10.0

CASE STUDIES ON DRINKING WATER QUALITY IN GUJARAT

10.0

CASE STUDIES ON DRINKING WATER QUALITY IN GUJARAT

As part of the office duty during the service at PHE Laboratory, Vadodara and subsequently at GJTI, Gandhinagar, the author has the occassion to Pilot some interesting case studies on pollution of Drinking Water due to various factors mostly industrial activities. These Studies were carried out with the support of office staff upon receiving complaints from public or directives of the authorities (GWSSB/Govt.).

Since the case studies have direct relevance with the present topic of research work, as it focuses on the assessment of impacts of pollution upon quality of water available in a particular area, factors contributing to the pollution and conclusions leading to the extent of impacts, it is thought prudent to incorporate them here as they will provide useful information for future reference and guidance. These case studies were piloted by the author and are not published any where so far. The publication of these studies will be interesting to know how water resources get polluted and to what extent.

The type of case studies carried out include the following.

10.1 Pollution due to GSFC, Dist. Vadodara (Mahi - Mini River).

10.2 Pollution due to Sari Printing Industries at Jetpur, Dist. Rajkot (Bhadar River)

10.3 Pollution due to Fluorspar mines - Kadipani, Dist. Vadodara (Sapan - Hiren Rivers)

10.4 Pollution due to industrial effluents discharged in Khari River at Bidaj - Sarsa, Dist. Ahmedabad. (Khari River).

These study locations are well spread over the large area of Gujarat, and give some idea on the impacts of water pollution due to discharges of industrial effluents in vicinity rivers. Due to rapid expansion of industrial sector, the concern for pollution of water resources is increasing as the effluents are mostly disposed of into surface water sources (Rivers). At many places the source of drinking water use to be a surface water (River). Although, the authorities while providing water supply to the communities, exercise great care in tapping the source to avoid pollution of water. However, subsequent developments pause threats to the raw water sources sometime forcing them to abandon the source. Secondly, the consumers are also concerned about the quality of water they receive. These case studies will therefore provide very useful information on these issues.

10.1 Water Pollution due to Fertilizer factory effluent at Vadodara.

10.1.1 Gujarat State Fertilizers Company (GSFC), one of the premier fertilizer manufacturing companies in the country, is located near Vadodara (10 km. in north) on Vadodara-Ahmedabad highway. The company commissioned in

1967, is producing nitrogenous fertilizers and some other chemicals like Caprolectum and sulfuric acid.

10.1.2 As shown in the location map at **Annexure - 10.1.1**, the location of the factory is in proximity to Bajawa Railway Station on west and Dashrath village on east. Towards its north west is village Karchia and on the southern side is village Chhani. All these villages are within a redium of about 0.5 km.

River Mahi which is one of the perennial rivers in the State is flowing about 7 kms away from the factory. A small river known as Mini River which is considered as effluent drain of many industries in that area is passing parallel to Mahi and is about 6 kms. away from the factory site.

The effluent from GSFC was also disposed off into this mini river through an open channel initially which was then let out through a cement concrete pipeline.

10.1.3 The residents of Dashrath village made a complaint to the State Government in 1978 that the drinking water source (a bore well) was getting polluted due to the ground water pollution caused by GSFC's effluent. The villagers were demanding an alternate water supply preferably from Mahi river (Radial well) as their source was rendered non-potable due to the above pollution. The complaint was subsequently turned into an agitation. The other villages like Bajawa, Karchia and Chhani also joined in that agitation. As a result of that, the State Government got the whole issue thoroughly examined by the PHE Laboratory at Vadodara which was then headed by the author under whose leadership the study was carried out.

10.1.4 The main argument of the villagers was that the factory was initially not having the systematic waste disposal devices. Also it has got large chalk pond which stores large volume of waters. There was suspicion that the chalk pond water was getting percolated down in to the ground water strata polluting them. An incident occurred at that time which increased the concern of the villagers. A circus was camping in the village Bajawa, which was keeping its own elephants for show. On one day, four elephants which went to the Bajawa village pond for bathing died instantaneously. People argued that GSFC effluent was occasionally let out in this pond. Rain water leachate of gypsum storage in open or accidental spillages were said to have access to this pond.

10.1.5 The main focus during investigation was on the deterioration of drinking water quality in the public supply sources. (Say village water works well). Survey and sample analysis was carried out for villages in vicinity to the factory (within radius of 1 km) and village away from the factory(5 km and above). Eight villages as marked in the map were selected under the survey. Water samples were collected from each source every month for a period of six months.

10.1.6 Chemical analysis was carried out for the salient parameters which decide the pollution of water. The main suspicion was about the nitrate and fluoride which were expected to come out from the factory as pollutants in the effluent. Average analytical values of six months are given in **Table 10.1.1**

10.1.7 Conclusion

- From the analysis results it was clear that there was no apparent evidence that the grond waters were contaminated.
- Except for nitrates, values of other parameters were found within permissible limit.
- Even nitrate values were also not very high, except for village padamala which was selected as distance village.
- Villages nearer to GSFC were showing less value of nitrate than the distance villages which proved that excessive amount of nitrate may not be due to GSFC otherwise it should be more in nearer villages.
- Many sources in other districts, which are not having any fertilizer factory in vicinity are also showing higher values of nitrate as shown in **Table 9.1** in chapter no - 9 on **"Occurrence of Nitrates in Gujarat"**, establishing the fact that higher values of nitrate are not only due to fertilizer factory but may be other reasons like increasing use of fertilizers and inherent characteristics of soil etc are also responsible for such situation. Wherever such situation arises, the villages are covered under NO Source Programme and provided safe water from alternate source by the state authorities.

