



MONITORING OF ENVIRONMENTAL PLAN FOR JN PORT ENVIRONMENTAL MONITORING REPORT

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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, namely Port Operational Centre (POC), Indian Molasses Company (IMC) and Residential Colony (RC) are identified. Three movable locations, namely Elephanta Caves (EC), North Gate Complex (NGC) and South Gate Complex (SGC) are also identified. 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	Port Operational Centre	Main Port Activity Location
2.	IMC	IMC compound in Liquid Chemical Terminal Area	Major industrial activity centre
3.	RC	JNP residential township	Impact on human population, receptor oriented
4.	EC	Elephanta Caves	Impact on archeological 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 Ambient Air Quality Monitoring, Volume-I, 2012. 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 October, 2015 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 October, 2015

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	8 hr	24 hr (Avg)	8 hr	24 hr (Avg)	8 hr	24 hr (Avg)
POC-1		01.10.2015 to 02.10.2015	14:00 to 22:00					15		37		15	
			22:00 to 06:00	130		55		25	17.0	40	36.2	18	15.8
			06:00 to 14:00					11		32		14	
POC-2		05.10.2015 to 06.10.2015	14:00 to 22:00					22		56		30	
			22:00 to 06:00	145		61		26	20.2	57	55.9	36	31.3
			06:00 to 14:00					13		55		28	
POC-3		08.10.2015 to 09.10.2015	14:00 to 22:00					26		29		17	
			22:00 to 06:00	109		45		28	24.7	32	28.8	20	16.9
			06:00 to 14:00					20		26		14	
POC-4		12.10.2015 to 13.10.2015	14:00 to 22:00					12		41		28	
			22:00 to 06:00	181		58		22	16.4	44	42.3	34	30.7
			06:00 to 14:00					15		42		30	
POC-5		15.10.2015 to 16.10.2015	14:00 to 22:00					15		48		3	
			22:00 to 06:00	232		80		21	16.9	57	52.2	10	6.0
			06:00 to 14:00					16		51		6	
POC-6		19.10.2015 to 20.10.2015	14:00 to 22:00					19		55		38	
			22:00 to 06:00	238		74		22	19.6	60	57.3	38	38.0
			06:00 to 14:00					17		58		38	
POC-7		22.10.2015 to 23.10.2015	14:00 to 22:00					10		61		1	
			22:00 to 06:00	111		35		13	11.2	64	61.5	3	1.4
			06:00 to 14:00					11		60		1	
POC-8		26.10.2015 to 27.10.2015	14:00 to 22:00					24		76		20	
			22:00 to 06:00	170		39		26	24.1	72	74.6	23	20.1
			06:00 to 14:00					22		76		17	
POC-9		29.10.2015 to 30.10.2015	14:00 to 22:00					11		54		15	
			22:00 to 06:00	198		66		12	<10	60	56.1	17	14.9
			06:00 to 14:00					6		55		13	
Average	Standard Dev			168		57			18.8		51.6		19.4
				48		15			4.4		13.9		12.0

Table 2: Results of Air Pollutant Concentration at POC Station of JNP Area during the month of October, 2015												
Sampling Period	Date	Time, [Hrs]	O ₃ , [µg/m ³]	Pb, [µg/m ³]	As, [ng/m ³]	24 hr	24 hr	Ni, [ng/m ³]	8 hr	5 µg/m ³	24 hr	CO ₂ , [ppm]
NAAQMS			100 µg/m ³	1.0 µg/m ³	6 ng/m ³	20 ng/m ³	1 ng/m ³	4 mg/m ³	Grab Sampling	CO, [mg/m ³]	Grab Sampling	CO ₂ , [ppm]
POC-1	01.09.2015	14:00 to 22:00										
	To	22:00 to 06:00	12	<0.01	<1	<1	<0.5	2.1	232			
POC-2	02.09.2015	06:00 to 14:00										
	To	22:00 to 06:00	8	<0.01	<1	<1	<0.5	0.9	194			
POC-3	05.09.2015	06:00 to 14:00										
	To	22:00 to 06:00	21	<0.01	<1	<1	<0.5	1.6	254			
POC-4	10.09.2015	14:00 to 22:00										
	To	22:00 to 06:00	15	<0.01	<1	<1	<0.5	0.4	281			
POC-5	14.09.2015	14:00 to 22:00										
	To	22:00 to 06:00	13	<0.01	<1	<1	<0.5	1.8	297			
POC-6	17.09.2015	14:00 to 22:00										
	To	22:00 to 06:00	7	<0.01	<1	<1	<0.5	2.2	263			
POC-7	21.09.2015	14:00 to 22:00										
	To	22:00 to 06:00	36	<0.01	<1	<1	<0.5	1.6	288			
POC-8	24.09.2015	14:00 to 22:00										
	To	22:00 to 06:00	11	<0.01	<1	<1	<0.5	1.8	239			
POC-9	28.09.2015	14:00 to 22:00										
	To	22:00 to 06:00	69	<0.01	<1	<1	<0.5	1.2	255			
Average	29.09.2015	06:00 to 14:00	21					1.5	256			
	Standard Dev		20					0.6	32			

Table 3: Results of Air Pollutant Concentration at IMC Station of JNP Area during the month of October, 2015

Sampling Period	Date	Time, [Hrs]	PM ₁₀ , [µg/m ³] 24 hr	PM _{2.5} , [µg/m ³] 24 hr	SO ₂ , [µg/m ³] 8 hr	24 hr (Avg) 80 µg/m ³	NO _x , [µg/m ³] 8 hr	24 hr (Avg) 80 µg/m ³	NH ₃ , [µg/m ³] 8 hr	24 hr (Avg) 400 µg/m ³
NAAQMS			100 µg/m ³	60 µg/m ³	-		-		-	
IMC-1	01.10.2015 To 02.10.2015	15:00 to 23:00			15		34		57	
		23:00 to 07:00	111	38	26	21	37	34.1	60	56.3
		07:00 to 15:00			21		32		53	
IMC-2	05.10.2015 To 06.10.2015	15:05 to 23:05			26		41		37	
		23:05 to 07:05	98	43	29	24	43	39.7	39	36.8
		07:05 to 15:05			16		35		35	
IMC-3	08.10.2015 To 09.10.2015	15:10 to 23:10			13		25		52	
		23:10 to 07:10	121	35	17	14	29	24.8	56	52.7
		07:10 to 15:10			12		21		50	
IMC-4	12.10.2015 to 13.10.2015	14:50 to 22:50			15		35		32	
		22:50 to 06:50	183	39	20	18	38	34.8	37	34.2
		06:50 to 14:50			17		32		34	
IMC-5	15.10.2015 to 16.10.2015	15:00 to 23:00			18		37		53	
		23:00 to 07:00	354	76	26	22	63	53.5	60	56.0
		07:00 to 15:00			23		60		55	
IMC-6	19.10.2015 to 20.10.2015	15:00 to 23:00			5		41		18	
		23:00 to 07:00	272	179	9	<10	65	65.4	19	18.7
		07:00 to 15:00			8		61		19	
IMC-7	22.10.2015 to 23.10.2015	15:00 to 23:00			18		63		21	
		23:00 to 07:00	262	20	25	20.9	77	65.4	23	21.4
		07:00 to 15:00			19		56		19	
IMC-8	26.10.2015 to 27.10.2015	15:00 to 23:00			13		71		14	
		23:00 to 07:00	208	71	19	15.4	75	72.7	17	14.4
		07:00 to 15:00			14		72		12	
IMC-9	29.10.2015 to 30.10.2015	15:00 to 23:00			24		67		51	
		23:00 to 07:00	284	36	27	24.7	71	68.7	57	54.5
		07:00 to 15:00			23		68		55	
Average Standard Dev			210	60		19.9		51.0		38.3
			89	48		3.9		17.9		17.2

Table 3: Results of Air Pollutant Concentration at IMC Station of JNP Area during the month of October, 2015												
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 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	Grab Sampling 4 mg/m ³	CO ₂ , [ppm]		
IMC-1	01.10.2015 to 02.10.2015	15:00 to 23:00										
		23:00 to 07:00	28	<0.01	<1	<1	<1	<0.5	1.8	288		
IMC-2	05.10.2015 to 06.10.2015	07:00 to 15:00										
		15:05 to 23:05	40	<0.01	<1	<1	<1	<0.5	2.2	241		
IMC-3	08.10.2015 to 09.10.2015	07:05 to 15:05										
		15:10 to 23:10	26	<0.01	<1	<1	1.2	<0.5	2.3	229		
IMC-4	12.10.2015 to 13.10.2015	07:10 to 15:10										
		14:50 to 22:50	35	<0.01	<1	<1	<1	<0.5	0.9	289		
IMC-5	15.10.2015 to 16.10.2015	22:50 to 06:50										
		06:50 to 14:50	12	<0.01	<1	<1	1.8	<0.5	1.7	277		
IMC-6	19.10.2015 to 20.10.2015	15:00 to 23:00										
		23:00 to 07:00	7	<0.01	<1	<1	1.4	<0.5	0.9	288		
IMC-7	22.10.2015 to 23.10.2015	07:00 to 15:00										
		15:00 to 23:00	16	<0.01	<1	<1	<1	<0.5	1.5	275		
IMC-8	26.10.2015 to 27.10.2015	23:00 to 07:00										
		07:00 to 15:00	15	<0.01	<1	<1	1.2	<0.5	0.8	214		
IMC-9	29.10.2015 to 30.10.2015	15:00 to 23:00										
		23:00 to 07:00	19	<0.01	<1	<1	<1	<0.5	2.1	217		
Average			24				1.4		1.6	258		
Standard Dev			10				0.3		0.6	32		

