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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

FEASIBILITY REPORT
WEROTA

(Volume II-IV)

FEBRUARY, 1996

SANYU CONSULTANTS INC.

KYOWA ENGINEERING CONSULTANTS CO., LTD.

GOVERNMENT OF JAPAN
JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)
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PREFACE

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

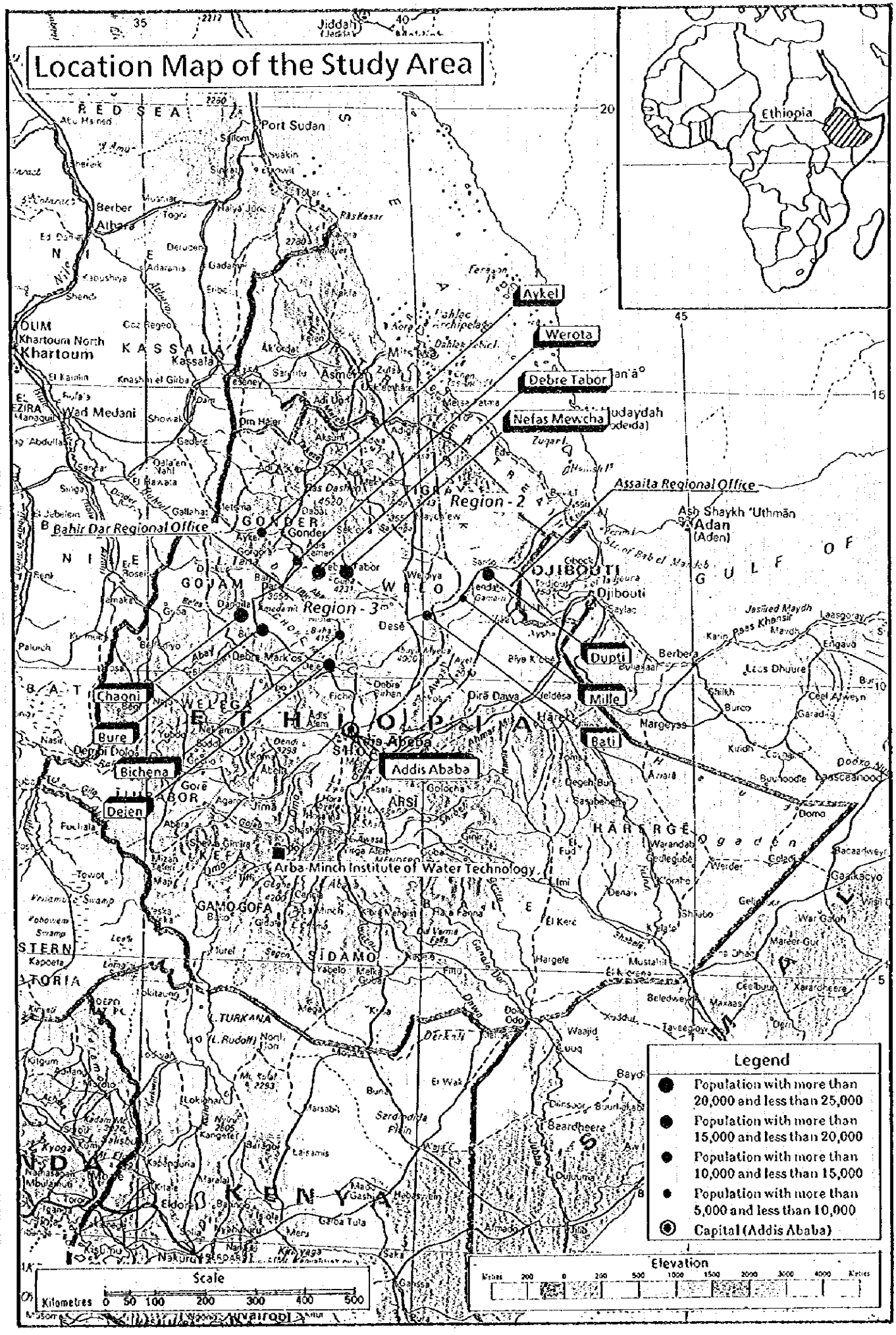
The major objectives of this Study are 1) to conduct a feasibility study on the water supply system in order to improve living condition of the population in the Study area by enhancing the level of the water supply services in terms of water quantity, water quality and its accessibility, 2) to formulate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

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

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

With the survey and the study, this report presents the formulation of the Project of the water supply system with the implementation program, improvement plan of sanitary facilities with the diffusion program, set-up and strengthening of organization, and strengthening of operation and management.

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.


Location Map of the Study Area
Ethiopia
Aykel
Werota
Debre Tabor
Nefas Mewcha
Assaita Regional Office
Bahir Dar Regional Office
Region - 2
Region - 3
Addis Ababa
Arba-Minch Institute of Water Technology
Dupti
Mille
Bati
Djibouti
Legend
Population with more than 20,000 and less than 25,000
Population with more than 15,000 and less than 20,000
Population with more than 10,000 and less than 15,000
Population with more than 5,000 and less than 10,000
Capital (Addis Ababa)
Scale
Kilometres 0 50 100 200 300 400 500
Elevation

General Description of Current Condition in Werota

Items	Description
Administration	Amhara Region, South Gonder, No. of Kebele : 2
Residents	Total population : 21,845 (34.1 persons/ha) Average family size : 6.3 persons Amhara : 97% Christians : 80% (2 churches) Tigre : 3% Moslems : 19% (2 mosques) Others : 1%
Educational Conditions	Kinder garden / Elementary school / Junior & Senior high s. No. of school: 1 / 2 / 1 No. of teachers: 2 / 101 / 62 No. of students: 81 / 2545 / 1191
Medical Conditions	Hospital : - Doctor : - Health center : - Nurse : 2 Health clinic : 1
Economic Conditions	Hotels/restaurants : 201 Shops : 520 Cottage industry : 79 Others : 12 Average monthly household income : 262 birr
Water Supply Condition	The source of WSS : Borehole (1) Major other sources : Hand dug well & spring Domestic consumption : 168.7 cum/day (8.0 lpcd) Other consumption : 48.9 cum/day (total 217.6) Water service coverage : 96% House connection : 28.6 lpcd (1%, 1.0 birr/cum) Yard connection : 39.1 lpcd (11%, 1.0 birr/cum) Neighbors : 8.8 lpcd (22%, 1.0(3.8) birr/cum) Public fountain : 1.5 lpcd (61%, 1.0(1.9) birr/cum)
Sanitary Condition	Septic toilet : 2/100HH Dry pit toilet : 54/100HH Community toilet : -/100HH Open field : 43/100HH Toilet condition : Ill-maintained and constructed. Most are being filled up and need to be emptied. Sullage disposal site : No allocated and vacuum track is required. Drainage facilities : No existed except along main road, poorly maintained.
People's Health Awareness and Needs	Group awareness : 75% Diarrhea awareness : 52% ORS awareness : 18% Sanitary behaviors score : 840/1600 (53%) Needs : Adequate Water, Improvement of Health
Remarks	1. Water charge in bracket is actually paid. 2. HH means "household". 3. ORS means Oral Rehydration Solution. 4. Faecal coliforms found in samples from connections and household containers.

Project Description of Werota

Items	Description
Project Title	Eleven Centers Water Supply and Sanitation
Executing Agency	Water Supply and Sewerage Service Department(WSSD)
Objectives	To supply domestic water which meets people's demand and to improve sanitary condition in the center.
Population Projected	in 1995 2000 2005 2010 21,845 (6.0%) 29,234 (5.5%) 38,208 (5.0%) 48,764
Water Demand Projected in cum/day	in 1995* 2000 2005 2010 Domestic : 169 642 1,032 1,697 Non Domestic : 49 151 221 317 Losses : 58 88 171 355 Total : 276 881 1,423 2,369
Dimensions of Water Supply System	Target Service Coverage: 100% (94% at present) Target Year of 2005 Deep Wells : 4 (316m) Rising Main : ϕ150 (3.52 km), ϕ100 (1.00 km) Booster of Rising : ϕ150mm,Q=0.76m^3/min,H=80m ϕ150mm,Q=0.43m^3/min,H=80m Reservoir : 480m^3(240×2) Distribution : ϕ300(445m),ϕ250(640m),ϕ200(430m), ϕ150(1,980m),ϕ75(4,178m), ϕ50(9,545m) Booster of Dist'n : ϕ300mm,Q=1.9m^3/min,H=20m Target Year of 2010 Deep Wells : 2 (188m) Rising Main : ϕ100(0.75km), ϕ75(0.35km)
Water Tariff Structure & Accounting System	Introduction of Progressive Water Tariff** HC: 3.01 birr/m^3,YC: 2.25 birr/m^3,PF: 1.04 birr/m^3 Introduction of Double Accounting System
Plan of Sanitary Facilities Improvement	Construction of 4 public toilets and facilitation of other type toilets. Provision of toilet emptying system. Maintenance of main drainage and construction of supplemental drainages. Facilitation of waste water disposal pit and dry solid waste disposal system.
Plan of Sanitary Education and Implementation Program	Utilization of sanitary education manual and video. Application of sanitary education priorities(see report). Set-up of Sanitary/Health Committee. Assignment of Community Participation Promoter.
Organization Set-up	Strengthening of Planning & Project Department of MWR and relationship among central, regional and town. WSS to be composed of Administration, Financial, Technical and Sanitary Service, and manpower to be 47 in 2005 and 58 in 2010.
Remarks	* Actual Consumption ** Water Tariff for industry and institution is same as HCs'.

Composition of the Report

Report
- Executive Summary
- Main Report (Volume I)
- Feasibility Report (Volume II-I to II-XI)
- Appendixes (Volume III-I to III-XI)

Others
- Operation and Maintenance Manual
- Sanitary Education Manual
- Sanitary Education Video (titled Simple Steps... for Better Health)

Table of Contents

Preface
Location Map of the Study Area
General Description of Current Condition
Project Discription
Table of Contents
Abbreviations and Glossaries
List of Tables
List of Figures

Chapter 1 Introduction ..... 1 - 1

Chapter 2 Natural Condition ..... 2 - 1
2.1 Meteorology and Hydrology ..... 2 - 1
2.2 Hydrogeology ..... 2 - 4

Chapter 3 Present Social, Water Supply and Sanitary Condition ..... 3 - 1
3.1 Result of Water Quality Analysis ..... 3 - 1
3.2 Current Water Consumption and Demand ..... 3 - 4
3.3 Water Supply Facilities Condition ..... 3 - 7
3.4 Sanitary Facilities Condition ..... 3 - 10
3.5 Organization and Management ..... 3 - 12
3.6 Financial Condition of WSS ..... 3 - 13
3.7 Social Background and Peoples' Awareness ..... 3 - 14
3.8 Socio-economy ..... 3 - 18
3.9 Town Planning and Development ..... 3 - 20

Chapter 4 Plan of Water Supply System ..... 4 - 1
4.1 Water Demand Projection ..... 4 - 1
4.2 Water Resources Development ..... 4 - 5
4.3 Plan of Water Supply System ..... 4 - 8
4.4 Implementation Schedule and Cost Estimation ..... 4 - 10
4.5 Financial Analysis ..... 4 - 12

Chapter 5 Improvement of Health and Sanitation ..... 5 - 1
5.1 Plan of Sanitary Facilities ..... 5 - 1
5.2 Financial Plan for Sanitary Facilities ..... 5 - 4
5.3 Application of Sanitary Education Programme ..... 5 - 9

Chapter 6 Reinforcement of Organization ..... 6 - 1
6.1 Comprehensive Organization and Management ..... 6 - 1
6.2 Organization and Management of Water Supply Service ..... 6 - 1
6.3 Organization and Management of Sanitation ..... 6 - 2
6.4 Community Building/Participation and WID ..... 6 - 6

Chapter 7 Project Evaluation ..... 7 - 1
7.1 Economic Evaluation ..... 7 - 1
7.2 Financial Evaluation ..... 7 - 5
7.3 Organizational Evaluation ..... 7 - 7
7.4 Technological Evaluation ..... 7 - 8
7.5 Environmental Impact Assessment ..... 7 - 9
7.6 Indirect Benefit Evaluation ..... 7 - 11

Chapter 8 Conclusion and Recommendation ..... 8 - 1
8.1 Conclusion ..... 8 - 1
8.2 Recommendation ..... 8 - 2

ABBREVIATIONS

[ORGANIZATION]

AfDB or ADB	- African Development Bank
AfDF or ADF	- African Development Fund
AWTI	- Arba-Minch Water Technology Institute
CIDA	- Canadian International Development Agency
CPPS	- Community Participation Promotion Services
CSA	- Central Statistical Authority
EELPA	- Ethiopian Electric Light and Power Authority
EIGS	- Ethiopian Institute for Geological Survey
EMA	- Ethiopian Mapping Authority
EPD	- Environmental Protection Department
GOE or TGE	- Transitional Government of Ethiopia
GOJ	- Government of Japan
IBRD	- International Bank for Reconstruction Development (The World Bank)
JICA	- Japan International Cooperation Agency
KFW	- Kreditanstalt fur Wiederaufbau
MEDP	- Ministry of Economic Development Planning
MEEC	- Ministry of External Economic Cooperation
MNRDEP	- Ministry of Natural Resources Development and Environmental Protection
MOA	- Ministry of Agriculture
MOH	- Ministry of Health
MPI	- Master Plan Institute
MPWUDH	- Ministry of Public Works and Urban Development and Housing
MWR	- Ministry of Water Resources
NMA	- National Meteorological Authority
NMSA	- National Meteorological Service Agency
NGO	- Non-Governmental Organization
NRDPEPB	- Natural Resources Development & Environmental Protection Bureau
PWUDB	- Public Works and Urban Development Bureau
REA	- Regional Education Authority
REWA	- Revolutional Ethiopian Women Association
RRC	- Relief and Rehabilitation Commission
UN	- United Nations
UNDP	- United Nations Development Program
UNICEF	- United Nations Children's Fund
TADE	- Tendaho Agricultural Development Enterprise
WAB	- Women's Affairs Bureau
WHO	- World Health Organization
WRDA	- Water Resources Development Authority
WSS	- Water Supply Service
WSSA	- Water Supply and Sewerage Agency
WSSD	- Water Supply and Sewerage Service Department (former WSSA)
WWCE	- Water Works Construction Enterprise
WWDE	- Water Well Drilling Enterprise

[OTHERS]

BOP	- Balance of Payment
CPP	- Community Participation Promoters
DCI	- Ductile Cast Iron
Dia	- Diameter
DWL	- Dynamic Water Level
EB	- Ethiopian Birr (Birr or birr)
E.C.	- Ethiopian Calender
ERRP	- Ethiopian Relief and Rehabilitation Programme
EIA	- Environmental Impact Assessment
EIRR	- Economic Internal Rate of Return
FIRR	- Financial Internal Rate of Return
FRP	- Fiberglass Reinforced Plastic
GDP	- Gross Domestic Product
GNP	- Gross National Product
GS	- Galvanized Steel
HC	- Household Connection
IEE	- Initial Environmental Examination
lpcd	- liters per capita per day
l/s	- liters per second
m.asl	- meters above mean sea level
mg/l	- milligram per liter
ND or DN	- nominal diameter
NP or PN	- nominal pressure
O & M	- Operation and Maintenance
pa	- per annum
PC	- Private Connection
PF or P.F.	- Public Fountain
pm	- per month
PCM	- Project Cycle Management
PDM	- Project Design Matrix
PVC	- polyvinyl chloride
SWL	- Static Water Level
TB	- Tuberculosis
TOR	- Terms of Reference
USD	- United States Dollar
VES	- Vertical Electric Sounding
WID	- Women in Development
YC	- Yard Connection

Exchange Rate

1 US Dollar = 6.3 Birr

1 US Dollar = 94.5 Yen

1 Birr = 15.0 Yen

GLOSSARY

Belg	- Short & moderate rain in spring, autumn or winter
Birr, Br	- Ethiopian currency unit
Debo	- Small association in rural area to work collectively in farm
Eder	- Community organization for social occasions & social problems
Kebele	- Smallest unit of administration
Keremt	- long & heavy rain in summer
Kilil	- Region (a group of zones)
Shet	- Stream
Wenz	- River
Woreda	- An administrative sub-district (also referred to as Wereda)
Zone	- A group of Weredas

Note: There is, as yet, no standardized spelling of Ethiopian words written in Roman Letters and based on English phonetics. Consequently, different spellings of the same word may be encountered in the report, particularly on the EMA maps.

List of Tables

Table 2.1.1	Long Term Monthly Mean Values of Precipitation, Potential Evapotranspiration and Air Temperature
Table 2.1.2	Water Balance Sheet of the Groundwater Recharge Area
Table 3.1.1	Result of Faecal Coliform Test Before/After Disinfection
Table 3.2.1	Water Production and Consumption in Werota
Table 3.2.2	Water Consumption and Demand
Table 3.3.1	Existing Pipeline Data
Table 3.4.1	Distribution of Housing Units by Type of Toilet Facility in Werota
Table 3.5.1	Number of Personnel and Positions/Functions
Table 4.1.1	Population of Werota
Table 4.1.2	Population Forecast by Service Modes
Table 4.1.3	Domestic Water Demand by Mode
Table 4.1.4	Non Domestic Water Demand in 1995
Table 4.1.5	Total Non Domestic Water Demand in Target Years
Table 4.1.6	Total Water Demand in Target Years
Table 4.1.7	Maximum Day Demand & Peak Day Demand
Table 4.2.1	Characteristics of Aquifers
Table 4.2.2	Optimal Yields and Water Levels of the Wells
Table 4.2.3	Dimensions of Wells
Table 4.3.1	Distribution Pipelines
Table 4.4.1	Total Project Cost of Water Supply in Thousand Birr
Table 4.4.2	Total Project Cost of Sanitary Facilities in Thousand Birr
Table 4.5.1	Water Price and Ratio of Water Payment to Income
Table 4.5.2	Planning of Revenues
Table 4.5.3	Financial Statement
Table 5.1.1	Water Demand in lpcd and Waste Water Production in lpcd
Table 5.1.2	Proposed Sanitation Systems in Relation to Types of Water Supply Services for Domestic Households
Table 5.1.3	Proposed Sanitation Technologies for Communities and Non Domestic Households
Table 5.2.1	Households in Werota for Target Years of 2005 & 2010 by Type of Water Services
Table 5.2.2	Indicative Cost of a Type of Sanitary Facility or Equipment
Table 5.2.3	Annual Operating and Maintenance Cost per Unit
Table 5.2.4	Capital Costs of Sanitary Facilities for Werota for the Year 2005
Table 5.2.5	Capital Costs of Sanitary Facilities for Werota for the Year 2010
Table 5.2.6	Annual Operating & Maintenance Costs for the Year 2005
Table 5.2.7	Annual Operating & Maintenance Costs by the Year 2010

Table 5.3.1 Sanitary Education Priorities in Werota
Table 6.1.1 Personnel Requirements
Table 7.1.1 Saved Time and Benefit
Table 7.1.2 Cost Benefit Streams
Table 7.2.1 Cost Benefit Streams

List of Figures

Figure 2.1.1	Locations of Meteorological, Hydrological Stations and Watershed
Figure 3.3.1	Schematic Layout of Existing Facilities
Figure 3.7.1	Income Related to Gender of Household Head
Figure 3.7.2	Indicator Sanitary Behaviors
Figure 3.9.1	Plan of Town Development
Figure 6.1.1	Proposed Model Organization Set-up of WSS

Chapter 1 Introduction

1.1 Background

Most of the Ethiopian population do not have adequate and safe access to potable water supplies or sanitation facilities, leaving people vulnerable to water-borne and sanitation-related infectious diseases.

