

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

**Monitoring Report - 4 of 4/2020-21
February 2021**

PROJECT CODE: 656041920



**MADHU SILICA PRIVATE LIMITED
BHAVNAGAR, GUJARAT**



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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) is 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.</p> <p>Status of reports for year 2020-21</p> <ul style="list-style-type: none"> • May 2020 – 1 of 4 – Due to COVID 19 sampling activities were not performed. • Aug 2020 – 2 of 4 – Sample was collected and report submitted • Nov 2020 – 3 of 4 – Due to COVID 19 sampling activities were not performed. • Feb 2021 – 4 of 4 – Present report <p><i>*Due to COVID-19 Nationwide lockdown and strict interstate travel protocols, quarterly monitoring study for the period Oct 2020 – Dec 2020 was not conducted. The task of quarterly monitoring study for Jan 2021 to Mar 2021 is taken up immediately after the interstate relaxations and this form as the 4th season Quarterly Monitoring Report for the year 2020-21.</i></p>				
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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 fourth periodic monitoring (February 2021) for the year 2020 - 2021.

Due to COVID-19 Nationwide lockdown and strict interstate travel protocols, quarterly monitoring study for the period Oct 2020 – Dec 2020 was not conducted. The task of quarterly monitoring study for Jan 2021 to Mar 2021 is taken up immediately after the interstate relaxations and this forms as the 4th 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/SA90 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 (Certificate and Period Extension Letter).

3. DATA COLLECTION FOR MONITORING

The creek water, creek bed sediments and biological samples were collected at three locations around the outfall points (SS1 to SS3) in February 2021. The samples for intertidal benthos were also collected at three locations (IB1 to 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 9) 1984
2	pH	IS 2720 (Part 11) 1983
3	Salinity	IND/SOP/WQ/13
4	Dissolved Oxygen	IS 3025 (Part 38) 1989
5	Total Dissolved Solids	IS 3025 (Part 16) 1984
6	BOD	IS 3025 (Part 44) 1993
7	COD	IS 3025 (part 58) 2006
8	Turbidity	IS 3025 (Part 10) 1984
9	Ammonium	IS 3025 (Part 34) 1988
10	Nitrite	IS 3025 (Part 34) 1988
11	Nitrate	IS 3025 (Part 34) 1988
12	Phosphate	IS 3025 (Part 31) 1988
13	Total Nitrogen	IS 3025 (Part 34) 1988
14	Total Phosphorous	IS 3025 (Part 31) 1988
15	Total Suspended Solids	IS 3025 (Part 17) 1984
16	Cadmium	IS 3025 (Part 2) 2014
17	Lead	IS 3025 (Part 2) 2014
18	Chromium	IS 3025 (Part 2) 2014
19	Mercury	IND/SOP/WQ/35
20	Phenols	IS 3025 (Part 43) 1992
21	Petroleum Hydrocarbons	TNRCC method 1055
Sediment quality		
1	Total Organic Carbon	IS 2720 (Part 22) 1972
2	Total Nitrogen	IS 14684 – 1999
3	Total Phosphorous	IS 10158 – 1982
4	Calcium carbonate	IS 2720 (Part 23) 1976
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 32.5 to 33.4 PSU. The values of salinity were in normal range during the present sampling period. pH range was 7.88 to 7.97 and it was found to be slightly high compared to previous study. The range of TSS (1270 to 1584 mg/l) was found to be slightly high compared to the previous sampling August 2020. Dissolved oxygen values varied from 5.3 to 5.6 mg/l which is small fluctuate to the earlier reported values. BOD values were also found to be normal (<2mg/l) like earlier periods at all the three stations.

Ammonium, Nitrite, Nitrate, Total Nitrogen, Phosphate and Total Phosphorus concentration levels show seasonal variation and however all the nutrients values are observed to be within the normal range. Cadmium levels ranged from 1.82 to 2.2 µg/l and Chromium concentration ranged from 2.24 to 2.48 µg/l. However, the metals were observed to be in trace level at these three study areas. 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 (SB1, SB2 and 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 nature at all stations. Total phosphorus, calcium carbonate, total nitrogen and total organic carbon values at all stations slightly varied compared than pre-project period study. Total nitrogen values ranged from 16.4 to 26.4 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 (22.4 to 32.6 mg/kg).

Sediment texture was found to be predominantly silt clay nature. 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 22.4 to 32.6 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 are 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 420 mgC/m³/day; the recorded average value is 370 mgC/m³/day (Table 8).

