PURPOSE DRIVEN STUDY ON
STUDY THE TREND IN WATER QUALITY OF THE LOCATIONS IDENTIFIED AS HOT SPOTS

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KALPASAR DEPARTMENT

HYDROLOGY PROJECT

PDS FINAL REPORT

TO STUDY THE TREND IN WATER QUALITY OF THE LOCATIONS IDENTIFIED AS HOT SPOTS

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6.	**PROJECT TITLE**	To study the trend in water quality of the locations identified as hot spots
7.	**PERIOD OF THE PROJECT**	3 Years

Abbreviations

APS	Auxiliary Pumping Station
BDL	Below Detectable Level
BOD	Biochemical Oxygen Demand
CETP	Common Effluent Treatment Plant
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CWC	Central Water Commission
DO	Dissolved Oxygen
GOI	Government of India
GEMS	Global Environmental monitoring System
GERI	Gujarat Engineering Research Institute
GIDC	Gujarat Industrial Development Corporation
GUDC	Gujarat Urban Development Corproation
GPCB	Gujarat Pollution Control Board
HIS	Hydrology Information System
HP-II	Hydrology Project Phase-II
MCM	Million Cubic Meter
MGD	Million Gallons per day
MINARS	Monitoring of Indian National Aquatic Resources System
MLD	Million Litres per day
MoEF	Ministry of Environment and Forest
MSW	Municipal Solid Waste
NGO	Non Government Organizations
PDS	Purpose Driven Study
PPM	Parts Per Million
SEZs	Special Economic Zones
SS	Suspended Solids
SSI	Small Scale Industries
STP	Sewerage Treatment Plant
SWM	Solid Waste Management
TPD	Tonnes Per Day
TSDF	Treatment Stabilization Disposal Faciltiies
WTP	Water Treatment Plant

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Chapter 1

Introduction

1.1 BACKGROUND

Water resources management is on top priority on government's agenda in India. For rational planning and implementation of water resources management, water related information is pre-requisite. Hydrology Project-I (HP-I) was taken up to develop Hydrological Information System (HIS) by creating facilities and standardized procedures for data collection, data compilation, processing and data storage for data use in 9 peninsular states of the country including Gujarat. HP-I was implemented during the period 1995 to 2003. Under Gujarat State Narmada, Water Resources, Water supply & Kalpsar Department 4 groundwater and 3 surface water labs were established. A network of water quality monitoring was established comprising of 2042 groundwater sampling sites and 154 surface water sampling sites. Activities accomplished during HP-I were the establishment and improvement of Data Collection Network, Data entry, validation and storage system, Computerised data banks.

As an extension to the HP-I, HP-II was conceived to include more agencies in the Project to establish facilities for hydrology information system (HIS) and further strengthen the HP activities in HP-I agencies. Gujarat has been monitoring water quality for about 8-10 years now and has developed a good competence, skill and expertise in sampling, analysis, data handling and storage. In order to optimally utilize the facilities and competence developed, it was thought appropriate to carry out studies on some water quality problems in the HP States as "Purpose Driven Study" (PDS). In Gujarat three PDS were conceived on water quality as follows:

1. Sabarmati River Study
2. Vishwamitri River Study
3. Hot spot study

1.2 GENERAL

Gujarat is emerging as one of the most preferred locations for industrial development in the country. Endowed with rich natural resources, a vast reservoir of skilled manpower and one of the most developed infrastructure, the State of Gujarat contributes significantly to the economic development of the nation. Major industrial clusters are located within 200 km reach of the Vadodara-Ankleswar-Hazira-Vapi belt, also called golden corridor of industries. This industrially vibrant belt has the honour of being the largest industrial cluster in India. In addition, at least 12 Special Economic Zones (SEZs) fall in the Vadodara-Hazira belt. Major polluting industries are located in the belt are Vadodara Petrochemical Complex, Nandesari, Ankleshwar, Vapi and Hazira near Surat. This stretch has become a hot bed of pollution. Gujarat's rivers are bearing the brunt of industrial pollution, as are the people living on the banks of these rivers. All the important rivers in this belt are in a bad state due to effluent discharged by industry, be it the Kolak, the Mahi, the Damanganga or the Amlakhadi. These industries also generates huge quantity of toxic and hazardous wastes. The residues of such wastes also get into the rivers during monsoon along the run-off water. The air pollution generated by these industries also deposit on land in the surrounding areas and during rain flushed into the rivers. Thus, the rivers in this belt are seriously affected by the industrial pollution. The industries are mostly pharmaceutical, petro-chemicals, pesticides, dyes and dye-intermediates, organic chemicals, textiles and inorganic chemicals, which generate highly toxic pollution. Thus, the water quality of the receiving water bodies is seriously affected, causing health and economic losses to the population living around these water bodies. Looking to the importance of such environmental conditions in the area, GERI took up a PDS to study some selected water bodies, so called hot-spots for their water quality in order to understand the nature and magnitude of pollution. This will help in rational planning of pollution control strategies for these important water bodies, which are life line of the surrounding population.

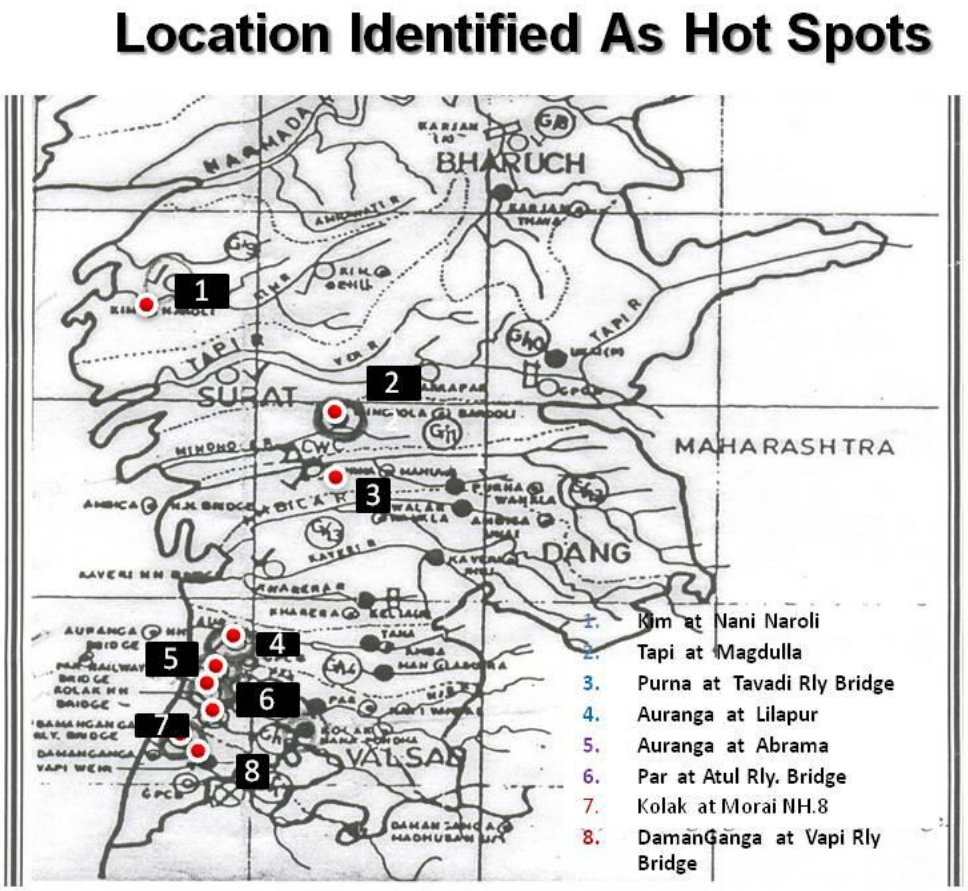
1.3 OBJECTIVES

- To assess the pollution due to human activity in terms of nutrients and micro pollutants.
- To assess the pollution due to urbanization and industrialization.
- Extent of pollutants and probable effect on human health which will help in deciding source of pollution and remedial measures to curb pollution in order to make our development truly sustainable.

1.4 BRIEF DESCRIPTION OF LOCATIONS OF PDS STUDIES

All the eight locations identified under study are on the rivers Kim, Tapi, Purna, Auranga, Par, Kolak and Damanganga. These are west flowing rivers in south Gujarat.

INDEX MAP



The following locations have been identified as Trend Stations.

1) Kim at Nani Naroli

Kim river flowing in Bharuch district and falls in Gulf of Khambhat near village Kantiajal of Hansot taluka of Bharuch district after flowing south west direction for a length of 107 km, for the first 80 km of its course passes through Rajpipala and Valia talukas. For the remaining the river flows in a western direction between Ankleshwar and Olpad taluka of Surat District. Kim river is Ghanta River and Tokri River. The river basin extends over an area of 1286 Sq.km of which the catchment area upto the site is 804 sq.km. The river basin lies between 21^0 19" to 21^0 38" North latitude and 72^0 40" to 73^0 27" East longitude. In the vicinity is a Lignite and thermal based power station.

2) Tapi at Magdalla

The Tapti rises near Multai in the Betul District of Madhya Pradesh. The total length of the river is 724 Km with basin area of 65,145 Km^2 The river is getting polluted from a large number of human activities and industries in its catchments. The river flow is highly regulated due to series of dams on it. Surat is the major city developed on the bank of this river. Magdalla located in Surat is one of the Hot spot under study.

The location identified in the hot-spot area is mostly affected by the effluent discharge from the city of Surat. The maximum temperature is 45^{o}C and Min. temp. is 10^{o}C. The average rain fall is 1000 to 1200 mm. Surat is mainly known for its textile, chemical, petrochemical and diamond processing industries. Hazira and Magdalla ports provide logistic support to industrial operations in the state.

On the banks of river fruit and vegetable, spices are grown. The major fruits grown are Papaya and Banana. Surat is largest producer of Okra. Among spices turmeric , Ginger, Chili is grown.

There are 605 medium and large scale industries and following are the major industries.

TABLE-1.1

Name of Company	Production
Indian Oil Corp. Limited	LPG
Oil and Natural Gas Corporation (ONGC)	LPG, Propane, ARN/NGL, Ethol Marcaptan
Reliance Industries Limited	Benzene, LPG, Naphtha, Chlorine, EDC, ED, Ethylene

Magdalla Port is 2 Km. away from the state highway and 15 km. from NH8 and is well connected through railway and road. It is a lighterage port located on the southern bank of river Tapi and 16 Km. upstream of river.

3) Purna at Tavadi Railway Bridge

The word Purna means Complete. It is also equivalent to word 'Sampurna'. It is a holy river in the surrounding region. It originates in Pokhran Village which is 2 KM away from Bhaisdehi, district place in Madhya Pradesh. adjoining Amravati district of Maharashtra and flows through Akola, Buldhana, Jalgaon, Jalna, Parbhani districts.. The river empties into the Gulf of Khambhat near the city of Navsari in Southern Gujarat. Purna river is an important west flowing river with its catchment in Gujarat and

Maharashtra. The length of the river from its source to outflow in the Arebean Sea is about 180 km. The important tributaries of the river are Dhodar nalla, Bardanala, Nagihpar nala, Girna river, Zankari river and Dumas khadi.The catchment area of the Purna basin is 2431 Km^2 with about 5% in Maharashtra and rest in Gujarat and a small portion in Madhya Pradesh.

Navsari district is located along Purna river In the coastal lowland. The district abounds in agriculture activities like sugarcane fields, chikoo plantations, and mango trees. It is a largest producer of cucurbits among vegetable. Turmeric is the main spice crop. It is also known for floriculture horticulture activities due to suitable climate and presence of major players Best Roses Biotech Pvt. Ltd. The focus sectors are agro & food processing industries, textiles, diamond, Sugar, Paper drugs and pharmaceuticals, mineral related industries and marine base industries. It is the largest procedure of Chiku and largest exporter of fruit in India.

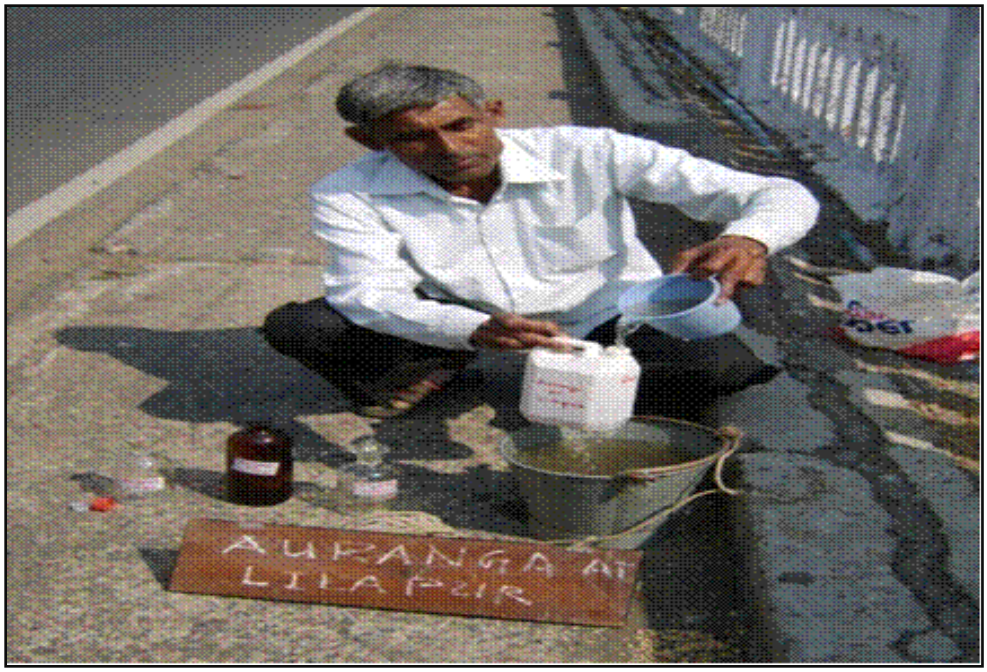
The maximum temperature is 40^oC and Min. temp. is 10^oC. The average rain fall is 2000 mm.

There are 23 medium and large scale industries, 7525 small scale industries consisting of food products, metal products, chemicals and rubber and plastic production.

TABLE-1.2

Name of Company	Production
Gufic Biosciences Ltd.	Drugs and Pharmaceuticals
Mafatlal Industries Ltd.	Textiles
Sahakari Khand Udyog Mandli Ltd.	Sugar
Tata Steel Ltd.	Hot Rolled Profiles and Cold Formed Profiles
The Navsari Cotton and Silk Mills Ltd.	Yam
VVF Limited	Chemicals
Best Roses Biotech Pvt. Ltd.	Cut Flowers
Bhukhanvala Tools Pvt. Ltd.	Machine tools

4) Auranga at Lilapur and Abrama



Lilapur and Abrama are villages located near Auranga in Valsad District. River Auranga originate from Shayadri Hills of Satpura Range, flows westward and joins Arabian Sea. It has a total basin area of 787 Km^2 of which about 10% is located in Maharashtra and rest in Gujarat. The Maharashtra portion of the basin is mostly in the hilly region and major human activities are related to agriculture. The river is mostly seasonal has very little flow in major part of the year. The Auranga is heavily polluted

river as it receives the wastewater from a large industrial complexes at Valsad town and nearby industrial areas. The main crops are vegetables, pulses (arhar, mung and urad), cereals. This area is known for the production of mangoes.

5) Par at Atul Railway Bridge

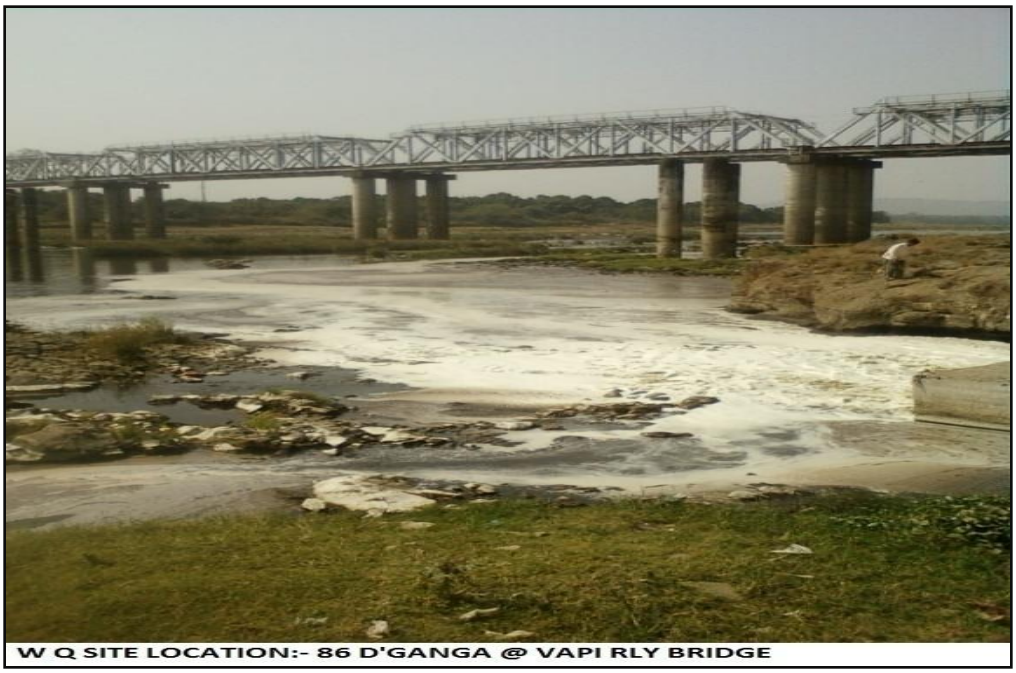
Par originate from Shyadri Hills of Satpura Range, flows westward and joins Arabian Sea. It has a total basin area of 1664 Km^2 of which nearly half is located in Maharashtra and half in Gujarat. The Maharashtra portion of the basin is mostly in the hilly region and major human activities are related to agriculture. The river is mostly seasonal in Maharashtra. Par River is a drinking water resource for several villages in Gujarat including the Umarsadi and Haria villages. The Par is heavily polluted river as it receives the waste water from a large industrial complex of Atul. The Atul is situated on the banks of the river Par in the Valsad district of Gujarat state, 200 km north of India's commercial capital, Mumbai. Earlier reports indicate high levels of lead in the water. The river banks are generally marshy due to deposition of silt during flood. The river receives industrial waste from the Atul Industries, Chemical Industries, etc. in the near by vicinity.

6) Kolak at Morai :

W Q SITE LOCATION:- 84 KOLAK @ MORAI NHB-8

Kolak river which originates from Saputara hills near Valvari and meets to Arabian Sea . It is located in South Gujarat, VAPI GIDC is situated in the vicinity and lies in north of Daman. Its length is 50 Km. and catchment area is 584 km. The latitude is 20.45^0N and Longitude is 72.87^0E.

7) Damanganga at Vapi Railway Bridge



W Q SITE LOCATION:- 86 D'GANGA @ VAPI RLY BRIDGE

River Damanganga originates from Sahyadri hills near Valveri village Nasik district in Maharashtra State. It travels a distance of 131.30 km. before it drains to Arabian Sea at Daman. Damanganga along with its tributaries mainly flows through the hilly areas of Maharashtra, Gujarat and Union Territory Dadra and Nagar Haveli and Daman. The major tributaries of the Damanganga River are Dawan, Shrimant, Val, Rayate, Lendi, Wagh, Sakartond, Roshni, Dudhni, and Piperiya. The basin is situated between 19^0 54' to 20^0 28' North latitude and 72^0 50' to 73^0 38' East longitude. The total drainage area of the basin is 2318 Sq. km. The industrial towns of Vapi, Dadra and Silvassa lie on the north bank of the river, and the town of Daman occupies both banks of the river's estuary. Damanganga River receives most of the effluent load from active industries in the Vapi Industrial Estate. It is also a major source of drinking , irrigation water.

Vapi an industrial town located in Pardi taluka , Valsad district is located on the banks of this river Since 1980 textile and chemicals have been the major sector for employment in the district. There are 300 hundred medium and large industries. One of the Asia's largest Common Effluent Treatment Plant (CEPT) is present in Vapi and which is promoted by Vapi Industrial Association consisting of 10716 units of small and medium enterprises, involved in different sectors, such as chemicals and dyes, textile, engineering and paper industries.

