JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)
FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
MINISTRY OF WATER RESOURCES

THE STUDY
ON
ELEVEN CENTERS WATER SUPPLY AND SANITATION
IN
FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

APPENDIXES
DEBRE TABOR

(Volume Ⅲ-Ⅵ)

FEBRUARY, 1996

SANYU CONSULTANTS INC.
KYOWA ENGINEERING CONSULTANTS CO., LTD.

GOVERNMENT OF JAPAN
JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)
FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
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PREFACE

This is the Appendixes for Debre Tabor presenting the results of the Study on Eleven Centers Water Supply and Sanitation (the Study) carried out in accordance with the Scope of Work agreed upon between the Government of Federal Democratic Republic of Ethiopia (GOE) through the Water Supply and Sewerage Agency (WSSA) of the Ministry of Natural Resources Development and Environmental Protection (MNRDEP), which was recently reorganized Water Supply and Sewerage Service Department (WSSD) under Ministry of Water Resources (MWR), on the one part and the Government of Japan (GOJ) through the Japan International Cooperation Agency (JICA) on the other part dated April 8, 1994.

The major objectives of this Study are 1) to conduct a feasibility study on the water supply system in order to improve living condition of the population in the Study area by enhancing the level of the water supply services in terms of water quantity, water quality and its accessibility, 2) to formulate a plan for sanitary education and the diffusion of sanitary facilities in order to raise peoples' awareness on hygiene and improve environmental sanitation, which will be able to prevent the contamination of water source(s) and to secure safe water supply, and 3) to transfer technologies to the Ethiopian counterpart personnel in order to strengthen the managerial aspects of water supply services.

The Study had been conducted over a two (2) Japanese fiscal year-period from 1994/95 to 1995/96 and divided into two (2) phases. The Phase I study was conducted between December 1994 and March 1995, and Phase II was conducted between May 1995 and February 1996, for a total study period of 15 months during which three (3) times of visit to Ethiopia were made.

The survey items and major activities are meteo-hydrological survey, geo-electric prospecting (GEP) survey, water quality, water use condition, sanitary and health condition and people's awareness, social background, socio-economy, initial environmental examination (IEE), environmental impact assessment (EIA), sanitary education practice, and existing pump investigation.

The Study Team extends heartiest thanks to WSSD especially those assigned counterparts for their close cooperation and hard work in both office and the field, and the officers of related agencies of Japan.

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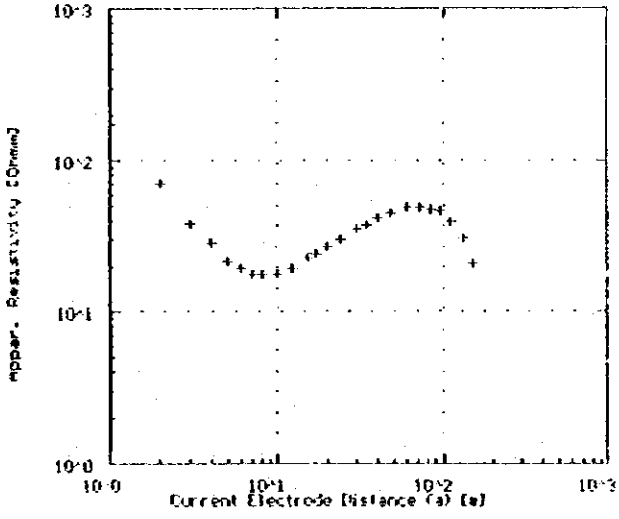
Appendix - 1

Resistivity Interpretation of VEP

Figure 1 Geoelectrical Survey, Wenner Array

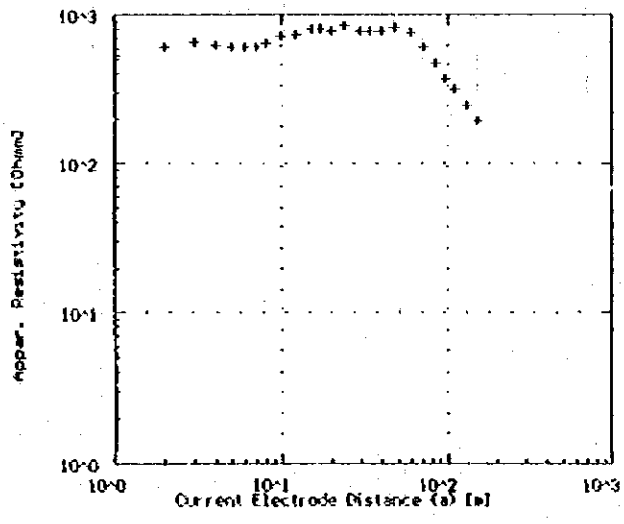
VES St. No.1 -DEBRE TABOR



Point (No)	MN/2 (Mr)	a (m)	Res (ohm)
1	0.00	172.700	
2	2.00	69.920	
3	3.00	39.410	
4	4.00	22.980	
5	5.00	21.250	
6	6.00	89.220	
7	7.00	10.020	
8	8.00	12.580	
9	10.00	11.900	
10	12.00	10.220	
11	15.00	22.510	
12	17.00	26.260	
13	20.00	27.090	
14	24.00	30.100	
15	30.00	34.050	
16	34.00	37.370	
17	40.00	41.100	
18	48.00	44.610	
19	60.00	48.610	
20	72.00	48.030	
21	84.00	50.000	
22	96.00	45.020	
23	110.00	39.380	
24	130.00	34.920	
25	150.00	28.720	

Specific Resistivity(Ω-m)	160	16	88	63	6.86

VES St. No.2 -DEBRE TABOR



Point (No)	MN/2 (Mr)	a (m)	Res (ohm)
1	1.00	527.570	
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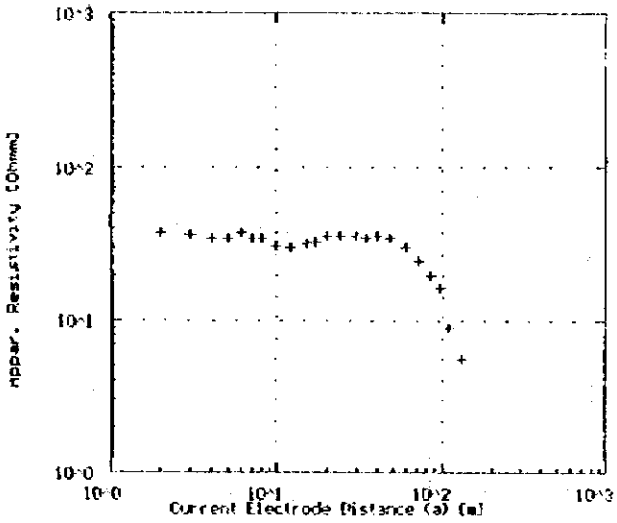
3	3.00	659.690	
4	4.00	630.510	
5	5.00	610.590	
6	6.00	602.080	
7	7.00	602.250	
8	8.00	640.100	
9	10.00	722.260	
10	12.00	720.530	
11	15.00	705.950	
12	17.00	705.350	
13	20.00	770.720	
14	24.00	859.100	
15	30.00	781.200	
16	34.00	790.020	
17	40.00	778.720	
18	48.00	811.970	
19	60.00	753.600	
20	72.00	610.420	
21	84.00	676.770	
22	96.00	723.190	
23	110.00	717.770	
24	130.00	744.020	
25	150.00	693.110	

Specific Resistivity(Ω-m)	470	705	600	900	780	156

VES St. No.3 -DEBRE TABOR

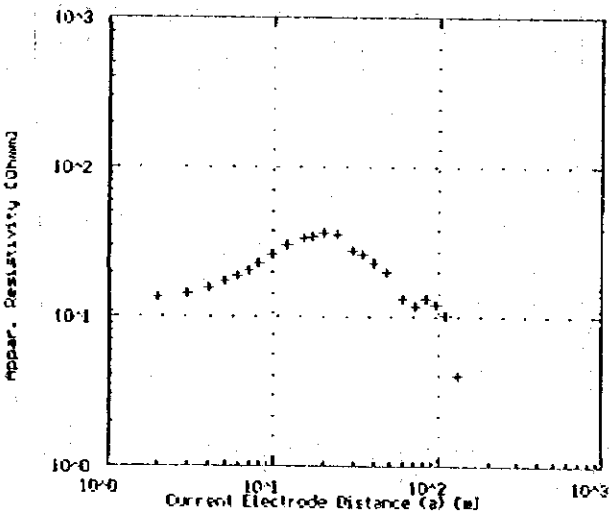


Point (No)	AB/2 (Mr)	a (m)	Res (ohm)
1	1.00	33.490	
2	2.00	32.620	
3	3.00	30.350	
4	4.00	34.610	
5	5.00	36.540	
6	6.00	37.300	
7	7.00	36.290	
8	8.00	36.640	
9	10.00	38.770	
10	12.00	38.160	
11	15.00	32.030	
12	17.00	32.650	
13	20.00	34.020	
14	24.00	28.550	
15	30.00	35.230	
16	36.00	26.670	
17	40.00	36.070	
18	50.00	32.910	
19	60.00	29.060	
20	72.00	26.290	
21	84.00	19.900	
22	96.00	18.500	
23	110.00	6.930	
24	130.00	5.650	

Specific Resistivity(Ω-m)	2.4	34.29	42	34	4.86

18.25

VES St. No.4 -DEBRE TABOR

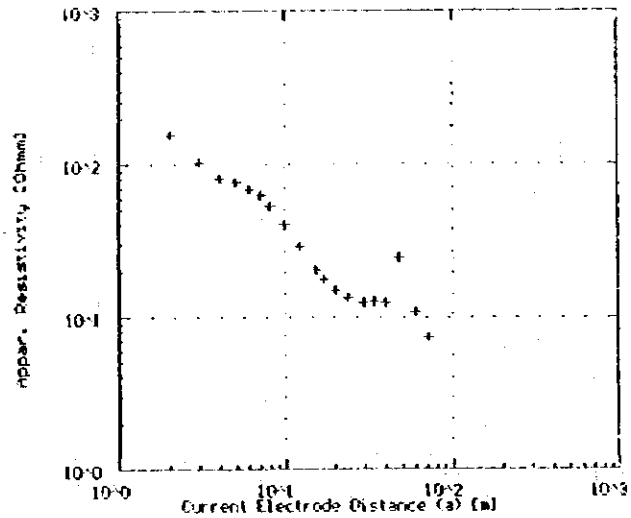


Point (No)	AB/2 (Mr)	a (m)	Res (ohm)
1	1.00	10.740	
2	2.00	13.570	
3	3.00	14.130	
4	4.00	15.320	
5	5.00	17.210	
6	6.00	18.040	
7	7.00	20.220	
8	8.00	22.610	
9	10.00	25.350	
10	12.00	30.040	
11	15.00	33.040	
12	17.00	36.160	
13	20.00	38.380	
14	24.00	35.220	
15	30.00	27.510	
16	36.00	25.040	
17	40.00	22.010	
18	50.00	19.590	
19	60.00	13.150	
20	72.00	11.350	
21	84.00	13.090	
22	96.00	12.060	
23	110.00	10.300	
24	130.00	6.020	

Specific Resistivity(Ω-m)	6.6	16.5	88.8	9

49.2

VES St. No.5 -DEBRE TABOR

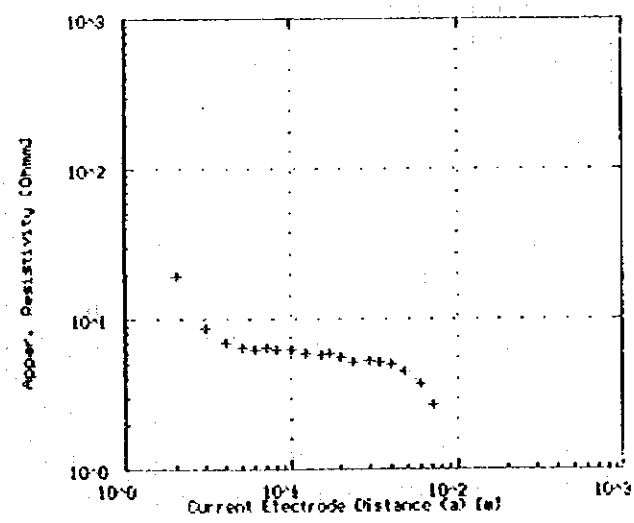


Point (No)	AB/2 (Nr)	a (m)	Est (ohm)
1	1.00	251.200	
2	2.00	155.710	
3	3.00	103.620	
4	4.00	80.230	
5	5.00	75.200	
6	6.00	67.920	
7	7.00	61.980	
8	9.00	53.250	
9	10.00	48.150	
10	12.00	29.390	
11	15.00	20.750	
12	17.00	17.939	
13	20.00	15.070	
14	24.00	13.520	
15	30.00	12.619	
16	34.00	12.010	
17	40.00	12.560	
18	49.00	25.020	
19	60.00	18.930	
20	72.00	7.490	

Specific Resistivity(Ω-m)	300	60	6.57	16.05	3.71

23.3

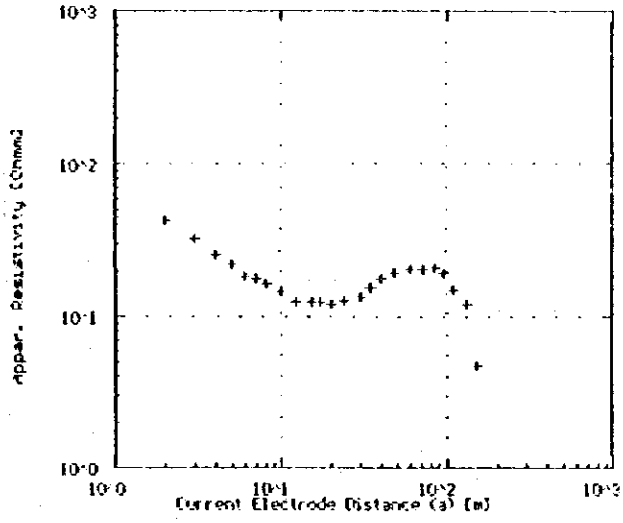
VES St. No.6 -DEBRE TABOR



Point (No)	AB/2 (Nr)	a (m)	Est (ohm)
1	1.00	68.470	
2	2.00	19.950	
3	3.00	8.670	
4	4.00	7.090	
5	5.00	6.670	
6	6.00	5.930	
7	7.00	5.420	
8	9.00	6.230	
9	10.00	5.220	
10	12.00	5.950	
11	15.00	5.040	
12	17.00	5.070	
13	20.00	5.590	
14	24.00	5.280	
15	30.00	5.280	
16	34.00	5.130	
17	40.00	5.020	
18	49.00	4.520	
19	60.00	3.770	
20	72.00	2.710	
21	81.00	0.530	

Specific Resistivity(Ω-m)	85	5.67	5.07	1.89

VES St. No.7 -DEBRE TABOR

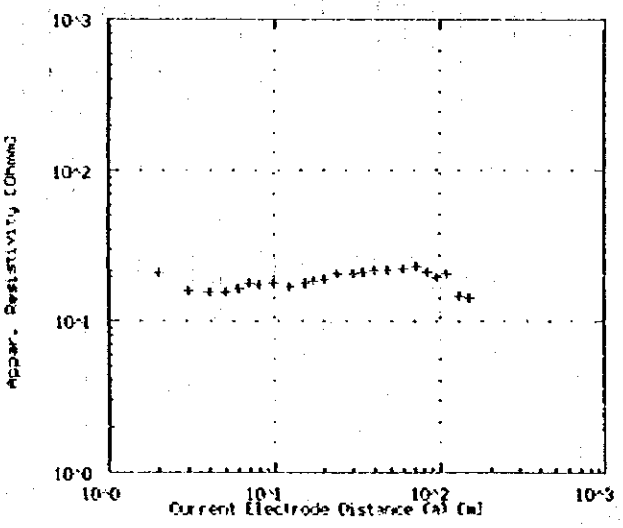


Point (No)	AB/2 (Mr)	a (m)	Res (ohms)
1	1.00	41.595	
2	2.00	42.700	
3	3.00	33.220	
4	4.00	25.620	
5	5.00	21.990	
6	6.00	18.950	
7	7.00	17.586	
8	8.00	16.560	
9	10.00	14.020	
10	12.00	12.380	
11	15.00	12.430	
12	17.00	12.650	
13	20.00	12.060	
14	24.00	12.810	
15	30.00	13.570	
16	34.00	15.320	
17	40.00	17.500	
18	48.00	19.440	
19	60.00	20.350	
20	72.00	20.350	
21	84.00	21.100	
22	96.00	19.290	
23	110.00	15.200	
24	130.00	12.250	
25	150.00	8.310	

Specific Resistivity(Ω-m)	58	14.5	8.4	41.6	7.46

27.9

VES St. No.8 -DEBRE TABOR

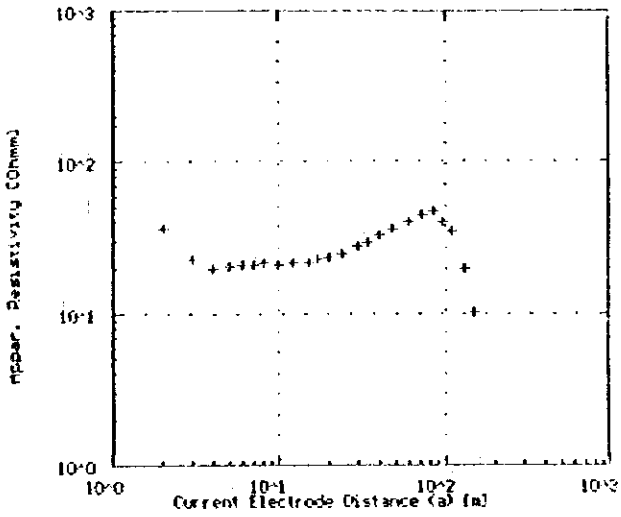


Point (No)	AB/2 (Mr)	a (m)	Res (ohms)
1	1.00	21.870	
2	2.00	20.950	
3	3.00	15.830	
4	4.00	15.320	
5	5.00	15.700	
6	6.00	16.590	
7	7.00	17.580	
8	8.00	17.330	
9	10.00	17.500	
10	12.00	16.330	
11	15.00	17.000	
12	17.00	16.350	
13	20.00	16.970	
14	24.00	20.200	
15	30.00	20.540	
16	34.00	20.710	
17	40.00	21.350	
18	48.00	21.600	
19	60.00	22.230	
20	72.00	22.610	
21	84.00	21.100	
22	96.00	19.290	
23	110.00	20.230	
24	130.00	16.709	
25	150.00	16.130	

Specific Resistivity(Ω-m)	29.8	14.9	12	24.3	11

23.25

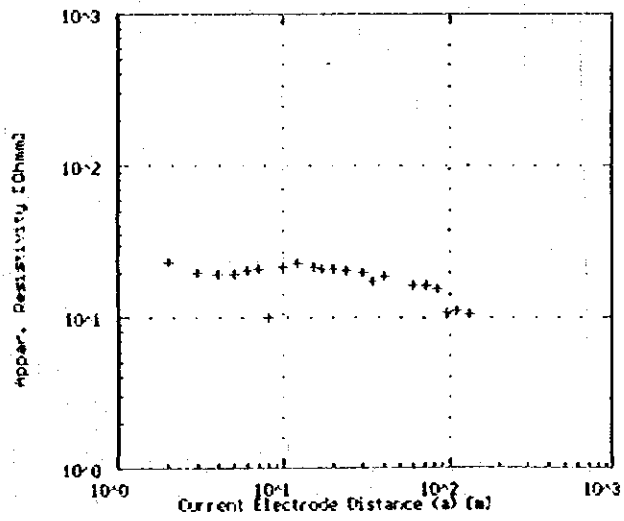
VES St. No.9 -DEBRE TABOR



Point (No)	MN/2 (Mr)	a (m)	Rs (ohm)
1	1.00	132.780	
2	2.00	56.130	
3	3.00	22.890	
4	4.00	20.100	
5	5.00	20.650	
6	6.00	20.220	
7	7.00	21.100	
8	8.00	21.500	
9	10.00	20.720	
10	12.00	21.480	
11	15.00	21.870	
12	17.00	22.980	
13	20.00	23.240	
14	24.00	25.870	
15	30.00	27.690	
16	36.00	28.910	
17	40.00	32.150	
18	48.00	35.210	
19	60.00	39.560	
20	72.00	43.310	
21	84.00	45.080	
22	96.00	38.790	
23	110.00	34.540	
24	130.00	19.590	
25	150.00	18.150	