In 1994, only 26 % of the total population and 18 % of the rural population were estimated to have access to potable water. Consequently, the majority of the population is exposed to polluted water and thus to water-borne diseases. It is also estimated that less than 12 % of the total population uses latrines. An estimated 1 % only of the rural population have access to adequate refuse disposal systems.

Surveys of morbidity patterns and levels have pointed the consequence to the effects of poor water supply and hygiene practice, and unsanitary excreta disposal. Addressing health problems through water supply and sanitation activities is evident.

In Werota, water service coverage is 96 %, however the water consumption per capita per day is extremely low with the amount of 8.0 lpcd in average. Although water quality of the source is acceptable with reference to WHO drinking water guideline in terms of physico-chemical aspects, many faecal coliforms have been detected in samples collected from connections and household containers. This means the contamination is expected in such ways of through cross-connections, leaking and back-siphonage associated with aged facilities.

Toilet coverage is 56 %, and those toilets are mostly ill-maintained and poorly designed/constructed in terms of ventilation and emptying, thus the majority of the population dispose off their body waste in open field. Also, sullage disposal sites are not prepared, making difficult to dispose of emptied ones. Drainage facilities are not well constructed except ones along main road, constructed by road authority. And, even the drainage along main road is not well maintained, accompanying blockade by garbage or refuse disposal.

In view of the above situation, the Government of Ethiopia (GOE) put priority on the Eleven Centers Water Supply and Sanitation among 230 rural centers listed in the National Development Plan (ERRP 1993-95). Werota is the one, located in Amhara Region, among the Eleven Centers along with Dupti, Mille, Bati, Nefas Mewcha, Debre Tabor, Aykel, Chagni, Bure, Bichena and Dejen as shown on the attached Location Map.

1.2 Overall Progress of the Study

The Team arrived in Ethiopia on January 5, 1995 and submitted the Inception Report to Water Supply and Sewerage Service Department (WSSD). Both parties had discussed and confirmed the plan of approach, plan of operation, schedule of the Study, undertakings of the both parties and other related matters. Following the confirmation, the Team immediately commenced the Phase I survey/study.

The Team had collected and reviewed the existing data and information related to the Study. After reviewing the data and information gathered, reconnaissance survey covering all Eleven Centers had been carried out throughout the month of January by the Team members and their counterparts. The survey was conducted to recognize the overall situation of the centers, give common understandings among the members, and identify the centers to be studied in Phase I and Phase II respectively. Werota was selected for the detailed survey during Phase I. The survey items and major activities are described below:

Meteorological and hydrological survey had been conducted through the aerial photographs, topographical maps, related rainfall/river discharge data collected, and further field observation in order to understand the drainage and recharge systems of the Study area.

For the geological part, geo-electric prospecting (GEP) survey had been conducted to identify the hydrogeological condition to be required for designing water supply systems. The 15 points at each center had been prospected with a maximum depth of 150 meters.

Water quality of the existing water sources and surface water had been examined in terms of physico-chemical characteristics. The analysis items and procedure were made in accordance with WHO drinking water quality guidelines. Also water samples had been undertaken for bacteriological tests, which were collected from the water sources, public fountains, private connections and household containers in order to identify the place of contamination.

Topographic survey had been made along the existing water supply transmission lines and distribution lines through the reservoirs. Also, proposed water supply distribution lines, which start at prospective water source(s) identified by GEP, had been surveyed.

Survey on water use condition had been conducted by filling-out questionnaire form(s) at 100 households as well as schools, institutions, industries, hotels and restaurants in each center. A census for water consumption had also been carried out in all areas being supplied with piped water. These surveys have clarified the water supply quantity and service rate as well as people's demand for water both in quantitative and qualitative aspects.

Survey of sanitary and health condition had been also carried out together with the above water use condition survey. Interviews had been conducted at the above 100 households, and sanitary facilities such as the type of toilet, condition of facility and utilization, treatment of dejecta/excretion and situation of solid wastes disposal had been observed.

Survey of social background aims at minimizing the possible negative effects which may be expected on the society and the people. The survey had been carried out by the same 100-household-interviews, questioning key informants such as Wereda, Kebele, school teachers, health workers and other community leaders, and meetings with various focused groups.

Socio-economic survey had been conducted with 100-household-interviews as well as questioning key organizations and institutions. This survey clarifies household level economy and financial condition of those organizations/institutions, contributing to introduction of affordable water tariff system and sound account of WSS.

Initial environmental examination (IEE) had been carried out on all Eleven Centers during reconnaissance and Phase I surveys. As a result of IEE conducted in Phase I, detailed environmental survey had been carried out during Phase II survey in accordance with the terms of reference made on IEE. Based on the result of IEE and the detailed environmental survey, environmental impact assessment (EIA) for each center had been made in parallel with the project formulation.

Besides the surveys mentioned above, construction of experimental toilet (community type) and experimental sanitary education practice have been carried out in Bati. Also, a sanitary education video titled "Simple Steps.....for Better Health" was firstly produced in this water & health sector of Ethiopia with different languages as Amharic, Afar and English.

With the completion of those surveys mentioned above, comprehensive evaluation and understanding of problems had been made based on the present situation. Then, concept and basic strategy of the Project had been formulated at the end of field survey in Phase II, and presented in the Interim Report.

After returning to Japan, the Team started Home Work in Japan to finalize the project formulation based on the concept mentioned in the Interim Report and agreed by WSSD through discussions. Those outcomes are presented in this report together with operation and maintenance manual and sanitary education manual.

Chapter 2 Natural Condition

2.1 Meteorology and Hydrology

Werota is located in the east of Lake Tana, on the Bahr Dar - Gondar road. The town is on a low hill surrounded by flood plain of Fogera.

Werota has a meteorological station in the town but the gauging station is on Rib river about 10 kms away from the town. In the south of the town there is Erza river and in the north there is Tishikena stream. These rivers do not have flow except the rainy season "Keremt" and disappear at the north west of the town in the plain (See Figure 2.1.1 for the locations and the watersheds around Werota).

Table 2.1.1 shows the long term monthly mean values of precipitation, potential evapotranspiration and air temperature obtained from NMSA.

Table 2.1.1 Long Term Monthly Mean Values of Precipitation, Potential Evapotranspiration and Air Temperature

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P(mm)	0.2	0.9	3	15.8	65.7	181.5	386.5	3.95	164.5	47.4	8.2	1.3	1,270.5
ETo(mm)	128	128	128	127	128	128	131	131	129	128	126	127	1,538
A.Temp.(°C)	18.7	19.8	21.1	21.0	20.7	19.6	17.1	17.1	17.9	18.4	18.4	18.1	19.1

Remark: * = Data of Bahir Dar

The distribution of the monthly precipitation throughout a year shows a very low record of 0.2 mm in January and a higher records of 386.5 mm and 395.5 mm in July and August.

Since the record of monthly potential evapotranspiration is not available with NMSA, the data of Bahir Dar is listed in the table. The monthly potential evapotranspiration does not vary very much. It is ranging from 127 mm in April and December to 131 mm in August.

The monthly mean air temperature has small variation throughout a year. It ranges from 17.1°C in July and August to 21.1°C in March.

The proposed sites for new wells are located along Erza river and Tishikena stream.

In order to assess the ground water recharge of the watershed areas, water balance sheet is prepared by assuming the runoff to be 40% of the precipitation and the reference crop evapotranspiration to be 70% of the potential evapotranspiration.

Table 2.1.2 Water Balance Sheet of the Ground Water Recharge Area, Werota

Unit : mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	0.2	0.9	3	15.8	65.7	181.5	386.5	395.5	164.5	47.4	8.2	1.3	1,270.5
Q	0.1	0.4	1.2	6.3	26.3	72.6	154.6	158.2	65.8	19.0	3.3	0.5	508.2
P-Q	0.1	0.5	1.8	9.5	39.4	108.9	231.9	237.3	98.7	18.4	4.9	0.8	761.8
ETo	128	128	128	127	128	128	130	131	129	128	126	127	1,538
ETcrop	89.6	89.6	89.6	88.9	89.6	89.6	91.0	91.7	90.3	89.6	88.2	88.9	1,076.6
ETa	0.1	0.5	1.8	9.5	39.4	89.6	91.0	91.7	90.3	28.7	4.9	0.8	448.3
ΔS	0	0	0	0	0	19.3	140.9	145.6	8.4	0	0	0	314.2

Note: P = Precipitation
Q = Runoff
ETo = Potential Evapotranspiration
ETcrop = Reference Crop Evapotranspiration
ETa = Actual Evapotranspiration
ΔS = Recharge

The ground water recharge takes place from June to September in an average year. The recharge is calculated for the watersheds of Erza river and Tishikena stream assuming the whole areas are the groundwater recharge areas;

Erza river (A = 34.88 km^2)

$0.3142 \times 34.88 \times 10^6 = 10.96 \times 10^6$ m^3/year

Tishikena stream (A = 10.63 km^2)

$0.3142 \times 10.63 \times 10^6 = 3.34 \times 10^6$ m^3/year

These are equivalent to 30,025 m^3/day and 9,150 m^3/day.

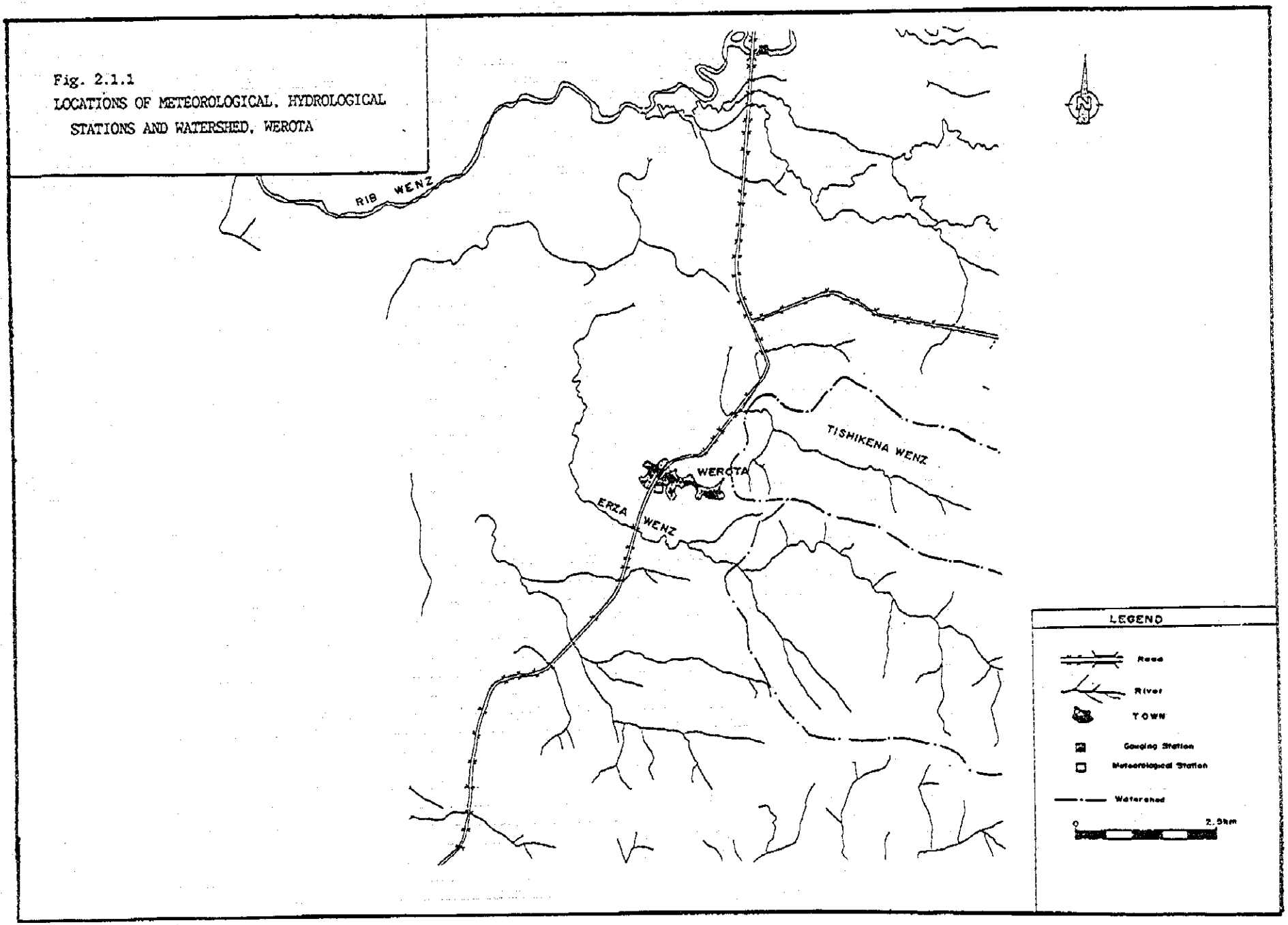


Fig. 2.1.1
LOCATIONS OF METEOROLOGICAL, HYDROLOGICAL STATIONS AND WATERSHED, WEROTA

2.2 Hydrogeology

2.2.1 Geology

Werota is located in the eastern edge of Lake Tana basin. The town is underlain by a thin ridge in the foot area of the mountains trending westward from Mt.Guna to Fogera Plain which is sometimes inundated during floods spread extensively in all sides of the town except the east side. This area is dominated by basalt of Ashangi group of the Tertiary period. Megascopically, on the top and hillsides of the thin ridge, this basalt is aphanitic, compact, hard and not vesicular. In some cases, this is characterized by the prevalence of the columnar joints as being observable on the escarpment 1 km southeast from the town along the Irza River. The weathered parts of this rock and overburden clay are reddish in color. Alluvial deposit mainly composed of dark clay and basalt boulders, which is mentioned as a lacustrine deposit in the geological Map of Ethiopia by V.Kazwin(1972), predominates in the plain area. The basalt at the foot of the hill which is highly weathered probably extends in the plain area being unconformably overlain by the alluvial deposits.

2.2.2 Hydrogeology

(1) Groundwater

In Werota town, there is only one borehole which is located at the north end of the town, that is, in the east edge of Fogera Plain. It was drilled by EWWCA in 1979. The depth of the borehole is 53.3 m and the safe yield is 5 l/s. According to the geological log of the borehole, the top 12 m is clayey sediment and the underlying layer is highly weathered and fissured or faulted basalt of 40 m thickness, which is recorded as gravelly and sandy layers with soil. The hard and fresh basalt appears at about 53 m depth. In the drilling report, it is described that ground water was struck at 20-30 m and 40-50 m depth, so the weathered and fissured basalt makes an economical aquifer in this area.

Hand dug wells are located at the foot sides of the ridge in the northwest end and south end of the town. People get water from these wells but they dry up during the dry season.

(2) Other Water Source

There is no spring in this area. People call the hand dug well as a spring.

All of the drainages in this area are intermittent. The Tishikena River flows in the north side of the town and seeps in the plain near the national road Route 3 (Bahir Dar - Gondar). The Irza River which is main drainage in this area drains westward in the south side of the town and turns to north at the west end of the town. Even the Irza River seeps in the plain at the east of Shaga Village. These rivers have negligible water perennially except during Keremt (in rainy season).

From the view of the stable supply of potable water, therefore, both spring water and surface water are against the object of this study.

Chapter 3 Present Social, Water Supply and Sanitation Condition

3.1 Result of Water Quality Analysis

Water quality analysis has been made in both physico-chemical and bacteriological aspects, using calorimetric, volumetric analysis and filtration technique methods respectively. In the operational procedure and application of guideline value, "WHO Guidelines for Drinking-Water Quality 1993" has been referred to. The results are shown in Appendix-2 "Result of Water Quality Test" of Appendixes (Volume III).

3.1.1 Physico-chemical aspects

Four (4) samples have been undertaken for physico-chemical test, among which two (2) samples were collected from the Borehole No.1 (the WSS source) on different date, one (1) from hand-dug-well and the last from Awragedel spring. The major source in Werota is Borehole No.1, and few hand-dug-wells are also used for drinking at present. The spring is located about one (1) km south away from the center of the town, and is used by mainly rural people.

The analyzed chemical constituents for the borehole and hand-dug-well are found within the acceptable range according to WHO drinking water guideline values except color and turbidity detected in one of samples of the Borehole. The cause of the observed color and turbidity is probably associated with runoff surface water from the surrounding area of the borehole.

The result of Awragedel spring shows that color, turbidity and nitrate concentrations are above the guideline values. WHO guideline recommends the nitrate value of 50 mg/l, and the sampled water shows 61.16 mg/l. Since the spring is located nearby farm land with lower elevation, it is expected that the spring is easily contaminated with fertilizer and/or sewage coming from Werota residential area. When nitrate presents in excessive amounts in water, it indicates that the pollution occurred could not have been recent since nitrate is the final oxidation product of the element nitrogen which is present in fertilizer and sewage. Excessive amount of nitrate in drinking water causes methaemoglobinaemia in bottle-fed infants in most cases and occasionally in some adults. Although no such report is heard at present, it is recommended that the spring be abandoned and alternate water source be introduced for the rural people. Also, new water outlet such as public fountain is required for the Werota residents relying on the spring.

3.1.2 Bacteriological Aspects

First, 31 samples from different sampling places with the source being Borehole No.1 had been undertaken for faecal coliform test dated June 18 and 19, 1995. The result indicates that all samples are contaminated with faecal coliforms. Specially, samples taken from household clay pot showed much contamination with too-many-to-count faecal coliforms. Although the borehole could not be tested on the dates, yard connection in a school nearby the source and to which water is directly supplied, showed 12 number of faecal coliforms per 100 ml. However, Second coliform test dated June 30 1995, in which 10 samples were undertaken showed little contamination quite different from the first result, and after the

chlorination carried out into the borehole and the reservoir, all tested samples became free from faecal coliform. This suggests that only an occasional sampling is not enough and consecutive samplings and testings are required in order to determine the extent of contamination. Also, occasional disinfection of the reservoir is at least recommended in order to make the water safe for drinking purpose.

To facilitate the household level sanitary improvement, bleaching agent (the available chlorine content is 4 to 6%) had been tried for the chlorination of the household clay pot with different dosages. The procedure is described below:

On July 3, 1995, 15 number of clay pots were washed by using the water from public fountain No.4, and then the pots were filled with the water. At the same time, the water collected directly from the public fountain No.4 was undertaken for coliform test, and showed 13 number of faecal coliforms per 100ml. The public fountain is located in a community in which experimental toilet was constructed by the Team.

About two (2) hours after the pots were filled with the water showing 13 number of faecal coliforms per 100 ml, those waters stored in the 15 number of clay pots had been undertaken for the faecal coliform test. The results are summarized below, and shows all clay pots were fairly to severely contaminated with the faecal coliform.

After collecting the samples from the 15 number of clay pots, bleaching agent was put in the clay pots with different dosages between 10 and 50 ppm. Then, the clay pots had been kept in the households for one (1) day.

On the following day of July 4, 1995, the waters containing the bleaching agent were thrown out, and those clay pots were washed and then filled with the water from the same public fountain No.4. At the same time, the water was collected directly from the public fountain for the purpose of faecal coliform test. The water from the fountain showed 54 number of faecal coliforms per 100 ml sample.

About two (2) hours after the pots were filled with the water, which showed 54 number of faecal coliforms, those waters in the pots had been tested for faecal coliform.

Although the result came out with faecal contamination as shown below because the water stored in the clay pots was not free from faecal coliform, it is notified that the number of faecal coliforms detected in the waters stored in the clay pots after the disinfection were more than that of the water from the public fountain No.4 with two (2) exceptions. This suggests that the bleaching agent is not enough to disinfect the coliforms inhabiting the clay pots, though clay pots which had shown too-many-to-count faecal coliforms before the disinfection became to be countable for the coliform with the effect of the bleaching agent.

