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National Training Camp On Iron Removal

October 7th – 8th 1987

Water Management

NATIONAL TRAINING CAMP ON IRON REMOVAL
GANGTOK (SIKKIM)

OCTOBER 7th - 8th, 1987

REPORT

NATIONAL ENVIRONMENTAL ENGINEERING RESEARCH INSTITUTE
NEHRU MARG, NAGPUR-440 020

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INTRODUCTION

National Environmental Engineering Research Institute (NEERI), Nagpur is one of the four National Laboratories, under Council of Scientific & Industrial Research (CSIR), New Delhi, which has to contribute technologies for Water Technology Mission activities. NEERI has considerable expertise in solving the problem of excessive iron in drinking water and related problems. The iron removal technologies developed by NEERI can be suitably adopted for domestic treatment, rural water supply and community water supply. Training of involved personnel and demonstration of technologies has been considered as the part of technology transfer. Water quality assessment has been considered as an essential step in identifying exact nature of water quality problem.

In keeping with the expectations of the central agencies NEERI is mobilising its originality and innovative expertise in planning and execution of several events of direct relevance to the advancement of technology mission objectives. During the Chief Engineers' Conference, held in NEERI on July 28-29, 1987, it was decided to organise a National Iron Removal Camp at Sikkim. As no laboratory facilities existed at Sikkim for determining the chemical and bacteriological quality of drinking water, it was decided to lay more emphasis on these aspects of water quality during the camp. After the camp, field visits were made by NEERI scientists to different villages of Sikkim and water samples were collected for assessing its quality. This was the first time that a CSIR laboratory visited the State of Sikkim and organsied a camp of this kind. The Iron Removal Camp was organised at the Hotel Tibet - Gangtok on October 7 and 8, 1987. This camp was jointly organsied by the Department of Rural Development (DRD), Government of Sikkim, and NEERI, Nagpur and was attended by the officials from DRD, Public Works Department and also from Educational Institutions. The camp was attened by 31 participants and had a great impact in the entire State of Sikkim.

STATE OF SIKKIM

Small but beautiful, Sikkim, the 22nd State of the Indian Union, is situated in the Eastern Himalayas. It is the smallest state in India. The state is entirely mountainous. Spread below the Mount Khanchendzonga (8603 mts.), the third highest mountain in the world and revered by the Sikkimese as their protective deity, Sikkim shares her borders with Tibet in the North, Bhutan in the East, Nepal in the West and State of West Bengal in the South. About one third of the land is covered with dense forests, where sal, simbal, bamboo and other plants thrive. Sikkim boasts of several hundred different kinds of orchids and is frequently referred to as a botanist's paradise.

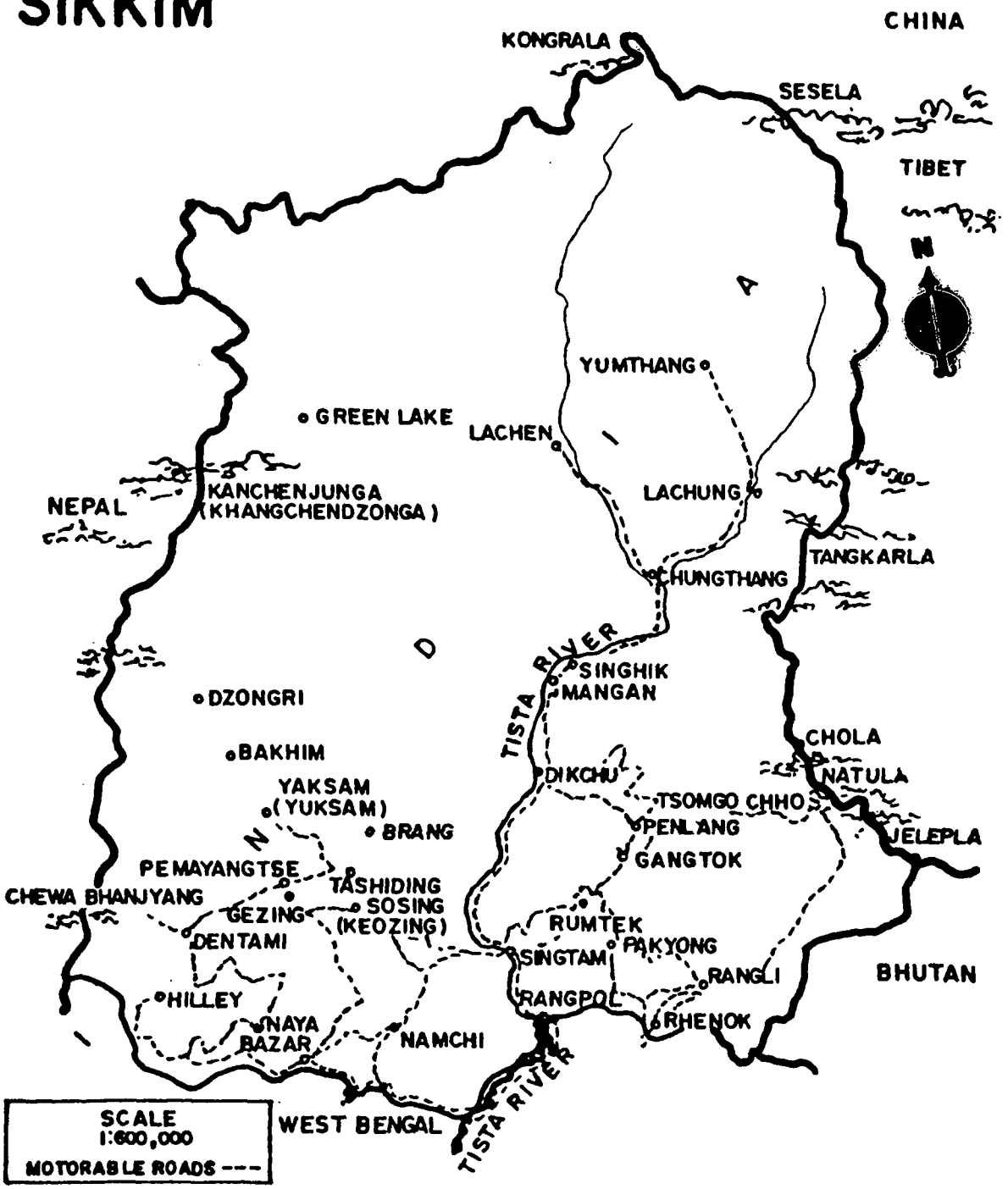
On an average Sikkim receives 125 cm rain. But the rainfall varies widely between various regions like sheltered valleys, foothills and high mountains. River Tista and its tributaries drain the State. Tista is a perennial river being both rainfed and snow-fed. Three main groups of people make up the population of Sikkim. The Lepchas, Bhutias and the Nepalese. Sikkim state has a unicameral legislature. Sikkim is divided into four districts. These districts with their area, head-quarters and population as per 1981 census are listed below :

District	Area (Sq.Km.)	Population (1981)	Head-quarters
East	964	1,38,105	Gangtok
North	4226	26,390	Mangan
South	750	75,691	Namchi
West	1166	74,813	Gyalshing

The principal crops in Sikkim are maize, paddy, millet, wheat & barley. Orange and cardamom are the main cash crops. Other important crops are potatoes, apples and buck-wheat.