Specific Resistivity(Ω-m)	178	17.6	21	66	6.46

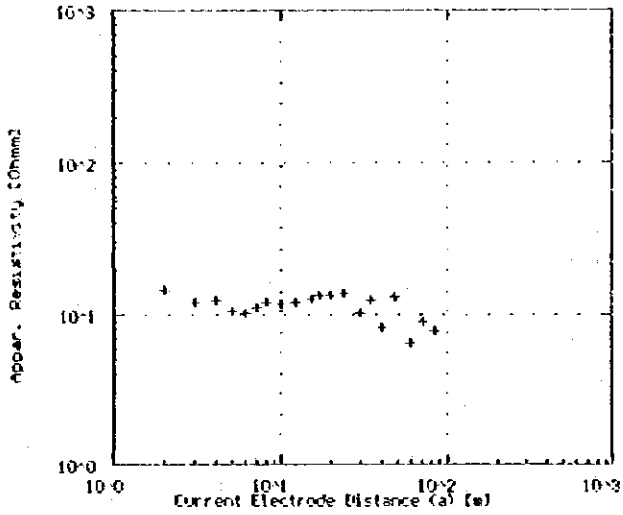
VES St. No.10 -DEBRE TABOR



Point (No)	MN/2 (Mr)	a (m)	Rs (ohm)
1	1.00	35.130	
2	2.00	23.260	
3	3.00	19.590	
4	4.00	19.050	
5	5.00	19.670	
6	6.00	20.350	
7	7.00	21.100	
8	8.00	19.200	
9	10.00	21.350	
10	12.00	22.630	
11	15.00	21.360	
12	17.00	20.930	
13	20.00	21.220	
14	24.00	20.500	
15	30.00	19.970	
16	36.00	17.360	
17	40.00	19.590	
18	48.00	16.500	
19	72.00	16.200	
20	84.00	15.700	
21	96.00	10.050	
22	110.00	11.050	
23	130.00	10.610	

Specific Resistivity(Ω-m)	5.15	1.72	28.2	15.07	4

VES St. No.11 -DEBRE TABOR



Point (No)	MN/2 (Mr)	a (m)	Res (ohm)
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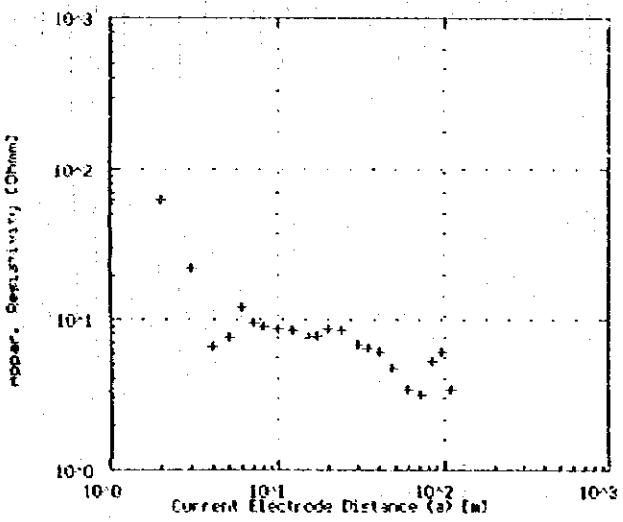
3	3.00	12.060	
4	4.00	12.559	
5	5.00	10.660	
6	6.00	10.320	
7	7.00	11.058	
8	9.00	12.810	
9	10.00	11.930	
10	12.00	12.060	
11	15.00	12.220	
12	17.00	11.670	
13	20.00	13.510	
14	24.00	14.920	
15	30.00	10.160	
16	36.00	12.380	
17	40.00	8.280	
18	48.00	13.269	
19	60.00	8.470	
20	72.00	9.040	
21	84.00	7.910	

Specific Resistivity(Ω-m)	195	9.75	16.5	7	6

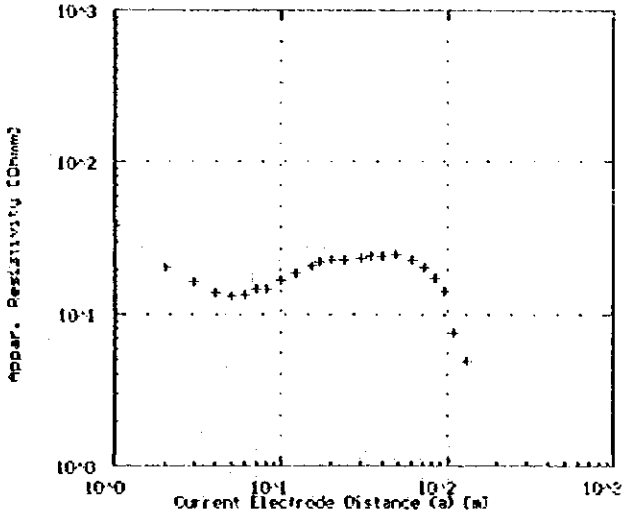
VES St. No.12 -DEBRE TABOR



Point (No)	MN/2 (Mr)	a (m)	Res (ohm)
1	1.00	62.800	
2	2.00	62.200	
3	3.00	22.230	
4	4.00	8.560	
5	5.00	7.540	
6	6.00	12.059	
7	7.00	9.650	
8	9.00	9.360	
9	10.00	8.290	
10	12.00	9.550	
11	15.00	7.540	
12	17.00	7.900	
13	20.00	8.290	
14	24.00	9.559	
15	30.00	6.280	
16	36.00	5.190	
17	40.00	6.030	
18	48.00	5.020	
19	60.00	3.390	
20	72.00	3.110	
21	81.00	5.260	
22	95.00	6.020	
23	110.00	3.450	

Specific Resistivity(Ω-m)	89	16.83	7.67	2.73	46.38

VES St. No.13 -DEBRE TABOR

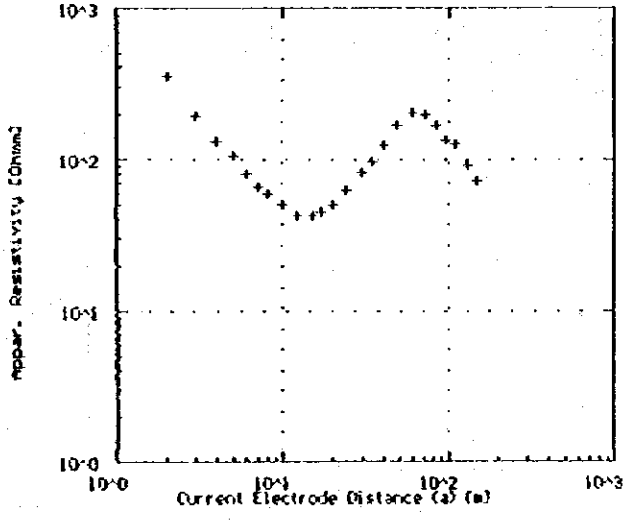


Point [No]	K=π/2 [Nr]	a [m]	Err [ohm]
1	1.00	39.310	
2	2.00	26.470	
3	3.00	15.390	
4	4.00	11.920	
5	5.00	13.190	
6	6.00	11.520	
7	7.00	14.510	
8	8.00	14.770	
9	10.00	16.370	
10	12.00	18.720	
11	15.00	21.010	
12	17.00	22.620	
13	20.00	22.730	
14	24.00	22.510	
15	30.00	23.550	
16	34.00	24.340	
17	40.00	23.860	
18	44.00	25.920	
19	50.00	22.890	
20	72.00	23.350	
21	84.00	17.010	
22	96.00	14.160	
23	110.00	7.550	
24	120.00	6.500	

Specific Resistivity(Ω-m)	64	12.8	14.4	57.6	30	2.42

12.5

VES St. No.14 -DEBRE TABOR

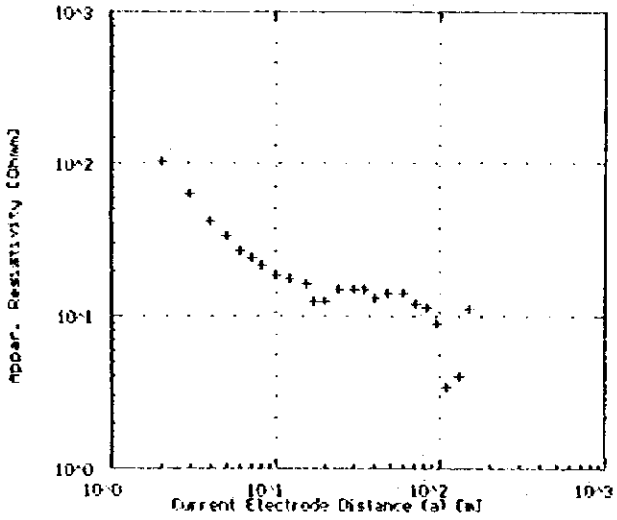


Point [No]	K=π/2 [Nr]	a [m]	Err [ohm]
1	1.00	420.760	
2	2.00	352.940	
3	3.00	292.170	
4	4.00	233.560	
5	5.00	206.760	
6	6.00	79.560	
7	7.00	85.940	
8	8.00	59.790	
9	10.00	50.240	
10	12.00	42.200	
11	15.00	43.330	
12	17.00	46.840	
13	20.00	50.240	
14	24.00	83.300	
15	30.00	82.900	
16	34.00	89.220	
17	40.00	123.890	
18	44.00	169.810	
19	50.00	203.670	
20	72.00	188.950	
21	84.00	160.830	
22	96.00	135.650	
23	110.00	120.180	
24	120.00	93.070	
25	150.00	72.530	

Specific Resistivity(Ω-m)	550	225	38.75	520	9.8	15.38

270

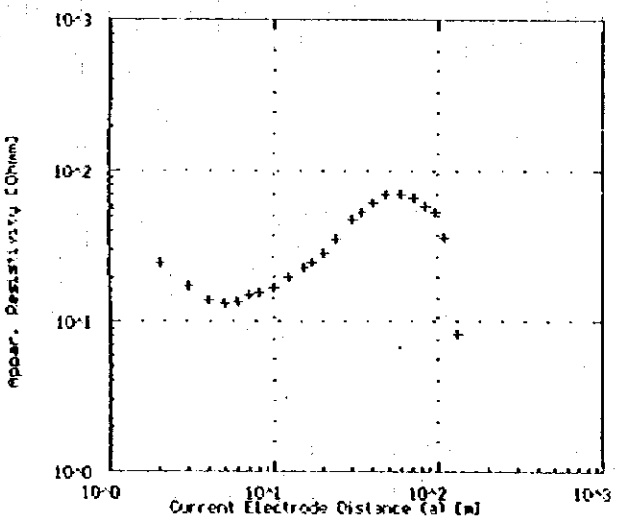
VES St. No.15 -DEBRE TABOR



Point (No)	AB/2 (Mr)	a (m)	Res (ohm)
1	1.00	166.920	
2	2.00	101.760	
3	3.00	82.110	
4	4.50	61.780	
5	5.00	32.920	
6	6.00	26.150	
7	7.00	23.740	
8	8.00	21.650	
9	10.00	18.910	
10	12.00	17.060	
11	15.00	16.450	
12	17.00	12.300	
13	20.00	12.310	
14	25.00	15.070	
15	30.00	15.010	
16	35.00	14.050	
17	40.00	13.310	
18	45.00	15.170	
19	50.00	15.220	
20	72.00	12.210	
21	80.00	11.610	
22	95.00	9.040	
23	110.00	3.450	
24	130.00	6.000	
25	150.00	11.700	

Specific Resistivity(Ω-m)	183	20.33	13.9	5.8	1.6

VES St. No.16 -DEBRE TABOR



Point (No)	AB/2 (Mr)	a (m)	Res (ohm)
1	1.00	56.520	
2	2.00	24.950	
3	3.00	17.520	
4	4.00	14.070	
5	5.00	13.150	
6	6.00	13.570	
7	7.00	14.050	
8	8.00	15.320	
9	10.00	17.020	
10	12.00	18.590	
11	15.00	22.610	
12	17.00	24.770	
13	20.00	28.130	
14	24.00	35.270	
15	30.00	47.790	
16	34.00	52.550	
17	40.00	66.280	
18	45.00	70.560	
19	50.00	69.340	
20	72.00	65.560	
21	84.00	50.580	
22	95.00	53.870	
23	110.00	35.920	
24	130.00	8.150	

Specific Resistivity(Ω-m)	70.95	10.14	20.55	64.8	420	36	1.83

Appendix - 2

Result of Water Quality Test

Result of Physico-Chemical Analysis in Debre Tabor

Sample No.1

Origin of Sample : Borehole No.1&No.2 (WSS)
Date of Collection: 29/Jan./95
Date of Analysis : 07/Feb./95

Physical Characteristics

Appearance	: Very Clear
Odor	: Odorless
Taste	: -
Color	: Nil
Settleable Solids	: Absent
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 110
Turbidity	: 2 FTU
Temperature	: -
Conductivity	: 0.20 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 100
Carbonate Hardness as $CaCO_3$	: 100
Non Carbonate Hardness as $CaCO_3$	: Nil
Total Alkalinity as $CaCO_3$	: 150
Bicarbonate Alkalinity as $CaCO_3$	: 150
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: 8.00
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: -	Cl^-	: 5.00
Na^+	: -	NO_2^-	: Nil
K^+	: -	NO_3^-	: 3.60
Ca^{++}	: 20.00	F^-	: 0.57
Mg^{++}	: 11.99	HCO_3^-	: 183.00
Fe(Total)	: 0.02	CO_3^{--}	: Nil
Mn^{++}	: 0.01	SO_4^{--}	: 24.00
Cu^{++}	: 0.04	PO_4^{---}	: 0.34

Remarks; All the analyzed chemical constituents are within the acceptable range in accordance with WHO drinking water quality guidelines.

Note; Unit is mg/litre unless otherwise stated.

Result of Physico-Chemical Analysis in Debre Tabor

Sample No.2

Origin of Sample : Borehole No.2 (WSS)
Date of Collection: 25/Jan./95
Date of Analysis : 06/Feb./95

Physical Characteristics

Appearance	: Clear
Odor	: Odorless
Taste	: -
Color	: 3 Pt-Co Unit (Apparent)
Settleable Solids	: Absent
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 140
Turbidity	: 2 FTU
Temperature	: -
Conductivity	: 0.24 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 80
Carbonate Hardness as $CaCO_3$	: 80
Non Carbonate Hardness as $CaCO_3$	: Nil
Total Alkalinity as $CaCO_3$	: 90
Bicarbonate Alkalinity as $CaCO_3$	: 90
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: 8.00
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: -	Cl^-	: 5.00
Na^+	: -	NO_2^-	: Nil
K^+	: -	NO_3^-	: 2.30
Ca^{++}	: 20.00	F^-	: 0.43
Mg^{++}	: 7.19	HCO_3^-	: 109.80
Fe(Total)	: 0.03	CO_3^{--}	: Nil
Mn^{++}	: 0.01	SO_4^{--}	: 15.00
Cu^{++}	: 0.02	PO_4^{---}	: 0.36

Remarks; All the analyzed chemical constituents are within the acceptable range in accordance with WHO drinking water quality guidelines.

Note; Unit is mg/litre unless otherwise stated.

Result of Physico-Chemical Analysis in Debre Tabor

Sample No.3

Origin of Sample : Chagnwaha Spring
Date of Collection: 12/Jun./95
Date of Analysis : 21/Jul./95

Physical Characteristics

Appearance	: Clear
Odor	: Odorless
Taste	: -
Color	: 14 Pt-Co Unit (Apparent)
Settleable Solids	: Present
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 120
Turbidity	: 3 FTU
Temperature	: 19.1 °C
Conductivity	: 0.20 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 100
Carbonate Hardness as $CaCO_3$	: 60
Non Carbonate Hardness as $CaCO_3$	: 40
Total Alkalinity as $CaCO_3$	: 60
Bicarbonate Alkalinity as $CaCO_3$	: 60
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: 6.89
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: 0.13	Cl^-	: 15.00
Na^+	: -	NO_2^-	: 0.04
K^+	: -	NO_3^-	: 36.96
Ca^{++}	: 24.00	F^-	: 0.092
Mg^{++}	: 9.76	HCO_3^-	: 73.20
Fe(Total)	: 0.10	CO_3^{--}	: Nil
Mn^{++}	: 0.10	SO_4^{--}	: Nil
Cu^{++}	: 0.12	PO_4^{---}	: 0.12

Remarks; All the analyzed chemical constituents are within the acceptable range in accordance with WHO drinking water quality guidelines.

Note; Unit is mg/litre unless otherwise stated.

Result of Physico-Chemical Analysis in Debre Tabor

Sample No.4

Origin of Sample : Hand dug well
Date of Collection: 16/Jun./95
Date of Analysis : 21/Jul./95

Physical Characteristics

Appearance	: Clear
Odor	: Odorless
Taste	: -
Color	: 54 Pt-Co Unit (Apparent)
Settleable Solids	: Present
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 330
Turbidity	: 11 FTU
Temperature	: 19.0 °C
Conductivity	: 0.55 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 80
Carbonate Hardness as $CaCO_3$	: 80
Non Carbonate Hardness as $CaCO_3$	: Nil
Total Alkalinity as $CaCO_3$	: 80
Bicarbonate Alkalinity as $CaCO_3$	: 80
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: 7.74
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: 0.12	Cl^-	: 65.00
Na^+	: -	NO_2^-	: 0.09
K^+	: -	NO_3^-	: 114.40
Ca^{++}	: 52.00	F^-	: 0.180
Mg^{++}	: 14.63	HCO_3^-	: 48.80
Fe(Total)	: 0.05	CO_3^{--}	: Nil
Mn^{++}	: 0.80	SO_4^{--}	: 7.00
Cu^{++}	: 0.16	PO_4^{---}	: 0.29

Remarks; Color, Turbidity and Nitrate concentrations are above WHO drinking water quality guidelines.

Note; Unit is mg/litre unless otherwise stated.

Result of Faecal Coliform Test in Debre Tabor, Sampled and Analyzed on June/6,12/'95

No.	Kebele	Source	Place of Sampling	No of F.C. per 100ml	Remarks
1	1	BH1	BH1	NIL	From the tap installed at Borehole No.1
2	1	BH2	BH2	NIL	Water was not pumped-up
3	1	BH1	Y.Conn.	NIL	Directly pumped from BH1
4	1	BH1 & BH2	P.Foun.-1	NIL	Mixtured with BH1 & BH2
5	1	BH1 & BH2	Clay pot	16	Covered by Papyrus
6	1	Spring	Chagnwuha	10	Well protected. About 180 users a day
7	1	Spring	Chagnwuha	TMTC	Sampled after rainfall. A little turbid
8	3	Spring	Aiget	TMTC	Not protected. About 500 users a day
9	9	Spring	Barrel	135	Asmera Hotel, Not covered
10	9	Spring	Clay pot	9	Fetched at Korch wha 1 day before
11	2	HDW	HDW	TMTC	Private hand-dug-well
12	3	HDW	HDW	TMTC	Private hand-dug-well, A little turbid
13	4	HDW	HDW	68	Private hand-dug-well, WL=-8m fr GL
14	4	HDW	HDW	47	Depth=32m, WL=-20m fr GL, Covered
15	5	HDW	HDW	17	A little turbid
16	5	HDW	HDW	94	WL=-14m fr GL, Very clean water
17	7	HDW	HDW	24	Depth>30m, A little turbid
18	7	HDW	HDW	49	HDW for orphanages, Well protected
19	8	HDW	HDW	44	HDW at Serdom Hotel, Very turbid
20	9	HDW	HDW	TMTC	Well Covered
21	3	HDW	Clay pot	TMTC	Fetched on the day, Covered by Papyrus
22	3	HDW	Clay pot	146	Fetched 1 day before, Covered by Papyrus
23	3	HDW	Clay pot	133	Fetched on the day, Covered by Papyrus
24	4	HDW	Clay pot	TMTC	Fetched on the day, Not covered
25	4	HDW	Clay pot	TMTC	Covered by tin lid
26	5	HDW	Clay pot	52	Fetched on the day, Covered by Papyrus
27	5	HDW	Clay pot	TMTC	Fetched on the day, Covered by Papyrus
28	4	HDW	Barrel	40	Covered by steel lid
29	4	HDW	Barrel	159	Sampled at Selam Hotel, Not covered
30	5	HDW	Jerry-can	TMTC	Capped Jerry-can
31	9	HDW	Bucket	TMTC	Fetched on the day, Not covered
32	4	Rainwater	Jerry-can	TMTC	Capped Jerry-can, Rainfall 1 day before
There are 2 water sources (BH1&BH2) operated by WSS.					

Note; "F.C. means Faecal Coliform.
"BH" means borehole.
"HDW" means hand-dug-well.
"P.Conn." means private connection.
"Y.Conn." means yard connection.
"P.Foun." means public fountain.
"Barrel" means Barrel-container made of steel.
"TMTC" means too many to count.