10.1.8 It was known that the factory is taking all precautions to control the liquid waste through proper treatment and disposal system. The company has installed a modern treatment plant. It has also contributed prominantly to share the expenses of a common effluent treatment plant which will further treat the effluent and carry it to bay of Cambay(Arabian Ocean) which is 65 kms away through an effluent channel (cement concrete) which will be the first in country.

10.1.9 In addition to that the company as a goodwill, drilled a new tubewell to supply water to the villagers of Dashrath which were main agitators. The water quality of the new tubewell was found to be well within the prescribed permissible limits and that also proved that there was no pollution of ground water due to the factory. The analysis results of new tubewell were as under :

1)	Distance from factory	0.2 km
2)	Depth	80 mt.
3)	pH	7.75
4)	Total Dissolved Solids (mg/l)	544
5)	Chloride as Cl^- (mg/l)	66

6)	Nitrate as NO_3^- (mg/l)	15.1
7)	Fluoride as F^- (mg/l)	0.05
8)	Total hardness (mg/l)	184

10.1.10 Values of effluent coming out from the GSFC factory are avialable from the record of PHE lab (GWSSB) which are as under and indicate that necessary treatment is provided to bring down the effluent whinin the permisible limits

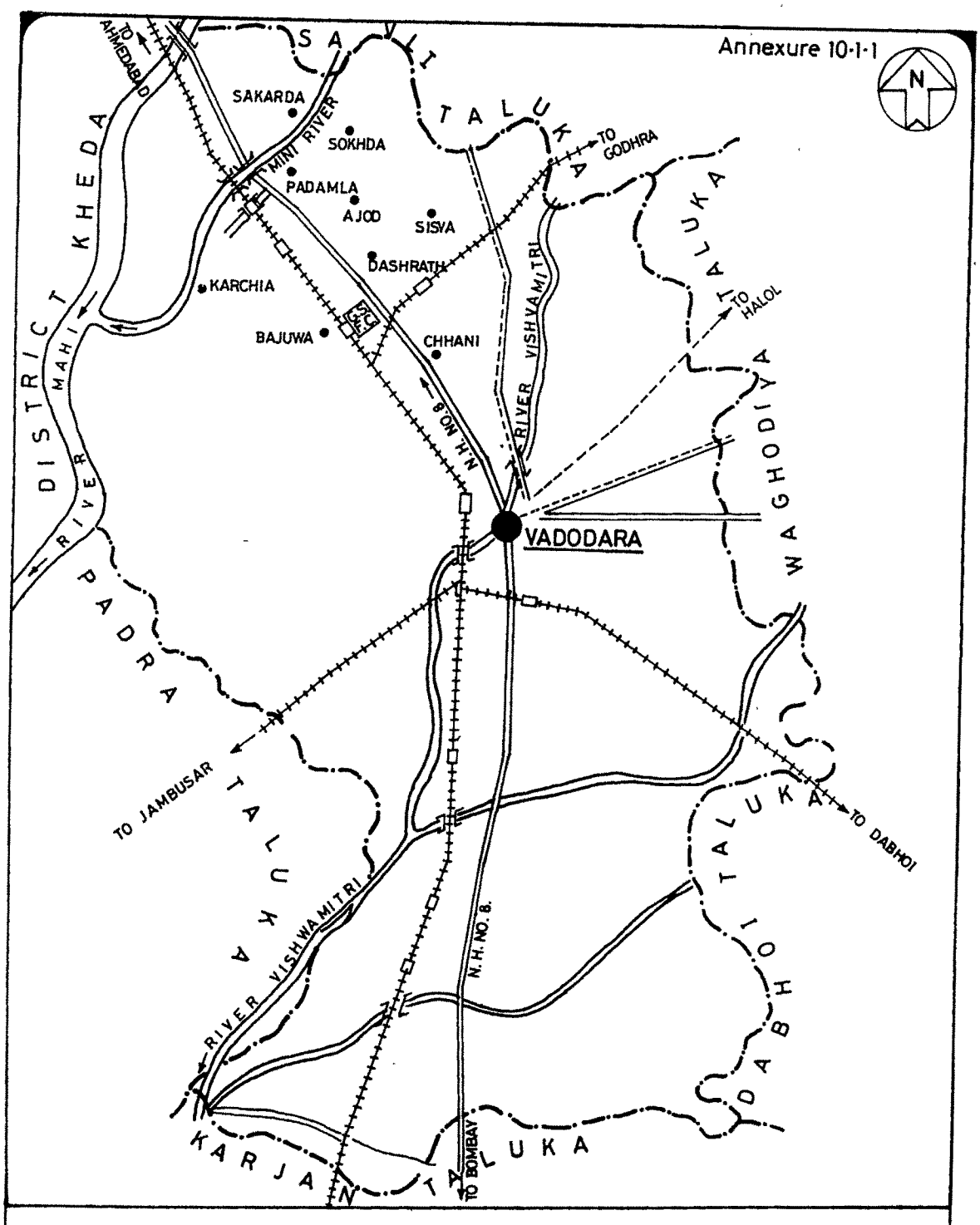
pH	9.5
Chemical Oxygen Demand (mg/l)	274
Biological Oxygen Demand (mg/l)	63
Total Dissolved Solids (mg/l)	2270
Suspended Solids (mg/l)	300
Chloride as Cl^- (mg/l)	365
Flow (mld)	22

