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
## CHAGNI

(Volume III-VIII)



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 Chagni 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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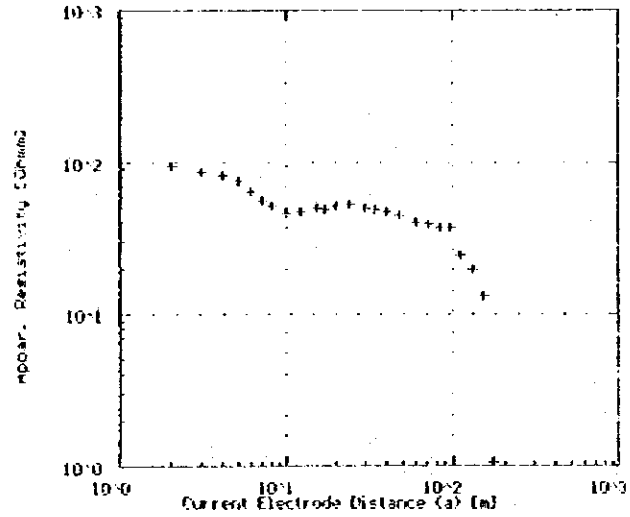
# Appendix - 1

# Resistivity Interpretation of VEP

## Figure 1 Geoelectrical Survey, Wenner Array

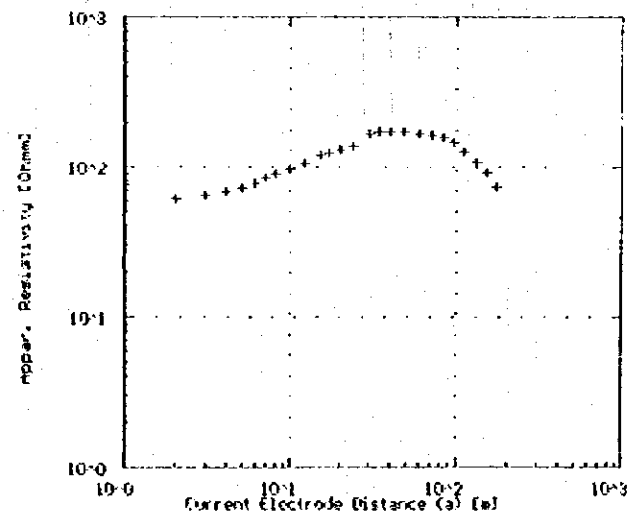
### VES St. No.1 -CHAGNI




| Point (No) | AB/2 (Mr) | a (m) | Res (ohmm) |
|---|---|---|---|
| 1 | 1.00 | 91.860 | |
| 2 | 2.00 | 84.200 | |
| 3 | 3.00 | 88.640 | |
| 4 | 4.00 | 92.980 | |
| 5 | 5.00 | 76.020 | |
| 6 | 6.00 | 65.190 | |
| 7 | 7.00 | 56.710 | |
| 8 | 8.00 | 51.150 | |
| 9 | 10.00 | 48.700 | |
| 10 | 12.00 | 47.850 | |
| 11 | 15.00 | 49.920 | |
| 12 | 17.00 | 50.180 | |
| 13 | 20.00 | 51.500 | |
| 14 | 24.00 | 52.150 | |
| 15 | 30.00 | 50.810 | |
| 16 | 34.00 | 50.130 | |
| 17 | 40.00 | 47.720 | |
| 18 | 48.00 | 46.920 | |
| 19 | 60.00 | 40.690 | |
| 20 | 72.00 | 35.190 | |
| 21 | 84.00 | 32.930 | |
| 22 | 96.00 | 27.320 | |
| 23 | 120.00 | 24.970 | |
| 24 | 330.00 | 19.530 | |
| 25 | 450.00 | 13.190 | |
| 26 | 570.00 | 1.970 | |

| Specific Resistivity(Ω-m) | 118 | 78.67 | 27.67 | 63.75 | 34.67 | 1.27 |
|---|---|---|---|---|---|---|

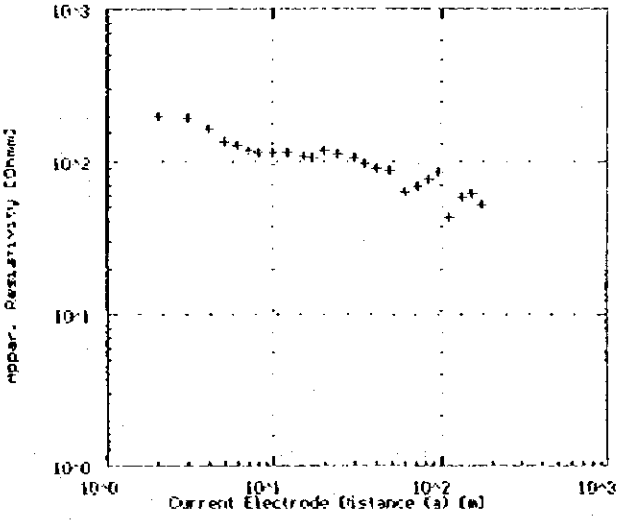
### VES St. No.2 -CHAGNI




| Point (No) | AB/2 (Mr) | a (m) | Res (ohmm) |
|---|---|---|---|
| 1 | 1.00 | 75.360 | |
| 2 | 2.00 | 91.595 | |
| 3 | 3.00 | 85.030 | |
| 4 | 4.00 | 87.570 | |
| 5 | 5.00 | 72.530 | |
| 6 | 6.00 | 77.520 | |
| 7 | 7.00 | 83.950 | |
| 8 | 8.00 | 93.030 | |
| 9 | 10.00 | 97.360 | |
| 10 | 12.00 | 105.590 | |
| 11 | 15.00 | 119.630 | |
| 12 | 17.00 | 123.060 | |
| 13 | 20.00 | 131.880 | |
| 14 | 24.00 | 138.050 | |
| 15 | 30.00 | 167.685 | |
| 16 | 34.00 | 170.920 | |
| 17 | 40.00 | 173.330 | |
| 18 | 48.00 | 171.970 | |
| 19 | 60.00 | 159.560 | |
| 20 | 72.00 | 152.700 | |
| 21 | 84.00 | 151.200 | |
| 22 | 96.00 | 147.210 | |
| 23 | 110.00 | 128.690 | |
| 24 | 130.00 | 100.590 | |
| 25 | 150.00 | 83.260 | |
| 26 | 170.00 | 76.190 | |

| Specific Resistivity(Ω-m) | 82 | 41 | 192 | 196.5 | 56.33 |
|---|---|---|---|---|---|

## VES St. No.3 -CHAGNI

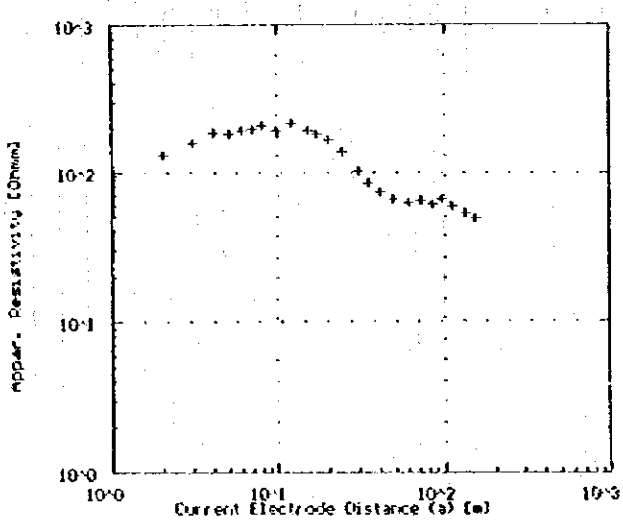



| Point [No] | AB/2 [Mr] | a [m] | Rs [ohm] |
|---|---|---|---|
| 1 | 1.00 | 156.170 | |
| 2 | 2.00 | 200.960 | |
| 3 | 3.00 | 194.890 | |
| 4 | 4.00 | 184.540 | |
| 5 | 5.00 | 135.020 | |
| 6 | 6.00 | 120.110 | |
| 7 | 7.00 | 116.490 | |
| 8 | 8.00 | 113.540 | |
| 9 | 10.00 | 110.920 | |
| 10 | 12.00 | 111.550 | |
| 11 | 15.00 | 102.320 | |
| 12 | 17.00 | 105.690 | |
| 13 | 20.00 | 110.370 | |
| 14 | 24.00 | 111.530 | |
| 15 | 30.00 | 104.550 | |
| 16 | 36.00 | 96.080 | |
| 17 | 40.00 | 89.170 | |
| 18 | 48.00 | 86.210 | |
| 19 | 60.00 | 62.110 | |
| 20 | 72.00 | 67.020 | |
| 21 | 84.00 | 75.160 | |
| 22 | 96.00 | 86.190 | |
| 23 | 110.00 | 62.030 | |
| 24 | 130.00 | 57.140 | |
| 25 | 150.00 | 61.230 | |
| 26 | 170.00 | 51.240 | |

| Specific Resistivity(Ω-m) | 128 | 320 | 73.33 | 112 | 56 | 160 | 30 |
|---|---|---|---|---|---|---|---|

37.5

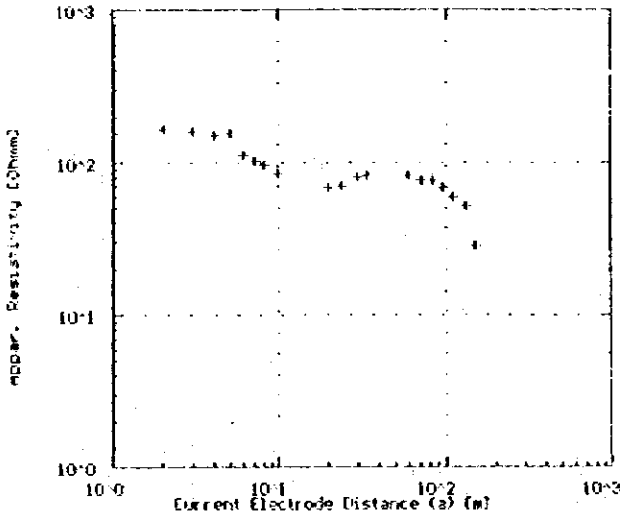
## VES St. No.4 -CHAGNI




| Point [No] | AB/2 [Mr] | a [m] | Rs [ohm] |
|---|---|---|---|
| 1 | 1.00 | 96.030 | |
| 2 | 2.00 | 130.620 | |
| 3 | 3.00 | 160.140 | |
| 4 | 4.00 | 185.090 | |
| 5 | 5.00 | 185.260 | |
| 6 | 6.00 | 197.120 | |
| 7 | 7.00 | 197.020 | |
| 8 | 8.00 | 211.010 | |
| 9 | 10.00 | 155.680 | |
| 10 | 12.00 | 204.200 | |
| 11 | 15.00 | 190.050 | |
| 12 | 17.00 | 181.090 | |
| 13 | 20.00 | 160.300 | |
| 14 | 24.00 | 137.150 | |
| 15 | 30.00 | 103.620 | |
| 16 | 36.00 | 85.410 | |
| 17 | 40.00 | 76.100 | |
| 18 | 48.00 | 66.620 | |
| 19 | 60.00 | 62.170 | |
| 20 | 72.00 | 65.010 | |
| 21 | 84.00 | 66.320 | |
| 22 | 96.00 | 65.020 | |
| 23 | 110.00 | 55.410 | |
| 24 | 130.00 | 53.000 | |
| 25 | 150.00 | 48.400 | |

| Specific Resistivity(Ω-m) | 74 | 222 | 50 | 64 | 32 |
|---|---|---|---|---|---|

## VES St. No.5 -CHAGNI

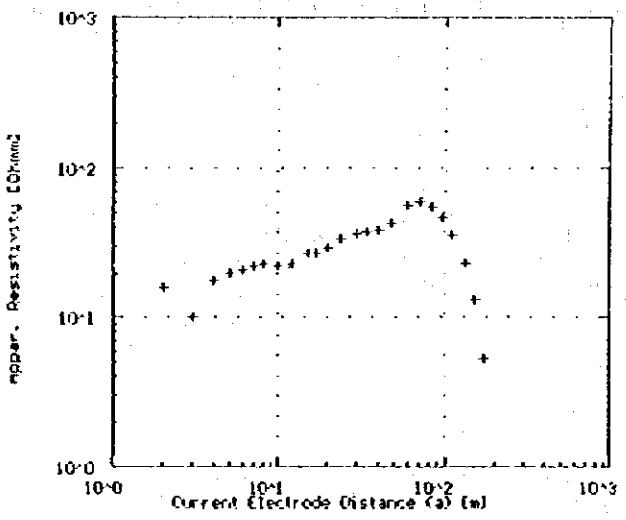



| Point (No) | AB/2 (m) | a (m) | Res (ohm) |
|---|---|---|---|
| 1 | 1.00 | 153.220 | |
| 2 | 2.00 | 153.290 | |
| 3 | 3.00 | 160.510 | |
| 4 | 4.00 | 159.120 | |
| 5 | 5.00 | 157.900 | |
| 6 | 6.00 | 113.060 | |
| 7 | 7.00 | 107.870 | |
| 8 | 8.00 | 97.970 | |
| 9 | 10.00 | 86.100 | |
| 10 | 20.00 | 58.550 | |
| 11 | 24.00 | 28.060 | |
| 12 | 30.00 | 81.010 | |
| 13 | 36.00 | 83.270 | |
| 14 | 60.00 | 82.360 | |
| 15 | 72.00 | 76.870 | |
| 16 | 84.00 | 76.695 | |
| 17 | 96.00 | 68.130 | |
| 18 | 110.00 | 59.820 | |
| 19 | 130.00 | 52.250 | |
| 20 | 150.00 | 28.260 | |

| Specific Resistivity(Ω-m) | 169 | 112 | 52 | 96 | 27.6 |
|---|---|---|---|---|---|

55.33

## VES St. No.6 -CHAGNI

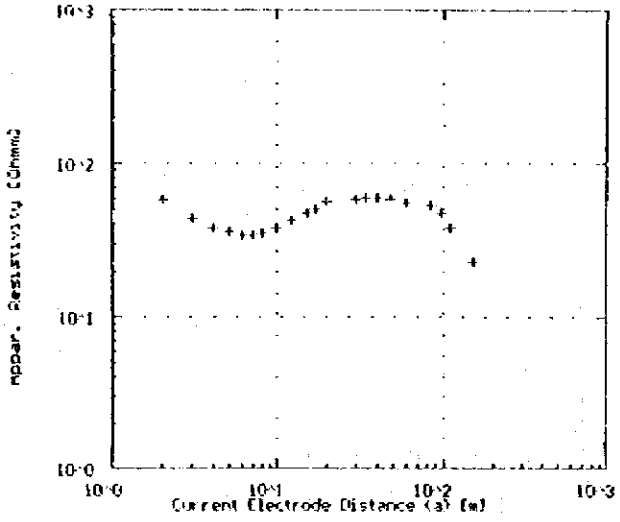



| Point (No) | AB/2 (m) | a (m) | Res (ohm) |
|---|---|---|---|
| 1 | 1.00 | 13.420 | |
| 2 | 2.00 | 15.020 | |
| 3 | 3.00 | 18.110 | |
| 4 | 4.00 | 17.580 | |
| 5 | 5.00 | 18.720 | |
| 6 | 6.00 | 21.100 | |
| 7 | 7.00 | 23.950 | |
| 8 | 8.00 | 22.610 | |
| 9 | 10.00 | 21.980 | |
| 10 | 12.00 | 22.610 | |
| 11 | 15.00 | 26.050 | |
| 12 | 17.00 | 26.690 | |
| 13 | 20.00 | 28.760 | |
| 14 | 24.00 | 33.010 | |
| 15 | 30.00 | 35.980 | |
| 16 | 36.00 | 37.370 | |
| 17 | 40.00 | 38.010 | |
| 18 | 50.00 | 42.010 | |
| 19 | 60.00 | 50.900 | |
| 20 | 72.00 | 50.700 | |
| 21 | 84.00 | 56.240 | |
| 22 | 96.00 | 67.610 | |
| 23 | 110.00 | 35.230 | |
| 24 | 130.00 | 22.050 | |
| 25 | 150.00 | 13.010 | |
| 26 | 170.00 | 5.310 | |

| Specific Resistivity(Ω-m) | 23 | 14 | 37 | 16.8 |
|---|---|---|---|---|

325

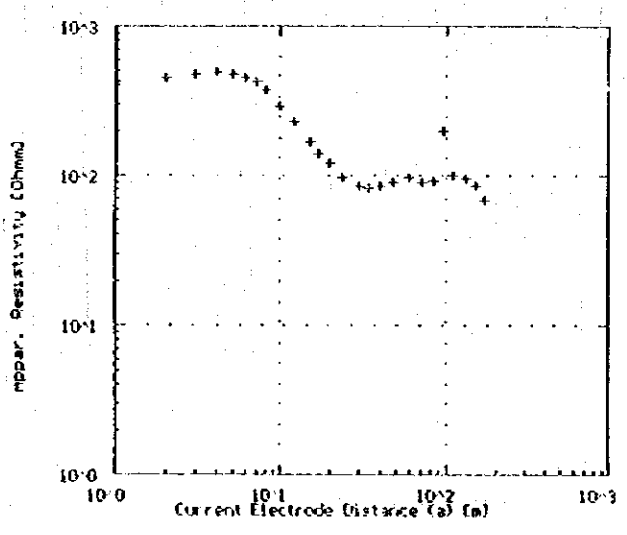
## VES St. No.7 -CHAGNI




| Point (No) | MN/2 (Mr) | a (m) | Res (ohmm) |
|---|---|---|---|
| 1 | 1.00 | 91.050 | |
| 2 | 2.00 | 57.750 | |
| 3 | 3.00 | 69.090 | |
| 4 | 4.00 | 38.430 | |
| 5 | 5.00 | 26.110 | |
| 6 | 6.00 | 24.290 | |
| 7 | 7.00 | 34.230 | |
| 8 | 8.00 | 35.170 | |
| 9 | 10.00 | 38.310 | |
| 10 | 12.00 | 42.200 | |
| 11 | 15.00 | 47.100 | |
| 12 | 17.00 | 50.150 | |
| 13 | 20.00 | 56.520 | |
| 14 | 30.00 | 59.450 | |
| 15 | 34.00 | 60.000 | |
| 16 | 40.00 | 59.520 | |
| 17 | 45.00 | 57.220 | |
| 18 | 50.00 | 55.010 | |
| 19 | 61.00 | 53.010 | |
| 20 | 90.00 | 47.630 | |
| 21 | 110.00 | 38.690 | |
| 22 | 150.00 | 22.610 | |

| Specific Resistivity(Ω-m) | 135 | 33.75 | 91.25 | 76.5 | 40 | 16.17 |
|---|---|---|---|---|---|---|