Additional faecal coliform test for the same clay pots above was carried out dated August 5 1995, which is about one (1) month later since the bleaching agent test aforementioned. Because two (2) clay pots were damaged during the one (1) month between the last two (2)

tests, 13 pots out of the 15 pots were undertaken for the faecal coliform test. The water stored in the clay pots was fetched from the neighboring private connections one (1) day before the test date in most cases, and two (2) samples from those private connections were tested for faecal coliform. The two (2) samples showed no faecal coliform, however the 13 clay pots showed contamination with too-many-to-count faecal coliforms per 100 ml except two (2) samples numbered 9 and 14, those of which showed 21 and 41 number of faecal coliform. Based on this result, it can be said that faecal coliform could develop easily from countable level to uncountable level (represented by too-many-to-count coliform) in clay pot within a short period.

Table 3.1.1 Result of Faecal Coliform Test Before/After Disinfection

No.	Kebele	Source	Place of Sampling	No of F.C. per 100ml	Remarks
Before/after disinfection by using bleaching agent					
1	1	BH1	P.Foun.4	13/54	WT=26/24-C, Not disinfected
2	1	P.Foun.4	Clay pot	57/85	WT=26/25-C, 10ppm
3	1	P.Foun.4	Clay pot	TMTC/103	WT=28/24-C, 10ppm
4	1	P.Foun.4	Clay pot	TMTC/123	WT=25/23-C, 10ppm
5	1	P.Foun.4	Clay pot	30/85	WT=27/26-C, 20ppm
6	1	P.Foun.4	Clay pot	TMTC/2	WT=26/24-C, 20ppm
7	1	P.Foun.4	Clay pot	12/83	WT=26/24-C, 20ppm
8	1		Clay pot	31/148	WT=26/25-C, 30ppm
9	1	P.Foun.4	Clay pot	18/97	WT=26/24-C, 30ppm
10	1	P.Foun.4	Clay pot	20/74	WT=26/ --C, 30ppm
11	1	P.Foun.4	Clay pot	27/0	WT=26/24-C, 40ppm
12	1	P.Foun.4	Clay pot	58/107	WT=25/23-C, 40ppm
13	1	P.Foun.4	Clay pot	84/119	WT=26/24-C, 40ppm
14	1	P.Foun.4	Clay pot	TMTC/108	WT=27/ --C, 50ppm
15	1	P.Foun.4	Clay pot	TMTC/124	WT=25/24-C, 50ppm
16	1	P.Foun.4	Clay pot	TMTC/93	WT=26/26-C, 50ppm
The former figure shows the number of Faecal Coliform before disinfection and the latter after disinfection by bleaching agent.					
The water in the clay pots above was fetched at P.Foun.4. The public fountain showed 13 and 54 number of Faecal Coliform on the days.					

Note: "F.C. means Faecal Coliform.
"BH" means borehole.
"P.Foun." means public fountain.
"TMTC" means too many to count.

3.2 Current Water Consumption and Demand

3.2.1 Current Water production and Consumption

The data of the production and the billed consumption for past 2 years were given by the staff and summarized in Table 3.2.1. According to the consumption data, monthly consumption rate decreases in rainy season. Total consumption and production for past two years are given below.

Production	121,240 m^3
Consumption	95,068 m^3
Losses	about 21 %

3.2.2 Current Water Consumption and Demand

According to the water consumption census conducted by the Team, it was found that the total population served by the water supply was about 22,000. Domestic, institutional, commercial and industrial consumption were estimated from the consumption records of Jan. 1995 and the census data. The domestic consumption was subdivided into the ones of house connection, yard connection, public fountains and those who bought or borrowed water from neighbors (vendors). Table 3.2.2 shows the results of the data processing.

Table 3.2.2 Water Consumption and Demand

Categories	No. of Customers	Population served		Day Consumption		Day Demand	
		Population	(%)	(m^3)	(LPCD)	(m^3)	(LPCD)
Domestic	4448	21014	(100)	168.7	(8.0)	560.1	(13.4)
House Connection	29	314	(1.5)	9.0	(28.6)	10.3	(32.9)
Yard Connection	327	2478	(11.8)	96.8	(39.1)	96.8	(39.1)
Public Fountain	2884	13407	(63.8)	20.3	(1.5)	319.1	(23.8)
Neighbors	1208	4815	(22.9)	42.6	(8.8)	133.9	(27.8)
Institutional	15			9.3			
Commercial	866			33.0			
Industrial	49			6.6			
Total	5378			217.6			

There were 33 customers with house connections. The major consumers are hotels (lodgings), restaurants, a garage and a blocket maker. There are 4 institutional customers namely the secondary school, WSS, the grain enterprise office and the district administration office.

There were 338 customers with yard connections. Almost all were private customers, and many of them used water for their business and sold water to their neighbors.

There were 93 commercial customers who used water for their businesses as well as domestic purposes. They are hotels (lodgings), breweries (tella houses), shops, tea rooms, etc. Their commercial consumption was estimated at 18.6 m^3 in Jan. 1995. There were 10 institutional customers including churches, mosques, army camp, offices and an

elementary school. Their consumption is summed to 5.2 m^3/day. There were 6 industrial customers including under construction mosque which used water of 3.4 m^3/day for constructing the new building. The others are oil mills and a blocket maker of which consumption is estimated at 2.4 m^3/day in total.

The majority of the water users were public fountain users, who accounted 70% of the total population served. There were only 7 public fountains of which 6 were functional. Their per capita consumption is just for drinking as little as 1.5 lpcd. Although there are many breweries (tella house) among the users, their consumption is negligible.

Those who borrowed and bought water from the neighbors were counted at 1,208 houses with the population of 4,815. Their consumption was obtained by the census survey and checked with the consumption of those who gave water. There were about 240 houses which engaged in businesses such as brewery, shops, coffee bar, eatery and even hotel (lodgings). Although their business is small, the consumption is not negligible. The per capita domestic consumption was estimated at 8.9 lpcd from 967 ordinary houses. The commercial consumption was then estimated at 6.6 m^3/day subtracting the domestic consumption and the institutional consumption from the total consumption of those who got water from neighbors. There was only one institutional customer i.e. kebele 01 office of which consumption was 500 l/day.

The per capita demand for the users of different modes of service and the quantity required for different domestic purposes was not estimated by WSSA unlike the other centers, so that the day demand was not calculated at this stage.

3.2.3 Current Water Demand

The characteristic feature in water use in this center is that PF users use water of the water supply only for drinking. The maximum lpcd among the PFs is 2.2, which is the lpcd of PF 1 users who live in the upper part of the town. This remarkably low consumption is caused by the availability of shallow wells.

They use water of shallow wells for domestic purposes other than drinking, so that their demand can be said to be 5 lpcd as much as the demand for drinking in the other centers.

The water required by the users of the other modes of service shall also be less than the other centers.

Table 3.2.1 Water Production and consumption in Werota

	Consumption (m3)								Production (m3)	Unaccounted Losses	
	IC	PF1	PF2	PF3	PF5	PF6	PF7	Sub Total	Grand Total	Well No.1	(m3)	(%)
Jul-93	3,046	300	150	150	200	100	100	1,000	4,046	4,682	636	13
Aug-93	1,099	100		100	100	50		350	1,449	2,866	1,417	49
Sep-93	2,884	250	100	100	100	150		700	3,584	4,450	866	19
Oct-93	2,714	250	100	250	250	200	50	1,100	3,814	4,913	1,099	22
Nov-93	3,724	300	100	100	100	150	50	800	4,524	5,275	751	14
Dec-93	5,881	300	100	100	150	150	50	850	6,731	5,621	-1,110	-19
Jan-94	2,868	500	50	150	250	200	50	1,200	4,068	6,447	2,379	36
Feb-94	2,903	300		50	50	100	50	550	3,453	5,779	2,326	40
Mar-94	3,984	200		100	150	50	50	550	4,534	6,151	1,617	26
Apr-94	3,860	250		50	100	100	50	550	4,410	4,053	-357	-8
May-94	2,321	100			50	50	50	250	2,571	3,077	506	16
Jun-94	4,208	300		50	250	100		700	4,908	4,994	86	1
Jul-94	3,112	200		50	100	100		450	3,562	4,620	1,058	22
Aug-94	2,180	150		100	100	100	50	500	2,680	4,395	1,715	39
Sep-94	3,512	200	50	100	200	50		600	4,112	5,700	1,588	27
Oct-94	4,146	200	50	150	150	150		700	4,846	4,234	-612	-14
Nov-94	4,081	150	50	150	150	150		650	4,731	6,024	1,293	21
Dec-94	4,625	350		50	150	100	50	700	5,325	6,663	1,338	20
Jan-95	5,313	300	50	50	200	150		750	6,063	7,529	1,466	19
Feb-95	4,447	300		100	200	100	50	750	5,197	7,781	2,584	33
Mar-95	3,846	100	150	100	150	50		550	4,396	7,814	3,418	43
Apr-95	5,464	250		50		150	150	600	6,064	8,172	2,108	25
Total	80,218							14,850	95,068	121,240	26,172	21
Average									4,321	5,511		
Maximum									6,731			

* Recorded in Ethiopian Calendar

IC: Individual Connection

PF: Public Fountain

3.3 Water Supply Facilities Condition

3.3.1 General

Water source in this town is groundwater, and water supply is served by the piped water system. Existing water supply system consists of one borehole, one transmission pipeline and distribution facilities as shown in Figure 3.3.1.

3.3.2 Water Source

Existing borehole was constructed by EWWCA in 1976. Existing submersible pump is driven by hydroelectric, and there is one standby generator with a capacity of 22 KVA. This generator is a Japanese-made and manufactured in 1980.

Existing borehole is equipped with a check valve and a flow meter, and the pumping rate was quantified at around 5.6 l/s. No information on the existing submersible pump is available.

It is reported that the submersible pump is generally operated twice a day: 6:00AM-10:00AM and 6:00PM-12:00PM. Switching on/off of the submersible pumps is being carried out by the operator by confirming water level in the reservoir.

3.3.3 Transmission and Distribution Facilities

Groundwater is pumped from the borehole to the service reservoir and supplied to the town by gravity. It was identified that there are some connections between the rising main. Existing service reservoir is made of R.C. with a capacity of about 100m3, and without any measurement appurtenance.

Existing distribution network is the branched system with galvanized steel pipes. The diameters of the pipes range from DN 20 to DN 80. The lengths of pipelines including rising main are summarized as follows:

Table 3.3.1 Existing pipeline data(Werota)

Diameter (mm)	Length (m)	Material
20	730	G.S
25	1050	-do-
40	230	-do-
50	1540	-do-
80	1330	-do-

3.3.4 Service Level

Water service level is divided into two modes: individual connection and public fountain. There are 385 individual connections, and it is subdivided into 4 categories: private(342), commercial(11), government institution(25), and public institution(7). According to the consumption data, individual connection is about 84% of the total consumption, and public fountain about 16%.

There are seven public fountains, and six operational public fountains. The public fountain was usually opened twice a day: 7:00AM-0:30PM and 2:00PM-6:30PM. These fountains are opened and maintained by only three P.F. attendant, so the opening of fountains is done on rotating basis. Generally, four faucets per public fountain are provided.

3.3.5 Disinfection

There is no disinfection facility in existing water supply system. It is reported that chlorine is added in the reservoir once every three months.

3.3.6 O & M

Werota is classified as urban town, and the waterworks is under the control of the Regional Office in Amhara Region. WSS office in Werota manages one rural town.

WSS office is managing not only financial works but also maintenance works. Daily routine work and simple maintenance such as switching on/off of the generator, the replacement of valve and meter, etc. are carried out by the staff stationed. Major maintenance such as the replacement of the pipes and pumps is carried out with the assistance of the Regional Office. WSS office has neither the vehicle nor spareparts and has only few tools for daily routine work.

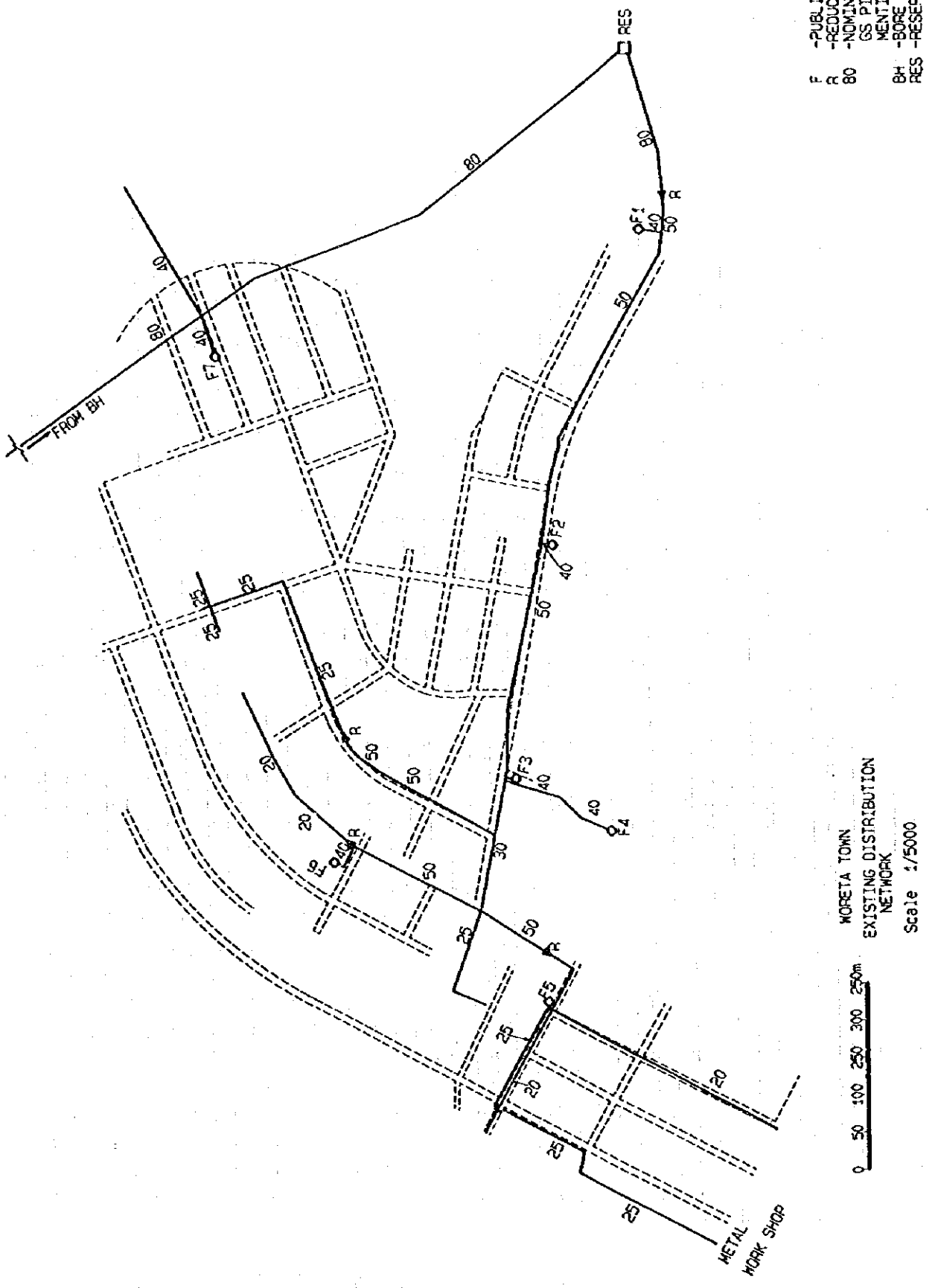


Figure 3.3.1 Schematic layout of Existing Facilities (No scale)

3.4 Sanitary Facilities Condition

3.4.1 Toilet Facilities

Presently considerable use of open-field defecation is being observed in several open spaces in the town especially near the schools, market places and bus terminals.

The Population and Housing Census of 1984 and as updated in 1993 has carried a sanitation survey of the whole town and has come up with the following results.

Table 3.4.1 Distribution of Housing Units by Type of Toilet Facility in Werota

Number and percentage	Type of Toilet Facility						
	Flush		Dry pit		None (open-field)	Other	Total
	Private	Shared	Private	Shared			
• Number	80	1	153	150	1,503	44	1,931
• Percentage (%)	4.1	0.1	7.9	7.8	77.8	2.3	100.0

Table 3.4.1 shows that 77.8% of households in Werota do not have any toilet facilities; 15.7% of the households use dry pit latrines, both private and shared; and only 4.2% have flush toilets. Werota does not have a public toilet.

The Team has carried a household survey of 100 households in Werota. The result showed that 54% of the 100 households surveyed use dry pit latrines, 43% do not have toilet facilities and use open-field for excrete disposal,and only 2% have flush toilets.

When the dry pit latrines are filled up the owners dig new ones if they have space or they will have emptied them if they can get Vacuum Truck from Bahir Dar or Gonder and if they can afford to pay for the Truck. Otherwise they will abandon them and start using open-area for defecation.

Werota dose not have sites prepared and reserved for dumping sludges that are evacuated from the toilet facilities. The dumping of sludge is done at the outskirts of the town on Bahir Dar road. This indiscriminate dumping has created environmental pollution, water contamination and serious health hazards.

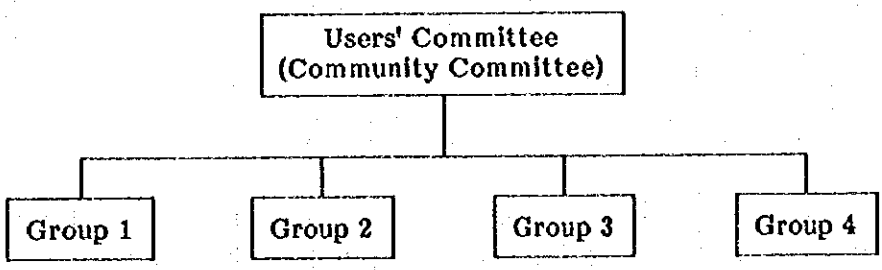
The Population and Housing Census of 1984 has also surveyed the distribution of housing units by types of materials used in the construction of walls, roofs and floors. The results of the survey showed that 77% of the housing units have their walls constructed of wood and mud, 4% of stone and mud, and another 4% of stone and cement. The roofing materials used were 61% of corrugated iron sheets and 29% of grass-thatch. Most of the floors, the result revealed, were constructed with earth and mud having 88%, cement and concrete with 4% and wood tiles with 5%. The construction of the superstructures of the toilet facilities follow and use similar materials.

3.4.2 Experimental Toilet

Werota is one of the two towns where an experimental toilet has been constructed. With the consent of the people of the community and the officials of Werota, a convenient site has been selected in the community where very poor people are living and who do not have any toilet facilities. These people were using open field for disposing excreta. These people are 46 in number. They have been organized and formed a user's committee consisting of 4 persons. The committee has a coordinator, an accountant, assistant each to them. They have also selected a guard from among themselves that will look after the experimental toilet. Some people from the community have participated in the construction of the toilet.

For the operation, maintenance, safeguard, and management of the toilet they have agreed to contribute from 0.5 to 2 Birr per household per month. The very poor ones are to contribute fifty cents per month, and the wealthier ones to contribute a maximum of two Birr per household per month.

The community has divided itself into groups and each group has a leader that coordinates the activities of the group and represents the group whenever the situation requires it. The organizational set up looks as follows:



The Werota's organizational set-up is different from that of Bati, and it does not have an Advisory and Control Committee above the User's Committee, because they did not want it.

Those members of the community that participated in the construction of the experimental toilet are availing themselves for the operation and maintenance of the toilet.

The people of the community are very happy to have this toilet in their community; and they have shown great appreciation to the Project for having done the toilet for them.