Various phytoplankton groups were observed, and their percentage composition and numerical abundance are shown in Tables 9 and 10. Phytoplankton diversity fluctuated from 16 to 21 species. Bacillariophyceae (Diatoms) formed the major group followed by Dinophyceae (Dinoflagellates) and Cyanophyceae (blue green algae). Phytoplankton population density varied from 1450 to 2900 cells/l (Table 11). In the present study, the number of species and population density observed were slightly high compared to previous report (Table 19).

Phytoplankton population mostly consists of Bacillariophyceae (63.15%), Dinophyceae (24.81%) and Cyanophyceae (12.40%). During the study periods *Skeletonema costatum* and *Chlorella* sp. were the most dominant species in the study area followed by *Pleurosigma directum*, *Trichodesmium erythraeum*, *Navicula henneydii* and *Diplosalopsis* sp.

Zooplankton: The numerical abundance of zooplankton varied from 7159 to 10034 nos./100m³ (Table 12). The highest zooplankton population was observed at SS2 and the lowest was observed at SS1. The zooplankton biomass varied from 9.6 to 11.7 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 erythraea*, *Tintinnopsis* sp., *Clausocalanus minor*, *Euterpina acutifrons* and *Oikopleura* sp. 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 280 to 400 nos./m² (Table 14). The subtidal fauna population was slightly higher, 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 150 and 210 nos./m² which is slightly higher 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 5.19×10³ CFU/ml. In the sediment, the population density varied from 0.01 to 5.26×10⁴ CFU/g. Bacterial population was slightly higher in sediment samples compared to the water samples. In general, there is not much of a variation observed between the present and earlier values both in creek water and sediment.

Primary production, phytoplankton, zooplankton, are found to be in normal values. The sub-tidal and inter-tidal benthic population showed normal range at all three stations during the study. 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 periodic monitoring results of February 2021 as given in Tables 17, 18 and 19. Comparison of water quality, sediment quality and biological parameters during monitoring period (February 2019 – February 2021) are shown in Figures 3, 4 and 5 respectively.

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 very marginal, and they are due to seasonal variation which is common for creek waters.

Sediment quality

Sediment texture was predominantly towards fine sand in nature 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 February 2021.

Microbiology

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

Table 1. Details of sampling locations

Station	UTM Coordinates (WGS 84)		Water depth (m)	Sampling depth* (m)
	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 (February 2021)

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	26.6	32.5	7.94	5.6	1320	680	2.0	0.53	3.5	6.10	0.79	2.63
	B	26.4	32.7	7.91	5.4	1400	760	2.2	0.91	4.1	7.25	0.94	3.26
SS2	S	26.8	32.8	7.97	5.5	1311	710	1.9	0.71	3.2	5.85	0.91	2.95
	B	26.6	33.0	7.94	5.3	1584	880	2.0	0.74	3.8	6.60	0.97	3.24
SS3	S	26.9	33.1	7.96	5.4	1270	610	1.8	0.60	3.1	5.55	0.86	2.53
	B	26.7	33.4	7.88	5.3	1489	760	2.0	0.76	3.3	6.10	0.91	3.35

*S = creek surface, B = creek bottom

Table 3. Biochemical Oxygen Demand and Chemical Oxygen Demand at Bhavnagar creek water (February 2021)

Station	Water depth*	BOD (mg/l)	COD (mg/l)
SS1	S	1.0	20.8
	B	1.2	21.6
SS2	S	1.1	19.4
	B	1.3	20.8
SS3	S	0.9	18.8
	B	1.0	19.4

*S = creek surface, B = creek bottom

Table 4. Concentration of Heavy Metals, Phenols and Total Petroleum Hydrocarbons at Bhavnagar creek water (February 2021)

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	1.9	<1.0	<1.0	2.24	<0.001	<0.1
	B	2.2	<1.0	<1.0	2.48	<0.001	<0.1
SS2	S	1.8	<1.0	<1.0	2.31	<0.001	<0.1
	B	2.1	<1.0	<1.0	2.45	<0.001	<0.1
SS3	S	1.9	<1.0	<1.0	2.28	<0.001	<0.1
	B	2.1	<1.0	<1.0	2.34	<0.001	<0.1

*S = creek surface, B = creek bottom

Table 5. Sediment Texture at Bhavnagar creek (February 2021)

Station	D ₅₀ (mm)	Sand (%)	Silt & Clay (%)	Description of Soil
		Fine Sand		
SB1	0.12	70.9	29.1	Fine Sand
SB2	0.11	63.5	36.5	Fine Sand
SB3	0.10	60.5	39.5	Fine Sand

Table 6. Sediment quality parameters at Bhavnagar creek (February 2021)

Station	Total Organic Carbon (%)	Total Nitrogen (mg/kg)	Total Phosphorus (mg/kg)	Calcium Carbonate (%)
SB1	1.17	26.4	18.6	18.9
SB2	0.52	22.6	17.4	20.6
SB3	0.20	16.4	15.8	12.5