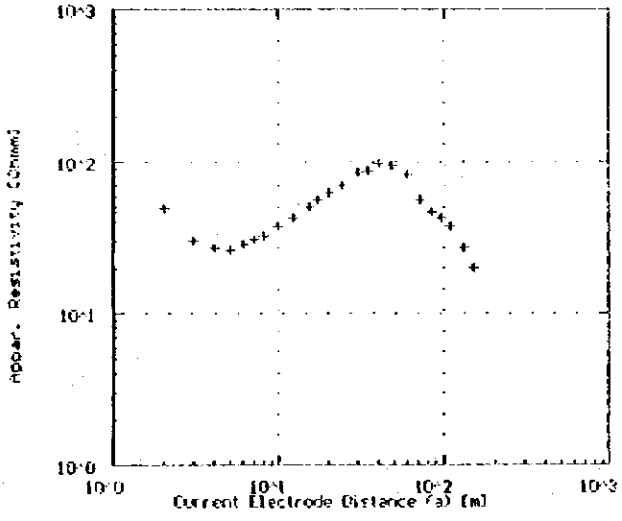
## VES St. No.8 -CHAGNI




| Point (No) | MN/2 (Mr) | a (m) | Res (ohmm) |
|---|---|---|---|
| 1 | 1.00 | 622.869 | |
| 2 | 2.00 | 452.160 | |
| 3 | 3.00 | 480.420 | |
| 4 | 4.00 | 410.580 | |
| 5 | 5.00 | 470.000 | |
| 6 | 6.00 | 452.160 | |
| 7 | 7.00 | 422.870 | |
| 8 | 8.00 | 376.860 | |
| 9 | 10.00 | 295.160 | |
| 10 | 12.00 | 229.695 | |
| 11 | 15.00 | 167.600 | |
| 12 | 17.00 | 139.860 | |
| 13 | 20.00 | 120.500 | |
| 14 | 25.00 | 95.160 | |
| 15 | 30.00 | 81.200 | |
| 16 | 35.00 | 83.270 | |
| 17 | 40.00 | 85.610 | |
| 18 | 45.00 | 90.630 | |
| 19 | 50.00 | 85.660 | |
| 20 | 72.00 | 85.000 | |
| 21 | 84.00 | 92.320 | |
| 22 | 95.00 | 130.950 | |
| 23 | 110.00 | 90.600 | |
| 24 | 130.00 | 36.700 | |
| 25 | 150.00 | 85.220 | |
| 26 | 170.00 | 60.310 | |

| Specific Resistivity(Ω-m) | 345 | 517 | 320 | 57.14 | 111 | 40 |
|---|---|---|---|---|---|---|

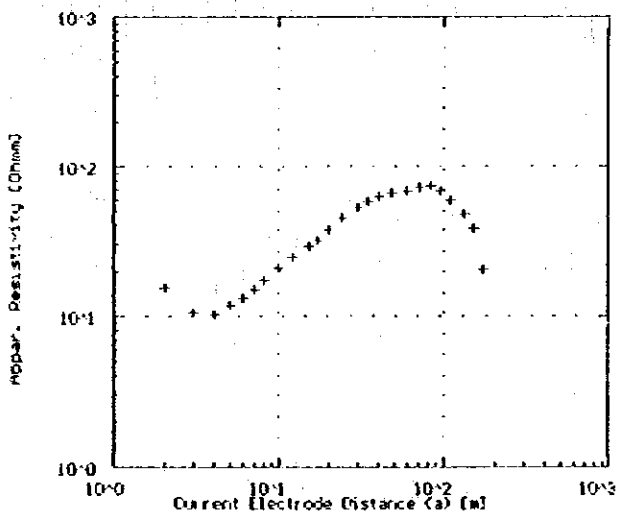
## VES St. No.9 -CHAGNI




| Point (No) | MN/2 (m) | a (m) | Res (ohm-m) |
|---|---|---|---|
| 1 | 1.00 | 46.470 | |
| 2 | 2.00 | 48.930 | |
| 3 | 3.00 | 29.190 | |
| 4 | 4.00 | 25.530 | |
| 5 | 5.00 | 24.280 | |
| 6 | 6.00 | 25.260 | |
| 7 | 7.00 | 30.550 | |
| 8 | 9.00 | 32.860 | |
| 9 | 10.00 | 33.680 | |
| 10 | 12.00 | 83.950 | |
| 11 | 15.00 | 50.010 | |
| 12 | 17.00 | 55.520 | |
| 13 | 20.00 | 62.600 | |
| 14 | 24.00 | 58.330 | |
| 15 | 30.00 | 83.840 | |
| 16 | 36.00 | 87.540 | |
| 17 | 40.00 | 97.970 | |
| 18 | 46.00 | 93.650 | |
| 19 | 60.00 | 83.270 | |
| 20 | 72.00 | 55.070 | |
| 21 | 86.00 | 46.690 | |
| 22 | 96.00 | 42.810 | |
| 23 | 110.00 | 37.300 | |
| 24 | 130.00 | 28.940 | |
| 25 | 150.00 | 19.780 | |

| Specific Resistivity(Ω-m) | 39 | 58.5 | 10.1 | 91 | 565 | 123 | 6 |
|---|---|---|---|---|---|---|---|

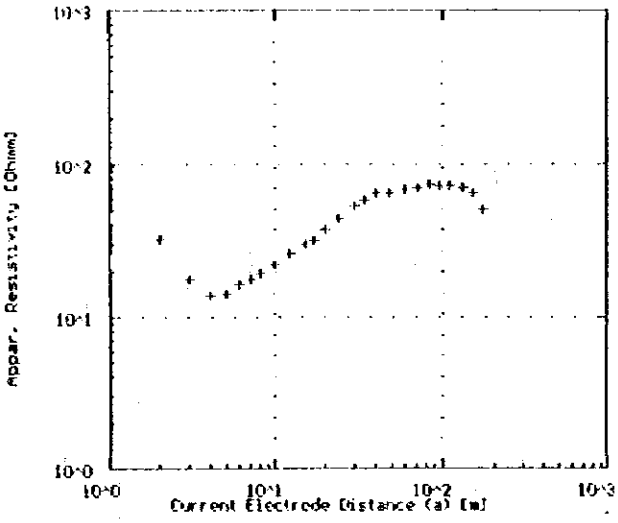
## VES St. No.10 -CHAGNI




| Point (No) | MN/2 (m) | a (m) | Res (ohm-m) |
|---|---|---|---|
| 1 | 1.00 | 20.160 | |
| 2 | 2.00 | 15.780 | |
| 3 | 3.00 | 10.550 | |
| 4 | 4.00 | 10.300 | |
| 5 | 5.00 | 11.930 | |
| 6 | 6.00 | 13.190 | |
| 7 | 7.00 | 15.470 | |
| 8 | 8.00 | 17.090 | |
| 9 | 10.00 | 20.720 | |
| 10 | 12.00 | 25.970 | |
| 11 | 15.00 | 29.200 | |
| 12 | 17.00 | 32.030 | |
| 13 | 20.00 | 37.600 | |
| 14 | 26.00 | 45.220 | |
| 15 | 30.00 | 53.690 | |
| 16 | 36.00 | 57.650 | |
| 17 | 40.00 | 62.050 | |
| 18 | 46.00 | 55.320 | |
| 19 | 60.00 | 57.260 | |
| 20 | 72.00 | 32.000 | |
| 21 | 86.00 | 33.320 | |
| 22 | 96.00 | 60.730 | |
| 23 | 110.00 | 59.060 | |
| 24 | 130.00 | 57.350 | |
| 25 | 150.00 | 38.020 | |
| 26 | 170.00 | 29.200 | |

| Specific Resistivity(Ω-m) | 42 | 7 | 168 | 144 | 26.18 |
|---|---|---|---|---|---|

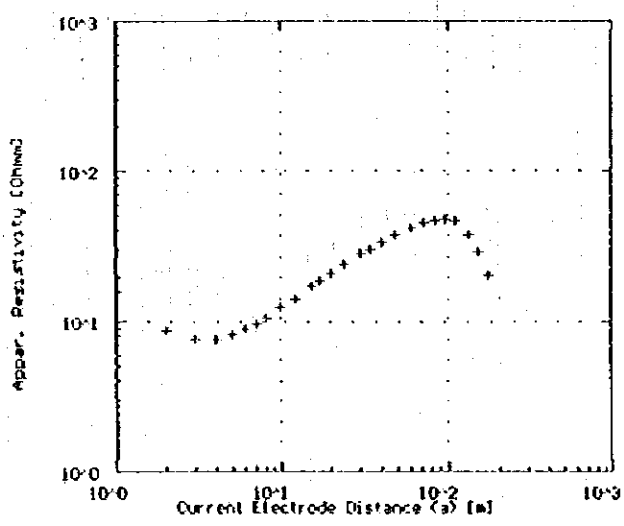
## VES St. No.11 -CHAGNI




| Point [No] | AB/2 [Mr] | a [m] | Ras [ohmm] |
|---|---|---|---|
| 1 | 1.00 | 98.210 | |
| 2 | 2.00 | 32.150 | |
| 3 | 3.00 | 17.000 | |
| 4 | 4.00 | 13.020 | |
| 5 | 5.00 | 10.130 | |
| 6 | 6.00 | 15.590 | |
| 7 | 7.00 | 17.000 | |
| 8 | 8.00 | 19.090 | |
| 9 | 10.00 | 21.980 | |
| 10 | 12.00 | 26.330 | |
| 11 | 15.00 | 30.100 | |
| 12 | 17.00 | 32.030 | |
| 13 | 20.00 | 33.550 | |
| 14 | 24.00 | 63.710 | |
| 15 | 30.00 | 52.750 | |
| 16 | 36.00 | 57.860 | |
| 17 | 40.00 | 63.010 | |
| 18 | 48.00 | 65.160 | |
| 19 | 60.00 | 67.020 | |
| 20 | 72.00 | 70.560 | |
| 21 | 84.00 | 71.300 | |
| 22 | 96.00 | 72.950 | |
| 23 | 110.00 | 71.550 | |
| 24 | 130.00 | 69.390 | |
| 25 | 150.00 | 65.000 | |
| 26 | 170.00 | 58.100 | |

| Specific Resistivity(Ω-m) | 180 | 12 | 198 | 112 | 39 |
|---|---|---|---|---|---|

## VES St. No.12 -CHAGNI

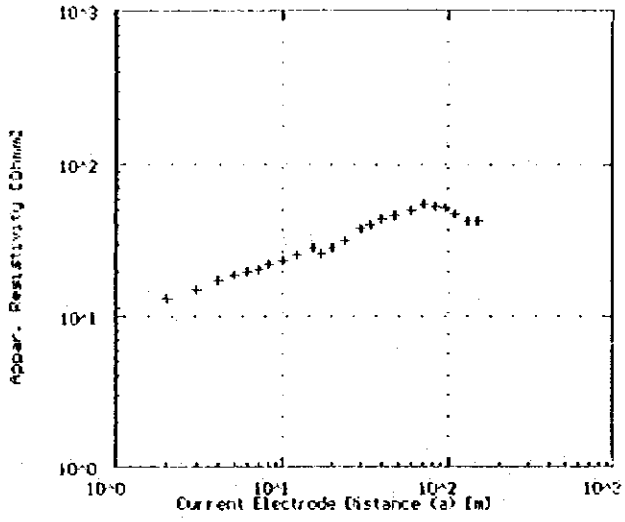



| Point [No] | AB/2 [Mr] | a [m] | Ras [ohmm] |
|---|---|---|---|
| 1 | 1.00 | 15.760 | |
| 2 | 2.00 | 8.790 | |
| 3 | 3.00 | 7.540 | |
| 4 | 4.00 | 7.560 | |
| 5 | 5.00 | 8.230 | |
| 6 | 6.00 | 8.870 | |
| 7 | 7.00 | 9.720 | |
| 8 | 8.00 | 10.650 | |
| 9 | 10.00 | 12.530 | |
| 10 | 12.00 | 14.320 | |
| 11 | 15.00 | 17.210 | |
| 12 | 17.00 | 18.750 | |
| 13 | 20.00 | 21.230 | |
| 14 | 24.00 | 23.910 | |
| 15 | 30.00 | 28.260 | |
| 16 | 36.00 | 30.900 | |
| 17 | 40.00 | 33.290 | |
| 18 | 48.00 | 37.590 | |
| 19 | 60.00 | 41.830 | |
| 20 | 72.00 | 44.750 | |
| 21 | 84.00 | 45.890 | |
| 22 | 96.00 | 48.230 | |
| 23 | 110.00 | 46.280 | |
| 24 | 130.00 | 37.559 | |
| 25 | 150.00 | 29.290 | |
| 26 | 170.00 | 20.280 | |

| Specific Resistivity(Ω-m) | 35.5 | 7.1 | 65 | | 11 |
|---|---|---|---|---|---|

95.5

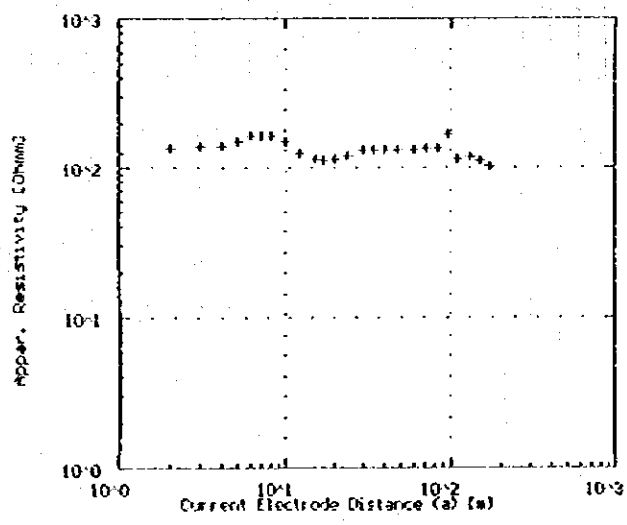
## VES St. No.13 -CHAGNI




| Point (No) | AB/2 (Mr) | a (m) | Rsr (ohm) |
|---|---|---|---|
| 1 | 1.00 | 31.620 | |
| 2 | 2.00 | 12.310 | |
| 3 | 3.00 | 15.070 | |
| 4 | 4.00 | 17.030 | |
| 5 | 5.00 | 18.840 | |
| 6 | 6.00 | 19.970 | |
| 7 | 7.00 | 20.220 | |
| 8 | 8.00 | 22.110 | |
| 9 | 10.00 | 23.240 | |
| 10 | 12.00 | 25.620 | |
| 11 | 15.00 | 28.260 | |
| 12 | 17.00 | 26.150 | |
| 13 | 20.00 | 28.390 | |
| 14 | 24.00 | 31.590 | |
| 15 | 30.00 | 38.810 | |
| 16 | 34.00 | 40.780 | |
| 17 | 40.00 | 43.950 | |
| 18 | 48.00 | 45.920 | |
| 19 | 60.00 | 50.870 | |
| 20 | 72.00 | 54.260 | |
| 21 | 84.00 | 53.280 | |
| 22 | 96.00 | 51.550 | |
| 23 | 110.00 | 48.360 | |
| 24 | 130.00 | 42.450 | |
| 25 | 150.00 | 42.860 | |

| Specific Resistivity(Ω-m) | 11.2 | 28 | 69 | 34.67 |
|---|---|---|---|---|

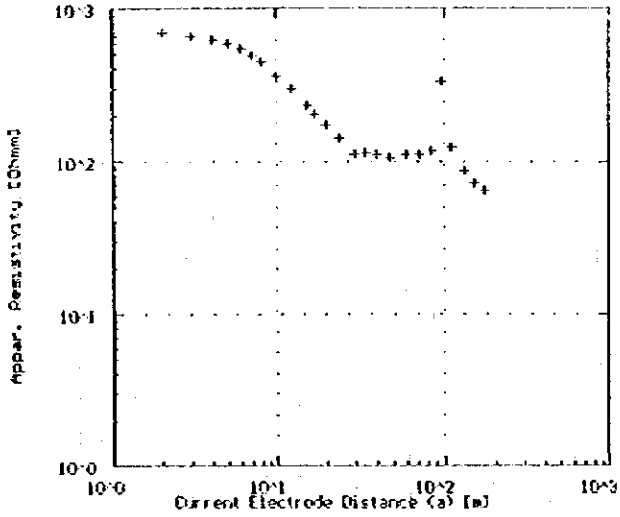
## VES St. No.14 -CHAGNI




| Point (No) | AB/2 (Mr) | a (m) | Rsr (ohm) |
|---|---|---|---|
| 1 | 1.00 | 125.600 | |
| 2 | 2.00 | 135.650 | |
| 3 | 3.00 | 140.360 | |
| 4 | 4.00 | 149.670 | |
| 5 | 5.00 | 150.320 | |
| 6 | 6.00 | 152.920 | |
| 7 | 7.00 | 162.650 | |
| 8 | 8.00 | 165.790 | |
| 9 | 10.00 | 150.320 | |
| 10 | 12.00 | 125.950 | |
| 11 | 15.00 | 132.960 | |
| 12 | 17.00 | 132.100 | |
| 13 | 20.00 | 135.555 | |
| 14 | 24.00 | 120.580 | |
| 15 | 30.00 | 129.990 | |
| 16 | 34.00 | 132.380 | |
| 17 | 40.00 | 133.140 | |
| 18 | 48.00 | 122.630 | |
| 19 | 60.00 | 129.990 | |
| 20 | 72.00 | 133.399 | |
| 21 | 84.00 | 136.630 | |
| 22 | 96.00 | 128.010 | |
| 23 | 110.00 | 116.170 | |
| 24 | 130.00 | 110.190 | |
| 25 | 150.00 | 103.060 | |
| 26 | 170.00 | 101.029 | |

| Specific Resistivity(Ω-m) | 107 | 160.5 | 60 | 147 | 69 |
|---|---|---|---|---|---|

