

PERIODIC MONITORING OF MARINE ENVIRONMENT FOR MSPL OUTFALL, BHAVNAGAR, GUJARAT

Monitoring Report – 2 of 4/2020-21
August 2020

PROJECT CODE: 656041920



MADHU SILICA PRIVATE LIMITED
BHAVNAGAR, GUJARAT



INDOMER COASTAL HYDRAULICS (P) LTD.

(ISO 9001: 2015 CERTIFIED, QCI - NABET & NABL)

63, GANDHI ROAD, ALWAR THIRUNAGAR, CHENNAI 600 087.

Tel: + 91 44 2486 2482 to 84; M: + 91 99401 41650; Fax: + 91 44 2486 2484

Web site: www.indomer.com, E-mail: ocean@indomer.com

**INDOMER COASTAL HYDRAULICS (P) LTD.**

(ISO 9001 : 2015 CERTIFIED, QCI-NABET & NABL ACCREDITED)

63, Gandhi Road, Alwar Thirunagar, Chennai 600 087.

Tel: + 91 44 2486 2482 to 84; M: + 91 99401 41650; Fax: + 91 44 2486 2484

Web site: www.indomer.com, E-mail: ocean@indomer.com

Client	Madhu Silica Private Limited, Bhavnagar.				
Project Title	Periodic Monitoring of Marine Environment for MSPL Outfall, Bhavnagar, Gujarat for the year 2020-21.				
Project Code	656041920				
Abstract	<p>Madhu Silica Private Limited (MSPL) has been discharging 10 MLD treated industrial effluent in Bhavnagar Creek for which MoEFCC-CRZ clearance was obtained vide F. No. 11-6/2015-IA-III dt. 29.06.2015.</p> <p>Subsequently, MSPL has been submitting the Periodic Monitoring Reports every 3 months since May 2017. The last monitoring report was submitted in February 2020.</p> <p><i>*Due to COVID-19 Nationwide lockdown and strict interstate travel protocols, quarterly monitoring study for the period April 2020 – June 2020 was not conducted. The task of quarterly monitoring study for July 2020 to September 2020 is taken up immediately after the interstate relaxations and this forms as the 2nd season Quarterly Monitoring Report for the year 2020-21.</i></p>				
Document type	Controlled				
References	W.O.Email dt. 23/04/2019				
Date	Report Type	Originator	Checked by	Approved by	Approver's sign
17.11.20	Final	Mr. J. Jaganmohan/ Dr. A. Kannathasan	Dr. S. Sundaramoorthy	Dr. P. Chandramohan	
1	Project Code	656041920		Text pages	29
2	File Location	F:/2020 projects/Aug. 20/656. MSPL		Tables	19
				Figures	2

CONTENTS	Page
Content	i
List of Tables	ii
List of Figures	iii
1 PROJECT DESCRIPTION	1
2 SCOPE OF MONITORING	2
3 DATA COLLECTION FOR MONITORING	3
4 RESULTS	6
4.1 Water quality	6
4.2 Sediment quality	7
4.3 Biological parameters	7
5 ENVIRONMENTAL STATUS - COMPARISON WITH PRE-PROJECT PERIOD	10
Annexure I – QCI NABET accreditation certificate	
Annexure II – NABL accreditation certificate	
Annexure III - NABL accreditation certificate of outsource laboratory	

LIST OF TABLES

Table

- 1 Details of sampling locations
- 2 Water quality parameters at Bhavnagar creek (August 2020)
- 3 Biochemical Oxygen Demand and Chemical Oxygen Demand at Bhavnagar creek water (August 2020)
- 4 Concentration of Heavy Metals, Phenols and Total Petroleum Hydrocarbons at Bhavnagar creek water (August 2020)
- 5 Sediment texture at Bhavnagar creek (August 2020)
- 6 Sediment quality parameters at Bhavnagar creek (August 2020)
- 7 Concentration of Heavy Metals, Phenols and Total Petroleum Hydrocarbons in sediments at Bhavnagar creek (August 2020)
- 8 Primary productivity at Bhavnagar creek water (August 2020)
- 9 Phytoplankton species composition at Bhavnagar creek water (August 2020)
- 10 Phytoplankton numerical abundance (cells/l) at Bhavnagar creek water (August 2020)
- 11 Phytoplankton population at Bhavnagar creek water (August 2020)
- 12 Numerical abundance of zooplankton (nos./100m³) at Bhavnagar creek water (August 2020)
- 13 Zooplankton diversity abundance and biomass at Bhavnagar creek water (August 2020)
- 14 Subtidal and Intertidal benthic population at Bhavnagar creek (August 2020)
- 15 Bacterial population at Bhavnagar creek water (x10³CFU/ml) (August 2020)
- 16 Bacterial population at Bhavnagar creek sediments (x 10⁴ CFU/g) (August 2020)
- 17 Comparison of Water quality parameters between Pre-project period (May 2013) and Monitoring periods
- 18 Comparison of Sediment quality parameters between Pre-project period (May 2013) and Monitoring periods
- 19 Comparison of Biological parameters between Pre-project period (May 2013) and Monitoring periods

LIST OF FIGURES

Figure

- 1 Location map
- 2 Sampling locations

1. PROJECT DESCRIPTION

Madhu Silica Pvt. Ltd. (MSPL), Bhavnagar, is the largest manufacturer of precipitated Silica in India and it is the 3rd largest company in the world. MSPL with its allied company Aqua gel Chemicals Pvt. Ltd., is having seven established plants capable of manufacturing around 95000 MT of precipitated Silica per annum. It has recently established a state of art plant with capacity of 45000 MT/Annum in Bhavnagar. The company has a large business associate network in India and Asia, Middle East, Latin America, US & Europe. Apart from the large Indian market, the company exports their products to more than 40 countries. The company has on its credit ISO 9001:2008, ISO 14001:2004, OHSAS 18001:2007, FAMI-QS, FDA certified and registered for each.

MSPL has planned for capacity expansion in 28 acres of land towards total installed capacity of precipitate Silica of 95000 MT/Annum. Under this development process, MSPL has obtained permission to discharge additional 10 MLD (417 m³/hour) treated industrial effluent in the marine environment. It has laid a submarine pipeline with diffuser on the creek bed for discharging the effluent.

MSPL obtained MoEFCC clearance vide F. No. 11-6/2015-IA-III dt. 29.06.2015. The post project monitoring is being carried out for four seasons in a year to comply the conditions of MoEFCC covering the aspects of seawater quality, seabed sediment quality and marine benthic flora & fauna. The monitoring studies are being carried out from May 2017 i.e. since the commencement of project on quarterly basis. The periodic monitoring reports are being regularly submitted to the Regional Office of MoEFCC, Bhopal. This report forms as the second periodic monitoring report (August 2020) for the year 2020 - 2021.

Due to COVID-19 Nationwide lockdown and strict interstate travel protocols, quarterly monitoring study for the period April 2020 – June 2020 was not conducted. The task of quarterly monitoring study for July 2020 to September 2020 is taken up immediately after the interstate relaxations and this forms as the 2nd season Quarterly Monitoring Report for the year 2020-21.