Table 7. Concentration of Heavy Metals, Phenols and Total Petroleum Hydrocarbons in Sediments at Bhavnagar creek (February 2021)

Station	Heavy metals (mg/kg)				Phenols (mg/kg)	Total Petroleum Hydrocarbons ($\mu\text{g/kg}$)
	Cadmium	Mercury	Lead	Chromium		
SB1	<0.1	<0.1	<0.1	32.6	<0.5	<0.5
SB2	<0.1	<0.1	<0.1	28.8	<0.5	<0.5
SB3	<0.1	<0.1	<0.1	22.4	<0.5	<0.5

Table 8. Primary productivity at Bhavnagar creek water (February 2021)

Station	Gross Photosynthetic activity	Net Photosynthetic activity	Primary production ($\text{mgC/m}^3/\text{day}$)
SS1	1.2	0.7	360
SS2	1.4	0.9	420
SS3	1.1	0.6	330
Average			370

Table 9. Phytoplankton species composition* at Bhavnagar creek water (February 2021)

Sl. No.	Species	Station		
		SS1	SS2	SS3
Class: Bacillariophyceae (Diatoms)				
Order: Centrales				
1	<i>Bacteriastrium</i> sp.	-	+	+
2	<i>Coscinodiscus</i> sp.	+	-	-
3	<i>Coscinodiscus centralis</i>	+	+	-
4	<i>Hemiaulus</i> sp.	+	-	+
5	<i>Helicotheca</i> sp.	-	+	-
6	<i>Odontella aurita</i>	+	-	+
7	<i>Planktoniella sol</i>	-	+	-
8	<i>Rhizosolenia</i> sp.	+	-	-
9	<i>Skeletonema</i> sp.	+	+	+
10	<i>Triceratium</i> sp.	-	+	+
Subtotal		6	6	5
Order: Pennales				
11	<i>Amphora</i> sp.	-	+	-
12	<i>Asterionella</i> sp.	+	-	-
13	<i>Guinardia striata</i>	-	+	+
14	<i>Navicula</i> sp.	-	-	+
15	<i>Navicula henneydii</i>	-	+	+
16	<i>Nitzschia</i> sp.	+	+	-
17	<i>Pleurosigma</i> sp.	+	-	+
18	<i>Pleurosigma directum</i>	-	+	+
19	<i>Gyrosigma</i> sp.	+	-	+
20	<i>Thalassionema nitzschioides</i>	-	+	-
Subtotal		4	6	6
Class: Dinophyceae (Dinoflagellates)				
21	<i>Ceratium furca</i>	-	+	-
22	<i>Ceratium macroceros</i>	-	+	-
23	<i>Dinophysis</i> sp.	+	+	-
24	<i>Diplopsalopsis</i> sp.	+	+	+
25	<i>Prorocentrum micans</i>	+	+	-
26	<i>Protoperidinium</i> sp.	+	+	+
27	<i>Protoperidinium depressum</i>	+	+	+
Subtotal		5	7	3
Class: Cyanophyceae (Blue-greens)				
28	<i>Trichodesmium erythraeum</i>	+	+	+
29	<i>Chlorella</i> sp.	+	+	-
Total		17	21	15

*Net sample

Table 10. Phytoplankton numerical abundance* (cells/l) at Bhavnagar creek water (February 2021)