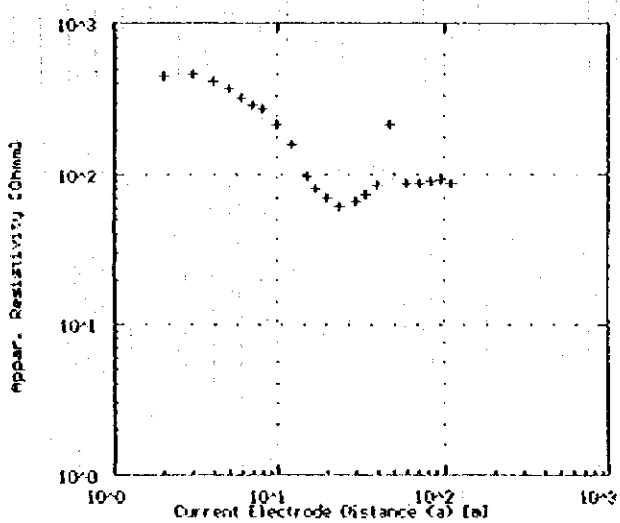
## VES St. No.15 -CHAGNI




| Point [No] | AB/2 [Mr] | a [m] | Res [ohm] |
|---|---|---|---|
| 1 | 1.00 | 682.560 | |
| 2 | 2.00 | 697.680 | |
| 3 | 3.00 | 659.400 | |
| 4 | 4.00 | 630.510 | |
| 5 | 5.00 | 596.600 | |
| 6 | 6.00 | 542.590 | |
| 7 | 7.00 | 487.960 | |
| 8 | 8.00 | 442.100 | |
| 9 | 10.00 | 354.240 | |
| 10 | 12.50 | 301.660 | |
| 11 | 15.00 | 239.260 | |
| 12 | 17.00 | 202.000 | |
| 13 | 20.00 | 172.020 | |
| 14 | 24.00 | 161.690 | |
| 15 | 30.00 | 111.700 | |
| 16 | 34.00 | 115.350 | |
| 17 | 40.02 | 113.700 | |
| 18 | 50.00 | 105.500 | |
| 19 | 60.00 | 110.400 | |
| 20 | 72.00 | 110.170 | |
| 21 | 84.00 | 110.017 | |
| 22 | 96.00 | 131.500 | |
| 23 | 110.00 | 124.340 | |
| 24 | 130.00 | 80.170 | |
| 25 | 150.00 | 70.550 | |
| 26 | 170.00 | 61.060 | |

| Specific Resistivity(Ω-m) | 675 | 675 | 96.43 | 110 | 44 |
|---|---|---|---|---|---|

## VES St. No.16 -CHAGNI

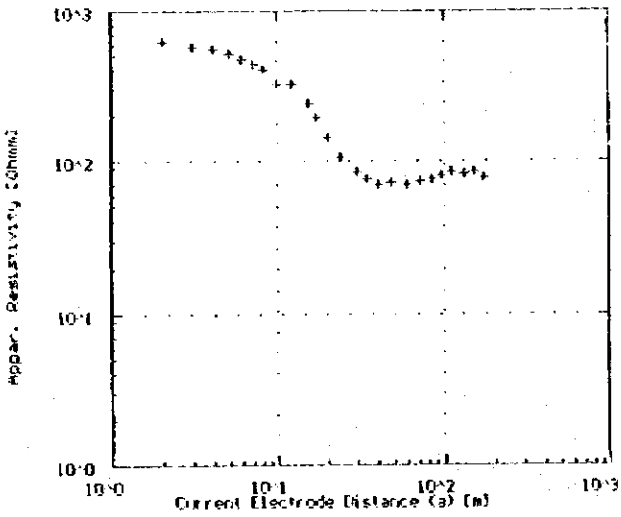



| Point [No] | AB/2 [Mr] | a [m] | Res [ohm] |
|---|---|---|---|
| 1 | 1.00 | 491.920 | |
| 2 | 2.00 | 452.160 | |
| 3 | 3.00 | 401.580 | |
| 4 | 4.00 | 441.970 | |
| 5 | 5.00 | 376.000 | |
| 6 | 6.00 | 324.050 | |
| 7 | 7.00 | 296.530 | |
| 8 | 8.00 | 276.320 | |
| 9 | 10.00 | 213.520 | |
| 10 | 12.00 | 158.260 | |
| 11 | 15.00 | 97.970 | |
| 12 | 17.00 | 80.020 | |
| 13 | 20.00 | 69.000 | |
| 14 | 24.00 | 61.000 | |
| 15 | 30.00 | 66.090 | |
| 16 | 34.00 | 76.730 | |
| 17 | 40.00 | 85.010 | |
| 18 | 50.00 | 210.020 | |
| 19 | 60.00 | 97.040 | |
| 20 | 72.00 | 89.170 | |
| 21 | 84.00 | 89.020 | |
| 22 | 96.00 | 91.040 | |
| 23 | 110.00 | 88.350 | |

| Specific Resistivity(Ω-m) | 340 | 510 | | 36.43 | 204 | 114.75 |
|---|---|---|---|---|---|---|

155.67

## VES St. No.17 -CHAGNI

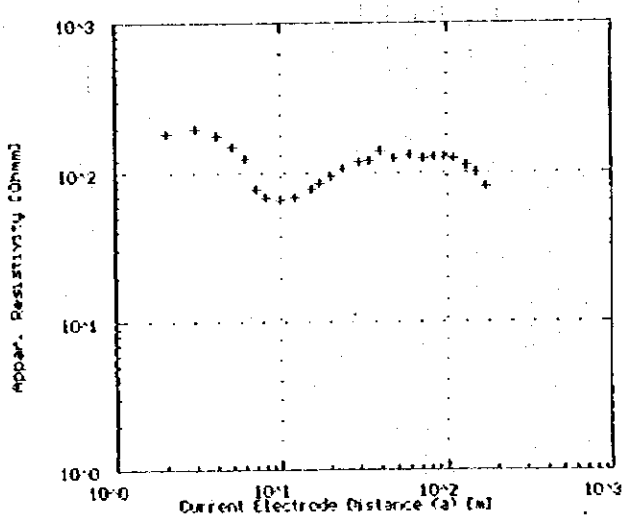



| Point [No] | MN/2 [Mr] | a [m] | Res [ohm] |
|---|---|---|---|
| 1 | 1.00 | 597.600 | |
| 2 | 2.00 | 529.980 | |
| 3 | 3.00 | 586.800 | |
| 4 | 4.00 | 595.200 | |
| 5 | 5.00 | 516.860 | |
| 6 | 6.00 | 478.560 | |
| 7 | 7.00 | 439.800 | |
| 8 | 8.00 | 401.920 | |
| 9 | 10.00 | 326.560 | |
| 10 | 12.00 | 324.059 | |
| 11 | 15.00 | 269.250 | |
| 12 | 17.00 | 192.120 | |
| 13 | 20.00 | 168.660 | |
| 14 | 25.00 | 107.010 | |
| 15 | 30.00 | 84.780 | |
| 16 | 35.00 | 75.090 | |
| 17 | 40.00 | 70.340 | |
| 18 | 45.00 | 72.350 | |
| 19 | 50.00 | 69.710 | |
| 20 | 55.00 | 76.010 | |
| 21 | 60.00 | 76.490 | |
| 22 | 65.00 | 79.530 | |
| 23 | 110.00 | 84.280 | |
| 24 | 130.00 | 91.630 | |
| 25 | 150.00 | 84.710 | |
| 26 | 170.00 | 77.950 | |

| Specific Resistivity(Ω-m) | 475 | 1187.5 | 288 | 38.75 | 90 |
|---|---|---|---|---|---|

180

## VES St. No.18 -CHAGNI




| Point [No] | MN/2 [Mr] | a [m] | Res [ohm] |
|---|---|---|---|
| 1 | 1.00 | 119.950 | |
| 2 | 2.00 | 192.120 | |
| 3 | 3.00 | 195.960 | |
| 4 | 4.00 | 175.980 | |
| 5 | 5.00 | 150.720 | |
| 6 | 6.00 | 125.340 | |
| 7 | 7.00 | 98.690 | |
| 8 | 8.00 | 87.920 | |
| 9 | 10.00 | 88.570 | |
| 10 | 12.00 | 89.583 | |
| 11 | 15.00 | 78.139 | |
| 12 | 17.00 | 85.015 | |
| 13 | 20.00 | 94.200 | |
| 14 | 25.00 | 105.500 | |
| 15 | 30.00 | 110.690 | |
| 16 | 35.00 | 119.570 | |
| 17 | 40.00 | 135.160 | |
| 18 | 45.00 | 123.590 | |
| 19 | 50.00 | 131.089 | |
| 20 | 55.00 | 126.150 | |
| 21 | 60.00 | 120.720 | |
| 22 | 65.00 | 126.010 | |
| 23 | 110.00 | 122.860 | |
| 24 | 130.00 | 110.210 | |
| 25 | 150.00 | 99.010 | |
| 26 | 170.00 | 81.140 | |

| Specific Resistivity(Ω-m) | 370 | 98.5 | 98.5 | 168 | 120 | 53.33 |
|---|---|---|---|---|---|---|

9.67

# Appendix - 2

# Result of Water Quality Test

## Result of Physico-Chemical Analysis in Chagni

Sample No.1

Origin of Sample : Borehole No.1 (WSS)
Date of Collection: 20/Jan./95
Date of Analysis : 09/Feb./95

Physical Characteristics

| | |
|---|---|
| Appearance | : Very Clear |
| Odor | : Odorless |
| Taste | : - |
| Color | : Nil |
| Settleable Solids | : Absent |
| Floating Solids | : Absent |
| Suspended Solids | : Absent |
| Total Dissolved Solids | : 240 |
| Turbidity | : Nil |
| Temperature | : - |
| Conductivity | : 0.49 ms/cm |

General Chemical Characteristics

| | |
|---|---|
| Total Hardness as $CaCO_3$ | : 80 |
| Carbonate Hardness as $CaCO_3$ | : 80 |
| Non Carbonate Hardness as $CaCO_3$ | : Nil |
| Total Alkalinity as $CaCO_3$ | : 260 |
| Bicarbonate Alkalinity as $CaCO_3$ | : 260 |
| Carbonate Alkalinity as $CaCO_3$ | : Nil |
| PH | : 6.80 |
| Silica | : - |
| Sulphide as Hydrogen Sulphide | : - |
| Carbondioxide | : - |
| Residual Chlorine | : - |
| Dissolved Oxygen | : - |

Ionic Contents

| Cations | | Anions | |
|---|---|---|---|
| $NH_4^+$ | : - | $Cl^-$ | : 15.00 |
| $Na^+$ | : - | $NO_2^-$ | : 0.07 |
| $K^+$ | : - | $NO_3^-$ | : 2.50 |
| $Ca^{++}$ | : 104.00 | $F^-$ | : 0.44 |
| $Mg^{++}$ | : 9.59 | $HCO_3^-$ | : 317.20 |
| Fe(Total) | : 0.01 | $CO_3^{--}$ | : Nil |
| $Mn^{++}$ | : 0.01 | $SO_4^{--}$ | : 1.00 |
| $Cu^{++}$ | : 0.03 | $PO_4^{---}$ | : 0.23 |

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 Chagni

Sample No.2

Origin of Sample : Bata Spring
Date of Collection: 08/Jul./95
Date of Analysis : 27/Jul./95

Physical Characteristics

| | |
|---|---|
| Appearance | : Clear |
| Odor | : Odorless |
| Taste | : - |
| Color | : 12 Pt-Co |
| Settleable Solids | : Absent |
| Floating Solids | : Absent |
| Suspended Solids | : Absent |
| Total Dissolved Solids | : 108 |
| Turbidity | : 2 FTU |
| Temperature | : 19.2 °C |
| Conductivity | : 0.18 ms/cm |

General Chemical Characteristics

| | |
|---|---|
| Total Hardness as $CaCO_3$ | : 90 |
| Carbonate Hardness as $CaCO_3$ | : 90 |
| Non Carbonate Hardness as $CaCO_3$ | : 10 |
| Total Alkalinity as $CaCO_3$ | : 100 |
| Bicarbonate Alkalinity as $CaCO_3$ | : 100 |
| Carbonate Alkalinity as $CaCO_3$ | : Nil |
| PH | : 6.85 |
| Silica | : - |
| Sulphide as Hydrogen Sulphide | : - |
| Carbondioxide | : - |
| Residual Chlorine | : - |
| Dissolved Oxygen | : - |

Ionic Contents

| Cations | | Anions | |
|---|---|---|---|
| $NH_4^+$ | : Nil | $Cl^-$ | : 5.00 |
| $Na^+$ | : - | $NO_2^-$ | : 0.02 |
| $K^+$ | : - | $NO_3^-$ | : 8.80 |
| $Ca^{++}$ | : 16.00 | $F^-$ | : 0.167 |
| $Mg^{++}$ | : 12.00 | $HCO_3^-$ | : 122.00 |
| Fe(Total) | : 0.07 | $CO_3^{--}$ | : Nil |
| $Mn^{++}$ | : Nil | $SO_4^{--}$ | : Nil |
| $Cu^{++}$ | : 0.02 | $PO_4^{---}$ | : Nil |

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 Chagni

Sample No.3

Origin of Sample : Hand dug well
Date of Collection: 08/Jul./95
Date of Analysis : 27/Jul./95

Physical Characteristics

| | |
|---|---|
| Appearance | : Clear |
| Odor | : Odorless |
| Taste | : - |
| Color | : 79 Pt-Co |
| Settleable Solids | : Present |
| Floating Solids | : Absent |
| Suspended Solids | : Absent |
| Total Dissolved Solids | : 162 |
| Turbidity | : 12 FTU |
| Temperature | : 20.3 °C |
| Conductivity | : 0.27 ms/cm |

General Chemical Characteristics

| | |
|---|---|
| Total Hardness as $CaCO_3$ | : 80 |
| Carbonate Hardness as $CaCO_3$ | : 80 |
| Non Carbonate Hardness as $CaCO_3$ | : Nil |
| Total Alkalinity as $CaCO_3$ | : 70 |
| Bicarbonate Alkalinity as $CaCO_3$ | : 70 |
| Carbonate Alkalinity as $CaCO_3$ | : Nil |
| PH | : 6.95 |
| Silica | : - |
| Sulphide as Hydrogen Sulphide | : - |
| Carbondioxide | : - |
| Residual Chlorine | : - |
| Dissolved Oxygen | : - |

Ionic Contents

| Cations | | Anions | |
|---|---|---|---|
| $NH_4^+$ | : Nil | $Cl^-$ | : 10.00 |
| $Na^+$ | : - | $NO_2^-$ | : Nil |
| $K^+$ | : - | $NO_3^-$ | : 19.36 |
| $Ca^{++}$ | : 1.00 | $F^-$ | : 0.148 |
| $Mg^{++}$ | : 1.22 | $HCO_3^-$ | : 85.40 |
| Fe(Total) | : 0.10 | $CO_3^{--}$ | : Nil |
| $Mn^{++}$ | : Nil | $SO_4^{--}$ | : Nil |
| $Cu^{++}$ | : 0.16 | $PO_4^{---}$ | : 0.42 |

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 Chagni, Sampled and Analyzed on July/8,10/'95

| No. | Kebele | Source | Place of Sampling | No of F.C. per 100ml | Remarks |
|---|---|---|---|---|---|
| 1 | 1 | BH1 | BH1 | 0 | The source, Ph=6.5, Sampled fr the tap |
| 2 | 2 | BH1 | Reservoir | 0 | WT=23°C, Cannot be fully stored always |
| 3 | 2 | BH1 | P.Foun.1 | 1 | WT=21.5°C |
| 4 | 2 | BH1 | P.Foun.2 | 7 | WT=22°C |
| 5 | 2 | BH1 | P.Foun.6 | 4 | WT=21°C |
| 6 | 1 | BH1 | P.Foun.7 | 0 | WT=22°C |
| 7 | 2 | BH1 | P.Foun.8 | 1 | WT=23°C |
| 8 | 2 | BH1 | P.Foun.9 | 0 | WT=21°C |
| 9 | 2 | BH1 | P.Foun.10 | 180 | |
| 10 | 1 | BH1 | Y.Conn. | 1 | WT=21.5°C |
| 11 | 2 | BH1 | Y.Conn. | 4 | WT=22°C |
| 12 | 2 | BH1 | Y.Conn. | 6 | WT=21°C |
| 13 | 1 | BH1 | Clay pot | TMTC | WT=18°C, Fetched 1 day before fr P.Conn. |
| 14 | 1 | BH1 | Clay pot | TMTC | WT=21°C, Fetched on the day, Covered |
| 15 | 1 | BH1 | Clay pot | 77 | WT=19°C, Fetched 1 day before, Covered |
| 16 | 1 | BH1 | Clay pot | TMTC | WT=18°C, Fetched 1 day before, Covered |
| 17 | 1 | BH1 | Clay pot | 66 | WT=17°C, Fetched 1 day before, Covered |
| 18 | 1 | BH1 | Clay pot | TMTC | WT=19°C, Fetched 1 day before, Covered |
| 19 | 1 | BH1 | Clay pot | 38 | WT=19°C, Fetched 1 day before, Covered |
| 20 | 2 | BH1 | Clay pot | TMTC | WT=19°C, Fetched 1 day before, Covered |
| 21 | 2 | BH1 | Clay pot | TMTC | WT=21°C, Fetched 1 day before, Covered |
| 22 | 2 | BH1 | Clay pot | TMTC | WT=18°C, Fetched 1 day before, Covered |
| 23 | 2 | BH1 | Clay pot | 134 | WT=18°C, Fetched 1 day before, Covered |
| 24 | 1 | BH1 | Jerry-can | 89 | WT=19°C, Fetched 1 day before, Covered |
| 25 | 1 | Borehole | P.Conn. | 52 | Ph=6.5, WT=21°C, At Tana Beles Hotel |
| 26 | 1 | HDW | HDW | TMTC | Ph=6.8, WT=23°C, Depth=18m, For laundry |
| 27 | 1 | HDW | HDW | TMTC | Ph=6.5, WT=23°C, Depth=14m, For drinking |
| 28 | 1 | Spring | Bata | TMTC | Ph=6.0, WT=24.5°C, Unprotected spring |
| 29 | 1 | Spring | Ard | TMTC | Ph=6.5, WT=23.5°C, Unprotected spring |
| There is only one water source (BH1) operated by WSS. | | | | | |

