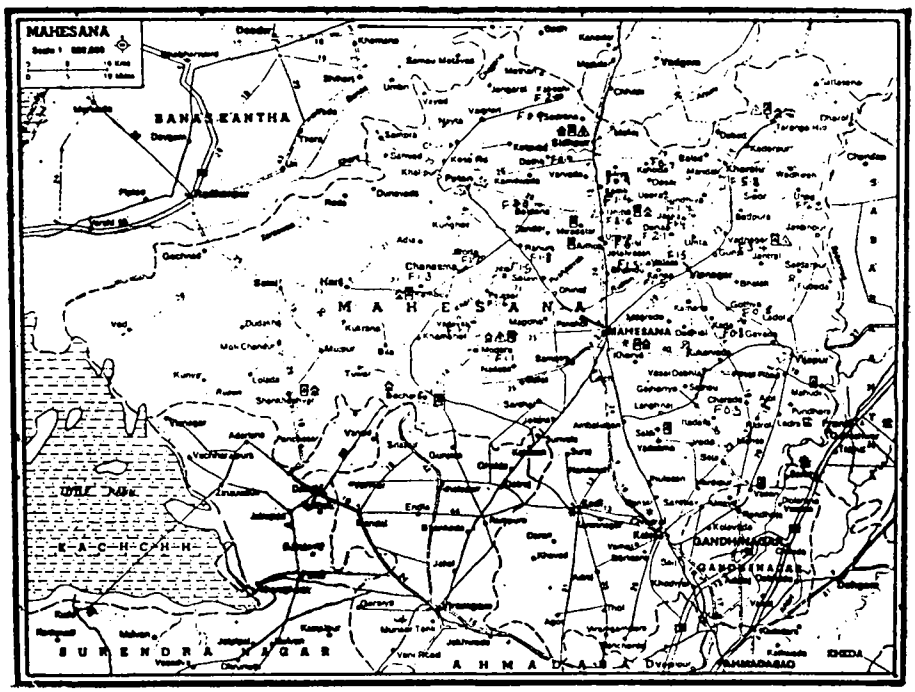
TECHNOLOGY MISSION ON DRINKING WATER IN VILLAGES AND RELATED WATER MANAGEMENT

DEFLUORIDATION CAMP

MEHSANA (GUJARAT).

DECEMBER 21-24, 1987



REPORT

NATIONAL ENVIRONMENTAL ENGINEERING RESEARCH INSTITUTE
NEHRU MARG, NAGPUR-440020.

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Introduction

Nalgonda Technique of Defluoridation is the technology identified for solving the problem of excess fluoride in drinking water and related health problems. This well established technology of defluoridation of drinking water supplies is the contribution of National Environmental Engineering Research Institute (NEERI), Nagpur, one of the National Laboratories, under Council of Scientific & Industrial Research (CSIR), New Delhi.

National Environmental Engineering Research Institute (NEERI) is one of the participating National Laboratories in "Technology Mission on drinking water in villages and Related water Management". This mission programme is introduced by the Department of Rural Development, Ministry of Agriculture, Govt. of India at the instance of the Prime Minister.

In keeping with the expectations of the central agencies, NEERI mobilised its orjginality and innovative expertise in planning and execution of several events of direct relevance to the advancement of technology mission objective. Two documents namely *"Action Plan" and "Milestones" were brought out as internal guidelines* for the NEERI personnel to brief them on the related completed/oncoming activities and thus enable them to contribute effectively and provide consolidated information to the concerned interacting agencies.

In accordance to the Action Plan, the Institute has organised National and State camps on Defluoridation and Iron Removal. The State Defluoridation Camp in Mehsana planned by NEERI under the Technology Mission was organised in the context of reported excessive fluorides in drinking water in the villages of the district. The camp was chiefly organised by Gujarat Water Supply & Sewerage Board (GWS & SB), Gandninagar in Collaboration with NEERI & Directorate, Health & Medical Education, Government of Gujarat.

Mehsana District

Mehsana is one of the 19 districts of the State of Gujarat and located in the North region of the State. Mehsana district has the district of Banaskantha on the North side and Ahmedabad on the South. East and West borders of Mehsana district are lined by the borders of Sabarkantha district and Rann of Kutch respectively. The total area of the district is 9,027 Sq. km. which is 4.6% of the total area of the Gujarat State. The district is divided in 11 Talukas which are Chanasma, Harij, Kalol, Kheralu, Mehsana, Patan, Sami, Sidhpur, Vijapur and Visnagar.

The population of Mehsana district is 25,48,787 (1981 Census) which is 7.48% of the total population of the state. The district has 1,099 villages, and 14 towns with a literacy rate of 46.74%. Of the total population, 64.89% are males and 35.11% females. The population density of the district is 282 per Sq. km. which is 1.6 times more, as compared to the total Gujarat State.

Mehsana is another district with few industries. It has ONGC oil fields near Kalol. The strong agricultural base is responsible for good crops of bajra, jowar, cotton and oilseeds. Major characteristics of the district particularly in relation to the economic resources are Agriculture, Irrigation, Co-operation, Industries, Power, Transport and Communication, Insurance, Live-stock and Animal Husbandry, Education, Medical and Public Health. The Dudhsagar Dairy and Cattle feed plant near Mehsana are amongst the biggest dairy operation in Gujarat.

At Mehsana is to be found the 900 year old Sun Temple, one of the finest examples of Indian temple architecture. The Umiya temple is also located here. Vadnagar is known for its architecturally renowned Toran and Hadkeswar temple. Taranga, Shankeshwar and Mahudi are famous for Jain temples.

The nearest airport is Ahmedabad, about 75 Km. from Mehsana and major transport is by road. The rail line network is meter gauge which is connected to Ahmedabad and Delhi.

Fluoride Concentration in Mehsana District

Out of these 11 talukas, some of the villages in Kheralu, Sidhpur, Patan, Chanasma and Visnagar are having groundwater sources containing high fluoride concentrations. The Govrnment of Gujarat through GWS & SB has taken commendable measures and planned a systematic programme to fight this menace. The GWS & SB is mentioned hereafter as "Board" in this communication. Water quality surveys conducted in the villages of Sidhpur, Kheralu, Visnagar, Patan, Chansma, Vijapur and Harij of Mehsana district, revealed that some villages of Kheralu, Sidhpur, Patan and Chanasma talukas are affected by the adverse health effects of excess fluoride in drinking water. 200 water samples were collected from the villages of Mehsana district. The taluka wise break-up was 54 samples in Sidhpur taluka, 47 in Kheralu, 45 in Chanasma, 28 in Patan, 18 in Visnagar and 7 and 1 in Harij and Vijapur rspectively. The highest Level of fluorides was observed to be 5.6 - 5.8 mg/l in water samples collected from the village Kheralu. A map showing fluoride levels in different villages is enclosed. The chemical charcteristics of the waters in various villages of Mehsana District are shown in Tables 1 to 6.

State Defluoridation Camp

The defluoridation camp at Mehsana was organised during December 21-24, 1987 as a joint venture of Gujarat Water Supply & Sewerage Board, National Environmental Engineering Research Institute and Directorate of Health Services and Medical Education, Gujarat. The camp was organised at the instance of Directorate, Technology Mission as spelt out by TAG III. The camp programme was planned by Shri K. R. Bulusu, Deputy Director and Coordinator, Technology Misson, NEERI, Nagpur. The basic objective of the camp was to impart training to the representatives of the participating agencies of various districts of Gujarat afflicted with the problem of excess fluoride in drinking water.

A public awareness campaign was made an integrated component of the camp. The programme included the following main activities.

a) Lecture and discussion with participants.
b) Demonstration of technology at the camp site.
c) Visit to fluorosis affected villages.
d) Demonstration of Nalgonda Technique under field conditions.
e) Evaluation of water quality and fixing the dose of chemicals for the identified sources
f) Public meetings and demonstration at selected villages.

Starting on 19 December, 1987, after preliminary preparation for the camp at NEERI, Headquarters, Nagpur and Ahmedabad Zonal Laboratory, the team reached Mehsana on 20th December, 1987. A total of 11 members comprised NEERI team for the camp. As per the decision earlier taken by GWS & SB, three training-cum-awareness camps on defluoridation were organised as per the following programme.

1) For Medical Officers : on 21-12-1987
2) For Paramedical workers : on 22-12-1987
3) For Engineers : on 23-24 December, 1987 (NEERI's Programme)

On 21st and 22nd December, 1987, NEERI team participated in the camp with Medical Officers and Paramedical workers and simultaneously analysed the water samples received through GWS & SB, PHE Laboratory, Baroda and District Health Officer, Mehsana. A total of 200 samples were analysed during the camp period. In response to the information circulated by GWS & SB to its officials at various district headquarters, in all 79 participants from all over the state participated in the camp. A list of the participants is given in Annexure I

A Special feature of the camp was the participation of number of villagers in the camp activities to get themselves acquainted with Nalgonda Technique, demonstration and discussion and to see the instruments like ion-meter and spectrophotometer for the estimation of fluoride, Nitrates and other related parameters of water quality

Programme

The camp was inaugurated by Chief guest Shri V. B. Patel, Secretary (W/S), Govt of Gujarat and Chairman, Gujarat Water Supply and Sewerage Board, Gandhinagar, on 21st December, 1987. Shri D. K. Rao IAS, Collector, Mehsana, presided over the function Shri Y. N. Nanjundiah, Member Secretary, GWS & SB was the Guest of Honour, The distinguished invitees to the function included Shri R. A. Bhatt, Chief Engineer (Trg &

Tech. Mission), Shri M. D. Dave, Chief Engineer, GWS & SB and the former Director of NEERI Prof. R. S. Mehta. Dr. A. K. Susheela of AIIMS, New Delhi was also present on the occasion.

