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FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
MINISTRY OF WATER RESOURCES

No. 22

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

FEASIBILITY REPORT
DEJEN

(Volume II-XI)

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 Dejen 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.

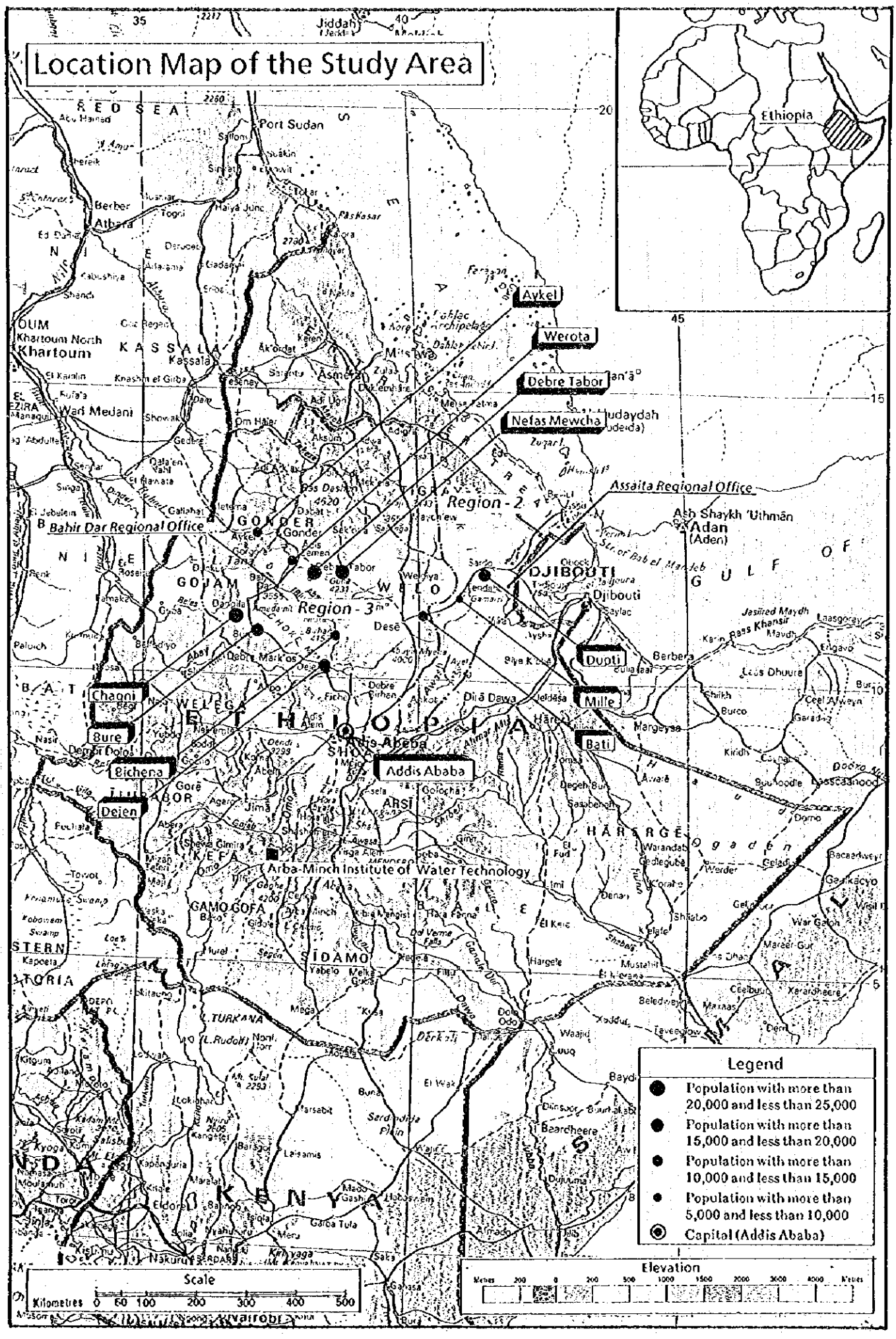
The major objectives of this Study are 1) to conduct a feasibility study on the water supply system in order to improve living condition of the population in the Study area by enhancing the level of the water supply services in terms of water quantity, water quality and its accessibility, 2) to formulate 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
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 60 100 200 300 400 500
Elevation
Meters -200 0 200 500 1000 1500 2000 3000 4000 Meters
Region - 2
Region - 3
Bahir Dar Regional Office
Assaita Regional Office
Addis Ababa
Arba-Minch Institute of Water Technology
Aykel
Werota
Debre Tabor
Nefas Mewcha
Dupti
Mille
Bati
Chagni
Bure
Bichena
Dejen
Port Sudan
Djibouti
Adan (Aden)
Nairobi

General Description of Current Condition in Dejen

Items	Description
Administration	Amhara Region, East Gojjam, No. of Kebele : 2
Residents	Total population : 10,250 (1.3 persons/ha) Average family size : 6.8 persons Amhara : 99% Christians : 65% (1 church) Tigre : 1% Moslems : 35% (2 mosques) : %
Educational Conditions	

	Kinder garden	Elementary school	Junior high s.	Senior high s.
No. of school	2	3	1	1
No. of teachers	4	64	21	27
No. of students	126	1371	454	710

Medical Conditions	Hospital : - Doctor : - Health center : - Nurse : - Health clinic : 1
Economic Conditions	Hotels/restaurants : 74 Shops : 240 Cottage industry : 29 Others : 2 Average monthly household income : 312 birr
Water Supply Condition	The source of WSS : Borehole (1) Major other sources : Hand dug well & Spring Domestic consumption : 88.6 cum/day (10.4 lpcd) Other consumption : 25.5 cum/day (total 114.1) Water service coverage : 83% House connection : 56.6 lpcd (1%, 1.0 birr/cum) Yard connection : 21.0 lpcd (22%, 1.0 birr/cum) Neighbors : 9.1 lpcd (12%, 1.0(3.9) birr/cum) Public fountain : 4.9 lpcd (48%, 1.0(2.0) birr/cum)
Sanitary Condition	Septic toilet : -/100HH Dry pit toilet : 46/100HH Community toilet : 6/100HH Open field : 48/100HH Toilet condition : Ill-maintained and constructed. 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 : 25% Diarrhea awareness : 35% ORS awareness : 5% Sanitary behaviors score : 862/1600 (54%) Needs : Adequate Water, Health Education, Electricity
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 Dejen

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 10,250 (3.0%) 11,883 (3.0%) 13,776 (2.5%) 15,586
Water Demand Projected in cum/day	in 1995* 2000 2005 2010 Domestic : 89 251 380 588 Non Domestic : 26 76 99 125 Losses : 16 36 65 126 Total : 131 363 545 839
Dimensions of Water Supply System	Target Service Coverage: 95%(83% at present) Target Year of 2005 Deep Wells : 2 (178m) Rising Main : ϕ150(0.90km),ϕ100(2.31km), Booster of Rising : ϕ150mm,Q=0.46m3/min,H=120m Reservoir : 140m3(70×2) Distribution : ϕ200(335m),ϕ150(2,830m), ϕ75(2,475m),ϕ50(9,035m) Booster of Dist'n : ϕ200mm,Q=0.8m3/min,H=15m Target Year of 2010 Deep Wells : 2 (128m) Rising Main : ϕ75(8.43km)
Water Tariff Structure & Accounting System	Introduction of Progressive Water Tariff** HC: 3.00 birr/m3,YC: 2.16 birr/m3,PF: 1.06 birr/m3 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 23 in 2005 and 29 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)

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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.

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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 Dejen, water service coverage is 87 %, which is relatively high, however the water consumption per capita per day is extremely low with the amount of 9.9 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 suggests that contamination is expected in such way through cross-connection, leaking and back-siphoning associated with aged facilities.

Toilet coverage is 52 % only, 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). Dejen is the one, located in Amhara Region, among the Eleven Centers along with Dupti, Mille, Bati, Nefas Mewcha, Aykel, Werota, Debre Tabor, Chagni, Bure and Bichena 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. Dejen was selected for the detailed survey during Phase II. 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 13 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, 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

Dejen is located at the east end of Gojam on the Addis Ababa-Bahir Dar road. The area is a narrow plateau surrounded by the gorges of the Abay and its tributaries in all directions except for north. Major tributaries are Muga river to the east and Bechet river to the west.

Dejen has a meteorological station of NMSA at Yet Nora and a river gauging station of WRDA on Muga river. Muga river has a large watershed area of 375 km^2 at the gauging station located on the road to Bichena. See Figure 2.1.1 for the locations and the watersheds around Dejen.

Table 2.1.1 shows the long term 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)	2.7	15.8	48.0	48.8	88.2	106.2	266.0	260.6	129.6	53.2	10.0	5.3	1,034.4
ETo(mm) *	117	116	116	116	115	114	112	111	112	113	115	116	1,373
A.Temp.(°C) +	17.2	17.1	17.5	17.8	19.4	17.4	15.6	15.7	-	16.7	16.3	16.5	17.0*

Remarks: * = Data of Debre Markos
+ = Data of Bichena

The monthly precipitation is distributed with a peak in July. It ranges from 2.7 mm in January to 266.0 mm in July. Since the record of potential evapotranspiration is not available, the data of Debre Markos is listed in the table. The monthly potential evapotranspiration has a little variation ranging from 11 mm in August and 117 mm in January. The record of air temperature is not available either, so that the data of Bichena is listed in the table. It ranges from 15.°C in July to 19.4°C in May.

