CHAPTER 2

2.1 INTRODUCTION

The present study had following broad objectives:

(1) To assess the quality of sewage water of Bhavnagar City

(2) To assess the quality of Water for domestic consumption supplied to the public of Bhavnagar, and

(3) To make an attempt to identify contribution and dominancy of pollution causing parameters.

The quality of sewage is dependent on quality and quantity of water supplies for the domestic use. Water, after it has been fouled by variety of uses becomes impure or not useful for other uses, and it is termed as **"WASTE WATER"** or **"SEWAGE"**. Sewage is essentially in direct proportion of water supplied to the community from various sources. Quantity of water used by the public reflects living standards. Per capita water consumption is usually high for well-to-do families and modern societies, compared to middle class and lower class of the society. Obviously sewage or Waste Water of the former will be dilute compared to the other part of society.

Several studies have been made in the past about the quality of ground waters and surface waters of Bhavnagar. A very extensive and remarkable study on water quality of various reservoirs, wells and other sources from where Bhavnagar City receives water for domestic consumption was made in near past by Dr G B Patel[1]. In the present study, principle source of water used for domestic consumption was, water supplied by Bhavnagar Municipal Corporation. The quality and quantity in terms of volume of water supplied for domestic uses was basically

controlled by Bhavnagar Municipal Corporation. The Bhavnagar Municipal Corporation was trying to manage the supply of water at the rate of 120 liters per capita per day during the period of study, that is calendar years of 1999 and 2000[2]. During the years under study, rainfall was below average, and Bhavnagar Municipal Corporation was forced by natural circumstances to control the schedule of water supply and control supply quantity. Average rainfall of the monsoon for Bhavnagar is 563 millimeters, and other rainfall is negligible[2].

The second or alternate source of water for domestic uses for majority the public of Bhavnagar is underground water, either from private tube-well or hand pump, or supplied by commercial agencies. Non-availability of Municipal water on scheduled days, and costly or difficult availability of consumable water from alternate sources had affected the daily consumption level of water of the public of Bhavnagar. The quality of ground water varies depending on place, type of tube-well or well, withdrawal rates, rainfall of the monsoon, season, and many more parameters.

2.2 SAMPLING POINTS

Sampling points for the,

(1) Municipal Water Supply for Domestic use,

(2) Ground Water from a private tube-well as an alternate source of water for domestic use and

(3) Sewage Water,

were selected as follows.

2.2.1 Municipal Water for Domestic use

The water samples of water supplied by Bhavnagar Municipal Corporation for domestic use, and samples water from alternate source were required to assess the degree and type of contaminants in the sewage quality as a result of domestic water consumption. In this connection a point of water supply of Bhavnagar Municipal Corporation water was selected for the period of study, from where regular sample can be collected. This point was a domestic water connection, in the network of one of the water supply overhead tank of capacity of 10,00,000 liters supplying water to large area of south and west zone of Bhavnagar city, near "Gaushala Gate" of "Victoria Park", near circuit house known as "Dilbahar Tanki". One sample was analyzed every month in the second week of the month from this sampling point.

2.2.2 Ground Water for Domestic use

Similarly a point for the collection of samples of ground water was selected, was a private tube-well, which was in use for about 20 years for the additional supply of water for domestic use, for the period of study. The point was located at Plot No. 100, Rupali Housing Society, Talaja

Road, Bhavnagar, P I N 364002. One sample was analyzed every month from this sampling point in the third week of the month. All care was taken for the representative sampling from the selected source of water supply in accordance to the schedule of the sampling.

2.2.3 Sewage Water

Topography of Bhavnagar city is not of a plain surface, Sewage of the city is collected in to Five Drainage Pumping Stations. Out of these five drainage-pumping stations, two pumping stations are discharging sewage directly into the sea. Sewage of other three pumping stations is pumped to primary sewage treatment plant, (which is not working for last several years)[2,3] from where it is discharged into the sea. In addition to this arrangement for sewage disposal, an open channel is passing through the boundaries of Bhavnagar city known as Kansara Nala. Many societies and communities are discharging their sewage into this open channel. Based on this facts three type of sampling points were identified for the sampling of sewage. One sample from each type of sewage sampling point was collected every week for the study. A Guide map of Bhavnagar city is given in Appendix 1 indicating sewage-sampling points. Description of location and identifications of sampling points are as follows.

