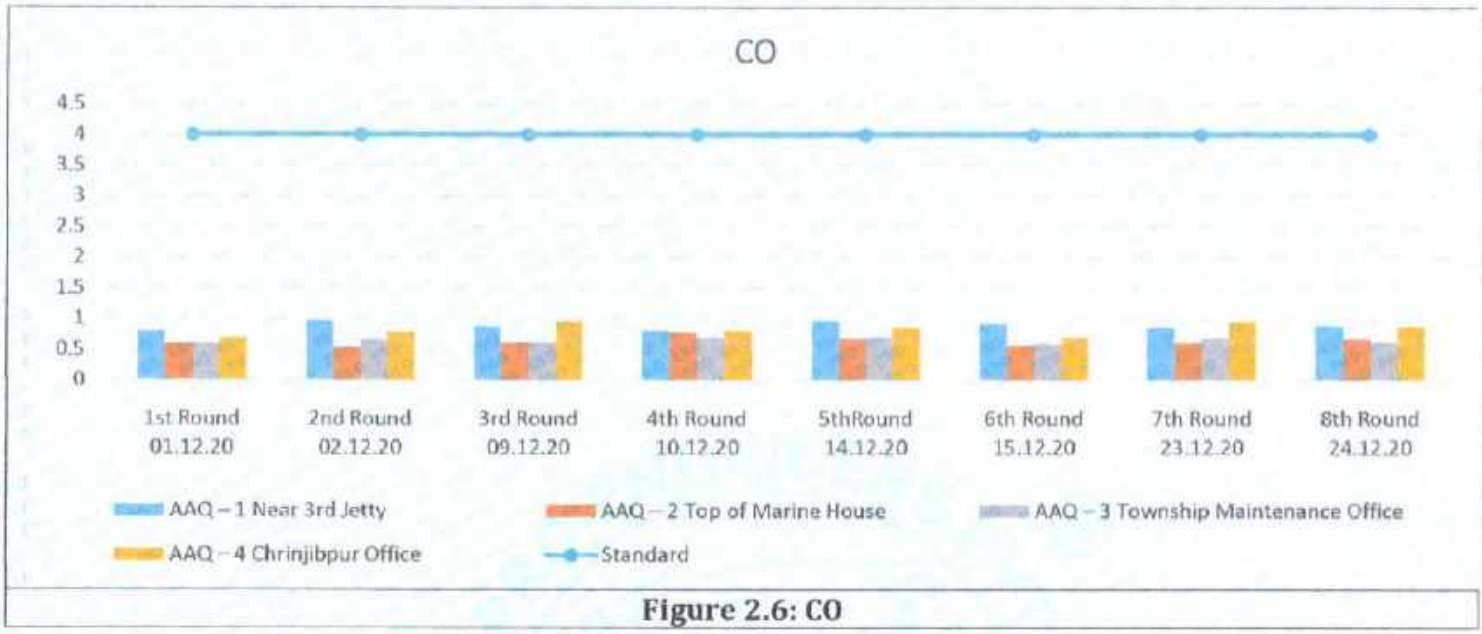

Figure 2.6: CO

The CO concentration varies between 0.57mg/m^{3}to 0.98 mg/m^3 in winter season. The values of CO were found well below the NAAQ standard.

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3. Ambient Noise Quality

3.1 Selection of Monitoring Station

Ambient Noise Quality Monitoring stations were set up at twelve locations for the period of April to June 2021. The monitoring station were setup by filed visit, identify the source noise, sensitive location of the site and official discussion with the Haldia Dock Complex officials. The monitoring locations are given in Table 3.1

Table 3.1: Monitoring Station of Ambient Noise Quality

S.NO	STATION CODE	LOCATION	LATITUDE	LONGITUDE
1	NQ-1	Chrinjibpur OB Gate	22°03'08.89"N	88°05'47.98"E
2	NQ-2	GC Berth Main Gate	22°02'45.86"N	88°05'12.08"E
3	NQ-3	Jawahar Tower Main Gate	22°01'05.98"N	88°04'02.71"E
4	NQ-4	MBC Jetty / Floating Jetty	22°01'11.83"N	88°04'34.53"E
5	NQ-5	CJB Gate	22°03'01.71"N	88°05'53.14"E
6	NQ-6	Lock Gate	22°01'29.11"N	88°05'06.40"E
7	NQ-7	Marine House	22°01'31.80"N	88°05'17.26"E
8	NQ-8	Master Control	22°02'02.16"N	88°05'25.13"E
9	NQ-9	Port Hospital (Township)	22°01'25.96"N	88°03'44.03"E
10	NQ-10	Cluster 4/61 (Township)	22°01'06.30"N	88°03'38.53"E
11	NQ-11	DAV School (Township)	22°01'25.33"N	88°03'34.30"E
12	NQ-12	Gate No.4 (Township)	22°01'35.06"N	88°03'54.55"E

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Figure 3.1 Ambient Noise Quality Location

3.2 Sampling Methodology and Parameter Selection

Noise monitoring has been carried out with using sound level meter ((Lutron SL Q-621819) at monthly basis, in winter season. (January - March, 2021). Noise level monitoring was carried out for 24 hours. Noise levels measured over a given period of time of interval, enable to describe scenario of noise using statistical techniques.

a) **Leq (d)**
b) **Leq(n)**
c) **L10**
d) **L50**
e) **L90**
f) **Lmax**

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g) Lmin
h) Ldn

- Lday: Average noise levels between 6.00 hrs to 22.00hrs
- Lnight: Average noise levels between 22.00 hrs to 6.00hrs.