The daily programme of the camp is given in Annexure II. The demonstration on Nalgonda Technique using bucket of 50 Litre capacity for Domestic Defluoridation was shown and the technique explained to the participants. Estimation of fluoride content in water samples by ion selective electrode method was also included in demonstration. All the units and methodologies were subsequently demonstrated to all the visitors, including several Health, Medical and water supply authorities. Shri K. R. Bulusu opened the topic of fluoridation and defluoridation and development of technique taking the participants into the details of chemistry and technology of defluoridation and posing the nature of the problems the trainees are expected to solve back-home.

A design example was solved as a working exercise for the participants to enable them to mobilize their own ideas in finding the solution to the problem of excessive fluorides in drinking water with bearing on the local conditions faced by them. This also helped in setting away the concept of typed designs or standard designs and making defluoridation plants which suit their local needs.

Defluoridation Exercise and Field Visits

Participants from the various districts of Gujarat attended the camp. The specific training programme included lectures, demonstrations and field visits. After the lectures and demonstration, participants carried out the experiments on defluoridation,

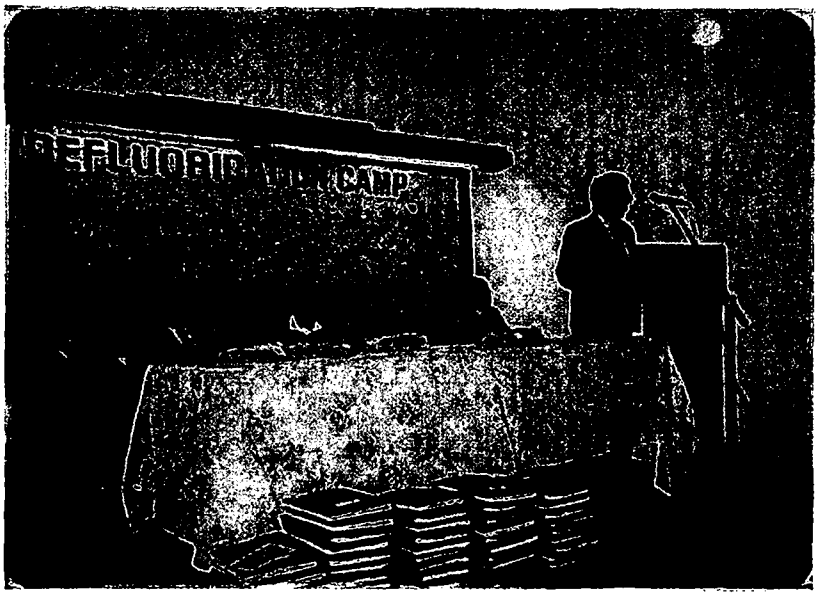
Observation on Excessive Fluoride Problems in Mehsana District

1) The Board is aware of the problem of excessive fluoride in drinking water in Mehsana district area and proposes certain steps to solve the problem.

2) The Board has undertaken extensive survey of water supply sources involving the Public Health Engineering Laboratory of GWS & SB.

Follow-up Action in Mehsana District

Considering the problems in villages of Mehsana district and as a result of the tremendous awareness amongst the fluoride affected villages in these areas, the following action is recommended consequent to the discussion between the NEERI team of Scientists and concerned senior Engineers of the Board to ameliorate the suffering of the several



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thousands in that area and to prevent adding daily incurable fluoretics to the society and consequent problems.

1) Domestic Defluoridation should be practised in all the villages containing excess fluoride in ground water villages until the time when community water supply comes to these villages. This in turn will prevent adding daily incurable fluoretics to the society and consequent problems.

2) Installation of Fill-and Draw type community Defluoridation water supply schemes in the evidently worst affected problem villages, viz. Tavadia (Taluka Sidhpur) and Badarpur (Taluka Kheralu) villages to supply at the rate of 40 lpcd to the 1,740 and 3,545 populations respectively.

3) Group water supply schemes with or without external aid to cover all or part of the fluoride affected villages by bringing water from a distance as a long range solution, where such low fluoride water becomes available within a reasonable distance from the fluoride areas.

While the efforts to think on a long range basis are commendable in the from of bringing water from a distance to quench the thirst of the fluoride affected areas, it is necessary and, in fact, highly essential that until such time the long range plants reach the people, some alternatives as indicated above, viz, domestic defluoridation and some Fill-and-draw type defluoridation systems are implemented without any further loss of time. As and when group water supply schemes materialise from surface sources with low fluoride, the domestic defluoridation and fill-and-draw type plant can be discontinued and the plants shifted to those places where they are still required, i. e. to those villages which may still not be fortunate to have been covered under group schemes.

Status of Fluoride Concentration in Water

Out of 200 samples collected from the equal number of villages in the belt. 92 villages have the fluoride concentration less than 1.6 mg/1, 69 villages have fluoride in the range of 1.6 to 2.5 mg/1, 32 villages have 2.6 to 3.5 mg/1 and 7 have fluoride concentration between 3.6 and 5.6 mg/1. However, this does not give a complete picture of the entire district. A decision in regard to installation of domestic defluoridation can be taken after the data on fluoride levels is available for the entire district

The participants from the various parts of the state having taken active part in the camp and following Demonstration at the village acquired the basic requirements for using Nalgonda Technique in the fluoride affected areas in various parts of the state. They were receptive, inquisitive, and innovative and were keen to propogate the idea to their respective areas. It is hoped that, the participants and voluntary agencies may take follow up action

in their respective problem zones and contribute to the amelioration of the suffering of the fluoride affected people.

The responsibility rests with the concerned state agencies. They should take up remedial measures by actively advocating domestic defluoridation in various villages and whenever possible install Fill-and-Draw type shiftable defluoridation plants without further delay. Some group of villages might require community continuous defluoridation plants. Such places may be identified and work commenced using the detailed design information contained in the "Defluoridation" package prepared and widely circulated by NEERI. A Gujarati version of this document was also brought out on the occasion and distributed to the participants to enable them to understand the techniques properly for subsequent adoption. The copies were given to the participants and were also sent to the Chief Engineers for guidance.

Health Aspect

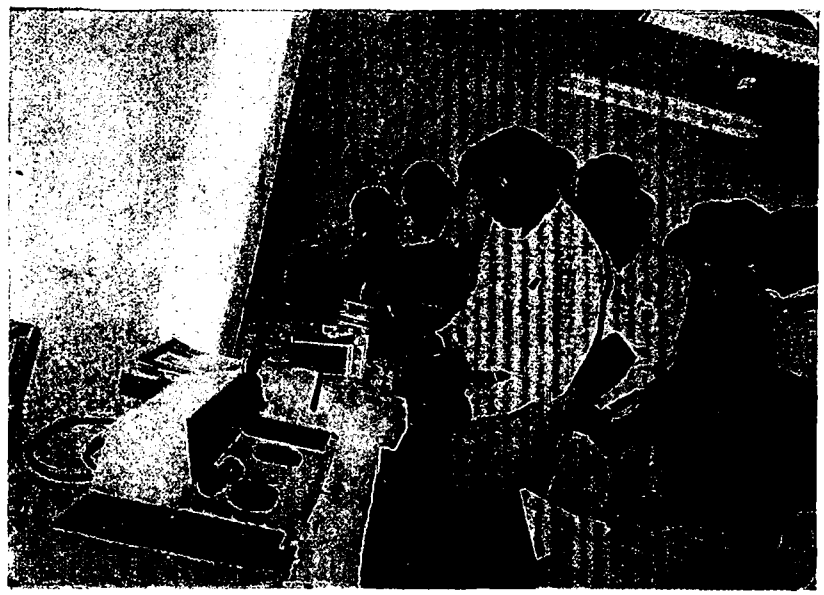
Fluoride although beneficial when present in concentrations 0.8-1.0 mg/1, has been associated with mottled enamel of the teeth when present in potable waters in concentrations in excess of 1 5 mg/1. Skeletal fluorosis has been observed at concentration beyond 3 mg F/1.

Some villages of Kheralu and Sidhpur talukas are observed to be affected by the adverse health effects of excess fluoride in drinking water. The fluoride concentrations were observed to be 3.5 mg/1 to 5 6 mg/1 in water samples collected from the villages of these two talukas. On the basis of fluoride concentrations, a decision to install fill-and-draw type community Defluoridation Plants at Tavadia (Sidhpur taluka) and Badarpur (Kheralu taluka) villages has been taken jointly by GWS & SB and NEERI. The fluoride concentrations in water samples collected from Tavadia and Badarpur are found as 4.0 mg/1 and 3.4 mg/1 respectively The physico-chemical quality of the waters in these villages are given in Table 7

Domestic Defluoridation

Domestic Defluoridation by Nalgonda Technique is an acceptable way of reducing fluorides. Once the level of fluoride and the alkalinity are known, provided the water is otherwise suitable, the method can be used with ease. The process besides fluoride will aiso remove suspended impurities, bacterial contamination and excessive alkalinity in the water,

During the demonstration and the participation of the villagers and the official participants from various districts of the state the natural waters in the villages visited namely Amudh and Devada and the defluor dated waters treated in buckets were tasted. While change in the taste of the treated water is inevitable, there were no discernible objection to it when specifically and repeatedly enquired about it IT HAS TO BE ENSURED THAT NOT MORE THAN WHAT IS REQUIRED TO BE ADDED IN THE FORM OF ALUM DOSE IS ADDED, Otherwise, a possibility of a residual metallic taste due to excess alum becomes perceptible, causing objection, Fortunately, the Mehsana water is characterised by sufficient alkalinity and such situation seldom arises unless



LABORATORY ANALYSIS IN PROGRESS

REACHING OUT TO THE VILLAGE PEOPLE

deliberately excessive alum dose is added out of ignorance. IT IS, THEREFORE ESSENTIAL THAT THE DOSE ADDED IS ON THE BASIS OF THE ACTUAL RECOMMENDATION OF THE N. E. E. R. I TEAM OF SCIENTISTS.