Appendix - 3

Social and Gender Data

DEBRE TABOR - Activity Profile by gender

Public Well / Spring Users

Activity	Gender			Time	Place
	M	F	Remarks		
Fetches drinking water	n	y	mostly women, some girls, few boys		well and spring at
Does the laundry	n	y			spring/river
Waters livestock	y	n			at river
Takes water from container	y	y	all		
Teaches children hygiene	n	y			
Disposes of solid waste	n	y	some burn waste		outside
Digs a compost pit	-	-			
Constructs a latrine	y	y			
Digs a drainage channel	n	n	some pits or drains		
Tends a kitchen garden	y	n	very few		
Disposes of animal waste	n	y			
Keeps latrine clean	n	y			
Keeps compound clean	n	y			
Takes sick child to clinic	y	y	whoever is at home at the time		

y = Yes, n = No

Public Well Users

Activity	Gender			Time	Place
	M	F	Remarks		
Fetches drinking water	n	y	mostly women		well/spring
Does the laundry	n	y			spring/river
Waters livestock	y	n			at river
Takes water from container	y	y	all		
Teaches children hygiene	n	y			
Disposes of solid waste	n	y	some burned		
Digs a compost pit	-	-	none		
Constructs a latrine	y	n			
Digs a drainage pit	y	n	some pits		
Tends a kitchen garden	-	-	none		
Disposes of animal waste	n	y			
Keeps latrine clean	n	y			
Keeps compound clean	n	y			
Takes sick child to clinic	y	y	whoever is at home at the time		

y = Yes, n = No

DEBRE TABOR - Activity Profile by gender (continued)

Private Well / Private Connection Users

Activity	Gender			Time	Place
	M	F	Remarks		
Fetches drinking water	y	y	mostly women		
Does the laundry	n	y			
Waters livestock	y	n	paid labor		
Takes water from container	y	y	all		
Teaches children hygiene	n	y			
Disposes of solid waste	n	y			anywhere
Digs a compost pit	n	n	mostly burned		
Constructs a latrine	n	n	paid labor		
Digs a drainage pit	n	n	paid labor		
Tends a kitchen garden	n	n	none		
Disposes of animal waste	n	y	or paid labor		
Keeps latrine clean	n	y			
Keeps compound clean	n	y			
Takes sick child to clinic	y	y	whoever is at home at the time		

y = Yes, n = No

DEBRE TABOR - Daily Schedule

Public Fountain Users

Man	Time	Woman
Wakes up and goes to church	6	Wakes up
Returns home and works at home	7	**Collects water**
Eats breakfast with family	8	Prepares/eats breakfast with family
Goes to Government office to work	9	Cleans house and compound
"	10	"
"	11	"
"	12	Prepares lunch
Returns home, eats lunch	13	Eats lunch with husband
Returns to Government office work	14	Cleans dishes, does laundry
"	15	*Spins cotton and sews*
"	16	"
Goes to school to study	17	"
"	18	"
"	19	Prepares supper
Returns home and plays with family	20	
Eats supper	21	Eats supper with family
Goes to sleep	22	Washes dishes, goes to sleep

Public Well Users

Man	Time	Woman
Gets up, Eats breakfast	6	Gets up, makes breakfast
Goes to work (daily laborer at bus station)	7	Eats breakfast after family
"	8	**Collects water**
"	9	Prepares and drinks coffee
"	10	Collects wood
"	11	*Prepares tela*
"	12	"
Returns home for lunch	13	Prepares and eats lunch
Returns to work	14	Cleans the dishes and house
"	15	*Spins cotton*
"	16	**Collects water**
"	17	Coffee ceremony with neighbors
"	18	*Sells tela*
Returns home	19	"
Eats supper	20	Prepares supper and eats with family
Drinks coffee	21	Drinks coffee
Goes to sleep	22	Goes to sleep

DEBRE TABOR - Daily Schedule (continued)

Private Connection/Private Well Users

Man	Time	Woman
Gets up, washes	6	Gets up, prepares breakfast, gets children ready for school
Eats breakfast, Drinks coffee	7	Eats breakfast with family
Goes to work (daily labor)	8	**Collects water**
"	9	Washes clothes, cleans house
"	10	"
"	11	Prepares lunch
Returns home	12	Eats lunch, drinks coffee
Eats lunch, Drinks coffee	13	"
Returns to work	14	Cleans house
"	15	"
"	16	Drinks coffee with neighbors
"	17	"
Goes with friends to tela house	18	Prepares supper
Returns home, plays with children	19	"
Eats supper	20	Eats supper with family
Goes to sleep	21	Goes to sleep

DEBRE TABOR - Access and control profile

Private Connection and Private Well Users

Resources	Access		Control		Comments
	male	female	male	female	
Money for water	y	y	y	y	
Money for soap	y	y	y	y	
Money for water container	y	y	y	y	
Money for water pot cover	y	y	y	y	
Money for building materials for drying shelf	y	y	y	y	women organize
Money for building latrine	y	y	y	y	
Money for medicine	y	y	y	y	
Money for school fees	y	y	y	y	
Tools for digging pits	y	y	y	y	daily labor
Tools for constructing latrine	y	y	y	y	daily labor
Seeds and tools for vegetable gardens	y	y	y	y	
Land for digging refuse disposal pits	y	y	y	y	not done
Land for digging latrines	y	y	y	y	
Land for digging drains	y	y	y	y	use existing
Land for digging vegetable gardens	y	y	y	y	few done
Income from selling water	y	y	y	y	provisional
Income from selling vegetables	-	-	-	-	not done
Improved health	y	y	y	y	mostly women
Reduced time spent collecting water	n	y	n	y	
Reduced time spent caring for sick	y	y	y	y	mostly women

Assumes both earning some income, as income is shared

Spring/Public Fountain/Well Vendor Users

Resources	Access		Control		Comments
	male	female	male	female	
Money for water	y	y	y	y	money is
Money for soap	y	y	y	y	shared by
Money for water container	y	y	y	y	husband and
Money for water pot cover	y	y	y	y	wife
Money for building materials for drying shelf	y	y	y	y	women organize
Money for building latrine	y	y	y	y	
Money for medicine	y	y	y	y	
Money for school fees	y	y	y	y	
Tools for digging pits	y	y	y	y	
Tools for constructing latrine	y	y	y	y	
Seeds and tools for vegetable gardens	y	y	y	y	few have
Land for digging pits	y	y	n	n	none have
Land for digging latrines	y	y	y	y	some have
Land for digging drains	n	n	n	n	not done
Land for vegetable gardens	y	y	y	y	few have
Income from selling water	n	n	n	n	
Income from selling vegetables	y	y	y	y	provisional
Improved health	n	n	n	n	mostly women
Reduced time spent collecting water	n	y	n	y	
Reduced time spent caring for sick	y	y	y	y	mostly women

DEBRE TABOR - Needs Analysis

Spring/Public Fountain/Well Vendor Users

Type of needs		Gender M	Gender F	Remarks
Practical needs				
Water	Additional public fountains required	y	y	Some rehabilitation of non-working public fountains also required
	Very few additional private connections required	y	y	Only very few can afford private connections
	Reliable and regular supply of high quality water from public supply. People prepared to pay more for better service	y	y	Spring water of good quality but inadequate quantity. Well water of inadequate quantity and quality
Sanitation	Shared latrines to be constructed on public land	y	y	Those in rented housing and those who are poor do not have access over land or money for latrine construction
	Communal refuse disposal areas need to be designated	y	y	People in rented housing and those who are poor do not have access over land for refuse disposal
Strategic needs				
Water	Community management of public fountains	y	y	Only those already using public fountains would not like to have community managed public fountains
Sanitation	Community to contribute labor for the construction of latrines	y	y	Materials such as gravel and sand could also be provided
	Community management of community latrines	y	y	Community management already working in some areas for shared electricity connections
Health education	-	-	-	No specific health needs mentioned

y = Yes, n = No

DEBRE TABOR - Needs Analysis (continued)

Public Well Users

Type of needs		Gender M	Gender F	Remarks
Practical needs				
Water	Improve existing wells	y	y	Existing rehabilitation not well thought of. Prefer cheap water supply to more expensive public fountains
	Prefer to have reliable access to water than covered wells with handpumps. Would construct fence round well and undertake other contamination prevention measures	y	y	Fear of breakdown is a major concern. VLOM may improve this. Would look after surroundings of well if such initiatives were supported by authorities
Sanitation	Shared latrines to be constructed on public land	y	y	People mostly do not have sufficient land for latrine construction
	Low cost public showers	y	y	Existing public shower too expensive
Strategic needs				
Water	Community management of well	y	y	Woreda/Red Cross to encourage initiatives to reduce contamination of the well
	Community management of handpumps	y	y	If handpumps are to be installed, local (women) representatives should be trained in simple maintenance (VLOM)
Sanitation	Community contribution to latrine construction and Government management of shared latrines	y	y	Woreda to provide land for latrines and management of latrines
	Community managed garbage disposal system	y	y	Woreda to allocate land and support the initiative
Health education	Awareness of water and sanitation related disease is high	y	y	Lack of control of land and lack of affordability prevents people from improving sanitary situation

y = Yes, n = No

DEBRE TABOR - Needs Analysis (continued)

Private Well and Private Connection Users

Type of needs		Gender		Remarks
		M	F	
Practical needs				
Water	Reliable water service for at least 4 hours each day	y	y	Prefer continuous 24 hour supply if possible
	Improved water service for the rest of the town	y	y	PC users realised that they were well off for water compared to others
Sanitation	Sanitation program for people who live in surrounding area	y	y	Private needs are met, but others use area around the compound as open field
Strategic needs				
Water	Government management of system	y	y	Prepared to pay more for better service
Sanitation	Improved excreta and solid waste disposal required for neighbors	y	y	Private needs fully met
Health education	No adult health problems, children suffer trachoma, fevers, coughs etc	-	-	No unmet health education needs

y = Yes, n = No

The source of this information was a household with both Private Connection and Private Well owner. Some of this user group would like the water situation to improve for others and some do not.

DEBRE TABOR - Social and Gender Considerations

Social/Gender differences	Underlying factors	Impact of the project	Possible measures to be taken
Private well owners selling water were not keen for improvements in public water supply system	Private income generated by well vendors relies on inadequate public supply	Private well vendors may intervene to stop improvements in public water supply system	Discuss with well vendors ways to maximize economic benefits for all sectors of the community
Daily laborers not keen on improvements in public water supply system	Some laborers generate their income from cartage of water from springs and wells	The improvements to the town water supply will take away the market for the labor of this group	Discuss and develop ways of providing income generation for this group of people
Women only defecate under cover of darkness	The need for privacy determines the time that women can defecate	Women may all require latrine facilities at the same time thus putting pressure on resources	Community latrines may be more suitable for women if shared by family rather than by sex
Low level of Muslims surveyed in Household Questionnaire	Low number of Muslims in the town all living in concentrated community	Muslims may not have equal access to resources or to benefits of the project	Special attention needs to be given to the situation for Muslims in this town
More female headed households in lower income groups	Women headed households tend to have fewer income earners in the household	Low income women headed households may not be able to utilize benefits of the project	Special attention to these women and targeted income generation projects need to be implemented

Appendix - 4

Summary of Group Meeting

DEBRE TABOR - Summary of group meetings

Group 1 details	Group characteristics	Group needs
General	Amhara, Christians, 15 women, 7 men, many children, Mixed incomes inc. labourers & beggars	1-Water, 2-Curative health, 3-Sanitation
Water	Public well users, also use springs and private well vendors. Laundry done at home in wet season. Pay 50c each month for guard to look after the public well, also helped with construction. RedCross involved with handpump installation.	Deepen the existing well. Involve the community in handpump maintenance - even so probably will not last long. Better not to install handpump. If water supply system, people would still use the well for all purposes due to lack of affordability.
Sanitation	Some people have latrines but they did not attend the meeting. All participants use open field. Women use same place but at dawn and dusk. Would like private latrines but can not afford. Community latrines would be an option. Would use showers.	Community latrines with community contribution for construction and community management. Public showers would also be used. Need to be allocated Government land for these purposes.
Health	Aware that poor sanitation round the well causes contamination but as it is on Govt land, they can not protect the well.	Health education needs to be supported with other health promotion activities such as allocation of land for community sanitation activities. Some income generation activities may also be needed to realise health improvements

Group 2 details	Group characteristics	Group needs
General	Amhara, 10 men, 10 women, mixed from labourers to Government workers	1-More public fountains, 2-Sanitation
Water	Handdug well users and spring users for washing and drinking. Women and children fetch water. Cattle watered at river by attendant. Large queue at spring particularly in the dry season. Handdug well vendors charge 20c/pot.	Require reliable public fountains. Are prepared to pay 10c for 50 litres and to provide labour. Some 6 people could afford private connections.
Sanitation	5 people have latrines, the rest use open field/forest areas for defaecation. Because of land problems there may be problems with community latrines. Garbage disposal is undertaken anywhere.	If community latrines are constructed, the Government would have to look after them. Garbage disposal site allocation and some supervision of the disposal activities is seen as important.
Health	TB, Asthma, Diarrhoea. Health awareness reasonable	Health education alone will not affect health behaviours.

DEBRE TABOR - Summary of group meetings (continued)

Group 3 details	Group characteristics	Group needs
General	Amhara, 15 men, 15 women, daily labourers, water collectors, carpenters and tradespeople	1-Water, 2-Sanitation, 3-Health, 4-Poverty alleviation
Water	Unprotected spring users for most drinking and cooking purposes, there is a long queue at the spring (5hours). Washing done at river by men and women. Men and Women are water collectors for money. Some handdug well vendors at 25c per pot.	Public fountains required and spring protection for contingencies. People not worried about loss of income from water collection. Will help with PF construction and with management including salary of water seller.
Sanitation	Open field defaecation practised by people in rented housing. Those with private housing have latrines. When they are filled they construct new ones. A community latrine /shower would work and people even prepared to pay for the water.	Community latrine/shower with community contribution to construction and community management Garbage disposal is a problem which also needs to be addressed.
Health	TB, Asthma, Trachoma and diarrhoea are common diseases. People aware of the link between poor water/sanitation and poor health. Health education carried out at clinics.	Would attend more health education sessions on Sundays when they have more free time.

Group 4 details	Group characteristics	Group needs
General	10 women, 5 men and many children, Amhara, Christians, Tela sellers and labouring people	1-Water, 2-Sanitation
Water	Spring users (near river) and community well users (households pay 50c per month for guard). Women fetch water. Use river water to wash clothes at home. Do not use well water for drinking- water is turbid and "hard"	Would like additional reliable public fountain, prepared to pay for the service and able to manage it themselves.
Sanitation	Some have latrines, most use open field where women go at dawn and dusk. Temporary holes are made near to house for sick women or women who have just given birth. Those with latrines construct new ones when the old ones fill but tend to use open fields	Community latrines would be used if the responsible authority would consider the emptying issue carefully. Would help in the latrine construction and in maintenance. Prefer to share with groups of families.
Health	Health problems include diarrhoea and TB, They are aware of the link between these and poor sanitary conditions.	People are aware of the health issues and have land but can not afford to change their sanitary conditions.

DEBRE TABOR - Summary of group meetings (continued)

Group 5 details	Group characteristics	Group needs
General	Amhara, 10 women, 8 men, Daily labourers, carpenters and petty traders	1-Water, 2-Sanitation, 3-Health, 4-Economic improvements
Water	Public fountain users, but only one pot/family/day allowed. Many people come to use the PF (inc. trucks for weddings etc) Insufficient water for demand. Supplemented by springs (large queues too) Women fetch water. Washing is done at the river.	Additional public fountain required in surrounding area to satisfy demands of neighbouring areas. Would pay more for better water service. Prefer Government management and payment for that service to community management.
Sanitation	Sanitation is mostly carried out in open field sites, both garbage disposal and defaecation. Some private houses have latrines and dig new ones when they are filled. Most people live in Kebele rented houses and do not own land for latrines.	Community latrines were thought to be a good option, and the community would help in their construction and would manage the operation and maintenance themselves. They already have some sort of community managed electricity supply which operates well.
Health	Health problems include amoeba, TB and diarrhoea. There is health education at the clinic	No specific health needs identified

Group 6 details	Group characteristics	Group needs
General	Amhara, Christians, 2 women, 2 men, some children, Business people and tela sellers	1-Improved sanitation for people in neighbouring area, 2-Improved water service for town
Water	Private connection users who realise they are better off as regards water than the rest of the town. Women fetch water and do laundry at home. If inadequate water then go an queue at spring or use private well.	Prepared to pay more for a better water service, preferably water every day for at least 4 hours each day or more (prefer continuous).
Sanitation	All have/use latrines constructed by daily labour. Latrines constructed in last 4 years so have no problems with filling or emptying yet. Other people round about do not have latrines and this causes a smell nuisance and health problems.	No needs for themselves, but would like to see sanitation improved for people living in nearby area.
Health	No adult health problems but children get fevers, coughs and trachoma occasionally. Aware of health risks from poor water/sanitation.	No unmet health needs

DEBRE TABOR - Summary of group meetings (continued)

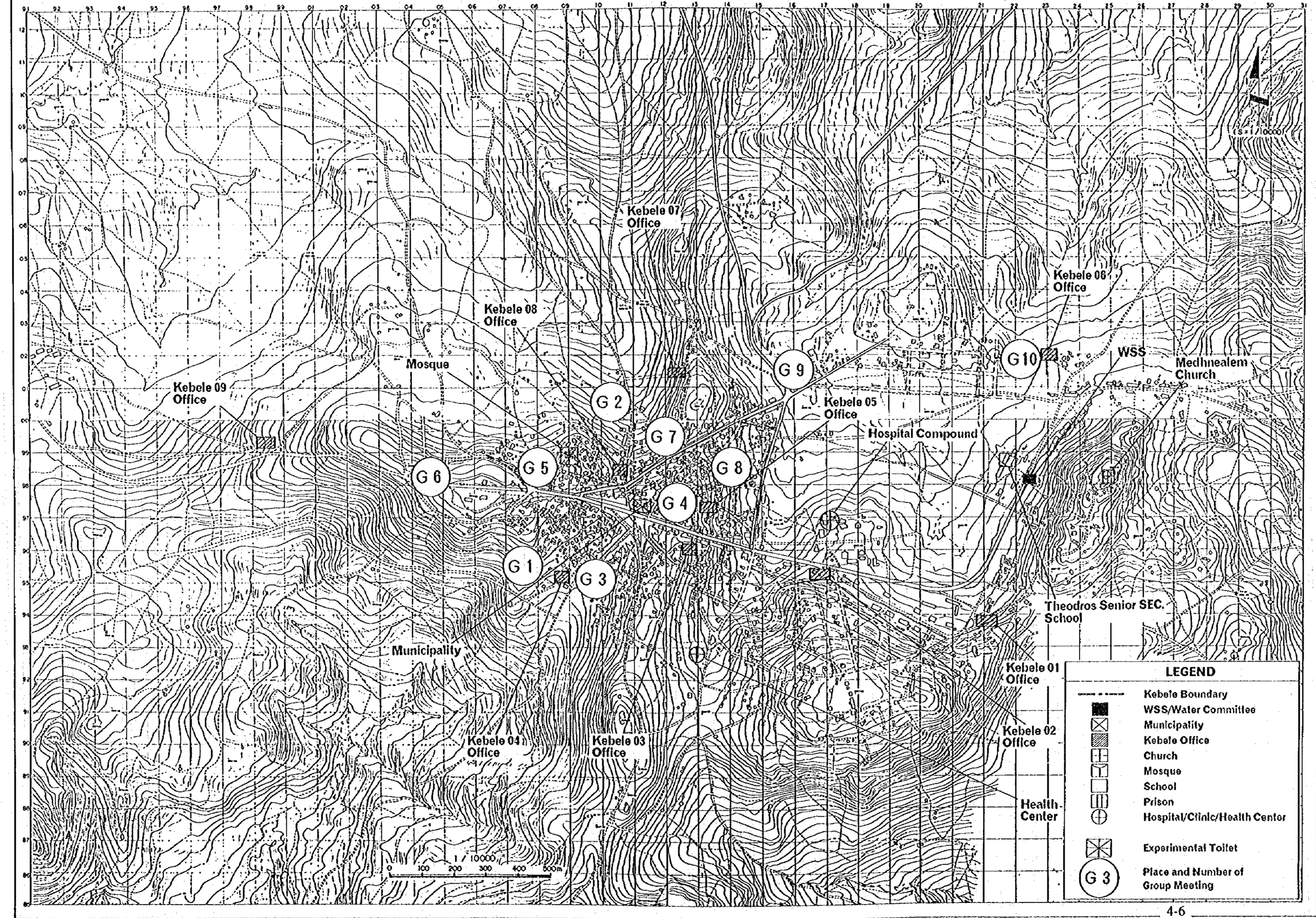
Group 7 details	Group characteristics	Group needs
General	Amhara, Christians, 11 women, 11 men, many children,	1-Water, 2-Sanitation
Water	Spring water users, but spring distance and queue mean collection takes 2-3 hours (too long). Spring water taste and quality is good. Only women fetch water, laundry done by women at the river. Public well also exists but almost dry and quality poor.	Prefer public fountain within 10 mins walk of home. Would participate in labour and would be able to manage the PF themselves.
Sanitation	No latrines, all practice open defaecation. Women go to the same place as men but the time is different, women must go during dark hours. Sometimes a bucket is used and the excreta thrown away.	Community latrine of interest. Prepared to help with labour for construction and would be able to organise the management themselves. Prefer family shared latrines.
Health	Diseases include TB, diarrhoea. Children taken to hospital with diarrhoea by mothers or older siblings.	Aware of cause of diarrhoea.