3.3. Sampling Techniques with Standards

The Lutron make sound level meter was used to record the sound data and the model number of used device is SL Q-621819 i.e. designed on the basis of "Type 2" professional requirements. The instrument has a frequency weighting of "A" type and allows the user to select Slow or Fast mode of measurement. A built-in Data Logger can record all the important Sound Level parameters in Non-Volatile Flash memory for 24 hours making detailed field data collection very simple. Each record contains the observation of each second, with the detailed data, L_{EQ}, L_{MIN} and L_{MAX} and many others calculations also can be drawn. Sound Pressure Level and Sound Exposure Level (SEL) observed during the recording interval. A built-in Real Time Clock maintains a Date and Time stamp in the recorded data.

Noise survey is conducted in areas where noise exposure is likely to be maximum. Noise level refers to the level of sound. A noise survey involves measuring noise level at selected locations throughout an entire plant or sections to identify noisy areas. This is usually done with a sound level meter (SLM). A reasonably accurate sketch showing the locations of workers and noisy machines is drawn. Noise level measurements are taken at a suitable number of locations around the area. National Ambient Noise Quality Standards as per CPCB is given in Table 3.2 to compression with the observed results.

Table 3-2: Ambient Noise Quality Standards as per CPCB

Type of Area	Limits in dB(A) Leq*	
	Day Time	Night Time
Industrial Area	75	70
Commercial Area	65	55
Residential Area	55	45
Silence Zone	50	40

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*-dB (A) Leq denotes the time weighted average of the level sound in decibels on scale A which is relatable to human hearing

Source: Pollution Control Acts, Rule and Notifications issued there under, by Pollution Control Law Series: PCLS/02/2006(Fifth Edition) of Central Pollution Control Board, January 2006, pp 926. Day and Night time shall mean from 6:00 a.m. to 10:00 p.m. and 10:00 p.m. to 6:00 a.m. respectively.

3.4 Analytical Result

Table 3.3: Location wise Noise Quality Results-

SN	Parameters	NQ-1 Chrinijibpur OB Gate	NQ-2 GC Berth Main Gate	NQ-3 Jawahar Tower Main Gate	NQ-4 MBC Jetty / Floating Jetty	NQ-5 CIB Gate	NQ-6 Lock Gate	NQ-7 Marine House	NQ-8 Master Control	NQ-9 Port Hospital Township	NQ-10 Cluster 4/61 (Township)	NQ-11 DAV School (Township)	NQ-12 Gate no.4 (Township)
1	Leq (d)	62.6	66.8	63.8	69.4	68.2	60.8	62.1	64.5	60.5	62.5	64.4	62.9
2	Leq(n)	53.2	51.2	51.9	52.6	49.8	50.3	52.4	49.1	48.6	51.7	50.8	49.6
3	L10	60.7	65.7	64.9	67.2	65.1	59.7	62.4	64.9	59.9	63.4	62.1	61.7
4	L50	54.2	61.5	58.6	61.9	60.4	53.4	58.4	57.4	55.6	56.4	56.4	57.4
5	L90	50.9	56.3	51.3	54.3	52.1	49.7	52.7	51.6	46.8	50.7	51.7	52.9
6	Lmax	73.1	75.6	80.5	82.1	75.9	72.8	74.5	77.9	70.4	72.4	78.3	75.1
7	Lmin	41.6	44.8	43.1	42.5	44.9	39.9	43.8	45.6	40.6	42.5	40.7	39.7
8	Ldn	57.9	59.0	57.8	61.0	59.0	55.5	57.2	56.8	54.5	55.5	57.6	56.2

3.5 Interpretation

In the study area, noise source was observed only by vehicular movement & construction activities. High wind velocity in the river front area is another major source for high sound level in the study area. Noise levels were observed below the CPCB standards for Ambient Noise Quality in day time &night time.