The water balance sheet for ground water recharge in the watershed area of Muga river is prepared as shown in Table 2.1.2.

It is assumed that the potential evapotranspiration is same as the long term one and the crop factor for the reference crop evapotranspiration is 0.7. The precipitation data and the runoff data are prepared for the seven (7) years between 1981 and 1990.

Table 2.1.2 Water Balance Sheet of the Ground Water Recharge, Muga River at Yetmen

Unit : mm

Elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
P	4.4	21.4	67.0	68.2	65.2	93.8	322.6	318.7	176.3	78.7	16.0	1.5	1,232.8
Q	2.0	2.1	3.9	3.3	8.1	14.4	83.8	164.4	80.3	30.1	3.6	2.4	398.4
P-Q	2.4	19.3	63.1	64.9	57.1	79.4	238.8	154.3	95.0	48.6	12.4	*	—
ETo	117	116	116	116	115	114	112	111	112	113	115	116	1,373
ETcrop	81.9	81.2	81.2	81.2	80.5	79.8	78.4	77.7	78.4	79.1	80.5	81.2	960.4
ETa	2.4	19.3	63.1	64.9	57.1	79.4	78.4	77.7	78.4	48.6	12.4	—	—
ΔS	0	0	0	0	0	0	160.4	76.6	16.6	0	0	—	253.6

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

According to this sheet, the recharge takes place in July, August and September. The annual recharge in an average year is found to be 253.6 mm neglecting the little distortion in December. The quantity of recharge is calculated with this value:

$$0.2536 \times 375 \times 10^6 = 95.1 \times 10^6 \text{ m}^3/\text{year}$$

This is equivalent to 260.5×10^3 m^3/day.

The proposed new wells and the existing wells are mostly located near the town in the upstream areas of Adowadem river and Asameteji river. Since both watershed areas are small i.e. 4.34 km^2 with Adewedem river at VES St. 1 and 5.56 km^2 with Asameteji river at VES St. 6, it must be checked if there is a sufficient recharge for the wells.

Yearly water balance sheets were prepared for the seven (7) years between 1981 and 1990 as shown in Appendices. The recharge of each year is shown in Table 2.1.3.

Applying the probability analysis for the annual recharge using log-normal two parameter distribution function, 5-year recharge and 10-year recharge of dry years are resulted at 249.1 mm and 224.6 mm respectively. If it is allowed to apply these values for the watershed areas of the Adowadem and the Asameteji, the quantity of recharge is estimated;

Table 2.1.3 Monthly Recharge Estimated by Means of Surface Water Balance Analysis Muga River at Yetmen

Unit : mm

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1981	—	—	0	0	0	17.3	245.4	72.6	0	0	0	0	335.3
1982	—	—	—	—	0	0	137.5	134.5	0	27.2	0	—	299.2
1985	0	—	0	35.4	30.2	0	97.8	69.7	4.1	0	—	0	237.2
1986	—	0	0	40.8	0	41.5	151.6	0	83.9	0	—	—	317.8
1987	—	0	38.3	0	7.0	0	128.2	126.6	1.4	0	—	—	301.5
1988	0	0	—	0	—	10.7	146.8	38.9	30.6	0	—	—	227.0
1990	—	0	23.5	0	0	42.9	215.2	108.6	71.2	0	—	—	461.4

Note: — = not calculated due to missing data

For the watershed area of Adowadem river at VES St. 1,

5-year recharge $0.2491 \times 4.34 \times 10^6 = 1.08 \times 10^6$ m^3/year
10-year recharge $0.2246 \times 4.34 \times 10^6 = 0.97 \times 10^6$ m^3/year

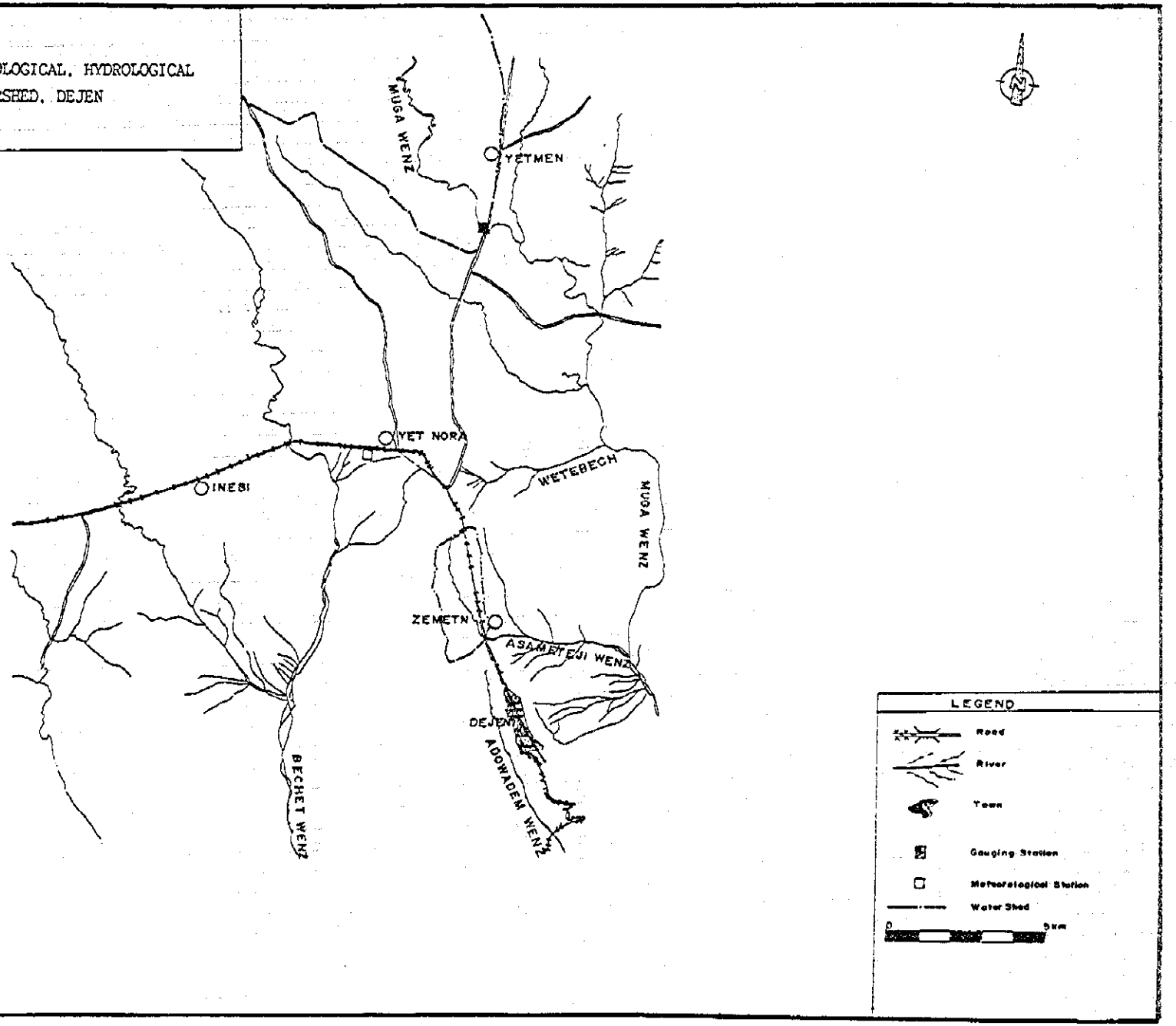
These are equivalent to 2,962 m^3/day and 2,671 m^3/day respectively.

For the watershed area of Asameteji river at VES St. 6,

5-year recharge $0.2491 \times 5.56 \times 10^6 = 1.38 \times 10^6$ m^3/year
10-year recharge $0.2246 \times 5.56 \times 10^6 = 1.25 \times 10^6$ m^3/year

These are equivalent to 3,795 m^3/day and 3,421 m^3/day respectively.

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



2.2 Hydrogeology

2.2.1 Geology

Dejen is located on the right bank of the Abay Gorge where the national road Route 3 (Addis Abeba - Bahir Dar) crosses over the gorge. The town is situated at the southeast edge of the narrow flat plateau, about 3 km wide and 8 km long, which slightly slopes toward the east. This plateau dominated by alkali-olivine basalt belonging to the Ashangi group of Paleocene - Miocene has the altitude about 2,500 m. asl and is surrounded by deep cut gorges on three sides except the north side. The difference of the elevation between the bottom of gorges and the top of the plateau is beyond 1,000 m. On the wall of gorges at the east and west of the plateau, vertical or overhanging basalt cliff makes a landform with several high steps. Such a step are matched each basalt lava flow unit, so at least, five units of the basalt lava flow are observed in this area. The basalt unconformably overlies the Mesozoic sedimentary rocks which crop out on the wall of gorges below about 2,000 m. asl. The wall exposes the sedimentary rocks forming the more gentle slope than the basalt wall.

2.2.2 Hydrogeology

(1) Groundwater

This area is situated on the narrow plateau dominated by basalt, therefore, the hydrogeological condition in this area is not more favorable than Bichena. Good aquifer is expected in case that the fractured zone by faulting and weathering is prevailed and extended to the deeper parts.

The clear lineament is observed along the small stream in the west of the town. The existing borehole, Borehole No. 2, for the resource of the water supply to the town is located at the 1 km northwest of the town in this small basin. This borehole was drilled in 1984 instead of Borehole No. 1. The hydrogeological characteristics of Borehole No. 2 are shown as follows.