10.1.11 The author has also carried out the extensive survey of various sources through out the state under this research study and values for Nitrate content are seperately reported at **Table No. 9.2** in chapter on **"Occurrence of nitrate in Gujarat"**. It will be seen from the table that except for few sources the values are within the permissible limit of 45 mg/l and in all cases below the relaxable limit of 100 mg/l. This shows that the water provided to the people of the State is safe from Nitrate content point of view.

Table : 10.1.1

Average analitical values for salient Chemical Parametres for villages around GSFC (Dist : Vadodara)

Village	Source	Depth (m)	Dist. from GSFC(km)	pH	TDS (mg/l)	Cl (mg/l)	NO_3 (mg/l)	Total Hardness (mg/l)	F (mg/l)
Dashrath	Bore Water	-	0.2	7.85	971	187	48	324	0.95
Karchia	Water-Works Well	55	0.25	8.05	819	134	49	258	0.69
Bajawa	Varigruh Well	85	0.2	7.95	1254	142	88	261	0.70
Padamala	Water-Works Bore	55	5.0	8.0	1065	256	131	575	0.80
Channi	Water-Works Bore	-	1.5	7.8	544	107	36	252	0.75
Sisva	Water-Works Bore	-	4.0	8.05	1226	287	23	203	0.55
Ajod	Vav Bore	-	4.0	8.18	826	151	82	307	0.56
Sankarda	Dug cum Bore	60	6.0	7.4	786	164	54	468	-



LOCATION MAP OF VILLAGES AROUND G.S.F.C.

LEGEND

RIVER

RAILWAY

NATIONAL HIGHWAY

VILLAGE

10.2 Water Pollution due to Sari printing (Textile) industries at Jetpur in Rajkot District

10.2.1 Jetpur town is located in Rajkot district of Saurashtra region in Gujarat State. It is a taluka (Block) head quarters of Jetpur taluka and is situated at about 70 kms away on western side from Rajkot. It is located on Rajkot -Porbandar road (N.H.No.8B) and also on river Bhadar which is one of the major rivers of Saurashtra. The population of Jetpur town was around 68000 souls when the study was carried out (1984-86).

10.2.2. Jetpur has become very famous in the country for textile industry particularly sari printing. There were about 1200 units located in Jetpur for processing of gray cloth mainly dyeing and printing of saris. The main processes involved are as under:

- Dyeing - Application of dye on the cloth.
- Printing - Screen printing.
- Washing - Washing with water.
- Drying - Sun evaporation.
- Packing - Packing in boxes.

10.2.3 This industry does not require power supply and spring as a cottage industry. It has spread to the neibouring villages also like Navagadh, Pithadia, Rabarika etc. It needs large quantities of water for washing purpose which the owner get from private sources and as such many units are seen on farm houses. It is highly labour intensive and hence provide employment to many people from surrounding areas. It is said that every third house in Jetpur is a process unit.

10.2.4 The raw materials used involves organic dyes and some other inorganic chemicals. The dyes are mostly Indigo, Rapid, Reactive and Direct type which are insolube in water but neutral in nature. They contain Nitroso, Azo and Carboxyl groups. The inorganic chemicals mainly include caustic soda. Since large quantities of water is used for process, obviously, effluent quantities are also large. The effluent contain dark colour due to dyes and some other inorganic chemicals.

10.2.5. The town has no organised sewerage system or waste water disposal works and hence the waste water is disposed off in a haphazard manner. The effluent passes through road side open drains and ultimately finds its way in the river Bhadar, which is a **non perennial river**. Many units are washing their saris in the river itself creating pollution of the river. The units which are located in the farms are disposing of their waste in the neibouring areas without any treatment.

10.2.6. Due to indiscriminate discharge of domestic and industrial waste water in the river Bhadar as well as vicinity areas, serious complaints were received about

the pollution of drinking water sources at Jetpur and downstream areas. Town Dhoraji which is also a taluka head quarters is located about 25 km in downstream on the river Bhadar. This town is dependent on river Bhadar for its water supply. The town receives water through infiltration wells in the river. The site is known as Bhukhi Head works. People started agitation for getting their water source polluted. The problem was characteristics know as "Red Water Problem" OR "Bhadar water pollution". Due to objectionable colour in the drinking water people at both Jetpur and Dhoraji were agitating. Many shallow well waters at Jetpur were also turn coloured due to ground water pollution.

10.2.7 The problem was investigated under the leadership of the author with the support of the staff of PHE laboratories, Vadodara and Rajkot during the period 1984-86 and useful recommendations ere made. The investigation included the following aspects.

- Pollution of River Bhadar.
- Assessment of waste water generated.
- Pollution of ground water sources at Jetpur.
- Pollution of water sources in down-stream villages.
- Pollution of water at Dhoraji

Detail investigation through site visits and analysis or water samples was carried out.

