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Assessment of Manmade Pollution and Predicting Water Quality Responses to Natural Phenomena in River Sabarmati

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Abstract : This study has been undertaken to investigate and Assessment of Manmade Pollution and Predicting Water Quality Responses to Natural Phenomena in river Sabarmati with help of Water Quality Model

I. INTRODUCTION

Freshwater, although a renewable resource, is finite and is very vulnerable. The overall water situation is likely to further deteriorate as a result of global changes. All the water on Earth, 97.5 % is located in the seas and oceans and that is available in rivers, lakes and reservoirs for immediate human consumption comprises no more than a mere 0.007 % of the total. To maintain and restore the wholesomeness of national aquatic resources by prevention and control of pollution is the basic objective of any water resource management study.
With the rapid development of modern economy and the continuous expansion of population, the situation of natural resources is becoming more and more serious. In order to realize the sustainable use of regional resources, people begin to choose to use environmental carrying capacity to judge the maximum endurance of external environmental changes. It is one of the most powerful and effective tool to study eco-environmental carrying capacity and assess regional sustainable development In terms of water resources, with the increasing shortage of water resources and the aggravation of water pollution problems, the research of field and urban water environment carrying capacity has attracted the attention of researchers .With the continuous improvement of the level of human social productivity, the increasing population and the further development of urbanization, the human demand for water resources is growing rapidly, and the problem of water shortage further restricts human development. At the same time, people do not pay attention to the protection of water environment with the development of the economy, resulting in a lot of water pollution, which has an important impact on the survival, growth and development of human beings and various organisms.

The Sabarmati River is one of the four major rivers which traverse the alluvial plains of Gujarat. It arises in the Aravalli hills at a North latitude of 24o40' and East longitude of 73o20' in the Rajasthan state at an elevation of 762 meters above mean sea level. The total length of the river from the head to its outfall into the sea is 371 km. River Sabarmati enters into Headband at Nana Chiloda and leaves at Village Vautha. Total length of River Sabarmati between Saroda to Vautha is 41 KM. Sabarmati River has been an integral part in the life of Ahmedabad. The Sabarmati River is a monsoon-fed river that flows north-south through Ahmedabad, bisecting the city into its western and eastern halves. At Ahmedabad, the river encompasses a total catchment area of 10,370 sq km, out of the total basin area of 27,820 sq km. It serves as a source of water for industrial, agricultural and domestic activities.

Scenario of Ahmedabad City Area

Traditionally, lot of commerce and trade activities have been originating here and is seen as the commercial capital of Gujarat. Ahmedabad is one of the industrially developed city in the state of Gujarat having Large, Medium and Small scale industries of various types. A large number of industries related to textiles, dyes & dye intermediates, chemicals, TPS, machinery, metal products, pharmaceutical, engineering, plastics etc. are located in the city. There are 04(major) Industrial Estates, and two major textile industrial clusters in Ahmedabad city. The entire domestic waste water from Ahmedabad city @ 1000 MLD discharging into River Sabarmati. Industrial waste water @ 170 MLD from CETPs of GIDCs and Narol & Danilimda-Behrampura Textile Clusters is discharged into river.

The phase I of Sabarmati River Front is completed; in which drainage interceptor line is provided on both sides due to which direct disposal of domestic waste water from both sides into River is stopped. This waste water is partly pumped to STPs and partly discharged at downstream of Vasana Barrage through interceptors provided for river front. Major Contamination is due to effluent & sewage both.

Major outfalls into river stretch are:

A. Domestic waste water discharge from STP of Ahmedabad.

B. Discharge of treated waste water from CETP of GIDCs, Narol Cluster and Danilimda & Behrampura cluster (Mega Pipeline – 40 MLD, NTIEM CETP – 100 MLD, Storm Water drain-30 MLD)

There is no any direct industrial or domestic w/w discharge in to River Sabarmati from Saroda to Vautha region. No any industry is permitted to discharge industrial waste water / domestic waste water into River Sabarmati and no industrial waste water / domestic waste water outfall observed in River Sabarmati from Saroda to vautha. Therefore, stretch of Sabarmati river from Hansol to Miroli Pumping station is selected for the study purpose. As distance between major outfalls in the river and Miroli pumping station is approx. 18 Km.