BH#2	Borehole Depth	54.0 m
	Static Water Level	4.92 m
	Safe Yield	5.87 l/s
	Transmissibility	113.6 m^2/day (9,148 gpd/ft)

(from "well Completion Report No. 68 Dejen well No. 2 Gojam Province" by Tibebe Dejene (EWWCA Northwest Regional Office), Nov. 3/1984)

Borehole No. 1 is located at about 1 km downstream side of the Borehole No. 2 point, at 500 m west of the town. This borehole was drilled in 1980. At present, This borehole is abandoned due to the low yield. The initial hydrogeological characteristics of this borehole are shown as follows.

BH#1	Borehole Depth	65.0 m
	Static Water Level	10.77 m

Safe Yield 0.7 l/s
Transmissibility 12.8 m^2/day
(from "PUMPTESTS AT BOREHOLE #1 DEJEN GOJAM PROVINCE" by J.C. Nonner)

There are two boreholes for surrounding villages, that is, for Zemetn village and Tik village. The former is located at about 4 km north of Dejen, along the Ada Wedeb River, and is productive now. The latter is located at about 8 km north of Dejen, near the junction between the Dejen - Debre Markos road and the Dejen - Bichena road, and it is not utilized at present because the generator was lost and the pump was damaged during the civil war. Both boreholes were constructed in 1987 and their hydrogeological characteristics are shown as follows.

Borehole for Zemetn village
Borehole Depth 44.0 m
Static Water Level unknown
Safe Yield 4 l/s (from verbal information)
Transmissibility unknown
Slotted Casing Position 12-16 m, 28-32 m, 36-40 m
(from "Drilling Field Report" by EWWCA Northwest Regional Office)

Borehole for Tik village
Borehole Depth 64.8 m
Static Water Level 8.5 m
Safe Yield 1.6 l/s
Transmissibility 59.0 m^2/day
Slotted Casing Position 5-10.7 m, 30.7-34.7 m, 38.7-43.4 m, 51.4-62.8 m
(from "REPORT ON PUMPING TEST OF TIK WELL NO. 1" by Yemana Abres)

From the existing borehole data, ground water was struck in fractured basalt layers.

(2) Other Water Source

There is no perennial river in the adjacent area of the town. The nearest perennial river is the Muga River which is tributary of the Abay River and is located at about 16 km north of Dejen. This surface water is not available for the resource of the water supply to the town because it requires the long pipeline. Many springs are observed on the steps of the gorge wall. Their yields range from 0.5 to 1 l/s and this water seeps out through tuffaceous of scoriaceous layers between the upper and lower basalt units. This spring water is also not available for the water resources development because it might be coutamineted in future as the springs are located below the township.

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

There is only one (1) source named Borehole No.1 which is currently serving water to the population. The analyzed constituents are all fit to the acceptable range set by WHO guideline.

A borehole is located about four (4) km away from Dejen toward Debre Markos, which is the source of Zemeten rural water supply. The sample was also tested as a reference of the groundwater, and the result showed all physico-chemical parameters were within the acceptable range set by the guideline.

3.1.2 Bacteriological Aspects

Total 32 samples had been undertaken for faecal coliform test, all of which originated in Borehole No.1. Although the sample collected directly from the borehole gave no faecal coliform, other samples from fountains and connections showed considerable faecal coliform contamination except three (3) public fountains free from the coliform. This result can justify how the potable water from the source can be contaminated with poor handling of the water distribution system.

For household containers, 16 samples had been tested and the results show all samples from the containers were contaminated with several number to too-many-to-count of coliforms.

The result above indicates that the contamination of the potable water from the source takes place through poor sanitary condition or presence of leakage of the distribution scheme and mostly improper handling of the household containers with poor awareness of sanitation of the consumers.

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, there is no remarkable variation due to seasonal change in the individual consumption in Dejen. The total consumption and production for past two years are given below.

Production	84,365 m³
Consumption	74,130 m³
Losses	about 12 %

3.2.2 Water Users

According to the water census conducted by the Team, the total population served by the water supply is about 8,500, which accounted for 83% of the total population. Domestic, institution, commercial and industrial consumption is estimated being based on the consumption records of May 1995, and the census data. Domestic consumptions are subdivided into those of house connection, yard connection, public fountains and those who buy and borrow water from neighbours (vendors), considering mode of services. Table 3.2.2 shown 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	(%)	(m³)	(LPCD)	(m³)	(LPCD)
Domestic	1826	8507	(100)	88.6	(10.4)	164.5	(19.3)
House Connection	9	90	(1.0)	5.1	(56.6)	5.1	(56.6)
Yard Connection	357	2294	(27.0)	48.2	(21.0)	53.0	(23.1)
Public Fountain	1104	4882	(57.4)	24.0	(4.9)	81.5	(16.7)
Neighbors	356	1241	(14.6)	11.3	(9.1)	24.9	(20.1)
Institutional	16			4.0			
Commercial	422			18.1			
Industrial	20			3.4			
Total	2284			114.1			

There are ten (10) customers with house connections. Out of them five are hotels (lodgings). The largest consumer is Tizale Dejen hotel which consumes 12.7 m³/day. The domestic lpcd is this very low lpcd is caused by the low consumption of the Hotel employees who reside in the hotels.

The domestic consumption of house connection customers is calculated at 5.1 m³/day and the lpcd was calculated at 56.6. From these figures, the populations served accounted at 90. Their commercial consumption is estimated at 10.6 m³/day, excluding their domestic consumption. The institutional consumption is 0.87 m³/day which is the consumption of the Commercial Bank of Ethiopia.

There are 370 customers with yard connections. Most of them are private customers and many use water for their businesses as well as domestic purposes. The domestic lpcd is calculated at 21.0 from the census data. The domestic consumption of yard connection customers is estimated at 48.2 m³/day. From these figures, the population served accounted at 2,294. There are 12 institutional customers. Their institutional consumption is estimated at 2.4 m³/day.

There are 132 commercial customers whose businesses are hotels (lodgings), eateries, coffee bars, breweries (Tej, Tala, Araki houses), shops, etc.. Their commercial consumption is estimated at 4.5 m³/day in the same way as the institutional consumption

was estimated. There are four (4) industrial customers whose businesses are grain mill, oil mill, butchery etc. Weroda education office is under construction, so that their consumption is sorted as industrial. The industrial consumption is estimated at 2.2 m^3/day in the same way of estimation as the institutional consumption was estimated.

Majority of the water users are public fountain users, accounting for 57% of the total population served. There are 212 households engaged in small businesses such as breweries (Tej, Tala, Araki houses). Since the lpcd of PF users is as little as 4.9, it is considered that their consumption for businesses is negligible. There is one institutional customer, i.e. ETCA. There are 37 residents in the camp and their consumption is 0.7 m^3/day. Their consumption is domestic, however it is sorted as institutional consumption because they are stationed temporarily.

Those who borrow and buy water from the neighbours (vendors) are accounted at 356 households, 2 institutions and a contractor. Their domestic lpcd is obtained at 9.1 from the census data. The domestic consumption of those who borrow and buy water are thereafter estimated at 11.3 m^3/day. There are 84 households engaged in businesses. All are small businesses except for two (2) coffee bars and a contractor who is building the rental houses of the municipality consuming 1.2 m^3/day, 1.0 m^3/day and 1.1 m^3/day respectively. The institutions are Health Center Office and Transport Corporation. However, their consumption is very minimal.

3.2.3 Current Water Demand

The water required by the users of different mode of services for different domestic purposes was surveyed. In the survey, five (5) major categories of the users are adopted including Traditional Source Users (TSU). Six (6) sample households of each category are selected from those which do not give or sell water to neighbours and do not engage any businesses either.

In area wise, Kebele 01 is selected because the area is relatively sufficient in water supply. For the samples of Traditional Source Users (TSU), the area in the neighbor hood of Adowadem Elementary School is selected, where there are hand-dug wells. The survey was not effective for the house connection users because there were very few houses which meet the selection criteria.

As a result, TSU needs 12 lpcd as the minimum and the yard connection users need 23 lpcd as the maximum among the four (4) different mode of services. The demand of house connection users in lpcd is estimated at the same value as the yard connection users.

