社会開発調査部報告書

No. 11

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
WEROTA

(Volume III-IV)

FEBRUARY, 1996

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

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

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PREFACE

This is the Appendixes for Werota 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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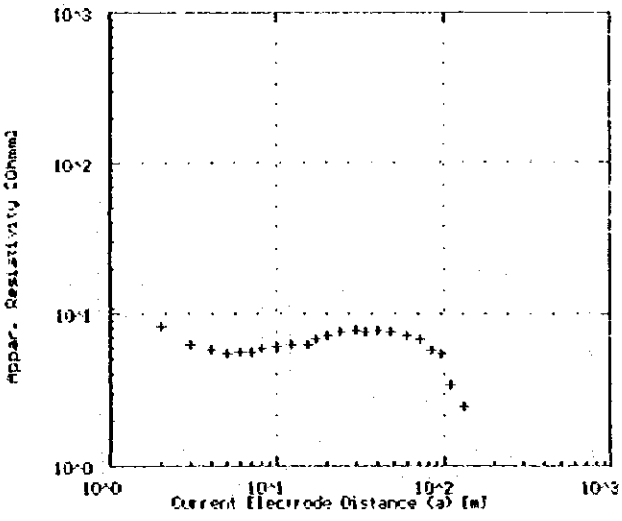
Appendix - 1

Resistivity Interpretation of VEP

Figure 1 Geoelectrical Survey, Wenner Array

VES St. No.1 -WEROTA

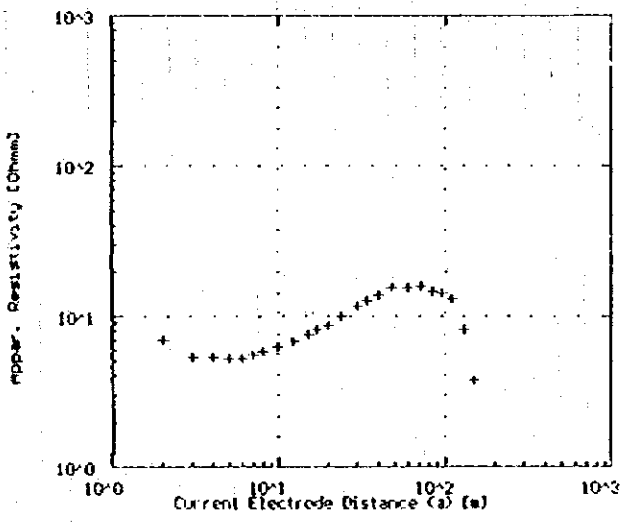


Point (No)	AB/2 (m)	a (m)	Ses (ohms)
1	1.00	10.050	
2	2.00	8.220	
3	3.00	6.210	
4	4.00	5.150	
5	5.00	5.500	
6	6.00	5.690	
7	7.00	5.870	
8	8.00	5.930	
9	10.00	6.090	
10	12.00	6.330	
11	15.00	6.230	
12	17.00	6.930	
13	20.00	7.230	
14	24.00	7.545	
15	30.00	7.810	
16	34.00	7.590	
17	40.00	7.790	
18	48.00	7.560	
19	60.00	7.160	
20	72.00	6.780	
21	86.00	5.900	
22	95.00	5.470	
23	110.00	3.450	
24	130.00	2.450	

Specific Resistivity(Ω-m)	12	4	7.5	9.6			0.55

5.27 3.4

VES St. No.2 -WEROTA



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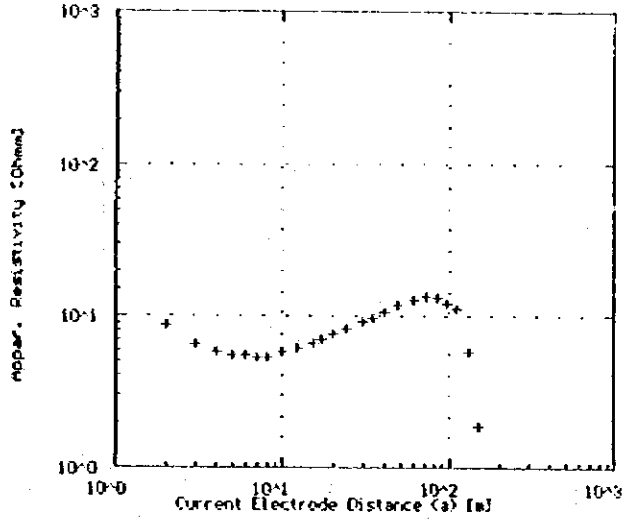
3	3.00	5.370	
4	4.00	5.300	
5	5.00	5.150	
6	6.00	5.240	
7	7.00	5.650	
8	8.00	5.870	
9	10.00	6.280	
10	12.00	6.780	
11	15.00	7.540	
12	17.00	8.220	
13	20.00	8.790	
14	24.00	9.955	
15	30.00	11.550	
16	34.00	12.010	
17	40.00	13.025	
18	48.00	15.320	
19	60.00	15.650	
20	72.00	15.830	
21	86.00	14.330	
22	95.00	10.470	
23	110.00	13.120	
24	130.00	8.160	
25	150.00	3.770	

Specific Resistivity(Ω-m)	10	3.33	5.2	26			0.42

25.6 10.2

VES St. No.3 -WEROTA



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1	1.00	15.160	
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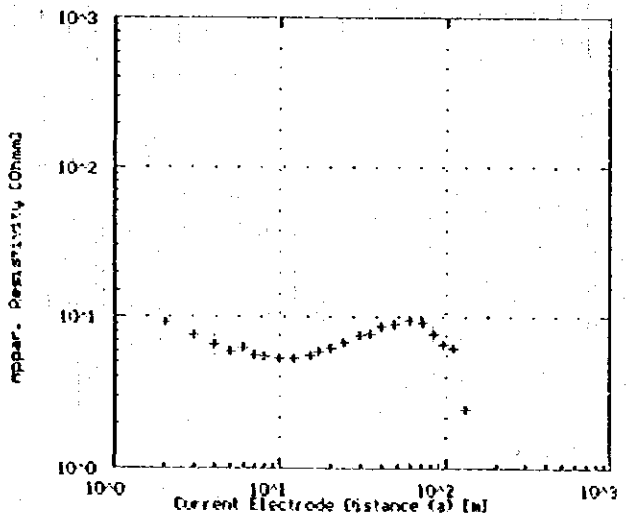
3	3.00	8.500	
4	4.00	5.730	
5	5.00	5.520	
6	6.00	5.530	
7	7.00	5.200	
8	8.00	5.330	
9	10.00	5.200	
10	12.00	6.160	
11	15.00	8.050	
12	17.00	6.960	
13	20.00	7.560	
14	24.00	8.290	
15	30.00	8.240	
16	34.00	9.920	
17	40.00	10.550	
18	50.00	11.760	
19	60.00	12.010	
20	72.00	13.570	
21	86.00	13.100	
22	96.00	12.060	
23	110.00	11.050	
24	130.00	5.720	
25	150.00	1.060	

Specific Resistivity(Ω-m)	20	5	20.8	0.23

8.53

VES St. No.4 -WEROTA



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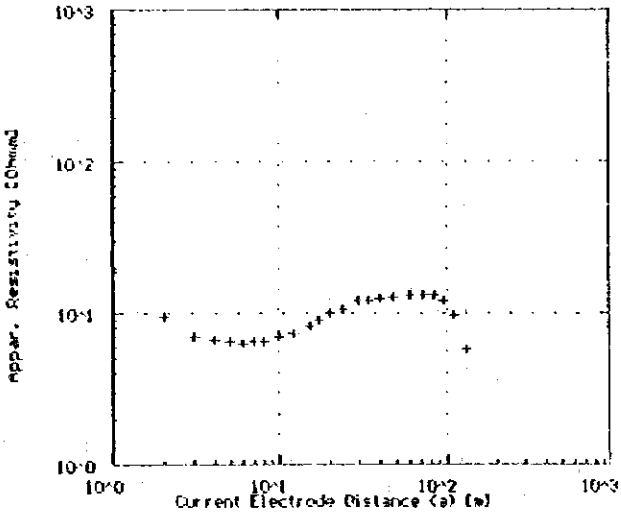
1	1.00	15.260	
2	2.00	9.280	
3	3.00	7.540	
4	4.00	6.030	
5	5.00	5.600	
6	6.00	6.220	
7	7.00	5.620	
8	9.00	5.530	
9	10.00	5.360	
10	12.00	5.350	
11	15.00	5.650	
12	17.00	5.900	
13	20.00	6.200	
14	24.00	6.700	
15	30.00	7.560	
16	34.00	7.900	
17	40.00	8.700	
18	50.00	9.040	
19	60.00	9.420	
20	72.00	9.080	
21	86.00	7.910	
22	96.00	6.630	
23	110.00	6.220	
24	130.00	2.450	

Specific Resistivity(Ω-m)	15	5	15.9	4.31

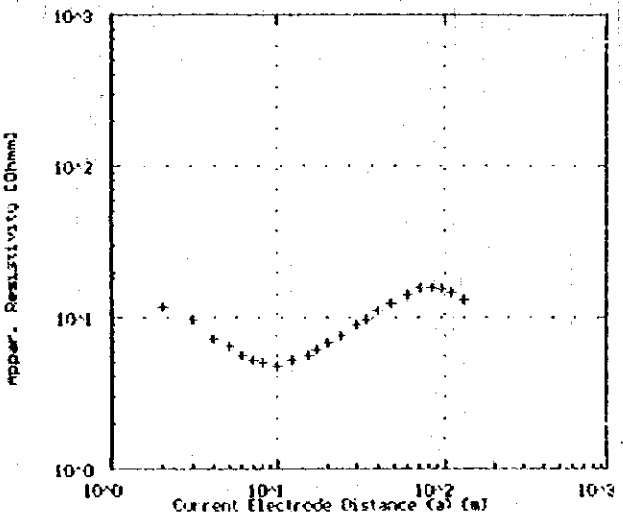
VES St. No.5 -WEROTA



Point (No)	AB/2 (Mr)	a (m)	Res (ohmm)
1	1.50	10.350	
2	2.00	9.670	
3	3.00	8.970	
4	4.00	8.660	
5	5.00	8.440	
6	6.00	8.260	
7	7.00	8.370	
8	8.00	8.530	
9	10.00	8.970	
10	12.00	7.390	
11	15.00	8.290	
12	17.00	8.920	
13	20.00	10.050	
14	25.00	10.200	
15	30.00	12.060	
16	35.00	14.560	
17	40.00	12.310	
18	45.00	12.960	
19	50.00	13.190	
20	72.00	13.810	
21	85.00	13.130	
22	95.00	12.980	
23	110.00	9.670	
24	130.00	5.720	

Specific Resistivity(Ω-m)	36	6	9.6	22.8	16.5	13	2

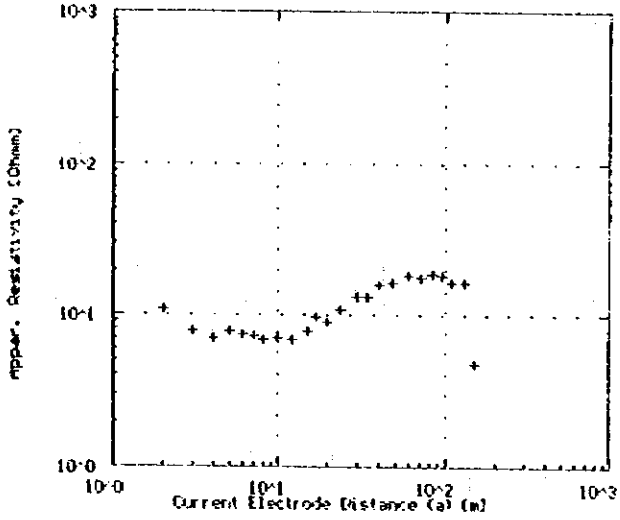
VES St. No.6 -WEROTA



Point (No)	AB/2 (Mr)	a (m)	Res (ohmm)
1	1.00	10.030	
2	2.00	11.950	
3	3.00	9.610	
4	4.00	7.260	
5	5.00	6.440	
6	6.00	5.850	
7	7.00	5.150	
8	8.00	5.070	
9	10.00	4.770	
10	12.00	5.200	
11	15.00	5.290	
12	17.00	6.090	
13	20.00	6.280	
14	24.00	7.540	
15	30.00	8.560	
16	34.00	9.020	
17	40.00	10.300	
18	42.00	12.360	
19	50.00	16.320	
20	72.00	15.030	
21	84.00	15.030	
22	96.00	15.670	
23	110.00	14.510	
24	130.00	13.860	

