



MONITORING OF ENVIRONMENTAL PLAN FOR JN PORT ENVIRONMENTAL MONITORING REPORT

REPORT NO. : UT/ELS/REPORT/EMR-38/2015

Month : January, 2016 & February, 2016

Issue No : 01

Revision No : 00

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1. AMBIENT AIR QUALITY MONITORING

1.1 INTRODUCTION

As per the Environmental Monitoring Plan of Jawaharlal Nehru Port (JNP), Air monitoring locations are selected in port and outside including nearby residential and eco-sensitive areas. Locations of stations are selected based on the significance of sources, receptors and to get representative data. Three fixed stations are identified namely Port Operational Centre (POC), Indian Molasses Company (IMC) and Residential Colony (RC). Three movable locations are also identified namely Elephanta Caves (EC), North Gate Complex (NGC) and South Gate Complex (SGC). The description of stations is given in **Table 1**. The location map of various air quality monitoring stations at JNP is depicted in **Annexure-I**.

Table 1: Description of Ambient Air Monitoring Stations

Station No.	Station	Location	Selection Criterion
1.	POC	At Port Operational Centre	Main Port Activity Location
2.	IMC	At IMC compound in Liquid Chemical Terminal Area	Major industrial activity centre
3.	RC	At JNP residential township	Impact on human population, receptor oriented
4.	EC	At Elephanta Caves	Impact on archaeological site, receptor oriented
5.	NGC	Near North Gate Complex	Heavy traffic movement
6.	SGC	Near South Gate Complex	Heavy traffic movement

1.2 AIR QUALITY MONITORING METHODOLOGY

The objective behind Air Quality monitoring survey is to determine the status of existing ambient air quality in the port and to compare it with CPCB specified standards. Sampling and analysis of ambient air samples are carried out as per CPCB Guidelines for Measurement of Ambient Air Pollutants, Volume-I, NAAQMS/36/2012-2013. The monitoring is carried-out as per air quality parameters mentioned in the National Ambient Air Quality Monitoring Standards (NAAQMS) CPCB Notification published on 18th November 2009. **Annexure-II** represents list of air quality parameters as per NAAQS along with frequency of monitoring.

The monitoring cycle at three fixed stations i.e. POC, IMC and RC is twice a week, while at NGC and SGC it is once a week. However, monitoring at Elephanta Caves is once a month as per schedule of EMP of JNPT.

In all above stations, sampling duration was 24 hour for PM₁₀, PM_{2.5}, SO₂, NO_x, NH₃, Pb, As, Ni, Benzo(α) pyrene, 8 hour for Ozone & Benzene, and Grab-sampling for CO & CO₂ measurements.

After a continuous operation of 8 hours of the sampler, the reagents are replaced to obtain 3 samples per day for each parameter namely, SO₂, NO_x and NH₃. The EPM 2000 filter paper and PTFE Membrane bound filter paper are used for a period of 24 hours to obtain one sample each of PM₁₀ & PM_{2.5}. After PM₁₀ measurement, EPM 2000 filter paper is used for estimation of Pb, As, Ni and Benzo (α) pyrene.

1.3 RESULTS

The ambient air quality monitoring data for three fixed stations, POC, IMC & RC for the month of January, 2016 and February, 2016 are given in **Tables 2, 3 & 4** respectively. The ambient air quality monitoring data for EC and two movable stations, NGC & SGC are given in **Tables 5, 6 & 7** respectively.

Table 2: Results of Air Pollutant Concentration at POC Station of JNP Area during the month of January & February, 2016														
Sampling Period	Date	Time, [Hrs]	PM ₁₀ , [µg/m ³]	PM _{2.5} , [µg/m ³]	SO ₂ , [µg/m ³]	NO _x , [µg/m ³]	8 hr	24 hr (Avg)	8 hr	24 hr (Avg)	NH ₃ , [µg/m ³]	8 hr	24 hr (Avg)	400 µg/m ³
NAAQMS			100 µg/m ³	60 µg/m ³	8 hr	24 hr	8 hr	24 hr (Avg)	8 hr	24 hr (Avg)	8 hr	24 hr (Avg)	8 hr	24 hr (Avg)
POC-1	01.01.2016 to 02.01.2016	14:00 to 22:00			64		35		11					
		22:00 to 06:00	304	110	59		46	55.0	12	40.4			11.5	
		06:00 to 14:00			42		40		11					
POC-2	04.01.2016 to 05.01.2016	14:00 to 22:00			61		72		11					
		22:00 to 06:00	185	69	69		84	71.2	13	78.5			11.9	
		06:00 to 14:00			84		79		11					
POC-3	07.01.2016 to 08.01.2016	14:00 to 22:00			53		45		8					
		22:00 to 06:00	367	141	79		66	65.5	10	58.0			9.0	
		06:00 to 14:00			64		63		9					
POC-4	11.01.2016 to 12.01.2016	14:00 to 22:00			49		52		13					
		22:00 to 06:00	280	120	70		57	60.0	14	56.3			13.6	
		06:00 to 14:00			61		60		14					
POC-5	14.01.2016 to 15.01.2016	14:00 to 22:00			54		63		14					
		22:00 to 06:00	231	160	59		67	58.3	16	63.0			14.4	
		06:00 to 14:00			62		59		14					
POC-6	18.01.2016 to 19.01.2016	14:00 to 22:00			66		70		14					
		22:00 to 06:00	248	85	58		52	56.0	17	63.7			15.3	
		06:00 to 14:00			44		69		15					
POC-7	21.01.2016 to 22.01.2016	14:00 to 22:00			80		71		9					
		22:00 to 06:00	252	90	45		85	61.7	15	68.3			12.5	
		06:00 to 14:00			60		49		13					
POC-8	25.01.2016 to 26.01.2016	14:00 to 22:00			67		64		20					
		22:00 to 06:00	239	86	59		67	56.0	20	65.0			18.9	
		06:00 to 14:00			42		64		17					
POC-9	28.01.2016 to 29.01.2016	14:00 to 22:00			59		75		8					
		22:00 to 06:00	337	185	76		79	68.8	8	76.9			7.8	
		06:00 to 14:00			72		77		7					
POC-1	01.02.2016 to 02.02.2016	14:00 to 22:00			36		61		9					
		22:00 to 06:00	307	120	25		76	27.9	7	64.0			7.8	
		06:00 to 14:00			23		55		7					
POC-2	04.02.2016 to 05.02.2016	14:00 to 22:00			64		55		13					
		22:00 to 06:00	272	119	37		60	43.6	15	60.1			16.8	
		06:00 to 14:00			31		65		22					
POC-3	08.02.2016 to 09.02.2016	14:00 to 22:00			47		32		16					
		22:00 to 06:00	246	123	26		29	33.7	22	32.3			17.1	
		06:00 to 14:00			28		36		13					
POC-4	11.02.2016 to 12.02.2016	14:00 to 22:00			39		27		12					
		22:00 to 06:00	160	48	33		34	36.6	20	30.6			15.8	
		06:00 to 14:00			38		31		15					
Average Standard Dev			264	112				53.4		58.2			13.3	
			57	37				13.8		15.2			3.6	

Table 2: Results of Air Pollutant Concentration at POC Station of JNP Area during the month of January & February, 2016

Table 2: Results of Air Pollutant Concentration at POC Station of JNP Area during the month of January & February, 2016																			
Sampling Period	Date	Time, [Hrs]	NAAQMS										CO ₂ [ppm]						
			O ₃ , [µg/m ³]	8 hr	24 hr	Pb, [µg/m ³]	24 hr	As, [ng/m ³]	24 hr	Ni, [ng/m ³]	24 hr	Cd/Hg, [µg/m ³]	8 hr	24 hr	BaP, [ng/m ³]	1 ng/m ³	CO, [mg/m ³]	Grab Sampling 4 mg/m ³	CO ₂ [ppm]
POC-1	01.01.2016 to 02.01.2016	14:00 to 22:00		18	<0.01	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	<0.5	1.2	231		
		22:00 to 06:00																	
POC-2	04.01.2016 to 05.01.2016	14:00 to 22:00		15	<0.01	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	<0.5	1.0	244		
		22:00 to 06:00																	
POC-3	07.01.2016 to 08.01.2016	14:00 to 22:00		17	<0.01	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	<0.5	1.2	265		
		22:00 to 06:00																	
POC-4	11.01.2016 to 12.01.2016	14:00 to 22:00		34	<0.01	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	<0.5	0.9	211		
		22:00 to 06:00																	
POC-5	14.01.2016 to 15.01.2016	14:00 to 22:00		38	<0.01	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	<0.5	1.5	289		
		22:00 to 06:00																	
POC-6	18.01.2016 to 19.01.2016	14:00 to 22:00		36	<0.01	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	<0.5	1.7	235		
		22:00 to 06:00																	
POC-7	21.01.2016 to 22.01.2016	14:00 to 22:00		38	<0.01	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	<0.5	2.3	220		
		22:00 to 06:00																	
POC-8	25.01.2016 to 26.01.2016	14:00 to 22:00		15	<0.01	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	<0.5	1.0	258		
		22:00 to 06:00																	
POC-9	28.01.2016 to 29.01.2016	14:00 to 22:00		15	<0.01	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	<0.5	0.9	255		
		22:00 to 06:00																	
POC-1	01.02.2016 to 02.02.2016	14:00 to 22:00		46	<0.01	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	<0.5	0.7	238		
		22:00 to 06:00																	
POC-2	04.02.2016 to 05.02.2016	14:00 to 22:00		66	<0.01	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	<0.5	0.7	218		
		22:00 to 06:00																	
POC-3	08.02.2016 to 09.02.2016	14:00 to 22:00		54	<0.01	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	<0.5	1.2	297		
		22:00 to 06:00																	
POC-4	11.02.2016 to 12.02.2016	14:00 to 22:00		38	<0.01	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	<0.5	1.0	244		
		22:00 to 06:00																	
Average	Standard Dev		27													1.2	247		
		17														0.4	26		

Table 3: Results of Air Pollutant Concentration at IMC Station of JNP Area during the month of January & February, 2016

Sampling Period	Date	Time, [Hrs]	PM ₁₀ , [µg/m ³]		PM _{2.5} , [µg/m ³]		SO ₂ , [µg/m ³]		NO _x , [µg/m ³]		NH ₃ , [µg/m ³]	
			24 hr	100 µg/m ³	24 hr	60 µg/m ³	8 hr	24 hr (Avg)	8 hr	24 hr (Avg)	8 hr	24 hr (Avg)
NAAQMS												
IMC-1	01.01.2016 to 02.01.2016	15:00 to 23:00	337		197		64		58		8	
		23:00 to 07:00					68	71	65	60.8	9	8.5
		07:00 to 15:00					80		60		9	
IMC-2	04.01.2016 to 05.01.2016	15:05 to 23:05	389		264		73		32		10	
		23:05 to 07:05					84	75	45	37.4	13	11.6
		07:05 to 15:05					69		35		12	
IMC-3	07.01.2016 to 08.01.2016	15:10 to 23:10	306		142		64		64		12	
		23:10 to 07:10					90	77	79	76.6	15	13.3
		07:10 to 15:10					75		87		13	
IMC-4	11.01.2016 to 12.01.2016	14:50 to 22:50	254		195		69		62		14	
		22:50 to 06:50					82	75	56	65.9	17	14.8
		06:50 to 14:50					73		80		14	
IMC-5	14.01.2016 to 15.01.2016	15:00 to 23:00	176		98		85		85		15	
		23:00 to 07:00					76	71	87	71.3	17	15.9
		07:00 to 15:00					52		42		16	
IMC-6	18.01.2016 to 19.01.2016	15:00 to 23:00	205		115		68		62		11	
		23:00 to 07:00					81	72.3	79	73.3	15	12.6
		07:00 to 15:00					67		80		12	
IMC-7	21.01.2016 to 22.01.2016	15:00 to 23:00	335		284		48		62		12	
		23:00 to 07:00					84	66.7	68	65.3	14	13.2
		07:00 to 15:00					68		66		13	
IMC-8	25.01.2016 to 26.01.2016	15:00 to 23:00	341		224		63		42		14	
		23:00 to 07:00					91	76.8	47	44.7	17	14.4
		07:00 to 15:00					76		45		12	
IMC-9	28.01.2016 to 29.01.2016	15:00 to 23:00	274		179		58		62		7	
		23:00 to 07:00					63	59.3	67	64.5	14	9.8
		07:00 to 15:00					57		64		8	
IMC-1	01.02.2016 to 02.02.2016	15:00 to 23:00	297		196		42		74		17	
		23:00 to 07:00					40	49.4	81	72.7	12	16.6
		07:00 to 15:00					65		63		20	
IMC-2	04.02.2016 to 05.02.2016	15:00 to 23:00	234		166		56		66		10	
		23:00 to 07:00					48	51.3	64	65.2	9	10.0
		07:00 to 15:00					50		66		11	
IMC-3	08.02.2016 to 09.02.2016	15:00 to 23:00	210		111		47		61		15	
		23:00 to 07:00					21	34.0	34	37.2	11	12.8
		07:00 to 15:00					34		16		12	
IMC-4	11.02.2016 to 12.02.2016	15:00 to 23:00	172		70		18		34		16	
		23:00 to 07:00					37	37.2	39	30.9	12	15.8
		07:00 to 15:00					57		20		19	
Average Standard Dev			272		172			62.7		58.9		13.0
			69		64			15.1		15.7		2.5

Table 3: Results of Air Pollutant Concentration at IMC Station of JNP Area during the month of January & February, 2016