Table 4: Results of Air Pollutant Concentration at RC School Station of JNP Area during the month of October, 2015

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]
NAAQMS			24 hr 100 µg/m ³	24 hr 60 µg/m ³	8 hr -	24 hr (Avg) 80 µg/m ³	8 hr -
RC-1	01.10.2015 to 02.10.2015	15:30 to 23:30			11		12
		23:30 to 07:30	101	32	24	16	14
		07:30 to 15:30			14		11
RC-2	05.10.2015 to 06.10.2015	15:30 to 23:30			15		30
		23:30 to 07:30	126	58	29	18	32
		07:30 to 15:30			11		26
RC-3	08.10.2015 to 09.10.2015	15:30 to 23:30			13		2
		23:30 to 07:30	64	40	18	13	3
		07:30 to 15:30			9		1
RC-4	12.10.2015 to 13.10.2015	15:30 to 23:30			11		17
		23:30 to 07:30	148	98	26	17	21
		07:30 to 15:30			15		32
RC-5	15.10.2015 to 16.10.2015	15:30 to 23:30			10		15
		23:30 to 07:30	255	68	16	13	21
		07:30 to 15:30			13		17
RC-6	19.10.2015 to 20.10.2015	15:30 to 23:30			7		27
		23:30 to 07:30	255	40	10	<10	28
		07:30 to 15:30			5		28
RC-7	22.10.2015 to 23.10.2015	15:30 to 23:30			13		11
		23:30 to 07:30	279	76	18	15	13
		07:30 to 15:30			14		10
RC-8	26.10.2015 to 27.10.2015	15:30 to 23:30			6		9
		23:30 to 07:30	244	81	12	<10	12
		07:30 to 15:30			8		9
RC-9	29.10.2015 to 30.10.2015	15:30 to 23:30			9		8
		23:30 to 07:30	318	176	13	11	9
		07:30 to 15:30			12		7
Average			199	74		15.0	21.0
Standard Dev			90	44		2.5	8.8

Table 4: Results of Air Pollutant Concentration at RC Station of JNP Area during the month of October, 2015

Sampling Period	Date	Time, [Hrs]	O ₃ , [$\mu\text{g}/\text{m}^3$]	Pb, [$\mu\text{g}/\text{m}^3$]	As, [ng/m^3]	24 hr 6 ng/m^3	Ni, [ng/m^3]	24 hr 20 ng/m^3	8 hr 5 $\mu\text{g}/\text{m}^3$	24 hr 1 ng/m^3	CO, [mg/m^3]	CO ₂ , [ppm]
NAAQMS			8 hr 100 $\mu\text{g}/\text{m}^3$	24 hr 1.0 $\mu\text{g}/\text{m}^3$	24 hr 6 ng/m^3	24 hr 20 ng/m^3	24 hr 1 ng/m^3	24 hr 4 mg/m^3	24 hr 1 ng/m^3	24 hr 1 ng/m^3	24 hr 1 ng/m^3	24 hr 1 ng/m^3
RC-1	01.10.2015 to 02.10.2015	15:30 to 23:30	17	<0.01	<1	<1	<1	<1	1.4	<0.5	1.9	299
		23:30 to 07:30										
		07:30 to 15:30										
RC-2	05.10.2015 to 06.10.2015	15:30 to 23:30	26	<0.01	<1	<1	<1	<1	1.4	<0.5	2.0	294
		23:30 to 07:30										
		07:30 to 15:30										
RC-3	08.10.2015 to 09.10.2015	15:30 to 23:30	20	<0.01	<1	<1	<1	<1	<1	<0.5	1.3	296
		23:30 to 07:30										
		07:30 to 15:30										
RC-4	12.10.2015 to 13.10.2015	15:30 to 23:30	21	<0.01	<1	<1	<1	<1	<1	<0.5	1.8	282
		23:30 to 07:30										
		07:30 to 15:30										
RC-5	15.10.2015 to 16.10.2015	15:30 to 23:30	11	<0.01	<1	<1	<1	<1	1.6	<0.5	1.2	214
		23:30 to 07:30										
		07:30 to 15:30										
RC-6	19.10.2015 to 20.10.2015	15:30 to 23:30	6	<0.01	<1	<1	<1	<1	<1	<0.5	2.3	226
		23:30 to 07:30										
		07:30 to 15:30										
RC-7	22.10.2015 to 23.10.2015	15:30 to 23:30	7	<0.01	<1	<1	<1	<1	<1	<0.5	1.2	274
		23:30 to 07:30										
		07:30 to 15:30										
RC-8	26.10.2015 to 27.10.2015	15:30 to 23:30	6	<0.01	<1	<1	<1	<1	1.2	<0.5	2.1	244
		23:30 to 07:30										
		07:30 to 15:30										
RC-9	29.10.2015 to 30.10.2015	15:30 to 23:30	17	<0.01	<1	<1	<1	<1	<1	<0.5	2.3	296
		23:30 to 07:30										
		07:30 to 15:30										
Average			14						1.4		1.8	269
Standard Dev			7						0.2		0.4	33

	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]	
Sampling Period			24 hr	24 hr	8 hr	24 hr (Avg)	8 hr	24 hr (Avg)
NAAQMS			100 µg/m ³	60 µg/m ³	-	80 µg/m ³	-	400 µg/m ³
EC	07.10.2015 to 08.10.2015	14:00 to 22:00	142	40	10	18	5	5.3
		22:00 to 06:00			17	22	8	
	06:00 to 14:00	9			15	3		

Table 5: Results of Air Pollutant Concentration at EC Station monitored during October, 2015

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]
NAAQMS			8 hr	24 hr	24 hr	24 hr	8 hr	24 hr	Grab Sampling	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	-
EC	07.10.2015 to 08.10.2015	14:00 to 22:00								
		22:00 to 06:00	21		<1	<1	<1	<0.5	1.1	278
		06:00 to 14:00								

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)
NG-1	04.10.2015 to 05.10.2015	14:30 to 22:30					13		30		11	
		22:30 to 06:30	129	34		22	16.4	34	31.1	13	11.2	
		06:30 to 14:30				14		29		10		
NG-2	08.10.2015 to 09.10.2015	14:30 to 22:30					8		21		64	
		22:30 to 06:30	174	50		20	12.8	28	22.7	65	63.5	
		06:30 to 14:30				11		19		62		
NG-3	15.10.2015 to 16.10.2015	14:30 to 22:30					10		40		65	
		22:30 to 06:30	263	76		16	15.4	44	41.6	72	68.8	
		06:30 to 14:30				20		41		69		
NG-4	22.10.2015 to 23.10.2015	14:30 to 22:30					11		50		12	
		22:30 to 06:30	279	79		14	11.2	56	53.3	14	12.4	
		06:30 to 14:30				9		53		11		
NG-5	29.10.2015 to 30.10.2015	14:30 to 22:30					11		50		7	
		22:30 to 06:30	279	79		14	11.2	56	53.3	12	8.4	
		06:30 to 14:30				9		53		6		
Average			225	64			13.4		40.4		32.8	
Standard Dev			69	21			2.4		13.6		30.5	

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	Ni, [ng/m ³]	24 hr	20 ng/m ³	8 hr	C ₆ H ₆ , [µg/m ³]	BaP, [ng/m ³]	24 hr	1 ng/m ³	CO, [mg/m ³]	Grab Sampling	4 mg/m ³	CO ₂ , [ppm]	Grab Sampling	
			100 µg/m ³	8 hr	1.0 µg/m ³	24 hr	24 hr	24 hr	24 hr	24 hr	24 hr	24 hr	24 hr	24 hr	24 hr	24 hr	24 hr	24 hr	24 hr	24 hr	24 hr	24 hr	24 hr
NG-1	04.10.2015 to 05.10.2015	14:30 to 22:30																					
		22:30 to 06:30																					
		06:30 to 14:30																					
NG-2	08.10.2015 to 09.10.2015	14:30 to 22:30																					
		22:30 to 06:30																					
		06:30 to 14:30																					
NG-3	15.10.2015 to 16.10.2015	14:30 to 22:30																					
		22:30 to 06:30																					
		06:30 to 14:30																					
NG-4	22.10.2015 to 23.10.2015	14:30 to 22:30																					
		22:30 to 06:30																					
		06:30 to 14:30																					
NG-4	29.10.2015 to 30.10.2015	14:30 to 22:30																					
		22:30 to 06:30																					
		06:30 to 14:30																					
Average																							
Standard Dev																							