Specific Resistivity(Ω-m)	24	8	3.1	15.6	32.6	8.15

VES St. No.7 -WEROTA

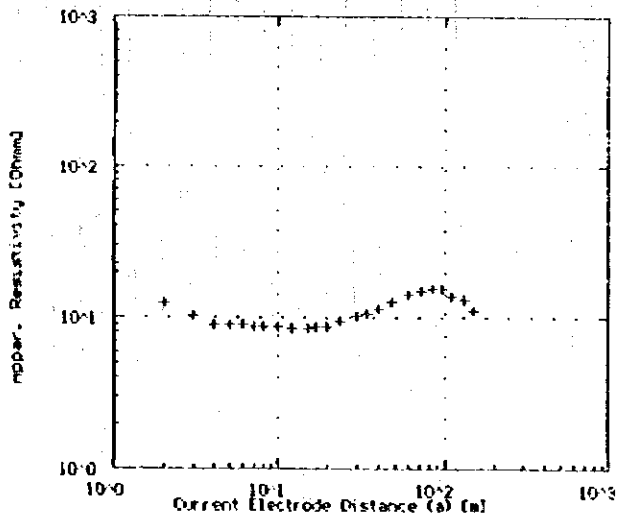


Point (No)	AB/2 (Mr)	a (m)	Res (ohm)
1	1.00	0.176	
2	2.00	10.000	
3	3.00	7.720	
4	4.00	7.050	
5	5.00	7.720	
6	6.00	7.380	
7	7.00	7.250	
8	8.00	6.730	
9	10.00	5.910	
10	12.00	6.730	
11	15.00	7.910	
12	17.00	8.660	
13	20.00	9.049	
14	24.00	10.950	
15	30.00	13.000	
16	36.00	13.020	
17	50.00	16.920	
18	60.00	16.500	
19	60.00	19.090	
20	72.00	17.030	
21	84.00	18.930	
22	96.00	18.030	
23	120.00	16.500	
24	130.00	16.330	
25	150.00	4.310	

Specific Resistivity(Ω-m)	8.8	6.6	27.2	30	33.87

17.6

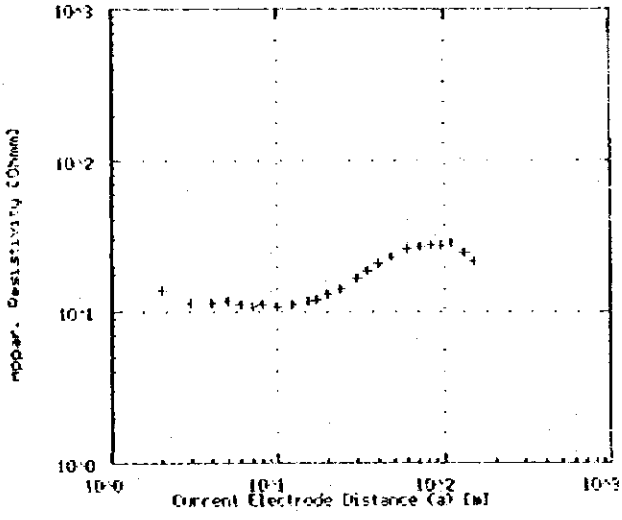
VES St. No.8 -WEROTA



Point (No)	AB/2 (Mr)	a (m)	Res (ohm)
1	1.00	22.610	
2	2.00	12.310	
3	3.00	10.310	
4	4.00	9.010	
5	5.00	8.930	
6	6.00	8.970	
7	7.00	8.020	
8	8.00	8.790	
9	10.00	8.790	
10	12.00	8.550	
11	15.00	8.600	
12	17.00	8.650	
13	20.00	8.790	
14	24.00	8.350	
15	30.00	10.360	
16	36.00	10.650	
17	50.00	17.560	
18	60.00	12.960	
19	60.00	14.320	
20	72.00	10.020	
21	84.00	15.300	
22	96.00	15.330	
23	120.00	13.020	
24	130.00	13.050	
25	150.00	11.300	

Specific Resistivity(Ω-m)	336	84	258	210	61.6

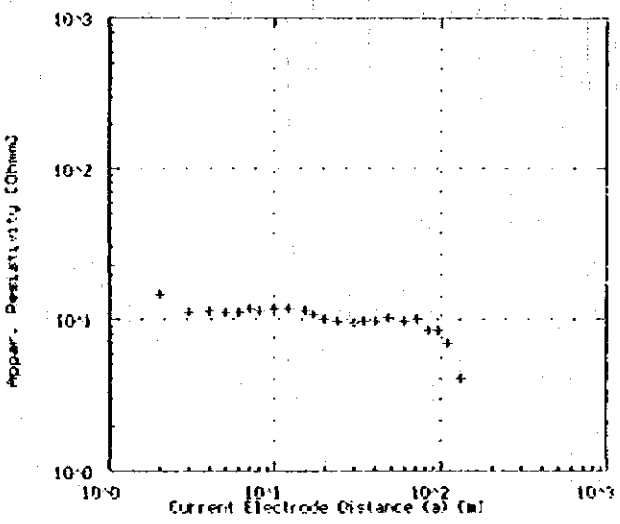
VES St. No.9 -WEROTA



Point (No)	MN/2 (m)	a (m)	Ras (ohm)
1	1.00	87.903	
2	2.00	13.020	
3	3.00	11.499	
4	4.00	11.550	
5	5.00	11.919	
6	6.00	12.040	
7	7.00	12.220	
8	8.00	12.850	
9	10.00	12.939	
10	12.00	13.300	
11	15.00	13.780	
12	17.00	13.280	
13	20.00	13.310	
14	24.00	14.320	
15	28.00	15.259	
16	34.00	18.390	
17	40.00	20.050	
18	49.00	22.870	
19	60.00	25.000	
20	72.00	25.850	
21	86.00	27.950	
22	96.00	27.230	
23	110.00	28.320	
24	130.00	26.490	
25	150.00	21.670	

Specific Resistivity(Ω-m)	22	11	16.8	51.2	43.8	11.2

VES St. No.10 -WEROTA

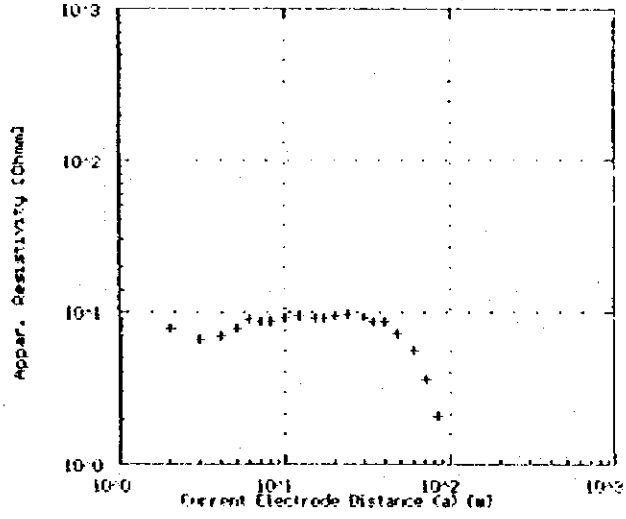


Point (No)	MN/2 (m)	a (m)	Ras (ohm)
1	1.00	22.610	
2	2.00	10.570	
3	3.00	11.390	
4	4.00	11.560	
5	5.00	11.290	
6	6.00	11.100	
7	7.00	11.010	
8	8.00	11.060	
9	10.00	11.015	
10	12.00	11.030	
11	15.00	11.590	
12	17.00	10.780	
13	20.00	9.920	
14	24.00	9.650	
15	30.00	9.120	
16	36.00	9.010	
17	40.00	9.000	
18	50.00	10.250	
19	60.00	9.900	
20	72.00	9.950	
21	86.00	8.650	
22	96.00	8.060	
23	110.00	8.910	
24	130.00	8.080	
25	150.00	8.910	

Specific Resistivity(Ω-m)	26.5	6.63	11.3	7.53	12.9	1.16

6.87

VES St. No.11 -WEROTA

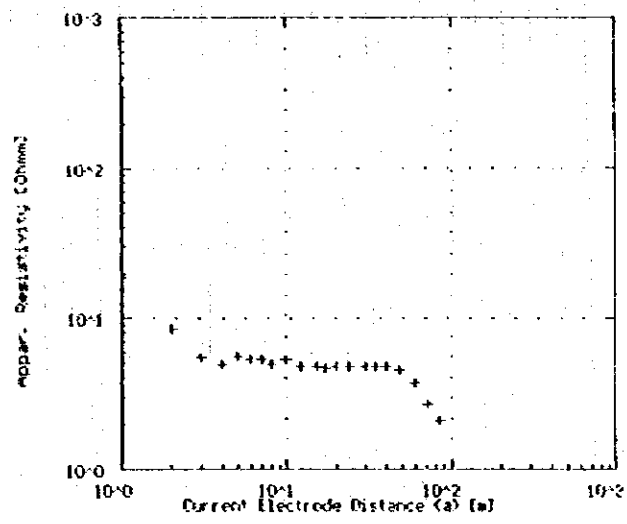


Point [No]	AB/2 [Mr]	a [m]	Res [ohm-m]
1	1.00	33.930	
2	2.00	7.290	
3	3.00	6.590	
4	4.00	8.930	
5	5.00	7.030	
6	6.00	9.910	
7	7.00	8.790	
8	9.00	8.190	
9	10.00	9.290	
10	12.00	9.420	
11	15.00	9.140	
12	17.00	9.230	
13	20.00	9.550	
14	24.00	9.900	
15	30.00	8.310	
16	36.00	8.750	
17	40.00	8.610	
18	49.00	7.240	
19	60.00	5.650	
20	72.00	3.820	
21	86.00	2.410	

Specific Resistivity(Ω-m)	22	5.5	12.8	9.2	1.08

6.13

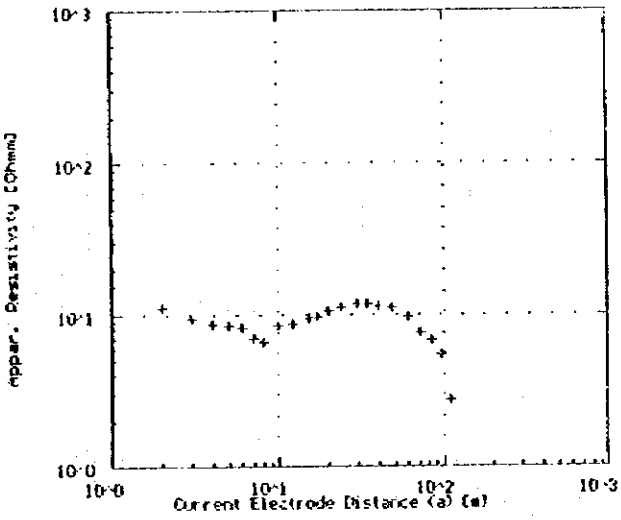
VES St. No.12 -WEROTA



Point [No]	AB/2 [Mr]	a [m]	Res [ohm-m]
1	1.00	19.530	
2	2.00	8.420	
3	3.00	5.460	
4	4.00	6.920	
5	5.00	5.605	
6	6.00	5.280	
7	7.00	5.200	
8	8.00	6.970	
9	10.00	5.200	
10	12.00	6.920	
11	15.00	6.000	
12	17.00	6.200	
13	20.00	6.370	
14	24.00	6.020	
15	30.00	6.730	
16	36.00	6.700	
17	40.00	6.370	
18	49.00	6.520	
19	60.00	5.370	
20	72.00	3.310	
21	86.00	2.410	

Specific Resistivity(Ω-m)	29	4.14	4.6	0.11

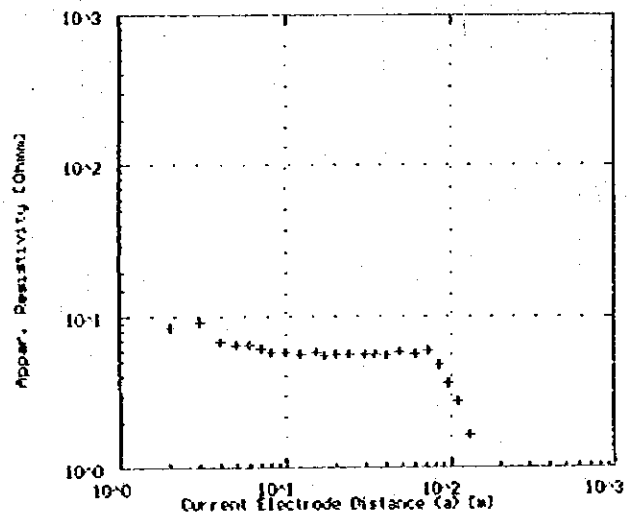
VES St. No.13 -WEROTA



Point (No)	MN/2 (Mr)	a (m)	Res (ohmm)
1	1.00	15.040	
2	2.00	11.180	
3	3.00	9.620	
4	4.00	8.750	
5	5.00	8.510	
6	6.00	8.290	
7	7.00	8.090	
8	8.00	8.030	
9	10.00	8.070	
10	12.00	8.240	
11	15.00	8.670	
12	17.00	9.320	
13	20.00	10.020	
14	24.00	11.150	
15	28.00	12.090	
16	34.00	13.740	
17	40.00	14.560	
18	48.00	14.150	
19	60.00	9.000	
20	72.00	7.530	
21	84.00	8.050	
22	98.00	5.430	
23	110.00	2.760	