Sampling Period	Date	Time, [Hrs]	0.1												CO ₂ [ppm]		
			O ₃ , [µg/m ³]		Pb, [µg/m ³]		As, [ng/m ³]		Ni, [ng/m ³]		C ₆ H ₆ , [µg/m ³]		BaP, [ng/m ³]			Grab Sampling	CO ₂ [mg/m ³]
			8 hr	100 µg/m ³	24 hr	1.0 µg/m ³	24 hr	6 ng/m ³	24 hr	20 ng/m ³	8 hr	5 µg/m ³	24 hr	1 ng/m ³			
NAAQMS	01.01.2016 to 02.01.2016	15:00 to 23:00															
IMC-1	02.01.2016 to 04.01.2016	23:00 to 07:00	26	<0.01	<1	<1	<1	<1	<1	1.8	<0.5	<0.5	1.9	235			
		07:00 to 15:00															
IMC-2	04.01.2016 to 05.01.2016	15:05 to 23:05	34	<0.01	<1	<1	<1	<1	<1	<1	<0.5	<0.5	2.6	297			
		23:05 to 07:05															
IMC-3	07.01.2016 to 08.01.2016	15:10 to 23:10	28	<0.01	<1	<1	<1	<1	<1	<1	<0.5	<0.5	1.0	220			
		23:10 to 07:10															
IMC-4	11.01.2016 to 12.01.2016	14:50 to 22:50	46	<0.01	<1	<1	<1	<1	<1	<1	<0.5	<0.5	1.3	285			
		22:50 to 06:50															
IMC-5	14.01.2016 to 15.01.2016	06:50 to 14:50															
		15:00 to 23:00	10	<0.01	<1	<1	<1	<1	<1	<1	<0.5	<0.5	1.1	264			
IMC-6	18.01.2016 to 19.01.2016	23:00 to 07:00															
		07:00 to 15:00	15	<0.01	<1	<1	<1	<1	<1	1.6	<0.5	<0.5	1.7	295			
IMC-7	21.01.2016 to 22.01.2016	15:00 to 23:00															
		07:00 to 15:00	17	<0.01	<1	<1	<1	<1	<1	1.2	<0.5	<0.5	1.5	215			
IMC-8	25.01.2016 to 26.01.2016	15:00 to 23:00															
		07:00 to 15:00	12	<0.01	<1	<1	<1	<1	<1	<1	<0.5	<0.5	1.2	214			
IMC-9	28.01.2016 to 29.01.2016	15:00 to 23:00															
		07:00 to 15:00	13	<0.01	<1	<1	<1	<1	<1	<1	<0.5	<0.5	1.8	274			
IMC-1	01.02.2016 to 02.02.2016	15:00 to 23:00															
		07:00 to 15:00	58	<0.01	<1	<1	<1	<1	<1	1.9	<0.5	<0.5	1.0	215			
IMC-2	04.02.2016 to 05.02.2016	15:00 to 23:00															
		07:00 to 15:00	50	<0.01	<1	<1	<1	<1	<1	<1	<0.5	<0.5	1.6	255			
IMC-3	08.02.2016 to 09.02.2016	15:00 to 23:00															
		07:00 to 15:00	30	<0.01	<1	<1	<1	<1	<1	<1	<0.5	<0.5	0.5	236			
IMC-4	11.02.2016 to 12.02.2016	15:00 to 23:00															
		07:00 to 15:00	26	<0.01	<1	<1	<1	<1	<1	1.1	<0.5	<0.5	0.6	218			
Average			23							1.5			1.4	248			
Standard Dev			13							0.4			0.6	32			

Table 4: Results of Air Pollutant Concentration at RC School Station of JNP Area during the month of January & February, 2016

Sampling Period NAAQMS	Date	Time, [Hrs]	PM ₁₀ , [µg/m ³]		PM _{2.5} , [µg/m ³]		SO ₂ , [µg/m ³]		NO _x , [µg/m ³]		NH ₃ , [µg/m ³]	
			100 µg/m ³ 24 hr	60 µg/m ³ 24 hr	80 µg/m ³ 24 hr	80 µg/m ³ 24 hr	8 hr	24 hr (Avg)	8 hr	24 hr (Avg)	8 hr	24 hr (Avg)
RC-1	01.01.2016 to 02.01.2016	15:20 to 23:20					47		43		10	
		23:20 to 07:20	313	80		54	60		50		12	10.7
		07:20 to 15:20					54		41		11	
RC-2	04.01.2016 to 05.01.2016	15:30 to 23:30					50		40		7	
		23:30 to 07:30	330	78		52	56		43		10	8.3
		07:30 to 15:30					49		41		8	
RC-3	07.01.2016 to 08.01.2016	15:35 to 23:35					59		54		7	
		23:35 to 07:35	411	51		72	89		87		9	7.9
		07:35 to 15:35					68		80		8	
RC-4	11.01.2016 to 12.01.2016	15:30 to 23:30					51		43		5	
		23:30 to 07:30	322	54		63	76		93		8	6.0
		07:30 to 15:30					61		68		6	
RC-5	14.01.2016 to 15.01.2016	15:30 to 23:30					53		79		8	
		23:30 to 07:30	247	140		77	105		63		12	10.0
		07:30 to 15:30					74		89		10	
RC-6	18.01.2016 to 19.01.2016	15:30 to 23:30					48		69		9	
		23:30 to 07:30	238	55		55	60		77		13	11.2
		07:30 to 15:30					56		78		12	
RC-7	21.01.2016 to 22.01.2016	15:30 to 23:30					60		62		14	
		23:30 to 07:30	330	79		71	78		76		18	16.3
		07:30 to 15:30					74		72		17	
RC-8	25.01.2016 to 26.01.2016	15:30 to 23:30					53		43		9	
		23:30 to 07:30	245	59		64	74		46		12	10.0
		07:30 to 15:30					64		45		9	
RC-9	28.01.2016 to 29.01.2016	15:30 to 23:30					51		34		8	
		23:30 to 07:30	336	226		55	61		38		9	7.9
		07:30 to 15:30					54		34		7	
RC-1	01.02.2016 to 02.02.2016	15:30 to 23:30					46		43		9	
		23:30 to 07:30	359	91		39	25		63		14	14.8
		07:30 to 15:30					44		56		21	
RC-2	04.02.2016 to 05.02.2016	15:30 to 23:30					35		38		14	
		23:30 to 07:30	271	60		23	20		34		21	14.0
		07:30 to 15:30					15		62		7	
RC-3	08.02.2016 to 09.02.2016	15:30 to 23:30					28		34		16	
		23:30 to 07:30	254	57		20	21		25		12	12.6
		07:30 to 15:30					10		15		9	
RC-4	11.02.2016 to 12.02.2016	15:30 to 23:30					57		13		25	
		23:30 to 07:30	182	26		40	36		37		25	25.6
		07:30 to 15:30					27		34		27	
Average Standard Dev			182	81		52.5						11.9
			62	51		17.9						5.1

Table 4: Results of Air Pollutant Concentration at RC Station of JNP Area during the month of January & February, 2016

Sampling Period	Date	Time, [Hrs]	O ₃ , [µg/m ³]	8 hr	Pb, [µg/m ³]	24 hr	1.0 µg/m ³	As, [µg/m ³]	24 hr	6 ng/m ³	Ni, [ng/m ³]	24 hr	20 ng/m ³	C ₆ H ₆ , [µg/m ³]	8 hr	5 µg/m ³	BaP, [ng/m ³]	24 hr	1 ng/m ³	CO, [mg/m ³]	Grab Sampling	CO ₂ , [ppm]
NAAQMS			100 µg/m ³																			
RC-1	01.01.2016 to 02.01.2016	15:20 to 23:20		16		<0.01	<1		<1		<1		<1		<1		<0.5		<0.5	1.0	Grab Sampling	284
		23:20 to 07:20																				
RC-2	04.01.2016 to 05.01.2016	15:30 to 23:30		9		<0.01	<1		<1		<1		<1		<1		<0.5		<0.5	1.2	Grab Sampling	236
		23:30 to 07:30																				
RC-3	07.01.2016 to 08.01.2016	15:35 to 23:35		26		<0.01	<1		<1		<1		<1		<1		<0.5		<0.5	1.9	Grab Sampling	212
		23:35 to 07:35																				
RC-4	11.01.2016 to 12.01.2016	15:30 to 23:30		42		<0.01	<1		<1		<1		<1		<1		<0.5		<0.5	1.3	Grab Sampling	277
		23:30 to 07:30																				
RC-5	14.01.2016 to 15.01.2016	15:30 to 23:30		36		<0.01	<1		<1		<1		<1		1.4		<0.5		<0.5	0.5	Grab Sampling	245
		23:30 to 07:30																				
RC-6	18.01.2016 to 19.01.2016	15:30 to 23:30		28		<0.01	<1		<1		<1		<1		<1		<0.5		<0.5	1.7	Grab Sampling	298
		23:30 to 07:30																				
RC-7	21.01.2016 to 22.01.2016	15:30 to 23:30		14		<0.01	<1		<1		<1		<1		1.4		<0.5		<0.5	2.0	Grab Sampling	296
		23:30 to 07:30																				
RC-8	25.01.2016 to 26.01.2016	15:30 to 23:30		16		<0.01	<1		<1		<1		<1		1.2		<0.5		<0.5	1.0	Grab Sampling	244
		23:30 to 07:30																				
RC-9	28.01.2016 to 29.01.2016	15:30 to 23:30		17		<0.01	<1		<1		<1		<1		1.5		<0.5		<0.5	1.3	Grab Sampling	268
		23:30 to 07:30																				
RC-1	01.02.2016 to 02.02.2016	15:30 to 23:30		50		<0.01	<1		<1		<1		<1		1.3		<0.5		<0.5	0.9	Grab Sampling	237
		23:30 to 07:30																				
RC-2	04.02.2016 to 05.02.2016	15:30 to 23:30		74		<0.01	<1		<1		<1		<1		1.1		<0.5		<0.5	1.7	Grab Sampling	251
		23:30 to 07:30																				
RC-3	08.02.2016 to 09.02.2016	15:30 to 23:30		36		<0.01	<1		<1		<1		<1		<1		<0.5		<0.5	1.5	Grab Sampling	279
		23:30 to 07:30																				
RC-4	11.02.2016 to 12.02.2016	15:30 to 23:30		18		<0.01	<1		<1		<1		<1		<1		<0.5		<0.5	2.0	Grab Sampling	212
		23:30 to 07:30																				
Average				17											1.3					1.4	Grab Sampling	257
				15											0.1					0.5	Grab Sampling	29
Standard Dev																						

Table 5: Results of Air Pollutant Concentration at EC Station monitored during January & February, 2016

Sampling Period	Date	Time, [Hrs]	PM ₁₀ , [µg/m ³]		PM _{2.5} , [µg/m ³]		SO ₂ , [µg/m ³]		NO _x , [µg/m ³]		NH ₃ , [µg/m ³]	
			24 hr	100 µg/m ³	24 hr	60 µg/m ³	8 hr	24 hr (Avg)	8 hr	24 hr (Avg)	8 hr	24 hr (Avg)
NAAQMS	04.01.2016 to 05.01.2016	14:00 to 22:00					66					
		22:00 to 06:00	163		25		88	76	76	72.2	14	12.8
		06:00 to 14:00					73		72		13	
EC												

Table 5: Results of Air Pollutant Concentration at EC Station monitored during January & February, 2016

Sampling Period	Date	Time, [Hrs]	O ₃ , [µg/m ³]		Pb, [µg/m ³]	As, [ng/m ³]		Ni, [ng/m ³]		C ₆ H ₆ , [µg/m ³]		BaP, [ng/m ³]		CO, [mg/m ³]		CO ₂ , [ppm]	
			8 hr	24 hr	24 hr	24 hr	24 hr	24 hr	8 hr	24 hr	24 hr	1 ng/m ³	4 ng/m ³	Grab Sampling	Grab Sampling		
NAAQMS	04.01.2016 to 05.01.2016	14:00 to 22:00	100 µg/m ³	1.0 µg/m ³	1.0 µg/m ³	6 ng/m ³	20 ng/m ³	5 µg/m ³	1 ng/m ³	4 ng/m ³	-						
		22:00 to 06:00	16	<0.01	<1	<1	<0.5	0.4	245								
		06:00 to 14:00															
EC																	

Table 6: Results of Air Pollutant Concentration at NGC Station of JNP Area during the month of January & February, 2016

Sampling Period	Date	Time, [Hrs]	PM ₁₀ , [µg/m ³]		PM _{2.5} , [µg/m ³]		SO ₂ , [µg/m ³]		NO _x , [µg/m ³]		NH ₃ , [µg/m ³]	
			24 hr	100 µg/m ³	24 hr	60 µg/m ³	8 hr	24 hr (Avg)	8 hr	24 hr (Avg)	8 hr	24 hr (Avg)
NGC-1	01.01.2016 to 02.01.2016	16:00 to 00:00					77		65		12	
		00:00 to 08:00	367		131		78	72.3	74	69.2	12	12.1
		08:00 to 16:00					62		69		12	
NGC-2	07.01.2016 to 08.01.2016	15:50 to 23:50					70		68		5	
		23:50 to 07:50	351		78		55	68.6	76	75.4	10	7.0
		07:50 to 15:50					81		82		6	
NGC-3	14.01.2016 to 15.01.2016	15:40 to 23:40					92		87		12	
		23:40 to 07:40	255		54		52	69.5	79	76.7	12	12.0
		07:40 to 15:40					64		64		12	
NGC-4	18.01.2016 to 19.01.2016	15:40 to 23:40					82		76		9	
		23:40 to 07:40	286		81		64	76.9	63	76.4	12	10.5
		07:40 to 15:40					85		90		10	
NGC-5	28.01.2016 to 29.01.2016	15:40 to 23:40					46		59		8	
		23:40 to 07:40	322		105		56	48.4	77	70.0	12	8.8
		07:40 to 15:40					44		74		6	
NGC-1	04.02.2016 to 05.02.2016	15:40 to 23:40					13		74		20	
		23:40 to 07:40	317		62		12	17.0	48	53.3	6	12.7
		07:40 to 15:40					26		38		12	
NGC-2	11.02.2016 to 12.02.2016	15:40 to 23:40					11		27		16	
		23:40 to 07:40	168		51		28	18.6	19	26.6	19	19.5
		07:40 to 15:40					17		34		23	
Average			295		80			53.1		63.9		11.8
Standard Dev			68		29			25.7		18.3		4.0

Table 6: Results of Air Pollutant Concentration at NGC Station of JNP Area during the month of January & February, 2016												
Sampling Period	Date	Time, [Hrs]	O ₃ , [µg/m ³]	Pb, [µg/m ³]	As, [µg/m ³]	24 hr 6 ng/m ³	24 hr 1.0 µg/m ³	24 hr 20 ng/m ³	8 hr 5 µg/m ³	BaP, [ng/m ³]	CO, [mg/m ³]	CO ₂ , [ppm]
NAAQMS			8 hr 100 µg/m ³	24 hr 1.0 µg/m ³	24 hr 6 ng/m ³	24 hr 20 ng/m ³	24 hr 1 ng/m ³	24 hr 1 ng/m ³	8 hr 5 µg/m ³	24 hr 1 ng/m ³	Grab Sampling 4 mg/m ³	Grab Sampling -
NGC-1	01.01.2016	16:00 to 00:00										
	to	00:00 to 08:00	18	<0.01	<1	<1	<1	<1	1.4	<0.5	1.9	287
NGC-2	02.01.2016	08:00 to 16:00										
	to	23:50 to 07:50	14	<0.01	<1	<1	<1	<1	<1	<0.5	0.3	296
NGC-3	08.01.2016	15:50 to 23:50										
	to	07:50 to 15:50										
NGC-4	14.01.2016	15:40 to 23:40										
	to	23:40 to 07:40	14	<0.01	<1	<1	<1	<1	<1	<0.5	0.9	215
NGC-5	15.01.2016	07:40 to 15:40										
	to	15:40 to 23:40	26	<0.01	<1	<1	<1	<1	<1	<0.5	1.7	236
NGC-1	19.01.2016	07:40 to 15:40										
	to	15:40 to 23:40	18	<0.01	<1	<1	<1	<1	1.2	<0.5	1.2	248
NGC-2	28.01.2016	15:40 to 23:40										
	to	23:40 to 07:40	68	<0.01	<1	<1	<1	<1	1.4	<0.5	1.1	295
NGC-3	29.01.2016	07:40 to 15:40										
	to	15:40 to 23:40	44	<0.01	<1	<1	<1	<1	<1	<0.5	0.9	213
NGC-4	04.02.2016	15:40 to 23:40										
	to	23:40 to 07:40	27	<0.01	<1	<1	<1	<1	1.3	<0.5	1.1	256
NGC-5	05.02.2016	07:40 to 15:40										
	to	15:40 to 23:40	17	<0.01	<1	<1	<1	<1	0.1	<0.5	0.5	37
Average												
Standard Dev												