Table 7: Results of Air Pollutant Concentration at SGC Station of JNP Area during the month of October, 2015

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	05.10.2015 to 06.10.2015	14:30 to 22:30	152		58		6	10.9	54	47.9	9	9.7
SG-1		22:30 to 06:30					16		56		12	
		06:30 to 14:30					11		34		8	
SG-2	12.10.2015 to 13.10.2015	14:30 to 22:30	212		161		16	19.6	27	27.3	19	21.5
		22:30 to 06:30					22		30		25	
		06:30 to 14:30					20		25		20	
SG-3	19.10.2015 to 20.10.2015	14:30 to 22:30	243		79		32	18.0	46	46.7	15	15.8
		22:30 to 06:30					12		48		18	
		06:30 to 14:30					11		46		14	
SG-4	26.10.2015 to 27.10.2015	14:30 to 22:30	199		55		7	<10	53	54.9	3	3.3
		22:30 to 06:30					10		57		5	
		06:30 to 14:30					11		55		2	
Average			202		88			16.1		44.2		12.6
Standard Dev			38		50			4.6		11.8		7.8

Table 7: Results of Air Pollutant Concentration at SGC Station of JNP Area during the month of October, 2015

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	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	24 hr	1 ng/m ³	24 hr	4 mg/m ³	Grab Sampling	Grab Sampling	Grab Sampling
NAAQMS	05.10.2015 to 06.10.2015	14:30 to 22:30	11		<0.01		<1		<1	<1	<1	<1	<0.5	<0.5	2.1	289	-	-
SG-1		22:30 to 06:30																
		06:30 to 14:30																
SG-2	12.10.2015 to 13.10.2015	14:30 to 22:30	14		<0.01		<1		<1	<1	<1	<1	<0.5	<0.5	1.2	241		
		22:30 to 06:30																
		06:30 to 14:30																
SG-3	19.10.2015 to 20.10.2015	14:30 to 22:30	17		<0.01		<1		<1	<1	1.4	<1	<0.5	<0.5	1.7	285		
		22:30 to 06:30																
		06:30 to 14:30																
SG-4	26.10.2015 to 27.10.2015	14:30 to 22:30	9		<0.01		<1		<1	<1	<1	<1	<0.5	<0.5	1.3	221		
		22:30 to 06:30																
		06:30 to 14:30																
Average			13								1.1				1.6	259		
Standard Dev			4												0.4	33		

1.4 DISCUSSION

In **Table 8**, the average values of air pollutants are provided at various stations of JNP area for October, 2015. 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 October, 2015

STATION	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]	O ₃ , [μg/m ³]	Pb [μg/m ³]	C ₆ H ₆ , [μg/m ³]	CO, [mg/m ³]	CO ₂ , [ppm]
NAAQMS	100	60	80	80	400	100	1	5	4	-
INDUSTRIAL AREA										
POC	168 ± 48	57 ± 15	18.8±4.4	51.6±13.9	19.4±20.0	26 ± 09	<0.01	1.4 ± 0.3	1.3 ± 0.4	250 ± 44
IMC	210±89	60 ± 48	19.9±3.9	51.0±17.9	38.3±17.2	24 ± 10	<0.01	1.6 ± 0.3	1.6± 0.6	258± 32
NG	225±69	64 ± 21	13.4±2.4	40.4±13.6	32.8±30.5	31 ± 9	<0.01	1.2 ± 0.1	1.7 ± 0.5	269± 25
SG	202 ± 38	88 ± 50	16.1±4.6	44.2±11.8	12.6 ± 7.8	13 ± 4	<0.01	1.1	1.6 ± 0.4	259± 33
RESIDENTIAL AREA										
RC	199± 90	74 ± 44	15.0±2.5	21.0 ± 8.8	15.7 ± 9.3	14 ± 7	<0.01	1.4 ± 0.2	1.8 ± 0.4	269± 33
ECO-SENSITIVE AREA										
EC	142	40	11.9	18.2	5.3	21	<0.01	<1	1.1	278

During the monitoring period, the overall Ambient Air Quality of the port area was found to be well within the desired levels for various pollutants. Daily average pollutant levels are presented in **Tables 2** through **7**. However, the concentrations obtained for particulate matter PM₁₀ at all stations were found to be exceeding the prescribed CPCB limits. All other pollutants were recorded well below the prescribed limits.

Results for the air quality parameters at Elephanta Caves [EC] station during 07th October'15 to 08th October'15 are represented in **Table 5**. **Tables 6 & 7** provide the results for NGC and SGC air monitoring stations respectively.

On October 15, particulate & gaseous pollutants were well within the prescribed limits, set for industrial as well as sensitive areas, except for PM₁₀ levels.

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 October'15:

- ✓ 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, which is slightly 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. Slightly increase in the PM₁₀ 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 PM_{2.5} and other parameters are well within the CPCB limits except for PM₁₀ Concentration which was found exceeding the CPCB limits twice the monitoring cycle. The development of yard for NSIGT and heavy vehicular movement causing the elevated values of PM₁₀ 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 October'15 for the Rail over bridge. Nearest AAQM 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.

The following measures can be taken to reduce further the PM₁₀ 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.
- ✓ Regular sprinkling of water at ITD yard is required to be done, as significant amount of dust is generated due to stone crushing activities at the site.

	
Civil Work at JNP Township	Land Preparation at 4th Container Terminal
	
Construction of Rail-Over bridge	ITD yard near Sheva hill

Conclusion:

From the results obtained for the month of October, 2015 it can be concluded that overall Ambient Air quality of the JN Port is within CPCB limits, except the levels of PM₁₀, 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.	7 th October, 2015
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	7 th October, 2015
3.	W3	Identified by the green buoy no. <u>FG2 Green</u> of JNPT approach channel and lies near the landing jetty.	8 th October, 2015
4.	W4	Located at Uran Patch Beacon (lighthouse on concrete platform) near the Butcher Island filling platform.	8 th October, 2015
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 Belpada to the creek water quality.	7 th October, 2015
	W11 to W14		7 th &9 th October,2015
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.	7 th October, 2015
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.	8 th October, 2015
8.	W9	Located in between GTI and Liquid Cargo Jetty. This station is selected to examine the impact of terminal activities on water qualities	8 th October, 2015
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.	8 th October, 2015

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, TotalSolids, 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 October, 2015

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	13.9	29.2	7.36	30.1	6	28410	82	28492
	SM		29	7.55	30.7	6	28930	88	29018
	SB		28.9	7.48	30.1	6	29360	94	29454
	NS	13.1	29.4	7.50	30.7	6	29210	60	29270
	NM		29.1	7.56	31.3	5	28430	40	28470
	NB		29.2	7.44	30.7	5	28900	95	28995
W2	SS	5.2	29.3	7.55	31.3	5	29110	61	29171
	SM		29	7.57	31.3	5	29040	57	29097
	SB		28.9	7.46	30.7	6	28730	78	28808
	NS	4.6	29.2	7.75	31.3	4	28550	59	28609
	NM		29.3	7.68	31.9	5	28430	79	28509
	NB		29.2	7.63	30.7	6	27930	102	28032
W3	SS	7.3	29.4	7.95	31.9	3	28440	41	28481
	SM		29.2	7.78	31.9	3	29810	58	29868
	SB		28.9	7.96	30.7	3	28320	77	28397
	NS	6.8	29.2	6.94	31.9	3	29420	78	29498
	NM		29.1	7.81	32.5	5	28310	79	28389
	NB		29	7.72	33.7	2	27880	83	27963
W4	SS	9.6	29.1	7.91	33.1	9	29206	97	29303
	SM		28.9	7.80	33.1	9	28310	131	28441
	SB		28.8	7.71	32.5	23	28430	93	28523
	NS	8.7	29.4	7.41	31.9	10	28270	46	28316
	NM		29.2	7.70	30.7	9	29310	54	29364
	NB		29.2	7.22	30.7	29	29370	104	29474
W5	SS	11.8	29.1	7.50	33.1	10	29130	83	29213
	SM		28.9	7.26	32.5	9	28880	83	28963
	SB		28.7	7.65	31.3	26	28660	68	28728
	NS	11.6	29.3	7.45	33.3	11	29130	90	29220
	NM		29.1	7.66	31.3	15	28910	97	29007
	NB		29.1	7.72	31.3	13	29220	144	29364