Group 8 details	Group characteristics	Group needs
General	Amhara, Muslims, 10 men, 10 women, Petty traders and business people	1-Water, 2-Asphalt Road, 3-Employment generation, 4-Cheaper food
Water	Handdug well vendor users at 25-50c/pot, even then there is a large queue. Also use spring (2 hours) and pay labourers to collect water. Men and women do laundry at river. Wells dry up in dry season (Feb.-April)	Prefer public fountains and private connections. Can pay for water but think 50c per pot is too much.
Sanitation	All use latrines and have used the suction truck from Bahir Dar to empty the latrine when it has filled up. Sanitation is a problem in the surrounding neighbourhood, particularly the bus station.	Public latrine required for the bus park area of the town, with government management.
Health	Diseases include TB and intestinal parasites. Health Education has been given to them at the clinic. Fully aware of the risks to health from poor sanitation.	No health needs expressed

DEBRE TABOR - Summary of group meetings (continued)

Group 9 details	Group characteristics	Group needs
General	Amhara, Christian, 3 men, 15 women, many children, Government workers, business people and tela sellers	1-Poverty alleviation, 2-Water, 3-Sanitation /latrine emptying system, 4-Asphalt Road,
Water	Spring (nr river) water users, women fetch water. Some have private wells but taste/quality not good. PF in area not worked since war. Some private connection vendors 10c/pot. Spring or water supply water required for making tela	Would like the existing public fountain rehabilitated and working regularly. Users prepared to manage the PF and pay for a better service. Some can afford private connections.
Sanitation	Most have latrines but have problems with the emptying system, hence 1 in 10 are now closed up. Can pay, but truck not available. Garbage is disposed of in a heap but is a problem	Latrine emptying system required. Garbage disposal system needs to be improved and supervised by authorities.
Health	Health problems include diarrhoea for children. Fully aware of the link between diarrhoea and poor sanitation	No health needs identified

Group 10 details	Group characteristics	Group needs
General	Amhara, Christian, 15 women, 5 men, Government employees, labourers, craftsmen and tela sellers	1-Water, 2-Electricity, 3-Asphalt Road
Water	Spring users from one unprotected and one protected spring also handdug well vendors and users. Women fetch water and go to the spring for laundry. Water is critical problem. Pay well owners 5 Birr monthly. Some conflict between vendors and users.	Those without wells would like public fountains and would be prepared to help with construction and management of the PF's. Would pay more for a better service. Those with wells are happy for the system to stay as it is.
Sanitation	All have private latrines. The nearby prison toilet is a problem causing smell nuisance and polluting the unprotected spring because of it's poor condition.	Reconstruction/ rehabilitation of prison latrine. Area is new so private latrines are also new and not filled up yet.
Health	Health problems include diarrhoea, cold, fever. No health education has been received.	No health needs specified


Kebele 07 Office
Kebele 08 Office
Kebele 06 Office
Mosque
Kebele 09 Office
G 9
G 10
WSS
Medhnealem Church
G 2
Kebele 05 Office
G 7
Hospital Compound
G 6
G 5
G 8
G 4
G 1
G 3
Theodros Senior SEC. School
Municipality
Kebele 01 Office
Kebele 02 Office
Kebele 04 Office
Kebele 03 Office
Health Center
0 100 200 300 400 500m
1 / 10000
LEGEND
Kebele Boundary
WSS/Water Committee
Municipality
Kebele Office
Church
Mosque
School
Prison
Hospital/Clinic/Health Center
Experimental Toilet
G 3
Place and Number of Group Meeting

DEBRE TABOR

Appendix - 5

Financial and Socio-Economic Data

Table 1 (1) Summary of Financial Aspects of WSS in Eleven Centers

Item	Dupti	Mille	Bati	Werota	Aykel	Debre Tabor
1. Population	14,737	3,902	14,354	21,845	11,718	25,575
2. Water production & consumption in 1993/1994 (m3)	n.a. 35,565e	n.a. 29,232e	113,523 90,218	58,318 46,104	11,303e 10,173e	11,930 9,773
*Water consumption/ population/day (l)	6.6e	20.5e	17.2	5.8	2.4e	1.0
*Leakage ratio (%)	n.a.	n.a.	20.5	20.9	10.0e	18.1
3. Income & Expenditure in 1993/1994 (birr)	51,267 60,188	48,818 38,182	131,144 132,245	64,648 53,304	50,863e 22,560e	31,337 78,328
*Bill collection rate (%)	85.7	79.1	94.4	99.9	-	67.8
*Income/consumption (birr/m3)	1.44e	1.67e	1.45	1.40	5.00e	3.21
*Expenditure/production (birr/m3)	n.a.	n.a.	1.16	0.91	2.00e	6.57
*Income/Expenditure (%)	85.2	127.9	99.2	121.3	225.5e	40.0
4. No. of personnel, female, temporary/contract	10 1 10	11 5 11	25 5 8	18 4 0	13 4 8	18 5 0
*Production/worker (m3)	n.a.	n.a.	4,541	3,240	3,478e	663
*Income/worker (birr)	5,126	4,438	5,246	3,592	3,913e	1,741
*Expenditure/ worker (birr)	6,019	3,471	5,290	2,961	1,735e	4,352
5. Average monthly salaries (birr)	129	96	204	217	70	173
6. No. of house/ yard connections, public fountains, hydrants	190(70) 8(2) 1	89 8(5) 1	852 12	396 7(6)	- 5(3)	320 13(2)

Notes: 1. e = estimates or assumptions 2. n.a.= not available
3. parenthesized figure = functional

Table 1 (2) Summary of Financial Aspects of WSS in Eleven Centers

Item	Nefas Mewcha	Chagni	Bure	Bichena	Dejen
1. Population	13,726	26,823	14,742	14,629	10,250
2. Water production & consumption in 1993/1994 (m3)	42,216 31,206	74,219 55,045	66,278 55,008	17,810 15,826	46,409 41,201
*Water consumption/ population/day (l)	6.2	5.6	10.2	3.0	11.0
*Leakage ratio (%)	26.1	25.8	17.0	11.1	11.6
3. Income & Expenditure in 1993/1994 (birr)	56,457 79,567	68,590 72,172	66,791 102,309	34,679 71,591	62,089 67,846
*Bill collection rate (%)	91.7	85.8	98.2	96.8	89.0
*Income/consumption (birr/m3)	1.81	1.25	1.21	2.19	1.51
*Expenditure/production (birr/m3)	1.88	0.97	1.54	4.02	1.46
*Income/Expenditure (%)	71.0	95.0	65.3	48.4	91.5
4. No. of personnel, female, temporary/contract	19 5 1	17 6 2	22 7 0	20 6 2	17 3 0
*Production/worker (m3)	2,222	4,366	3,013	891	2,745
*Income/worker (birr)	2,971	4,035	3,035	1,735	3,652
*Expenditure/ worker (birr)	4,188	4,245	4,650	3,580	3,991
5. Average monthly salaries (birr)	153	143	241	170	211
6. No. of house/ yard connections, public fountains, hydrants	383 14(13)	327 12	478 13(12)	238 7	390 7

Notes: 1. e = estimates or assumptions 2. n.a. = not available
3. parenthesized figure = functional

Table 2 (1) Financial Condition of Water Supply Service in Nefas Debre Tabor

1. Official Water Price: 1 birr/m3 for all clients

2. Production and Consumption of Water, Oct., 1993 - Sep.,1994

1) Production : 11,930 m3

2) Consumption: 9,773 m3

* Daily water consumption as divided by total population = 1.0 litre

* Leakage ratio = 18.1%

3. Income and Expenditure, 1994

1) Income : 31,336.63 birr

Major sources of income

(1) Water sales	8,292.00 birr	(26.5%)
(2) Service charge	6,791.27 birr	(21.7%)
(3) Public fountains	2,443.50 birr	(7.8%)
(4) Water meters	1,957.00 birr	(6.2%)

* Bill collection rate = 67.8%

* Income per unit consumption of water = 3.21 birr/m3

2) Expenditure: 78,327.84 birr

Major items of expenditure

(1) Salaries	37,425.00 birr	(47.8%)
(2) Fuel		
(3) Electricity		

* Expenditure per unit production of watern = 6.57 birr/m3

* Income-expenditure ratio: 40.0%

4. Organization and Personnel

1) No. of personnel: 18 (5)

(1) Head, WSS	1
(2) Administration 1 store keeper, 4 guards, 1 (1) janitor	6 (1)
(3) Finance 1 accounting clerk, 1 meter reader, 1 bill collector, 1 (1) cashier, 4 (3) water sellers	8 (4)
(4) Urban water supply & sewerage 1 plumber, 2 motor operators	3

Note: Parenthesized figure denotes the number of female workers.

* Production per worker = 663 m3/year

* Income and expenditure per worker = 1,741 birr, 4,352 birr/year

2) Average monthly salaries of employees: 173 birr

5. No. of Distribution Facilities

1) Yard connections : 320

(1) Household	: 251
(2) Governmental & public	: 33
(3) Commercial	: 36

2) Public fountains : 13 (2 functional)

Note: Many households use hand-dug wells.

6. Problems and Bottlenecks

1) Shortage of water sources.
2) Maintenance problems for pumps and generators.
3) The size of the reservoir is too small.
4) The distribution system does not cover all the town.
5) Shortage of pipes and fittings.
6) Lack of transport.
7) Lack of tool kits.

Table 2 (2) Financial Condition of Water Supply Service in Debre Tabor

Table 3 (1) Summary of Socio-Economic Aspects of Eleven Centers

Item	Dupti	Mille	Bati	Werota	Aykel	Debre Tabor
I. Administrative Conditions						
1. No. of gov't employees	500e	336	366	322	412	1,674
*No. of gov't employees/1,000 population	34	86	25	15	35	65
2. Average salaries of gov't employees (birr)	311	311	355	308	391	397
II. Population						
1. Population	14,737	3,902	14,354	21,845	11,718	25,575
2. Ethinic composition for top two (%)[Amh.=Amhara, Afa.=Afar, Oro.=Oromo, Tig.=Tigre, Kim.=Kimant, Age.=Agew]	Amh.84 Afa. 6	Amh.69 Oro.14	Amh.49 Oro.28	Amh.97 Tig. 3	Amh.73 Kim.20	Amh.100
3. Religious composition, Christians & Moslems (%)	42 58	43 57	12 88	80 19	81 19	95 5
4. Family size	4.5	4.6	6.2	6.3	5.5	5.7
5. Area (ha)	1,600e	68	260	640	322	1,402
*Population density (persons/ha)	9.2e	57.4	55.2	34.1	36.4	18.2
III. Educational Conditions						
1. No. of pupils/ students	3,182	457	2,500	3,817	3,944	7,950
*No. of pupils/ students per 100 population	22	12	17	17	34	31
2. Literacy ratio (%)	70	62	48	63	80e	74
3. Primary school enrollment ratio (%)	62	53	53	57	85e	75
IV. Medical Conditions						
1. No. of medical personnel	36	4	22	9	18	81

Table 3 (2) Summary of Socio-Economic Aspects of Eleven Centers

Item	Dupti	Mille	Bati	Werota	Aykel	Debre Tabor
*No. of medical personnel per 1,000 population	2.4	1.0	1.5	0.4	1.5	3.2
2. No. of cases for top ten diseases	14,943	1,611	11,642	18,084	13,683	21,318
*Estimated No. of cases per year as percentage of population (%)	30.4	12.4	24.3	24.8	35.0	25.0
3. Under 5 mortality rate (/1000)[n.a.=not available]	213	154	163	95	n.a.	73
4. Life expectancy (years)	47	53	52	61	55e	64
5. Households using septic tank / pit latrine (%)	86	45	68	61	39	65
V. Economic Conditions						
1. No. of commercial/industrial establishments [parenthesized figures=No. of hotels/restaurants]	1,105 (331)	204 (162)	243 (68)	812 (201)	450 (115)	1,672 (574)
*No. of establishments per 1,000 population	75 (22)	52 (42)	17 (5)	37 (9)	38 (10)	65 (22)
2. Monthly household income (birr)	334	223	306	262	182	248

Note: e=estimates

Table 3 (3) Summary of Socio-Economic Aspects of Eleven Centers

Item	Nefas Mewcha	Chagni	Bure	Bichena	Dejen
I. Administrative Conditions					
1. No. of gov't employees	541	727	845	499	378
*No. of gov't employees/1,000 population	39	27	57	57	37
2. Average salaries of gov't employees (birr)	297	368	292	374	407
II. Population					
1. Population	13,726	26,823	14,742	14,629	10,250
2. Ethinic composition for top two (%) [Amh.=Amhara, Afa.=Afar, Oro.=Oromo, Tig.=Tigre, Kim.=Kimant, Age.=Agew]	Amh.100	Amh.74 Age.19	Amh.94 Age. 4	Amh.99 Oro. 1	Amh.99 Tig. 1
3. Religious composition, Christians & Moslems (%)	94 6	44 56	92 7	67 33	65 35
4. Family size	5.9	6.1	6.8	6.2	6.8
5. Area (ha)	648	920	1,280	200	280
*Population density (persons/ha)	21.2	29.2	11.5	73.1	36.6
III. Educational Conditions					
1. No. of pupils/students	3,743	5,339	4,388	3,465	2,661
*No. of pupils/students per 100 population	27	20	30	24	26
2. Literacy ratio (%)	70	74	61	69	61
3. Primary school enrollment ratio (%)	59	77	69	68	64
IV. Medical Conditions					
1. No. of medical personnel	43	25	22	27	5

Table 3 (4) Summary of Socio-Economic Aspects of Eleven Centers

Item	Nefas Mewcha	Chagni	Bure	Bichena	Dejen
*No. of medical personnel per 1,000 population	3.1	0.9	1.5	1.8	0.5
2. No. of cases for top ten diseases	22,002	11,782	15,112	7,441	3,790
*Estimated No. of cases per year as percentage of population (%)	48.1	13.2	30.7	15.3	11.1
3. Under 5 mortality rate (/1000) [n.a.=not available]	196	144	131	173	155
4. Life expectancy (years)	49	54	56	52	53
5. Households using septic tank / pit latrine (%)	58	61	58	45	54
V. Economic Conditions					
1. No. of commercial/industrial establishments	860 (209)	546 (91)	246 (65)	414 (47)	345 (74)
[parenthesized figures=No. of hotels/restaurants]					
*No. of establishments per 1,000 population	63 (15)	20 (3)	17 (4)	28 (3)	34 (7)
2. Monthly household income (birr)	202	203	253	324	312

Note: e=estimates

Table 4 (1) Socio-Economic Condition of Debre Tabor

I. Administrative Conditions

1. Administrative Classification: Region 3, Zone = South Gonder

2. Government Organizations
1) Agricultural Bureau
2) Natural Resources Development and Environmental Protection (NRDEP)
3) Weroda Administration
4) Merchandise Wholesale Trading and Import Enterprise
5) Financial Department
6) Educational Department
7) Health Center
8) Hospital
9) Ethiopian Electric Light and Power Authority (EELPA)
10) Ethiopian Grain Trade Enterprise
11) News Agency
12) Police
13) Post Office
14) Telecommunications
15) Higher Court
16) Higher Attorney
17) Commercial Bank of Ethiopia
18) Chamber of Commerce
19) Labor and Social Affairs
20) Zonal Administration
21) Malaria Eradication and Control Service
22) Town Planning and Construction Department
23) Planning and Economic Development Department
24) Culture and Sports Department
25) WSSA
26) Transport and Communications
27) Industry and Handicraft Department
28) Relief and Rehabilitation Commission (RRC)
29) Road Construction Authority
30) Water Supply Service (WSS)

Notes: 1. Schools are not included in the above organizations.
2. There is one NGO.

3. No. of Government Employees and Their Average Monthly Salaries: 1,674, 397 birr

* No. of government employees per 1,000 population: 65

4. No. of Kebele: 9

Table 4 (2) Socio-Economic Condition of Debre Tabor

II. Socio-Economic Conditions

1. Population
1) Total population: 25,575

2) Ethnic composition: Amhara (100.0%)

3) Religious composition: Christians (95.0%), Moslems (5.0%)

4) Average family size: 5.7 persons

2. Area: 1,402 ha * Population density: 18.2 persons/ha

3. Educational Conditions
1) No. of schools, class rooms, teachers and pupils/students

Items	Kinder-garten	Elementary School	Junior High S.	Senior High S.
(1) No. of schools	1	5	1	1
(2) No. of class rooms	2	43	8	12
(3) No. of teachers	3	195	28	52
(4) No. of pupils/students	143	5,008	1,065	1,734

* No. of pupils/students per 100 population: 31

2) Literacy ratio: 73.8% (1984)

3) Primary school enrollment ratio: 74.5% (1984)

4. Medical Conditions
1) No. of medical institutions/establishments:
1 Hospital, 1 Health Center, 5 pharmacies (2 governmental, 2 private, 1 public)

2) No. of medical personnel:
(1) Hospital
7 doctors, 2 midwives, 15 nurses, 1 pharmacist, 3 laboratory technicians, 3 X-ray technicians, 1 assistant optician, 28 health assistants ... 60 in total

Other related personnel: 1 sanitarian

Table 4 (3) Socio-Economic Condition of Debre Tabor

(2) Health Center
2 doctors, 1 midwife, 1 nurse, 1 laboratory technician
16 junior health assistants ... 21 in total

Other related personnel: 1 sanitarian

3) Incidence of diseases (Jul. 1993 - Jun. 1994)

(1) Top ten diseases

a. Hospital

i.	Lower respiratory tract infection	2,870 cases	
ii.	TB all types	2,143	
iii.	Intestinal parasite	1,608	
iv.	Eye infection	1,276	
v.	Other diseases of the eyes	1,096	
vi.	Gastritis and Duodenitis	983	
vii.	Trachoma	909	
viii.	All forms of diarrhea	760	
ix.	Urinary tract infection	734	i. to x.
x.	Upper respiratory tract infection	666	= 13,045

b. Health Center

i.	Lower respiratory tract infection	1,558 cases	
ii.	Skin infection	1,338	
iii.	Helminthiasis	1,225	
iv.	Upper respiratory tract infection	1,054	
v.	Acute fever illness	1,052	
vi.	Sexually transmitted diseases	498	
vii.	Urinary tract infection	432	
viii.	Diarrhea	417	
ix.	Malnutrition	387	i. to x.
x.	Conjunctivitis	365	= 8,326

(2) Estimated number of cases per year as percentage of population:
(21,371 x 1.5) / (25,575 x 5) = 25.1%

Notes: 1.5 = coefficient to estimate the total number of cases
5 = coefficient to estimate covered population

4) Under 5 mortality rate: 72.6/1000 (1984)

5) Life expectancy: 63.7 years (1984)

6) Households more or less using septic tank and pit latrine: 65.0%

Table 4 (4) Socio-Economic Condition of Debre Tabor

5. No. of Holy Places: 6 churches, 1 mosque

6. Economic Conditions
1) No. of commercial and industrial establishments

Classification	Annual Income (birr)			
	< 1,000	1,000 - 3,000	3,000 <	Total
1. Hotels and restaurants				
Hotels	10	31	20	61
Pensions	1	1	0	2
Restaurants	72	20	10	102
Bars	17	20	10	47
Tea rooms	343	7	5	355
Tej houses	5	1	1	7
Sub-total	448	80	46	574
2. Shops	953	52	48	1,053
3. Cottage industry	35	5	3	43
4. Filling station	1	0	1	2
Total	1,437	137	98	1,672

Notes: 1. Cottage industry includes grain mills, manufacturing of furniture and garages.

* No. of commercial and industrial establishments per 1,000 population: 65

2) Major occupations
(1) Commercial activities (2) Government employees
(3) Day laborers (4) Animal husbandry

3) Major products: grain powder, edible oil, metal

4) Market
(1) Major marketable items:
grains, livestock, household items, clothes, fruit, vegetables, etc.

Table 4 (5) Socio-Economic Condition of Debre Tabor

(2) Prices of major marketable items

Grains (unit: birr/100 kg)

tef	barley	wheat	beans	peas	chick peas
200	180	170	200	230	160

Livestock (unit: birr/one)

ox	cow	sheep/goat	donkey	mule	chicken
500	400	60	120	600	5

Consumers' items (unit: birr)

butter (kg)	milk (litre)
22	1.5

(3) Market day - Monday (20,000 people gather.)

4) Average monthly household income: 247.8 birr

Sources: Water Supply Service, Weroda Council, Financial Bureau, Educational Bureau and Hospital in Debre Tabor; Socio-Economic Sampling Questionnaire Survey by JICA; Central Statistical Authority

Appendix - 6

Result of Initial Environmental Examination

Project Description on Initial Environmental Examination in Debre Tabor

Items	Description
Project Title	Eleven Centers Water Supply and Sanitation
Background	1. Insufficient water supply and low per-capita-consumption due mainly to shortage of water caused by insufficient facilities. 2. Because of shortage of water, there is poor hygienic condition which could contaminate the water source(s).
Objectives	To supply domestic water which meets people's demand and to improve sanitary condition.
Location	Debre Tabor, South Gonder, Region-3
Executing Agency	Water Supply and Sewerage Service Department Ministry of Water Resource
Beneficiaries	About 25,600 of the population to be benefited. As of July 1995, about 90% do not get WSS water.
Dimensions of the Plan	Rehabilitation of existing facilities, and new boreholes, reservoir and distribution network.
Type of Work	Rehabilitation and new construction work
Purpose	To provide domestic water and improve sanitation facilities, and to initiate people's awareness on water use and sanitation.
Water Resource	Groundwater, There are many hand dug wells and springs but not to be used as the drinking sources because of biological contamination.
Water Quality	Hand dug wells are often turbid and biological contamination is notified.
Main Facilities	Boreholes with pumping system.
Water Storage Facilities	Reservoir (ground tank type) with enough capacity.
Filtration Plant	Not to be considered.
Related facilities	Distribution pipes, public fountains, drainage system and latrines
Remarks	Calcium hypochlorite was used for disinfection in the town's HDWs occasionally, which was provided by UNICEF.