Table 7: Results of Air Pollutant Concentration at SGC Station of JNP Area during the month of January & February, 2016														
Sampling Period NAAQMS	Date	Time, [Hrs]	PM ₁₀ , [µg/m ³] 24 hr 100 µg/m ³	PM _{2.5} , [µg/m ³] 24 hr 60 µg/m ³	SO ₂ , [µg/m ³]		NO _x , [µg/m ³]		NH ₃ , [µg/m ³]					
					8 hr -	24 hr (Avg) 80 µg/m ³	8 hr -	24 hr (Avg) 80 µg/m ³	8 hr -	24 hr (Avg) 400 µg/m ³				
SGC-1	04.01.2016 to 05.01.2016	16:30 to 00:30	357	117	43	45.2	70	71.6	9	10.4				
		00:30 to 08:30			47		57		12					
		08:30 to 16:30			45		88		11					
SGC-2	11.01.2016 to 12.01.2016	16:15 to 00:15	370	98	55	78.6	70	75.3	12	13.4				
		00:15 to 08:15			99		75		14					
		08:15 to 16:15			82		81		14					
SGC-3	21.01.2016 to 22.01.2016	16:15 to 00:15	234	97	92	74.8	83	65.1	8	9.6				
		00:15 to 08:15			81		59		12					
		08:15 to 16:15			51		53		9					
SGC-4	25.01.2016 to 26.01.2016	16:15 to 00:15	286	78	69	72.2	74	76.2	3	4.6				
		00:15 to 08:15			75		80		5					
		08:15 to 16:15			72		75		6					
SGC-1	01.02.2016 to 02.02.2016	16:15 to 00:15	316	104	63	34.3	78	77.9	22	17.0				
		00:15 to 08:15			27		76		15					
		08:15 to 16:15			13		80		14					
SGC-2	08.02.2016 to 09.02.2016	16:15 to 00:15	268	75	28	20.2	67	50.5	23	22.3				
		00:15 to 08:15			14		36		27					
		08:15 to 16:15			18		48		17					
Average			305	95		54.2		69.4		12.9				
Standard Dev			53	16		24.4		10.3		6.2				

Sampling Period	Date	Time, [Hrs]	NAAQMS										CO ₂ , [ppm]	
			O ₃ , [µg/m ³]	Pb, [µg/m ³]	As, [ng/m ³]	24 hr	24 hr	24 hr	24 hr	8 hr	24 hr	24 hr		Grab Sampling
			100 µg/m ³	1.0 µg/m ³	6 ng/m ³	20 ng/m ³	5 µg/m ³	1 ng/m ³	4 mg/m ³					
SGC-1	04.01.2016 to 05.01.2016	16:30 to 00:30												
		00:30 to 08:30	30	<0.01	<1	<1	1.6	<0.5	1.2					
		08:30 to 16:30												
SGC-2	11.01.2016 to 12.01.2016	16:15 to 00:15	17	<0.01	<1	<1	1.2	<0.5	1.9					
		00:15 to 08:15												
		08:15 to 16:15												
SGC-3	21.01.2016 to 22.01.2016	16:15 to 00:15	9	<0.01	<1	<1	<1	<0.5	0.6					
		00:15 to 08:15												
		08:15 to 16:15												
SGC-4	25.01.2016 to 26.01.2016	16:15 to 00:15	18	<0.01	<1	<1	<1	<0.5	1.7					
		00:15 to 08:15												
		08:15 to 16:15												
SGC-1	01.02.2016 to 02.02.2016	16:15 to 00:15	50	<0.01	<1	<1	1.2	<0.5	1.2					
		00:15 to 08:15												
		08:15 to 16:15												
SGC-2	08.02.2016 to 09.02.2016	16:15 to 00:15	22	<0.01	<1	<1	<1	<0.5	0.9					
		00:15 to 08:15												
		08:15 to 16:15												
Average			22				1.2		1.3			254		
Standard Dev			12						0.5			37		

1.4 DISCUSSION

In **Table 8**, the average values of air pollutants are provided at various stations of JNP area for January, 2016 & February, 2016. The values obtained are compared with respective CPCB standards described for Industrial, Residential, Rural and ecologically sensitive areas. The values obtained for As, Ni and Benzo (α) Pyrene [BaP] are below detection limits of measurements at all air monitoring stations and hence these parameters are not included in **Table 8**.

Table 8: Monthly Average Values of Air Pollutants at Various Stations in JNP Area during January, 2016 & February, 2016

STATION	PM ₁₀ , [$\mu\text{g}/\text{m}^3$]	PM _{2.5} , [$\mu\text{g}/\text{m}^3$]	SO ₂ , [$\mu\text{g}/\text{m}^3$]	NO _x , [$\mu\text{g}/\text{m}^3$]	NH ₃ , [$\mu\text{g}/\text{m}^3$]	O ₃ , [$\mu\text{g}/\text{m}^3$]	Pb [$\mu\text{g}/\text{m}^3$]	C ₆ H ₆ , [$\mu\text{g}/\text{m}^3$]	CO, [mg/m ³]	CO ₂ , [ppm]
NAAQMS	100	60	80	80	400	100	1	5	4	-
INDUSTRIAL AREA										
POC	264 \pm 57	112 \pm 37	53.4 \pm 13.8	58.2 \pm 15.2	13.3 \pm 3.6	27 \pm 17	<0.01	1.4 \pm 0.2	1.2 \pm 0.4	247 \pm 33
IMC	272 \pm 69	172 \pm 64	62.7 \pm 15.1	58.9 \pm 15.7	13.0 \pm 2.5	23 \pm 13	<0.01	1.5 \pm 0.4	1.4 \pm 0.6	248 \pm 32
NG	295 \pm 68	80 \pm 29	53.1 \pm 25.7	63.9 \pm 18.3	11.8 \pm 4.0	27 \pm 17	<0.01	1.3 \pm 0.1	1.1 \pm 0.5	256 \pm 37
SG	305 \pm 53	95 \pm 16	54.2 \pm 24.4	69.4 \pm 10.3	12.9 \pm 6.2	22 \pm 12	<0.01	1.2	1.3 \pm 0.5	254 \pm 37
RESIDENTIAL AREA										
RC	182 \pm 62	81 \pm 51	52.5 \pm 17.9	52.4 \pm 18.3	11.9 \pm 5.1	17 \pm 15	<0.01	1.3 \pm 0.1	1.4 \pm 0.5	257 \pm 29
ECO-SENSITIVE AREA										
EC	163	25	76	72.2	12.8	16	<0.01	<1	0.4	245

During the monitoring period, the overall Ambient Air Quality of the port area was found to be complied with the desired levels for various pollutants except PM₁₀ & PM_{2.5}. Daily average pollutant levels are presented in **Tables 2** through **7**.

The concentrations obtained for PM₁₀ at all stations were found to be exceeding the prescribed CPCB limits [100 $\mu\text{g}/\text{m}^3$]; while, PM_{2.5} values were found to be complying at location EC for rest other locations values are exceeding the prescribed CPCB limits [60 $\mu\text{g}/\text{m}^3$].

Results for the air quality parameters at Elephanta Caves [EC] station during 04th January'16 to 05th January'16 are represented in **Table 5**. **Tables 6** & **7** provide the results for NGC and SGC air monitoring stations respectively.

In January'15 & February'16, gaseous pollutants were well within the prescribed limits, set for industrial as well as sensitive areas.

1.5 OBSERVATIONS AND CONCLUSIONS

The environmental implications of a port and harbor operational activities must be considered prior to further developments. The process of environmental assessment involves an analysis of the quality of the existing environment due to the port and harbor operational activities and any degradation in the environmental quality because of the execution of additional developmental expansions within the region. Keeping in view the above said objectives, the present environmental monitoring study has been conducted for the JNP to assess Ambient Air Quality. Following are the monthly observations.

Observations for the month of January'16 & February'16:

- ✓ All the public and community buildings in residential complex / township are under Renovation. Being temporary activity; it will not affect ambient air quality in long run. Existing Ambient air Quality of RC station is well within CPCB permissible limits except for PM₁₀ and PM_{2.5}, which are higher than the prescribed CPCB standard.
- ✓ *Construction of 4th Container Terminal on South side of JNPT:* Land preparation work of 4th C.T. is underway: The transportation of soil and earth shall be considered a vital part as it is potential source of particulates. The overall ambient air quality around the Port area shows no adverse effect. Increase in the PM₁₀ and PM_{2.5} Concentration at South Gate may be attributed to the earth filling activity of 4th C.T. where the Dumpers carrying earth filling materials were ferrying without any tarpaulin cover and heavy traffic movement at SGC.
- ✓ *Construction of NSIGT Yard is underway to the North side of JNPT:* The nearest Ambient Air Monitoring location is North gate Complex. The overall values of gaseous parameters are well within the CPCB limits except for PM₁₀ and PM_{2.5} Concentration which are found exceeding the CPCB limits. The development of yard for NSIGT and heavy vehicular movement causing the elevated values of PM₁₀ and PM_{2.5} Concentration at NGC.
- ✓ *Vehicular Traffic at three gates:* The monitoring of ambient air Quality at South and North gate complexes has been done once a week. The location is covered by large control sections and dense tree cover accounting as pollutant trap. The initiative taken by the port in terms of maintenance of port vehicles, PUC checking of vehicles visiting port and enough green cover provided in and around the area contributes significantly to reduce overall pollution.
- ✓ Road connecting tank farm and township is being updated with construction of over bridge on the railway crossing. Land preparation and foundation work continued during the month of January'16 for the Rail over bridge. Nearest location i.e. RC does not show any adverse impact due to this activity. All the AAQM parameters are well within the prescribed CPCB limits except the values of PM₁₀ and PM_{2.5}.

The following measures can be taken to reduce further the PM_{10} and $PM_{2.5}$ levels in and around the port area:

- ✓ Renovation work, being carried out at JNP Township, should be executed under controlled conditions.
- ✓ Debris and raw material carrying trucks must be covered with tarpaulin sheet during transportation.
- ✓ Minimizing emissions by regular maintenance and PUC checkup of vehicles.
- ✓ Increasing the plantations in and around the port area as well as developing and maintaining thick green cover on both sides of the roads and tank farms.
- ✓ Cleaning and maintaining of paved and unpaved roads regularly to remove spillage of earth/soil material.

	
Civil Work at JNP Township	Land Preparation at 4th Container Terminal
	
Construction of yard near POC	NSIGT Yard filling work

Conclusion:

From the results obtained for the month of January and February, 2016 it can be concluded that overall Ambient Air quality of the JN Port is within CPCB limits, except the levels of PM_{10} and $PM_{2.5}$, which are higher at all locations due to port development activities.

2. MARINE WATER QUALITY MONITORING [HARBOR& CREEK] INCLUDING STUDY OF SEDIMENT CHARACTERISTICS

2.1 INTRODUCTION

For study of Marine ecology, Total 8 fixed harbor stations [W1 to W7 and W9] and 1 movable station [W8/W10] are identified. At Nhava creek 4 fixed stations [W11 to W14] are identified. All above mentioned stations are selected for studying aquatic flora and fauna as well as benthic fauna. The description of stations is mentioned in **Table 9**. The location map of various Marine ecology monitoring stations along with direction of towing is depicted in **Annexure-IV**.

2.2 MARINE WATER QUALITY MONITORING METHODOLOGY

The objective of Marine water quality monitoring is to assess compliance with statutory water quality objectives, to reveal long term changes in water quality and to provide a basis for the planning of pollution control strategies.

Harbor Water Quality Monitoring – Three samples from the surface, mid depth and bottom are collected during spring and neap tidal cycle. The samples are taken after 1st, 3rd and 5th hour of the tide from eight fixed and one moving stations and composited from each harbor water quality monitoring station. In all 54 samples are collected from nine stations.

Creek Water Quality Monitoring– Three samples from the surface, mid depth and bottom are collected and composited from four water quality monitoring stations in the Nhava Creek during spring and 3rd hour of neap tide only because of very low water depth available (mud flat) at these stations. In all 24 samples are collected from four Nhava creek stations.

Study of Sediment Characteristics – Sediment samples are collected from all 13 stations.

The list of parameters analyzed to assess the Marine Water Quality is presented in **Table 10** along with parameters monitored for sediment characterization. Annexure-V describes Primary Water Quality Criterion for **Class SW-IV** Waters (For Harbor Waters).

Table 9: Description of Marine Water Quality Monitoring Stations

Sr. No.	Station	Description	Date of Sampling
1.	W1	Between Elephanta and Nhava Islands, and can be identified at the last green buoy no. <u>F1Green</u> of JNPT approach channel and just opposite to ONGC Depot at the Nhava Island.	4 th January, 2016
2.	W2	Denoted by buoy no. <u>FG2 RED</u> of JNPT channel. It is near the Elephanta Island, and opposite to Port Craft Jetty	4 th January, 2016
3.	W3	Identified by the green buoy no. <u>FG2 Green</u> of JNPT approach channel and lies near the landing jetty.	5 th January, 2016
4.	W4	Located at Uran Patch Beacon (lighthouse on concrete platform) near the Butcher Island filling platform.	5 th January, 2016
5.	W5	W5 is near to the guide bund and others are along Nhava creek upto Belpada. These are selected to examine the impact of neighboring Nhava Villages and Belpadato the creek water quality.	4 th January, 2016
	W11 to W14		6 th January, 2016
6.	W6	This is a mobile station and hence its location is changed during every visit. This sampling station was selected in order to examine the variation of water quality in the area not represented by the fixed stations.	4 th January, 2016
7.	W7	This station is located near landing jetty. This station was selected in order to examine the water quality due to liquid cargo jetty.	5 th January, 2016
8.	W9	Located in between GTI and Liquid Cargo Jetty. This station is selected to examine the impact of terminal activities on water qualities	5 th January, 2016
9.	W8/W10	Located near proposed chemical berth. These stations are variable and selected to examine the impact of proposed chemical terminal and IVth Container terminal activities on water quality.	5 th January, 2016

Table 10: List of Parameters Monitored for Marine Water Quality

Marine Water Quality Parameters [Harbor Area & Creek Area]
A] Physical parameters of Water: Depth, Temperature, pH, Salinity, Turbidity, Total Solids, Total Dissolved Solids, Total Suspended Solids.
B] Bio-chemical Analysis of Water: Dissolved Oxygen, COD [Chemical Oxygen Demand], BOD [Biochemical Oxygen Demand], NH ₃ - N, Phenol, Oil & Grease, SPC [Standard Plate Count], Bacteriological count [MPN], Fecal Coliform
C] Sediment Analysis: Total Organic Matter, Organic Carbon, Inorganic Phosphates

2.3 RESULTS

The marine water quality data for nine Harbor water quality monitoring stations are presented in **Table 11** for Physico-chemical parameters, **Table 12** for Bio-chemical parameters and **Table 13** for Sediment samples collected at these nine locations. The creek water quality data for four Nhava creek water quality monitoring stations are reported in **Table 14** for Physico-chemical parameters, **Table 15** for Bio-chemical parameters and **Table 16** for Sediment samples, collected at these locations.