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

# Appendix - 3

# Social and Gender Data

CHAGNI - Activity profile by gender

All Water Users

| Activity | Gender | | | Time | Place |
|---|---|---|---|---|---|
| | M | F | Remarks | | |
| Fetches drinking water | n | y | mostly women | | |
| Does the laundry | n | y | mostly women | | |
| Waters livestock | y | n | also paid labor | | river |
| Takes water from container | y | y | | | |
| Teaches children hygiene | y | y | whoever is about | | |
| Disposes of solid waste | n | y | | | |
| Digs a compost pit | n | n | mostly PC Users | | |
| Constructs a latrine | y | n | often paid labor | | |
| Digs a drainage channel | n | n | | | |
| Tends a kitchen garden | y | n | restricted mainly to PC Users | | |
| Disposes of animal waste | n | y | | | |
| Keeps latrine clean | n | y | some have | | |
| Keeps compound clean | y | y | some men do this | | |
| Takes sick child to clinic | y | y | whoever is about | | |

y = Yes, n = No

CHAGNI - Daily schedule

Private Connection Vendor Users

| Man | Time | Woman |
|---|---|---|
| Gets up, washes | 5 | Wakes up, washes |
| Eats breakfast | 6 | Prepares and eats breakfast |
| *Works (weaver based at home)* | 7 | *Opens tea/tela shop* |
| " | 8 | *(While operating the shop also* |
| " | 9 | *does domestic chores)* |
| " | 10 | *Preparation of local alcohol* |
| " | 11 | " |
| Eats lunch, drinks coffee | 12 | Preparation, eating lunch |
| Goes to Mosque | 13 | Drinks coffee |
| *Weaves* | 14 | *Sells local alcohol/tela/tea* |
| " | 15 | " |
| " | 16 | " |
| " | 17 | " |
| Goes out to visit friends | 18 | " |
| *Works* | 19 | " |
| " | 20 | Prepares supper |
| Eats dinner | 21 | Eats dinner with husband |
| Goes to sleep | 22 | Clears dishes and cleans house |
| | 23 | Goes to sleep |

NB. Daughter helps woman with domestic chores and activities

Public Fountain Users

| Man | Time | Woman |
|---|---|---|
| Gets up, washes, goes to kitchen garden | 7 | Wakes up, washes |
| " | 8 | Prepares breakfast |
| Returns home for breakfast | 9 | Eats breakfast with family |
| *Opens shop and trades from home* | 10 | **Fetches water** |
| *(Selling vegetables, soap etc)* | 11 | Eats lunch and goes to school |
| " | 12 | School |
| Eats lunch | 13 | " |
| Cleans compound | 14 | " |
| *Sells from shop* | 15 | " |
| " | 16 | " |
| " | 17 | " |
| Listens to radio | 18 | Returns from school and cleans house |
| Drinks coffee | 19 | Other domestic chores |
| Eats dinner | 20 | Eats supper |
| Relaxes | 21 | Studies |
| Goes to sleep | 22 | " |
| | 23 | Goes to sleep |

NB. mother-in-law helps with chores around the house but fetching water and doing laundry is this woman's task
Family pay 1.3 Birr each month to Sanbati, he attends monthly meetings

CHAGNI - Daily schedule (continued)

Private Connection Users

| Man | Time | Woman |
|---|---|---|
| Man is a Government Agricultural Office Worker, transferred to a different location two years ago. He sends her money to pay for the running of the house including money to pay for the private connection etc. | 6 | Gets up, washes |
| | 7 | Eats breakfast |
| | 8 | Assists maid with domestic work |
| | 9 | " |
| | 10 | Drinks coffee with neighbors |
| | 11 | " |
| | 12 | Assists the maid |
| | 13 | Eats lunch |
| | 14 | Spins cotton (for household use) |
| | 15 | " |
| | 16 | " |
| | 17 | " |
| | 18 | Relaxes |
| | 19 | Eats dinner |
| | 20 | Relaxes |
| | 21 | " |
| | 22 | Goes to sleep |

NB. Woman used to sell cooked food and home made drinks, but made no profit at this that she does not do it any longer.

CHAGNI - Access and Control Profile

Some Public Fountain and Private Connection Users

| Resources | Access | | Control | | Comments |
|---|---|---|---|---|---|
| | male | female | male | female | |
| Money for water | y | y | y | n | some women have control |
| Money for soap | y | y | y | n | of money, |
| Money for water container | y | y | y | n | but most do |
| Money for water pot cover | y | y | y | n | not earn |
| Money for building materials for drying shelf | y | y | y | y | Mostly women organise |
| Money for building latrine | y | y | y | n | |
| Money for medicine | y | y | y | n | |
| Tools for digging pits | y | y | n | n | paid labour |
| Tools for constructing latrine | y | y | n | n | paid labour |
| Seeds and tools for vegetable gardens | y | y | n | n | some have |
| Land for digging pits | y | y | y | y | few have |
| Land for digging latrines | y | y | y | y | |
| Land for digging drains | y | y | y | y | |
| Land for vegetable gardens | y | y | y | y | |
| Income from selling water | y | y | y | n | provisional |
| Income from selling vegetables | y | y | y | y | " |
| Improved health | - | - | - | - | |
| Reduced time spent collecting water | - | - | - | - | |
| Reduced time spent caring for sick | y | y | y | y | |

Money and resources are seen as a shared pot

Some PF Users/PC Vendor Users/Other Users

| Resources | Access | | Control | | Comments |
|---|---|---|---|---|---|
| | male | female | male | female | |
| Money for water | y | y | y | y | |
| Money for soap | y | y | y | y | |
| Money for water container | y | y | y | y | |
| Money for water pot cover | y | y | y | y | |
| Money for building materials for drying shelf | y | y | y | y | |
| Money for building latrine | y | y | y | y | not all |
| Money for medicine | y | y | y | y | not all |
| Tools for digging pits | y | y | y | y | |
| Tools for constructing latrine | y | y | y | y | |
| Seeds and tools for vegetable gardens | y | y | y | y | some have |
| Land for digging pits | y | y | n | n | some have |
| Land for digging latrines | y | y | n | n | access to |
| Land for digging drains | y | y | n | n | land |
| Land for vegetable gardens | y | y | y | y | |
| Income from selling water | - | - | - | - | |
| Income from selling vegetables | y | y | y | y | |
| 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 | |

CHAGNI - Needs Analysis

Private Connection Users and some PF Users

| | | Gender | | Remarks |
|---|---|---|---|---|
| | | M | F | |
| Practical needs | | | | |
| Water | Longer service time at PFs | n | y | Only short queues observed |
| | Occasional breaks in water service to be reduced/ avoided | y | y | |
| Sanitation | Requirement for latrine emptying system to be initiated | y | y | Some latrines are full and must be closed, where insufficient land for new latrines people use open field. |
| Strategic needs | | | | |
| Water | Mostly prefer Government managed water supply system | y | y | |
| Sanitation | None identified | | | |
| Health education | None identified | | | |

y = Yes, n = No

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 | PFs in areas where there are none |
| | Reduced time spent for water collection | y | y | Reduced queues and reduced distance to water supply facilities |
| Sanitation | Improved access to latrines | y | y | Community latrines for rented housing and those who can not afford private |
| | Allocate areas for refuse disposal and provide training/support for the safe disposal of refuse. | y | y | |
| Health education | Muslim communities need to be targeted for health education | y | y | Muslims have lower access to sanitation and health education |
| Strategic needs | | | | |
| Water | Public fountains possible to be managed by the community with support from Authorities | y | y | community helped in construction of exisiting system |
| | Additional public fountains to be constructed with the help of community labour. | y | y | Could assist with labour and with transportation of materials. |
| Sanitation | Community latrines to be managed by the community | y | y | Need support/ enforcement from Authorities for use/ management of such latrines. |
| Health education | Increase access to existing health education initiatives by improved motivation for action | y | y | |

y = Yes, n = No

CHAGNI - Social and Gender Considerations

| Social/Gender differences | Underlying factors | Impact of the project | Possible measures to be taken |
|---|---|---|---|
| Variation in type and level of water service demanded | Variations in social and economic status | Richer households will not be satisfied without private connections. Poor people can not afford PCs | Improvements to the water system should include both public fountains and private connections |
| Muslim community have lower levels of access to sanitation facilities and to health education | Incomes for Muslim households are lower than for Christian households | Muslims may not benefit from improvements to the same degree as Christians | Muslims must be targeted specifically for improvements in sanitation. Income generation programs for poor households, particularly poor Muslim households should be considered |
| Women only defecate under cover of darkness | The need for privacy determines the time that women can defecate | Women may all require latrine facilities at the same time thus putting pressure on resources | Sharing and management of community latrines must be facilitated with discussion of all community members |
| Women and to a lesser extent girls fetch water most of the time and women usually do the laundry. Boys help in collection of water from other sources | Water collection and laundry are undertaken mostly by women and girls and less often by young males | Females will benefit most from time and energy savings from having a reliable water supply available near their homes | The project needs to help women identify how to spend any time released through improved water supply |

# Appendix - 4

# Summary of Group Meeting

CHAGNI - Summary of group meetings

| Group 1 details | Group characteristics | Group needs |
|---|---|---|
| General | Mostly Amhara, mostly Muslims, Shop keepers, traders, peasants | 1-Water, 2-Road drainage, 3-Electricity |
| Water | Private connection vendor / handdug well / rainwater users in the wet season and spring users in the dry season. They used to use the disconnected PF but it was not open sufficiently long to satisfy demand. Women fetch water and do the laundry. | Would like additional public fountains (x3) , Would help with labour and cash for the construction of PFs, could pay more for a better water supply service and could easily manage the PFs themselves - even by paying for the salary of the water seller. |
| Sanitation | Most have their own private traditionally built latrines, but they are not well constructed. When they fill up they pay labourers to dig and build new ones. For some there is no extra land and there is a need for and emptying system of the old latrines. | Would like to have latrines with some sort of emptying system. Would use public showers if there was one available. Problem of poor drainage caused by the road needs to be remedied. |
| Health | Common diseases include Malaria, TB, Pneumonia. Health education has not been received. The community feel isolated from services. | Health education sessions appreciated on days other than market days. A local (or any trained) person could be trained up to give some community based health education sessions. |

| Group 2 details | Group characteristics | Group needs |
|---|---|---|
| General | Mixed ethnicity, Muslims, 16 women, 3 men, petty traders, spinners and weavers, daily labourers | 1-Water, 2-Allocation of Land, 3-Electricity, 4-Latrines |
| Water | Former public fountain users (shut by vandals), now using private connection vendors and springs in dry season. PC vendors charge 10c per 2 pots. Some have handdug wells but supply is inadequate. Women fetch water and do laundry (at river or home). | Would like public fountain near to homes, existing site of public fountain is still open to vandalism and could not be guarded. Prepared to help with construction of PF (were forced to help with the last one) and to manage the PF. Prepared to pay extra. |
| Sanitation | No latrines in the area due to lack of control over land. These people have settled without permission (squatted) on Government land. Solid waste is disposed of in open field also. No cultural block for women to defaecate only in dark. | Would like to have land allocated and plots given for latrines. Community latrines shared by sex would be appropriate, but these must have water for washing. Would be prepared to help with labour and management of the latrines. Would use public shower. |
| Health | Fully aware of the health risks of poor sanitation and water supply. Have suffered significantly from related diseases including diarrhoea, vomiting and malaria. Children suffer trachoma and skin infections. Men and women take care of sick children. | No additional health needs identified. Health education being received at Health Centre. |

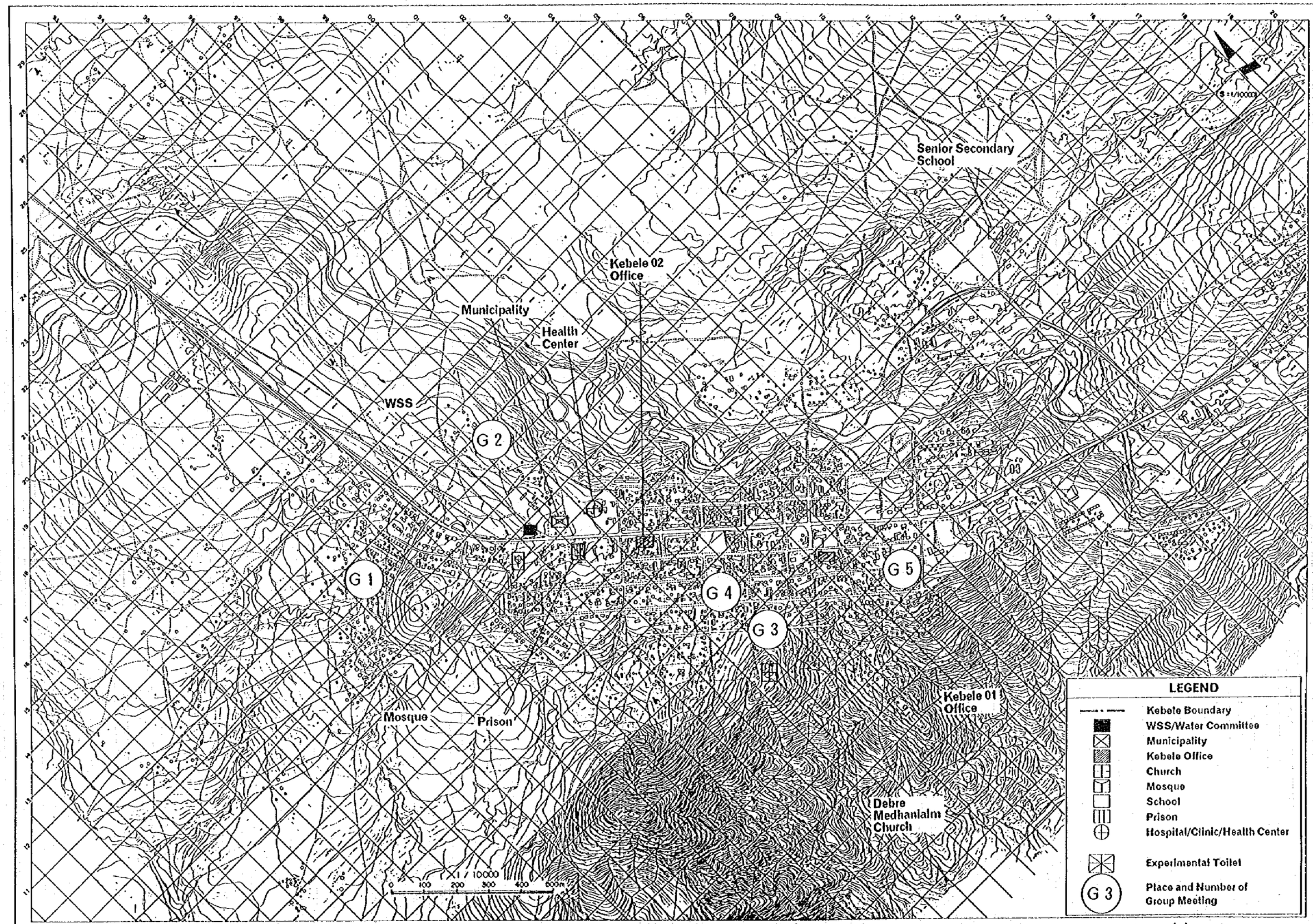
CHAGNI - Summary of group meetings

| Group 3 details | Group characteristics | Group needs |
|---|---|---|
| General | Mixed ethnicity, mixed religions, 8 women, 2 men, some children, Daily labourers, tela and local alcohol sellers | 1-Employment, 2-Water, 3-Electricity |
| Water | PF Users and PC Vendor Users, PC Vendors supplement supply of the PFs because they do not supply adequate amounts of water in the time they are open. Women fetch water. | Would like longer service time from the existing PF, price is not expensive for water at present, and could pay more for a better service. |
| Sanitation | Half of the people in the area live in rented housing and these people do not have latrines. They do not have control of the land for latrine construction. They felt that community latrines are a good idea but not clear over management. | Those in rented Kebele housing would like community latrines but would need assistance in arranging suitable management mechanism. Those with their own land have latrines and did not mention any problems with them. |
| Health | Common diseases are Malaria and diarrhoea. People felt the diarrhoea was due to open defaecation by children (mostly boys). Health education has been received from the health centre but considered ineffective | Health education after Church on Sundays would be a good time for extra health information to be given. |

| Group 4 details | Group characteristics | Group needs |
|---|---|---|
| General | Mixture of Amhara, Agew, Oromo and Tigre, Kebele 02, 7 women, 11 men, many children, Traders, hotel/tea/tela shop proprietors | 1-Latrine emptying system, 2-Solid Waste disposal, 3-Electricity, 4-Hospital and availability of medicines |
| Water | Private connection users. All get adequate supplies of piped water usually, occasionally there are disruptions to supply for a few days. This is caused by a variety of technical problems (e.g. broken pump or pipe) in dry season the water becomes muddy. | Slight improvement to the water supply needed to prevent breakdowns. Are prepared to pay more for water service to help remedy this inconsistent service. However the supply is generally very good and there are no urgent needs. |
| Sanitation | All have latrines. For those with enough land the latrines are covered when they are full and new ones are dug. For others there is insufficient land to do this. Men, women and children use the latrines. Most own their land. Refuse disposed in open. | Would like a latrine emptying system and are mostly able to pay for such a service. Compost latrines are new and have not been tried, but might work. Municipality needs to fill in mosquito breeding sites and allocate areas for refuse disposal. |
| Health | Common diseases include malaria (recent epidemic) and dysentery. Aware of the links between water and sanitation related diseases, but Health Education at HC not effective. HC only started anti malaria information after the epidemic had started. | Improved health education programme including house to house visits to provide advise and motivation to individual householders |