Table 3.2.1 Water Production and Consumption in Dejen

	Consumption (m3)										Production (m3)	Unaccounted Losses	
	IC	PF1	PF2	PF3	PF4	PF5	PF6	PF7	Sub Total	Grand Total	Well No.1	(m3)	(%)
Jul-93	1,478	43	70	74	170	100	150	140	747	2,225	3,193	968	30
Aug-93	1,782	58	74	70	84	80	86	80	532	2,314	2,869	555	19
Sep-93	3,100	73	80	76	89	84	80	74	556	3,656	3,528	-128	-4
Oct-93	2,085	113	171	30	105	91	90	70	670	2,755	3,093	338	11
Nov-93	2,368	112	155	96	90	93	103	135	784	3,152	1,410	-1,742	-124
Dec-93	2,283	129	184	109	115	86	130	172	925	3,208	3,608	400	11
Jan-94	2,565	120	190	108	100	77	120	120	835	3,400	3,700	300	8
Feb-94	2,545	134	193	110	108	78	121	131	875	3,420	4,173	753	18
Mar-94	2,749	131	113	114	114	17	62	152	703	3,452	4,240	788	19
Apr-94	2,796	80	117	71	66	68	87	90	579	3,375	4,164	789	19
May-94	3,023	90	118	72	66	69	80	95	590	3,613	3,813	200	5
Jun-94	2,181	111	165	90	87	74	89	103	719	2,900	3,667	767	21
Jul-94	2,165	95	129	72	85	61	64	107	613	2,778	3,091	313	10
Aug-94	2,012	90	153	86	80	60	68	121	658	2,670	2,939	269	9
Sep-94	2,312	92	129	82	75	68	107	107	660	2,972	3,488	516	15
Oct-94	2,579	105	171	83	88	71	104	114	736	3,315	3,909	594	15
Nov-94	2,521	96	158	90	106	77	110	112	749	3,270	3,812	542	14
Dec-94	2,559	122	162	92	93	65	104	122	760	3,319	4,120	801	19
Jan-95	2,890	119	151	87	95	85	101	124	762	3,652	4,194	542	13
Feb-95	2,940	123	177	102	115	86	100	125	828	3,768	4,467	699	16
Mar-95	3,081	106	168	103	112	80	101	120	790	3,871	4,347	476	11
Apr-95	2,861	116	168	94	102	100	96	128	804	3,665	4,362	697	16
May-95	2,613	120	169	95	91	102	65	125	767	3,380	4,179	798	19
Total	57,488								16,642	74,130	84,365	10,235	12
Average										3,223	3,668		
Maximum										3,871			

* Recorded in Ethiopian Calendar

IC: Individual Connection PF: Public Fountain

3.3 Water Supply Facilities Condition

3.3.1 General

Water supply in Dejen is served by the piped water system. The 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

The existing borehole is located at about 3 km west of the town, and existing submersible pump is driven by the on-site generator. No information on the existing submersible pump is available, because the pump investigation was not carried out due to the difficulty of taking out the pump.

The existing generator is an Indian-made with a capacity of 30 KVA, however,the date it was manufactured and installed are not available.

The borehole is equipped with a pressure gauge, flow meter, and a check valve. Of these appurtenances, the pressure gauge was however not operational. The pumping rate was quantified at the rate of 5.8 l/s.

3.3.3 Transmission and Distribution Facilities

Groundwater pumped from the boreholes is supplied directly to the town. The existing reservoir is located in the compound of the Health Center. It is a rectangular R.C.reservoir with a capacity of 50 m^3. No measurement appurtenance was provided, and no leakage was observed.

The distribution network is branched system with galvanized steel pipes. The diameters of the pipes range from DN 40 to DN 80. The lengths of pipelines including the rising main are summarized as follows:

Table 3.3.1 Existing pipeline data

Diameter (mm)	Length (m)	Material
40	1720	G.S.
50	610	-do-
80	1780	-do-

3.3.4 Service Level

Water service level is divided into two modes: individual connection and public fountain. There are 241 individual connections, and the individual connection is subdivided into 3 categories: private(172), commercial(56), and public institution(13).

There are 12 operational public fountains in the town. Of these public fountains, one public fountain has no concrete structure. Four or Six faucets per fountain were provided.

3.3.5 Disinfection

No measure is taken for disinfection to secure water quality. It is reported that water quality is occasionally analyzed by Health Center and once a year by the Regional Laboratory .

3.3.6 O & M

Dejen is classified as urban town, and the waterworks are under the control of the Regional Office in Amhara Region. WSS office in Dejen is managing not only financial matters but also the maintenance works.

WSS office has no vehicle and has only few tools for daily routine work. Motorcycle was provided at this office, but it is not functioning at present.

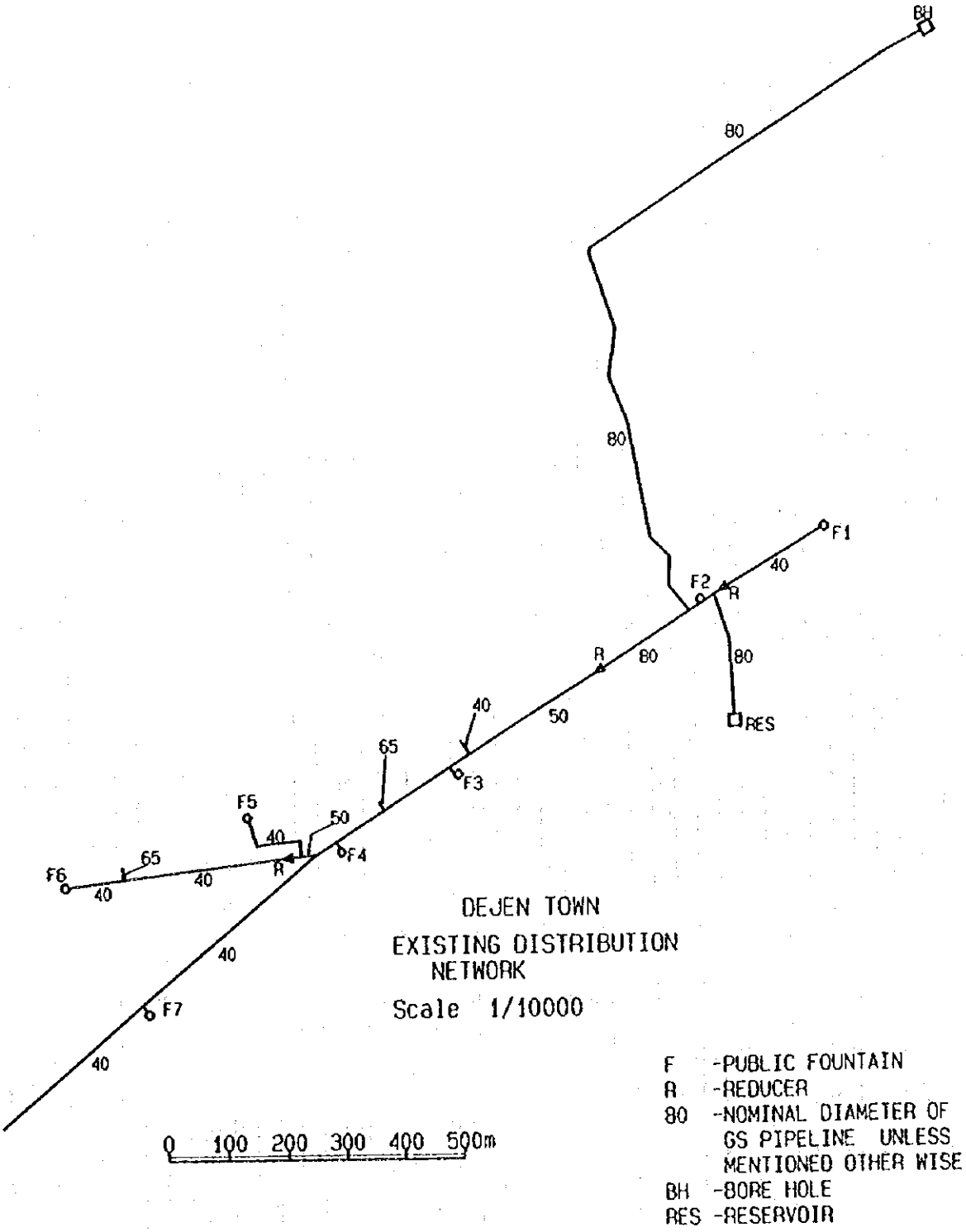


Figure 3.3.1 Schematic layout of Existing Facilities (No scale)

3.4 Sanitary Facilities Condition

3.4.1 Toilet Facilities

Most of the people of Dejen use open-area to dispose of their body wastes. Consequently the sanitation of Dejen is very poor. Dejen has four public toilets, 3 of which are filled-up and not functioning. Two of these four public toilets are located near the market area. One near the bus terminal; and the fourth one near the town hall called Karmar Hall. Those who have been using the public toilets that are presently filled up are now using open-field for excreta disposal.

The Population and Housing Census of 1984 and as updated in 1993 has carried out a sanitation survey of the whole Dejen and has come up with the information indicated in Table 3.4.1.

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

Number and percentage	Type of Toilet Facility						
	Flush		Dry pit		None (open-field)	Other	Total
	Private	Shared	Private	Shared			
• Number	32	9	168	117	1,174	19	1,519
• Percentage (%)	2.1	0.6	11.1	7.1	77.3	1.2	100

Table 3.4.1 shows about 77% Dejen people do not have toilets and use open-area; about 18% use traditional pit latrines and only about 2.7% use flush toilets.

The survey of 100 households carried out by the Team has revealed that out of 100 households 48% use open-field for excreta disposal; 46% use dry pit latrines; 6% use community toilet and not a single one uses flush toilets. One can see how bad the sanitation situation of Dejen from these two surveys.

The Population and Housing Census of 1984 has also undertaken survey of housing units in by types of materials of which the walls, the roofs and the floors are constructed. The result of the survey showed that 84% of the walls of the households were constructed out of wood and mud; 89% of the roofs out of corrugated iron sheets and 82% of the floors out of earth and mud. The toilets follow the same pattern of the households except for cement and concrete which are also popularly used for flooring of toilets.

Most of any pit latrines that are used in Dejen get filled up in about 2-3 years. The owners who do have space dig new ones. Those who do not have space they try to have them emptied by vacuum truck if they can afford to pay and can arrange to get the truck from Debre Markos. Usually, due to shortage of trucks at Debre Markos itself, it is difficult to get during the time of need. Those households that can not have new ones or can not empty their toilets, they do not have any other alternative but to resort to open-field defecation.