II. Aim of the Study

Assessment of Pollution load received at river Sabarmati from the different sources of treated sewage and industrial wastewater discharge and Predicting Water Quality Responses to Natural Phenomena in river Sabarmati with help of Water Quality Model

III. Objective of the Study

The water quality management in India is performed under the provision of Water (Prevention and Control of Pollution) Act, 1974. The basic objective of this Act is to maintain and restore the wholesomeness of national aquatic resources by prevention and control of pollution. Since the natural water bodies have got to be used for various competing as well as conflicting demands, the objective is aimed at restoring and/or maintaining natural water bodies or their parts to such a quality as needed for their best uses.

1. To assess pollution load entering into river Sabarmati from treated domestic & industrial effluent
2. To finalise locations for sampling from river to decide stretch under consideration.
3. To take samples and get sample analysed for DO, BOD & COD.
4. To obtain water quality response to natural phenomena.
5. To use Water Quality Model of USEPA for prediction of water Quality of river Sabarmati downstream Ahmedabad with change in pollution load.

IV. Outfalls in River Sabarmati

The major outfalls of treated / untreated, domestic / industrial waste water are as below.

i. MEGA 45 MLD (Wastewater Discharge from NEPL-8 MLD, GESCSL-22 MLD, Reliance-4 MLD, OEPL-1 MLD, OGEPL-1 MLD, GVMM-1 MLD, Narol Dyes-0.45 MLD, Sewage-8 MLD)
ii. Narol Textile Infrastructure Environment Management CETP 100 MLD
iii. Storm drain from Danilimda Behrampura area Approx 30 MLD
iv. AMC, Pirana-extra untreated sewage-Pirana Terminal Sewage Pumping Station
v. 180 MLD STP of AMC,Pirana
vi. 106 MLD STP of AMC, Old Pirana
vii. 60 MLD STP of AMC, Old Pirana
viii. 126 MLD STP of AMC, Vasna
ix. 240 MLD STP of AMC, Vasna
x. AMC, Vasna-extra untreated sewage-Vasna Sewage Pumping Station
xi. Sewage from Riverfront Interceptors

V. Scope of the Study

This thesis aims to study water quality response to natural phenomena So as quality of river water can be predicted downstream when the pollution load both in terms of domestic as well as industrial received by the river is reduced/changed.

METHODOLOGY

Methodology Adopted

The following Methodology has been adopted for project execution :

1. To identify the basis of evolution of discharge norms for wastewater discharge into river/streams/water bodies etc. through Literature Survey;

2. To identify the upstream and downstream river water sampling locations as well as the various wastewater discharge lines to the river Sabarmati;

3. To undertake sampling and analysis of representative wastewater samples collected from the following locations after Vasna Barrage mentioned hereunder to assess pollution load

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3. To undertake sampling and analysis of representative wastewater samples collected from the following locations after Vasna Barrage mentioned hereunder to assess pollution load