CHAGNI - Summary of group meetings

| Group 5 details | Group characteristics | Group needs |
|---|---|---|
| General | Mixed ethnicity, mixed religions, Traders, Government Employees and Pensioners | 1-Improved health facilities, 2-Water/Electricity |
| Water | PF and PC Vendor users. The PCs do not always have adequate water for selling. Women and female children mostly fetch water for all purposes | Piped water needs to be available for longer service time for PCs and PFs, the number of PFs is also inadequate and additional PFs are needed. Would like the Government to manage the extra PFs. Can pay more for better water service. |
| Sanitation | All use own private latrines. When they fill others are dug in a different area. Lack of land is not an issue. | Prepared to pay for latrine emptying system (i.e. vacuum truck) Would like to use public shower if it was available at a reduced rate (1.5 Birr is too expensive) |
| Health | Common diseases include TB, Malaria and Giardia. Aware of the link between poor water quality and disease. Health education has been received at the health centre. | Health education sessions on Sunday afternoons would be the most convenient time |


Senior Secondary School
Kebele 02 Office
Municipality
Health Center
WSS
G 2
G 1
G 4
G 3
G 5
Mosque
Prison
Kebele 01 Office
Debre Medhanialm Church
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



CHAGNI

# 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.<br>35,565e | n.a.<br>29,232e | 113,523<br>90,218 | 58,318<br>46,104 | 11,303e<br>10,173e | 11,930<br>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<br>60,188 | 48,818<br>38,182 | 131,144<br>132,245 | 64,648<br>53,304 | 50,863e<br>22,560e | 31,337<br>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,<br>female,<br>temporary/contract | 10<br>1<br>10 | 11<br>5<br>11 | 25<br>5<br>8 | 18<br>4<br>0 | 13<br>4<br>8 | 18<br>5<br>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,<br>public fountains,<br>hydrants | 190(70)<br>8(2)<br>1 | 89<br>8(5)<br>1 | 852<br>12 | 396<br>7(6) | -<br>5(3) | 320<br>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<br>31,206 | 74,219<br>55,045 | 66,278<br>55,008 | 17,810<br>15,826 | 46,409<br>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<br>79,567 | 68,590<br>72,172 | 66,791<br>102,309 | 34,679<br>71,591 | 62,089<br>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,<br>female,<br>temporary/contract | 19<br>5<br>1 | 17<br>6<br>2 | 22<br>7<br>0 | 20<br>6<br>2 | 17<br>3<br>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,<br>public fountains,<br>hydrants | 383<br>14(13) | 327<br>12 | 478<br>13(12) | 238<br>7 | 390<br>7 |

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

## Table 2 (1) Financial Condition of Water Supply Service in Nefas Chagni

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

2. Production and Consumption of Water, 1993/94

1) Production : 74,219 m3

2) Consumption: 55,045 m3

* Daily water consumption as divided by total population = 7.3 litre

* Leakage ratio = 25.8%

3. Income and Expenditure

1) Income : 68,590.02 birr

Major sources of income

| | | |
|---|---|---|
| (1) Water sales | 44,123.00 birr | (64.3%) |
| (2) Public fountains | 14,165.50 birr | (20.7%) |
| (3) Service charge | 6,247.17 birr | ( 9.1%) |
| (4) Sales of materials | 774.65 birr | ( 1.1%) |

* Bill collection rate = 85.8%

* Income per unit consumption of water = 1.25 birr/m3

2) Expenditure: 72,171.93 birr

Major items of expenditure

| | | |
|---|---|---|
| (1) Salaries | 29,128.21 birr | (40.4%) |
| (2) Fuel | 26,796.00 birr | (37.1%) |
| (3) Lubricant | 3,504.00 birr | ( 4.9%) |
| (4) Office supply | 2,844.30 birr | ( 3.9%) |

* Expenditure per unit production of water: 0.97 birr/m3

* Income-expenditure ratio = 95.0%

4. Organization and Personnel

1) No. of personnel: 17 (6) [2]

## Table 2 (2) Financial Condition of Water Supply Service in Chagni

| | |
|---|---|
| (1) Head, WSS | 1 |
| (2) Administration<br>4 guards, 2 [2] store keepers | 6 [2] |
| (3) Finance<br>1 accounting clerk, 1 (1) bill collector,<br>6 (5) water sellers | 8 (6) |
| (4) Urban water supply & sewerage<br>1 motor operator, 1 plumber | 2 |

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

* Production per worker = 4,366 m3/year

* Income and expenditure per worker = 4,035 birr, 4,245 birr/year

2) Average monthly salaries of employees: 143 birr

5. No. of Distribution Facilities

1) Yard connections : 327

| | |
|---|---|
| (1) Household | : 246 |
| (2) Governmental & public | : 37 |
| (3) Commercial | : 44 |

2) Public fountains : 12 (all functional)

Note: There are 97 hand-dug wells.

6. Problems and Bottlenecks

1) Shortage of water sources. There is only one water source.
2) Main distribution lines do not cover the whole town.
3) Shortage of pipes and fittings.
4) Financial problem. The cost of materials and fuel is rising due to inflation. But, water tariff stays the same for a long time.
5) Public fountains are not protected by fences due to lack of fund.
6) Manpower is not enough because of financial constraints.
7) No vehicle.
8) Office furniture is borrowed from outside.

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<br>6 | 44<br>56 | 92<br>7 | 67<br>33 | 65<br>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 | 13.3 | 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 | 546 | 246 | 414 | 345 |
| [parenthesized figures=No. of hotels/restaurants] | (209) | (91) | (65) | (47) | (74) |
| *No. of establishments per 1,000 population | 63 | 20 | 17 | 28 | 34 |
| | (15) | (3) | (4) | (3) | (7) |
| 2. Monthly household income (birr) | 202 | 203 | 253 | 324 | 312 |

Note: e=estimates

## Table 4 (1) Socio-Economic Condition of Chagni

I. Administrative Conditions

1. Administrative Classification: Region 3, Zone = Agewaw

2. Government Organizations
 1) Agricultural Department
 2) Natural Resources Development and Environmental Protection (NRDEP)
 3) Weroda Council
 4) Financial Department
 5) Educational Office
 6) Municipality
 7) Health Center
 8) Health Department
 9) Animal Husbandry Station
 10) Customs Office
 11) Merchandise Wholesale Trading and Import Enterprise
 12) Police
 13) Post Office
 14) Telecommunications
 15) Weroda Court
 16) Weroda Attorney
 17) Ethiopian Grain Trade Enterprise
 18) Prison Administration
 19) Match and Tobacco Plantation
 20) Commercial Bank of Ethiopia
 21) Road Construction Authority
 22) Water Supply Service (WSS)

Notes: 1. Schools are not included in the above organizations.
 2. There is one NGO, called Family Planning Project.

3. No. of Government Employees and Their Average Monthly Salaries: 727, 368 birr

 * No. of government employees per 1,000 population: 27

4. No. of Kebele: 2

II. Socio-Economic Conditions

1. Population
 1) Total population: 26,823

 2) Ethnic composition: Amhara (73.9%), Agew (18.9%), Shinasha (3.6%), Gurage (1.8%), Oromo (0.9%), Tigre (0.9%)

## Table 4 (2) Socio-Economic Condition of Chagni

 3) Religious composition: Christians (44.0%), Moslems (56.0%)

 4) Average family size: 6.1 persons

2. Area: 920 ha * Population density: 29.2 persons/ha

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

| Items | Kinder-garten | Elementary School | Junior High School | Senior High School | Adult Education Center |
|---|---|---|---|---|---|
| (1) No. of schools | 2 | 2 | 1 | 1 | 1 |
| (2) No. of class rooms | 6 | 24 | 14 | 14 | 4 |
| (3) No. of teachers | 4 | 72 | 28 | 35 | 3 |
| (4) No. of pupils/students | 184 | 2,570 | 1,240 | 1,231 | 84 |

 * No. of pupils/students per 100 population: 20

 2) Literacy ratio: 73.5% (1984)

 3) Primary school enrollment ratio: 76.5% (1984)

4. Medical Conditions
 1) No. of medical institutions/establishments:
 1 Health Center, 2 drug vendors

 2) No. of medical personnel:
 2 physicians, 7 nurses, 14 health assistants, 2 laboratory technicians ... 25 in total

 Other related personnel: 1 sanitarian, 1 statistician

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

 (1) Top ten diseases
 i. Other unspecified malaria 1,834 cases
 ii. Infection of skin and subcutaneous tissue 1,475
 iii. Other helmantitis (Intestinal parasite) 1,436

## Table 4 (3) Socio-Economic Condition of Chagni

| | | | |
|---|---|---|---|
| iv. | All other respiratory diseases | 1,199 | |
| v. | Other unspecified dysentery | 1,173 | |
| vi. | Muscular rheumatism and rheumatism unspecified | 1,159 | |
| vii. | All other diseases of skin | 1,015 | |
| viii. | Acute upper respiratory infection | 873 | |
| ix. | Amoebiasis excl. symptomless carriers | 852 | i. to x. |
| x. | Hookworms | 766 | = 11,782 |

(2) Estimated number of cases per year as percentage of population:
(11,782 x 1.5) / (26,823 x 5) = 13.2%

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

4) Under 5 mortality rate: 144.4/1000 (1984)

5) Life expectancy: 54.4 years (1984)

6) Households more or less using septic tank and pit latrine: 61.0%

5. No. of Holy Places: 1 church, 3 mosques

6. Economic Conditions
i) 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 | 17 | 11 | 28 |
| Bars | 0 | 43 | 0 | 43 |
| Tea rooms | 19 | 0 | 0 | 19 |
| Tej houses | 1 | 0 | 0 | 1 |
| Sub-total | 20 | 60 | 11 | 91 |
| 2. Shops | 22 | 335 | 44 | 401 |
| 3. Cottage industry | | | | |
| Oil factories | 0 | 0 | 3 | 3 |
| Flour mills | 0 | 0 | 30 | 30 |
| Tyre repairing | 0 | 1 | 0 | 1 |
| Stone and sand producers | 0 | 8 | 0 | 8 |

## Table 4 (4) Socio-Economic Condition of Chagni

| | | | | |
|---|---|---|---|---|
| | Sub-total | 0 | 9 | 33 | 42 |
| 4. | Others | 2 | 8 | 2 | 12 |
| | Total | 44 | 412 | 90 | 546 |

Notes: 1. Shops include traders of clothes, thread, textiles, spices and hot sauce, kerosene, salt, leather and skin, leather products, cigarettes, grains, butter & honey, cotton, coffee, rural drug, bakeries, groceries, tailors, photo shops, stationeries and watch & radio repair shops.

2. Others include filling stations, butcheries, barber's shop, typist training schools and goldsmiths.

3. No. of local drink producers: 725 households

* No. of commercial and industrial establishments per 1,000 population: 20

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

3) Major products: edible oil, flour

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

(2) Prices of major marketable items

Grains (unit: birr/100 kg)

| tef | maize | sorghum |
|---|---|---|
| 200 | 130 | 130 |

## Table 4 (5) Socio-Economic Condition of Chagni

Livestock (unit: birr/one)

| ox | cow | sheep | goat | donkey | mule |
|---|---|---|---|---|---|
| 800 | 600 | 120 | 80 | 250 | 1,000 |

Consumers' items (unit: birr)

| butter (kg) | honey (kg) | milk (litre) |
|---|---|---|
| 20 | 10 | 1.5 |

(3) Market days - Mon., Thu. & Sat.
(10,000 people gather on a market day.)

4) Average monthly household income: 202.8 birr

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

# Appendix - 6

# Result of Initial Environmental Examination

Project Description on Initial Environmental Examination in Chagni

| 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.<br>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 | Chagni, Gangua Weroda, Region-3 |
| Executing Agency | Water Supply and Sewerage Service Department Ministry of Water Resource |
| Beneficiaries | About 26,800 of the population to be benefited. |
| Dimensions of the Plan | Rehabilitation of existing facilities, and new boreholes, reservoir and distribution network. |
| Type of Work | Rehabilitation and new construction work |
| Purpose | 1. To provide domestic water and improve sanitation facilities.<br>2. To initiate people's awareness on water use and sanitation. |
| Water Resource | Groundwater, (Surface water namely Ardi and Doder rivers might 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) 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 Chagni

| Items | Description |
|---|---|
| Project Title | Eleven Centers Water Supply and Sanitation |
| Social Environment | |
| Residents (population, tribe, consciousness) | Population about 26,800, mostly Amhara and Agaw |
| Facilities related to life (electricity, etc.) | The electricity is currently generated, but shortly hydropower electricity is expected. |
| Health and Sanitation (diseases, clinic, etc.) | 0 hospital, 1 health center, 2 drug vendors, Intestinal parasites are the most common. |
| Natural Environment | |
| Topography, Geology and Hydrogeology | Located on transitional zone to western low land Alkali-olivine basalt dominates the foundation. Groundwater depends on fractures of the basalt. |
| Meteo-hydrology Groundwater/spring/river | Annual rainfall about 1690mm. Dura, Ardi and Donder perennial rivers, There are some springs. |
| Endangered fauna and flora | Nil |
| Public Nuisance | |
| Nuisances | Along the trunk road, the drainage condition is poor and stagnant water was observed in July, 1995. |
| Regulations and Compensation | Although the land is officially owned by the state, those who lose their dwelling and commercial area because of the project will be given substitute land. Also, Compensation will be made for properties such as houses and trees, which will be damaged. |
| Remarks | 1. Because of water shortage, appreciable part of the population are using rivers' water and springs.<br>2. At present, the main drainage system is rehabilitated by the municipality.<br>3. DAP is used as major fertilizer, and pesticides are used only during outbreak of insect. |

Scoping Format for Initial Environmental Examination in Chagni

| 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.<br>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 Chagni

| No. | Description | F.C.(B) | L.C.(B) | Total(B) |
|---|---|---|---|---|
| I. | Target year of 2005 | | | |
| 1 | Civil Work | | | |
| | Mobilization and Demobilization | 142,000 | 266,000 | 408,000 |
| | Excavation and Earth-work | 4,420 | 14,720 | 19,140 |
| | Trench excavation | 369,840 | 839,020 | 1,208,860 |
| | Pipe-work | 640,590 | 640,590 | 1,281,180 |
| | Reservoir | 297,000 | 297,000 | 594,000 |
| | Pumping station, R.C.pump house | 88,032 | 58,656 | 146,688 |
| | Access road | 356,000 | 828,000 | 1,184,000 |
| | Bore-hole (200mm casing) | 145,920 | 218,880 | 364,800 |
| | Water purifiction unit | 10,000 | 15,000 | 25,000 |
| | Booster pump and necessary works | 240,000 | 400,000 | 640,000 |
| | Electric submersible pump and necessary works | 120,000 | 180,000 | 300,000 |
| | Power supply | 29,550 | 34,325 | 63,875 |
| | Concrete work | 175,980 | 305,680 | 481,660 |
| | Masonsy work | 12,000 | 49,000 | 61,000 |
| | Structure | 94,300 | 220,060 | 314,360 |
| | Temporary work(10% of above total) | 272,563 | 436,693 | 709,256 |
| | Total of civil work | 2,998,195 | 4,803,624 | 7,801,819 |
| 2 | Material & Equipment | 8,557,278 | 599,009 | 9,156,287 |
| | Sub Total | 11,555,473 | 5,402,633 | 16,958,106 |
| 3 | Engineering cost(12% of sub tatal) | 2,034,973 | | 2,034,973 |
| 4 | Contingency(5% of above cost) | 679,522 | 270,132 | 949,654 |
| | Total(birr) | 14,269,968 | 5,672,765 | 19,942,733 |
| | Total(Yen:1birr=15yen) | | | 299,141,000 |
| 5 | Buildings | | 2,726,018 | 2,726,018 |
| 6 | WSSD's management cost | | 453,375 | 453,375 |
| | Total(birr) | | 3,179,393 | 3,179,393 |
| 7 | Prise escalation(6%) | 856,198 | 190,764 | 1,046,962 |
| | Grand Total | 15,126,166 | 9,042,922 | 24,169,088 |
| II. | Target year of 2010 | | | |
| 1 | Morbilization and demorbilization | | | 300,000 |
| 2 | Rising line | | | 678,000 |
| 3 | Distribution network | | | 1,200,000 |
| 4 | New boreholes including pumps and meterials | | | 1,977,000 |
| 5 | Booster pump with house | | | 534,000 |
| 6 | Generating set | | | 560,000 |
| 7 | Chamber and structures | | | 324,000 |
| 8 | Buildings | | | 937,000 |
| 9 | Others | | | 564,000 |
| | Sub total | | | 7,074,000 |
| 10 | Engineering cost (10%) | | | 707,400 |
| 11 | Contingency (10%) | | | 778,140 |
| | Total | | | 8,560,000 |
| | Prise escalation(42%) | | | 3,595,000 |
| | Grand Total | | | 12,155,000 |