Specific Resistivity(Ω-m)	21	8.4	12.9	3.83

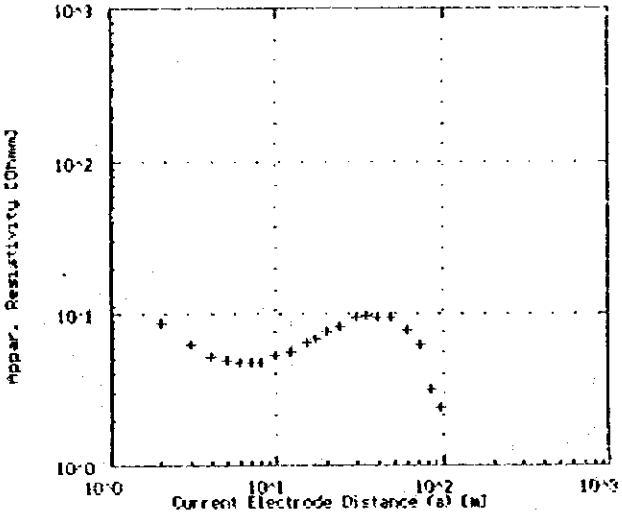
VES St. No.14 -WEROTA



Point (No)	MN/2 (Mr)	a (m)	Res (ohmm)
1	1.00	15.160	
2	2.00	8.560	
3	3.00	9.230	
4	4.00	6.830	
5	5.00	6.410	
6	6.00	6.110	
7	7.00	6.150	
8	8.00	5.810	
9	10.00	5.720	
10	12.00	5.650	
11	15.00	5.150	
12	17.00	5.050	
13	20.00	5.650	
14	24.00	5.500	
15	30.00	5.650	
16	34.00	5.550	
17	40.00	5.530	
18	48.00	5.730	
19	60.00	5.650	
20	72.00	5.880	
21	84.00	6.350	
22	98.00	3.820	
23	110.00	2.760	
24	130.00	1.030	

Specific Resistivity(Ω-m)	16.5	5.5	0.95

VES St. No.15 -WEROTA



Point [No]	AB/2 [Mr]	a [m]	Rst [ohms]
1	1.00	11.300	
2	2.00	8.790	
3	3.00	6.220	
4	4.00	5.250	
5	5.00	4.960	
6	6.00	4.710	
7	7.00	4.750	
8	8.00	4.820	
9	10.00	5.200	
10	12.00	5.650	
11	15.00	6.590	
12	17.00	6.900	
13	20.00	7.540	
14	25.00	8.280	
15	30.00	8.420	
16	36.00	9.010	
17	40.00	9.550	
18	50.00	9.310	
19	60.00	7.910	
20	72.00	6.330	
21	86.00	3.920	
22	86.00	2.610	

Specific Resistivity(Ω·m)	13	4.33	18.8	9.4	1.45

Appendix - 2

Result of Water Quality Test

Result of Physico-Chemical Analysis in Werota

Sample No.1

Origin of Sample : Borehole No.1 (WSS)
Date of Collection: 24/Jan./95
Date of Analysis : 06/Feb./95

Physical Characteristics

Appearance	: Clear
Odor	: Odorless
Taste	: -
Color	: 11 Pt-Co
Settleable Solids	: Absent
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 220
Turbidity	: 3 FTU
Temperature	: -
Conductivity	: 0.47 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 $CaCO_3$	: 240
Bicarbonate Alkalinity as $CaCO_3$	: 240
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: 7.50
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: -	Cl^-	: 10.00
Na^+	: -	NO_2^-	: Nil
K^+	: -	NO_3^-	: 1.18
Ca^{++}	: 28.00	F^-	: 0.21
Mg^{++}	: 2.40	HCO_3^-	: 292.80
Fe(Total)	: 0.16	CO_3^{--}	: Nil
Mn^{++}	: Nil	SO_4^{--}	: 2.00
Cu^{++}	: 0.01	PO_4^{---}	: 0.44

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 Werota

Sample No.2 (Same as sample No.1, but date is different)

Origin of Sample : Borehole No.1 (WSS)
Date of Collection: 01/Jul./95
Date of Analysis : 24/Jul./95

Physical Characteristics

Appearance	: Clear
Odor	: Odorless
Taste	: -
Color	: 54 Pt-Co
Settleable Solids	: Present (Small)
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 276
Turbidity	: 11 FTU
Temperature	: 19.0 °C
Conductivity	: 0.46 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 130
Carbonate Hardness as $CaCO_3$	: 130
Non Carbonate Hardness as $CaCO_3$	: Nil
Total Alkalinity as $CaCO_3$	: 260
Bicarbonate Alkalinity as $CaCO_3$	: 260
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: 8.01
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: Nil	Cl^-	: 20.00
Na^+	: -	NO_2^-	: 0.02
K^+	: -	NO_3^-	: 10.56
Ca^{++}	: 28.00	F^-	: 0.282
Mg^{++}	: 14.30	HCO_3^-	: 317.20
Fe(Total)	: 0.26	CO_3^{--}	: Nil
Mn^{++}	: 0.10	SO_4^{--}	: Nil
Cu^{++}	: 0.01	PO_4^{---}	: 0.60

Remarks; All the analyzed chemical constituents, except Turbidity and Color, 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 Werota

Sample No.3

Origin of Sample : Hand dug well
Date of Collection: 24/Jan./95
Date of Analysis : 06/Feb./95

Physical Characteristics

Appearance	: Clear
Odor	: Odorless
Taste	: -
Color	: 8 Pt-Co
Settleable Solids	: Absent
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 220
Turbidity	: 2 FTU
Temperature	: -
Conductivity	: 0.44 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 200
Carbonate Hardness as $CaCO_3$	: 200
Non Carbonate Hardness as $CaCO_3$	: Nil
Total Alkalinity as $CaCO_3$	: 120
Bicarbonate Alkalinity as $CaCO_3$	: 120
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: 7.20
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: -	Cl^-	: 50.00
Na^+	: -	NO_2^-	: 0.72
K^+	: -	NO_3^-	: 18.60
Ca^{++}	: 60.00	F^-	: 0.31
Mg^{++}	: 11.99	HCO_3^-	: 146.40
Fe(Total)	: 0.03	CO_3^{--}	: Nil
Mn^{++}	: Nil	SO_4^{--}	: 1.00
Cu^{++}	: 0.03	PO_4^{---}	: 0.61

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 Werota

Sample No.4

Origin of Sample : Awragedel Spring
Date of Collection: 01/Jul./95
Date of Analysis : 56/Jul./95

Physical Characteristics

Appearance	: Cloudy
Odor	: Odorless
Taste	: -
Color	: 1040 Pt-Co (Aparent)
Settleable Solids	: Present
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 90
Turbidity	: 165 FTU
Temperature	: 19.2 °C
Conductivity	: 0.15 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 70
Carbonate Hardness as $CaCO_3$	: 60
Non Carbonate Hardness as $CaCO_3$	: 10
Total Alkalinity as $CaCO_3$	: 60
Bicarbonate Alkalinity as $CaCO_3$	: 60
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: 6.87
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: 1.15	Cl^-	: 15.00
Na^+	: -	NO_2^-	: 0.01
K^+	: -	NO_3^-	: 61.16
Ca^{++}	: 12.00	F^-	: 0.142
Mg^{++}	: 9.76	HCO_3^-	: 73.20
Fe(Total)	: 0.17	CO_3^{--}	: Nil
Mn^{++}	: Nil	SO_4^{--}	: 5.00
Cu^{++}	: Nil	PO_4^{---}	: 0.27

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

Note; Unit is mg/litre unless otherwise stated.

Result of Physico-Chemical Analysis in Werota

Sample No.4

Origin of Sample : Awragedel Spring
Date of Collection: 01/Jul./95
Date of Analysis : 56/Jul./95

Physical Characteristics

Appearance	: Cloudy
Odor	: Odorless
Taste	: -
Color	: 1040 Pt-Co (Aparent)
Settleable Solids	: Present
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 90
Turbidity	: 165 FTU
Temperature	: 19.2 °C
Conductivity	: 0.15 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 70
Carbonate Hardness as $CaCO_3$	: 60
Non Carbonate Hardness as $CaCO_3$	: 10
Total Alkalinity as $CaCO_3$	: 60
Bicarbonate Alkalinity as $CaCO_3$	: 60
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: 6.87
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: 1.15	Cl^-	: 15.00
Na^+	: -	NO_2^-	: 0.01
K^+	: -	NO_3^-	: 61.16
Ca^{++}	: 12.00	F^-	: 0.142
Mg^{++}	: 9.76	HCO_3^-	: 73.20
Fe(Total)	: 0.17	CO_3^{--}	: Nil
Mn^{++}	: Nil	SO_4^{--}	: 5.00
Cu^{++}	: Nil	PO_4^{---}	: 0.27

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 Werota, Sampled and Analyzed on June/17,18/'95

No.	Kebele	Source	Place of Sampling	No of F.C. per 100ml	Remarks
1	2	BH1	Y.Conn.	12	Nearest tap to the source, At school Supplied directly fr the source
2	2	BH1	Reservoir	17	
3	2	BH1	P.Foun.1	15	Supplied through reservoir
4	1	BH1	P.Foun.4	14	Supplied through reservoir
5	1	BH1	P.Conn.	16	
6	1	BH1	P.Conn.	31	
7	1	BH1	P.Conn.	27	
8	1	BH1	P.Conn.	19	
9	2	BH1	P.Conn.	22	
10	2	BH1	P.Conn.	23	
11	2	BH1	P.Conn.	TMTC	
12	2	BH1	P.Conn.	35	
13	2	BH1	Y.Conn.	17	WSS yard connection
14	2	BH1	Y.Conn.	15	Near market
15	2	BH1	P.Conn.	15	
16	1	BH1	Clay pot	TMTC	Fetched 1 day before, Not covered
17	1	BH1	Clay pot	TMTC	Fetched 1 day before, Covered by Papyrus
18	1	BH1	Clay pot	TMTC	Fetched 1 day before, Covered by Papyrus
19	1	BH1	Clay pot	TMTC	Fetched 1 day before, Covered by tin-lid
20	1	BH1	Clay pot	TMTC	Fetched 1 day before, Covered by Papyrus
21	1	BH1	Clay pot	TMTC	Fetched 1 day before, Covered by Papyrus
22	2	BH1	Clay pot	TMTC	Fetched on the day, Covered by tin-lid
23	2	BH1	Clay pot	TMTC	Fetched on the day, Covered by Papyrus
24	2	BH1	Clay pot	TMTC	Fetched on the day, Covered by Papyrus
25	2	BH1	Clay pot	TMTC	Fetched on the day, Covered by Papyrus
26	2	BH1	Clay pot	TMTC	Fetched on the day, Covered by Papyrus
27	2	BH1	Clay pot	TMTC	Fetched on the day, Covered by Papyrus
28	2	BH1	Barrel	82	Stored fr own P.conn, Not covered
29	2	BH1	Jerry-can	4	Fetched fr own P.conn, Capped
30	2	BH1	Jerry-can	13	Fetched fr own P.conn, Capped
31	2	BH1	Jerry-can	65	Fetched on the day
There is only one source (BH1) operated 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.

Result of Faecal Coliform Test in Werota, Sampled and Analyzed on June/30&July/1/'95

No.	Kebele	Source	Place of Sampling	No of F.C. per 100ml	Remarks
Before chlorination dated on June/30/1995					
1	2	BH1	BH1	0	Sampled directly fr the source, Ph=7.6
2	2	BH1	Reservoir	0	WT=26°C
3	2	BH1	Y.Conn.	0	Nearest tap to the source, WT=26°C
4	2	BH1	P.Foun.1	3	WT=25°C, Supplied through reservoir
5	1	BH1	P.Foun.3	0	WT=26°C, Supplied through reservoir
6	1	BH1	P.Foun.4	0	Supplied through reservoir
7	2	BH1	P.Foun.7	1	WT=26°C, Supplied fr pressure line
8	2	BH1	P.Conn.	0	WT=26°C, Supplied through reservoir
9	1	BH1	P.Conn.	0	Supplied through reservoir
10	1	BH1	P.Conn.	0	WT=26°C, Supplied through reservoir
After Chlorination dated on July/1/1995					
1	2	BH1	BH1	0	Sampled directly fr the source, WT=25°C
2	2	BH1	Reservoir	0	
3	2	BH1	Y.Conn.	0	Nearest tap to the source, WT=24°C
4	2	BH1	P.Foun.1	0	Supplied through reservoir
5	1	BH1	P.Foun.3	0	Supplied through reservoir
6	2	BH1	P.Foun.7	0	WT=26°C, Supplied fr pressure line
Chlorination was done on June 30 in the Borehole and the Reservoir.					

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.