During the domestic defluoridation by Nalgonda Technique, the excessive alkalinity is destroyed and excessive bicarbonates are removed. This is an advantage which improves the taste of tea and other beverages due to lesser extraction of tanning like substance by the treated water. Since the villagers are used to the preparation from alkaline waters, it takes time and creation ot awareness among them to make them realise the usefulness of the changed taste brought about by the process of defluoridation.

Audio-Visual Coverage of the Camp :

The over whelming participation and mass movement during the camp is depicted in a video-coverage prepared by the Gujarat Water Supply & Sewerage Board.

Installation Of Fill-And-Draw Type Community Defluoridation Plants

Two Fill-and-Draw type Defluoridation Plants are recommended for installation at the villages namely Tavadia and Badarpur in Mehsana district. A brief description of these two villages is as under :

Sr. No.	Description	Tavadia	Badarpur
1.	Population (1981 Census)	1,286	2,633
2.	Total area (Hectares)	538.36	460.33
3.	Educational Facilities	Primary School	Primary, High School
4.	Medical facilities	Community Health Worker 1 No.	Community Health Worker-2 Nos.
5.	Post and Telegraph	Post Office, Phone	Post office, Phone
6.	Drinking water source	Tube Well & Open Well	Tube Well & Open Well
7.	Mode of communication	Road	Road
8.	Approach to village	Kaccha road	Pucca road
9.	Nearest town and distance	Sidhpur, 5 Km.	Vadnagar, 5 Km.
10.	Crops	Bajri, Jowar. Wheat	Bajri, wheat
11.	Irrigation facility	Available	Available
12.	Power Availability (per day)	12 hrs.	16 hrs.
13.	Fluoride level	4.0 mg/l	3.4 mg/l

In view of the high fluoride levels (4.0 mg/1 and 3.4 mg/1 respectively in the water of these two villages as against the permissive limit 1 mg F/1, a need is felt to install defluoridation systems at these villages, pending the arrival of group or regional water supply schemes. Here too, as and when the group schemes are successfully commissioned the operating defluoridation fill-and-draw type plants can be shifted to other fluoride affected villages which shall not be covered under the group scheme by them.

The estimated demands of defluoridated water at Tavadia and Badarpur are 77 m3/day and 144 m3/day respectively, based on a supply rate of 40 lpcd. The defluoridation at Tavadia is proposed to be achieved through the installation of removable/shiftable HDPE system and a Ferro-Cement system is proposed at village Badarpur. A system comprising of two 10,000 litres capacity HDPE one-piece moulded cylindricical vertical containers will be installed at the village Tavadia to treat fluoride water on a batch process and supply treated water through public stand posts/house connection. The same capacity (10,000 liters) ferro-cement units will be installed at village Badarpur to treat fluoride water on a batch process system.

The jar test experiment (treatability studies) were carried out on the water samples collected from Tavadia and Badarpur villages and the different concentrations of alum doses were applied for determination of actual dose to treat the high fluoride containing water. The result of the treatability studies for Tavadia and Badarpur villages are shown in Table-8. It has been observed that the optimum dose of alum to reduce the fluoride levels to permissible limit lies between 500 and 600 mg alum/1.

Cost of Treatment

1. **Domestic Defluoridation** : It may be recalled that in the domestic defluoridation, there is no other expenditure except that of the chemical, aluminium sulphate, which is taken as Rs. 2/- per kg in Gujarat. The only other material required is a bucket of 60 liters capacity, where 40 liters of water to be treated is taken, chemical added, stirred for ten minutes and then settled for an hour or overnight where possible. The settled water is withdrawn from the tap provided to the bucket and the settled sludge is thrown away.

Alum is to be added in the form of 10% solution and the local merchants can prepare, store and sell it to the villagers to suit the specific requirement of the water source, decided earlier on the basis of alkalinity, fluoride and other water characteristics.

2. **Fill-and-Draw Type Community Defluoridation** : The estimated capital cost of these two fill-and-draw type systems works out to Rs. 3,14,434/- for Tavadia (HDPE system) and Rs. 2,90,430/- for Badarpur (Ferro-Cement system). The cost is exclusive of civil works and stand posts, which are to be constructed by GWS & SB. A lay-out plan of fill-and- draw type systems for Tavadia and Badarpur are given in Fig. 1 & 2. The break-up of running cost per annum for each of the system calculated on the basis of population, water requirements, electricity, alum and chlorine needed and manpower, etc. are given in Table-9.

The cost of treatment of water for these villages works out to Rs. 5.10 and Rs. 3.30 per m3 respectively. These correspond to Rs. 82.45 and Rs. 49.00 per year per person, which is a reasonable and workable proposition.

Acknowledgements

The state Defluoridation Camp was organised following directives of TAG III. The concept has been highly acclaimed by one and all who participated in the camp. The guidance from the Ministry of Agricultural, Department of Rural Development and CSIR Head Quarters is really commendable and NEERI is grateful for the same.

The main source of inspiration is from the unflinching support and constant encouragement from Prof. P. Khanna, Director, NEERI. The strength of the camp is derived from Shri Y. N. Nanjudiah, Member Secretary, Gujarat Water Supply & Sewerage Board, whose constant presence, guidance and direction were valuable in organising this camp.

NEERI is grateful to Dr. G. Ghose, Mission Director, Water Technology Mission, Govt. of India, Dr. Ram K. Iyenger, Additional Director General, CSIR and Shri V. B. Patel Secretary, (Water Supply), Govt. of Gujarat and Chairman, Gujarat Water Supply & Sewerage Board, Gandhinagar for their kind help in giving shape to the camp. NEERI expresses its gratitude to Shri D. K. Rao, IAS, Collector Mehsana (Gujarat) for his keen interest and support to this camp. The institute is grateful to him for presiding over the function and valuable suggestion and look forward to his continued support to ameliorate the sufferings of fluoride affected people in Mehsana District.

NEERI would like to place on record its appreciation of Shri R. A. Bhatt, Chief Engineer (Trg. & Tech. Mission) and Shri M. D. Dave, Chief Engineer (Mehsana Zone), GWS & SB for their constant support and excellent guidance in all the camp activities. The institute also thanks all the participants for sharing their experiences with the faculty and also for their active involvement in village demonstration campaigns during the camp.

NEERI's thanks are also due to Shri J. M. Barot, Chief Scientific Officer, PHE Laboratory, Baroda, Shri N. P. Patel, Executive Engineer, Shri I. M. Panjwani, Deputy Executive Engineer, Mehsana and Shri R. S. Mehta, Regional officer, PHE Laboratory, Mehsana and all other staff of Gujarat Water Supply & Sewerage Board, Mehsana, for their active involvement and support in organising this camp. The institute is also immensely ankful to the management, Dudhsagar Dairy, Mehsana for generously making available their premises to set up the camp.

The entire exercise of organising the camp was undertaken under the guidance of Prof. P. Khanna, Director, NEERI. Preparations required the active participation of several Divisions at Headquarters and Zonal Laboratory, Ahmedabad. The faculty for the camp was

also drawn from various divisions to make the camp a meaningful learning and sharing ground. Space makes it difficult to enlist all those who directly assisted in making the exercise a cherishable success, but special credits are due to the staff of Water Division, Technical Publication Division, Workshop and Zonal Laboratory, Ahmedabad. Their whole hearted participation, co-operation and involvement are gratefully acknowledged.

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(ANNEXURE I)