10.2.8. The details of water use and discharge were found as under :

• Total No. of units	1200
• Total No. of saris printed	3000 (minimum) per day. 80000 (maximum) per day.
• Total water require/1000 saris	15000 to 20000 liters.
• Total waste water discharged/1000 saris.	12000 to 15000 liters.
• Average flow of waste water	7.5 mld.
• Mode of present disposal	Through open drains into River Bhadar.

10.2.9. Average characteristics of the industrial effluent were found as under:

Sr. No.	Parameter	Minimum	Maximum	Average
1.	pH	6	9	7.3
2.	Total solids(mg/l)	1500	6000	2730

3.	Total dissolved solids (mg/l)	1200	4000	2250
4.	Suspended solids(mg/l)	28	2042	406
5.	Volatile solids(mg/l)	700	3700	1505
6.	BOD (mg/l)	100	1200	387
7.	COD (mg/l)	300	2900	995
8.	Percent sodium	30	90	59

10.2.10 Average characteristics of the mixed effluent stream at Jetpur near the Railway bridge were as under :

Sr. No.	Parameter	Value
1.	pH	7.6
2.	Suspended solids	430
3.	Total Dissolved Solids	1768
4.	Total volatile solids	316
5.	BOD	210
6.	COD	574
7.	Chlorides	222
8.	Sulphates	54
9.	Total Nitrogen	71
10.	Percent sodium	56.5
11.	Colour	Dark in colour. Reddish or pink.

Note : Values of parameters at Sr No 2 to 9 are in mg/l

10.2.11 Although the river Bhadar is major river of Saurashtra it has seized to be a perennial river at Jetpur and downstream due to construction of Bhadar dam on it near Jetpur about 20 kms. in upstream.

Some time there would be little flow in the river due to seepage etc. otherwise it remains dry and carries only effluent from Jetpur town. The people of Dhoraji town get water through wells in the river bed at Bhukhi Headwork which are vulnerable to the pollution from Jetpur industrial discharge.

The river water at Dhoraji had shown the following characteristics.

Sr.No.	Parameter	At Dhoraji	
		1984	1985
1	Colour	Nil	Pink(60 units)
2	pH	7.3	7.3
3	Turbidity	Nil	Nil
4	Total Dissolved Solids	500	560
5	Total hardness	220	250
6	Calcium	50	64
7	Magnesium	21	22
8	Chloride	138	140
9	Sulphate	31	41
10	Nitrate	1.0	3.5

10.2.12. Survey of water sources of villages around Jetpur and in the downstream on both sides of river Bhadar was carried out to check the effect of pollution in the water sources of these villages/towns. During personal interviews with the villagers by the author, it was revealed that the effect of pollution of Bhadar has not reached to the ground water sources in the villages surveyed. This fact was also established by carrying out the analysis of the samples collected from these villages.

The analysis results of water samples collected from these villages is given in the **Table - 10.2.1.** The analysis has established that the ground waters around and in the downstream of Jetpur have not been affected due to effluent disposal in river Bhadar.

10.2.13. From the above study following useful conclusions were drawn:

- River water at Jetpur is found contaminated due to disposal of untreated effluent from the textile processing units.
- The pollution of river water is not very heavy but moderate as the textile processing units are not containing strong pollutants except dyes.
- The dyes are producing objectionable colour in the surface water of river and some of the shallow wells at Jetpur.
- Since the dyes are insoluble in water, they gets settle all along their travel in the river bed and due to deposition of reddish coloured dyes the whole river bed from the top appears reddish
- Colour of dyes reaches upto Dhoraji town which is about 25 km in the down stream from Jetpur but the concentration at that point gets reduced to 5.0 units which is permissible in drinking water.
- No organic pollution is traced from all the samples analysed.

- The water supply in villages on both the banks is also not affected due to river water pollution.
- Except for Dhoraji town no other village people have complained about contamination of their local water supply sources.
- These conditions are attributed to the facts that river bed itself and the soild strata in the surrounding area is rocky which do not allow the percolation of the dyes pollution to the sub soil strata.
- The soil itself also work as a strainer which might be filtering out insoluble dyes particles and other contaminants.

10.2.14 Due to the river pollution problem, the Jetpur town which was getting its supply from Bhadar river at Jetpur has to get water from the Bhadar dam which is about 20 km in upstream. This scheme was executed at a cost of Rs.2.0 crores. Where as the Dhoraji town is now provided water from Fofal dam on river Fofal which is about 11 km away from Dhoraji in eastern direction. This scheme has also cost Rs.1.30 crores. Thus Rs.3.13 crores has to be spent to provide alternate water due to pollution or river Bhadar.