Major Industries

Aarti Industries Ltd.	Chemical products such as chloroaniline, calcium phosphate, sulphuric acid, single super phosphate etc.
GHCL Ltd	Madeups of curtains and bed covers etc.
Hindustan Inks Ltd.	Printing Inks, synthetic resins, prepared glues and adhesives etc.
Pidilite Industries Ltd.	Synthetic resins, adhesive, colour pigments and tubricating chemicals etc.
Raymond Ltd.	Weaving and processing of artificial and synthetic textile fibres etc.

Ruby Mascot Ltd.	Uncoated craft paper, news print and poster paper tec.
Sun Pharmaceuticals	Pharmaceutical Products
United Phosphorus Ltd.	Electronic equipments for environmental and air pollution control, Phosphorus Peentasuiphide, Benzoate etc.
Welspun Polyesters India Ltd.	Cotton yarns, madeups of cotton terry towel and fabrics

Chapter 2

Methodology

2.1 ROLE OF GERI:

Gujarat Engineering Research Institute (GERI), Vadodara is a research institution headed by Chief Engineer and Director comprises of various section viz (1) Irrigation (2) Dam Safety Organization (3) soil Drainage & Reclamation (4) Roads There are 14 divisions working in different disciplines at the main office and three more regional divisions situated at Gandhinagar, Surat and Rajkot related with testing. These laboratories are well equipped with sophisticated instruments and testing of various parameters are carried out in these laboratories for various engineering materials.

Surface water quality testing facilities is established in this institute since its inception. The scientist are conversant with the testing facilities .Water quality laboratory of level II at Rajkot and two water quality laboratories of Level II+ at Vadodara and Gandhinagar are developed under Hydrology World Bank aided project , HP-I wherein the objectives was with special reference to surface water quality to monitor for establishing base line water quality, and observing trend in water quality changes. GERI was entrusted surface water testing, analysis, compilation of data, its interpretation and recommendations for water quality monitoring.

As a result of studies carried out under HP-I &HP-II, out of 154+23(New Locations)= Total 177nos monitoring stations, eight locations viz hot spots are identified as trend stations. GERI has been entrusted the work of four schemes narrated as below:

1. Study of water quality fluctuation in river Viswamitri.
2. To study the trend in water quality of locations identified as Hot Spots.
3. Monitoring of water quality fluctuations in river Sabarmati.
4. Crop water requirement of Central province of Gujarat for optimum utilization of irrigation water.

2.2 PARAMETERS TESTED

Samples are tested for the parameters as mentioned in "Uniform Protocol for Water Quality Monitoring" circulated by MOWR, New Delhi.

TABLE-2.1

Sr. No.	Parameter
1.	Colour
2.	Odour
3.	Temp.
4.	pH
5.	Electrical Conductivity (EC)
6.	Dissolved Oxygen
7.	Turbidity (NTU)
8.	TDS (Total Dissolved Solid)
9.	NH_4-N (Ammonical Nitrogen)
10.	NO_3-N (Nitrate – Nitrogen)
11.	NO_2-N (Nitrite – Nitrogen)
12.	Total-P (Total Phosphate)
13.	BOD (Bacteriological Oxygen Demand)
14.	COD (Chemical Oxygen Demand
15.	Na^+ (Sodium as Na^+)
16.	K^+ (Potassium as K)
17.	Ca^{++} (Calcium as Ca^{++})
18.	Mg^{++} (Magnesium as Mg^{++})
19.	CO^{--} (Carbonate as CO_3^{--})
20.	HCO_3^- (By Carbonate as HCO_3^-)
21.	Cl^- (Chloride as Cl^-)
22.	SO_4^{--}(Sulphate as SO_4^{--})
23.	Fluoride as F^{---}

2.3 TECHNIQUES APPLIED FOR ANALYSIS OF WATER SAMPLES

1) Sample collection: The procedure for sample collection for surface water are as below
    - Samples are collected from well mixed section of river and should be of the point of interest, such as bathing ghat, downstream point discharge, water supply intakes and other sources.

2) Procedure for sample preservation and Transportation
    a) The type of containers and sample preservation technique to be adopted are mentioned as below :

TABLE-2.2

Parameter	Type of Container	Preservation Technique
pH	Glass, PE	Analysis Preferably on site or Transportation at lower temperature
Temperature	Container	Record immediately
Electrical Conductivity	Glass, PE	Analysis as soon as possible
TDS	Glass, PE	Analysis as soon as possible
BOD,COD	Glass, PE	PH$\leq$2 by acidifying with H_2 SO_4, cooling at 4^oC, store in dark
DO	BOD Bottle	Fixed DO at site by using DO fixing chemicals
Turbidity	Glass, PE	Store in dark up to 24hrs.
Nitrogen-Ammonia	Glass, PE	PH$\leq$2 by acidifying with H_2 SO_4, cooling at 4^oC
Nitrate	Glass, PE	PH$\leq$2 by acidifying with H_2 SO_4, cooling at 4^oC
Sulphate	Glass, PE	PH$\leq$2 by acidifying with H_2 SO_4, cooling at 4^oC
Phosphate	Glass, PE	PH$\leq$2 by acidifying with H_2 SO_4, cooling at 4^oC
Heavy Metal	Glass, PE	PH$\leq$2 by acidifying with HNO_3, cooling at 4^oC

Coliform	Glass, PE sterilized	cooling at 4^{o}C,Store in dark
Flouride	PE	-
Boron	PE	-

b) Samples are transported to concerned laboratory as soon as possible preferably within 48 hrs. of collection.

c) Analysis of parameters such as pH, Temperature, EC measured immediately at site.

d) DO should be fixed at site by DO fixing chemicals and titration is done either at site or lab.

e) For analysis of Heavy metals, preserved it with HNO_3 up to pH<2. Prepared the sample for solid extraction by addition of HNO_3 and evaporate the sample up to certain extent then used it for analysis of heavy metals by Atomic Absorption Spectrophotometer.

TABLE-2.3

Sr. No.	**Parameter**	**Instrument used**
1.	pH	pH meter
2.	Electrical Conductivity	EC meter
3.	Turbidity	Turbidity meter
4.	Total Dissolved Solids (TDS)	Gravimetric method
5.	Ammonical Nitrogen	UV/Vis Spectrophotometer
6.	Nitrate – Nitrogen	″
7.	Nitrite – Nitrogen	″
8.	Total phosphate	″
9.	Sulphates as SO_4^{--}	″
10.	Boron as B^{+++}	″
11.	Fluoride as F^{---}	″

Sr. No.	Parameter	Instrument used
12.	Carbonates as CO_3^{--}	Titration Method
13.	Bicarbonates as HCO_3^-	Titration Method
14.	Calcium as Ca^{++}	″
15.	Magnesium as Mg^{++}	″
16.	Sodium as Na^+	Flame photometer
17.	Potassium as K^+	″
18.	Dissolved Oxygen	DO meter
19.	Bacteriological Oxygen demand	Titration method
20.	Chemical Oxygen demand	COD digester

2.4 Water Quality Standards

Water quality standards may be classified as ambient water quality standards, specific water use related standards and effluent water quality standards.

The Central Pollution Control Board has classified the surface water in to 5categories-A to E on the basis of the best possible use of the water. The classification has been made in such a manner that the water quality requirement becomes progressively lower from class A to class E.

TABLE - 2.4

Primary water quality criteria for Designated Best Uses of surface Water

Designated	Class	criteria
Drinking Water Source without conventional treatment but after disinfection	A	1.Total Coliforms Organism MPN/100ml shall be 50 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 6mg/l or more

Outdoor bathing (organized)	B	1.Total Coliforms Organism MPN/100ml shall be 500 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 5mg/l or more 4. Biochemical Oxygen Demand 5
Drinking water source after conventional treatment and disinfection	C	1. Total Coliforms Organism MPN/100ml shall be 5000 or less 2. pH between 6 and 9 3. Dissolved Oxygen 4mg/l or more
Propagation of Wild life and Fisheries	D	1. pH between 6.5 and 8.5 2. Dissolved Oxygen 4mg/l or more 3. Free Ammonia (as N) 4. Biochemical Oxygen Demand 5 days 20 °C, 2mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	1. pH between 6.0 and 8.5 2. Electrical Conductivity at 25 °C micro mhos/cm, maximum 2250
	Below-E	Not meeting any of the A, B, C, D & E criteria

In India, CPCB has identified water quality requirements in terms of a few chemical characteristics, known as primary water quality criteria. Further Bureau of Indian Standards has also recommended water quality parameters for different uses in the standard IS 2296:1982.

TABLE – 2.5

Water Quality Standards in India (Source IS 2296:1982)

Characteristics	**Designated best use**				
	A	B	C	D	E
Dissolved Oxygen (DO)mg/l, min.	6	5	4	4	-
Biochemical Oxygen Demand (BOD)mg/l, max	2	3	3	-	-

Total coliform organisms MPN/100ml,max	50	500	5,000	-	-
pH value	6.5-8.5	6.5-8.5	6.0-9.0	6.5-8.5	6.0-8.5
Colour, Hazen units, max.	10	300	300	-	-
Odour	Un-objectionable			-	-
Taste	Tasteless	-	-	-	-
Total dissolved solids, mg/l, max.	500	-	1,500	-	2,100
Total Hardness (as $CaCO_3$), mg/l, max.	200	-	-	-	-
Calcium Hardness (as $CaCO_3$), mg/l, max.	200	-	-	-	-
Magnesium Hardness (as $CaCO_3$), mg/l, max.	200	-	-	-	-
Copper (as Cu), mg/l, max.	1.5	-	1.5	-	-
Iron (as Fe), mg/l, max.	0.3	-	0.5	-	-
Manganese (as Mn), mg/l, max.	0.5	-	-	-	-
Cholorides (as Cu), mg/l, max.	250	-	600	-	600
Sulphates (as SO_4), mg/l, max.	400	-	400	-	1,000
Nitrates (as NO_3), mg/l, max.	20	-	50	-	-
Fluorides (as F), mg/l, max.	1.5	1.5	1.5	-	-
Phenolic compounds (as C_2H_5OH),mg/l, max.	0.002	0.005	0.005	-	-
Mercury (as Hg), mg/l, max.	0.001	-	-	-	-
Cadmium (as Cd), mg/l, max.	0.01	-	0.01	-	-
Salenium (as Se), mg/l, max.	0.01	-	0.05	-	-
Arsenic (as As), mg/l, max.	0.05	0.2	0.2	-	-
Cyanide (as Pb), mg/l, max.	0.05	0.05	0.05	-	-
Lead (as Pb), mg/l, max.	0.1	-	0.1	-	-
Zinc (as Zn), mg/l, max.	15	-	15	-	-
Chromium (as Cr^{6+}), mg/l, max.	0.05	-	0.05	-	-
Anionic detergents (as MBAS), mg/l, max.	0.2	1	1	-	-
Barium (as Ba), mg/l, max.	1	-	-	-	-
Free Ammonia (as N), mg/l, max	-	-	-	1.2	-
Electrical conductivity, micromhos/cm, max	-	-	-	-	2,250
Sodium absorption ratio, max	-	-	-	-	26
Boron, mg/l, max	-	-	-	-	2

STATEMENT-1

Statement Showing Surface Water Analysis of Location No 1 : Kim at Naninaroli

Sr. No.	Month	General				Nutrient			Organic matter				Major Ions				Other Inorganic		Microbio-logical	Major Cations				Alkalinity		Hardness	
		Temp.	EC	TDS mg/l	pH	Nh_4-N mg/l	NO2-NO3 mg/l	PO_4 mg/l	BOD mg/l	DO mg/l	COD mg/l	Turbidity NTU	CO3 mg/l	HCO3 mg/l	SO_4 mg/l	CL mg/l	B mg/l	F mg/l	Coli-form	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Ph.Alkalinity mg/l	Total Alkalinity mg/l	Ca-Hardness mg/l	Total Hardness mg/l
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	Mar-09	25	772	375	7.8	__	1.20	0.15	0	_	10	0	0	101	71	55	NP	0.10	0	31	0.1	21	11	0.00	83	53	98
2	Apr-09	29.5	435	265	8.2	1.30	2.20	0.45	0	_	10	0	0	110	75	61	NP	0.20	1	41	0.1	25	15	0.00	90	63	124
3	May-09	27	1090	710	7.3	0.00	2.02	0.21	0	_	20	0	1	146	99	75	NP	0.10	0	51	0.1	31	21	0.00	120	78	164
4	Jun-09	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
5	Jul-09	30	580	325	7.2	0.00	1.20	0.14	0	_	0	0	0	74	50.5	35	NP	0.10	0	23.28	0.1	25	14	0.00	61	63	120
6	Aug-09	27	279	182	7.2	0.00	2.64	1.51	0	_	0	0	0	81	63	30.0	NP	0.10	0	23.5	0.1	21	14	0.00	66	53	110
7	Sep-09	27	530	345	6.9	0.00	0.33	0.42	0	_			0	153	51	26.6	NP	0.00	0	20	0.1	44	25	0.00	125	110	211
8	Oct-09	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
9	Nov-09	28	553	360	7.3	0.00	3.10	0.40	0	_	0	0	0	201	51	85	NP	0.39	0	56	0.1	68	49	0.00	165	170	373
10	Dec-09	32.5	476	309	7.6	0.00	1.54	0.26	0	_	0	0	0	241	52.5	67	NP	0.20	0	45	0.1	76	49	0.00	198	190	392
11	Jan-10	35	600	385	7.2	0.00	0.70	0.18	0	_	0	10	0	247	64	104	NP	0.00	0	80	0.1	40	51	0.00	202	100	310
12	Feb-10	25	301	281	8.1	0.00	0.80	0.18	0	_	0	5	0	250	61	180	NP	0.20	0	155	0.1	45	25	0.00	205	113	215
13	Mar-10	25	373	231	8.3	0.00	0.91	0.18	__	6	10	10	0	101	6.5	36	NP	0.20	0	28	0.1	35	22	0.00	151	88	178
14	Apr-10	29	1297	843	7.6	0.00	0.00	1.21	__	5.6	10	10	0	223	47	178	NP	0.11	0	135	0.1	46	37	0.00	168	140	211
15	May-10	35	525	341	8.4	0.00	1.01	0.31	__	5.8	10	0	12	153	45	261	NP	0.54	0	176	0.1	48	38	10.00	125	70	229
16	Jun-10	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
17	Jul-10	23	409	266	7.8	0.00	1.57	0.90	__	7.5	0	10	0	101	6.9	35.00	NP	0.05	0	25	0.1	55	25	0.00	83	138	281
18	Aug-10	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
19	Sep-10	23.5	973	633	7.7	1.30	12.60	0.87	__	8	10	15	0	201	25	75.00	NP	0.05	0	49	0.1	75	52	0.00	165	188	399
20	Oct-10	25	1010	656	8.5	0.00	14.40	0.81	__	6		10	0	206	37.9	110.00	NP	0.20	0	76	0.1	66	62	0.00	169	165	420
21	Nov-10	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
22	Dec-10	29	612	398	7.9		11.90	0.16	__	6	10	10	0	225	15	31	NP	0.20	0	21	0.1	81	71	0.00	184	203	494.635
23	Jan-11	20	602	392	8.6	0.00	11.71	0.29	__	5.8	0	10	0	185	49.6	120	NP	0.00	0	86	46.6	48	34	12.50	130	120	261
24	Feb-11	20	525	341	8.4	0.00	1.04	0.31	__	5.8	0	10	12	153	45	161	NP	0.00	0	146	0.1	26	39	10.00	125	65	224
	Max	35.00	1297.00	843.00	8.55	1.30	14.40	1.51	0.00	8.00	20.00	15.00	12.00	250.00	99.00	261.00	0.00	0.54	1.00	176.00	46.60	81.00	71.00	12.50	204.92	202.50	494.64
	Min	20.00	279.00	182.00	6.93	0.00	0.00	0.14	0.00	5.60	0.00	0.00	0.00	74.00	6.50	26.60	0.00	0.00	0.00	20.00	0.10	21.00	11.00	0.00	60.66	52.50	97.74
	Average	27.13	628.53	402.00	7.78	0.15	3.73	0.47	0.00	6.28	5.29	5.56	1.32	165.89	48.21	90.79	0.00	0.14	0.05	66.73	2.55	46.11	34.43	1.71	137.64	114.00	253.39

STATEMENT-1

Statement Showing Surface Water Analysis of Location No 1 : Kim at Naninaroli

Sr. No.	Month	General				Nutrient			Organic matter				Major Ions				Other Inorganic		Microbio-logical	Major Cations				Alkalinity		Hardness	
		Temp.	EC	TDS mg/l	pH	Nh_4-N mg/l	NO2-NO3 mg/l	PO_4 mg/l	BOD mg/l	DO mg/l	COD mg/l	Turbidity NTU	CO3 mg/l	HCO3 mg/l	SO_4 mg/l	CL mg/l	B mg/l	F mg/l	Coli-form	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Ph.Alkalinity mg/l	Total Alkalinity mg/l	Ca-Hardness mg/l	Total Hardness mg/l
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	Mar-09	25	772	375	7.8	__	1.20	0.15	0	_	10	0	0	101	71	55	NP	0.10	0	31	0.1	21	11	0.00	83	53	98
2	Apr-09	29.5	435	265	8.2	1.30	2.20	0.45	0	_	10	0	0	110	75	61	NP	0.20	1	41	0.1	25	15	0.00	90	63	124
3	May-09	27	1090	710	7.3	0.00	2.02	0.21	0	_	20	0	1	146	99	75	NP	0.10	0	51	0.1	31	21	0.00	120	78	164
4	Jun-09	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
5	Jul-09	30	580	325	7.2	0.00	1.20	0.14	0	_	0	0	0	74	50.5	35	NP	0.10	0	23.28	0.1	25	14	0.00	61	63	120
6	Aug-09	27	279	182	7.2	0.00	2.64	1.51	0	_	0	0	0	81	63	30.0	NP	0.10	0	23.5	0.1	21	14	0.00	66	53	110
7	Sep-09	27	530	345	6.9	0.00	0.33	0.42	0	_			0	153	51	26.6	NP	0.00	0	20	0.1	44	25	0.00	125	110	211
8	Oct-09	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
9	Nov-09	28	553	360	7.3	0.00	3.10	0.40	0	_	0	0	0	201	51	85	NP	0.39	0	56	0.1	68	49	0.00	165	170	373
10	Dec-09	32.5	476	309	7.6	0.00	1.54	0.26	0	_	0	0	0	241	52.5	67	NP	0.20	0	45	0.1	76	49	0.00	198	190	392
11	Jan-10	35	600	385	7.2	0.00	0.70	0.18	0	_	0	10	0	247	64	104	NP	0.00	0	80	0.1	40	51	0.00	202	100	310
12	Feb-10	25	301	281	8.1	0.00	0.80	0.18	0	_	0	5	0	250	61	180	NP	0.20	0	155	0.1	45	25	0.00	205	113	215
13	Mar-10	25	373	231	8.3	0.00	0.91	0.18	__	6	10	10	0	101	6.5	36	NP	0.20	0	28	0.1	35	22	0.00	151	88	178
14	Apr-10	29	1297	843	7.6	0.00	0.00	1.21	__	5.6	10	10	0	223	47	178	NP	0.11	0	135	0.1	46	37	0.00	168	140	211
15	May-10	35	525	341	8.4	0.00	1.01	0.31	__	5.8	10	0	12	153	45	261	NP	0.54	0	176	0.1	48	38	10.00	125	70	229
16	Jun-10	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
17	Jul-10	23	409	266	7.8	0.00	1.57	0.90	__	7.5	0	10	0	101	6.9	35.00	NP	0.05	0	25	0.1	55	25	0.00	83	138	281
18	Aug-10	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
19	Sep-10	23.5	973	633	7.7	1.30	12.60	0.87	__	8	10	15	0	201	25	75.00	NP	0.05	0	49	0.1	75	52	0.00	165	188	399
20	Oct-10	25	1010	656	8.5	0.00	14.40	0.81	__	6		10	0	206	37.9	110.00	NP	0.20	0	76	0.1	66	62	0.00	169	165	420
21	Nov-10	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
22	Dec-10	29	612	398	7.9		11.90	0.16	__	6	10	10	0	225	15	31	NP	0.20	0	21	0.1	81	71	0.00	184	203	494.635
23	Jan-11	20	602	392	8.6	0.00	11.71	0.29	__	5.8	0	10	0	185	49.6	120	NP	0.00	0	86	46.6	48	34	12.50	130	120	261
24	Feb-11	20	525	341	8.4	0.00	1.04	0.31	__	5.8	0	10	12	153	45	161	NP	0.00	0	146	0.1	26	39	10.00	125	65	224
	Max	35.00	1297.00	843.00	8.55	1.30	14.40	1.51	0.00	8.00	20.00	15.00	12.00	250.00	99.00	261.00	0.00	0.54	1.00	176.00	46.60	81.00	71.00	12.50	204.92	202.50	494.64
	Min	20.00	279.00	182.00	6.93	0.00	0.00	0.14	0.00	5.60	0.00	0.00	0.00	74.00	6.50	26.60	0.00	0.00	0.00	20.00	0.10	21.00	11.00	0.00	60.66	52.50	97.74
	Average	27.13	628.53	402.00	7.78	0.15	3.73	0.47	0.00	6.28	5.29	5.56	1.32	165.89	48.21	90.79	0.00	0.14	0.05	66.73	2.55	46.11	34.43	1.71	137.64	114.00	253.39