Site Description on Initial Environmental Examination in Debre Tabor

Items	Description
Project Title	Eleven Centers Water Supply and Sanitation
Social Environment	
Residents (population, tribe, consciousness)	Population about 25,600, almost Amhara with about 100% (origin of Amhara)
Facilities related to life (electricity, etc.)	Hydropower is provided from Blue Nile station for 24 hours, semi-automatic telecommunication.
Health and Sanitation (diseases, clinic, etc.)	1 hospital, 1 health center, 5 drug stores Lower respiratory tract is prevailing.
Natural Environment	
Topography, Geology and Hydrogeology	Located at plateau with altitude of 2,600m. Alkaline basalt and tuff are major structure.
Meteo-hydrology Groundwater/spring/river	Annual rainfall about 1590mm. There are many springs, hand dug wells and a river.
Endangered fauna and flora	Nil
Public Nuisance	
Nuisances	Because of water shortage, only 1 public fountain is working among 12. The drainage near the working fountain is so insufficient that flood overflows over the road.
Regulations and Compensation	Although the land is officially owned by the state, those who lose their dwelling and commercial area because of the project will be given substitute land. Also, Compensation will be made for properties such as houses and trees, which will be damaged.
Remarks	1. Because of water shortage, utmost 100 among 350 customers of the WSS got the service as of July 1995. 2. There are 562 hand dug wells in the town. 3. Except 1994, farmers don't use any pesticide or insecticide, however they are using urea and DAP as fertilizers. Based on the recent chemical test of the boreholes, no indication of fertilizer contamination was detected.

Scoping Format for Initial Environmental Examination in Debre Tabor

Environmental Components	Classi-fication	Description
1.Social Environment		
1.1 Resettlement	B	The facilities are small and expected to give no resettlement.
1.2 Economic Activities	D	The economic activities will be enhanced by the water supply and sanitation improvement.
1.3 Facilities	B	The construction work and the facilities have little impact on existing facilities such as schools and hospitals.
1.4 Collapse of Communities	B	Nil. If a water users committee was organized by the community itself to look after the facilities especially public fountains, the community would be enhanced
1.5 Archaeological and Cultural Heritage	B	Nil
1.6 Vested Rights	C	Compensation shall be given for land and properties if these were affected by the Project. Water vendors may lose their income source by the newly supplied water.
1.7 Public Health and Hygienic Condition	D/C	Sanitary improvement will enhance the condition. Drainage system must be accompanied with the improvement of water supply. The most typical water borne disease like diarrhea ranked at 8th will decrease.
1.8 Waste Disposal	B	During construction works, there will be little waste disposal from the view of the small construction scale. After commissionning, no waste disposal is expected.
1.9 Accidental Damages to Facilities	C	Consideration be paid to the alignment of pipelines in order to avoid public nuisance to dwellers.
2. Natural Environment		
2.1 Geographic and Geological Condition	B	No effect is expected to geographic and geological condition.
2.2 Soil Erosion	C	The earth work gives little soil erosion, judging from the construction scale.

Note) A; Advance Impact, B; Negligible Impact C; Unknown Impact D; Enhancement

to be continued.....

2.3 Surface Water Quality and Quantity	B	Nil
2.4 Groundwater Quality and Quantity	C	Effect of overpumping be considered.
2.5 Hydrological Situation	B	No effect is expected to hydrological situation.
2.6 Terrestrial Fauna	B	Nil
2.7 Aquatic Fauna	B	Nil
2.8 Vegetation	B	Little effect is expected to vegetation.
2.9 Climatic Conditions	B	No effect is expected to climatic conditions.
2.10 Aesthetic Condition	B	The facilities would give little change to the condition judging from the size.
3. Public Nuisance		
3.1 Air Pollution	B	Nil
3.2 Water Pollution	B	Nil
3.3 Soil Pollution	B	Nil
3.4 Noise and Vibration	B	The construction works do not give rise to noticeable noise and vibration.
3.5 Land Subsidence	B	The location of new boreholes is designed away from the dwelling area. The land is composed of basalt lava mainly, giving little expectation of land subsidence.
3.6 Odour	B	Nil
3.7 Traffic Nuisance	C	In case of pipeline being laid across road the traffic will be interrupted.

Note) A; Advance Impact, B; Negligible Impact C; Unknown Impact D; Enhancement

Appendix - 7

Project Cost Break-Down (Water Supply)

Summary of Cost Estimation of Water Supply in Debre

No.	Description	F.C.(B)	L.C.(B)	Total(B)
I.	Target year of 2005			
1	Civil Work			
	Mobilization and Demobilization	150,000	250,000	400,000
	Excavation and Earth-work	8,240	27,700	35,940
	Trench excavation	602,200	1,357,500	1,959,700
	Pipe-work	727,110	727,110	1,454,220
	Reservoir	360,000	360,000	720,000
	Pumping station, R.C.pump house	176,064	117,312	293,376
	Access road	178,000	414,000	592,000
	Bore-hole (200mm casing)	232,320	348,480	580,800
	Water purifiction unit	10,000	15,000	25,000
	Booster pump and necessary works	540,000	900,000	1,440,000
	Electric submersible pump and necessary works	160,000	240,000	400,000
	Power supply	47,550	56,325	103,875
	Concrete work	111,700	193,500	305,200
	Masonsy work	6,000	24,500	30,500
	Structure	153,610	358,420	512,030
	Temporary work(10% of above total)	346,279	538,985	885,264
	Total of civil work	3,809,073	5,928,832	9,737,905
2	Material & Equipment	12,550,886	878,562	13,429,448
	Sub Total	16,359,959	6,807,394	23,167,353
3	Engineering cost(12% of sub tatal)	2,780,082		2,780,082
4	Contingency (5%)	957,002	340,370	1,297,372
	Total(birr)	20,097,043	7,147,764	27,244,807
	Total(Yen:1birr=15yen)			408,672,000
5	Buildings		2,829,638	2,829,638
6	WSSD's management cost		601,489	601,489
	Total		3,431,127	3,431,127
7	Prise escalation(6%)	1,205,823	634,733	1,840,556
	Grand Total	21,302,866	11,213,624	32,516,490
II.	Target year of 2010			
1	Morbilization and demorbilization			300,000
2	Rising line			1,299,000
3	Distribution network			1,095,000
4	New borehole with pumps & material			2,636,000
5	Booster pump with house			534,000
6	Power supply facilities			170,000
7	Chamber and structures			270,000
8	Buildings			1,030,700
9	Others			623,300
	Sub total			7,958,000
10	Engineering cost (10%)			795,800
11	Contingency (10%)			875,380
	Total			9,629,000
	Prise escalation(42%)			4,044,000
	Grand Total			13,673,000

Cost Estimation of Construction & Materials/Equipment of Debre : Target year of 2005

No.	Description	Unit	Q'ty	Unit-Rate F.C.(B)	Unit-Rate L.C.(B)	Amount F.C.(B)	Amount L.C.(B)	Remarks
1.	Mobilization and Demobilization	LS				150,000	250,000	
2.	Excavation and Earth-work							
2-1	Clearing and grubbing the site	ha	3	480	2,400	1,440	7,200	to remove bushes, small forest and trees
2-2	Clear off the site	sqm	3,000	1	4	3,000	12,000	to remove top soil to an average depth of 20cm
2-3	Bulk excavation							
	a) Earth excavation	cum	100	6	14	600	1,400	
	b) Excavation of weathered rock	cum	100	10	20	1,000	2,000	
	c) Soft rock excavation	cum	50	14	32	700	1,600	
	d) Sound rock excavation	cum	50	30	70	1,500	3,500	
3.	Trench excavation							
3-1	Trench excavation for water pipe							
	1) Single pipe in trench							
	a) 0.6~1.0m depth	m	31,100	4	8	124,400	248,800	
	b) 1.0~1.5m depth	m	16,100	7	17	112,700	273,700	
	c) 1.5~2.5m depth	m	1,700	10	23	17,000	39,100	
3-2	Trench, Rock excavation	cum	200	30	70	6,000	14,000	
3-3	Back-fill with the same material	m	24,500	5	11	122,500	269,500	
3-4	Selected soil bedding	m	24,400	2	5	48,800	122,000	150mm thick below barrel
3-5	Back-fill with selected material	m	24,400	7	16	170,800	390,400	compacted in layers not more than 20cm thick
4.	Pipe-work							
4-1	Presure pipe NP 10							with push-in flexible joints
	1) PVC pipe							
	a) DN 50mm	m	18,000	5	5	90,000	90,000	
	b) DN 75mm	m	13,290	8	8	106,320	106,320	
	c) DN 100mm	m		10	10	0	0	
	d) DN 150mm	m	16,100	17	17	273,700	273,700	
4-2	Pressure steal pipe							fitting and supports for bridge and road
	a) DN 200mm	m	1,100	137	137	150,700	150,700	
	b) DN 250mm	m	310	149	149	46,190	46,190	
	c) DN 300mm	m	350	172	172	60,200	60,200	
5.	Reservoir							
5-1	Ground level reservoir	m3	400	900	900	360,000	360,000	

No.	Description	Unit	Q'ty	Unit-Rate F.C.(B)	Unit-Rate L.C.(B)	Amount F.C.(B)	Amount L.C.(B)	Remarks
6.	Pumping station, R.C.pump house	sqm	96	1,834	1,222	176,064	117,312	with accessaries
7.	Access road	m	2,000	89	207	178,000	414,000	3m wide gravel road with draine ditch
8.	Bore-hole							
8-1	New driling	m	626	320	480	200,320	300,480	including, casing, packing and pumping test
8-2	Rehabiritation	set	2	16,000	24,000	32,000	48,000	
9.	Water purifiction unit	No.	1	10,000	15,000	10,000	15,000	
10.	Booster pump	No.	9	60,000	100,000	540,000	900,000	foundation, pump, and motor with accessories
11.	Electric submersible pump (for deep well)	No.	8	20,000	30,000	160,000	240,000	foundation, and pump with accessories
12.	Power supply							
12-1	Generating set	No.	3	5,850	8,775	17,550	26,325	gererater with accessaries
12-2	High tension line	m	2,000	8	7	16,000	14,000	
12-3	Low tension line	m	1,000	6	4	6,000	4,000	
12-4	Trensformer	No.	2	4,000	6,000	8,000	12,000	transformer with accessaries
13.	Concrete work							
13-1	Normal concrete (250kg of cement per cum)	cum	100	250	500	25,000	50,000	including form-work, vibration and curing
13-2	Reinforced concrete (360kg of cement per cum)							including vibration and curing
	Water retaining sturcture	cum	200	275	642	55,000	128,400	
13-3	Form-work							including all necessary works
	Wall	sqm	100	37	87	3,700	8,700	
13-4	Reinforcement bars; Steel bars	kg	4,000	7	2	28,000	6,400	including cutting, bending and placing
14.	Masonsy work							
14-1	Roughly dressed 40cm thick stone elevation wall	sqm	100	60	245	6,000	24,500	
14-2	Brick work with mortor							
	25cm thick	sqm		23	92	0	0	
15.	Structure							
15-1	Construction of public fountains	No.	8	1,580	3,680	12,640	29,440	
15-2	Construction of hydrant	No.	15	230	540	3,450	8,100	
15-3	Construction of R.C.C. aeration chamber	No.	6	5,730	13,370	34,380	80,220	
15-4	Construction of R.C.C. valve chamber	No.	18	5,730	13,370	103,140	240,660	

Cost Estimation of Construction & Materials/Equipment of Debre : Target year of 2005 3/3

No.	Description	Unit	Q'ty	Unit-Rate F.C.(B)	Unit-Rate L.C.(B)	Amount F.C.(B)	Amount L.C.(B)	Remarks
	Sub-Total of Construction work					3,462,794	5,389,847	
16.	Material & Equipment (Ref.table)							
16-1	CIF Cost at Addis Ababa					12,550,886		
16-2	Inland transportation cost						878,562	CIF cost x 7 %
	Sub-Total of Material & Equipment					12,550,886	878,562	
	Total					16,013,680	6,268,409	
17.	Building							
17-1	Office	sqm	280		1,910		534,800	
17-2	Workshop	sqm	137		1,624		222,488	
17-3	Store	sqm	230		1,337		307,510	
17-4	Residence	sqm	840		2,101		1,764,840	
	Total						2,829,638	

Imported Cost (Material & Equipment) of Debre :Target year of 2005

No.	Description	Unit	Q'ty	Unit Rate (B)	Amount (B)
1.	Pipe material				
	including joint and accessories				
1.1	PVC pipe NP-10				
	a) DN 50mm	m	18,900	15	283,500
	b) DN 75mm	m	14,000	30	420,000
	c) DN 150mm	m	16,900	80	1,352,000
1.2	Suspended pressure steel pipe				
	a) DN 200mm W/O gilt and screw	m	1,160	288	334,080
	b) DN 250mm	m	330	334	110,220
	c) DN 300mm	m	370	418	154,660
1.3	Fitting cost Total cost × 20%				530,892
2	Pumps (Pump with electric motor/accessories)				
2.1	Centrifugal pumps				
	a) Q= 1.9 m3/min H= 17m HP= 11 kw	set	2	300,000	600,000
	b) Q= 0.43m3/min H= 100m HP= 22 kw	set	5	500,000	2,500,000
	c) Q= 0.17m3/min H= 70m HP= 7.5kw	set	2	300,000	600,000
2.2	Submersible pumps with accessories				
	a) Q= 0.12m3/min H= 100m HP= 3 kw	set	2	130,000	260,000
	b) Q= 0.3m3/min H= 100m HP= 5.5kw	set	6	171,000	1,026,000
3	Power Supply(Materials&accessories)				
3.1	Power supply generating set				
	50 KVA	set	3	450,000	1,350,000
3.2	Tension line				
	a) High tension over head line 15KV	m	2,000	50	100,000
	b) Low tension over head line	m	1,000	28	28,000
3.3	Plate-form mounted transformer				
	Supply of transformer wiht acccessories				
	Transformer 100 KVA (H-Type)	set	2	75,800	151,600
4	Valve (Valve with accessories)				
4.1	Sluice valve				
	a) ϕ150	set	6	1,700	10,200
	b) ϕ200	set	1	2,200	2,200
4.2	High speed air valve				
	a) ϕ50	set	6	7,000	42,000
4.3	Pressure reducing valve				
	b) ϕ75	set	6	7,000	42,000
	c) ϕ150	set	3	10,000	30,000
	d) ϕ250	set	1	15,000	15,000
4.4	Check valve				
	150mm	set	3	15,000	45,000
5	Flow meter (Meter with accessories ϕ150)	set	3	60,000	180,000
6	Reservoir equipment	set	2	100,000	200,000
7	Well (Materials with accessories)				
7.1	Casing pipe FRP				
	DN 200	m	438	2,093	916,734
7.2	Screen FRP				
	DN 200	m	188	5,700	1,071,600
7.3	Riser pipe, stainless DN 65	m	640	180	115,200
8	Water purification unit	set	1	80,000	80,000
	Total				12,550,886

Investment Cost of Target Year 2010 in Debre

No.	Description	Unit	Q'ty	Unit Rate (B)	Amount (B)
1	Morbilization and demorbilization	LS			300,000
2	Rising line	Km	4.33	300,000	1,299,000
3	Distribution network	Km	7	150,000	1,095,000
4	New borehole with pumps & mateial	Set	4	659,000	2,636,000
6	Booster pump with house	Set	1	534,000	534,000
7	Power supply facilities	Site	1	170,000	170,000
8	Chamber and structures	Set	10	27,000	270,000
9	Buildings	M2	11	93,700	1,030,700
	Others	LS			623,300
	Sub total				7,958,000
11	Enginering cost (10%)				795,800
12	Contingency (10%)				875,380
	Total				9,629,180

Appendix - 8

Meteorological Data

Table 1 Monthly Precipitation

Station: Debre Tabor

Unit:mm

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1951	0.0	0.0	--	0.0	63.4	--	510.1	441.1	126.3	--	--	--	--
1952	0.0	--	--	56.2	40.7	247.2	350.4	446.1	142.8	13.8	0.0	45.0	--
1953	0.0	41.2	4.6	114.4	92.9	191.4	538.7	570.6	--	--	--	--	--
1954	0.0	--	--	--	--	219.0	499.5	519.5	195.0	0.0	0.0	0.0	--
1955	0.0	0.0	--	0.0	0.0	--	--	--	--	--	--	--	--
1956	--	--	--	--	--	201.5	588.5	460.3	253.0	237.5	35.0	6.5	--
1957	0.0	4.0	127.5	22.0	121.5	142.8	463.5	507.0	70.0	59.0	3.0	0.0	1520.3
1958	11.5	0.0	24.0	37.5	92.5	278.5	604.5	468.0	158.5	--	43.0	21.5	--
1959	0.0	11.5	32.5	68.0	74.5	86.0	494.0	520.0	300.0	98.0	27.5	11.0	1723
1960	39.0	32.0	30.0	3.0	167.0	91.5	466.5	401.0	206.0	10.5	0.0	0.0	1446.5
1961	0.0	63.5	58.5	80.0	33.0	159.0	665.0	588.5	264.5	27.5	--	--	--
1974	--	--	--	--	--	181.9	495.8	418.3	231.9	36.0	0.0	0.0	--
1975	68.1	12.8	2.6	17.8	38.7	266.0	402.7	501.0	129.6	0.0	0.0	0.0	1439.3
1976	0.0	0.0	13.6	9.7	--	137.9	298.2	390.0	215.3	98.0	134.9	6.1	--
1977	0.0	0.0	49.7	3.5	137.7	289.5	598.9	541.5	253.1	266.0	3.3	32.1	2175.3
1978	0.0	23.0	8.8	25.3	73.2	492.7	564.6	390.6	236.2	56.1	64.7	26.6	1961.8
1979	6.6	2.0	0.0	5.2	128.1	144.8	553.4	464.3	260.1	182.5	0.0	0.0	1747
1980	0.0	10.1	--	103.8	37.6	164.7	571.6	489.1	225.0	97.6	141.1	0.0	--
1981	0.0	0.0	0.0	7.2	27.0	144.5	456.4	467.7	247.3	155.7	58.0	0.0	1563.8
1982	14.3	0.6	57.9	3.9	78.6	98.5	266.5	670.6	201.8	182.6	67.9	0.0	1643.2
1983	0.0	0.0	0.0	20.8	89.6	0.0	387.5	506.7	196.4	60.6	46.3	0.0	1307.9
1984	0.0	0.0	0.0	14.2	155.1	197.6	--	320.6	116.7	0.0	13.0	0.0	--
1985	5.0	10.0	14.6	54.8	97.9	118.8	333.7	298.6	165.4	16.2	15.7	11.0	1141.7
1986	3.3	2.3	45.0	14.3	5.6	352.5	447.5	440.6	193.1	44.4	0.0	22.9	1571.5
1987	16.1	0.3	58.3	21.4	172.3	127.8	273.8	371.4	60.1	65.1	27.2	0.0	1193.8
1988	--	--	--	31.9	69.8	155.5	590.5	462.5	182.3	84.9	7.5	5.5	--
1989	6.2	--	84.4	45.8	94.8	84.7	304.5	425.5	139.3	103.6	12.4	--	--

1991	--	--	--	--	--	--	--	--	--	--	38.1	2.2	--
1992	0.5	0.0	12.8	98.8	38.6	115.9	330.5	365.5	124.6	--	60.5	5.9	--
1993	0.8	2.0	86.3	74.8	199.0	136.5	429.8	289.9	208.8	118.6	43.3	1.1	1590.9
1994	1.8	9.1	0.0	17.0	89.7	237.7	495.8	633.5	--	--	--	--	--

Table 2 Long Term Monthly Mean Potential Evapotranspiration (PET)

Station: Debre Tabor Unit:mm

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1st 10 days	42	44	46	44	45	51	54	60	59	57	57	56	
2nd 10 days	57	57	52	51	46	42	40	36	36	37	37	39	
3rd 10 days	40	42	43	43	44	43	41	40	40	40	40	41	
Total	139	143	141	138	135	136	135	136	135	134	134	136	1642

Table 3 Monthly Average Air Temperature

Station: Debre Tabor Unit: ℃

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1974	--	--	--	--	--	15.3	12.8	13.6	14.3	15.0	14.7	16.0
1975	15.0	17.1	17.2	17.2	18.3	15.5	13.6	13.5	14.5	14.2	14.6	14.1
1976	15.2	16.3	17.4	16.9	--	15.5	12.9	13.3	14.5	15.3	13.9	14.7
1977	15.3	17.3	17.1	18.6	17.5	14.6	13.7	13.8	15.1	14.3	15.2	15.5
1978	16.2	17.4	17.5	17.9	22.4	14.5	12.9	12.8	13.9	14.1	14.3	14.7
1979	14.6	17.3	17.7	18.0	15.1	14.4	13.4	13.1	13.7	14.4	15.6	16.2
1980	17.0	17.7	--	17.5	18.0	17.9	13.4	12.3	12.7	13.2	14.4	14.8
1981	16.6	17.6	18.5	18.1	18.4	16.6	12.4	12.5	12.8	15.4	16.1	16.3
1982	16.8	17.2	18.4	18.4	20.4	17.4	14.0	12.8	13.9	14.1	14.0	15.3
1983	17.3	17.5	18.2	18.8	19.1	17.8	--	14.4	14.6	14.7	15.1	15.2
1984	16.3	--	17.7	18.3	16.9	15.6	--	14.8	14.8	14.8	15.1	14.8
1985	15.4	14.3	15.2	16.0	--	15.1	14.8	--	--	15.2	14.6	14.8
1986	15.4	15.5	14.7	16.5	15.7	15.0	14.6	13.7	13.8	14.2	15.3	14.9
1987	15.1	27.6	14.5	17.5	15.8	15.6	15.6	14.3	15.0	15.2	15.3	15.4