10.2.15 The authorities are separately arranging to provide collective treatment to the effluent before its disposal. The project include renovation and execution of new drainage lines as well as effluent treatment plant. The treatments envisaged include

- Neutralization
- Flash mixing
- Flocculation
- Sedimentation
- Sludge drying

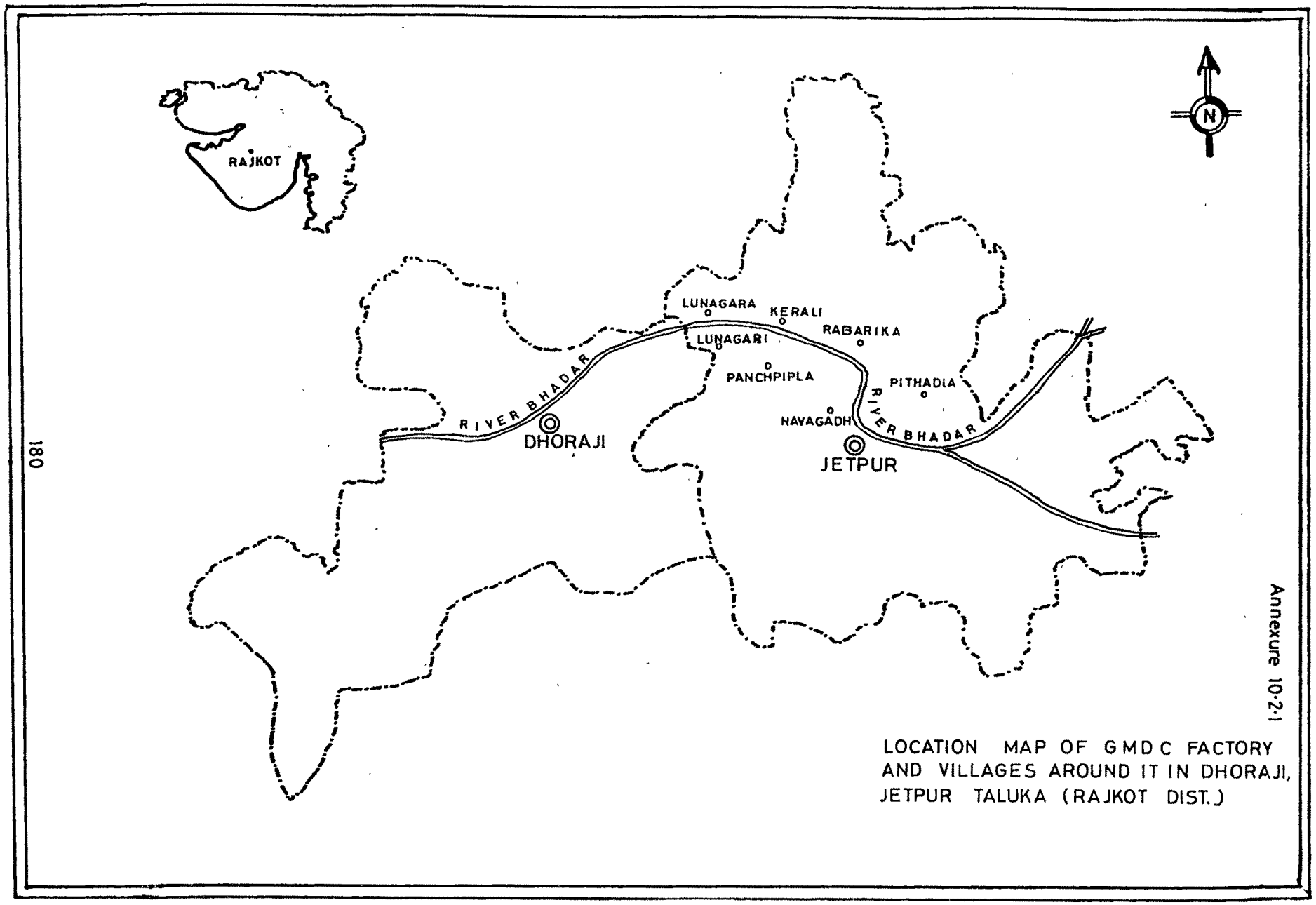
The treated effluent is proposed to be stored in a pond(oxidation) and used for irrigation. Junagadh Agricultural University has opined that the treated effluent will not be deleterious to crop. The operation and maintenance of the plant is proposed to be handled by the **Jetpur Textile Owners Association**

Table 10.2.1

Results of Water analysis carried out for villages in the affected areas on both banks of river Bhadar

Sr.. No	Parameter	Villages around Jetpur town				Villages in the down stream of Jetpur town						
		Pvt.well of Bhikhabhai Harijbhai.	Bore well of GHB colony.	Public well	Pvt.well of Devabhai	Navagadh	Pithadia	Rabarika	Panchpipala	Kerali	Lunagari	Lunagara
1	Distance from Jetpur (in km)	0	0	0	0	2	5	12	12	12	13	13
2	Distance from River Bhadar(Vertical)km.	0.2	0.5	0.3	0.3	0.2	4	3	3	0.5	0.3	0.5
3	On which Bank of River	Right	Left	Left	Right	Left	Right	Right	Left	Right	Left	Right
4	Type of source	Well	Bore well	Public well	Well	Bore well	Bore well	Public well	Hand pump	Public well	Public well	Hand pump
5	Depth of Source(mt			160		30	62	7.0	45	4.75	11	60
6	Colour	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
7	Turbidity	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
8	pH	7.5	7.3	7.3	7.3	7.7	7.0	7.6	7.6	7.6	7.7	7.4
9	TDS	408	852	810	510	366	400	840	936	764	850	1742
10	Total Hardness	224	320	450	296	180	186	260	294	290	354	512
11	Calcium	51	74	106	62	34	53	102	103	37	72	130
12	Magnesium	23	35	45	35	23	13	10	9	48	42	45
13	Chloride	34	212	122	80	50	74	66	84	190	188	582
14	Sulphate	23	58	50	29	24	53	Nil	35	46	38	101
15	Nitrate	3.5	97	88	14	1.0	28	Nil	35	35	2.0	127
16	COD	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

Note Values of Sr No 9 to 16 are expressed in mg/l.