STATEMENT-2

Statement Showing Surface Water Analysis of Location No 2 : Purna at Tavdi Railway Bridge

Sr. No.	Month	General				Nutrient			Organic matter				Major Ions				Other Inorganic		Micro bio-	Major Cations				Alkalinity		Hardness	
		Temp.	EC	TDS mg/l	pH	Nh_4-N mg/l	NO2-NO3 mg/l	PO_4 mg/l	BOD mg/l	DO mg/l	COD mg/l	Turbidity NTU	CO3 mg/l	HCO3 mg/l	SO_4 mg/l	CL mg/l	B mg/l	F mg/l	Coli-form	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Ph.Alkalinity mg/l	Total Alkalinity mg/l	Ca-Hardness mg/l	Total Hardness mg/l
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	Mar-09	25	910	592	8.2	0.00	1.24	0.57	0	_	10	12	6	381	157	320.0	NP	_	0	291	0.1	172	101	5	312	253	845
2	Apr-09	24.5	1840	1196	8.7	0.00	1.31	0.22	0	_	10	12	12	256	75	655	NP	0.40	0	570	0.1	60	51	10	210	150	360
3	May-09	30.5	3190	2075	8.2	0.00	3.06	1.99	0	_	10	12	6	395	215	1243	NP	0.40	0	808	0.1	162	55.0	5	324	138	631
4	Jun-09	32	11110	7222	8.0	0.00	10.73	0.24	0	_	10	12	0	336	335	4331	NP	0.20	0	3250	0.1	245	210.0	0	277	260	1477
5	Jul-09	30	765	497	7.5	0.00	1.13	0.26	0	_	10	70	6	238	13.9	157	NP	0.20	0	42.6	0.1	98	81.8	0	275	245	582
6	Aug-09	28.5	466	303	7.5	0.00	10.73	0.24	0	_	7	70	0	332	13.9	45.0	NP	0.30	0	34	0.1	52	26.9	5	238	130	241
7	Sep-09	30	418	272	7.9	0.00	1.46	0.46	0	_	0	70	12	189	1.7	60.0	NP	_	0	25	0.1	20	24.2	10	155	50	150
8	Oct-09	31	542	352	7.7	0.00	0.00	0.55	0	_	10	75	6	204	16	107.0	NP	0.22	0	80	0.1	44	16.30	5.0	167	110	177
9	Nov-09	34.5	1064	692	7.8	0.00	0.34	0.88	0	_	0	75	24	256	107	391.0	NP	0.30	0	293	0.1	64	56	20.0	210	160	390
10	Dec-09	32	873	587	8.4	0.00	0.93	0.91	0	_	10	70	9	137	41	462	NP	0.30	0	347	0.1	56	27	7.5	112	683	252
11	Jan-10	36	1174	763	7.8	0.00	0.66	0.17	0	_	10	70	0	262	54	533	NP	0.25	0	401	0.1	152	92	0.0	215	130	758
12	Feb-10	23	17780	11557	7.5		2.58	1.44	0	_	10	75	0	366	366	9479	NP	0.20	0	7109	0.1	248	140	0.0	300	620.0	1196
13	Mar-10	32	4450	2893	8.3	_	10.73	1.29	0	_	20	65	0	299	46.2	533	NP	0.25	0	438	0.1	104	91	0	245	260	634
14	Apr-10	28	2110	1372	8.0	_	1.79	0.99	0	_	10	80	21	259	84	655	NP	0.21	0	426	0.1	154	93	18	212	385	313
15	May-10	34.5	10260	6670	8.5	_	0.93	_	0	_	10	85	42	293	282	4295	NP	0.41	0	3221	0.1	152	96.0	25	240	380	519
16	Jun-10	29.5	15720	10218	8.2	1.98	4.01	1.46	0	_	10	85	18	348	212	6932	NP	0.40	0	5192	0.1	190	136.0	15	285	475	950
17	Jul-10	29.5	1198	787	7.8	_	0.39	5.37	0	_	20	80	0	201	126	497	NP	0.13	0	376	0.1	184	64.0	0	165	460	473
18	Aug-10	27.5	521	343	8.0	_	1.04	0.25	0	_	10	95	0	306	19.7	90.0	NP	0.13	0	58	0.1	56	31.5	0	251	140	295
19	Sep-10	24	679	441	8.5	_	11.80	2.42	0	_	10	85	3	151	17	100.0	NP	0.15	0	72	0.1	51	46.0	3	124	128	317
20	Oct-10	25.5	680	442	8.6	_	3.70	0.01	0	_	10	80	15	240	10.5	235.0	NP	0.30	0	145	0.1	74	69.50	12.0	197	185	471
21	Nov-10	24.5	855	556	7.6	_	3.14	0.67	0	_	10	125	0	189	134	430.0	NP	0.22	0	323	0.1	50	35.10	0.0	155	125	598
22	Dec-10	27	678	439	8.0	_	3.08	0.11	0	_	10	42	18	234	122	270.0	NP	0.20	0	175	0.1	72	56.90	15.0	192	180	455
23	Jan-11	20.5	880	561	7.6	_	3.15	0.68	0	_	0	55	0	189	134	430.0	NP	_	0	278	0.1	81	84.50	0.0	155	203	523
24	Feb-11	25	1023	665	8.2	2.90	2.30	2.9	0	8	10	50	0	295	132	355	NP	_	0	230	0.1	48	48.40	0.0	242	120	319
	Max	36.00	17780	11557	8.70	2.90	11.80	5.37	0.00	8.00	20.00	125.00	42.00	395.0	366.00	9479	0.00	0.41	0.00	7109	0.10	248.0	210.00	25.00	324.0	683.0	1477
	Min	20.50	418.0	272.00	7.47	0.00	0.00	0.01	0.00	8.00	0.00	12.00	0.00	137.0	1.70	45.00	0.00	0.13	0.00	25.0	0.10	20.00	16.30	0.00	112.0	50.00	149.6
	Average	28.52	3299	2145.63	8.01	0.38	3.34	1.05	0.00	8.00	9.46	64.58	8.25	264.8	113.12	1359	0.00	0.26	0.00	1008	0.10	107.9	72.23	6.44	219.1	248.7	538.56

STATEMENT-3

Statement Showing Surface Water Analysis of Location No 3 : Tapi At Magdalla

Sr. No.	Month	General				Nutrient			Organic matter				Major Ions				Other Inorganic		Microbio-logical	Major Cations				Alkalinity		Hardness	
		Temp.	EC	TDS mg/l	pH	Nh_4-N mg/l	NO2-NO3 mg/l	PO_4 mg/l	BOD mg/l	DO mg/l	COD mg/l	Turbidity NTU	CO3 mg/l	HCO3mg/l	SO_4 mg/l	CL mg/l	B mg/l	F mg/l	Coli-form	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Ph.Alkalinity mg/l	Total Alkalinity mg/l	Ca-Hardness mg/l	Total Hardness mg/l
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	Mar-09	25	29,400	18051	7.30	0.00	3.69	0.52	0	_	10	10	15	432	386	7750	NP	0.40	0	5050	0.1	320	96	12.30	354	800	1194
2	Apr-09	24.5	39450	25642	7.7	2.94	4.07	0.21	0	7.86	30	10	13.5	229	410	14970	NP	0.50	0	11225	0.1	421	232	11.07	188	1053	2007
3	May-09	32.5	40750	26490	7.3	0.00	10.7	0.24	23	_	46	10	15	410	465	14555	NP	0.40	0	10916	6.1	301	212	12.30	336	753	1625
4	Jun-09	268	49700	32305	7.0	0.00	10.7	0.28	30	_	54	10	0	268	236	12425	NP	0.40	0	9318	6.2	350	210	0.00	220	875	1739
5	Jul-09	32.5	1321	859	6.7	0.00	1.08	0.3	0	_	18	15	0	390	32	340	NP	0.20	0	256	0.1	35.6	26.6	0.00	320	89	198
6	Aug-09	28.5	843	548	6.7	0.00	1.90	0.96	0	_	10	110	6	277	44.8	155	NP	0.20	0	116	0.1	44	35.0	4.92	227	110	253.998
7	Sep-09	31	1894	1231	7.5	0.00	1.02	0.45	0	_	10	115	0	426	28	555	NP	0.20	0	66	0.1	28	51.0	0.00	349	70	280
8	Oct-09	31	2890	1880	7.2	0.00	1.88	1.76	0	_	25	110	6	229	129	1065	NP	0.20	0	799	0.1	72	39.7	4.92	188	180	343
9	Nov-09	33	23960	15815	7.1	0.00	1.36	1.37	0	_	32	110	0	610	232	10650	NP	0.30	0	7990	0.1	200	44.8	0.00	500	500	684
10	Dec-09	32	26250	17325	7.7	0.00	7.77	0.65	0	_	30	101	3	348	354	9124	NP	0.30	0	6843	0.1	200	133	2.46	285	500	1047
11	Jan-10	35	36250	22913	7.2	0.00	1.78	0.84	20	_	50	106	0	339	434	13348	NP	0.25	0	10011	0.1	340	87	0.00	278	850	1207
12	Feb-10	23	48800	31720	7.3	0.00	1.34	1.2	35	_	72	110	0	230	210	10423	NP	0.20	0	7818	0.1	312	114	0.00	189	780	1249
13	Mar-10	32	38,800	25220	7.15	_	0.14	0.41	35	_	70	10	0	229	466	13490	NP	0.20	0	10117	0.12	304	201	0.00	1876	760	1587
14	Apr-10	29.5	48,700	31,665	7.0	_	2.56	0.52	20	_	68	15	18	262	423	10880	NP	0.31	0	8160	0.1	348	213	15.00	215	870	1746
15	May-10	32.5	43250	28112	7.9	_	0.7		15	_	55	17	30	275	435	16475	NP	0.44	0	12354	0.1	308	170	25	225	970	2492
16	Jun-10	33	36500	23920	7.6	_	1.6	0.4	0	_	25	17	12	275	466	18105	NP	0.20	0	13579	0.1	318	244	10.00	225	1000	2004
17	Jul-10	30.5	32600	21242	7.0	_	0.49	2.25	0	_	20	17	0	281	251	14000	NP	0.19	0	10500	0.1	328	28.6	0.00	230	82	200
18	Aug-10	_	2550	1668	8.6	_	0.91	0.31	0	_	15	15	0	440	46.6	960	NP	0.20	0	420	0.1	32	33.9	0.00	361	80	220
19	Sep-10	25	415	270	8.3	_	4.30	0.21	0	_	10	19	0	151	58	130	NP	0.20	0	98	0.1	45	41.0	0.00	124	113	281
20	Oct-10	27	2030	1319	8.4	_	8.70	0.15	0	_	10	17	24	226	170	490	NP	0.20	0	307	0.1	180	36.3	0.00	677	450	1944
21	Nov-10	31	14910	9692	7.2	_	9.14	0.36	0	_	30	80	0	271	176	4376	NP	0.12	0	3264	2.1	104	12.1	0.00	222	520	1714
22	Dec-10	28.5	29300	19335	7.4	_	11.4	0.43	15	_	42	80	0	265	168	9285	NP	0.25	0	7495	0.3	204	650	0.00	217	510	3186
23	Jan-11	18.5	14550	9692	7.4	_	9.13	0.36	0	_	30	80	0	281	176	6377	NP	0.30	0	4075	2.1	208	298	0.00	230	520	1747
24	Feb-11	26.5	22040	14326	6.7	1.38	25.4	0.73	10	_	40	80	0	338	173	10650	NP	0.40	0	6901	30	460	46.10	0.00	277	1150	1338
	Max	268	49700	32305	8.61	2.94	25.4	2.25	35	7.86	72	115	30	610	466	18105	0	0.5	0	13579	30	460	650	25	1876	1150	3186
	Min	18.5	415	270	6.7	0	0.14	0.15	0	0	10	10	0	151	28	130	0	0.115	0	66	0.1	28	12.1	0	124	70	198.432
	Average	39.565	24465	15885	7.393	0.332	5.07	0.65	8.46	3.93	41	52.7	5.938	312	248.7	8357	0	0.2735	0	6153	2.026	227.61	135.6	4.0813	346.32	566	1261.9

STATEMENT-4

Statement Showing Surface Water Analysis of Location No 4: Auranga at Lilapur

Sr. No.	Month	General				Nutrient			Organic matter				Major Ions				Other Inorganic		Microbio-	Major Cations				Alkalinity		Hardness	
		Temp.	EC	TDS mg/l	pH	Nh_4-N mg/l	NO2-NO3 mg/l	PO_4 mg/l	BOD mg/l	DOmg /l	COD mg/l	Turbidity NTU	CO3 mg/l	HCO3 mg/l	SO_4 mg/l	CL mg/l	B mg/l	F mg/l	Coli-form	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Ph.Alkalinity mg/l	Total Alkalinity mg/l	Ca-Hardness mg/l	Total Hardness mg/l
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	Mar-09	25	35500	18610	7.4	-	10.73	0.56	0	_	10	Nil	15	255	357	1704	NP	-	-	1251	0.1	400	196	12.3	209	1000	1806
2	Apr-09	27	39450	25632	8.17	2.51	8.23	0.27	0	_	-	Nil	17	244	448	14550	NP	0.40	0	10960	0.1	440	182	13.9	200	1100	1848
3	May-09	29	36550	23750	7.3	-	4.29	0.26	0	_	10	10.0	15	275	400	12532	NP	0.40	0	9399	0.1	400	180	12.3	225	1000	1740
4	Jun-09	32	50300	32501	8.5	-	6.48	0.12	0	_	10	_	6	232	470	12925	NP	0.43	0	9320	0.1	421	146	4.9	190	1053	1652
5	Jul-09	31	13390	8704	7.3	0.00	1.37	0.3	0	_	10	_	6	155	112	4615	NP	0.30	0	2990	0.1	421	140	4.9	127	1053	1628
6	Aug-09	26	316	208	7.3	0.00	1.37	0.28	0	_	10	40.0	6	238	13.9	45	NP	0.20	0	34	0.1	52	27	4.9	195	130	241
7	Sep-09	27	252	155	7.4	0.00	1.13	0.14	0	_	10	38.0	0	134	7.3	36	NP	-	0	27	0.1	16	19	0.0	110	40	120
8	Oct-09	32	7970	5180	7.8	0.00	4.16	0.45	0	_	10	70.0	0	125	274	3621	NP	0.25	0	2715	0.1	112	36	0.0	102	280	429
9	Nov-09	26	9860	6409	7.4	0.00	11.84	1.04	0	_	10	71.0	12	183	259	3864	NP	0.40	0	2901	0.1	164	22	9.8	150	410	500
10	Dec-09	32	28250	18363	7.8	0.00	10.73	0.27	0	_	10	37.0	0	244	366	11081	NP	0.30	0	8386	0.1	280	254	0.0	200	700	1745
11	Jan-10	35	40150	26098	7.2	0.00	10.73	1.67	0	_	10	37.0	0	153	415	16330	NP	0.35	0	12250	0.1	400	133	0.0	125	1000	1546
12	Feb-10	21	47200	30843	7.7	0.00	12.05	1	0	_	10	40.0	0	165	365	19479	NP	0.20	0	16054	0.1	320	140	0.0	135	800	1376
13	Mar-10	26	42850	27853	6.4	3.30	0.14	0.31	6	_	30	35	0	268	466	15017	NP	0.00	0	10150	0.1	348	46.0	0.0	201	870	1058
14	Apr-10	30	54800	35670	6.41	3.23	3.27	0.52	0	_	30	37	0	299	466	19265	NP	0.20	0	17448	0.1	332	141.0	0.0	245	830	1616
15	May-10	35	16200	10530	7.3	3.00	10.74	_	10	_	10	35	42	293	375	6568	NP	0.39	0	4926	0.1	326	86.0	35.0	240	740	928
16	Jun-10	29	15120	9828	7.6	1.98	0.20	0.01	0	_	10	35	0	478	385	6745	NP	0.30	0	5059	0.1	290	96.0	0.0	392	600	709
17	Jul-10	28	24750	16088	7.8	1.99	0.32	1.44	0	_	_	35	6	381	466	9824	NP	0.08	0	7376	0.1	160	86.0	5.0	312	400	630
18	Aug-10	27	168	107	7.8	_	0.89	1.62	0	_	8	45.00	0	137	19.4	30	NP	0.08	0	23	0.1	26	16.9	0.0	251	140	295
19	Sep-10	28.5	509	310	8.5	3.60	5.20	0.32	0	_	0	35.0	3	135	18.3	65	NP	0.08	0	45	0.3	45	45.0	41.0	116	113	281
20	Oct-10	31	383	249	8.4	4.00	2.30	0	0	_	0	35.00	0	159	6.7	30	NP	0.20	0	19	0.1	60	42.1	0.0	130	150	323
21	Nov-10	20	427	278	7.9	4.00	14.80	0.72	0	_	0	15.00	0	175	46	95	NP	0.17	0	71	0.1	80	39.0	0.0	143	200	360
22	Dec-10	29	1338	870	7.6	3.60	15.10	0.84	0	_	10	15.00	15	201	35	321	NP	0.20	0	208	0.1	72	52.0	12.0	165	180	394
23	Jan-11	17	14500	10800	7.9	3.00	13.75	0.73	0	_	10	15.00	0	175	460	6950	NP	0.20		5710	0.1	381	139.0	0.0	144	203	363
24	Feb-11	20.5	18450	11923	7.4	3.50	46.70	0.14	0	6	10	15.00	0	430	473	7250	NP	_	0	6830	0.1	184	50.6	0.0	353	210	418
	Max	35.00	54800.00	35670.00	8.52	4.00	46.70	1.67	10.00	6.00	30.00	71.00	42.00	478.00	473.00	19479.00	0.00	0.43	0.00	17448.00	0.30	440.00	254.00	41.00	392.00	1100.00	1848.16
	Min	17.00	168.00	107.00	6.35	0.00	0.14	0.00	0.00	0.00	0.00	10.00	0.00	125.00	6.70	30.00	0.00	0.00	0.00	19.00	0.10	16.00	16.90	0.00	102.46	40.00	119.84
	Average	**27.67**	**20778.46**	**13373.29**	**7.58**	**1.89**	**8.19**	**0.56**	**0.67**	**3.00**	**10.36**	**34.75**	**5.96**	**230.58**	**279.32**	**7205.92**	**0.00**	**0.24**	**0.00**	**5589.67**	**0.11**	**238.75**	**96.47**	**6.50**	**194.24**	**550.04**	**916.93**