2.2.3.A Sampling from Drainage / Sewage Pumping Stations

Three of the Sewage (Drainage) Pumping Stations, pumping sewage to the primary sewage treatment plant were selected for sampling by rotation were,

(1)Bhidbhanjan Drainage pumping station, Kavarram choke,

(2)Valcutgate Drainage pumping station K.para and,

(3)Sutarvad / Latibazar Drainage pumping station Sutarvad

One sample of sewage was collected for analysis from one of these three sampling points by rotation every week.

2.2.3.B Sampling from Kansara Nala Open Sewage Channel.

Three sampling points were selected on Kansara Nala open drainage channel representing south - east part of the city. These points were

(1) Near Jawahar nagar, Ram mantra mandir – Talaja Road,

(2) Subhasnagar Bridge Aerodrom Road, and

(3) Near Bridge, on road connecting to Sardar nagar and Ghogha Road.

One sample of sewage was collected for analysis from one of these three sampling points by rotation every week.

2.2.3.C Sampling from Final Discharge Points of Sewage

As two of the sewage pumping stations namely

(1)Kumbharvada drainage pumping station and,

(2)Khedutvas Drainage pumping station, Khedutvas,

are discharging sewage directly into the sea, these two sewage-pumping stations are discharging sewage directly into sea, these two drainage pumping stations were considered as final discharge points for sample collection. Sewage from Primary sewage treatment plant is an official final discharge point for sewage, and Kansara is also discharging

sewage into the sea near Ruvapari Mandir. Considering this fact, sampling points for final discharge were,

(1) Kumbharvada drainage pumping station

(2) Khedutvas Drainage pumping station, Khedutvas

(3) Disposal plant behind Anandnagar / Khedutvas and

(4) Kansara outlet near Ruvapari Mandir.

One sample of sewage was collected for analysis from one of these four sampling points by rotation every week.

According to these schedules three samples of sewage were collected for analysis every week from these three types of sampling points. Total number of samples collected during the period of study for analysis from,

(1) Municipal Water for domestic use were 24 in number,

(2) Tube-well Water for domestic use were 24 in number and

(3) Sewage water samples from three different type of sources were 315 in number.

2.3 METHODS OF SAMPLING

Samples of Water for domestic use and samples of Sewage water were collected in accordance with the prevaling Indian Standard Method. These were[3,4,5],

(A) **I S 4733, Indian Standard Methods of Sampling and Test for Sewage Effluents**, for sampling of sewage water.

(B) **I S 3025, Indian Standard Method of Sampling and Test (Physical and Chemical) for Water and Wastewater, Part 1**,for the collection and preservation of samples for analysis for the water for domestic use and sewage water and,

(C) **I S 1622, Indian Standard Methods of Sampling and Microbiological Examination of Water,** for the samples of water for domestic use and sewage water for the microbiological examination.

As mentioned in previous section, according to these schedules three samples of sewage were collected for analysis every week from these three types of sampling points. Total number of samples collected during the period of study for analysis from,

(1) Municipal Water for domestic use were 24 in number,

(2) Tube-well Water for domestic use were 24 in number and

(3) Sewage water samples from three different type of sources were 315 in number.

2.4 METHOD OF ANALYSIS

Method of analysis plays very important and significant role in the interpretation of the data. Normal variations in process described for the analytical method in the texts, variations in the equipments from laboratory to laboratory, and human practices may have some effect on analytical results. New analytical methods bases on instrumentation are described in many texts, and literatures supplied by the manufacturers of the instruments. Many on-line or automatic instruments are now available, that can analyze several parameters at a time using very small quantity of sample within very small duration of time. Very high claims are made for the accuracy and precision even for very small quantities of component to be analyzed for such instruments, but these instruments are very costly, and not easily available in most laboratories.

Bureau of Indian Standards is working for the establishment of standards for consumer products, industrial products, methods of analysis, procedures, standard procedures and many aspects of standards. Analytical methods selected for various parameters for this study were selected from relevant I S standard methods of analysis, or N E E R I publications, or methods published by A P H A, A W W A and Water Environment Fedaration – U S A. These were,

(1) I S 1622 of 1981, (Microbial Examinations),

(2) I S 3025 of 1964, revised in 1987 and other revisions made for any particular part or reprints made time to time, made available from the office of B I S and in use at present,

(3) I S 7232 of 1974,

(4) I S 10500 of 1991, for specification of Drinking Water.

(5) Standard Methods for the examination of Water and Wastewater 19th Edition, 1995 Jointly published by A P H A, A W W A and Water Environment Federation – U S A, and

(6) Manual on Water a ıd Wastewater analysis of 1988, N E E R I – Nagpur.

