社会開発調査部報告書

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

MINISTRY OF WATER RESOURCES

No. 1 1

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

APPENDIXES
BICHENA

(Volume Ⅲ-X)

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 Bichena 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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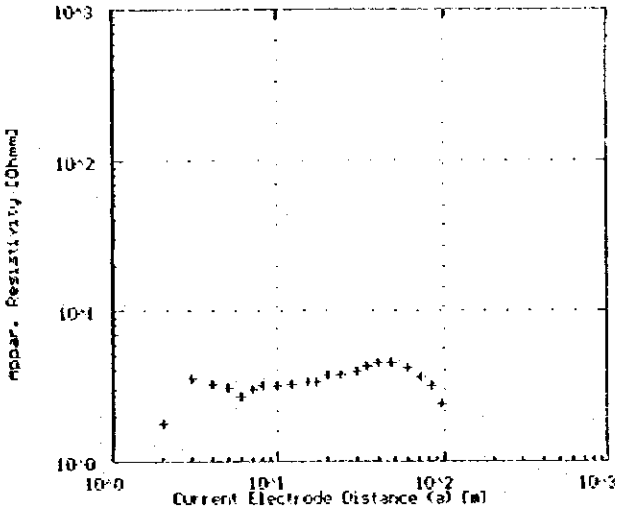
Appendix - 1

Resistivity Interpretation of VEP

Figure 1 Geoelectrical Survey, Wenner Array

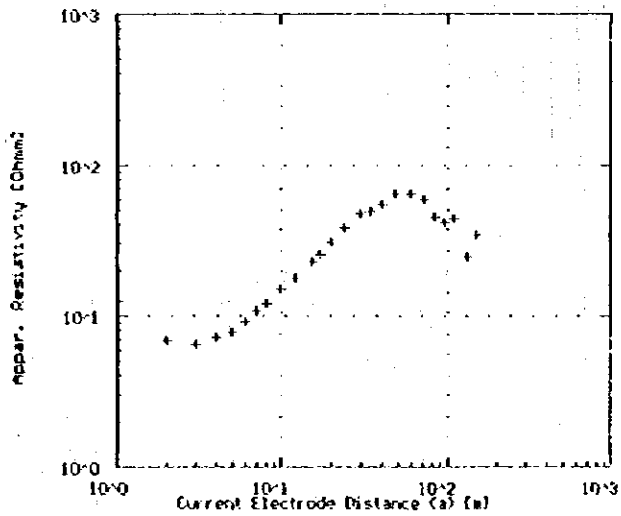
VES St. No.1 -BICHENA



Point (No)	AB/2 (m)	a (m)	Res (ohms)
1	1.00	0.910	
2	2.00	1.930	
3	3.00	3.490	
4	4.00	3.240	
5	5.00	3.110	
6	6.00	2.100	
7	7.00	3.030	
8	8.00	3.120	
9	10.00	3.140	
10	12.00	3.250	
11	15.00	2.300	
12	17.00	3.340	
13	20.00	3.210	
14	24.00	3.210	
15	30.00	3.060	
16	36.00	4.210	
17	40.00	4.520	
18	46.00	4.520	
19	50.00	4.130	
20	72.00	3.670	
21	84.00	3.370	
22	96.00	2.410	

Specific Resistivity(Ω-m)	12	3	6.4	1.31

VES St. No.2 -BICHENA



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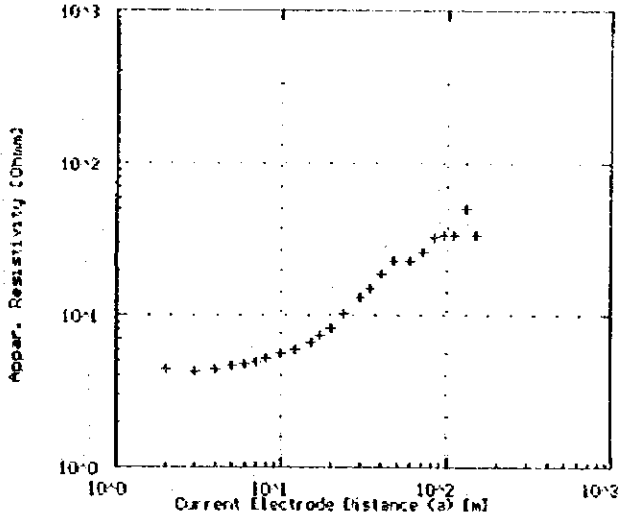
4	4.00	7.210	
5	5.00	7.910	
6	6.00	9.190	
7	7.00	10.810	
8	8.00	12.810	
9	10.00	15.010	
10	12.00	17.560	
11	15.00	22.700	
12	17.00	25.620	
13	20.00	30.370	
14	24.00	38.260	
15	30.00	47.290	
16	36.00	48.900	
17	40.00	56.810	
18	46.00	64.930	
19	50.00	66.810	
20	72.00	58.280	
21	84.00	46.840	
22	96.00	41.500	
23	110.00	44.210	
24	130.00	24.490	
25	150.00	33.810	

Specific Resistivity(Ω-m)	26.2	5.24	24	500	26

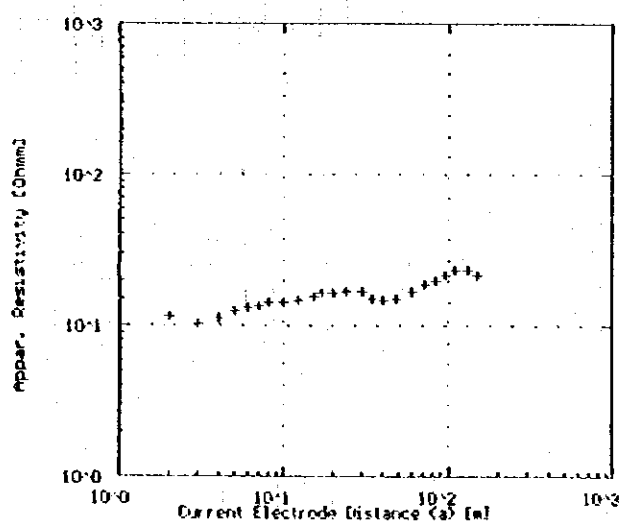
VES St. No.3 -BICHENA



Point [No]	AB/2 [Mr]	a [m]	Rss [ohm]
1	1.00	0.910	
2	2.00	1.690	
3	3.00	2.320	
4	4.00	3.370	
5	5.00	4.020	
6	6.00	4.710	
7	7.00	4.880	
8	8.00	5.180	
9	10.00	5.590	
10	12.00	5.950	
11	15.00	6.610	
12	17.00	7.370	
13	20.00	8.290	
14	24.00	10.690	
15	30.00	12.990	
16	36.00	15.160	
17	40.00	18.970	
18	60.00	22.610	
19	60.00	22.610	
20	72.00	26.230	
21	81.00	32.230	
22	95.00	31.160	
23	110.00	33.160	
24	130.00	50.620	
25	150.00	32.970	

Specific Resistivity(Ω-m)	8.5	2.12	5.4	24.5	204

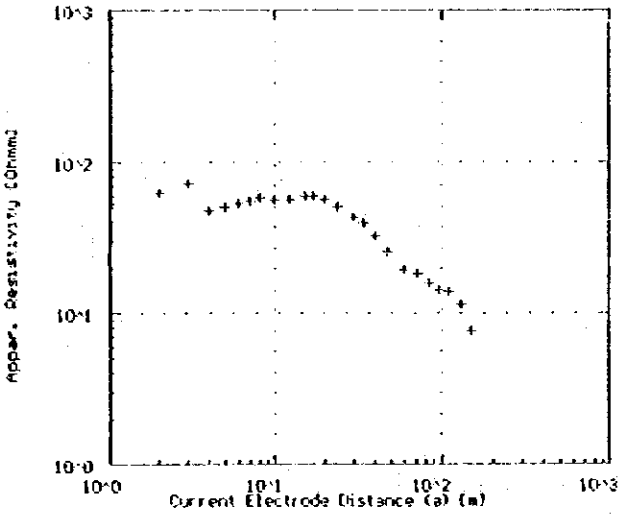
VES St. No.4 -BICHENA



Point [No]	AB/2 [Mr]	a [m]	Rss [ohm]
1	1.00	15.260	
2	2.00	11.030	
3	3.00	10.350	
4	4.00	11.390	
5	5.00	12.400	
6	6.00	13.190	
7	7.00	13.530	
8	8.00	14.020	
9	10.00	14.410	
10	12.00	14.720	
11	15.00	15.619	
12	17.00	15.550	
13	20.00	16.050	
14	24.00	16.320	
15	30.00	16.065	
16	36.00	15.165	
17	40.00	14.570	
18	60.00	15.070	
19	60.00	10.960	
20	72.00	19.560	
21	86.00	20.050	
22	96.00	21.700	
23	110.00	23.690	
24	130.00	23.680	
25	150.00	21.070	

Specific Resistivity(Ω-m)	17	8.5	15.75	21.3	9	50	22

VES St. No.5 -BICHENA



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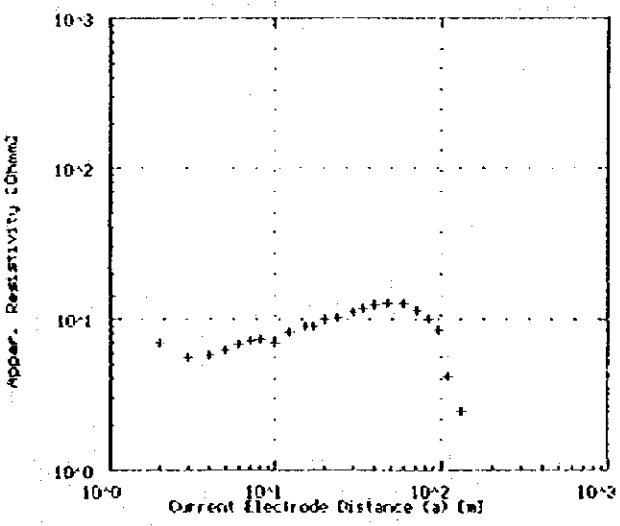
4	4.00	63.230	
5	5.00	58.550	
6	6.00	53.139	
7	7.00	55.390	
8	8.00	57.270	
9	10.00	55.690	
10	12.00	55.375	
11	15.00	59.350	
12	17.00	58.320	
13	20.00	56.528	
14	25.00	49.760	
15	30.00	43.330	
16	35.00	39.079	
17	40.00	32.050	
18	45.00	25.470	
19	50.00	19.220	
20	72.00	10.090	
21	81.00	15.030	
22	95.00	14.979	
23	110.00	13.020	
24	130.00	14.430	
25	150.00	7.549	

Specific Resistivity(Ω-m)	46	92	33.5	89	22.67	8.12

VES St. No.6 -BICHENA

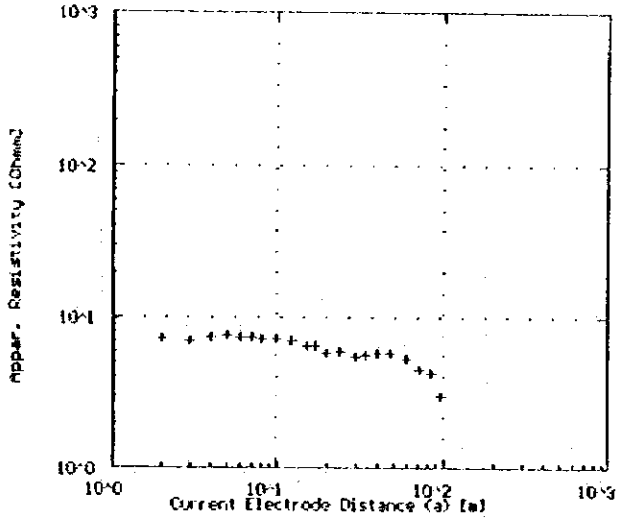


Point (No)	AB/2 (Mr)	a (m)	Res (ohms)
1	1.00	10.010	
2	2.00	6.010	
3	3.00	5.050	
4	4.00	5.999	
5	5.00	6.290	
6	6.00	6.780	
7	7.00	7.020	
8	8.00	7.310	
9	10.00	7.060	
10	12.00	8.290	
11	15.00	8.550	
12	17.00	9.080	
13	20.00	10.050	
14	24.00	10.170	
15	30.00	11.300	
16	36.00	11.260	
17	40.00	12.560	
18	45.00	12.950	
19	50.00	12.810	
20	72.00	10.590	
21	84.00	10.020	
22	95.00	8.650	
23	110.00	8.150	
24	130.00	2.450	