The location map is shown in Fig. 1 and the effluent outfall location is shown in Fig. 2.

2. SCOPE OF MONITORING

Periodic monitoring near the outfall location as suggested in the Post Project Monitoring Plan of the EIA report was recommended by the MoEFCC. Accordingly, MSPL has asked Indomer Coastal Hydraulics (P) Ltd, Chennai, to take up periodic monitoring programme. It was proposed to conduct quarterly monitoring covering four times in a year i.e., in the months of May, August, November and February every year during the project operational period.

Indomer Coastal Hydraulics (P) Ltd., Chennai is an ISO 9001:2015 organization, NABL and QCI - NABET accredited organization vide NABET/EIA/1720/SA 90 dt. 27.05.2019 for *Sector 27: Oil & Gas Transportation pipeline (crude and refinery/ petrochemical products), passing through national parks/ sanctuaries/ coral reefs/ ecologically sensitive areas including LNG Terminal and Sector 33: Ports, harbours, jetties, marine terminals, breakwaters and dredging.* QCI-NABET accreditation certificate is attached as Annexure I.

3. DATA COLLECTION FOR MONITORING

The creek water, creek bed sediments and biological samples were collected at three locations around the outfall points (Stn. SS1 to Stn. SS3) during the field sample collection. The samples for intertidal benthos were also collected at three locations (Stn. IB1 to Stn. IB3). The details of the sampling locations are given in Table 1 and shown in Fig. 2. The monitoring work covered is listed below:

i) Creek water quality parameters at three locations at surface and bottom:

- Temperature
- pH
- Salinity
- Dissolved Oxygen (DO)
- Total Dissolved Solids (TDS)
- Biochemical Oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)
- Ammonium
- Nitrite
- Nitrate
- Total nitrogen
- Phosphate
- Total phosphorus
- Turbidity
- Total Suspended Solids (TSS)
- Cadmium
- Lead
- Mercury
- Total Chromium
- Phenols and
- Total Petroleum Hydrocarbons

ii) Creek bed sediment quality parameters at three locations:

- Sediment structure
- Total Nitrogen
- Total Phosphorous
- Total organic carbon
- Calcium carbonate
- Cadmium
- Lead

Mercury
Total Chromium
Phenols and
Total Petroleum Hydrocarbons

iii) Biological parameters at three locations on:

Primary Productivity
Phytoplankton, its biomass and diversity
Zooplankton, its biomass and diversity
Sub-tidal and inter-tidal macro benthos, its biomass and diversity and
Microbial population in creek water and sediment

Analysis: All the water and sediment parameters were analyzed by Indomer Coastal Hydraulics Pvt. Ltd., which is accredited by the National Accreditation Board for Testing and Calibration Laboratories (NABL) vide certificate no. TC – 5232/13.01.2019. NABL – QCI accreditation certificate of Indomer is attached as Annexure II. Analysis of Total Petroleum Hydrocarbons in creek water and sediment samples was outsourced to NABL accredited Laboratory. NABL – QCI accreditation certificate of outsourced laboratory is attached as Annexure III.

Sample Analysis Protocol: Creek water and creek bed sediment samples were analyzed as per the IS/APHA/USEPA standard methods, details of which are given below.

Sl.No.	Parameters	Protocol
Water quality		
1	Temperature	IS 3025 (Part 35)/APHA 23 rd Edtn. 2017-2550 B
2	pH	IS 2720 (Part 26)/APHA 23 rd Edtn. 2017-4500 H ⁺
3	Salinity	APHA 23 rd Edtn. 2017 - 2520 B
4	Dissolved Oxygen	IS 3025 (Part 38)/APHA 23 rd Edtn. 2017-4500-O (G)
5	Total Dissolved Solids	IS 3025 (Part 16)/APHA 23 rd Edtn. 2017-2540 B
6	BOD	IS 3025 (Part 44)/APHA 23 rd Edtn. 2017-5210 B
7	COD	IS 3025 (part 58)/APHA 23 rd Edtn. 2017-5220 B
8	Turbidity	IS 3025 (Part 10)/APHA 23 rd Edtn. 2017-2130 B
9	Ammonium	IS 3025 (Part 34)/APHA 23 rd Edtn. 2017-4500NH ₃ (F)
10	Nitrite	IS 3025 (Part 34)/APHA 23 rd Edtn. 2017-4500NO ₂ (B)
11	Nitrate	IS 3025 (Part 34)/APHA 23 rd Edtn. 2017-4500NO ₃ (E)
12	Phosphate	IS 3025 (Part 31)/APHA 23 rd Edtn. 2017-4500P (E)
13	Total Nitrogen	IS 3025 (Part 34)/APHA 23 rd Edtn. 2017-4500NO ₃ (E)
14	Total Phosphorous	IS 3025 (Part 31)/APHA 23 rd Edtn. 2017-4500-P (J)
15	Total Suspended Solids	IS 3025 (Part 17)/APHA 23 rd Edtn. 2017-2540 D
16	Cadmium	IS 3025 (Part 41)/APHA 23 rd Edtn. 2017-3120 B
17	Lead	IS 3025 (Part 47)/APHA 23 rd Edtn. 2017-3120 B
18	Chromium	IS 3025 (Part 52)/APHA 23 rd Edtn. 2017-3120 B
19	Mercury	IS 3025 (Part 48)/APHA 23 rd Edtn. 2017-3120 B
20	Phenols	IS 3025 (Part 43)/APHA 23 rd Edtn. 2017
21	Petroleum Hydrocarbons	TNRCC method 1055
Sediment quality		
1	Total Organic Carbon	IS 2720 (Part 22) 1972 (R 2001)
2	Total Nitrogen	IS 14684 – 1999
3	Total Phosphorous	IS 10158 – 1982
4	Calcium carbonate	IS 2720 (Part 23) 1976 (R 2006)
5	Cadmium	USEPA 3050 B
6	Lead	USEPA 3050 B
7	Chromium	USEPA 3050 B
8	Mercury	USEPA 3050 B
9	Phenols	USEPA 8041 & 3545 A
10	Petroleum Hydrocarbons	TNRCC method 1055

4. RESULTS

4.1. Water quality

The estimated creek water quality parameters on temperature, pH, salinity, total dissolved solids, dissolved oxygen, ammonium-nitrogen, nitrite-nitrogen, nitrate-nitrogen, total nitrogen, phosphate-phosphorus, total phosphorus, total suspended solids, and turbidity are presented in Table 2. Biochemical Oxygen Demand and Chemical Oxygen Demand are presented in Table 3. Results of the heavy metals cadmium, lead, total chromium, mercury, phenols and total petroleum hydrocarbons are presented in Table 4.