Table 11: Results of Physical parameters of Water Samples Collected from JNP Harbor Area during January, 2016

Sample Name		Depth, [m]	Temp., [°C]	pH	Salinity, [ppt]	Turbidity, [NTU]	TDS, [mg/L]	TSS, [mg/L]	TS, [mg/L]
Standard		-	-	6.5 - 9.0	-	-	-	-	-
W1	SS	11.5	25.4	7.62	32.2	12	31240	62	31302
	SM		25.0	7.51	30.5	11	31150	65	31215
	SB		24.6	7.58	31.6	11	31080	42	31122
	NS	10.5	28.8	7.60	33.3	11	31060	56	31116
	NM		27.9	7.57	32.7	12	31110	58	31168
	NB		26.8	7.54	31.6	11	31140	49	31189
W2	SS	6.0	24.1	7.68	32.7	12	30890	84	30974
	SM		24.2	7.54	33.8	11	30940	76	31016
	SB		23.9	7.71	32.2	12	30980	88	31068
	NS	5.0	27.9	7.64	33.3	12	31090	75	31165
	NM		26.7	7.57	31.6	10	31080	68	31148
	NB		27.0	7.69	31.0	12	31160	98	31258
W3	SS	11.5	24.0	7.71	30.5	12	30990	84	31074
	SM		24.1	7.68	32.2	11	31170	71	31241
	SB		24.2	7.59	32.7	12	31210	76	31286
	NS	10.5	28.7	7.64	31.6	11	31240	89	31329
	NM		28.1	7.67	31.0	12	31280	94	31374
	NB		28.2	7.74	33.3	13	31190	88	31278
W4	SS	10.5	24.7	7.67	29.9	13	30970	76	31046
	SM		25.0	7.65	31.6	12	31090	82	31172
	SB		24.8	7.71	32.7	12	31060	84	31144
	NS	9.5	24.8	7.64	33.8	10	31140	69	31209
	NM		25.0	7.65	32.2	13	31220	95	31315
	NB		25.2	7.73	33.3	12	30960	78	31038
W5	SS	12.5	25.7	7.72	33.3	13	30890	96	30986
	SM		25.9	7.68	32.2	14	31160	102	31262
	SB		25.3	7.78	33.8	13	31240	80	31320
	NS	12.0	27.2	7.81	32.7	13	31190	76	31266
	NM		26.7	7.75	30.5	12	31270	71	31341
	NB		26.8	7.66	31.0	13	31250	84	31334

SS# - SPRING SAMPLE
SS - SPRING SURFACE
SM - SPRING MIDDLE
SB - SPRING BOTTOM

NS# - NEAP SAMPLE
NS - NEAP SURFACE
NM - NEAP MIDDLE
NB - NEAP BOTTOM

Sample Name		Depth, [m]	Temp., [°C]	pH	Salinity, [ppth]	Turbidity, [NTU]	TDS, [mg/L]	TSS, [mg/L]	TS, [mg/L]
Standard		-	-	6.5 - 9.0	-	-	-	-	-
W6	SS	15.0	27.2	7.59	32.2	14	30940	53	30993
	SM		27.3	7.68	33.3	11	31090	31	31121
	SB		27.5	7.72	31.6	12	31070	34	31104
	NS	13.5	27.1	7.57	32.7	13	31120	44	31164
	NM		26.9	7.66	31.0	12	31160	34	31194
	NB		27.0	7.69	30.5	12	31190	27	31217
W7	SS	10.5	23.7	7.71	32.2	9	31170	21	31191
	SM		23.9	7.59	33.3	10	31220	26	31246
	SB		24.1	7.68	32.7	10	31240	34	31274
	NS	10.0	23.9	7.73	31.6	10	31180	36	31216
	NM		24.1	7.61	33.8	11	31150	71	31221
	NB		24.2	7.70	31.0	10	31260	39	31299
W8	SS	7.5	25.8	7.59	33.8	9	30870	33	30903
	SM		26.1	7.73	30.5	9	31080	37	31117
	SB		25.7	7.68	32.2	10	31150	27	31177
	NS	6.5	25.7	7.75	33.3	9	31180	17	31197
	NM		26.0	7.61	31.6	9	31270	31	31301
	NB		26.1	7.71	32.7	10	31290	24	31314
W9	SS	16.5	23.8	7.81	30.5	11	31160	57	31217
	SM		24.1	7.72	33.3	10	31230	83	31313
	SB		24.3	7.68	31.0	11	31170	48	31218
	NS	15.0	23.9	7.84	32.2	12	31240	45	31285
	NM		24.1	7.75	33.9	13	30890	55	30945
	NB		24.2	7.76	31.6	12	30980	86	31066

SS# - SPRING SAMPLE
SS - SPRING SURFACE
SM - SPRING MIDDLE
SB - SPRING BOTTOM

NS# - NEAP SAMPLE
NS - NEAP SURFACE
NM - NEAP MIDDLE
NB - NEAP BOTTOM

Table 12: Results of Bio-Chemical Analysis of Water Samples Collected from JNP Harbor Area during January, 2016

Sample Name	DO, [mg/L]	COD, [mg/L]	BOD, [mg/L]	NH ₃ -N, [mg/L]	Phenol, [mg/L]	O&G, [mg/L]	TPC, [CFU/mL]	Fecal Coliforms, [MPN/100 mL]
Standard	3.0 mg/L or 40% of saturation value	-	5	-	-	10	-	500
W1	SS#	-	-	-	-	3	135	26
	SS	6.4	49	<2	<0.1	<0.01		
	SM	6.3	41	-	-	-		
	SB	6.2	33	-	-	-		
	NS#	-	-	-	-	2	120	11
	NS	5.9	37	<2	<0.1	<0.01		
	NM	5.7	45	-	-	-		
	NB	5.6	29	-	-	-		
W2	SS#	-	-	-	-	1	<30	8
	SS	6.0	45	<2	<0.1	<0.01		
	SM	5.8	37	-	-	-		
	SB	5.7	29	-	-	-		
	NS#	-	-	-	-	2	<30	17
	NS	5.7	49	<2	<0.1	<0.01		
	NM	5.6	41	-	-	-		
	NB	5.6	33	-	-	-		
W3	SS#	-	-	-	-	2	184	60
	SS	4.9	49	<2	<0.1	<0.01		
	SM	4.7	37	-	-	-		
	SB	4.6	41	-	-	-		
	NS#	-	-	-	-	2	57	4
	NS	4.9	33	<2	<0.1	<0.01		
	NM	4.7	45	-	-	-		
	NB	4.5	29	-	-	-		
W4	SS#	-	-	-	-	2	120	27
	SS	4.9	45	<2	<0.1	<0.01		
	SM	4.8	33	-	-	-		
	SB	4.7	29	-	-	-		
	NS#	-	-	-	-	3	<30	4
	NS	4.9	37	<2	<0.1	<0.01		
	NM	4.7	49	-	-	-		
	NB	4.5	41	-	-	-		
W5	SS#	-	-	-	-	2	112	50
	SS	4.7	44	<2	<0.1	<0.01		
	SM	4.7	36	-	-	-		
	SB	4.3	48	-	-	-		
	NS#	-	-	-	-	2	<30	11
	NS	4.7	40	<2	<0.1	<0.01		
	NM	4.6	28	-	-	-		
	NB	4.5	32	-	-	-		

SS# - SPRING SAMPLE
SS - SPRING SURFACE
SM - SPRING MIDDLE
SB - SPRING BOTTOM

NS# - NEAP SAMPLE
NS - NEAP SURFACE
NM - NEAP MIDDLE
NB - NEAP BOTTOM

Sample Name		DO, [mg/L]	COD, [mg/L]	BOD, [mg/L]	NH ₃ -N, [mg/L]	Phenol, [mg/L]	O&G, [mg/L]	TPC, [CFU/mL]	Fecal Coliforms, [MPN/100 mL]
Standard		3.0 mg/L or 40% of saturation value	-	5	-	-	10	-	500
W6	SS#	-	-	-	-	-	2	<30	4
	SS	5.8	28	<2	<0.1	<0.01	-	-	-
	SM	5.6	40	-	-	-	-	-	-
	SB	5.3	32	-	-	-	-	-	-
	NS#	-	-	-	-	-	2	<30	<2
	NS	5.2	44	<2	<0.1	<0.01	-	-	-
	NM	5.1	36	-	-	-	-	-	-
	NB	5.0	48	-	-	-	-	-	-
W7	SS#	-	-	-	-	-	1	89	17
	SS	5.3	48	<2	<0.1	<0.01	-	-	-
	SM	5.2	36	-	-	-	-	-	-
	SB	4.9	44	-	-	-	-	-	-
	NS#	-	-	-	-	-	2	<30	2
	NS	4.6	40	<2	<0.1	<0.01	-	-	-
	NM	4.5	28	-	-	-	-	-	-
	NB	4.5	32	-	-	-	-	-	-
W8	SS#	-	-	-	-	-	2	137	70
	SS	4.9	32	<2	<0.1	<0.01	-	-	-
	SM	4.7	40	-	-	-	-	-	-
	SB	4.6	28	-	-	-	-	-	-
	NS#	-	-	-	-	-	2	<30	8
	NS	4.6	36	<2	<0.1	<0.01	-	-	-
	NM	4.5	48	-	-	-	-	-	-
	NB	4.5	44	-	-	-	-	-	-
W9	SS#	-	-	-	-	-	1	54	14
	SS	5.7	48	<2	<0.1	<0.01	-	-	-
	SM	5.6	32	-	-	-	-	-	-
	SB	5.4	44	-	-	-	-	-	-
	NS#	-	-	-	-	-	2	<30	2
	NS	5.3	40	<2	<0.1	<0.01	-	-	-
	NM	5.1	32	-	-	-	-	-	-
	NB	5.0	28	-	-	-	-	-	-

SS# - SPRING SAMPLE
SS - SPRING SURFACE
SM - SPRING MIDDLE
SB - SPRING BOTTOM

NS# - NEAP SAMPLE
NS - NEAP SURFACE
NM - NEAP MIDDLE
NB - NEAP BOTTOM

Table 13: Results of Sediment Samples Collected from JNP Harbor Area during Jan., 2016

Station Name	Organic Matter		Total Carbon		Inorganic Phosphate
	mg/g	%	mg/g	%	
	mg/kg				
W1	Sample not found				
W2	89.0	8.9	51.6	5.2	240
W3	137.0	13.7	79.5	7.9	140
W4	54.0	5.4	31.3	3.1	160
W5	138.0	13.8	80.0	8.0	150
W6	152.0	15.2	88.2	8.8	250
W8	202.0	20.2	117.2	11.7	220
W9	196.8	19.7	114.2	11.4	180

Table 14: Results of Physico-Chemical Analysis of Water Samples from Nhava Creek Area

Sample Name		Depth, [m]	Temp., [°C]	pH	Salinity, [ppt]	Turbidity, [NTU]	TDS, [mg/L]	TSS, [mg/L]	TS, [mg/L]
Standard		-	-	6.5 - 9.0	-	-	-	-	-
W11	SS	4.5	25.9	7.67	31.6	11	31180	40	31220
	SM		25.9	7.80	32.7	9	31190	26	31216
	SB		26.0	7.78	33.3	9	31250	26	31276
	NS	4.0	26.1	7.82	33.9	8	31210	23	31233
	NM		25.9	7.71	30.5	9	31240	28	31268
	NB		25.8	7.81	32.2	9	30960	33	30993
W12	SS	3.5	26.9	7.77	33.3	9	31160	27	31187
	SM		27.0	7.65	30.5	9	31230	24	31254
	SB		26.9	7.82	32.7	10	31280	21	31301
	NS	3.0	26.9	7.69	32.2	10	31180	21	31201
	NM		27.0	7.76	31.6	10	31090	32	31122
	NB		26.8	7.92	33.9	11	31070	28	31098
W13	SS	3.0	28.0	7.74	32.7	8	31050	27	31077
	SM		27.8	7.67	33.9	8	31140	33	31173
	SB		27.9	7.81	30.5	10	31170	32	31202
	NS	2.5	27.8	7.69	32.2	9	31210	26	31236
	NM		27.9	7.84	31.0	10	31300	34	31334
	NB		28.0	7.91	31.6	11	31280	39	31319
W14	SS	2.5	25.7	7.79	31.0	8	30980	16	30996
	SM		25.6	7.90	32.7	9	31080	27	31107
	SB		25.4	7.88	30.5	11	31060	19	31079
	NS	2.0	26.1	7.80	32.2	11	31170	23	31193
	NM		25.9	7.78	33.3	12	31190	17	31207
	NB		25.8	7.63	33.9	10	31240	24	31264

SS# - SPRING SAMPLE
SS - SPRING SURFACE
SM - SPRING MIDDLE
SB - SPRING BOTTOM

NS# - NEAP SAMPLE
NS - NEAP SURFACE
NM - NEAP MIDDLE
NB - NEAP BOTTOM

Table 15: Results of Bio-Chemical Analysis of Water Samples Collected from Nhava Creek

Sample Name	DO, [mg/L]	COD, [mg/L]	BOD, [mg/L]	NH ₃ -N, [mg/L]	Phenol, [mg/L]	O&G, [mg/L]	TPC, [CFU/mL]	Fecal Coliforms, [MPN/100 mL]
Standard	3.0 mg/L or 40% of saturation value	-	5	-	-	10	-	500
W11	SS	5.9	51	<2	<0.1	<0.01	2	<30
	SM	5.8	43	-	-	-	-	-
	SB	5.6	34	-	-	-	-	-
	NS	5.2	47	<2	<0.1	<0.01	3	59
	NM	5.0	38	-	-	-	-	-
	NB	5.0	56	-	-	-	-	-
W12	SS	5.6	38	<2	<0.1	<0.01	2	<30
	SM	5.2	47	-	-	-	-	-
	SB	5.1	56	-	-	-	-	-
	NS	5.1	51	<2	<0.1	<0.01	2	<30
	NM	4.9	34	-	-	-	-	-
	NB	4.7	43	-	-	-	-	-
W13	SS	4.9	47	<2	<0.1	<0.01	1	138
	SM	4.7	38	-	-	-	-	-
	SB	4.5	51	-	-	-	-	-
	NS	4.6	43	<2	<0.1	<0.01	2	87
	NM	4.5	30	-	-	-	-	-
	NB	4.5	34	-	-	-	-	-
W14	SS	4.6	34	<2	<0.1	<0.01	2	97
	SM	4.5	43	-	-	-	-	-
	SB	4.5	30	-	-	-	-	-
	NS	4.7	47	<2	<0.1	<0.01	2	<30
	NM	4.5	51	-	-	-	-	-
	NB	4.5	38	-	-	-	-	-

SS# - SPRING SAMPLE
SS - SPRING SURFACE
SM - SPRING MIDDLE
SB - SPRING BOTTOM

NS# - NEAP SAMPLE
NS - NEAP SURFACE
NM - NEAP MIDDLE
NB - NEAP BOTTOM

Table 16: Results of Sediment Samples Collected from Nhava Creek during Jan., 2016

Sample Name	Organic Matter		Total Carbon		Inorganic Phosphate
	mg/g	%	mg/g	%	
W11	Sample not found				
W12	Sample not found				
W13	156.5	15.7	90.8	9.1	320
W14	70.8	7.1	41.1	4.1	310

2.4 DISCUSSION

Tables 17 and 18 present concentration ranges of various parameters for Harbor and Nhava regions respectively. The observed values are compared with Primary Water Quality Criteria for **Class IV Waters** [Harbor Waters] given by CPCB [refer **Annexure V**].