STATEMENT-5

Statement Showing Surface Water Analysis of Location No 5: Auranga at Abrama

Sr. No.	Month	General				Nutrient			Organic matter				Major Ions				Other Inorganic		Microbio-logical	Major Cations				Alkalinity		Hardness	
		Temp.	EC	TDS mg/l	pH	Nh_4-N mg/l	NO2-NO3 mg/l	PO_4 mg/l	BOD mg/l	DOm g/l	COD mg/l	Turbidity NTU	CO3 mg/l	HCO3 mg/l	SO_4 mg/l	CL mg/l	B mg/l	F mg/l	Coliform	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Ph.Alkalinity mg/l	Total Alkalinity mg/l	Ca-Hardness mg/l	Total Hardness mg/l
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	Mar-09	25	18840	12246	7.8	0.00	8.05	0.24	0	_	10	15	4.5	684	423	11010	NP	0.00	0.0	8050	0.1	604	145.00	3.69	561	1510	2105
2	Apr-09	29.5	40400	26664	8.2	1.30	8.32	0.22	0	_	9	14.5	4.5	701	399	14550	NP	0.40	0.0	10902	0.1	575	105	3.69	575	1438	1868
3	May-09	29	35650	23175	7.3	0.00	6.90	0.50	0	_	9	14.5	4.5	710	466	10757	NP	0.40	0.0	868	0.1	610	125	3.69	582	1525	2038
4	Jun-09	30	74840	49340	7.5	0.00	10.73	0.19	20	_	110	11	0	415	470	1994	NP	0.20	0.0	1745	0.1	485	380	0.00	340	1213	2776
5	Jul-09	31	3700	2405	7.3	0.00	1.18	0.22	26	_	110	15	0	268	470	355	NP	0.20	0.0	266	0.1	495	75	0.00	220	1238	1545
6	Aug-09	26	273	177	7.5	0.00	1.34	0.21	20	_	110	110	0	105	13	25	NP	0.06	0.0	19	0.1	21	10	0.00	86	53	93
7	Sep-09	27.5	251	163	7.4	1.10	0.69	0.17	0	_	7	115	0	140	21.8	25	NP	0.20	0.0	19	0.3	28	13	0.00	115	70	123
8	Oct-09	31.5	605	393	7.4	0.00	5.72	0.30	0	_	20	110	3	201	17.3	45	NP	0.20	0.0	26.6	0.2	48	5	2.46	165	120	140
9	Nov-09	24	9880	6521	7.0	0.00	11.87	1.68	70	_	10	101	9	220	288	3798	NP	0.30	0.0	2850	0.1	200	104	7.38	180	500	928
10	Dec-09	30	15040	9926	7.5	0.00	10.73	0.58	70	_	140	120	0	372	304	6035	NP	0.20	0.0	4525	0.1	252	104	0.00	305	630	1058
11	Jan-10	17.5	40750	26488	7.4	0.00	9.15	0.19	25	_	100	120	0	368	365	15265	NP	0.20	0.0	11448	0.1	412	178	0.00	302	1030	1762
12	Feb-10	21	33500	20800	7.9	3.31	8.62	0.43	30	_	110	105	0	351	466	13870	NP	0.40	0.0	10357	0.1	432	141	0.00	288	1080	1659
13	Mar-10	27.5	23450	18745	7.5	0.00	10.73	0.28	18	_	70	110	0	356	466	4366	NP	0.40	0.0	3275	0.1	444	132	0.00	209	360	903
14	Apr-10	30	55550	36075	6.9	_	3.14	0.09	50	_	150	95.0	0	259	326	18697	NP	0.29	0.0	13523	0.1	440	139	0.00	212	1100	2495
15	May-10	35	46780	28068	7.9	_	0.18	_	40	_	140	110	36	317	830	8999	NP	0.38	0.0	5830	0.1	466	153	30.00	260	790	2243
16	Jun-10	35.5	44910	26946	7.8	_	10.74	0.18	44	_	150	115	24	699	403	16745	NP	0.40	0.0	10058	0.1	410	154	20.00	528	610	726
17	Jul-10	28	21750	13813	7.9	_	10.74	1.10	12	_	70	115	0	966	395	10685	NP	0.07	0.0	8015	0.1	401	166	0.00	1611	503	938
18	Aug-10	25	156	101	7.5	_	1.34	0.51	_	_	10	125	0	134	17.5	25	NP	0.07	0.0	18	0.1	40	10	0.00	110	100	140
19	Sep-10	28.5	497	323	8.4	_	4.70	0.45	_	_	10	120	0	131	21.8	65	NP	0.08	0.0	34	0.3	44	41	0.00	107	110	279
20	Oct-10	31.5	482	313	8.4	_	1.20	0.30	_	_	10	135	3	201	17.3	45	NP	0.40	0.0	35	0.2	68	68	1.50	165	170	451
21	Nov-10	24	651	424	7.8	_	13.90	0.44	_	_	10	110	0	151	15.9	55	NP	0.18	0.0	31.5	0.1	40.5	0	0.00	124	203	483
22	Dec-10	24.5	1208	785	7.3	_	14.19	0.58	_	_	10	120	0	168	58	235	NP	0.30	0.0	172	0.2	56	40	0.00	138	140	305
23	Jan-11	17.5	1325	750	7.8	_	13.50	1.20	_	_	20	110	0	261	16.5	59	NP	0.20	0.0	35	0.1	84	71	0.00	214	210	502
24	Feb-11	21	18920	12298	7.9	3.31	15.60	0.00	15	6.2	40	90	0	427	173	9976	NP	0.20	2.0	5880	2.45	312	190	0.00	350	780	1561
	Max	35.50	74840.00	49340.00	8.43	3.31	15.60	1.68	70.00	6.20	150.00	135.00	36.00	966.00	830.00	18697.00	0.00	0.40	2.00	13523.00	2.45	610.00	380.00	30.00	1611.00	1525.00	2775.89
	Min	17.50	156.00	101.00	6.91	0.00	0.18	0.00	0.00	6.20	7.00	11.00	0.00	105.00	13.00	25.00	0.00	0.00	0.00	18.00	0.10	21.00	0.00	0.00	86.07	52.50	92.79
	Average	27.08	20392.00	13205.79	7.63	0.64	7.64	0.44	24.44	6.20	59.79	91.92	3.69	358.54	268.46	6153.38	0.00	0.24	0.08	4082.59	0.23	290.31	106.18	3.02	322.72	645.04	1129.98

STATEMENT-6

Statement Showing Surface Water Analysis Of Location No 6:Par at Atul Railway Bridge

Sr. No.	Month	General				Nutrient			Organic matter				Major Ions				Other Inorganic		Microbio-logical	Major Cations				Alkalinity		Hardness	
		Temp.	EC	TDS mg/l	pH	Nh_4-N mg/l	NO2-NO3 mg/l	PO_4 mg/l	BOD mg/l	DOmg/l	COD mg/l	Turbidity NTU	CO3 mg/l	HCO3 mg/l	SO_4 mg/l	CL mg/l	B mg/l	F mg/l	Coliform	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Ph.Alkalinity mg/l	Total Alkalinity mg/l	Ca-Hardness mg/l	Total Hardness mg/l
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	Mar-09	30	49000	32340	7.3	0.00	8.50	0.253	56	_	160	15	6	872	225	23018	NP	_	0	14145	0.1	401	206	5	715	1003	1850
2	Apr-09	28	33450	22077	8.3	8.77	2.97	0.203	40	_	120	110	6	885	410	11729	NP	0.4	0	8796	0.1	421	210	5	725	1053	1916
3	May-09	31.5	49800	32670	7.1	0.00	10.73	0.082	42	_	110	15	6	850	465	17751	NP	0.4	0	13313	0.1	432	215	5	697	1080	1964
4	Jun-09	30.5	8300	5395	7.9	0.00	10.73	0.334	10	_	40	-	0	520	280	4118	NP	0.3	0	3088	0.1	240	145	0	426	600	1196
5	Jul-09	32	231	150	7.0	0.00	1.30	0.195	0	_	10	20	0	98	4.2	30.00	NP	0.40	0	23	0.1	18	9	0	80	45	81
6	Aug-09	28	200	122	7.7	0.00	1.10	0.125	0	_	6	14	0	98	20	35	NP	0.4	0	13	0.1	15	7	0	80	38	64
7	Sep-09	28.5	490	318	7.2	0.00	1.39	0.613	0	_	6	25	0	262	17.2	70.00	NP		0	53	0.1	44	41	0	215	110	279
8	Oct-09	30	289	127	7.3	0.00	0.00	0.616	0	_	40	21	3	137	33	35.50	NP	0.21	0	26.6	0.1	24	24	3	112	60	159
9	Nov-09	28	15080	9953	7.1	1.26	0.91	3.029	0	_	20	20	0	171	13.6	6532	NP		0	4901	0.1	160	19.4	0	140	400	479
10	Dec-09	32.5	17510	12882	7.3	0.00	0.89	0.748	0	_	10	17	0	383	245	9840	NP	0.30	0	7130	0.1	100	189	0	314	250	1028
11	Jan-10	35.5	50700	32955	7.1	0.00	1.58	0.233	28	_	70	17	0	186	375	20129	NP	0.25	0	15096	0.1	364	200	0	152	910	1733
12	Feb-10	23.5	46750	30388	7.1	0.00	0.64	0.33	25	_	65	20	0	195	466	25560	NP	0.30	0	19170	0.1	588	92	0	160	1470	1847
13	Mar-10	27.5	49750	32337	6.8	0.00	0.14	0.331	32	_	90	25	0	465	466	1065	NP	0.30	_	799	0.1	220	174	0	381	550	1266
14	Apr-10	32	67300	43745	6.6	0.00	10.74	0.116	70	_	210	30	0	204	414	19170	NP	0.3	_	14862	0.1	284	197	0	168	710	1520
15	May-10	36	48850	31752	7.2	0.00	0.69	__	60	_	200	45	12	448	205	18815	NP	0.4	_	14111	0.1	295	195	10	203	736	1539
16	Jun-10	31.5	30520	19838	7.3	0.00	1.28	0.394	65	_	180	55	6	375	340	20945	NP	0.4	_	15708	0.1	260	194	5	307	360	1448
17	Jul-10	30	24500	15925	7.2	0.00	1.28	0.922	61	_	210	45	3	304	386	10082	NP	0.1	_	7561	0.1	260	172	2.50	249	650	1358
18	Aug-10	26	146	95	7.9	0.00	0.74	0.28	0	_	10	55	0	113	21.9	15.00	NP	0.07	_	11	0.1	32	14.5	0.00	93	80	140
19	Sep-10	29.9	244	159	8.1	0.00	0.90	0.52	0	_	10	55	3	105	20.5	12.00	NP	0.07	_	7	0.1	41	24	2.50	86	103	202
20	Oct-10	31.5	4100	2665	7.2	0.00	27.30	0.11	0	_	10	65	0	321	110	900	NP	0.30	_	600	0.1	104	106	0.00	263	260	695
21	Nov-10	27	15850	10303	7.6	0.00	10.40	0.13	20	_	60	51	9	201	276	9080	NP	0.35	_	5900	2.3	80	52.0	7.50	165	400	910
22	Dec-10	27.5	11060	6890	7.4	0.00	9.03	0.29	25	_	70	50	0	301	174	5430	NP	0.20	_	3520	0.1	240	217	0.00	247	60	954
23	Jan-11	29	15350	10101	7.6	0.00	10.45	0.15	30	_	100	45	9	205	275	9080	NP	0.30	_	5885	2.1	160	124	10.80	168	400	910
24	Feb-11	22	34100	22165	5.6	0.00	6.07	0.45	65	8	150	55	0	216	173	20300	NP	0.20	_	12500	4.2	290	201	0.00	177	725	1552
	Max	36.00	67300.00	43745.00	8.30	8.77	27.30	3.03	70.00	8.20	210.00	110.00	12.00	885.00	466.00	25560.00	NP	0.40	0.00	19170.00	4.20	588.00	217.00	10.80	725.41	1470.00	1964.07
	Min	22.00	146.00	95.00	5.59	0.00	0.00	0.08	0.00	8.20	6.00	14.00	0.00	98.00	4.20	12.00	NP	0.07	0.00	7.00	0.10	15.00	6.50	0.00	80.33	37.50	64.22
	Average	29.50	23898.75	15639.67	7.28	0.42	4.99	0.45	26.21	8.20	81.54	37.83	2.63	329.79	225.64	9739.23	NP	0.28	0.00	6967.44	0.45	211.38	126.14	2.33	263.51	502.15	1045.43

STATEMENT-7

Statement Showing Surface Water Analysis of Location No: Kolak at Morai

Sr. No.	Month	General				Nutrient			Organic matter				Major Ions				Other Inorganic		Micro bio-	Major Cations				Alkalinity		Hardness	
		Temp.	EC	TDS mg/l	pH	Nh_4-N mg/l	NO2-NO3 mg/l	PO_4 mg/l	BOD mg/l	DO mg/l	COD mg/l	Turbidity NTU	CO3 mg/l	HCO3 mg/l	SO_4 mg/l	CL mg/l	B mg/l	F mg/l	Coli-form	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Ph.Alkalinity mg/l	Total Alkalinity mg/l	Ca-Hardness mg/l	Total Hardness mg/l
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	Mar-09	29	888	577	8.1	0.00	0.48	0.22	0	_	10	29	9	184	36	135	NP	0.00	0.00	85	0	64	48	7.5	150.8	160.0	357
2	Apr-09	30	1143	743	8.5	1.69	0.36	0.26	0	_	9	5	6.5	169	36	426	NP	0.20	0.00	320	0	59	44	5.4	138.5	147.5	329
3	May-09	32.5	1461	949	7.6	0.00	0.13	1.10	0	_	10	11	9	174	53.8	439	NP	0.20	0.00	280	0	69	40	7.5	142.6	172.5	337
4	Jun-09	32	1178	720	8.3	0.00	0.25	0.19	0	_	8	9	12	149	49	410	NP	0.30	0.00	240	0	28	26	10.0	122.1	70.0	177
5	Jul-09	29	278	181	7.2	0.00	0.82	0.30	0	_	8	0	0	141	4.8	45	NP	0.30	0.00	34	0	25	15	0.0	115.6	62.5	122
6	Aug-09	30.8	321	186	7.0	0.00	1.06	0.30	0	_	7	15	0	214	26.8	71	NP	0.30	0.00	65	0	35.6	27	0.0	175.4	89.0	198
7	Sep-09	28.5	290	189	7.3	0.00	0.53	0.17	0	_	10	0	0	171	8.2	44	NP	0.00	0.00	23	0	40	5	0.0	140.2	100.0	120
8	Oct-09	31	337	213	7.3	0.00	0.00	0.62	0	_	10	0	3	165	0	36	NP	0.28	0.00	26.6	0	32	15	2.5	135.2	80.0	140
9	Nov-09	28	1181	772	7.6	0.33	0.05	0.58	0	_	10	0	12	140	241	213	NP	0.20	0.00	160	0	64	49	10.0	114.8	160.0	360
10	Dec-09	32	536	348	7.8	0.00	0.15	0.64	0	_	10	0	0	207	17	107	NP	0.20	0.00	80	0	72	39	0.0	169.7	180.0	340
11	Jan-10	35	1256	816	8.0	0.00	0.00	0.24	0	_	10	0	0	195	51	410	NP	0.13	0.00	333	0	89	71	0.0	159.8	222.5	515
12	Feb-10	24	1275	829	8.0	0.00	0.00	0.46	0	_	10	0	0	162	55	439	NP	0.00	0.00	280	0	41	38	0.0	132.8	102.5	259
13	Mar-10	27	1257	817	7.9	0.00	10.73	0.36	0	_	10	0	0	159	470	410	NP	0.00	0.00	335	0.1	106	97	2.5	130.0	265.0	663
14	Apr-10	30.5	1691	1099	8.0	0.00	1.30	0.15	0	_	0	10	0	165	53	515	NP	0.21	0.00	416	0.1	103	105	0.0	135.0	533.0	4211
15	May-10	35.5	1474	848	7.9	0.00	0.43	_	0	_	20	20	12	207	31	465	NP	0.72	0.00	326	0.1	108	88	10.0	170.0	421.0	632
16	Jun-10	32	1283	784	7.8	0.00	0.34	0.24	0	_	10	15	12	151	52.4	355	NP	0.70	0.00	266	0.1	60	21	10.0	124.0	150.0	297
17	Jul-10	30	767	494	8.4	0.00	10.73	3.13	0	_	0	25	12	137	62	91	NP	0.07	0.00	29.3	0.1	58	12	10.0	112.0	145.0	195
18	Aug-10	25.5	571	331	7.2	0.00	0.75	0.28	0	_	0	25	0	134	62	40	NP	0.08	0.00	26	0.1	44	10	0.0	112.0	110.0	150
19	Sep-10	30.5	250	163	8.1	0.00	1.30	0.45	0	_	0	25	3	121	25	32	NP	0.07	0.00	17	0	32	49	2.5	99.0	80.0	239
20	Oct-10	31	484	315	8.4	0.00	2.10	0.47	0	_	10	20	6	201	12.2	45	NP	0.20	0.00	26	0.1	58	56	5.0	165.0	145.0	376
21	Nov-10	28	473	307	8.2	0.00	0.00	0.88	0	_	10	10	9	179	21.7	185	NP	0.19	0.00	108	0.1	34	33	7.5	147.0	85.0	220
22	Dec-10	26	445	289	8.0	0.00	0.00	0.97	0	_	10	10	0	189	16.7	135	NP	0.20	0.00	93	0.1	45	44	0.0	155.0	113.0	294
23	Jan-11	23	475	308	8.2	0.00	1.50	0.88	0	_	10	10	9	181	21.7	188	NP	0.20	0.00	85	0.1	68	79	10.8	146.0	170.0	495
24	Feb-11	21	1119	727	7.9	0.00	0.00	0.00	0	6	10	10	15	186	71.2	391	NP	0.20	0.00	255	1.2	40	41	12.5	153.00	100.00	269
	Max	35.50	1691.00	1099.00	8.48	1.69	10.73	3.13	0.00	6.00	20.00	29.00	15.00	214.00	470.00	515.00	0.00	0.72	0.00	416.00	1.20	108.00	105.00	12.50	175.41	533.00	4211.00
	Min	21.00	250.00	163.00	7.00	0.00	0.00	0.00	0.00	6.00	0.00	0.00	0.00	121.00	0.00	32.00	0.00	0.00	0.00	17.00	0.00	25.00	4.80	0.00	99.00	62.50	119.65
	Average	29.24	851.38	541.88	7.85	0.08	1.37	0.56	0.00	6.00	8.42	10.38	5.40	170.04	61.56	234.44	0.00	0.21	0.00	162.87	0.09	57.28	43.76	4.74	139.40	160.98	470.63

STATEMENT - 8

Statement Showing Surface Water Analysis of Location No 8 : Damanganga at Vapi Railway Bridge