Sikkim as a whole has been declared industrially backward. The main industrial units are Food Preservation Factory at Singtam, Sikkim Tanneries Limited at Mojitar, Sikkim Flour Mills at Tadong and Sikkim Distilleries at Rangpo and HMT watch assembly unit (Sikkim Time Corporation). The Rs.50 lakh Roller Flour Mill set up at Tadong has added an extruder food processing plant since 1983 to produce meals of higher nutritive value for school children under a programme sponsored by UNICEF.

SIKKIM


CHINA
KONGRALA
SESELA
TIBET
N
YUMTHANG
GREEN LAKE
LACHEN
LACHUNG
NEPAL
KANCHENJUNGA
(KHANGCHENDZONGA)
TANGKARLA
CHUNGTHANG
TISTA RIVER
SINGHIK
MANGAN
DZONGRI
BAKHIM
CHOLA
NATULA
DIKCHU
YAKSAM
(YUKSAM)
TSOMGO CHHO
PENLANG
BRANG
JELEPLA
GANGTOK
PEMAYANGTSE
TASHIDING
CHEWA BHANJYANG
GEZING
SOSING
(KEOZING)
RUMTEK
DENTAMI
PAKYONG
SINGTAM
RANGLI
BHUTAN
HILLEY
RANGPO
RHENOK
NAYA
BAZAR
NAMCHI
TISTA RIVER
WEST BENGAL
SCALE
1:600,000
MOTORABLE ROADS ---

NATIONAL IRON REMOVAL CAMP

Preparations and Participation

The Camp at Gangtok during October 7-8, 1987, was a joint venture of the Department of Rural Development (DRD), Government of Sikkim and National Environmental Engineering Research Institute (NEERI), Nagpur. The camp programme was planned by Shri K.R. Bulusu, Deputy Director and Co-ordinator, Technology Mission, NEERI, Nagpur. NEERI faculty reached Gangtok on 5th October, 1987. Water sampling programme from various places commenced from October 6, 1987 and continued until October 11, 1987. Nearly 160 water samples were collected from north, east, west and south Sikkim by NEERI Scientists. Sikkim has mostly spring water sources. The terrain of Sikkim is difficult and most of the water sources are inaccessible. Scientists struggled to collect these water samples for representative assessment of water quality in Sikkim. South Sikkim is facing water shortage and Government of Sikkim is augmenting the water supply through borewells and by pumping water from Tista river. Accordingly water samples were collected from springs, bore wells, Tista river and also dug-wells.

Programme

The camp was inaugurated by Mr. P.K. Pradhan, IAS, Secretary, Government of Sikkim, Department of Rural Development, on October 7, 1987. The camp was attended by the officials from DRD, Public Works Department and also from various Educational Institutions. The camp was attended by 31 participants. The daily programme of the camp is given in ANNEXURE-II. Various aspects of water quality parameters, disinfection, principles and methods of iron removal were explained to the participants. Demonstration was given to the participants on bacteriological examination of water and estimation of pH, conductivity and iron. Field testing kit for iron developed by NEERI was demonstrated to the participants. Design problem to be solved as an exercise by the

participants was a special feature of the camp programme. This enabled the participants to mobilize their own ideas in finding the solution to the problem of excessive iron in drinking water with a bearing on the local conditions faced by them. This also helped them in setting away the concept of typed designs or standard design and making the participants aware of the freedom they have in design of appropriate iron removal plants which suit their local needs Iron removal plant designed by NEERI for domestic use was also demonstrated to the participants.

Audio-visual Coverage of the Camp

The overall proceedings of the camp covering the inaugural session, lectures, demonstration and discussion between the faculty and participants have been depicted in a video coverage of the camp. The original cassette is lasting for about 60 minutes.

Field Visits

Water samples collected by NEERI scientists from north, south, east & west parts of Sikkim were analysed for pH, conductivity and iron at Gangtok. About 160 water samples were brought from Sikkim to Nagpur for detailed physico-chemical analysis. The list of parameters together with the units of expression are given in TABLE 1. The main source at most of the sampling points is spring water. Some of the samples were analysed for pH and conductivity by the participants themselves during the demonstration classes in the camp. Other parameters of the water samples were analysed at NEERI head-quarters, Nagpur. The results are given in TABLE 2.

Water samples collected from north, south, east and west parts of Sikkim were characterised by low dissolved solids content. These samples did not indicate any chemical pollution. Iron and manganese were estimated in all these samples. None of the samples showed the presence of these heavy metals, except one bore-well sample at Kazitar in West Sikkim which indicated iron concentration as high as 3.2 mg/L.

TABLE 1 : Water Analysis Parameters

Sl.No.	Parameters	Units
1.	Turbidity	NTU
2.	pH	-
3.	Conductivity	µS/cm.
4.	Total dissolved solids	mg/L as calculated from Conductivity
5.	Total Alkalinity	mg $CaCO_3$/L
6.	P-Alkalinity	mg $CaCO_3$/L
7.	M-Alkalinity	mg $CaCO_3$/L
8.	Total Hardness	mg $CaCO_3$/L
9.	Calcium Hardness	mg $CaCO_3$/L
10.	Magnesium Hardness	mg $CaCO_3$/L
11.	Fluoride	mg F/L
12.	Sulphate	mg SO_4/L
13.	Chlorides	mg Cl/L
14.	Nitrate	mg NO_3/L
15.	Iron	mg Fe/L
16.	Manganese	mg Mn/L