Table 17: Observed Concentration Ranges of Various Parameters for JNP Harbor Area

Sr. No.	Parameter	Observed Range	Unit	Prescribed Limits
1	Temperature	23.7 – 28.8	°C	-
2	pH	7.51 – 7.84	-	6.5 - 9.0
3	Salinity	29.9 – 33.9	ppt	-
4	Turbidity	9 – 14	NTU	-
5	TDS	30870 – 31290	mg/L	-
6	TSS	17 - 102	mg/L	-
7	TS	30903 – 31374	mg/L	-
8	DO	4.5 – 6.4	mg/L	3.0 mg/L(min.) or 40% of saturation value
9	COD	28 – 49	mg/L	-
10	BOD	<2	mg/L	5 (max.)
11	NH ₃ -N	<0.1	mg/L	-
12	Phenol	< 0.01	mg/L	-
13	Oil & Grease	1– 3	mg/L	10 (max.)
14	Total Plate Count	<30 - 184	CFU/ml	-
15	Fecal Coliforms	<2- 70	MPN/100 mL	500 (max.)

Table 18: Observed Concentration Ranges of Various Parameters for Nhava Creek Area

Sr. No.	Parameter	Observed Range	Unit	Prescribed Limits
1	Temperature	23.7 – 28.0	°C	-
2	pH	7.63 – 7.92	-	6.5 - 9.0
3	Salinity	30.5 – 33.9	ppt	-
4	Turbidity	8 – 12	NTU	-
5	TDS	30960 – 31300	mg/L	-
6	TSS	16 – 40	mg/L	-
7	TS	30993 - 31334	mg/L	-
8	DO	4.5 – 5.9	mg/L	3.0 mg/L(min.) or 40% of saturation value
9	COD	30 – 56	mg/L	-
10	BOD	< 2.0	mg/L	5 (max.)
11	NH ₃ -N	< 0.1	mg/L	-
12	Phenol	< 0.01	mg/L	-
13	Oil & Grease	1 – 3	mg/L	10 (max.)
14	Total Plate Count	<30 - 138	CFU/ml	-
15	Fecal Coliforms	<2 -21	MPN/100 mL	500 (max.)

It is seen from **Table 17** that, the values of various parameters such as pH, Dissolved Oxygen, BOD, Oil & Grease and Fecal *coliforms* obtained for water samples collected from

JNP Harbor area during the month of January, 2016 are within the prescribed limits. Also, the concentration ranges observed for various parameters for water samples collected from Nhava Creek area during January, 2016 are also within prescribed limits.

Observed salinity values for Harbor and Creek water samples in the month of January, 2016 varied from 29.9 - 33.9 ppt and 30.5 - 33.9 ppt respectively [Tables 11&14]. The earth filling activity for the development of 4th Container Terminal and Dredging works in the region does not seem to be affecting on Marine water Quality. The ranges observed for COD values in mg/L are 28 - 49 and 30-56 respectively for Harbor and Creek water samples. The DO levels were found between 4.5 & 6.4 mg/L and 4.5 & 5.9 mg/L for water samples collected from Harbor and Creek areas respectively. The concentrations of Phenol and NH₃ - N were found to be very less in both Harbor and Creek water samples. Bacteriological parameters were also found to be far below the prescribed limits, set for Harbor region.

Table 13 provides the results obtained for sediment quality parameters for the JNP Harbor samples. The values obtained for Organic Matter, Total Organic Carbon and Inorganic Phosphate varied from 5.4 - 20.2 %, 3.1 - 11.7 % and 140 - 280 mg/kg, respectively. **Table 16** shows the values for Organic Matter, Total Organic Carbon and Inorganic Phosphate as 7.1 to 15.7 %, 4.1 to 9.1 % and 310- 320 mg/kg, respectively in Nhava Creek sediments during January, 2016.

2.5 OBSERVATIONS AND CONCLUSION

- ✓ *Construction of 4th Container Terminal on South side of JNPT:* Earth Filling work and dredging work of 4th C.T. is underway.
- ✓ *Construction of NSIGT Yard is underway to the North side of JNPT.*
- ✓ *Plying of Ferry Boats:* There were large numbers of ferry boats plying in the area from Gateway of India to Elephanta. The discharges from these boats were not monitored.

It is seen from the data as reported in **Tables 11** through **18** and subsequently discussed in above paragraphs; all the parameters mentioned comply with prescribed standard limits, as given in Primary Water Quality Criteria for **Class IV Waters** [Harbor Water by CPCB for Physico-Chemical parameters and Bio-Chemical parameters. The characteristic parameters for sediments also show normal variations.

Conclusion:

Considering the activities in the Harbor area and the results obtained for the month of January, 2016 it can be concluded that the Port's working does not affect the Quality of the Marine water. The overall Marine water Quality of the Port's Harbor and Creek waters is in good category.

3. MARINE ECOSYSTEM MONITORING

3.1 INTRODUCTION

For study of Marine ecology, Total 8 fixed harbor stations [W1 to W7 and W9] and 1 movable station [W8/W10] are identified. At Nhava creek 4 fixed stations [W11 to W14] are identified. All above mentioned stations are selected for studying aquatic flora and fauna as well as benthic fauna. The description of stations is presented in **Table 9**. The location map of various Marine ecology monitoring stations along with direction of towing are presented in **Annexure-IV**.

3.2 MARINE ECOSYSTEM MONITORING METHODOLOGY

The objective of Marine ecology monitoring is to assess aquatic flora & fauna, benthic fauna and nutrient contents in water and sediments.

Marine Ecology Monitoring –Monitoring of marine ecology was carried out on the levels of high & low water of spring and neap tides at twelve fixed stations and one moving station in Port's water limit. Phytoplankton and Zooplankton samples were collected during spring and neap tides from all the 12 fixed [W1 to W7, W9 and W11 to W14] and one moving [W8/W10] water quality monitoring stations.

The list of parameters analyzed to assess the Marine Ecology is presented in **Table 19** along with parameters monitored for sediment characterization. **Annexure-VI** describes recommended ranges of the Ecological parameters for Arabian Sea.

Table 19: List of Parameters to Monitor Marine Ecology

Marine Ecology Parameters [Harbor Area & Creek Area]
A] Aquatic Flora & Fauna: Primary Productivity (Net & Gross), Phytoplankton Diversity: Population Density, Species Identification, Relative Abundance, Zooplankton Diversity: Population Density, Species Identification, Relative Abundance, Particulate Organic Carbon, Chlorophyll-a, Pheophytin-a, Secchi Depth
B] Benthic Fauna: Species Identification & Density
C] Nutrients Analysis in Water: Anions: Silicates, PO_4^{3-} - P, SO_4^{2-} , NO_2^- - N, NO_3^- - N, Cations: Ca^{2+} , Mg^{2+} , Na^+ , K^+
D] Sediment Analysis: Anions: Silicates, PO_4^{3-} - P, SO_4^{2-} , NO_2^- - N, NO_3^- - N, Cations: Ca^{2+} , Mg^{2+} , Na^+ , K^+

3.3 RESULTS

The net and gross primary productivity of three water quality monitoring stations of JNP and one water quality monitoring station at Nhava creek were measured and values are presented in **Table 20**.

The enumeration of phytoplankton genera, observed in the JNP Harbor area and Nhava creek area are furnished in **Tables 21** and **22**. The details of Secchi Depth of JNP Harbor and Nhava creek areas are given in **Table 23**. The enumeration of zooplankton genera, recorded in the JNP Harbor area and Nhava creek areas, are represented in **Tables 24** and **25**. **Table 26** shows Chlorophyll-*a* contents in JNP Harbor and Nhava creek areas.

Benthic fauna recorded in JNP Harbor area and Nhava creek were collected and the data are presented in **Table 28**. Concentrations of nutrients in water and sediments at JNP have been presented in **Tables 29** and **30** respectively.

Table 20: Primary productivity of JNP Harbor area and Nhava Creek

Sr. No.	Station	Gross Primary Productivity [mgC/m ³ /d]	Net Primary Productivity [mgC/m ³ /d]
JNP Harbour Area			
1.	W1	315	275
2.	W2	475	315
3.	W3	315	215
4.	W4	315	215
5.	W5	575	415
6.	W6	415	375
7.	W7	315	275
8.	W8	275	215
9.	W9	415	375
JNP Nhava Creek Area			
10.	W11	315	275
11.	W12	375	275
12.	W13	375	315
13.	W14	375	315

Table 21: Enumeration of Phytoplankton in JNP Harbor area and Nhava Creek

Sr. No.	Sampling station	Sample Location	Phyto-plankton [No/ml]	Percent Composition of Algal Groups		
				Bacillario-phyceae	Chloro-phyceae	Cyano-phyceae
JNP Harbour Area						
1	W1	Surface	420	50	30	20
		Bottom	310	65	25	10
2	W2	Surface	370	50	25	25
		Bottom	210	55	25	20
3	W3	Surface	320	45	30	25
		Bottom	210	55	30	15
4	W4	Surface	410	50	20	30
		Bottom	310	65	25	10
5	W5	Surface	510	52	28	20
		Bottom	470	45	25	30
6	W6	Surface	315	60	30	10
		Bottom	209	55	30	15
7	W7	Surface	307	70	20	10
		Bottom	210	50	40	10
8	W8	Surface	420	75	25	-
		Bottom	370	50	20	30
9	W9	Surface	215	50	30	20
		Bottom	195	40	35	25
JNP Nhava Creek						
10	W11	Surface	315	55	35	10
		Bottom	217	45	35	20
11	W12	Surface	410	50	30	20
		Bottom	307	55	20	25
12	W13	Surface	209	60	20	20
		Bottom	115	50	30	20
13	W14	Surface	210	55	25	20
		Bottom	175	60	20	20

Table 22: Phytoplankton Genera Observed in JNP Harbor and Nhava Creek Areas

Sr. No.	Bacillariophyceae	Chlorophyceae	Cyanophyceae
1.	<i>Navicula</i> sp.	<i>Cosmarium</i> sp.	<i>Oscillatoria</i> sp.
2.	<i>Nitzschia</i> sp.	<i>Scenedesmus</i> sp.	<i>Anabaena</i> sp.
3.	<i>Fragillaria</i> sp.	<i>Ulothrix</i> sp.	<i>Aphanocapsa</i> sp.
4.	<i>Surirella</i> sp.	<i>Closterium</i> sp.	-
5.	<i>Gyrosigma</i> sp.	-	-

Table 23: Secchi Depth Details of JNP Harbor and Nhava Creek Area

Sr. No.	Station	Secchi Depth [cm]
JNP Harbour Area		
1.	W1	30
2.	W2	20
3.	W3	20
4.	W4	20
5.	W5	25
6.	W6	20
7.	W7	15
8.	W8	25
9.	W9	20
JNP Nhava Creek Area		
10.	W11	20
11.	W12	20
12.	W13	15
13.	W14	15

Table 24: Enumeration of Zooplankton in JNP Harbor and Nhava Creek Area

Sr. No.	Towing between Stations	Zoo-plankton, [No/m³]	Percent Composition of Zooplankton Groups			
			Copepoda	Cladocera	Foraminifera	Rotifera
JNP Harbour Area						
1.	W1-W2	180	40	30	20	10
2.	W2-W5	420	50	40	10	-
3.	W5-W1	370	60	40	-	-
4.	W5-W6	320	45	45	10	-
5.	W6-W2	185	40	30	20	10
6.	W4-W3	425	50	40	10	-
7.	W3-W7	190	45	35	10	10
8.	W7-W8	375	50	40	-	10
9.	W8-W3	420	40	30	10	20
10.	W9-W3	175	50	30	10	10
JNP Nhava Creek						
11.	W5-W11	190	40	40	10	10
12.	W11-W12	250	50	30	10	10
13.	W12-W13	365	50	45	5	-
14.	W13-W14	410	50	40	10	-

Table 25: Zooplankton Genera Recorded in JNP Harbor Area and Nhava Creek Area

Sr. No.	Copepoda	Rotifera	Cladocera	Foraminifera
1.	<i>Cyclops</i> sp.	<i>Keratella</i> sp.	<i>Daphnia</i> sp.	<i>Rotalia</i> sp.
2.	<i>Diaptomus</i> sp.	<i>Brachionus</i> sp.	<i>Moina</i> sp.	-
3.	<i>Bryocamptus</i> sp.	<i>Asplanchna</i> sp.	-	-

Table 26: Chlorophyll-a Content in JNP Harbor and Nhava Creek areas

Sr. No.	Station	Chlorophyll- <i>a</i> [mg/m ³]		Pheophytin- <i>a</i> [mg/m ³]		Algal Biomass
		Surface	Bottom	Surface	Bottom	(mg/m ³)
JNP Harbour Area						
1.	W1	3.1	2.7	BDL	BDL	206
2.	W2	2.9	1.8	0.2	BDL	193
3.	W3	1.6	1.0	BDL	BDL	106
4.	W4	3.9	2.7	BDL	BDL	260
5.	W5	5.4	4.2	BDL	BDL	361
6.	W6	2.4	1.9	BDL	BDL	160
7.	W7	4.0	2.5	BDL	BDL	266
8.	W8	2.6	1.9	BDL	BDL	450
9.	W9	3.8	2.9	BDL	BDL	253
Nhava Creek Area						
10.	W11	3.8	2.7	BDL	BDL	253
11.	W12	4.1	2.4	BDL	BDL	273
12.	W13	3.2	1.9	BDL	BDL	213
13.	W14	2.8	1.2	BDL	BDL	186

Table 27: Concentration of Particulate Oxidizable Organic Carbon [POC]

Sr. No.	Station	POC, [mg/m ³]
Standard		10 - 100
JNP Harbor Area		
1.	W1	847
2.	W2	904
3.	W3	978
4.	W4	748
5.	W5	904
6.	W6	929
7.	W7	789
8.	W8	863
9.	W9	830
Nhava Creek Area		
10.	W11	986
11.	W12	1028
12.	W13	921
13.	W14	1085

Table 28: Benthic Fauna Recorded at JNP Harbor and Nhava Creek Areas

Sr. No.	Station	Macrobenthos [No/m ²]	Percent Composition of Macrobenthos			
			Gastropods	Polychaeta	Foraminifera	Chironomidae
JNP Harbour Area						
1.	W1	175	50	20	30	-
2.	W2	215	60	30	10	-
3.	W3	75	50	30	20	-
4.	W4	115	50	30	15	5
5.	W5	175	40	30	30	-
6.	W6	65	60	30	10	-
7.	W7	90	55	30	15	-
8.	W8	95	40	40	10	10
9.	W9	115	50	40	10	-
JNP Nhava Creek Area						
10.	W13	105	40	30	20	10
11.	W14	95	50	20	20	10

Note: No sediment was found at W11 and W12

Table 29: Concentration of Nutrients in Water at JNP Harbour area and Nhava Creek