Specific Resistivity(Ω-m)	9.2	3.68	12.12		1.34

30.6 6.3

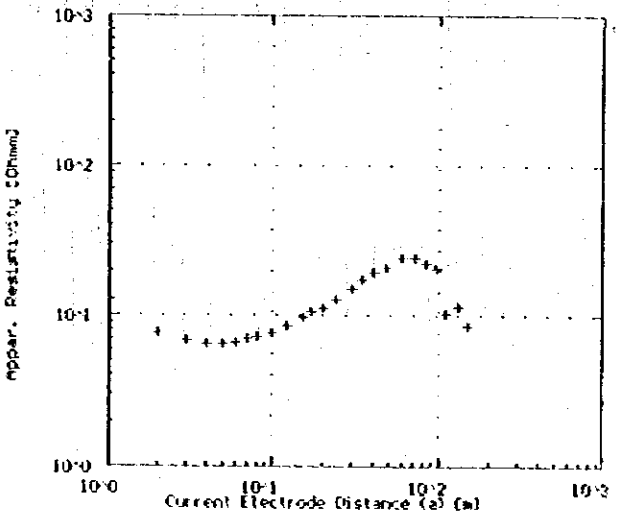
VES St. No.7 -BICHENA



Point (No)	MN/2 (Mr)	a (m)	Res (ohm-m)
1	1.00	0.870	
2	2.00	7.190	
3	3.00	0.970	
4	4.00	7.260	
5	5.00	7.570	
6	6.00	7.390	
7	7.00	7.670	
8	8.00	7.240	
9	10.00	7.220	
10	12.00	7.090	
11	15.00	8.500	
12	17.00	6.310	
13	20.00	5.010	
14	24.00	5.690	
15	30.00	5.060	
16	36.00	5.550	
17	40.00	5.780	
18	49.00	5.120	
19	60.00	5.200	
20	72.00	6.520	
21	86.00	6.720	
22	96.00	3.010	

Specific Resistivity(Ω-m)	18	7.2	4.93	5.6	2.24

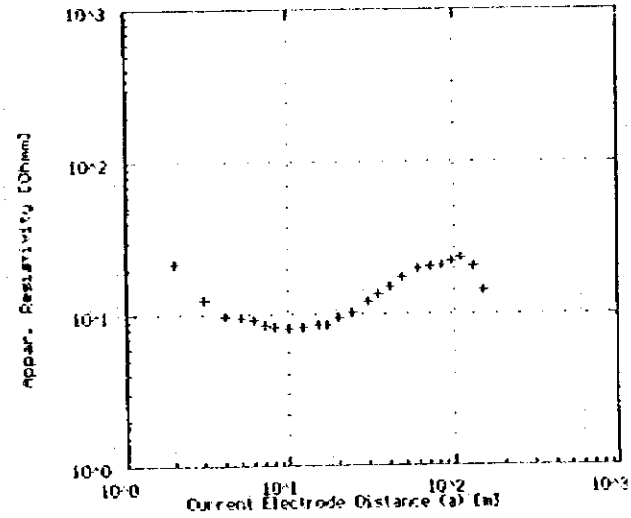
VES St. No.8 -BICHENA



Point (No)	MN/2 (Mr)	a (m)	Res (ohm-m)
1	1.00	12.010	
2	2.00	1.510	
3	3.00	6.780	
4	4.00	6.110	
5	5.00	6.410	
6	6.00	6.710	
7	7.00	6.950	
8	8.00	7.240	
9	10.00	7.550	
10	12.00	8.370	
11	15.00	9.610	
12	17.00	10.510	
13	20.00	11.100	
14	24.00	12.960	
15	30.00	15.260	
15	36.00	17.050	
17	40.00	18.090	
18	50.00	21.100	
19	60.00	24.020	
20	72.00	27.970	
21	86.00	22.160	
22	96.00	29.500	
23	130.00	18.360	
24	110.00	11.430	
25	150.00	0.440	

Specific Resistivity(Ω-m)	21	4.2	16.8	63	22	0.73

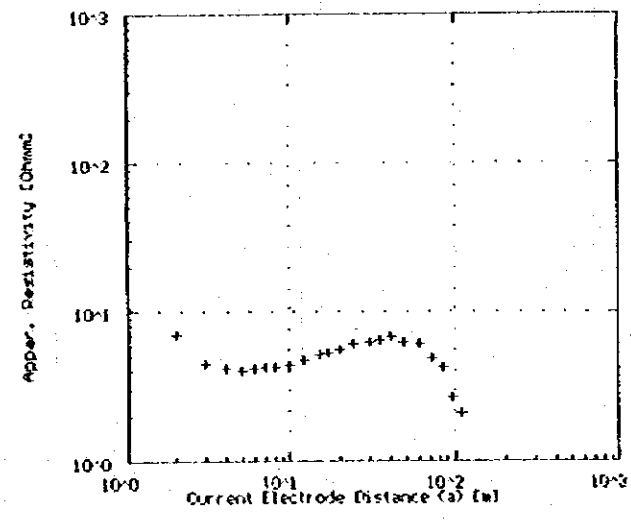
VES St. No.9 -BICHENA



Point (No)	MN/2 (m)	a (m)	Res (ohmm)
1	1.00	47.100	
2	2.00	21.480	
3	3.00	12.360	
4	4.00	9.800	
5	5.00	8.670	
6	6.00	8.270	
7	7.00	8.510	
8	9.00	9.290	
9	10.00	7.980	
10	12.00	8.290	
11	15.00	8.490	
12	17.00	8.510	
13	20.00	8.620	
14	24.00	10.690	
15	30.00	12.250	
16	36.00	13.450	
17	40.00	15.070	
18	48.00	17.190	
19	60.00	19.920	
20	72.00	20.570	
21	86.00	21.100	
22	96.00	22.310	
23	110.00	23.450	
24	130.00	28.610	
25	150.00	34.030	

Specific Resistivity(Ω-m)	73	8.11	35.2	7.33

VES St. No.10 -BICHENA

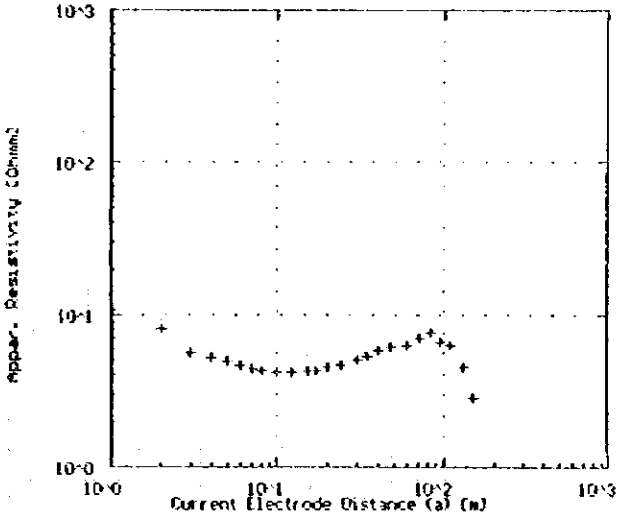


Point (No)	MN/2 (m)	a (m)	Res (ohmm)
1	1.00	10.390	
2	2.00	7.010	
3	3.00	6.500	
4	4.00	6.070	
5	5.00	6.050	
6	6.00	6.150	
7	7.00	6.310	
8	8.00	6.320	
9	10.00	6.400	
10	12.00	6.150	
11	15.00	5.160	
12	17.00	5.250	
13	20.00	5.650	
14	24.00	6.030	
15	30.00	6.220	
16	36.00	6.410	
17	40.00	6.780	
18	48.00	6.330	
19	60.00	6.030	
20	72.00	6.070	
21	86.00	6.220	
22	96.00	2.710	
23	110.00	2.070	

Specific Resistivity(Ω-m)	19	3.8	8	0.75

6.27

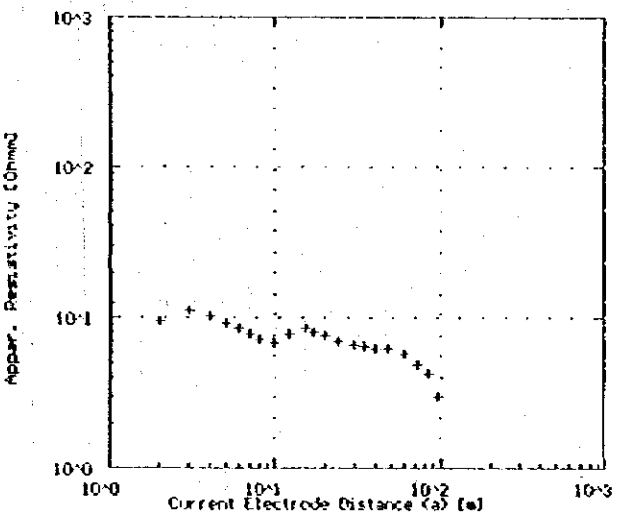
VES St. No.11 -BICHENA



Point [No]	AB/2 [Mr]	a [m]	Res [ohms]
1	1.00	10.000	
2	2.00	8.000	
3	3.00	5.650	
4	4.00	5.650	
5	5.00	4.840	
6	6.00	4.500	
7	7.00	4.400	
8	8.00	4.320	
9	10.00	4.210	
10	12.00	4.100	
11	15.00	4.260	
12	17.00	4.310	
13	20.00	4.520	
14	24.00	4.610	
15	30.00	5.090	
16	36.00	5.340	
17	40.00	5.700	
18	50.00	6.030	
19	60.00	8.220	
20	72.00	7.910	
21	84.00	7.650	
22	98.00	6.630	
23	110.00	8.220	
24	130.00	4.690	
25	150.00	2.830	

Specific Resistivity(Ω-m)	16.5	4.12	6.6	11.2	3.93	0.8

VES St. No.12 -BICHENA



Point [No]	AB/2 [Mr]	a [m]	Res [ohms]
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4	4.00	10.300	
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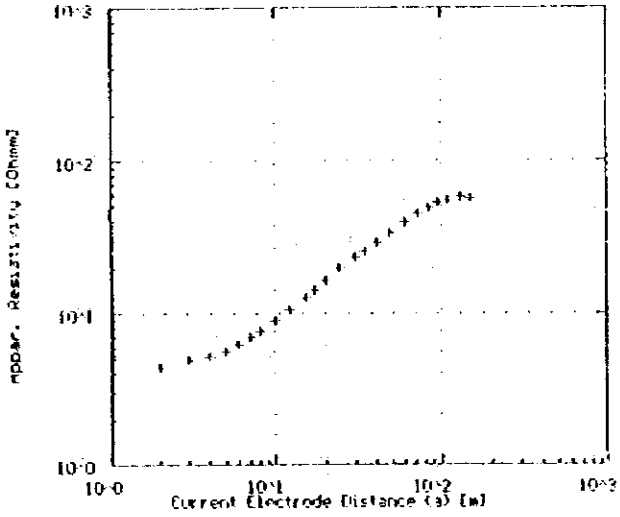
6	6.00	8.370	
7	7.00	7.810	
8	9.00	7.290	
9	10.00	6.780	
10	12.00	7.010	
11	15.00	9.380	
12	17.00	8.110	
13	20.00	7.560	
14	24.00	6.930	
15	30.00	6.590	
16	36.00	6.410	
17	40.00	6.280	
18	48.00	6.330	
19	60.00	5.810	
20	72.00	6.970	
21	84.00	6.220	
22	98.00	3.810	
23	110.00	0.630	

Specific Resistivity(Ω-m)	12.8	8.53	4.9	13.2	5.2	6.3	2.56

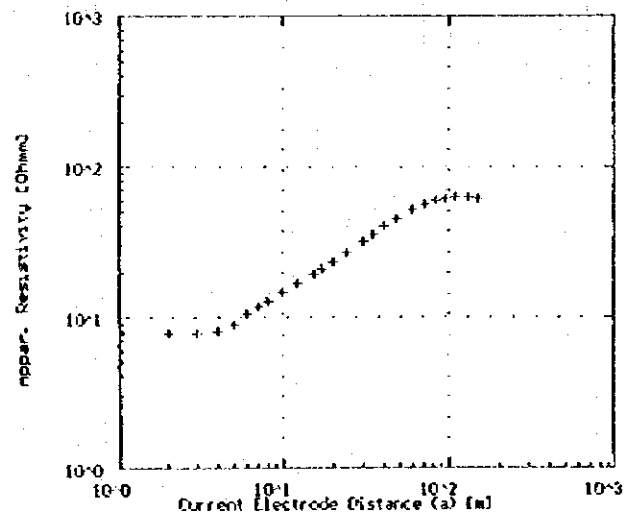
VES St. No.13 -BICHENA



Point [No]	AB/2 [M]	a [m]	Res [ohm]
1	1.00	5.200	
2	2.00	4.600	
3	3.00	4.900	
4	4.00	5.450	
5	5.00	5.500	
6	6.00	6.200	
7	7.00	6.950	
8	9.00	7.550	
9	10.00	9.000	
10	12.00	10.550	
11	15.00	12.320	
12	17.00	14.200	
13	20.00	16.550	
14	24.00	19.500	
15	28.00	23.250	
16	34.00	25.520	
17	40.00	30.600	
18	48.00	33.650	
19	60.00	39.550	
20	72.00	44.700	
21	86.00	49.000	
22	96.00	52.050	
23	110.00	55.200	
24	130.00	57.350	
25	150.00	55.500	