3.4.3 Emptying Toilets in Werota

The Team has arranged to get Vacuum Truck from WSSA of Bahir Dar on payment basis. 36 sludge disposal trips have been carried out to de-sludge pit latrines in Werota. Priority was given to schools, clinics, toilets of non-affordable communities. There is no properly prepared and reserved sludge-dumping site in Werota. The vacuum truck dumped its load at the outskirt of the town along the Bahir Dar road. The people were very appreciative of the work and openly expressed their gratitude to the work.

3.4.4 Other Sanitary Facilities

The survey of 100 households in Werota showed that 88% of the households throw their dry solid wastes anywhere, whereas 5% of the households dump them in open pit, 2% in covered pit, and 5% of the households burn their dry solid wastes. The conclusion from this result is that a large amount of dry solid wastes being thrown everywhere has created considerable environmental pollution and serious health hazards.

The survey of 100 households has also revealed that 100% if Werota people dump their sullages in front of their houses, along the streets, in open-area nearby available creating great environmental pollution water contamination and considerable health problems and hazards.

The Bahir Dar-Gonder road passes through Werota and has both cross and side drainage facilities. But due to lack of proper and timely maintenance, blockage of water passages are frequent and formations of stagnant water are considerable especially on the sides of the main road in the direction of Bahir Dar. Most of other parallel and side streets in Werota do not have proper drainage ditches. Whatever there are,they are blocked by solid materials and maintenance is completely neglected. The Werota Municipality need to play an active role in providing drainage facilities and maintaining the existing ones.

3.5 Organization and Management

It is advised to refer to Tables 1 and 2 of Appendix-5 when you read this section.

The number of personnel for the Water Supply Service of Werota is 18, which is a medium size among the 11 towns. Its breakdown by position/function is shown below.

Table 3.5.1 Number of Personnel and Positions/Functions

Positions/Functions	Gender		Type of Employment		
	M	F	Permanent	Contract	Temporary
1. Head, WSS	1	0	1	0	0
2. Administration					
Store keeper	0	1	1	0	0
Guards	4	0	4	0	0
Sub-total	4	1	5	0	0
3. Finance					
Accountant	0	1	1	0	0
Cashier	1	0	1	0	0
Bill collector	0	1	1	0	0
Meter reader	1	0	1	0	0
Water sellers	2	1	3	0	0
Sub-total	4	3	7	0	0
4. Technical					
Heads	2	0	2	0	0
Motor operator	1	0	1	0	0
Plumbers	2	0	2	0	0
Sub-total	5	0	5	0	0
Total	14	4	18	0	0

As the table shows, there are only permanent workers. Female workers are 4 in number or 22%. It is less than 27%, which is the average percentage of female workers in 11 towns. When one classifies the functions into administrative, financial and technical ones, the head of WSS being included in technical functions, their respective shares work out to 28%, 39% and 33%. On the other hand, their 11 town averages are 37%, 41% and 22%. It means that the share of administrative functions is lower and that of technical functions is higher compared to their respective 11 town averages.

Annual water production per worker, which is the broadest labor productivity indicator is calculated at 3,240 m^3. It is on the high side among the 9 towns excluding Dupti and Mille. The monthly remuneration per worker is 217 birr, which is the second highest.

It follows from the above that the participation rate of female workers is a little low, there might be a sufficient technical manpower and the size of workforce seems to be controlled.

3.6 Financial Condition of WSS

It is advised to refer to Tables 1 and 2 in Appendix-5 when you read this section.

The price of water per m^3 is 1 birr for all clients.

Production and consumption of water in the last fiscal year (Jul. 1993 to Jun. 1994) were 58,318 m^3 and 46,104 m^3 respectively. Both are on the large side among the 11 towns. Leakage ratio works out to 20.9%, which is one of the highest. The daily water consumption as divided by population comes to 5.8 liter. This is on the low side.

Income for the last year was 64,648 birr. Major sources of income are water sales (78.6%), public fountains (13.1%) and service charge (5.3%). Income per m^3 of water consumed works out to 1.40 birr, which is one of the lowest among the 11 towns. Bill collection rate is 99.9%, which is the highest.

Expenditures for the same year were 53,304 birr. The major items of expenditures are salary, electricity and uniforms. Expenditures per m^3 of water produced work out to 0.91 birr, which is the lowest. The income-expenditure ratio comes to 121.3%. That is to say, Water Supply Service (WSS) in Werota earned a substantial surplus. It is to be noted in this regard that Werota is one of the three among the 11 towns where water supply business is in the black, the other two being Mille and Aykel.

The number of personnel is 18. It is a medium size among the 11 towns. Annual water production per worker is calculated at 3,240 m^3, which is on the high side. Annual income per worker is 3,592 birr, which is on the low side. Expenditures per worker is 2,961 birr, which is the second lowest, next to the estimated 1,735 birr in Aykel. Average monthly salaries are 217 birr. It is the second highest among the 11 towns, following 241 birr in Bure.

It follows from the above that WSS in Werota is financially successful on account of lower cost and fewer employees in spite of a comparatively large volume of water produced and consumed. Lowering of leakage ratio may contribute to improving financial performances even more.

3.7 Social Background and People's Awareness

3.7.1 Population and social composition

The population in Werota was about 21,845 at the time of the field survey. According to the household survey there were 80% Christians and 19% Muslim at that time. Amhara are the dominant ethnic group accounting for about 97% of the total population with the remainder being Tigre and Oromo. The proportion female headed households was relatively high at 54% of households surveyed. Women headed households in the Werota households survey are generally poorer than male headed households. Of the 14 poorest households surveyed, 13 of them were female headed households (See Figure 3.7.1). No difference was discernible between Muslim and Christian households in the survey. Werota seemed like a typical Amhara town. The Eder system is functioning in Werota, but only as many small Eder groups and with no strong overall coordination.

In a number of group discussions it became evident that the population generally was not motivated to bring about changes in the community, either it's structure or it's facilities. There were many small businesses in Werota, including 45% of survey households brewing

and/or selling Tela (local beer). This activity traditionally has only been done by women. Other businesses included trading and transportation of crops and spinning/weaving cotton cloth.

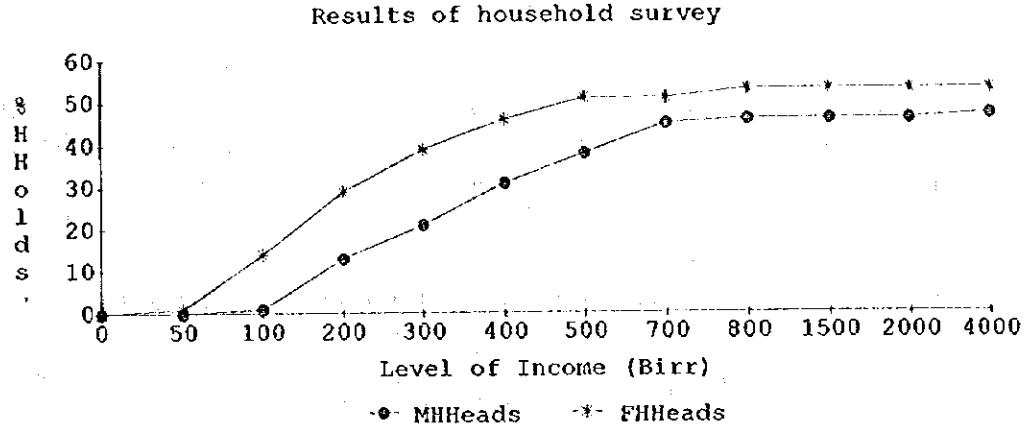


Figure 3.7.1 Income Related to Gender of Hheads

3.7.3 Sanitary condition

Excreta and solid waste were littered throughout the town. Men and women were generally aware of the health risks of such poor sanitation but were doing nothing to improve the situation. For some the limitation is lack of control over land, for others it is lack of money but the real issue seems to be lack of motivation. Improving the sanitary conditions will not be easy. CPPs will have to adopt a long term and programmatic approach using respected leaders of the community like the religious leaders. Teachers, students or health center staff alone will not make an impact.

There was a problem with existing latrines becoming full. They require emptying by suction truck from Bahir Dar. However there did not seem to be problems in mobilizing the truck. There was a feeling among the people we spoke with that pour flush latrines were not the ideal latrine option because of problems with maintenance.

People were receptive to the idea of community latrines located close to their homes, to be cleaned and maintained by the community. Only one group requested public latrines to be managed by the municipality because they had already paid a tax for sanitation. This group was located near to the site of the experimental toilet facility.

Women did not go far from their homes to defecate and rural women in particular seemed reluctant to use latrines. At the high school the male and female latrines were close together but separate. The girls did not use the latrines because the latrines were too close together. This privacy issue might be an important consideration for latrine sitings in Werota.

3.7.3 Water situation

Women were the principal collectors of water and mostly undertake the laundry. Girls assisted with this task and some boys helped to fetch water from PFs and spring sources. Along the main road in the hotel area, there was a reliable supply of piped and hand dug well water. Hand dug wells were also found in the North/East end of the town. Well water was generally not used for purposes other than laundry or bathing, except where PFs were too far away. People without PCs rely on the PF supply for drinking water. This supply is closed on Sundays, when most PF users fetched water from springs. The taste and quality of piped water was preferred by everyone we discussed with. Some people with PCs sell water. One female vendor was allegedly making 100 Birr profit each month from selling water.

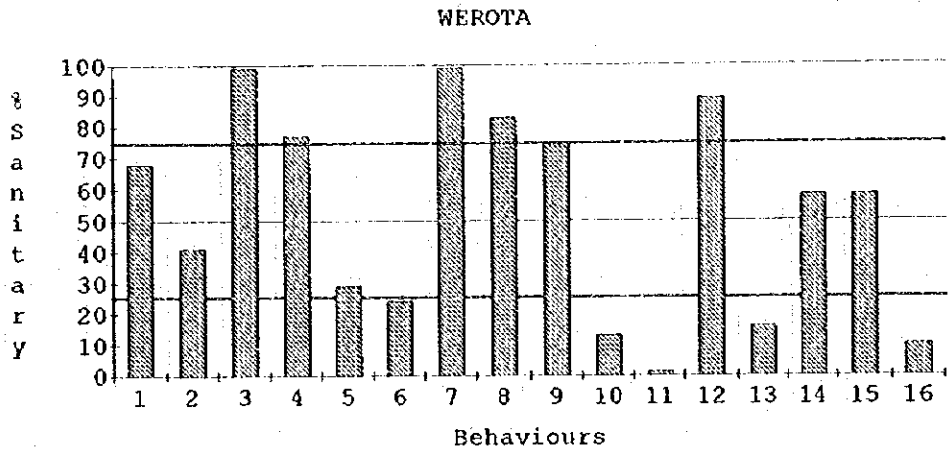
Near the river there was a very poor access to water. The river does not flow throughout the year and the quality was consistently poor. However, the nearest PF was some distance away and does not function sufficiently long hours to supply demand. People in this area sometimes bought water from a nearby house with a PC. The area of high ground around the weekly market also had poor access to water. The PF in this area did not function for sufficient hours to satisfy the demand. These people also purchase water from vendors at times of shortage. Those areas where access to piped water was poor wanted to have extra PFs rather than PCs for reasons of affordability. These people saw piped water as a priority need and in some cases were keen to manage these PFs by themselves with support from the kebeles or municipality. Near the bus stand the supply of water to PFs and PCs was insufficient and required more water.

Public showers were of interest to PF users near to the center of the town. These could be managed by the community if given sufficient support from the administration.

3.7.4 Health indicators

Health services were provided by a health center. This included some standard health education but not individual advice. There used to be community health workers and traditional birth attendants operating in Werota but this had been stopped. This left a gap in the outreach work of the clinic. There was a high incidence of malaria, diarrhea (including dysentery) and eye infections in the town. There were many flies which the children in particular did not seem to be bothered by. The climate was also hot and dusty, particularly for a highland area.

The indicator sanitary behaviors reported in the household survey are recorded in Figure 3.7.2.



No.	SANITARY BEHAVIOURS	%Sanitary
1	Access to piped water	68
2	Use piped water supply always	41
3	Covered water container	99
4	Water scoop kept off the floor	77
5	Handwashing with soap after defecating	29
6	" after handling childrens stools*	24
7	Covering cooked food during storage	99
8	Not eating unwashed raw fruit and vegetables	83
9	Kitchen utensils stored off the floor	75
10	Rubbish burried or burned	13
11	Wastewater disposed in pit/drain/veg. garden	1
12	No animals kept in the house	89
13	Home not infested with flies	16
14	Latrine in use by household	58
15	Latrine in use by all household members	58
16	Infant's excreta disposed of in latrine*	10
TOTAL SCORE FOR SANITARY BEHAVIOURS		840

*As proportion of houeholds with young children

Figure 3.7.2 Indicator Sanitary Behaviours

The summary of indicator behaviors suggests areas where sanitary improvements are required. The highest priority areas are handwashing after handling of children's stools, sanitary disposal of children's excreta, sanitary solid waste and wastewater disposal and fly control. The high-middle priorities are the use of piped water always and handwashing with soap after defecation. The low-middle priorities are access to piped water, latrine access and latrine use by all family members. The item of keeping kitchen utensils off the floor is borderline with low-middle priority along with keeping water scoops off the floor and should be included with the program.

There are significant differences, particularly between the households with incomes below 100 Birr each month and the average. For example the overall average sanitary behaviour

score for Werota is 840, while the average sanitary behaviour score for the low income group is only 571. The biggest areas of difference are use of piped water supply always, keeping water scoops and kitchen utensils off the floor, not eating raw unwashed fruit and vegetables and access and use of latrines for households, all family members and for disposing of children's stools. Special attention needs to be paid to these differences in the sanitary education program.

There are also significant differences between household questionnaire responses for PC users and those of other water users, PC users having much better access to resources and better sanitary behaviours than other users. They have a higher average income level (between 300 to 399 Birr monthly) compared with the average for the town (between 100 and 199 Birr each month).

The result of the household survey indicates that there are some differences also between Christians and Muslims. These include an increase in piped water availability always for Muslims. Muslims also have poorer water storage and handling practices and poorer handwashing practices. Attention needs to be given to this in the implementation period also.

3.7.5 Education

There were two elementary schools and one high school. The high school had a total of 1500 students of which 650 were girls. There was a higher dropout rate for girls and in the 12th grade only 35 of the 123 students were girls. The school took a high proportion of children from rural areas (65%). There was an HIV/Health Club structure which could be used for hygiene promotion. Posters were not thought to be effective but dramas might be an effective way of portraying the problem to the town to stimulate active learning. This was the conclusion of the experimental sanitary education program.

3.7.6 Religious Institutions

The leaders from one church and one mosque were contacted. They were both concerned about the water and sanitation situation in the town and agreed to use their religious teachers in hygiene education. For this they would require some additional training and materials. They would also need improved water and sanitation facilities in order to practice what they promote. The mosque may only reach male Muslims and the church only Christians (both male and female).

3.8 Socio-Economy

It is advised to refer to Table 3 and 4 in Appendix-5 when you read this section.

3.8.1 Administrative Conditions

There are 17 governmental organizations excluding schools dealing with general administration, finance, education, health, water supply and sanitation, communications, police ,justice, electricity, agricultural training, commerce and municipal affairs.

The number of government employees is 322. It is the smallest among the 11 towns. The number of them per 1,000 population works out to 15, which is the lowest. Their average monthly salaries are 308 birr, which is one of the lowest.

One does not have much to stress upon administratively for this town.

Werota has 2 Kebele. There is no NGO.

3.8.2 Population

The population of the town is estimated at 21,845 according to the preliminary results of the 1994 population census. It is one of the biggest among the 11 towns. Ethnically, it is composed of only two groups, Amhara (97%) and Tigre (3%). This is just the Amhara town. Religion-wise, Christian population comprises 80%, Moslem population 19% and others 1%. The town has 2 churches and 2 mosques.

This is one of Amhara and Christian towns.

The average family size is 6.3 persons. This is one of the biggest among the towns concerned. The area of the town is 640 ha. It is a medium size. The population density is calculated at 34.1 persons/ha. This is at a medium level.

3.8.3 Educational Conditions

There are 1 kindergarten, 2 elementary schools and 1 high school with up to 12th grade. The total number of pupils/students comes to 3,817. It is rather on the large side. The number of pupils/students per 100 population is calculated at 21, which is on the low side.

Literacy ratio and primary school enrollment ratio were 63% and 57% respectively according to the 1984 population census. The former is on the low side and the latter is one of the lowest among the 11 towns.

3.8.4 Medical Conditions

There are 1 health clinic and 3 private drug vendors. The total number of medical personnel in the health clinic comes to 9, which is one of the smallest among the 11 towns. It means that there is 0.4 medical personnel for every 1,000 population. It is the lowest. This situation is going to be rectified as one health center is going to be constructed.

The types of diseases people suffer most are water-borne diseases such as malaria, intestinal parasite and diarrhea and respiratory tract infections. Incidence of water-borne diseases seems to be especially high. It may have something to do with shortage of piped water and climatic conditions in the town. The number of top ten disease cases treated in the Health Clinic in 1993/94 was 18,084, which is one of the largest among the 11 towns.

The estimated total number of cases treated last year in the Health Clinic was divided by the estimated service population. It came to 24.8%, which is at a medium level.

Under 5 mortality rate and life expectancy were 95/1000 and 61 years respectively according to the 1984 population census. The former is the second lowest, next to 73/1000 in Debre Tabor and the latter is the second highest, next to 64 years in Debre Tabor.

Ratio of households more or less using septic tanks and pit latrines is 61%. This is on the high side.

The Sanitary/health situation in Werota appears to be on a better side among the 11 towns despite constraints in medical facilities. It is hoped that the health center will be constructed soon.

3.8.5 Economic Conditions

The number of hotels and restaurants is 201 (24.8%), that of shops 532 (65.5%) and that of cottage industry 79 (9.7%), adding up to 812 (100.0%). This total number of commercial/industrial establishments is on the large side among the 11 towns. The total number per 1,000 population comes to 37, which is at a medium level. The number of hotels and restaurants per 1,000 population is 9, which is also at a medium level.

Major occupations are trade, government employees, cottage industry, day laborers and handicraft. It is to be noted that the town has a substantial number of cottage industry centering on oil factories and flour mills. It is also to be noted that handicraft is ranked as one of major occupations.

Major products are edible oil and flour. Major marketable items are agricultural products such as tef, barley, wheat, peas, chick peas, guaya beans, lentil and oil seed, animals such as ox, cow, sheep, goat, donkey and chicken, and consumers' items such as butter, milk and honey.

There is a big market every Saturday. About 8,000 to 10,000 people are said to gather on that day.

Average monthly household income is 262 birr. This is rather on the high side among the 11 towns.

The population of the town is one of the biggest among the 11 towns. Business appears to be active commensurate with the size of population.

3.9 Town Planning and Development

The master plan for town planning has been formulated in the era of the Imperial government. According to the field survey, it is expected that ninety percent of the current master plan has been completed as shown in Figure 3.9.1.

The electric power is now supplied to the Center by the hydroelectric power by EELPA, but the existing water supply facilities is operated by the on-site generators. The future water supply facilities at the target year of 2005 and 2010 will be also operated by the hydroelectric power.