During the present study, creek water salinity ranged from 6.8 to 7.2 PSU. The low values of salinity were recorded during the present sampling period due to fresh water influx and effect of monsoon rain runoff blended in the creek water. pH range was from 7.52 to 7.67 and it found to be low compared to the previous study. Moreover, very high amount of fresh water flow was observed in the creek during the sample collection. Hence the pH and salinity were low in the creek water. The range of TSS (1095 to 2124 mg/l) was found to be slightly low compared to the previous sampling periods. Dissolved oxygen values varied from 5.7 to 6.0 mg/l which is almost similar to the earlier reported values. BOD values were also found to be normal (<2 mg/l) like in the earlier monitoring periods.

Ammonium, Nitrite, Nitrate, Total Nitrogen, Phosphate and Total Phosphorus concentration shows seasonal variation and however all the nutrients values are observed to be within the normal range. Cadmium level ranged from 0.65 to 0.73 µg/l and Chromium concentration levels were found to be 1.1 to 1.3 µg/l. However, all the metal parameters were observed to be in trace level at all the three stations. Similarly, phenols and total petroleum hydrocarbons were also found to be below detectable levels during the present study.

Creek water values of Turbidity, TSS, DO, BOD, nutrients, heavy metals and other organic compounds were found to be in normal range. Hence, it can be confirmed that treated effluent has been discharging into the creek environment at appropriate time and intervals.

4.2. Sediment quality

The creek bed sediment quality parameters collected at 3 locations (Stn. SB1, Stn. SB2 and Stn. SB3) are given in Tables 5 and 6. Results of cadmium, lead, total chromium, mercury, phenols and total petroleum hydrocarbons in sediments are presented in Table 7. Sediment texture during the present study period was fine sand at all stations. Total phosphorus, calcium carbonate, total nitrogen and total organic carbon values were found slightly varied at all stations compared than pre-project period study. Total nitrogen values ranged from 23.5 to 36.1 mg/kg at the three stations. Cadmium, mercury, lead, phenols and total petroleum hydrocarbon levels were found to be below detectable limit at all the three stations. However, marginal difference was observed in the chromium level, between the pre-project period and the present study (38.8 to 42.4 mg/kg).

Sediment texture was found to be predominantly fine sand. The levels of trace metals mercury and lead at all three stations along with phenols and petroleum hydrocarbons in the sediment were found to be below detectable level. Chromium values ranged from 38.8 to 42.4 mg/kg at all three stations. In general, these conditions reflect that the creek bed sediments are normal and remain uncontaminated.

4.3. Biological parameters

Phytoplankton and primary productivity: Phytoplankton is the primary source of food in the marine environment. The concentration and numerical abundance of the phytoplankton indicate the fertility of a region. The phytoplankton population depends primarily upon the nutrients present in the creek water and the sunlight for photosynthesis. This primary production is an important source of food for the higher organisms in the marine environment. The measured primary production results indicate that the area is moderately productive, and the values varied between 330 and 390 mgC/m³/day; the recorded average value is 360 mgC/m³/day (Table 8)

Various phytoplankton groups were observed, and their percentage composition and numerical abundance are shown in Tables 9 and 10. The floral diversity fluctuated from 23 to 26 species. Bacillariophyceae (Diatoms) formed the major group followed by Dinophyceae,

(Dinoflagellates) and Cyanophyceae (blue green algae). Phytoplankton population density varied from 1750 to 1850 cells/l (Table 11). In the present study, the number of species and population density observed was slightly high compared to previous report (Table 19).

Phytoplankton population mostly consists of Bacillariophyceae (70.09%), Dinophyceae (14.95%) and Cyanophyceae (14.95%). *Amphora* sp. the most dominant species followed by *Trichodesmium erythraeum*, *Ditylum brightwellii*, *Dinophysis caudate*, *Pleurosigma directum*, *Odontella mobiliensis*, *Coscinodiscus* sp., *Thalassiosira subtilis*, *Ceratium furca*, *Odontella mobiliensis* and *Navicula* sp.

Zooplankton: The numerical abundance of zooplankton varied from 6063 to 7097 nos./100 m³ (Table 12). The highest zooplankton population was observed at SS2 and the lowest was observed at SS3. The zooplankton biomass varied from 8.7 to 10.0 ml/100m³ (Table 13). In the present study, zooplankton biomass and density showed marginal variation when compared to previous study (Table 19). The most dominant zooplankton species were *Acartia danae*, *Acartia erythraea*, *Paracalanus parvus*, *Oncaea venusta*, *Macrosetella* sp., and Polychaete larvae than the other species.

Benthos: Benthic faunal population in an environment depends on the nature of the substratum and the organic matter content of the substratum.

Sub-tidal benthos: The numerical abundance of the benthic fauna varied from 240 to 360 nos./m² (Table 14). The sub-tidal fauna population was slightly lower, when compared to previous study period (Table 19).

Inter-tidal benthos: The intertidal faunal population is shown in Table 14. The existence of fauna appeared to be moderate in the three (IB1 to IB3) locations. The numerical abundance of the intertidal benthic fauna varied between 165 and 195 nos./m² which is slightly lower than the earlier recorded values (Table 19).

Microbiology: Bacterial counts in the water and sediment samples were analyzed and are presented in Tables 15 and 16. In the water samples, population density varied from 0.02 to 5.18×10³ CFU/ml. In the sediment, the population density varied from 0.01 to 5.29×10⁴

CFU/g. Bacterial population was slightly higher in sediment samples compared to the water samples. In general, there is not much variation observed between the present and earlier values both in creek water and sediment.

Primary production, phytoplankton, zooplankton, sub-tidal and inter-tidal benthic population showed normal range at all three stations. Bacterial population in water and sediments also indicated normal range.

5. ENVIRONMENTAL STATUS - COMPARISON WITH PRE-PROJECT PERIOD

Comparison of water quality, sediment quality and biological parameter results were carried out between the pre-project period (May 2013) and the present periodic monitoring results of August 2020 as given in Tables 17, 18 and 19.

Water Quality:

It is inferred that the water quality parameters showed normal range as applicable for the creek waters in Bhavnagar and they are comparable with the pre-project period results. The differences are marginal, and they are due to seasonal variation.

Sediment quality:

Sediment texture was predominantly fine sand during present study and other chemical properties are observed to be in normal range and there is no significant change in the creek bed sediment quality.

Biological Parameters:

Primary production, Phytoplankton and Zooplankton population were showing marginal seasonal variation but within normal range in the present observation attributing to optimum water quality conditions. The sub-tidal and intertidal benthic population showed only marginal difference between pre-project period and monitoring period of August 2020. Between quarterly monitoring, seasonal variations were also noticed.

Microbiology:

There are no changes observed in bacterial population, in water and sediments, among the different sampling periods in the creek.