List of Participants

1 Shri N. A. Patel, Deputy Executive Engineer, Sidhpur.
2 ,, S. J. Patel Deputy Executive Engineer, Mehsana.
3 ,, B. B. Patel Deputy Executive Engineer, Unjha.
4 ,, M. R. Patel Deputy Executive Engineer, Radhanpur.
5 ,, R. K. Patel Deputy Executive Engineer, Kadi,
6 Miss Kiran Chholar, Project Officer, Centre for Environment Education, Ahmedabad.
7 Miss Madhavi Joshi, Programme Associate, Centre for Environment Education, Ahmedabad.
8 Shri B. B. Patel, Assistant Engineer, Mehsana,
9 ,, M. V. Memon, Addl. Assistant Engineer. Mehsana.
10 ,, Nikhil R. Gandhi, Assistant Engineer, GWS & SB, Gandhinagar.
11 ,, H. M. Jhala, Deputy Executive Engineer, GWS & SB, Kalol.
12 ,, B. M. Patel, Junior Geologist, Mehsana.
13 ,, A. M. Patel, Deputy Executive Engineer, Mansa.
14 ,, H. V. Contractor, Assistant Engineer, kalol.
15 ,, J. H. Pancholy, Overseer, Municipality, Sidhpnr.
16 ,, S. N. Patel, Assistant Engineer' Mansa.
17 ,, S. U. Bhatt, Deputy Executive Engineer, Patan.
18 ,, I. M. Patel, Hydrologitst, Mehsana.
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23 ,, K. D. Patel, Assistant Engineer Sidhpur.
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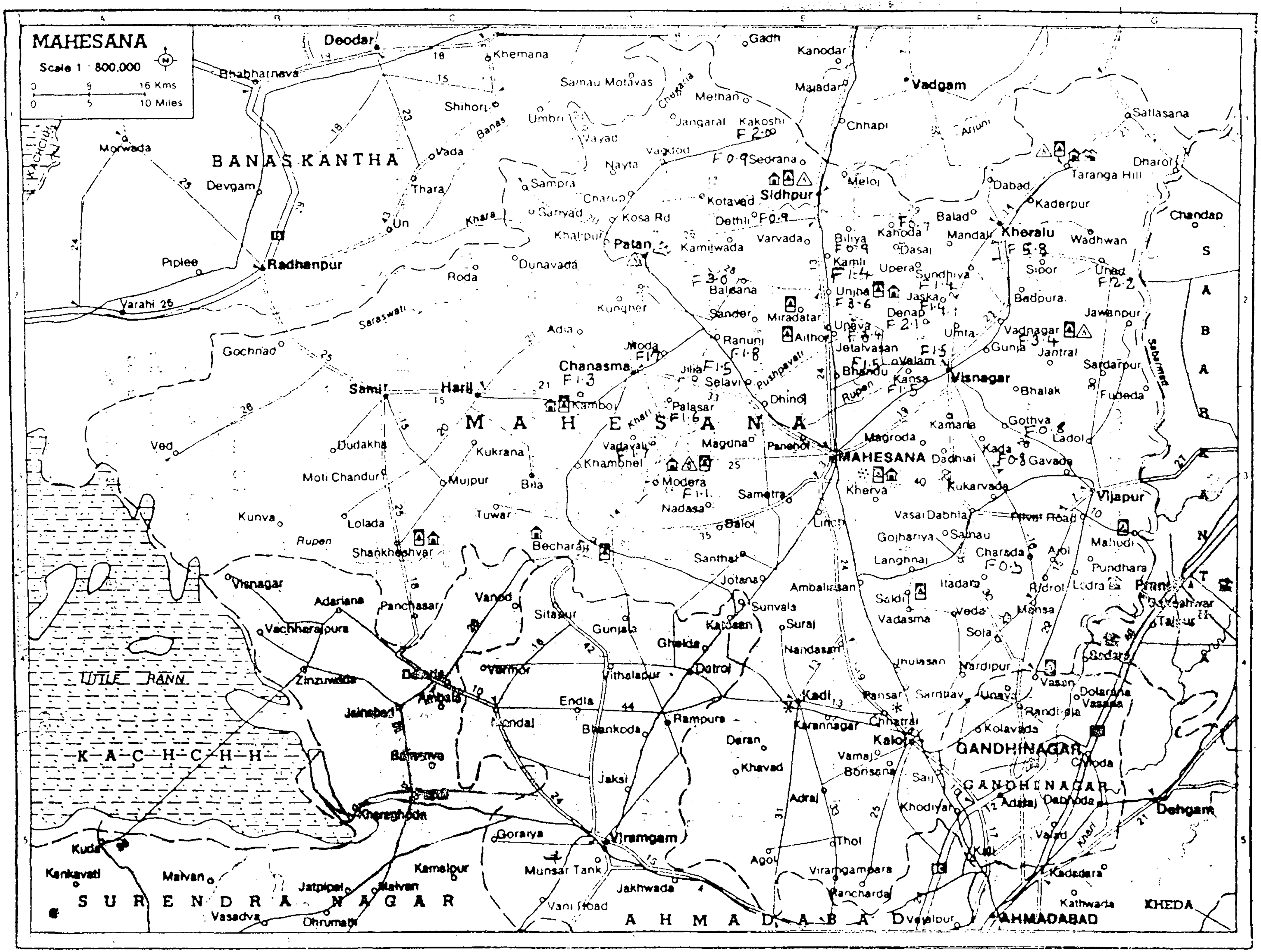
64 ,, Y. R. Khodalia, A.A.E., P.H Mech. Dn., Mehsana.
65 ,, A. B. Chaudhari, A.E., Patan.
66 ,, D. N. Patel, A.A.E., P H S. Sub. Dn , Kadi.
67 ,, K. B. Oza, A.A.E., P H. Project Sub. Dn., Mehsana.
68 ,, T D. Patel, A A E., P. H. Project Sub Dn ,Patan.
69 ,, A. H Malik, A.E., P.H Project Sub, Dn , Mehsana.
70 ,, D, B. Vimal, Overseer P H S. Sub, Dn., Sidhpur.
71 ,, R. N. Darji Overseer, P.H.S Sub Dn., Mehsana
72 ,, G. S Patel, Overseer, P H.S Sub, Dn. Kalol.
73 ,, A. R. Thakarda, Overseer, P.H S. Sub. Dn., Kalol.
74 ,, L. M. Rawal, Overseer, P.H Works Dn., Sidhpnr.
75 ,, M M. Patel. Overseer, P H.S. Sub. Dn., Mehsana.
76 ,, H. B Brahmbhatt, Overseer, P.H S. Sub. Dn., Unjha.
77 ,, J. M Kagathra, Deputy Executive Engineer, P.H.S. Sub. Dn., Dhrangadhar, Dist. Surendranagar.
78 ,, H. R. Momin, P.H.S. Dn, Unjha.
79 ,, P, K. Patel, Addl. Assistant Engineer, P.H S, Sub. Dn., Patan.



MAHESANA
Scale 1 : 800,000
0 8 16 Kms
0 5 10 Miles
BANASKANTHA
MAHESANA
KACHCHH
LITTLE RANN
SURENDRANAGAR
AHMADABAD
GANDHINAGAR
SABARKANTHA
KHEDA
Deodar
Khemana
Bhabharnava
Gadh
Kanodar
Vadgam
Majadar
Methan
Samau Motavas
Shihori
Umbri
Jangaral
Kakoshi
Chhapi
Arjuni
Satlasana
Morwada
Devgam
Vada
Thara
Vayad
Vagdod
Nayta
Sedrana
Sampra
Charup
Kotavad
Sidhpur
Meloi
Dabad
Taranga Hill
Dharoi
Kaderpur
Chandap
Un
Khara
Sariyad
Kosa Rd
Dethli
Khalipur
Patan
Kamliwada
Varvada
Biliya
Kahoda
Balad
Mandali
Kheralu
Wadhwan
Dasai
Piplee
Radhanpur
Roda
Dunavada
Kamli
Upera
Sundhiya
Sipor
Unad
Varahi
Saraswati
Balisana
Unjha
Jaska
Badpura
Kungher
Sander
Miradatar
Denap
Jawanpur
Adia
Unava
Umta
Vadnagar
Aithor
Gochnad
Ranuj
Jetalvasan
Gunja
Jantral
Modia
Valam
Sardarpur
Chanasma
Jilia
Selavi
Pushpavati
Bhandu
Kansa
Visnagar
Bhalak
Sami
Harij
Kamboi
Dhinoj
Rupen
Fudeda
Palasar
Khari
Kamana
Gothva
Ved
Dudakha
Kukrana
Vadavali
Maguna
Panchot
Magroda
Ladol
MAHESANA
Dadhiai
Kada
Gavada
Khambhel
Modera
Kherva
Kukarvada
Moti Chandur
Mujpur
Bila
Nadasa
Sametra
Vijapur
Kunva
Lolada
Tuwar
Balol
Linch
Vasai Dabhla
Mahudi
Shankheshvar
Becharaji
Santhal
Gojhariya
Sanau
Charada
Ajol
Langhnaj
Pundhara
Jotana
Ambaliasan
Itadara
Bidrol
Ledra
Visnagar
Adariana
Panchasar
Vanod
Sunvala
Saldi
Veda
Mansa
Vachharajpura
Sitapur
Gunjala
Katosan
Suraj
Vadasma
Sola
Ghelda
Nandasan
Jhulasan
Nardipur
Zinzuwada
Dasada
Vanmor
Vithalapur
Dotrol
Vasan
Dolarana Vasana
Jainabad
Endla
Kadi
Pansar
Sardhav
Unava
Randheja
Kamalpur
Patdi
Mandal
Bhankoda
Rampura
Karannagar
Chhatral
Kalol
Kolavada
Bajana
Daran
Vamaj
Khavad
Borisana
Saij
Chiloda
Jaksi
Adraj
Khodiyar
Adalaj
Dabhoda
Dehgam
Kharaghoda
Goraiya
Viramgam
Thol
Valad
Kuda
Kankavati
Malvan
Munsar Tank
Agol
Viramgampara
Kali
Kadadara
Jatpipali
Malvan
Jakhwada
Ranchardа
Vasadva
Dhrumath
Vani Road
Vejalpur
AHMADABAD
Kathwada
Banas
Rupen
Sabarmati
Khari
Chegania

(ANNEXURE II)

TECHNOLOGY MISSION ON DRINKING WATER IN VILLAGES AND RELATED WATER MANAGEMENT STATE DEFLUORIDATION CAMP, MEHSANA

PROGRAMME

December 21-24, 1987

Water Quality Assessment of Samples brougnt form Villages in Mehsana District - Techniques Demonstration,
Visit to Jiliya & Ruppur Villages Identified by GWSSB, for the location of Defluoridation System.

December 23, 1987

0900 - 0910	Introduction to the Camp. Shri P. Nema
0910 - 0920	Introduction of participants.
0920 - 0930	Water Technology Mission - an overview Shri K. R. Bulusu
0930 - 0010	Inaugural address - Shri Y. N. Nanjundiah
0010 - 1015	Presendential Address - Shri M. D. Dave
1015 - 1020	Presentation of topies - Shri V. P. Deshpande
1020 - 1025	Vote of Thanks Shri S. N. Bhatnagar
1025 - 1045	T E A
1045 - 1230	Video films-(NEERI, Nalgonda Technique, Bacteriological Analysis, Amreli Camp and Iron removal)
1230 - 1300	Methods of Fluoride Estimation - Analytical part- Shri W. G. Nawlakhe.
1300 - 1400	L U N C H
1400 - 1500	Defluoridation of Water and Treatment Method by Shri K. R. Bulusu,
1500 - 1515	T E A
1515 - 1730	Design Exercise and Discussion, Shri V. P. Deshpande/Shri P. Nema
1730 - 1800	Participants Experience.