LOCATION MAP OF GMDC FACTORY AND VILLAGES AROUND IT IN DHORAJI, JETPUR TALUKA (RAJKOT DIST.)

Annexure 10·2·1

10.3 Water Pollution Due to Fluorspar Industry at Kadipani Mines in Vadodara District.

10.3.1 Kadipani mines are located in Chhota-Udepur taluka of Vadodara district in Gujarat. They are about 30 km away from Chhoa Udepur, on the borders of Madhya Pradesh and Maharashtra. Fluorspar (also known as Fluorite) is a mine product which is a raw material for producing calcium fluoride (C_aF_2) which has its uses in many industries like

- Metallurgical Industries such as copper, steel, aluminium.
- Ceramic and Cement Industries
- Glass Industries
- Electrodes and Refrigerant gases

The site for mining activities is known as Ambadunger. The area is hilly with origin of some rivers like Hiren and Sapan. The mining operation was started in 1968 and until 1971, only raw material was sold directly to the customers. The processing plant to get 90-96% pure calcium fluoride came into existence in 1972. The plant is run by Gujarat Mineral Development Corporation (GMDC) of Government of Gujarat

10.3.2. The process involves various stages like mining, crushing, floatation, filtering, drying and packaging, through which the raw material in which 25-30% C_aF_2 is available is upgraded to get 96% C_aF_2. About 500 tonnes of raw material is mined and processed per day. Annually 30000 tons of final product is produced. Water requirement for the process is about 1500 m^3/day.The effluent from the plant is disposed of in the valleys which ultimately finds its way in the river Sapan

The effluent from the process plant contains following parameters (June 1992) observed in a grab sample.

Sr.No.	Parameters	Concentration
1	pH	7 35
2	Colour	Dark brown
3	Total Dissolved Solids	1694
4	Suspended Solids	37364
5	Hardness	340
6	Chloride	32
7	Sulfate	160

8	Fluoride	13.5
9	Alkalinity	800
10	Nitrate	2.2
11	Phosphate	3.06
12	BOD	161
13	COD	358

Nopte :

- The effluent contains very high amount of suspended solids which could be removed by settlement before disposal.
- The dissolved fluoride content is also high causing concern.
- All values except pH and colour are expressed in mg/l.

10.3.3 The process effluent, in addition to causing siltation of the river bed and imparting brown colour to the river water is also increasing the fluoride content in water which has got adverse health effects. Excessive amount of fluoride causes fluorosis of bones and teeth which is elaborately discussed in chapter - 8 on **"Occurrence of Fluoride in Gujarat"**.

Public complaints were received about the pollution of the river jeopardising the riparian rights of the downstream users. Complaints regarding pollution of ground waters in the downstream are particularly about increase of fluoride content in well waters were also received (1992-93).

10.3.4 Through investigation in the case was made by visiting the factory site, and downstream villages. Samples of effluent from the plant, river and public sources in the downstream areas were also collected. The public water sources were mostly shallow wells or handpumps.

Results of analysis are given in **Table - 10.3.1**

10.3.5. Following conclusions were drawn from the study.

- Processing of fluorspar mine produces large amount of effluent which is having excessively high concentration of suspended solids, colour, and fluoride.
- The large amount of suspended solid causes siltation in the disposal site (River bed).
- The excessive amount of fluoride causes problem of fluorosis and renders water sources unfit for potable used,
- Ground water in the villages of downstream area of the river Sapan are found contaminated due to excessive fluoride.

- The river water(surface water) also is severely affected upto a long distance due to turbidity,colour and fluoride.
- The process plant needs adequate treatment before final disposal into any water source.

10.3.6. The factory authorities (GMDC) are known to be in a process of upgrading the treatment plant facilities so as to control the pollution of environment due to its effluent disposal.