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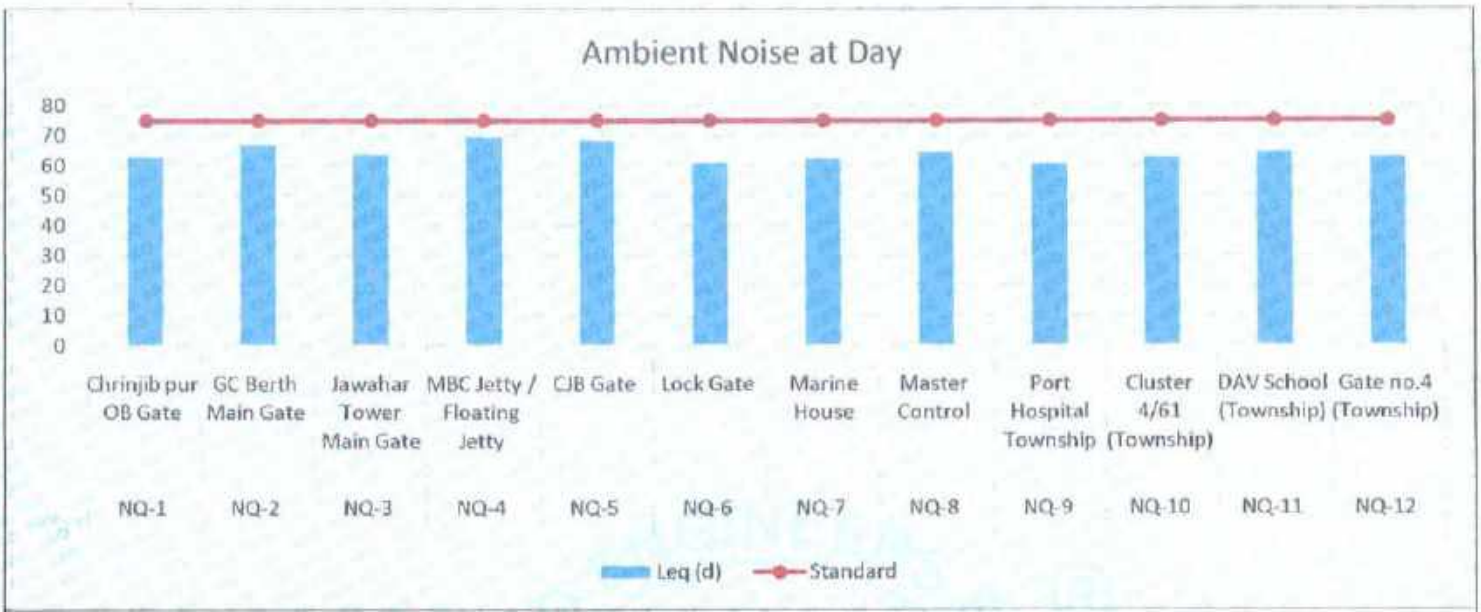