Station Name	Ca ²⁺ , [mg/L]	Mg ⁺ , [mg/L]	K ⁺ , [mg/L]	Na ⁺ , [mg/L]	PO ₄ ³⁻ -P, [mg/L]	NO ₃ ⁻ -N, [mg/L]	NO ₂ ⁻ -N, [mg/L]	SiO ₂ ²⁻ , [mg/L]	SO ₄ ²⁻ , [mg/L]
Standard	-	-	-	-	0.1 - 90	1.0 - 500	<125	10 - 5000	-
JNP HARBOUR AREA									
W1	432	1215	186	10400	51	820	<10	1542	2442
W2	471	1286	174	10600	49	910	<10	1541	2364
W3	393	1405	168	10800	44	480	<10	1644	2413
W4	511	1191	177	10300	55	720	<10	1594	2504
W5	432	1334	189	10500	68	860	<10	1532	2482
W6	393	1381	184	10700	42	920	<10	1568	2372
W7	550	1334	166	10900	53	845	<10	1548	2314
W8	432	1286	162	11000	67	640	<10	1555	2292
W9	393	1357	185	10400	69	1040	<10	1527	2462
JNP NHAVA CREEK AREA									
W11	511	1215	196	10700	57	940	<10	1520	2348
W12	471	1357	193	10600	48	970	<10	1635	2423
W13	393	1334	176	11000	50	980	<10	1558	2534
W14	511	1310	174	10900	69	890	<10	1597	2492

Table 30: Concentration of Nutrients in Sediments at JNP Harbour area and Nhava Creek

Station Name	Ca ²⁺ , [mg/kg]	Mg ⁺ , [mg/kg]	K ⁺ , [mg/kg]	Na ⁺ , [mg/kg]	PO ₄ ³⁻ -P, [mg/kg]	NO ₃ ⁻ -N, [mg/kg]	NO ₂ ⁻ -N, [mg/kg]	SiO ₂ ²⁻ , [mg/kg]	SO ₄ ²⁻ , [mg/kg]
Standard	-	-	-	-	-	-	-	-	-
JNP HARBOUR AREA									
W1	Sample not found								
W2	4960	291	272	4383	300	10	0.05	34	5681
W3	4880	243	380	6722	240	20	0.07	22	4142
W4	5520	243	249	5318	200	8	0.09	30	4765
W5	6000	340	327	5822	190	14	0.13	44	6689
W6	4560	194	382	4767	330	7	0.06	30	6528
W7	4720	194	372	6003	310	27	0.12	56	8434
W8	7680	194	304	5183	270	5	0.09	55	4208
W9	7440	292	261	4683	290	9	0.14	96	6303
JNP NHAVA CREEK AREA									
W11	Sample not found								
W12	Sample not found								
W13	6160	340	330	5288	420	11	0.11	35	4918
W14	7040	340	348	6182	440	11	0.12	71	5428

3.4 DISCUSSION

3.4.1 Water Quality: Biotic

3.4.1.a Primary Productivity

The highest estimated gross and net primary productivity was measured as 575 and 415 mgC/m³/d at station W5 [Table 20]. Compared with other coastal ecosystems, primary productivity of JNP Harbour area and Nhava creek was at a moderate level. The dredging activity near W7 location does not seem to be affecting the primary productivity.

3.4.1.b Plankton

A] Phytoplankton:

Count : Phytoplankton counts, recorded at different sampling stations, are presented in Table 21. Total algal population varied between 115 and 510 algal cells/ml. Samples collected at stations W13(B) and W5(S) showed lowest and highest counts respectively. Bacillariophyceae dominated all samples followed by Chlorophyceae. The phytoplankton population comprised of twelve genera under 3 major groups, namely Bacillariophyceae, Chlorophyceae and Cyanophyceae [Table 22]. Apparently there is no adverse effect of dredging activities in harbour and creek. As the dredging activities are going on around W7, it may not affect plankton count, as the count at station W7 was not the least as compared to other stations. Planktonic organisms respond quickly to environmental changes. Even if there is any adverse effect during dredging; plankton recover within a short time post-dredging. Also due to intense tidal effect, there is always replenishment.

Secchi Disk Transparency: Secchi disk transparency refers to the depth to which the black and white Secchi disk can be seen in the water. Water clarity, as determined by a Secchi disk, is affected by two primary factors: algae and suspended particulate matter. Light penetration was measured in the JNP Harbour Area and Nhava creek with the help of Secchi Disk (Table 23). Transparency varied between 15 and 30 cm.

B] Zooplankton:

Zooplankton counts, recorded at different sampling stations, are shown in Table 24. Since huge quantity of water was to be filtered through plankton net, middle and bottom samples could not be collected. Density of zooplankton varied between 175 and 425 N/m³ at stations W9-W3 and W4-W3. Total nine genera of zooplankton were recorded. Copepoda dominated all the samples [Table 25].

3.4.1.c Photosynthetic Pigments [Chlorophyll-*a*, Pheophytin-*a*]:

The algal biomass is the main source of food for the primary consumers and it was evaluated by chlorophyll-*a* method and its value is given in **Table 26**. In JNP harbor area, the range of algal biomass was found between 106 and 360 mg/m³. The minimum algal biomass was (106 mg/m³) found at W3 and maximum (360 mg/m³) was found at W5 station. The lowest and highest chlorophyll *a* levels from surface water sample varied from 1.6 mg/m³ at station W3(S) to 5.4 mg/m³ at W5(S). High chlorophyll might be a cause of high phytoplankton at respective station. Pheophytin concentrations of many samples were below detectable limit [**Table 26**]. Based on values of Chlorophyll-*a*, these waters can be classified as mostly oligotrophic, that is of good quality.

3.4.1. d Particulate Organic Carbon [POC]:

The concentration of particulate oxidizable carbon [POC] is given in Table 27. In JNP harbour POC content was found to be between 748 and 978 mg/m³ with an average of 866 mg/m³. The minimum concentration of POC i.e. 748 mg/m³ was found at W4 station and maximum concentration i.e. 978 mg/m³ at W3 station. In Nhava creek the POC content was found to be from 921 - 1085 mg/m³ with an average of 1005 mg/m³. The minimum concentration of POC i.e. 921 mg/m³ was found at W13 station and maximum concentration i.e. 1085 mg/m³ was found at W14 station. The POC concentration was found to be higher than the prescribed standard range i.e. 10- 100 mg/m³ at all stations in JNP Harbour and Nhava Creek regions. This may be due to detritus material originated from Mangrove swamps or detritus plankton. The higher values for POC were also reported in Tulaskar *et al* [Ind. J. Marine Sci., Vol. 21, 1992] for Rajapur and Vagothan estuaries (west coast of India).

3.4.2 Sediment Quality: Biotic

Benthos:

A total of four macrobenthic groups were obtained from the sediment samples. Gastropod is abundant. Among the Gastropods, the dominant species were *Litiopa* sp., *Littorina* sp., and *Morula* sp. The highest count was 215 No/m² at station W2 while lowest (65 No/m²) was found at station W6. No sediment was found at stations W11 and W12. Presence of comparatively less number of macrobenthos around sampling stations W3, W8 and W14 may be attributed to rocky bottom and abundance of predators in this region. While at station W7, dredging activities might be the cause of less number of macrobenthos.

3.4.3 Nutrients

Nutrients are measured using a variety of wet chemistry techniques, which generate a color reaction measurable with a colorimeter or spectrophotometer. The technique involves adding a reagent (or reagents) to the seawater sample, allowing a color to develop and then measuring the intensity of the color against blanks and standards. Manual methods usually allow the color to develop fully before measurement, whereas most automated methods (e.g. segmented flow analysis, flow injection analysis) provide partial color development with time controls. Concentrations of nutrients are measured in optical cells (static or flow through), using a spectrophotometer tuned to defined wavelengths.

a. Anions:

The nutrients at various stations in JNP harbor water and Nhava Creek are presented in **Table 29**. In harbor region the Phosphate was found to be in the range of 42µg/L – 69µg/L. The average concentration of Phosphate was found to be 55µg/L in JNP harbor region, the Phosphate values are within the prescribed standard range [0.1 – 90µg/L]. Nitrate was found to be between 480µg/L – 1040µg/L. The minimum value of Nitrate 480µg/L was found at W3 station and maximum value 1040µg/L at W9 station. The average concentration of Nitrate was found to be 804µg/L. At locations W1, W2, W4, W5, W6, W7, W8, & W9 the Nitrate concentration was found to be above prescribed standard range [1.0 to 500 µg/L]. Silica is another important nutrient in seawater. The requirement of silica by diatoms is however, entirely limited to skeletal formation and has particular importance in coastal upwelling region where diatoms form a dominant part of phytoplankton. Silica in the form of silicate in JNP harbor water was found between 1527 – 1644 µg/L with an average of 1561µg/L. The minimum concentration of silica was found at W9 station of JNP harbor region and the maximum concentration of silica was found at W3 station. The values of silica were observed to be well within the prescribed limits [10 to 5000 µg/L]. The Sulphate was found between 2292 – 2504 mg/L, the minimum value recorded at W8 station and maximum at W4 station. The average concentration of Sulphate was found to be 2405 mg/L.

In Nhava Creek, Phosphate was found between 48µg/L – 69µg/L with an average 56µg/L which is within the prescribed standard range [0.1-90µg/L]. The minimum value was recorded at W12 and maximum at W14 location. Nitrate was found to be 890 (at W14) – 980 µg/L (at W13) with an average 945 µg/L. The silica content in Nhava creek was found to be 1520 – 1635 µg/L with an average of 1578 µg/L. The minimum silica content was found at station W11 station and maximum was found at W12 station. The values of silica were observed to be well within the prescribed limits. Sulphate was found between 2348 – 2534 mg/L with an average of 2449 mg/L. The minimum value for Sulphate was found at W11 station and maximum value at W13 station.

The nutrients in sediments at various stations in JNP harbor area and Nhava Creek area are given in **Table 30**. In harbor region, the sediment was found at eight out of nine locations. Phosphate was found between 190 – 330 mg/kg with an average of 266 mg/kg. The minimum value of 190mg/kg was found at W5 location while maximum value (330mg/kg) was found at W6. The Nitrate was found to be minimum at W8 station i.e. 5 mg/kg and maximum at W7 station i.e. 27mg/kg. The average concentration of Nitrate was found to be 13 mg/kg. The Nitrite was found to be between 0.05 – 0.14 mg/kg with an average of 0.12 mg/kg. The minimum concentration of nitrite was found at W2 station and maximum value at W9 station. Silica in the form of silicate in JNP harbor sediments were found between 22 and 96 mg/kg with an average of 46 mg/kg. The minimum concentration of silica was found at W3 station i.e. 22 mg/kg and maximum value was found at W9 station i.e. 96 mg/kg. The Sulphate was found between 4142 - 8434 mg/kg, with minimum value i.e. 4142 mg/kg at W3 station and maximum value i.e. 8434 mg/kg at W7 station. The average concentration of Sulphate was found to be 5844 mg/kg.

In Nhava Creek region the sediment found at two locations out of four. Phosphate levels were 420 and 440 mg/kg with an average of 430 mg/kg. Nitrate was found to be 11 mg/kg. The average concentration of Nitrate was found to be the same i.e. 11 mg/kg. The Nitrite was found to be 0.11 and 0.12 mg/kg. The average concentration of Nitrite was found to be 0.015 mg/kg. Silica in the form of silicate in JNP harbor sediments was found to be 35 to 71 mg/kg with an average of 53 mg/kg. The Sulphate was found to be 4918 and 5428 mg/kg. The average concentration of Sulphate was found to be 5173 mg/kg.

b. Cations:

In harbor region water, the Calcium was found between 393 to 550 mg/L with an average of 445 mg/L given in **Table 29**. The minimum value for Calcium i.e. 393 mg/L was found at W3 location whereas the maximum value i.e. 550 mg/L was found at W7 location. The Magnesium was found to be 1191 – 1405 mg/L, with minimum value i.e. 1191 mg/L at W4 location whereas maximum value i.e. 1405 was found at W3 stations. The average concentration of Magnesium was found to be 1310 mg/L. The minimum concentration of Potassium 162 mg/L was found at W8 location and maximum concentration 189 mg/L at W5 location with an average of 177 mg/L. The Sodium was found between 10300 to 11000 mg/L with an average of 10622 mg/L. The minimum concentration of sodium i.e. 10300 mg/L was found at W4 stations and maximum value i.e. 11000 mg/L of at W8 station.

In Nhava Creek, Calcium concentration was found with an average 472 mg/L given in **Table 29**. The minimum value 393 mg/L was found at W13 and maximum 511 mg/L at W11 station. Magnesium concentration was found to be 1215 – 1357 mg/L with an average of 1304 mg/L. The minimum value i.e. 1215 mg/L of Magnesium was found at W11 station and maximum value 1357 mg/L was found at W12 stations. The Potassium

content in Nhava creek was found to be 174 mg/L at W14 – 196 mg/L at W11 station with an average of 185 mg/L. Sodium minimum concentration was found to be 10600 mg/L at W12 and maximum of 11000 mg/L at W13. The average concentration of sodium was found to be 10800 mg/L.

In harbor region sediments, the Calcium was found to be 4560 to 7680 mg/Kg with an average of 5720 mg/Kg given in **Table 30**. The minimum Concentration of Calcium 4560 mg/kg was found at W6 station and maximum concentration 7680 mg/kg at W8 station. Magnesium was found to be 194 to 340 mg/Kg, with minimum value 194 mg/kg at W6, W7, & W8 stations and maximum 340 mg/kg was recorded at W5 station. The average concentration of Magnesium was found to be 249 mg/Kg. Potassium in JNP harbor sediment was found to be 249 to 382 mg/Kg with an average of 318 mg/Kg. The minimum concentration of Potassium 249 mg/kg was found at W4 station and maximum value 382 mg/kg at W6 station. Sodium was found to be 4383 to 6722 mg/Kg with an average of 5360 mg/Kg. The minimum concentration of sodium 4383 mg/kg was found at W2 station and maximum value 6722 mg/kg at W3 station.

In Nhava Creek sediments, Calcium was found to be 6160 mg/kg at W13 and 7040 mg/Kg at W14 locations, with an average 6600 mg/Kg given in **Table 30**. Average magnesium was found to be 340 mg/Kg. The minimum concentration of magnesium was found at W13 location i.e. 340 mg/kg, whereas maximum concentration was observed at W14 location with value 340 mg/kg. The minimum concentration of potassium 330 mg/kg was observed at W13 and maximum concentration 348 mg/kg was observed at W14 station. Average potassium content in Nhava creek was found to be 339 mg/Kg. The minimum sodium value 5288 mg/kg was found at W13 station and maximum value 6182 mg/kg at W14. The average concentration of sodium was found to be 5735 mg/kg.

3.5 OBSERVATIONS AND CONCLUSIONS

Considering the various activities in JNP Harbour and NHAVA Creek area, it is seen from the following table that apparently the marine ecosystem is not adversely affected by following activities.

- ✓ *Construction of 4th Container Terminal on South side of JNPT:* Earth Filling work of 4thC.T. is underway.
- ✓ *Construction of NSIGT Yard is underway to the North side of JNPT.*
- ✓ *Plying of Ferry Boats:* There were large numbers of ferry boats plying in the area from Gateway of India to Elephanta.

