社会開発調査部報告書

No. I-1

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
MILLE

(Volume III-II)

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 Mille 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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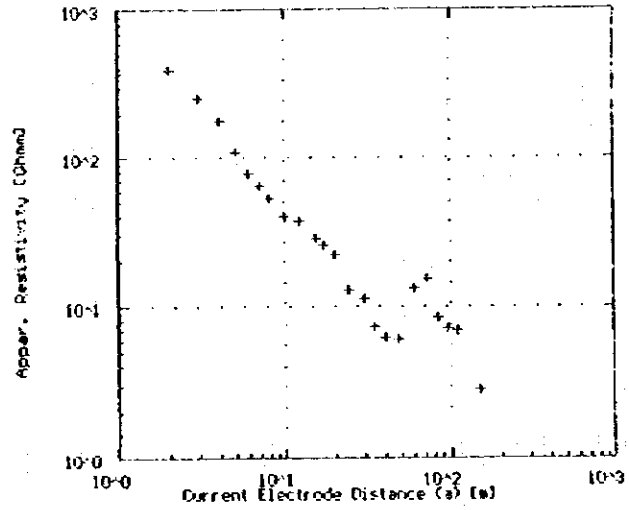
Appendix - 1

Resistivity Interpretation of VEP

Figure 1 Geoelectrical Survey, Wenner Array

VES St. No.1 -MILLE

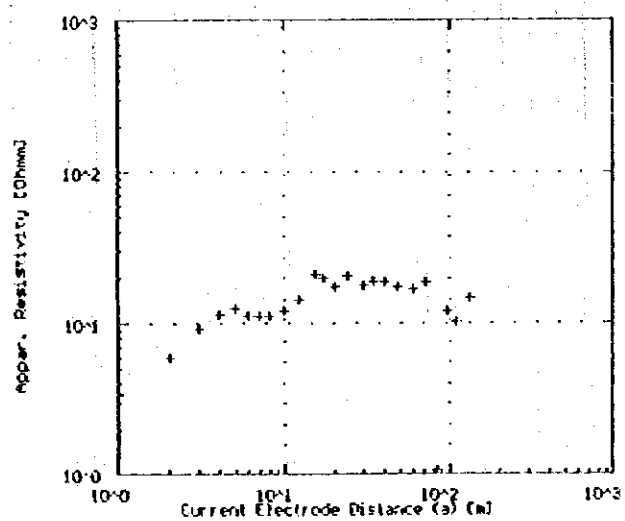


Point (No)	MN/2 (Mr)	a (m)	Rez (ohm)
1	1.00	376.500	
2	2.00	303.350	
3	3.00	256.220	
4	4.00	225.840	
5	5.00	109.900	
6	6.00	78.150	
7	7.00	63.740	
8	8.00	52.750	
9	10.00	40.820	
10	12.00	37.650	
11	15.00	28.260	
12	17.00	25.230	
13	20.00	21.980	
14	26.00	12.960	
15	30.00	11.300	
16	34.00	7.470	
17	40.00	6.280	
18	48.00	6.030	
19	60.00	03.190	
20	72.00	16.920	
21	84.00	8.640	
22	96.00	7.240	
23	110.00	6.910	
24	150.00	2.830	

Specific Resistivity(Ω-m)	390	73	19.71	2.58	148.5	2.34

260

VES St. No.2 -MILLE

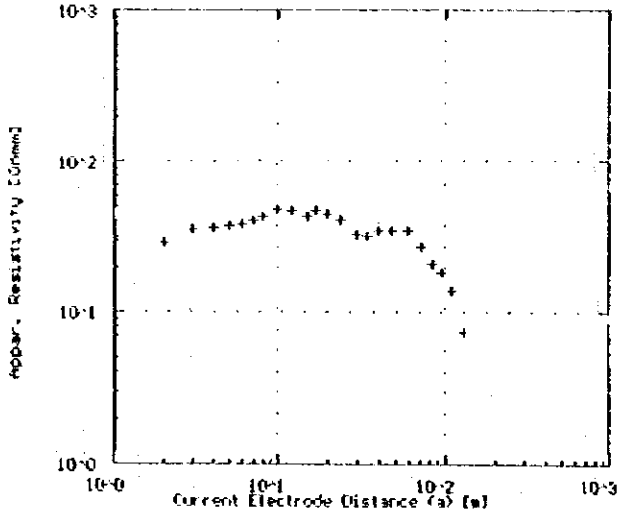


Point (No)	MN/2 (Mr)	a (m)	Rez (ohm)
1	1.00	3.450	
2	2.00	5.900	
3	3.00	9.230	
4	4.00	11.560	
5	5.00	12.560	
6	6.00	11.300	
7	7.00	17.120	
8	8.00	51.050	
9	10.00	12.750	
10	12.00	14.330	
11	15.00	20.220	
12	17.00	20.070	
13	20.00	17.330	
14	24.00	20.350	
15	30.00	17.900	
16	34.00	18.590	
17	40.00	10.060	
18	48.00	13.100	
19	60.00	16.950	
20	72.00	10.000	
21	84.00	1.960	
22	90.00	12.050	
23	110.00	10.300	
24	130.00	10.100	

Specific Resistivity(Ω-m)	1.6	24	98			24	3.1

8.13 26.5 112.5

VES St. No.3 -MILLE

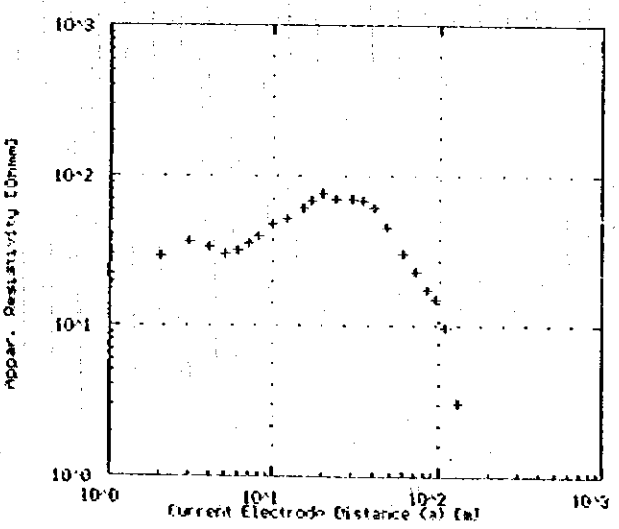


Point (No)	MN/2 (No)	a (m)	Rai (ohmm)
1	1.00	33.000	
2	2.00	28.350	
3	3.00	34.050	
4	4.00	35.600	
5	5.00	37.370	
6	6.00	39.030	
7	7.00	40.190	
8	8.00	42.200	
9	10.00	47.000	
10	12.00	55.720	
11	15.00	53.330	
12	17.00	56.910	
13	20.00	57.950	
14	24.00	60.240	
15	30.00	32.550	
16	36.00	32.030	
17	40.00	34.610	
18	44.00	36.570	
19	60.00	33.910	
20	72.00	27.130	
21	84.00	27.100	
22	96.00	10.000	
23	110.00	13.020	
24	130.00	7.350	

Specific Resistivity(Ω-m)	33	22	43.5	58.2	19.2			2.33

46.5 22.67 4.33

VES St. No.4 -MILLE

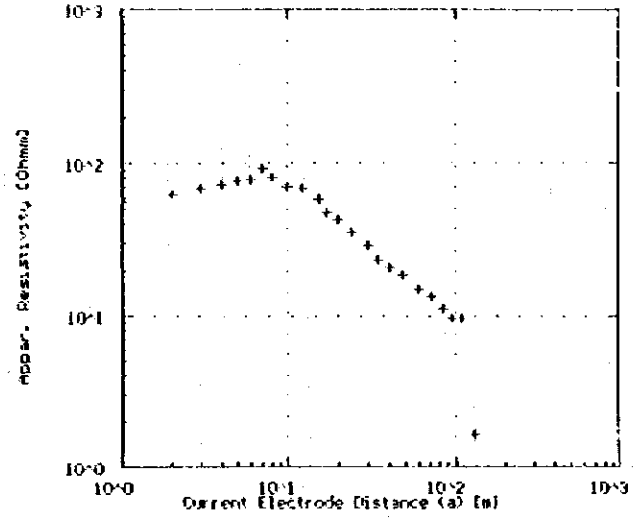


Point (No)	MN/2 (No)	a (m)	Rai (ohmm)
1	1.00	28.500	
2	2.00	28.950	
3	3.00	35.850	
4	4.00	33.160	
5	5.00	28.030	
6	8.00	31.650	
7	7.00	35.170	
8	8.00	39.650	
9	10.00	47.100	
10	12.00	52.000	
11	15.00	61.230	
12	17.00	60.330	
13	20.00	75.360	
14	24.00	69.330	
15	30.00	69.710	
16	34.00	60.330	
17	60.00	60.000	
18	60.00	65.220	
19	60.00	30.150	
20	72.00	22.610	
21	84.00	17.610	
22	95.00	15.070	
23	110.00	9.510	
24	130.00	3.070	

Specific Resistivity(Ω-m)	20	60	24.8	245	94.5	4.2	0.14

46.67

VES St. No.5 -MILLE

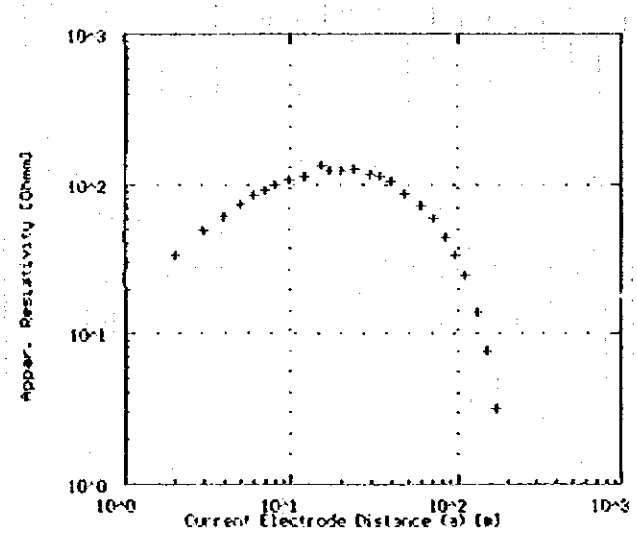


Point (No)	AB/2 (Mr)	a (m)	Res (ohmm)
1	1.00	56.520	
2	2.00	62.200	
3	3.00	67.820	
4	4.00	72.899	
5	5.00	76.930	
6	6.00	78.750	
7	7.00	80.930	
8	8.00	80.390	
9	10.00	70.340	
10	12.00	63.559	
11	15.00	57.469	
12	17.00	50.060	
13	20.00	42.700	
14	24.00	34.820	
15	30.00	29.910	
16	36.00	23.499	
17	40.00	21.100	
18	48.00	15.899	
19	60.00	15.019	
20	72.00	13.550	
21	84.00	11.080	
22	96.00	9.550	
23	110.00	9.679	
24	130.00	1.630	