Fig: 3.2 Noise Quality in Day Time

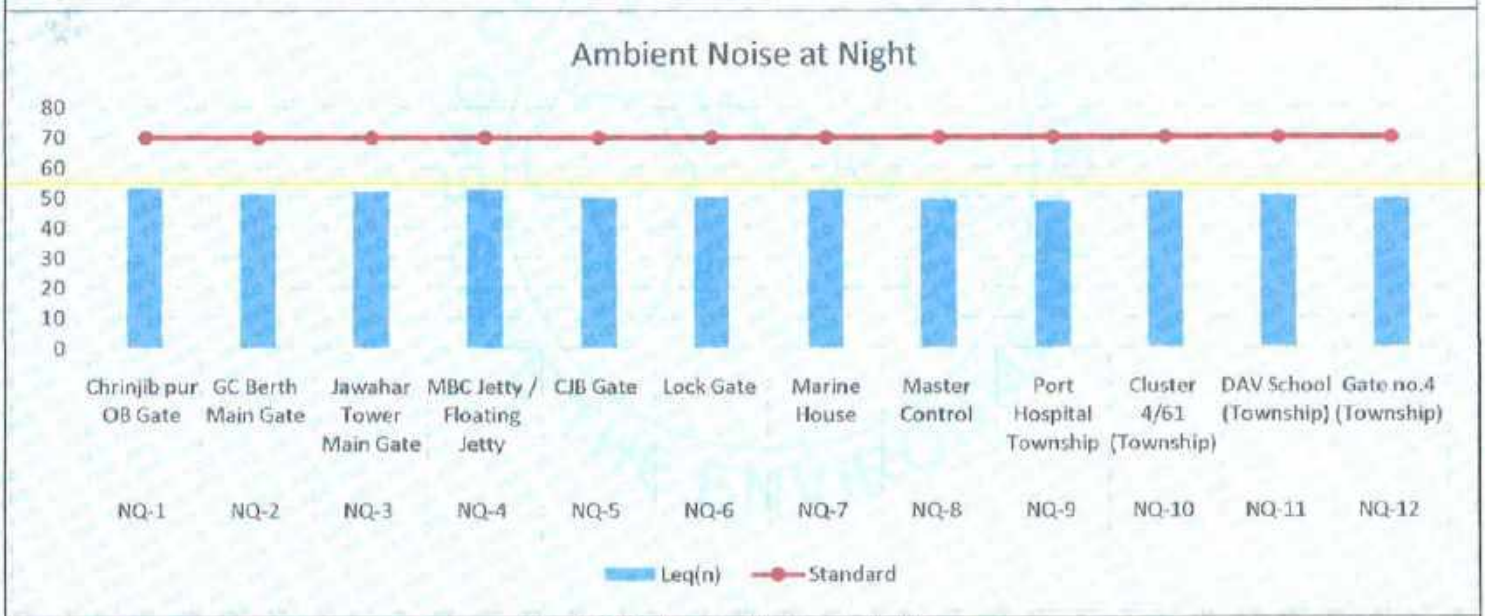

Fig: 3.3 Noise Quality in Night Time

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4. Water Quality

4.1 Selection of Monitoring Station

Water Quality Monitoring stations were set up at four locations. The monitoring stations were setup by filed visit, sensitive location of the site and official discussion with the Haldia Dock Complex officials. The monitoring locations are given in **Table 4.1**

Table 4.1: Monitoring Station of Water Quality

S.No	STATION CODE	LOCATION	LATITUDE	LONGITUDE
1	WQ-1	Near 1st Oil Jetty	22°01'55.32"N	88°06'03.16"E
2	WQ-2	Near 2nd Oil Jetty	22°01'43.42"N	88°05'50.88"E
3	WQ-3	Near 3rd Oil Jetty	22°01'02.13"N	88°04'32.26"E
4	WQ-4	Near Lock Gate	22°01'19.59"N	88°05'11.12"E

Figure 4.1 Water Quality Location

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4.2 Sampling Methodology and Parameter Selection

The parameter selections for the marine sediment quality are described below.

A. Physio-Chemical Parameters

- Colour
- Turbidity
- pH
- Electrical Conductivity (EC)
- Total Dissolve Solids (TDS)
- Total Suspended Solid (TSS)
- Floating matters
- Oil & Grease
- Petroleum Hydrocarbons
- Salinity
- Alkalinity as $CaCO_3$
- Total Hardness as $CaCO_3$
- Calcium as Ca
- Magnesium as Mg
- Sodium as Na
- Potassium as K
- Chloride as Cl
- Sulphate as SO_4
- Nitrate as NO_3
- Flouride as F
- Phenolic compound as C_6H_5OH
- Cyanide
- Aluminium
- Arsenic
- Cadmium
- Chromium as Cr^{+6}
- Iron
- Copper
- Lead
- Manganese
- Mercury

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- Zinc
- Dissolve Oxygen
- BOD, 27°C 3 days
- COD
- Total coliform

B. Biological Parameters

- Phytoplankton
- Zooplankton
- Shell Fishes
- Fin Fishes
- Chlorophyll Content
- Gross Primary Productivity
- Net Primary Productivity
- Community Respiration

Marine water samples shall be collected at the rate of 2 samples per location (one sample at surface i.e. 0.3 meter depth and another sample form bottom (6 meter to 16 meter depth). Sampling for Marine water quality shall be conducted inside the protected water i.e., within break waters. The analysis of marine water for physico-chemical parameters as per the procedures specified in Standard Methods for the Examination of Water and Wastewater published by American Public Health Association (APHA) and Lab SOP-W/66. Samples for physico-chemical analysis were collected in polyethylene and glass bottle and preserved as per standard procedure. Samples collected for metal content were acidified with 1ml HNO_3. Samples for bacteriological analysis were collected in sterilized bottles. The details sample collection procedures are described in below.

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Table 4.2: Sample Collection Procedure

S.No	Parameter	Sample collection	Sample Size	Storage/ Preservation
1	pH, EC, TDS	Grab sampling Plastic container	50 ml	On site analysis
2	Other Physico-Chemical Parametrs	Grab sampling Plastic glass container	2000 ml	As per SOP
3	Oil & Grease	Wide mouth glass container	500 ml	Add HCl to pH>2, refrigeration, 28 days
5	Cyanide	Grab sampling glass container	500 ml	As per SOP
6	BOD	Grab sampling glass container	1000 ml	Cooling between 2 to 5 degree
7	COD	Grab sampling plastic container	100 ml	Add HNO3 to pH <2
8	Heavy Metals	Glass rinsed with 1+1 HNO_3	500 ml	HNO_3 to pH>2; Grab sample; 6 months
9	Biological Sample	Sterilized plastic container	500 ml	As per SOP

Plankton

Plankton samples were collected from the surface waters of the study areas by towing a plankton net (mouth diameter 0.35 m) made of bolting silk (No.25 mesh size 48 µm) for half an hour. These samples were preserved in 5% neutralized formalin and used for qualitative analysis. For the quantitative analysis of phytoplankton, the settling method described by Sukhanovo (1978) was adopted. Numerical plankton analysis was carried out using Utermohl's inverted plankton microscope

4.3 Analysis Technique

The analysis techniques were followed by Standard Methods for the Examination of Water and Wastewater published by American Public Health Association (APHA) and Lab SOP-W/66. After the analysis the results were compared as per the SW Class IV (CPCB). The instrument used for the above mention parameters are given below.