Result of Faecal Coliform Test in Worota, Sampled and Analyzed on July/3,4/'95

No.	Kebele	Source	Place of Sampling	No of F.C. per 100ml	Remarks
Before/after disinfection by using bleaching agent					
1	1	BH1	P.Foun.4	13/54	WT=26/24°C, Not disinfected
2	1	P.Foun.4	Clay pot	57/85	WT=26/25°C, 10ppm
3	1	P.Foun.4	Clay pot	TMTC/103	WT=28/24°C, 10ppm
4	1	P.Foun.4	Clay pot	TMTC/123	WT=25/23°C, 10ppm
5	1	P.Foun.4	Clay pot	30/85	WT=27/26°C, 20ppm
6	1	P.Foun.4	Clay pot	TMTC/2	WT=26/24°C, 20ppm
7	1	P.Foun.4	Clay pot	12/83	WT=26/24°C, 20ppm
8	1	P.Foun.4	Clay pot	31/148	WT=26/25°C, 30ppm
9	1	P.Foun.4	Clay pot	18/97	WT=26/24°C, 30ppm
10	1	P.Foun.4	Clay pot	20/74	WT=26/ -°C, 30ppm
11	1	P.Foun.4	Clay pot	27/0	WT=26/24°C, 40ppm
12	1	P.Foun.4	Clay pot	58/107	WT=25/23°C, 40ppm
13	1	P.Foun.4	Clay pot	84/119	WT=26/24°C, 40ppm
14	1	P.Foun.4	Clay pot	TMTC/108	WT=27/ -°C, 50ppm
15	1	P.Foun.4	Clay pot	TMTC/124	WT=25/24°C, 50ppm
16	1	P.Foun.4	Clay pot	TMTC/93	WT=26/26°C, 50ppm

The former figure shows the number of Faecal Coliform before disinfection and the latter after disinfection by bleaching agent.

The disinfection was made by bleaching agent into the same clay pots above for the purpose of knowing household level disinfection.

The water in the clay pots above was fetched at P.Foun.4. The public fountain showed 13 and 54 number of Faecal Coliform on the days.

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.

Result of Faecal Coliform Test in Werota, Sampled and Analyzed on Aug./5/'95

No.	Kebele	Source	Place of Sampling	No of F.C. per 100ml	Remarks
1	1	BH1	P.Conn.	0	WT=25°C, Near experimental toilet
	1	BH1	P.Conn.	0	WT=25°C, Near Market
2	1	BH1	Clay pot	TMTC	WT=19°C, Fr. P.Conn., 1 day before
3	1	BH1	Clay pot	TMTC	WT=19°C, Fr. P.Conn., 1 day before
4					
5	1	BH1	Clay pot	TMTC	WT=20°C, Fr. P.Conn., 1 day before
6	1	BH1	Clay pot	TMTC	WT=23°C, Fr. P.Conn., on the day
7	1	BH1	Clay pot	TMTC	WT=19°C, Fr. P.Conn., 1 day before
8	1	BH1	Clay pot	TMTC	WT=21°C, Fr. P.Conn., 1 day before
9	1	BH1	Clay pot	21	WT=19°C, Fr. P.Conn.
10	1	BH1	Clay pot	TMTC	WT=20°C, Fr. P.Conn., 1 day before
11	1	BH1	Clay pot	TMTC	WT=18°C, Fr. P.Conn., visible organisms
12	1	BH1	Clay pot	TMTC	WT=22°C, Fr. P.Conn., visible organisms
13	1	BH1	Clay pot	TMTC	WT=19°C, Fr. P.Conn., 1 day before
14	1	BH1	Clay pot	41	WT=21°C, Fr. P.Conn., on the day
15					
16	1	BH1	Clay pot	TMTC	WT=21°C, Fr. P.Conn., 1 day before

These tests had been carried out on same clay pots, which had been undertaken for the effect of bleaching agent on July 3 and 4, 1995.

Sample No. between 2 and 16 are samples collected from same containers which are numbered as shown in test result on July 3 and 4, 1995.

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

Werota – Activity Profile by Gender (Public Fountain and Vendor Users)

Activities	Gender		Remarks/Time/Place
	Male	Female	
Fetches drinking water	n	y	And children. Pot queuing system saves time
Does laundry	n	y	Also girls. Done at home
Waters livestock	n	n	Boys at river
Takes water from storage vessel	n	y	Also children at any time
Disposes of solid waste	n	y	Anywhere
Constructs - compost pits	-	-	No pits
- latrines	-	-	No latrines
- kitchen gardens	-	-	No kitchen garden
Keeps latrine clean	-	-	No latrine
Teaches children about hygiene	n	y	Mostly women
Takes sick child to health center	n	y	Mostly women

y = Yes, n = No

Werota – Diagnosis of Each Group by Activities (Private Connection Users)

Activities	Gender			Remarks/Time/Place
	Male	Female	Maid	
Fetches drinking water	n	y	y	
Does laundry	n	n	y	
Waters livestock	n	n	y	
Takes water from storage vessel	n	n	y	
Disposes of solid waste	n	n	y	
Constructs - compost pits/drains	-	-	-	Paid labor
- latrine	-	-	-	Paid labor
- kitchen gardens	-	-	-	
Keeps latrine clean	n	n	y	
Teaches children about hygiene	y	y	y	
Takes sick child to health center	n	y	y	

y = Yes, n = No

Werota – Diagnosis of Each Group by Activities (Hand-dug Well Users)

Activities	Gender		Remarks/Time/Place
	Male	Female	
Fetches drinking water	n	y	Also girls from PFs
Does laundry	n	y	Also girls at home
Waters livestock	n	n	Boys at home
Takes water from storage vessel	n	n	All, but mostly females
Disposes of solid waste	n	y	Anywhere
Constructs - compost pits/drains	n	n	
- latrines	y	n	Men dig shallow latrines
- kitchen gardens	n	n	
Keeps latrine clean	n	y	Not often kept clean
Teaches children about hygiene	y	y	Do not have much knowledge
Takes sick child to health center	n	y	Mostly women

y = Yes, n = No

Werota – Daily Schedule (Public Fountain Users)

Man	Time	Female
	6	Gets up, puts container in PF queue
Gets up, bathes, goes open field	7	Instructs children to stay in queue and makes breakfast.
Eats breakfast with family	8	Eats breakfast with family
Collects wood for family	9	Fetches water, *starts making tela*
〃	10	*Makes tela and arakie (alcohol)*
〃	11	〃
(Used to weave, lost eyesight and now can	12	〃
not work)	13	〃
Talks with neighbors/	14	〃
blind relative	15	〃
〃	16	〃
Looks after cows	17	Does some housework and laundry
Talks with family/friends	18	〃
〃	19	Prepares supper
Eats supper with family	20	Eats supper with family
Goes to sleep	21	Cleans up dishes and goes to sleep

Note: Family are very poor, and Tela selling gives weekly profit of 3 Birr. Tela sold mostly on Saturdays and Sundays. Sometimes water is bought from vendors. A more regular supply of water may save this family a maximum of 50 cents/week. An income generating programme would be required for these people if full advantage is to be realized from a water and sanitation programme.

Werota – Daily Schedule (Household Connection Users)

Man	Time	Female
Gets up, bathes, uses toilet	6	Gets up, bathes, uses toilet
Goes to church	7	Goes to church
Returns from church	8	Returns from church and organizes breakfast
Eats breakfast with family	9	Eats breakfast with family
Goes to work (family business - selling	10	Organizes maid to do housework
〃 *crops, trucking, etc.)*	11	Drinks coffee with daughter and family
	12	〃
Returns home, eats lunch, rests	13	Eats lunch with family
〃	14	Makes social visits
Returns to work	15	〃
〃	16	〃
〃	17	〃
Goes to have drink with friends	18	Organizes supper preparation
〃	19	〃
Returns home, eats supper	20	Eats supper with family
Watches TV with family	21	Watches TV with family
〃	22	〃
Goes to sleep	23	Goes to sleep

Note: They have no time when they do not have access to running water. They do not sell water to other people because they don't want them on their property.

Werota – Daily Schedule (Hand-dug Well Users)

Man	Time	Female
Gets up, washes face, goes to toilet	6	
Goes to church	7	
Returns home to work (tailor)	8	Gets up (sick), washes, goes to latrine
〃	9	Takes breakfast
〃	10	Prepares tela/lunch
〃	11	〃
Takes lunch with family	12	Takes lunch with family
Goes to tela house to drink	13	Cleans dishes and house
Goes back to home to work	14	Washing (laundry)
〃	15	*Takes tela to tela house to sell*
〃	16	〃
〃	17	Returns home, drinks coffee alone
〃	18	Prepares supper
Goes to tela house to drink	19	Eats supper with children
Goes home, eats supper	20	Cleans up dishes
Plays with children, talks with wife	21	Goes to sleep
Goes to sleep	22	

Note : The woman in this household is not well. When the children are not at school, they prepare the tela and sell it for their mother.

Werota – Access and Control Profile (Public Fountain and Vendor Users)

Items	Access		Control		Comments
	M	F	M	F	
Resources					
Adequate water supply	n	n	n	n	
Money for PF/water vendor	n	y	n	y	Not enough money available
〃 for soap	y	y	y	y	Priorities are decided upon by the
〃 for water containers	y	y	y	y	household
〃 for pot cover	y	y	y	y	
〃 for drying shelf	y	y	y	y	
〃 for latrine	y	y	y	y	
〃 for medicine	y	y	y	y	
〃 for schooling	n	n	n	n	School is not free
Labor/tools for drying shelf	y	y	y	y	
〃 for digging pits	y	y	y	y	
〃 for constructing latrines	y	y	y	y	
〃 for constructing soakaways	y	y	y	y	
Benefits					
Income from vegetable sales	-	-	-	-	Not enough land/water for gardens
Income from selling water	-	-	-	-	
Improved health	-	-	-	-	
Reduced time collecting water	n	y	n	y	
Reduced time looking after sick	n	y	n	n	

Note : Woman is the only income earner in this family. Many women in this beneficiary group make money by selling tela thus having control of money.
y = Yes, n = No

Werota – Access and Control of Resources/Benefits (Private Connection Users)

Items	Access		Control		Comments
	M	F	M	F	
Resources					
Piped water resources	y	y	y	y	24 hour supply to home
Money for water vendor	-	-	-	-	
〃 for soap	y	y	y	n	
〃 for water containers	y	y	y	n	
〃 for pot cover	y	y	y	n	
〃 for drying shelf	y	y	y	n	
〃 for latrine	y	y	y	n	
〃 for medicine	y	y	y	n	
〃 for schooling	y	y	y	n	
Labor/tools for drying shelf	y	y	y	y	
〃 for digging pits	y	y	y	y	Paid labor
〃 for constructing latrines	y	y	y	y	Paid labor
〃 for constructing soakaways	y	y	y	y	Paid labor
Land for vegetable gardens	y	y	y	n	No vegetable gardens
〃 for latrines	y	y	y	n	
〃 for compost pits	y	y	y	n	
Benefits					
Income from vegetable sales	-	-	-	-	They already enjoy most benefits.
Income from selling water	-	-	-	-	Don't like selling water
Improved health	-	-	-	-	
Reduced time collecting water	-	-	-	-	
Reduced time looking after sick	-	-	-	-	

y = Yes, n = No

Werota – Access and Control of Resources/Benefits (Hand-dug Well/PF Users)

Items	Access		Control		Comments
	M	F	M	F	
Resources					
24 hour water supply	y	y	y	y	
Money for water public fountain	n	y	n	y	Income from tela
〃 for soap	y	y	y	n	
〃 for water containers	y	y	y	n	
〃 for pot cover	y	y	y	n	
〃 for drying shelf	-	-	-	-	
〃 for latrine	y	y	y	n	
〃 for medicine	y	y	y	n	
〃 for schooling	y	y	y	n	
Labor/tools for drying shelf	-	-	-	-	
〃 for digging pits	-	-	-	-	
〃 for constructing latrines	y	y	y	n	
〃 for constructing soakaways	-	-	-	-	
Land for vegetable gardens	-	-	-	-	
〃 for latrines	y	y	y	n	
〃 for compost pits	y	y	y	n	
Benefits					
Income from vegetable sales	-	-	-	-	
Income from selling water	-	-	-	-	
Improved health	y	y	y	y	
Reduced time collecting water	n	y	n	y	
Reduced time looking after sick	n	y	n	y	

Note: The household income is shared. The man earns the money in most households in this group but women may earn enough to buy water from selling tela.
y = Yes, n = No

Werota – Needs Analysis (Private Connection Users)

Items	Gender		Comments
	Male	Female	
Practical needs			
Water			
-increased water pressure	y	y	Particularly those on hilly area
Health			
-more medicines need to be stocked at health center	y	y	
Sanitation			
-improved latrine design	y	y	Most have latrines but often traditional type.
-pit emptying system	y	y	Not enough space to keep building new latrines in new locations
Strategic needs			
Water - system OK	y	y	
Sanitation - system OK	y	y	
Health - OK	y	y	But not enough medicines at health center

y = Yes, n = No

Werota – Needs Analysis (Handdug Well, Public Fountain and Vendor Users)

Items	Gender		Comments
	Male	Female	
Practical needs			
Water - More PF quality water	y	y	PCs take most of the supply
- Improved access to PFs	n	y	Longer opening times for PFs
- Increased numbers of PFs	n	y	
- Reduced distance to PFs	n	y	
Sanitation - Community pit latrine nearby	y	y	Low maintenance type
- Solid waste pits	y	y	
- Showers	y	y	Could be community managed in some places if supported
Health - Improved health	y	y	
- More medicines needed at the health center	y	y	
Strategic needs			
Water - Community management of additional PFs	y	y	With adequate support from WSSA. Some fear that this will cause rifts in the society
Sanitation - Community management of latrines	y	y	For the people on the edge of town. People did not really discuss how they would manage
- Community showers			them

y = Yes, n = No

Werota – Social and Gender Considerations

Social/Gender Differences	Underlying Factors	Impact on the Project	Possible Measures to be Taken to Improve Situation
Richer people have better access to piped and well water than poor people. Poor people spend more time and energy collecting water.	Poor people rely on public fountains which are not open long enough to meet demand. At times of shortage these people buy water from farm households with wells or private connections.	Private connections are not affordable by poor people. Middle income families may be able to afford private connections.	Increase number of public fountains and the times that the public fountains are open.
High number of people aware of health risks with poor sanitation but lack motivation to change hygiene behavior.	Traditional sanitation methods include open defecation and indiscrete disposal of solid waste.	Standard health education will not be effective. Provision of sanitation facilities alone will not be effective.	Novel approach to hygiene promotion required - perhaps including some incentives to households who keep their compounds clean and health/hygiene ceremonies or exhibitions.
Many people were in favour of community managed communal latrines. However others mentioned that this might be difficult.	Enforcement of community member by other members can cause disharmony in a society.	Community latrine management may start well but fail in the middle to long term.	Support and training needs to be given to community groups and leaders. Support and enforcement must also be provided by Kebele/municipality.
People, particularly those near the centre of town were keen on community showers.	In areas outside the centre of town water shortage is a great problem and better access to Water is a greater priority than different ways to use more water.	Community showers are potentially good income generating initiatives for communities. Poorer communities on the edge of town will miss out on this opportunity because of their low expectations from the project.	Initiate community shower facilities together with community latrine programme. Initiate income generation activities for poor and disadvantaged households.