Specific Resistivity(Ω-m)	56	64	1	12	4.9

50.67

VES St. No.6 -MILLE

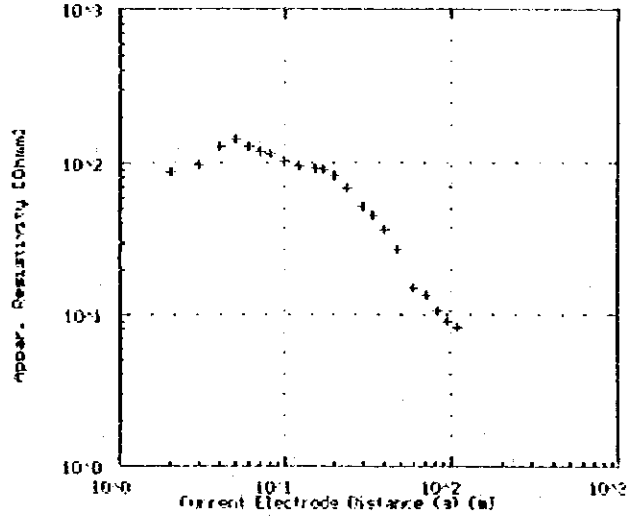


Point (No)	AB/2 (Mr)	a (m)	Res (ohmm)
1	1.00	30.100	
2	2.00	33.190	
3	3.00	69.670	
4	4.00	60.290	
5	5.00	73.790	
6	6.00	85.530	
7	7.00	91.440	
8	8.00	99.490	
9	10.00	109.990	
10	12.00	115.200	
11	15.00	116.590	
12	17.00	123.480	
13	20.00	125.600	
14	24.00	126.610	
15	30.00	118.690	
16	36.00	113.170	
17	40.00	105.500	
18	48.00	87.420	
19	60.00	72.350	
20	72.00	59.230	
21	84.00	44.370	
22	96.00	33.360	
23	110.00	24.070	
24	130.00	13.000	
25	150.00	7.540	
26	170.00	3.200	

Specific Resistivity(Ω-m)	14	210	368	6.17

13.7

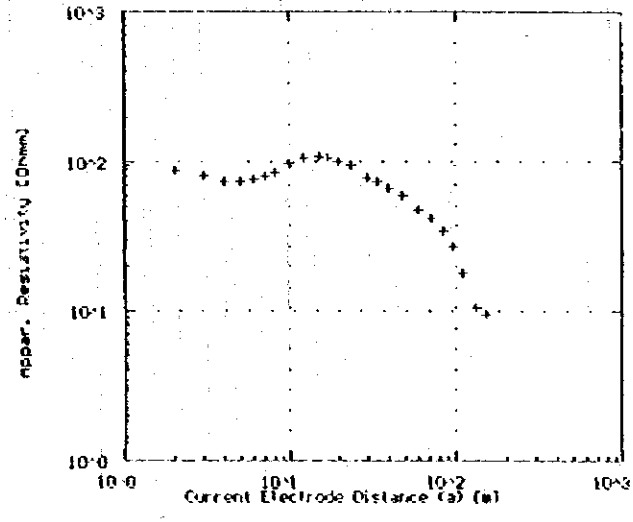
VES St. No.7 -MILLE



Point (No)	AB/2 (Mr)	a (m)	Rx (ohm)
1	1.00	29.520	
2	2.00	56.860	
3	3.00	98.000	
4	4.00	129.150	
5	5.00	161.100	
6	6.00	178.410	
7	7.00	178.690	
8	8.00	115.550	
9	10.00	103.620	
10	12.00	96.200	
11	15.00	92.320	
12	17.00	70.150	
13	20.00	81.650	
14	25.00	67.920	
15	30.00	51.630	
16	35.00	35.650	
17	40.00	35.930	
18	50.00	21.020	
19	60.00	15.870	
20	72.00	13.560	
21	85.00	10.550	
22	95.00	9.060	
23	110.00	8.290	
24	130.00	8.020	

Specific Resistivity(Ω-m)	60	240	67	5.07

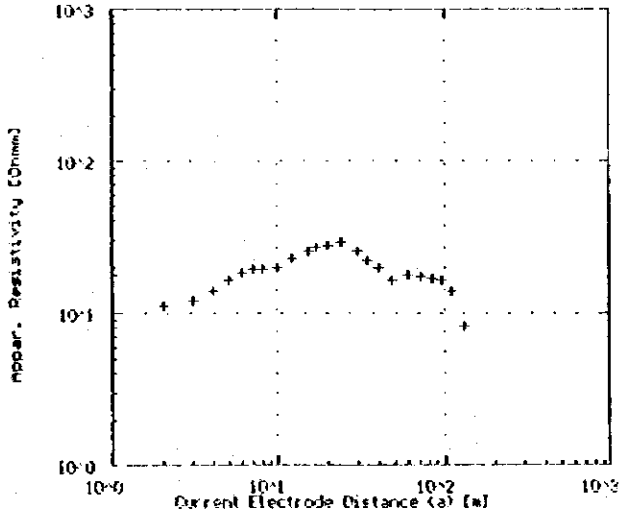
VES St. No.8 -MILLE



Point (No)	AB/2 (Mr)	a (m)	Rx (ohm)
1	1.00	91.570	
2	2.00	87.920	
3	3.00	81.010	
4	4.00	72.350	
5	5.00	72.790	
6	6.00	75.070	
7	7.00	80.030	
8	8.00	85.410	
9	10.00	96.710	
10	12.00	105.530	
11	15.00	107.390	
12	17.00	100.530	
13	20.00	100.400	
14	25.00	93.650	
15	30.00	79.030	
16	35.00	71.330	
17	40.00	60.520	
18	50.00	50.200	
19	60.00	42.100	
20	72.00	42.050	
21	85.00	36.290	
22	95.00	27.020	
23	110.00	22.500	
24	130.00	18.590	
25	150.00	9.020	

Specific Resistivity(Ω-m)	94	62.67	20.4	72	8.2	4.5

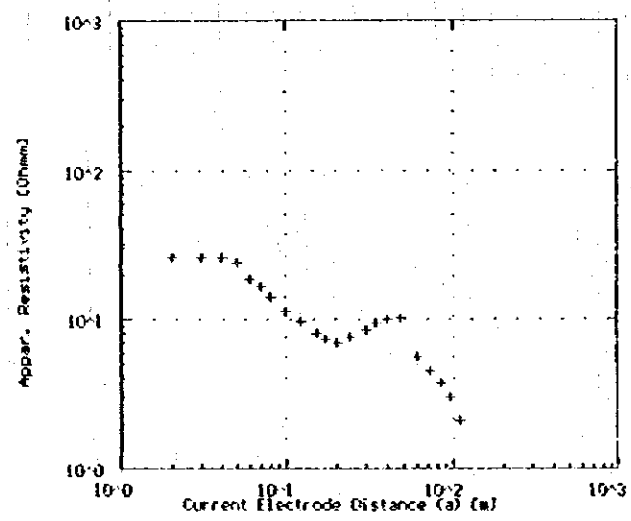
VES St. No.9 -MILLE



Point (No.)	MN/2 (Mr)	a (m)	Res (ohmm)
1	1.00	47.550	
2	2.00	31.700	
3	3.00	12.259	
4	4.00	16.070	
5	5.00	16.339	
6	6.00	14.890	
7	7.00	19.340	
8	8.00	69.050	
9	10.00	20.100	
10	12.00	22.010	
11	15.00	25.430	
12	17.00	27.170	
13	20.00	27.760	
14	26.00	29.350	
15	30.00	25.430	
16	36.00	22.623	
17	40.00	19.599	
18	50.00	15.550	
19	60.00	12.210	
20	72.00	12.120	
21	86.00	10.950	
22	95.00	10.200	
23	110.00	93.020	
24	130.00	0.160	

Specific Resistivity(Ω-m)	23	7.67	37.6	36.75	13.5	13.33	2

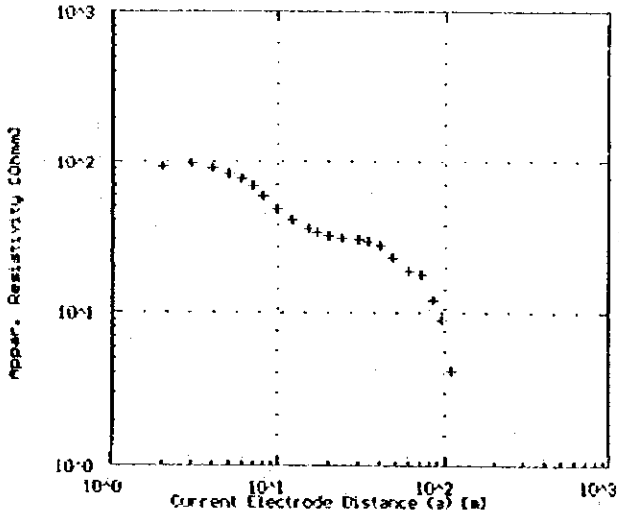
VES St. No.10 -MILLE



Point (No.)	MN/2 (Mr)	a (m)	Res (ohm)
1	1.00	32.030	
2	2.00	26.250	
3	3.00	26.390	
4	4.00	25.870	
5	5.00	23.920	
6	6.00	18.840	
7	7.00	16.710	
8	8.00	14.220	
9	10.00	10.560	
10	12.00	9.800	
11	15.00	8.810	
12	17.00	7.470	
13	20.00	7.030	
14	25.00	7.560	
15	30.00	8.480	
16	36.00	9.600	
17	40.00	10.050	
18	50.00	10.250	
19	60.00	5.650	
20	72.00	4.520	
21	86.00	3.650	
22	95.00	3.010	
23	110.00	2.070	