Table 1. Details of sampling locations

Station	UTM Coordinates (WGS 84)		Water depth (m)	Sampling depth*
	X (m)	Y (m)		
WATER AND SEDIMENT SAMPLING				
SS1& SB1	204022	2414736	2.7	S & B
SS2& SB2	204458	2414511	2.9	S & B
SS3& SB3	204951	2414447	3.1	S & B
INTERTIDAL BENTHOS				
IB1	204178	2414637	Intertidal zone	
IB2	204435	2414473	Intertidal zone	
IB3	204650	2414381	Intertidal zone	

*S = creek surface, B = creek bottom

Table 2. Water quality parameters at Bhavnagar creek (August 2020)

Station	Water depth*	Temp. (°C)	Salinity (PSU)	pH	DO (mg/l)	TSS (mg/l)	Turbidity (NTU)	Ammonium (µmol/l)	Nitrite (µmol/l)	Nitrate (µmol/l)	Total Nitrogen (µmol/l)	Phosphate (µmol/l)	Total phosphorus (µmol/l)
SS1	S	25.9	6.8	7.52	5.9	1104	542	3.0	1.4	16.9	22.5	1.73	2.16
	B	25.5	6.9	7.60	5.8	1286	598	2.2	1.7	17.0	22.3	1.81	2.30
SS2	S	26.0	6.9	7.65	5.9	1982	915	3.2	1.6	17.0	22.3	1.83	2.44
	B	25.6	7.0	7.67	5.7	2124	965	2.1	1.7	18.2	22.6	2.17	2.63
SS3	S	26.1	7.2	7.63	6.0	1095	538	2.7	1.6	17.5	22.6	1.78	2.26
	B	25.7	7.2	7.64	5.8	1421	646	1.9	1.8	18.0	22.4	2.03	2.34

*S = creek surface, B = creek bottom

Table 3. Biochemical Oxygen Demand and Chemical Oxygen Demand at Bhavnagar creek water (August 2020)

Station	Water depth*	BOD (mg/l)	COD (mg/l)
SS1	S	1.3	24.8
	B	1.4	25.4
SS2	S	1.2	24.4
	B	1.4	25.6
SS3	S	1.3	23.4
	B	1.4	24.0

*S = creek surface, B = creek bottom

Table 4. Concentration of Heavy Metals, Phenols and Total Petroleum Hydrocarbons at Bhavnagar creek water (August 2020)

Station	Water depth*	Heavy metals ($\mu\text{g/l}$)				Phenols (mg/l)	Total Petroleum Hydrocarbons ($\mu\text{g/l}$)
		Cadmium	Mercury	Lead	Chromium		
SS1	S	0.72	<1.0	<1.0	1.1	<0.001	<0.1
	B	0.73	<1.0	<1.0	1.2	<0.001	<0.1
SS2	S	0.65	<1.0	<1.0	1.2	<0.001	<0.1
	B	0.68	<1.0	<1.0	1.3	<0.001	<0.1
SS3	S	0.70	<1.0	<1.0	1.3	<0.001	<0.1
	B	0.72	<1.0	<1.0	1.2	<0.001	<0.1

*S = creek surface, B = creek bottom

Table 5. Sediment Texture at Bhavnagar creek (August 2020)

Station	D ₅₀ (mm)	Sand (%)			Silt & Clay (%)	Description of Soil
		Coarse Sand	Medium Sand	Fine Sand		
SB1	0.10	0.1	4.6	85.4	9.9	Fine sand
SB2	0.10	0.1	5.9	87.9	6.1	Fine sand
SB3	0.09	0.1	2.7	81.0	16.1	Fine sand

Table 6. Sediment quality parameters at Bhavnagar creek (August 2020)

Station	Total Organic Carbon (%)	Total Nitrogen (mg/kg)	Total Phosphorus (mg/kg)	Calcium Carbonate (%)
SB1	0.33	23.5	4.5	18.2
SB2	0.50	36.1	8.0	15.7
SB3	0.33	28.5	6.3	16.9

Table 7. Concentration of Heavy Metals, Phenols and Total Petroleum Hydrocarbons in Sediments at Bhavnagar creek (August 2020)

Station	Heavy metals (mg/kg)				Phenols (mg/kg)	Total Petroleum Hydrocarbons ($\mu\text{g}/\text{kg}$)
	Cadmium	Mercury	Lead	Chromium		
SB1	<0.1	<0.1	<0.1	42.4	<0.5	<0.5
SB2	<0.1	<0.1	<0.1	39.6	<0.5	<0.5
SB3	<0.1	<0.1	<0.1	38.8	<0.5	<0.5

Table 8. Primary productivity at Bhavnagar creek water (August 2020)

Station	Gross Photosynthetic activity	Net Photosynthetic activity	Primary production ($\text{mgC}/\text{m}^3/\text{day}$)
SS1	1.2	0.8	360
SS2	1.1	0.7	330
SS3	1.0	0.7	390
Average			360

Table 9. Phytoplankton species composition* at Bhavnagar creek water (August 2020)

Sl. No.	Species	Station		
		SS1	SS2	SS3
Class: Bacillariophyceae (Diatoms)				
Order: Centrales				
1	<i>Bacteriastrum</i> sp.	+	+	+
2	<i>Chaetoceros</i> sp.	+	-	+
3	<i>Coscinodiscus</i> sp.	+	+	+
4	<i>Coscinodiscus centralis</i>	-	+	-
6	<i>Ditylum brightwellii</i>	+	+	+
7	<i>Hemiaulus</i> sp.	+		+
8	<i>Odontella mobiliensis</i>	+	+	+
9	<i>Planktoniella sol</i>	-	+	-
10	<i>Rhizosolenia</i> sp.	+	+	+
11	<i>Rhizosolenia setigera</i>	-	+	-
12	<i>Triceratium</i> sp.	+	+	+
Subtotal		8	9	8
Order: Pennales				
13	<i>Amphora</i>	+	+	+
14	<i>Asterionella</i> sp.	+	+	+
15	<i>Bellerocha malleus</i>	+	+	-
16	<i>Guinardia striata</i>	-	+	+
17	<i>Navicula</i> sp.	+	+	+
18	<i>Navicula hennedii</i>	-	+	+
19	<i>Nitzschia</i> sp.	+	+	-
20	<i>Nitzschia longisima</i>	+	+	+
21	<i>Pleurosigma</i> sp.	+	+	+
22	<i>Pleurosigma directum</i>	+	-	-
23	<i>Thalassiothrix frauenfeldii</i>	-	+	+
24	<i>Thalassionema nitzschioides</i>	+	-	+
Subtotal		9	10	9
Class: Dinophyceae (Dinoflagellates)				
25	<i>Ceratium furca</i>	-	+	+
26	<i>Ceratium macroceros</i>	+	+	+
27	<i>Dinophysis caudata</i>	+	+	-
28	<i>Prorocentrum micans</i>	-	+	+
29	<i>Proto-peridinium</i> sp.	+	-	+
30	<i>Proto-peridinium depressum</i>	+	+	+
Subtotal		4	5	5
Class: Cyanophyceae (Blue-greens)				
31	<i>Trichodesmium erythraeum</i>	+	+	+
32	<i>Chlorella</i> sp.	+	+	+
		2	2	2
Total		23	26	24

*Net sample

Table 10. Phytoplankton numerical abundance* (cells/l) at Bhavnagar creek water (August 2020)