Appendix - 4

Summary of Group Meeting

WEROTA - Summary of group meetings

Group 1 details	Group characteristics	Group needs
General	Mixed ethnicity and religion, 10 women, 10 men, many children, Daily labourers, Business people and Local Alcohol sellers	1-Community latrine, 2-Re-opening of Public Fountain
Water	Former PF Users, now rely on hand dug wells (5c/pot), but the water has taste problems. Some use other PFs but there are long queues and not open for long enough (only 30 mins). Women fetch water and pay 30-50c/pot.	Would like closed PF to be opened. Prepared to pay 20c/pot and to manage the PF themselves if that was made possible.
Sanitation	People all practice open defecation. There are no latrines partly because they live in rented housing and there is a problem of shortage of space. There used to be a public shower but no longer functioning. Rubbish disposal also open field (children)	Would like to have a community latrines and would be prepared to look after it and manage it with support from the Authorities. Would assist with labour for construction. Would like to have a public shower. Need a pit allocated for rubbish disposal.
Health	Common diseases include diarrhoea and Bilharzia, and people realise this is because of poor water and sanitation facilities. Men and women teach children about health	No other health needs identified

Group 2 details	Group characteristics	Group needs
General	Amhara, Mixed religions, Mixed income	1-Water, 2-Community Latrine, 3-Electricity
Water	Public fountain users and well vendor users. PF working time too short.	Need additional PF with longer working hours. Could manage the PF themselves.
Sanitation	Most practice open defecation.	Would like community latrines with shower facilities. Could pay for the use of the latrine and shower facilities.
Health	N/A	N/A

WEROTA - Summary of group meetings (Continued)

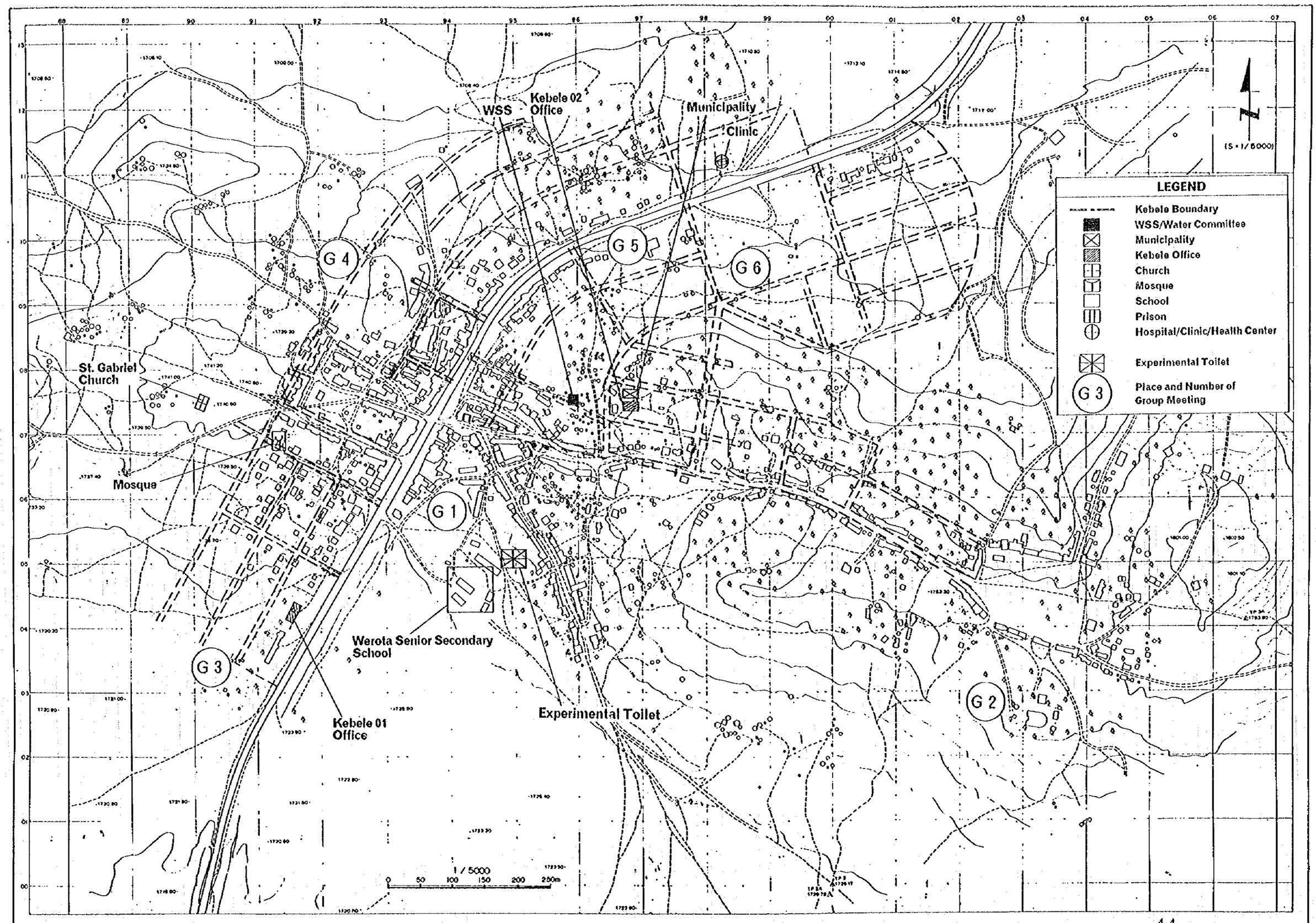
Group 3 details	Group characteristics	Group needs
General	Mixed ethnicity and mixed religions, 10 women, 4 men, many children, Daily Labourers (m), cotton spinners (f), tej brewers (f) and wood collectors (m)	1-Water With water we can improve both sanitation and health
Water	River water users (early morning before river becomes turbid), and sometimes PF Users, but PFs are very far (1 hour journey). Women fetch water and do laundry. River dries up before the rains and causes shortage. Sometimes use PC vendors (10c/pot)	Would like additional public fountain to be managed by community committee. Would provide labour for construction and materials for fencing.
Sanitation	All practice open defecation, there are no latrines. Women go early morning or late evening. Women go nearer to the homes and men further away. Very difficult to control children's excreta, but it is women's role. Soil difficult to build latrines.	Would like community latrines and could organise a committee to keep it clean. Would require sharing by sex. Showers might be used but unlikely.
Health	Common diseases include Malaria, diarrhoea and vomiting. Aware that these are water and sanitation related diseases.	Water will be the key to improved health

Group 4 details	Group characteristics	Group needs
General	Mixed ethnicity and religion, 5 women, 8 men, many children, Government workers, Daily Labourers (m), Tej makers/ sellers (w), Cotton spinners (w)	1- Water
Water	Public Fountain Users, but in times of shortage use pond (for payment). Prefer PF taste and quality. Laundry done with PF water but at times of shortage use well/pond. Queue at PF also long with a short opening time (3hours).	Would like additional PF and PCs. Would manage the PF by themselves and would construct a fence for protection and labour for latrine construction. People would like to be consulted on the design of PF and possible laundry area.
Sanitation	Some people have and use latrines, those who do not practice open defecation. Those without latrines tend to be in rented housing while those with latrines are in private housing. Latrines not in good condition. Rubbish disposal also open field.	Some would like a community latrine if Municipality allocated land, could assist with labour and manage it themselves. Would need to be near to their dwellings. Some would prefer household latrines. Would like allocated place for rubbish disposal.
Health	Aware that water and sanitation are linked to diarrhoea and malaria.	Priority need is water, if they were given sanitation and not water they would be angry

WEROTA _ Summary of group meetings (Continued)

Group 5 details	Group characteristics	Group needs
General	N/A	Refused to discuss with team
Water	Private Connection Users	N/A
Sanitation	N/A	N/A
Health	N/A	N/A

Group 6 details	Group characteristics	Group needs
General	Mostly Amhara, Mixed religions, Mixed income including tela sellers and Government workers	1-Health, 2-Piped water supply, 3-Increased income
Water	Hand-dug well users and Private Connection Vendor users. The nearest pubic fountain is too far away.	Would like a local public fountain but want to have them managed by the Government. They fear the responsibility of major repairs.
Sanitation	Some have and use shallow latrines particularly over the last year. Most use open field sites for defecation.	Would like a community latrine (pit latrine with water point and shower). They could manage the latrine themselves, but not the shower.
Health	N/A	N/A


WSS
Kebele 02 Office
Municipality
Clinic
N
(S = 1/5000)
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
G 1
G 2
G 3
G 4
G 5
G 6
St. Gabriel Church
Mosque
Werota Senior Secondary School
Kebele 01 Office
Experimental Toilet
1 / 5000
0 50 100 150 200 250m

WEROTA

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	42,216	74,219	66,278	17,810	46,409
& consumption in	31,206	55,045	55,008	15,826	41,201
1993/1994 (m3)					
*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 & Expendi-	56,457	68,590	66,791	34,679	62,089
ture in 1993/1994	79,567	72,172	102,309	71,591	67,846
(birr)					
*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/pro- duction (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,	19	17	22	20	17
female, tempo-	5	6	7	6	3
rary/contract	1	2	0	2	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/	383	327	478	238	390
yard connections,	14(13)	12	13(12)	7	7
public fountains, hydrants					

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 Werota

1. Official Water Price: 1 birr/m3 for all clients
2. Production and Consumption of Water, 1993/94
   1) Production : 58,318 m3
   2) Consumption: 46,104 m3
      * Daily water consumption as divided by total population = 4.9 litre
      * Leakage ratio = 20.9%
3. Income and Expenditure
   1) Income : 64,648.25 birr

      Major sources of income

(1) Measured water sales	50,657.00 birr	(78.6%)
(2) Cash water sales	8,457.00 birr	(13.1%)
(3) Service charge	3,423.48 birr	(5.3%)

      * Bill collection rate: 99.9%
      * Income per unit consumption of water = 1.40 birr/m3

   2) Expenditure: 53,304.01 birr

      Major items of expenditure

      (1) Salaries (2) Electricity
      (3) Uniform (4) Day laborers

      * Expenditure per unit production of water: 0.91 birr/m3
      * Income-expenditure ratio: 121.3%
4. Organization and Personnel
   1) No. of personnel: 18 (4)

(1) Head, WSS	1
(2) Administration 4 guards, 1 (1) store keeper	6 (1)

Table 2 (2) Financial Condition of Water Supply Service in Werota

(3) Finance 1 (1) accountant, 1 (1) bill collector, 3 (1) water sellers, 1 meter reader, 1 cashier	7 (3)
(4) Rural water supply 1 head	1
(5) Urban water supply & sewerage 1 head, 2 plumbers, 1 operator	4

Note: Parenthesized figure denotes the number of female workers.

* Production per worker = 3,240 m3/year
* Income and expenditure per worker = 3,592 birr, 2,961 birr/year

2) Average monthly salaries of employees: 217 birr

5. No. of Distribution Facilities
   1) Yard/house connections : 396

(1) Household	:	336
(2) Governmental & public	:	15
(3) Commercial	:	45

   2) Public fountains : 7 (6 functional)
      * Service ratio: 100%

      Note: There are 10-15 hand-dug wells.

6. Problems and Bottlenecks
   1) Shortage of pipes and fittings
   2) Shortage of water meters.
   3) Shortage of water.
   4) Limited capacity of the reservoir.
   5) Limited coverage of distribution lines.
   6) Shortage of public fountains.
   7) Technical problem. No telephone to communicate between the reservoir and the water source.
   8) Lack of vehicle.
   9) Lack of shelter for guards.