December 24, 1987

0800 - 1300	Field Visit.
1300 - 1400	L U N C H
1400 - 1430	Defluoridation - Shri J. M. Barot.
1430 - 1600	Demonstration of Estimation of Alum dose, Fluoride, Alkalinity and Conductivity. Shri W.G. Nawlakhe/Dr N C. Kankal Shri D. N. Kulkarni/Shri S. L. Lutade Shri C. G. Mehta/Shri B. H. Gokhe Shri A. V. J Rao,
1600 - 1615	T E A
1615 - 1700	Discussion with participants.
1700 - 1730	Valedictory Function,

(ANNEXURE III)

Impressions, Assurances and Suggestions From Participants

Trainees have highly appreciated the efforts of Water Technology Mission to conduct such course through NEERI. They displayed keenness and enthusiasm for taking the technology to their villages for implementation. They felt the need for creating awareness in the villagers on long term intake of excessive fluoride in their daily drinking water. A common consensus was noticed amongst the participants regarding the benefits of R & D efforts of NEERI on Defluoridation.

(ANNEXURE IV)

NEERI Team at the Defluoridation Camp Mehsana

Shr K. R. Bulusu

Shri P. Nema

Shri V. P. Deshpande

Shri W. G. Nawlakhe

Dr. N. C. Kankal

Shri D. N. Kulkarni

Shri S. L. Lutade

Shri A. V. J. Rao

Shri C. G. Mehta

Shri B. H. Gokhe

Shri P. G. Dave

TABLE- 1 : Chemical Characteristics of water in Villages of Chanasma Taluka

Sl. No.	Source of Water	pH	Conductivity uS/cm	P-Alkalinity ($CaCO_3$) mg/1	M-Alkalinity ($CaCO_3$) mg/1	Total Hardness ($CaCO_3$) mg/1	Ca-Hardness ($CaCO_3$) mg/1	Mg-Hardness ($CaCO_3$) mg/1	Fluoride (F) mg/1	Sulphate (SO_4) mg/1	Chloride (Cl) mg/1	Nitrate (N) mg/1
1	2	3	4	5	6	7	8	9	10	11	12	13
1	Naranpura : Panchayat Bore well	7.9	4200	0	220	790	470	320	0.5	205	1000	1.5
2	Surpura : Private Bore Well	7.5	5600	0	272	950	470	480	1.0	260	1410	2.7
3	Mandlop : Well in lake	7.6	1300	0	394	390	250	140	0.3	52	135	4.3
4	Jasalpur : Panchayat Bore	8.1	1500	0	388	150	60	90	1.8	56	190	4.3
5	Dhanodharda : Private Bore Well	8.1	10000	0	600	700	410	290	0.9	215	2825	4.3
6	Jiliya Vasna : Private Bore Well	7.9	2600	0	366	280	150	130	1.6	30	490	5.1
7	Keshani : Panchayat Bore Well	8.2	2300	0	384	200	80	120	2.0	43	460	5.3
8	Ganget : Panchayat Bore Well	8.0	1300	0	324	150	60	90	3.5	64	200	5.3
9	Dantkarodi : Panchayat Bore Well	7.9	3400	0	380	400	200	200	1.7	140	735	12.0
10	Danodarda : Panchayat Bore Well	7.8	3600	0	408	390	150	240	1.7	76	800	8.5
11	Kakasana : Private Bore	8.0	3700	0	528	350	150	200	1.8	165	765	13.5
12	Kamalpur : Panchayat Bore Well	7.9	4600	0	460	590	250	340	1.0	80	1040	10.0
13	Ranasan : Panchayat Bore	8.8	1900	32	324	180	50	130	1.7	102	330	3.2
14	Merwada : Panchayat Bore	8.7	3600	20	316	500	150	350	1.0	145	890	1.8
15	Chavell : Panchayat Bore	8.6	3100	12	156	370	110	260	1.4	110	775	2.4

1	2	3	4	5	6	7	8	9	10	11	12	13
16	Mitha Dharwa : Panchayat Bore	8.5	4400	12	396	170	50	120	2.4	84	460	10.5
17	Pimdharpur : Panchayat Bore	8.2	3200	0	316	450	210	240	1.7	156	730	4.3
18	Palasar : Panchayat Bore	8.3	3600	0	256	420	160	260	1.6	115	880	9.6
19	Virta : Village Well	8.7	980	24	276	320	150	170	0.6	28	150	6.8
20	Garod : Panchayat Bore	8.4	3600	20	396	450	190	260	1.2	132	800	8.4
21	Vadavali : Panchayat Bore	8.5	2800	20	348	300	110	190	1.7	110	600	3.5
22	Samisa : Panchayat Bore	8.3	6000	—	124	800	360	440	0.6	165	1720	1.6
23	Bramhanwada : Panchayat Bore	8.4	2800	16	124	380	160	220	1.0	165	560	2.8
24	Maniyari : Panchayat Bore	8.6	2050	20	392	150	50	100	1.7	80	365	3.8
25	Delpara : Panchayat Well	8.8	2700	32	448	150	50	100	2.3	120	465	3.8
26	Sajanpura : Panchayat Well	8.4	2200	12	292	320	120	200	0.8	120	415	11.5
27	Panchasar : Panchayat Bore Well	8.6	2000	36	392	170	80	90	1.8	85	325	3.2
28	Bramhanwada : Panchayat Bore Well	7.5	3000	0	265	520	250	270	0.9	380	550	2.0
29	Sengha : Panchayat Bore Well	7.3	2200	0	336	350	150	200	2.8	100	410	2.0
30	Iroha : Panchayat Bore Well	7.4	4000	0	182	750	400	350	1.1	320	1000	2.0
31	Dodivada : Panchayat Bore Well	7.4	3100	0	272	560	240	320	1.9	344	780	7.6
32	Dharpur Khant : Village Well	7.9	3000	0	304	330	80	250	2.8	210	570	0
33	Modhera : Panchayat Bore Well	7.8	3000	0	540	440	100	340	1.1	280	710	2.6
34	Maniyari : Panchayat Bore Well	7.7	2000	0	416	200	80	120	1.9	103	350	4.6

Contd...

TABLE- 1 : Chemical Characteristics of Water in some Villages of Chanasma Taluka

Sl. No.	Source of Water	pH	Conduc-tivity uS/cm	P-Alka-linity ($CaCO_3$) mg/1	M-Alka-linity ($CaCO_3$) mg/1	Total Hardness ($CaCO_3$) mg/1	Ca-Hard-ness ($CaCO_3$) mg/1	Mg-Hard-ness ($CaCO_3$) mg/1	Fluoride (F) mg/1	Sulphate (SO_4) mg/1	Chloride (Cl) mg/1	Nitrate (N) mg/1
1	2	3	4	5	6	7	8	9	10	11	12	13
35	Brahmanwada : Hand pump (P.H.C.)	7.9	2200	0	570	200	50	150	2.8	158	370	1.2
36	Sassanpur : Panchayat Bore Well	8.3	3000	0	340	350	120	230	1.7	156	650	3.8
37	Jiliya : Village Well	7.5	1000	0	304	300	170	130	0.4	20	140	1.6
38	Jiliya : Asharam overhead Tank	7.6	2400	0	360	350	120	230	1.5	98	420	3.0
39	Jotida : Panchayat Bore Well	7.9	1400	0	372	230	80	150	1.7	61	220	3.4
40	Chanasma : Kotvadia Bore Well	7.7	2200	0	370	350	150	200	1.3	260	400	2.6
41	Jiliya : Tube Well	7.8	2200	0	340	280	190	90	1.5	165	420	3.4
42	Ruppur : Panchayat dug Well	7.6	1600	0	360	320	180	140	0.9	52	260	3.8
43	Ruppur : Bhagetiya dug Well	7.7	1400	0	312	430	180	250	0.8	60	250	2.3
44	Ruppur : Tube Well	7.6	1600	0	364	200	100	100	1.9	88	250	3.2
45	Unjha : Tube Well	7.7	1200	0	288	110	30	80	3.6	50	180	—

TABLE 2 : Chemical Characteristics of Water in some Villages of **Kheralu** Taluka

Sl No.	Source of Water	pH	Conductivity uS/cm	P-Alkalinity ($CaCO_3$) mg/l	M-Alkalinity ($CaCO_3$) mg/l	Total Hardness ($CaCO_3$) mg/l	Ca-Hardness ($CaCO_3$) mg/l	Mg-Hardness ($CaCO_3$) mg/l	Fluoride (F) mg/l	Sulphate (SO_4) mg/l	Chloride (Cl) mg/l	Nitrate (N) mg/l
1	2	3	4	5	6	7	8	9	10	11	12	13
1	Jaska : Panchayat Bore	8.2	1100	0	340	170	90	80	1.4	23	120	10.3
2	Chachaliya Private Bore	8.0	2200	0	520	160	80	80	2.6	47	325	7.5
3	Nani Hirvani ; Private Well	7.8	1400	0	440	250	150	100	0.4	68	150	3.4
4	Manekhpur : Panchayat Well	7.8	1400	0	352	250	140	110	1.8	33	215	8.5
5	Shekhpurkhe I Public Well	7.8	900	0	248	280	160	120	1.1	24	130	9.5
6	Sulipur : Public Well	7.8	1500	0	162	540	280	260	0.8	15	200	5.6
7	Nanivada : Panchayat Bore	8.3	1300	0	328	240	100	140	2.3	37	170	23
8	Laluvada : Panchayt Bore	7.9	680	0	276	300	120	180	1.1	17	50	8.7
9	Arethi : Private Bore (Keshar Punja)	8.0	1200	0	404	180	80	100	2.2	35	105	5.3
10	Miyasana : Private Well (Jivabhai)	7.7	1300	0	344	270	100	170	2.2	35	160	5.2
11	Chansol : Panchayat Bore	8.7	1200	28	332	220	80	140	1.6	31	125	14.0
12	Kesampa : Public Bore	8.1	2200	0	384	300	160	140	1.5	24	485	8.7
13	Limdi ; Village Well	7.9	1000	0	328	300	110	190	2.4	47	40	7.8
14	Rasulpur : Public Bore	7.7	1600	0	420	310	90	120	2.3	52	240	9.5
15	Sudikpur : Public Bore	8.0	1800	0	456	230	80	150	2.7	42	285	5.8
16	Khatasan : Private Well (K. M. Thakore)	8.5	1400	22	480	160	50	110	2.1	33	150	8.5
17	Sarna : Public Well	7.8	1000	0	312	250	60	190	1.1	18	85	5.1