Specific Resistivity(Ω-m)	36.5	24.3	5	24	0.61

VES St. No.11 -MILLE

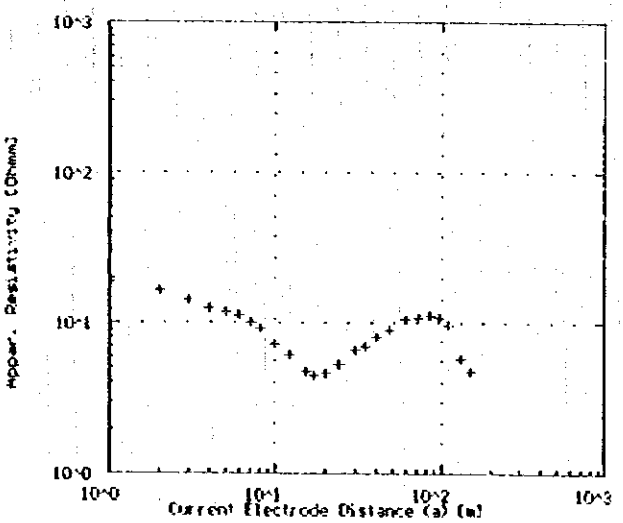


Point [No]	AB/2 [Ar]	a [m]	Res [ohm]
1	1.00	60.450	
2	2.00	91.699	
3	3.00	96.000	
4	4.00	90.420	
5	5.00	83.850	
6	6.00	76.050	
7	7.00	69.500	
8	8.00	57.700	
9	10.00	47.100	
10	12.00	40.650	
11	15.00	36.050	
12	17.00	33.100	
13	20.00	32.010	
14	24.00	30.900	
15	30.00	30.330	
16	34.00	29.250	
17	40.00	27.600	
18	49.00	22.610	
19	60.00	18.060	
20	72.00	17.630	
21	86.00	12.030	
22	96.00	9.060	
23	110.00	6.150	

Specific Resistivity(Ω-m)	56.5	162	52		25.33	11	2.21

36.5 19.33

VES St. No.12 -MILLE

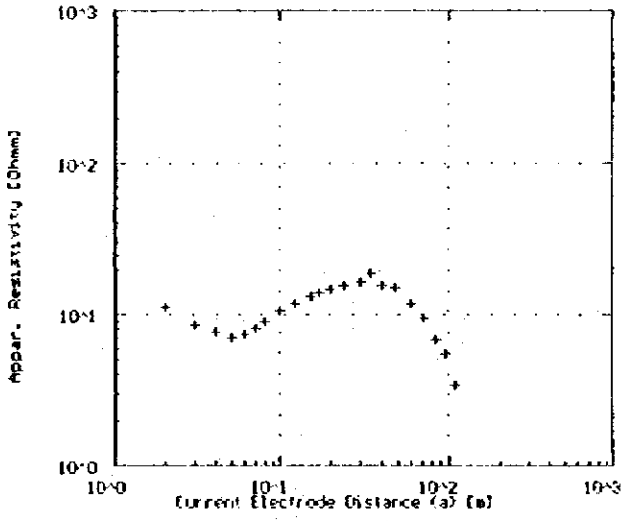


Point [No]	AB/2 [Ar]	a [m]	Res [ohm]
1	1.00	18.840	
2	2.00	16.330	
3	3.00	14.130	
4	4.00	12.560	
5	5.00	11.930	
6	6.00	11.300	
7	7.00	10.410	
8	8.00	8.100	
9	10.00	7.290	
10	12.00	6.830	
11	15.00	6.000	
12	17.00	5.490	
13	20.00	4.550	
14	24.00	5.280	
15	30.00	6.590	
16	34.00	7.050	
17	40.00	9.040	
18	49.00	9.040	
19	60.00	10.550	
20	72.00	10.050	
21	84.00	11.000	
22	96.00	10.050	
23	110.00	9.470	
24	130.00	5.320	
25	150.00	8.710	

Specific Resistivity(Ω-m)	20	10	2.2	33.6		0.34

22.5 7.2

VES St. No.13 -MILLE

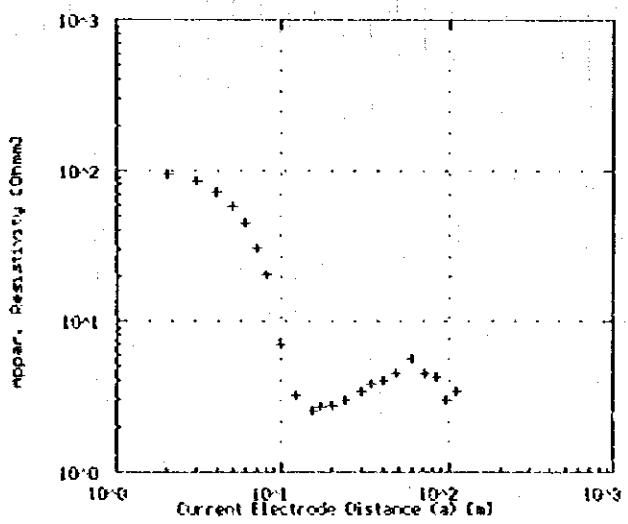


Point (No)	MN/2 (Mr)	a (m)	Res (ohm)
1	1.00	26.650	
2	2.00	11.300	
3	3.00	8.480	
4	4.00	7.510	
5	5.00	7.030	
6	6.00	7.350	
7	7.00	8.130	
8	9.00	9.990	
9	10.00	10.650	
10	12.00	11.760	
11	15.00	12.930	
12	17.00	13.370	
13	20.00	14.570	
14	24.00	15.690	
15	30.00	16.580	
16	36.00	19.500	
17	40.00	15.570	
18	48.00	15.070	
19	60.00	15.680	
20	72.00	9.500	
21	84.00	6.860	
22	96.00	5.610	
23	110.00	3.650	
24	130.00	0.820	

Specific Resistivity(Ω-m)	33	6.6	21.6	2.28

10.67

VES St. No.14 -MILLE

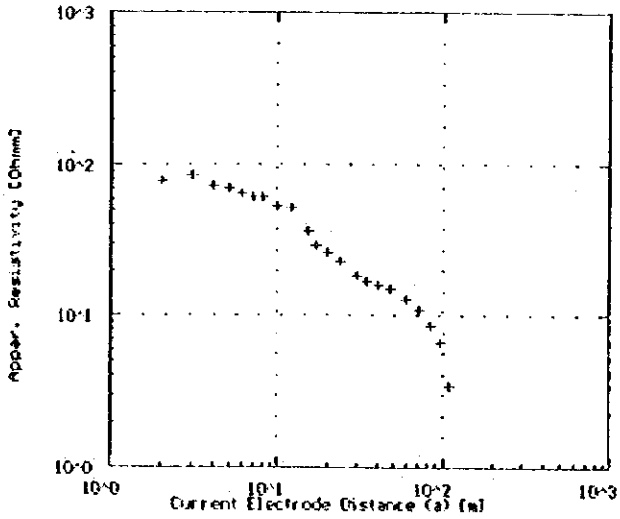


Point (No)	MN/2 (Mr)	a (m)	Res (ohm)
1	1.00	82.270	
2	2.00	94.200	
3	3.00	86.790	
4	4.00	79.590	
5	5.00	57.450	
6	6.00	41.860	
7	7.00	30.370	
8	8.00	20.690	
9	10.00	8.970	
10	12.00	3.760	
11	15.00	2.510	
12	17.00	2.670	
13	20.00	2.760	
14	24.00	2.910	
15	30.00	3.390	
16	36.00	3.840	
17	40.00	4.020	
18	48.00	4.520	
19	60.00	5.650	
20	72.00	4.520	
21	84.00	4.220	
22	96.00	3.010	
23	110.00	3.450	

Specific Resistivity(Ω-m)	74	111	1.95	3.81	11.6	1.9

15.67

VES St. No.15 -MILLE



Point [No]	AN/2 [Mr]	a [m]	Res [ohm]
1	1.00	59.240	
2	2.00	78.430	
3	3.00	84.790	
4	4.00	72.850	
5	5.00	69.090	
6	6.00	64.430	
7	7.00	61.540	
8	8.00	60.280	
9	10.00	57.520	
10	12.00	50.950	
11	15.00	35.802	
12	17.00	29.360	
13	20.00	26.390	
14	24.00	22.660	
15	30.00	19.490	
16	36.00	16.860	
17	40.00	16.090	
18	48.00	15.070	
19	60.00	12.810	
20	72.00	10.850	
21	86.00	8.440	
22	96.00	8.030	
23	110.00	3.450	

Specific Resistivity(Ω-m)	46	184	5.07	54	2.5

Appendix - 2

Result of Water Quality Test

Result of Physico-Chemical Analysis in Mille

Sample No.1

Origin of Sample : Borehole No.1 (WSS)
Date of Collection: 17/Jan./95
Date of Analysis : 03/Feb./95

Physical Characteristics

Appearance	: Clear
Odor	: Odorless
Taste	: -
Color	: Nil
Settleable Solids	: Absent
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 370
Turbidity	: Nil
Temperature	: -
Conductivity	: 0.77 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 250
Carbonate Hardness as $CaCO_3$	: 250
Non Carbonate Hardness as $CaCO_3$	: Nil
Total Alkalinity as $CaCO_3$	: 300
Bicarbonate Alkalinity as $CaCO_3$	: 300
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: 8.50
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: -	Cl^-	: 65.00
Na^+	: -	NO_2^-	: Nil
K^+	: -	NO_3^-	: 2.20
Ca^{++}	: 60.00	F^-	: 0.64
Mg^{++}	: 23.98	HCO_3^-	: 366.80
Fe(Total)	: 0.01	CO_3^{--}	: Nil
Mn^{++}	: Nil	SO_4^{--}	: 130.00
Cu^{++}	: 0.01	PO_4^{---}	: 1.25

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 Mille

Sample No.2

Origin of Sample : Borehole No.2 (WSS)
Date of Collection: 17/Jan./95
Date of Analysis : 03/Feb./95

Physical Characteristics

Appearance	: Very Clear
Odor	: Odorless
Taste	: -
Color	: Nil
Settleable Solids	: Absent
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 260
Turbidity	: Nil
Temperature	: -
Conductivity	: 0.45 ms/cm

General Chemical Characteristics

Total Hardness as $CaCO_3$	: 180
Carbonate Hardness as $CaCO_3$	: 180
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	: 8.50
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: -	Cl^-	: 45.00
Na^+	: -	NO_2^-	: Nil
K^+	: -	NO_3^-	: 1.60
Ca^{++}	: 36.00	F^-	: 0.64
Mg^{++}	: 21.58	HCO_3^-	: 292.80
Fe(Total)	: 0.03	CO_3^{--}	: Nil
Mn^{++}	: Nil	SO_4^{--}	: 66.00
Cu^{++}	: 0.07	PO_4^{---}	: 1.90

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 Mille

Sample No.3

Origin of Sample : Mille River
Date of Collection: 19/Feb./95
Date of Analysis : 17/Mar./95

Physical Characteristics

Appearance	: Clear
Odor	: Odorless
Taste	: -
Color	: 12,775 Pt-Co (Apparent)
Settleable Solids	: Present
Floating Solids	: Absent
Suspended Solids	: Absent
Total Dissolved Solids	: 160
Turbidity	: 2,375 FTU
Temperature	: -
Conductivity	: 0.34 ms/cm at 21.2 °C

General Chemical Characteristics

Total Hardness as $CaCO_3$	: -
Carbonate Hardness as $CaCO_3$	: -
Non Carbonate Hardness as $CaCO_3$	: -
Total Alkalinity as $CaCO_3$	: 140
Bicarbonate Alkalinity as $CaCO_3$	: 140
Carbonate Alkalinity as $CaCO_3$	: Nil
PH	: -
Silica	: -
Sulphide as Hydrogen Sulphide	: -
Carbondioxide	: -
Residual Chlorine	: -
Dissolved Oxygen	: -