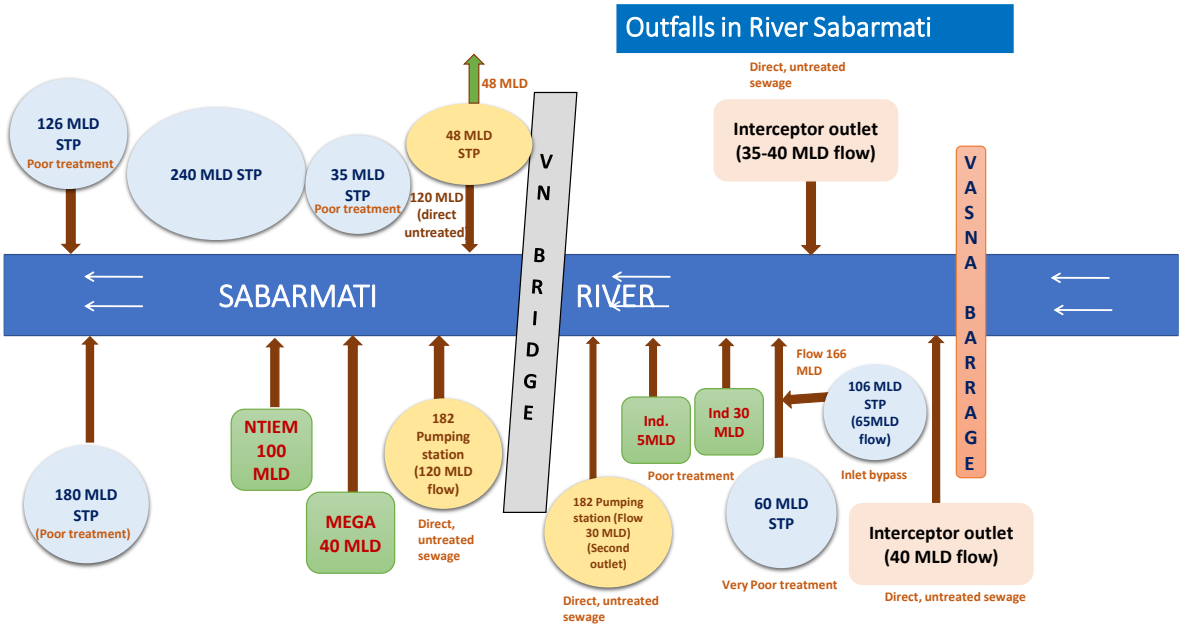
I. 180 MLD STP of AMC,Pirana
II. AMC, Pirana-extra untreated sewage-Pirana Terminal Sewage Pumping Station
III. Narol Textile Infrastructure Environment Management CETP 100 MLD
IV. MEGA 45 MLD (Wastewater Discharge from NEPL-8 MLD, GESCSL-22 MLD, Reliance-4 MLD, OEPL-1 MLD, OGEPL-1 MLD, GVMM-1 MLD, Narol Dyes-0.45 MLD, Sewage-8 MLD)
V. Approx 30 MLD Dischage Storm drain from Danilimda Behrampura area
VI. 60 MLD STP of AMC, Old Pirana
VII. 106 MLD STP of AMC, Old Pirana
VIII. 126 MLD STP of AMC, Vasna
IX. 240 MLD STP of AMC, Vasna
X. 35 MLD STP of AMC, Vasna
XI. AMC, Vasna-extra untreated sewage-Vasna Sewage Pumping Station
XII. Sewage from Riverfront Interceptors

4. To undertake sampling and analysis of representative river water samples collected from the following locations mentioned hereunder.

i. Near Hansol Bridge (Upstream Location)
ii. From Riverfront Opp SRFDCL office (Upstream Location)
iii. From Vasna-Narol Bridge (in-between outfalls)
iv. Kamod Village (Downstream Location)
v. Miroli Pumping Station (Downstream Location)

5. The Google Earth Map of the above mentioned location were established;
6. The above mentioned representative water/wastewater samples of treated Sewage and Industrial Wastewater were analyzed for BOD,COD and DO;
7. Sampling and Analysis were undertaken for 4 days.
8. The particulars with respect to Industrial Wastewater/Treated Sewage flow rate (MLD) and other related details were collected from the individual treatment plants/related sources and noted/recorder and form the basis for assessment of pollution load;
9. Analyzed and evaluated the test results and baseline findings to assess the Pollution Load received at River Sabarmati from the different sources of Treated Sewage and Industrial Wastewater Discharge.
10. Use of Waer quality analysis simulation program (WASP) to interpret collected data and to predict water quality response to natural phenomena and suggested possibilities/measures to maintain the BOD concentration of river water in the downstream to desired water quality of less than 3 mg/L.
11. Have followed the Central Pollution Control Board (CPCB) criteria for Water Quality Standards, and standard methods for analysis.