Sr. No.	Month	General				Nutrient			Organic matter				Major Ions				other inorganic		Micr obio-	Major Cations				Alkalinity		Hardness	
		Temp.	EC	TDS mg/l	pH	Nh_4-N mg/l	NO2-NO3 mg/l	PO_4 mg/l	BOD mg/l	COD mg/l	Do mg/l	Turbidity NTU	CO3 mg/l	HCO3 mg/l	SO_4 mg/l	CL mg/l	B mg/l	F mg/l	Coli-form	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Ph.Alkalinity mg/l	Total Alkalinity mg/l	Ca-Hardness mg/l	Total Hardness mg/l
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	Mar-09	29	10590	6880	7.2	0.00	10.71	7.46	70	270	_	7	0	665	465	4260	NP	0.00	3	3050	0	501	121	0	545	1253	1749
2	Apr-09	32	11450	7163	7.1	1.93	9.16	0.58	75	270	_	8.00	0	685	465	3088	NP	0.40	3	2516	0.1	515	120	0.0	561	1288	1780
3	May-09	34	12690	8250	6.9	2.10	8.80	2.39	72	280	_	8.00	0	650	475	3621	NP	1.00	3	2715	0.1	510	125	0	533	1313	1788
4	Jun-09	32	11390	7403	7.9	2.00	8.89	0.97	60	235	_	7.00	0	187	210	3852	NP	0.40	3	2529	0.1	572	189	0.00	535	1180	2780
5	Jul-09	30.4	2710	1587	7.9	0.20	8.90	0.96	65	240	_	7.00	0	153	180	710	NP	0.40	7	525	0.1	132	53	0.0	104	330	549
6	Aug-09	28.5	2160	1470	8.4	1.25	8.80	0.92	75	250	_	7.50	0	125	210	490	NP	0.40	7	368	0.1	64	41	0.0	481	160	329
7	Sep-09	29	2980	1937	6.5	0.00	7.56	0.55	35	220	_	7.50	0	171	256	908	NP	0.00	7	581	0.1	156	73	0.0	140	390	690
8	Oct-09	32	5920	3750	6.8	0.00	10.73	5.37	45	140	_	7.00	0	210	466	1917	NP	0.80	7	1438	0.1	146	84	0.0	170	115	255
9	Nov-09	30	10640	6916	6.7	0.00	11.73	9.07	62	200	_	5.00	0	505	372	3408	NP	0.40	7	2556	0.1	300	97	0.0	415	750	1148
10	Dec-09	32.5	10220	6643	7.7	0.00	10.74	2.72	50	210	_	5.00	0	610	466	3373	NP	0.40	3	2530	0.1	400	130	0.0	500	575	1946
11	Jan-10	35	14900	8685	7.4	0.99	10.74	1.32	60	230	_	5.00	0	259	486	3905	NP	0.42	6	2928	0.1	460	189	0.0	213	650	1428
12	Feb-10	26	12220	7943	7.2	0.00	10.73	1.52	25	130	_	15.00	0	515	415	2805	NP	0.40	5	2705	0.1	480	180	0.0	422	450	1180
13	Mar-10	28	11400	7410	7.2	0.00	10.73	1.44	60	270	3.8	15	0	475	466	3692	NP	0.40	6	2770	0.1	301	184	0	225	753	1509
14	Apr-10	33	10760	6944	7.3	0.00	10.20	1.5	75	275	4.2	15	0	447	460	3586	NP	0.41	6	2689	0.1	320	160	0.0	202	800	1048
15	May-10	34.5	11710	7612	7.7	__	12.15	1.65	70	320	3.9	15	36	232	566	3656	NP	0.61	5	2742	0.1	240	136	30	140	1350	1498
16	Jun-10	31	11380	7397	7.6	__	9.72	5.95	56	290	_	17	0	401	201	3450	NP	0.60	6	2338	0.1	282	72	0.0	328	205	501
17	Jul-10	33	1538	950	7.3	__	1.69	0.44	60	250	_	25	6	140	51.9	410	NP	0.13	7	333	0.1	278	131	5.0	115	78	222
18	Aug-10	32	971	631	7.5	__	2.16	0.83	60	240	5.6	15	0	149	55.1	305	NP	0.15	7	229	0.1	32	19	0.0	122	80	160
19	Sep-10	21.8	817	531	7.9	__	14.10	0.4	50	210	6.2	17	0	101	10	105	NP	0.13	_	72	1.2	41	31	0.0	83	103	230
20	Oct-10	33	1540	1001	7.4	__	9.40	0.6	51	255	_	15	0	375	125	344	NP	0.20	_	217	0.1	280	115	0.0	307	450	1747
21	Nov-10	28	3450	2643	8.5	2.06	8.30	0.54	67	240	_	16	0	251	176	1210	NP	_	7	907	2.4	100	94	0.0	206	500	1434
22	Dec-10	26	3745	2484	7.6	__	9.00	0.5	62	180	_	17	0	443	133	1300	NP	_	7	719	0.1	440	342	0.0	117	110	251
23	Jan-11	25	3450	2843	8.5	2.06	2.06	5.5	70	250	4.2	17	0	255	176	1427	NP	_	6	885	2.4	101	125	0.0	209	253	767
24	Feb-11	26	8650	5623	7.9	4.69	5.95	0	75	175	4.2	18	0	247	173	3373	NP	_	6	2320	0.19	191	121	0.0	203	253	751
	Max	35.00	14900.00	8685.00	8.51	4.69	14.10	9.07	75.00	320.00	6.20	25.00	36.00	685.00	566.00	4260.00	0.00	1.00	7.00	3050.00	2.40	572.00	342.00	30.00	561.00	1350.00	2780.00
	Min	21.80	817.00	531.00	6.51	0.00	1.69	0.00	25.00	130.00	3.80	5.00	0.00	101.00	10.00	105.00	0.00	0.00	3.00	72.00	0.00	32.00	19.40	0.00	83.00	78.00	160.00
	Average	30.07	7386.71	4779.00	7.50	1.02	8.87	2.22	60.42	234.58	4.59	12.13	1.75	343.79	294.13	2299.79	0.00	0.38	5.64	1694.25	0.34	285.08	122.20	1.46	286.50	557.88	1072.50

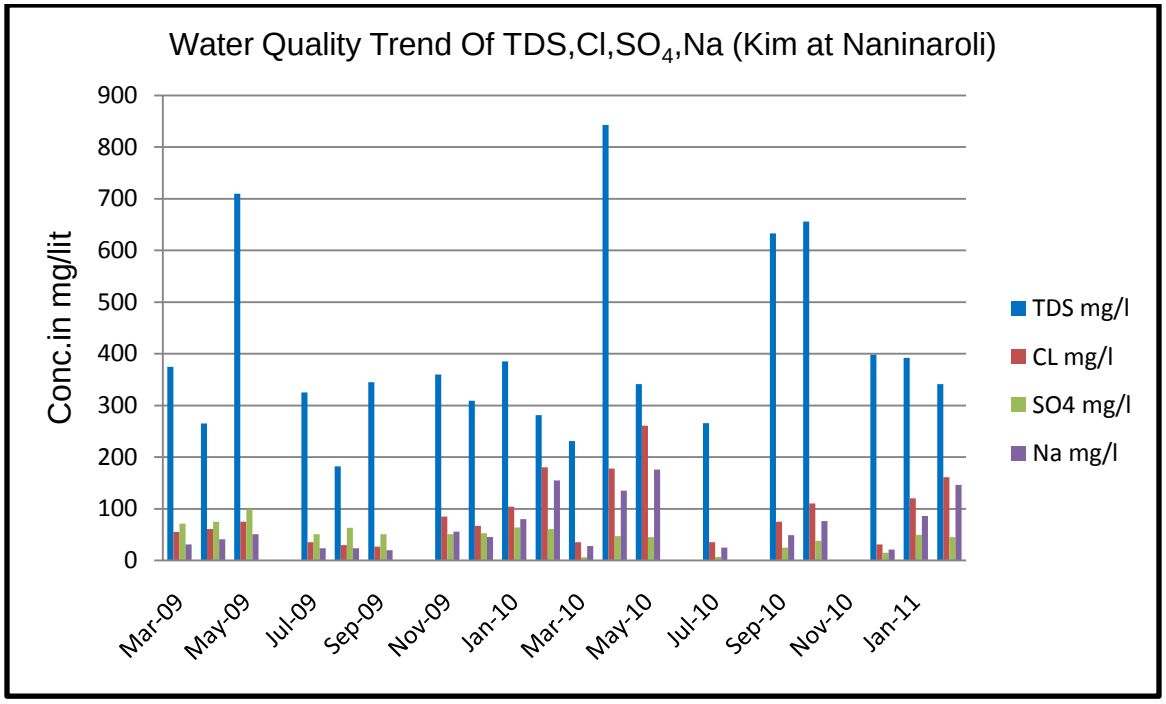
STATEMENT - 9

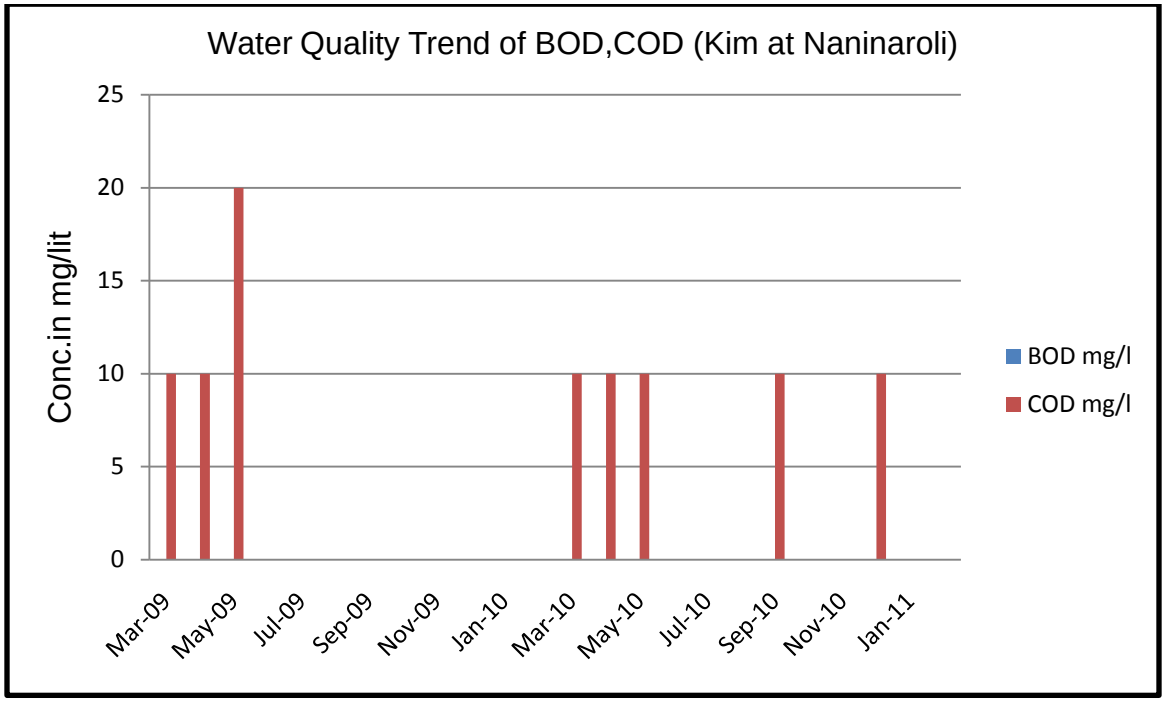
Statement Showing Surface Water Analysis of Eight Location

Sr.No.	Month	General				Nutrient			Organic matter				Major Ions				Other Inorganic		Microbio-logical	Major Cations				Alkalinity		Hardness	
		Temp.	EC	TDS mg/l	pH	Nh_4-N mg/l	NO2-NO3 mg/l	PO_4 mg/l	BOD mg/l	DO mg/l	COD mg/l	Turbidity NTU	CO3 mg/l	HCO3 mg/l	SO_4 mg/l	CL mg/l	B mg/l	F mg/l	Coliform	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Ph.Alkalinity mg/l	Total Alkalinity mg/l	Ca-Hardness mg/l	Total Hardness mg/l
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Kim at Nani Naroli	Max	35.0	1297	843	8.55	1.30	14.40	1.51	0.00	8.00	20	15	12	250	99	261	0.0	0.54	1.00	176	47	81	71	13	205	203	495
	Min	20.0	279	182	6.93	0.00	0.00	0.14	0.00	5.60	0	0	0	74	7	27	0.0	0.00	0.00	20	0	21	11	0	61	53	98
	Average	27.1	629	402	7.78	0.15	3.73	0.47	0.00	6.28	5	6	1	166	48	91	0.0	0.14	0.05	67	3	46	34	2	138	114	253
Purna	Max	36.0	17780	11557	8.70	2.90	11.80	5.37	0.00	8.00	20	125	42	395	366	9479	0.0	0.41	0.00	7109	0	248	210	25	324	683	1477
	Min	20.5	418	272	7.47	0.00	0.00	0.01	0.00	8.00	0	12	0	137	2	45	0.0	0.13	0.00	25	0	20	16	0	112	50	150
	Average	28.5	3299	2146	8.01	0.38	3.34	1.05	0.00	8.00	9	65	8	265	113	1359	0.0	0.26	0.00	1008	0	108	72	6	219	249	539
Tapi	Max	35.0	49700	32305	8.61	2.94	25.4	2.254	35.00	7.86	72	115	30	610	466	18105	0.0	0.50	0.00	13579	30	460	650	25	1876	1150	3186
	Min	18.5	415	270	6.7	0	0.141	0.15	0.00	0.00	10	10	0	151	28	130	0.0	0.12	0.00	66	0	28	12	0	124	70	198
	Average	29.1	24465	15885	7.39	0.33	5.07	0.65	8.46	3.93	41	53	6	312	249	8357	0.0	0.27	0.00	6153	2	228	136	4	346	566	1262
Lilapur	Max	35.0	54800	35670	8.52	4.00	46.70	1.67	10.00	6.00	30	71	42	478	473	19479	0.0	0.43	0.00	17448	0	440	254	41	392	1100	1848
	Min	17.0	168	107	6.35	0.00	0.14	0.00	0.00	0.00	0	10	0	125	7	30	0.0	0.00	0.00	19	0	16	17	0	102	40	120
	Average	27.7	20778	13373	7.58	1.89	8.19	0.56	0.67	3.00	10	35	6	231	279	7206	0.0	0.24	0.00	5590	0	239	96	7	194	550	917
Abrama	Max	35.5	74840	49340	8.43	3.31	15.60	1.68	70.00	6.20	150	135	36	966	830	18697	0.0	0.40	2.00	13523	2	610	380	30	1611	1525	2776
	Min	17.5	156	101	6.91	0.00	0.18	0.00	0.00	6.20	7	11	0	105	13	25	0.0	0.00	0.00	18	0	21	0	0	86	53	93
	Average	27.1	20392	13206	7.63	0.64	7.64	0.44	24.44	6.20	60	92	4	359	268	6153	0.0	0.24	0.08	4083	0	290	106	3	323	645	1130
Par	Max	36.0	67300	43745	8.30	8.77	27.30	3.03	70.00	8.20	210	110	12	885	466	25560	NP	0.40	0.00	19170	4	588	217	11	725	1470	1964
	Min	22.0	146	95	5.59	0.00	0.00	0.08	0.00	8.20	6	14	0	98	4	12	NP	0.07	0.00	7	0	15	7	0	80	38	64
	Average	29.5	23899	15640	7.28	0.42	4.99	0.45	26.21	8.20	82	38	3	330	226	9739	NP	0.28	0.00	6967	0	211	126	2	264	502	1045
Kolak	Max	35.5	1691	1099	8.48	1.69	10.73	3.13	0.00	6.00	20	29	15	214	470	515	0.0	0.72	0.00	416	1	108	105	13	175	533	4211
	Min	21.0	250	163	7.00	0.00	0.00	0.00	0.00	6.00	0	0	0	121	0	32	0.0	0.00	0.00	17	0	25	5	0	99	63	120
	Average	29.2	851	542	7.85	0.08	1.37	0.56	0.00	6.00	8	10	5	170	62	234	0.0	0.21	0.00	163	0	57	44	5	139	161	471
Damanganga	Max	35.0	14900	8685	8.51	4.69	14.10	9.07	75.00	6.20	320	25	36	685	566	4260	0.0	1.00	7.00	3050	2	572	342	30	561	1350	2780
	Min	21.8	817	531	6.51	0.00	1.69	0.00	25.00	3.80	130	5	0	101	10	105	0.0	0.00	3.00	72	0	32	19	0	83	78	160
	Average	30.1	7387	4779	7.50	1.02	8.87	2.22	60.42	4.59	235	12	2	344	294	2300	0.0	0.38	5.64	1694	0	285	122	1	287	558	1073

Graph 1A ,1B

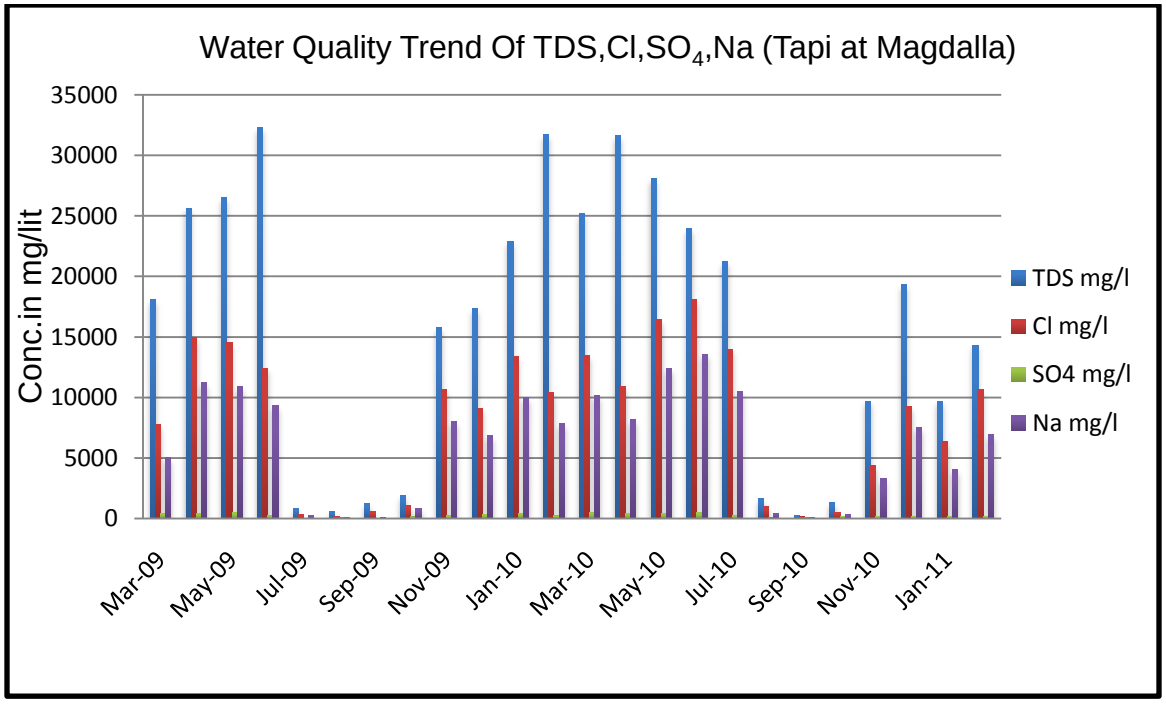
Surface water quality graph for location Kim at Naninaroli