Sl. No.	Genus / Species	SS1	SS2	SS3	Total	(%)
Phylum: Heterokontophyta						
Class: Bacillariophyceae (Diatoms)						
Order: Centrales						
1	<i>Bacteriastrum hyalinum</i>	100	-	50	150	2.80
2	<i>Chaetoceros</i> sp.	100	100	-	200	3.74
3	<i>Chaetoceros affinis</i>	-	150	-	150	2.80
4	<i>Coscinodiscus</i> sp.	150	-	100	250	4.67
5	<i>Climacodium frauenfeldianum</i>	50	-	50	100	1.87
6	<i>Ditylum brightwellii</i>	100	50	150	300	5.61
7	<i>Hemiaulus</i> sp.	50	100	-	150	2.80
8	<i>Odontella mobiliensis</i>	100	50	100	250	4.67
9	<i>Rhizosolenia</i> sp.	-	100	-	100	1.87
10	<i>Triceratium</i> sp.	-	-	100	100	1.87
Order: Pennales						
11	<i>Amphora</i> sp.	150	300	250	700	13.08
12	<i>Bacilaria paradaxa</i>	50	100	-	150	2.80
13	<i>Guinardia striata</i>	-	50	50	100	1.87
14	<i>Navicula</i> sp.	100	-	150	250	4.67
15	<i>Navicula</i> sp.	-	100	-	100	1.87
16	<i>Nitzschia</i> sp.	50	-	100	150	2.80
17	<i>Nitzschia</i> sp.	-	-	-	-	0.00
18	<i>Pleurosigma directum</i>	100	50	100	250	4.67
19	<i>Pleurosigma elongatum</i>	150	-	50	200	3.74
20	<i>Thalassiothrix frauenfeldii</i>	-	100	-	100	1.87
Class: Dinophyceae (Dinoflagellates)						
21	<i>Ceratium furca</i>	-	100	50	150	2.80
22	<i>Ceratium macrocerus</i>	100	-	-	100	1.87
23	<i>Dinophysis caudate</i>	150	50	100	300	5.61
24	<i>Protoperdinium divergen</i>	-	100	-	100	1.87
25	<i>Pronocentrum micans</i>	100	-	50	150	2.80
Class: Cyanophyceae (Blue greens)						
26	<i>Trichodesmium erythraeum</i>	150	250	200	600	11.21
27	<i>Chlorella</i> sp.	100	-	100	200	3.74
Total		1850	1750	1750	5350	100

* Bottle sample

Table 11. Phytoplankton population at Bhavnagar creek water (August 2020)

Station	No of genera or species (*net sample)	Population (cells/l) (*bottle sample)
SS1	23	1850
SS2	26	1750
SS3	24	1750

Table 12. Numerical abundance of zooplankton (nos./100m³) at Bhavnagar creek water (August 2020)

Sl. No.	Genus / Species	Station				
		SS1	SS2	SS3	Total	%
Phylum: Protozoa						
Order: Tintinnids (Ciliate groups)						
1	<i>Dictyocysta</i> sp.	462	323	-	785	4.0
2	<i>Favella</i> sp.	308	-	455	763	3.9
3	<i>Tintinnopsis</i> sp.	-	323	152	475	2.4
Class: Polychaeta						
4	Polychaeta larvae	308	161	606	1075	5.5
Phylum: Arthropoda						
Order: Copepoda						
Sub- order: Calanoida						
5	<i>Acartia danae</i>	462	645	909	2016	10.4
6	<i>Acartia erythraea</i>	769	484	606	1859	9.5
7	<i>Acartia spinicauda</i>	-	806	-	806	4.1
8	<i>Calanopia minor</i>	308	161	303	772	4.0
9	<i>Clausocalanus minor</i>	-	323	-	323	1.7
10	<i>Centropages furcatus</i>	308	-	303	611	3.1
11	<i>Eucalanus</i> sp.	-	806	-	806	4.1
12	<i>Labidocera acuta</i>	462	-	303	765	3.9
13	<i>Paracalanus parvus</i>	462	806	152	1420	7.3
14	<i>Temora discaudata</i>	308	-	303	611	3.1
15	Copepod nauplii	154	323	-	477	2.4
Sub- order: Cyclopoida						
16	<i>Corycaeus danae</i>	-	161	303	464	2.4
17	<i>Oithona</i> sp.	308	-	455	763	3.9
18	<i>Oithona Brevicornis</i>	-	484	-	484	2.5
19	<i>Oncaea venusta</i>	615	161	303	1079	5.5

Sl. No.	Genus / Species	Station				
		SS1	SS2	SS3	Total	%
Sub- order: Harpacticoida						
20	<i>Euterpina sp.</i>	-	323	152	475	2.4
21	<i>Macrosetella sp.</i>	462	-	606	1068	5.5
Other Crustaceans						
22	Crustacean larvae	308	323	-	631	3.2
Phylum: Chordata						
22	Fish larvae	308	484	152	944	4.8
Total		6312	7097	6063	19472	100

Table 13. Zooplankton diversity abundance and biomass at Bhavnagar creek water (August 2020)

Station	No. of genera or species	Population (nos./100 m ³)	Biomass (ml/100 m ³)
SS1	16	6312	9.8
SS2	17	7097	10.0
SS3	16	6063	8.7

Table 14. Sub tidal and Inter tidal benthic population at Bhavnagar creek (August 2020)

Sl. No.	Groups	Sub tidal benthic population (nos./m ²)			Intertidal benthic Population (nos./m ²)		
		SB1	SB2	SB3	IB1	IB2	IB3
Phylum: Annelida							
Class: Polychaeta							
1	<i>Ancistrosyllis sp.</i>	80	40	80	45	30	45
3	<i>Cossura sp.</i>	40	-	80	-	30	15
4	<i>Glycera sp.</i>	-	80	40	30	-	45
6	<i>Perinereis sp.</i>	80	80	-	15	45	-
7	<i>Prionospio sp.</i>	-	80	120	15	15	15
8	Unidentified polychaetes	-	-	40	45	30	15
Phylum: Mollusca							
	Unidentified bivalves	-	40	-	15	-	30
	Unidentified gastropods	40	-	-	-	45	-
	Total	240	320	360	165	195	165

Table 15. Bacterial population at Bhavnagar creek water ($\times 10^3$ CFU/ml) (August 2020)

Media	Type of Bacteria	Stations		
		SS1	SS2	SS3
Nut Agar	TVC	4.89	5.03	5.18
Mac Agar	TC	0.56	0.60	0.59
Mac Agar	FC	0.49	0.47	0.52
Mac Agar	ECLO	0.32	0.40	0.38
XLD Agar	SHLO	0.16	0.14	0.13
TCBS Agar	VLO	0.10	0.13	0.14
TCBS Agar	VPLO	0.12	0.09	0.10
TCBS Agar	VCLO	-	-	0.02

Table 16. Bacterial population at Bhavnagar creek sediments ($\times 10^4$ CFU/g) (August 2020)

Media	Type of Bacteria	Stations		
		SS1	SS2	SS3
Nut Agar	TVC	5.20	5.17	5.29
Mac Agar	TC	0.72	0.68	0.70
Mac Agar	FC	0.42	0.43	0.41
Mac Agar	ECLO	0.27	0.26	0.27
XLD Agar	SHLO	0.17	0.18	0.19
TCBS Agar	VLO	0.16	0.13	0.15
TCBS Agar	VPLO	0.14	0.13	0.15
TCBS Agar	VCLO	0.01	0.03	0.03

TVC - Total Viable Counts; TC - Total Coliforms; FC- Fecal coliform; ECLO - *Escherichia coli* like organisms; SHLO - *Shigella* like organisms; VLO - *Vibrio* like organisms; VPLO - *Vibrio parahaemolyticus* like organisms; VCLO-*Vibrio cholerae* like organisms.