It is seen from the data, as reported in **Tables 20 to 29** and subsequently discussed in above paragraphs, the major parameters comply with recommended ranges of the ecological parameters for Arabian Sea during January, 2016 except parameters like Particulate Organic Carbon and Nitrate.

The increased levels of POC, Phosphate and Nitrate, although not at alarming state, might be attributed to:

- ❖ There are four lotic water bodies; viz. Thane creek, Ulhas river, Panvel creek and Patalganga river that join the sea in the vicinity of the sampling area. Amongst these four, most of the sampling points are either within or close to Thane and Panvel creek confluence, resulting in direct impact on harbor water
- ❖ The creek is narrow at Northern end, where it is fed partially by River Ulhas. Along the east and west sides of the creek, many industrial units have come up. Thane and Panvel creek is the ultimate recipient of all the liquid discharges from these industries and mostly untreated sewage discharges. The discharges into the creek on its western side are dominated by Mumbai city sewerage and wastes from petrochemical, fertilizer and thermal plants at Chembur, besides the pharmaceutical and chemical complexes at Vikhroli, Bhandup and Mulund.
- ❖ The comparatively high values for POC might be the offshoot of detritus materials originating from Mangrove swamps due to tidal effects or enriched by detritus plankton & other organisms, coming from the creeks located on the Northern side of the Port.
- ❖ It may be mentioned that JN Port is not handling any dry bulk cargo containing Phosphate

Based on observations of the overall ecological parameters in JNP Harbour and Nhava Creek area, it can be inferred that the marine ecosystem is not affected due to port operational activities. The undesirable levels of POC and Nitrate are the result of untreated discharges of sewage and industrial waste from the towns / villages around the area, like Navi-Mumbai, Thane, Panvel etc. Accordingly certain mitigation measures, corresponding to parameters, are recommended in **Table 31**.

Table 31: Suggested mitigating measures for the Ecological parameters

Sr. No.	Parameter	Criteria	Observations	Remarks	Mitigation Measures
1.	Net primary productivity	<1500 mgC/m ³ /day at surface	The observed values falls under 215 – 415 mgC/m ³ /day	-	Within Range
2.	Chlorophyll- <i>a</i>	< 4 mg/m ³ [Oligotrophic class] 4-10 mg/m ³ [Mesotrophic class] >10 mg/m ³ [Eutrophic class]	The observed values falls under 1.6 – 5.4 mg/m ³	Stations follow mostly Oligotrophic class of water	Does not require since the values fall under Oligotrophic class of water
3.	Phosphate	0.1- 90 µg/L	Harbour area – 55 µg/L; Creek area – 56 µg/L	The nutrient acts as fertilizer. High level of nutrient from industrial waters from nearby mega cities may lead to excessive algal growth in aquatic ecosystem	Within Range
4.	Nitrate	1.0- 500 µg/L	Harbour area – 804 µg/L; Creek area – 945 µg/L	Besides wastes from sewage / industries, the nutrient is also produced in natural water by decomposition of nitrogenous organic compounds. Moderate level of nitrate in the area.	Proper treatment to Sewage and Industrial waste into the sea water by the concerned authorities like BMC, TMC, Panvel Municipal Corporation etc.
5.	Nitrite	<125 µg/L	Harbour area – <10 µg/L & Creek area – <10µg/L	A nutrient produced in natural water by decomposition of nitrogenous organic compounds. Moderate level of nitrite.	-----
6.	Particulate Organic Carbon	10 – 100 mg/m ³	Harbour area – 866 mg/m ³ ; Creek area – 1005 mg/m ³	This may be due to detritus material originating from Mangrove swamps / detritus plankton, benthos, fish etc. / untreated sewage discharges from towns /villages around the area.	Natural Phenomenon regarding mangrove and other living organisms. Treatment of sewage and industrial wastes before discharging into the sea water by the concerned authorities.
7.	Silicate (SiO ₂)	10-5000 µg/L	Harbour area – 1561 µg/L; Creek area – 1578 µg/L	Nucleic acid synthesis and skeletal formation of Diatoms.	Within Range

4. DRINKING WATER QUALITY MONITORING

4.1 INTRODUCTION

Drinking Water Quality Monitoring was carried out at eighteen stations in the port and port's township area. A list of locations for collecting the drinking water samples is presented below:

Table 32: Description of Drinking Water Quality Monitoring Stations

Sr. No.	Stations	Locations
Outside the Port Area		
1	DW1	Administration Building
2	DW2	Secondary School
3	DW3	PUB Canteen
4	DW4	Hospital Canteen
5	DW5	JNPT Inlet
6	DW9	Sector II
7	DW08	Sector III
8	DW13	CISF Canteen
9	DW14	Custom Canteen
10	DW15	JNPT Guest House
Inside the Port Area		
11	DW6	NSICT Canteen
12	DW7	GTI Canteen
13	DW10	POC Canteen
14	DW11	JNPT Workshop
15	DW12	C.T. Canteen
16	DW16	PPD Site Office
17	DW17	GTI -2
18	DW18	GTI CGC

Out of 18 stations, 10 are in outside the port while 8 are inside the port. All samples were collected from the port area of JNP on 11th January, 2016.

The water samples are analyzed for various parameters, viz. Colour, Odour, pH, Turbidity, Total Dissolved Solids, Aluminium as Al, NH₃ - N, Barium as Ba, Boron, Calcium as Ca, Chloride as Cl⁻, Copper as Cu, Fluoride, Free Residual Chlorine, Iron as Fe, Magnesium as Mg, Manganese as Mn, Oil & grease, Nitrate as NO₃⁻, Phenolic compound, Selenium as Se, Silver as Ag, Sulphate as SO₄⁻², Total Alkalinity as CaCO₃, Total Hardness as CaCO₃, Zinc as Zn, Cyanide, Lead as Pb, Mercury as Hg, Molybdenum as Mo, Nickel as Ni, Pesticides, Total Arsenic as As, Total Chromium as Cr, Total Coliforms and *E. coli*.

4.2 RESULTS

The drinking water quality monitoring data for eighteen stations are given in **Table 33**.

Table 33: Results of Drinking water quality monitoring [Sample collected on JANUARY 2016]

Parameter	Unit of Measurement	Station Name						Standards*
		DW1	DW2	DW3	DW4	DW5	DW6	
Colour	Hazen	<5	<5	<5	<5	<5	<5	5
Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
pH	-	7.26	7.38	7.57	7.56	7.40	7.27	6.5 to 8.5
Turbidity	NTU	<1	<1	<1	<1	<1	<1	1
Total Dissolved Solids	mg/L	83	90	86	85	81	84	500
Aluminium as Al	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03
NH ₃ -N	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.5
Barium as Ba	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7
Boron	mg/L	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.5
Calcium as Ca	mg/L	8	9	9	10	9	10	75
Chloride as Cl	mg/L	12	10	11	13	12	11	250
Copper as Cu	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05
Fluoride	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1.0
Free Residual Chlorine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2
Iron as Fe	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.3
Magnesium as Mg	mg/L	5	5	5	6	5	5	30
Manganese as Mn	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1
Oil and grease	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Nitrate as NO ₃ ⁻	mg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	45
Phenolic compound	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Selenium as Se	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Silver as Ag	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Sulphate as SO ₄ ²⁻	mg/L	5	5	6	5	6	7	200
Total Alkalinity as CaCO ₃	mg/L	35	34	39	38	35	36	200
Total Hardness as CaCO ₃	mg/L	42	45	41	47	44	46	200
Zinc as Zn	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	5
Cyanide	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Lead as Pb	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Mercury as Hg	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.001
Molybdenum as Mo	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07
Nickel as Ni	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02
Pesticides	mg/L	ND	ND	ND	ND	ND	ND	0.5
Total Arsenic as As	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.01
Total Chromium as Cr	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Total Coliforms	MPN/100ml	<2	<2	<2	<2	<2	<2	Nil
E coli	-	Absent	Absent	Absent	Absent	Absent	Absent	Absent

*: IS 10500:2012, Drinking Water - Specification

Table 33: Results of Drinking water quality monitoring [Sample collected on JANUARY 2016]

Parameter	Unit of Measurement	Station Name						Standard
		DW7	DW8	DW9	DW10	DW11	DW12	
Colour	Hazen	<5	<5	<5	<5	<5	<5	5
Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
pH	-	7.36	7.51	7.39	7.46	7.57	7.46	6.5 to 8.5
Turbidity	NTU	<1	<1	<1	<1	<1	<1	1
Total Dissolved Solids	mg/L	83	82	81	84	83	85	500
Aluminium as Al	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03
NH ₃ - N	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.5
Barium as Ba	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7
Boron	mg/L	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.5
Calcium as Ca	mg/L	9	9	10	10	9	9	75
Chloride as Cl	mg/L	11	13	13	13	12	11	250
Copper as Cu	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05
Fluoride	mg/L	0.1	<0.1	<0.1	<0.1	0.1	0.14	1.0
Free Residual Chlorine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2
Iron as Fe	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.3
Magnesium as Mg	mg/L	6	5	5	5	6	6	30
Manganese as Mn	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1
Oil and grease	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Nitrate as NO ₃ ⁻	mg/L	<0.2	<0.2	<0.2	<0.2	<0.2	0.8	45
Phenolic compound	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Selenium as Se	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Silver as Ag	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Sulphate as SO ₄ ⁻²	mg/L	6	5	5	6	6	6	200
Total Alkalinity as CaCO ₃	mg/L	38	40	32	35	33	38	200
Total Hardness as CaCO ₃	mg/L	47	45	44	46	47	45	200
Zinc as Zn	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	5
Cyanide	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Lead as Pb	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Mercury as Hg	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.001
Molybdenum as Mo	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07
Nickel as Ni	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02
Pesticides	mg/L	ND	ND	ND	ND	ND	ND	0.5
Total Arsenic as As	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.01
Total Chromium as Cr	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Total Coliforms	MPN/100ml	<2	<2	<2	<2	<2	<2	Nil
E coli	-	Absent	Absent	Absent	Absent	Absent	Absent	Absent

*: IS 10500:2012, Drinking Water - Specification

Table 33: Results of Drinking water quality monitoring [Sample collected on JANUARY 2016]

Parameter	Unit of Measurement	Station Name						Standard
		DW13	DW14	DW15	DW16	DW17	DW18	
Colour	Hazen	<5	<5	<5	<5	<5	<5	5
Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
pH	-	7.18	7.36	7.49	7.50	7.49	7.53	6.5 to 8.5
Turbidity	NTU	<1	<1	<1	<1	<1	<1	1
Total Dissolved Solids	mg/L	86	83	84	85	86	87	500
Aluminium as Al	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03
NH ₃ - N	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.5
Barium as Ba	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7
Boron	mg/L	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.5
Calcium as Ca	mg/L	9	10	9	9	9	9	75
Chloride as Cl ⁻	mg/L	11	12	12	13	11	12	250
Copper as Cu	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05
Fluoride	mg/L	<0.1	<0.1	0.11	<0.1	<0.1	<0.1	1.0
Free Residual Chlorine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2
Iron as Fe	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.3
Magnesium as Mg	mg/L	6	6	6	6	6	6	30
Manganese as Mn	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1
Oil and grease	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Nitrate as NO ₃ ⁻	mg/L	0.9	<0.2	<0.2	<0.2	<0.2	<0.2	45
Phenolic compound	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Selenium as Se	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Silver as Ag	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Sulphate as SO ₄ ²⁻	mg/L	5	5	6	5	6	7	200
Total Alkalinity as CaCO ₃	mg/L	36	34	35	32	38	35	200
Total Hardness as CaCO ₃	mg/L	46	48	44	45	47	48	200
Zinc as Zn	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	5
Cyanide	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Lead as Pb	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Mercury as Hg	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.001
Molybdenum as Mo	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07
Nickel as Ni	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02
Pesticides	mg/L	ND	ND	ND	ND	ND	ND	0.5
Total Arsenic as As	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.01
Total Chromium as Cr	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Total Coliforms	MPN/100ml	<2	<2	<2	<2	<2	<2	Nil
E coli	-	Absent	Absent	Absent	Absent	Absent	Absent	Absent

*: IS 10500:2012, Drinking Water - Specification

4.3 DISCUSSION

Table 33 provides the observed results for various parameters analyzed for drinking water samples collected from eighteen stations in and around the port's activity during the monitoring period of January, 2016 are compared with acceptable limits as prescribed in **IS 10500:2012** – Drinking Water Specification. It is seen from the analysis data that during the study period the water was safe for human consumption at all drinking water monitoring stations in and around the port.

The colour of all drinking water samples was < 5 Hazen unit and odour of the samples was also agreeable. The values of turbidity, Iron as Fe and Ammonia as NH₃-N were observed to be below detection limits of measurement i.e. <0.1 NT, <0.03 mg/L and <0.1 mg/L respectively. Apparently these parameters are not at alarming levels.

Values observed for TDS for all the samples were in the range of 81 to 90 mg/L which are well below the acceptable standard limits (500 mg/L). pH values of all the samples were in the range of 7.18 to 7.57 which is within the permissible standard 6.5 to 8.5. Total Hardness as CaCO₃ values of all the eighteen samples were found to be in the range of 41 to 48 mg/L and found to be within the acceptable limit (200 mg/L).

Concentration levels observed for Chlorides as Cl⁻ and Sulphate as SO₄²⁻ were in the range of 10.0 to 13.0 mg/L, 5.0 to 7.0 mg/L respectively. The observed values for these parameters are well within the acceptable standard limits.

Analysis of the bacteriological parameter at all location is below the prescribed limits. Total Coliforms values are well within the standard limits. Hence E-Coli and Total coliforms values showed that all the other drinking water samples were safe from any bacteriological contamination.