1	2	3	4	5	6	7	8	9	10	11	12	13
18	Daby : Village Well	7.9	1000	0	360	190	50	140	2.0	16	75	4.3
19	Unad : Village	8.1	1000	0	400	280	60	220	2.2	30	125	10.3
20	Khanpur : Village Well	8.3	1200	0	600	150	30	120	5.0	45	310	14.5
21	Badarpur : Public Bore	7.8	2006	0	520	110	30	30	3.3	37	160	8.0
22	Malekpur Bore Well	8.0	3000	0	370	290	90	200	2.5	168	490	14.0
23	Vadnagar : Tube Well	8.0	2000	0	260	180	70	110	3.4	60	200	5.2
24	Kahipur : Bore Well	7.5	1000	0	410	260	100	160	1.8	22	120	6.4
25	Sultanpur : Bore Well	7.7	1400	0	388	500	200	300	1.2	20	210	14.4
26	Undhai : Bore Well	7.8	1000	0	300	400	170	230	1.8	21	170	5.2
27	Siyor : Well Water	7.8	1600	0	440	280	70	210	3.4	47	110	15.6
28	Jaska : Bore Well	7.8	1000	0	308	250	90	160	1.4	19	130	10.4
29	Machhava Bore Well	7.7	4000	0	416	400	130	270	2.7	156	1020	13.2
30	Vithoda : Well Water	7.8	1000	0	300	300	100	200	3.3	35	140	5.2
31	Shalipur : Well Water	7.5	1400	0	224	500	190	310	0 8	19	240	13.2
32	Sundhiya : Well Water	7.9	1800	0	520	270	70	200	1.4	46	210	5.2
33	Kheralu : River Bore Well	7.8	1000	0	352	320	90	230	3.0	56	290	5.6

1	2	3	4	5	6	7	8	9	10	11	12	13
34	Kheralu ; Savala Bore Well	7.9	1300	0	360	140	50	90	5.8	34	170	6.2
35	Kheralu ; Bore Well (Near Office)	7.9	1600	0	362	160	40	120	5.6	58	220	12.0
36	Satlasana ; Village Well (tank)	7.5	600	0	164	270	120	150	1.4	5	40	5.2
37	Ambaghanta Ashram ; Village Well	7.3	800	0	200	320	150	170	2.5	10	50	1.0
38	Bhalusana ; Well Water	7.9	400	0	280	320	120	200	2.1	5	50	3.8
39	Mumanvas ; Village Well	7.3	400	0	172	300	120	180	4.2	5	40	2,0
40	Motibhalu ; Village Well	7.3	400	0	148	270	110	160	3.5	5	40	4.4
41	Umari ; Village Well	7.3	800	0	140	200	70	130	4.8	10	50	12.8
42	Junasadosana ; Village Well	7.2	400	0	140	260	110	150	3.2	5	40	7.0
43	Chansol ;Tube Well	7.8	1100	0	370	300	100	200	1.8	40	140	14.8
44	Lalavada ; Tube Well	7.5	800	0	300	310	100	210	1,3	8	60	7.4
45	Nanivada ; Tube Well	7.3	1200	0	390	330	110	220	2.1	37	160	5.2
46	Dabheda ; Tube Well	7.2	1000	0	400	320	110	210	1.3	35	80	10.4
47	Mahetnubpura ; Tube Well	7.2	1000	0	420	230	60	170	3.3	11	110	2.0

TABLE 3 : Chemical Characteristics of Water in some Villages of **Sidhpur** Taluka

Sl No.	Source of Water	pH	Conductivity uS/cm	P-Alkalinity ($CaCO_3$) mg/l	M-Alkalinity ($CaCO_3$) mg/l	Total Hardness ($CaCO_3$) mg/l	Ca-Hardness ($CaCO_3$) mg/l	Mg-Hardness ($CaCO_3$) mg/l	Fluoride (F) mg/l	Sulphate (SO_4) mg/l	Chloride (Cl) mg/l	Nitrate (N) mg/l
1	2	3	4	5	6	7	8	9	10	11	12	13
1	Khatasana : Panchayat Bore	7.7	960	0	260	150	70	80	2.7	24	100	5.1
2	Bhunav ; Panchayat Bore	8.1	1200	0	320	150	50	100	2.2	64	100	6.4
3	Nagvasna ; Panchayat Bote	7.9	630	0	208	180	150	30	0.8	8	55	6.8
4	Ganvada : Dug-cum-Bore	7.5	620	0	240	210	180	30	0.7	198	60	5.5
5	Biliya : Panchayat Bore	7.8	730	0	244	170	80	90	0.9	8	60	5.5
6	Dethli : Public Well	7.9	1800	0	360	320	150	170	0.9	28	325	4.6
7	Chadnsar : Panchayat Bore	8.1	2800	0	348	370	200	170	1.3	31	500	2,2
8	Hisor : Panchayat Bore	8.0	7500	0	260	100	60	40	0.9	220	2000	3.6
9	Brahmanwada : Panchayat Bore Well	7.8	1200	0	300	200	100	100	0.9	22	155	8,7
10	Maktupura : Panchayat Bore	8.0	1400	0	324	130	60	70	2.3	15	205	9.0
11	Sunok : Public Bore Well	8.0	1800	0	400	160	50	110	1.9	30	280	6.8
12	Sinhi : Public Bore Well	7.6	2600	0	420	200	80	120	2.0	140	475	6.8
13	Unava ; Public Bore Well	8.2	3000	0	432	210	80	130	2,4	105	85	16.0
14	Sujanpur : Public Bore Well	7.6	5000	0	340	280	190	90	1,5	165	420	3.4
15	Sedrona : Public Bore	7.7	1800	0	360	320	180	140	0.9	52	260	3.8
16	Gaglasan : New Public Well	8.2	1800	0	456	190	30	160	1.6	44	240	14.5
17	Ganalasan : Old Public Well	8.2	1800	0	340	150	30	120	0 8	40	325	5.5

1	2	3	4	5	6	7	8	9	10	11	12	13
18	Gaglasana : Public Bore	7.9	2600	0	300	370	200	170	2.8	120	600	3.5
19	Waghna ; Private Well	7.8	1000	0	300	220	90	130	1.2	42	185	2.8
20	Khahoda ; Public Bore	7.9	1000	0	280	260	140	120	0.7	25	140	8.5
21	Samoda : Public Bore Well	7.5	780	0	242	230	130	100	0.8	18	70	9.5
22	Chatavada : Public Well	7.5	700	0	216	270	140	130	1.0	45	95	2.1
23	Khali : Public Well	7.8	740	0	208	210	80	130	1.1	23	90	2.7
24	Kanesara : Public Well	7.6	780	0	200	230	110	120	1.2	23	90	3,1
25	Tundav : Public Bore	7.3	2000	0	372	180	70	110	1.1	42	350	6.4
26	Amudh : Public Bore	8.2	1000	0	332	100	40	60	3.4	25	180	5,7
27	Haslupur : Bore Well	7,9	1600	0	408	200	100	100	3.5	49	285	2.4
28	Tavadia : Bore Well	7.6	1400	0	340	170	50	120	3 6	58	255	7.2
29	Kakosi :Bore Well	7 9	1200	0	352	80	40	40	2.0	49	285	4.2
30	Dethali ; Bore Well	7.5	1400	0	340	350	140	210	0,9	54	310	4.8
31	Ankavi : Bore Well	7.6	1600	0	340	240	100	140	1,2	64	285	9.6
32	Thakarasana : Bore Well	7.8	1800	0	352	150	90	60	4.2	64	260	8.2
33	Lavara : Well Water	7.7	1100	0	352	180	60	120	0.9	30	140	3.1
34	Varsina : Bore Well	7.6	2000	0	388	160	80	80	2 0	78	325	5 5
35	Kholwada ; Bore Well	7.8	1600	0	388	140	70	70	2.5	68	205	9 2
36	Dashawada : Bore Well	7 9	1200	0	300	240	70	170	1 7	58	425	8.6

1	2	3	4	5	6	7	8	9	10	11	12	13
37	Nidroda : Bore Well	8.3	2400	0	384	130	50	80	1.4	130	170	4.2
38	Kanvara : Bore Well	8.0	1600	0	270	110	50	60	1.9	72	255	4.5
39	Dasaj : Bore Well	8.1	900	0	300	180	100	80	3.2	84	140	4.6
40	Bhankhar : Bore Well	7.3	200	0	408	250	150	100	2.5	104	360	4.8
41	Jagannathpur ; Bore Well	7.8	1000	0	300	330	180	150	0.6	22	320	6.2
42	Kahoda ; Bore Well	7.4	1000	0	304	330	180	150	0.6	20	140	12.4
43	Khatasana ; Bore Well	7.6	1000	0	280	150	90	60	3.0	20	110	—
44	Varvada ; Bore Well	8.1	1200	0	312	200	110	90	1.6	18	190	7.6
45	Sunok ; Bore Well	7.9	1800	0	436	180	50	130	2.1	29	290	6.6
46	Surajnagar : Bore Well	7.7	2200	0	304	210	100	110	2.2	84	460	6.2
47	Unava ; Bore Well	7.7	3000	0	420	280	100	180	2.7	26	590	14.0
48	Kamali ; Bore Well	7.6	1200	0	300	230	110	120	1.4	32	220	0.8
49	Muktipur ; Bore Well	7.6	1400	0	312	160	90	70	2.5	7	210	7.4
50	Biliya ; Bore Well	7.4	800	0	256	160	100	60	0.9	8	70	6.2
51	Nedra ; Bore Well	7.4	560	0	244	240	120	120	1.4	8	80	0.8
52	Kanesara ; Bore Well	7.2	640	0	220	230	120	110	0.5	120	70	1.6
53	Amudh ; Tap Water	7.2	1400	0	404	180	50	130	3.2	12	120	5.6
54	Devada ; Tap Water	7.4	3400	0	640	350	100	250	2.6	100	80	12.0