Specific Resistivity(Ω-m)	9	4.5	6.6	13.75	115	112.5

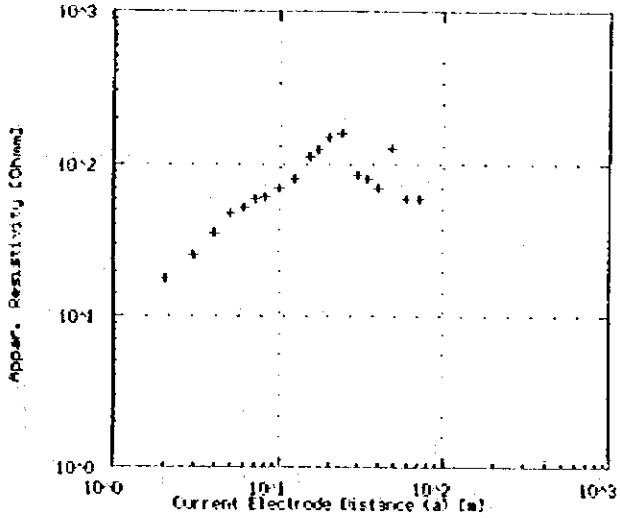
VES St. No.14 -BICHENA



Point [No]	AB/2 [M]	a [m]	Res [ohm]
1	1.00	3.200	
2	2.00	3.200	
3	3.00	3.220	
4	4.00	4.040	
5	5.00	4.950	
6	8.00	10.500	
7	7.00	11.050	
8	8.00	12.010	
9	10.00	14.760	
10	12.00	15.500	
11	15.00	18.310	
12	17.00	20.010	
13	20.00	23.210	
14	24.00	26.900	
15	30.00	31.040	
16	34.00	35.220	
17	40.00	40.150	
18	48.00	45.520	
19	60.00	52.000	
20	72.00	56.970	
21	84.00	59.080	
22	96.00	60.290	
23	110.00	62.470	
24	130.00	67.950	
25	150.00	60.290	

Specific Resistivity(Ω-m)	7.7	7.7	34.8	148	126	81

VES St. No.15 -BICHENA



Point (No)	AB/2 (Mr)	a (m)	Res (ohmm)
1	1.00	16.130	
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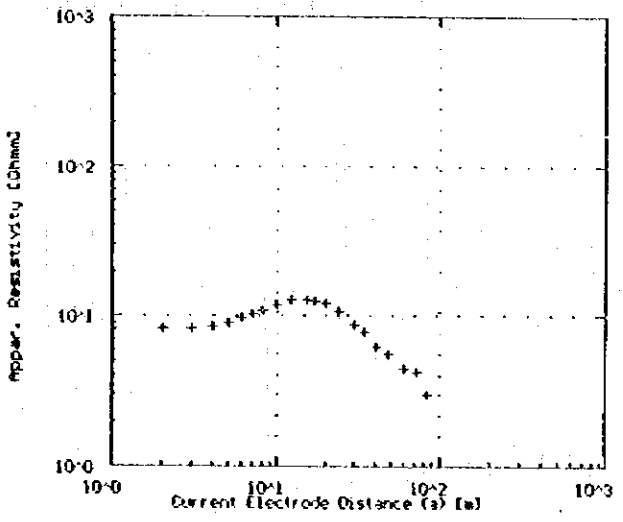
3	3.05	25.820	
4	4.00	33.920	
5	5.00	67.100	
6	6.00	57.020	
7	7.00	50.910	
8	8.00	60.290	
9	10.00	69.710	
10	12.00	79.510	
11	15.00	110.210	
12	17.00	123.050	
13	20.00	150.720	
14	26.00	155.760	
15	30.00	85.720	
16	36.00	81.140	
17	40.00	70.340	
18	48.00	120.620	
19	60.00	58.280	
20	72.00	58.180	

Specific Resistivity(Ω-m)	12.2	30.5	370	43.6

VES St. No.16 -BICHENA

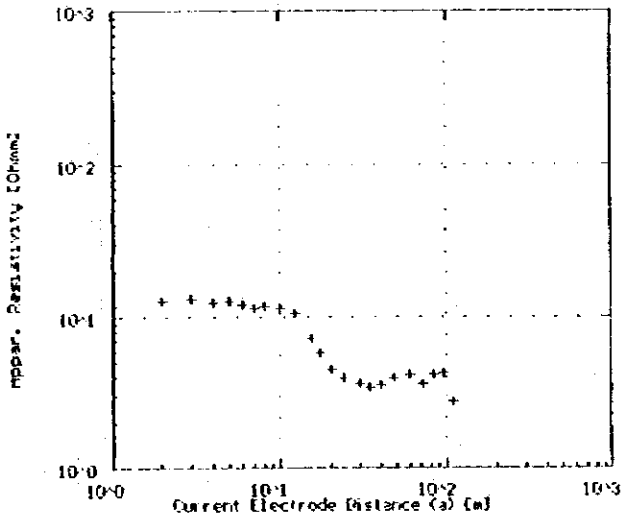


Point (No)	AB/2 (Mr)	a (m)	Res (ohmm)
1	1.00	0.160	
2	2.00	0.180	
3	3.00	0.290	
4	4.00	0.540	
5	5.00	0.890	
6	6.00	9.610	
7	7.00	10.290	
8	8.00	10.750	
9	10.00	11.930	
10	12.00	12.710	
11	15.00	12.070	
12	17.00	12.600	
13	20.00	12.060	
14	24.00	10.700	
15	30.00	8.610	
16	34.00	7.330	
17	40.00	6.330	
18	48.00	5.650	
19	60.00	4.520	
20	72.00	4.200	
21	84.00	3.010	
22	96.00	0.890	

Specific Resistivity(Ω-m)	9.1	9.1	24.6	3.8	2.6	0.43

8.93

VES St. No.17 -BICHENA



Point [No]	AB/2 [m]	a [m]	Res [ohm]
1	1.00	00.000	
2	2.00	00.000	
3	3.00	00.000	
4	4.00	00.000	
5	5.00	00.000	
6	6.00	00.000	
7	7.00	00.000	
8	8.00	00.000	
9	10.00	00.000	
10	12.00	00.000	
11	15.00	00.000	
12	17.00	00.000	
13	20.00	00.000	
14	26.00	00.000	
15	30.00	00.000	
16	36.00	00.000	
17	40.00	00.000	
18	48.00	00.000	
19	60.00	00.000	
20	72.00	00.000	
21	84.00	00.000	
22	98.00	00.000	
23	119.00	00.000	

Specific Resistivity(Ω-m)	11	16.5	9.07	2	3.9	0.15

Appendix - 2

Result of Water Quality Test

Result of Physico-Chemical Analysis in Bichena

Sample No.1

Origin of Sample : Borehole No.1 (WSS)
Date of Collection: 19/Jan./95
Date of Analysis : 08/Feb./95

Physical Characteristics

Appearance	: Very Clear
Odor	: Odorless
Taste	: -
Color	: Nil
Settleable Solids	: Absent
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 220
Turbidity	: Nil
Temperature	: -
Conductivity	: 0.46 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 230
Carbonate Hardness as $CaCO_3$	: 230
Non Carbonate Hardness as $CaCO_3$	: Nil
Total Alkalinity as $CaCO_3$	: 230
Bicarbonate Alkalinity as $CaCO_3$	: 230
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^-	: 15.00
Na^+	: -	NO_2^-	: Nil
K^+	: -	NO_3^-	: 3.20
Ca^{++}	: 92.00	F^-	: -
Mg^{++}	: 19.18	HCO_3^-	: 280.60
Fe(Total)	: 0.08	CO_3^{--}	: Nil
Mn^{++}	: 0.01	SO_4^{--}	: 11.00
Cu^{++}	: 0.05	PO_4^{---}	: 0.24

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 Bichena

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

Origin of Sample : Borehole No.1 (WSS)
Date of Collection: 12/Jul./95
Date of Analysis : 28/Jul./95

Physical Characteristics

Appearance	: Clear
Odor	: Odorless
Taste	: -
Color	: 6 Pt-Co
Settleable Solids	: Absent
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 348
Turbidity	: 1 FTU
Temperature	: 19.1 °C
Conductivity	: 0.58 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 275
Carbonate Hardness as $CaCO_3$	: 275
Non Carbonate Hardness as $CaCO_3$	: Nil
Total Alkalinity as $CaCO_3$	: 290
Bicarbonate Alkalinity as $CaCO_3$	: 290
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: 8.09
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: Nil	Cl^-	: 15.00
Na^+	: -	NO_2^-	: 0.05
K^+	: -	NO_3^-	: 17.16
Ca^{++}	: 76.00	F^-	: 0.275
Mg^{++}	: 20.70	HCO_3^-	: 353.80
Fe(Total)	: 0.01	CO_3^{--}	: Nil
Mn^{++}	: Nil	SO_4^{--}	: 5.00
Cu^{++}	: 0.01	PO_4^{---}	: 0.11

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 Bichena

Sample No.3

Origin of Sample : Hand dug well
Date of Collection: 12/Jul./95
Date of Analysis : 25/Jul./95

Physical Characteristics

Appearance	: Clear
Odor	: Odorless
Taste	: -
Color	: 6 Pt-Co
Settleable Solids	: Absent
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 348
Turbidity	: Nil
Temperature	: 19.1 °C
Conductivity	: 0.58 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 300
Carbonate Hardness as $CaCO_3$	: 250
Non Carbonate Hardness as $CaCO_3$	: 50
Total Alkalinity as $CaCO_3$	: 250
Bicarbonate Alkalinity as $CaCO_3$	: 250
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: 7.48
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: Nil	Cl^-	: 20.00
Na^+	: -	NO_2^-	: 0.05
K^+	: -	NO_3^-	: 36.52
Ca^{++}	: 92.00	F^-	: 0.424
Mg^{++}	: 28.00	HCO_3^-	: 350.00
Fe(Total)	: 0.01	CO_3^{--}	: Nil
Mn^{++}	: Nil	SO_4^{--}	: Nil
Cu^{++}	: 0.06	PO_4^{---}	: 1.63

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

Note; Unit is mg/litre unless otherwise stated.

Result of Faecal Coliform Test in Bichena, Sampled and Analyzed on July/12,13/'95

No.	Kebele	Source	Place of Sampling	No of F.C. per 100ml	Remarks
1	1	BH1	Reservoir	3	WT=20°C, 20% filled
2	2	BH1	P.Foun.3	3	WT=20°C
3	2	BH1	P.Foun.4	2	WT=20°C
4	1	BH1	P.Foun.5	6	WT=20°C, Ph=7.8
5	1	BH1	P.Foun.6	4	WT=19°C
6	1	BH1	P.Foun.7	4	WT=19°C, Temperature=17°C
7	1	BH1	P.Conn.	1	WT=20°C
8	1	BH1	P.Conn.	3	WT=19.5°C
9	1	BH1	P.Conn.	2	WT=20°C
10	1	BH1	Y.Conn.	0	At health center
11	1	BH1	P.Conn.	2	WT=19°C, At a hotel
12	1	BH1	P.Conn.	5	WT=15°C, At Enmay Hotel
13	1	BH1	Y.Conn.	3	WT=17°C
14	1	BH1	P.Conn.	5	WT=16°C, At Gihon Hotel
15	1	BH1	Clay pot	4	WT=19°C, Fetched on the day, Covered
16	1	BH1	Clay pot	16	WT=19°C, Fetched on the day, Covered
17	1	BH1	Clay pot	24	WT=18°C, Fetched 1 day before, Covered
18	1	BH1	Clay pot	12	WT=18°C, Fetched on the day, Covered
19	2	BH1	Clay pot	TMTC	WT=17°C, Fetched 2 days before, Covered
20	2	BH1	Clay pot	8	WT=15°C, Fetched 2 days before, Covered
21	2	BH1	Clay pot	TMTC	WT=16°C, Fetched 1 day before, Covered
22	2	BH1	Clay pot	3	WT=17°C, Fetched 1 day before, Covered
23	2	BH1	Clay pot	4	WT=18°C, Fetched 1 day before, Covered
24	2	BH1	Clay pot	26	WT=17°C, Fetched 1 day before, Covered
25	2	BH1	Clay pot	20	WT=18°C, Fetched 1 day before, Covered
26	2	HDW	HDW	TMTC	WT=20°C, Ph=6.5, Depth=25m, Very clean
27	2	HDW	HDW	23	WT=20°C, Ph=7.0, Depth=30m, Covered
28	2	HDW	HDW	TMTC	WT=20°C, Ph=7.0, Depth=25m, Covered
29	2	HDW	HDW	TMTC	WT=20°C, Ph=7.4, Depth=25m, Covered
30	2	HDW	HDW	25	WT=20°C, Ph=7.0, Depth=25m, Covered
31	2	HDW	HDW	TMTC	WT=20°C, Ph=6.8, Depth=30m, Covered
32	2	Rainwater	Clay pot	30	WT=15°C, Stored on the day, Covered

There are two water sources (BH1 & BH2), of which BH1 (near to the town) was working.
Because of rainy season, the water sources could not be accessed.