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



| No. | Description | Unit | Q'ty | Unit-Rate F.C.(B) | Unit-Rate L.C.(B) | Amount F.C.(B) | Amount L.C.(B) | Remarks |
|---|---|---|---|---|---|---|---|---|
| 1. | Mobilization and Demobilization | LS | | | | 142,000 | 266,000 | |
| 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 | 500 | 1 | 4 | 500 | 2,000 | to remove top soil to an average depth of 20cm |
| 2-3 | Bulk excavation | | | | | | | |
| | a) Earth excavation | cum | 80 | 6 | 14 | 480 | 1,120 | |
| | b) Excavation of weathered rock | cum | 80 | 10 | 20 | 800 | 1,600 | |
| | c) Soft rock excavation | cum | | 14 | 32 | 0 | 0 | |
| | d) Sound rock excavation | cum | 40 | 30 | 70 | 1,200 | 2,800 | |
| 3. | Trench excavation | | | | | | | |
| 3-1 | Trench excavation for water pipe | | | | | | | |
| | 1) Single pipe in trench | | | | | | | |
| | a) 0.6~1.0m depth | m | 16,900 | 4 | 8 | 67,600 | 135,200 | |
| | b) 1.0~1.5m depth | m | 12,700 | 7 | 17 | 88,900 | 215,900 | |
| 3-2 | Trench, Rock excavation | cum | 200 | 30 | 70 | 6,000 | 14,000 | |
| 3-3 | Back-fill with the same material | m | 14,810 | 5 | 11 | 74,050 | 162,910 | |
| 3-4 | Selected soil bedding | m | 14,810 | 2 | 5 | 29,620 | 74,050 | 150mm thick below barrel |
| 3-5 | Back-fill with selected material | m | 14,810 | 7 | 16 | 103,670 | 236,960 | 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 | 8,440 | 5 | 5 | 42,200 | 42,200 | |
| | b) DN 75mm | m | 8,460 | 8 | 8 | 67,680 | 67,680 | |
| | c) DN 100mm | m | 2,630 | 10 | 10 | 26,300 | 26,300 | |
| | d) DN 150mm | m | 7,400 | 17 | 17 | 125,800 | 125,800 | |
| 4-2 | Pressure steal pipe | | | | | | | fitting and supports for bridge and road |
| | a) DN 200mm | m | 1,850 | 137 | 137 | 253,450 | 253,450 | |
| | b) DN 250mm | m | 840 | 149 | 149 | 125,160 | 125,160 | |
| 5. | Reservoir | | | | | | | |
| 5-1 | Ground level reservoir | m3 | 330 | 900 | 900 | 297,000 | 297,000 | |
| 6. | Pumping station, R.C.pump house | sqm | 48 | 1,834 | 1,222 | 88,032 | 58,656 | with accessaries |

| 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 | 4,000 | 89 | 207 | 356,000 | 828,000 | 3m wide gravel road with draine ditch |
| 8. | Bore-hole (200mm casing) | | | | | | | |
| 8-1 | New driling | m | 406 | 320 | 480 | 129,920 | 194,880 | including, casing, packing and pumping test |
| 8-2 | Rehabiritation | set | 1 | 16,000 | 24,000 | 16,000 | 24,000 | |
| 9. | Water purifiction unit | No. | 1 | 10,000 | 15,000 | 10,000 | 15,000 | |
| 10. | Booster pump | No. | 4 | 60,000 | 100,000 | 240,000 | 400,000 | foundation, pump, and motor with accessories |
| 11. | Electric submersible pump | No. | 6 | 20,000 | 30,000 | 120,000 | 180,000 | 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 | 2,000 | 6 | 4 | 12,000 | 8,000 | |
| 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 | 200 | 250 | 500 | 50,000 | 100,000 | including form-work, vibration and curing |
| 13-2 | Reinforced concrete (360kg of cement per cum) Water retaining structure | cum | 300 | 275 | 642 | 82,500 | 192,600 | including vibration and curing |
| 13-3 | Form-work Wall | sqm | 40 | 37 | 87 | 1,480 | 3,480 | including all necessary works |
| 13-4 | Reinforcement bars; Steel bars | kg | 6,000 | 7 | 1.6 | 42,000 | 9,600 | including cutting, bending and placing |
| 14. | Masonsy work | sqm | 200 | 60 | 245 | 12,000 | 49,000 | |
| 14-1 | Roughly dressed 40cm thick stone elevation wall | | | | | | | 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. | 20 | 230 | 540 | 4,600 | 10,800 | |
| 15-3 | Construction of R.C.C. aeration chamber | No. | 3 | 5,730 | 13,370 | 17,190 | 40,110 | |
| 15-4 | Construction of R.C.C. valve chamber | No. | 11 | 5,730 | 13,370 | 63,030 | 147,070 | |
| | Sub-Total of Construction work | | | | | 2,725,632 | 4,366,931 | |

| No. | Description | Unit | Q'ty | Unit-Rate F.C.(B) | Unit-Rate L.C.(B) | Amount F.C.(B) | Amount L.C.(B) | Remarks |
|---|---|---|---|---|---|---|---|---|
| 16. | Material & Equipment (Ref.table) | | | | | | | |
| 16-1 | CIF Cost at Addis Ababa | | | | | 8,557,278 | | |
| 16-2 | Inland transportation cost | | | | | | 599,009 | CIF cost x 7 % |
| | Sub-Total of Material & Equipment | | | | | 8,557,278 | 599,009 | |
| | Grand Total | | | | | 11,282,910 | 4,965,940 | |
| 17. | Building | | | | | | | |
| 17-1 | Office | sqm | 270 | | 1,910 | | 515,700 | |
| 17-2 | Workshop | sqm | 132 | | 1,624 | | 214,368 | |
| 17-3 | Store | sqm | 220 | | 1,337 | | 294,140 | |
| 17-4 | Resience | sqm | 810 | | 2,101 | | 1,701,810 | |
| | Total | | | | | | 2,726,018 | |

Imported Cost (Material & Equipment) of Chagni :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 | 8,870 | 15 | 133,050 |
| | b) DN 75mm | m | 8,890 | 30 | 266,700 |
| | c) DN 100mm | m | 2,760 | 40 | 110,400 |
| | d) DN 150mm | m | 7,770 | 80 | 621,600 |
| 1.2 | Suspended pressure steel pipe | | | | |
| | a) DN 200mm W/O gilt and screw | m | 1,950 | 288 | 561,600 |
| | b) DN 250mm | m | 890 | 334 | 297,260 |
| 1.3 | Fitting cost Total cost × 20% | | | | 398,122 |
| 2 | Pumps (Pump with electric motor/accessories) | | | | |
| 2.1 | Centrifugal pumps | | | | |
| | a) Q= 1.6 m3/min H= 9m HP= 5.5kw | set | 2 | 300,000 | 600,000 |
| | b) Q= 1.00m3/min H= 70m HP= 30 kw | set | 2 | 600,000 | 1,200,000 |
| 2.2 | Submersible pumps with accessories | | | | |
| | a) Q= 0.12m3/min H= 100m HP= 3 kw | set | 1 | 130,000 | 130,000 |
| | b) Q= 0.3m3/min H= 100m HP= 5.5kw | set | 5 | 171,000 | 855,000 |
| 3 | Power Supply(Materials&accessories) | | | | |
| 3.1 | Power supply generating set | | | | |
| | 50 KVA | set | 3 | 450,000 | 1,350,000 |
| 3.2 | Tension line | | | | |
| | a) High tension over head line 15KV | m | | 50 | 0 |
| | b) Low tension over head line | m | 2,000 | 28 | 56,000 |
| 3.3 | Plate-form mounted transformer | | | | |
| | Supply of transformer wiht acccessories | | | | |
| | a) Transformer 30 KVA (H-type) | set | | 44,600 | 0 |
| | b) Transformer 60 KVA ( 〃 ) | set | | 55,300 | 0 |
| 4 | Valve (Valve with accessories) | | | | |
| 4.1 | Sluice valve | | | | |
| | a) φ50 | set | 3 | 1,000 | 3,000 |
| | b) φ75 | set | 3 | 1,300 | 3,900 |
| | c) φ150 | set | 2 | 1,700 | 3,400 |
| | d) φ200 | set | 1 | 2,200 | 2,200 |
| 4.2 | High speed air valve | | | | |
| | a) φ50 | set | 3 | 7,000 | 21,000 |
| 4.3 | Check valve | | | | |
| | a) 200mm | set | | 20,000 | 0 |
| | b) 150mm | set | 1 | 15,000 | 15,000 |
| 5 | Flow meter (Meter with accessories φ150) | set | 1 | 60,000 | 60,000 |
| 6 | Reservoir equipment | set | 2 | 100,000 | 200,000 |
| 7 | Well (Materials with accessories) | | | | |
| 7.1 | Casing pipe FRP | | | | |
| | DN 200 | m | 222 | 2,093 | 464,646 |
| 7.2 | Screen FRP | | | | |
| | DN 200 | m | 184 | 5,700 | 1,048,800 |
| 7.3 | Riser pipe, stainless DN 65 | m | 420 | 180 | 75,600 |
| 8 | Water purification unit | set | 1 | | 80,000 |
| | Total | | | | 8,557,278 |

Investment Cost of Target Year 2010 in Chagni

| No. | Description | Unit | Q'ty | Unit Rate (B) | Amount (B) |
|---|---|---|---|---|---|
| 1 | Mobilization and demobilization | LS | | | 300,000 |
| 2 | Rising line | Km | 2.26 | 300,000 | 678,000 |
| 3 | Distribution network | Km | 8 | 150,000 | 1,200,000 |
| 4 | New boreholes including pumps and meterials | Set | 3 | 659,000 | 1,977,000 |
| 5 | Booster pump with house | Set | 1 | 534,000 | 534,000 |
| 6 | Generating set | Set | 1 | 560,000 | 560,000 |
| 7 | Chamber and structures | Set | 12 | 27,000 | 324,000 |
| 8 | Buildings | M2 | 10 | 93,700 | 937,000 |
| 9 | Others | LS | | | 564,000 |
| | Sub total | | | | 7,074,000 |
| 11 | Enginering cost (10%) | | | | 707,400 |
| 12 | Contingency (10%) | | | | 778,140 |
| | Total | | | | 8,559,540 |

# Appendix - 8

# Meteorological Data

## Table 1 Monthly Precipitation

Station: Chagni Unit:mm

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1973 | – | – | – | – | – | 229.3 | 263.4 | 434.1 | 279.5 | 139.1 | 5.0 | 2.4 | – |
| 1974 | 12.8 | 0.0 | 2.2 | 1.4 | 225.2 | 328.8 | 287.5 | 417.2 | 330.1 | 147.3 | 0.0 | 2.5 | 1755.0 |
| 1975 | 9.1 | 85.6 | 6.0 | 18.8 | 139.3 | 191.0 | 451.5 | 467.4 | 344.4 | – | 26.0 | 2.0 | – |
| 1976 | – | – | 76.0 | 22.6 | 188.8 | 264.3 | 281.7 | 319.4 | 249.5 | 177.4 | 66.2 | 8.8 | – |
| 1977 | 0.0 | 0.0 | 13.6 | 1.9 | 128.8 | 370.9 | 278.1 | 281.1 | 269.2 | 151.7 | 78.4 | – | – |
| 1978 | 0.0 | 0.0 | 11.7 | – | – | 298.4 | 278.1 | 357.8 | 319.6 | 239.5 | 80.7 | 1.2 | – |
| 1979 | 0.0 | 0.0 | 0.0 | 54.3 | 181.0 | – | 300.7 | 185.1 | 289.4 | 191.5 | 9.2 | 0.0 | – |
| 1980 | 0.0 | 12.8 | 38.6 | 88.3 | 125.6 | 225.0 | 289.5 | 359.6 | 269.3 | 166.0 | 35.4 | 0.5 | 1610.6 |
| 1981 | 16.5 | 0.0 | 0.0 | 5.6 | 108.8 | – | 503.1 | 337.2 | 267.4 | 84.4 | 44.9 | 0.0 | – |
| 1982 | 14.4 | 0.0 | 86.5 | 59.3 | 115.2 | 288.0 | 462.3 | 355.6 | 279.1 | – | 0.0 | – | – |
| 1983 | 0.0 | 0.0 | 0.0 | 0.0 | – | – | 368.5 | 459.5 | 335.8 | 199.2 | 17.2 | 0.0 | – |
| 1984 | 0.0 | 0.0 | 11.4 | 30.5 | 219.7 | 262.5 | 385.0 | 295.1 | 265.0 | 123.3 | 6.4 | 11.9 | 1610.8 |
| 1985 | 0.0 | 0.0 | 15.7 | 14.8 | 322.0 | 308.4 | 545.7 | 504.5 | 268.8 | 140.5 | 16.5 | 31.9 | 2168.8 |
| 1986 | 0.0 | 0.0 | 0.0 | 9.8 | 17.5 | 299.9 | 250.4 | 302.2 | 235.2 | 174.1 | 21.6 | 0.0 | 1310.7 |
| 1987 | 13.6 | 0.0 | 0.3 | 53.1 | 200.4 | 202.1 | 284.3 | 393.4 | 292.6 | 203.2 | 26.5 | 0.3 | 1669.8 |
| 1988 | 3.1 | – | 2.1 | 0.0 | 149.6 | 394.7 | 344.1 | 325.2 | 322.8 | 219.5 | – | 0.3 | – |
| 1989 | 0.0 | 0.0 | 17.3 | 35.5 | 219.1 | 278.4 | 395.7 | 373.5 | 224.0 | 161.5 | 5.1 | 7.2 | 1717.3 |
| 1990 | 17.4 | 0.0 | 10.7 | 0.1 | 65.2 | 165.3 | 388.2 | – | 283.8 | 170.2 | 6.0 | 0.0 | – |

## Table 2 Long Term Monthly Mean Potential Evapotranspiration (PET)

Station : Chagni Unit:mm

| | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1st 10 days | 35 | 36 | 37 | 37 | 38 | 42 | 44 | 49 | 50 | 50 | 52 | 48 | |
| 2nd 10 days | 46 | 43 | 38 | 37 | 33 | 32 | 33 | 32 | 31 | 31 | 30 | 31 | |
| 3rd 10 days | 31 | 32 | 35 | 37 | 40 | 39 | 37 | 36 | 35 | 35 | 34 | 35 | |
| Total | 112 | 111 | 110 | 111 | 111 | 113 | 114 | 117 | 116 | 116 | 116 | 114 | 1361 |

Note: – = not calculated due to missing data

Table 3 Monthly Average Maximum Air Temperature

Station: Chagni

unit: ℃

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1973 | – | – | – | – | – | 25.3 | 24.2 | 24.0 | 24.5 | 25.9 | 26.6 | 28.1 |
| 1974 | 28.9 | 30.6 | 30.1 | 32.2 | 26.8 | 24.2 | 22.4 | 23.1 | 23.5 | 26.2 | 28.2 | 28.6 |
| 1975 | 28.9 | 29.5 | 31.4 | 30.8 | 28.5 | 23.9 | 23.2 | 22.3 | 23.8 | – | 26.3 | 26.8 |
| 1976 | – | – | – | 30.6 | 27.5 | 24.6 | 23.2 | 23.2 | 24.9 | 26.0 | 26.0 | 27.5 |
| 1977 | 28.3 | 30.2 | 31.3 | 32.0 | 28.8 | 25.4 | 23.7 | 23.5 | 25.1 | 25.8 | 26.8 | – |
| 1978 | 29.5 | 30.9 | 32.0 | – | – | 24.0 | 23.2 | 23.9 | 25.2 | 26.5 | 27.2 | 28.0 |
| 1979 | 28.5 | 30.8 | 32.1 | 32.2 | 27.2 | – | 24.2 | 24.8 | 25.4 | 26.9 | 27.5 | 29.0 |
| 1980 | 30.9 | 31.6 | 32.3 | 31.1 | 28.3 | 25.4 | 23.6 | 24.2 | 25.9 | 26.6 | 27.4 | 28.8 |
| 1981 | 30.2 | 31.9 | 31.4 | 32.4 | 29.0 | – | 23.9 | – | – | 27.4 | 28.2 | 29.7 |
| 1982 | 30.1 | 30.8 | 31.4 | 32.0 | 29.4 | – | – | 24.2 | – | – | 27.3 | – |
| 1983 | 29.7 | 31.7 | 34.5 | 35.5 | – | – | 26.1 | 24.2 | 25.7 | 26.5 | 28.1 | 29.1 |
| 1984 | 29.3 | 32.4 | 34.6 | – | 29.2 | 25.0 | 24.1 | 24.5 | 25.1 | 27.2 | – | 28.9 |
| 1985 | 30.5 | 29.4 | 31.8 | 30.5 | 26.7 | 24.4 | 23.1 | 23.5 | 24.4 | 26.3 | 27.4 | 28.5 |
| 1986 | 29.7 | 31.4 | 32.7 | 31.5 | 32.2 | 25.5 | 23.6 | 23.9 | 24.8 | 26.3 | 28.8 | 28.9 |
| 1987 | 29.9 | 31.3 | 32.2 | 32.0 | 28.2 | 25.3 | 25.0 | 24.8 | 25.9 | 26.4 | 28.0 | 29.1 |
| 1988 | 30.1 | – | 32.7 | 32.8 | 28.4 | 25.0 | 23.1 | 23.6 | 24.5 | 26.8 | – | 28.0 |
| 1989 | – | 29.5 | 30.3 | 30.4 | 26.7 | 24.5 | 23.6 | 23.9 | 24.5 | 25.6 | 27.6 | 27.5 |
| 1990 | 29.1 | 29.2 | 30.8 | 31.8 | 30.3 | 26.7 | 23.8 | – | 24.4 | 26.3 | 28.1 | 29.3 |