SS – SPRING SURFACE
SM – SPRING MIDDLE
SB – SPRING BOTTOM

NS – NEAP SURFACE
SM – NEAP MIDDLE
SB – NEAP BOTTOM

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	-	-	-	-	-
W6	SS	10.8	29.4	7.59	33.1	12	27990	107	28097
	SM		29.1	7.64	33.7	15	28330	84	28414
	SB		29.1	7.51	33.7	17	29710	88	29798
	NS	10.2	29.4	7.59	32.5	13	29310	80	29390
	NM		29.2	7.69	33.1	18	29880	74	29954
	NB		29.1	7.59	31.9	15	28920	101	29021
W7	SS	9	29.3	7.06	33.1	11	28110	47	28157
	SM		29.2	7.86	31.9	30	28690	134	28824
	SB		29.2	7.76	31.9	45	28090	205	28295
	NS	7.9	29.5	7.79	32.5	12	29210	79	29289
	NM		29	7.85	31.3	34	28420	96	28516
	NB		29.2	7.68	31.3	34	29610	208	29818
W9	SS	16	29.3	7.83	33.1	3	27880	52	27932
	SM		29.1	7.64	32.5	7	28880	82	28962
	SB		29.1	7.47	31.3	24	28910	199	29109
	NS	14.5	29.4	7.67	31.9	3	29630	155	29785
	NM		29.1	7.79	31.3	16	28740	99	28839
	NB		28.6	7.81	30.7	44	29440	167	29607
W10	SS	9	29.3	7.56	33.1	16	29226	97	29323
	SM		29.1	7.70	32.5	63	28320	104	28424
	SB		28.9	7.60	33.1	48	27930	217	28147
	NS	8.5	29.4	7.71	33.7	12	28930	149	29079
	NM		29.3	7.51	33.7	20	29640	132	29772
	NB		29.3	7.71	34.5	97	29110	204	29314

SS – SPRING SURFACE
SM – SPRING MIDDLE
SB – SPRING BOTTOM

NS – NEAP SURFACE
SM – NEAP MIDDLE
SB – NEAP BOTTOM

Table 12: Results of Bio-Chemical Analysis of Water Samples Collected from JNP Harbor Area during October, 2015

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#		-	-	-	-	<2	89	50
	SS	6.1	32	<2	<0.1	<0.01			
	SM	5.9	36	-	-	-			
	SB	5.9	40	-	-	-			
	NS#			-	-	-	<2	40	4
	NS	6	28	<2	<0.1	<0.01			
	NM	6	32	-	-	-			
	NB	5.8	44	-	-	-			
W2	SS#						<2	50	8
	SS	6.2	40	<2	<0.1	<0.01			
	SM	6.1	48	-					
	SB	6	28	-					
	NS#						2	<30	<2
	NS	6.4	20	<2	<0.1	<0.01			
	NM	6.2	32	-					
	NB	6	36	-					
W3	SS#		-	-	-	-	2	130	17
	SS	5.9	36	<2	<0.1	<0.01			
	SM	6	44	-	-	-			
	SB	5.7	52	-	-	-			
	NS#			-	-	-	2	50	11
	NS	5.9	32	<2	<0.1	<0.01			
	NM	6	48	-	-	-			
	NB	5.9	36	-	-	-			
W4	SS#		-	-	-	-	2	<30	26
	SS	6.1	40	<2	<0.1	<0.01			
	SM	6.1	28	-	-	-			
	SB	5.9	32	-	-	-			
	NS#			-	-	-	<2	70	17
	NS	6	44	<2	<0.1	<0.01			
	NM	5.8	28	-	-	-			
	NB	5.8	36	-	-	-			
W5	SS#		-	-	-	-	2	152	13
	SS	6	32	<2	<0.1	<0.01			
	SM	6.1	36	-	-	-			
	SB	6	52	-	-	-			
	NS#		-	-	-	-	<2	80	2
	NS	5.9	44	<2	<0.1	<0.01			
	NM	6	40	-	-	-			
	NB	6	48	-	-	-			

SS – SPRING SURFACE
SM – SPRING MIDDLE
SB – SPRING BOTTOM

NS – NEAP SURFACE
SM – NEAP MIDDLE
SB – 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	13
	SS	6	32	<2	<0.1	<0.01	-	-	-
	SM	6.1	28	-	-	-	-	-	-
	SB	5.9	36	-	-	-	-	-	-
	NS#		-	-	-	-	2	<30	<2
	NS	6.2	40	<2	<0.1	<0.01	-	-	-
	NM	5.9	44	-	-	-	-	-	-
	NB	5.8	32	-	-	-	-	-	-
W7	SS#		-	-	-	-	3	70	26
	SS	6.2	48	2.2	<0.1	<0.01	-	-	-
	SM	5.9	52	-	-	-	-	-	-
	SB	6	36	-	-	-	-	-	-
	NS#		-	-	-	-	3	<30	11
	NS	5.9	44	<2	<0.1	<0.01	-	-	-
	NM	5.8	52	-	-	-	-	-	-
	NB	5.8	40	-	-	-	-	-	-
W9	SS#		-	-	-	-	<2	48	11
	SS	6.2	46	<2	<0.1	<0.01	-	-	-
	SM	6.1	40	-	-	-	-	-	-
	SB	6	28	-	-	-	-	-	-
	NS#		-	-	-	-	<2	<30	4
	NS	5.9	36	<2	<0.1	<0.01	-	-	-
	NM	6	42	-	-	-	-	-	-
	NB	6	52	-	-	-	-	-	-
W10	SS#		-	-	-	-	3	52	8
	SS	6.1	52	2.4	<0.1	<0.01	-	-	-
	SM	6	28	-	-	-	-	-	-
	SB	5.9	36	-	-	-	-	-	-
	NS#		-	-	-	-	2	<30	4
	NS	6.3	40	<2	<0.1	<0.01	-	-	-
	NM	6.2	44	-	-	-	-	-	-
	NB	6	32	-	-	-	-	-	-

SS – SPRING SURFACE
SM – SPRING MIDDLE
SB – SPRING BOTTOM

NS – NEAP SURFACE
SM – NEAP MIDDLE
SB – NEAP BOTTOM

Table 13: Results of Sediment Samples Collected from JNP Harbor Area during Oct., 2015

Station Name	Organic Matter		Total Carbon		Inorganic Phosphate
	mg/g	%	mg/g	%	mg/kg
W1	Sediment not found				
W2	130.0	13.0	75.4	7.5	150
W3	149.0	14.9	86.4	8.6	210
W4	110.5	11.1	64.1	6.4	200
W5	Sediment not found				
W6	105.6	10.6	61.3	6.1	240
W7	Sediment not found				
W9	Sediment not found				
W10	138.0	13.8	80.0	8.0	220

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

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	-	-	-	-	-
W11	SS	3	29.3	7.70	32.5	4	29310	53	29363
	SM		29.1	7.54	31.3	6	29150	52	29202
	SB		29	7.96	31.3	7	28870	83	28953
	NS	2.5	29.5	7.62	31.9	5	29080	66	29146
	NM		29.3	7.49	30.7	9	29110	81	29191
	NB		29.2	7.73	30.1	6	29060	57	29117
W12	SS	3	29.4	7.77	33.1	7	29130	43	29173
	SM		29.3	7.54	33.1	6	28980	94	29074
	SB		29.2	7.65	31.9	7	29090	76	29166
	NS	2.5	29.6	7.75	33.1	10	29150	67	29217
	NM		29.5	7.74	33.1	3	29170	49	29219
	NB		29.4	7.78	33.3	13	29210	68	29278
W13	SS	2.5	29.4	7.74	33.1	6	29140	82	29222
	SM		29.2	7.49	32.5	8	28940	59	28999
	SB		29.1	7.50	31.9	5	28660	53	28713
	NS	2	29.5	7.40	33.1	5	28950	83	29033
	NM		29.4	7.71	33.1	4	28980	27	29007
	NB		29.3	7.58	31.9	8	29120	73	29193
W14	SS	2.5	29.4	7.60	32.5	5	29140	68	29208
	SM		29.3	7.34	31.3	4	29050	58	29108
	SB		29.1	7.70	30.7	3	29130	60	29190
	NS	2	29.5	7.06	30.1	2	29060	47	29107
	NM		29.3	7.61	30.7	9	28880	83	28963
	NB		29.2	7.61	30.1	8	29170	60	29230

SS – SPRING SURFACE
SM – SPRING MIDDLE
SB – SPRING BOTTOM

NS – NEAP SURFACE
SM – NEAP MIDDLE
SB – 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	6	36	<2	<0.1	<0.01	3	78	34
	SM	6	28	-	-	-	-	-	-
	SB	5.8	24	-	-	-	-	-	-
	NS	6.2	32	<2	<0.1	<0.01	2	56	13
	NM	5.9	40	-	-	-	-	-	-
	NB	6	48	-	-	-	-	-	-
W12	SS	6.1	40	<2	<0.1	<0.01	<2	127	23
	SM	5.9	36	-	-	-	-	-	-
	SB	5.9	48	-	-	-	-	-	-
	NS	6	28	<2	<0.1	<0.01	<2	68	4
	NM	6	32	-	-	-	-	-	-
	NB	5.9	40	-	-	-	-	-	-
W13	SS	6.2	40	<2	<0.1	<0.01	2	<30	4
	SM	6	48	-	-	-	-	-	-
	SB	5.9	36	-	-	-	-	-	-
	NS	5.8	28	<2	<0.1	<0.01	2	<30	<2
	NM	5.9	36	-	-	-	-	-	-
	NB	5.9	40	-	-	-	-	-	-
W14	SS	6.2	36	<2	<0.1	<0.01	<2	<30	2
	SM	6	40	-	-	-	-	-	-
	SB	5.9	24	-	-	-	-	-	-
	NS	5.8	28	<2	<0.1	<0.01	2	52	13
	NM	6.1	36	-	-	-	-	-	-
	NB	6	36	-	-	-	-	-	-