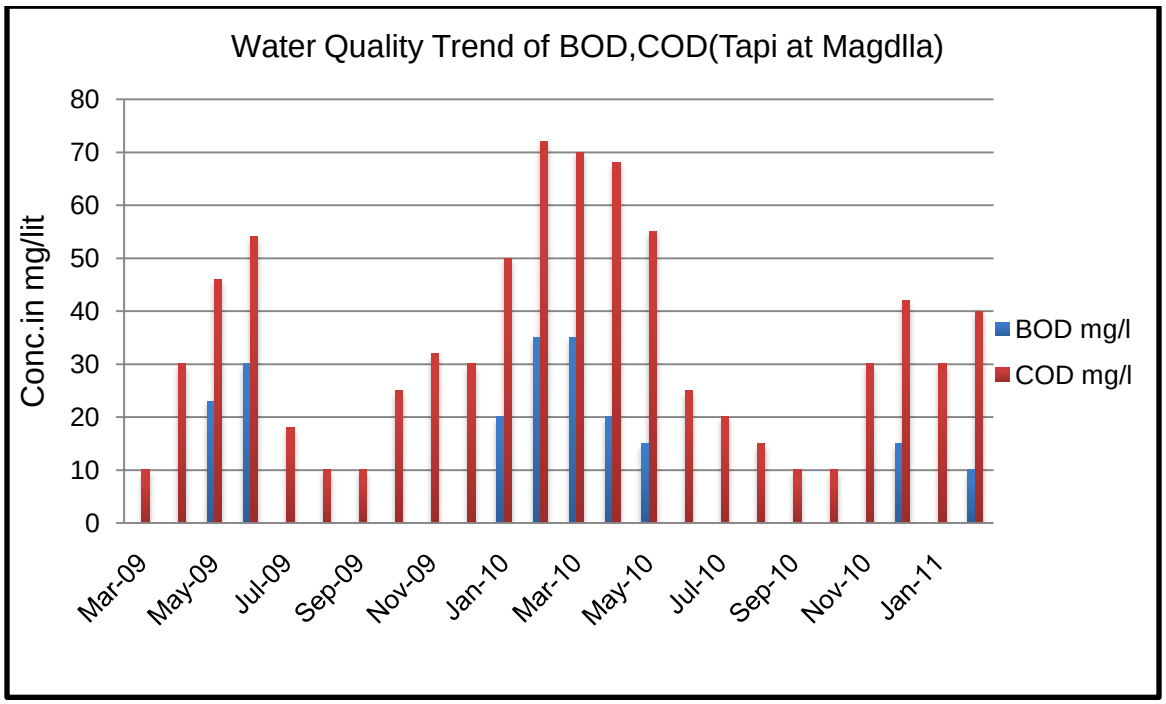




Graph 2A ,2B

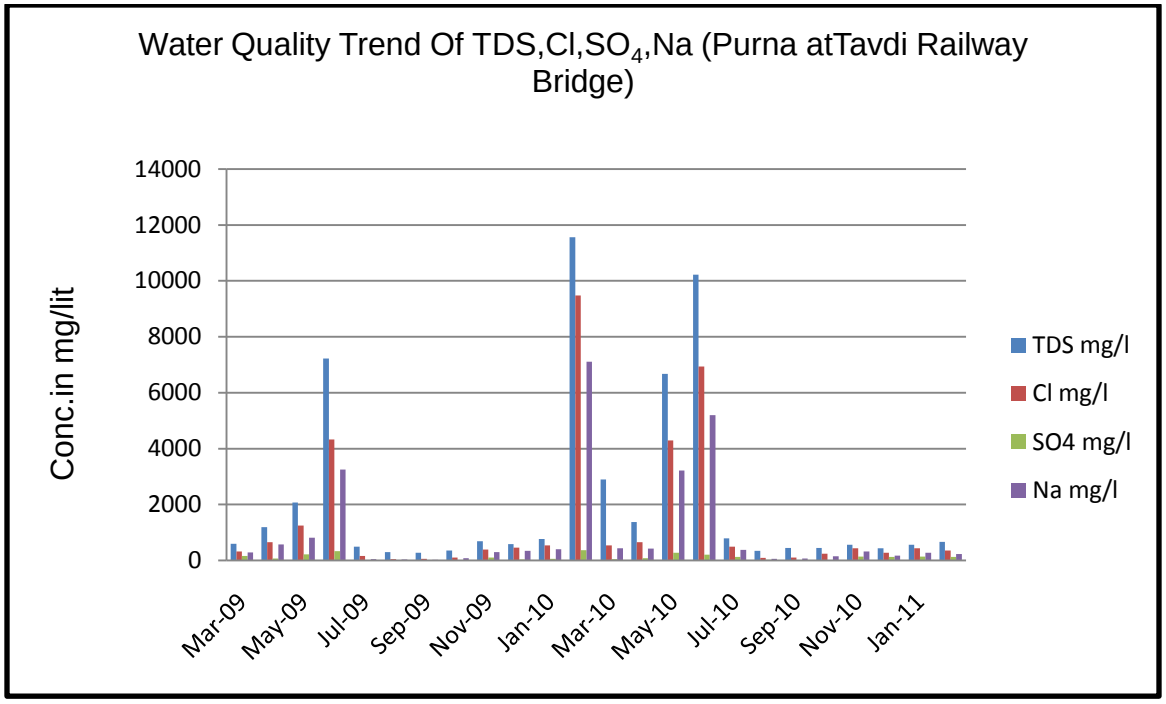
Surface water quality graph for location Tapi at Magdalla

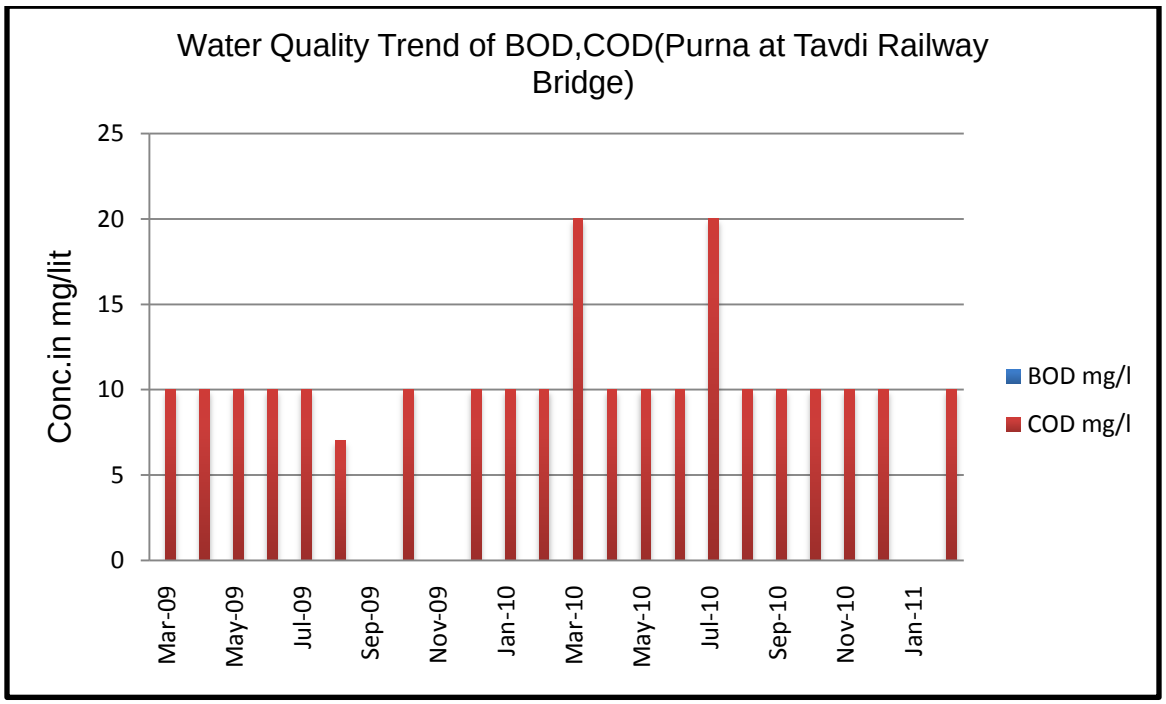




Graph 3A ,3B

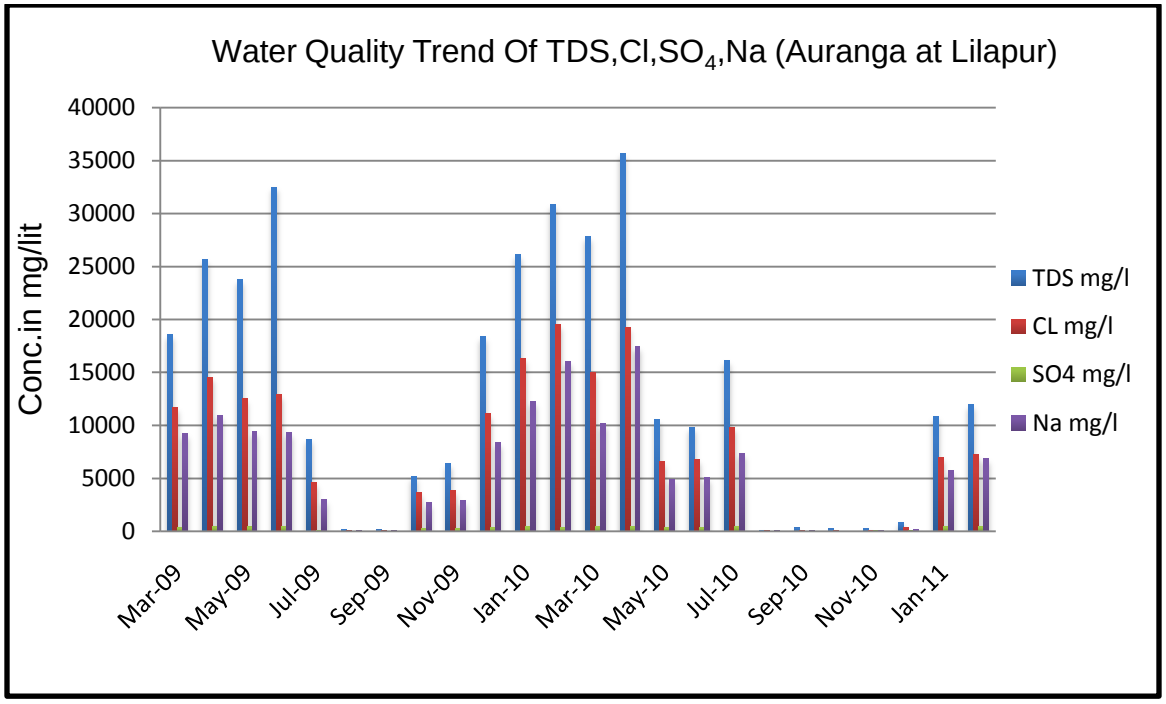
Surface water quality graph for location Purna at Tavdi Railway Bridge

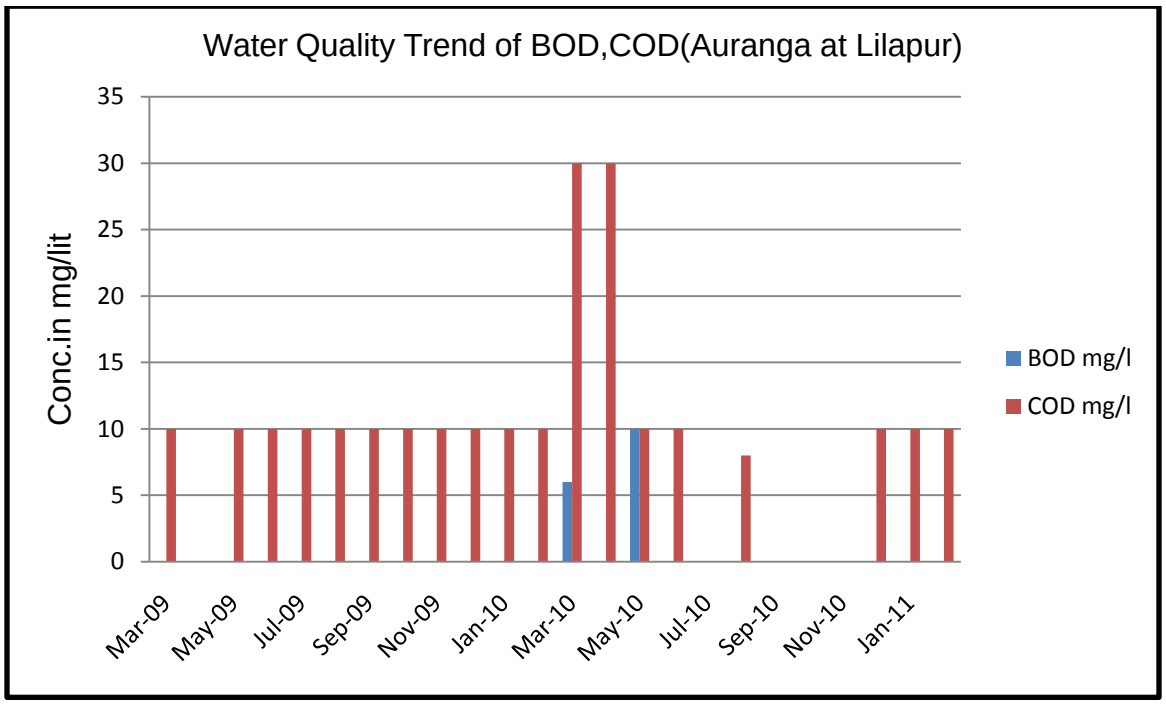




Graph 4A ,4B

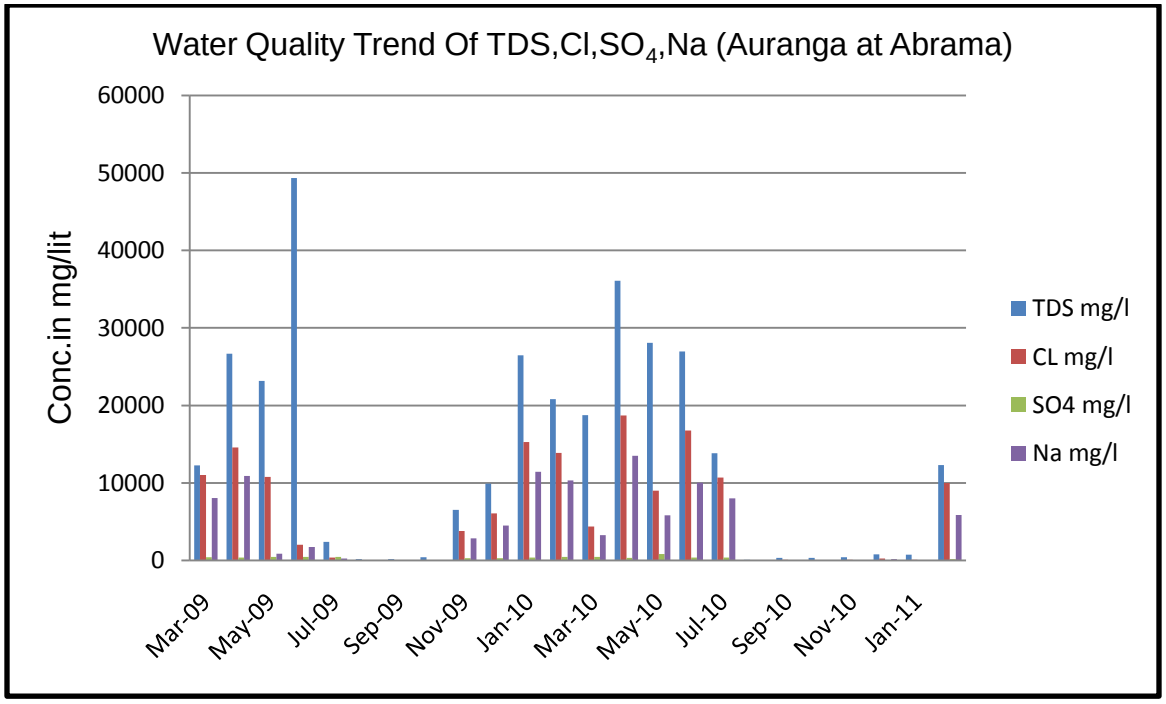
Surface water quality graph for location Auranga at Lilapur

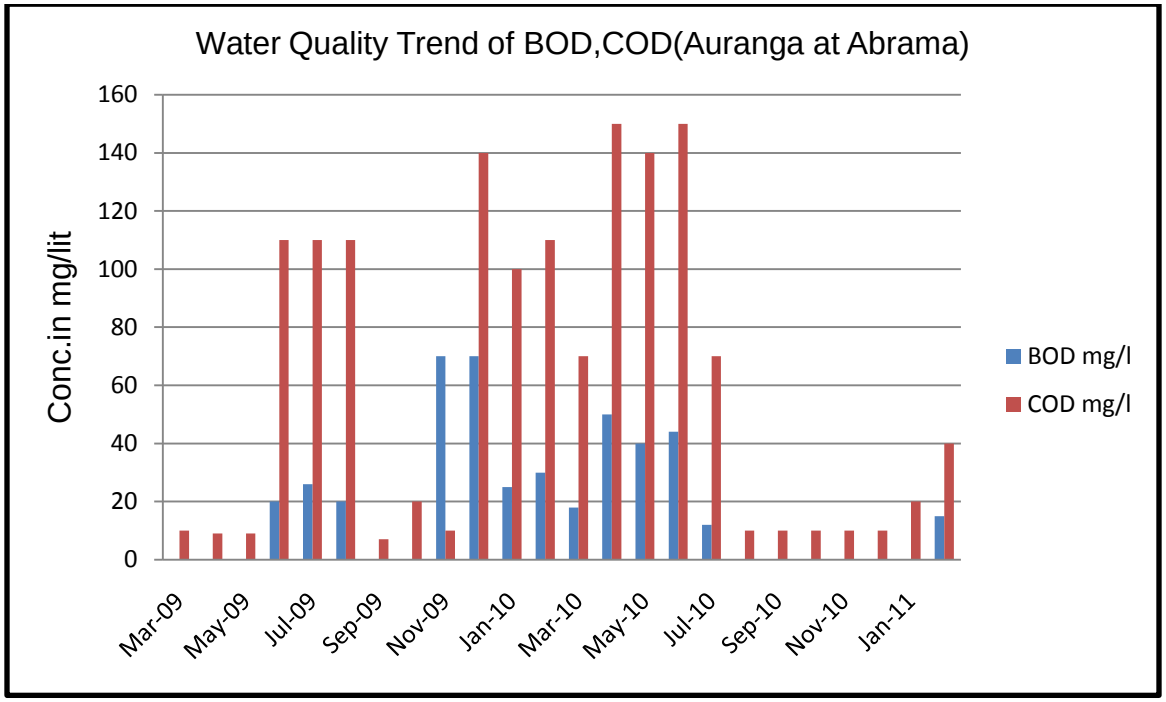




Graph 5A ,5B

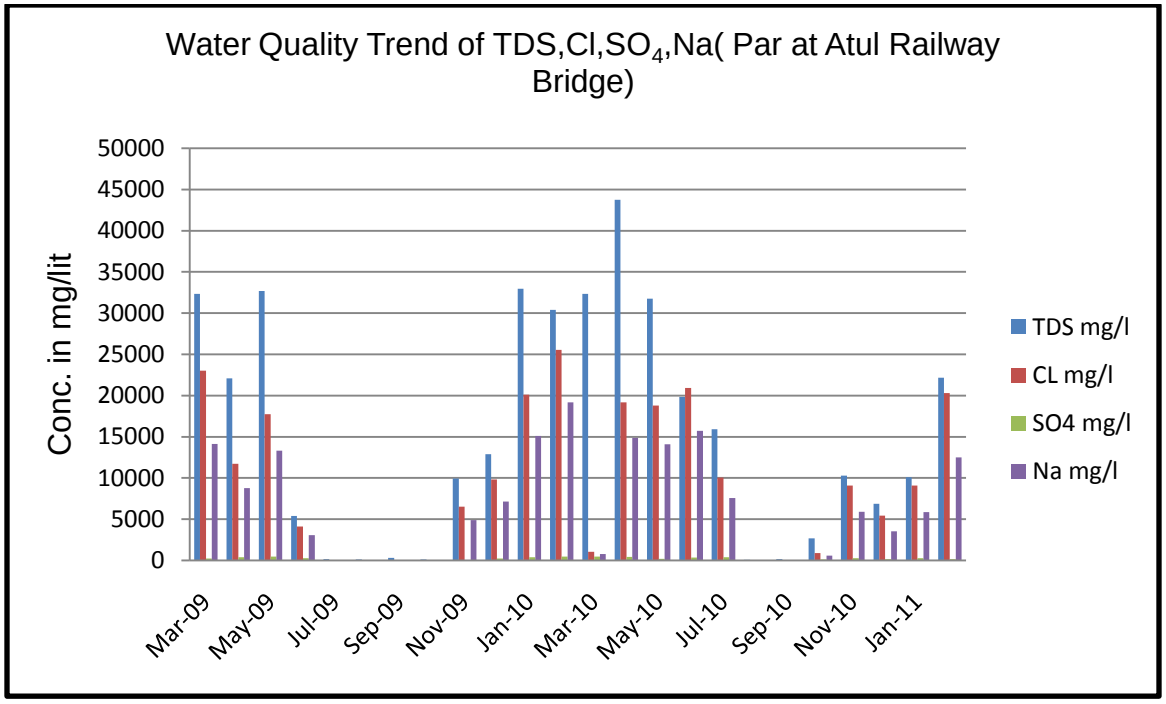
Surface water quality graph for location Auranga at Abrama