Industrial Wastewater and Sewage Outfalls in River Sabarmati



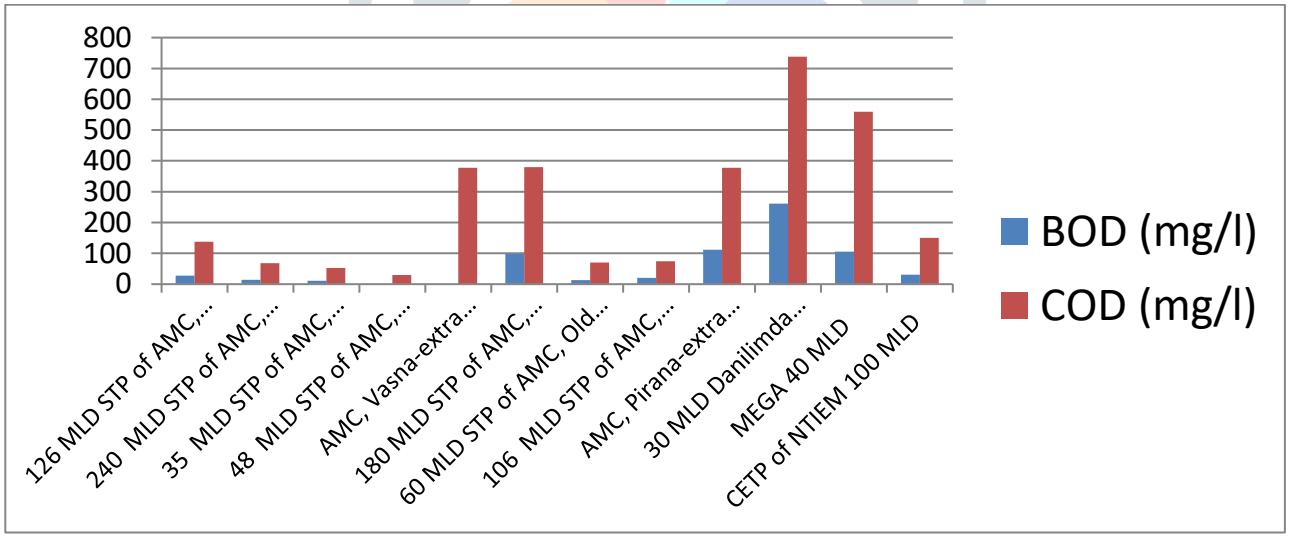
VI. MATERIALS AND METHODS

Sample Collection :-

IS:3025-1987 Methods of sampling of Water & Wastewater

Preservation of sample, selection of sample containers and analysis duration is important for the accuracy of results

Results of Wastewater Sampling



Estimation of BOD Load and COD Load

SR NO	LOCATION	FLOW MLD	BOD mg/L	COD mg/L	BOD LOAD T/DAY	COD LOAD T/DAY
1	126 MLD STP of AMC, Vasna	60	28	138	1.68	8.28
2	240 MLD STP of AMC, Vasna	124	14	68	1.736	8.432
3	35 MLD STP of AMC, Vasna	16.3	11	53	0.179	0.864
4	48 MLD STP of AMC, Vasna	48	<5	30	0.24	1.44
5	AMC, Vasna-extra untreated sewage-Vasna TSPS	70	112	378	7.84	26.46
6	180 MLD STP of AMC, Pirana	162.62	98	380	15.937	61.796
7	60 MLD STP of AMC, Old Pirana	30	13.5	70.5	0.405	2.115