Note: - = not calculated due to missing data

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1988	–	–	–	18.8	18.5	16.7	14.2	14.3	14.7	14.6	14.6	14.9
1989	14.5	–	16.0	16.3	16.8	16.8	10.1	14.9	14.6	14.6	14.8	–
1991	–	–	–	–	–	–	–	–	–	–	14.5	14.2
1992	15.0	16.0	17.9	17.8	17.4	16.8	14.3	13.9	13.9	–	13.6	14.2
1993	–	–	–	16.4	16.4	15.6	14.5	14.7	14.5	14.9	13.9	15.0
1994	15.9	16.6	–	18.9	17.2	15.8	13.8	13.8	–	–	–	–

Table 4 Monthly Average Maximum Air Temperature

Station: Debre Tabor Unit: ℃

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1974	–	–	–	–	–	21.3	17.4	18.1	19.6	20.7	21.2	21.6
1975	21.5	22.0	23.7	24.0	23.8	19.5	18.6	15.9	18.3	19.2	20.4	19.8
1976	21.2	22.5	22.7	22.8	–	21.5	16.9	17.5	19.1	20.7	19.1	19.8
1977	21.1	22.8	22.8	24.5	23.3	19.8	18.5	18.5	20.3	19.2	20.7	21.3
1978	22.4	23.3	23.1	23.4	23.3	19.3	17.2	17.4	19.0	19.2	19.5	20.8
1979	21.3	23.3	24.4	24.1	20.6	19.7	18.1	17.9	18.7	19.3	21.0	21.8
1980	22.2	22.7	–	23.3	23.7	22.5	18.4	17.3	17.9	19.7	20.1	20.4
1981	21.8	22.8	23.8	23.9	24.0	22.4	16.4	16.2	17.2	20.1	21.6	23.1
1982	23.3	23.4	24.5	24.4	26.8	24.3	19.1	17.5	18.7	19.2	19.6	21.4
1983	22.8	22.8	23.8	24.7	25.0	23.8	–	19.4	19.4	19.5	20.0	20.2
1984	19.8	22.2	23.7	24.2	22.3	21.0	–	19.9	19.7	19.9	19.9	19.7
1985	20.6	19.6	20.1	22.8	–	20.9	19.9	19.8	19.4	20.7	19.9	19.7
1986	20.9	21.5	19.7	23.9	22.6	21.0	20.5	18.8	18.9	19.7	21.1	20.7
1987	21.3	22.6	22.9	23.6	20.6	20.3	20.6	19.3	21.1	21.1	21.5	22.0
1988	–	–	–	25.7	24.9	22.1	17.5	17.7	19.2	19.9	21.0	22.0
1989	21.9	–	22.3	22.4	22.8	21.6	19.1	18.9	19.8	20.6	22.1	–
1991	–	–	–	–	–	–	–	–	–	–	21.3	20.9
1992	21.7	23.0	24.8	24.1	23.5	23.1	18.6	17.4	18.8	–	19.1	20.8
1993	–	–	–	22.0	22.1	20.7	18.8	19.5	19.9	20.2	21.5	21.9
1994	22.8	24.1	31.4	25.8	23.5	21.1	17.1	17.6	–	–	–	–

Note: - = not calculated due to missing data

Table 5 Monthly Average Minimum Air Temperature

Station: Debre Tabor Unit: ℃

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1974	–	–	–	–	–	9.2	8.1	9.0	9.0	9.2	8.1	8.3
1975	8.5	10.1	10.7	10.3	10.8	9.5	8.6	9.0	8.7	9.1	8.7	8.4
1976	9.1	10.1	12.1	11.0	–	9.4	8.8	9.1	9.9	9.9	8.7	9.5
1977	9.5	11.8	11.3	12.6	11.6	9.3	8.9	9.1	9.9	9.5	9.7	9.7
1978	9.9	11.4	11.8	12.3	11.4	9.7	8.5	8.1	8.8	9.0	9.0	8.5
1979	7.9	9.2	11.0	11.9	9.5	9.1	8.7	8.3	8.6	9.4	10.2	10.5
1980	11.7	12.6	–	11.7	12.2	13.2	8.4	7.3	7.5	6.7	8.7	9.1
1981	11.4	12.3	13.2	12.2	12.8	10.8	8.3	8.8	8.3	10.6	10.6	9.4
1982	10.3	11.0	12.2	12.4	13.9	10.5	8.9	8.1	9.0	9.0	8.4	9.2
1983	11.7	12.1	12.6	12.8	13.1	11.7	–	9.3	9.8	9.8	10.1	10.1
1984	9.7	–	11.6	12.4	11.4	10.1	–	9.7	9.8	9.7	10.2	9.9
1985	10.2	9.0	10.3	9.2	–	9.3	9.7	–	–	9.9	9.2	9.9
1986	9.9	9.4	9.7	9.1	8.8	9.0	8.9	8.6	8.7	8.7	9.5	9.1
1987	8.9	9.9	10.0	11.3	10.9	10.8	10.6	9.3	8.8	9.3	9.1	8.7
1988	–	–	–	11.9	12.0	11.3	10.9	10.8	10.1	9.2	8.2	7.8
1989	7.0	–	9.7	10.2	10.7	10.5	10.2	9.9	9.3	8.3	7.5	–
1991	–	–	–	–	–	–	–	–	–	–	7.6	7.4
1992	8.3	8.9	11.0	11.4	11.3	10.5	9.9	10.3	9.0	–	8.0	7.6
1993	7.1	8.2	9.8	10.8	10.7	10.4	10.1	9.8	9.1	9.5	8.7	8.1
1994	8.9	9.1	–	12.0	10.9	10.5	10.4	10.0	–	–	–	–

Note: - = not calculated due to missing data

Appendix - 9

Hydrological Data

Table 1 Monthly Runoff of Zufil River

Station: Debre Tabor Unit: Upper in Million m3, Lower in mm

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1984	0.025 8.3	0.010 3.3	0.005 1.7	0.003 1.0	0.011 3.7	0.043 14.3	0.323 107.7	0.413 137.7	0.265 88.3	0.062 20.7	0.023 7.7	0.016 5.3	1.199 399.6
1985	0.005 1.7	0.004 1.3	0.005 1.7	—	0.076 25.3	0.008 2.7	1.620 534.7	7.580 2501.7	0.550 181.5	0.055 18.3	0.017 5.6	0.012 4.0	— —
1986	0.006 2.0	0.005 1.7	0.004 1.3	0.002 0.7	0.001 0.3	0.226 75.3	3.460 1141.9	1.080 356.4	0.437 144.2	0.173 57.7	0.018 6.0	0.011 3.7	5.423 1789.8
1987	0.006 2.0	0.003 1.0	0.003 1.0	0.000 0.0	0.005 1.7	0.057 19.0	0.309 103.0	0.509 167.0	0.139 46.3	0.030 10.0	0.016 5.3	0.011 3.6	1.080 356.4
1988	—	0.005 1.7	0.004 1.3	0.003 1.0	0.004 1.3	0.005 1.7	0.627 209.0	0.786 262.0	0.329 109.7	0.081 27.0	0.026 8.7	0.009 3.0	— —
1989	0.006 2.0	0.004 1.3	0.008 2.7	0.005 1.7	0.006 2.0	0.082 27.3	0.484 161.3	0.666 222.0	1.160 382.8	0.085 28.3	0.107 35.7	0.007 2.3	2.620 864.7

Note: - =Not calculated due to missing data

Figure 1 TANK Model for Zufil River at Debre Tabor

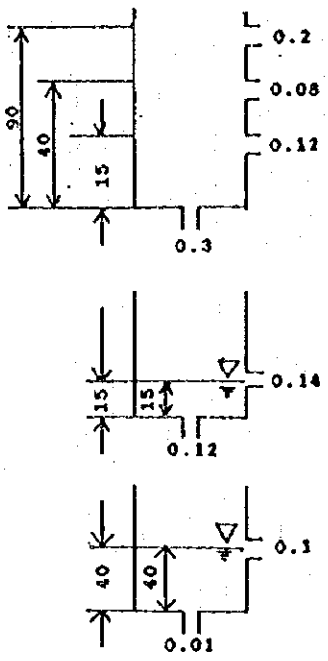


Figure 2 Runoff Analysis by TANK Model
Zufil River at Debre Tabor

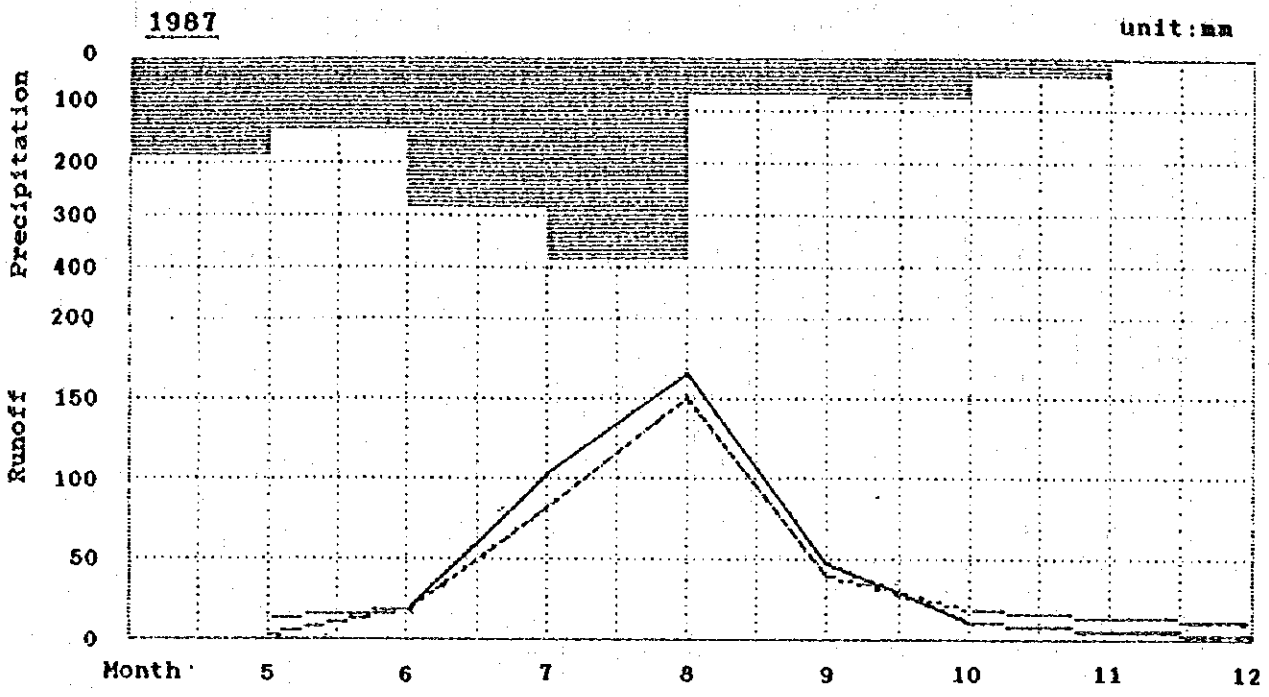


Figure 3 Runoff Analysis by TANK Model
Zufil River at Debre Tabor

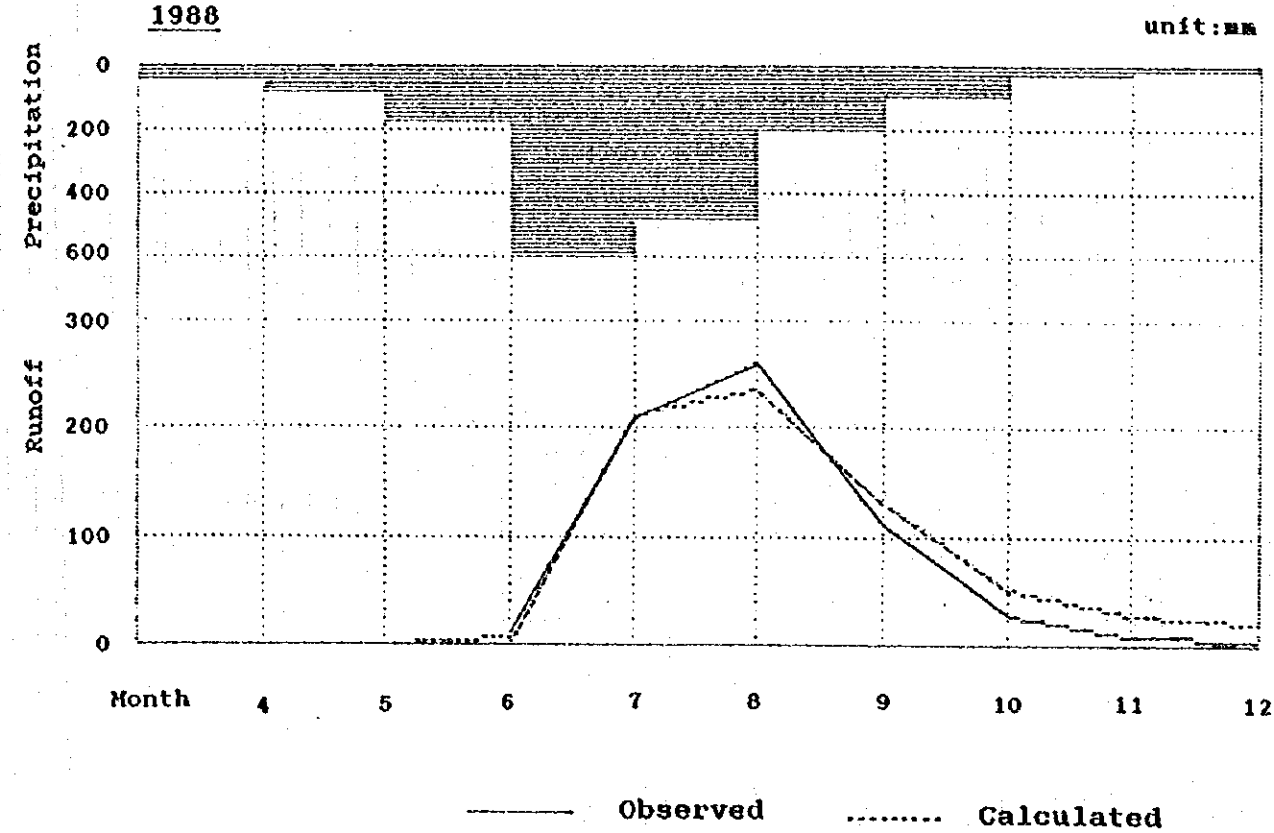
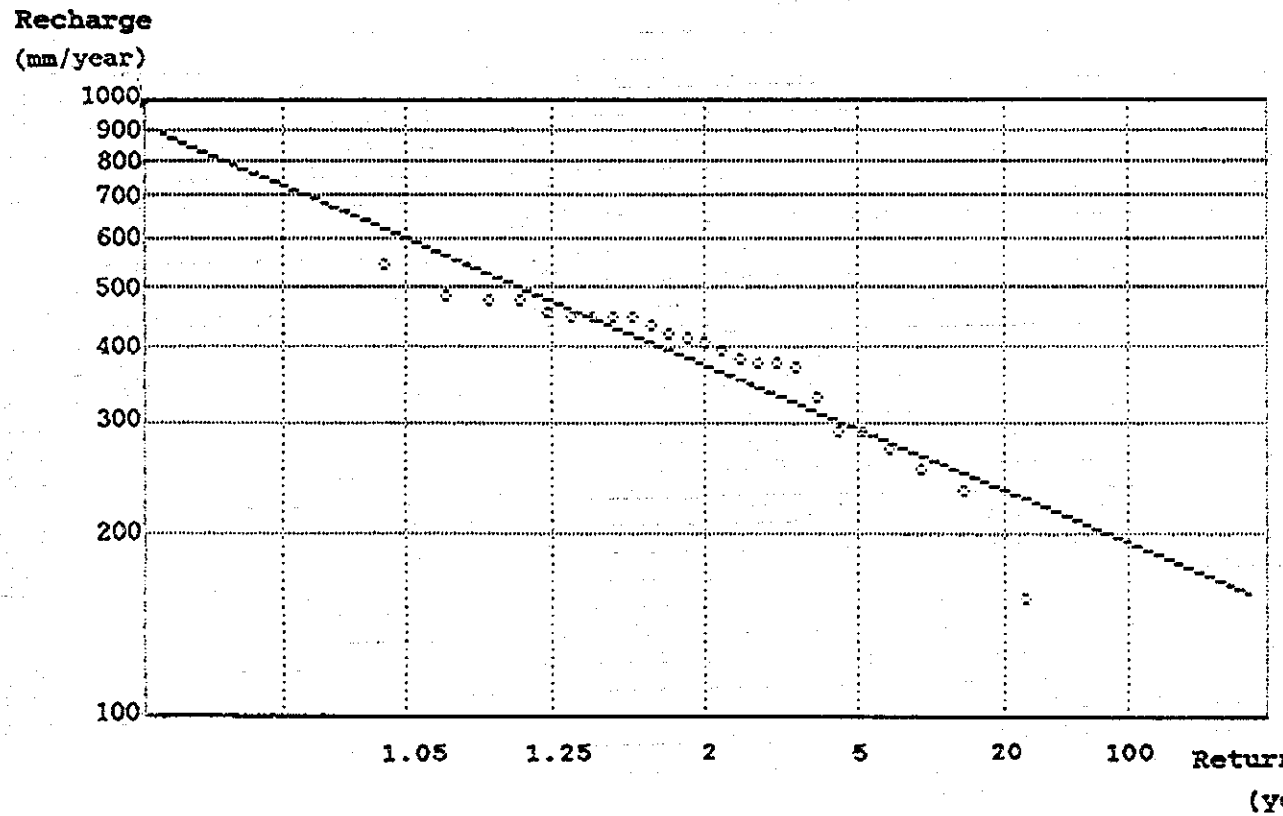


Figure 4 Probability Analysis on Annual Ground Water Recharge, Zufil River at Debre Tabor



Results of Analysis

Return Period (year)	Probability of Exceedance	Theoretical Values
2	.5	373.69
5	.2	294.45
10	.1	259.98
100	.01	234.59

Table 2 Monthly Water Balance Sheet for Ground Water Recharge, Zufil River at Debre Tabor

1952

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	0.0	--	--	56.2	40.7	247.2	350.4	446.1	142.8	13.8	0.0	45.0	--
Q	--	--	--	7.5*	5.6*	48.5*	128.5*	201.7*	98.3*	27.5*	20.8*	15.8*	--
P - Q	--	--	--	48.7	35.1	198.7	221.9	244.4	44.5	--	--	29.2	--
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,643
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	--	--	--	48.7	35.1	95.2	94.5	95.2	44.5	--	--	29.2	--
ΔS	--	--	--	0	0	103.5	127.4	149.2	0	--	--	0	380.1

1954

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	0.0	--	--	--	--	219.0	499.5	519.5	195.0	0.0	0.0	0.0	--
Q	--	--	--	--	--	43.8*	196.0*	261.6*	147.1*	39.4*	29.6*	22.8*	--
P - Q	--	--	--	--	--	175.2	303.5	257.9	47.9	--	--	--	--
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,643
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	--	--	--	--	--	95.2	94.5	95.2	47.9	--	--	--	--
ΔS	--	--	--	--	--	80.0	209.0	162.7	0	--	--	--	451.7

1956

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	--	--	--	--	--	201.5	588.5	460.3	253.0	237.5	35.0	6.5	--
Q	--	--	--	--	--	41.7*	237.0*	252.5*	172.0*	139.6*	47.5*	33.4*	--
P - Q	--	--	--	--	--	159.8	351.5	207.8	81	97.9	--	--	--
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,643
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	--	--	--	--	--	95.2	94.5	95.2	81	93.8	--	--	--
ΔS	--	--	--	--	--	64.6	257	112.6	0	4.1	--	--	438.3

Note: * = Estimated by the Tank Model
- = not calculated due to missing data or distorted data

1957

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	0.0	4.0	1275	22.0	121.5	142.8	463.5	567.0	70.7	59.0	3.0	0.0	1,580.3
Q	26.0*	20.5*	19.3*	14.3*	14.3*	21.5*	167.9*	272.1*	95.4*	40.3*	28.6*	22.6*	--
P - Q	--	--	108.2	7.7	107.2	121.3	295.6	294.9	--	18.7	--	--	--
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,642
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	--	--	98.7	7.7	94.5	95.2	94.5	95.2	--	18.7	--	--	--
△S	--	--	9.5	0	12.7	26.1	201.1	199.7	--	0	--	--	449.0

1958

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	11.5	0.0	24.0	37.5	92.5	278.5	604.5	468.0	158.5	--	43.0	21.5	--
Q	41.1*	32.0*	25.3*	20.3*	16.6*	71.9*	254.6*	263.2*	135.8*	--	12.1*	9.3*	--
P - Q	--	--	--	17.2	75.9	206.6	349.9	204.8	22.7	--	30.9	12.2	--
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,642
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	--	--	--	17.2	75.9	95.2	94.5	95.2	22.7	--	30.9	12.2	--
△S	--	--	--	0	0	111.4	255.4	109.6	0	--	0	0	476.4

1959

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	0.0	11.5	32.5	68.0	74.5	86.0	494.0	520.0	300.0	98.0	27.5	11.0	1,723.0
Q	7.3*	5.7*	4.6*	3.7*	3.1*	2.6*	156.0*	242.7*	182.7*	76.9*	31.2*	23.7*	737.1*
P - Q	--	5.8	27.9	64.3	71.4	83.4	338.0	277.3	117.3	21.1	--	--	--
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,642
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	--	5.8	27.9	64.3	71.4	83.4	94.5	95.2	94.5	21.1	--	--	--
△S	--	0	0	0	0	0	243.5	182.1	22.8	0	--	--	448.4