Sl. No.	Genus / Species	SS1	SS2	SS3	Total	(%)
Phylum: Heterokontophyta						
Class: Bacillariophyceae (Diatoms)						
Order: Centrales						
1	<i>Bacteriastrum</i> sp.	0	100	100	200	3.01
2	<i>Coscinodiscus</i> sp.	50	0	0	50	0.75
3	<i>Coscinodiscus centralis</i>	100	100	0	200	3.01
4	<i>Hemiaulus</i> sp.	50	0	100	150	2.26
5	<i>Helicotheca</i> sp.	0	200	0	200	3.01
6	<i>Odendella aurita</i>	50	0	100	150	2.26
7	<i>Planktoniella sol</i>	0	100	0	100	1.50
8	<i>Rhizosolenia</i> sp.	50	0	100	150	2.26
9	<i>Skeletonema</i> sp.	100	100	300	500	7.52
10	<i>Triceratium</i> sp.	0	100	100	200	3.01
Order: Pennales						
11	<i>Amphora</i> sp.	0	200	0	200	3.01
12	<i>Asterionella</i> sp.	100	0	0	100	1.50
13	<i>Guinardia striata</i>	0	100	200	300	4.51
14	<i>Navicula</i> sp.	0	0	200	200	3.01
15	<i>Navicula henneydii</i>	0	100	200	300	4.51
16	<i>Nitzschia</i> sp.	50	200	0	250	3.76
17	<i>Pleurosigma</i> sp.	100	0	100	200	3.01
18	<i>Pleurosigma directum</i>	0	200	200	400	6.02
19	<i>Gyrosigma</i> sp.	50	0	100	150	2.26
20	<i>Thalassionema nitzschioides</i>	0	200	0	200	3.01
Class: Dinophyceae (Dinoflagellates)						
21	<i>Ceratium furca</i>	0	200	0	200	3.01
22	<i>Ceratium macroceros</i>	0	100	0	100	1.50
23	<i>Dinophysis</i> sp.	100	200	0	300	4.51
24	<i>Diplopsalopsis</i> sp.	100	100	100	300	4.51
25	<i>Prorocentrum micans</i>	100	100	0	200	3.01
26	<i>Protoperidinium</i> sp.	100	100	0	200	3.01
27	<i>Protoperidinium depressum</i>	100	100	100	300	4.51
Class: Cyanophyceae (Blue greens)						
28	<i>Trichodesmium erythraeum</i>	100	100	200	400	6.02
29	<i>Chlorella</i> sp.	150	200	100	450	6.77
Total		1450	2900	2300	6650	100.0

* Bottle sample

Table 11. Phytoplankton population at Bhavnagar creek water (February 2021)

Station	No of genera or species (*net sample)	Population (cells/l) (*bottle sample)
SS1	17	1450
SS2	21	2900
SS3	15	2300

Table 12. Numerical abundance of zooplankton (nos./100m³) at Bhavnagar creek water (February 2021)

Sl. No.	Genus / Species	Station				
		SS1	SS2	SS3	Total	%
Phylum: Protozoa						
Order: Tintinnids (Ciliate groups)						
1	<i>Favella</i> sp.	377	0	749	1126	4.24
2	<i>Tintinnopsis</i> sp.	1130	372	375	1877	7.07
Phylum: Mollusca						
3	Gastropod larvae	377	743	0	1120	4.22
Phylum: Arthropoda						
Order: Copepoda						
Sub-order: Calanoida						
4	<i>Acrocalanus</i> sp.	753	372	375	1500	5.65
5	<i>Acartia erythraea</i>	753	1115	749	2617	9.85
6	<i>Clausocalanus minor</i>	0	743	1124	1867	7.03
7	<i>Centropages furcatus</i>	377	0	749	1126	4.24
8	<i>Eucalanus</i> sp.	377	743	0	1120	4.22
9	<i>Labidocera acuta</i>	377	0	0	377	1.42
10	<i>Temora turbinata</i>	753	372	375	1500	5.65
11	<i>Temora discaudata</i>	0	0	375	375	1.41
12	Copepod nauplii	377	743	375	1495	5.63
Sub-order: Cyclopoida						
13	<i>Corycaeus danae</i>	377	0	749	1126	4.24
14	<i>Corycaeus asiaticus</i>	0	372	375	747	2.81
15	<i>Oncaea venusta</i>	0	372	749	1121	4.22
Sub-order: Harpacticoida						
16	<i>Euterpina acutifrons</i>	377	743	375	1495	5.63
17	<i>Miracia efferata</i>	0	372	0	372	1.40
Other Crustaceans						
18	Crustacean larvae	377	743	375	1495	5.63
19	<i>Lucifer</i> sp.	0	743	749	1492	5.62
Phylum: Chordata						
20	Fish larvae	377	743	0	1120	4.22

Sl. No.	Genus / Species	Station				
		SS1	SS2	SS3	Total	%
21	<i>Oikopleura</i> sp.	0	743	749	1492	5.62
Total		7159	10034	9367	26560	100

Table 13. Zooplankton diversity, abundance and biomass at Bhavnagar creek water (February 2021)

Station	No. of genera or species	Population (nos./100 m ³)	Biomass (ml/100 m ³)
SS1	14	7159	9.6
SS2	16	10034	11.7
SS3	16	9367	11.2

Table 14. Sub tidal and Inter tidal benthic population at Bhavnagar creek (February 2021)

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</i> sp.	0	80	80	45	15	30
2	<i>Armandia</i> sp.	40	80	0	0	0	0
3	<i>Cossura</i> sp.	40	0	40	30	0	15
4	<i>Glycera</i> sp.	0	40	0	30	0	45
5	<i>Perinereis</i> sp.	80	0	40	0	30	45
6	<i>Nereis diversicolor</i>	0	80	40	0	30	30
7	<i>Onuphis</i> sp.	40	0	40	0	15	30
8	<i>Prionospio</i> sp.	0	40	80	15	0	15
9	Unidentified polychaetes	40	0	40	30	0	0
Phylum: Mollusca							
10	Unidentified bivalves	0	40	0	0	30	0
11	Unidentified gastropods	40	40	0	0	45	0
Total		280	400	360	150	165	210