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

BICHENA - Activity Profile by gender

Public Fountain Users

Activity	Gender			Time	Place
	M	F	Remarks		
Fetches drinking water	n	y	women and girls		PF or well
Does the laundry	y	y	mostly females		at home
Waters livestock	y	n			
Takes water from container	y	y			
Teaches children hygiene	y	y	whoever is home		
Disposes of solid waste	n	y	few burn, few bury their refuse		
Digs a compost pit	y	n	very few		
Constructs a latrine	y	n	some have		
Digs a drainage channel	-	-	none		
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 home		

Well Water and Private Connection Users

Activity	Gender			Time	Place
	M	F	Remarks		
Fetches drinking water	n	y	women/girls/maids		
Does the laundry	n	y	women/girls/maids		at home
Waters livestock	y	n	often paid labor		
Takes water from container	n	y			
Teaches children hygiene	y	y	whoever is home		
Disposes of solid waste	n	y	women/girls/maids		
Digs a compost pit	y	n	some burn, some bury their refuse		
Constructs a latrine	y	n	if latrine, built by laborers		
Digs a drainage channel	-	-	none		
Tends a kitchen garden	y	n	gardens not irrigated		
Disposes of animal waste	n	y	girls/maids		anywhere
Keeps latrine clean	n	y			
Keeps compound clean	n	y	women/girls/maids		
Takes sick child to clinic	y	y	whoever is home		

BICHENA - Activity Profile by gender (continued)

Spring Users

Activity	Gender			Time	Place
	M	F	Remarks		
Fetches drinking water	y	y	mostly women/girls		
Does the laundry	y	y	males and females		at spring or home
Waters livestock	y	n	also laborers		
Takes water from container	n	y			
Teaches children hygiene	y	y	whoever is home		
Disposes of solid waste	n	y	anywhere, some use pits		
Digs a compost pit	y	n			
Constructs a latrine	y	n			
Digs a drainage channel	-	-	none		
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 home		

y = Yes, n = No

BICHENA - Daily Schedule (continued)

Private Connection Users

Man	Time	Woman
	6	Wakes up
Wakes up, washes	7	Supervises maid to make or sometimes makes breakfast
Eats breakfast	8	Eats breakfast
Looks after the children	9	*Sells tela, tea and food from home*
"	10	"
Drinks coffee with neighbor	11	"
"	12	"
Eats lunch with family	13	Eat lunch with family
Drinks coffee	14	*Sells tela, tea and food from home*
Makes social visits (EDER member)	15	"
"	16	"
"	17	(Also spins cotton for home use)
"	18	"
Returns home, looks after children	19	"
Eats supper with family	20	"
Relaxes	21	*Closes shop when last customer leaves*
Goes to sleep	22	Eats supper, clears up
	23	Goes to sleep

This couple are elderly, and the man no longer works.
The woman is the breadwinner in this family.
Water is stored in barrels from the PC for when it is needed.
Children fetch additional water from certain wells if required.
While woman is selling, she is also doing other household activities including spinning cotton for garments for the family.

BICHENA - Daily Schedule

Public Fountain Users

Man	Time	Woman
	6	
Wakes up, washes	7	Wakes up, washes, prepares breakfast
Goes to purchase Chat	8	**Fetches water**
"	9	Eats breakfast with children
Returns home, eats breakfast	10	*Goes to market to trade butter*
Goes to shop to sell Chat	11	"
"	12	"
"	13	Returns home, prepares lunch
"	14	Eats lunch, drinks coffee
"	15	Domestic chores, cleaning etc.
Returns home, eats lunch	16	"
Goes to shop to sell Chat	17	Cotton spinning (for home use)
"	18	Cleaning the home
"	19	Looking after the children
"	20	Prepares supper
"	21	Eats supper with children
Returns home, eats supper	22	Drinks coffee with neighbors
Goes to sleep	23	Clears up, goes to sleep

This is a Christian family (Chat is mostly a Muslim associated trade)
The woman pays for the children's food and for coffee from her earnings.

Private Well Owners

Man	Time	Woman
Gets up, washes	6	
Opens shop	7	
Eats breakfast	8	Gets up and eats breakfast
Works in shop (grain merchant)	9	Drinks coffee
"	10	Domestic chores like cleaning,
"	11	washing, sweeping, etc.
"	12	"
Eats lunch with family	13	Eats lunch
Drinks coffee	14	Drinks coffee with family
Tends the garden	15	Spins cotton (for home use)
(Eucalyptus, onions etc.)	16	"
Socializes and chews Chat	17	Makes baskets (for home use)
"	18	Takes care of the children
Returns home	19	"
Eats supper	20	Eats supper
Relaxes	21	Relaxes
Goes to sleep	22	Goes to sleep
	23	

The woman in the household gets much help from oldest daughters including fetching water. This is a Muslim family.

BICHENA - Access and Control Profile*

Handdug 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	not bought
Money for drying shelf	y	y	y	y	none seen
Money for building latrine	y	y	y	y	most have
Money for medicine	y	y	y	y	
Tools for digging pits	y	y	y	y	
Tools for constructing latrine	-	-	-	-	varies
Seeds and tools for vegetable gardens	y	y	y	y	
Land for digging pits	y	y	y	y	varies
Land for digging latrines	y	y	y	y	most do have
Land for digging drains	y	y	y	y	
Land for vegetable gardens	y	y	y	y	some have but do not irrigate
Income from selling water	y	y	y	y	
Income from selling vegetables	y	y	y	y	those with vegetables
Improved health	y	y	y	y	
Reduced time spent collecting water	n	y	n	y	
Reduced time spent caring for sick	y	y	y	y	

Spring/Public Fountain/Vendor 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	not bought
Money for drying shelf	y	y	y	y	
Money for building latrine	y	y	y	y	some do have the money
Money for medicine	y	y	y	y	
Tools for digging pits	y	y	n	n	may not own
Tools for constructing latrine	y	y	n	n	"
Seeds and tools for vegetable gardens	y	y	n	n	"
Land for digging pits	y	y	n	n	"
Land for digging latrines	n	n	n	n	some have
Land for digging drains	n	n	n	n	
Land for vegetable gardens	n	n	n	n	some have
Income from selling water	y	y	y	y	provisional
Income from selling vegetables	y	y	y	y	provisional
Improved health	y	y	y	y	
Reduced time spent collecting water	n	y	n	y	
Reduced time spent caring for sick	y	y	y	y	mostly women

y = Yes, n = No

*It is likely that the methodology we have used does not disclose this type of data adequately.

All members of the community we spoke with said that money was a shared pot and that purchase of items was a joint decision. The major factor influencing access and control seems to be decided by who is earning money.

BICHENA - Needs Analysis

Private Connection Users

		Gender		Remarks
		M	F	
Practical needs				
Water	Adequate quantities of water from the water supply system each day	y	y	At least four hours supply daily
	Price of water to remain the same	y	y	Already feel they pay enough for water
	Keep wells maintained	y	y	Wells are useful contingency supply
Sanitation	Financial assistance to build reasonable latrines	y	y	
	Allocation of area for disposal of solid waste	y	y	Nowhere allocated at present and is causing nuisance
	Public latrines for those in Kebele rented housing	y	y	Other people use surrounding area for defecation
Strategic needs				
Water	Prefer Government managed water supply system	y	y	
	PFs could be managed by the communities	y	y	
Sanitation	Public toilets to be managed by the authorities	y	y	
	Rubbish disposal facilities to be organized and managed by authorities	y	y	
Health education	Community level health education	y	y	Already aware of clinic based program

y = Yes, n = No

BICHENA - Needs Analysis (continued)

Public Fountain/PC Vendor/Well/Spring Users

		Gender		Remarks
		M	F	
Practical needs				
Water	Adequate quantities of water from the water supply system each day	y	y	
	Reduced time spent for water collection	y	y	Reduced queues and reduced distance to water supply facilities
Sanitation	Improved access to latrines. Need for women to have access to latrines even during daylight hours	y	y	Community latrines for those in rented housing and those who can not afford private latrines
	Allocate areas for refuse disposal and provide training and support for the safe disposal of refuse.	y	y	
Health education	Discussion groups for sanitary education required	y	y	No special attention required by poorest communities
Strategic needs				
Water	Public fountains possible to be managed by the community with support from Authorities	y	y	
	Additional public fountains to be constructed with the help of community labor.	y	y	All groups could assist with labor and with transportation of materials.
Sanitation	Community latrines to be managed by the community	y	y	Need to have support and even enforcement from Authorities for improvements in sanitation, including the use and management of community latrines.
	Public showers to be managed by the Authorities	y	y	Only would be used if inexpensive
Health education	Strengthen existing health education with community approach	y	y	

y = Yes, n = No

BICHENA - Social and gender considerations

Social and/or gender differences	Underlying factors	Impact of the project	Possible measures to be taken
Women fetch water most of the time and women usually do the laundry	Water collection and laundry are woman's roles in this society	Women will benefit significantly from time and energy savings from having more water available nearer to their homes	The project needs to identify what women would like to do with any time released from the water supply improvements
More difficult here than other towns to get people to meetings, except for elderly and infirm	Men and women in Bichena seemed to be busy trading and making business	Without other incentives sanitary education alone may be of little interest	Sanitary education must use all possible channels including house to house style activities on Sunday afternoons
Adults busy with other activities, not even interested in attending children's school programs	Men and women have little time available for extra activities	Health education should be organizes at times suitable to the community, i.e. Friday solat times for Muslims and Sunday mornings for Christians	There may need to be some incentives/ enforcement to insure improvements in sanitation
Poor income groups experience the worst access to existing water and sanitation facilities	Poor people have little disposable income for water or sanitation improvements	Poor people may not benefit from project. Comparably more women headed households are in the low income groups	Income generation activities must be supported through the project particularly for low income households
Muslims tend to be richer than Christians	Muslims tend to be more involved with trading and business	Muslims may be able to benefit more from the project than Christians	Attention must be given to ensure that Christians obtain an equal share of the benefits of the projects

Appendix - 4

Summary of Group Meeting

BICHENA - Summary of group meetings

Group 1 details	Group characteristics	Group needs
General	Amhara, Mixed Christians and Muslims, 2 women, 13 men, Traders, Government Employees, Shop Keepers etc	1-Water, 2-Improved Health Facilities, 3-Asphelt Road Surface
Water	Spring users, but there are problems over water rights with local peasants over the use of the springs (pots have been broken). Women fetch the water and both men and women do laundry at spring. Fetching water takes 2 hours (!) Spring is contaminated.	Would like private connections and for the minority who can not afford them there is a need for a public fountain. Can assist with labour/cash for PF and could pay for attendant for PF management.
Sanitation	Most people use open field defecation due to lack of control over the land (rented houses), lack of land for latrines and lack of cash and lack of motivation.	Community latrines would be a good idea and could work (not asked about loans for private latrines). Do not want pour flush latrines but do want water for washing. Can afford to pay water charge and emptying costs.
Health	Common diseases include Amoebic dysentery and eye infections (dust related). Health education occurs at the clinic only.	Would appreciate health education at community level with poster etc, probably Sunday afternoons is best as most people have free time.