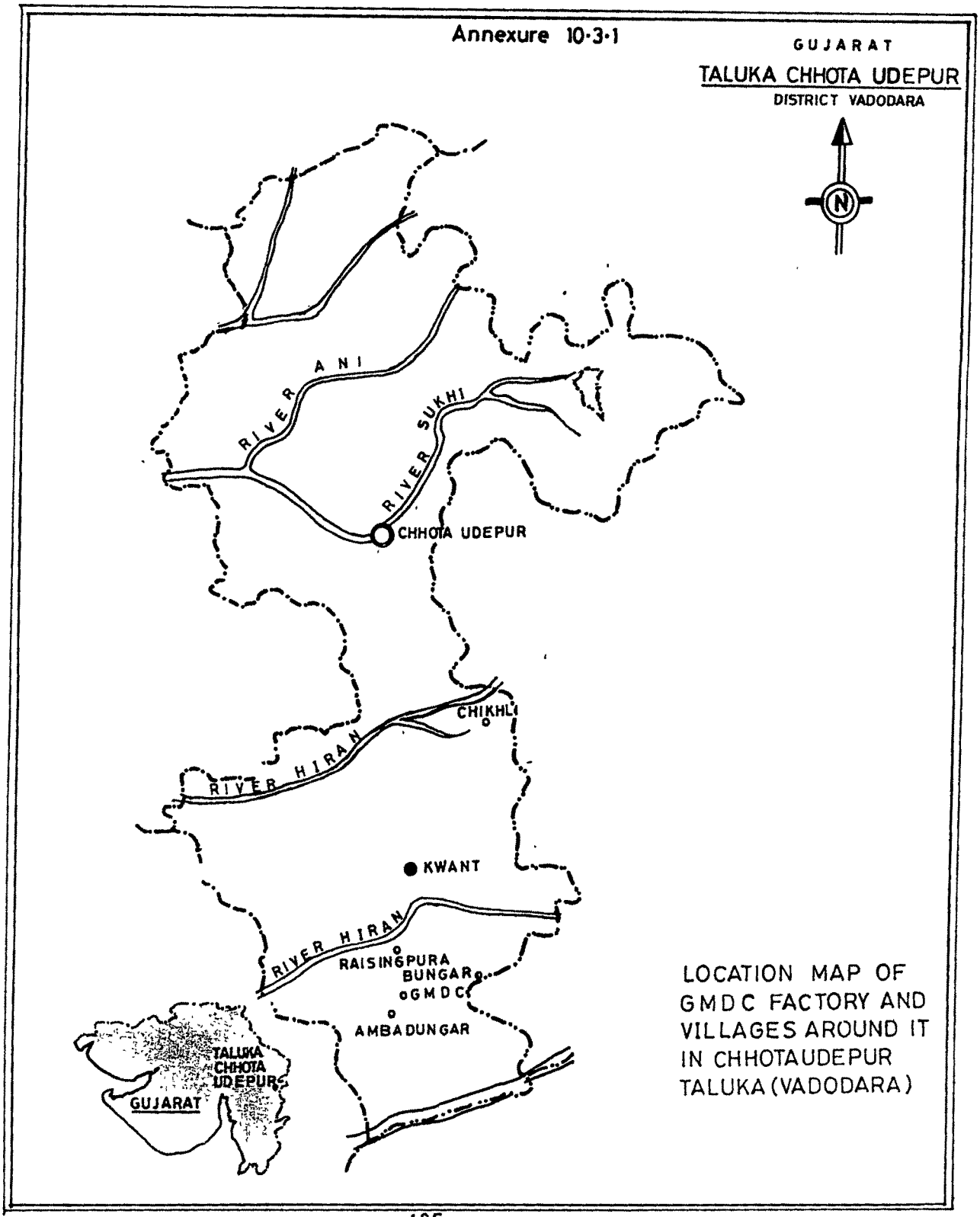
Table - 10.3.1

Chemicals analysis results of water sources in downstream of GMDC's Fluorspar processing plant at Kadipani on the banks of Sapan River in Chhota Udepur taluka of Vadodara district (June 1992).

1	Village Name	Bunjar	Bunjar	Bunjar	Chikhali	Raising-pura	Raising-pura	Kwant
2	Source	Tap water from GMDC pipe- line	Hand pump	Pvt.well	Public well	Public well	Sapan river water	Public well
3	Distance in km	0	0	0	1	4.5	4.5	15
4	Colour	Nil	Nil	Nil	Nil	Nil	Nil	Nil
5	Turbidity (NTU)	Nil	Nil	Nil	Nil	Nil	61	Nil
6	pH	8.20	7.60	7.85	7.90	7.95	8.25	7.85
7	Total Dissolved Solids	340	468	448	588	452	612	47
8	Total hardness	288	310	300	332	280	256	268
9	Chloride	16	32	28	88	32	120	40
10	Nitrates	13.3	44.3	28.8	Nil	17.7	N il	6.65
11	Alkalinity	230	256	260	340	332	252	276
12	Fluoride	0.39	0.55	0.80	3.50	2.20	5.50	0.80

Note : Values of parameters at Sr No 7 to 12 are in mg/l

Annexure 10-3-1



10.4 Water Pollution Due to Industrial Effluents discharged in River Khari in Mehemedabad taluka of Ahmedabad District

10.4.1. Public complaints were received during 1982-83 regarding pollution of drinking water sources due to pollution of Khari River. Khari river is a small river passing by outskirt of Ahmedabad city, and flows through Mehemedabad taluka. It is a non-perennial river which mostly carries effluent from industries at Vatva Industrial Estate near Ahmedabad. The river water is used for irrigation by lifting through pumps. People from villages Bidaj and Sarsa in Mehemadabad taluka complained about the pollution demanding new sources of potable water.

10.4.2. A detailed survey and sampling were carried out by a scientific team of PHE Laboratory, Vadodara headed by the author. Since the main complaint was from Bidaj and Sarsa villages in Mehemedabad taluka of Kheda district, the samples of following sources were carried out.

1. River Khari at Bidaj.
2. Public well at Bidaj.
3. Private well at Bidaj.
4. River Khari at Sarsa.
5. .Public well at Sarsa.