These methods are National Standard Methods, and / or most suitable and acceptable methods that can be trusted for the reproducibility of results.

Colorimetric methods were used for the analysis of Color of Sample, Fe content, Fluorides, Total Phosphorous, Nitrate, Nitrites, Phenolic compounds, Arsenic, Mercury and Zinc. Direct or Indirect methods of Volumetric Titrations were preferred for Total Hardness, Ca, Mg, Acidity / Alkalinity, Chlorides, Dissolved Oxygen, and C O D. Similarly gravimetric methods were applied for the analysis of Oil / grease, Total Solids, Total Dissolved Salts, and Total Suspended Solids. So_4^{-2} was analyzed by gravimetric method or turbidity method. Suitable instruments were used for the measurements of Turbidity, pH, Electrical Conductivity, Na^+, K^+, Biological Oxygen Demand, Chemical Oxygen Demand, Microscopy and Standard Plate Count. A list of parameters and method adopted for the analysis of Water for Domestic use is given in Table No 2.1. A list of parameters and method adopted for the analysis for Sewage Water is given in Table No 2.2.

A list of instruments used for the analysis of some of the chemical and biological parameters for Water for Domestic Use and Sewage Water is given in Table No 2.3. List of glassware and common laboratory chemicals used foı the analysis is omitted, as it is the most common and required facilities of any Analytical and Research oriented laboratory.

Table 2.1

ANALYTICAL METHODS FOR WATER FOR DOMESTIC USE

Sr.No.	Parameter	I S No. and Part	Method
(01)	Test	10500	
(02)	Odor	3025,05	
(03)	Color	3025,04	Platinum-Cobalt method
(04)	Temperature	3025,09	Mercury in glass thermometer
(05)	Turbidity	3025,10	Nephelometer- Turbidity meter
(06)	Oil/Grease	3025,39	Partition Gravimetric method
(07)	pH	3025,11	pH meter
(08)	Electrical Conductivity	3025,14	Conductivity meter
(09)	Total Solids	3025,15	Gravimetric
(10)	Total Dissolved Solids	3025,16	Gravimetric
(11)	Total Suspended Solids	3025,17	Gravimetric
(12-a)	Total Hardness	3025,21	E D T A titration
(12-b)	Ca^{+2}	3025,21	E D T A titration
(12-c)	Mg^{+2}	3025,21	E D T A titration
(13)	Fe	3025,32 of 1964	Thioglycolic acid method
		A P H A 15th Ed	1,10 Phenanthroline method
(14-a)	Acidity/Alkalinity	3025,22	Acid-base titration
		3025,23	Acid-base titration
(14-b)	$CO3^{-2}$	3025,23	Acid-base titration P alkalinity
(14-c)	$HCO3^{-1}$	3023,23	Acid-base titration M alkalinity

(15)	F^{-1}	3025,23 of 1964	Colorimetric method
(16)	Chloride	3025,32	Argentometric titration
(17)	SO4-2	3025,24	Gravimetric method
		A P H A 15th Ed.	Turbidity method
(18)	Residual Free Chlorine	3025,26	Iodometric method
(19-a)	Nitrate	N E E R I	manual on water and
(19-b)	Nitrite	wastewater analysis 1988 pp 123-126	
		Spectrophometry	
(20)	Dissolved Oxygen	3025,38	Winkler titration method
(21)	Phenolic Compounds	3025,43	Spectro-photometry
(22)	Biological Oxygen Demand	3025,44 and A P H A 19th Ed.	
(23)	Microscopy	1622	Compound Microscope
(24)	Standard Plate Count	1622	Total Viable Count

Table 2.2

ANALYTICAL METHODS FOR WATER FOR DOMESTIC USE

Sr.No.	Parameter	I S No. and Part	Method
(01)	Odor	3025,05	
(02)	Color	3025,04	Platinum-Cobalt method
(03)	Temperature	3025,09	Mercury in glass thermometer
(04)	Turbidity	3025,10	Nephelometer- Turbidity meter
(05)	Oil/Grease	3025,39	Partition Gravimetric method
(06)	pH	3025,11	pH meter
(07)	Electrical Conductivity	3025,14	Conductivity meter
(08)	Total Solids	3025,15	Gravimetric
(09)	Total Dissolved Solids	3025,16	Gravimetric
(10)	Settelable Matter	3025,19	Volumetric monitoring
		7232	Imhoff cone test
(11)	Total Suspended Solids	3025,17	Gravimetric
(12-a)	Total Hardness	3025,21	E D T A titration
(12-b)	Ca^{+2}	3025,21	E D T A titration
(12-c)	Mg^{+2}	3025,21	E D T A titration
(13)	Fe	3025,32 of1964	Thioglycolic acid method
		A P H A 15th Ed	1,10 Phenanthroline method
(14-a)	Na+1	3025,45	Flame Photometry
(14-b)	K+1	3025,45	Flame Photometry