TABLE 2 : Water Quality of the Villages in Sikkim

Sr.No.	Source of Water	Physico-chemical Parameters											
		Turbidity	pH	Total Dissolved Solids	P-Alkalinity	M-Alkalinity	Total Hardness	Ca. Hardness	Mg. Hardness	Fluoride	Sulphate	Chloride	Nitrates
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Epica Garden	<5	6.2	30	0	2	16.0	4.0	12.0	0.06	0	12.0	2.8
2.	Chola Sonthem School	<5	6.7	20	0	2	14.0	8.0	6.0	0.05	2.8	4.0	1.1
3.	Chubba Khola	<5	6.4	17	0	2	12.0	4.0	8.0	0.07	6.2	10.0	2.5
4.	Rural Drinking Water Supply Scheme for Dugalakha,Pachey Khola	<5	6.7	15	0	2	10.0	2.0	8.0	0.09	9.6	10.0	1.6
5.	Namcheybong	<5	6.4	26	0	2	10.0	4.0	6.0	0.07	10.2	12.0	1.5
6.	Saramsa	<5	6.6	23	0	2	10.0	2.0	8.0	0.09	14.8	8.0	0.7
7.	Samdur	<5	6.7	51	0	2	16.0	4.0	12.0	0.08	12.6	12.0	4.8
8.	Fifth Mile Tadong (Dhobidhara)	<5	5.9	60	0	2	26.0	12.0	14.0	0.08	13.2	14.0	7.0
9.	Fifth Mile Tadong (Jorkhola)	<5	6.2	114	0	2	50.0	24.0	26.0	0.07	8.0	16.0	27.8
10.	Sixth Mile Tadong (Jorkhola)	<5	6.1	108	0	2	46.0	20.0	26.0	0.08	74	20.0	24.4

1	2	3	4	5	6	7	8	9	10	11	12	13	14
11.	Tadong Water Supply (Bijua Dhara)	<5	6.4	102	0	2	44.0	24.0	20.0	0.16	0	12.0	19.8
12.	Sichey Gaon	<5	6.1	54	0	2	24.0	8.0	16.0	0.08	1.2	8.0	11.8
13.	Burtak	<5	6.4	17	0	2	8.0	4.0	4.0	0.06	1.2	2.0	2.6
14.	Rural Drinking Water Supply Scheme, Sotak	<5	6.6	17	0	2	16.0	8.0	8.0	0.06	0.6	4.0	1.1
15.	Raw Water Sump-Gangtok Water Supply (Phenlong Stream)	<5	6.7	15	0	2	12.0	4.0	8.0	0.06	5.2	6.0	1.2
16.	Second Mile Chandmari (Kultoni Dhara)	<5	6.2	28	0	2	12.0	8.0	4.0	0.07	4.0	8.0	6.2
17.	Chandmari Scheme (Tap Water)	<5	6.7	34	0	2	20.0	12.0	8.0	0.09	2.8	8.0	3.2
18.	Rural Water Supply Scheme Rongnek (Rongnekkhola)	<5	6.6	36	0	3	24.0	12.0	12.0	0.08	3.4	6.0	2.4
19.	Rural Water Supply Phenlong Bazar	<5	5.8	32	0	2	16.0	4.0	12.0	0.07	2.8	8.0	8.4
20.	Navey Village Ichu Khola	<5	5.7	24	0	1	16.0	8.0	8.0	0.07	4.0	4.0	5.6
21.	Navey Village Nenchuzhora	<5	6.3	17	0	1	8.0	4.0	4.0	0.06	0	4.0	4.0

1	2	3	4	5	6	7	8	9	10	11	12	13	14
22.	Rural Water Supply Scheme Tum Labung	<5	6.7	30	0	2	16.0	4.0	12.0	0.07	1.2	6.0	3.5
23.	Middle Camp	<5	6.6	24	0	2	12.0	6.0	6.0	0.14	0	8.0	2.6
24.	Rural Water Supply Scheme, Upper Chisopani	<5	7.1	57	0	5	48.0	12.0	36.0	0.14	0.6	4.0	2.2
25.	Berdang (West Pendam)	<5	7.3	38	0	4	20.0	8.0	12.0	0.12	4.0	4.0	1.2
26.	Khanigaon (West Pendam)	<5	6.9	40	0	4	20.0	12.0	8.0	0.11	0	6.0	1.4
27.	Rumtek (Daldhara)	<5	5.9	16	0	2	8.0	8.0	0.0	0.08	0.6	4.0	1.6
28.	Tapwater, Near Durga Mandir	<5	6.5	29	0	2	12.0	6.0	6.0	0.07	1.2	8.0	4.6
29.	Dhanbari Village	<5	6.3	22	0	2	12.0	4.0	8.0	0.07	0	6.0	3.2
30.	Rumtek Monastry (Martam Khola)	<5	6.5	21	0	1	14.0	4.0	10.0	0.05	0	6.0	2.4
31.	Rural Water Supply Scheme-Martam Village	<5	6.7	18	0	2	8.0	4.0	4.0	0.06	1.2	4.0	1.4
32.	Upper Martam Rural Water Supply Scheme-Najtam Block.	<5	6.6	15	0	1	12.0	4.0	8.0	0.05	1.2	6.0	2.2
33.	Rural Water Supply Scheme-Phegyong	<5	6.7	13	0	2	12.0	6.0	6.0	0.06	1.8	6.0	0.9
34.	Rural Water Supply Scheme-Sakyong	<5	6.8	20	0	2	14.0	8.0	6.0	0.06	1.8	4.0	0.9

1	2	3	4	5	6	7	8	9	10	11	12	13	14
35.	Lingchom-Phenyo Tram Khola	<5	6.7	22	0	1	12.0	4.0	8.0	0.05	2.2	8.0	2.1
36.	Kabi Village-Yungang Gaon Khola	<5	6.2	25	0	2	16.0	10.0	6.0	0.06	1.8	6.0	4.8
37.	Bakcha-Spring Water W.S	<5	6.6	20	0	2	12.0	4.0	8.0	0.08	2.2	4.0	1.1
38.	Menrongong W.S.-Rongong Khola	<5	6.5	11	0	1	8.0	6.0	2.0	0.07	1.8	4.0	2.9
39.	Phamtam W.S. Solung Khola	<5	5.8	17	0	1	12.0	4.0	8.0	0.06	1.8	6.0	4.2
40.	Chawang W.S. Rumpak Khola	<5	6.1	21	0	1	8.0	4.0	4.0	0.06	1.8	4.0	1.3
41.	Tumlong W.S. Near Labrang Gumpa	<5	6.5	19	0	2	12.0	6.0	6.0	0.06	2.2	4.0	0.3
42.	Phodong Monastry Pakchey Khola	<5	6.7	17	0	2	12.0	4.0	8.0	0.06	3.4	6.0	1.7
43.	Labrang Monastry Sokeygaong Khola	<5	6.2	11	0	1	8.0	4.0	4.0	0.06	2.2	8.0	0.6
44.	Rongong Village Richu Khola	<5	6.6	19	0	2	12.0	8.0	4.0	0.06	2.2	4.0	0.8
45.	Phodong Village Lumpey Kyong	<5	6.4	11	0	1	8.0	4.0	4.0	0.05	3.4	4.0	1.1