Village Bidaj is situated just on bank of river Khari. Its population in 1982 was estimated to be 2500 persons (1971-2016 persons). In addition to public water source, the village has got about 45 private handpumps.

Village Sarsa is in downstream of Bidaj and is about 2 km. away from the river Kari. The population of Sarsa in 1982 was estimated to be 1500 persons (1971 census - 1373 persons). To consider the seasonal variations in the water quality, samples in all the 3 seasons (winter, summer, monsoon) were collected.

10.4.3. Physico-chemical analysis of all the sample was carried out considering the significant parameters which decide potability of water. Minimum, maximum and average values of all samples are reported in the **Table - 10.4.1.** Following observations were drawn.

- The river water does not contain regular flow of water. It has some scattered and stagnant pools of water.
- The colour of the river water was always dark indicating presence of industrial effluents.
- The values of pollution indicative parameters like TDS, SS, COD and Oil/grease are on higher side but are moderate.
- Public well water at Bidaj is found unpotable but water in a private well is found potable.

- Public well water at Sarsa is found potable.

10.4.4. Based on the study carried out, following conclusions were drawn.

- The river water is found highly coloured and turbid. High concentration of TDS, S.S., COD, BOD, Oil and grease indicate presence of pollution in the river. Presence of dark colour indicates that the pollution is from industries. However, the concentration of pollutants is not that strong.
- Looking to the meagre flow of water in the river(except monsoon) the river does not pose any capability to pollute the surrounding ground water sources.
- Public well water at Bidaj is found to be unfit for potable use due to excessive values of parameters like TDS,Cl,hardness and nitrate, etc. However the values are not very high. The values of all parameters have remained constant throughout the study unlike the river. Moreover, absence of COD and BOD values indicate that there is no pollution due to river water which otherwise contain industrial effluents.
- The results of water samples drawn from private well from Bidaj show that it is safe and acceptable for potable use. This also proves that if the river water is the cause for contamination of public well at Bidaj, it ought to have polluted the private source also which is not the case. Thus there appears to be no pollution of public sources at Bidaj due to Khari River carrying effluent.
- Values of some of the parameters like sulfate are even higher in public well water at Bidaj than the river water. This indicates that there is no direct connection between river water and well water.
- The excessive values of some of the parameters in the public well at Bidaj are not because of river pollution but may be due to some other reason. One of the attribution is that it may be due to constant drawal of water, the quality of water might have deteriorated. Or some other reasons like inherent characteristics of the local soil.
- Absence of COD and BOD values in the public well at Bidaj also proves that there is no access of industrial effluent from river to the public well water at Bidaj.
- The other source at village Bidaj i.e. private well shows all parameters within permissible limit establishing the fact that the ground water at village Bidaj is yet not affected by the river water pollution.
- Water at Sarsa in the public well source is also found fit for potable use. This also proves the fact that there is no effect of river water pollution on the ground waters of the area.

- Obviously when the villages situated on the bank river or in vicinity are not polluted, possibility of pollution of other ground water sources (at distance)are ruled out.

10.4.5. The study has established the fact that so far the ground waters are not affected by the Khari river carrying industrial pollutants. But the river itself is polluted. This is going to increase in the years to come as the process of industrialization in and around Ahmedabad is increasing rapidly. In view of that the authorities should take action to force the industries to treat their wastes before disposal. Also the authorities should provide safe disposal system. It was learnt that the authorities are thinking of providing a common effluent channel like Vadodara to carry the effluent to the Arabian ocean.

Table - 10.4.1
Results of analysis for sample collected at Bidaj, Sarsa and river Khari in Mehmedabad (1982-83)

Para-meters	BIDAJ									SARSA					
	River Khari			Public Well			Private Well			River			Public Well		
	Min	Max.	Average	Min	Max.	Average	Min	Max.	Average	Min	Max.	Average	Min	Max.	Average
Colour	Coloured			--	--	--	-	--	--	Coloured			--	--	--
pH	7.30	8.10	7.70	7.20	7.70	7.40	7.80	8.00	7.70	7.35	8.05	7.60	7.40	8.15	7.70
Turbidity	--	--	--	--	14	9	6	38	18	--	--	--	2	8	4.8
Hardness	--	--	--	728	778	748	466	546	512	--	--	--	262	284	270
Total Dissolved Solid	264	5428	3604	2100	2186	2140	962	1132	1048	278	4656	2516	826	916	881
Suspended Solid	452	828	648	--	--	--	--	--	--	120	634	303	--	--	--
Cl	38	1550	1016	552	624	590	166	234	204	38	1320	687	200	228	213
SO_4	17	123	82	108	123	113	17	95	73	15	115	77	60	77	72
NO_3	--	--	--	95	146	124	13	33	19	--	--	--	2	29	13
Ca	--	--	--	127	163	151	22	43	35	--	--	--	7	79	61
Mg	--	--	--	77	98	88	17	31	24	--	--	--	20	79	32
COD	17	79	49	--	--	--	--	--	--	8.5	332	118	--	--	--
BOD	7	56	28	--	--	--	--	--	--	--	--	--	--	--	--
Oil & Grease	0.6	41	26	--	--	--	--	--	--	--	--	--	--	--	--

Annexure 10·4·1

LOCATION MAP OF VILLAGES AROUND RIVER KHARI