SS – SPRING SURFACE
SM – SPRING MIDDLE
SB – SPRING BOTTOM

NS – NEAP SURFACE
SM – NEAP MIDDLE
SB – NEAP BOTTOM

Table 16: Results of Sediment Samples Collected from Nhava Creek during Oct., 2015

Sample Name	Organic Matter		Total Carbon		Inorganic Phosphate mg/g
	mg/g	%	mg/g	%	
W11	Sample not found				
W12	Sample not found				
W13	136.3	13.6	79.1	7.9	300
W14	109.0	10.9	63.2	6.3	340

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	29.0-30.0	°C	-
2	pH	7.0-8.0	-	6.5 - 9.0
3	Salinity	30.0-33.0	ppt	-
4	Turbidity	2.0-13.0	NTU	-
5	TDS	28660-29310	mg/L	-
6	TSS	27-94	mg/L	-
7	TS	28713-29363	mg/L	-
8	DO	6.0-6.0	mg/L	3.0 mg/L(min.) or 40% of saturation value
9	COD	20-52	mg/L	-
10	BOD	2-5	mg/L	5 (max.)
11	NH ₃ -N	< 1.0	mg/L	-
12	Phenol	< 0.01	mg/L	-
13	Oil & Grease	2-10	mg/L	10 (max.)
14	Total Plate Count	40-152	CFU/ml	-
15	Fecal Coliforms	2-34	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	29.3-29.1	°C	-
2	pH	7.18- 7.97	-	6.5 - 9.0
3	Salinity	29.4-33.1	ppt	-
4	Turbidity	2-29	NTU	-
5	TDS	28492-29334	mg/L	-
6	TSS	24-159	mg/L	-
7	TS	28574-29366	mg/L	-
8	DO	6.0-6.0	mg/L	3.0 mg/L(min.) or 40% of saturation value
9	COD	24-48	mg/L	-
10	BOD	< 2.0	mg/L	5 (max.)
11	NH ₃ -N	< 1.0	mg/L	-
12	Phenol	< 0.01	mg/L	-
13	Oil & Grease	2 - 3	mg/L	10 (max.)
14	Total Plate Count	52-127	CFU/ml	-
15	Fecal Coliforms	2-34	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 October, 2015 are within the prescribed limits. Also, the concentration ranges observed for various parameters for water samples collected from Nhava Creek area during October, 2015 are also within prescribed limits.

Salinity values for Harbor and Creek water samples in the month of October, 2015 varied from 30.0-35.0 ppt and 30.0-33.0 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 as Turbidity values and TSS values are decreased as compared to September month's data. The ranges observed for COD values in mg/L are 20-52 and 24-48 respectively for Harbor and Creek water samples. The DO levels were found between 5.7 & 6.4 mg/L and 5.8 & 6.2 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 11 – 15%, 6-9% and 150 – 240mg/kg, respectively. **Table 16** shows the values for Organic Matter, Total Organic Carbon and Inorganic Phosphate as 11-14 %, 6-8 % and 300-340 mg/kg, respectively in Nhava Creek sediments during October, 2015.

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 October, 2015 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 depicted 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 in water and sediments at JNP have been presented in **Tables 29** and **30** respectively. Harbor area and Nhava were collected and the data are presented in **Table 28**. Concentrations of nutrients

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	425	315
2.	W2	375	275
3.	W3	315	375
4.	W4	515	475
5.	W5	475	315
6.	W6	615	575
7.	W7	350	250
8.	W9	315	275
9.	W10	350	275
JNP Nhava Creek Area			
10.	W11	375	275
11.	W12	415	375
12.	W13	375	215
13.	W14	475	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	Pyro-phyceae
JNP Harbour Area							
1	W1	Surface	510	60	20	20	-
		Bottom	455	45	30	20	5
2	W2	Surface	540	50	20	30	-
		Bottom	465	50	20	20	10
3	W3	Surface	420	60	30	10	-
		Bottom	315	55	25	20	-
4	W4	Surface	410	45	20	25	10
		Bottom	345	50	20	10	20
5	W5	Surface	420	65	25	10	-
		Bottom	340	60	20	20	-
6	W6	Surface	620	55	25	15	5
		Bottom	560	60	20	20	-
7	W7	Surface	540	50	20	20	10
		Bottom	480	60	20	10	10
8	W9	Surface	550	50	20	20	10
		Bottom	455	65	20	10	5
9	W10	Surface	490	50	20	15	5
		Bottom	350	40	40	20	-
JNP Nhava Creek							
10	W11	Surface	450	60	20	20	-
		Bottom	370	55	20	15	10
11	W12	Surface	460	50	20	20	10
		Bottom	320	60	20	10	10
12	W13	Surface	520	45	25	20	10
		Bottom	470	55	15	20	-
13	W14	Surface	550	50	10	20	20
		Bottom	475	60	20	20	-

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

Sr. No.	Bacillariophyceae	Chlorophyceae	Cyanophyceae	Pyrophyceae
1.	<i>Navicula</i> sp.	<i>Closterium</i> sp.	<i>Gloeocapsa</i> sp.	<i>Ceratium</i> sp.
2.	<i>Nitzschia</i> sp.	<i>Cosmarium</i> sp.	<i>Oscillatoria</i> sp.	-
3.	<i>Gyrosigma</i> sp.	<i>Scenedesmus</i> sp.	<i>Anabaena</i> sp.	-
4.	<i>Coscinodiscus</i> sp.	<i>Ulothrix</i> sp.	<i>Aphanocapsa</i> sp.	-
5.	<i>Stephanodiscus</i> sp.	-	-	-
6.	<i>Gomphoneis</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	25
3.	W3	30
4.	W4	30
5.	W5	25
6.	W6	20
7.	W7	15
8.	W9	20
9.	W10	25
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/m ³]	Percent Composition of Zooplankton Groups			
			Copepoda	Cladocera	Foraminifera	Rotifera
JNP Harbour Area						
1.	W1-W2	375	50	20	20	10
2.	W2-W5	315	45	25	20	10
3.	W5-W1	420	45	25	25	5
4.	W5-W6	575	40	20	20	20
5.	W6-W2	310	55	25	20	-
6.	W4-W3	375	45	20	5	30
7.	W3-W7	312	55	25	-	20
8.	W7-W10	475	60	20	10	10
9.	W10-W3	310	50	25	15	10
10.	W9-W3	425	50	20	10	20
JNP Nhava Creek						
11.	W5-W11	375	50	20	20	10
12.	W11-W12	350	65	25	10	-
13.	W12-W13	275	50	20	10	20
14.	W13-W14	415	45	25	20	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>Filinia</i> sp.	<i>Alonella</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	4.1	3.2	0.5	BDL	273
2.	W2	4.5	3.6	BDL	BDL	300
3.	W3	4.6	3.9	BDL	BDL	306
4.	W4	3.2	2.1	BDL	BDL	213
5.	W5	4.5	3.7	BDL	BDL	300
6.	W6	5.1	2.5	0.9	BDL	340
7.	W7	4.2	2.6	BDL	BDL	280
8.	W9	4.1	3.9	BDL	BDL	273
9.	W10	3.5	2.8	BDL	BDL	233
Nhava Creek Area						
10.	W11	4.2	3.7	BDL	BDL	280
11.	W12	4.1	3.5	BDL	BDL	273
12.	W13	3.9	2.7	BDL	BDL	260
13.	W14	4.0	3.4	BDL	BDL	266

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

Sr. No.	Station	POC, [mg/m ³]
Standard		10 - 100
JNP Harbor Area		
1.	W1	704
2.	W2	730
3.	W3	835
4.	W4	904
5.	W5	713
6.	W6	904
7.	W7	791
8.	W9	670
9.	W10	644
Nhava Creek Area		
10.	W11	939
11.	W12	887
12.	W13	922
13.	W14	852

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

Sr. No.	Station	Macrobenthos [No/m²]	Percent Composition of Macrobenthos			
			Gastropods	Polychaeta	Foraminifera	Chironomidae
JNP Harbour Area						
1.	W2	270	40	20	30	10
2.	W3	210	40	20	30	10
3.	W4	270	50	30	20	-
4.	W5	240	40	30	20	10
5.	W6	220	55	25	20	-
6.	W10	200	40	20	30	10
JNP Nhava Creek Area						
7.	W13	150	55	25	20	-
8.	W14	230	45	25	30	-

Note: No sediment was found at W1, W5, W7, W9, 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	436	1410	138	10500	56	590	<10	1573	3222
W2	396	1395	142	10400	49	660	<10	1532	3453
W3	475	1400	144	10300	39	380	<10	1555	3577
W4	436	1386	161	10200	43	370	<10	1527	3543
W5	397	1347	154	10000	50	260	<10	1595	3385
W6	397	1371	149	10000	62	210	<10	1635	3342
W7	475	1424	184	10600	64	665	19	1673	3467
W9	436	1289	172	10200	56	640	<10	1542	3187
W10	475	1299	167	10500	58	420	18	1644	3525
W11	436	1410	173	10400	51	720	<10	1520	3458
W12	436	1227	159	10300	48	600	<10	1597	3255
W13	396	1371	146	10200	50	555	<10	1557	3205
W14	436	1227	150	10400	52	585	<10	1541	3337