Note: - = not calculated due to missing data

Table 4 Monthly Average Minimum Air Temperature

Station: Chagni unit: ℃

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1973 | – | – | – | – | – | 14.3 | 14.7 | 14.1 | 13.2 | 12.3 | 11.3 | 6.4 |
| 1974 | 8.0 | 9.8 | 11.1 | 12.7 | 14.7 | 13.6 | 13.2 | 13.8 | 13.0 | 12.1 | 8.1 | 7.8 |
| 1975 | 9.3 | 12.9 | 9.9 | – | 12.8 | 12.4 | 12.3 | 12.6 | 12.0 | – | 8.7 | 7.0 |
| 1976 | – | – | 13.4 | 13.1 | 14.1 | 13.7 | 14.2 | 13.9 | 13.2 | 13.8 | 12.6 | 11.4 |
| 1977 | 11.6 | 11.2 | 14.3 | 12.9 | 15.1 | 15.6 | 14.5 | 14.9 | 14.0 | 14.1 | 11.4 | – |
| 1978 | 9.0 | 10.1 | 11.5 | – | – | 13.8 | 14.4 | 13.8 | 13.4 | 12.9 | 10.7 | 9.1 |
| 1979 | 8.6 | 9.3 | 10.2 | 12.2 | 15.6 | – | 13.9 | 13.4 | 13.3 | 12.5 | 10.6 | 8.8 |
| 1980 | 8.6 | 10.7 | 12.1 | 14.6 | 15.0 | 14.7 | 14.7 | 13.9 | 13.9 | 13.2 | 11.1 | 9.3 |
| 1981 | 10.2 | – | 12.0 | 12.7 | 14.8 | – | 14.5 | – | 13.7 | – | 11.4 | 8.5 |
| 1982 | 9.6 | 9.4 | 12.7 | 11.9 | 13.8 | – | – | 14.8 | 13.4 | – | 10.7 | – |
| 1983 | 8.8 | 10.2 | 12.1 | 13.5 | – | – | 15.0 | 14.7 | 14.2 | 12.9 | 11.2 | 8.2 |
| 1984 | 8.5 | 10.4 | 13.3 | – | 14.9 | 14.8 | 12.7 | 13.7 | 13.4 | 12.5 | – | 8.4 |
| 1985 | 9.0 | 9.1 | 14.3 | 16.1 | 20.0 | 14.9 | 14.0 | 13.7 | 13.4 | 12.8 | 11.1 | 10.3 |
| 1986 | 8.3 | 10.4 | 13.5 | 13.4 | 15.4 | 15.3 | 15.0 | 13.3 | 13.1 | 12.5 | 10.9 | 9.1 |
| 1987 | 8.4 | 10.9 | 12.9 | 15.0 | 16.6 | 15.5 | 15.3 | 15.1 | 14.3 | 14.4 | 11.7 | 10.6 |
| 1988 | 10.4 | – | 13.7 | 13.1 | 16.0 | 14.7 | 15.3 | 14.4 | 14.4 | 13.8 | – | 7.3 |
| 1989 | 6.9 | 8.3 | 10.5 | 11.7 | 14.2 | 14.0 | 14.6 | 14.5 | 14.2 | 13.4 | 10.1 | 8.8 |
| 1990 | 10.0 | 9.5 | – | 12.6 | 15.2 | – | – | – | 14.2 | 12.8 | 9.7 | 8.0 |

Note: - = not calculated due to missing data

Table 5 Monthly Average Air Temperature

Station: Chagni

Unit: ℃

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1973 | – | – | – | – | – | 19.8 | 19.5 | 19.1 | 18.9 | 19.1 | 19.0 | 17.3 |
| 1974 | 18.5 | 20.2 | 21.1 | 22.5 | 20.8 | 18.9 | 17.8 | 18.5 | 18.3 | 19.2 | 18.2 | 18.2 |
| 1975 | – | – | – | – | 20.2 | 18.5 | 17.8 | 17.9 | 17.9 | – | 17.5 | 16.9 |
| 1976 | – | – | – | 37.2 | 34.6 | 19.2 | 18.7 | 18.6 | 19.1 | 19.9 | 19.3 | 19.5 |
| 1977 | 20.0 | 20.7 | 22.8 | 22.5 | 22.0 | 20.5 | 19.1 | 19.2 | 19.6 | 20.0 | 19.1 | – |
| 1978 | 19.3 | 20.5 | 21.8 | – | – | 18.9 | 18.8 | 18.9 | 19.3 | 19.7 | 19.0 | 18.6 |
| 1979 | 18.6 | 20.1 | 21.2 | 22.2 | 21.4 | – | 19.1 | 19.1 | 19.4 | 19.7 | 19.1 | 18.9 |
| 1980 | 19.8 | 21.2 | 22.2 | 22.9 | 21.7 | 20.1 | 19.2 | 19.1 | 19.9 | 19.9 | 19.3 | 19.1 |
| 1981 | 20.2 | – | 21.7 | 22.6 | 21.9 | – | 19.2 | – | – | – | 19.8 | 19.1 |
| 1982 | 19.9 | 20.1 | – | – | – | – | – | 19.2 | – | – | 19.3 | – |
| 1983 | 19.3 | 21.0 | 22.8 | 24.1 | – | – | 19.7 | 19.0 | 19.4 | 19.3 | 18.1 | 18.5 |
| 1984 | 18.9 | 21.4 | 22.3 | – | 21.0 | 18.7 | 18.2 | 18.6 | 18.6 | – | – | 18.0 |
| 1985 | 19.8 | 19.3 | 22.6 | 21.8 | 20.4 | 19.1 | 18.7 | 18.7 | 18.8 | 20.1 | 20.0 | 20.0 |
| 1986 | 19.0 | 20.9 | 23.5 | 22.2 | 23.7 | 20.6 | 19.1 | 19.4 | 19.4 | 20.2 | 20.1 | – |
| 1987 | 19.2 | 21.1 | 21.9 | – | – | 19.6 | 19.7 | 19.3 | 19.7 | 19.7 | 19.4 | 19.1 |
| 1988 | 20.3 | – | 21.5 | 21.5 | 22.0 | – | 18.5 | 18.5 | 18.9 | 19.7 | – | 18.4 |
| 1989 | – | 18.9 | 21.2 | 22.5 | 20.9 | 19.6 | 19.2 | 18.9 | 19.2 | 19.4 | 19.4 | 18.4 |
| 1990 | 19.6 | 19.4 | 21.4 | 22.3 | 22.6 | – | 19.2 | – | 19.1 | – | 19.8 | 18.9 |

Note: - = not calculated due to missing data

# Appendix - 9

# Hydrological Data

Table 1 Monthly Runoff of Ardi River

Station: Chagni Unit: Upper in Million m3, Lower in mm

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1977 | — | — | — | — | — | 11.85 | 55.54 | 65.16 | 64.92 | 45.34 | 16.03 | 6.18 | 274.32 |
| | | | | | | 54.1 | 253.6 | 296.8 | 296.4 | 207.0 | 73.2 | 28.2 | 1252.6 |
| 1978 | 3.00 | 1.48 | — | — | 2.18 | 12.87 | 36.51 | 61.75 | 71.15 | 55.98 | 15.01 | 5.92 | 267.95 |
| | 13.7 | 6.8 | | | 9.7 | 58.8 | 166.7 | 282.0 | 324.9 | 255.6 | 68.5 | 27.0 | 1223.5 |
| 1979 | 3.39 | 1.77 | 1.27 | 0.89 | 3.48 | 22.94 | 62.99 | 46.04 | 72.99 | 36.46 | 16.59 | 3.78 | 272.59 |
| | 15.5 | 8.1 | 5.8 | 4.1 | 15.9 | 104.8 | 287.6 | 210.2 | 333.3 | 166.5 | 75.8 | 17.3 | 1244.7 |
| 1980 | 2.00 | 1.42 | 1.00 | 1.11 | 3.48 | 14.52 | 43.93 | 85.59 | 60.55 | 27.25 | 7.80 | 3.90 | 252.55 |
| | 9.1 | 6.5 | 4.6 | 5.1 | 15.9 | 66.3 | 200.6 | 390.8 | 276.5 | 124.4 | 35.6 | 17.8 | 1153.2 |
| 1981 | 4.20 | 2.94 | 2.61 | 2.16 | 4.62 | 12.20 | 55.66 | 69.61 | 63.99 | 32.26 | 9.17 | 5.43 | 264.85 |
| | 19.2 | 11.1 | 11.9 | 9.9 | 21.1 | 55.7 | 254.2 | 317.9 | 292.2 | 147.3 | 41.9 | 24.8 | 1209.4 |
| 1982 | 4.06 | 2.80 | 3.11 | 2.27 | 2.89 | 11.05 | 65.55 | 56.32 | 48.66 | 32.55 | 9.96 | 5.52 | 244.74 |
| | 18.5 | 12.8 | 14.2 | 10.4 | 13.2 | 50.5 | 299.3 | 257.2 | 222.2 | 148.6 | 45.5 | 25.2 | 1117.5 |
| 1983 | 1.94 | 0.10 | 0.53 | 0.22 | 0.69 | 6.87 | 53.84 | 61.06 | 80.48 | 38.07 | 14.57 | 4.59 | 263.66 |
| | 8.9 | 0.5 | 2.4 | 1.0 | 3.2 | 31.4 | 245.8 | 278.8 | 367.5 | 173.8 | 66.5 | 21.0 | 1203.9 |
| 1984 | 2.08 | 1.07 | 0.66 | 0.45 | 1.72 | 18.62 | 59.25 | 62.33 | 72.53 | 24.60 | 5.78 | 2.39 | 251.51 |
| | 9.5 | 4.9 | 3.0 | 2.1 | 7.9 | 85.0 | 270.6 | 284.6 | 331.2 | 112.3 | 26.4 | 10.9 | 1148.5 |
| 1985 | 1.39 | 0.68 | 0.47 | 0.57 | 3.59 | 19.80 | 47.94 | 99.37 | 67.16 | 24.68 | 12.17 | 3.40 | 281.22 |
| | 6.4 | 3.1 | 2.1 | 2.6 | 16.4 | 90.4 | 218.9 | 453.7 | 306.7 | 112.7 | 55.6 | 15.5 | 1284.1 |
| 1986 | 1.73 | 0.84 | 0.13 | — | — | — | — | 63.76 | 59.99 | 28.15 | 7.54 | 2.60 | 233.74 |
| | 7.9 | 3.8 | 0.6 | | | | | 291.1 | 273.9 | 128.5 | 34.4 | 11.9 | 1067.3 |
| 1987 | 1.27 | 0.66 | 0.26 | 0.30 | 1.25 | 26.39 | 41.68 | 69.43 | 59.94 | 43.35 | 12.31 | 3.71 | 260.55 |
| | 5.8 | 3.0 | 1.2 | 1.4 | 5.7 | 120.5 | 190.3 | 317.0 | 273.7 | 198.0 | 56.2 | 16.9 | 1189.7 |
| 1988 | 1.86 | 0.92 | 0.49 | 0.18 | 1.43 | 20.98 | 52.78 | 62.70 | 58.74 | 39.51 | 9.64 | 3.53 | 252.76 |
| | 8.5 | 4.2 | 2.2 | 0.8 | 6.5 | 95.8 | 238.7 | 286.3 | 268.2 | 180.4 | 44.0 | 16.1 | 1154.1 |
| 1989 | 1.65 | 0.45 | 0.13 | 0.20 | 3.70 | 16.50 | 64.99 | 77.90 | 75.31 | 32.37 | 8.78 | 3.55 | 285.54 |
| | 7.5 | 2.1 | 0.6 | 0.9 | 16.9 | 75.3 | 296.8 | 355.7 | 343.9 | 147.8 | 40.1 | 16.2 | 1303.8 |
| 1990 | 1.89 | 1.17 | 0.77 | 0.37 | 0.68 | 3.73 | 23.86 | 61.09 | 55.36 | 25.01 | 4.74 | 2.01 | 180.68 |
| | 8.6 | 5.3 | 3.5 | 1.7 | 3.1 | 17.0 | 108.9 | 278.9 | 252.8 | 114.2 | 21.6 | 9.2 | 825.0 |
| 1991 | 1.04 | 0.31 | 0.10 | 0.00 | 1.15 | 18.64 | 46.15 | 51.24 | 62.46 | 28.07 | 8.12 | 3.08 | 220.36 |
| | 4.8 | 1.4 | 0.4 | 0.0 | 5.3 | 88.1 | 210.7 | 234.0 | 285.2 | 128.2 | 37.1 | 14.1 | 1006.2 |
| 1992 | 1.87 | 1.01 | 0.60 | 0.67 | 1.43 | 13.03 | 32.98 | 55.02 | 44.14 | 34.29 | 11.24 | 5.33 | 201.73 |
| | 8.5 | 4.6 | 2.7 | 3.1 | 6.5 | 59.5 | 150.6 | 251.2 | 201.6 | 156.6 | 51.3 | 24.3 | 921.1 |

Note: — = not calculated due to missing data or distorted data

# Appendix - 10

# Calculation of Water Pipeline

Output data on distribution network for Chagni 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 | 250 | 530 | 26.69 | 0.54 | 0.99 | 1.87 | 110 | |
| 2 | 2 | 2 | 3 | 250 | 230 | 21.52 | 0.44 | 0.29 | 1.26 | 110 | |
| 3 | 3 | 3 | 4 | 150 | 340 | 7.81 | 0.44 | 0.79 | 2.32 | 110 | |
| 4 | 4 | 4 | 5 | 75 | 230 | 0.54 | 0.12 | 0.11 | 0.48 | 110 | |
| 5 | 5 | 5 | 2 | 75 | 340 | -1.57 | -0.36 | -1.19 | -3.49 | 110 | |
| 6 | 6 | 3 | 8 | 75 | 80 | 2.25 | 0.51 | 0.54 | 6.77 | 110 | |
| 7 | 7 | 8 | 9 | 75 | 410 | 0.81 | 0.18 | 0.42 | 1.03 | 110 | |
| 8 | 8 | 9 | 4 | 150 | 150 | -5.38 | -0.30 | -0.17 | -1.16 | 110 | |
| 9 | 9 | 4 | 6 | 75 | 340 | 1.32 | 0.30 | 0.86 | 2.53 | 110 | |
| 10 | 10 | 6 | 7 | 75 | 225 | -0.21 | -0.05 | -0.02 | -0.08 | 110 | |
| 11 | 11 | 7 | 5 | 75 | 340 | -1.21 | -0.27 | -0.73 | -2.15 | 110 | |
| 12 | 12 | 9 | 10 | 75 | 340 | 1.10 | 0.25 | 0.62 | 1.82 | 110 | |
| 13 | 13 | 10 | 6 | 75 | 150 | 0.51 | 0.12 | 0.07 | 0.44 | 110 | |
| 14 | 14 | 9 | 13 | 150 | 180 | 4.55 | 0.26 | 0.15 | 0.85 | 110 | |
| 15 | 15 | 13 | 12 | 150 | 900 | 3.15 | 0.18 | 0.39 | 0.43 | 110 | |
| 16 | 16 | 12 | 11 | 75 | 700 | 0.99 | 0.22 | 1.04 | 1.48 | 110 | |
| 17 | 17 | 11 | 6 | 75 | 580 | -1.01 | -0.23 | -0.90 | -1.54 | 110 | |
| 18 | 18 | 2 | 16 | 75 | 265 | 2.20 | 0.50 | 1.72 | 6.49 | 110 | |
| 19 | 19 | 16 | 15 | 75 | 235 | -0.94 | -0.21 | -0.31 | -1.34 | 110 | |
| 20 | 20 | 15 | 3 | 150 | 255 | -11.02 | -0.62 | -1.12 | -4.38 | 110 | |
| 21 | 21 | 15 | 14 | 75 | 80 | -0.51 | -0.11 | -0.03 | -0.43 | 110 | |
| 22 | 22 | 14 | 8 | 75 | 260 | -1.19 | -0.27 | -0.54 | -2.08 | 110 | |
| 23 | 23 | 16 | 17 | 75 | 395 | 1.69 | 0.38 | 1.58 | 4.01 | 110 | |
| 24 | 24 | 17 | 18 | 75 | 310 | 0.17 | 0.04 | 0.02 | 0.06 | 110 | |
| 25 | 25 | 18 | 15 | 150 | 510 | -10.14 | -0.57 | -1.92 | -3.76 | 110 | |
| 26 | 26 | 18 | 19 | 150 | 100 | 9.08 | 0.51 | 0.31 | 3.06 | 110 | |
| 27 | 27 | 19 | 20 | 75 | 250 | 2.26 | 0.51 | 1.71 | 6.84 | 110 | |
| 28 | 28 | 19 | 21 | 150 | 450 | 5.72 | 0.32 | 0.59 | 1.30 | 110 | |
| 29 | 29 | 21 | 22 | 150 | 900 | 2.66 | 0.15 | 0.28 | 0.32 | 110 | |
| 30 | 30 | 22 | 23 | 75 | 1700 | 0.24 | 0.05 | 0.18 | 0.11 | 110 | |