1	2	3	4	5	6	7	8	9	10	11	12	13	14
46.	Ramthang (Tapping 1) Phyda Kyong	<5	6.4	12	0	1	8.0	4.0	4.0	0.07	2.8	6.0	1.3
47.	Ramthang (Tapping 2) Phyda Kyong	<5	6.6	14	0	1	10.0	6.0	4.0	0.06	4.0	4.0	1.6
48.	Tanek Tap Stand	<5	6.3	10	0	1	8.0	4.0	4.0	0.05	2.8	8.0	1.4
49.	Syem Village Lichung Khola	<5	6.4	11	0	1	8.0	2.0	6.0	0.05	1.8	6.0	2.2
50.	Namok Village	<5	6.5	31	0	2	16.0	6.0	10.0	0.10	2.2	10.0	3.1
51.	Mangsila W.S. Chubba Khola	<5	6.6	23	0	2	12.0	4.0	8.0	0.20	0	6.0	1.2
52.	Ting Chim W.S. Devithan Kholsa	<5	6.6	25	0	2	16.0	8.0	8.0	0.09	0	4.0	1.0
53.	Rang Rang Village Tap Stand Below Rang Rang bye pass	<5	6.1	39	0	2	20.0	8.0	12.0	0.06	0	6.0	4.8
54.	Tang Tang (Mangan) Rimik Kyong	<5	6.9	32	0	2	16.0	8.0	8.0	0.06	2.8	8.0	3.3
55.	Ambithang Village Ambithang Khola	<5	6.6	25	0	1	12.0	4.0	8.0	0.07	1.2	6.0	0.1
56.	Rang Rang Village Jor Dhara	<5	5.1	18	0	1	16.0	6.0	10.0	0.07	2.2	4.0	1.1
57.	Chim Chim Village Ting Chim Kholsa	<5	6.5	18	0	2	12.0	6.0	6.0	0.08	0.6	4.0	1.4

1	2	3	4	5	6	7	8	9	10	11	12	13	14
58.	Phensong Village Payong Khola	<5	5.8	10	0	1	8.0	2.0	6.0	0.05	0.6	4.0	0.9
59.	Phensong Village Tanang Khola	<5	6.6	16	0	2	12.0	6.0	6.0	0.06	1.8	8.0	0.9
60.	Jalipul Village beyond river Ramipol	<5	5.1	19	0	2	8.0	2.0	6.0	0.07	1.2	4.0	0.8
61.	Saramsa Village	<5	4.9	28	0	1	16.0	4.0	12.0	0.09	2.8	4.0	1.7
62.	Aho Kisan School	<5	6.6	18	0	2	12.0	6.0	6.0	0.07	1.8	8.0	0.8
63.	Pachey Samsing Village	<5	5.0	14	0	2	8.0	4.0	4.0	0.06	1.8	6.0	1.6
64.	Pakyong Village Pachey Khola	<5	5.6	14	0	1	12.0	4.0	8.0	0.09	3.4	6.0	0.7
65.	Damlakha	<5	5.3	22	0	1	12.0	4.0	8.0	0.08	5.2	4.0	1.3
66.	Sajbotey-Pacheykhani	<5	5.8	15	0	2	8.0	2.0	6.0	0.06	5.6	8.0	0.9
67.	Mohan Dhara	<5	5.7	17	0	1	10.0	4.0	6.0	0.06	5.2	12.0	0.5
68.	Lower Howsey, Bhasmey	<5	6.0	45	0	2	28.0	10.0	18.0	0.09	4.6	4.0	1.5
69.	Panbanchi Well	<5	5.8	23	0	2	12.0	4.0	8.0	0.08	4.6	12.0	0.3
70.	Lakhotimohan Panchey Khani	<5	5.9	26	0	2	16.0	6.0	10.0	0.07	6.2	12.0	0.6
71.	Kitgolai	<5	6.4	156	0	2	144.0	42.0	102.0	0.11	5.2	6.0	0.8

1	2	3	4	5	6	7	8	9	10	11	12	13	14
72.	Benthaso- Near Rarathang river	<5	7.1	28	0	2	20.0	6.0	14.0	0.11	6.2	8.0	0.8
73.	Rarathang Gammon Bridge near Green Rock	<5	7.3	276	0	7	208.0	136.0	72.0	0.35	184.0	8.0	0.8
74.	Rhenock W.S.-Paha Khola	<5	5.8	17	0	2	12.0	4.0	8.0	0.08	5.2	6.0	0.3
75.	Chalisey Chowdhalatey	<5	6.8	28	0	2	20.0	6.0	14.0	0.14	4.0	8.0	0.1
76.	Chang Changey	<5	6.9	24	0	2	20.0	6.0	14.0	0.07	3.4	6.0	0.3
77.	Rate Khola	<5	6.8	36	0	3	24.0	6.0	18.0	0.09	4.0	8.0	0.4
78.	Alleray Hitti-Rongli PHC	<5	6.8	48	0	3	36.0	10.0	26.0	0.07	5.2	6.0	2.5
79.	Devithan - Chujachen	<5	6.1	39	0	3	28.0	8.0	20.0	0.08	5.2	4.0	0.3
80.	Jorkhola Reservior - Chujachen	<5	7.4	45	0	4	44.0	24.0	20.0	0.16	5.2	8.0	0.1
81.	Sunnu Kholsa	<5	6.3	57	0	4	44.0	12.0	32.0	0.12	6.8	8.0	0.7
82.	Sawa Khola - Rongte Bazar	<5	6.6	28	0	2	20.0	6.0	14.0	0.08	5.6	6.0	0.4
83.	Rhenock Village - Khamdong Dhara	<5	6.9	19	0	2	16.0	4.0	12.0	0.07	5.2	8.0	0.6
84.	Pakyong Village - Hel Khola	<5	6.9	26	0	2	28.0	6.0	22.0	0.09	6.2	6.0	0.8
85.	Lower Tarku Village	<5	6.9	23	0	3	16.0	6.0	10.0	0.08	5.6	8.0	1.9