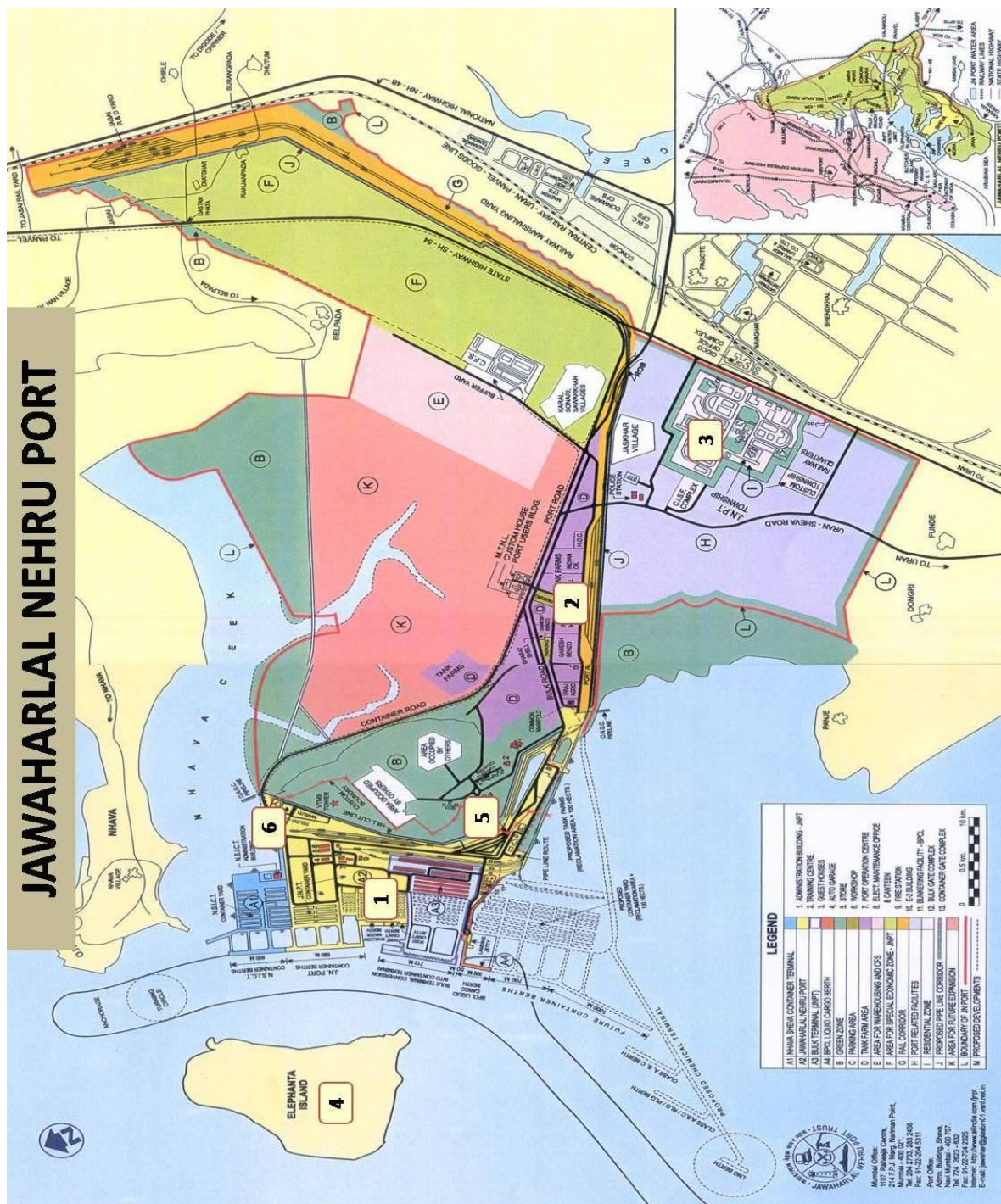
4.4 CONCLUSIONS AND MITIGATION MEASURES:

As per the drinking water specifications, given in IS 10500:2012 and also on the basis of above described analysis parameters, the water is safe for drinking purpose at all drinking water monitoring stations around port areas.

It is advisable that, utmost care has to be taken to keep drinking water premises clean and sanitized. Water Filters and purifiers have to be regularly cleaned.

5. ANNEXURES

Annexure-I: Location map for Ambient Air Monitoring Stations



Annexure-II: National Ambient Air Quality Monitoring Standard

Sr. No.	Pollutant	Time Weighted Average	Concentration in Ambient Air		
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (notified by Central Government)	Methods of Measurement
1.	Sulphur Dioxide (SO ₂), µg/m ³	Annual*	50	20	-Improved West and Geake
		24 hours**	80	80	-Ultraviolet fluorescence
2.	Nitrogen Dioxide (NO ₂), µg/m ³	Annual*	40	30	-Modified Jacob & Hochheiser (Na-Arsenite)
		24 hours**	80	80	-Chemiluminescence
3.	Particulate Matter (size less than 10µm) or PM ₁₀ , µg/m ³	Annual*	60	60	-Gravimetric
		24 hours**	100	100	-TOEM -Beta attenuation
4.	Particulate Matter (size less than 2.5µm) or PM _{2.5} , µg/m ³	Annual*	40	40	-Gravimetric
		24 hours**	60	60	-TOEM -Beta attenuation
5.	Ozone (O ₃), µg/m ³	8 hours**	100	100	-UV photometric
		1 hour**	180	180	-Chemiluminescence -Chemical Method
6.	Lead (Pb), µg/m ³	Annual*	0.5	0.5	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper
		24 hours**	1.0	1.0	-ED-XRF using Teflon filter
7.	Carbon Monoxide (CO), mg/m ³	8 hours**	02	02	-Non Dispersive Infra-Red (NDIR)
		1 hour**	04	04	spectroscopy
8.	Ammonia (NH ₃), µg/m ³	Annual*	100	100	-Chemiluminescence
		24 hours**	400	400	-Indophenol blue method
9.	Benzene (C ₆ H ₆), µg/m ³	Annual*	05	05	-Gas chromatography based continuous analyzer -Adsorption and Desorption followed by GC analysis
10.	Benzo Pyrene (BaP) – particulate phase only, ng/m ³	Annual*	01	01	-Solvent extraction followed by HPLC/GC analysis
11.	Arsenic (As), ng/m ³	Annual*	06	06	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper
12.	Nickel (Ni), ng/m ³	Annual*	20	20	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper

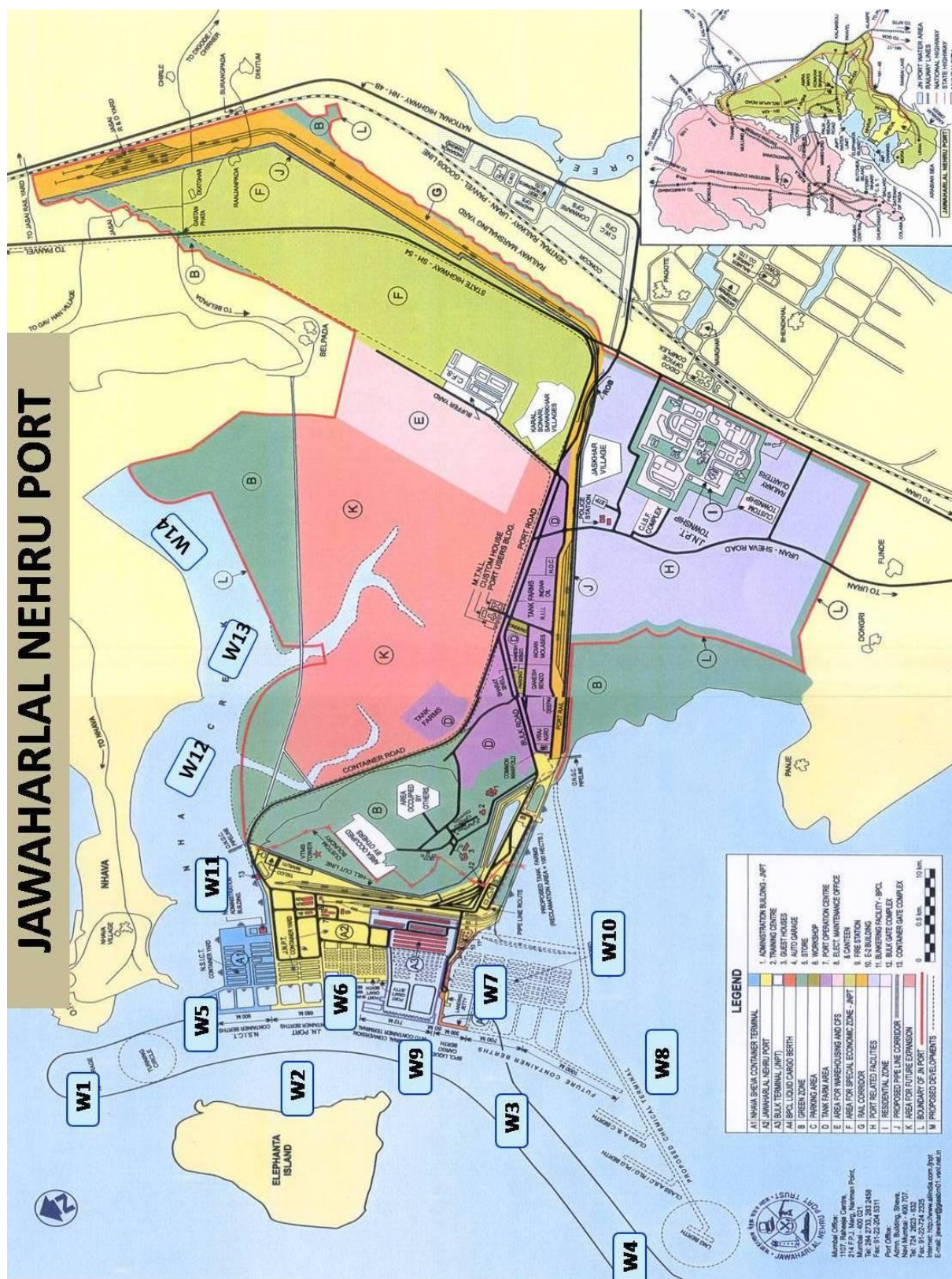
* Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals

** 24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be compiled with 98% of the time in a year.

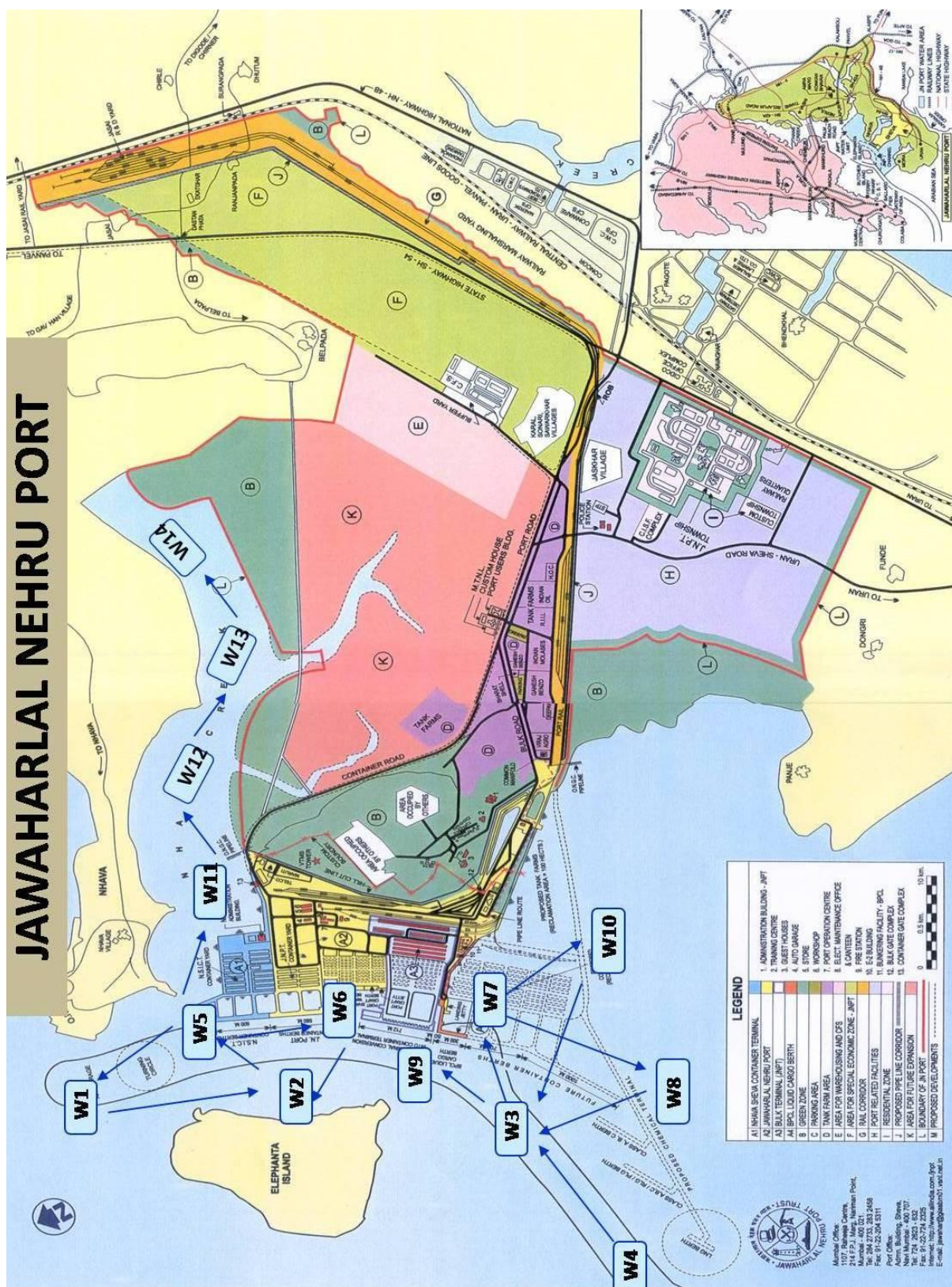
2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Note – Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigations.

Annexure-III: Location map for Marine Water Monitoring Stations



Annexure-IV: Map for Ecological monitoring Stations and Towing Directions



Annexure-V: Primary Criterion for Class SW-IV Waters (For Harbor Waters)

Sr. No.	Parameter	Criteria	Rationale/Remarks
1.	pH range	6.5 - 9.0	To minimize the corrosive and scaling effects.
2.	Dissolved Oxygen	3.0 mg/L or 40 % of the saturation value, whichever is higher	Considering bio-degradation of oil and inhibition to oxygen production through photosynthesis.
3.	Color and Odor	No visible color or offensive order	None from reactive chemicals which may corrode paints/metallic surfaces.
4.	Floating objects oil, grease and scum (including the petroleum products)	10 mg/L	Floating matter should be free from excessive living organisms which may clog or coat operative parts of marine vessels/equipment.
5.	Fecal Coliform	500/ 100 ml (MPN)	Not exceeding 1000/100 ml in 20 % of the samples in the year and in 3 consecutive samples in the monsoon months.
6.	Biochemical Oxygen Demand (3 days at 27°C)	5 mg/L	To maintain water relatively free from the pollution caused by sewage and other decomposable wastes.

Annexure-VI: Recommended Ranges of the Ecological Parameters for Arabian Sea

Sr. No.	Parameter	Criteria	Rationale/Remarks
1.	Net primary productivity	<1500 mgC/m ³ /day at surface	High productivity indicates the abundance of phytoplankton crop available to primary producers this could lead to poor water quality.
2.	Chlorophyll-a	< 4 mg/m ³ 4-10 mg/m ³ >10 mg/m ³	Oligotrophic class of water Mesotrophic class of water Eutrophic class of water
3.	Phosphate	0.1- 90 µg/L	A nutrient that acts as a fertilizer. High level of this nutrient causes excessive plant and algal growth in aquatic ecosystem
4.	Nitrate	1.0- 500 µg/L	This is also a nutrient produced in natural water by decomposition of nitrogenous organic compounds. High level of nitrate represents the presence of more nitrogenous compounds and resulting in to excessive growth of algae and other aquatic vegetation.
5.	Nitrite	<125 µg/L	Nitrite in water poisons the fish by binding to the hemoglobin in the blood preventing oxygen carrying capacity, in effect suffocating the fish .The gills of fish dying as a result of nitrite poisoning are characteristic brown color.
6.	Particulate Organic Carbon (POC)	10-100 mg/m ³	POC is directly related to primary productivity. High concentration of POC represents the region of high productivity.
7.	Silicate (SiO ₂)	10-5000 µg/L	Nucleic acid synthesis and skeletal formation of Diatoms.