Ionic Contents

Cations		Anions	
NH_4^+	: -	Cl^-	: 20.00
Na^+	: -	NO_2^-	: 0.007
K^+	: -	NO_3^-	: 10.12
Ca^{++}	: 28.00	F^-	: 0.73
Mg^{++}	: -	HCO_3^-	: 170.80
Fe(Total)	: 0.29	CO_3^{--}	: Nil
Mn^{++}	: Nil	SO_4^{--}	: 19.0
Cu^{++}	: 2.24	PO_4^{---}	: 0.58

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 Faecal Coliform Test in Mille, Sampled and Analyzed on Feb./22,26/'95

No.	Kebele	Source	Place of Sampling	No of F.C. per 100ml	Remarks
1	Upper	BH1	BH1	1	Sampled fr hydrant with rubber hose
2	Lower	BH2	BH2	3	Sampled fr tap installed at the borehole
3	Upper	BH1	P.Foun.5	17	Directly supplied fr the pressure line
4		BH1	P.Foun.6	4	Directly supplied fr the pressure line
5		BH1	P.Conn.	TMTC	Equipped with small tank at Ephrem Hotel
6	3rd	BH1	Barrel	22	Covered, Fetched fr own P.Conn.
7		BH1	Barrel	TMTC	Covered, Fetched fr P.Foun.
8		BH1	Barrel	TMTC	Covered by dirty cloth
9		BH1	Barrel	TMTC	Very dirty Barrel
10		BH1	Clay pot	TMTC	Not covered
11	Lower	BH2	P.Foun.1	42	Directly supplied fr the pressure line
12		BH2	P.Foun.2	TMTC	Directly supplied fr the pressure line
13		BH2	P.Foun.3	43	Directly supplied fr the pressure line
14		BH2	P.Conn.	3	Directly supplied fr the pressure line
15		BH2	Barrel	TMTC	Fetched fr P.Foun.1, Uncovered
16		BH2	Barrel	TMTC	Fetched fr P.Foun.3, Uncovered
17		BH2	Clay pot	TMTC	
18		BH2	Clay pot	TMTC	Covered by tin-lid
19		BH2	Jerry-can	45	Not well cleaned

There are two sources (BH1 & BH2) operated WSS, those of which supplies water to Upper/3rd and Lower Mille separately without passing 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.

Appendix - 3

Social and Gender Data

Mille – Activity Profile by Gender (Public Fountain Users)

Activities	Gender		Remarks/Time/Place
	Male	Female	
Fetches drinking water	y	y	Mostly women
Does laundry	n	y	
Waters livestock	-	-	
Takes water from container	y	y	All household members
Disposes of solid waste	n	y	
Constructs - compost pits	-	-	
- latrines	-	-	Use open field mostly
- kitchen gardens	-	-	
Keeps latrine clean	-	-	
Keeps compound clean	n	y	
Teaches children about hygiene	y	y	
Takes care of sick children	n	y	

y = Yes, n = No

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

Activities	Gender		Remarks/Time/Place
	Male	Female	
Fetches drinking water	y	y	Mostly women maids
Does laundry	n	y	Mostly women maids
Waters livestock	-	-	
Disposes of solid waste	n	y	Mostly women maids
Constructs - compost pits	-	-	No compost pits
- latrines	y	n	Use labor
- kitchen gardens	-	-	
Keeps compound clean	n	y	Mostly women maids
Keeps latrine clean	n	y	Very few latrines in Mille
Teaches children about hygiene	y	y	Both men and women
Takes care of sick children	n	y	

y = Yes, n = No

Mille – Daily Schedule (School Children's Parents)

Man	Time	Female
	6	Gets up, goes open field, washing
	7	Prepares breakfast
	8	Drinks coffee and fetches water
Some men collect wood from a 10 km	9	Cleans house
distance and participate in charcoal	10	Collects wood and kerosene
production, others are nomads, drivers,	11	Prepares food
mechanics and other similar activities	12	〃
	13	Eats lunch
	14	Drinks coffee with friends
	15	〃
	16	House activities
	17	Collects wood
	18	Prepares supper
	19	Eats supper
	20	Cleans up dishes and house
	21	Bathes
	22	Goes to sleep

Mille – Daily Schedule (School Children)

Man	Time	Female
Gets up, bathes	6	Gets up, bathes
Eats breakfast, goes to school	7	Eats breakfast, goes to school
School	8	School
〃	9	〃
〃	10	〃
〃	11	〃
〃	12	〃
Eats lunch	13	Eats lunch and fetches water
Studies/fetches water	14	Prepares coffee for mother
〃	15	〃
Plays-outside	16	Prepares food, clean house/dishes
〃	17	〃
〃	18	〃
	19	〃
Eats supper	20	Eats supper
Bathes	21	Bathes
Goes to sleep	22	Goes to sleep

Mille – Access and Control Profile (Public Fountain Users)

Items	Access		Control		Comments
	M	F	M	F	
Resources					
Piped water resources	y	y	n	n	
Money for water, soap etc.	y	y	y	y	Money shared, not willing to discuss how
Labor for latrines	y	y	y	y	
Land for latrines	n	n	n	n	Most people living in rented homes
Benefits					
Water - better service time	y	y	y	y	If community managed PFs
- more water	y	y	y	y	〃
Sanitation - improved privacy					Not willing or interested*
- reduced diseases					〃

Note : * No interest in sanitation.
would have more time for child care if water supply management was improved.
y = Yes, n = No

Mille – 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	
Money for water, soap etc.	y	y	y	y	Most hoteliers are women and own their
Land for latrines	y	y	y	y	hotels/land
Labor for latrines	y	y	y	y	
Benefits					
Improved water service	-	-	-	-	Burden of the maids would be reduced
Improved health	-	-	-	-	

y = Yes, n = No

Mille -- Needs Analysis (Public Fountain Users)

Items	Gender		Comments
	Male	Female	
Practical needs			
Water - more public fountains	y	y	Mostly women will benefit
- greater service time	y	y	Some said they need 2-5 pots per day from
- reduced distance	y	y	water vendor
- more efficient service	y	y	
- reduced queues	y	y	
- water supply to school	y	y	School children
Sanitation			
-privacy (if community latrine)	y	y	Most do not favor latrines due to lack of
-no smell	y	y	awareness.
-open field preferred	y	y	Community latrines would be an option after long term awareness raising project.
Jobs are a similar level of priority to water			For some, jobs were major priority, for others water
Strategic needs			
Water			
-community management of four extra public fountains	y	y	Open dissatisfaction with water seller. PFs to be managed as group PC
Sanitation	y	y	No strong desire for sanitation facilities, often antagonistic towards them

Note: Need improved management, more service time for pump and four additional public fountains (community managed private connections)
y = Yes, n = No

Mille – Needs Analysis (Household Connection Users)

Items	Gender		Comments
	Male	Female	
Practical needs			
Water - increased service hours	y	y	Current hours too short
Sanitation - less smell	y	y	Hotel owners have latrines but use open field due to smell
- privacy	y	y	
Electricity, jobs and education were greater priority than water	y	y	Mostly satisfied with water service more than other groups anyway
Strategic needs			
Water			
-do not want community management of water supply system	y	y	Not discussed with them

y = Yes, n = No

Mille – 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 water than poor people, and sometimes charge poor people excessive amounts as water vendors.	Poor people use badly managed public fountains which are opened irregularly and are inconveniently located.	Private connections are not affordable to the middle and low income households.	Increase number and opening times of public fountains in priority to private connections.
High rate of unemployment particularly in the form labouring social group.	Closure of Mille Plantation in 1992.	Low income families can not afford to use more water, even if it was more available.	Initiate other income generation activities as project components.
Majority of population not in favour of latrines.	Latrines in Mille are smelly and poorly used and maintained. Health hygiene awareness is poor.	Very difficult to initiate a sanitation project in Mille.	Extensive long term campaign and motivational activities required prior to any latrine construction work using respected community leaders the school and the health centre.

Appendix - 4

Summary of Group Meeting

MILLE - Summary of group meetings

Group 1 details	Group characteristics	Group needs
General	70% Highlanders, 30% Afar, Wood Collectors, Livestock husbanders, Bar Proprietors and petty Traders	1 - Water and Health, 2-Education, 3-Jobs
Water	Public Fountain, vendor Users and River Users. Piped water in short supply. Problems associated with distance from public fountains, inefficient service by water sellers and hence collect water from the river.	Extended service time for public fountains and additional public fountains required. Would like the PF to be a private connection managed as a PF by the users.
Sanitation	Open Field defecation preferred by all and children use area beside the river. Stones and water used for anal cleansing although boys use rough paper.	No interest in improved sanitation and antagonistic towards community toilet because associated with heat and odour problems.
Health	Unable to identify malaria from the chart used, although knew the symptoms of the disease. Bilharzia not common.	No health needs identified

Group 2 details	Group characteristics	Group needs
General	Highlanders, mainly involved with hotel based employment	1-Electricity and jobs, 2-Education and health
Water	Mostly public fountain and private connection users. Inadequate supply of water mostly because water does not flow at the set times, i.e. from 6-10am and 4-6pm. Some breakdowns mean that water supply may not be functioning for periods of months.	Increased hours for water supply required. Prefer the system to be managed by the Government.
Sanitation	Most practice open defecation including hotel owners with latrines. Women use water mostly for anal cleansing others use stones	No sanitation needs identified
Health	Relatively high level of health awareness compared with other groups in Mille, as all able to easily identify diseases on the charts.	No health needs identified