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.100	Amh.74 Age.19	Amh.94 Age. 4	Amh.99 Oro. 1	Amh.99 Tig. 1
[Amh.=Amhara, Afa.=Afar, Oro.=Oromo, Tig.=Tigre, Kim.=Kimant, Age.=Agew]					
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 Werota

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 Council
4) Agricultural Training Center
5) Financial Bureau
6) Educational Bureau
7) Municipality
8) Health Clinic
9) Ethiopian Electric Light and Power Authority (EELPA)
10) Ethiopian Grain Trade Enterprise
11) Adult Education Office
12) Police
13) Post Office
14) Telecommunications
15) Weroda Court
16) Weroda Attorney
17) Water Supply Service (WSS)

Notes: 1. Schools are not included in the above organizations.
2. There is one NGO, called Children's Home.

3. No. of Government Employees and Their Average Monthly Salaries: 322, 308 birr

* No. of government employees per 1,000 population: 15

4. No. of Kebele: 2

II. Socio-Economic Conditions

1. Population
1) Total population: 21,845

2) Ethnic composition: Amhara (97%), Tigre (3%)

3) Religious composition: Christians (80%), Moslems (19%), Others (1%)

4) Average family size: 6.3 persons

Table 4 (2) Socio-Economic Condition of Werota

2. Area: 640 ha * Population density: 34.1 persons/ha

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

Items	Kinder-garten	Elementary School	Junior and Senior High School
(1) No. of schools	1	2	1
(2) No. of class rooms	15	30	25
(3) No. of teachers	2	101	62
(4) No. of pupils/students	81	2,545	1,191

* No. of pupils/students per 100 population: 17

2) Literacy ratio: 63% (1984)

3) Primary school enrollment ratio: 57% (1984)

4. Medical Conditions
1) No. of medical institutions/establishments:
1 Health Clinic, 4 private drug vendors

2) No. of medical personnel:
2 nurses, 5 health assistants, 1 malaria laboratory technician
1 junior health assistant ... 9 in total

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

i.	Lower respiratory tract infection	4,205 cases	
ii.	Malaria of all forms	2,802	
iii.	Intestinal parasite	2,663	
iv.	Diarrhea	2,471	
v.	Upper respiratory tract infection	1,394	
vi.	Sexually transmitted diseases	1,296	
vii.	Skin infection	1,086	
viii.	Fever of unknown origin	778	
ix.	Rheumatic arthritis	733	i. to x.
x.	Tropical ulcer	656	= 18,084

(2) Estimated number of cases per year as percentage of population:
(18,084 x 1.5) / (21,845 x 5) = 24.8%

Table 4 (3) Socio-Economic Condition of Werota

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

4) Under 5 mortality rate: 95/1000 (1984)

5) Life expectancy: 61 years (1984)

6) Households more or less using septic tank and pit latrine: 61%

5. No. of Holy Places: 2 churches, 2 mosques

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	0	56	15	71
Restaurants	0	25	0	25
Bars	0	34	7	41
Tea rooms	0	61	0	61
Tej houses	0	3	0	3
Sub-total	0	179	22	201
2. Shops	106	196	218	520
3. Cottage industry				
Oil factories	0	0	17	17
Flour mills	0	0	53	53
Garages	0	0	1	1
Tyre repairing	0	1	0	1
Brick factories	0	0	2	2
Wood factories	0	0	3	3
Machine leasing	0	0	2	2
Sub-total	0	1	78	79
4. Others	6	4	2	12
Total	112	380	320	812

Table 4 (4) Socio-Economic Condition of Werota

Notes: 1. Shops include traders of clothes, consumers' items & utensils, thread, textiles, red chilli & spices, cigarettes, grains, fuels, metal products, butter & honey, building materials, coffee, salvage, shoes & leather products, pastry and drugs, bakeries, groceries, tailors, photo shops and music shops.

2. Others include filling stations, butcheries, cabarets and beauty salons.

3. 40% of households are local drink producers.

* No. of commercial and industrial establishments per 1,000 population: 37

2) Major occupations
(1) Trade
(2) Government employees
(3) Cottage industry
(4) Day laborers
(5) Handicraft

3) Major products: edible oil

4) Market
(1) Major marketable items:
grains, livestock, fruit, butter, milk, honey, etc.

(2) Prices of major marketable items

Grains (unit: birr/100 kg)

tef	barley	wheat	beans	peas	chick peas	guaya beans	lentil	oil seed
200	130	200	180	180	170	190	250	200

Livestock (unit: birr/one)

ox	cow	sheep	goat	donkey	chicken
600	600	90	70	200	7

Table 4 (5) Socio-Economic Condition of Werota

Consumers' items (unit: birr)		
butter (kg)	milk (litre)	honey (kg)
16	1.5	10

(3) Market day - Saturday (8,000 - 10,000 people gather.)

4) Average monthly household income: 262 birr

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

Appendix - 6

Result of Initial Environmental Examination

Project Description on Initial Environmental Examination in Werota

Items	Description
Project Title	Eleven Centers Water Supply and Sanitation
Background	1. Insufficient water supply and low per-capita-consumption due mainly to high population growth, aged facilities and poor O&M. 2. Poor sanitation prevailing the Project site which could contaminate the water source(s).
Objectives	To supply domestic water which meets people's demand and to improve sanitary condition.
Location	Werota, South Gonder, Region-3
Executing Agency	Water Supply and Sewerage Service Department Ministry of Water Resource
Beneficiaries	About 21,800 of the population to be benefited.
Dimensions of the Plan	Rehabilitation of existing facilities, and new boreholes, reservoir and distribution network.
Type of Work	Rehabilitation and new construction work
Purpose	1. To provide domestic water and improve sanitation facilities. 2. To initiate people's awareness on water use and sanitation.
Water Resource	Groundwater, There are minor springs outside town but not to be considered as the source.
Water Quality	Chemical aspects are within WHO guideline values Biological contamination is notified.
Main Facilities	Boreholes with pumping system.
Water Storage Facilities	Reservoir (ground tank type)
Filtration Plant	Not to be considered.
Related facilities	Distribution pipes, public fountains, drainage system and latrines
Remarks	1. Chlorine or its derivatives such as mainly calcium hypochlorite is used for disinfection in Ethiopia. 2. Existing borehole is often affected by flood.

Site Description on Initial Environmental Examination in Werota

Items	Description
Project Title	Eleven Centers Water Supply and Sanitation
Social Environment	
Residents (population, tribe, consciousness)	Population about 21,800, almost Amhara
Facilities related to life (electricity, etc.)	The electricity is hydro-powered and supplied for 24 hours.
Health and Sanitation (diseases, clinic, etc.)	0 hospital, 1 health clinic, 4 drug stores Malaria is very common in this town.
Natural Environment	
Topography, Geology and Hydrogeology	Located at edge of Lake Tana basin. Ashangi basalt is the major structure of the area with alluvial deposit.
Meteo-hydrology Groundwater/spring/river	Annual rainfall about 1270mm, 1 spring outside the town but barely used by the town people. Existing borehole yield is 5 l/s.
Endangered fauna and flora	Nil
Public Nuisance	
Nuisances	Water supply condition is not good. During rainy season, stagnant water appear in places west side of the main 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	

Scoping Format for Initial Environmental Examination in Werota

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.
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 the main 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 Werota

No.	Description	F.C.(B)	L.C.(B)	Total(B)
I.	Target year of 2005			
1	Civil Work			
	Mobilization and Demobilization	200,000	300,000	500,000
	Excavation and Earth-work	19,900	75,500	95,400
	Trench excavation	296,060	667,180	963,240
	Pipe-work	467,180	467,180	934,360
	Reservoir	432,000	432,000	864,000
	Pumping station, R.C.pump house	132,048	87,984	220,032
	Access road	267,000	621,000	888,000
	Bore-hole (200mm casing)	117,120	175,680	292,800
	Water purifiction unit	10,000	15,000	25,000
	Booster pump and necessary works	360,000	600,000	960,000
	Electric submersible pump and necessary works	100,000	150,000	250,000
	Power supply	35,850	38,775	74,625
	Concrete work	67,980	120,880	188,860
	Masonsy work	12,000	49,000	61,000
	Structure	147,720	344,680	492,400
	Temporary building(10% of above total)	266,486	414,486	680,972
	Total of civil work	2,931,344	4,559,345	7,490,689
2	Material & Equipment	8,409,172	588,642	8,997,814
	Sub Total	11,340,516	5,147,987	16,488,503
3	Engineering cost(12% of sub tatal)	1,978,620		1,978,620
4	Contingency(5% of above cost)	665,957	257,399	923,356
	Total(birr)	13,985,093	5,405,386	19,390,479
	Total(Yen:1birr=15yen)			290,857,000
5	Buildings		2,924,949	2,924,949
6	WSSD's management cost		446,309	446,309
	Total		3,371,258	3,371,258
7	Prise escalation(6%)	839,105	526,599	1,365,704
	Grand Total	14,824,198	9,303,243	24,127,441
II.	Target year of 2010			
1	Morbilization and demorbilization			400,000
2	Rising line			330,000
3	Distribution network			1,200,000
4	New borehole with pums & material			1,318,000
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			522,300
	Sub total			5,775,000
10	Engineering cost (10%)			577,500
11	Contingency (10%)			635,250
	Total			6,988,000
12	Prise escalation(42%)			2,935,000
	Grand Total			9,923,000

No.	Description	Unit	Q'ty	Unit-Rate F.C.(B)	Unit-Rate L.C.(B)	Amount F.C.(B)	Amount L.C.(B)	Remarks
1.	Mobilization and Demobilization	LS				200,000	300,000	
2.	Excavation and Earth-work							
2-1	Clearing and grubbing the site	ha	10	480	2,400	4,800	24,000	to remove bushes, small forest and trees
2-2	Clear off the site	sqm	10,000	1	4	10,000	40,000	to remove top soil to an average depth of 20cm
2-3	Bulk excavation							
	a) Earth excavation	cum	200	6	14	1,200	2,800	
	b) Excavation of weathered rock	cum	100	10	20	1,000	2,000	
	c) Soft rock excavation	cum	100	14	32	1,400	3,200	
	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	15,100	4	8	60,400	120,800	
	b) 1.0~1.5m depth	m	9,560	7	17	66,920	162,520	
3-2	Trench, Rock excavation	cum	200	30	70	6,000	14,000	
3-3	Back-fill with the same material	m	14,800	5	11	74,000	162,800	
3-4	Selected soil bedding	m	9,860	2	5	19,720	49,300	150mm thick below barrel
3-5	Back-fill with selected material	m	9,860	7	16	69,020	157,760	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	10,500	5	5	52,500	52,500	
	b) DN 75mm	m	4,600	8	8	36,800	36,800	
	c) DN 100mm	m	1,920	10	10	19,200	19,200	
	d) DN 150mm	m	6,050	17	17	102,850	102,850	
4-2	Pressure steal pipe							fitting and supports for bridge and road
	a) DN 200mm	m	480	137	137	65,760	65,760	
	b) DN 250mm	m	710	149	149	105,790	105,790	
	c) DN 300mm	m	490	172	172	84,280	84,280	
5.	Reservoir							
5-1	Ground level reservoir	m3	480	900	900	432,000	432,000	
6.	Pumping station, R.C.pump house	sqm	72	1,834	1,222	132,048	87,984	with accessaries

Cost Estimation of Construction & Materials/Equipment of Werota : 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
7.	Access road	m	3,000	89	207	267,000	621,000	3m wide gravel road with draine ditch
8.	Bore-hole							
8-1	New driling	m	316	320	480	101,120	151,680	including, casing, packing and pumping test
8-2	Rehabiritation	set	1	16,000	24,000	16,000	24,000	
9.	Water purifiction unit	No.	1	10,000	15,000	10,000	15,000	
10.	Booster pump	No.	6	60,000	100,000	360,000	600,000	foundation, pump, and motor with accessories
11.	Electric submersible pump (for deep well)	No.	5	20,000	30,000	100,000	150,000	foundation, and pump with accessories
12.	Power supply							
12-1	Generating set	No.	1	5,850	8,775	5,850	8,775	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 structure	cum	100	275	642	27,500	64,200	
13-3	Form-work							including all necessary works
	Wall	sqm	40	37	87	1,480	3,480	
13-4	Reinforcement bars; Steel bars	kg	2,000	7	2	14,000	3,200	including cutting, bending and placing
14.	Masonsy work							
14-1	Roughly dressed 40cm thick stone elevation wall	sqm	200	60	245	12,000	49,000	up to 3m height
14-2	Brick work with mortor							
	25cm thick	sqm		23	92	0	0	
15.	Structure							
15-1	Construction of public fountains	No.	5	1,580	3,680	7,900	18,400	
15-2	Construction of hydrant	No.	10	230	540	2,300	5,400	
15-3	Construction of R.C.C. aeration chamber	No.	5	5,730	13,370	28,650	66,850	
15-4	Construction of R.C.C. valve chamber	No.	19	5,730	13,370	108,870	254,030	
	Sub-Total of Construction work					2,664,858	4,144,859	