8	106 MLD STP of AMC, Old Pirana	50	20	74	1	3.7
9	AMC, Pirana-extra untreated sewage-Pirana TSPS	258.78	112	378	28.983	97.819
10	30 MLD Danilimda Behrampura Outlet	30	261	738	7.83	22.14
11	MEGA 40 MLD	35.69	105	559	3.747	19.951
12	CETP of NTIEM 100 MLD	94.4	31	150	2.926	14.16
				TOTAL	**72.503**	**267.157**

Estimation of Average BOD Load and Percentage Contribution of various discharge Locations

SR NO	LOCATION	BOD Load (7/10/21)	BOD Load (20/10/21)	BOD Load (9/11/21)	BOD Load (7/12/21)	Average BOD Load (T/Day)	Percent Contribution (%)
1	126 MLD STP of AMC, Vasna	1.95	3	1.615	1.68	2.06	2.48
2	240 MLD STP of AMC, Vasna	1.38	O.55	2.193	1.736	1.77	2.13
3	35 MLD STP of AMC, Vasna	0.252	0.152	0.216	0.179	0.20	0.24
4	48 MLD STP of AMC, Vasna	0.235	0.144	0.864	0.24	0.37	0.45
5	AMC, Vasna-extra untreated sewage-Vasna TSPS	8.051	7.47	7.59	7.84	7.74	9.29
6	180 MLD STP of AMC, Pirana	14.758	17.289	12.089	15.937	15.02	18.04
7	60 MLD STP of AMC, Old Pirana	3.04	1.4	1.305	0.405	1.54	1.85
8	106 MLD STP of AMC, Old Pirana	7.6	2.078	1.474	1	3.04	3.65
9	AMC, Pirana-extra untreated sewage-Pirana TSPS	42.935	34.29	40.35	28.983	36.64	44.00
10	30 MLD Danilimda Behrampura Outlet	9.45	8.97	9.9	7.83	9.04	10.85
11	MEGA 40 MLD	3.873	2.691	2.182	3.747	3.12	3.75
12	CETP of NTIEM 100 MLD	3.128	3.952	2.674	2.926	3.17	3.81
	TOTAL	**96.7**	**81.436**	**82.45**	**72.503**	**83.27**	**100.00**

Estimation of Average COD Load and Percentage Contribution of various discharge Locations

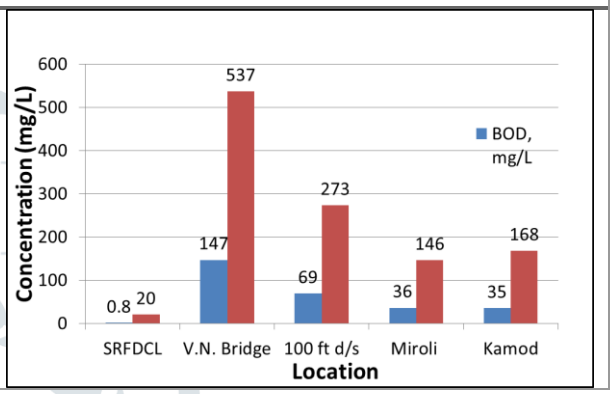
SR NO	LOCATION	COD Load (7/10/21)	COD Load (20/10/21)	COD Load (9/11/21)	COD Load (7/12/21)	Average COD Load (T/Day)	Percent Contribution (%)
1	126 MLD STP of AMC, Vasna	9.594	7.676	10.129	8.28	8.92	3.19
2	240 MLD STP of AMC, Vasna	8.97	4.216	12.9	8.432	8.63	3.09
3	35 MLD STP of AMC, Vasna	1.584	0.942	1.176	0.864	1.14	0.41
4	48 MLD STP of AMC, Vasna	1.081	1.15	4.848	1.44	2.13	0.76
5	AMC, Vasna-extra untreated sewage-Vasna TSPS	21.825	20.25	26.4	26.46	23.73	8.50
6	180 MLD STP of AMC, Pirana	46.315	51.255	41.01	61.796	50.09	17.93
7	60 MLD STP of AMC, Old Pirana	10.52	5.6	5.76	2.115	6.00	2.15
8	106 MLD STP of AMC,	26.3	8.312	6.968	3.7	11.32	4.05