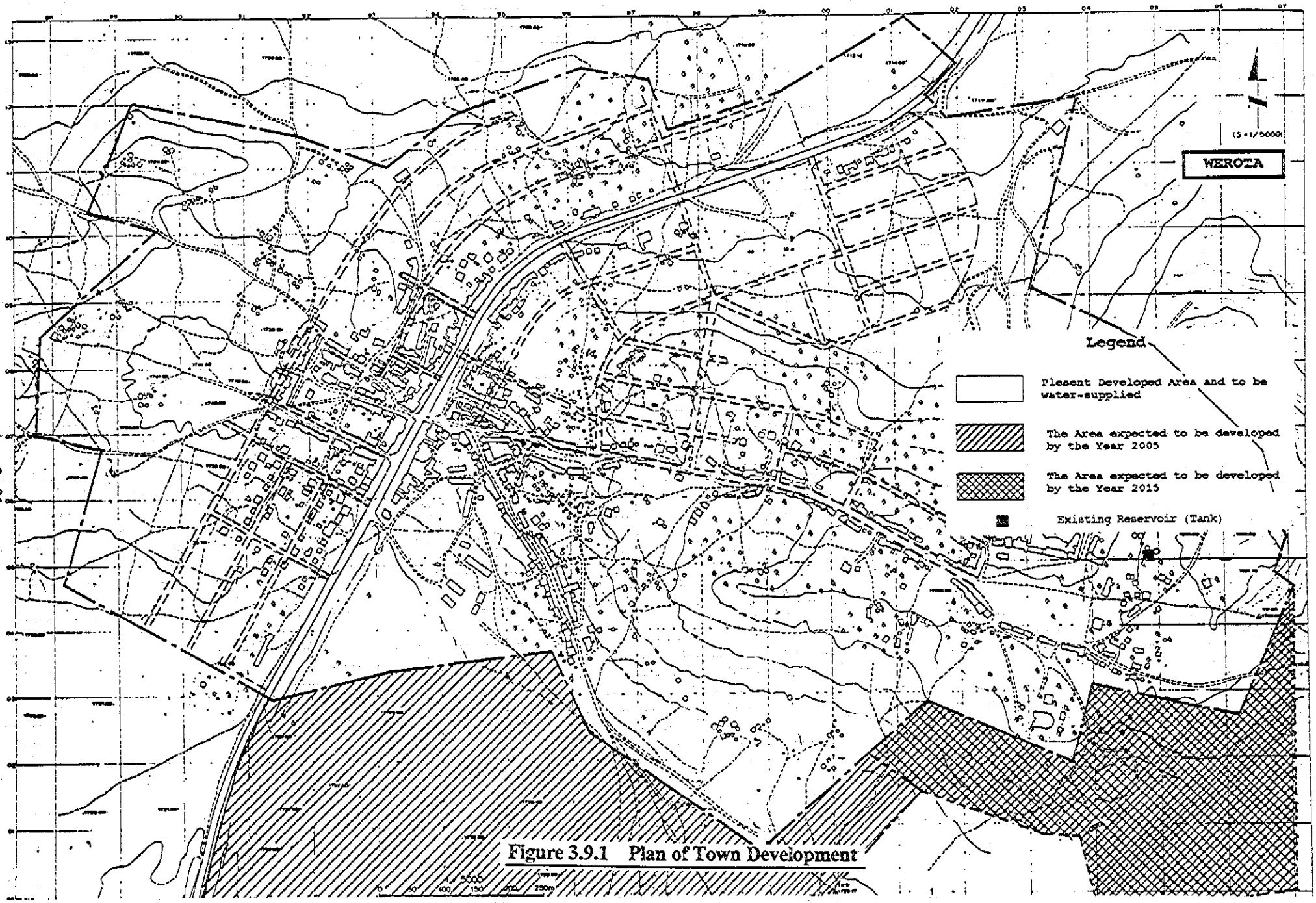


Figure 3.9.1 Plan of Town Development

Chapter 4 Plan of Water Supply System

4.1 Water Demand Projection

4.1.1 Population Projection

The population of Werota was 8,941 in 1984 according to the results of the 1984 Population Census. The census is the first one the Ethiopian government has ever took.

Before 1984 no established population figures are available. However, Central Statistical Authority (CSA) published 1974 population estimates for those towns whose population was supposed to be more than 2,000. Also, it had similar 1972 and 1973 estimates.

According to CSA estimates, 1974 population for the town was 4,810. Similarly, 1972 and 1973 population was 4,290 and 4,540 respectively. When one adopts CSA estimates, the average annual population growth rate during the 10 years 1974 to 1984 is calculated at 6.40%.

Since 1984 also CSA published its own estimates of population. According to them population of the town in 1992 and 1993 was 16,340 and 17,418 respectively.

In 1993 to 1994 CSA conducted the Cartographic Census for all the towns over the nation, using its own staff just before the 1994 Population Census. CSA says the results of the former is dependable, even more than those of the latter.

According to the Cartographic Census the population of the town was 15,707 in 1993. When one uses the figures, the average annual population growth rate during the 9 years from 1984 to 1993 works out to 6.46%. The JICA Study Team projected future population of the town based on the rate.

In October, 1994 the second Population Census was carried out. The results are not yet published. However, the team has gotten the preliminary figures of the census for Werota during the field survey. They are 21,845. The team adopted them for the 1995 population of the town.

As the average annual population growth rate 1995 to 2000 6.0% was adopted based on the average annual population growth rate 1984 to 1993. The more a projection is long-term, the more the incertainty increases regarding the projection. Therefore, one should be more cautious and conservative for a longer-term projection. In line with this reasoning the average annual population growth rates 2000 to 2005 and 2005 to 2010 were projected to be 5.5% and 5.0% respectively.

As a result the projected population of the town for 2000, 2005 and 2010 works out to 29,234, 38,208 and 48,764 respectively (Refer to Table 4.1.1).

Table 4.1.1 Population of Werota

1. Past Population

1974 Estimates by CSA	1984 Population Census	Average Annual Growth Rate 1974 to 1984
4,810	8,941	6.40%
1984 Population Census	1993 Cartographic Census	Average Annual Growth Rate 1984 to 1993
8,941	15,707	6.46%

2. Population Projection

1995	2000	Average Annual Growth Rate 1995 to 2000
21,845	29,234	6.0%
2000	2005	Average Annual Growth Rate 2000 to 2005
29,234	38,208	5.5%
2005	2010	Average Annual Growth Rate 2005 to 2010
38,208	48,764	5.0%

4.1.2 Water Demand Projection

(1) Domestic Water Demand

a) Population Projection by Service Modes

Based on the current population data by service modes, the population at the target years by modes is projected and estimated in the Table 4.1.2.

75% of the population is targeted at the year of 2010 to be served by the piped water system, considering the current ratio of the population served. Based on the ratio of the households who are payable for the mode-wise water charge, target ratio of the sum of house and yard connections (YC) at the year of 2010 is 61%, and 18% of this ratio is house connection (HC).

Table 4.1.2 Population Forecast by Service Modes

	Population (%)							
	1995		2000		2005		2010	
HC	314	(1.4)	1257	(4.3)	3859	(10.1)	9265	(19.0)
YC	7293	(33.4)	10436	(35.7)	15397	(40.3)	22919	(47.0)
PF	13407	(61.4)	17126	(58.6)	18952	(49.6)	16580	(34.0)
Sub total	21014	(96.2)	28819	(98.6)	38208	(100.0)	48764	(100.0)
TSU	831	3.8	415	1.4	0	0.0	0	0.0
Total	21845	100.0	29234	100.0	38208	100.0	48764	100.0

b) Projection of Domestic Water Demand

Water demand figure by service modes formulated by WSSA is applied for the projection, i.e, House Connection 60 lpcd, Yard Connection 35 lpcd, Public Fountain 15 lpcd. In addition, these figures multiply by 0.9, considering the natural condition (annual mean rainfall is less than 900 mm). Based on these conditions, the domestic water demands at the years of 2000, 2005 and 2010 are obtained as follows:

Table 4.1.3 Domestic Water Demand by Modes

	m^3/day (lpcd)							
	1995		2000		2005		2010	
HC	9.0	(28.6)	67.9	(54)	223.8	(58)	583.7	(63)
YC	139.3	(19.1)	334.0	(32)	523.5	(34)	848.0	(37)
PF	20.1	(1.5)	239.8	(14)	284.3	(15)	265.3	(16)
Total	168.4		641.6		1031.6		1697.0	
Average	56.1	(8.0)	213.9	(22)	343.9	(27)	565.7	(35)

(2) Non Domestic Water Demand

a) Current Non Domestic Water Demand

As a result of field survey, the following current non domestic water demand is obtained.

Table 4.1.4 Non Domestic Water Demand in 1995

Item	Unit	Nos.	Demand (m^3/day)	Remarks
School	5 l/person	3817	19.1	
Hospital	20 l/staff	9	0.2	
Hotel	100 l/bed	576	57.6	6 beds/place × 96 places = 576 beds
Bar...	200 l/bar	105	21.0	
Mosque	5 l/visitor	400	2.0	200 visitors/place × 2 places = 400
Offices	5 l/person	189	0.9	
Total			100.8	

b) Non Domestic Water Demand in Target Years

The public and institutional water demand increase in a geometric ratio of population growth, and the commercial water demand increases in a geometric ratio of population growth plus 3%. Non domestic water demands in the target years are estimated as follows:

Table 4.1.5 Total Non Domestic Water Demand in Target Years

Item	Demand (m^3/day)				Remarks
	1995	2000	2005	2010	
School	19.1	25.6	33.5	42.8	Population growth rate
Hospital	0.2	0.3	0.4	0.5	-do-
Hotel	57.6	88.6	133.2	195.7	Population growth rate +3%
Bar, Tea shop	21.0	32.3	48.6	71.4	-do-
Mosques	2.0	2.7	3.5	4.5	Population growth rate
Offices	0.9	1.2	1.6	2.0	-do-
Total	100.8	151	221	317	

(3) Total Water Demand

Total water demand at the target years including the accounted losses are estimated as follows:

Table 4.1.6 Total Water Demand in Target Years (m^3/day)

	1995*	2000	2005	2010
Domestic	169	642	1032	1697
Non Domestic	49	151	221	317
Losses	58	88	171	355
Total	276	881	1423	2369

* Actual consumption

(4) Maximum Day Demand and Peak Day Demand

Taking the seasonal difference into account, the factor 1.2 is adopted for the projection of maximum day demand. Furthermore, the factor 1.6 is adopted for the projection of peak day demand. The maximum day demand and peak day demand at the target years are obtained as follows:

Table 4.1.7 Maximum Day Demand Peak Day Demand

Item	Factor	1995	2000	2005	2010
Average Water Demand (m^3/day)		276	881	1423	2369
Maximum Day Demand (m^3/day)	1.2	331	1057	1708	2843
Peak Day Demand (m^3/hour)	1.6	22	70	114	190

4.2 Water Resources Development

4.2.1 Evaluation of Water Resources

Werota has annual precipitation of 1,270.5 mm and annual ground water recharge of 314.2 mm in an average year. The town is located on a low hill being surrounded by Irza river to the south and Tishikena stream to the north. Erza river is intermittent and has negligible flow in dry seasons. Tishikena stream has flow only in the rainy season. The real perennial river nearest to the town is Rib river which is 10 kms far from the town to the north. There are many hand dug wells and some springs at the foot of the hill. However, their yield is little and far insufficient for water supply.

On the other hand, the ground water development might be feasible. The WWS has an operational well at the north end of the town. Its safe yield is reported at 5 l/s (432 m^3/day). The watershed area for the well is not clear but may extend to Fogera plain. The problem with this well is that the site is inundated in the rainy season.

The geology of the area is categorized into two. The hills are composed of basalts and the plains are occupied by lacustrine deposits in which clay and basalt boulders dominate. The thickness of the lacustrine deposits varies from place to place, being underlain by basalts. The basalts are more feasible than the lacustrine deposits in terms of ground water exploitation because they are dissected by the linearments according to the aerial photograph interpretation. The primary permeability of basalts is low but it could be increased with secondary prosity caused by faults and fracture openings. It is expected that rocks are fractured and weathered along the linearments as favorable as for ground water exploitation.

Geoelectrical survey was conducted at 15 points around the hill as shown in Drawing including the site of WSS BH No.1.

The apparent resistivity curves at the points in the lowland plain show simple shapes whose minimum inflection points having resistivity values about 5 ohm-m are found at about 5 to 20 m depth and the values gently rise up as the depth increases and then reach about 20 ohm-m at about 100 m depth. In the valleys, that is at VES Station No.10, No.11, No.12 and No.13, the curves show the bumpy shapes with the resistivity values of about 10 ohm-m. These bumpy curves are reflected by saturated fissured basalt layers, so these layers are expected to have ground water. The results of VES interpretation is shown in Appendices.

Considering the lineation, the result of VES interpretation and the watershed area, borehole sites are selected at VES St. No.7, No.8, No.10, No.12, No.13 and No.14 totally six (6) sites. Station No.7, No.8 and No.10 are located along Erza river and Station No.12, No.13 and No.14 are located along Tishikena stream. Although Tishikena stream has smaller watershed area than the one of Erza river, the area is 10.63 km^2 at the bridge on the highway, which is far sufficient for those three (3) wells in terms of ground water recharge even though the plain area is not counted as the recharge area.

4.2.2 Strategy of Water Resources Development

The characteristics of the major aquifers of the WSS well and the proposed well sites are shown in Table 4.2.1. The depths of the major aquifers of WSS BH No.1 were obtained from the geological log. The others were detected by the geoelectrical survey. Excluding the WSS well, the thickness of major aquifers is reduced into a half because a part of basalts are highly weathered and may become clayish. The permeabilities are assumed at 1 m/day according to the design criteria. For Well No.1, the permeability must be much better in reality according to the current production record. Since it is described that the materials of the aquifers are decomposition of highly weathered and fractured basalts as seen in 2.2.2, the design permeability for basalts is applied.

Table 4.2.1 Characteristics of Aquifers

Well No.	Locations	Depths of Major Aquifers (GL-m)	Lithology of the Aquifers	Total Thickness of the Aquifers (m)	Permeabilities (m/day)	Remarks
1	VES St.1	12 - 46 50 - 53.3	Intercalation of Gravel and Sand Layers Sand with Gravel	37.3	1	WSS BH No.1
2	VES St.10	2 - 81 81 - 90※	Weathered and Fractured Basalt Highly Weathered and Fractured Basalt	44	1	New Well
3	VES St.14	1 - 63 63 - 90※	Weathered and Fractured Basalt Highly Weathered and Fractured Basalt	44	1	-Ditto-
4	VES St.8	1 - 30※	Weathered Basalt	14.5	1	-Ditto-
5	VES St.7	15 - 90※	Weathered and Fractured Basalt	37.5	1	-Ditto-
6	VES St.12	1 - 90※	Highly Weathered and Fractured Basalt	44.5	1	-Ditto-
7	VES St.13	1 - 11 11 - 56 56 - 90※	Highly Weathered and Fractured Basalt Weathered and Fractured Basalt Highly Weathered and Fractured Basalt	44.5	1	-Ditto-

Note: ※ = The aquifer bottom is probably deeper than the figure.

The optimal yields of the wells are estimated with the formula listed in the design criteria with a drawdown of 20 m and diameters of wells to be 200 mm. The optimal yield of the wells are shown in Table 4.2.2.

Table 4.2.2 Optimal Yields and Water Levels of the Wells

Well No.	Dia. of Well (m)	Optimal Yield (m^3/day)	Static Water Level (GL-m)	Dynamic Water Level (GL-m)	Remarks
1	0.15	113	0.5	20.5	WSS BH No.1
2	0.20	533	0	20	New Well for Year 2005
3	0.20	539	0.5	20.5	-Ditto-
4	0.20	176	0.5	20.5	-Ditto-
5	0.20	454	0.5	20.5	-Ditto-
6	0.20	539	0	20	New Well for Year 2010
7	0.20	539	0	20	-Ditto-

The optimal yields of Well No.1 to No.5 totaling to 1,815 m^3/day cover the demands of year 2005. The total yield of all the wells will cover the demand of year 2010.

It is recommended to drill four (4) wells i.e. Well No.2 to Well No.5 because the sites of Well No.6 and Well No.7 are not accessible without a road construction. In case it is clarified that the life of WSS BH No.1 is sustainable, Well No.4 must be ranked as a supplement.

4.2.3 Design of Water Source Facilities

The new deep wells are designed as follows.

(1) Casing

Fiber Reinforced Plastic (FRP) pipe is adopted considering its elasticity for the case that the drilled hole is not straight. The diameter of casing is decided at 200 mm, taking into consideration the outer diameter of the submersible pump (standard 80 - 140 mm) and the allowance. The length of the pipe is six (6) m per piece.

(2) Screen

Corresponding with the casing, FRP screen is adopted. The opening ratio is 12% and the length is four (4) m per piece. The total screen length is longer than the calculated by the following formula.

$$Ls = \frac{\alpha \cdot Q}{10 \cdot A \cdot N \cdot V}$$

where
- Ls: Length of screen (m)
- Q: Pumping rate (l/s) (assumed equal to the optimal yield)
- A: Surface area of screen 0.66 m^2/m
- N: Opening ratio 0.12
- V: Inflow velocity 0.5 cm/s (assumed)
- α: Safety factor 3

The dimensions of the wells are summarized as shown in Table 4.2.3.

Table 4.2.3 Dimensions of Wells

Well No.		2	3	4	5	6	7
Pumping Rate	(m^3/day)	533	539	176	454	539	539
	(l/s)	(6.2)	(6.2)	(2.0)	(5.3)	(6.2)	(6.2)
Diameter of Well	(mm)	200	200	200	200	200	200
Casing Length	(m)	30	30	12	36	30	30
Screen Length	(m)	64	64	24	56	64	64
Well Depth	(m)	94	94	36	92	94	94
Drilling Diameter	(mm)	300	300	300	300	300	300

4.3 Plan of Water Supply System

The water supply system proposed for the center of Werota would be implemented in two phases: first phase (target year 2005) and second phase (target year 2010).

The water supply system, which is composed of intake facilities, rising mains and distribution facilities, is proposed in the first phase to meet the water demand.

The water supply system, which is composed of additional intake facilities, transmission facilities, is planned in the second phase to meet the water demand at the target year of 2010.

4.3.1 Water Supply System in 2005

(1) Boreholes

There are six potential sites for borehole well as stated in chapter 4.2. Among these proposed sites, four potential sites for borehole will be constructed in the first phase. The groundwater pumped up is transferred to the new reservoir directly. The production rate planned is summarized as follows.

W1 (Existing Well)	113 m^3/day
W2 (proposed)	533 m^3/day
W3 (proposed)	539 m^3/day
W4 (proposed)	176 m^3/day
W5 (proposed)	454 m^3/day
Total	1,815 m^3/day

(2) Borehole Pumps

Each borehole will be equipped with a submersible motor pump. The characteristics of the pumps to be installed are assumed as follows:

W1 (Existing Well) Q = 0.09 m^3/min., H = 34 m
W2 ~ W5 (proposed) Q = 0.2 ~ 0.5 l/min., H = 70 ~ 100 m, P = 5 kw Set No.4

(3) Boosting Facility and Rising Mains

The booster pump with following capacity will be installed to transfer the water to reservoir. And the collecting chamber with the capacity of 20 m^3 will be constructed as well.

BP1 ϕ150 mm Q = 0.76 m^3/min., H = 80 m, P = 30 kw
BP2 ϕ150 mm Q = 0.43 m^3/min., H = 80 m, P = 18.5 kw

Rising mains will range from 100 mm to 150 mm and transferred water to the new reservoir. Total length is about 4,520 m.

(4) Reservoir

The existing reservoirs is replaced to new reservoirs due to the lack of capacity of existing reservoirs. The capacity of the reservoir is required to meet the water demand at the year of 2005, and the required capacity is about 480 m^3 including reserve for fire fighting.

(5) Distribution Network

The distribution network is designed for the peak hour demand and fire fighting case, according to the design criteria.

The layout of the network follows the existing roads. The pipe with Dia. 75 mm is adopted as the minimum dia., and the pipe with dia. 50 mm is automatically adopted for the small distribution zone. Existing galvanized steel pipes will be replaced, if necessary.

The layout of distribution network for the target year of 2005 is prepared and attached in the Drawings. The main pipelines planned are shown as follows:

Table 4.3.1 Distribution pipelines

DN (mm)	Length (m)
300	445
250	640
200	430
150	1,980
100	3,961
75	9,545

(6) Disinfection

Disinfection will be performed by the injection system directly into the outlet of the reservoirs. Daily consumption ratio of chemical will be estimated at about 1.9 kg and necessary more than 0.11 PPM at the end of distribution pipe.