1	2	3	4	5	6	7	8	9	10	11	12	13	14
86.	Upper Tarku Village	<5	7.1	17	0	3	12.0	4.0	8.0	0.08	6.2	6.0	1.6
87.	Ben Village - Spring I	<5	7.2	27	0	3	20.0	6.0	14.0	0.07	5.2	8.0	0.7
88.	Ben Village - Spring II	<5	7.1	24	0	2	16.0	4.0	12.0	0.06	6.8	6.0	1.1
89.	Ben Village - Spring III	<5	6.5	17	0	2	16.0	8.0	8.0	0.06	5.6	6.0	0.8
90.	Kewzing - Mamring	<5	6.8	16	0	2	16.0	4.0	12.0	0.08	7.4	8.0	0.6
91.	Legship Village - after SSF	<5	6.9	32	0	2	28.0	8.0	20.0	0.10	4.0	8.0	0.8
92.	Legship Village - before treatment	<5	7.0	36	0	3	28.0	6.0	22.0	0.10	4.6	10.0	0.8
93.	Middle Gayzing Village	<5	7.4	45	0	3	32.0	8.0	24.0	0.11	4.0	6.0	1.8
94.	Malbasey Village	<5	6.9	37	0	2	28.0	6.0	22.0	0.07	3.4	12.0	1.8
95.	Kyongsa Village	<5	6.7	30	0	2	24.0	6.0	18.0	0.07	4.0	10.0	3.7
96.	Geyzing Omchung	<5	6.9	28	0	2	20.0	4.0	16.0	0.08	3.4	8.0	1.1
97.	Guruthang Village	<5	6.9	31	0	2	24.0	6.0	18.0	0.08	2.6	8.0	3.2
98.	Yangtey Water Supply Source I	<5	7.0	25	0	2	16.0	4.0	12.0	0.06	3.1	12.0	1.2
99.	Yangtey Water Supply Source II	<5	6.9	29	0	2	20.0	4.0	16.0	0.11	3.4	8.0	0.2
100.	Onglop Village	<5	6.8	21	0	1	20.0	4.0	16.0	0.05	3.4	6.0	0.7

1	2	3	4	5	6	7	8	9	10	11	12	13	14
101.	Gayzing W.S.	<5	7.0	13	0	2	12.0	4.0	8.0	0.05	3.1	6.0	0.8
102.	Tikjukkyangsa W.S.	<5	6.7	14	0	2	12.0	4.0	8.0	0.04	2.8	8.0	0.9
103.	Razong Village	<5	7.1	32	0	3	28.0	8.0	20.0	0.07	2.6	6.0	0.4
104.	Tashiding Village - Sinek	<5	6.9	31	0	3	24.0	8.0	16.0	0.07	3.1	6.0	1.0
105.	Tashiding Village - Rinzang Khola	<5	7.1	41	0	3	36.0	10.0	26.0	0.06	4.0	6.0	0.7
106.	Rangit Village	<5	7.4	90	0	7	72.0	26.0	46.0	0.12	4.8	8.0	0.3
107.	Sindrang - Phimkhola	<5	6.7	26	0	2	20.0	4.0	16.0	0.09	7.4	6.0	0.4
108.	Singyang	<5	7.1	38	0	3	28.0	12.0	16.0	0.08	7.4	6.0	0.6
109.	Pelling	<5	7.0	24	0	2	16.0	6.0	10.0	0.05	0	8.0	0.7
110.	Lingchom	<5	6.8	27	0	2	20.0	8.0	12.0	0.07	2.8	6.0	0.2
111.	Lunzik	<5	6.6	23	0	2	20.0	4.0	16.0	0.07	1.2	6.0	3.5
112.	Bungten	<5	6.8	16	0	2	16.0	6.0	10.0	0.07	0.6	6.0	0.8
113.	Sninagi - Bar Khola	<5	6.8	15	0	2	12.0	4.0	8.0	0.07	2.8	4.0	0.5
114.	Berfung W.S. - Lingtam	<5	6.2	23	0	1	16.0	2.0	14.0	0.06	1.2	8.0	1.8
115.	Semana Kholsa	<5	6.6	23	0	2	16.0	6.0	10.0	0.06	2.2	6.0	0.4
116.	Tista River (below Mamring Suspensing Bridge)	<5	6.9	34	0	3	32.0	12.0	20.0	0.09	2.8	4.0	0.6

1	2	3	4	5	6	7	8	9	10	11	12	13	14
117.	Devithan Source for Mamring W.S.	<5	6.9	60	0	3	40.0	8.0	32.0	0.12	3.4	8.0	0.5
118.	Mamring Khola	<5	7.4	54	0	5	36.0	10.0	26.0	0.13	2.8	6.0	0.4
119.	Chharchhare Dhara	<5	7.1	54	0	5	44.0	12.0	32.0	0.13	4.6	6.0	0.5
120.	Jugey Pani - Intake point of Mamring W.S.	<5	7.4	72	0	6	48.0	20.0	28.0	0.15	3.4	6.0	0.3
121.	Donok W.S.	<5	6.7	41	0	4	20.0	4.0	16.0	0.16	3.4	10.0	2.2
122.	Turung Block-Kasur Khola	<5	7.0	22	0	2	16.0	4.0	12.0	0.13	3.4	4.0	0.4
123.	Turung Dhara	<5	6.8	45	0	2	28.0	6.0	22.0	0.14	4.6	10.0	3.9
124.	Tek Jor Dhara	<5	6.8	59	0	5	24.0	8.0	16.0	0.13	3.4	6.0	3.4
125.	Kanamtek W.S. - Rebdung Dhara	<5	6.5	28	0	2	20.0	4.0	16.0	0.09	4.6	8.0	2.2
126.	Nalum W.S.-Kolbung Dhara	<5	6.5	31	0	2	16.0	4.0	12.0	0.08	6.2	10.0	3.2
127.	Phong W.S. - Har Katey Khola	<5	7.1	18	0	3	16.0	8.0	8.0	0.07	4.6	6.0	0.3
128.	Tangi W.S.S. - Harisey Khola	<5	7.3	84	0	7	80.0	52.0	28.0	0.06	5.6	4.0	1.1
129.	Bikmat W.S.S. - Ramaram	<5	7.0	51	0	5	48.0	32.0	16.0	0.07	5.2	6.0	0.3
130.	Rasi Khola	<5	7.7	128	0	8	108.0	72.0	36.0	0.08	5.6	4.0	0.5