Table 15. Bacterial population at Bhavnagar creek water (x 10³CFU/ml) (February 2021)

Media	Type of Bacteria	Stations		
		SS1	SS2	SS3
Nut Agar	TVC	4.74	5.02	5.19
Mac Agar	TC	0.41	0.44	0.45
Mac Agar	FC	0.34	0.31	0.38
Mac Agar	ECLO	0.17	0.24	0.24
XLD Agar	SHLO	0.21	0.19	0.18
TCBS Agar	VLO	0.15	0.17	0.19
TCBS Agar	VPLO	0.17	0.14	0.16



TCBS Agar	VCLO	0.02	0.10	0.07
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Table16. Bacterial population at Bhavnagar creek sediments (x 10⁴CFU/g) (February 2021)

Media	Type of Bacteria	Stations		
		SB1	SB2	SB3
Nut Agar	TVC	5.09	5.21	5.26
Mac Agar	TC	0.61	0.57	0.59
Mac Agar	FC	0.31	0.32	0.30
Mac Agar	ECLO	0.16	0.15	0.16
XLD Agar	SHLO	0.20	0.21	0.22
TCBS Agar	VLO	0.19	0.13	0.18
TCBS Agar	VPLO	0.17	0.16	0.15
TCBS Agar	VCLO	0.01	0.02	0.05

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

Table17. Comparison of Water quality parameters between Pre-Project period (May 2013) and Monitoring period (February 2021)

Sl. No.	Parameters	Unit	Pre-project period	Monitoring period						Remarks
			May 2013	May 2019	August 2019	November 2019	February 2020	August 2020	February 2021	
			Range	Range	Range	Range	Range	Range	Range	
1	Temperature	(°C)	32-34	25.1-25.6	27.5-27.9	26.2-26.6	25.4-25.9	25.5-26.1	26.5-26.8	Seasonal variation
2	pH	-	8.0-8.2	7.90-8.01	7.15-7.36	7.82-8.07	7.94-8.04	7.52-7.67	7.88-7.97	Seasonal variation
3	Salinity	ppt	36-37	42.4-43.3	6.3-7.0	15.7-19.4	32.5-33.4	6.8-7.2	32.5-33.4	Seasonal variation
4	Turbidity	NTU	>1000	>1000	314-618	2084-2615	750-996	538-965	610-880	Seasonal variation
5	TSS	mg/l	980-13052	1586-2130	1011-2295	3064-3845	1645-2241	1095-2124	1270-1584	Seasonal variation
6	DO	mg/l	3.84-4.32	5.1-5.5	5.7-5.9	5.3-5.7	5.3-5.6	5.7-6.0	5.35-5.6	No significant change
7	BOD	mg/l	1.44-3.20	0.8-1.1	1.1-1.3	1.2-1.5	0.8-1.1	1.2-1.4	0.9-1.3	No significant change
8	COD	mg/l	37.3-52.5	18.0-25.3	27.6-36.2	32.2-38.2	21.4-23.4	23.4-25.6	18.8-21.6	Seasonal variation
9	Ammonium	µmol/l	0.43-0.74	0.9-1.9	3.6-6.8	4.9-7.3	1.5-2.1	1.9-3.2	1.5-2.2	Seasonal variation
10	Nitrite	µmol/l	1.56-3.47	0.6-1.2	1.3-2.1	2.9-3.5	0.4-0.8	1.4-1.8	0.53-0.91	Seasonal variation
11	Nitrate	µmol/l	3.76-7.78	2.5-3.2	31.3-38	17.0-19.8	2.9-3.6	16.9-18.2	3.12-4.10	Seasonal variation
12	Total Nitrogen	µmol/l	13.92-26.36	4.7-5.8	40.1-49.7	25.3-30.4	5.3-6.9	22.3-22.6	5.55-7.25	Seasonal variation
13	Phosphate	µmol/l	0.38-2.77	0.3-0.7	1.1-1.8	3.2-4.1	0.94-1.30	1.73-2.17	0.79-0.97	Seasonal variation
14	Total Phosphorus	µmol/l	5.23-7.22	0.6-1.1	3.2-4.6	5.3-6.9	2.80-3.24	2.16-2.63	2.53-3.35	Seasonal variation
15	Cadmium	µg/l	<1.0	5.6-7.2	0.71-1.17	0.99-1.32	1.8-2.6	0.65-0.73	1.8-2.2	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	5.8-6.7	<1.0	0.80-0.92	2.2-2.9	1.1-1.3	2.24-2.48	Seasonal variation
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 to August 2020 (1st and 2nd 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 period (February 2021)