	Old Pirana						
9	AMC, Pirana-extra untreated sewage-Pirana TSPS	118.349	96.52	139.1857	97.819	112.97	40.44
10	30 MLD Danilimda Behrampura Outlet	26.13	29.13	29.94	22.14	26.84	9.61
11	MEGA 40 MLD	14.845	11.16192	10.278	19.951	14.06	5.03
12	CETP of NTIEM 100 MLD	15.64	15.9068	8.404	14.16	13.53	4.84
	TOTAL	301	252.1197	296.9987	267.157	279.32	100.00

River Water Samples

Results of River water Sample

SR NO	LOCATION	pH	DO mg/L	BOD, mg/L	COD, mg/L	Faecal Coliform (cfu/100 mL)
1	River front, Opp. SRFDCL office	7.55	5.6	0.8	20	6
2	Vasna-Narol Bridge	8.36	BDL	147	537	>1600
3	100 ft Downstream of all discharge	7.7	BDL	69	273	>1600
4	Kamod Village	7.3	BDL	35	168	>1600
5	Miroli Pumping Station	7.45	BDL	36	146	>1600



- **Estimated T0tal Score U/s and D/s Locations of River Sabarmati** (as per CPCB Criteria for Prioritization of Polluted River Location)

SR NO	LOCATION	BOD Weightage (70%)	Faecal Coliform Weightage (30%)	Total Score Z = X+Y	PRIORITY CLASS	CATEGORY AS PER CPCB
		BOD Score (X)	FC Score (Y)			
1	River front, Opp. SRFDCL office	14	6	20	V	Good or Fit for Bathing
2	Vasna-Narol Bridge	70	30	100	I	Critically Polluted
3	100 ft Downstream of all discharge	70	30	100	I	Critically Polluted
4	Kamod Village	70	30	100	I	Critically Polluted
5	Miroli Pumping Station	70	30	100	I	Critically Polluted

VII. Observations

Most of the Wastewater Treatment Plants were found to be operating on lesser load. Average BOD at the Upstream of river Sabarmati (SRFDCL office) is 0.97 mg/L and in downstream (Miroli Pumping Station) is 53.5 mg/L.

SR NO	LOCATION	FLOW MLD
1	126 MLD STP of AMC, Vasna	60
2	240 MLD STP of AMC, Vasna	124
3	35 MLD STP of AMC, Vasna	16.3
4	48 MLD STP of AMC, Vasna	48
6	180 MLD STP of AMC, Pirana	162.62
7	60 MLD STP of AMC, Old Pirana	30
8	106 MLD STP of AMC, Old Pirana	50

BOD load Contribution Vs flow

SR NO	LOCATION	Average flow MLD	Average BOD Load (T/Day)	Percent Contribution (%)
1	AMC, Pirana-extra untreated sewage-Pirana TSPS	249	36.64	44
2	180 MLD STP of AMC, Pirana	157	15.02	18.04
3	30 MLD Danilimda Behrampura Outlet	30	9.04	10.85
4	AMC, Vasna-extra untreated sewage-Vasna TSPS	92	7.74	9.29
5	CETP of NTIEM 100 MLD	95	3.17	3.81
6	MEGA 40 MLD	36	3.12	3.75
7	106 MLD STP of AMC, Old Pirana	65	3.04	3.65
8	126 MLD STP of AMC, Vasna	74	2.06	2.48
9	240 MLD STP of AMC, Vasna	132	1.77	2.13
10	60 MLD STP of AMC, Old Pirana	36	1.54	1.85
11	48 MLD STP of AMC, Vasna	47	0.37	0.45
12	35 MLD STP of AMC, Vasna	18	0.2	0.24
	TOTAL	1031	83.27	100

Average COD at the Upstream of river Sabarmati (SRFDCL office) is 19 mg/L and in d/s (Miroli Village) is 229 mg/L.