1	2	3	4	5	6	7	8	9	10	11	12	13	14
131.	Bikmat W.S.S. - Khurlong Dhara	<5	7.4	85	0	9	80.0	64.0	16.0	0.08	3.4	8.0	0.4
132.	Bikmat W.S.S. - Ambokey Dhara	<5	7.6	60	0	6	48.0	40.0	8.0	0.07	4.0	6.0	0.3
133.	Maniram Bazar Supply	<5	7.0	34	0	2	28.0	12.0	16.0	0.06	4.6	8.0	1.8
134.	Saley Bong W.S.S.	<5	7.8	156	0	14	140.0	72.0	68.0	0.13	2.2	4.0	1.8
135.	Kazitar Borewell	<5	6.0	37	0	1	28.0	16.0	12.0	0.09	2.2	8.0	1.7
136.	Purano Namchi W.S.S. (Reserve Tank without chlorination)	<5	6.0	52	0	1	44.0	16.0	28.0	0.09	0	6.0	0.7
137.	Purano Namchi W.S.S. (Reserve Tank with chlorination)	<5	7.2	53	0	4	44.0	16.0	28.0	0.11	1.8	6.0	0.6
138.	Assangthang W.S.S. (near helipad)	<5	7.1	29	0	2	24.0	8.0	16.0	0.10	1.2	4.0	0.3
139.	Poklok Denchung W.S.S.	<5	7.6	96	0	8	80.0	36.0	44.0	0.11	1.2	4.0	5.8
140.	Tinik Chisopani Source - No.1	<5	7.3	90	0	9	84.0	68.0	16.0	0.10	1.2	6.0	2.6
141.	Tinik Chisopani Source - No.2	<5	7.2	102	0	9	80.0	64.0	16.0	0.10	0.6	8.0	4.8
142.	Tinik Chisopani Source - No.3	<5	7.7	90	0	10	72.0	48.0	24.0	0.10	2.2	6.0	1.5

1	2	3	4	5	6	7	8	9	10	11	12	13	14
143.	Dugwell CRPF Camp (near Jorethang) - I	<5	8.1	192	0	18	92.0	64.0	28.0	0.12	3.4	6.0	6.0
144.	Dugwell CRPF Camp (near Jorethang) - II	<5	7.7	186	0	19	148.0	112.0	36.0	0.13	1.8	4.0	0
145.	Chakung - Ghanti Khola	<5	6.9	24	0	2	20.0	12.0	8.0	0.09	0	6.0	11.8
146.	Soreng - Hitti Dhara	<5	6.8	31	0	2	20.0	8.0	12.0	0.10	1.2	4.0	0
147.	Soreng - Reshi Khola	<5	6.7	23	0	2	16.0	4.0	12.0	0.07	0.6	6.0	5.8
148.	Soreng - Kharka Bazar Dhara	<5	6.1	37	0	2	28.0	8.0	20.0	0.07	1.2	4.0	0.6
149.	Dharamdin - Devithan	<5	6.9	37	0	3	16.0	8.0	8.0	0.08	1.8	6.0	5.6
150.	Budang - Gokal Dhara	<5	6.4	23	0	2	16.0	4.0	12.0	0.07	0.6	6.0	0.4
151.	Soreng - Ghanti Khola	<5	6.9	24	0	2	20.0	8.0	12.0	0.06	0.6	6.0	5.0
152.	Soreng - Devithan Dhara	<5	6.4	23	0	2	20.0	4.0	16.0	0.06	0.6	4.0	0.4
153.	Soreng - Hitti Dhara	<5	6.5	30	0	2	24.0	16.0	8.0	0.08	1.2	6.0	4.9
154.	Soreng - Chisopani Dhara Tharpu	<5	6.6	22	0	2	8.0	2.0	6.0	0.06	1.8	8.0	1.4
155.	Soreng - Okhar Botey Dhara	<5	5.9	36	0	1	24.0	10.0	14.0	0.08	2.2	10.0	4.6
156.	Malbasay - Dhamai Dhara	<5	6.8	15	0	2	12.0	4.0	8.0	0.06	1.2	4.0	2.4

1	2	3	4	5	6	7	8	9	10	11	12	13	14
157.	Rungdung Khola	<5	7.4	66	0	6	56.0	40.0	16.0	0.18	3.4	6.0	4.6
158.	Jorethang - Devithan Jhora	<5	7.4	186	0	18	136.0	112.0	24.0	0.13	2.2	8.0	1.1
159.	Jorethang - Chhar Chhare Khola	<5	7.7	150	0	12	112.0	84	28.0	0.14	5.2	4.0	8.2
160.	Jorethang - Manpur Khola	<5	7.2	57	0	4	44.0	16.0	28.0	0.17	4.6	4.0	7.6
161.	Jorethang - Roluk Khola	<5	7.1	42	0	3	32.0	16.0	16.0	0.12	3.4	6.0	7.4

RURAL SANITATION IN SIKKIM

In India less than 1% rural population has access to sanitary latrine facilities at present. Apart from constituting a major health hazard it has created a special problem for women because of lack of privacy. In this connection Prime Minister has suggested taking up of an integrated programme for rural sanitary latrines during the seventh plan with a special emphasis on the need to protect and uphold the dignity of women. Accordingly Government of India has initiated implementation of rural sanitary latrines in massive scale all over the country. Such latrines are being constructed under various centre's as well as State Govt's programme, such as : Rural Landless Employment Guarantee Programme (RLEGP), National Rural Employment Programme (NREP), Central Rural Sanitary Programme (CRSP), State Plan etc.

Sikkim has taken up this rural sanitation scheme in a massive scale from the year 1986-87. In fact scheme under rural sanitation was started in right earnest from 1985-86 when a total of 160 house hold latrines were constructed. Works on 1,760 sanitary latrines are under progress in the rural areas of Sikkim at present. The construction is being taken up under various programmes. These are enumerated as follows:

1. State Plan programme with UNICEF assistance - 300 Nos.
2. Rural landless employment guarantee programme (RLEGP) - 349 Nos.
3. National rural employment programme (NREP) - 90 Nos.
4. State Plan Programme - 166 Nos.
5. Central Rural Sanitary Programme - 855 Nos.

Out of the above, 1,594 latrines are for individual household and the balance 166 are for primary schools and other institutions like Panchayat Ghar, I.C.D.S. Centres in the rural areas. Provision of sanitary latrine has been made an integral part of the housing programme for Scheduled casts and tribes under 'Indira Awwas Yojna' and accordingly the above mentioned household latrines include 150 for such houses constructed during 1985-86 and 1986-87.

As per programme envisaged in the Decade Programme under Drinking Water and Sanitation at least 25% of the rural population are to be covered with proper sanitary facilities by the end of 1990-91. With the progress and physical target being achieved, Rural Development Department expects to give more coverage during the period. The response is quite heartening and there is awareness amongst the rural population.

Government is giving due priority to sanitation activities, and has already implemented the sewarge system and its treatment plant for Gangtok town to serve the same objectives.