4.3.2 Water Supply System in 2010

(1) Borehole

Two boreholes will be additionally constructed in the second phase to meet the water demand at the year of 2010. The production rate planned is summarized as follows.

W6 (proposed)	539 m^3/day
W7 (proposed)	539 m^3/day
Total	1,078 m^3/day

(2) Borehole Pumps

The boreholes will be equipped with submersible motor pumps. The characteristics of the pumps to be installed are assumed as follows:

W6, W7 (proposed) $Q = 0.38\ m^3/min.$, $H = 40\ m$

(3) Distribution Network

The layout of distribution network for the target year of 2010 is not prepared in this Study. It is because current town master plan has been almost achieved. It is preferable to design a layout plan after formulation of next town master plan.

(4) Disinfection

Disinfection will be performed by the injection system directly into the reservoirs. Daily consumption ratio of chemical will be estimated at about 3.3 kg and necessary more than 0.11 PPM at the end of distribution pipe.

4.4 Implementation Schedule and Cost Estimation

4.4.1 Executing and Responsible Agencies

The executive agency of this Project is to be the Water, Mine and Energy Bureau of the Amhara National Regional Government, while the Ministry of Water Resources is to be responsible to coordinate and facilitate the implementation of the Project.

WSSD is to be responsible for the close coordination with the agencies concerned on the project approval, finance and project implementation. The Project would be required to be of great importance in the coordination of activities among the departments in the Ministry and between the central and regional offices concerned.

Prior to the implementation of the Project, the Project Manager is to be appointed under WSSD, who rests with the day-to-day works. Under the manager, aiming at the smooth implementation, coordination be maintained among such departments/services as Planning & Project, Administration & Finance, Contract Administration, Design and WSSD. The Project Manager be also required to keep close relationship with regional and town offices concerned.

4.4.2 Construction Schedule

The construction works for pipeline and reservoir related to water supply works have been carried out mostly by manual labor in Ethiopia. However, it would be recommended to introduce certain number of construction machines in order to speed up the construction works.

As this Project requires urgent intermediation to counteract the current deteriorating water supply condition, the aforementioned measures shall be employed for the purpose of keeping-up smooth execution of the construction works.

The construction schedule is divided into two stages; namely, 1) preparation of finance including the foreign currency portion and detail design accompanied with tender document, and 2) implementation of the Project. The schedule is proposed in the following, taking into consideration the above two stages and the construction amount.

First stage : Preparation in 1996
Second stage : Implementation after 1996 with reference to the priority among Eleven Centers

4.4.3 Project Construction Cost

The Project cost is estimated with both local currency and foreign currency. The unit price is estimated with reference to the standard unit price specified in Guideline for Preparation of Project, WSSA, July 1991. The unit price in this Project is price-escalated from the guideline prices based on the inflation rate shown in Economic Sensus between 1991 and 1995. WSSD's overhead, design and supervision fees and physical contingency are estimated according to the guideline.

In respect of foreign currency portion, the cost is required for the preparation of construction equipment and machinery, and procurement of such equipment and material as pump and pipe. Also, fuel, cement and other local materials made of imported row material are partly counted into foreign currency portion.

Engineering staff will be required for the detail design work and the implementation of the Project, since the Project is relatively large in the scale comparing to those existing water supply system. Consultant will also be employed by WSSD, MWR and be responsible for the all necessary work to be required and cooperate together with the WSSD's engineers.

Total project costs regarding water supply in years of 2005 and 2010 are summarized in Table 4.4.1.

Table 4.4.1 Total Project Cost of Water Supply in Thousand Birr

Year	F.C.	L.C.	Total
2005	14,824	9,303	24,127
2010			9,923

Note: Transportation Cost for Construction Equipment, Vehicles and Office Equipment are not included.

In this Study, sanitary improvement was also designed and required costs are summarized in Table 4.4.2. The costs are composed of 1) toilet facilities to be constructed in schools, medical institutions and public, 2) vacuum track, 3) refuse disposal track, 4) sludge dumping site, 5) refuse disposing site and 6) refuse collecting bins. Household sanitary facilities such as toilet (including community type) and waste water disposal pit shall be managed by the individuals or otherwise subsidized. Although drainage facilities are important, those are to be managed by Municipality and community participation in coordination with WSS. Therefore, the cost does not include the drainage facilities.

Table 4.4.2 Total Project Cost of Sanitary Facilities in Thousand Birr

Year	Cost
2005	1,656
2010	450

4.5 Financial Analysis

4.5.1 Financial Plan

(1) Estimation of Revenues

(a) Determination of Water Tariff

It was decided that there will be three water prices. One will be applied to house connection owners and non-domestic clients. The second and the last will be applied to yard connection users and public fountain users respectively.

The water tariff was so constructed that house connection owners and non-domestic clients will cross-subsidize yard connection and public fountain users, and yard connection users will, in turn, cross-subsidize public fountain users.

The tariff was determined in such a way that house connection owners, yard connection users and public fountain users will pay 4%, 4% and 2% of their income for water respectively in the target year of 2010.

Eventually, it is recommended that the following tariff will be applied from 1999 onward:

Clients	Water Price (birr/m^3)
1. House Connection Owners and Non-Domestic Clients	3.01
2. Yard Connection Users	2.25
3. Public Fountain Users	1.04

Important information concerned such as average monthly household income, share of households, water consumption per household per month, payment for water supply per household per month and ratio of water payment to income by type of clients and by the target year is shown in Table 4.5.1.

(b) Projection of Revenues

The major income source of water supply services is as every one knows revenue from water charge.

It is calculated by (No. of households by year by type of clients) × (annual water consumption per household by year by type of clients) × (water price by type of clients) × (bill collection rate).

The number of households was estimated based on the service population projection in the other chapter.

Annual water consumption was estimated based on the water demand projection in the other chapter.

Water price is already mentioned above.

The bill collection rate in the future was assumed as 95%.

There is the second revenue source. It is the revenue from technical service charge. This is the installation charge of connections. They say that the charge is 40% of the material and transportation cost actually incurred.

The revenue is calculated by (No. of connections to be newly installed by year) × (average technical service charge per connection).

The number of connections to be newly installed every year is estimated based on the projected number of house/yard connection owners.

According to the field surveys conducted by JICA, the average technical service charge per connection worked out to 195 birr although the charge varies depending on the diameter and length of the pipe, distance, etc.

The third revenue source is the the revenue from meter rent. For every new connection installed a water meter will be rented. The rental fee is 1 birr per month.

There are other revenues such as those from material sales, contract fee, connection fee, road crossing, etc. They are assumed to be 2% of the sum total of the preceding three revenues.

Projected revenues by source are shown in Table 4.5.2.

(2) Estimation of Cost

There are two types of cost. One is capital cost and the other is operation and maintenance (O & M) cost.

Capital cost is required to construct and replace water supply facilities. O & M cost is an recurrent cost daily required for the proper functioning of water supply facilities.

(a) O & M Cost

Seven types of O & M cost can be identified.

The first is electricity cost. It is estimated that 137 birr, 221 birr and 367 birr will be daily required in 2000, 2005 and 2010 respectively.

The second is fuel cost. It will not be required as there will be sufficient electricity so far as Werota is concerned.

The third is disinfection cost. It is estimated that 12 birr, 20 birr and 35 birr will be daily required in 2000, 2005 and 2010 respectively.

The fourth cost is personnel cost. It is estimated that 42, 47 and 58 employees will be required for WSS in 2000, 2005 and 2010 respectively. It is recommended that the average monthly remuneration per employee will be 481 birr. It was worked out based on the standard salaries the authorities are now proposing for each type/position of personnel comprizing WSS.

The fifth is installation cost of connections. It is projected that 117, 216 and 369 connections will be annually newly installed from 1999 to 2004, from 2005 to 2009 and from 2010 onward respectively. Installation cost per connection is estimated at 488 birr on average.

The sixth is the purchase cost of water meters. For each connection to be newly installed one water meter will be required. The purchase price of a water meter widely varies depending on the diameter of the pipe and the country from which it was imported. It was assumed that it will be 276 birr based on the bulk purchase price of Indian imports.

The last is other cost including office supplies, uniform, per diem and travel, postage & telephone, transport, maintenance of office, motor house, etc. , insurance, cleaning items, etc. It was assumed that the cost will be 10% of the six preceding cost combined.

(b) Capital Cost

Capital cost can be classified into initial cost and replacement cost. The former is required at the time of initial investment and the latter at the time of investment for replacement.

So far as the Project is concerned, replacement cost will be required every 15 years for water purification units only. The average life of other equipment and facilities is assumed to be 30 years, which is the assumed life of the Project.

The summary of the estimated initial cost is as follows:

Item	Foreign Components	Local Components	Total
1. Phase 1			
1) Construction Cost	11,340	5,148	16,488
2) Engineering Cost (12% of 1))	1,979		1,979
3) Contingency (5% of 1) + 2))	666	257	923
Sub-Total	13,985	5,405	19,390
4) Buildings		2,925	2,925
5) WSSD's Management Cost (2% of 1) + 2) + 3) + 4))		446	446
Sub-Total		3,371	3,371
Total	13,985	8,776	22,761
6) Water Purification Units (included in total)	10	15	25
2. Phase 2			
1) Construction Cost			5,775
2) Engineering Cost (10% of 1))			578
3) Contingency (10% of 1) + 2))			635
Total			6,988
Grand-Total			29,749

The Phase 1 Project will start in 1996 and end in 1998, while the Phase 2 Project will start in 2007 and end in 2009. The first year of project implementation is for detail design, and the second and third years are for the construction of facilities. The progress of construction work was assumed to be 50% for 1997/2008 and the remaining 50% for 1998/2009.

4.5.2 Financial Analysis

Financial statements (income statement and fund statement) were projected for 30 years starting in 1996.

In doing so, the following conditions were assumed:

1. External Loan for Initial Cost

Ratio of Loan	:	100%
Grace Period	:	10 years
Repayment Period	:	30 years
Interest Rate	:	1%

2. Governmental Subsidy to WSS

   60% of Initial Cost

It is to be noted that the cost related to the construction of accommodation facilities as well as WSSD's management is not included in the above initial cost. Such cost will be borne by the Ethiopian government and WSS will pay it back on the same repayment terms as in the case of external loan.

Also, it was assumed that the existing corporate income tax system will be applied, including 40% tax rate on before-tax income in case the income is over 50 thousand birr.

Further, inflation was not considered.

The results are shown in Table 4.5.3.

As it shows, WSS will be financially sound and stable in terms of earnings as well as solvency in the years to come except initial years, if all the above mentioned conditions, estimates and assumptions are met.

As representative managerial indicators, the weighted averages of the ratio of revenues to expenditures and the ratio of working capital to revenues for the 30 years from 1996 to 2025 work out to the following:

Revenues/Expenditures = 144.3%
Working Capital/Revenues = 35.0%

Generally, it will be all right if the ratio of revenues to expenditures is equal to or more than 100%, or preferably 110%. Also, it will be all right if the ratio of working capital to revenues is equal to or more than 10%.

It is to be noted that the above values exceed the required levels by a thick margin.

Table 4.5.1 Water Price and Ratio of Water Payment to Income

Item	1995	2000	2005	2010
1. Average Monthly Household Income (birr)				
1) House Connection Owners	825	904	912	895
2) Yard Connection Users	460	471	445	393
3) Public Fountain Users	161	166	166	156
2. Share of Households (%)				
1) House Connection Owners	1.4	4.3	10.1	19.0
2) Yard Connection Users	33.4	35.7	40.3	47.0
3) Public Fountain Users	61.4	58.6	49.6	34.0
3. Water Consumption/Household/Month (m^3)				
1) House Connection Owners	5.4	10.2	11.0	11.9
2) Yard Connection Users	3.6	6.0	6.4	7.0
3) Public Fountain Users	0.3	2.6	2.8	3.0
4. Water Price (birr/m^3)				
1) House Connection Owners	1.00	3.01	3.01	3.01
2) Yard Connection Users	1.00	2.25	2.25	2.25
3) Public Fountain Users	1.00	1.04	1.04	1.04
5. Payment for Water Supply/Household/Month (birr)				
1) House Connection Owners	5.4	30.7	33.0	35.8
2) Yard Connection Users	3.6	13.6	14.5	15.7
3) Public Fountain Users	0.3	2.8	2.9	3.1
6. Ratio of Water Payment to Income (%)				
1) House Connection Owners	0.7	3.4	3.6	4.0
2) Yard Connection Users	0.8	2.9	3.2	4.0
3) Public Fountain Users	0.2	1.7	1.8	2.0

Source: JICA

Table 4.5.2 Planning of Revenues

(Unit: birr)

Year	H./Y. Connec.	Public Founta.	Non-Domest.	Techni. Servic.	Meter Rent	Other Revenue	Total
1996	38,838	8,626	12,833	3,423	-	2,151	65,871
1997	39,615	8,799	13,089	3,423	-	2,191	67,117
1998	40,407	8,975	13,351	3,423	-	2,233	68,389
1999	202,143	49,442	95,417	22,765	18,644	10,743	399,153
2000	331,451	86,477	157,601	22,765	20,045	12,367	630,706
2001	393,563	89,686	172,213	42,137	22,638	14,405	734,642
2002	455,675	92,896	186,825	42,137	25,231	16,055	818,820
2003	517,788	96,105	201,437	42,137	27,824	17,706	902,997
2004	579,900	99,315	216,050	42,137	30,417	19,356	987,174
2005	642,012	102,524	230,662	42,137	33,010	21,007	1,071,352
2006	767,773	101,154	250,701	72,027	37,443	24,582	1,253,680
2007	893,534	99,784	270,740	72,027	41,875	27,559	1,405,520
2008	1,019,295	98,413	290,780	72,027	46,308	30,536	1,557,359
2009	1,145,056	97,043	310,819	72,027	50,740	33,514	1,709,199
2010	1,270,817	95,672	330,858	72,027	55,173	36,491	1,861,039
2011	1,270,817	95,672	330,858	0	55,173	35,050	1,787,571
2012	1,270,817	95,672	330,858	0	55,173	35,050	1,787,571
2013	1,270,817	95,672	330,858	0	55,173	35,050	1,787,571
2014	1,270,817	95,672	330,858	0	55,173	35,050	1,787,571
2015	1,270,817	95,672	330,858	0	55,173	35,050	1,787,571
2016	1,270,817	95,672	330,858	0	55,173	35,050	1,787,571
2017	1,270,817	95,672	330,858	0	55,173	35,050	1,787,571
2018	1,270,817	95,672	330,858	0	55,173	35,050	1,787,571
2019	1,270,817	95,672	330,858	0	55,173	35,050	1,787,571
2020	1,270,817	95,672	330,858	0	55,173	35,050	1,787,571
2021	1,270,817	95,672	330,858	0	55,173	35,050	1,787,571
2022	1,270,817	95,672	330,858	0	55,173	35,050	1,787,571
2023	1,270,817	95,672	330,858	0	55,173	35,050	1,787,571
2024	1,270,817	95,672	330,858	0	55,173	35,050	1,787,571
2025	1,270,817	95,672	330,858	0	55,173	35,050	1,787,571

Note: H./Y. Connec. = House/Yard Connection
Public Founta. = Public Fountain
Non-Domest. = Non-Domestic
Techni. Servic. = Technical Service
'-' = included in 'Other Revenue', if any

Table 4.5.3(1) Financial Statement

(Unit: thousand birr)

No.	1	2	3	4	5	6	7	8	9	10
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Income Statement										
Revenue	66	67	68	399	631	735	819	903	987	1071
Operation and Maintenance	54	55	57	386	425	522	535	549	563	577
Depreciation	0	164	329	329	329	329	329	329	329	329
Payment of Interest	0	0	0	0	0	0	0	0	0	0
Expenditure	54	220	385	715	753	850	864	878	891	905
Profit before Tax	12	-153	-317	-316	-123	-116	-45	25	96	166
Tax	0	0	0	0	0	0	0	0	0	0
Profit after Tax	12	-153	-317	-316	-123	-116	-45	25	96	166
Funds Statement										
Profit after Tax	12	-153	-317	-316	-123	-116	-45	25	96	166
Loans	831	5148	5148	0	0	0	0	0	0	0
Subsidies	1247	5194	5194	0	0	0	0	0	0	0
Depreciation	0	164	329	329	329	329	329	329	329	329
Sources	2089	10353	10353	13	206	213	284	354	424	495
Capital Works	2078	8656	8656	0	0	0	0	0	0	0
Payment of Principal	0	0	0	0	0	0	0	0	0	0
Working Capital	12	1697	1697	13	206	213	284	354	424	495
Applications	2089	10353	10353	13	206	213	284	354	424	495
Loan Liabilities	839	6047	11307	11420	11534	11650	11766	11884	12003	12123
Cash Balance	23	1720	3417	3430	3637	3850	4133	4487	4911	5406

Source: JICA

Table 4.5.3(2) Financial Statement

(Unit: thousand birr)

No.	11	12	13	14	15	16	17	18	19	20
Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Income Statement										
Revenue	1254	1406	1557	1709	1861	1788	1788	1788	1788	1788
Operation and Maintenance	732	759	786	813	840	530	530	530	530	530
Depreciation	329	329	371	413	413	413	413	413	413	413
Payment of Interest	9	66	119	114	108	102	97	91	85	79
Expenditure	1070	1153	1276	1340	1361	1046	1040	1034	1028	1022
Profit before Tax	184	252	281	369	500	742	748	754	760	765
Tax	0	0	0	0	0	0	0	0	0	0
Profit after Tax	184	252	281	369	500	742	748	754	760	765
Funds Statement										
Profit after Tax	184	252	281	369	500	742	748	754	760	765
Loans	0	254	1270	1270	0	0	0	0	0	0
Subsidies	0	381	1906	1906	0	0	0	0	0	0
Depreciation	329	329	371	413	413	413	413	413	413	413
Sources	512	1217	3828	3959	913	1155	1161	1167	1173	1179
Capital Works	0	636	3176	3176	0	0	13	13	0	0
Payment of Principal	42	300	562	567	573	579	584	590	596	602
Working Capital	471	281	90	215	340	577	564	564	577	577
Applications	512	1217	3828	3959	913	1155	1161	1167	1173	1179
Loan Liabilities	12193	12206	12930	13661	13117	12567	12011	11450	10884	10312
Cash Balance	5877	6158	6248	6463	6803	7380	7944	8508	9085	9662

Source: JICA

Table 4.5.3(3) Financial Statement

(Unit: thousand birr)

No.	21	22	23	24	25	26	27	28	29	30
Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Income Statement										
Revenue	1788	1788	1788	1788	1788	1788	1788	1788	1788	1788
Operation and Maintenance	530	530	530	530	530	530	530	530	530	530
Depreciation	413	413	413	413	413	413	413	413	413	413
Payment of Interest	73	70	77	85	77	69	61	53	45	37
Expenditure	1016	1013	1021	1028	1020	1012	1004	996	988	980
Profit before Tax	771	775	767	760	768	775	783	791	799	807
Tax	0	0	0	0	0	0	0	0	0	0
Profit after Tax	771	775	767	760	768	775	783	791	799	807
Funds Statement										
Profit after Tax	771	775	767	760	768	775	783	791	799	807
Loans	0	0	0	0	0	0	0	0	0	0
Subsidies	0	0	0	0	0	0	0	0	0	0
Depreciation	413	413	413	413	413	413	413	413	413	413
Sources	1185	1188	1180	1173	1181	1189	1197	1204	1212	1221
Capital Works	0	0	0	0	0	0	0	0	0	0
Payment of Principal	608	627	697	768	775	783	791	799	807	815
Working Capital	577	561	483	406	406	406	406	406	406	406
Applications	1185	1188	1180	1173	1181	1189	1197	1204	1212	1221
Loan Liabilities	9734	9134	8451	7683	6908	6125	5334	4535	3728	2913
Cash Balance	10238	10800	11283	11689	12094	12500	12905	13311	13717	14122

Source: JICA

Chapter 5 Improvement of Health and Sanitation

5.1 Plan for Sanitary Facilities

The sanitation situation in Werota is very bad. The critical shortage of water supply in the town plays a considerable role in aggravating the sanitation situation. Therefore, any plan of improving the sanitary facilities should go hand-in-hand with the improvement of the water supply. The waste water production in liters per capita per day was estimated using the water demand data for each types of water supply services.