Table 17. Comparison of Water quality parameters between Pre-Project period (May 2013) and Monitoring periods

Sl. No.	Parameters	Unit	Pre-project period	Monitoring period						Remarks
			May 2013	February 2019	May 2019	August 2019	November 2019	February 2020	August 2020	
			Range	Range	Range	Range	Range	Range	Range	
1	Temperature	(°C)	32-34	24.1-25.2	25.1-25.6	27.5-27.9	26.2-26.6	25.4-25.9	25.5-26.1	Seasonal variation
2	pH	-	8.0-8.2	7.99-8.09	7.90-8.01	7.15-7.36	7.82-8.07	7.94-8.04	7.52-7.67	Seasonal variation
3	Salinity	ppt	36-37	35.8-36.6	42.4-43.3	6.3-7.0	15.7-19.4	32.5-33.4	6.8-7.2	Seasonal variation
4	Turbidity	NTU	>1000	423-450	>1000	314-618	2084-2615	750-996	538-965	Seasonal variation
5	TSS	mg/l	980-13052	1495-1835	1586-2130	1011-2295	3064-3845	1645-2241	1095-2124	Seasonal variation
6	DO	mg/l	3.84-4.32	5.4-5.6	5.1-5.5	5.7-5.9	5.3-5.7	5.3-5.6	5.7-6.0	No significant change
7	BOD	mg/l	1.44-3.20	1.0-1.3	0.8-1.1	1.1-1.3	1.2-1.5	0.8-1.1	1.2-1.4	No significant change
8	COD	mg/l	37.3-52.5	26-30.9	18.0-25.3	27.6-36.2	32.2-38.2	21.4-23.4	23.4-25.6	Seasonal variation
9	Ammonium	µmol/l	0.43-0.74	1.2-1.5	0.9-1.9	3.6-6.8	4.9-7.3	1.5-2.1	1.9-3.2	Seasonal variation
10	Nitrite	µmol/l	1.56-3.47	0.3-0.5	0.6-1.2	1.3-2.1	2.9-3.5	0.4-0.8	1.4-1.8	Seasonal variation
11	Nitrate	µmol/l	3.76-7.78	2.8-3.6	2.5-3.2	31.3-38	17.0-19.8	2.9-3.6	16.9-18.2	Seasonal variation
12	Total Nitrogen	µmol/l	13.92-26.36	4.7-5.5	4.7-5.8	40.1-49.7	25.3-30.4	5.3-6.9	22.3-22.6	Seasonal variation
13	Phosphate	µmol/l	0.38-2.77	0.6-2.3	0.3-0.7	1.1-1.8	3.2-4.1	0.94-1.30	1.73-2.17	Seasonal variation
14	Total Phosphorus	µmol/l	5.23-7.22	3.0-9.7	0.6-1.1	3.2-4.6	5.3-6.9	2.80-3.24	2.16-2.63	Seasonal variation
15	Cadmium	µg/l	<1.0	4.8-8.9	5.6-7.2	0.71-1.17	0.99-1.32	1.8-2.6	0.65-0.73	No significant change
16	Mercury	µg/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	No change
17	Lead	µg/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	No change
18	Chromium	µg/l	2.95-5.64	4.6-6.4	5.8-6.7	<1.0	0.80-0.92	2.2-2.9	1.1-1.3	No significant change
19	Phenols	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	No change
20	Total Petroleum Hydrocarbons	µg/l	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	No change

*For May 2020 (1st quarterly monitoring season of the year 2020-21), samples not collected due to Nationwide ban on travel due to COVID-19 pandemic.

Table 18. Comparison of Sediment quality parameters between Pre-Project period (May 2013) and Monitoring periods

Sl. No.	Parameters	Unit	Pre-project period	Monitoring period						Remarks
			May 2013	February 2019	May 2019	August 2019	November 2019	February 2020	August 2020	
			Range	Range	Range	Range	Range	Range	Range	
1	Soil texture	-	Fine sand	Fine Sand	Fine Sand	Silty clay	Silty Clay	Fine sand	Fine Sand	Seasonal variation
2	Total phosphorous	mg/kg	0.26-0.38	15.5-17.7	16.2-19.4	7.8-8.5	16.7-23.6	16.1-17.2	4.5-8.0	Seasonal variation but within normal range
3	Total nitrogen	mg/kg	0.86-1.22	17.4-19.6	7.6-21.4	22-38.6	56.8-75.4	10.6-17.5	23.5-36.1	Seasonal variation but within normal range
4	Total organic carbon	%	0.47-0.77	0.99-1.12	0.26-1.22	1.2-2.0	0.43-0.57	0.43-1.04	0.33-0.50	Seasonal variation but within normal range
5	Calcium carbonate	%	5.76-7.72	6.2-7.2	5.0-11.5	18.7-20.7	6.9-10.2	6.5-8.5	15.7-18.2	Seasonal variation but within normal range
6	Cadmium	mg/kg	<1.0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	No change
7	Chromium	mg/kg	30.48-35.08	28.6-44.6	37.3-40.3	42.6-48.6	45.8-51.7	32.6-38.5	38.8-42.4	Marginal change but within normal range
8	Mercury	mg/kg	<1.0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	No change
9	Lead	mg/kg	<1.0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	No change
10	Phenols	mg/kg	<0.05	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	No change
11	Petroleum Hydrocarbons	µg/kg	2.12-3.37	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	No change

*For May 2020 (1st quarterly monitoring season of the year 2020-21), samples not collected due to Nationwide ban on travel due to COVID-19 pandemic.

Table 19. Comparison of Biological parameters between Pre-Project period (May 2013) and Monitoring periods

Sl. No.	Parameters	Unit	Pre-project period	Monitoring period						Remarks
			May 2013	February 2019	May 2019	August 2019	November 2019	February 2020	August 2020	
Phytoplankton										
1	Primary Productivity	mgC/m ³ /day	240-480	300-390	210-300	240-270	210-270	300-360	330-390	No significant change
2	Species composition	nos./100m ³	12-31	15-21	16-17	20-23	17-19	16-19	23-26	Seasonal variation
3	Abundance	nos./l	399-2530	1800 - 3550	1350-1600	1950-2200	1500-2050	1400-1900	1750-1850	No significant change
Zooplankton										
4	Biomass	ml/100m ³	5.14-14.85	19.8 - 30.6	9.6-16.7	10.5 - 11.2	9.0-13.3	8.2-15.2	8.7-10.0	No significant change
5	Abundance	nos./100m ³	7368-50048	5945 - 7232	5744-6973	6237-7819	4179-6478	5534-7479	6063-7097	Seasonal variation
Benthos										
6	Subtidal	nos./m ²	20-30	280 - 400	240-400	320-400	360-440	280-400	240-360	No significant change
7	Intertidal	nos./m ²	20-40	120 - 165	105-150	135-180	105-135	75-120	165-195	No significant change
Microbiology										
8	Water	nos. x10 ³ /ml	0.01-5.31	0.01 - 5.34	0.01-5.34	0.01-5.28	0.01-5.31	0.01-5.28	0.02-5.18	No significant change
9	Sediment	nos. x10 ⁴ /g	0.01-5.48	0.01 - 5.64	0.01-5.45	0.02-5.41	0.01-5.43	0.01-5.36	0.01-5.29	No significant change

*For May 2020 (1st quarterly monitoring season of the year 2020-21), samples not collected due to Nationwide ban on travel due to COVID-19 pandemic.