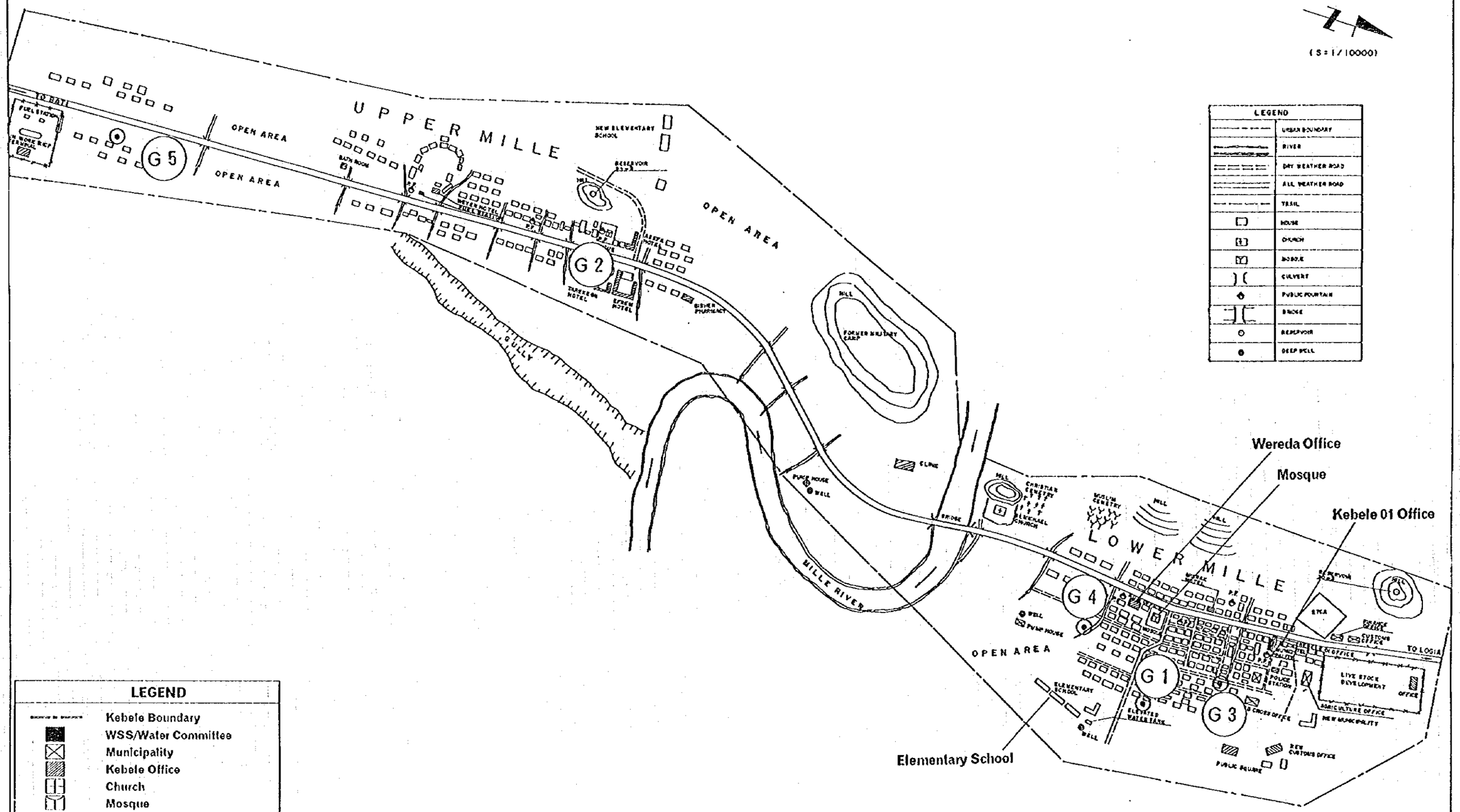
MILLE - Summary of group meetings (continued)

Group 3 details	Group characteristics	Group needs
General	Mainly Afar, Semi-nomadic and practice animal husbandry.	1-Water, 2-Electricity, 3-Health (same for males and females)
Water	Public fountain users and vendor users. Shortage of water due to breakdowns and the distance between public fountains.	Would like additional private connection to be managed by the community as a public fountain. Unable to pay for the cost of a Government water seller.
Sanitation	All practice open defecation, use stones water and paper for anal cleansing.	No sanitation needs identified
Health	Low awareness of water and sanitation related diseases. Only able to identify malaria from the charts, not diarrhoea etc. Poor access to health facilities.	No health needs identified

Group 4 details	Group characteristics	Group needs
General	Mostly highlanders, Wood Collectors, Government Employees and Daily Labourers	1-Jobs, 2-Water, 3-Health, 4-Electtricity
Water	Public fountain users and vendor users. Problems with water mainly due to large distance from homes to public fountains and large queues at public fountains.	Would like additional private connection to be managed as a public fountain by the community. One site would not be adequate and two were identified.
Sanitation	all practice open defecation. Use stone and water for anal cleansing.	No sanitation needs identified
Health	Low awareness of water and sanitation related diseases. Only able to identify malaria from the charts, not diarrhoea etc.	No health needs identified

MILLE - Summary of group meetings (continued)

Group 5	Group Characteristics	Group Needs
General	Mostly Highlanders but some Afar. Previous occupations mainly linked to former plantation now working in hotels and shops or doing daily labour work.	1-Jobs, 2-Water, 3-Health and electricity
Water	Public fountain and cart vendor users. Water problem due to problems with water sellers and short public fountain opening hours. Water vendors used to supplement the PF supply. Also long distance from homes to PFs.	Requirement for additional public fountain and for additional private connections (some willing to pay up to 600 Birr for PC). Also willingness for the PF to be a PC with community management .
Sanitation	All practice open defecation. Males use rough paper or stones for anal cleansing, females use water.	No felt need for latrines or other sanitation facilities
Health	Relatively poor health awareness, not able to identify malaria, TB, Giardia and diarrhoea from the charts although prevalent diseases in the area.	No health needs identified


(S = 1/10000)
LEGEND
URBAN BOUNDARY
RIVER
DRY WEATHER ROAD
ALL WEATHER ROAD
TRAIL
HOUSE
CHURCH
MOSQUE
CULVERT
PUBLIC FOUNTAIN
BRIDGE
RESERVOIR
DEEP WELL
UPPER MILLE
LOWER MILLE
OPEN AREA
OPEN AREA
OPEN AREA
OPEN AREA
G5
G2
G4
G1
G3
TO BATI
FUEL STATION
NEW ELEMENTARY SCHOOL
RESERVOIR
BATH ROOM
BEHER PHARMACY
TAREKEGN HOTEL
EFREM HOTEL
GULLY
HILL
FORMER MILITARY CAMP
CLINIC
PUMP HOUSE
WELL
BRIDGE
MILLE RIVER
CHRISTIAN CEMETERY
ST. MICHAEL CHURCH
MUSLIM CEMETERY
Wereda Office
Mosque
Kebele 01 Office
Elementary School
TO LOGIA
LIVE STOCK DEVELOPMENT OFFICE
AGRICULTURE OFFICE
NEW MUNICIPALITY
POLICE STATION
ELEVATED WATER TANK
PUBLIC SQUARE
1 / 10000
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

MILLE

Appendix - 5

Financial and Socio-Economic Data

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

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

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

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

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

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

Table 2 (1) Financial Condition of Water Supply Service in Mille

1. Official Water Price: 1.25 birr/m3 for all clients
2. Production and Consumption of Water, 1993/94
   1) Production : not available
   2) Consumption: 29,232 m3 (assumption)
      * Daily water consumption as divided by total population = 20.5 litre (excl. hydrants)
      * Leakage ratio = not available
3. Income and Expenditure
   1) Income : 48,818.21 birr

      Major sources of income

(1) Yard connection customers	20,567.95 birr	(42.1%)
(2) Hydrant users	18,864.35 birr	(38.6%)
(3) Public fountain users	7,107.59 birr	(14.6%)
(4) Technical service	1,502.42 birr	(3.1%)

      * Bill collection rate = 79.1%
      * Income per unit consumption of water = 1.67 birr/m3
   2) Expenditure: 38,182.14 birr

      Major items of expenditure

(1) Fuel	19,607.46 birr	(51.4%)
(2) Salaries	12,628.25 birr	(33.1%)
(3) Per diem	2,747.58 birr	(7.2%)

      * Expenditure per unit production of water = not available
      * Income-expenditure ratio = 127.9%
4. Organization and Personnel
   1) No. of personnel: 11 (5) [11]

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

(1) Administration 3 [3] guards	3 [3]
(2) Finance 5 (5) [5] water sellers	5 (5) [5]
(3) Urban water supply & sewerage 2 [2] operators, 1 [1] plumber	3 [3]

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

      * Production per worker = not available
      * Income and expenditure per worker = 4,438 birr, 3,471 birr/year
   2) Average monthly salaries of employees: 96 birr
5. No. of Distribution Facilities
   1) Yard connections : 89
   2) Public fountains : 8 (5 functional)
   3) Hydrant : 1
6. Problems and Bottlenecks
   1) Leakage in pipelines and reservoir.
   2) No spare pumps.
   3) The generator is overloaded.
   4) No transportation facilities for maintenance.

Table 3 (1) Summary of Socio-Economic Aspects of Bleven 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	1,105 (331)	204 (162)	243 (68)	812 (201)	450 (115)	1,672 (574)
[parenthesized figures=No. of hotels/restaurants]						
*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 Mille

I. Administrative Conditions

1. Administrative Classification: Region 2, Zone 1

2. Government Organizations
1) Weroda Council
2) Customs Control Bureau
3) Agricultural Bureau
4) Natural Resources Development and Environmental Protection (NRDEP)
5) Weroda Administration
6) Financial Bureau
7) Educational Bureau
8) Municipality
9) Health Clinic
10) North-Eastern Livestock Project Office
11) Road Maintenance Project Office
12) Police
13) Post Office
14) Telecommunications
15) Weroda Court
16) Weroda Attorney
17) Weroda Justice Bureau
18) Water Supply Service (WSS)

Notes: Schools are not included in the above organizations.

3. No. of Government Employees and Their Average Monthly Salaries: 336, 311 birr

* No. of government employees per 1,000 population: 86

4. No. of Kebele: 1

II. Socio-Economic Conditions

1. Population
1) Total population: 3,902

2) Ethnic groups: Amhara (69.2%), Oromo(13.5%), Tigre (12.5%), Afar (3.8%), Gurage (1.0%)

3) Religious groups: Christians (43%), Moslems (57%)

4) Average family size: 4.6 persons

Table 4 (2) Socio-Economic Condition of Mille

2. Area: 68 ha * Population density: 57.4 persons/ha

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

Items	Elementary School + Junior High School
(1) No. of schools	1
(2) No. of class rooms	8
(3) No. of teachers	18
(4) No. of pupils/students	457

Notes: 1. Another elementary school is now under construction.

* No. of pupils/students per 100 population: 12

2) Literacy ratio: 62% (1984)

3) Primary school enrollment ratio: 53% (1984)

4. Medical Conditions
1) No. of medical institutions/establishments:
1 Health Clinic, 2 private drug stores

2) No. of medical personnel:
3 health assistants, 1 health assistant ... 4 in total

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

(1) Top ten diseases

i.	Bronchitis & pneumonia	352 cases
ii.	Intestinal parasite	271
iii.	Skin infection	191
iv.	Unknown febrile illness	181
v.	Anemia	160
vi.	Malaria	127
vii.	Sexually transmitted diseases	106
viii.	Rheumatism	95
ix.	Gastritis	77
x.	Tuberculosis (all types)	51
	i. to x. =	1,611

Table 4 (3) Socio-Economic Condition of Mille

(2) Estimated number of cases per year as percentage of population:
(1,611 x 1.5) / (3,902 x 5) = 12.4%

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

4) Under 5 mortality rate: 154/1000 (1984)

5) Life expectancy: 53 years (1984)

6) Households more or less using septic tank and pit latrine: 45%

5. No. of Holy Places: 1 church, 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	7	1	8
Restaurants	0	19	3	22
Bars	90	30	0	120
Tea rooms	7	0	0	7
Snacks	2	0	0	2
Tej houses	3	0	0	3
Sub-total	102	56	4	162
3. Shops	12	18	12	42
Total	114	74	16	204

Notes: 1. There are 20 family local drink producers.
2. There is no cottage industry.
* No. of commercial and industrial establishments per 1,000 population: 52

2) Major occupations
(1) Commerce
(2) Day laborers
(3) Government employees

Table 4 (4) Socio-Economic Condition of Mille

3) Market
(1) Major marketable items:
vegetables, fruit, maize, barley, wheat, goat, sheep, etc.