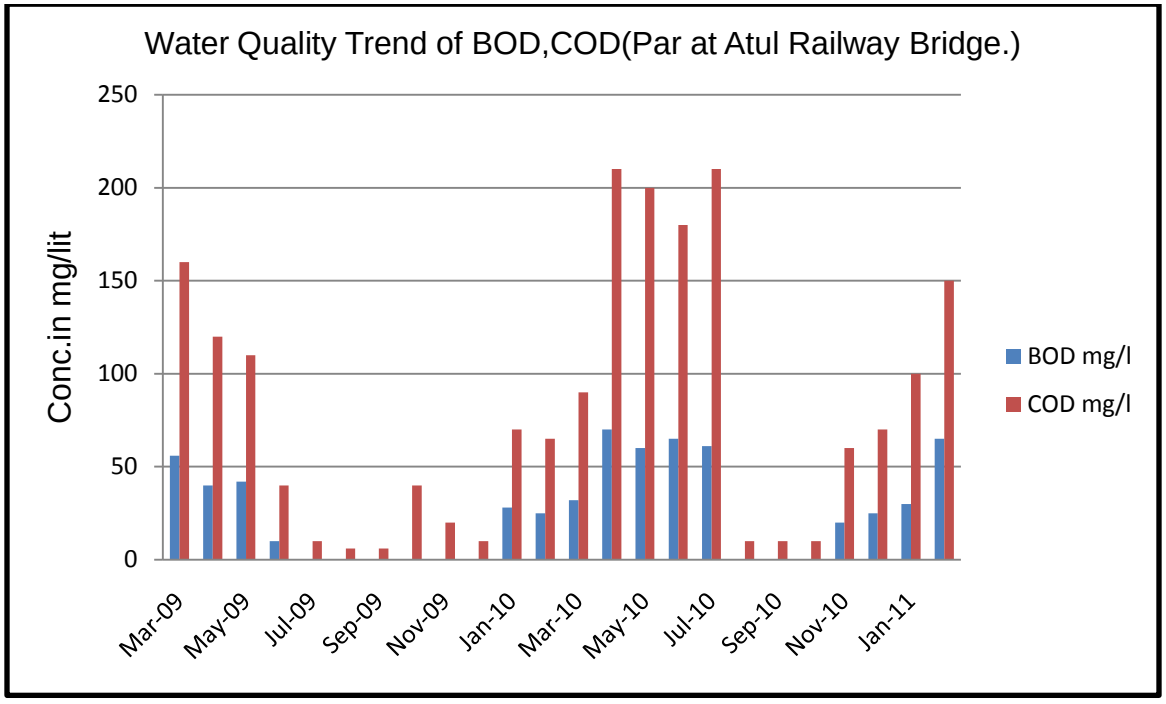




Graph 6A ,6B

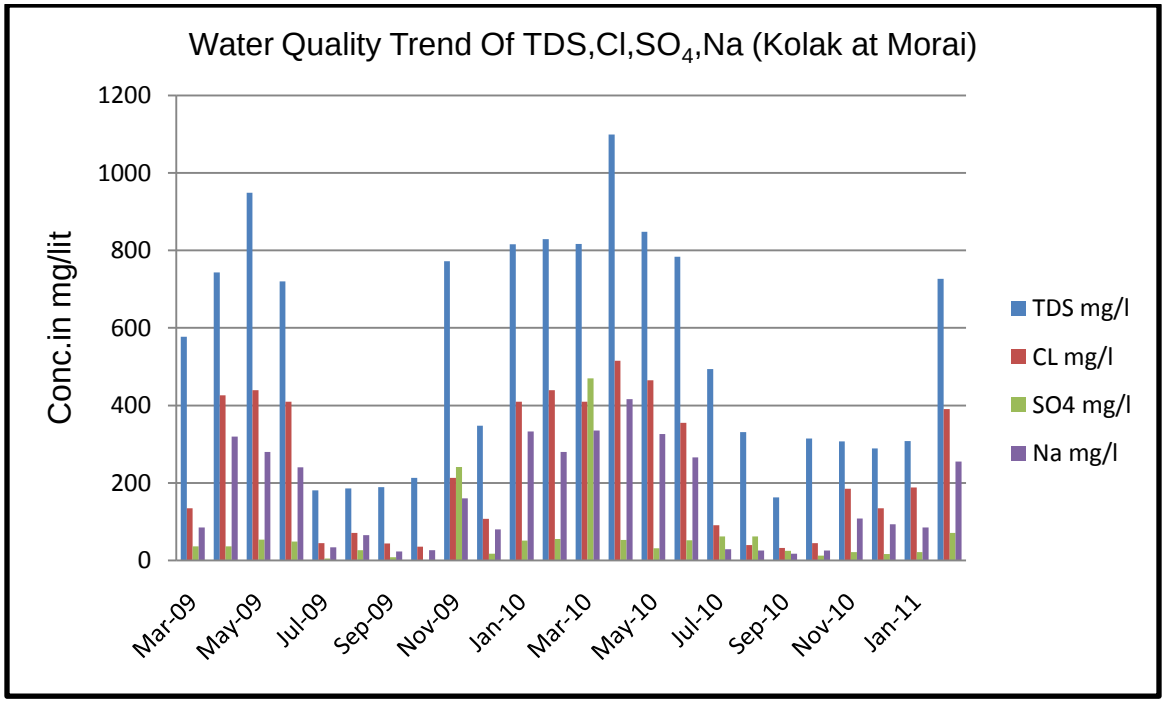
Surface water quality graph for location Par at Atul Railway Bridge.

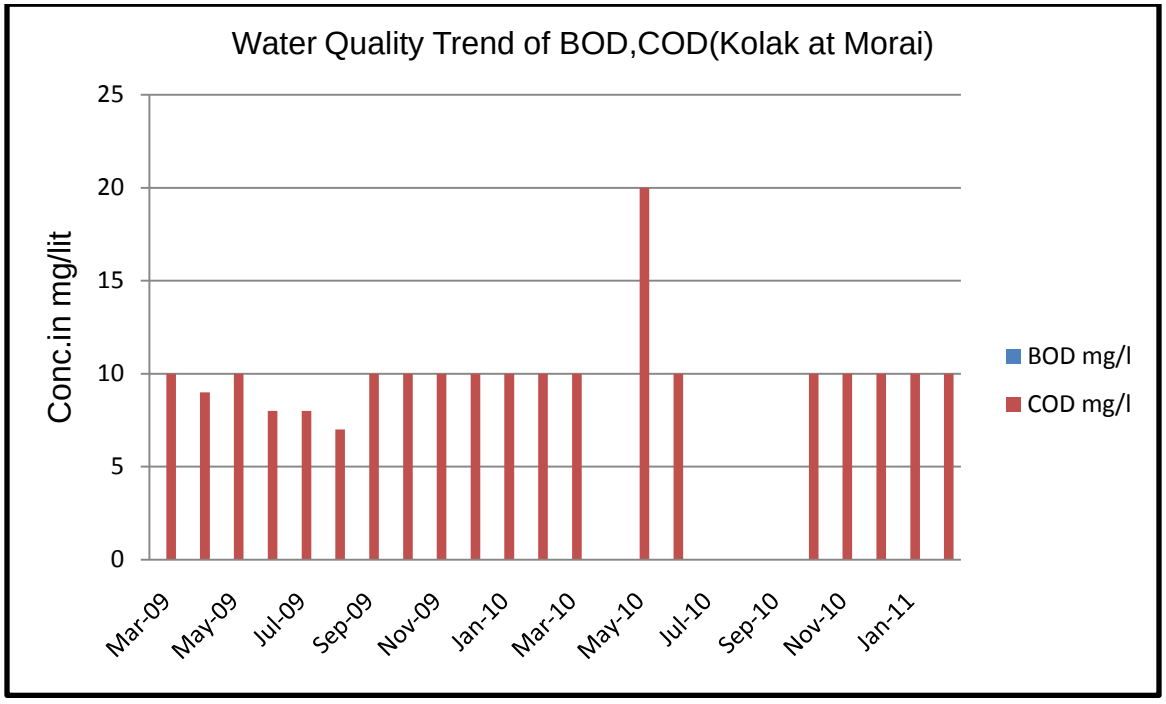




Graph 7A ,7B

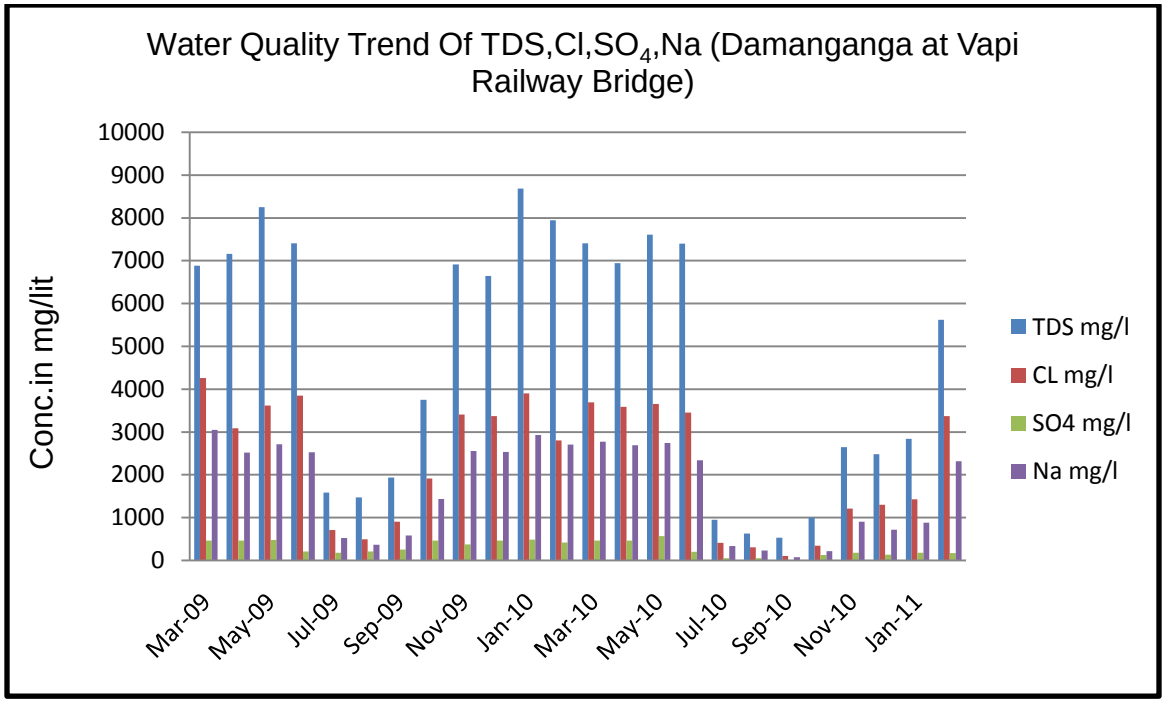
Surface water quality graph for location Kolak at Morai

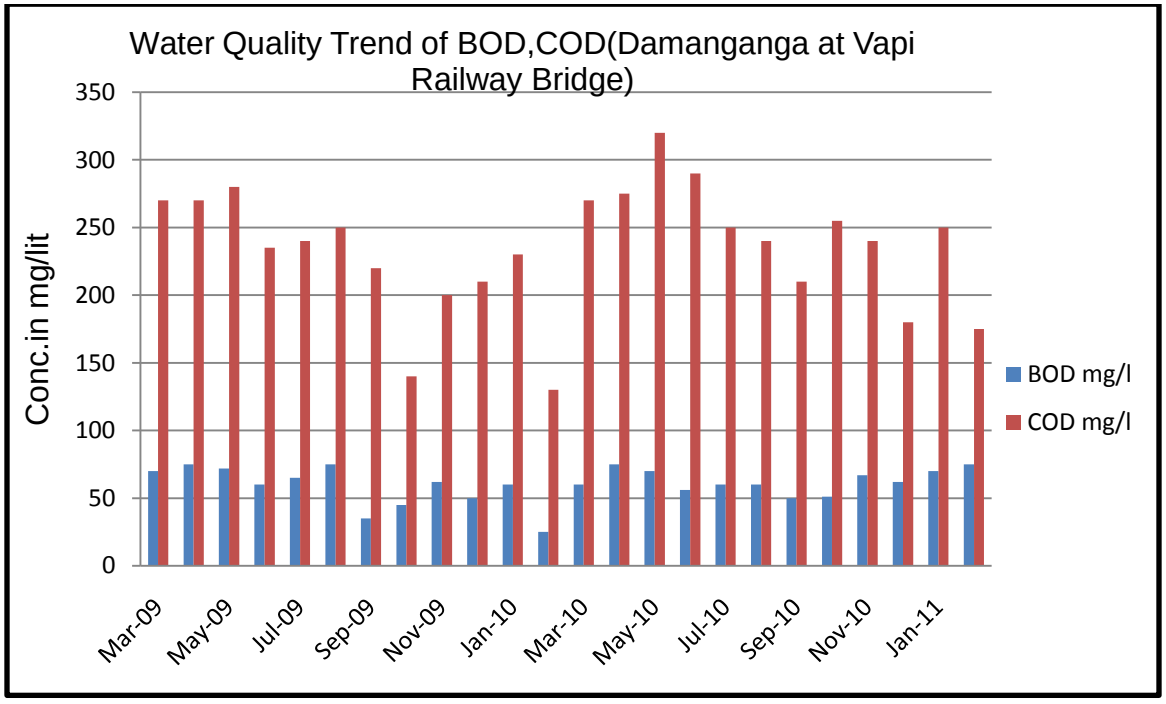




Graph 8A ,8B

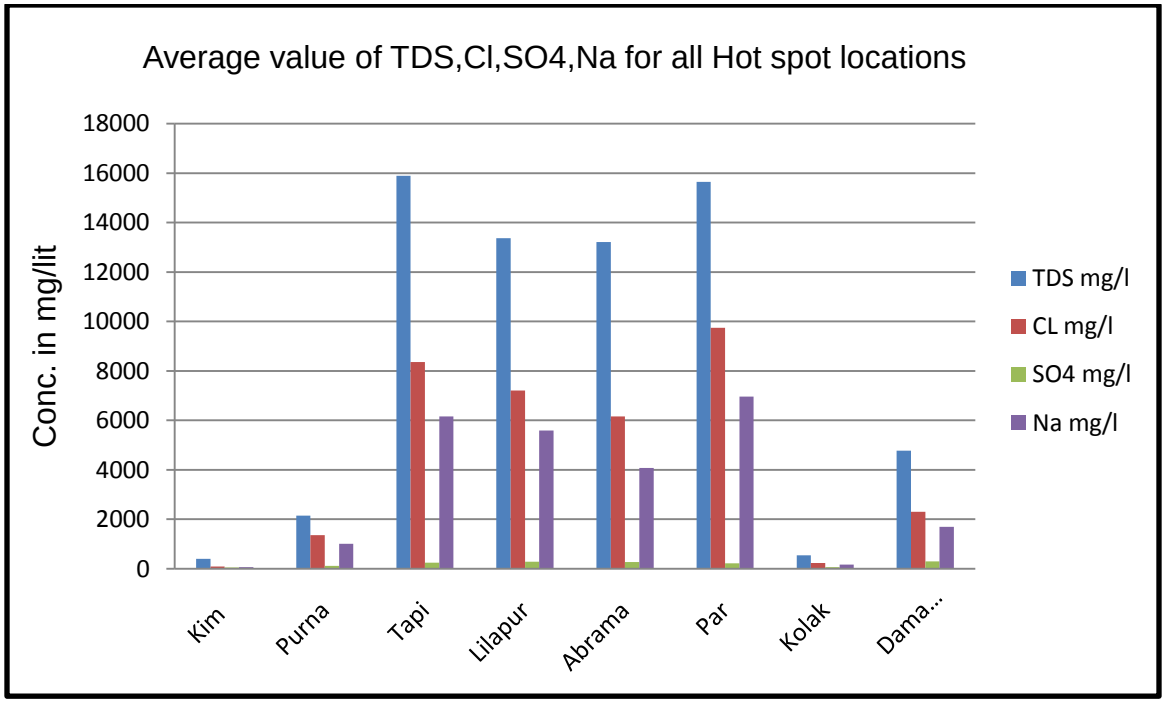
Surface water quality graph for location Damanganga at Vapi Railway Bridge

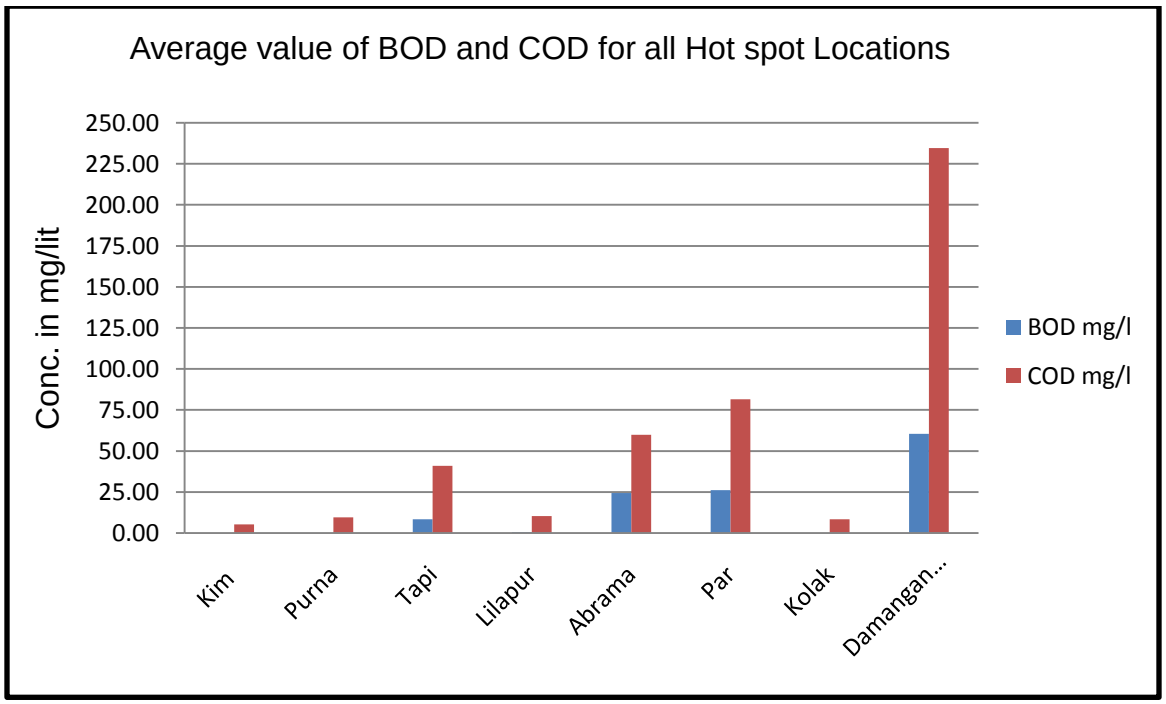




Graph 9A ,9B

Surface water quality graph for all Hot spots locations





Chapter 3

Observations And Findings

3.1 RIVER WATER QUALITY OF HOTSPOT

The river water quality monitoring is most essential aspect for restoring the water quality. One of the main objectives of the river water quality monitoring is to assess the suitability of river water for drinking purposes, irrigation, outdoor bathing and propagation of wildlife, fisheries. The physical and chemical quality of river water is important in deciding its suitability for drinking purposes. As such the suitability of river water for potable uses with regard to its chemical quality has to be deciphered and defined on the basis of the some vital characteristics of the water. Bureau of Indian Standards (BIS) vide its document IS: 10500:1991, Water Quality standards in India IS: 2296:1982 has recommended the quality standards for drinking water and Designated best use of water have been used for finding the suitability of river water. Based on this classification, the natural river water of India has been categorized as desirable, permissible and unfit for human consumption.

River water quality is very important aspect in India. The physico-chemical parameters like pH, TDS, Chloride, Fluoride, Iron, Nitrate, Sulphate, Total hardness, Calcium and Magnesium are main constituents defining the quality of river water in surface water.

The study reveals that the temperature has direct effect on certain parameters due to chemical activities. Since the Gujarat is hot and semi -arid region the temperature of study sites ranges between 10℃ in January to 32+c in May. The temperature gradually increases from the month of March till the onset of monsoon season in July and gradually decreases from the rainy season to the post monsoon months. The rise in temperature could be due to shorter winter period less intense than summer.

3.2 OBSERVATIONS AND FINDINGS

The parameters are tested as per standard analytical procedures described under methodology and are enlisted from Statement No. 1 to 8 for 8 locations, Statement No. 9 for Abstract of Hot spot locations.

TDS, Chloride, Sulphate, Na are represented in graphical form from Graph No. 1 A to 8 A. BOD and COD are represented in graphical form from graph 1B to 8 B. The over all findings for the above parameters for eight locations are represented in graphs 9 A and 9 B.