Dejen doses not have sites prepared for dumping sludges that are emptied from the toilets. The vacuum truck dumps the sludge any convenient place along the main road to the Blue Nile Gorge.

3.4.2 Other Facilities

Most of the people of Dejen throw their dry solid wastes and sullage everywhere, in front of their households, along the streets and in nearby open area.

The results of the survey of 100 households made by the Team, have shown that 75% of the households throw their solid wastes anywhere; whereas 17% dump in open pits; 3% in covered and only 5% burn the refuse.

When it comes to disposal of sullage, the same survey indicated that 82% of the 100 households dump their sullages everywhere; 13% in drains; 4% in pits and 1% in vegetable garden. From the indiscriminate dumping of both dry solid wastes and sullages, environmental pollution, water contamination and considerable health hazards have resulted.

Dejen does not have industries and there are no industrial wastes.

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 Dejen is 17, which is on the small side 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					
Head	1	0	1	0	0
Aid clerk	1	0	1	0	0
Guards	5	0	5	0	0
Sub-total	7	0	7	0	0
3. Finance					
Accountant	0	1	1	0	0
Cashier	1	0	1	0	0
Water sellers	3	2	5	0	0
Sub-total	4	3	7	0	0
4. Technical					
Plumbers	2	0	2	0	0
Total	14	3	17	0	0

As the table shows, all the workers are permanently employed. Female workers are 3 in number or 18%. 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 41%, 41% and 18%. On the other hand, their 11 town averages are 37%, 41% and 22%. It means that the share of administrative functions is higher and that of technical functions is lower compared to their respective 11 town averages.

Annual water production per worker, which is the broadest labor productivity indicator is calculated at 2,745 m^3. It is on the low side. The monthly remuneration per worker is 211 birr, which is one of the highest.

It follows from the above that the participation rate of female workers is low, more technical personnel might be in need, and there might be problems regarding the size of workforce and the level of remuneration.

3.6 Financial Condition of WSS

It is advised to refer to Table 1 and 2 in Appendix-5 and Table 3.6.1 when you read this section.

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

Production and consumption of water in the last fiscal year (Jul. 1993 to Jun. 1994) were 46,409 m^3 and 41,201 m^3 respectively. Both are on the high side among the 11 towns (NO. 4). Leakage ratio works out to 11.0%, which is one of the lowest. The daily water consumption as divided by population comes to 11.0 liter. This is on the high side (No. 4).

Income for the last year was 62,089 birr. The major sources of income are water sales (58.4%), cash water sales (19.0%), service charge (11.4%) and deposit (7.5%). Income per m^3 of water consumed works out to 1.51 birr, which is at a medium level. Bill collection rate is 89.0%, which is at a medium level.

Expenditures for the same year were 67,846 birr. Major items of expenditures were salaries (63.5%), fuel (22.1%) and office supply (3.7%). Expenditures per m^3 of water produced work out to 1.46 birr, which is on the low side. Income-expenditure ratio comes to 91.5%. This is at a medium level.

The number of personnel is 17. It is on the small side among the 11 towns. Annual water production per worker is calculated at 2,745 m^3, which is on the low side. Annual income per worker is 3,652 birr, which is at a medium level. Expenditures per worker are 3,991 birr, which is on the low side. Average monthly salaries are 211 birr. It is one of the highest among the 11 towns (No. 3).

It follows from the above that WSS in Dejen is supplied with water more than many of the 11 towns, but it is, nevertheless, financially in the red. On the income side it appears that there is a need to diversify income sources aside from water sales and also to raise bill

collection rate. On the expenditures side the curtailment of personnel cost seems to be a requisite.

3.7 Social Background and People's Awareness

3.7.1 Population and Social Composition

Dejen had a population of about 10,250 people at the time of the field survey in July 1995. At that time the population were mostly Amhara. The responses from the household survey were 98% Amhara, 1% Guragie and 1% Tigre for whom 99% have Amharic as their first language. The religious mix according to the responses from the household survey were 71% Christian and 29% Muslim. The survey also gave a figure of 32% of female headed households with an average household size of 6.4. 57% of female headed households in the survey were in income groups 1 to 3. This compares with 19% of male headed households in the same range. Land ownership as taken from the survey was only 5%. The town had a number of EDERs. The town was split into two Kebeles, the business area covers both Kebeles. The population was mixed, poor with rich and Muslims with Christians.

3.7.2 Sanitary Condition

Many people in Dejen practiced open defecation, especially the poor and those in rented houses. Some people, particularly the people with higher incomes do have latrines. For most people in Dejen the financial constraints seemed to be a major reason for the lack of latrines. For some there was also the issue of lack of security of land tenure and lack of health awareness. The bad sanitary condition of the public latrine was a disincentive for sanitary facilities throughout the town. The Municipality did not have any budget for the operation or maintenance of the two public latrines.

Some people were in favor of community latrines and said that they could manage them and keep them clean by themselves but would require the support of officials to enforce latrine use and cleanliness. Other groups said that they were more interested in loans for private household latrines because public/communal latrine facilities tended to get neglected. Most groups said they could afford to consider having water in the latrines for cleaning purposes and to pay for the desludging.

If a public shower facility were available in the center of Dejen it would probably not be used. There was a public shower which was damaged in the war, but it was underused due to the cold climate.

3.7.3 Water Situation

The water situation in Dejen was serious in some areas during our visit, and although not the top priority for many, improvements in the system were agreed by many people. The central roadside area was served with adequate numbers of public fountains and private connections. Their service time may be sufficient if areas away from the road were supplied with additional public fountains and private connections but they did not provide

adequate water. The peripheral areas were some distance from the piped supply and those people relied on springs and handdug wells for their water. The supply seemed to be inadequate for the areas on the high ground near the market. The price of water was fixed at 10 cents for three average size clay pots from public fountains and 2-3 Birr per month for one household from well vendors. Most groups were not prepared to pay more for a better water supply service and would like to have Government management for any additional public fountains.

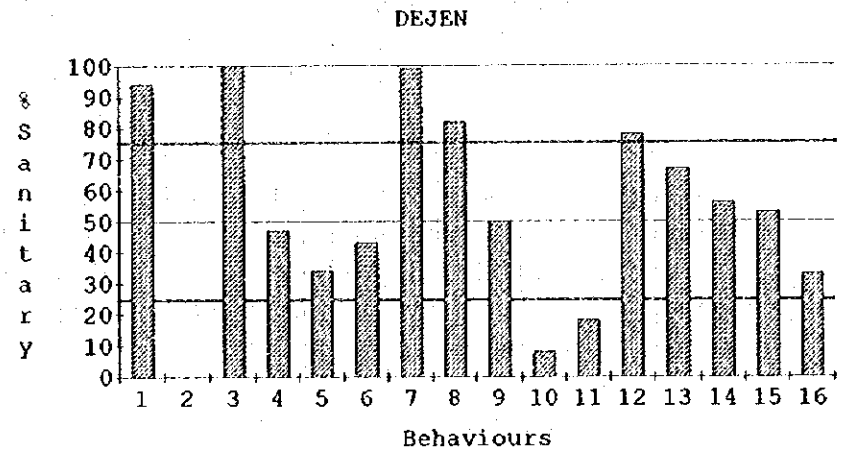
Water collection and laundry were undertaken exclusively by women and by female children. Some men assist with laundry occasionally. Women and girls living on the periphery of the town would benefit most from improvements in the availability of piped water in Dejen.

3.7.4 Health Indicators

The town had a Health Clinic which served a population of 44,268, (i.e. 13 farmers associations). The sanitarian for Dejen was based at the Woreda rather than the clinic and suffered from lack of budget. Intestinal Parasites and diarrhoeal disease were the second and third most common diseases of people presenting at the clinic in 1994/5. Cases were equally likely to be from urban or rural areas. All of the people we spoke with in the town were aware of the health education program being carried out to outpatients at the clinic. Clinic staff felt that people listened but did not take any action. The Clinic had tried some education sessions on Immunization (EPI) education after Church and Mosque services, but people preferred to return home. Community Health Agents were not working in Dejen, but Traditional Birth Attendants (TBAs) were active but not on water or sanitation education.

The Clinic was involved with a Health Committee in Dejen which comprises Kebele officials, community elders and other Woreda officials. The committee was involved with a program of checking hoteliers and female hotel workers and to give advice through the health educator about epidemics. The role of the committee could be expanded.

The majority of groups were aware of the link between poor water, sanitation and ill health, however the household survey results were the lowest for all of the Study centers. Only 36% of respondents knew the cause of diarrhea while the number of households able to prepare ORS correctly was only 4%. 32% of respondents to the household survey had attended health education sessions in the town and only one of which was not satisfied with them. The sanitary indicator behaviors are summarized in Figure 3.7.1.