(15-a)	Acidity/Alkalinity	3025,22	Acid-base titration
		3025,23	Acid-base titration
(15-b)	$CO3^{-2}$	3025,23	Acid-base titration P alkalinity
(15-c)	$HCO3^{-1}$	3023,23	Acid-base titration M alkalinity
(16)	F^{-1}	3025,23 of 1964	Colorimetric method
(17)	Chloride	3025,32	Argentometric titration
(18)	SO_4^{-2}	3025,24	Gravimetric method
		A P H A 15th Ed.	Turbidity method
(19)	Total Nitrogen	3025,34	Macro Kjeldahl method
(20)	Total Phosphorous	Phospho-Moly Blue	Colourimetry
(21-a)	Nitrate	N E E R I	manual on water and
(21-b)	Nitrite	wastewater analysis 1988 pp 123-126	
		Spectro-Phometry	
(22)	Dissolved Oxygen	3025,38	Winkler titration method
(23)	Phenolic Compounds	3025,43	Spectro-photometry
(24)	Heavy Metals		
	Arsenic	3025,37	Mercurybromide stain method
	Lead	3025,47	Qualitative
	Mercury	3025,48	Spectro Photometer
	Zinc	3025,49	Spectro Photometer
(25)	Biological Oxygen Demand	3025,44 and A P H A 19th Ed.	
(26)	Microscopy	1622	Compound Microscope
(27)	Standard Plate Count	1622	Total Viable Count

Table 2.3

LIST OF IMPORTANT LABORATORY INSTRUMENTS

Sr.No	Name of Instrument	Model No , Manufacturer
1	Scientific Balance	Mettler A E 200
2	U V Visible Spectrophotometer	Chemito 2500
3	Spctro-Photometer	Systronic 106
4	pH Meter Digital	Systronic 335
5	Conductivity Meter	Systronic 304 Direct Reading
6	Flame Photo Meter	Systronic 121 Burner unit 122 Compressor 125 Digital Unit
7	Laboratory Centrifuge	REMI R - 8 – C 0 to 6000 R P M 0 to 60 min Timer
8	Laboratory Centrifuge	eltak T C 450 – D 0 to 4500 R P M digital 0 to 60 min Timer
9	Laboratory Oven	Shital Scientific Instrument Digital, S S Chamber Air circulation.
10	Autoclave	Media Instrument Mfg. Co. 2.5 Kg rating, 5000 Vot, S S
11	Biological Incubator	Shital Scientific Instrument Digital, S S Chamber
12	B O D Incubator	S R N Eng. Industries Digital, S S Chamber
13	B O D Incubator	Wadgati Lab equip Corp. Digital, S S Chamber
14	Microscope	BIOPLAN CXL
15	Colony Counter	LAPIZ–Bacteriological, digital
16	Muffle Furnace	Tempo 6" X 6" X 12", 3.5 K V A, digital controls

REFERENCE:

(1) G E Patel, Thesis Submitted for the degree of Ph.D. "The Studies of Various Reservoirs, Wells and other Sources from where Bhavnagar City receives Water for Drinking Purposes" January 1997, Department of Chemistry, Bhavnagar University, Bhavnagar.(1997)

(2) Nitaben Trivedi, Chair Person, Standing Comity, year 2000-2001, Bhavnagar Municipal Corporation, Bhavnagar.

(3) I S 3025, Indian Standard Method of Sampling and Test (Physical and Chemical) for Water and Wastewater, Part 1 – (1987)

(4) I S 4733 - 1972 Indian Standard Methods of Sampling and Test for Sewage Effluents clue 2 for sampling(1972)

(5) I S 1622 - 1981, Indian Standard Methods of Sampling and Microbiological Examination of Water.(1981)

(6) I S 10500 - 1991, Indian Standard for Drinking Water Specification(1991)

(7) I S 3025, Indian Standard Method of Sampling and Test (Physical and Chemical) for Water and Wastewater, Parts mentioned against the particular parameter.

(8) I S 4733 - 1972 Indian Standard Methods of Sampling and Test for Sewage Effluents.(1972)

(9) I S 1622 - 1981, Indian Standard Methods of Sampling and Microbiological Examination of Water.(1972)