3.3 PARAMETERS ANALYSIS FOR SURFACE WATER

1. 0 pH

pH is the scale of intensity of acidity and alkalinity of water and measures the concentration of hydrogen ions. In the present study the mean values of pH at all the eight sites of river ranges between 6.5- 8.7 which is in accordance with the prescribed limit of 6.5-8.5.At the location of par at Atul Rly Bridge once the pH value observed low up to 5.6 which may be due to contamination of acidic water coming from industries.

2. 0 DO

Dissolved oxygen (DO) is required to maintain the health of aquatic ecosystems. It is very crucial for the survival of aquatic organisms and it is also used to evaluate the degree of freshness of river. It oxidizes many sources of objectionable tastes and odors. Oxygen becomes dissolved in surface waters by diffusion from the atmosphere and from aquatic–plant photosynthesis. As per prescribed limit of Designated best use as per CPCB, the value of DO should not be less than 4mg/l for propagation of aquatic life. In the present study the average value of DO ranges between 6mg/l to 8mg/l for most of the locations, which indicates good quality of surface water. At Vapi rly bridge location, the average and minimum value of DO are 4.6mg/l and 3.8mg/lit due to discharge of substantial amount of human and industrial waste in to the river.

3.0 COD And BOD

COD is a measure of oxygen equivalent to the organic matter content of the water susceptible to oxidation.COD is used to determine degree of pollution

in water bodies and their self purification capacity. In the present study, Kim at Nani naroli and Kolak at Morai, the value of COD are very less up to 10 to 20mg/l which indicates less pollution loads in the surface water. Auranga at Abrama, Par at Atul rly Bridge and Damanganga at Vapi railway Bridge are locations containing very high value of COD up to 150mg/l, 210mg/l and 320mg/l. There are several chemical and dyes industries situated in the vicinity of river basin. This might be due to the discharge of industrial waste in the river. Water observed is very thick, muddy and black in colour.

Biochemical oxygen demand (BOD) is usually defined as the amount of oxygen required by bacteria while stabilizing decomposable organic matter under aerobic conditions. It is widely used to determine the pollution strength of domestic and industrial wastes in terms of the oxygen. The test is one of the most important in stream- pollution- control activities. When COD values are very low in the fresh water region, the BOD values are not required to be monitored. It is required only when the water is highly polluted or COD values are high which may affect the aquatic life. In the present study, the maximum value of BOD at Auranga at Abrama, Par at Atul rly Bridge and Damanganga at Vapi railway Bridge are 70mg/l, 70mg/l and 75mg/l. Higher value of BOD indicates higher pollution load due to pollution i.e. discharge from industries and sewage. At the location of Kim at Naninaroli, Purna at Tavdi rly bridge and Kolak at morai the BOD value observed is almost nil.

4.0 TDS

TDS value is low in the fresh water zone that is at Kim at Naninaroli(182 to 843mg/l) and Kolak at Morai (163 to 543 mg/l), while at other locations Tapi @ Magdalla, Purna at Tavadi rly Br, Auranga at Lilapur,Auranga at Abrama, Par at Atul Rly Br, Damanganga at Vapi rly Bridge have the high value of TDS due to increases in industrialization and urbanization waste. In this study the primary source for high TDS level in river water may be due to salinity which ingress in the river. Other sources for high TDS may be due to pollution i.e. discharge from industries and sewage. The average value of TDS at Purna at Tavadi rly Bridge (2146mg/), Auranga at Lilapur (13373mg/l) and Damanganga at Vapi Rly.

Bridge (4779mg/l), is mainly due to industrial and domestic pollution in the vicinity. Auranga at Abrama (13206mg/), Par at Atul Rly Bridge (15640mg/l), and Tapi at Magdalla (15885mg/l) contain high TDS due to tidal effect in the river in rainy season, TDS value is reduced drastically due to dilution effect of rain water and vise-a-versa in summer it increases due to high evaporation effect which may increase the concentration of TDS in river water.

5.0 Calcium and Magnesium

Calcium and Magnesium are most common constitutes of natural water, arising mostly from dissolution of minerals. Water hardness is caused by the presence of dissolved calcium and magnesium all of which form insoluble precipitates with soaps. Magnesium form salt with chlorides and mainly remains present as $MgCl_2$. It may also remain present with phosphate, sulphate and Nitrates. At Kim at Naninaroli and Kolak at Morai, the values of Calcium and Magnesium observed are very less compare to other locations. The average value of Calcium of both locations are 46.11mg/l and 57.28mg/l, and the average value of magnesium are 34.43mg/l and 43.76mg/l respectively.Locations Tapi @ Magdalla, Purna at Tavadi rly Br, Auranga at Lilapur,Auranga at Abrama, Par at Atul Rly Br, @ Damanganga at Vapi rly Bridge have the high value of calcium and Magnesium due to industrial and urban waste. The average value of Calcium and Magnesium at Auranga at Abrama are 290.31mg/l and 106.18mg/l and at Damanganga Vapi Railway Bridge are 285.08mg/l and 122.20mg/l.

6.0 Chloride

Chlorides are widely distributed in nature, usually in the form of sodium, potassium, and calcium salts (NaCl, KCl, and $CaCl_2$), although many minerals contain small amounts of chloride as an impurity. The presence of chloride in surface water can be attributed to the dissolution of salt deposits, effluents from chemical industries, sewage, irrigation drainage, refuse leachates, sea spray and seawater intrusion in coastal areas. High chloride value in river water may not produce any crucial effect on aquatic life, but its effect can be seen while using the river water for other purpose such as Domestic, Industrial and Irrigation. In the present study, Kim

at Nani naroli (90.8mg/l) and Kolak at Morai (234mg/l) contains desired amount of Chloride as there are no pollution and no sea water effect can be seen. The highest average value of Chloride observed at Par at Atul Rly Bridge (9739mg/l) and Tapi at Magdalla(8357mg/l) due to combined effect of industrial pollution and saline water.

7.0 Sulphate and Phosphate

The sulfate anion (SO_4^{-2}) is stable and oxidized form of sulfur. Sulfate minerals are widely distributed in nature, and most sulfate compounds are readily soluble in water. In the river the sulfate load arises from mineral weathering , biochemical and anthropogenic sources, Industrial discharges, agricultural runoff from fertilized lands, pulp and paper mills, textile mills, tanneries, sulfuric acid production, and metal- working industries are all sources of sulfate in surface water. In the present study, the average sulphate value of Kim at Nani naroli and Kolak at Morai are 48mg/l and 62mg/l. For other stations average value varies from Purna at Tavadi RLY bridge(113mg/l) to Damanganga at Vapi Rly Bridge(294mg/l).

Phosphate is present in natural waters as soluble phosphates and organic phosphates. It is contributed due to human wastes and use of synthetic detergents. Excessive amount of phosphate and nitrates promote plant growth which ultimately depletes DO in water. The oxygen depletion can reduce the populations of indigenous fish and other oxygen-consuming organisms. In the present study, The average value of phosphate varies from 0.44mg/l to 2.22mg/l to river water. The maximum value of phosphate in Kim at Naninaroli are observed up to 1.51mg/l due to excessive use of detergent from urban areas. Also Damanganga at Vapi railway bridge contain maximum value of phosphate up to 9.07mg/l due to discharge of industrial waste water.

8.0 Ammonical Nitrogen and Nitrates

Ammonical Nitrogen is mainly the conversion of organic nitrogen. In aerobic conditions, ammonical Nitrogen is oxidized and convert in to Nitrate. It is highly soluble in water and remain in water until consumed by plants or other organisms. The main source of nitrate are potassium nitrate and

ammonium nitrate. Both salts are used mainly as fertilizers. Ammonium nitrate is also used in explosives and blasting agents. The Oxidation of ammonical nitrogen to Nitrates may reduced the DO level in water. In the present study, The average value of Ammonical nitrogen are varies between 0.15mg/l to 1.89mg/l. In the entire stretch the concentration of Ammonical Nitrogen is found only once at highest level . i.e. 8.7 mg/l that too only once during the entire scheme at Par at Atul railway Bridge location in April 2009, this may be due to mere coincidence of untreated discharge from the industry. The average value of Nitrates varies between 1.37mg/l at Kolak at Morai to 8.87mg/l at Damanganga at Vapi Rly Bridge.

9.0 Fluoride

High fluoride content in water causes mottled enamel (dental fluorosis) i.e. disfigurement in the teeth. Low fluoride in water supplies results in dental caries. was observed that fluoride is not a cause of worry so far as the surface water is concern. The maximum value observed was 0.72 mg/l at Kolak at morai location in May 2010. However this value is within the permissible limit of drinking water standards.

10.0 Heavy Metals

Statement showing the location wise Value of Heavy metals for the Period from March 2009 to Feb 2011.

TABLE – 3.1

Sr No	Location	Ni ppm	Cu ppm	Zn ppm	Cr ppm	Se ppm	Mn ppm	Pb ppm	Cd Ppm
1	Damanganga @Vapi Rly Bridge	0	0.05	2.04	0.05	0.41	1.49	0.16	0.07
2	Par @ Atul Rly Bridge	0	0.25	2.23	0.07	nil	2.52	0.19	0.09
3	Auranga@Abrama	0	0.03	2.62	0.03	0.0	0.28	4	0.05
4	Auranga@Lilapur	0	0.05	0.04	0.02	0.93	1.19	0.11	0.05
5	Purna@Tavadi Rly Bridge	0.05	0.09	2.21	0.05	0.98	1.29	0.14	0.07
6	Tapi@Magdalla	0	0.35	2.0	0.04	0.55	0.91	0	0.05

Various heavy metals were tested for 6 critical locations where there was a probability of presence of heavy metals due to industrial pollution. As per observation of other parameters, Kim at Nani Naroli and Kolak at Morai are within the fresh water stretch where the chances of presence of heavy metals are almost BDL due to absence of industrial pollution.

In the present study, the value of Nickel is nil in all location except Purna at Tavadi Rly Bridge where the Nickel value observed up to 0.05mg/l.

Copper is extremely toxic to micro fauna and algae. The value of Copper ranges between 0.03ppm to 0.35ppm for all 6 locations which are within the permissible limit of 1.5ppm prescribed by designated best use by CPCB.

The value of Zinc for all locations varies between 0.04ppm to 2.62ppm which are within the permissible limit of 15ppm.High Concentration of Zinc imparts undesirable taste of water.

The value of chromium at Par at Rly bridge observed is 0.07ppm which is more than the permissible limit of 0.05ppm. For all other locations, chromium content observed are within the permissible limit.

The observed value of Selenium is nil at Par at Atul Rly Bridge and Auranga at Abrama locations and at other locations selenium is high amount up to 0.98ppm at Purna at Tavdi Rly Bridge which is much higher than permissible limit of 0.01ppm.

The minimum value of Manganese observed is 0.28ppm at Auranga at Abrama which is within permissible limit of 0.5ppm. Other locations contains high amount of Manganese up to maximum value is 2.52ppm at Par at Atul Rly Bridge.

The miniumum value of lead is 0 ppm at Tapi at Magdalla and maximum value is 4 at Auranga at Abrama. For other locations contain amount of lead ranges from 0.11ppm to 0.19ppm which are higher than the permissible value of lead of 0.1 ppm.

The value of Cadmium observed ranges between 0.05 ppm to 0.09 ppm which is also higher than the permissible value of 0.01ppm.

Chapter – 4
Results and Conclusions

4.1 RIVER WATER POLLUTION

Rivers are our lifeline and we all have the responsibility of preserving it, to make our development and consequently quality of life sustainable. Pollution of rivers does not mean that they are polluted from its source to mouth, but there are stretches in some rivers which are polluted and actions are being taken by the Government to bring these stretches to acceptable conditions.

The major sources of pollution from industries, agriculture and domestic are concentrated along the rivers. Industries and cities havehistorically been located along rivers because the rivers provide transportation and havetraditionally been a convenient place to discharge waste. Agricultural activities areconcentrated near rivers, because river floo dplains areexceptionally fertile due to the many nutrients that are deposited in the soil when the river overflows.

4.2 SOURCE OF POLLUTION

Due to the fast pace of industrialization and urbanization a lot of effluent and sewage is being generated, for a major portion of which there are inadequate capacity effluent treatments. This has resulted in discharge of this sewage in to the rivers in the form of untreated or only partially treated. . Examples of such pollutants include chromium, zinc, lead, copper, cadmium and nickel. These substances may enter the water in such high concentrations that fish and other animals are killed immediately. Sometimes the pollutants enter a food chain and accumulate until they reach toxic levels, eventually killing birds, fish and mammals.

Farmers put fertilizers and pesticides on their crops for them to grow better. These fertilizers and pesticides can be washed through the soil by rain, to end up in rivers. If large amounts of fertilizers or farm waste drain into a river the concentration of nitrate and phosphate in the water increases considerably. Algae use these substances to grow and multiply rapidly turning the water green. This massive

growth of algae, called eutrophication, leads to pollution. When the algae die they are broken down by the action of the bacteria which quickly multiply, using up all the oxygen in the water which leads to the death of many animals.

Besides this rampant use of fertilizers and pesticides, open defecation, Industrial waste, lack of solid waste management practices contributes to surface water pollution.

4.3 WATER QUALITY OF ALL HOTSPOT LOCATIONS:

a) Kim at Naninaroli

This location falls under fresh water zone. The water can be used for drinking and irrigation purpose.

b) Tapi at Magdalla

Water is Polluted due to industries and Salinity ingress as this it is located near Arabian Sea.Due to heavy growth of industries such as textile, chemical and petrochemical industries ,and urbanization of Surat city, water quality pollution is increased in the river. This location can be classify as polluted –saline zone.

c) Purna at Tavdi railway bridge

Water quality deteriorates mainly due to salinity ingress as this location is near the vicinity of Arabian Sea. During the tidal effect, there is an increase the value of TDS other solids. Industries such as drugs and pharmaceuticals, sugar, textile also has deteriorated the surface water quality. Water can be classify as polluted –saline zone.

d) Auranga at Lilapur And Auranga at Abrama

The Auranga is heavily polluted river as it receives the wastewater from a large industrial complexes at Valsad town and nearby industrial areas. The location of Auranga at Lilapur is in the vicinity of Arabian sea hence high TDS values are observed due to back water effect of sea compare to Lilapur, Abrama is located away from the sea. several chemical industries located in the vicinity. Industrial waste is discharge in the river resulting heavy pollution.

e) Par @ Atul Rly. Bridge

There are many dyes and chemical factories situated in the vicinity. Pollution is mainly due to discharge of waste water from industries and tidal effect of Arabian sea.

f) Kolak at Morai

This location is away from the Arabian sea as no tidal effect can be seen. The water quality deteriorates is mainly due to industrial and domestic pollution.

g) Damanganga at Vapi Railway Bridge

This location is situated in the vicinity of Vapi GIDC. CETP one of Asia's largest effluent treatment plant is located here. Medium and major industries ofdifferent sectors, such as chemicals and dyes, textile, engineering and paper industries are contribute to the pollution of river water.

4.4 ROLE OF GPCB IN SURFACE WATER QUALITY MONITORING

I. Water quality Monitoring Programs

(a)GEMS (Global Environmental monitoring System)

GPCB is assisting CPCB in implementing the GEMS project since 1980 .The scope of this project includes an assessment of the quality of water of the major rivers of the State, viz. Narmada, Tapi, Mahi and Sabarmati.

(b) MINARS (Monitoring of Indian National Aquatic Resources System)

On account of various discharge of wastewater in river, the quality is likely to be adversely affected. It is therefore, necessary to monitor the quality of the various river waters. This is a continuous project of previous years as approved by the CPCB and known as MINARS. It is monitoring the water quality from 102 sampling station located on various rivers in the State. These rivers include Sabarmati, Meshwo, Anas, Mahi, Panam, Narmada, Damanganga, Kolak, Par, Tapi, Ambica etc.

(c) Parameters tested by GPCB:

TABLE – 4.1 (year 2011-2012)

Sr No	River	location	Parameter			
			ph	DO	BOD	COD
1	Tapi	Kathor bridge	8.2	6.8	2	9
2	Tapi	Mandvi bridge	8.1	7	2	8
3	Tapi	Sherulla bridge	8.1	6.8	1	7
4	Tapi	Varachcha bridge	8.2	6.9	2	8
5	Purna	At Suart – Navsari	8.1	6.4	2	9
6	Purna	state highway	8.0	6.4	2	10
7	Damanganga	Kachigaon Bridge	8.1	6.5	3	20
8	Damanganga	GIDC Weir, Vapi	7.9	7.1	1	10
9	Kolak	Pataliya Bridge	8.1	5.4	4	22
10	Par	Rly. Bridge, Atul	8.3	6.4	2	10
11	Auranga	Lilapur bridge, Valsad	8.0	7.1	1	9

II. Environmental Awareness Program

- Government are making efforts in various ways to create and implement environmental awareness among people through various activities like, programs on All India Radio, Doordarshan, rallies, exhibitions, distribution of saplings, distribution of booklets , screening of videos ,essay competitions, painting and drawing contests., Organizing Seminars and workshop with Social Forestry Dept, Gujarat Agriculture Universities, Industries personnel, universities and other state government agencies.
- Conducting various activities on Earth day on 22ndApril ,World environment day on 5thJune, Ozone Day on 16th September . Preparation and displacement of banners , distribution of booklets with themes on caring for mother earth ,oath to mother earth, educating on green belt development, awareness about e-wastes and plastic wastes.

III Remedial activities carried out such as :

1. Control of pollution at source to the maximum extent possible with due regard to technological achievement and economic viability.
2. Identifications of sites and development of procedures and methods for the disposal of hazardous wastes.
3. Maximization of re-use and re-cycle of sewage and trade effluent on land for irrigation and for industrial purpose after giving appropriate treatment and thereby economizing and saving on the use of water. The practice also helps in stopping pollution of water due to reduction in discharges of waste into water bodies.
4. Minimization of adverse effect of pollution by selecting suitable locations for the establishment of the new industrial projects.
5. Co-ordination with other agencies of the State Government and local authorities to encourage the Common Effluent Treatment Plants and Treatment Stabilization
6. Close co-ordination and support with educational institutions, non government organizations, Industries Associations, Government organizations, etc. to create environmental awareness.
7. Third party monitoring by educational institute, professional associations.
8. Gujarat was the first State to address hazardous wastes issue and brought about a novel concept of common Treatment Stabilization and Disposal Facility for cluster of industries(TSDF). Development of TSDF by individual industries is commonly unviable due to small quantity of hazardous waste generated. GPCB has allowed TSDF imposing compliance of the guidelines issued by Central and State government from time to time.
9. Municipal solid waste(MSW)The Government of Gujarat has constituted a Nodal Agency, Gujarat Urban DevelopmentCompany Ltd for development of infrastructure for treatment, transportation and disposal of MSW with the authorization and approval of GPCB. With detailed study of the each and every municipalities, it is ultimately arrived on to provide treatment facilities (i.e. vermicomposting) at the town level and to develop the regional landfill site for the cluster of municipalities in @ 50km radius and connected with road

network. GUDC has initiated the preparation of operational plan for the implementation of MSW.

4.5 ROLE OF INDUSTRIES

(a) It is observed that many industrial units have installed their effluent treatment plants and many units have also upgraded and modified their existing effluent treatment plants. Couple of industries located in groups or cluster have also initiated activities for the common effluent treatment plant for eg CETP is now functional @ Vapi Industrial Area .The following are few Effluent treatment plant listed below:

TABLE - 4.2:

Sr No	Management's Name and Location	Nos. of Members	Capacity in MLD	Status
1	Pandesara Infrastructure Ltd, GIDC Pandesara, Surat	129	100	operational
2	Vapi Waste & Effluent Management Co Ltd., 4807, Phase IV, GIDC, Vapi, Valsad	854	70	operational

(b) Various industries also have their own in house programs on educating their personnel on environmental issues. They support ecofriendly dyes and chemicals, promote green belt, Bio-manure through Vemicompose, use of natural gas in power generation.

4.6 ROLE OF NGOs

NGOs are motivated to keep a proper watch on industries and other stake holders for overall improvement in environment and hence benefit the society as a whole, to create public awareness about environmental issues and their mitigation measures so as to have a sustainable development.

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