SR NO	LOCATION	Average COD Load (T/Day)	Percent Contribution (%)
1	AMC, Pirana-extra untreated sewage-Pirana TSPS	113	40.44
2	180 MLD STP of AMC, Pirana	50.09	17.93
3	30 MLD Danilimda Behrampura Outlet	26.84	9.61
4	AMC, Vasna-extra untreated sewage-Vasna TSPS	23.73	8.5
5	MEGA 40 MLD	14.06	5.03
6	CETP of NTIEM 100 MLD	13.53	4.84
7	106 MLD STP of AMC, Old Pirana	11.32	4.05
8	126 MLD STP of AMC, Vasna	8.92	3.19
9	240 MLD STP of AMC, Vasna	8.63	3.09
10	60 MLD STP of AMC, Old Pirana	6	2.15
11	48 MLD STP of AMC, Vasna	2.13	0.76
12	35 MLD STP of AMC, Vasna	1.14	0.41
	TOTAL	279.3	100

VIII. Conclusion

- The average BOD, COD, Faecal Coliform in the upstream locations (SRFDCL Office) were found to be on a lower side as Riverfront of Sabarmati has sufficient e-flow.
- As per the calculation, it is found that river water quality at SRFDCL Office (Upstream Location) falls under Priority V Class and is categorized as Good or Fit for Bathing.
- river water quality downstream Vasna Barrage at all locations falls under Priority I Class and is categorized as Critically Polluted.
- All the Sampling Locations (under study) are found to be contributing to the contamination of Sabarmati river water.
- it is evident that there is increase in river water pollution in the downstream.
- The STP's and CETP's were found not able to meet the stipulated discharge standards
- Due to the stagnation of water in the Vasna Barrage (Upstream) over a period of time, there is an increase in the concentration of Faecal Coliform
- The untreated sewage directly discharged from Pirana Terminal Sewage Pumping Station and Vasna Terminal Sewage Pumping Station into River Sabarmati must be treated adequately before discharge.
- The STP's and CETP's need to review and undertake Performance Evaluation/Assessment to improvise further in meeting with the discharge norms.
- Thrust must be on maximizing recycle and reuse of wastewater and reducing treated wastewater discharge.
- 30 MLD CETP for the textile cluster of Danilimda-Behrampura area is under construction stage and after commissioning of which pollution load will be reduced from that outfall considerably.
- Approximate 15.6% of industrial effluent contribute 20% of BOD & COD load and 33% of untreated domestic sewage contribute @ 50% of BOD & COD load.
- This indicates that if the pollution load in the untreated domestic drains is addressed, water quality would show substantial improvement.
- Capacity utilization wise STPs needs immediate attention. All the STPs needs improvement in its performance.
- As with respect to sewage, in order to achieve higher quality discharge effluent, Tertiary treatment may be required to further reduce organics and pathogens. Treatment options in tertiary treatment depend upon the characteristics of effluent after secondary treatment and what kind of water is needed at the end of the treatment.

Future Scope of Study

- Further studies of can be done With time series data of water quality for all three seasons can be considered for water quality modeling for prediction of water quality downstream in surface water.
- Advanced Photo Oxidation Processes is a new concept at sewage treatment plants for excellent bathing water quality. The principle in the system is that light from ultraviolet lamps is able to destroy mechanisms inside bacteria and remove chemical substances from wastewater with use of oxidants, e.g. ozone or chloride dioxide. The technology is suitable for disinfection and removal of endocrine disruptors; thus Biodegradability of the treated sewage can be studied after various advanced oxidation processes.

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