Note: * = Estimated by the Tank Model
- = not calculated due to missing data or distorted data

1960

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	39.0	32.0	30.0	3.0	167.0	91.5	466.5	401.0	206.0	10.5	0.0	0.0	1,446.5
Q	18.4*	14.4*	11.3*	9.1*	20.0*	12.7*	160.1*	194.1*	125.1*	32.5*	24.6*	19.2*	641.5
P - Q	20.6	17.6	18.7	--	147	78.8	306.4	206.9	80	--	--	--	--
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,642
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	20.6	17.6	18.7	--	94.5	78.8	94.5	95.2	80	--	--	--	--
△S	0	0	0	--	52.5	0	211.9	111.7	0	--	--	--	376.1

1961

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	0.0	63.5	58.5	80.0	33.0	159.0	665.0	588.5	264.5	27.5	--	--	--
Q	15.1*	12.1*	9.9*	8.2*	6.9*	16.4*	253.0*	311.5*	197.1*	58.8*	--	--	--
P - Q	--	51.4	48.6	71.8	26.1	142.6	412	277.0	67.4	--	--	--	--
ETo	139	143	141	138	135	136	135	136	135	134	134	136	164.2
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	--	51.4	48.6	71.8	26.1	95.2	94.5	95.2	67.4	--	--	--	--
△S	--	0	0	0	0	47.4	317.5	181.8	0	--	--	--	546.7

1974

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	--	--	--	--	--	181.9	495.8	418.3	231.9	36.0	0.0	0.0	--
Q	--	--	--	--	--	71.8*	215.0*	232.0*	159.1*	54.7*	37.5*	29.4*	--
P - Q	--	--	--	--	--	110.1	280.8	186.3	72.8	--	--	--	--
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,642
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	--	--	--	--	--	95.2	94.5	95.2	72.8	--	--	--	--
△S	--	--	--	--	--	14.9	186.3	91.1	0	--	--	--	292.3

Note: * = Estimated by the Tank Model
- = not calculated due to missing data or distorted data

1975

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	68.1	12.8	2.6	17.8	38.7	266.0	402.7	501.0	129.6	0.0	0.0	0.0	1,439.3
Q	23.4*	18.9*	15.6*	13.0*	11.1*	62.3*	160.2*	241.4*	111.3*	35.7*	28.2*	28.6*	743.7*
P - Q	44.7	--	--	4.8	27.6	203.7	242.5	260.6	18.3	--	--	--	--
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,642
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	44.7	--	--	4.8	27.6	95.2	94.5	95.2	18.3	--	--	--	--
ΔS	0	--	--	0	0	108.5	148.0	165.4	0	--	--	--	421.9

1976

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	0.0	0.0	13.6	9.7	--	137.9	298.9	390.0	215.3	98.0	134.9	6.1	--
Q	18.4*	15.2*	12.9*	11.1*	--	23.4*	95.8*	169.9*	122.4*	56.4*	49.2*	27.3*	--
P - Q	--	--	0.7	--	--	114.5	203.1	220.1	92.9	41.6	85.7	--	--
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,642
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	--	--	0.7	--	--	95.2	94.5	95.2	92.9	41.6	85.7	--	--
ΔS	--	--	0	--	--	19.3	108.6	124.9	0	0	0	--	252.8

1977

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	0.0	0.0	49.7	3.5	137.7	289.5	598.9	541.5	253.1	266.0	3.3	32.1	2,175.3
Q	22.4*	18.7*	15.9*	13.8*	17.7*	87.1*	257.7*	297.5*	191.2*	162.9*	51.1*	39.4*	1,175.4*
P - Q	--	--	33.8	--	120.0	202.4	341.2	244.0	61.9	103.1	--	--	--
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,642
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	--	--	33.8	--	94.5	95.2	94.5	95.2	61.9	93.8	--	--	--
ΔS	--	--	0	--	25.5	107.2	246.7	148.8	0	9.3	--	--	379.4

Note: * = Estimated by the Tank Model
- = not calculated due to missing data or distorted data

1978

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	0.0	23.0	8.8	25.3	73.2	492.7	564.4	390.6	236.2	56.1	64.7	26.6	1,961.8
Q	31.5*	25.7*	21.3*	18.0*	15.5*	166.5*	272.7*	239.0*	164.3*	62.2*	41.3*	33.0*	1,091.0*
P - Q	—	—	—	7.3	57.7	326.2	291.9	151.6	71.9	—	23.4	—	—
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,642
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	—	—	—	7.3	57.7	95.2	94.5	95.2	71.9	—	23.4	—	—
ΔS	—	—	—	0	0	231.0	197.4	56.4	0	—	0	—	484.8

1979

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	6.6	2.0	0.0	5.2	128.1	144.8	553.4	464.3	269.1	182.5	0.0	0.0	1,747.0
Q	26.8*	22.3*	18.8*	16.2*	17.9*	26.0*	212.5*	245.5*	173.1*	116.7*	41.7*	33.4*	950.9*
P - Q	—	—	—	—	110.2	118.8	340.9	218.8	87.0	65.8	—	—	—
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,642
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	—	—	—	—	94.5	95.2	94.5	95.2	87.0	65.8	—	—	—
ΔS	—	—	—	—	15.7	23.6	246.4	123.6	0	0	—	—	409.3

1980

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	0.0	10.1	—	103.8	37.6	164.7	571.6	489.1	225.0	97.6	141.1	0.0	—
Q	27.1*	22.5*	—	0.3*	0*	11.6*	207.4*	247.5*	151.9*	65.5*	53.6*	25.2*	—
P - Q	—	—	—	103.5	37.6	153.1	364.2	241.6	73.1	32.1	87.5	—	—
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,642
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	—	—	—	96.6	37.6	95.2	94.5	95.2	731	32.1	87.5	—	—
ΔS	—	—	—	6.9	0	57.9	269.7	146.4	0	0	0	—	480.9

Note: * = Estimated by the Tank Model
- = not calculated due to missing data or distorted data

1981

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	0.0	0.0	0.0	7.2	27.0	144.5	456.4	467.7	247.3	155.7	58.0	0.0	1,563.8
Q	19.0*	14.4*	10.9*	8.4*	6.5*	12.1*	155.8*	220.8*	151.6*	90.8*	35.8*	24.7*	750.8*
P - Q	–	–	–	–	20.5	132.4	300.6	246.9	95.7	64.9	20.2	–	–
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,643
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	–	–	–	–	20.5	95.2	94.5	95.2	94.5	64.9	20.2	–	–
ΔS	–	–	–	–	0	37.2	206.1	151.7	1.2	0	0	–	396.2

1982

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	14.3	0.6	57.9	3.9	78.6	98.5	266.5	670.6	201.8	182.6	67.9	0.0	1,643.2
Q	19.0*	14.8*	11.6*	9.3*	7.5*	6.3*	59.4*	274.9*	149.7*	102.1*	41.1*	26.3*	722.0*
P - Q	–	–	46.3	–	71.1	92.2	207.1	395.7	52.1	80.5	26.8	–	–
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,642
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	–	–	96.3	–	71.1	95.2	94.5	95.2	52.1	80.5	26.8	–	–
ΔS	–	–	–	–	0	0	112.6	300.5	0	0	0	–	413.1

1983

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	0.0	0.0	0.0	20.8	89.6	0.0	387.5	506.7	196.4	60.6	46.3	0.0	1,307.9
Q	20.4*	16.1*	12.9*	10.4*	8.6*	7.3*	112.8*	222.8*	130.0*	44.0*	26.5*	20.7*	632.5*
P - Q	–	–	–	10.4	81.0	–	274.7	283.9	66.4	16.6	19.8	–	–
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,642
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	–	–	–	10.4	81.0	–	94.5	95.2	66.4	16.6	19.8	–	–
ΔS	–	–	–	0	0	–	180.2	182.7	0	0	0	–	368.9

Note: * = Estimated by the Tank Model
- = not calculated due to missing data or distorted data

1985

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	5.0	10.0	14.6	54.8	97.9	118.8	333.7	298.6	165.4	16.2	15.7	11.0	1,141.7
Q	1.7	1.3	1.7	--	25.3	2.7	99.3*	129.8*	84.2*	18.3	5.7	4.0	--
P - Q	3.3	8.7	12.9	--	72.6	116.1	234.4	168.8	81.2	--	1.0	7.0	--
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,642
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	3.3	8.7	12.9	--	72.6	95.2	94.5	95.2	81.2	--	1.0	7.0	--
ΔS	0	0	0	--	0	20.9	139.9	73.6	0	--	0	0	234.4

1986

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	3.3	2.3	45.0	14.3	5.6	352.5	447.5	440.6	193.1	44.4	0.0	22.9	1,571.5
Q	2.0	1.7	1.3	0.7	0.3	75.3	194.0*	231.6*	139.5*	57.7	6.0	3.7	672.2*
P - Q	1.3	0.6	43.7	13.6	5.3	277.2	253.5	209.0	53.6	--	--	19.7	--
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,642
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	1.3	0.6	43.7	13.6	5.3	95.2	94.5	95.2	53.6	--	--	19.7	--
ΔS	0	0	0	0	0	182.0	159.0	113.8	0	--	--	0	454.8

1987

Uint:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	16.1	0.3	58.3	21.4	172.3	127.8	273.8	371.4	60.1	65.1	27.2	0.0	1,193.8
Q	2.0	1.0	1.0	0.0	1.7	19.0	103.0	167.0	46.3	10.0	5.3	3.7	--
P - Q	14.1	--	57.3	21.4	170.6	108.8	170.8	204.4	13.8	55.1	21.9	--	--
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,642
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	14.1	--	57.3	21.4	94.5	95.2	94.5	95.2	13.8	55.1	21.9	--	--
ΔS	0	0	0	0	76.1	13.6	76.3	109.2	0	0	0	0	275.2

Note: * = Estimated by the Tank Model
- = not calculated due to missing data or distorted data

1988

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	–	–	–	31.9	69.8	155.5	590.5	462.5	182.3	84.5	7.5	5.5	–
Q	–	1.7	1.3	1.0	1.3	1.7	209.0	262.0	109.7	27.0	8.7	3.0	–
P - Q	–	–	–	30.9	68.5	153.8	381.5	200.5	72.6	57.5	–	2.5	–
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,642.0
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	–	–	–	30.9	68.5	95.2	94.5	95.2	72.6	57.5	–	2.5	–
△S	–	–	–	0	0	58.6	287.0	105.3	0	0	–	0	450.9

1989

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	6.2	–	84.4	45.8	94.8	84.7	304.5	425.5	139.3	103.6	12.4	–	–
Q	2.0	1.3	2.7	1.7	2.0	27.3	161.3	222.0	84.6*	28.3	35.7	2.3	571.2*
P - Q	4.2	–	81.7	44.1	92.8	57.4	143.2	203.5	54.7	75.3	–	–	–
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,642.0
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	4.2	–	81.7	44.1	92.8	57.4	94.5	95.2	54.7	75.3	–	–	–
△S	0	–	0	0	0	0	48.7	108.3	0	0	–	–	157.0

1992

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	0.5	0.0	12.8	98.8	38.6	115.9	330.5	365.5	124.6	–	60.5	5.9	–
Q	0.0*	0.0*	0.0*	0.1*	0.1*	0.8*	87.3*	147.4*	66.5*	–	22.3*	14.5*	–
P - Q	0.5	0.0	12.8	98.1	38.5	115.1	243.2	218.1	58.1	–	38.2	–	–
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,642.0
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	–	–	–	96.6	38.5	95.2	94.5	95.2	58.1	–	38.2	–	–
△S	–	–	–	1.5	0	19.9	148.7	122.9	0	–	0	–	293.0

Note: * = Estimated by the Tank Model
- = not calculated due to missing data or distorted data

1993

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	0.8	2.0	86.3	74.8	199.0	136.5	429.8	289.9	208.6	118.6	43.3	1.1	1,590.7
Q	10.8*	8.0*	6.0*	4.5*	26.6*	25.1*	155.6*	142.5*	105.9*	55.2*	23.5*	17.8*	581.5*
P - Q	–	–	80.3	70.3	172.4	111.4	274.2	147.4	102.7	63.4	19.8	–	–
ETo	139	143	141	138	135	136	135	136	135	134	134	136	1,642.0
ET crop	97.3	100.1	98.7	96.6	94.5	95.2	94.5	95.2	94.5	93.8	93.8	95.2	1,149.4
ETa	–	–	80.3	70.3	94.5	95.2	94.5	95.2	94.5	63.4	19.8	–	–
ΔS	–	–	0	0	77.9	16.2	179.7	52.2	8.2	0	0	–	334.2

Note: * = Estimated by the Tank Model
- = not calculated due to missing data or distorted data

Appendix - 10

Existing Pump Condition

Survey Site: DebreTabor Date: 28/7/95 (21/11/87 E.C.)

1. # 1 Well

Well Accessories			Submersible Pump	
Check valve	101.6	mm	Manufacturer:	INDIA CALMANA INDUSTRIES-BOMBAY 400062
Pressure gauge	28-400	kg/cm²	Head:	150 m
Flow meter	303	m³/ day	Capacity:	180 lt/sec.
Gate valve	101.6	mm	R.P.M:	N2900
Conveyance pipe	101.6	mm	Hz:	50
			Stage:	17
			Others:	9 kw. 12 HP

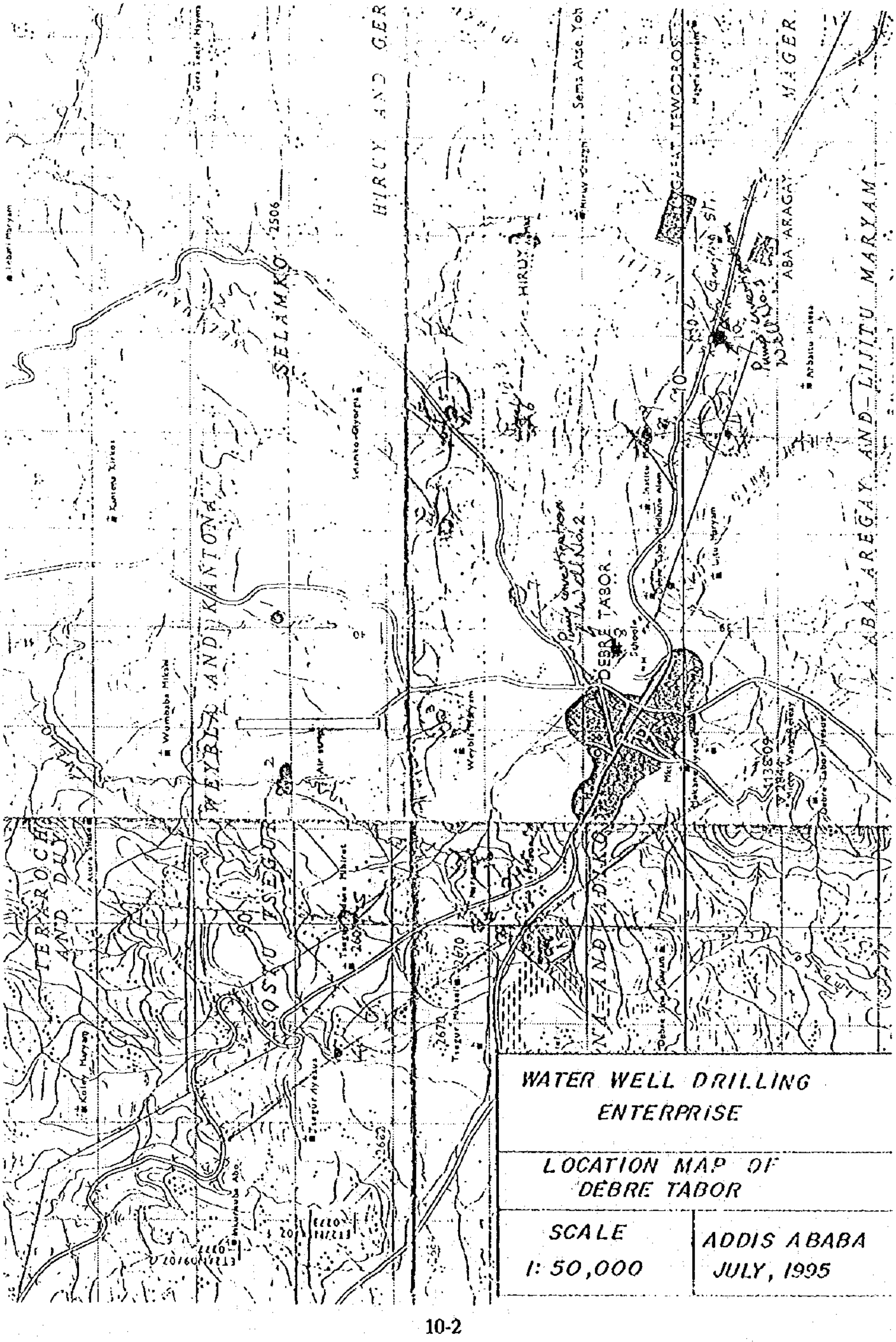
Well Data			Others
Static Water Level	9.36	m	- Type of pump N66/xV11 + Vb - 58
*Dyanamic Water Level		m	- Relay Cable 96m.
Dia. & Length of a riser pipe	50.8, 96	m	
Total number of riser pipes	16	nos.	
Relay cable	Yes	No	
Well Dia.	152.4	mm	

22/11/87 (29/7/95)

2. # 2 Well

Well Accessories			Submersible Pump	
Check valve	76.2	mm	Manufacturer:	
Pressure gauge	no.	kg/cm²		
Flow meter	30	m³/ H	Head:	NO m
Gate valve	50.8	mm	Capacity:	NO
Conveyance pipe	76.2	mm	R.P.M:	NO
			Hz:	
			Stage:	13
			Others:	

Well Data			Others
Static Water Level	5.20	m	
Dyanamic Water Level		m	
Dia. & Length of a riser pipe	Ø 50.8 mm and 96	m	
Total number of riser pipes	16	nos.	
Relay cable	Yes	No	
Well Dia		mm	


WATER WELL DRILLING
ENTERPRISE
LOCATION MAP OF
DEBRE TABOR
SCALE
1: 50,000
ADDIS ABABA
JULY, 1995
DEBRE TABOR
SELAMKO
HIRUY AND GER
ABA AREGAY AND LIJITU MARYAM
WEYBLA AND KANTONA
SOSTU TSEGUR

Appendix - 11

Calculation of Water Pipeline

Output data on distribution network for Debre Tabor Case: Ordinary, 2005

Serial Number	Pipeline Number	Nord Number Start	Nord Number End	Dia. (mm)	Pipeline Length(m)	Flow (liter/sec)	Velocity (m/sec)	Hydraulic Gradient (m/1000)	Loss of Head (m)	Velocity Coefficient	Remarks
1	1	1	2	300	10	30.88	0.44	0.01	1.01	110	
2	2	2	3	75	410	0.37	0.08	0.10	0.24	110	
3	3	2	4	300	305	30.05	0.43	0.29	0.96	110	
4	4	4	5	250	190	25.91	0.53	0.34	1.77	110	
5	5	5	7	150	250	2.91	0.16	0.09	0.37	110	
6	6	7	8	75	365	1.03	0.23	0.58	1.59	110	
7	7	8	9	75	50	-1.32	-0.30	-0.13	-2.53	110	
8	8	9	6	150	290	-3.60	-0.20	-0.16	-0.55	110	
9	9	6	5	150	550	-4.10	-0.23	-0.39	-0.70	110	
10	10	7	13	75	640	0.89	0.20	0.78	1.22	110	
11	11	13	8	75	800	-0.38	-0.09	-0.20	-0.25	110	
12	12	8	12	75	210	1.17	0.26	0.42	2.02	110	
13	13	9	10	75	475	1.70	0.38	1.92	4.04	110	
14	14	10	11	75	250	0.74	0.17	0.22	0.87	110	
15	15	4	16	150	525	3.38	0.19	0.26	0.49	110	
16	16	16	17	150	280	0.20	0.01	0.00	0.00	110	
17	17	16	18	75	295	2.24	0.51	1.98	6.71	110	
18	18	18	15	75	300	0.09	0.02	0.00	0.02	110	
19	19	15	5	200	750	-17.50	-0.56	-1.91	-2.54	110	
20	20	18	20	75	445	1.34	0.30	1.16	2.60	110	
21	21	20	19	150	40	-0.75	-0.04	-0.00	-0.03	110	
22	22	19	15	150	365	-9.21	-0.52	-1.15	-3.15	110	
23	23	20	21	150	20	1.93	0.11	0.00	0.18	110	
24	24	21	22	150	625	0.36	0.02	0.00	0.00	110	
25	25	21	23	75	360	1.09	0.25	0.64	1.78	110	
26	26	23	24	75	660	0.38	0.09	0.17	0.26	110	
27	27	24	25	150	160	-6.12	-0.35	-0.24	-1.48	110	
28	28	25	19	150	230	-8.16	-0.46	-0.58	-2.51	110	
29	29	25	26	75	160	1.05	0.24	0.27	1.66	110	
30	30	26	27	75	610	1.15	0.26	1.20	1.96	110	
31	31	26	28	75	570	-1.11	-0.25	-1.04	-1.83	110	
32	32	28	14	150	225	-6.94	-0.39	-0.42	-1.88	110	
33	33	14	15	150	260	-7.28	-0.41	-0.53	-2.04	110	
34	34	28	29	150	40	4.43	0.25	0.03	0.81	110	
35	35	29	30	150	220	2.65	0.15	0.07	0.31	110	
36	36	30	31	75	70	1.71	0.39	0.29	4.08	110	
37	37	30	32	150	490	0.61	0.03	0.01	0.02	110	
38	38	29	33	150	615	0.76	0.04	0.02	0.03	110	
39	39	33	34	75	90	0.14	0.03	0.00	0.04	110	
40	40	33	35	150	105	0.05	0.00	0.00	0.00	110	
41	41	24	36	75	400	1.71	0.39	1.63	4.08	110	
42	42	24	37	150	390	4.12	0.23	0.28	0.71	110	
43	43	37	38	75	180	0.58	0.13	0.10	0.55	110	
44	44	37	39	75	450	2.93	0.66	4.98	11.06	110	
45	45	39	40	75	790	1.65	0.37	3.02	3.82	110	