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	5040	292	330	4928	350	38	0.26	59	5431
W3	4080	1750	324	4634	300	41	0.16	46	3977
W4	2560	194	276	5112	220	36	0.25	34	3962
W5	Sample not found								
W6	6960	535	371	5148	280	30	0.15	91	6305
W7	Sample not found								
W9	Sample not found								
W10	5360	146	402	4932	250	35	0.13	91	5469
JNP NHAVA CREEK AREA									
W11	Sample not found								
W12	Sample not found								
W13	8160	194	384	5210	320	39	0.11	72	6616
W14	8400	292	472	5325	360	41	0.15	47	6885

3.4 DISCUSSION

3.4.1 Water Quality: Biotic

3.4.1.a Primary Productivity

Water samples from three different sampling points of various depths were collected both in a transparent and completely opaque (dark) high quality glass bottle. From each sampling points two samples were collected in transparent bottles and the rest one was collected in dark bottle. Dark bottles were completely covered by a black cloth so as to avoid light penetration. The DO of one bottle was fixed on spot during the sample collection, while DO of other two light and dark bottles were fixed after a duration of six hours from sampling. DO of all the samples were analyzed using standard Sodium thiosulphate solution (***Standard Method, APHA 2005***).

The highest estimated gross and net primary productivity was measured as 615 and 575 mgC/m³/d at station W6 [**Table 20**]. Compared with other coastal ecosystems, primary productivity of JNP Harbour area and Nhava creek was at a moderate level. Dredging activities might be the cause for increased turbidity and comparatively less primary productivity at station W7, W3, W9 & W10 which is temporary effect. Apparently there is no remarkable adverse effect on the harbour and creek waters.

3.4.1.b Plankton

Phytoplankton were enumerated from unfiltered water samples by Lackey Drop method (Lackey, 1983). For zooplankton, desired volume of waters were filtered through plankton net to represent all the available groups. The samples were fixed immediately with 5 % buffered formalin. The S-R cell is a device commonly used for zooplankton counting because it is easily manipulated. The parameters studied were numerical count of individual species, groups and indices, as described hereunder. In view of this, studies were carried out towards distribution, diversity and other ecological aspects of phytoplankton and zooplankton from different sampling locations of JNP Harbour area and Nhava creek.



Plate 3.1: Collection of Plankton from Nhava creek

A] Phytoplankton:

Count : Phytoplankton counts, recorded at different sampling stations, are presented in **Table 21**. Total algal population varied between 315 and 620 algal cells/ml. Samples collected at stations W3(B) and W6(S) showed lowest and highest counts respectively. Bacillariophyceae dominated all samples followed by Chlorophyceae. The phytoplankton population comprised of fifteen genera with 4 major groups, namely Bacillariophyceae, Chlorophyceae, Cyanophyceae and Pyrophyceae with thirteen different genera [**Table 22**]. In spite of dredging activities around W7 and W8, plankton density did not vary remarkably from those of nearby stations (W3 and W9). Although planktonic organisms respond quickly to environmental changes they recover within a short time in pelagic sea due to intense wave action.

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. comparatively lower transparency at W7 which is temporary effect was the result of dredging activities.

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 275 and 575 N/m³ at stations W12-W13 and W5-W6 which is at moderate level. Total nine

genera of zooplankton were recorded. Copepoda dominated all the samples [Table 25]. Some of Hydromedusae species also found in the JNP harbor & Nhava creek.

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 213 and 340 mg/m³. The minimum algal biomass was (213 mg/m³) found at W4 and maximum (340 mg/m³) was found at W6 station. The lowest and highest chlorophyll *a* levels from surface water sample varied from 3.2 mg/m³ at station W4(S) to 5.1 mg/m³ at W6(S). 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. In view of higher TSS at W7 which is temporary effect, algal concentration as well as chlorophyll level were less at bottom water.

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 644 and 904 mg/m³ with an average of 766 mg/m³. The minimum concentration of POC i.e. 644 mg/m³ was found at W10 station and maximum concentration i.e. 904 mg/m³ at W6 station. In Nhava creek the POC content was found to be from 852-939 mg/m³ with an average of 900 mg/m³.

The minimum concentration of POC i.e. 852 mg/m³ was found at W14 station and maximum concentration i.e. 939 mg/m³ was found at W11 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 and Polychaete are abundant. Among the Gastropods, the dominant species were *Litiopa* and *Morula*. The highest count was 270 No/m² at station W4 while lowest (150 No/m²) was found at station W13. Dredging activities around W7 might be the cause of non availability of benthic organisms at that station which is temporary effect.

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 39µg/L – 64µg/L. The average concentration of Phosphate was found to be 53µg/L in JNP harbor region, the Phosphate values are within the prescribed standard range [0.1 – 90µg/L]. Nitrate was found to be between 210µg/L – 665µg/L. The minimum value of Nitrate 210µg/L was found at W6 station and maximum value 665µg/L at W7 station. The average concentration of Nitrate was found to be 466µg/L. At locations W1, W2, W7 & 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 – 1673 µg/L with an average of 1589µg/L. The minimum concentration of silica was found at W4 station of JNP harbor region and the maximum concentration of silica was found at W7 station. The values of silica were observed to be well within the prescribed limits. The Sulphate was found between 3187 – 3577 mg/L, the minimum value recorded at W9 station and maximum at W3 station. The average concentration of Sulphate was found to be 3411 mg/L.

In Nhava Creek, Phosphate was found between 48µg/L – 52µg/L with an average 50µg/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 555 (at W13) – 720 µg/L (at W11) with an average 615 µg/L. The silica content in Nhava creek was found to be 1520 – 1597 µg/L with an average of 1554 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 3205 – 3458 mg/L with an average of 3314 mg/L. The minimum value for Sulphate was found at W13 station and maximum value at W11 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 seven out of nine locations. Phosphate was found between 220 – 350 mg/kg with an average of 280 mg/kg. The minimum value of 220 mg/kg was found at W4 location while maximum value (350 mg/kg) was found at W2. The Nitrate was found minimum value at W6 station i.e. 30 mg/kg and maximum value at W3 station i.e. 41 mg/kg. The average concentration of Nitrate was found to be 36 mg/kg. The Nitrite was found to be between 0.13 – 0.26 mg/kg with an average of 0.19 mg/kg. The minimum concentration of nitrite was found at W10 station and maximum value at W2 station. Silica in the form of silicate in JNP harbor sediments were found between 34 and 91 mg/kg with an average of 64 mg/kg. The minimum concentration of silica was found at W4 station i.e. 34 mg/kg and maximum value was found at W6 & W10 station i.e. 91 mg/kg. The Sulphate was found between 3962 and 6305 mg/kg, with minimum value i.e. 3962 mg/kg at W4 station and maximum value i.e. 6305 mg/kg at W6 station. The average concentration of Sulphate was found to be 5029 mg/kg.

In Nhava Creek region the sediment found at three locations out of four. Phosphate levels were 320 and 360 mg/kg with an average of 340 mg/kg. Nitrate was found to be 39 and 41 mg/kg. The average concentration of Nitrate was found to be 40 mg/kg. The Nitrite was found to be 0.11 and 0.15 mg/kg. The average concentration of Nitrite was found to be 0.13 mg/kg. Silica in the form of silicate in JNP harbor sediments was found to be 47 to 72 mg/kg with an average of 59 mg/kg. The Sulphate was found to be 6616 and 6885 mg/kg. The average concentration of Sulphate was found to be 6751 mg/kg.

b. Cations:

In harbor region water, the Calcium was found between 396 to 475 mg/L with an average of 436 mg/L given in **Table 29**. The minimum value for Calcium i.e. 396 mg/L was found at W2 location whereas the maximum value i.e. 475 mg/L was found at W7 location. The Magnesium was found to be 1289 – 1424 mg/L, with minimum value i.e. 1289 mg/L at W9 location whereas maximum value i.e. 1424 was found at W7 stations. The average concentration of Magnesium was found to be 1369 mg/L. The minimum concentration of Potassium 138 mg/L was found at W1 location and maximum concentration 184 mg/L at W7 location with an average of 157 mg/L. The Sodium was found between 10000 to 10600 mg/L with an average of 10300 mg/L. The minimum concentration of sodium i.e. 10000 mg/L was found at W5 & W6 stations and maximum value i.e. 10600 mg/L of at W7 station.