Sl. No.	Parameters	Unit	Pre-project period	Monitoring period						Remarks
			May 2013	May 2019	August 2019	November 2019	February 2020	August 2020	February 2021	
			Range	Range	Range	Range	Range	Range	Range	
1	Soil texture	-	Fine sand	Fine Sand	Silty clay	Silty Clay	Fine sand	Fine Sand	Fine Sand	No change
2	Total phosphorous	mg/kg	0.26-0.38	16.2-19.4	7.8-8.5	16.7-23.6	16.1-17.2	4.5-8.0	15.8-18.6	Seasonal variation but within normal range
3	Total nitrogen	mg/kg	0.86-1.22	7.6-21.4	22-38.6	56.8-75.4	10.6-17.5	23.5-36.1	16.4-26.4	Seasonal variation but within normal range
4	Total organic carbon	%	0.47-0.77	0.26-1.22	1.2-2.0	0.43-0.57	0.43-1.04	0.33-0.50	0.20-1.17	Seasonal variation but within normal range
5	Calcium carbonate	%	5.76-7.72	5.0-11.5	18.7-20.7	6.9-10.2	6.5-8.5	15.7-18.2	12.5-20.6	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	37.3-40.3	42.6-48.6	45.8-51.7	32.6-38.5	38.8-42.4	22.4-32.6	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 to August 2020 (1st and 2nd 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 period (February 2021)

Sl. No.	Parameters	Unit	Pre-project period	Monitoring period						Remarks
			May 2013	May 2019	August 2019	November 2019	February 2020	August 2020	February 2021	
Phytoplankton										
1	Primary Productivity	mgC/m ³ /day	240-480	210-300	240-270	210-270	300-360	330-390	330-420	No significant change
2	Species composition	nos./100m ³	12-31	16-17	20-23	17-19	16-19	23-26	16-21	Seasonal variation
3	Abundance	nos./l	399-2530	1350-1600	1950-2200	1500-2050	1400-1900	1750-1850	1450-2900	No significant change
Zooplankton										
4	Biomass	ml/100m ³	5.14-14.85	9.6-16.7	10.5 - 11.2	9.0-13.3	8.2-15.2	8.7-10.0	9.6-11.7	No significant change
5	Abundance	nos./100m ³	7368-50048	5744-6973	6237-7819	4179-6478	5534-7479	6063-7097	7159-10034	Seasonal variation
Benthos										
6	Subtidal	nos./m ²	20-30	240-400	320-400	360-440	280-400	240-360	280-400	No significant change
7	Intertidal	nos./m ²	20-40	105-150	135-180	105-135	75-120	165-195	150-210	No significant change
Microbial count										
8	Water	nos. x10 ³ /ml	0.01-5.31	0.01-5.34	0.01-5.28	0.01-5.31	0.01-5.28	0.02-5.18	0.02-5.02	No significant change
9	Sediment	nos. x10 ⁴ /g	0.01-5.48	0.01-5.45	0.02-5.41	0.01-5.43	0.01-5.36	0.01-5.29	0.01-5.21	No significant change

*For May to August 2020 (1st and 2nd quarterly monitoring season of the year 2020-21), samples not collected due to Nationwide ban on travel due to COVID-19 pandemic.