Group 2 details	Group characteristics	Group needs
General	Amhara, Muslims and Christians, 2 women, 10 men, Small business proprietors	1 - Water, 2 - Electricity
Water	Well water users, wells in this area are sufficient all year. Those without wells buy from well owners for up to 10 cents/pot depending on water quality. Those who can not afford use river water. Women fetch water and do laundry.	Would like piped water supply to include private connections (mostly) and a public fountain for those who can not afford PCs. Could assist with labour/money for PF construction and for management. They helped to construct the existing system.
Sanitation	Most use open field for defaecation because of lack of affordability, wood for construction is very expensive. Women go early morning and late evening and must not be seen. Garbage disposal is also open field.	Would like communal latrines for poorer people and loans for private latrines for those who can afford as these are easier to look after. Preference for latrines which can be kept clean easily and do not smell, and that can be emptied easily.
Health	Common diseases are few but include flu and occasional diarrhoea for children. Do not know why children get diarrhoea. Health education is carried out at the clinic, otherwise there is none.	Would be interested in community level health education, but require improvements in water and sanitation first (or at least together).

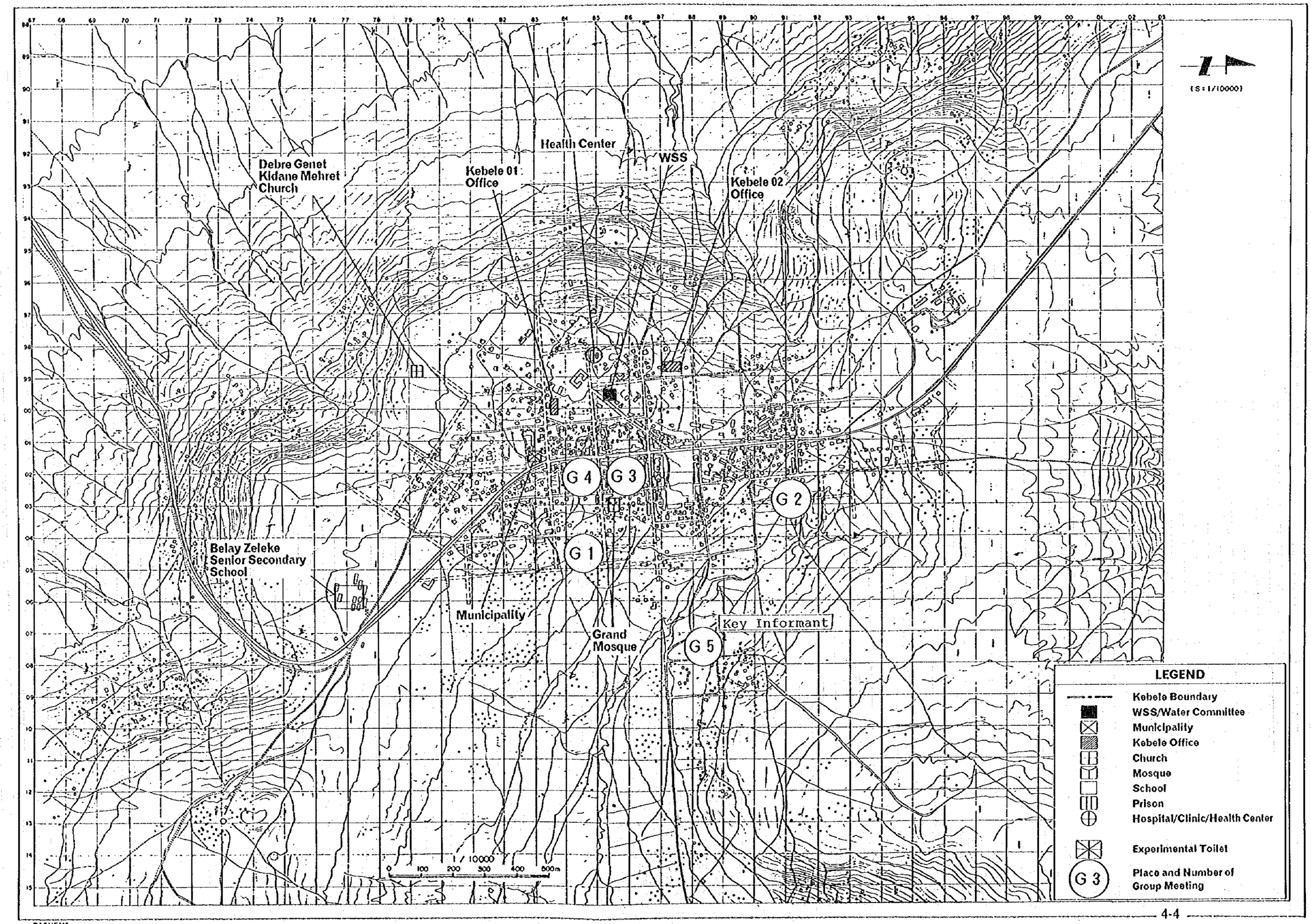
BICHENA - Summary of group meetings (continued)

Group 3 details	Group characteristics	Group needs
General	Public fountain users, Mixed Christians and Muslims, 15 women, 10 men, many children, Petty traders(mostly food items), and daily labourers	1-Water, 2-House repairs, 3-Improved health service
Water	Public fountain users but PF only open 1 time in two days (2-4 hours). 3 Pots cost 10 cents. Water needs supplemented by wells at 1 pot for 10 cents. Women fetch water. Women use both sources for drinking, washing and laundry.	PF to be open each day for 4 hours would be adequate. Could pay more for improved service.
Sanitation	Most practice open field defecation because they live in Kebele rented housing and lack control of land. Women go late at night or early morning to defecate, as they require privacy. Garbage disposal is also open.	Would like community latrines to be shared by sex rather than by groups of families. Difficult to pay for emptying of the latrines. Require some enforcement to use the latrines and also enforcement for the improved disposal of garbage.
Health	Common diseases include TB and diarrhoea (due to poor sanitation) Have some health awareness. Health education been received at clinic only.	Health education is of interest but alone it will make no difference. Some enforcement is required to improve the condition of the environment and thus improve public health.

Group 4 details	Group characteristics	Group needs
General	Amhara, Mixed Christians and Muslims, 5 women, 6 men, lots of children, shop keepers, small business people and daily labourers.	1-Water, 2-Latrines, 3-Health
Water	Private connection users when they function which is only once in 3 days for 3 hours. PCs do not work when the PFs are open. When no water use handdug wells. Women and female children fetch water and do laundry at home. They do not sell water.	Would like 24 hour water supply from PCs or at least 4 hours daily. PFs need to be open more as there are long queues. Not prepared to pay more for PCs - price already high, although more reasonable price at PFs.
Sanitation	Most do not have latrines and use open places for defecation during dark hours. Other people also use the area round their homes for defecation. People lack the land and the financial means to construct latrines. Most live in Kebele rented housing.	Would like public latrine for the area to be managed by the municipality. Those who can afford to pay to use it will do so. Would also like a public shower also to be managed by the Municipality. Prefer the latrine/shower to be built away from them.
Health	Common diseases include flu and diarrhoea for children. Do not know the cause of these diseases. Health education received at clinic.	Would like health education programme at community level. Also problem of solid waste disposal needs to be addressed.

BICHENA - Summary of group meetings (continued)

Key Informant	Key Informant Characteristics	Key Informant Needs
General	Amhara, Muslim, Male, 79 yr. old former Judge, Village representative for Finyaladur	1-Water, 2-Electricity
Water	Private well users but laundry done at the stream, plenty of water in wet season but in dry season there is not enough and must go to springs. Those who do not have wells use spring water all year or must buy water from well owners.	Would like the water supply system extended to cover the village with both PCs and a PF. Could assist with labour and in management.
Sanitation	Only a few households in the area have latrines. Rubbish is disposed of anywhere. Those without latrines lack land or cash and are too busy doing other things (business).	Community latrines would work in the village but perhaps in town would need some authority to supervise them. Penalties for open defecation or open waste disposal might also work.
Health	Not aware of health education programme at the clinic	


(S=1/10000)
Debre Genet
Kidane Mehret
Church
Kebele 01
Office
Health Center
WSS
Kebele 02
Office
G 4
G 3
G 2
G 1
G 5
Belay Zeleke
Senior Secondary
School
Municipality
Grand
Mosque
Key Informant
0 100 200 300 400 500m
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

BICHENA

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,	10	11	25	18	13	18
female, tempo-	1	5	5	4	4	5
rary/contract	10	11	8	0	8	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/	190(70)	89	852	396	-	320
yard connections,	8(2)	8(5)	12	7(6)	5(3)	13(2)
public fountains,	1	1				
hydrants						

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 Bichena

1. Official Water Price: 1.25 birr/m3 for all clients

2. Production and Consumption of Water, 1993/94

1) Production : 17,810 m3

2) Consumption: 15,826 m3

* Daily water consumption as divided by total population = 2.4 litre

* Leakage ratio = 11.1%

3. Income and Expenditure

1) Income : 34,678.68 birr

Major sources of income

(1) Water sales	17,442.25 birr	(50.3%)
(2) Service charge	7,204.75 birr	(20.8%)
(3) Public fountains	4,752.75 birr	(13.7%)
(4) Service charge	1,506.47 birr	(2.3%)

* Bill collection rate = 96.8%

* Income per unit consumption of water = 2.19 birr/m3

2) Expenditure: 71,590.98 birr

Major items of expenditure

(1) Salaries	40,730.45 birr	(56.9%)
(2) Fuel (for generator)	19,760.28 birr	(27.6%)
(3) Transport & per diem	2,462.60 birr	(3.4%)

* Expenditure per unit production of water = 4.02 birr/m3

* Income-expenditure ratio = 48.4%

4. Organization and Personnel

1) No. of personnel: 20 (6) [2]

(1) Head, WSS 1

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

(2) Administration 10 (4) [2]
1 head, 5 [2] guards, 1 (1) store keeper, 2 (2) administrative clerks, 1 (1) cleaner

(3) Finance 6 (2)
1 head, 1 cashier, 1 water meter reader, 3 (2) water sellers

(4) Urban water supply & sewerage 3
1 head, 2 motor operators

Note: Parenthesized and bracketed figures denote the number of female and temporary workers respectively.

* Production per worker = 891 m3/year

* Income and expenditure per worker = 1,734 birr, 3,580 birr/year

2) Average monthly salaries of employees: 170 birr

5. No. of Distribution Facilities

1) House connections : 2

2) Yard connections : 236

(1) Household	:	185
(2) Governmental & public	:	12
(3) Commercial	:	39

3) Public fountains : 7 (all functional)

6. Problems and Bottlenecks

1) Shortage of water sources.
2) Limited distribution line. Only one straight line.
3) Loss of head for the reservoir.
4) Shortage of financial resources.
5) Shortage of pipes and fittings. (Formerly they were provided by WSSA.)
6) No transport.

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 Bichena

I. Administrative Conditions

1. Administrative Classification: Region 3, Zone = East Gojjam

2. Government Organizations
1) Agricultural Department
2) Natural Resources Development and Environmental Protection (NRDEP)
3) Weroda Administration
4) Financial Department
5) Educational Office
6) Municipality
7) Health Center
8) Health Office
9) Merchandise Wholesale and Import Trade Enterprise
10) Culture and Sports Department
11) Prison Administration
12) Police
13) Post Office
14) Telecommunications
15) Weroda Court
16) Weroda Attorney
17) Ethiopian Grain Trade Enterprise
18) Commercial Bank of Ethiopia
19) Water Supply Service (WSS)

Notes: 1. Schools are not included in the above organizations.
2. There is no NGO. There are 5 public organizations.