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Table 4.3: Instrument Used

S. No.	Parameters	Instrument Used
1	pH	pH meter
2	Turbidity	Nephelo Meter
3	Conductivity (at 25^{0}C)	Conductivity meter
4	Total Dissolve Solids	Gravimetric
5	Alkalinity as $CaCO_3$	Titrimetric Method
6	Total Hardness as $CaCO_3$	Titrimetric Method
7	Calcium as Ca	Titrimetric Method
8	Magnesium as Mg	Calculation
9	Sodium	Flame Photometric
10	Potassium	Flame Photometric
11	Chloride as Cl	Argentometric
12	Sulphate as SO_4	Turbidimetric
13	Nitrate as NO_3	Spectro photometric
14	Phosphate	Spectrophotometric
15	Fluoride as F	Spectrophotometric
16	Phenolic compound as C_6H_5OH	Spectrophotometric
17	Cyanide	Spectrophotometric/Spot test
18	Dissolve Oxygen	Winkler Method
19	Oil & Grease	Gravimetric
20	Heavy Metal	Induced Couple Plasma- Mass Spectro Meter (ICP-MS)
21	Total Coliform	MPN Method
22	Plankton Study	Microscope

Onsite Parameter Analyses

pH, temperature and conductivity were analyzed at the time of sample collection. For dissolved oxygen, samples were collected in standard BOD bottle and fixed the oxygen by manganese oxide and alkaline iodide immediately after collection of the sample.

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4.4Analytical Result and Interpretation

A. Physio-Chemical Parameters

S. No.	PARAMETERS	UOM	WQ-1 Near Ist Oil Jetty	WQ-2 Near 2nd Oil Jetty	WQ-3 Near 3rd Oil Jetty	WQ-4 Near Lock Gate	CPCB GUIDELINE (CLASS SW-IV)
			11.06.21	11.06.21	11.06.21	11.06.21	
(0.3 Meter Depth)							
1	Colour	Haze n	40	50	60	50	No visible colour
2	Turbidity	NTU	415	410	320	412	-
3	pH	-	7.58	7.68	7.71	7.68	6.5-9.0
4	Conductivity	µs/cm	5290	5840	6790	5450	-
5	Total Dissolved Soild	mg/l	3210	3520	3890	3310	-
6	Total Suspended Soilds	mg/l	565	710	670	588	-
7	Floating Matters	mg/l	0.22	0.31	0.19	0.28	10.0
8	Oil & Grease	mg/l	<4.0	<4.0	<4.0	<4.0	-
9	Petroleum Hydrocarbons	mg/l	<0.01	<0.01	<0.01	<0.01	-
10	Salinity	mg/l	4920	5090	5460	5010	-
11	Alkalinity as CaCO3	mg/l	190	164	197	182	-
12	Total Hardness as CaCO3	mg/l	614	704	730	578	-

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13	Calcium as Ca	mg/l	147	169	175	138	-
14	Magnesium as Mg	mg/l	59.8	68.5	71.2	56.4	-
15	Sodium as Na	mg/l	820	710	870	810	-
16	Potassium as K	mg/l	80	65	67	55	-
17	Chloride as Cl	mg/l	1120	1217	1650	1140	-
18	Sulphate as SO4	mg/l	264	242	324	250	-
19	Nitrate as NO3	mg/l	4.12	6.51	5.84	7.57	-
20	Flouride as F	mg/l	0.91	0.84	0.74	0.69	-
21	Phenolic Compound as C6H5OH	mg/l	<0.001	<0.001	<0.001	<0.001	-
22	Cyanide	mg/l	Absent	Absent	Absent	Absent	-
23	Aluminium	mg/l	8.51	10.8	17.4	14.9	-
24	Arsenic	mg/l	0.006	0.008	0.034	0.061	-
25	Cadmium	mg/l	<0.005	<0.005	<0.005	<0.005	-
26	Chromium as Cr+6	mg/l	<0.05	<0.05	<0.05	<0.05	-
27	Iron	mg/l	21.7	25.6	24.8	10.4	-
28	Copper	mg/l	0.24	0.28	0.34	0.23	-
29	Lead	mg/l	0.04	0.09	0.15	0.081	-
30	Manganese	mg/l	1.62	1.10	1.29	1.02	-
31	Mercury	mg/l	<0.005	<0.005	<0.005	<0.005	-

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32	Zinc	mg/l	2.51	1.86	3.24	2.77	-
33	Dissolved Oxygen	mg/l	5.4	5.2	5.1	5.5	3.0
34	BOD, 27°C 3 Days	mg/l	5.6	5.1	5.7	5.6	5.0
35	COD	mg/l	22.4	21.7	25.6	20.2	-
36	Total Coliform	MPN/100ml	1600	1700	1500	1900	-

In the physico –chemical analysis of the marine water quality from 0.3 meter depth, the pH variation was found from 7.58 to 7.71, Conductivity is found from 5290µs/cm to 6790µs/cm, Magnesium is found from 56.4 mg\l to 71.2 mg\l and Calcium is found from 138mg\l to 175 mg\l.