No.	Description	Unit	Q'ty	Unit-Rate F.C.(B)	Unit-Rate L.C.(B)	Amount F.C.(B)	Amount L.C.(B)	Remarks
16.	Material & Equipment (Ref.table)							
16-1	CIF Cost at Addis Ababa					8,409,172		
16-2	Inland transportation cost						588,642	CIF cost x 7 %
	Sub-Total of Material & Equipment					8,409,172	588,642	
	Total					11,074,030	4,733,501	
17.	Building							
17-1	Office	sqm	290		1,910	0	553,900	
17-2	Workshop	sqm	141		1,624	0	228,984	
17-3	Store	sqm	235		1,337	0	314,195	
17-4	Residence	sqm	870		2,101	0	1,827,870	
	Total						2,924,949	

Imported Cost (Material & Equipment) of Werota :Target year of 2005 1/2

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	11,030	15	165,450
	b) DN 75mm	m	4,830	30	144,900
	c) DN 100mm	m	2,020	40	80,800
	d) DN 150mm	m	6,360	80	508,800
1.2	Suspended pressure steel pipe				
	a) DN 200mm W/O gilt and screw	m	510	288	146,880
	b) DN 250mm	m	750	334	250,500
	c) DN 300mm	m	520	418	217,360
1.3	Fitting cost Total cost × 20%				302,938
2	Pumps (Pump with electric motor/accessories)				
2.1	Centrifugal pumps				
	a) Q= 1.9 m3/min H= 20m HP= 11 kw	set	2	300,000	600,000
	b) Q= 0.76m3/min H= 80m HP= 30 kw	set	2	600,000	1,200,000
	c) Q= 0.43m3/min H= 80m HP= 18.5kw	set	2	400,000	800,000
2.2	Submersible pumps with accessories				
	a) Q= 0.12m3/min H= 100m HP= 3 kw	set	1	130,000	130,000
	b) Q= 0.3m3/min H= 100m HP= 5.5kw	set	4	171,000	684,000
3	Power Supply(Materials&accessories)				
3.1	Power supply generating set 50 KVA	set	2	450,000	900,000
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	3	1,700	5,100
	b) ϕ200	set	1	2,200	2,200
	c) ϕ250	set	2	2,800	5,600
	d) ϕ300	set	2	3,700	7,400
4.2	High speed air valve ϕ50	set	5	7,000	35,000
4.3	Pressure reducing valve				
	ϕ75	set	2	7,000	14,000
	ϕ200	set	2	12,000	24,000
4.4	Check valve 150mm	set	2	15,000	30,000
5	Flow meter (Meter with accessories ϕ150)	set	2	60,000	120,000
6	Reservoir equipment	set	2	100,000	200,000
7	Well (Materials with accessories)				
7.1	Casing pipe FRP DN 200	m	108	2,093	226,044
7.2	Screen FRP DN 200	m	208	5,700	1,185,600
7.3	Riser pipe, stainless DN 65	m	350	180	63,000

No.	Description	Unit	Q'ty	Unit Rate (B)	Amount (B)
8	Water purification unit	set	1	80,000	80,000
	Total				8,409,172

Investment Cost of Target Year 2010 in Werota

No.	Description	Unit	Q'ty	Unit Rate (B)	Amount (B)
1	Mobilization and demobilization	LS			400,000
2	Rising line	Km	1.1	300,000	330,000
3	Distribution network	Km	8	150,000	1,200,000
4	New borehole with pumps & materials	Set	2	659,000	1,318,000
5					
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			522,300
	Sub total				5,775,000
11	Enginering cost (10%)				577,500
12	Contingency (10%)				635,250
	Total				6,987,750

Appendix - 8

Meteorological Data

Table 1 Monthly Precipitation

Station: Woreta

Unit:mm

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1972	–	–	–	–	–	–	296.6	–	88.5	6.0	19.5	0.0	–
1973	–	–	0.0	–	–	–	–	–	59.0	49.0	0.0	0.0	–
1974	–	–	–	0.0	52.2	285.6	415.0	–	–	0.0	0.0	–	–
1975	–	1.0	0.0	0.0	19.6	208.4	345.2	–	–	0.0	0.0	–	–
1976	0.0	0.0	0.0	0.0	0.0	35.0	20.3	–	91.3	–	10.4	–	–
1977	–	–	–	–	–	–	–	–	–	–	0.0	3.3	–
1978	0.0	0.0	–	–	–	–	–	–	–	–	–	–	–
1979	–	–	–	–	–	–	–	–	–	–	–	–	–
1980	–	–	–	–	–	–	–	226.0	155.9	52.3	19.8	0.0	–
1981	0.0	0.0	0.0	0.0	65.8	163.8	397.2	464.2	108.2	28.4	23.3	0.0	1250.9
1982	0.0	0.0	5.5	33.7	18.3	150.6	399.4	428.2	117.3	80.6	2.9	0.0	1236.5
1983	2.5	0.0	0.0	0.0	27.3	36.4	314.4	406.6	143.1	58.2	0.1	0.0	988.6
1984	–	–	4.1	1.0	126.7	159.6	283.2	–	145.6	0.0	0.0	14.7	–
1985	0.0	0.0	0.2	24.9	125.7	–	–	360.5	–	33.4	3.2	0.0	–
1986	0.0	0.0	7.0	9.6	8.9	219.7	356.9	357.7	158.6	26.6	0.0	0.0	1145
1987	0.0	0.0	14.0	6.5	176.4	–	368.8	548.4	96.6	194.1	35.2	0.0	–
1988	0.0	11.7	0.0	0.0	41.4	164.1	728.2	340.2	311.9	125.3	5.0	0.5	1728.3
1989	0.0	0.0	11.5	16.0	163.1	169.1	365.9	354.8	294.5	88.2	2.1	1.2	1466.4
1990	1.0	0.0	–	5.0	25.4	116.2	333.7	354.0	234.1	3.4	–	–	–
1991	0.0	0.0	0.0	99.5	149.7	492.0	–	–	295.2	41.7	–	–	–
1992	–	–	–	67.0	28.8	241.8	641.2	820.7	234.6	90.1	26.4	0.0	–
1993	–	–	–	4.9	67.8	43.2	275.2	480.2	98.0	22.4	0.0	0.0	–
1994	0.0	0.0	0.0	0.0	19.3	236.6	641.5	–	–	0.0	–	–	–

Note: - = not calculated due to missing data

Table 2 Long Term Monthly Mean Potential Evapotranspiration (PET)

Station: Bahir Dar Unit:mm

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1st 10 days	36	37	39	37	40	47	52	60	59	57	56	55	
2nd 10 days	55	53	49	49	45	40	39	34	34	36	36	37	
3rd 10 days	37	38	40	41	43	41	39	37	36	35	34	35	
Total	128	128	128	127	128	128	130	131	129	128	126	127	1538

Table 3 Monthly Average Maximum Air Temperature

Station: Woreta Unit: ℃

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1972	—	—	—	—	—	—	—	—	25.1	28.0	27.7	27.6
1973	—	—	30.8	—	—	—	—	25.0	25.0	26.6	27.9	28.4
1974	—	—	—	31.7	31.5	30.6	28.9	—	—	28.9	28.8	—
1975	—	—	30.9	—	—	—	—	—	—	—	—	—
1976	27.4	—	—	—	—	—	—	—	25.1	—	—	—
1977	—	—	—	—	—	—	—	—	—	—	27.8	28.0
1978	—	28.9	—	—	—	—	—	—	—	—	—	—
1979	—	—	—	—	—	—	—	—	—	—	—	—
1980	—	—	—	—	—	—	—	23.7	24.8	26.3	26.9	27.2
1981	27.6	28.6	29.3	30.1	28.3	27.2	23.5	23.3	24.0	26.6	27.4	27.3
1982	27.9	27.7	29.5	29.7	29.0	27.1	24.0	22.8	24.7	25.7	27.7	28.5
1983	28.8	29.4	30.6	31.5	30.7	28.2	25.0	23.2	24.6	26.0	27.6	27.8
1984	—	—	31.1	32.3	29.4	25.7	23.8	—	25.3	28.6	29.1	28.6
1985	29.1	28.5	31.1	30.3	28.8	—	—	23.8	24.8	26.2	27.9	28.4
1986	28.7	29.3	30.8	29.6	30.9	26.3	23.4	23.2	23.8	26.5	28.1	28.3
1987	29.3	30.5	30.6	31.0	27.4	—	25.6	24.9	27.0	30.0	30.4	31.2
1988	30.3	30.0	32.4	32.1	30.4	27.1	23.0	22.4	24.4	26.7	28.6	29.9
1989	29.8	29.5	30.2	30.2	29.7	27.1	24.9	23.1	25.0	29.7	31.4	30.0
1990	30.9	30.6	—	30.7	30.9	26.9	25.7	20.2	19.8	20.5	—	—

1991	31.9	32.5	31.5	31.2	26.3	25.4	–	–	26.9	26.8	–	–
1992	–	–	–	27.5	26.3	25.8	25.0	25.4	26.4	27.2	27.2	27.6
1993	27.9	27.5	28.0	28.0	27.8	27.1	26.7	25.8	26.2	27.1	27.9	27.6
1994	27.8	28.1	28.2	28.1	28.0	26.6	25.4	–	–	27.5	–	–

Table 4 Monthly Average Minimum Air Temperature

Station: Woreta Unit: ℃

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1972	–	–	–	–	–	–	–	–	6.8	5.1	6.1	3.9
1973	–	–	–	–	–	–	–	–	–	–	–	3.8
1974	–	–	–	5.3	–	–	–	–	–	–	–	–
1975	–	–	–	–	–	–	–	–	–	–	–	–
1976	–	–	–	–	–	–	–	–	16.8	–	12.1	–
1977	–	–	–	–	–	–	–	–	–	–	11.0	10.8
1978	–	10.4	–	–	–	–	–	–	–	–	–	–
1979	–	–	–	–	–	–	–	–	–	–	–	–
1980	–	–	–	–	–	–	–	12.6	11.2	9.6	9.2	6.2
1981	8.4	9.1	11.8	12.0	12.9	13.2	12.5	12.5	11.9	10.4	8.6	5.7
1982	7.7	9.4	12.2	11.0	12.5	13.0	12.8	12.0	11.0	10.2	7.6	6.7
1983	5.8	9.2	11.3	12.0	12.6	13.3	12.5	12.8	12.7	11.7	7.9	5.0
1984	–	–	12.0	13.7	13.3	13.6	12.4	–	11.5	7.3	8.2	9.8
1985	7.9	9.8	–	12.0	13.1	–	12.2	12.5	12.1	13.6	9.6	9.2
1986	7.5	11.0	13.6	14.0	15.8	15.4	13.7	13.5	13.0	11.8	9.2	8.3
1987	8.5	11.8	13.0	10.9	10.5	–	8.7	8.2	7.3	7.4	6.9	7.5
1988	6.7	10.0	12.1	11.7	9.1	9.3	8.3	8.6	7.9	6.8	2.9	8.2
1989	4.8	5.8	7.5	6.7	6.8	6.6	5.5	5.1	4.9	4.6	5.0	5.0
1990	6.2	6.4	–	9.6	10.1	9.1	7.1	5.7	6.4	6.2	–	–
1991	12.1	14.0	13.2	13.9	14.6	13.9	–	–	14.3	14.5	–	–
1992	–	–	–	15.4	15.1	14.3	12.5	12.4	12.9	12.9	12.4	13.0
1993	11.6	12.2	12.2	12.9	13.6	12.3	12.0	11.9	12.3	12.8	12.2	11.6
1994	12.4	12.6	12.6	12.6	12.3	11.1	13.1	–	–	12.4	–	–

Note: - = not calculated due to missing data

Table 5 Monthly Average Air Temperature

Station: Woreta Unit: ℃

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1972	–	–	–	–	–	–	–	–	16.0	16.6	33.8	15.8
1973	–	–	–	–	–	–	–	–	–	–	–	16.1
1974	–	–	–	18.5	–	–	–	–	–	–	–	–
1975	–	–	–	–	–	–	–	–	–	–	–	–
1976	–	–	–	–	–	–	–	–	21.0	–	–	–
1977	–	–	–	–	–	–	–	–	–	–	–	19.4
1978	–	39.3	–	–	–	–	–	–	–	–	–	–
1979	–	–	–	–	–	–	–	–	–	–	–	–
1980	–	–	–	–	–	–	–	18.2	18.0	18.0	15.1	16.7
1981	18.0	18.9	20.6	21.1	20.6	20.2	18.0	17.9	18.0	18.5	18.0	16.5
1982	17.8	18.6	20.9	20.4	20.8	20.1	18.4	17.4	17.9	18.0	17.7	17.6
1983	17.3	14.7	21.0	21.8	21.7	20.8	18.8	18.0	18.2	18.9	17.8	16.4
1984	–	–	21.6	23.0	21.4	19.7	18.1	–	18.4	18.1	18.7	19.2
1985	18.5	19.1	–	21.6	21.0	–	–	18.2	18.5	19.9	19.8	18.8
1986	18.1	20.2	22.1	21.8	23.4	20.9	18.6	18.4	18.4	19.2	18.7	18.3
1987	18.9	21.2	22.7	21.0	19.0	–	17.2	16.6	17.2	18.7	18.7	19.6
1988	18.5	20.0	21.2	21.9	19.8	18.2	15.7	15.5	16.2	16.8	15.8	19.1
1989	17.3	17.7	–	18.5	18.3	17.2	15.2	14.6	15.0	17.2	18.2	17.5
1990	18.6	18.5	–	20.2	20.5	18.0	16.4	13.0	13.1	13.5	–	–
1991	22.0	23.3	22.4	22.6	20.5	19.7	–	–	20.6	20.7	–	–
1992	–	–	–	21.5	20.7	20.1	18.8	18.9	19.7	20.1	19.8	20.3
1993	19.8	19.9	20.1	20.5	20.7	19.7	19.4	18.9	19.3	20.0	20.2	19.6
1994	20.1	20.4	20.4	20.4	20.2	18.9	19.3	–	–	20.0	–	–