In Nhava Creek, Calcium concentration was found with an average 426 mg/L given in **Table 29**. The minimum value 396 mg/L was found at W13 and maximum 436 mg/L at W12 station. Magnesium concentration was found to be 1227 – 1410 mg/L with an average of 1369 mg/L. The minimum value i.e. 1227 mg/L of Magnesium was found at W14 station and maximum value 1410 mg/L was found at W11 stations. The Potassium

content in Nhava creek was found to be 146 mg/L at W13 – 173 mg/L at W11 station with an average of 157 mg/L. Sodium minimum concentration was found to be 10200 mg/L at W13 and maximum of 10400 mg/L at W11 & W14. The average concentration of sodium was found to be 10325 mg/L.

In harbor region sediments, the Calcium was found to be 2560 to 6960 mg/Kg with an average of 4800 mg/Kg given in **Table 30**. The minimum Concentration of Calcium 2560 mg/kg was found at W4 station and maximum concentration 6960 mg/kg at W6 station. Magnesium was found to be 146 to 1750 mg/Kg, with minimum value 146 mg/kg at W10 station and maximum 1215 mg/kg was recorded at W3 station. The average concentration of Magnesium was found to be 583 mg/Kg. Potassium in JNP harbor sediment was found to be 276 to 402 mg/Kg with an average of 341 mg/Kg. The minimum concentration of Potassium 276 mg/kg was found at W4 station and maximum value 402 mg/kg at W10 station. Sodium was found to be 4634 to 5148 mg/Kg with an average of 4951 mg/Kg. The minimum concentration of sodium 4634 mg/kg was found at W3 station and maximum value 5148 mg/kg at W6 station.

In Nhava Creek sediments, Calcium was found to be 8160 mg/kg at W13 and 8400 mg/Kg at W14 locations, with an average 8280 mg/Kg given in **Table 30**. Average magnesium was found to be 243 mg/Kg. The minimum concentration of magnesium was found at W13 location i.e. 194 mg/kg, whereas maximum concentration was observed at W14 location with value 292 mg/kg. The minimum concentration of potassium 384 mg/kg was observed at W13 and maximum concentration 472 mg/kg was observed at W14 station. Average potassium content in Nhava creek was found to be 428 mg/Kg. The minimum sodium value 5210 mg/kg was found at W13 station and maximum value 5325 mg/kg at W14. The average concentration of sodium was found to be 5268 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 the marine ecosystem is not affected by these activities.

- ✓ *Construction of 4th Container Terminal on South side of JNPT:* Earth Filling 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.

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 October, 2015 except parameters like Particulate Organic Carbon and Nitrate.

The increased levels of POC 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 – 575 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 3.1 – 5.1 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 – 53 µg/L; Creek area – 50 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 – 466 µg/L; Creek area – 615 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 – 18 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 – 766 mg/m ³ ; Creek area – 900 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 – 1586 µg/L; Creek area – 1554 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 October, 2015.

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 Oct 2015]

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	-	7.74	7.80	8.08	8.06	7.57	7.70	6.5 to 8.5
Turbidity	NTU	<1	<1	<1	<1	<1	<1	1
Total Dissolved Solids	mg/L	134	124	98	86	80	136	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	18	18	18	15	12	22	75
Chloride as Cl ⁻	mg/L	17	17	12	10	10	16	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	8	7	3	4	4	8	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	19	19	8	6	3	14	200
Total Alkalinity as CaCO ₃	mg/L	69	61	53	53	43	78	200
Total Hardness as CaCO ₃	mg/L	79	75	55	55	48	87	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	80	27	30	<2	14	Nil
E coli	-	Absent	Absent	Present	Present	Absent	Absent	Absent

*: IS 10500:2012, Drinking Water - Specification

Table 33: Results of Drinking water quality monitoring [Sample collected on Oct 2015]

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	-	7.44	7.55	7.46	7.68	7.44	7.12	6.5 to 8.5
Turbidity	NTU	<1	<1	<1	<1	<1	<1	1
Total Dissolved Solids	mg/L	134	138	84	128	86	140	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	22	22	11	19	12	23	75
Chloride as Cl ⁻	mg/L	16	18	10	16	11	20	250
Copper as Cu	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05
Fluoride	mg/L	0.2	<0.1	<0.1	<0.1	<0.1	0	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	7	7	5	6	4	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	13	26	7	19	7	22	200
Total Alkalinity as CaCO ₃	mg/L	74	62	43	63	44	63	200
Total Hardness as CaCO ₃	mg/L	82	82	48	74	48	83	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	17	4	Nil
E coli	-	Absent	Absent	Absent	Absent	Present	Absent	Absent

*: IS 10500:2012, Drinking Water - Specification

Table 33: Results of Drinking water quality monitoring [Sample collected on Oct 2015]

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	-	7.87	7.76	7.86	7.18	7.38	7.48	6.5 to 8.5
Turbidity	NTU	<1	<1	<1	<1	<1	<1	1
Total Dissolved Solids	mg/L	132	126	120	136	128	140	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	23	19	18	20	24	21	75
Chloride as Cl ⁻	mg/L	16	17	16	20	16	18	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	4	7	7	7	6	7	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	19	20	19	23	20	19	200
Total Alkalinity as CaCO ₃	mg/L	59	59	59	59	75	60	200
Total Hardness as CaCO ₃	mg/L	75	75	75	82	84	81	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	27	12	<2	<2	<2	Nil
E coli	-	Absent	Present	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 October, 2015 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 $\text{NH}_3\text{-N}$ 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.

Conductivity values of all the samples were found to be in the range of 98 to 287 $\mu\text{S/cm}$. Values observed for TDS for all the samples were in the range of 80 to 140 mg/L which are well below the acceptable standard limits (500 mg/L). pH values of all the samples were in the range of 7.1 to 8.1 which is within the permissible standard 6.5 to 8.5. Total Hardness as CaCO_3 values of all the eighteen samples were found to be in the range of 48 to 87 mg/L and found to be within the acceptable limit (200 mg/L).

Concentration levels observed for Chlorides as Cl^- , Sulphate as SO_4^{2-} and Phosphate as PO_4^{2-} were in the range of 10.0 to 21.0 mg/L, 3.0 to 26.0 mg/L and <0.1 to 0.9 mg/L respectively. The observed values for these parameters are well within the acceptable standard limits.

Analysis of the bacteriological parameter at location DW3, DW4, DW11 & DW14 Total Coliform value is deviated from standard. Except at Custom Canteen, NSICT canteen, JNPT Guest House, C.T. canteen, JNPT workshop, Hospital canteen, PUB canteen, and Secondary School the Total Coliform showed that all the other drinking water samples were safe from any bacteriological contamination.

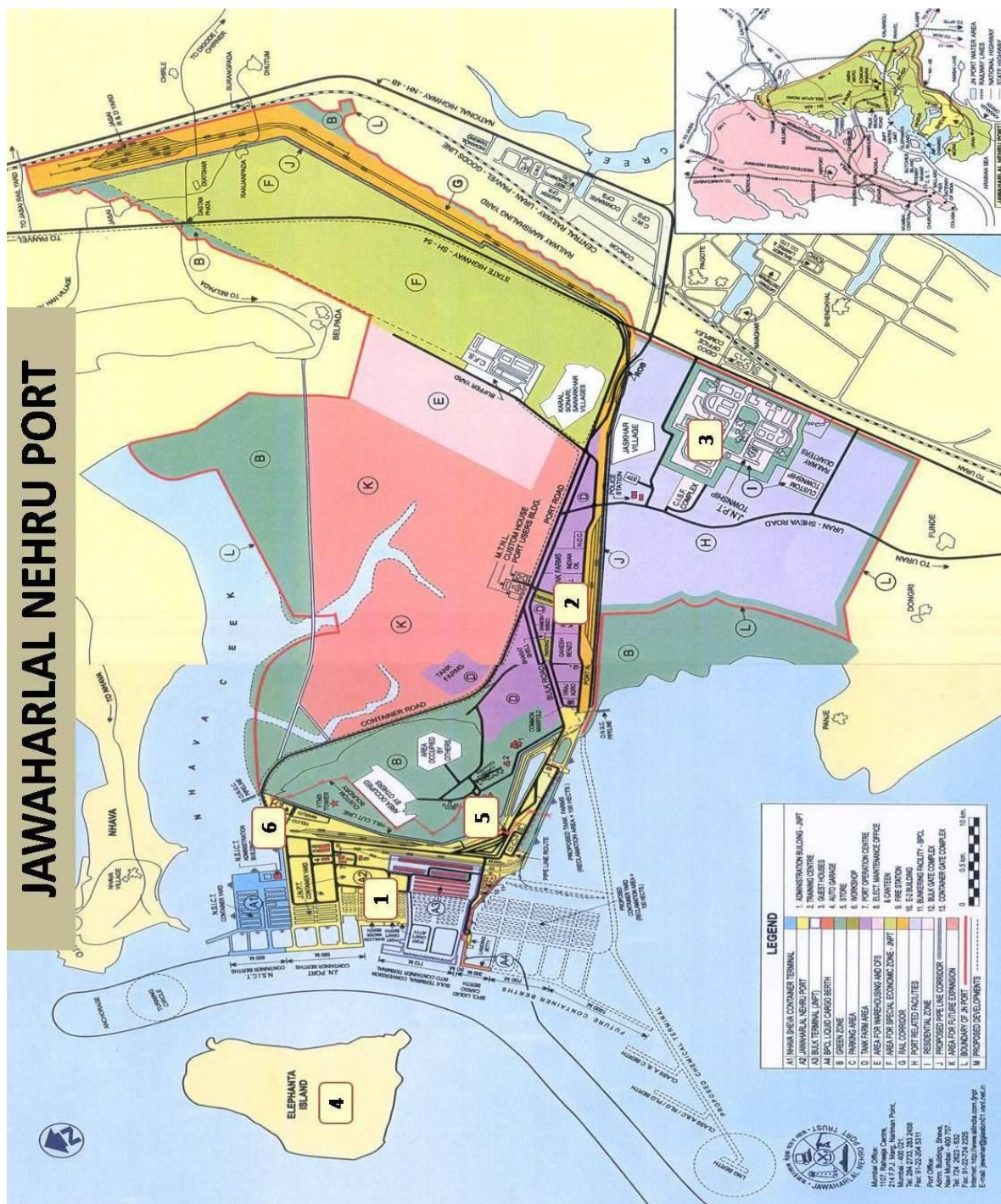
4.4 CONCLUSIONS AND MITIGATION MEASURES:

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 area except at NSICT canteen and C.T. canteen.