Output data on distribution network for Debre Tabor Case: Fire Fighting, 2005

Serial Number	Pipeline Number	Nord Number Start	Nord Number End	Dia (mm)	Pipeline Length(m)	Flow (liter/sec.)	Velocity (m/sec.)	Hydraulic Gradient (m/1000)	Loss of Head (m)	Velocity Coefficient	Remarks
1	1	1	2	300	10	35.91	0.51	0.01	1.33	110	
2	2	2	3	75	410	0.23	0.05	0.04	0.10	110	
3	3	2	4	300	305	35.39	0.50	0.40	1.30	110	
4	4	4	5	250	190	32.59	0.66	0.51	2.71	110	
5	5	5	7	150	250	6.05	0.34	0.36	1.44	110	
6	6	7	8	75	365	3.41	0.77	5.33	14.61	110	
7	7	8	9	75	50	3.41	0.77	0.73	14.61	110	
8	8	9	6	150	290	-14.68	-0.83	-2.16	-7.46	110	
9	9	6	5	150	550	-14.99	-0.85	-4.26	-7.75	110	
10	10	7	13	75	640	2.02	0.46	3.56	5.56	110	
11	11	13	8	75	800	1.23	0.28	1.78	2.22	110	
12	12	8	12	75	210	0.73	0.17	0.18	0.85	110	
13	13	9	10	75	475	1.06	0.24	0.80	1.69	110	
14	14	10	11	75	250	0.46	0.10	0.09	0.38	110	
15	15	4	16	150	525	2.33	0.13	0.13	0.25	110	
16	16	16	17	150	280	0.12	0.00	0.00	0.00	110	
17	17	16	18	75	295	1.63	0.37	1.11	3.76	110	
18	18	18	15	75	300	0.27	0.06	0.04	0.13	110	
19	19	15	5	200	750	-10.68	-0.34	-0.76	-1.62	110	
20	20	18	20	75	445	0.87	0.20	0.52	1.16	110	
21	21	20	19	150	40	-0.44	-0.03	-0.00	-0.01	110	
22	22	19	15	150	365	-5.72	-0.32	-0.48	-1.30	110	
23	23	20	21	150	20	1.21	0.07	0.00	0.07	110	
24	24	21	22	150	625	0.23	0.01	0.00	0.00	110	
25	25	21	23	75	360	0.68	0.15	0.27	0.74	110	
26	26	23	24	75	660	0.24	0.05	0.07	0.11	110	
27	27	24	25	150	160	-3.82	-0.22	-0.10	-0.62	110	
28	28	25	19	150	230	-5.09	-0.29	-0.24	-1.05	110	
29	29	25	26	75	160	0.66	0.15	0.11	0.70	110	
30	30	26	27	75	610	0.72	0.16	0.50	0.82	110	
31	31	26	28	75	570	-0.69	-0.16	-0.43	-0.76	110	
32	32	28	14	150	225	-4.33	-0.25	-0.18	-0.78	110	
33	33	14	15	150	260	-4.54	-0.26	-0.22	-0.85	110	
34	34	28	29	150	40	2.76	0.16	0.01	0.34	110	
35	35	29	30	150	220	1.65	0.09	0.03	0.13	110	
36	36	30	31	75	70	1.07	0.24	0.12	1.71	110	
37	37	30	32	150	490	0.38	0.02	0.00	0.00	110	
38	38	29	33	150	615	0.48	0.03	0.00	0.01	110	
39	39	33	34	75	90	0.09	0.02	0.00	0.02	110	
40	40	33	35	150	105	0.03	0.00	0.00	0.00	110	
41	41	24	36	75	400	1.07	0.24	0.69	1.71	110	
42	42	24	37	150	390	2.57	0.15	0.12	0.30	110	
43	43	37	38	75	180	0.36	0.08	0.04	0.23	110	
44	44	37	39	75	450	1.83	0.41	2.08	4.63	110	
45	45	39	40	75	790	1.03	0.23	1.26	1.60	110	

Output data on distribution network for Debre Tabor Case: Ordinary, 2010

Serial Number	Pipeline Number	Nord Number Start	Nord Number End	Dia (mm)	Pipeline Length(m)	Flow (liter/sec.)	Velocity (m/sec.)	Hydraulic Gradient (m/1000)	Loss of Head (m)	Velocity Coefficient	Remarks
1	1	1	2	300	10	50.87	0.72	0.03	2.54	110	
2	2	2	3	75	410	0.37	0.08	0.10	0.24	110	
3	3	2	4	300	305	50.04	0.71	0.75	2.46	110	
4	4	4	5	250	190	39.62	0.81	0.74	3.89	110	
5	5	5	7	150	250	2.91	0.16	0.09	0.37	110	
6	6	7	8	75	365	1.03	0.23	0.58	1.59	110	
7	7	8	9	75	50	-1.32	-0.30	-0.13	-2.53	110	
8	8	9	6	150	290	-3.60	-0.20	-0.16	-0.55	110	
9	9	6	5	150	550	-4.10	-0.23	-0.39	-0.70	110	
10	10	7	13	75	640	0.89	0.20	0.78	1.22	110	
11	11	13	8	75	800	-0.38	-0.09	-0.20	-0.25	110	
12	12	8	12	75	210	1.17	0.26	0.42	2.02	110	
13	13	9	10	75	475	1.70	0.38	1.92	4.04	110	
14	14	10	11	75	250	0.74	0.17	0.22	0.87	110	
15	15	4	16	150	525	9.66	0.55	1.80	3.43	110	
16	16	16	17	150	280	5.28	0.30	0.31	1.12	110	
17	17	16	18	75	295	3.44	0.78	4.38	14.86	110	
18	18	18	15	75	300	0.47	0.11	0.11	0.37	110	
19	19	15	5	200	750	-31.21	-0.99	-5.56	-7.41	110	
20	20	18	20	75	445	2.16	0.49	2.80	6.28	110	
21	21	20	19	150	40	-5.04	-0.29	-0.04	-1.03	110	
22	22	19	15	150	365	-14.45	-0.82	-2.64	-7.24	110	
23	23	20	21	150	20	7.04	0.40	0.04	1.91	110	
24	24	21	22	150	625	5.44	0.31	0.74	1.19	110	
25	25	21	23	75	360	1.12	0.25	0.67	1.87	110	
26	26	23	24	75	660	0.41	0.09	0.19	0.29	110	
27	27	24	25	150	160	-6.09	-0.34	-0.23	-1.46	110	
28	28	25	19	150	230	-9.11	-0.52	-0.71	-3.08	110	
29	29	25	26	75	160	2.03	0.46	0.90	5.60	110	
30	30	26	27	75	610	1.15	0.26	1.20	1.96	110	
31	31	26	28	75	570	-0.13	-0.03	-0.02	-0.04	110	
32	32	28	14	150	225	-15.79	-0.89	-1.92	-8.53	110	
33	33	14	15	150	260	-16.13	-0.91	-2.31	-8.87	110	
34	34	28	29	150	40	14.26	0.81	0.28	7.06	110	
35	35	29	30	150	220	7.57	0.43	0.48	2.19	110	
36	36	30	31	75	70	1.71	0.39	0.29	4.08	110	
37	37	30	32	150	490	5.53	0.31	0.60	1.22	110	
38	38	29	33	150	615	5.67	0.32	0.79	1.28	110	
39	39	33	34	75	90	0.14	0.03	0.00	0.04	110	
40	40	33	35	150	105	4.96	0.28	0.11	1.00	110	
41	41	24	36	75	400	1.71	0.39	1.63	4.08	110	
42	42	24	37	150	390	4.12	0.23	0.28	0.71	110	
43	43	37	38	75	180	0.58	0.13	0.10	0.55	110	
44	44	37	39	75	450	2.93	0.66	4.98	11.06	110	
45	45	39	40	75	790	1.65	0.37	3.02	3.82	110	

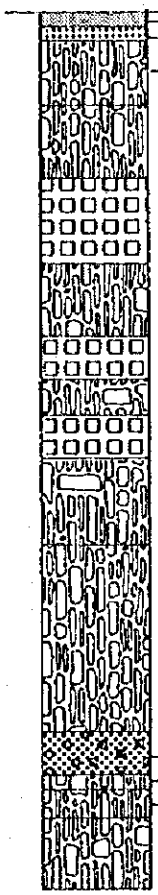
Output data on distribution network for Debre Tabor Case: Fire Fighting, 2010

Serial Number	Pipeline Number	Nord Number Start	Nord Number End	Dia (mm)	Pipeline Length(m)	Flow (liter/sec)	Velocity (m/sec)	Hydraulic Gradient (m/1000)	Loss of Head (m)	Velocity Coefficient	Remarks
1	1	1	2	300	10	65.21	0.92	0.04	4.02	110	
2	2	2	3	75	410	0.23	0.05	0.04	0.10	110	
3	3	2	4	300	305	64.69	0.92	1.21	3.96	110	
4	4	4	5	250	190	56.06	1.14	1.40	7.39	110	
5	5	5	7	150	250	6.05	0.34	0.36	1.44	110	
6	6	7	8	75	365	3.41	0.77	5.33	14.61	110	
7	7	8	9	75	50	3.41	0.77	0.73	14.61	110	
8	8	9	6	150	290	-14.68	-0.83	-2.16	-7.46	110	
9	9	6	5	150	550	-14.99	-0.85	-4.26	-7.75	110	
10	10	7	13	75	640	2.02	0.46	3.56	5.56	110	
11	11	13	8	75	800	1.23	0.28	1.78	2.22	110	
12	12	8	12	75	210	0.73	0.17	0.18	0.85	110	
13	13	9	10	75	475	1.06	0.24	0.80	1.69	110	
14	14	10	11	75	250	0.46	0.10	0.09	0.36	110	
15	15	4	16	150	525	8.16	0.46	1.32	2.51	110	
16	16	16	17	150	280	3.33	0.19	0.13	0.48	110	
17	17	16	18	75	295	4.25	0.96	6.48	21.97	110	
18	18	18	15	75	300	0.59	0.13	0.17	0.57	110	
19	19	15	5	200	750	-34.15	-1.09	-6.57	-8.76	110	
20	20	18	20	75	445	3.16	0.71	5.65	12.70	110	
21	21	20	19	150	40	-2.74	-0.16	-0.01	-0.34	110	
22	22	19	15	150	365	-21.41	-1.21	-5.47	-14.98	110	
23	23	20	21	150	20	5.80	0.33	0.03	1.34	110	
24	24	21	22	150	625	3.44	0.19	0.32	0.51	110	
25	25	21	23	75	360	2.06	0.47	2.08	5.78	110	
26	26	23	24	75	660	1.62	0.37	2.45	3.71	110	
27	27	24	25	150	160	-19.11	-1.08	-1.94	-12.14	110	
28	28	25	19	150	230	-18.48	-1.05	-2.62	-11.40	110	
29	29	25	26	75	160	-1.24	-0.28	-0.36	-2.26	110	
30	30	26	27	75	610	0.72	0.16	0.50	0.82	110	
31	31	26	28	75	570	-2.59	-0.59	-5.02	-8.81	110	
32	32	28	14	150	225	-12.44	-0.70	-1.23	-5.49	110	
33	33	14	15	150	260	-12.65	-0.72	-1.47	-5.66	110	
34	34	28	29	150	40	8.97	0.51	0.12	3.00	110	
35	35	29	30	150	220	4.76	0.27	0.20	0.93	110	
36	36	30	31	75	70	1.07	0.24	0.12	1.71	110	
37	37	30	32	150	490	3.49	0.20	0.26	0.52	110	
38	38	29	33	150	615	3.58	0.20	0.34	0.55	110	
39	39	33	34	75	90	0.09	0.02	0.00	0.02	110	
40	40	33	35	150	105	3.13	0.18	0.04	0.43	110	
41	41	24	36	75	400	1.07	0.24	0.69	1.71	110	
42	42	24	37	150	390	19.24	1.09	4.79	12.29	110	
43	43	37	38	75	180	0.36	0.08	0.04	0.23	110	
44	44	37	39	75	450	1.83	0.41	2.08	4.83	110	
45	45	39	40	75	790	1.03	0.23	1.26	1.60	110	

Appendix - 12

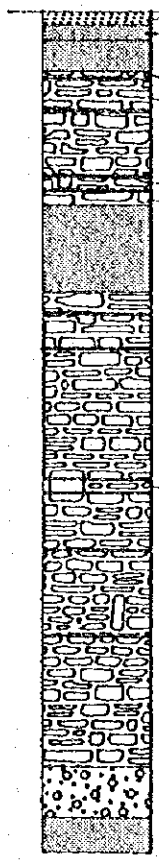
Geological Logs of Existing Boreholes

WSS Borehole No.2 in Debre Tabor



Depth	Lithology
0 - 2 m	Dark Clay with Traces of Sand
2 - 4 m	Sand with Pebbles
4 - 13 m	Weathered Basalt Pale Brown
13 - 23 m	Weathered Basalt Gray
23 - 35 m	Deep Brown Laterite
35 - 45 m	Dark Basalt
45 - 51 m	Laterite
51 - 56 m	Slightly Weathered Basalt
56 - 62 m	Laterite
62 - 74 m	Vesicular Basalt
74 -100 m	Dark Basalt
100-106 m	River Sand and Pebbles
106-108 m	Basalt
108-112 m	Basalt Slightly Weathered
112-122 m	Fresh Basalt

WSS Borehole No.3 in Debre Tabor

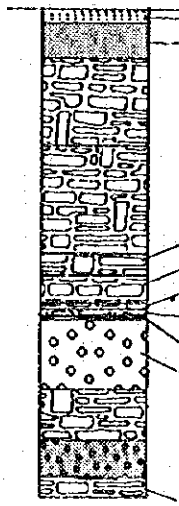


Depth	Lithology
0 - 2 m	Top soil
2 - 4 m	Clay, black
4 -8.3 m	Clay with sand and silt
8.3-9.5 m	Weathered basalt
9.5- 14 m	Slightly weathered basalt with sec. minerals
14 - 23 m	Fresh basalt
23 - 25 m	Moderately weathered basalt
25 - 27 m	Intensively weathered basalt
27 - 39 m	Plastic clay, reddish
39 - 42 m	Highly weathered basalt
42 - 47 m	Slightly weathered basalt
47 - 65 m	Intensively weathered basalt
65 - 67 m	Scoracious basalt
67 - 75 m	Intensively weathered basalt
75 - 87 m	Fractured basalt
87 -105 m	Slightly weathered basalt
105-112 m	Gravel with sand
112-117 m	Clay

Location : About 4 km northeast from the town center

Source : from "Hydrogeological Borehole report of D/T(BH#3)" by EWWCA,1992

Borehole No.4 in Debre Tabor



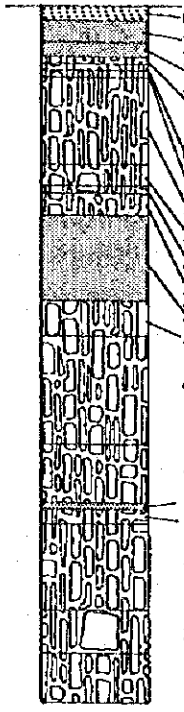
Depth	Lithology
0 - 2 m	Top soil
2 - 7 m	Clay, black
7 - 19 m	Weathered basalt with gravel
19 - 34 m	Weathered trachytic basalt
34 - 37 m	Trachytic basalt
37 - 41 m	Slightly weathered trachytic basalt
41 - 42 m	Scoracious Basalt
42 - 43 m	Slightly weathered trachytic basalt
43 -43.3m	Scoracious basalt
43.3-53 m	Pebbles
53 - 60 m	Weathered trachytic basalt
60 - 65 m	Clay with gravel
65 - 68 m	Slightly weathered basalt

Location : About 5 km northeast from the town center

Source : from "Borehole report of D/Tabor (well#1)" by EWWCA, 1993

Note : During casing installation, the hole collapsed and abandoned.

Borehole No.5 in Debre Tabor

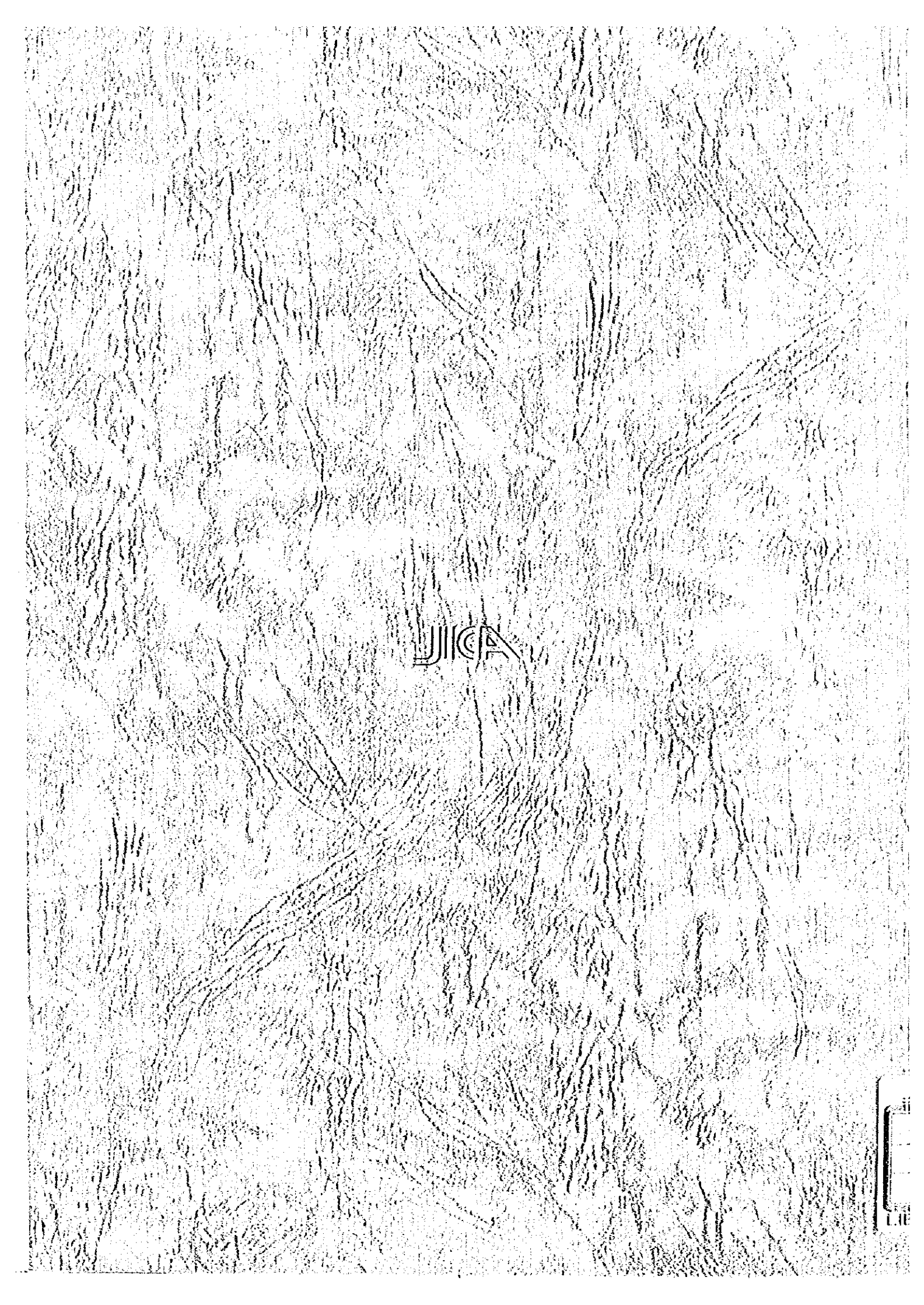


Depth	Lithology
0 - 2 m	Top soil
2 - 5 m	Clay, black
5 - 7 m	Clay with gravel
7 - 8 m	Highly weathered basalt, with silt sand & gravel
8 - 9 m	Moderately weathered basalt
9 - 10 m	Slightly weathered basalt with sec. minerals
10 - 22 m	Fresh basalt
22 - 25 m	Weathered basalt
25 - 26 m	Intensively weathered basalt
26 - 29 m	Highly weathered basalt
29 - 41 m	Plastic Clay
41 - 46 m	Slightly weathered basalt
46 - 61 m	Weathered scoracious basalt
61 - 69 m	Slightly weathered basalt
69 - 70 m	Clay
70 - 72 m	Slightly weathered basalt
72 - 84 m	Moderately weathered fractured basalt
84 - 90 m	Slightly weathered basalt
90 - 97 m	Fresh basalt

Location : Location is unknown

Source : from "Report of D/T well #2" by EWWCA,1992

Note : During rimming, the bit was broken so that the hole was abandoned.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