(2) Prices of major marketable items

Livestock (unit: birr/one)		Consumers' item (unit: birr/kg)
sheep	goat	Butter
50	60	26

(3) Market day - every day

4) Average monthly household income: 223 birr

Sources: Woroda Administration, Financial Bureau and Health Clinic in Mille; Socio-Economic Sampling Questionnaire Survey by JICA; Central Statistical Authority

Appendix - 6

Result of Initial Environmental Examination

Project Description on Initial Environmental Examination in Mille

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	Mille, Region-2, 3rd Mille to be considered.
Executing Agency	Water Supply and Sewerage Service Department Ministry of Water Resource
Beneficiaries	About 3,900 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 of Mille river not to be considered.
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	Chlorine or its derivatives such as mainly calcium hypochlorite is used for disinfection in Ethiopia.

Site Description on Initial Environmental Examination in Mille

Items	Description
Project Title	Eleven Centers Water Supply and Sanitation
Social Environment	
Residents (population, tribe, consciousness)	Population about 3,900, mostly Amhara and other highlanders with utmost 10% of Afar.
Facilities related to life (electricity, etc.)	The electricity is currently generated by some individual generators only.
Health and Sanitation (diseases, clinic, etc.)	0 hospital, 1 health clinic, 2 drug stores. Malaria is prevailing.
Natural Environment	
Topography, Geology and Hydrogeology	Relatively flat land, semi-arid area. There are 3 dwelling areas such as lower, upper and 3rd. Mainly basalt lava and alluvial/aeolian deposit.
Meteo-hydrology Groundwater/spring/river	Annual rainfall about 290mm, perennial Mille river is flowing near town, groundwater table is considered low because of no hand dug well.
Endangered fauna and flora	Nil
Public Nuisance	
Nuisances	There are 6 number of public fountains. Only 3 water sellers are managing the P.F.s. People's water demand is not met due to the few sellers. During rainy season many stagnant waters appear specially in south part of lower Mille.
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. Afar people express their own land right. 2. They are aware of that the improvement of water supply is vital since they are suffering from serious water shortage as of Feb. 1995. 3. They have little awareness of sanitation, because they prefer open field(People can access open field very easily spreading just backward of the town).

Scoping Format for Initial Environmental Examination in Mille

Environmental Components	Classification	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. Afar claiming of their owing to land be considered.
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	If pipeline was laid across the main road, noticeable traffic interruption happened.

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 Mille

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	7,740	26,700	34,440
	Trench excavation	188,760	437,660	626,420
	Pipe-work	188,310	188,310	376,620
	Reservoir	126,000	126,000	252,000
	Pumping station, R.C.pump house	88,032	58,656	146,688
	Access road	178,000	414,000	592,000
	Bore-hole (200mm casing)	80,640	120,960	201,600
	Water purifiction unit	10,000	15,000	25,000
	Booster pump and necessary works	120,000	200,000	320,000
	Electric submersible pump and necessary works	60,000	90,000	150,000
	Power supply	23,550	30,325	53,875
	Concrete work	55,850	96,750	152,600
	Masonsy work	6,000	24,500	30,500
	Structure	103,920	242,480	346,400
	Temporary work(10% of above total)	133,680	222,134	355,814
	Total of civil work	1,470,482	2,443,475	3,913,957
2	Material & Equipment	3,586,132	251,029	3,837,161
	Sub Total	5,056,614	2,694,504	7,751,118
3	Engineering cost(12% of sub tatal)	930,134		930,134
4	Contingency(5% of above total)	299,337	134,725	434,062
	Total(birr)	6,286,085	2,829,229	9,115,314
	Total(Yen:1birr=15yen)			136,725,000
5	Buildings		1,123,013	1,123,013
6	WSSD's management cost		204,767	204,767
	Total		1,327,780	1,327,780
7	Prise escalation(6%)	377,165	249,421	626,586
	Grand Total	6,663,250	4,406,430	11,069,680
II.	Target year of 2010			
1	Morbilization and demorbilization			300,000
2	Rising line			285,000
3	Distribution network			990,000
4	New borehole with pump & material			659,000
				560,000
5	Generating set			534,000
6	Power supply facilities			170,000
7	Chamber and structures			243,000
8	Buildings			562,200
9	Others			365,800
	Sub total			4,669,000
10	Engineering cost (10%)			466,900
11	Contingency (10%)			513,590
	Total			5,649,000
12	Prise escalatin(42%)			2,373,000
	Grand Total			8,022,000

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	50	10	20	500	1,000	
	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	2,840	4	8	11,360	22,720	
	b) 1.0~1.5m depth	m	11,650	7	17	81,550	198,050	
3-2	Trench, Rock excavation	cum	200	30	70	6,000	14,000	
3-3	Back-fill with the same material	m	10,140	5	11	50,700	111,540	
3-4	Selected soil bedding	m	4,350	2	5	8,700	21,750	150mm thick below barrel
3-5	Back-fill with selected material	m	4,350	7	16	30,450	69,600	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	1,720	5	5	8,600	8,600	
	b) DN 75mm	m	1,120	8	8	8,960	8,960	
	c) DN 100mm	m	3,900	10	10	39,000	39,000	
	d) DN 150mm	m	7,750	17	17	131,750	131,750	
5.	Reservoir							
5-1	Ground level reservoir	m3	140	900	900	126,000	126,000	
6.	Pumping station, R.C.pump house	sqm	48	1,834	1,222	88,032	58,656	with accessaries
7.	Access road	m	2,000	89	207	178,000	414,000	3m wide gravel road with draine ditch

No.	Description	Unit	Q'ty	Unit-Rate F.C.(B)	Unit-Rate L.C.(B)	Amount F.C.(B)	Amount L.C.(B)	Remarks
8.	Bore-hole							
8-1	New driling	m	152	320	480	48,640	72,960	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.	2	60,000	100,000	120,000	200,000	foundation, pump, and motor with accessories
11.	Electric submersible pump (for deep well)	No.	4	15,000	22,500	60,000	90,000	foundation, and pump with accessories
12.	Power supply							
12-1	Generating set	No.	3	5,850	8,775	17,550	26,325	gererater with accessaries
12-2	High tension line	m		8	7	0	0	
12-3	Low tension line	m	1,000	6	4	6,000	4,000	
12-4	Trensformer	No.		4,000	6,000	0	0	transformer with accessaries
13.	Concrete work							
13-1	Normal concrete (250kg of cement per cum)	cum	50	250	500	12,500	25,000	including form-work, vibration and curing
13-2	Reinforced concrete (360kg of cement per cum) Water retaining structure	cum	100	275	642	27,500	64,200	including vibration and curing
13-3	Form-work Wall	sqm	50	37	87	1,850	4,350	including all necessary works
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	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.	6	1,580	3,680	9,480	22,080	
15-2	Construction of hydrant	No.	12	230	540	2,760	6,480	
15-3	Construction of R.C.C. aeration chamber	No.	4	5,730	13,370	22,920	53,480	
15-4	Construction of R.C.C. valve chamber	No.	12	5,730	13,370	68,760	160,440	
	Sub-Total of Construction work					1,336,802	2,221,341	

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					3,586,132		
16-2	Inland transportation cost						251,029	CIF cost x 7 %
	Sub-Total of Material & Equipment					3,586,132	251,029	
	Total					4,922,934	2,472,370	
17.	Building							
17-1	Office	sqm	110		1,910		210,100	
17-2	Workshop	sqm	57	487	1,624		92,568	
17-3	Store	sqm	95	401	1,337		127,015	
17-4	Resience	sqm	330	630	2,101		693,330	
	Total						1,123,013	

Imported Cost (Material & Equipment) of Mille :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	1,800	15	27,000
	b) DN 75mm	m	1,180	30	35,400
	c) DN 100mm	m	4,100	40	164,000
	d) DN 150mm	m	8,140	80	651,200
	Fitting cost Total cost × 20%	LS			175,520
2	Pumps (Pump with electric motor/accessories)				
2.1	Centrifugal pumps				
	a) Q=0.5m3/min H= 13m HP= 2.2	set	4	100,000	400,000
2.2	Submersible pumps with accessories				
	a) Q= 0.12m3/min H= 100m HP= 3	set	1	130,000	130,000
	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				
	20 KVA	set	3	200,000	600,000
3.2	Tension line				
	Low tension over head line	m	1,000	28	28,000
4	Valve (Valve with accessories)				
4.1	Sluice valve				
	a) ϕ50	set	2	1,000	2,000
	b) ϕ75	set	2	1,300	2,600
	c) ϕ150	set	2	1,700	3,400
4.2	High speed air valve				
	ϕ50	set	4	7,000	28,000
4.3	Check valve				
	a) 75mm	set	1	10,000	10,000
	b) 100mm	set	1	13,000	13,000
5	Flow meter (Meter with accessories ϕ100)	set	2	50,000	100,000
6	Reservoir exuipment	set	2	100,000	200,000
7	Well (Materials with accessories)				
7.1	Casing pipe FRP				
	DN 200	m	84	2,093	175,812
7.2	Screen FRP				
	DN 200	m	68	5,700	387,600
7.3	Riser pipe, stainless DN 65	m	170	180	30,600
8	Water purification unit	set	1	80,000	80,000
	Total				3,586,132

Investment Cost of Target Year 2010 in Mille

No.	Description	Unit	Q'ty	Unit Rate (B)	Amount (B)
1	Mobilization and demobilization	LS			300,000
2	Rising line	Km	1	300,000	285,000
3	Distribution network	Km	7	150,000	990,000
4	New borehole with pump & material	Set	1	659,000	659,000
5	Generating set	Set	1	560,000	560,000
6	Booster pump with house	Set	1	534,000	534,000
7	Power supply facilities	Site	1	170,000	170,000
8	Chamber and structures	Set	9	27,000	243,000
9	Buildings	M2	6	93,700	562,200
	Others	LS			365,800
	Sub total				4,669,000
11	Enginering cost (10%)				466,900
12	Contingency (10%)				513,590
	Total				5,649,490