BACTERIOLOGICAL QUALITY OF WATER

In developing countries, biological pollution of water is of more serious concern than chemical pollution. It is mainly due to lack of sewage treatment facilities. Sewage is a diluted faecal matter which contain disease producing microorganism such as *Vibrio cholera, Salmonella typhi, Paratyphi,* etc. When water sources are contaminated with sewage or faecal matter from birds and cattle, these disease producing organisms get access to water body and if water is consumed without treatment or disinfection, people suffer with these diseases. In urban areas when water is treated conventionally, it is likely that due to leakages, surrounding polluted water may enter pipe line during non-supply hours. Hence, it is important to monitor residual chlorine at consumer end and it should be 0.2 mg/L. It is suggested that drinking water should be devoid of sewage microorganisms particularly the coliform group of organisms which are present only in faecal matter of birds, animals and human beings. Their presence particularly of *E.coli* indicate that disease producing organisms are likely to be present due to recent contamination of water with faecal matter. Hence, the drinking water standards are laid down on the presence of coliform group of organisms. According to the standard, 100 ml of drinking water sample should not contain even one number of *E.coli*. If they are present, water has to be disinfected before drinking. In rural areas, water is not treated conventionally but only disinfected by using

bleaching powder which is economical, easy to handle and readily available. However, during chlorination, contact period is an important criteria and it should be 30 minutes to kill all disease producing organisms. The presence of indicator organism, i.e., coliform, may indicate the improper contact period during disinfection. The residual chlorine in the concentration of 0.2 ppm should be maintained after 30 minutes contact period, i.e. after satisfying the chlorine demand of water. Hence, it is also necessary to find out the chlorine demand of water to be supplied to consumer.

In Sikkim State, most of the township and villages are situated on hills. The main source of water in villages is spring water. Water from these springs are collected in a cement constructed tank by gravity. Bleaching powder solution is added in these tanks and water is supplied through pipes to consumer directly or through the taps.

In order to assess the bacteriological quality of water membrane filter technique was used. Samples were collected from different areas of Sikkim in sterilised bottles containing sodium thiosulphate to neutralize the chlorine if present in water samples. 100 mL of water samples were filtered through membrane filter of 0.45 μ size and placed over pad in petridish saturated with medium (m-Endo Broth-Difco). These petridishes containing pad and membranes were incubated at 37°C in humid condition. Typical dark brown colonies with metallic sheen developed by coliform organisms were counted. Results of bacteriological analysis of water samples collected from different parts of Sikkim are reported in TABLE 3.

A total of 22 samples were analysed for bacteriological quality. Out of these, five samples were of good quality since the count of coliform per 100 mL is less than 1. Rest of the samples were polluted as coliform count was more than 1. These five samples, according to drinking water quality standards, may be fit for human consumption whereas rest of the samples are unfit because of high coliform count.

TABLE 3 : Results of Bacteriological Analysis

Sl.No.	Source of Sample	Coliform Colonies per 100 mL of Sample
1.	Epica Garden	1
2.	Chola Sonthen School	2
3.	Chubba Khola	26
4.	RDWSS Dugalakha, Pachey Khola	12
5.	Namcheybong	34
6.	Saramsa	16
7.	Samdur	1
8.	Fifth Mile Tadong (Dhobidhara)	1
9.	Fifth Mile Tadong (Jorkhola)	5
10.	Sixth Mile Tadong (Jorkhola)	1
11.	Tadong Water Supply (Bijua Dhara)	1
12.	RWSS Tum Labung	2400+
13.	Middle Camp	2400+
14.	RWSS Upper Chisopani	240
15.	Berdang (under West Pendam)	93
16.	Khanigaon (under West Pendam)	2400+
17.	Rumtek (Dal Dhara)	75
18.	Tap Water Near Durga Mandir	210
19.	Dhanbari Village	2400
20.	Rumtek Monastry (Martam Khola)	240
21.	RWSS Martam Village	2400
22.	RWSS Upper Martam (Najtam Block)	2400

TABLE 4 : Coliform Count in Different Samples

Coliform Range (MPN/100 mL)	No. of Samples	Percentage of Samples
1	5	22.7
1-25	3	13.6
26-50	2	9.1
50-100	3	13.6
101-500	3	13.6
Above 500	6	27.3

It is alarming to note that out of these 22 samples collected, five samples have very high count of coliform (2400 + per 100 mL) indicating gross pollution of water samples even after disinfection. It may be due to handling of PVC pipes in unhygienic way, additional pollution due to defecations from birds, improper chlorination dose or insufficient contact period. Since spring water is flowing from hill in an open system, it is likely that it may be contaminated with birds' faecal matter. It was also observed that at public stand posts, other activities such as bathing, washing of clothes and cleaning of utensils, were prevailing. These activities may also contribute in the deterioration of water quality.

In general, it is observed that more than 75 per cent of samples (TABLE 4) collected were highly contaminated and this may be attributed to improper contact period during chlorination or mismanagement in disinfection process. Monitoring of residual chlorine at regular interval of time and proper adjusting of chlorine dose is recommended.

ACKNOWLEDGEMENTS

The National Camp on Iron Removal was decided during the Chief Engineers Conference held at NEERI during July 28-29, 1987. The concept has been highly acclaimed by one and all who participated in the camp. The guidance from the Ministry of Agriculture, Department of Rural Development and CSIR Headquarters 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 N.S. Lepcha, Chief Engineer, Rural Development Department, Tashiling, Gangtok, whose constant presence, guidance and direction were valuable in organising the camp.

NEERI is grateful to Dr. G. Ghosh, Director, Water Technology Mission, Government of India, Dr. Ram K. Iyengar, Additional Director General, CSIR, for their kind help in giving shape to the camp. NEERI expresses its gratitude to Shri P.K. Pradhan, IAS, Secretary, Rural Development Department, Tashiling, Gangtok for his keen interest and support to this programme. The active services offered by his staff are acknowledged. The Institute also thanks all the participants for sharing their rich experiences with the Faculty and also for their active involvement in the field studies at various places in Sikkim.

The organisation of the camp by NEERI is a complex exercise under the guidance of Prof. P. Khanna, Director, NEERI. Preparations required the active participation of several divisions at Headquarters. The Faculty for the camp is 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, Waste Water Engineering Division, Life Sciences Division, Environmental Impact Analysis and Consultancy Division, Workshop and Technical Publications Division. Their whole-hearted participation, co-operation, and involvement are gratefully acknowledged.

ANNEXURE - I

LIST OF PARTICIPANTS

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6. Shri R.B. Kumar, Co-ordinator, Education Department, Government of Sikkim, Gangtok.