GALLERY



Seawater sample collection



Sediment sample collection



Plankton sample collection



Intertidal benthos sample collection

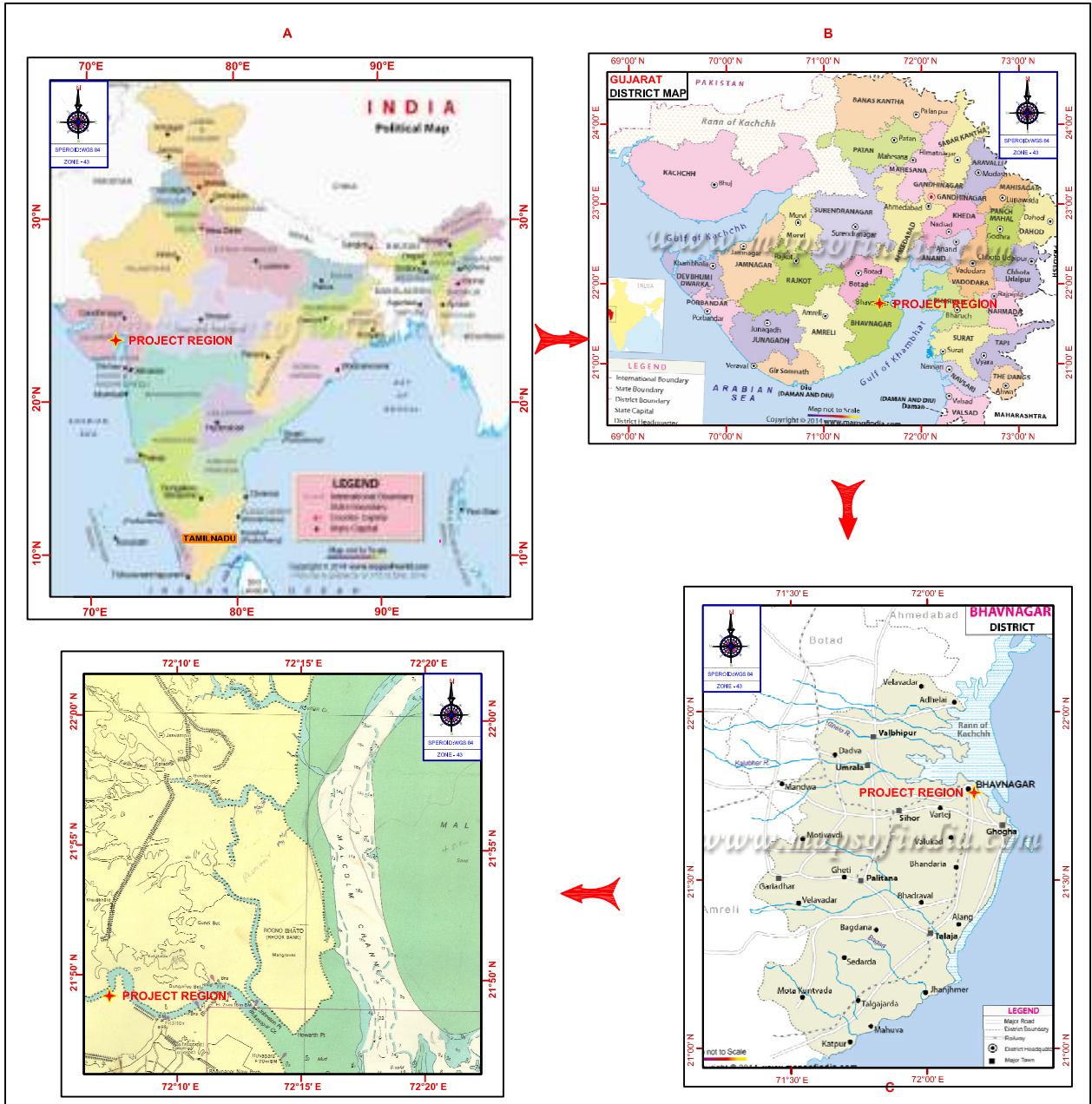


FIG.1. LOCATION MAP

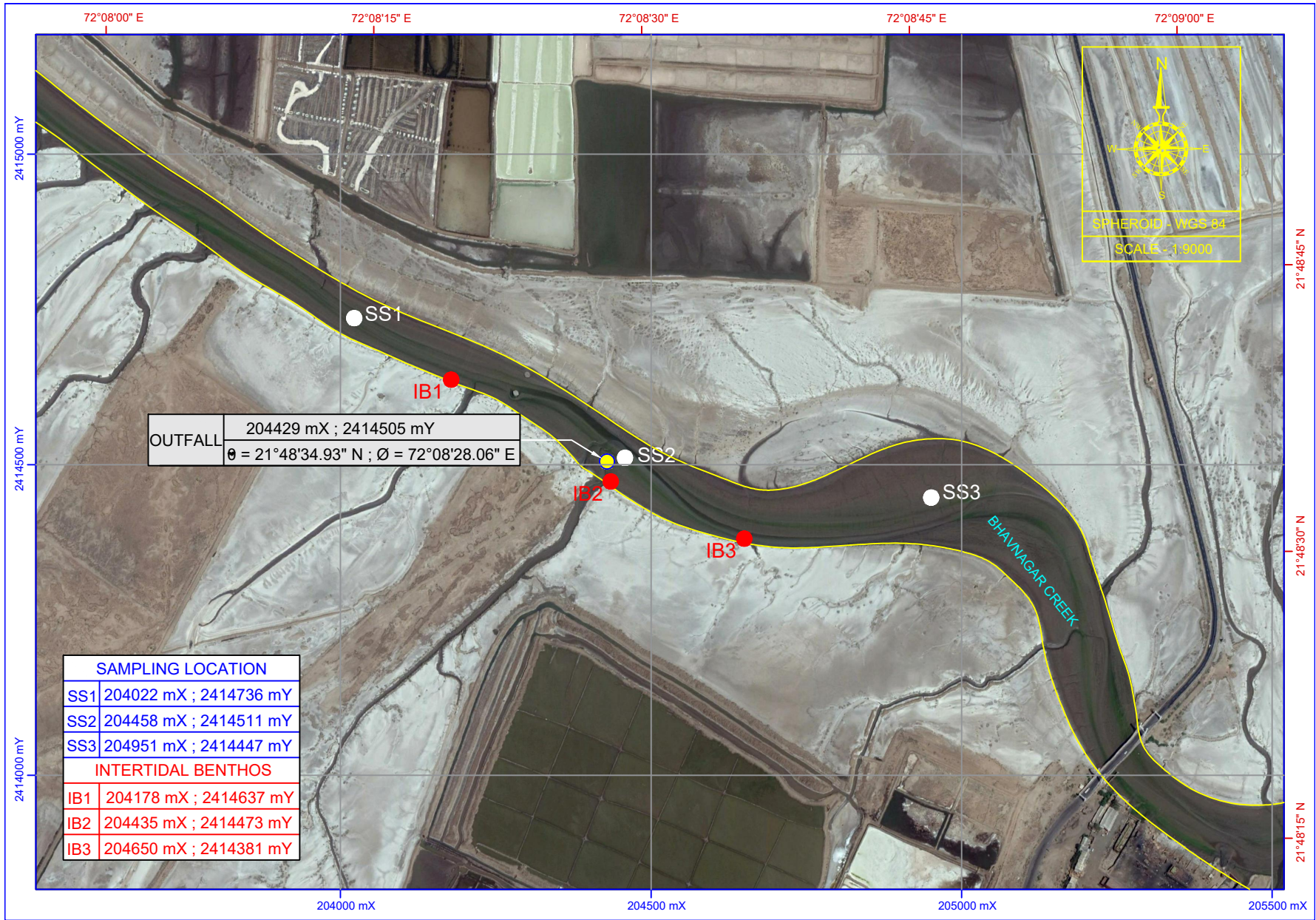


FIG. 2 . SAMPLING LOCATIONS

Annexure I – QCI NABET accreditation certificate



Quality Council of India



National Accreditation Board for
Education & Training

Certificate of Accreditation

Indomer Coastal Hydraulics (P) Ltd

63, Gandhi Road, Alwar Thirunagar, Chennai 600087

Accredited as Category - A organization under the QCI-NABET Scheme for Accreditation of EIA Consultant Organizations: Version 3 for preparing EIA-EMP reports in the following Sectors:

S.No	Sector Description	Sector (as per)		Cat.
		NABET	MoEFCC	
1	Oil & gas transportation pipeline (crude and refinery/ petrochemical products), passing through national parks/ sanctuaries/coral reefs / ecologically sensitive areas including LNG terminal	27	6 (a)	A
2	Ports, harbours, break waters and dredging	33	7 (e)	A

Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in SA AC minute dated March 29,2019 posted on QCI-NABET website.

The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in QCI-NABET's letter of accreditation bearing no. QCI/NABET/ENV/ACO/19/0992 dated May 27, 2019. The accreditation needs to be renewed before the expiry date by Indomer Coastal Hydraulics (P) Ltd following due process of assessment.

Sr. Director, NABET
Dated: May 27, 2019

Certificate No.
NABET/EIA/1720/ SA 90

Valid up to
Sep 12, 2020

For the updated List of Accredited EIA Consultant Organizations with approved Sectors please refer to QCI-NABET website.





**National Accreditation Board
for Education and Training**

(Member - International Accreditation Forum & Pacific Accreditation Cooperation)



QCI/NABET/ENV/ACO/20/1472

Sept 07, 2020

To

Indomer Coastal Hydraulics (P) Ltd.

63, Gandhi road, Alwarthirunagar, Chennai 600087

Sub.: Extension of Validity of Accreditation till December 06, 2020 - regarding

Dear Sir/Madam

In view of the outbreak of Corona Virus (COVID-19) and subsequent lockdown declared for its control vide order dated 24th March 2020, issued by Ministry of Home Affairs, Govt. of India, NABET hereby extends the Validity of your Accreditation till December 06, 2020.

As soon as, NABET office opens/resumes its operation necessary action regarding issuance of certificate/extension of validity letters / other may be initiated, therefore, ACO to ensure their complete application with NABET, if applicable.

Meanwhile, you may enclose this with your EIA reports along with the certificate/validity letter. The EAC/SEIAA/SEAC/Other are hereby requested to consider the same as a valid document for the preparation of EIA/EMP report.

With best regards.

Sd/-

(A K Jha)

Sr. Director, NABET