S. No.	PARAMETERS	UOM	WQ-1 Near Ist Oil Jetty	WQ-2 Near 2nd Oil Jetty	WQ-3 Near 3rd Oil Jetty	WQ-4 Near Lock Gate	CPCB GUIDELINES (CLASS IV)
			11.06.21	11.06.21	11.06.21	11.06.21	
(7 Meter Depth)							
1	Colour	Hazen	60	70	80	60	No visible colour
2	Turbidity	NTU	490	480	530	495	-
3	pH	-	7.62	7.60	7.74	7.72	6.5-9.0
4	Conductivity	µs/cm	5840	6084	7140	5592	-
5	Total Dissolved Soild	mg/l	3520	3680	4190	3290	-
6	Total Suspended Soilds	mg/l	580	790	650	620	-

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7	Floating Matters	mg/l	0.29	0.31	0.36	0.39	10.0
8	Oil & Grease	mg/l	<4.0	<4.0	<4.0	<4.0	-
9	Petroleum Hydrocarbons	mg/l	<0.01	<0.01	<0.01	<0.01	-
10	Salinity	mg/l	4970	5300	5640	4870	-
11	Alkalinity as CaCO3	mg/l	194	168	204	198	-
12	Total Hardness as CaCO3	mg/l	620	730	760	650	-
13	Calcium as Ca	mg/l	148	175	182	155	-
14	Magnesium as Mg	mg/l	60.5	71.2	74.1	63.4	-
15	Sodium as Na	mg/l	830	810	750	770	-
16	Potassium as K	mg/l	65	84	90	58	-
17	Chloride as Cl	mg/l	1240	1410	1750	1310	-
18	Sulphate as SO4	mg/l	250	254	350	265	-
19	Nitrate as NO3	mg/l	5.24	7.16	6.82	7.27	-
20	Flouride as F	mg/l	0.84	0.78	0.72	0.86	-
21	Phenolic Compound as C6H5OH	mg/l	<0.001	<0.001	<0.001	<0.001	-
22	Cyanide	mg/l	Absent	Absent	Absent	Absent	-
23	Aluminium	mg/l	11.6	12.4	13.2	12.7	-

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24	Arsenic	mg/l	0.006	0.007	0.005	0.008	-
25	Cadmium	mg/l	<0.005	<0.005	<0.005	<0.005	-
26	Chromium as Cr+6	mg/l	<0.05	<0.05	<0.05	<0.05	-
27	Iron	mg/l	13.2	22.6	23.9	12.9	-
28	Copper	mg/l	0.24	0.31	0.34	0.21	-
29	Lead	mg/l	0.039	0.12	0.13	0.081	-
30	Manganese	mg/l	1.56	1.24	1.32	1.19	-
31	Mercury	mg/l	<0.005	<0.005	<0.005	<0.005	-
32	Zinc	mg/l	2.76	1.42	3.76	2.72	-
33	Dissolve Oxygen	mg/l	5.1	4.8	5.6	4.9	3.0
34	BOD, 27°C 3 Days	mg/l	6.2	5.4	5.8	6.1	5.0
35	COD	mg/l	30.5	26.7	32.2	33.7	-
36	Total Coliforms	MPN/100ml	1500	2200	1600	1800	-

In the physico-chemical analysis of the marine water quality from 7 meter depth, the pH variation was found from 7.60 to 7.74, Conductivity is found from 5592µs/cm to7140µs/cm, Magnesium is found from 60.5 mg\l to 74.1mg\l and Calcium is found from 155 mg\l to 182 mg\l.

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5. Marine Biological Parameters

S.NO.	PARAMETERS		UOM	WQ-1 Near Ist Oil Jetty	WQ-2 Near 2nd Oil Jetty	WQ-3 Near 3rd Oil Jetty	WQ-4 Near Lock Gate
				11.06.21	11.06.21	11.06.21	11.06.21
1	**Phytoplankton**						
	1.	Coscinodiscuscentralis	Cells/l	900	780	760	1140
	2.	Dinophysiscaudata	Cells/l	700	800	600	710
	3.	Odontellaaurita	Cells/l	560	570	1200	710
	4.	Triceratiumbroeckii	Cells/l	880	760	810	450
	5.	Cerataulinapelagica	Cells/l	690	710	510	380
	6.	Hemiaulussinensis	Cells/l	210	118	175	240
	7.	Ceratiumsp	Cells/l	880	740	910	850
	8.	Guinardiastriata	Cells/l	1300	1000	890	940
	9.	Coscinodiscuswailesii	Cells/l	650	810	910	850
	10.	Coscinodiscus marginatus	Cells/l	560	610	792	750
	11.	Rhizosolenia sp	Cells/l	120	310	108	105
	12.	Lauderia annulata	Cells/l	105	550	410	310
	13.	Achnanthessp	Cells/l	650	320	310	520