Appendix - 8

Meteorological Data

Table 1 Monthly Precipitation

Station: Mille

Unit:mm

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1979	5.4	--	50.8	--	--	--	--	86.0	13.5	--	--	--	--
1986	--	--	--	--	--	--	51.0	75.1	27.9	0.0	0.0	0.0	--
1987	0.0	0.0	0.0	164.0	17.9	0.0	0.0	79.7	13.8	--	--	--	--
1988	0.0	0.0	0.0	0.0	--	3.8	118.3	121.8	82.2	4.4	0.0	0.0	--
1989	--	--	54.0	--	--	--	--	31.4	--	--	--	--	--
1990	--	--	--	--	2.3	0.0	--	--	--	--	--	--	--
1991	0.3	2.0	48.8	24.7	--	--	82.9	39.1	19.8	0.0	0.0	--	--
1992	46.2	6.3	0.0	26.8	2.5	0.0	21.7	152.4	19.8	20.8	0.0	0.0	296.5
1993	17.9	30.8	0.0	84.6	67.9	0.0	60.7	35.5	34.3	--	--	--	--

Table 2 Long Term Monthly Mean Potential Evapotranspiration (PET)

Station: Mille

Unit:mm

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1st 10 days	63	60	62	63	65	69	70	75	80	85	91	85	
2nd 10 days	82	76	70	69	63	59	59	56	56	57	56	57	
3rd 10 days	55	55	62	67	74	73	71	70	69	70	68	65	
Total	200	191	194	199	202	201	200	201	205	212	215	207	2427

Note: - = not calculated due to missing data

Table 3 Monthly Average Maximum Air Temperature

Station: Mille

unit: ℃

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1979	31.4	--	35.7	--	--	--	--	--	--	--	--	--
1986	--	--	--	--	--	--	41.0	--	--	--	34.7	32.3
1987	31.4	33.8	34.7	--	--	42.4	42.0	40.4	41.1	--	--	--
1988	33.3	35.2	38.4	39.1	--	42.8	39.0	37.5	38.7	36.2	34.0	--
1989	--	--	34.2	--	--	--	--	40.6	--	--	--	--
1990	--	--	--	--	41.5	43.0	--	--	--	--	--	--
1991	--	--	--	39.5	--	--	39.6	39.9	39.6	--	33.8	33.3
1992	32.1	31.0	35.5	38.2	40.5	42.4	40.7	37.4	--	--	34.3	33.5
1993	31.4	31.3	36.6	36.4	38.7	42.3	40.8	40.9	--	--	--	--

Table 4 Monthly Average Minimum Air Temperature

Station: Mille

unit: ℃

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1979	23.3	--	22.9	--	--	--	--	--	--	--	--	--
1986	--	--	--	--	--	--	24.5	--	--	--	20.3	18.5
1987	18.1	19.4	22.1	--	--	28.6	29.3	25.9	27.2	--	--	--
1988	20.6	21.9	22.6	23.7	--	28.4	24.3	22.5	24.9	23.8	13.9	--
1989	--	--	20.4	--	--	--	--	23.8	--	--	--	--
1990	--	--	--	--	25.5	27.2	--	--	--	--	--	--
1991	--	20.4	--	25.9	--	--	27.0	26.6	26.3	--	20.7	21.2
1992	21.7	21.7	23.4	25.0	27.8	--	27.3	24.2	25.2	--	22.0	--
1993	20.7	20.8	22.9	24.4	25.8	28.9	26.8	27.3	--	--	--	--

Note: - = not calculated due to missing data

Table 5 Monthly Average Air Temperature

Station: Mille Unit: ℃

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1979	27.4	–	29.3	–	–	–	–	–	–	–	–	–
1986	–	–	–	–	–	–	32.8	–	–	–	27.5	25.4
1987	24.8	26.6	28.4	–	–	35.5	35.7	33.2	34.2	–	–	–
1988	27.0	28.6	30.5	31.4	–	35.6	31.7	30.0	31.8	30.0	24.0	–
1989	–	–	27.3	–	–	–	–	32.2	–	–	–	–
1990	–	–	–	–	33.5	35.1	–	–	–	–	–	–
1991	–	–	–	32.7	–	–	33.3	33.3	33.0	–	27.3	27.3
1992	26.9	26.4	29.5	31.6	34.2	–	34.0	30.8	–	–	28.2	–
1993	26.1	26.1	29.8	30.4	32.3	35.6	33.8	34.1	–	–	–	–

Table 6 Area Precipitation of Mille River Basin

Unit:㎜

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1987	–	–	–	–	–	2.1	41.0	201.6	43.2	–	–	–	–
1988	7.6	26.6	4.1	58.6	–	16.8	318.3	205.5	121.3	16.8	0.0	11.0	–
1989	–	–	82.5	–	–	–	–	131.6	–	–	–	–	–
1990	–	–	–	–	19.2	0.0	–	–	–	–	–	–	–
1991	3.8	80.2	173.4	30.5	–	–	–	146.4	55.4	31.0	0.0	–	–
1992	82.3	39.7	17.5	28.9	11.6	8.1	123.3	286.1	129.1	34.8	0.3	59.3	821.0
1993	76.9	89.7	0.0	189.9	106.4	4.4	177.8	107.6	76.3	–	–	–	–
Avg.	42.7	59.1	55.5	77.0	45.7	7.9	165.1	179.8	85.1	27.5	0.1	35.2	780.7

Table 7 Long Term Monthly Mean Potential Evapotranspiration of Mille River Basin

Station: Mille Unit:㎜

Station/Area	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Mille	200	191	194	199	202	201	200	201	205	212	215	207	2427
Bati	134	135	139	139	141	141	141	142	137	135	132	133	1649
Mille River Basin	145.9	145.1	148.9	149.8	152.0	151.8	151.6	152.6	149.2	148.9	146.9	146.3	1789

Note: - = not calculated due to missing data

Table 8 Monthly Precipitation

Station: Bati

Unit:mm

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1960	--	--	--	--	--	2.0	217.2	141.1	118.6	0.0	34.8	0.0	--
1961	--	99.9	126.9	122.3	10.0	68.9	--	--	--	--	--	--	--
1962	1.0	--	--	--	--	--	--	--	--	--	--	--	--
1963	--	--	--	--	--	15.3	229.1	201.0	41.6	--	--	--	--
1964	--	--	99.3	156.7	69.8	100.4	--	--	--	--	--	58.7	--
1965	52.4	0.0	--	0.0	0.0	2.0	290.1	330.3	74.1	--	40.7	0.0	--
1966	0.0	112.3	3.0	77.6	--	77.9	78.3	--	--	--	0.0	0.0	--
1967	0.0	0.0	56.5	132.0	54.6	20.0	210.0	224.0	62.0	42.0	129.0	--	--
1968	--	--	--	198.0	0.0	10.0	352.1	113.1	54.0	0.0	62.0	10.2	--
1969	269.0	0.0	73.4	80.0	70.0	0.0	182.0	--	10.0	--	--	0.0	--
1971	0.0	0.0	62.0	128.0	63.0	0.0	126.1	228.0	43.5	--	--	--	--
1974	--	--	--	--	--	--	--	81.5	147.9	0.0	--	--	--
1978	--	--	48.9	116.7	34.6	--	--	221.7	77.1	62.5	5.9	--	--
1980	--	--	--	--	22.0	--	199.6	--	--	--	--	--	--
1987	--	--	--	--	--	2.5	50.0	228.3	49.6	48.2	0.0	36.3	--
1988	9.3	32.4	5.0	71.5	10.4	19.6	362.2	223.9	129.9	19.5	0.0	13.4	897.1
1989	38.3	126.4	88.8	129.4	27.7	13.6	118.1	153.6	75.7	32.5	0.0	170.1	974.2
1990	57.1	258.4	20.9	68.5	22.9	0.0	160.6	94.1	83.6	3.0	0.0	0.0	769.1
1991	4.6	97.3	200.8	31.8	--	--	--	170.0	63.2	37.8	0.0	91.3	--
1992	90.2	47.0	21.3	29.3	13.6	9.9	145.6	315.4	152.9	37.9	0.4	72.3	935.8
1993	89.9	102.6	0.0	213.0	114.9	5.3	203.5	123.4	85.5	77.0	0.0	0.0	1015.1
1994	0.0	2.3	64.6	28.9	18.1	15.2	333.2	207.5	106.3	0.0	--	--	--

Note: -- = not calculated due to missing data

Appendix - 9

Hydrological Data

Table 1 Monthly Runoff of Mille River

Station: Mille

Unit: Upper in Million m3, Lower in mm

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1962	4.32 1.0	2.88 0.7	20.55 4.7	45.00 10.3	5.00 21.8	3.00 0.7	25.00 5.7	200.01 46.0	80.00 18.4	17.81 4.1	1.76 0.4	1.50 0.3	402.38 92.5
1963	1.66 0.4	1.98 0.5	2.68 0.6	78.53 18.1	39.94 9.2	3.47 0.8	30.01 6.9	34.78 8.0	8.92 2.1	1.66 0.4	5.00 1.1	5.79 1.3	212.94 49.0
1964	10.66 2.5	13.78 3.2	6.30 1.4	42.78 9.8	10.60 2.4	2.80 0.6	156.21 35.9	343.93 79.1	20.08 4.6	12.72 2.9	7.98 1.8	4.25 1.0	643.37 147.9
1965	11.72 2.7	6.74 1.5	4.37 1.0	19.31 4.4	3.06 0.7	1.55 0.4	8.87 2.0	58.81 13.5	14.37 3.3	8.40 1.9	8.08 1.9	4.60 1.1	149.52 34.4
1966	4.62 1.1	28.40 6.5	6.36 1.5	15.28 3.5	2.56 0.6	1.32 0.3	4.11 0.9	31.41 7.2	16.40 3.8	5.32 1.2	3.22 0.7	2.53 0.6	121.53 27.9
1967	2.79 0.6	2.78 0.6	7.73 1.8	13.87 3.2	50.68 11.7	2.80 0.6	31.68 7.3	80.68 18.5	13.56 3.1	10.56 2.4	40.26 9.3	5.46 1.3	261.35 60.1
1968	4.08 0.9	17.62 4.1	12.04 2.8	39.46 9.1	7.00 1.6	4.11 0.9	48.36 11.1	25.83 5.9	7.81 1.8	6.08 1.4	5.05 1.2	4.61 1.1	181.15 41.6
1969	22.10 5.1	33.43 7.7	33.26 7.6	28.00 6.4	21.34 4.9	5.49 1.3	19.91 4.6	59.52 13.7	19.52 4.5	8.58 2.0	6.37 1.5	5.93 1.4	259.22 59.6
1970	21.86 5.0	7.60 1.7	28.88 6.6	7.39 1.7	6.84 1.6	3.47 0.8	46.20 10.6	116.58 26.8	17.00 3.9	7.81 1.8	4.48 1.0	4.28 1.0	272.39 62.6
1971	4.80 1.1	3.73 0.9	4.76 1.1	8.21 1.9	13.69 3.1	2.81 0.6	7.81 1.8	34.37 7.9	7.87 1.8	25.54 5.9	6.18 1.4	5.52 1.3	102.30 23.5
1972	5.41 1.2	20.33 4.7	12.91 3.0	36.53 8.4	16.37 3.8	6.02 1.4	8.14 1.9	27.69 6.4	10.83 2.5	2.39 0.5	2.12 0.5	4.10 0.9	152.04 35.0
1973	2.60 0.6	1.49 0.3	1.33 0.3	3.47 0.8	8.08 1.9	0.60 0.1	36.56 8.4	311.68 71.7	19.04 4.4	0.64 0.1	5.41 1.24	0.42 0.1	391.44 90.0
1974	0.39 0.1	0.37 0.1	16.66 3.8	27.07 6.2	14.14 3.3	2.98 0.7	31.61 7.3	92.29 21.2	17.18 3.9	1.15 0.3	0.78 0.2	0.62 0.1	205.24 47.2
1975	12.40 2.9	83.19 19.1	6.20 1.4	22.67 5.2	4.13 0.9	1.13 0.3	3.80 0.9	102.90 23.7	19.06 4.4	7.14 1.6	9.03 2.1	3.84 0.9	276.51 63.6
1976	5.74 1.3	5.28 1.2	85.72 19.7	30.18 6.9	9.45 2.2	2.11 0.5	15.85 3.6	24.03 5.5	12.28 2.8	3.85 0.9	29.80 6.9	4.48 1.0	227.72 52.3
1977	—	—	—	—	51.41 11.8	0.69 0.2	85.75 19.7	262.60 60.4	43.62 10.0	167.69 38.5	15.60 3.6	4.73 1.1	—