TABLE- 4 : Chemical Characteristics of Water in some Villages of Patan Taluka

Sl. No.	Source of Water	pH	Conductivity uS/cm	P-Alkalinity ($CaCO_3$) mg/l	M-Alkalinity ($CaCO_3$) mg/l	Total Hardness ($CaCO_3$) mg/l	Ca-Hardness ($CaCO_3$) mg/l	Mg-Hardness ($CaCO_3$) mg/l	Fluoride (F) mg/l	Sulphate (SO_4) mg/l	Chloride (Cl) mg/l	Nitrate (N) mg/l
1	2	3	4	5	6	7	8	9	10	11	12	13
1	Kanthravi : Panchayat Bore	7.8	4900	0	424	500	200	300	1.8	210	1175	16.5
2	Kanthravi : Public Well	7.6	2000	0	300	680	210	470	0.6	56	425	16.5
3	Navapura : Panchayat Bore	7.8	3900	0	496	350	140	210	1.8	140	850	8.0
4	Pali : Panchayat Bore	7.7	3300	0	400	280	110	170	2.2	92	675	15.5
5	Ruvari : Public Well	7.7	1900	0	456	330	70	260	1.4	53	290	6.4
6	Dhabadi : Panchayat Bore	7.6	1400	0	340	150	50	100	2.7	73	200	4.4
7	Matpur : Panchayat Bore	7.7	1400	0	320	100	50	50	2.6	33	230	8.0
8	Digdi : Panchayat Bore	7.5	4400	0	400	500	170	330	1.0	140	1000	7.2
9	Sankhari : Public Well	7.7	3300	0	496	310	90	220	1.8	99	700	4.8
10	Sander : Panchayat Bore	7.8	1900	0	320	170	50	120	2.3	96	325	4.8
11	Manund : Panchayat Bore	7.1	1800	0	400	150	50	100	2.1	46	310	8.1
12	Lolada : Public Bore	7.9	4100	0	248	200	80	120	1.1	84	1050	1.0
13	Shipur : Public Bore	8.1	3000	0	208	100	40	60	0.3	78	750	1.3
14	Gondhana : Public Well	7.9	15200	0	620	1600	420	1180	4.8	310	4300	16.5
15	Vaval : Public Bore	7 9	3900	0	172	210	100	110	0.4	84	1050	1.2
16	Visalvasna : Public Bore	8.0	1600	0	348	160	50	110	1.6	40	300	5.8
17	Ranaj : Old Bore Well	7.7	2600	0	304	250	130	120	1.8	38	625	5.3
18	Sankhari : Village Well	7.6	3200	0	360	360	140	120	2.0	130	700	5.1
19	Gadosan : Bore Well	7.7	2000	0	400	180	50	130	2.2	105	375	3.4
20	Chandumana : Bore Well	7.5	3300	0	260	500	190	310	0.8	260	750	1.6

1	2	3	4	5	6	7	8	9	10	11	12	13
21	Khanpur : (Rajkuva) Bore Well	8.1	2900	0	364	250	100	140	1.9	175	625	4.3
22	Dharkuva : Bore Well	8.2	1800	0	324	110	40	70	2.7	55	375	4.5
23	Malpur : Bore Well	8.0	1400	0	336	130	50	80	2.8	38	220	6.8
24	Balisana : New Bore Well	7.8	1500	0	320	130	60	70	3.0	78	215	4.4
25	Anavada : Well Water	7.7	2200	0	342	150	50	100	2.8	46	180	2.2
26	Aghar : Well Water	7.7	3400	0	360	700	300	400	1.0	200	915	4.0
27	Sariyad : Bore Well	7.5	2000	0	290	370	140	230	0.7	86	410	3.0
28	Vahana : Well Water	7.9	2400	0	368	250	100	150	2.5	92	460	10.4

TABLE- 5 : Chemical Characteristics of Water in some Villages of Visnagar Taluka

Sl. No.	Source of Water	pH	Conductivity uS/cm	P-Alkalinity ($CaCO_3$) mg/1	M-Alkalinity ($CaCO_3$) mg/1	Total Hardness ($CaCO_3$) mg/1	Ca-Hardness ($CaCO_3$) mg/1	Mg-Hardness ($CaCO_3$) mg/1	Fluoride (F) mg/1	Sulphate (SO_4) mg/1	Chloride (Cl) mg/1	Nitrate (N) mg/1
1	2	3	4	5	6	7	8	9	10	11	12	13
1	Gothra : Panchayat Bore	7.8	980	0	364	240	120	120	0.8	15	210	10.5
2	Bakarpur : Panchayat Bore	7.5	1100	0	360	250	130	120	0.9	16	95	8.7
3	Rangakui : Panchayat Bore	7.6	850	0	280	270	120	150	0.5	140	850	8.0
4	Ghagret : Panchayat Bore	7.9	1400	0	420	290	150	140	0.9	24	155	6.5
5	Kuvasana : Panchayat Bore	7.7	1600	0	440	320	170	150	1.1	42	185	7.0
6	Kada : Panchayat Bore	7.7	1600	0	420	350	200	150	0.8	49	190	11.0
7	Kansa : Public Bore No. 2	7.8	1600	0	536	120	90	30	1.5	31	185	10.0
8	Kansa : Public Bare No. 1	7.8	1700	0	520	140	90	50	1.5	36	170	4.8
9	Valam : Panchayat Bore	8.0	2800	0	488	260	110	150	1.5	95	490	7.5
10	Danap : Panchayat Bore	7.9	2400	0	450	260	150	110	2.1	60	420	11.0
11	Khadalpur : Panchayat Bore	8.1	4300	0	624	370	90	280	2.1	76	575	10.5
12	Bhandu : Public Bore	8.0	3000	0	536	360	140	220	0.8	140	85	11.0
13	Davada : Public Bore	8.2	1600	0	648	250	40	210	2.4	66	75	12.5
14	Kharasada : Public Bore	8.0	3200	0	320	360	180	180	1.2	212	690	4.5
15	Vadu : Public Bore	7.4	4000	0	640	320	160	160	1.4	124	860	20.5
16	Satusana : Public Bore	8.5	2200	10	432	350	150	200	1.6	94	485	4.7
17	Jetalvasana : Public Bore	7.1	1400	0	300	280	170	110	0.7	44	170	8.4
18	Bokarvada : Private Bore (H. S. Patel)	7.8	2400	0	472	270	110	160	0.9	84	460	9.6

TABLE- 6 : Chemical Characteristics of Water in some Villages of Harij Taluka

Sl. No.	Source of Water	pH	Conductivity uS/cm	P-Alkalinity ($CaCO_3$) mg/l	M-Alkalinity ($CaCO_3$) mg/l	Total Hardness ($CaCO_3$) mg/l	Ca-Hardness ($CaCO_3$) mg/l	Mg-Hardness ($CaCO_3$) mg/l	Fluoride (F) mg/l	Sulphate (SO_4) mg/l	Chloride (Cl) mg/l	Nitrate (N) mg/l
1	2	3	4	5	6	7	8	9	10	11	12	13
1	Nanamonka : Public Well	7.8	10000	0	164	1040	420	620	0.6	265	3100	2.8
2	Nana : Public Well	7.8	15400	0	392	2650	1350	1300	0.3	420	4800	3.1
3	Malsand : Public Bore	7.9	4000	0	272	600	220	380	0.5	159	900	1.8
4	Roda : Public Bore	8.0	3400	0	292	450	150	300	0.6	120	775	1.4
5	Masa : Private Bore	7.9	2300	0	292	320	130	190	0.5	88	500	2.4
6	Finchal : Panchayat Well	8.5	980	6	200	290	100	190	0.3	28	200	4.4
7	Pinpal : Panchayat Bore	8.5	1800	8	460	120	40	80	2.1	52	300	4.8
										Vijapur Taluka		
1	Charada : Tube Well	7.9	940	0	300	280	150	130	0.5	24	150	—

TABLE-7 : Physico—Chemical Characteristics of raw water in the Villages Selected for Installation of Defluoridation Systems :

Parameters	Village +	
	Tavadia	Badarpur
pH	7.2	7.9
Conductivity (uS/cm)	1700	1800
Total Alkalinity (CaCO3) mg/l	365	576
Total Hardness (CaCO3) mg/l	156	86
Ca-Hardness (CaCO3) mg/l	88	46
Mg-Hardness (CaCO3) mg/l	68	40
Chloride (C1) mg/1	240	145
Sulphate (S04) mg/l	117	17
Nitrate (N) mg/1	6.5	3.4
Fluoride (F) mg/1	4.0	3.4

+ Water Source ; Tube Well

TABLE 8 — Treatability Studies for the water Samples of the Villages Tavadia and Badarpur

Sourec of Water Tube well	Village	
	Tavadia	Badarpur
Alum Dose	Residual Fluoride mg/1	Residual Fluoride mg/1
Raw Water	4.0	3.4
200 mg/1	—	2.4
400 mg/1	1 8	1.3
500 mg/1	1.2	—
600 mg/1	0.82	0 76
700 mg/1	0.54	—
800 mg/1	—	0.48
1000 mg/1	—	0.32