Water & Sediment sample collection



Plankton Sample collections



Intertidal Benthos sample collection

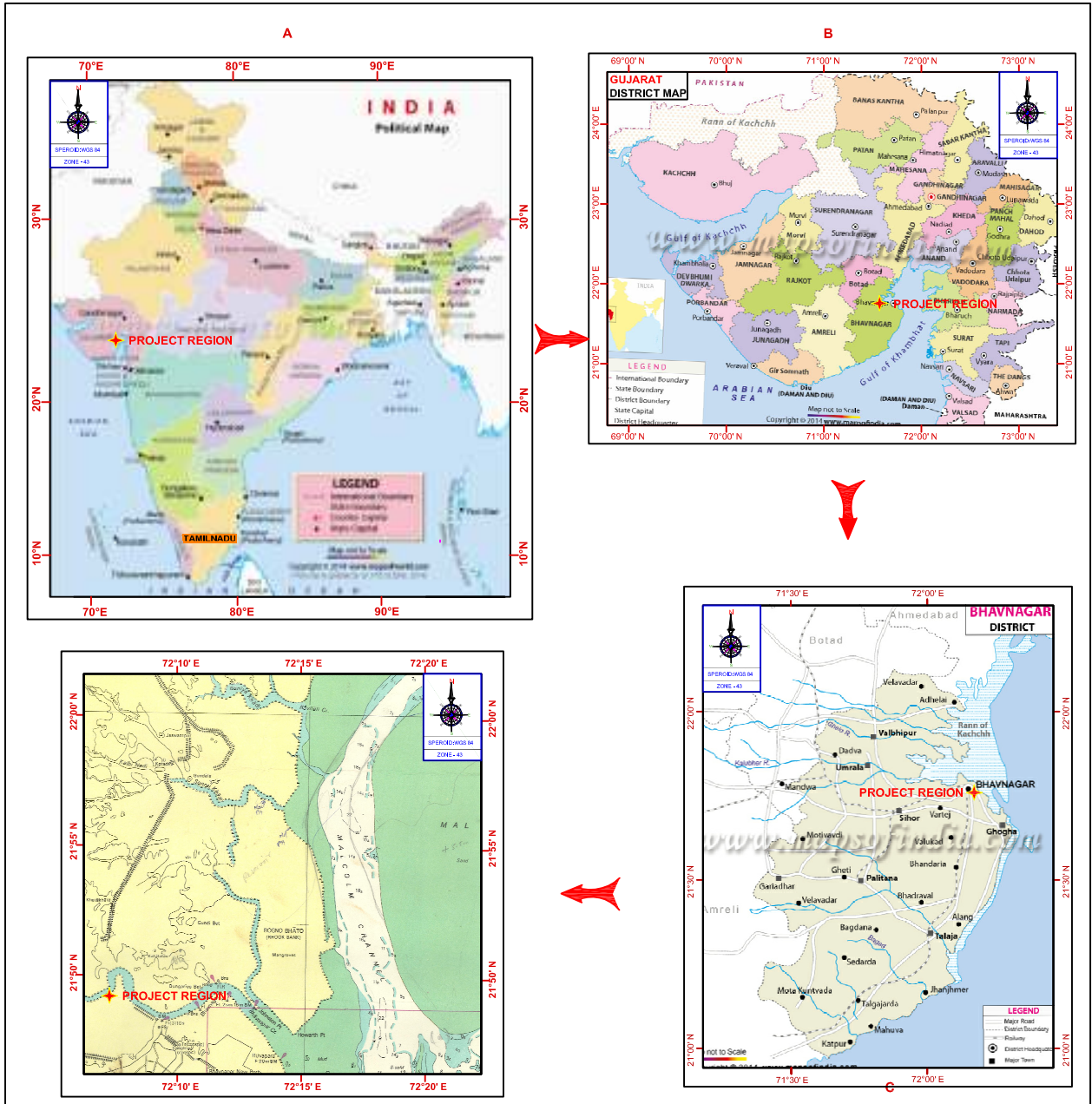


FIG.1. LOCATION MAP

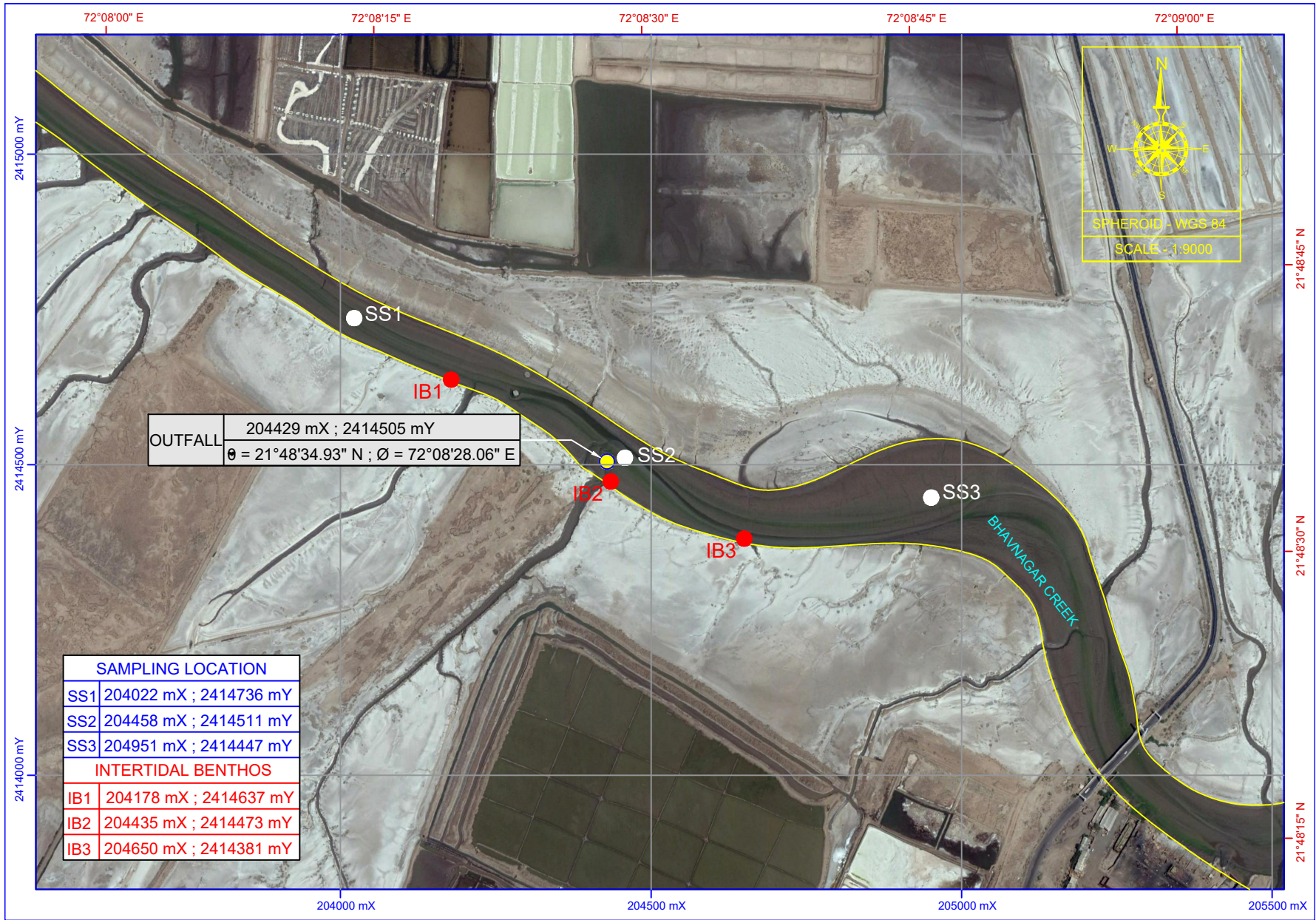


FIG. 2 . SAMPLING LOCATIONS

Annexure I – QCI NABET accreditation certificate

	Quality Council of India National Accreditation Board for Education & Training			
Certificate of Accreditation				
<u>Indomer Coastal Hydraulics (P) Ltd</u> 63, Gandhi Road, Alwar Thirunagar, Chennai 600087				
<i>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:</i>				
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
<i>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.</i>				
<i>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.</i>				
 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



National Accreditation Board for Testing and Calibration Laboratories

(A Constituent Board of Quality Council of India)



26.06.2020

Extension in Validity of Accreditation

NABL Policy: It is decided to extend the validity of accreditation for a period of one year to all conformity assessment bodies (CABs) where renewal of accreditation is to take place and accreditation validity date is between 01.01.2020 and 30.06.2022 **subject to the following:**

1. Providing satisfactory documents based on NABL-218 wrt compliance to the requirements of the relevant Standard and NABL requirements.
2. The CABs are required to conduct additional internal audit to ensure compliance with the standard requirements (by increasing the existing frequency of their audit plan) and submit the document.
3. The CABs are required to provide control charts and trends for assuring the validity of results.