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.	BenzoPyrene (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

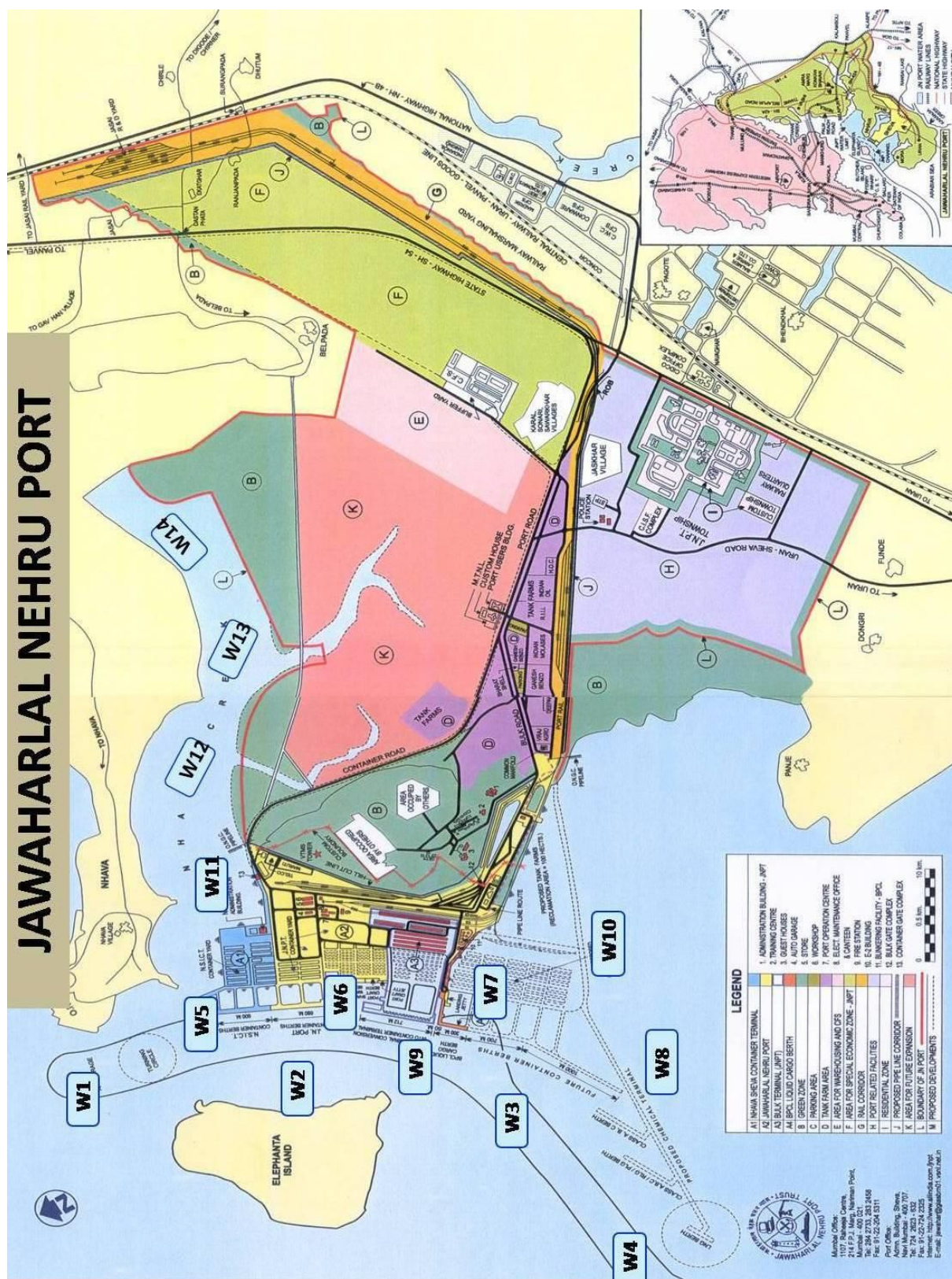
* Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals

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

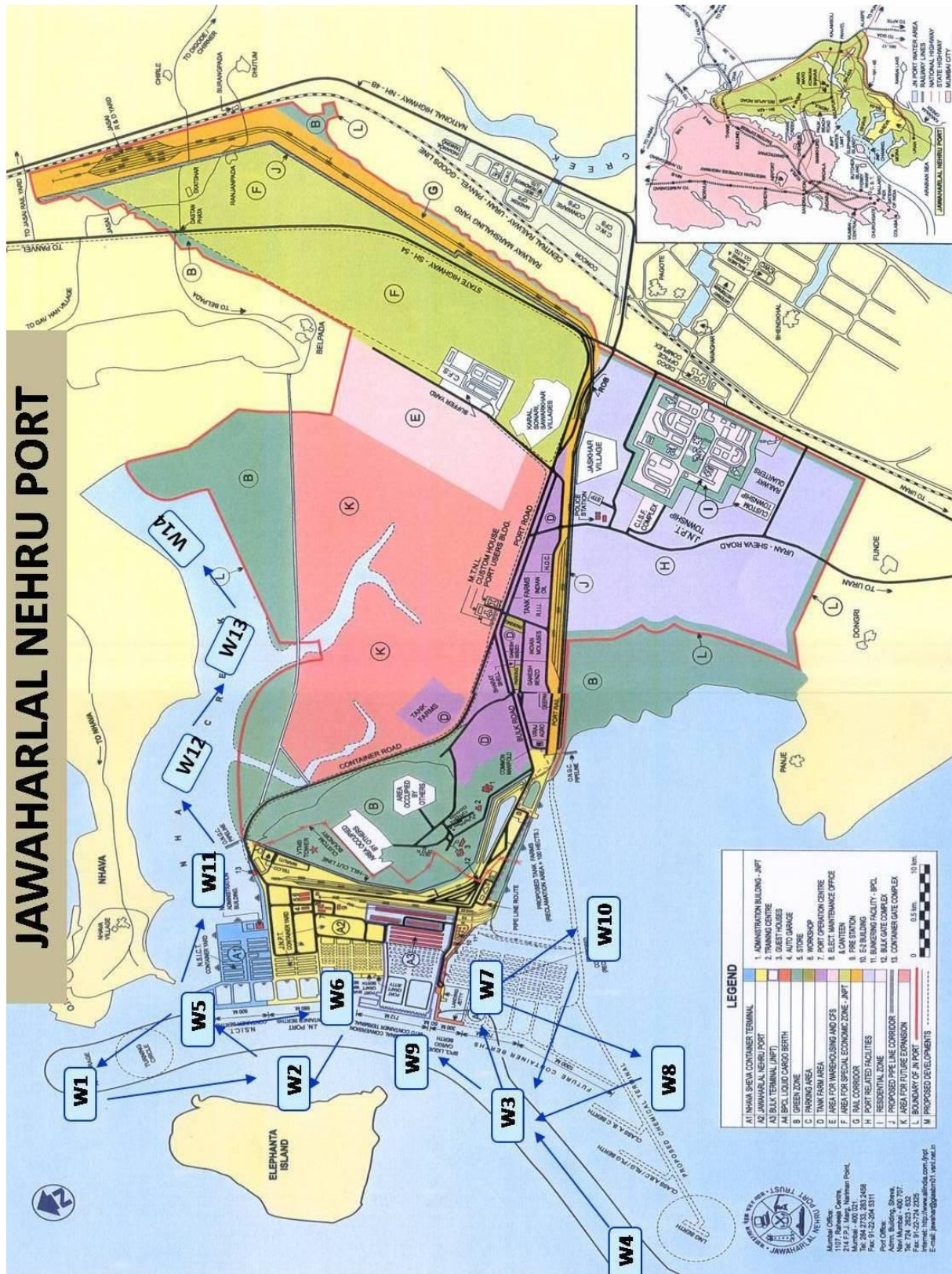
2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

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.