3. No. of Government Employees and Their Average Monthly Salaries: 499, 374 birr

* No. of government employees per 1,000 population: 57

4. No. of Kebele: 2

II. Socio-Economic Conditions

1. Population
1) Total population: 14,629

2) Ethnic composition: Amhara (99.0%), Oromo (1.0%)

3) Religious composition: Christians (67.0%), Moslems (33.0%)

4) Average family size: 6.2 persons

Table 4 (2) Socio-Economic Condition of Bichena

2. Area: 200 ha * Population density: 73.1 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	2	2	1	1
(2) No. of class rooms	2	35	8	15
(3) No. of teachers	4	104	27	30
(4) No. of pupils/students	132	1,850	618	865

* No. of pupils/students per 100 population: 24

2) Literacy ratio: 69.1% (1984)

3) Primary school enrollment ratio: 67.8% (1984)

4. Medical Conditions
1) No. of medical institutions/establishments:
1 Health Center (10 beds), 1 private drug store , 1 pharmacy under the jurisdiction of Health Center

2) No. of medical personnel:
2 doctors (physicians), 4 nurses, 16 health assistants, 1 laboratory technician, 1 pharmacy technician, 3 junior health assistants ... 27 in total

Other related personnel: 2 sanitarians

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

(1) Top ten diseases

i.	Skin diseases	1,246 cases
ii.	Intestinal parasite	1,088
iii.	Gastritis	889
iv.	T.B.	834
v.	Urinary tract infection	700
vi.	Aromatism (joint illness)	641
vii.	Fever of unknown origin	558
viii.	Pneumonia	529

Table 4 (3) Socio-Economic Condition of Bichena

ix. Upper respiratory tract infection	527	1. to x.	
x. Disseminated T.B.	429	=	7,441

(2) Estimated number of cases per year as percentage of population:
(7,441 x 1.5) / (14,629 x 5) = 15.3%

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

4) Under 5 mortality rate: 173.4/1000 (1984)

5) Life expectancy: 51.9 years (1984)

6) Households more or less using septic tank and pit latrine: 45.0%

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	2	2	4
Bars	7	32	3	42
Tej houses	1	0	0	1
Sub-total	8	34	5	47
2. Shops	244	92	1	337
3. Cottage industry				
Flour mills	0	0	26	26
Tyre repairing	1	0	0	1
Sub-total	1	0	26	27
4. Others	2	0	1	3
Total	255	126	33	414

Notes: 1. Shops include traders of clothes, thread, textiles, spices and hot sauce, kerosene, leather and skin, leather products, grains, butter & honey, coffee, fruit &

Table 4 (4) Socio-Economic Condition of Bichena

vegetables, building materials, cotton, salt, kitchen utensils, drugs, chickens & egges, beverages, bakeries, groceries, photo shops, stationeries, sweet factories and watch & radio maintenance shops.

2. Others include filling stations and butcheries.

3. No. of local drink producers: 300-350 households

4. No. of households making tea & "arake": 400-500

* No. of commercial and industrial establishments per 1,000 population: 28

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

3) Major products: flour

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

(2) Prices of major marketable items

Grains (unit: birr/100 kg)

tef	wheat	peas	beans	chick peas
220	190	220	190	180

Livestock (unit: birr/one)

ox	cow	sheep	goat	donkey	chicken
1,000	850	100	100	250	10

Table 4 (5) Socio-Economic Condition of Bichena

Consumers' items (unit: birr)		
butter (kg)	honey (kg)	milk (litre)
24	11	2

(3) Market days - Thursday and Saturday (4,000-5,000 and 10,000 (people gather on Thursday and Saturday, respectively.)

4) Average monthly household income: 323.9 birr

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

Appendix - 6

Result of Initial Environmental Examination

Project Description on Initial Environmental Examination in Bichena

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	Bichena, Inemay, Weroda, Region-3
Executing Agency	Water Supply and Sewerage Service Department Ministry of Water Resource
Beneficiaries	About 14,600 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, Surface water as river 5km away. There are many hand dug wells.
Water Quality	Chemical aspects are within WHO guideline values Biological contamination is notified.
Main Facilities	Boreholes with pumping system.
Water Storage Facilities	Reservoir (elevated type) with enough capacity.
Filtration Plant	Not to be considered.
Related facilities	Distribution pipes, public fountains, drainage system and latrines
Remarks	Chlorine or its derivatives such as mainly calcium hypochlorite is used for disinfection in Ethiopia.

Site Description on Initial Environmental Examination in Bichena

Items	Description
Project Title	Eleven Centers Water Supply and Sanitation
Social Environment	
Residents (population, tribe, consciousness)	Population about 14,600, mostly Amhara with relatively low consciousness regarding sanitat'n
Facilities related to life (electricity, etc.)	The electricity is supplied from hydropower.
Health and Sanitation (diseases, clinic, etc.)	0 hospital, 1 health center, 2 drug stores, Giardiasis and amboesis are among top 10 disease
Natural Environment	
Topography, Geology and Hydrogeology	Located on a gentle slope plateau with NW-SE. Alkali-olivine basalt dominates the foundation. Groundwater depends on fractures of the basalt.
Meteo-hydrology Groundwater/spring/river	Annual rainfall about 784mm. Potential of ground water is likely to be less.
Endangered fauna and flora	Nil
Public Nuisance	
Nuisances	There are stagnant waters in the town because of poor drainage system and O&M. There is a part of town not getting water because of the pressure.
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. Since all current drainages are filled, rehabilitation works are needed. 2. The present elevation of the reservoir is too low to cover all town's area.

Scoping Format for Initial Environmental Examination in Bichena

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 (No water vendor depends totally on water selling for the income).
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, 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 Bichena

No.	Description	F.C.(B)	L.C.(B)	Total(B)
I.	Target year of 2005			
1	Civil Work			
	Mobilization and Demobilization	100,000	150,000	250,000
	Excavation and Earth-work	8,240	27,700	35,940
	Trench excavation	415,550	937,500	1,353,050
	Pipe-work	339,260	339,260	678,520
	Reservoir	144,000	144,000	288,000
	Pumping station, R.C.pump house	132,048	87,984	220,032
	Access road	267,000	621,000	888,000
	Bore-hole (200mm casing)	92,800	139,200	232,000
	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	80,000	120,000	200,000
	Power supply	35,850	38,775	74,625
	Concrete work	112,440	195,240	307,680
	Masonsy work	6,000	24,500	30,500
	Structure	116,660	272,190	388,850
	Temporary work(10% of above total)	221,985	371,235	593,220
	Total of civil work	2,441,833	4,083,584	6,525,417
2	Material & Equipment	6,096,042	426,722	6,522,764
	Sub Total	8,537,875	4,510,306	13,048,181
3	Engineering cost(12% of sub tatal)	1,565,782		1,565,782
4	Contingency(5% of above cost)	505,183	225,515	730,698
	Total(birr)	10,608,840	4,735,821	15,344,661
	Total(Yen:1birr=15yen)			230,170,000
5	Buildings		1,097,437	1,097,437
6	WSSD's management cost		328,842	328,842
	Total		1,426,279	1,426,279
7	Prise escalation(6%)	636,530	369,726	1,006,256
	Grand Total	11,245,370	6,531,826	17,777,196
II.	Target year of 2010			
1	Morbilization and demorbilization			400,000
2	Rising line			552,000
3	Distribution network			1,350,000
4	New borehole with pumps & material			1,318,000
5	Booster pump with house			534,000
6	Power supply facilities			170,000
7	Chamber and structures			351,000
8	Buildings			1,124,400
9	Others			554,600
	Sub total			6,354,000
10	Engineering cost (10%)			635,400
11	Contingency (10%)			698,940
	Total			7,688,000
12	Prise escalation(6%)			3,229,000
	Grand Total			10,917,000

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				100,000	150,000	
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	21,500	4	8	86,000	172,000	
	b) 1.0~1.5m depth	m	11,700	7	17	81,900	198,900	
	c) 1.5~2.5m depth	m	350	10	23	3,500	8,050	
3-2	Trench, Rock excavation	cum	300	30	70	9,000	21,000	
3-3	Back-fill with the same material	m	16,700	5	11	83,500	183,700	
3-4	Selected soil bedding	m	16,850	2	5	33,700	84,250	150mm thick below barrel
3-5	Back-fill with selected material	m	16,850	7	16	117,950	269,600	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	14,360	5	5	71,800	71,800	
	b) DN 75mm	m	6,410	8	8	51,280	51,280	
	c) DN 100mm	m	4,480	10	10	44,800	44,800	
	d) DN 150mm	m	7,180	17	17	122,060	122,060	
4-2	Pressure steal pipe							fitting and supports for bridge and road
	DN 200mm	m	360	137	137	49,320	49,320	
5.	Reservoir							
5-1	Ground level reservoir	m3	160	900	900	144,000	144,000	
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 Bichena : 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	190	320	480	60,800	91,200	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.	6	60,000	100,000	360,000	600,000	foundation, pump, and motor with accessories
11.	Electric submersible pump (for deep well)	No.	4	20,000	30,000	80,000	120,000	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
	a) Water retaining structure	cum	200	275	642	55,000	128,400	
	b) Building	cum		230	534	0	0	
13-3	Form-work							including all necessary works
	Wall	sqm	120	37	87	4,440	10,440	
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	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.	10	1,580	3,680	15,800	36,800	
15-2	Construction of hydrant	No.	15	230	540	3,450	8,100	
15-3	Construction of R.C.C. aeration chamber	No.	8	5,730	13,370	45,840	106,960	
15-4	Construction of R.C.C. valve chamber	No.	9	5,730	13,370	51,570	120,330	

Cost Estimation of Construction & Materials/Equipment of Bichena : 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
	Sub-Total of Construction work					2,219,848	3,712,349	
16.	Material & Equipment (Ref.table)							
16-1	CIF Cost at Addis Ababa					6,096,042		
16-2	Inland transportation cost						426,722	CIF cost x 7 %
	Sub-Total of Material & Equipment					6,096,042	426,722	
	Total					8,315,890	4,139,071	
17.	Building							
17-1	Office	sqm	90		1,910		171,900	
17-2	Workshop	sqm	93		1,624		151,032	
17-3	Store	sqm	155		1,337		207,235	
17-4	Resience	sqm	270		2,101		567,270	
	Total						1,097,437	

Imported Cost (Material & Equipment) of Bichena: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	15,080	15	226,200
	b) DN 75mm	m	6,450	30	193,500
	c) DN 100mm	m	4,710	40	188,400
	d) DN 150mm	m	7,540	80	603,200
1.2	Suspended pressure steel pipe DN 200mm W/O gilt and screw	m	380	288	109,440
1.3	Fitting cost Total cost × 20%				264,148
2	Pumps (Pump with electric motor/accessories)				
2.1	Centrifugal pumps				
	a) Q= 1.1 m3/min H= 13m HP= 3.7kw	set	2	300,000	600,000
	b) Q= 0.32m3/min H= 70m HP= 11 kw	set	4	300,000	1,200,000
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	2	171,000	342,000
3	Power Supply(Materials&accessories)				
3.1	Power supply generating set 70 KVA	set	1	510,000	510,000
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 60 KVA (H-TYpe)	set	2	55,300	110,600
4	Valve (Valve with accessories)				
4.1	Sluice valve				
	a) ϕ75	set	3	1,300	3,900
	b) ϕ150	set	2	1,700	3,400
	c) ϕ200	set	1	2,200	2,200
	d) ϕ250	set	3	2,800	8,400
4.2	High speed air valve ϕ50	set	8	7,000	56,000
4.3	Pressure reducing valve				
	a) ϕ75	set	2	7,000	14,000
	b) ϕ150	set	1	10,000	10,000
4.4	Check valve				
	a) 100mm	set	1	10,000	10,000
	b) 150mm	set	1	15,000	15,000
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	78	2,093	163,254
7.2	Screen FRP DN 200	m	112	5,700	638,400
7.3	Riser pipe, stainless DN 65	m	200	180	36,000
8	Water purification unit	set	1	80,000	80,000
	Total				6,096,042

Investment Cost of Target Year 2010 in Bichena

No.	Description	Unit	Q'ty	Unit Rate (B)	Amount (B)
1	Mobilization and demobilization	LS			400,000
2	Rising line	Km	1.84	300,000	552,000
3	Distribution network	Km	9	150,000	1,350,000
4	New borehole with pumps & material	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	13	27,000	351,000
9	Buildings	M2	12	93,700	1,124,400
	Others	LS			554,600
	Sub total				6,354,000
11	Enginering cost (10%)				635,400
12	Contingency (10%)				698,940
	Total				7,688,340

Appendix - 8

Meteorological Data

Table 1 Monthly Precipitation

Station: Bichena

Unit:mm

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1968	--	87.0	7.0	73.0	65.0	99.0	288.0	218.0	--	25.0	26.5	--	--
1969	--	--	--	--	--	--	--	--	--	0.2	--	0.0	--
1970	20.0	76.0	101.0	22.0	17.0	--	465.5	0.0	--	43.0	0.0	0.0	--
1971	--	--	--	--	--	--	--	325.0	--	--	--	--	--
1972	--	--	--	--	--	37.3	229.7	157.0	79.4	--	--	--	--
1973	--	--	0.0	36.0	65.9	85.8	230.0	249.6	116.0	50.4	0.0	24.0	--
1974	0.0	0.0	34.4	24.5	163.3	120.6	379.3	260.6	90.7	0.0	0.0	0.0	--
1975	0.0	0.0	67.2	31.7	47.6	208.6	304.2	--	--	--	--	--	--
1976	27.4	94.0	103.4	32.3	64.9	82.3	362.6	250.3	144.2	124.1	50.6	0.0	1336.1
1977	--	--	--	--	121.2	380.6	353.1	--	--	--	--	--	--
1978	--	--	--	--	39.2	170.8	--	--	--	7.5	25.8	44.5	--
1979	--	--	106.5	39.9	288.1	149.4	367.6	--	--	--	--	--	--
1987	--	32.8	159.5	144.0	--	--	--	--	--	--	--	--	--
1988	12.8	39.1	0.0	23.0	13.0	--	--	--	--	--	--	--	--