Table 5.1.1 Water Demand in lpcd and Waste Water Production in lpcd for Werota

Item	HC			YC			PF		
	1995	2005	2010	1995	2005	2010	1995	2005	2010
• Water demand (lpcd)	28.6	58	63	29.3	19.1	34	1.5	15	16
• Waste water generation rate (%)	66	74	75	64	67	66	60	63	63
• Waste water production (lpcd)	19	43	47	12	23	25	0.9	9	10

Form the water demand and waste water production as indicated in Table 5.1.1, conventional sewerage system can not be introduced in Werota even by the year 2010.

Therefore, the sanitary technologies envisaged for Werota are on-site technologies such as drainage and waste water disposal pit.

5.1.1 Plan of Toilet Facilities

The sanitary technologies planned for Werota are categorized into four major groups:

- Improved Traditional Pit Latrines
- VIP Latrines
- Compost Toilets
- Flush Toilets

These technologies are related to the types of water supply services of house connections(HC), yard Connections(YC) and public fountain(PF). The proposed toilet facilities are considered for residential or domestic households as well as for non-domestic households taking the water supply services of HC, YC and PF into account.

Table 5.1.2 Proposed Sanitation System in Relation to Types of Water Supply Services for Domestic Households

Types of Water Supply Services	Proposed Sanitary System for Domestic Households
1. Traditional Water Sources + Public Fountain (PF)	• Improved traditional pit latrine • VIP latrine, single-pit or double-pit • Soakaway pit for sullage
2. Yard Connection (YC)	• VIP latrine, single-pit or double-pit • Compost latrine • Pour-flush toilet with simple water seal and on-site pit • Pour-flush latrine + soakaway pit • Soakaway pit for sullage
3. House Connection (HC)	• Pour-flush toilet + soakaway pit • Cistern-flush toilet + soakaway pit • Pour-flush or cistern-flush toilet + septic tank • Soakaway pit for sludge

In each category, the first sanitation technology proposed is generally the cheapest and the simplest. Those that can afford more can have the subsequent ones depending on their choices and paying capacity.

For communities, schools, bus, terminals, market areas, health facilities, government offices, hotels, restaurants, bakeries, pastries, bars, tej and tella drinking houses, etc. the sanitation technologies proposed are indicated in Table 5.1.3.

Table 5.1.3 Proposed Sanitation Technologies for Communities and Non-domestic Households

Category	Proposed Sanitation System
1. Communities	• VIP community latrine with washbasin
2. Schools & training centers	• VIP collective toilet with washbasin
3. Market & bus terminals	• VIP public toilet with washbasin or shower
4. Government institutions	• VIP latrine with washbasin • Cistern-flush toilet + soakaway pit • Cistern-flush toilet + septic tank
5. Commercials	• VIP latrine with washbasin • Pour-flush or cistern-flush toilet + soakaway pit • Pour-flush or cistern-flush toilet + septic tank
6. Hotels, restaurants, drinking place, etc.	• Collective VIP latrine with washbasin • Pour-flush toilet with washbasin + soakaway pit • Cistern-flush toilet with washbasin + septic tank • Soakaway pit for sullage
7. Hospitals, health centers, clinics	• Collective VIP latrine with washbasin • Pour-flush toilet with washbasin + soakaway pit • Cistern-flush toilet with washbasin + septic tank • Soakaway pit for sullage

5.1.2 Plan of Sullage, Dry Solid Waste and Drainage

(1) Sullage

Sullage is the waste water which does not contain excrete but comes out from each household. Sullage always contains some pathogens though the concentration is much lower than that in sewage. In Werota, sullage is presently being dumped in front of the households or along the streets. This poses a health risk if it is allowed to continue to be dumped everywhere.

The plan considers sullage soakaway pits of various sizes depending on the size and type of households for its disposal. The sullage soakaway pits need to be properly lined with stone, adobe, and other local materials with open joints for the major posts of the depth leaving about 30 cm from the top for pointed lining. If the waste water or sullage is too much for the soakaway pits to handle, then drainage field channels should be used.

(2) Dry Solid Waste

The dumping of dry solid wastes every where has created environmental pollution and water contamination in Werota which should not be allowed to continue in order to improve the sanitation situation in the town. Four refuse disposal sites are proposed an locations are to be at outskirt of the town. The Municipality, the kobeles and the communities being coordinated, strategic sites for locating the refuse collecting bins should be carried so that the members of the communities can dump their household dry solid wastes without going long distance. The contents of the bins should be carried to the refuse dumping sites by refuse disposal truck or animal-drawn cart.

(3) Drainage

Sullage soakaway pits are planned for disposal of sullage from domestic as well as non-domestic households. Sometimes the waste water may be too much for soakaway pits to handle or the soaking capability of the pit may be too low creating excess waste water to be drained. When this condition arises, "drain field channels" have to be used, the size being directed by the quantity of excess waste water.

When rain falls during the rainy season, the surface water created should be drained properly to avoid formation of stagnant waters. The main road that passes through the middle of Werota has proper side as wall as cross drainage facilities. Most of these facilities are not functioning adequately due to blockages by rubbishes and solid wastes that have been dumped on them. The lack of regular maintenance is the major cause. Therefore, the first drainage plan for Werota is to open up all blocked drainage facilities and carry out regular maintenance to keep them open. The secondary roads within Werota do not have adequate drainage facilities. These should be provided and regularly maintained. The low areas where water stagnates(e.g. near the Senior High School, the bus terminal, the clinic, etc.) should be provided with earth channels to drain the water.

5.2 Financial Plan for Sanitary Facilities

To estimate both the capital cost of building the sanitary facilities and the annual operation and maintenance cost, based on the 1995 prices, the following assumptions have been made.

- The calculated waste water flows for Werota are too low to justify the installation of conventional sewerage system in Werota. On account of this, the sanitary facilities proposed for Werota are on-site sanitary technologies.
- Those households that do not have any toilet facilities in Werota at present are assumed to have one type of toilet facility by the year 2010.
- Sanitary technologies that are new to the culture of the people living in Werota are to be introduced gradually and with proper prior education as to the benefits and usefulness of the new technologies. Social acceptability of the new technology has to be confirmed prior to its introduction.
- Proposals for the appropriate sanitary technologies are drawn up based on the types of water services rendered in Werota.
- The households in the same water service category can have toilets of the standard they can afford to pay for.

5.2.1 Households

From projected population of Werota for target years of 2005 and 2010, households have been estimated using the family size for each type of water services.

Table 5.2.1 Households in Werota for Target Years of 2005 & 2010 by Type of Water Services

Target Year	Households		
	HC	YC	PF
• 2005	610	2,440	3,010
• 2010	1,470	3,640	2,630

5.2.2 Estimate of Costs

(1) Capital Costs per Unit

For each type of toilet facility that is considered appropriate for Werota and some equipment required, indicative costs for constructing each type of sanitary facilities and for purchasing the equipment are estimated as follows.

Table 5.2.2 Indicative Cost of a Type of Sanitary Facility or Equipment

Type of Sanitary Facility or Equipment	Indicative Cost of One Facility or Equipment (Birr)
1. Improved traditional pit latrine	1,000
2. VIP toilet, single pit	1,500
3. VIP toilet, double pit	2,000
4. VIP toilet, shared	15,000
5. VIP toilet, community	45,000
6. VIP toilet, collective (e.g. schools)	65,000
7. VIP toilet, public (e.g. market)	95,000
8. Compost latrine	2,500
9. Pour-flush + soakaway pit	3,000
10. Pour-flush + septic tank + soakaway pit	7,500
11. Cistern-flush + soakaway pit	4,000
12. Cistern-flush + septic tank + soakaway pit	8,500
13. Sullage soakaway pit	800
14. Drain field channel	4,000
15. Medium size vacuum truck	250,000
16. Medium size refuse collection and disposal truck	180,000
17. Animal-drawn cart	12,000
18. Refuse collection bin	250
19. Sludge dumping site	10,000
20. Refuse disposing and burning site	6,500

(2) Annual Operating and Maintenance Costs per Unit

The annual operating and maintenance cost is based on the assumption that most of the work is going to be done by labor only. For the equipment both running and maintenance costs are included.

Table 5.2.3 Annual Operating and Maintenance Cost per Unit

Type of Sanitary Facility or Equipment	Annual Operating and Maintenance Cost (Birr)
1. Improved traditional pit latrine	200
2. VIP toilet, single pit	250
3. VIP toilet, double pit	300
4. VIP toilet, shared	400
5. VIP toilet, community	700
6. VIP toilet, collective (e.g. schools)	800
7. VIP toilet, public (e.g. market)	3,000
8. Compost latrine	750
9. Pour-flush + soakaway pit	1,000
10. Pour-flush + septic tank + soakaway pit	1,250
11. Cistern-flush + soakaway pit	1,200
12. Cistern-flush + septic tank + soakaway pit	1,400
13. Sullage soakaway pit	100
14. Drain field channel	800
15. Vacuum truck	7,500
16. Refuse collection and disposal truck	8,500
17. Animal-drawn cart	3,000
18. Refuse collection bin	50
19. Sludge dumping site	2,000
20. Refuse disposing and burning site	2,500

(3) Assumptions for Estimating the number of Toilets to be Implemented in Werota by the Year 2005 and 2010

To find the number of toilets to be implemented in Werota by the year 2005 and 2010, the following assumptions have been made.

- By the year 2005

  - All schools in Werota will have, at least, VIP collective toilets.
  - The Werota clinic and possibly a health center will have VIP collective toilets.
  - Werota market area and bus terminal will have VIP public toilet.
  - 100% of households that have house water supply connections (HC) will have some kind of flush toilet.
  - 75% of the households that have yard water supply connections (YC) will have VIP or higher toilets.
  - 75% of households that use public fountain (PF) as a source of water supply will have improvement traditional toilets or VIP toilets.

- By the year 2010

  - 50% of households that have HC water supply will have some kind of flush toilets.
  - 50% of households that have YC will have VIP or higher toilets.
  - 100% of household that use PF will have improved traditional latrine or VIP latrine or higher grade toilets.

- In each category (HC,YC,PF), those that can afford more can have higher standard of toilets of their choices.

- All equipment will be replaced by this time.

(4) Total Capital Cost

Indicative capital costs for sanitary facilities for Werota based on 1995 prices are shown in Table 5.2.4 for the year 2005 and in Table 5.2.5 for the year 2010.

Table 5.2.4 Capital Costs of Sanitary Facilities for Werota for Year 2005

Facilities	No	Unit Cost (birr)	Total Cost (1,000 Birr)
• VIP collective toilets for schools	8	65,000	520
• VIP collective toilets for clinics and health centers	4	65,000	260
• VIP public toilet for market area and bus terminal	4	95,000	380
• 100% households with HC to have PF toilets	610	7,500	4,575*
• 75% households with YC to have VIP shared toilets or higher toilets	1,830	15,000	27,450*
• 75% households with PF to have VIP toilets	2,258	2,000	4,516*
• Vacuum truck	1	250,000	250
• Refuse disposal truck	1	180,000	180
• Sludge dumping site	2	10,000	20
• Refuse disposing site	4	6,500	26
• Refuse collecting bins	80	250	20
Total			38,197
Excluding Households' (*)			1,656

Table 5.2.5 Capital Costs of Sanitary Facilities for Werota for the Year 2010

Facilities	No	Unit Cost (birr)	Total Cost (1,000 Birr)
• 50% of households in Werota with HC to have flush toilets	735	7,500	5,513*
• 50% of Werota households with YC to have VIP toilets or higher	1,820	3,000	5,460*
• 100% of Werota households with PF to have VIP toilets	2,630	2,000	5,260*
• Replacement of vacuum truck	1	250,000	250
• Replacement of refuse disposal truck	1	180,000	180
• Replacement of refuse collecting bin	80	250	20
Total			16,683
Excluding Households' (*)			450

(5) Total Operating and Maintenance Cost

Indicative operating and maintenance cost for sanitary facilities for Werota are shown in Tables 5.2.6 and 5.2.7 for the years of 2005 and 2010 each.

Table 5.2.6 Annual Operating & Maintenance Costs for the Year 2005

Facilities	No	Unit Cost (birr)	Total Cost (1,000 Birr)
• VIP collective toilets for schools	8	800	6.40
• VIP collective toilets for clinics and health centers	4	800	3.20
• VIP public toilet for market area and bus terminal	4	3,000	12.00
• 100% households with HC to have PF toilets	610	1,250	762.50*
• 75% households with YC to have VIP shared or higher toilets	1,830	400	732.00*
• 75% households with PF to have VIP toilets	2,258	300	677.40*
• Vacuum truck	1	7,500	7.50
• Refuse disposal truck	1	8,500	8.50
• Sludge dumping site	2	2,000	4.00
• Refuse disposing site	4	2,500	10.00
• Refuse collecting bins	80	50	4.00
Total			2,227.50
Excluding Households' (*)			55.60

Table 5.2.7 Annual Operating & Maintenance Costs by the Year 2010

Facilities	No	Unit Cost (birr)	Total Cost (1,000 Birr)
• Flush toilets for households with HC	735	1,250	918.75*
• VIP or higher toilets for households with YC	1,820	1,000	1,820.00*
• VIP toilets for households using PF	2,630	300	789.00*
• Vacuum truck	1	7,500	7.50
• Replacement disposal truck	1	8,500	8.50
• Replacement collecting bins	80	50	4.00
Total			3,547.75
Excluding Households' (*)			20.00

(6) Summary of Costs

- Capital Costs

Year	Cost in 1,000 Birr (Total)	Excluding Households'
2005	38,197	1,656
2010	16,683	450
Total	54,880	2,106

- Annual Operating & Maintenance Costs

Year	Cost in 1,000 Birr (Total)	Excluding Households'
2005	2,227.50	55.60
2010	3,547.75	20.00
Total	5,775.25	75.60

5.3 Application of Sanitary Education Program

The sanitary education program approach outlined in the Main Report, will use a four pronged approach with the Health Center, Schools, Religious Institutions and a health/ sanitation promotion committee. In line with that approach and with reference to the material gathered during the field survey and experimental sanitary education program the following specific recommendations are made for Werota.

The impression of Werota is a traditional type of community lacking the motivation to change. Before sanitation improvements can be realized in Werota this attitude must soften. Teachers, students, health staff and religious leaders are all willing to participate in a hygiene promotion campaign. This can be done with the CPP taking an intensive facilitative role.

Suggested priorities for sanitary behavior improvements are outlined in Table 5.3.1. There are significant differences between this chart and the lowest income groups, which must be accounted for in the implementation of the programme.

Table 5.3.1 Sanitary Education Priorities in Werota

Priority level	Type of Behavior	Blocks to Improved Practice
Medium -Low*	Handwashing after handling children's stools	Personal hygiene (women/boys/girls roles) made easier by improving access to water and soap/ ash nearer to latrine (women) and improving the status of such behavior (all)
High	Solid waste disposal in covered pits or burned	Sites not allocated for public waste disposal sites or not managed strictly (Municipality/ Woreda) Individuals (women) must be informed of where (Municipality/ Woreda) and how to dispose of waste (CPP/ all)
High	Waste water disposal in pits, drains or vegetable gardens	Drainage insufficient and disposal into drains not strictly managed (Municipality/Woreda) Individuals (women) must be informed of where to dispose waste water (Municipality/Woreda) and shown safe disposal techniques (CPP/all)
Medium -Low	Fly Control	Associated with climate but also related to solid and liquid waste disposal and excreta disposal (Municipality/Woreda /All role) Behaviors like covering of food and water pots during storage should be maintained (CPP/All)
Medium -High	Sanitary disposal of children's excreta	Small children should be encouraged to use the latrine as soon as they are able (all family members) Clearing up of children's excreta (women/girls) to be encouraged, information about health risks of children's excreta provided (CPP/all)
High	Piped water used always*	Piped water not always available in sufficient quantities (WSS role) and not available when required by people (WSS role) at sites convenient for collection (WSS role). People (women/girls) must be encouraged to use piped water always for drinking (CPP)
Medium -High	Handwashing with soap after defecation	Personal hygiene (all) made more easy by making access to water and soap/ash nearer to the latrine (women's role) and by improving the status of the improved behavior (all)
Medium -High	Access to Piped water	Improved access and level of piped water supply (WSS role) All use water but this depends mostly on opening times, location of supply sources and to a lesser extent to price (women/girls/(boys))
Medium -Low	Latrine coverage for all households*	Latrines to be built and maintained (Public - Municipality/Woreda and Community/private latrines -WSS/CPP/All (made easier with examples of low cost latrines and loans (WSS)
Medium -Low	Latrine use by all members of household*	Where there is a latrine, not all (children) of the household members use it. Use by all family members should be encouraged and status of latrine users promoted (CPP/all)
Optional	Kitchen utensils and water scoop kept off the floor**	Domestic hygiene (women) although facilitated by shelf or similar available in kitchen to keep utensils off floor (women/ men) Construction of such shelves to be promoted (CPP)
	*High priority for low income groups	
	**Medium-High priority for low income groups	

Chapter 6 Reinforcement of Organization

It is advised to refer to Table 6.1.1 and Figure 6.1.1 when you read this section.

6.1 Comprehensive Organization and Management

The production of water will increase markedly under the proposed plan from 276 m^3/day in 1995 to 881 m^3/day in 2000, 1,423 m^3/day in 2005 and 2,369 m^3/day in 2010.

In line with it, the organizational structure will be enlarged, new functions will be added and the number of employees will be increased.

Basically the number of employees in the target years was estimated dividing water production by water production per employee. In estimating water production per employee, labor efficiency resulting from a greater production was assumed. It is proposed that sanitation functions be introduced in the organization of WSS from 2000 on. It means that more manpower will be required.

In adding sanitation functions to WSS the full name of WSS will be changed to Water Supply and Sanitation Service. But, the abbreviated name will be WSS as has been the case.

Considering the above factors, it is proposed that the number of employees will increase from 18 in 1995 to 42 in 2000, 47 in 2005 and 58 in 2010.

The organizational structure will get enlarged and more diversified. The ultimate organizational structure of WSS to be realized in the last target year of 2010 is shown in Figure 6.1.1.

As it shows, the organizational structure of WSS will be basically composed of 7 elements: Manager, Internal Audit, Customer Services, Administration Service, Financial Service, Technical Service and Sanitary Service. These are a skeletal structure or fundamental requirements of water supply and sanitation services. The functions of the last four big Services will get more diversified as years go by in accordance with greater water production.

6.2 Organization and Management of Water Supply

The number of personnel for water supply functions of WSS will be 40, 43 and 53 in 2000, 2005 and 2010 respectively.

Personnel for Administration, Financial and Technical Services will be basically distributed in such a way that their respective shares will be 30%, 35% and 35%.

A brief explanation on the ultimate organizational structure and functions will be given below:

The objectives of water supply functions of WSS are to supply sufficient piped water on one hand and to financially stand on its own feet. In this regard Customer Services and Internal Audit are typical functions of WSS. Besides them there will be three major Services.