No.	SANITARY BEHAVIOURS	%Sanitary
1	Access to piped water	94
2	Use piped water supply always	0
3	Covered water container	100
4	Water scoop kept off the floor	47
5	Handwashing with soap after defecating	34
6	" after handling childrens stools*	43
7	Covering cooked food during storage	99
8	Not eating unwashed raw fruit and vegetables	82
9	Kitchen utensils stored off the floor	50
10	Rubbish burried or burned	8
11	Wastewater disposed in pit/drain/veg. garden	18
12	No animals kept in the house	78
13	Home not infested with flies	67
14	Latrine in use by household	56
15	Latrine in use by all household members	53
16	Infant's excreta disposed of in latrine*	33
TOTAL SCORE FOR SANITARY BEHAVIOURS		862

*As proportion of households with young children

Figure 3.7.1 Indicator Sanitary Behaviours

There was little variation in this score between water user groups. The only noticeable difference in scores was with low income households. This was due to their lack of access to latrines. The highest priority area were use of piped water for drinking always, burning or burial of solid waste and sanitary disposal of waste water. The medium-high priority areas were keeping water scoops and kitchen utensils off the floor, handwashing with soap after defecation and after handling children's stools, and the sanitary disposal of children's excreta. The lack of access to latrines for poorest user groups resulted in lower sanitary scores for them.

3.7.5 Education

Dejen had three elementary schools, one junior school, and one high school. The percentage of female staff at the schools in the questionnaire survey was 31% for elementary schools and 22% at the high school. There were 915 pupils at the high school of which 269 were boys and 646 were girls. In all classes there were more girls than boys, with 200% more girls in class 9 and 50% more in class 12. The reason stemmed from the high level (60-70%) of rural students, where boys were needed for agriculture. Girls tended to have a higher drop out rate and do less well at their studies than boys. Girls generally had more work to do in the home and therefore have less time to study than boys. The school had a Red Cross Club and an Anti-AIDS Club led by the science teachers and supported by Clinic staff about three times a year. The school could help in awareness raising activities for sanitary education campaign.

The school had a private connection with no problem of water supply. The school had one latrine building for all to use, but girls used it to a much lesser extent.

3.7.6 Religious institutions

St. George's Church was already involved with HIV/AIDS education program and also undertook sanitary education on an ad hoc basis. The Clinic had not been involved but the Church welcomed their support and a coordination link with the Health Committee. However, the Priests felt that the poor sanitary condition in the town was related to the poor economic conditions and that if there was electricity then people would be able to generate more income. The Church had a private water connection but not enough water supplied through it. They also did not have access to latrines.

The Mosque had a PC but without adequate water and were relying on water from the surrounding area before prayer times. They had a latrine but no water so it was not convenient to use. They felt that communal latrines could be appropriate but that they would need to be officially inspected and controlled. The Mosque had not been involved in sanitary education to date but was willing to get involved. Females did not attend Solat and so a different time to suit women would have to be considered, perhaps on Sundays with the rest of the town people.

3.8 Socio-Economy

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

3.8.1 Administrative Conditions

There are 22 governmental organizations excluding schools dealing with general administration, finance, education, health, water supply and sanitation, communications, police, justice, water resources development, agriculture, culture & sports, commerce, road transport and municipal affairs.

The number of government employees is 378. It is on the small side among the 11 towns. The number of them per 1,000 population works out to 37, which is at a medium level. Their average monthly salaries are 407 birr, which is the highest.

This town has two Kebele. There is no NGO, but there are six public organizations.

3.8.2 Population

The population of the town is estimated at 10,250 based on the results of the cartographic census conducted by Central Statistical Authority in 1993. It is on the small side among the 11 towns. Ethnically, Amhara is overwhelming, occupying 99% of population, the remainder being Tigre. Religion-wise, 65% of the population is Christians and 35% Moslems. There are 1 church and 2 mosques.

This is one of the Amhara and Christian towns.

The average family size is 6.8 persons. This is the biggest along with Bure among the towns concerned. The area of the town is 280 ha. It is one of the smallest. The population density is calculated at 36.6 persons/ha. This is the on the high side.

3.8.3 Educational Conditions

There are 2 kindergartens, 3 elementary schools, and 1 junior high school and 1 senior high school. The total number of pupils/students is 2,661. It is on the small side among the 11 towns. The number of pupils/students per 100 population is calculated at 26, which is on the high side.

Literacy ratio and primary school enrollment ratio were 60.6% and 63.9% respectively according to the 1984 population census. The former is the second lowest, next to 48% in Bati. The latter is at a medium level.

Dejen is educationally at a medium level.

3.8.4 Medical Conditions

There are 1 health clinic and 1 drug shop. The total number of medical personnel in the health center is 5, which is the second smallest, next to 4 in Mille among the 11 towns. It means that there is 0.5 medical personnel for every 1,000 population. It is at the lowest level.

The types of diseases people suffer most are water-borne and sanitation-related diseases such as skin infection, diarrhea, intestinal parasite and malaria, and respiratory tract infection such as pneumonia. The number of top ten disease cases treated in the health clinic in 1993/94 was 3,790, which is the second lowest, following 1,611 in Mille.

The estimated total number of cases treated last year in the hospital was divided by the estimated service population. It came to 11.1%, which is the lowest among the 11 towns.

Under 5 mortality rate and life expectancy were 154.7/1,000 and 53.2 years respectively according to the 1984 population census. Both are at a medium level.

Ratio of households more or less using septic tanks and pit latrines is 54.0%. This is on the low side (No. 4 from the bottom).

The above tells that Dejen suffers from a dearth of medical personnel and a low dissemination level of sanitation facilities.

3.8.5 Economic Conditions

The number of hotels and restaurants is 74 (21.4%), that of shops 240 (69.6%), that of cottage industry 29 (8.4%) and that of others 2 (0.6%), adding up to 345 (100.0%). This total number of commercial/industrial establishments is on the small side among the 11 towns. The total number per 1,000 population comes to 34, which is on the low side. The number of hotels and restaurants per 1,000 population is 7, which is also on the low side.

It appears that there are no encouraging indicators regarding the economic activities.

Major occupations in the town are trade, day laborers and government employees.

Major products are edible oil and flour. Major marketable items are agricultural products such as tef, sorghum, beans, chick peas, lentil and oil seed, livestock such as oxes, cows, sheep, goats, donkeys, and chickens, etc.

Saturday is the market day. 3,000 people are said to gather on the day.

The average monthly household income is 311.6 birr. This is one of the highest among the 11 towns (No. 3).

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 sixty percent of the current master plan has been completed as shown in Figure 3.9.1.

The electric power is now supplied to the Centers by the on-site generator by EELPA, and the existing water supply facilities is also operated by the on-site generators. According to the tentative plan, the hydroelectricity is scheduled to supply within 1997. Thus, the future water supply facilities at the target year of 2005 and 2010 will be also operated by the hydroelectric power.

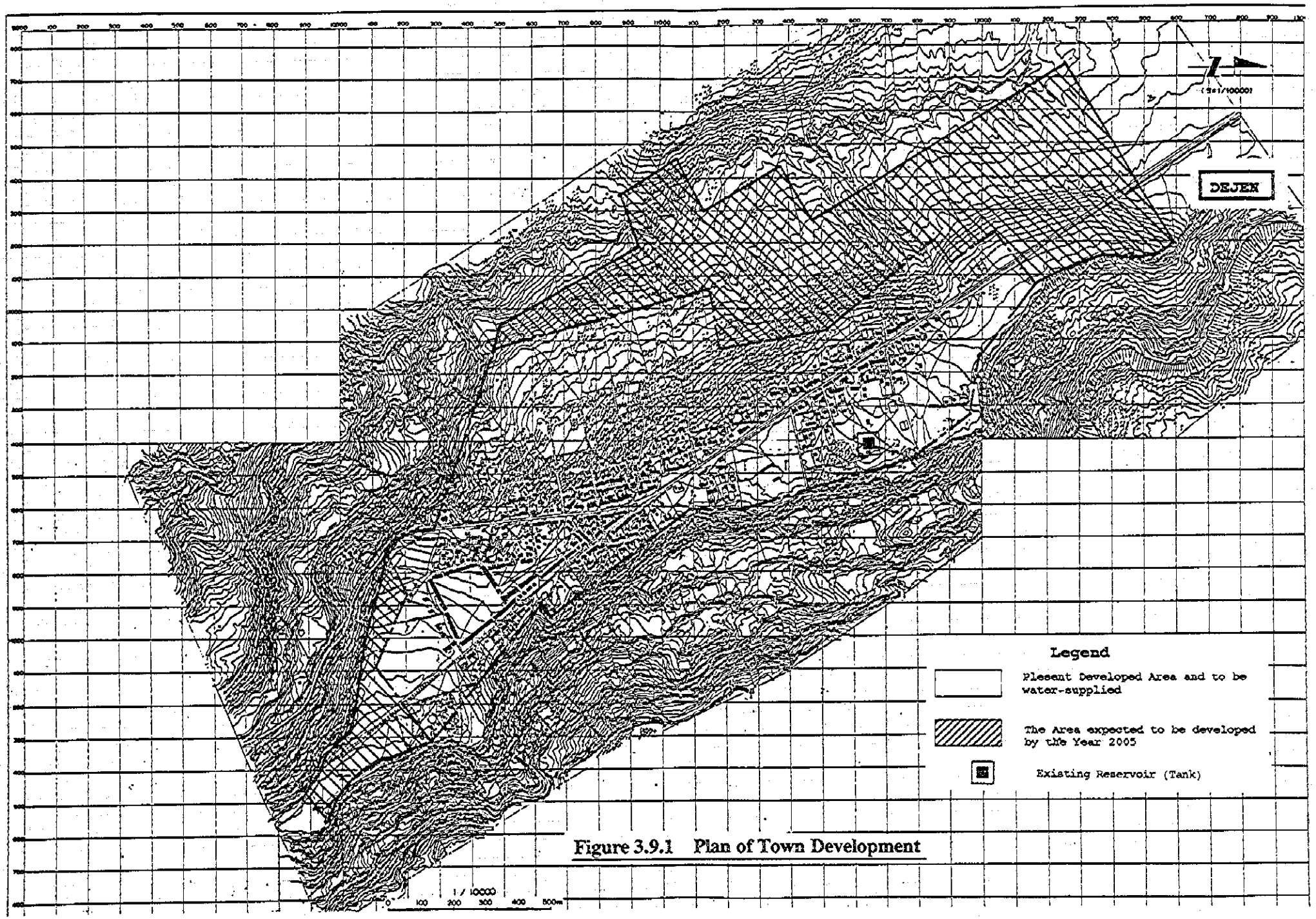


Figure 3.9.1 Plan of Town Development

Chapter 4 Plan of Water Supply System

4.1 Water Demand Projection

4.1.1 Population Projection

The population of Dejen was 7,239 in 1984 according to the results of the 1984 Population Census. The census is the first one the Ethioplan 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 4,700. Similarly, 1972 and 1973 population was 4,190 and 4,440 respectively. When one adopts CSA estimates, the average annual population growth rate during the 10 years 1974 to 1984 is calculated at 4.41%.