Table 2 Long Term Monthly Mean Potential Evapotranspiration (PET)

Station: Debre Markos

Unit:mm

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1st 10 days	38	39	40	39	40	43	44	47	48	47	48	46	
2nd 10 days	46	43	39	38	34	32	32	30	30	31	31	33	
3rd 10 days	33	34	37	39	41	39	36	34	34	35	36	37	
Total	117	116	116	116	115	114	112	111	112	113	115	116	1712

Note: - = not calculated due to missing data

Table 3 Monthly Average Minimum Air Temperature

Station: Bichena unit: ℃

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1968	--	8.7	8.9	9.8	12.0	11.5	10.7	11.3	--	10.1	8.6	--
1969	--	--	--	--	--	--	--	--	--	10.3	--	7.5
1970	9.5	10.6	10.6	10.9	11.6	--	9.9	10.0	--	10.0	10.0	9.9
1971	--	--	--	--	--	--	--	10.5	--	--	--	--

Table 4 Monthly Average Maximum Air Temperature

Station: Bichena unit: ℃

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1968	--	23.2	26.5	24.5	26.3	23.3	20.2	20.9	--	22.5	23.2	--
1969	--	--	--	--	--	--	--	--	--	23.6	--	24.5
1970	24.9	25.9	23.9	25.9	27.7	--	21.6	20.9	--	23.8	23.5	23.9
1971	--	--	--	--	--	--	--	20.7	--	--	--	--

Table 5 Monthly Average Air Temperature

Station: Bichena unit: ℃

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1968	--	16.0	15.5	17.2	19.2	17.4	15.5	16.1	--	16.3	15.9	--
1969	--	--	--	--	--	--	--	--	--	17.0	--	16.0
1970	17.2	18.3	17.3	18.4	19.7	--	15.8	15.5	--	16.9	16.8	16.9
1971	--	--	--	--	--	--	--	15.6	--	--	--	--

Note: - = not calculated due to missing data

Appendix - 9

Hydrological Data

Table 1 Monthly Runoff of Suha River

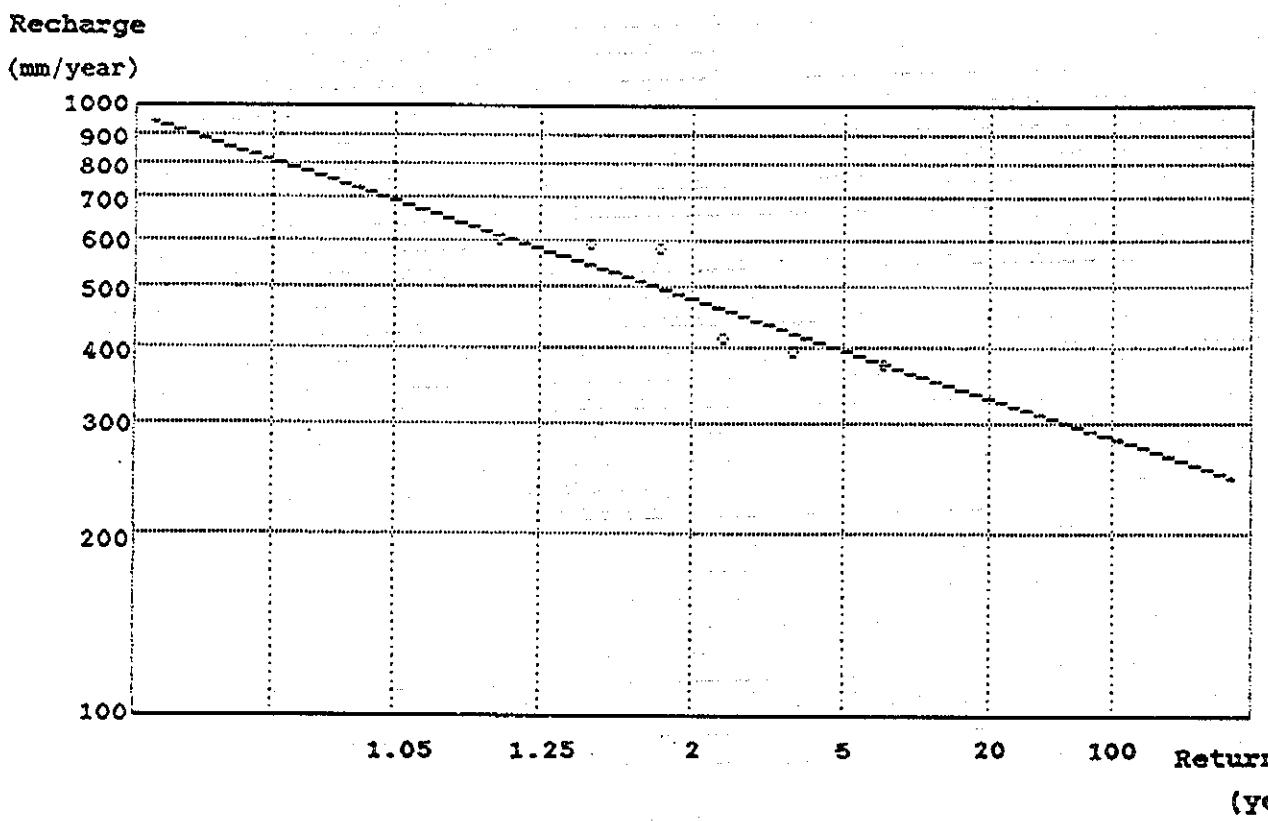
Station: Bichena

Unit: Upper in Million m3, Lower in mm

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1985	--	--	0.04 0.1	0.30 0.8	1.05 2.9	0.54 1.5	15.57 43.4	18.97 52.8	9.47 26.4	2.82 7.9	0.93 2.6	0.69 1.9	--
1986	0.47 1.3	0.41 1.2	0.39 1.1	0.30 0.8	0.25 0.7	2.98 8.3	32.48 90.4	58.97 164.3	22.47 62.6	5.33 14.9	1.16 3.2	5.86 16.3	125.77 350.3
1987	0.59 1.6	0.22 0.6	1.76 4.9	0.66 1.8	3.58 10.4	5.09 14.2	6.23 17.4	41.72 116.2	3.99 11.1	1.44 4.0	0.68 1.9	0.53 1.5	66.47 185.1
1988	0.43 1.2	0.83 2.3	0.17 0.5	0.08 0.2	0.02 0.1	0.39 0.1	34.75 96.8	48.35 134.7	26.33 73.3	9.66 26.9	1.37 3.8	0.42 1.2	122.77 342.0
1989	0.24 0.7	0.17 0.5	1.63 4.5	3.06 8.5	1.80 5.0	0.85 2.4	18.84 52.5	31.53 87.8	12.00 33.4	2.15 6.0	0.63 1.8	2.60 7.2	75.50 210.3
1990	0.62 1.7	0.76 2.1	0.37 1.0	0.24 0.7	0.43 1.2	0.24 0.7	15.39 42.9	20.51 57.1	4.40 12.3	2.58 7.2	0.37 1.0	0.31 0.9	49.56 138.1
1991	0.23 0.7	0.03 0.1	0.18 0.5	0.09 0.3	0.16 0.5	0.49 1.4	24.36 67.9	60.17 167.6	8.20 22.8	1.68 4.7	0.52 1.5	--	--
1992	0.36 1.0	1.48 4.1	0.33 0.9	0.29 0.8	0.42 1.2	0.27 0.7	7.85 21.9	47.57 132.5	23.78 66.2	--	--	--	--

Note: - =Not calculated due to missing data

Figure 1 Probability Analysis on Annual Ground Water Recharge, Suha River at Bichena



Results of Analysis

Return Period (year)	Probability of Exceedance	Theoretical Values
2	.5	481.29
5	.2	398.67
10	.1	361.30
20	.05	333.12

Table 2 Monthly Water Balance Sheet for Ground Water Recharge, Suha River at Bichena

1985

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P *	10.1	0.0	25.3	119.3	117.9	40.4	250.1	282.1	166.0	67.9	0.4	3.4	1,082.9
Q	–	–	0.1	0.8	2.9	1.5	43.4	52.8	26.4	7.9	2.6	1.9	–
P - Q	–	–	25.2	118.5	115.0	38.9	206.7	229.3	139.6	60.0	NG	1.5	–
ETo	117	116	116	116	115	114	112	111	112	113	115	116	1,373
ET crop	81.9	81.2	81.2	81.2	80.5	79.8	78.4	77.7	78.4	79.1	80.5	81.2	961.1
ETa	–	–	25.2	81.2	80.5	38.9	78.4	77.7	78.4	60.0	–	1.5	–
△S	–	–	0	37.3	34.5	0	128.3	151.6	61.2	0	–	0	412.9

1986

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P *	0.0	53.0	75.6	124.3	51.4	159.8	334.6	220.0	254.5	75.3	–	0.0	–
Q	1.3	1.2	1.1	0.8	0.7	8.3	90.4	164.3	62.6	14.9	3.2	16.3	365.1
P - Q	NG	51.8	74.5	123.5	50.7	151.5	244.2	55.7	191.9	60.4	–	NG	–
ETo	117	116	116	116	115	114	112	111	112	113	115	116	1,373
ET crop	81.9	81.2	81.2	81.2	80.5	79.8	78.4	77.7	78.4	79.1	80.5	81.2	961.1
ETa	–	51.8	74.5	81.2	50.7	79.8	78.4	55.7	78.4	60.4	–	–	–
△S	–	0	0	42.3	0	71.7	165.8	0	113.5	0	–	–	393.3

1987

Uint:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P *	0.0	21.4	126.8	34.5	115.4	89.3	249.0	343.3	95.9	62.1	0.0	2.0	1,139.7
Q	1.6	0.6	4.9	1.8	10.0	14.2	17.4	116.2	11.1	4.0	1.9	1.5	185.2
P - Q	NG	20.8	121.9	32.7	105.4	75.1	231.6	227.1	84.8	58.1	NG	0.5	–
ETo	117	116	116	116	115	114	112	111	112	113	115	116	1,373
ET crop	81.9	81.2	81.2	81.2	80.5	79.8	78.4	77.7	78.4	79.1	80.5	81.2	961.1
ETa	–	20.8	81.2	32.7	80.5	75.1	78.4	77.7	78.4	58.1	–	0.5	–
△S	–	0	40.7	0	24.9	0	153.2	149.4	6.4	0	–	0	374.6

Remark: * = Precipitation observed at Dejen
NG = Distorted data
– = 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 *	18.3	41.9	0.0	26.3	11.4	93.4	382.4	432.6	216.2	113.5	0.0	0.3	1,336.3
Q	1.2	2.3	0.5	0.2	0.1	1.1	9.7	134.7	73.3	26.9	3.8	1.2	255.0
P - Q	17.1	39.6	NG	26.1	11.3	92.3	372.7	297.9	142.9	86.6	NG	NG	--
ETo	117	116	116	116	115	114	112	111	112	113	115	116	1,373
ET crop	81.9	81.2	81.2	81.2	80.5	79.8	78.4	77.7	78.4	79.1	80.5	81.2	961.1
ETa	17.1	39.6	--	26.1	11.3	79.8	78.4	77.7	78.4	79.1	--	--	--
ΔS	0	0	--	0	0	12.5	294.3	220.2	64.5	7.5	--	--	599.0

1989

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P *	0.0	18.7	159.9	117.9	43.1	103.2	216.2	429.7	215.2	69.5	0.0	65.1	1,438.5
Q	0.7	0.5	4.5	8.5	5.0	2.4	52.5	87.8	33.4	6.0	1.8	7.2	210.3
P - Q	NG	18.2	155.4	109.4	38.1	100.8	163.7	341.9	181.8	63.5	NG	57.9	--
ETo	117	116	116	116	115	114	112	111	112	113	115	116	1,373
ET crop	81.9	81.2	81.2	81.2	80.5	79.8	78.4	77.7	78.4	79.1	80.5	81.2	961.1
ETa	--	18.2	81.2	81.2	38.1	79.8	78.4	77.7	78.4	63.5	--	57.9	--
ΔS	--	0	74.2	28.2	0	21.0	85.3	264.2	103.4	0	--	0	576.3