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	14.	Striatella unipunctata	Cells/l	560	880	610	340
2	**Zooplankton**						
	1	Parvocalanussp	Org./m³	170	130	140	150
	2	Centropagesorsini	Org./m³	110	108	140	110
	3	Oithona nana	Org./m³	80	30	100	120
	4	Oithonasp	Org./m³	170	210	240	-
	5	Mysis larvae	Org./m³	24	10	15	-
	6	Oikopleura larvae	Org./m³	180	170	110	220
	7	Oithonaplumifera	Org./m³	240	130	80	50
	8	Centropagessp	Org./m³	160	120	116	90
	9	Copepod nauplii	Org./m³	-	120	140	155
	10	Calanopiaeliptica	Org./m³	90	105	80	110
	11	Dikopleura larvae	Org./m³	160	210	40	110
	12	Temora sp.	Org./m³	110	170	120	140
	13	Tintinnopsissp	Org./m³	30	60	40	-
	14	Calanopia sp	Org./m³	40	50	40	80
	15	Temoraturbinata	Org./m³	110	175	250	160
	16	Pseudodiaptomussp	Org./m³	30	40	50	70
3	**Shell Fishes**		Nos.	5	2	6	1
	Penaeus vannamei		Nos.	2	1	1	1

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	Penaeus monodon	Nos.	3	2	1	-
	Penaeus semisulcatus	Nos.	-	1	1	-
	Penaeus indicus	Nos.	-	1	-	-
	Macrobrachium malcolmsonii	Nos.	-	-	1	1
	Macrobrachium rosenbergii	Nos.	-	1	-	1
	Schylla serrata	Nos.	-	1	-	1
	Schylla tranquebarica	Nos.	1	1	1	-
4	**Fin Fishes**	Nos.	15	25	30	35
5	**Chlorophyll Content**	µg/L	0.24	0.45	0.38	0.40

4.5 Interpretation

A total number of 14 Phytoplankton species were found, out of which the higher number of Phytoplankton is Guinardiastriata and the lowest number of Phytoplankton is Lauderia annulata.

On the other hand, total 16 species were found of Zooplankton, out of which the higher number of Zooplankton is Temoraturbinata the lowest number of Zooplankton is Mysis larvae.

Shell fishes and fin fishes were recorded during the marine biological survey carried out in the study area.

Addition, along with the above, the gross primary productivity is found 0.441 to 0.550 gcm^3/h. Thenet primary value is found 0.420 to 0.530 gcm^3/h. and community respiration is found from 0.032 to 0.061 gcm^3/h.

Light penetration is found in the study area and which is found low to moderate.

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6. Marine Sediment Quality

6.1 Selection of Monitoring Station

Sediment Quality Monitoring stations were set up at four locations. The monitoring stations were setup by filed visit, sensitive location of the site and official discussion with the Haldia Dock Complex officials. The monitoring locations are given in **Table 3.1**

Water Quality Location				
1	S 1	Near 1st Oil Jetty	22° 1'55.63"N	88° 5'58.27"E
2	S 2	Near 2nd Oil Jetty	22° 1'46.05"N	88° 5'43.49"E
3	S 3	Near 3rd Oil Jetty	22° 1'03.26"N	88° 4'25.38"E
4	S 4	Near Lock Gate	22° 1'20.72"N	88° 5'06.04"E

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Figure 5.1 Sediment Quality Location

6.2 Sampling Methodology and Parameter Selection

The samples were collected and analyzed as per the procedures specified in Standard existing procedure. Sediment samples are collected as grab sampling procedure. The samples were collected using a Petersen grab sampler from bottom of the river. The collected samples were taken by a fresh plastic container and marked the lab code for physico-chemical analysis. The samples were taken into the laboratory and dry in normal temperature. .

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The biological analysis for microbenthic, meiobenthic and macrobenthic community structure, samples were also collected using a Petersen grab sampler and collected sample were taken in the sterilized plastic container.

The parameter selections for the marine sediment quality are described below.

C. Physio-Chemical Parameters

- Texture
- pH
- Sodium as Na
- Potassium as K
- Cadmium as Cd
- Copper as Cu
- Lead as Pb
- Zinc as Zn
- Magnesium as Mg
- Arsenic as As
- Phosphate as PO4
- Chloride as Cl
- Sulphate as SO4

D. Biological Parameters

- Meiobenthos
- Microbenthos
- Macrobenthos

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6.3 Analysis Technique

The samples were analyses in laboratory with the procedures of APHA 22nd Edition and SOP (Standard Operating Procedure) of the Laboratory. For the biological analysis the collected wet sediment samples are sieved with varying mesh sizes for segregating the organisms. Macrobenthos are organisms which are retained in the sieve having mesh size between 0.5 and 1 mm. The term meiofauna loosely defines a group of organisms by their size, larger than microfauna but smaller than macrofauna, rather than a taxonomic grouping. In practice, that is organisms that can pass through a 1 mm mesh but will be retained by a 45 µm mesh. Organisms below size of 45 µm are regarded as microbenthos. The sieved organisms are then stained with Rose Bengal and sorted into different groups. The number of organisms in each grab sample is expressed in number per meter square.