Since 1984 also CSA published its own estimates of population. According to them population of the town in 1992 and 1993 was 13,566 and 14,395 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 9,622 in 1993. When one uses the figures, the average annual population growth rate during the 9 years from 1984 to 1993 works out to 3.21%. 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. There was no way for the team to get even the preliminary figures of the census for Dejen. Therefore, the team projected the 1995 population using the 1984 to 1993 average annual growth rate. It came to 10,250.

Regarding the future development of the town, the Fincha - Debre Markos - Bichena Hydro-Electric Power Project with a substantial capacity will be completed at the end of this year. And soon after that the electricity is expected to be extended to Dejen. In such an event flour mills, oil factories and others are expected to be constructed there.

As the average annual population growth rate 1995 to 2005 3.0% 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 rate 2005 to 2010 was projected to be 2.5%.

As a result the projected population of the town for 2000, 2005 and 2010 works out to 11,883, 13,776 and 15,586 respectively (Refer to Table 4.1.1).

Table 4.1.1 Population of Dejen

1. Past Population

1974 Estimates by CSA	1984 Population Census	Average Annual Growth Rate 1974 to 1984
7,440	8,191	0.97%
1984 Population Census	1993 Cartographic Census	Average Annual Growth Rate 1984 to 1993
8,191	13,250	5.49%

2. Population Projection

1995	2000	Average Annual Growth Rate 1995 to 2000
10,250	18,819	5.0%
2000	2005	Average Annual Growth Rate 2000 to 2005
18,819	13,776	4.5%
2005	2010	Average Annual Growth Rate 2005 to 2010
23,452	15,586	4.0%

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.

95% of the population is targeted at the year of 2010 to be served by the piped water system, and the ratio served by the traditional water source is estimated at 5%, 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	90	(0.9)	606	(5.1)	1,860	(13.5)	4,052	(26.0)
YC	3,535	(34.5)	4,385	(36.9)	5,745	(41.7)	7,637	(49.0)
PF	4,882	(47.6)	5,559	(46.8)	5,152	(37.4)	3,118	(20.0)
Sub total	8,507	(83.0)	10,550	(88.8)	12,757	(92.6)	14,807	(95.0)
TSU	1,743	17.0	1,333	11.2	1,019	7.4	779	5.0
Total	10,250	100.0	11,883	100.0	13,776	100.0	15,586	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 more 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	5.1	(56.6)	32.7	(54)	107.9	(58)	255.3	(63)
YC	59.4	(16.8)	140.3	(32)	195.3	(34)	282.6	(37)
PF	23.9	(4.9)	77.8	(14)	77.3	(15)	49.9	(16)
Total	88.4		250.9		380.5		587.7	
Average	29.5	(10.4)	83.6	(24)	126.8	(30)	195.9	(40)

(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	2,661	13.3	
Hospital	20 l/staff	5	0.1	
Hotel	100 l/bed	408	40.8	6 beds/place × 68 places = 408 beds
Bar...	200 l/bar	6	1.2	
Mosque	5 l/visitor	400	2.0	200 visitors/place × 2 places = 400
Offices	5 l/person	378	1.9	
Total			59.3	

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	13.3	15.4	17.9	20.3	Population growth rate
Hospital	0.1	0.1	0.1	0.1	-do-
Hotel	40.8	54.6	73.1	95.5	Population growth rate +3%
Bar, Tea shop	1.2	1.6	2.1	2.7	-do-
Mosques	2.0	2.3	2.7	3.1	Population growth rate
Offices	1.9	2.2	2.6	2.9	-do-
Total	59	76	99	125	

(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	89	251	380	588
Non Domestic	26	76	99	125
Losses	16	36	65	126
Total	131	363	545	839

* 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)		131	363	545	839
Maximum Day Demand (m^3/day)	1.2	157	436	654	1,007
Peak Day Demand (m^3/hour)	1.6	10	29	44	67

4.2 Water Resources Development

4.2.1 Evaluation of Water Resources

Dejen has annual precipitation of 1,034.4 mm and annual ground water recharge of 253.6 mm in an average year. The perennial rivers near the town are Muga river and Bechet river. In the vicinity of the town, they are in the deep gorges. The use of the river water require number of pumping stations for lifting water. The possible intake points of these rivers in the plateau are far from the town and they require long pipelines at least 15 km long.

A number of springs are found along the gorge wall sloping to Muga river. Since they are located in the vicinity of the town, the water would be contaminated in future because of infiltration of polluted water.

In Dejen, ground water development might be feasible. The WSS has an operational well i.e. BH No.2 near the town in the watershed area of Adowadem river. Its safe yield is reported at 5.87 l/s (507 m^3/day). On the other hand, the 5-year recharge of dry years is estimated at 249.1 mm/year, which is equivalent to 1,522 m^3/day for the area. The geology is basalts of Ashangi group which is dissected by the linearments according to the aerial photograph interpretation. The primary permeability of volcanic rocks is low but it could be increased with secondary porosity caused by faults and fracture openings. It is expected that the rocks are fractured and weathered along the linearments as favorable as for ground water exploitation.

Geoelectrical survey was conducted at 13 points as shown in Drawing including the existing borehole sites. In general, the apparent resistivity curves show the simple forms in which the inflection point with the values of 5 to 10 ohm-m is present at about 5 m depth and the values simply increase up to 50 - 80 ohm-m as the depth become deeper. The curves implies that clay which basalt is disintegrated into predominates in the subsurface and fresh or slightly weathered basalt underlies the surface clay. However, at Station No.6, No.12 and No.13, the curves show the bumpy forms and the specific resistivity values range from 5 to 40 ohm-m. The results of VES interpretation are shown in Appendices.

Considering the lineations and the results of VES interpretation and the watershed areas, borehole sites are selected at VES Station No.1, No.3, No.6 and No.13 totally four (4) sites. Station No.1 and No.3 are located along Adowadem river, in which Station No.3 is located adjacent to WSS BH No.1. Station No.6 is located in the watershed area of Asameteji river near the highway. Station No.13 is located in the watershed area of Wetebech river.

4.2.2 Strategy of Water Resources Development

The characteristics of the major aquifers of the operational well and the proposed well sites are shown in Table 4.2.1.

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.4	11 - 33 34 - 53	Weathered and Fractured Basalt -Ditto-	41	1	WSS BH No.2
2	VES St.6	15.5 - 60※	Fractured Basalt	22	1	New Well
3	VES St.3	68 - 112※	Highly Weathered and Fractured Basalt	22	1	-Ditto-
4	VES St.1	20 - 47	Weathered and Fractured Basalt	13.5	1	-Ditto-
5	VES St.13	23 - 72	Weathered and Fractured Basalt	24.5	1	-Ditto-

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

The depths of the major aquifers of WSS BH No.2 was obtained from the geological log. The others were detected by the geoelectrical survey. Excluding the existing 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. The optimal yields of the wells are estimated with the formula listed in the design criteria with a drawdown of 20 m and the diameters of wells to be 200 mm. The optimal yields of the wells are shown in Table 4.2.2.

Table 4.2.2 Optimal Yields and Water Levels of the Wells

Well No.	Optimal Yield (m^3/day)	Static Water Level (GL-m)	Dynamic Water Level (GL-m)	Remarks
1	124	4.92	24.92	WSS BH No.2
2	270	8	28	New Well for Year 2005
3	267	6	26	-Ditto-
4	163	10	30	New Well for Year 2010
5	297	1	21	-Ditto-

The optimal yields of Well No.1 to Well No.3 totaling to 661 m^3/day covers the demands of year 2005. The total optimal yield of all the wells will cover the demands of year 2010.

It is recommended to drill these two (2) wells i.e. Well No.2 and Well No.3 before year 2005 because the locations are nearer to the town. Well No.5 might not be necessary for year 2010 if the WSS can buy water from Zemetn VWS and Tik VWS.