1990

Unit:mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P *	0.8	19.6	109.3	57.9	27.3	124.3	348.0	304.9	214.9	20.8	0.0	0.0	1,227.8
Q	1.7	2.1	1.0	0.7	1.2	0.7	42.9	57.1	12.3	7.2	1.0	0.9	128.8
P - Q	NG	17.5	108.3	57.2	26.1	123.6	305.1	247.8	202.6	13.6	NG	NG	--
ETo	117	116	116	116	115	114	112	111	112	113	115	116	1,373
ET crop	81.9	81.2	81.2	81.2	80.5	79.8	78.4	77.7	78.4	79.1	80.5	81.2	961.1
ETa	--	17.5	81.2	57.2	26.1	79.8	78.4	77.7	78.4	13.6	--	--	--
ΔS	--	0	27.1	0	0	43.8	226.7	170.1	124.2	0	--	--	591.9

Remark: * = Precipitation observed at Dejen
NG = Distorted data
- = not calculated due to missing data or distorted data

Appendix - 10

Calculation of Water Pipeline

Output data on distribution network for Bichena 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	200	30	16.94	0.54	0.07	2.39	110	
2	2	2	6	200	90	14.28	0.45	0.16	1.74	110	
3	3	6	5	200	200	12.36	0.39	0.27	1.34	110	
4	4	5	4	75	230	2.37	0.54	1.72	7.47	110	
5	5	4	3	75	410	-1.36	-0.31	-1.10	-2.68	110	
6	6	3	2	75	170	-2.13	-0.48	-1.04	-6.14	110	
7	7	6	18	75	470	1.63	0.37	1.76	3.75	110	
8	8	18	17	75	110	0.80	0.18	0.11	1.01	110	
9	9	17	19	150	955	0.80	0.05	0.03	0.03	110	
10	10	17	16	150	120	-0.45	-0.03	-0.00	-0.01	110	
11	11	16	21	150	1015	0.40	0.02	0.00	0.00	110	
12	12	16	5	150	480	-9.52	-0.54	-1.61	-3.35	110	
13	13	16	15	150	110	8.20	0.46	0.28	2.54	110	
14	14	15	20	75	595	1.88	0.43	2.89	4.86	110	
15	15	15	14	150	215	5.95	0.34	0.30	1.40	110	
16	16	14	10	150	155	5.35	0.30	0.18	1.15	110	
17	17	10	11	150	395	2.75	0.16	0.13	0.34	110	
18	18	11	12	75	460	0.35	0.08	0.10	0.22	110	
19	19	11	13	150	380	1.52	0.09	0.04	0.11	110	
20	20	10	9	75	120	1.96	0.44	0.63	5.24	110	
21	21	9	7	75	810	1.50	0.34	2.59	3.19	110	
22	22	7	4	75	340	-2.97	-0.67	-3.86	-11.36	110	
23	23	7	8	75	1390	1.65	0.37	5.31	3.82	110	

Output data on distribution network for Bichena 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	200	30	27.31	0.87	0.17	5.79	110	
2	2	2	6	200	90	24.61	0.78	0.43	4.78	110	
3	3	6	5	200	200	21.46	0.68	0.74	3.71	110	
4	4	5	4	75	230	2.65	0.60	2.11	9.17	110	
5	5	4	3	75	410	-1.89	-0.43	-2.01	-4.90	110	
6	6	3	2	75	170	-2.37	-0.54	-1.27	-7.46	110	
7	7	6	18	75	470	2.97	0.67	5.34	11.37	110	
8	8	18	17	75	110	2.45	0.56	0.88	7.97	110	
9	9	17	19	150	955	0.50	0.03	0.01	0.01	110	
10	10	17	16	150	120	1.67	0.09	0.02	0.13	110	
11	11	16	21	150	1015	0.25	0.01	0.00	0.00	110	
12	12	16	5	150	480	-18.51	-1.05	-5.49	-11.44	110	
13	13	16	15	150	110	19.63	1.11	1.40	12.76	110	
14	14	15	20	75	595	1.18	0.27	1.22	2.06	110	
15	15	15	14	150	215	18.22	1.03	2.39	11.12	110	
16	16	14	10	150	155	17.84	1.01	1.66	10.69	110	
17	17	10	11	150	395	18.39	1.04	4.47	11.31	110	
18	18	11	12	75	460	0.22	0.05	0.04	0.09	110	
19	19	11	13	150	380	17.62	1.00	3.97	10.45	110	
20	20	10	9	75	120	-0.95	-0.21	-0.16	-1.37	110	
21	21	9	7	75	810	-1.24	-0.28	-1.81	-2.24	110	
22	22	7	4	75	340	-4.06	-0.92	-6.86	-20.18	110	
23	23	7	8	75	1390	1.04	0.24	2.26	1.63	110	

Output data on distribution network for Bichena 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	200	30	31.67	1.01	0.23	7.61	110	
2	2	2	6	200	90	28.44	0.91	0.56	6.24	110	
3	3	6	5	200	200	24.64	0.78	0.96	4.78	110	
4	4	5	4	75	230	2.70	0.61	2.19	9.51	110	
5	5	4	3	75	410	-1.93	-0.44	-2.09	-5.10	110	
6	6	3	2	75	170	-2.70	-0.61	-1.61	-9.50	110	
7	7	6	18	75	470	3.52	0.80	7.31	15.55	110	
8	8	18	17	75	110	2.69	0.61	1.04	9.46	110	
9	9	17	19	150	955	8.16	0.46	2.40	2.51	110	
10	10	17	16	150	120	-5.92	-0.33	-0.17	-1.39	110	
11	11	16	21	150	1015	7.77	0.44	2.33	2.30	110	
12	12	16	5	150	480	-21.46	-1.21	-7.22	-15.05	110	
13	13	16	15	150	110	7.30	0.41	0.23	2.05	110	
14	14	15	20	75	595	1.88	0.43	2.89	4.86	110	
15	15	15	14	150	215	5.05	0.29	0.22	1.04	110	
16	16	14	10	150	155	4.45	0.25	0.13	0.82	110	
17	17	10	11	150	395	2.75	0.16	0.13	0.34	110	
18	18	11	12	75	460	0.35	0.08	0.10	0.22	110	
19	19	11	13	150	380	1.52	0.09	0.04	0.11	110	
20	20	10	9	75	120	1.06	0.24	0.20	1.69	110	
21	-21	9	7	75	810	0.60	0.14	0.48	0.59	110	
22	22	7	4	75	340	-3.87	-0.88	-6.29	-18.50	110	
23	23	7	8	75	1390	1.65	0.37	5.31	3.82	110	

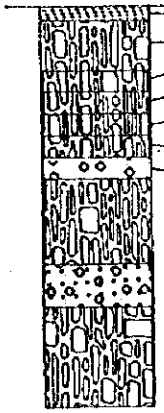
Output data on distribution network for Bichena Case: Fire Fighting, 2010

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	200	30	36.47	1.16	0.30	9.89	110	
2	2	2	6	200	90	33.39	1.06	0.76	8.40	110	
3	3	6	5	200	200	29.09	0.93	1.30	6.51	110	
4	4	5	4	75	230	2.86	0.65	2.43	10.56	110	
5	5	4	3	75	410	-2.27	-0.51	-2.82	-6.88	110	
6	6	3	2	75	170	-2.75	-0.62	-1.67	-9.82	110	
7	7	6	18	75	470	4.12	0.93	9.78	20.81	110	
8	8	18	17	75	110	3.60	0.82	1.78	16.22	110	
9	9	17	19	150	955	5.08	0.29	1.00	1.05	110	
10	10	17	16	150	120	-1.76	-0.10	-0.02	-0.15	110	
11	11	16	21	150	1015	4.83	0.27	0.97	0.95	110	
12	12	16	5	150	480	-25.93	-1.47	-10.25	-21.35	110	
13	13	16	15	150	110	19.04	1.08	1.33	12.06	110	
14	14	15	20	75	595	1.18	0.27	1.22	2.06	110	
15	15	15	14	150	215	17.63	1.00	2.25	10.46	110	
16	16	14	10	150	155	17.25	0.98	1.56	10.05	110	
17	17	10	11	150	395	18.39	1.04	4.47	11.31	110	
18	18	11	12	75	460	0.22	0.05	0.04	0.09	110	
19	19	11	13	150	380	17.62	1.00	3.97	10.45	110	
20	20	10	9	75	120	-1.54	-0.35	-0.40	-3.35	110	
21	21	9	7	75	810	-1.83	-0.41	-3.73	-4.61	110	
22	22	7	4	75	340	-4.65	-1.05	-8.82	-25.94	110	
23	23	7	8	75	1390	1.04	0.24	2.26	1.63	110	

Appendix - 11

Geological Logs of Existing Boreholes

WSS Borehole No.3 in Bichena

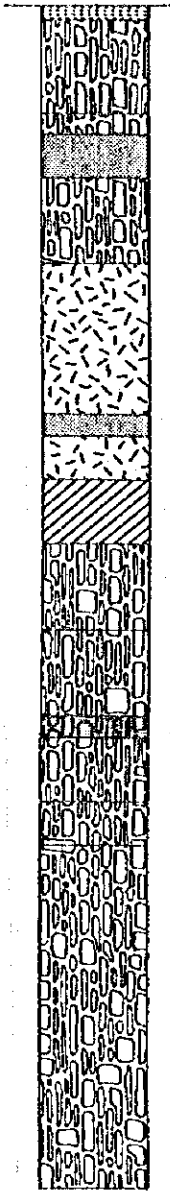


Depth	Lithology
0 - 2 m	Top soil
2 - 9 m	Slightly weathered basalt
9 - 12 m	Vesicular Basalt
12 - 15 m	Moderately weathered fractured basalt
15 - 18 m	Slightly weathered basalt
18 - 21 m	Slightly weathered basalt with sand
21 - 24 m	Gravel and pebbles
24 - 36 m	Weathered rock with gravel
36 - 42 m	Gravel with sand
42 - 56 m	Slightly weathered basalt

Location : About 5 km east-southeast of the town

Source : from "Hydrogeological Borehole Report of Bichena(Well #3)"

Borehole No.3' in Bichena



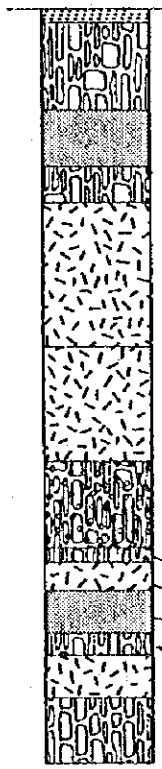
Depth	Lithology
0 - 2 m	Top soil
2 - 15 m	Slightly weathered basalt with black minerals
14 - 18 m	Slightly weathered basalt
18 - 24 m	Clay, reddish
24 - 36 m	Intensively weathered rock
36 - 57 m	Volcanic ash
57 - 60 m	Plastic clay
60 - 66 m	Volcanic ash
66 - 75 m	Pyroclastic rock, gray
75 - 87 m	Intensively weathered rock
87 - 99 m	Slightly weathered basalt
99 -102 m	Weathered rock with clay
102-111 m	Vesicular basalt with shiny black minerals, slightly weathered
111-117 m	Intensively weathered rock
117-165 m	Slightly weathered basalt

Note : Borehole is abandoned due to little yield.

Location : Beside the Borehole No.3.

Source : from "Strata log of Bichena(Well #2)" by EWWCA

Borehole No.3 in Bichena



Depth	Lithology
0 - 2 m	Top soil
2 - 14 m	Slightly weathered basalt
14 - 22 m	Clay
22 - 27 m	Intensively weathered rock
27 - 47 m	Volcanic ash, gray
47 - 63 m	Volcanic ash, white
63 - 75 m	Weathered rock with gravel
75 - 77 m	Intensively weathered rock
77 - 81 m	Volcanic ash
81 - 87 m	Clay, black
87 - 90 m	Highly weathered basalt
90 - 96 m	Volcanic ash
96 -105 m	Basalt with shiny black minerals

Note : Borehole is abandoned due to the drilling problem.

Location : About 2 km north of the town, near the Kuy River

Source : from "Geological log of Bichena(BH#1)" by EWWCA