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26. Shri J.K. Sarkar, Junior Engineer, Rural Development Department, Government of Sikkim, Gangtok.

27. Shri Khagendra Tamang, Junior Engineer (W/S), Public Works Department, Gangtok.

28. Krishna Kr. Chhetri, Junior Engineer (H.O.), Rural Development Department, Gangtok.

29. Shri P. Sresta, Assistant Engineer, Rural Development Department, Government of Sikkim, Pakyong.

30. Shri H.L. Ram, Assistant Engineer, Rural Development Department, Government of Sikkim, Gangtok.

31. Shri G.S. Lama, Superintendent Engineer, Rural Development Department, Tashiling, Gangtok.

ANNEXURE - II

NATIONAL IRON REMOVAL CAMP AT GANGTOK, SIKKIM
(October 7-8, 1987)

DAILY PROGRAMME

October 7, 1987

- Inaugural Function : Mr. P.K. Pradhan, IAS, Secretary, Government of Sikkim, Department of Rural Development, inaugurated the camp.
- Welcome speech by Mr. K.R. Bulusu, Deputy Directory & Chief Co-ordinator, WTM, NEERI.
- Water Technology Mission and its various facets by K.R. Bulusu.
- Audion-visual Programme on NEERI
- Audion-visual Programme on :
  * Defluoridation Camp at Amreli, Gujrat
  * Iron Removal Camp at Agartala, Tripura
  * Bacteriological Examination of water
- Lecture on various aspects of Water Quality Parameters by Dr. S.P. Pande
- Lecture on Principles of Iron Removal by Mr. K.R. Bulusu
- Lecture on Methods of Iron Removal by Dr. S.N. Kaul
- Lecture on Design Problems on Iron Removal by Mr. V.P. Deshpande
- Demonstration of Iron Removal Plant 600 L/min capacity
- Incubation of water samples for Bacteriological Examination

October 8, 1987

- Lecture on Disinfection by Dr. S.R. Joshi
- Demonstration of water analysis with specific reference to pH and conductivity. Demonstration of Field Testing Kit for Iron.
- Demonstration of Bacteriological Examination of water
- Discussions on various aspects of water treatment between faculty and the participants
- Valedictory Function : Mr. P.K. Pradhan, IAS, Secretary Government of Sikkim, concluded the proceedings and Mr. K.R. Bulusu summarised the salient features of Iron Removal Camp

October 9/10, 1987 Field visits to North South, East & West Parts of Sikkim

ANNEXURE - III

NEERI TEAM AT IRON REMOVAL CAMP GANGTOK

Shri K.R. Bulusu

Dr. S.N. Kaul

Dr. S.R. Joshi

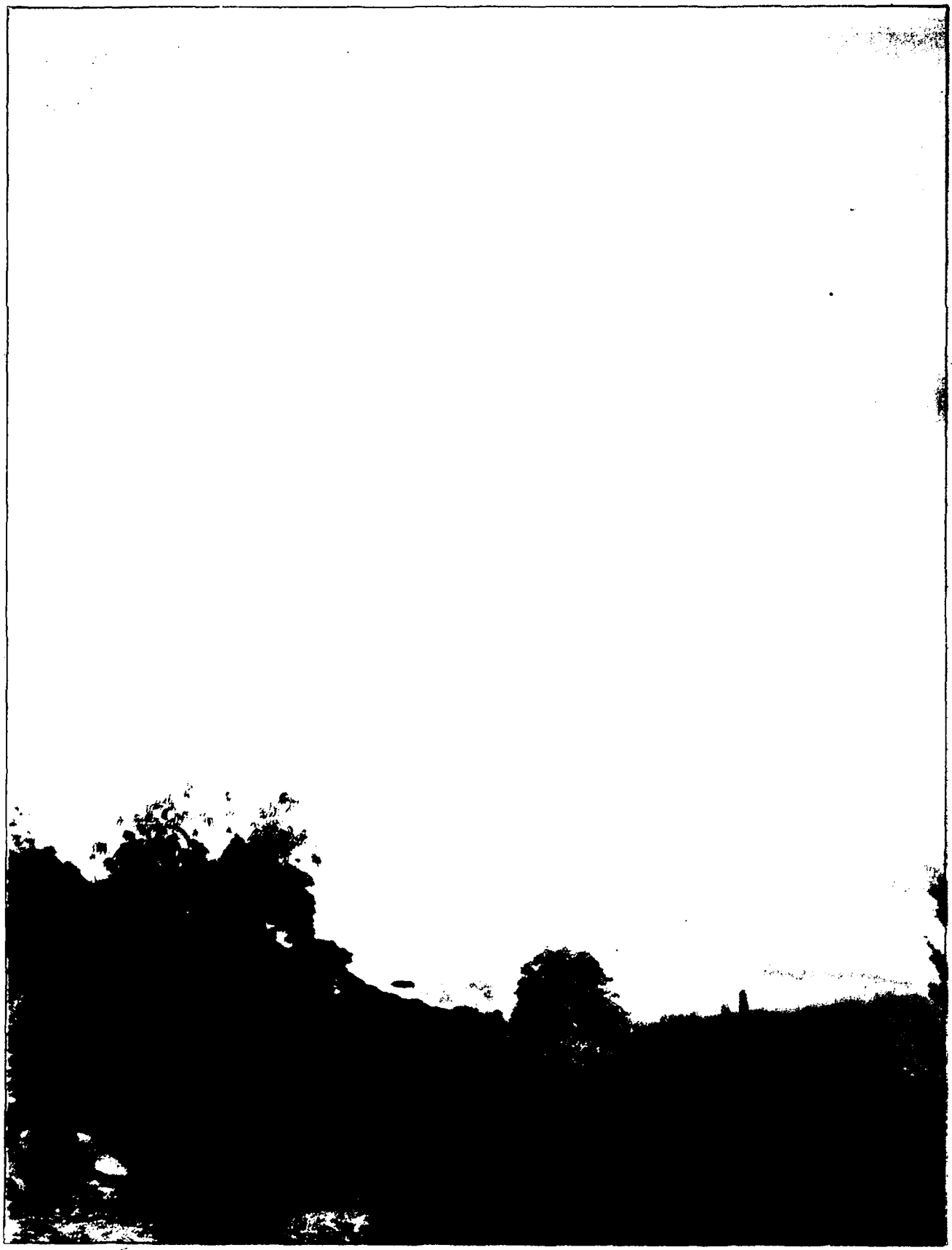
Dr. S P. Pande

Shri V.P. Deshpande

ANALYTICAL ASSISTANCE

Shri A.V.J. Rao

Shri R.A. Pandey



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