1978	3.72 0.9	61.61 14.2	13.52 3.1	18.86 4.3	7.56 1.7	0.00 0.0	188.30 43.3	219.60 50.5	60.20 13.8	14.53 3.3	11.79 2.7	15.91 3.7	615.60 141.5
1979	28.63 6.6	10.21 2.3	26.56 6.1	44.47 10.2	21.21 4.9	7.27 1.7	29.60 6.8	147.36 33.9	36.94 8.5	15.03 3.5	5.56 1.3	9.21 2.1	376.05 86.4
1980	8.05 1.9	11.60 2.7	11.16 2.6	46.10 10.6	14.77 3.4	4.17 1.0	46.10 10.6	316.80 72.8	15.62 3.6	7.10 1.6	2.96 0.7	2.18 0.5	486.61 111.9
1981	2.35 0.5	2.03 0.5	216.36 49.7	88.04 20.2	2.21 0.5	--	--	91.23 21.0	63.39 14.6	7.23 1.7	4.23 1.0	3.69 0.8	--
1982	4.58 1.1	5.62 1.3	38.97 9.0	22.99 5.3	43.50 10.0	1.28 0.3	5.99 1.4	16.07 3.7	7.26 1.7	52.03 12.0	56.69 13.0	46.39 10.7	301.32 69.3
1983	6.12 1.4	8.93 2.1	7.48 1.7	18.65 4.3	13.94 3.2	2.44 0.6	4.54 1.0	15.93 3.7	8.60 2.0	4.22 1.0	4.49 1.0	4.62 1.1	105.26 24.2
1984	3.84 0.9	3.36 0.8	3.12 0.7	2.46 0.6	52.76 12.1	1.08 0.2	1.25 0.3	0.60 0.1	23.35 5.4	1.80 0.4	1.25 0.3	6.40 1.5	101.27 23.3
1985	0.48 0.1	0.28 0.1	1.94 0.4	56.91 13.1	16.61 3.8	0.68 0.2	10.96 2.5	38.06 8.7	38.81 8.9	0.65 0.1	0.15 0.0	1.34 0.3	166.87 38.4
1986	0.33 0.1	8.33 1.9	10.12 2.3	22.85 5.3	4.53 1.0	5.50 1.3	18.95 4.4	56.17 12.9	30.86 7.1	1.18 0.3	0.29 0.1	1.22 0.3	160.28 36.8
1987	0.16 0.0	0.46 0.1	24.83 5.7	27.20 6.3	20.91 4.8	3.53 0.8	0.57 0.1	33.40 7.7	8.00 1.8	4.42 1.0	0.33 0.1	2.33 0.5	126.14 29.0

Note: - =Not calculated due to missing data

Appendix - 10

Calculation of Water Pipeline

Output data on distribution network for Mille 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	150	40	8.93	0.51	0.12	2.97	110	
2	2	2	3	150	80	0.24	0.01	0.00	0.00	110	
3	3	2	4	150	300	8.23	0.47	0.77	2.55	110	
4	4	4	5	150	1830	5.76	0.33	2.42	1.32	110	
5	5	4	6	150	2950	0.81	0.05	0.10	0.04	110	
6	6	6	7	150	120	0.00	0.00	0.00	0.00	110	CLOSE
7	7	7	8	150	600	-0.49	-0.03	-0.00	-0.01	110	
8	8	8	9	150	190	4.17	0.24	0.14	0.72	110	
9	9	9	10	75	355	-0.68	-0.15	-0.27	-0.75	110	
10	10	10	11	75	165	-0.97	-0.22	-0.24	-1.44	110	
11	11	8	11	150	300	-5.53	-0.31	-0.37	-1.22	110	
12	12	11	12	150	310	-6.86	-0.39	-0.57	-1.82	110	
13	13	12	13	150	170	-7.47	-0.42	-0.36	-2.14	110	
14	14	12	14	150	150	0.11	0.00	0.00	0.00	110	

Output data on distribution network for Mille 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	150	40	21.14	1.20	0.59	14.63	110	
2	2	2	3	150	80	0.12	0.00	0.00	0.00	110	
3	3	2	4	150	300	20.79	1.18	4.26	14.19	110	
4	4	4	5	150	1830	19.55	1.11	23.17	12.66	110	
5	5	4	6	150	2950	0.41	0.02	0.03	0.00	110	
6	6	6	7	150	120	0.00	0.00	0.00	0.00	110	CLOSE
7	7	7	8	150	600	-0.25	-0.01	-0.00	-0.00	110	
8	8	8	9	150	190	0.35	0.02	0.00	0.00	110	
9	9	9	10	75	355	-2.07	-0.47	-2.07	-5.82	110	
10	10	10	11	75	165	-2.22	-0.50	-1.09	-6.63	110	
11	11	8	11	150	300	-17.70	-1.00	-3.16	-10.53	110	
12	12	11	12	150	310	-20.10	-1.14	-4.13	-13.33	110	
13	13	12	13	150	170	-20.40	-1.15	-2.33	-13.70	110	
14	14	12	14	150	150	0.05	0.00	0.00	0.00	110	

Output data on distribution network for Mille 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	150	40	26.11	1.48	0.87	21.63	110	
2	2	2	3	150	80	6.90	0.39	0.15	1.84	110	
3	3	2	4	150	300	18.75	1.06	3.52	11.72	110	
4	4	4	5	150	1830	5.76	0.33	2.42	1.32	110	
5	5	4	6	150	2950	11.33	0.64	13.62	4.62	110	
6	6	6	7	150	120	10.52	0.60	0.49	4.06	110	V1
7	7	7	8	150	600	10.03	0.57	2.21	3.69	110	
8	8	8	9	150	190	5.03	0.28	0.20	1.03	110	
9	9	9	10	75	355	0.18	0.04	0.02	0.06	110	
10	10	10	11	75	165	-0.11	-0.02	-0.00	-0.02	110	
11	11	8	11	150	300	4.13	0.23	0.21	0.71	110	
12	12	11	12	150	310	3.66	0.21	0.18	0.57	110	
13	13	12	13	150	170	-3.61	-0.20	-0.09	-0.56	110	
14	14	12	14	150	150	6.77	0.38	0.27	1.78	110	

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

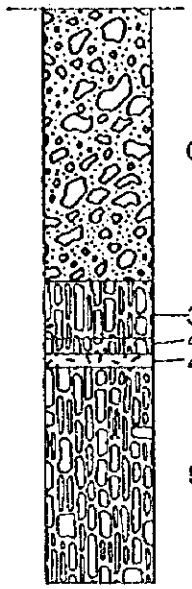
Serial Number	Pipeline Number	Nord Number Start	Nord Number End	Dia (mm)	Pipeline Length(m)	Flow (liter/sec.)	Velocity (m/sec.)	Hydraulic Gradient (m/1000)	Loss of Head (m)	Velocity Coefficient	Remarks
1	1	1	2	150	40	34.37	1.94	1.44	35.96	110	
2	2	2	3	150	80	3.45	0.20	0.04	0.51	110	
3	3	2	4	150	300	30.69	1.74	8.75	29.16	110	
4	4	4	5	150	1830	19.54	1.11	23.15	12.65	110	
5	5	4	6	150	2950	10.33	0.58	11.47	3.89	110	
6	6	6	7	150	120	9.93	0.56	0.44	3.64	110	V1
7	7	7	8	150	600	9.69	0.55	2.07	3.45	110	
8	8	8	9	150	190	1.40	0.08	0.02	0.10	110	
9	9	9	10	75	355	-1.02	-0.23	-0.56	-1.56	110	
10	10	10	11	75	165	-1.17	-0.26	-0.33	-2.02	110	
11	11	8	11	150	300	-8.81	-0.50	-0.87	-2.90	110	
12	12	11	12	150	310	-10.16	-0.58	-1.17	-3.77	110	
13	13	12	13	150	170	-13.79	-0.78	-1.13	-6.64	110	
14	14	12	14	150	150	3.39	0.19	0.07	0.50	110	

Appendix - 11

Geological Logs of Existing Boreholes

WSS Borehole No.1 in Mille

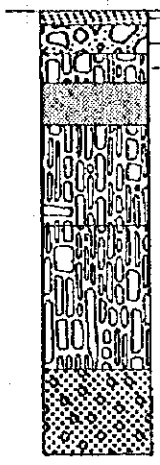
Depth	Lithology
0 - 38 m	Over Burden
38 - 46 m	Hard Rock
46 - 48 m	Decomposed Rock
48 - 50 m	Red Ash
50 - 80 m	Hard Rock



Location : Upper Mille

WSS Borehole No.2 in Mille

Depth	Lithology
0 - 2 m	Top Soil
2 - 6 m	Boulders
6 - 10 m	Rocks
10 - 16 m	Clay
16 - 30 m	Decomposed Rock
30 - 50 m	Hard Rock
50 - 62 m	Gravel and Sand



Location : Lower Mille