Note: - = not calculated due to missing data

Appendix - 9

Calculation of Water Pipeline

Output data on distribution network for Werota 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	55	31.67	0.45	0.06	1.06	110	
2	2	2	3	300	390	29.64	0.42	0.36	0.94	110	
3	3	3	4	250	230	26.31	0.54	0.42	1.82	110	
4	4	4	5	250	265	24.29	0.49	0.42	1.57	110	
5	5	5	6	75	115	0.80	0.18	0.11	1.00	110	
6	6	6	7	75	300	-0.72	-0.16	-0.25	-0.83	110	
7	7	7	4	75	115	-1.30	-0.29	-0.28	-2.46	110	
8	8	6	12	75	305	1.01	0.23	0.47	1.54	110	
9	9	12	11	75	220	1.89	0.43	1.08	4.91	110	
10	10	11	10	75	285	0.17	0.04	0.02	0.06	110	
11	11	10	9	75	225	-0.75	-0.17	-0.20	-0.89	110	
12	12	9	8	75	295	-1.29	-0.29	-0.72	-2.43	110	
13	13	8	3	75	270	-2.09	-0.47	-1.60	-5.92	110	
14	14	5	13	250	145	23.02	0.47	0.21	1.42	110	
15	15	13	14	150	285	12.55	0.71	1.59	5.58	110	
16	16	14	15	150	45	13.60	0.77	0.29	6.47	110	
17	17	14	16	75	335	-1.75	-0.40	-1.43	-4.26	110	
18	18	16	13	200	185	-9.87	-0.31	-0.16	-0.88	110	
19	19	16	17	200	85	7.66	0.24	0.05	0.55	110	
20	20	17	18	150	175	3.24	0.18	0.08	0.46	110	
21	21	18	12	150	370	2.29	0.13	0.09	0.24	110	
22	22	18	19	75	188	0.59	0.13	0.11	0.58	110	
23	23	19	20	75	410	0.16	0.04	0.02	0.05	110	
24	24	20	12	75	150	-0.40	-0.09	-0.04	-0.27	110	
25	25	17	25	200	160	3.87	0.12	0.02	0.16	110	
26	26	25	24	150	210	1.77	0.10	0.03	0.15	110	
27	27	24	22	150	200	1.04	0.06	0.01	0.06	110	
28	28	22	23	150	75	0.11	0.00	0.00	0.00	110	
29	29	22	21	75	265	0.51	0.12	0.12	0.43	110	
30	30	21	19	75	150	0.13	0.03	0.00	0.03	110	
31	31	25	26	150	330	1.31	0.07	0.03	0.08	110	
32	32	26	27	150	210	0.55	0.03	0.00	0.02	110	
33	33	27	28	150	80	0.13	0.00	0.00	0.00	110	
34	34	27	24	75	325	-0.01	-0.00	-0.00	-0.00	110	
35	35	26	29	75	225	0.12	0.03	0.00	0.03	110	

Output data on distribution network for Werota 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	55	53.13	0.75	0.15	2.75	110	
2	2	2	3	300	390	51.86	0.73	1.03	2.63	110	
3	3	3	4	250	230	48.03	0.98	1.28	5.55	110	
4	4	4	5	250	265	45.42	0.93	1.33	5.01	110	
5	5	5	6	75	115	2.18	0.49	0.73	6.39	110	
6	6	6	7	75	300	-1.80	-0.41	-1.34	-4.47	110	
7	7	7	4	75	115	-2.16	-0.49	-0.72	-6.27	110	
8	8	6	12	75	305	3.65	0.83	5.07	16.63	110	
9	9	12	11	75	220	-0.57	-0.13	-0.12	-0.54	110	
10	10	11	10	75	285	-1.64	-0.37	-1.08	-3.78	110	
11	11	10	9	75	225	-2.21	-0.50	-1.48	-6.56	110	
12	12	9	8	75	295	-2.55	-0.58	-2.52	-8.55	110	
13	13	8	3	75	270	-3.05	-0.69	-3.22	-11.91	110	
14	14	5	13	250	145	42.96	0.88	0.65	4.51	110	
15	15	13	14	150	285	9.90	0.56	1.02	3.59	110	
16	16	14	15	150	45	8.50	0.48	0.12	2.71	110	
17	17	14	16	75	335	0.96	0.22	0.47	1.40	110	
18	18	16	13	200	185	-32.69	-1.04	-1.49	-8.07	110	
19	19	16	17	200	85	33.36	1.06	0.71	8.38	110	
20	20	17	18	150	175	13.17	0.75	1.07	6.10	110	
21	21	18	12	150	370	11.93	0.68	1.88	5.08	110	
22	22	18	19	75	188	1.01	0.23	0.29	1.53	110	
23	23	19	20	75	410	1.49	0.34	1.30	3.17	110	
24	24	20	12	75	150	1.14	0.26	0.29	1.94	110	
25	25	17	25	200	160	19.85	0.63	0.51	3.21	110	
26	26	25	24	150	210	4.82	0.27	0.20	0.95	110	
27	27	24	22	150	200	1.41	0.08	0.02	0.10	110	
28	28	22	23	150	75	0.07	0.00	0.00	0.00	110	
29	29	22	21	75	265	1.08	0.24	0.46	1.73	110	
30	30	21	19	75	150	0.84	0.19	0.16	1.09	110	
31	31	25	26	150	330	14.54	0.82	2.42	7.32	110	
32	32	26	27	150	210	14.06	0.80	1.44	6.88	110	
33	33	27	28	150	80	16.75	0.95	0.76	9.51	110	
34	34	27	24	75	325	-2.96	-0.67	-3.66	-11.27	110	
35	35	26	29	75	225	0.08	0.02	0.00	0.01	110	

Output data on distribution network for Werota 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	55	52.79	0.75	0.15	2.72	110	
2	2	2	3	300	390	50.76	0.72	0.99	2.53	110	
3	3	3	4	250	230	46.70	0.95	1.21	5.27	110	
4	4	4	5	250	265	43.96	0.90	1.25	4.71	110	
5	5	5	6	75	115	1.32	0.30	0.29	2.52	110	
6	6	6	7	75	300	-1.44	-0.33	-0.90	-2.99	110	
7	7	7	4	75	115	-2.02	-0.46	-0.64	-5.58	110	
8	8	6	12	75	305	2.25	0.51	2.07	6.80	110	
9	9	12	11	75	220	1.16	0.26	0.44	2.00	110	
10	10	11	10	75	285	-0.56	-0.13	-0.15	-0.52	110	
11	11	10	9	75	225	-1.48	-0.33	-0.70	-3.12	110	
12	12	9	8	75	295	-2.02	-0.46	-1.64	-5.55	110	
13	13	8	3	75	270	-2.82	-0.64	-2.78	-10.29	110	
14	14	5	13	250	145	42.17	0.86	0.63	4.36	110	
15	15	13	14	150	285	13.21	0.75	1.75	6.13	110	
16	16	14	15	150	45	13.60	0.77	0.29	6.47	110	
17	17	14	16	75	335	-1.09	-0.25	-0.60	-1.79	110	
18	18	16	13	200	185	-28.36	-0.90	-1.15	-6.21	110	
19	19	16	17	200	85	26.81	0.85	0.48	5.59	110	
20	20	17	18	150	175	3.27	0.18	0.08	0.46	110	
21	21	18	12	150	370	1.22	0.07	0.03	0.07	110	
22	22	18	19	75	188	1.69	0.38	0.75	4.00	110	
23	23	19	20	75	410	-0.74	-0.17	-0.36	-0.87	110	
24	24	20	12	75	150	-1.30	-0.29	-0.37	-2.46	110	
25	25	17	25	200	160	22.99	0.73	0.67	4.21	110	
26	26	25	24	150	210	11.78	0.67	1.04	4.96	110	
27	27	24	22	150	200	9.60	0.54	0.68	3.40	110	
28	28	22	23	150	75	10.67	0.60	0.31	4.13	110	
29	29	22	21	75	265	-1.49	-0.34	-0.84	-3.17	110	
30	30	21	19	75	150	-1.87	-0.42	-0.72	-4.82	110	
31	31	25	26	150	330	10.42	0.59	1.31	3.96	110	
32	32	26	27	150	210	9.66	0.55	0.72	3.44	110	
33	33	27	28	150	80	10.69	0.60	0.33	4.14	110	
34	34	27	24	75	325	-1.46	-0.33	-0.99	-3.03	110	
35	35	26	29	75	225	0.12	0.03	0.00	0.03	110	

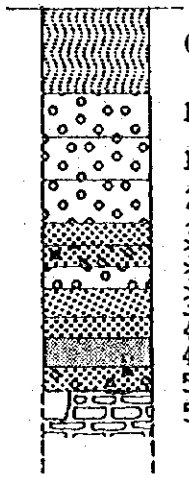
Output data on distribution network for Werota Case: Fire Fighting, 2010

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	55	66.27	0.94	0.23	4.14	110	
2	2	2	3	300	390	65.00	0.92	1.56	4.00	110	
3	3	3	4	250	230	60.71	1.24	1.97	8.56	110	
4	4	4	5	250	265	57.69	1.18	2.06	7.79	110	
5	5	5	6	75	115	2.41	0.55	0.89	7.71	110	
6	6	6	7	75	300	-2.20	-0.50	-1.96	-6.53	110	
7	7	7	4	75	115	-2.56	-0.58	-0.99	-8.64	110	
8	8	6	12	75	305	4.29	0.97	6.84	22.43	110	
9	9	12	11	75	220	-1.03	-0.23	-0.35	-1.60	110	
10	10	11	10	75	285	-2.10	-0.48	-1.70	-5.98	110	
11	11	10	9	75	225	-2.67	-0.60	-2.10	-9.32	110	
12	12	9	8	75	295	-3.01	-0.68	-3.43	-11.64	110	
13	13	8	3	75	270	-3.51	-0.79	-4.17	-15.46	110	
14	14	5	13	250	145	54.99	1.12	1.03	7.13	110	
15	15	13	14	150	285	10.67	0.60	1.18	4.13	110	
16	16	14	15	150	45	8.50	0.48	0.12	2.71	110	
17	17	14	16	75	335	1.73	0.39	1.40	4.19	110	
18	18	16	13	200	185	-43.95	-1.40	-2.58	-13.96	110	
19	19	16	17	200	85	45.39	1.44	1.26	14.82	110	
20	20	17	18	150	175	13.62	0.77	1.14	6.49	110	
21	21	18	12	150	370	11.36	0.64	1.72	4.64	110	
22	22	18	19	75	188	2.03	0.46	1.05	5.59	110	
23	23	19	20	75	410	0.96	0.22	0.57	1.40	110	
24	24	20	12	75	150	0.61	0.14	0.09	0.61	110	
25	25	17	25	200	160	31.43	1.00	1.20	7.51	110	
26	26	25	24	150	210	10.81	0.61	0.89	4.23	110	
27	27	24	22	150	200	6.42	0.36	0.32	1.61	110	
28	28	22	23	150	75	6.64	0.38	0.13	1.72	110	
29	29	22	21	75	265	-0.48	-0.11	-0.10	-0.39	110	
30	30	21	19	75	150	-0.72	-0.16	-0.12	-0.82	110	
31	31	25	26	150	330	20.13	1.14	4.41	13.37	110	
32	32	26	27	150	210	19.65	1.11	2.68	12.78	110	
33	33	27	28	150	80	23.32	1.32	1.40	17.55	110	
34	34	27	24	75	325	-3.94	-0.89	-6.21	-19.10	110	
35	35	26	29	75	225	0.08	0.02	0.00	0.01	110	

Appendix - 10

Geological Logs of Existing Boreholes

WSS Borehole No.1 in Werota



Depth	Lithology	
0 - 12 m	Soil:	clayey
12 - 18 m	Gravel:	with pebbles, calcite cement
18 - 24 m	Gravel:	calcite cement
24 - 30 m	Gravel:	
30 - 33 m	Sand:	medium-fine, chlorite
33 - 36 m	Sand:	with gravel
36 - 39 m	Gravel:	with pebble
39 - 43 m	Sand:	fine, petrifying wood
43 - 46 m	Sand:	fine,
46 - 50 m	Clay:	fossil wood
50 - 53.3m	Sand:	fine-medium, with gravel
53.3-	Basalt:	fresh and hard

Location : About 1 km north of the town center

Source : from "WOROTA GEOLOGICAL LOG BOREHOLE #1 - EWRA" by J.TAYLOR 1979