Administration Service is composed of General Administration, Personnel, Storage and Legal Sections. General Administration Section will be in charge of secretarial/clerical work. Guards and sweepers also belong to this section. Personnel Section will be in charge of recruitment, assignment and training of personnel, and remuneration. Storage and purchasing of materials and supplies will be done in Storage Section. Such matters as complaints and penalties can be taken care of by Legal Section.

Financial Service controls Budgeting, Accounting, Financial Management and Operation Sections. Annual and monthly budget of income and expenditures will be prepared in Budgeting Section. Monthly and annual accounting of expenditures and income will be performed in Accounting Section. Financial Management Section makes analysis and evaluation of financial performances. Operation Section is in charge of meter reading, billing and collection, and cash water selling.

Technical Service covers Technical Records, Operation and Maintenance, Inspection and Work Sections, and Workshop. Records of equipment and supplies such as acquired dates, number, plans, dimension, breakdowns and repairs will be kept in Technical Records Section. Operation and maintenance of pumping stations, reservoirs, pipelines, public fountains, etc. will be taken care of by the section of the same name. Inspection of the above-mentioned facilities will be regularly done by the section of the same name. Repairing and manufacturing belong to Workshop. Works Section is in charge of rehabilitation/replacement/construction of facilities.

The number of personnel to be assigned by position/function in 2000, 2005 and 2010 is shown in the latter half of Table 6.1.1.

6.3 Organization and Management of Sanitation

The number of personnel for sanitation functions of WSS will be 2, 4 and 5 in 2000, 2005 and 2010 respectively.

A brief explanation on the ultimate organizational structure and functions will be given below:

An independent department called Sanitation Service will be introduced. The Service will be comprized of Public Relations, Loan Service and Maintenance Sections.

Public Relations Section will be in charge of the provision of information and public relations services to help people to install septic tank toilets and dry pit latrines. Loan Service Section will provide loan/subsidy to clients for the installation of septic tank toilets and keep related records. Maintenance Section will have a vacuum truck to regularly empty toilets and will regularly clean and maintain drainages.

The number of personnel to be assigned by position/function in 2000, 2005 and 2010 is shown in the latter half of Table 6.1.1.

Table 6.1.1 Personnel Requirements

1. Total No. of Personnel

Item	1995	2000	2005	2010
1. Total Production of Water (m^3/day)	276	881	1,423	2,369
2. Water Production per Worker (m^3/day/worker)	15.3	20	30	40
3. Coefficient	1	0.9	0.9	0.9
4. No. of Personnel	18	40	43	53
5. Additional Personnel for Sanitation	0	2	4	5
6. Final No. of Personnel	18	42	47	58

2. Breakdown of Personnel by Position/Function

Positions/Functions	1995	2000	2005	2010
1. Manager	1	1	1	1
2. Customer Services	0	1	1	1
3. Internal Audit	0	1	1	1
4. Administration Service				
1) Head	0	1	1	1
2) General Administration Section				
Secretaries/Typists/Clerks	0	1	1	1
Guards	4	6	7	8
Sweepers/Janitors	0	1	1	1
Drivers	0	0	0	1
Sub-Total	4	8	9	11
3) Personnel Section				
Recruitment and Assignment	0	1	1	1
Training	0	0	0	0
Remuneration	0	0	0	0
Sub-Total	0	1	1	1
4) Storage Section				
Store Keepers	1	1	1	1
Purchase of Materials/Supplies	0	0	0	0
Sub-Total	1	1	1	1
5) Legal Section	0	0	0	1
Total	5	11	12	15

2. Breakdown of Personnel by Position/Function (Continued)

Positions/Functions	1995	2000	2005	2010
5. Financial Service				
1) Head	0	1	1	1
2) Budgeting Section	0	1	1	1
3) Accounting Section				
Accountants	1	1	1	1
Cashiers/Treasurers	1	1	1	2
Sub-Total	2	2	2	3
4) Financial Management Section				
Financial Analysts	0	1	0	1
5) Operation Section				
Meter Readers	1	2	2	3
Bill Distributors/Collectors	1	1	1	3
Water Sellers	3	5	6	5
Sub-Total	5	8	9	11
Total	7	13	14	17
6. Technical Service				
1) Head	2	2	2	2
2) Technical Records Section	0	1	1	1
3) Operation and Maintenance Section				
Mechanics	0	1	1	1
Electricians	0	1	1	1
Motor Operators	1	4	4	4
Plumbers	2	2	2	2
Sub-Total	3	8	8	8
4) Inspection Section				
Water Meter Technicians	0	1	1	1
Leakage Detectors	0	1	1	1
Water Quality Analysts	0	0	0	1
Sub-Total	0	2	2	3
5) Workshop	0	0	1	2
6) Works Section				
Contracting	0	0	0	1
Designing/Drafting	0	0	0	1
Sub-Total	0	0	0	2
Total	5	13	14	18
7. Sanitary Service				
1) Public Relations Section	0	1	1	1
2) Loan Service Section	0	1	1	1

2. Breakdown of Personnel by Position/Function (Continued)

Positions/Functions	1995	2000	2005	2010
3) Maintenance Section				
Technicians	0	0	1	2
Drivers	0	0	1	1
Sub-Total	0	0	2	3
Total	0	2	4	5
Grand-Total	18	42	47	58

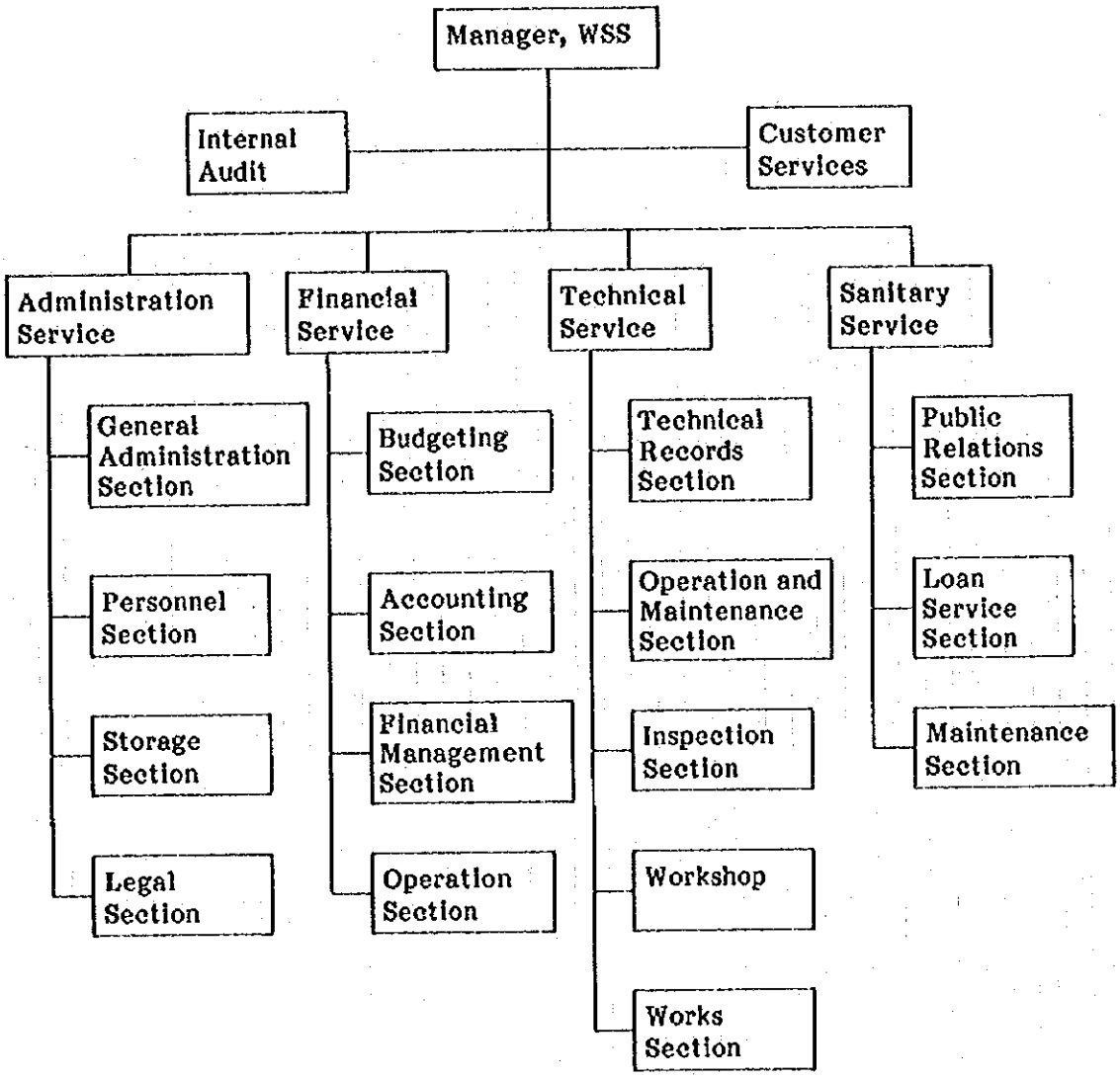


Figure 6.1.1 Proposed Model Organization Set-up of WSS

6.4 Community Building / Participation and WID

Based on the approach outlined in the Main Report, the following details are recommendations specifically for Werota based on the field survey.

- Werota water supply system needed to be upgraded and redistributed so that extra PFs are provided for people on the outskirts of the town who currently have poor water access.

- There is demand for a limited number of extra PCs in the area near the bus station only. Existing PFs need to be opened for longer hours to supply the demand for water. PFs could be community managed if committees were given adequate support. Without this there is a fear of creating division in the community.

- The community lack the motivation to change. Before sanitation improvements can be realized in Werota this attitude must soften. Teachers, students, health staff and religious leaders are all willing to participate in a hygiene promotion campaign.

- Sanitation facilities would best be provided by community managed communal latrines. These must be easy to use and simple to maintain and copy. Pit latrines are therefore the preferred option, either simple or ventilated pit latrines (VIPs). Public latrine with shower may be appropriate in the center of town, either near the dismantled public fountain or at the bus terminal.

- People with poorer access to water have lower expectations of a potential water supply intervention and should not loose out on novel opportunities if they are implemented.

Chapter 7 Project Evaluation

7.1 Economic Evaluation

7.1.1 Economic Benefits

(1) General

There are two major benefits deriving from the implementation of the Project.

One is the time benefit. Under the present circumstances people in the eleven centers more or less go to the far-away springs/rivers and/or public fountains every day to fetch water. The time spent in such a way comes to an enormous amount when it is aggregated as an annual total for the whole town.

If the Project is implemented, less people will go to the above-mentioned water sources as more people will use house connections or yard connections. That is to say, the time for water fetching will be greatly reduced.

The JICA Study Team calculated the time to be reduced annually for the whole town in the future years under the "with project" conditions.

Eventually, the team converted the time into financial terms. This is the time benefit.

Another is the reduction of water-borne diseases. When the Project is implemented, more people will have an access to clean piped water. It will reduce the opportunities for them to get in touch with contaminated water and contract such diseases as diarrhea, dysentery, typhoid and scabies.

However, how many such cases will be reduced is very hard to estimate. Therefore, the team just wants to remind people that such an important benefit will be realized in the "with project" case.

(2) Calculation of Economic Benefits

How the above-mentioned time benefit was calculated is summarized below:

As a result of the socio-economic questionnaire survey conducted by JICA, the following information was collected:

Users	Time spent at a time (min.)	Daily frequency (times)	No. of persons at a time
Public fountains	77	2.9	1.1
Springs/rivers	71	1.5	1.1

If the number of households using public fountains and the number of households using springs/rivers is estimated in both the "without project" and "with project" cases in the

target years, one can work out the total time spent fetching water every year in both cases by utilizing the above tabulated information.

The respective number of households using the above two water sources in the "with project" case was estimated based on the service population projection in the other chapter. The respective number of such households in the "without project" case was calculated on the assumption that piped water users will increase by 2% every year.

Then, the difference in the aggregated annual water-fetching time between the two cases was calculated for each year.

Finally, such a time was converted into financial terms by using the following information:

Monthly household income (birr)	Family size (persons)	Waking hours in a day	Time value per hour (birr)
A	B	C	D=A/30/B/C
262	6.3	16	0.0866

The results are shown in Table 7.1.1.

7.1.2 Cost

The cost can be divided into capital cost and operation and maintenance (O & M) cost.

Capital cost is huge compared to the economic benefits resulting from the reduction of water fetching time. If one could quantitavely incorporate the subdual of water-borne diseases, benefit related to WID and multiplier economic effect into benefits, then one could consider the total cost including capital cost. But, the reality is such that one considers O & M cost - actually, a part of it - only for the sake of convenience.

O & M cost consists of electric cost, fuel cost, disinfection cost, personnel cost, installation cost of connections, purchase cost of water meters and other cost. (For more details refer to 4.5.) It was estimated as an annual recurrent cost for future years.

It turned out that the whole O & M cost is too large in comparison with the above benefits. Eventually, personnel cost was picked up, representing O & M cost.

The personnel cost used here is the incremental one, that is to say, the difference between the personnel cost in the " with project " case and the personnel cost in the " without project " case.

7.1.3 Economic Evaluation

Based on the data calculated in the above-mentioned way, cost benefit streams were prepared as shown in Table 7.1.2.

As it shows, the cumulative cost and benefits for 30 years come to 6,693 thousand birr and 5,611 thousand birr respectively. It means benefits are 84% of cost at the discount rate of zero.

That is to say, the cumulative benefits of the reduction of water fetching time for 30 years are equal to 84% of the cumulative personnel cost of WSS at 0 opportunity cost.

It is to be noted that time benefit resulting from project implementation is substantial, comparable to the personnel cost of WSS.

Table 7.1.1 Saved Time and Benefit

Year	Saved Time (hours)	Benefit (birr)
1996	0	0
1997	0	0
1998	0	0
1999	311,897	27,023
2000	586,839	50,844
2001	755,821	65,484
2002	936,671	81,153
2003	1,130,070	97,909
2004	1,336,737	115,815
2005	1,557,478	134,940
2006	1,832,020	158,727
2007	2,119,364	183,622
2008	2,420,176	209,685
2009	2,735,155	236,974
2010	3,065,037	265,555
2011	3,065,037	265,555
2012	3,065,037	265,555
2013	3,065,037	265,555
2014	3,065,037	265,555
2015	3,065,037	265,555
2016	3,065,037	265,555
2017	3,065,037	265,555
2018	3,065,037	265,555
2019	3,065,037	265,555
2020	3,065,037	265,555
2021	3,065,037	265,555
2022	3,065,037	265,555
2023	3,065,037	265,555
2024	3,065,037	265,555
2025	3,065,037	265,555

Table 7.1.2 Cost Benefit Streams

CC=Capital Costs; OM=O/M Costs; CS=Costs; BF=Benefits
CF=Cash Flow (=BF - CS)

(Unit:thousand birr)

NO.	YEAR	CC	OM	CS	BF	CF
1	1996	0	0	0	0	0
2	1997	0	0	0	0	0
3	1998	0	0	0	0	0
4	1999	0	164	164	27	-137
5	2000	0	191	191	51	-140
6	2001	0	195	195	65	-130
7	2002	0	200	200	81	-119
8	2003	0	205	205	98	-107
9	2004	0	209	209	116	-94
10	2005	0	214	214	135	-79
11	2006	0	226	226	159	-67
12	2007	0	237	237	184	-53
13	2008	0	249	249	210	-39
14	2009	0	260	260	237	-23
15	2010	0	272	272	266	-6
16	2011	0	272	272	266	-6
17	2012	0	272	272	266	-6
18	2013	0	272	272	266	-6
19	2014	0	272	272	266	-6
20	2015	0	272	272	266	-6
21	2016	0	272	272	266	-6
22	2017	0	272	272	266	-6
23	2018	0	272	272	266	-6
24	2019	0	272	272	266	-6
25	2020	0	272	272	266	-6
26	2021	0	272	272	266	-6
27	2022	0	272	272	266	-6
28	2023	0	272	272	266	-6
29	2024	0	272	272	266	-6
30	2025	0	272	272	266	-6

7.2 Financial Evaluation

7.2.1 Calculation of FIRR

Regarding detailed information on revenues and cost, refer to Section 4.5.

(1) Initial Trial

The value exceeds 1%, which is the assumed interest rate of external loan by 5.7%. It is judged to be sufficiently and reasonably high considering the nature and objective of the Project.

Initially it was assumed that the central government would provide subsidy to the Werota WSS amounting to 80% of initial cost.

It is to be noted that the cost related to the construction of accommodation facilities as well as WSSD's management is not included in the above initial cost.

Based on the revenues and cost estimated in Section 4.5 under such an assumption, cost benefit streams were prepared for the 30 years starting in 1996.

Using them, financial internal rate of return (FIRR) was calculated. As a result, it worked out to 7.3%.

The value was judged to be too high in consideration of the nature and objective of the Project.

Besides, it is important for the central government to be paid back initial cost as much as possible, thus lessening its budgetary burden.

After repeated simulations, it was finally decided that the subsidy ratio of initial cost would be 60%.

(2) Final Results

Under the above-mentioned subsidy conditions, cost benefit streams were prepared as shown in Table 7.2.1.

Using the streams, FIRR was calculated. As a result, the value of 3.9% was obtained.

The value exceeds 1%, which is the assumed interest rate of external loan by 2.9%. It is judged to be sufficiently and reasonably high considering the nature and objective of the Project.

7.2.2 Sensitivity Analysis

To see how the value will be affected under different circumstances, sensitivity analysis was conducted. The conditions and results are shown below:

Item	Conditions		Results	Difference from Base Case
1. Case 1	Benefits	: -10%	FIRR: 2.6%	-1.3%
2. Case 2	Initial Cost	: +10%	FIRR: 3.2%	-0.7%
3. Case 3	Progress of Construction	: 1997=70% 1998=30%	FIRR: 4.1%	+0.2%
4. Case 4	Progress of Construction	: 1998=70% 1999=30%	FIRR: 3.0%	-0.9%

In Cases 3 and 4 detail design will be done in 1996 and 1997 respectively.

As the table shows, the value of FIRR is robust enough by maintaining the level of substantially more than 1% under adverse circumstances conceivable.

Case wise, the shortage of revenues will deal the strongest negative impact on the financial feasibility of the Project, followed by the delayed progress of works and cost overrun, while earlier completion of works will raise the feasibility by a significant margin.

Table 7.2.1 Cost Benefit Streams

CC=Capital Costs; OM=O/M Costs; CS=Costs; BF=Benefits
CF=Cash Flow (=BF - CS)

(Unit:thousand birr)

NO.	YEAR	CC	OM	CS	BF	CF
1	1996	831	54	886	66	-820
2	1997	5148	55	5203	67	-5136
3	1998	5148	57	5204	68	-5136
4	1999	0	386	386	399	13
5	2000	0	425	425	631	206
6	2001	0	522	522	735	213
7	2002	0	535	535	819	284
8	2003	0	549	549	903	354
9	2004	0	563	563	987	424
10	2005	0	577	577	1071	495
11	2006	0	732	732	1254	522
12	2007	254	759	1013	1406	392
13	2008	1270	786	2056	1557	-499
14	2009	1270	813	2083	1709	-374
15	2010	0	840	840	1861	1021
16	2011	0	530	530	1788	1258
17	2012	13	530	542	1788	1245
18	2013	13	530	542	1788	1245
19	2014	0	530	530	1788	1258
20	2015	0	530	530	1788	1258
21	2016	0	530	530	1788	1258
22	2017	0	530	530	1788	1258
23	2018	0	530	530	1788	1258
24	2019	0	530	530	1788	1258
25	2020	0	530	530	1788	1258
26	2021	0	530	530	1788	1258
27	2022	0	530	530	1788	1258
28	2023	0	530	530	1788	1258
29	2024	0	530	530	1788	1258
30	2025	0	530	530	1788	1258