NABET

Annexure II – NABL accreditation certificate



**National Accreditation Board for
Testing and Calibration Laboratories**

(A Constituent Board of Quality Council of India)



CERTIFICATE OF ACCREDITATION

INDOMER COASTAL HYDRAULICS PRIVATE LIMITED

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2005

**"General Requirements for the Competence of Testing &
Calibration Laboratories"**

for its facilities at

NO 63, GANDHI ROAD, ALWAR THIRUNAGAR, CHENNAI, TAMIL NADU, INDIA

in the field of

TESTING

Certificate Number: TC-5232

Issue Date: 13/01/2019

Valid Until: 12/01/2021

In view of the transition deadline for ISO/IEC 17025:2017, the validity of this accreditation certificate will cease on 30.11.2020.

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the relevant requirements of NABL.
(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Signed for and on behalf of NABL



Anil Relia
Chief Executive Officer

Annexure III - NABL accreditation certificate of outsource laboratory



**National Accreditation Board for
Testing and Calibration Laboratories**

(A Constituent Board of Quality Council of India)



CERTIFICATE OF ACCREDITATION

CAPITAL RE ENERGY AND LABORATORY PVT. LTD.

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2005

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

Plot No. 2/244, Pattanathamman Koil Street, Periyapilleri, Thaiyur,
Kelambakkam, Chennai, Tamil Nadu

in the field of

TESTING

Certificate Number TC-7237

Issue Date 08/05/2018

Valid Until 07/05/2020

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the relevant requirements of NABL.

(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Signed for and on behalf of NABL



89076970100030001561

Anil Relia
Chief Executive Officer

Regarding NABL Accreditation Certificate Extension

Yandex.Mail

March 26, 2020 6:51 PM

From: «Suman Kharayat» <suman@nabl.qcin.org>

To: dhamu@carelab.in

Dear Sir/Madam,

I am pleased to inform that NABL has decided to extend the validity of your current accreditation certificate TC-7237 in chemical and Biological testing for the existing scope till 30.06 2020 or till NABL takes the decision on the application/report after scheduling the assessment whichever is earlier.

Being an accredited laboratory of NABL, you must fulfil all the terms laid down in our document NABL-131. You are requested to follow the latest NABL-133 for using NABL symbol.

The laboratory may continue to issue test reports with NABL symbol for the existing scope only.

Thanks & Regards

Suman Kharayat

Assistant Director

**National Accreditation Board for Testing and Calibration Laboratories
(NABL)**

A constituent board of Quality Council of India (QCI)

NABL House, Plot- 45, Sector 44, Gurgaon-122002, Haryana

Tel. no.: 91-124-4594829, Fax: 91-124-4679799

Email: suman@nabl.qcin.org