6.4 Analytical Result

A. Physico-chemical Parameter

S.NO.	PARAMETERS	UOM	S-1 Near Ist Oil Jetty	S-2 Near 2nd Oil Jetty	S-3 Near 3rd Oil Jetty	S-4 Near Lock Gate
			11.06.21	11.06.21	11.06.21	11.06.21
1	Texture	-	Sandy Clay	Silty Clay	Silty Clay	Silty Clay
2	pH	-	7.62	7.69	7.76	7.65
3	Sodium as Na	mg/kg	970	980	1078	1120
4	Potassium as K	mg/kg	398	650	592	704
5	Cadmium as Cd	mg/kg	<1.0	<1.0	<1.0	<1.0
6	Copper as Cu	mg/kg	<1.0	<1.0	<1.0	<1.0
7	Lead as Pb	mg/kg	<1.0	<1.0	<1.0	<1.0

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8	Zinc as Zn	Mg/kg	2.69	2.71	2.19	2.42
9	Magnesium as Mg	Mg/kg	860	940	874	792
10	Arsenic as As	Mg/kg	<1.0	<1.0	<1.0	<1.0
11	Phosphate as PO4	Mg/kg	180	202	198	190
12	Chloride as Cl	Mg/kg	592	670	610	550
13	Sulphate as SO4	Mg/kg	330	294	280	320

7.0 Marine Sediment Quality- Biological Parameters

S.NO.	PARAMETERS	UOM	WQ-1 Near Ist Oil Jetty	WQ-2 Near 2nd Oil Jetty	WQ-3 Near 3rd Oil Jetty	WQ-4 Near Lock Gate
			11.06.21	11.06.21	11.06.21	11.06.21
3	**Benthos**					
3.1	Capitellacapitata	Org./10 m^2	68	20	10	15
3.2	Neantheschingrighattensis	Org./10 m^2	15	20	3	15
3.3	Ceratonereis sp.	Org./10 m^2	31	40	51	55
3.4	Nepthyspolybranchia	Org./10 m^2	75	55	45	52
3.5	Perinereis sp.	Org./10 m^2	35	20	18	16

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3.6	Notocirrusaustralis	Org./10 m^2	18	-	-	40
3.7	Nereiscapensis	Org./10 m^2	18	20	12	40
3.8	*Neanthes chingrighattensis*	Org./10 m^2	20	15	14	11
3.9	*Notocirrus australis*	Org./10 m^2	65	-	50	45
3.10	*Nerita articulata*	Org./10 m^2	35	-	20	-
3.11	*Neritina cornucopia*	Org./10 m^2	-	120	140	80
3.12	*Neripteron rubicundus*	Org./10 m^2	20	40	80	-
3.13	*Littoraria vespacea*	Org./10 m^2	-	50	60	40
3.14	*Littoraria strigata*	Org./10 m^2	35	36	15	31
3.15	*Littoraria melanostoma*	Org./10 m^2	18	22	11	-
3.16	*Littoraria scabra*	Org./10 m^2	2	-	4	-
3.17	*Littoraria undulata*	Org./10 m^2	-	9	15	-
3.18	*Cerithidea cingulata*	Org./10 m^2	20	--	10	-
3.19	*Cerithidea obtusa*	Org./10 m^2	18	-	33	22
3.20	*Nodilittorina vidua*	Org./10 m^2	-	14	35	40
3.21	*Telescopium telescopium*	Org./10 m^2	20	-	30	-
3.22	*Bellamya contracta*	Org./10 m^2	-	13	22	-
3.23	*Barbitonia sp.*	Org./10 m^2	8	22	-	11

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3.24	*Amaea acuminate*	**Org./10 m²**	5	-	18	32
3.25	*Anadara granosa*	**Org./10 m²**	1	-	--	2
3.26	*Crassostrea cuttackensis*	**Org./10 m²**	20	25	-	30
3.27	*Crassostrea gryphoides*	**Org./10 m²**	-	18	-	22
3.28	*Saccostrea cucullata*	**Org./10 m²**	32	-	14	18
3.29	*Enigmonia aenigmatica*	**Org./10 m²**	20	6	-	15
3.30	*Macoma birmanica*	**Org./10 m²**	6	-	-	4
3.31	*Brachiopod*	**Org./10 m²**	4	-	6	-
3.32	*ciliophora*	**Org./10 m²**	-	5	-	1

6.5 Interpretation

As per the analysis of Biological parameters of Sediment quality, Benthos community found. The number of species which includes Meiobenthos, Microbenthos and Macrobenthos.

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