Output data on distribution network for Chagni 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 | 250 | 530 | 49.98 | 1.02 | 3.17 | 5.97 | 110 | |
| 2 | 2 | 2 | 3 | 250 | 230 | 42.28 | 0.86 | 1.01 | 4.38 | 110 | |
| 3 | 3 | 3 | 4 | 150 | 340 | 17.53 | 0.99 | 3.52 | 10.35 | 110 | |
| 4 | 4 | 4 | 5 | 75 | 230 | -0.79 | -0.18 | -0.23 | -0.98 | 110 | |
| 5 | 5 | 5 | 2 | 75 | 340 | -3.15 | -0.71 | -4.30 | -12.65 | 110 | |
| 6 | 6 | 3 | 8 | 75 | 80 | 4.38 | 0.99 | 1.86 | 23.30 | 110 | |
| 7 | 7 | 8 | 9 | 75 | 410 | 2.33 | 0.53 | 2.97 | 7.24 | 110 | |
| 8 | 8 | 9 | 4 | 150 | 150 | -16.02 | -0.91 | -1.31 | -8.76 | 110 | |
| 9 | 9 | 4 | 6 | 75 | 340 | 1.95 | 0.44 | 1.76 | 5.18 | 110 | |
| 10 | 10 | 6 | 7 | 75 | 225 | -1.18 | -0.27 | -0.46 | -2.05 | 110 | |
| 11 | 11 | 7 | 5 | 75 | 340 | -1.80 | -0.41 | -1.53 | -4.49 | 110 | |
| 12 | 12 | 9 | 10 | 75 | 340 | 0.86 | 0.19 | 0.39 | 1.14 | 110 | |
| 13 | 13 | 10 | 6 | 75 | 150 | 0.49 | 0.11 | 0.06 | 0.40 | 110 | |
| 14 | 14 | 9 | 13 | 150 | 180 | 17.17 | 0.97 | 1.79 | 9.96 | 110 | |
| 15 | 15 | 13 | 12 | 150 | 900 | 16.30 | 0.92 | 8.14 | 9.04 | 110 | |
| 16 | 16 | 12 | 11 | 75 | 700 | -1.72 | -0.39 | -2.90 | -4.14 | 110 | |
| 17 | 17 | 11 | 6 | 75 | 580 | -2.97 | -0.67 | -6.59 | -11.36 | 110 | |
| 18 | 18 | 2 | 16 | 75 | 265 | 3.68 | 0.83 | 4.47 | 16.87 | 110 | |
| 19 | 19 | 16 | 15 | 75 | 235 | -0.41 | -0.09 | -0.07 | -0.29 | 110 | |
| 20 | 20 | 15 | 3 | 150 | 255 | -20.08 | -1.14 | -3.39 | -13.31 | 110 | |
| 21 | 21 | 15 | 14 | 75 | 80 | -1.47 | -0.33 | -0.25 | -3.10 | 110 | |
| 22 | 22 | 14 | 8 | 75 | 260 | -1.89 | -0.43 | -1.28 | -4.93 | 110 | |
| 23 | 23 | 16 | 17 | 75 | 395 | 3.19 | 0.72 | 5.12 | 12.97 | 110 | |
| 24 | 24 | 17 | 18 | 75 | 310 | 2.24 | 0.51 | 2.09 | 6.75 | 110 | |
| 25 | 25 | 18 | 15 | 150 | 510 | -20.87 | -1.18 | -7.28 | -14.28 | 110 | |
| 26 | 26 | 18 | 19 | 150 | 100 | 22.34 | 1.26 | 1.62 | 16.21 | 110 | |
| 27 | 27 | 19 | 20 | 75 | 250 | 1.41 | 0.32 | 0.71 | 2.86 | 110 | |
| 28 | 28 | 19 | 21 | 150 | 450 | 3.57 | 0.20 | 0.23 | 0.54 | 110 | |
| 29 | 29 | 21 | 22 | 150 | 900 | 1.66 | 0.09 | 0.12 | 0.13 | 110 | |
| 30 | 30 | 22 | 23 | 75 | 1700 | 0.15 | 0.03 | 0.08 | 0.05 | 110 | |

Output data on distribution network for Chagni: 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 | 250 | 530 | 43.63 | 0.89 | 2.46 | 4.65 | 110 | |
| 2 | 2 | 2 | 3 | 250 | 230 | 36.22 | 0.74 | 0.76 | 3.29 | 110 | |
| 3 | 3 | 3 | 4 | 150 | 340 | 14.24 | 0.81 | 2.39 | 7.04 | 110 | |
| 4 | 4 | 4 | 5 | 75 | 230 | -0.23 | -0.05 | -0.02 | -0.10 | 110 | |
| 5 | 5 | 5 | 2 | 75 | 340 | -2.65 | -0.60 | -3.13 | -9.20 | 110 | |
| 6 | 6 | 3 | 8 | 75 | 80 | 3.79 | 0.86 | 1.42 | 17.79 | 110 | |
| 7 | 7 | 8 | 9 | 75 | 410 | 1.77 | 0.40 | 1.78 | 4.34 | 110 | |
| 8 | 8 | 9 | 4 | 150 | 150 | -12.32 | -0.70 | -0.81 | -5.39 | 110 | |
| 9 | 9 | 4 | 6 | 75 | 340 | 1.58 | 0.36 | 1.20 | 3.53 | 110 | |
| 10 | 10 | 6 | 7 | 75 | 225 | -0.52 | -0.12 | -0.10 | -0.46 | 110 | |
| 11 | 11 | 7 | 5 | 75 | 340 | -1.52 | -0.34 | -1.12 | -3.29 | 110 | |
| 12 | 12 | 9 | 10 | 75 | 340 | 0.84 | 0.19 | 0.37 | 1.10 | 110 | |
| 13 | 13 | 10 | 6 | 75 | 150 | 0.25 | 0.06 | 0.02 | 0.12 | 110 | |
| 14 | 14 | 9 | 13 | 150 | 180 | 12.71 | 0.72 | 1.03 | 5.71 | 110 | |
| 15 | 15 | 13 | 12 | 150 | 900 | 2.84 | 0.16 | 0.32 | 0.36 | 110 | |
| 16 | 16 | 12 | 11 | 75 | 700 | 0.68 | 0.15 | 0.52 | 0.74 | 110 | |
| 17 | 17 | 11 | 6 | 75 | 580 | -1.32 | -0.30 | -1.47 | -2.54 | 110 | |
| 18 | 18 | 2 | 16 | 75 | 265 | 3.36 | 0.76 | 3.77 | 14.21 | 110 | |
| 19 | 19 | 16 | 15 | 75 | 235 | -0.93 | -0.21 | -0.31 | -1.32 | 110 | |
| 20 | 20 | 15 | 3 | 150 | 255 | -17.74 | -1.00 | -2.70 | -10.58 | 110 | |
| 21 | 21 | 15 | 14 | 75 | 80 | -1.09 | -0.25 | -0.14 | -1.78 | 110 | |
| 22 | 22 | 14 | 8 | 75 | 260 | -1.77 | -0.40 | -1.13 | -4.36 | 110 | |
| 23 | 23 | 16 | 17 | 75 | 395 | 2.85 | 0.64 | 4.14 | 10.47 | 110 | |
| 24 | 24 | 17 | 18 | 75 | 310 | 1.33 | 0.30 | 0.79 | 2.55 | 110 | |
| 25 | 25 | 18 | 15 | 150 | 510 | -17.45 | -0.99 | -5.24 | -10.27 | 110 | |
| 26 | 26 | 18 | 19 | 150 | 100 | 17.55 | 0.99 | 1.04 | 10.37 | 110 | |
| 27 | 27 | 19 | 20 | 75 | 250 | 2.26 | 0.51 | 1.71 | 6.84 | 110 | |
| 28 | 28 | 19 | 21 | 150 | 450 | 14.19 | 0.80 | 3.15 | 7.00 | 110 | |
| 29 | 29 | 21 | 22 | 150 | 900 | 11.13 | 0.63 | 4.02 | 4.47 | 110 | |
| 30 | 30 | 22 | 23 | 75 | 1700 | 0.24 | 0.05 | 0.18 | 0.11 | 110 | |

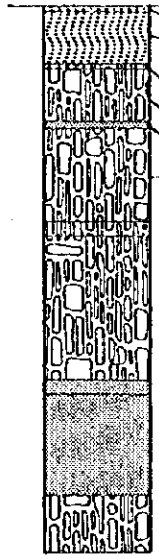
Output data on distribution network for Chagni Case: Fire Fighting, 2010

| 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 | 250 | 530 | 60.64 | 1.24 | 4.53 | 8.54 | 110 | |
| 2 | 2 | 2 | 3 | 250 | 230 | 51.51 | 1.05 | 1.45 | 6.32 | 110 | |
| 3 | 3 | 3 | 4 | 150 | 340 | 21.59 | 1.22 | 5.17 | 15.22 | 110 | |
| 4 | 4 | 4 | 5 | 75 | 230 | -1.19 | -0.27 | -0.48 | -2.08 | 110 | |
| 5 | 5 | 5 | 2 | 75 | 340 | -3.82 | -0.87 | -6.15 | -18.08 | 110 | |
| 6 | 6 | 3 | 8 | 75 | 80 | 5.34 | 1.21 | 2.68 | 33.55 | 110 | |
| 7 | 7 | 8 | 9 | 75 | 410 | 2.92 | 0.66 | 4.52 | 11.02 | 110 | |
| 8 | 8 | 9 | 4 | 150 | 150 | -20.25 | -1.15 | -2.03 | -13.51 | 110 | |
| 9 | 9 | 4 | 6 | 75 | 340 | 2.18 | 0.49 | 2.18 | 6.42 | 110 | |
| 10 | 10 | 6 | 7 | 75 | 225 | -1.45 | -0.33 | -0.68 | -3.02 | 110 | |
| 11 | 11 | 7 | 5 | 75 | 340 | -2.07 | -0.47 | -1.98 | -5.83 | 110 | |
| 12 | 12 | 9 | 10 | 75 | 340 | 0.51 | 0.12 | 0.15 | 0.44 | 110 | |
| 13 | 13 | 10 | 6 | 75 | 150 | 0.14 | 0.03 | 0.00 | 0.04 | 110 | |
| 14 | 14 | 9 | 13 | 150 | 180 | 22.33 | 1.26 | 2.91 | 16.19 | 110 | |
| 15 | 15 | 13 | 12 | 150 | 900 | 16.13 | 0.91 | 7.98 | 8.87 | 110 | |
| 16 | 16 | 12 | 11 | 75 | 700 | -1.89 | -0.43 | -3.44 | -4.92 | 110 | |
| 17 | 17 | 11 | 6 | 75 | 580 | -3.14 | -0.71 | -7.30 | -12.58 | 110 | |
| 18 | 18 | 2 | 16 | 75 | 265 | 4.44 | 1.00 | 6.32 | 23.84 | 110 | |
| 19 | 19 | 16 | 15 | 75 | 235 | -0.30 | -0.07 | -0.04 | -0.17 | 110 | |
| 20 | 20 | 15 | 3 | 150 | 255 | -24.30 | -1.37 | -4.83 | -18.93 | 110 | |
| 21 | 21 | 15 | 14 | 75 | 80 | -1.83 | -0.42 | -0.37 | -4.65 | 110 | |
| 22 | 22 | 14 | 8 | 75 | 260 | -2.25 | -0.51 | -1.77 | -6.81 | 110 | |
| 23 | 23 | 16 | 17 | 75 | 395 | 3.84 | 0.87 | 7.21 | 18.25 | 110 | |
| 24 | 24 | 17 | 18 | 75 | 310 | 2.89 | 0.65 | 3.35 | 10.79 | 110 | |
| 25 | 25 | 18 | 15 | 150 | 510 | -25.55 | -1.45 | -10.59 | -20.77 | 110 | |
| 26 | 26 | 18 | 19 | 150 | 100 | 27.67 | 1.57 | 2.41 | 24.08 | 110 | |
| 27 | 27 | 19 | 20 | 75 | 250 | 1.41 | 0.32 | 0.71 | 2.86 | 110 | |
| 28 | 28 | 19 | 21 | 150 | 450 | 8.90 | 0.50 | 1.33 | 2.95 | 110 | |
| 29 | 29 | 21 | 22 | 150 | 900 | 6.99 | 0.40 | 1.70 | 1.89 | 110 | |
| 30 | 30 | 22 | 23 | 75 | 1700 | 0.15 | 0.03 | 0.08 | 0.05 | 110 | |

# Appendix - 11

# Geological Logs of Existing Boreholes

WSS Borehole No.1 in Chagni

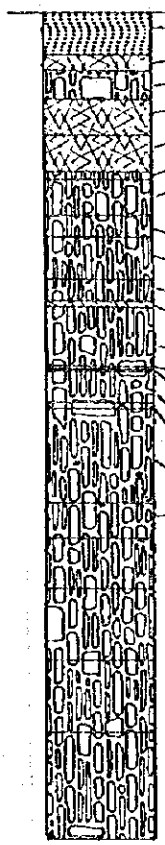


| Depth | Lithology |
|---|---|
| 0 - 1 m | Soil, reddish brown, with organic materials |
| 1 - 8 m | Soil, reddish brown, with weathered rock fragment |
| 8 -8.8 m | Weathered basalt, like rock fragment |
| 8.8- 16 m | Basalt, hard, with small vesicles |
| 16 - 17 m | Clay, brown, with weathered basalt |
| 17 - 30 m | Black basalt, with large fragment of silica and calcite |
| 30 - 32 m | Weathered vesicular basalt |
| 32 - 52 m | Fresh basalt, dark gray to black |
| 52 - 54 m | Clay, black, carbonaceous |
| 54 - 68 m | Clay, with sand and fragment |
| 68 - 76 m | Fresh vesicular basalt with silica filling |

Location : About 2 km east from the town

Source : from "REPORT ON PUMPING TEST OF CHAGNE BORE NO.1 (16-18 Jan.1984)"

Borehole No.4 in Chagni

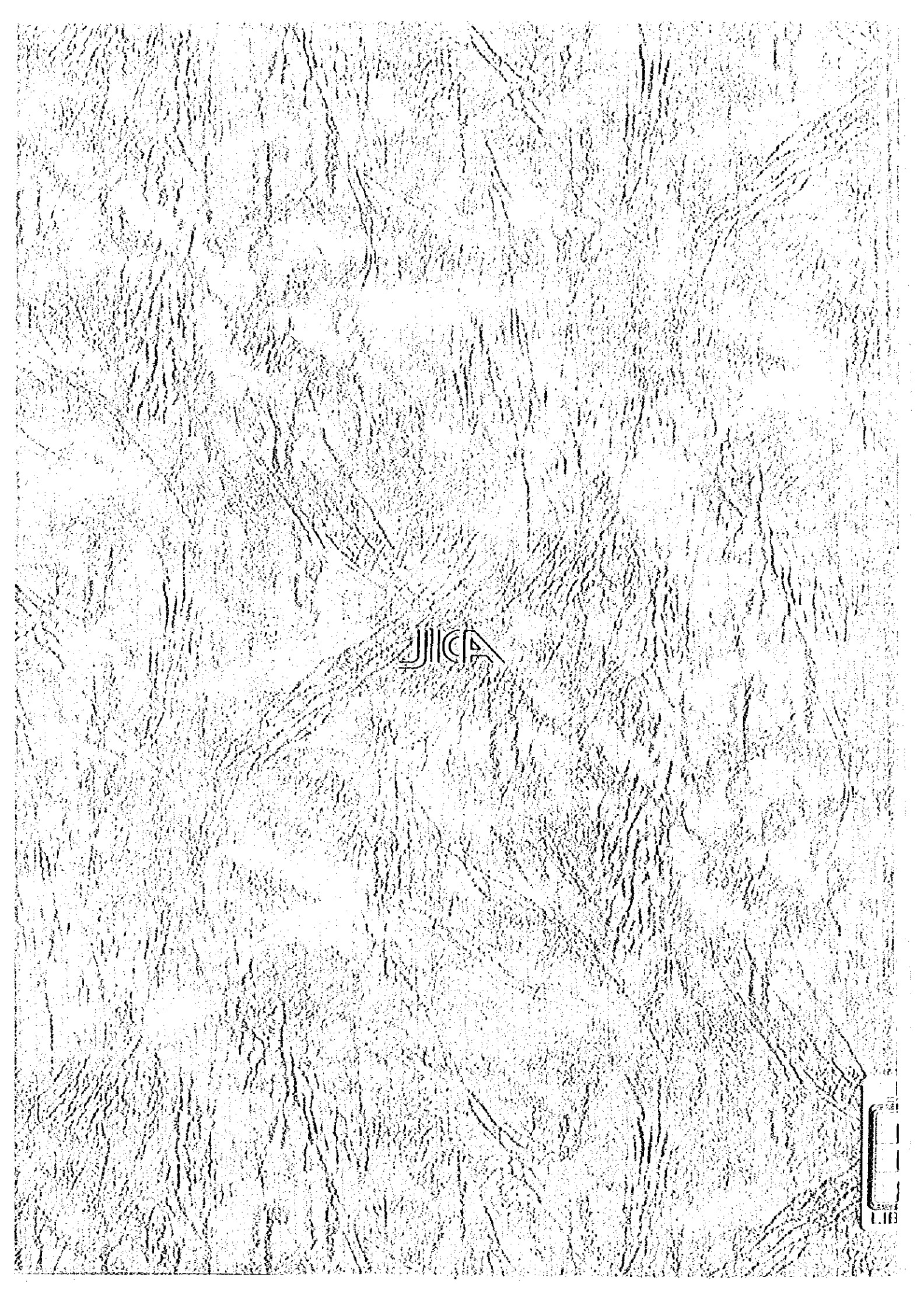


| Depth | Lithology |
|---|---|
| 0 - 6 m | Top soil, brown clay |
| 6 - 8 m | Highly weathered scoria |
| 8 - 12 m | Massive basalt |
| 12 - 17 m | Intensively weathered red scoria |
| 17 - 22 m | Moderately weathered scoria, sec. minerals |
| 22 - 23 m | Highly weathered scoriaceous basalt |
| 23 - 28 m | Vesicular basalt, with sec. minerals<br>amygdaloidal basalt |
| 28 - 31 m | Scoriaceous basalt, baking effect is observed |
| 31 - 37 m | Vesicular basalt, fresh, with sec. minerals |
| 37 - 40 m | Moderately weathered scoriaceous basalt |
| 40 - 41 m | Highly weathered scoria |
| 41 - 49 m | Slightly weathered vesicular basalt |
| 49 -49.3m | Black baked silty clay |
| 49.3-49.5m | Intensively weathered basalt |
| 49.5-54 m | Weathered basalt, with rich sec. minerals |
| 54 - 55 m | Slightly weathered vesicular basalt |
| 55 - 68 m | Fresh scoriaceous basalt |
| 68 - 73 m | Scoriaceous basalt |
| 73 - 80 m | Scoriaceous basalt, fractured,<br>with rich sec. minerals |
| 80 - 90 m | Fresh basalt, crackly |
| 90 -100 m | Slightly weathered basalt |
| 100-115 m | Fresh basalt |

Note : Water stroke: 1st at 23 m, 2nd at 50 m
3rd at 68 m

Location : About 1 km north from the town

Source : from "Chagni Well # 4" by EWWCA Region 3


JICA