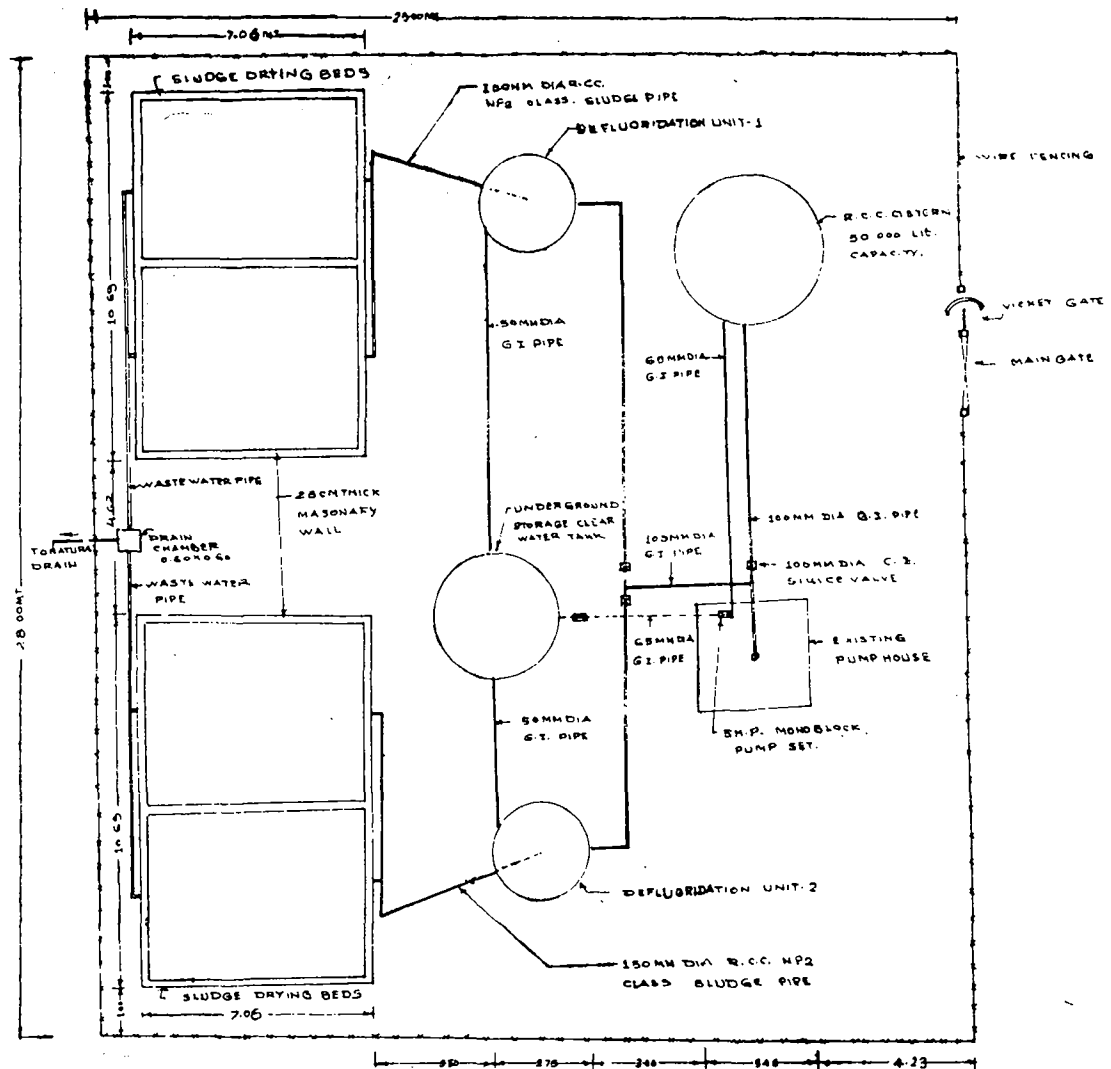
Estimated alum doses to bring down fluoride level to about 1 mg/1 :
550 mg/1 for Tavadia water & 510 mg/1 for Badarpur water

TABLE 9 — Break-up of total cost (Capital and Running) for HDPE and FERRO-CEMENT Systems to be installed at Village Tavadia and Badarpur (Dist. Mehsana)

Particulars	HDPE System (Tavadia)	* Ferro-cement System (Badarpur)
1. Capital Cost Rs. (System + Civil Work)	3,14,434-00	2,90,430-00
2. Running Cost (Rs./annum)		
a) Power @ Rs. 1/- per unit	6,843-75	9,170-63
b) Chemicals		
i. Alum @ Re 2/- per kg	31,390-00	54,020-00
ii. Chlorine @ Re. 1/- per kg. (Bleaching powder Re. 0.35 per kg)	58-40	109-50
c) Depreciation @ 5% p. a.	15,721-70	14,521-50
d) Interest @ 12% p a	37,732-00	34,851-60
e) Maintenance @ 5% p. a.	15,721-70	14,521-50
f) Personnel	36,000-00	43,200 00
Total Running Cost Rs.	1,43,467-55	1,70,394-73

Cost estimation based on the projected population for the year 1991
Tavadia : 1740
Badarpur : 3545
(Growth rate @ 3% per annum)

*The cost estimate for the village is based on the system comprising two Units only. However, subsequent addition of units may be necessary in view of the higher water demand.

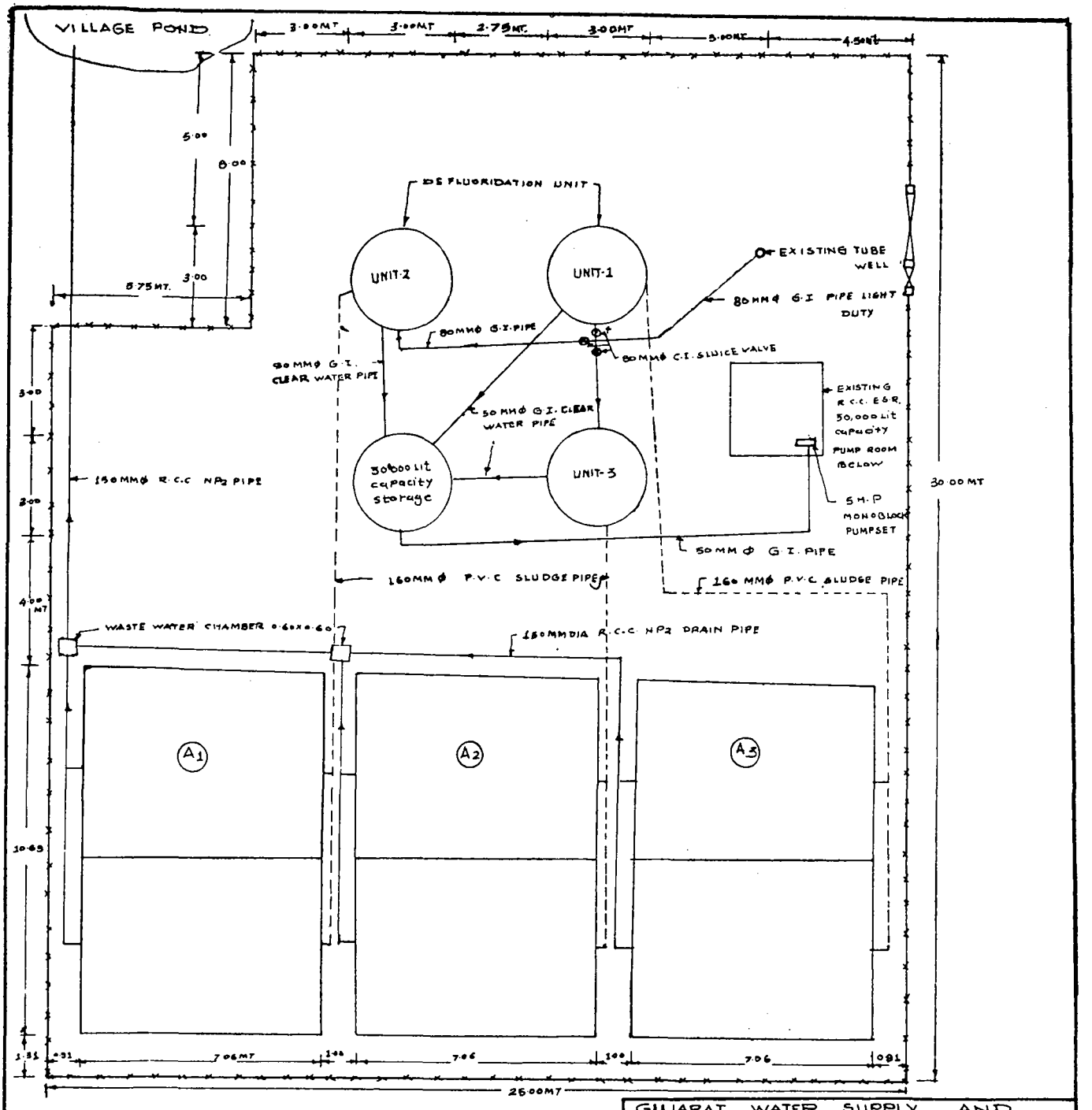


LAYOUT PLAN

GUJARAT WATER SUPPLY AND SEWERAGE BOARD GANDHINAGAR

FILL AND DRAW TYPE DEFLUORIDATION PLANT AT TAVADIYA TA:SIDHPUR DIST: MEHSANA (GUJARAT)

DRN BY		EXECUTIVE ENGINEER PUBLIC HEALTH WORKS DN SIDHPUR
CHK BY		BY: EXECUTIVE ENGINEER PUBLIC HEALTH SANI. SUB DN SIDHPUR



A1, A2 & A3 - SLUDGE DRYING BEDS 10.00Mt x 6.60 Mt SIZE

LAY-OUT PLAN

GUJARAT WATER SUPPLY AND SEWERAGE BOARD GANDHINAGAR

KEY PLAN FOR DEFLUORIDATION PLANT AT:- BADARPUR TA:KHERALU DIST:- MEHSANA (N.G.)

DRN BY		EXECUTIVE ENGINEER PUBLIC HEALTH WORKS DN. SIDHPUR.
COMP. BY		DEPUTY EXECUTIVE ENGINEER P.H. SANITARY SUB DIVISION SIDHPUR.