4. CABs are required to provide an undertaking to undergo unannounced assessment (onsite and/or remotely, depending on the situation) and actions as per NABL-216 thereof, at any point of time during the validity period.
5. Making payment of **annual accreditation fee** for the extended period.

Examples:

- Accredited CABs with date of issue 15.01.2018 and valid till 14.01.2020, then their Accreditation validity will be extended till 14.01.2021.
- Accredited CABs with date of issue 15.02.2019 and valid till 14.02.2021, then their Accreditation validity will be extended till 14.02.2022.
- Accredited CABs with date of issue 15.06.2020 and valid till 14.06.2022, then their Accreditation validity will be extended till 14.06.2023

NOTE:

1. The above will be applicable to the laboratories for which transition to ISO/IEC 17025:2017 version has been completed. For the laboratories which are accredited as per ISO/IEC 17025:2005 version, they have to undergo transition assessment (onsite and/or remotely, depending on the situation) and follow transition plan defined.
2. The above is not applicable to CABs where there will be a change in name of CAB and/or legal identity change and/or Premises change.
3. Also, **the above is not applicable to the CABs which are not registered in portal** (exemption- International accredited CABs).
4. Routine assessments will take place for any scope extension /addition.
5. Payment due to NABL can be deferred (postpone the payment) upto a period of Six (6) months. There will be no waive-off of any fee for any CABs. If payments are not made, then action as per procedure (NABL-216) will be initiated. There will be no relaxations wrt payment from 01.01.2021.

N.Venkateswaran
CEO, NABL