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 borehole 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
Pumping Rate	(m^3/day)	270	267	163	197
	(l/s)	(3.1)	(3.1)	(1.9)	(3.4)
Diameter of Well	(mm)	200	200	200	200
Casing Length	(m)	30	84	30	42
Screen Length	(m)	32	32	20	36
Well Depth	(m)	64	116	50	78
Drilling Diameter	(mm)	300	300	300	300

4.3 Plan of Water Supply System

The water supply system proposed for the center of Dejen 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 and 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 four potential sites for borehole as stated in chapter 4.2. Among these proposed sites, two boreholes 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)	124 m^3/day
W2 (proposed)	270 m^3/day
W3 (proposed)	267 m^3/day
Total	661 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 = 0.07 m^3/min., H = 71 m, P = 3 kW
W2, W3 (proposed)	Q = 0.22 m^3/min., H = 100 m, P = 5 kW

(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 following capacity will be constructed as well.

Q = 0.46 m^3/min., H = 120 m, Dia = 150 mm, P = 30 kW

Rising mains will range from 100 mm to 150 mm and transferred water to the new reservoir. Total length is about 3,210 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 140 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)
200	335
150	2,830
100	2,475
75	9,035

(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 0.7 kg and necessary more than 0.11 PPM at the end of distribution pipe.

(7) Administration Building

In order to manage daily basis waterworks such as operation works, bill collecting, a building is required to be built by the year of 2005. The building is preferable to be built in the center of the town, and it has a store room.

4.3.2 Water Supply System in 2010

(1) Borehole

Three shallow wells 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.

W4 (proposed)	163 m^3/day
W5 (proposed)	297 m^3/day
Total	460 m^3/day

(2) Borehole Pumps

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

W4, W5 (proposed) $Q = 0.20$ m^3/min., $H = 120$ m

(3) Boosting Facility and Rising Mains

The booster pump will be additionally installed to transfer the water to reservoir.

(4) Distribution Network

The layout of distribution network for the year of 2010 is not prepared in this Study. It is needed to revise the current master plan of town planning to match up to current situation. It is, therefore, preferable to design a layout plan after revision of the master plan.

(5) Disinfection

Disinfection will be performed by the injection system directly into the reservoirs. Daily consumption ratio of chemical will be estimated at about 1.1 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. The order among Eleven Centers is detailed in "Chapter 10 Development Strategy of the Project" in the Main Report.

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	9,152	5,643	14,795
2010			11,158

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	1,753
2010	440

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	3.00
2. Yard Connection Users	2.16
3. Public Fountain Users	1.06

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 91 birr, 136 birr and 210 birr will be daily required in 2000, 2005 and 2010 respectively.

The second is fuel cost. It is projected that it will not be required for pumps so far as Dejen is concerned.

The third is disinfection cost. It is estimated that 5 birr, 8 birr and 12 birr will be daily required in 2000, 2005 and 2010 respectively.

The fourth cost is personnel cost. It is estimated that 22, 23 and 29 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 39, 75 and 117 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:

(Unit : thousand birr)

Item	Foreign Components	Local Components	Total
1. Phase 1			
1) Construction Cost	6,954	4,087	11,041
2) Engineering Cost (12% of 1))	1,325		1,325
3) Contingency (5% of 1) + 2))	354	205	559
Sub-Total	8,633	4,292	12,925
4) Buildings		758	758
5) WSSD's Management Cost (2% of 1) + 2) + 3) + 4))		274	274
Sub-Total		1,032	1,032
Total	8,633	5,324	13,957
6) Water Purification Units (included in total)	10	15	25
2. Phase 2			
1) Construction Cost			6,494
2) Engineering Cost (10% of 1))			650
3) Contingency (10% of 1) + 2))			714
Total			7,858
Grand-Total			21,815

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

   85% 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 te existing corporate income tax will be applied, including 40% tax rate on the 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 = 136.9%
Working Capital/Revenues = 30.3%

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 substantial 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	1,123	1,083	1,026	963
2) Yard Connection Users	547	540	477	407
3) Public Fountain Users	213	216	195	173
2. Share of Households (%)				
1) House Connection Owners	0.9	5.1	13.5	26.0
2) Yard Connection Users	34.5	36.9	41.7	49.0
3) Public Fountain Users	47.6	46.8	37.4	20.0
3. Water Consumption/Household/Month (m^3)				
1) House Connection Owners	11.5	11.0	11.8	12.9
2) Yard Connection Users	3.4	6.5	6.9	7.5
3) Public Fountain Users	1.0	2.9	3.1	3.3
4. Water Price (birr/m^3)				
1) House Connection Owners	1.00	3.00	3.00	3.00
2) Yard Connection Users	1.00	2.16	2.16	2.16
3) Public Fountain Users	1.00	1.06	1.06	1.06
5. Payment for Water Supply/Household/Month (birr)				
1) House Connection Owners	11.5	33.0	35.5	38.6
2) Yard Connection Users	3.4	14.1	15.0	16.3
3) Public Fountain Users	1.0	3.0	3.2	3.5
6. Ratio of Water Payment to Income (%)				
1) House Connection Owners	1.0	3.1	3.5	4.0
2) Yard Connection Users	0.6	2.6	3.1	4.0
3) Public Fountain Users	0.5	1.4	1.7	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	26,093	11,917	10,518	7,054	6,683	7,894	70,160
1997	26,354	12,036	10,623	7,054	7,151	8,015	71,234
1998	26,618	12,157	10,730	7,054	7,619	8,137	72,314
1999	84,866	17,243	48,060	7,611	8,088	4,605	170,472
2000	139,098	28,596	79,059	7,611	8,556	5,258	268,178
2001	162,982	28,559	83,844	14,564	9,452	5,988	305,389
2002	186,866	28,522	88,629	14,564	10,348	6,579	335,509
2003	210,751	28,486	93,414	14,564	11,245	7,169	365,628
2004	234,635	28,449	98,200	14,564	12,141	7,760	395,747
2005	258,519	28,412	102,985	14,564	13,037	8,350	425,867
2006	302,263	26,398	108,394	22,754	14,437	9,485	483,730
2007	346,006	24,384	113,803	22,754	15,838	10,456	533,240
2008	389,750	22,369	119,213	22,754	17,238	11,426	582,750
2009	433,494	20,355	124,622	22,754	18,638	12,397	632,260
2010	477,238	18,341	130,031	22,754	20,038	13,368	681,770
2011	477,238	18,341	130,031	0	20,038	12,913	658,561
2012	477,238	18,341	130,031	0	20,038	12,913	658,561
2013	477,238	18,341	130,031	0	20,038	12,913	658,561
2014	477,238	18,341	130,031	0	20,038	12,913	658,561
2015	477,238	18,341	130,031	0	20,038	12,913	658,561
2016	477,238	18,341	130,031	0	20,038	12,913	658,561
2017	477,238	18,341	130,031	0	20,038	12,913	658,561
2018	477,238	18,341	130,031	0	20,038	12,913	658,561
2019	477,238	18,341	130,031	0	20,038	12,913	658,561
2020	477,238	18,341	130,031	0	20,038	12,913	658,561
2021	477,238	18,341	130,031	0	20,038	12,913	658,561
2022	477,238	18,341	130,031	0	20,038	12,913	658,561
2023	477,238	18,341	130,031	0	20,038	12,913	658,561
2024	477,238	18,341	130,031	0	20,038	12,913	658,561
2025	477,238	18,341	130,031	0	20,038	12,913	658,561

Note: H./Y. Connec. = House/Yard Connection
Public Founta. = Public Fountain
Non-Domest. = Non-Domestic
Techni. Servic. = Technical Service

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	70	71	72	170	268	305	336	366	396	426
Operation and Maintenance	69	69	70	200	211	246	251	257	262	267
Depreciation	0	42	83	83	83	83	83	83	83	83
Payment of Interest	0	0	0	0	0	0	0	0	0	0
Expenditure	69	111	153	283	294	330	335	340	345	350
Profit before Tax	2	-40	-81	-113	-26	-24	1	26	51	75
Tax	0	0	0	0	0	0	0	0	0	0
Profit after Tax	2	-40	-81	-113	-26	-24	1	26	51	75
Funds Statement										
Profit after Tax	2	-40	-81	-113	-26	-24	1	26	51	75
Loans	209	1381	1381	0	0	0	0	0	0	0
Subsidies	1183	4902	4902	0	0	0	0	0	0	0
Depreciation	0	42	83	83	83	83	83	83	83	83
Sources	1393	6285	6285	-29	57	59	84	109	134	159
Capital Works	1391	5767	5767	0	0	0	0	0	0	0
Payment of Principal	0	0	0	0	0	0	0	0	0	0
Working Capital	2	518	518	-29	57	59	84	109	134	159
Applications	1393	6285	6285	-29	57	59	84	109	134	159
Loan Liabilities	211	1608	3019	3049	3079	3110	3141	3173	3204	3236
Cash Balance	3	521	1039	1010	1067	1126	1211	1319	1453	1612

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	484	533	583	632	682	659	659	659	659	659
Operation and Maintenance	316	330	344	358	371	273	273	273	273	273
Depreciation	83	83	101	119	119	119	119	119	119	119
Payment of Interest	2	17	32	30	29	27	26	24	23	21
Expenditure	402	431	477	507	519	420	418	417	415	413
Profit before Tax	82	102	106	125	162	239	240	242	244	245
Tax	0	0	0	0	0	0	0	0	0	0
Profit after Tax	82	102	106	125	162	239	240	242	244	245
Funds Statement										
Profit after Tax	82	102	106	125	162	239	240	242	244	245
Loans	0	107	536	536	0	0	0	0	0	0
Subsidies	0	607	3036	3036	0	0	0	0	0	0
Depreciation	83	83	101	119	119	119	119	119	119	119
Sources	165	900	3779	3816	281	358	360	361	363	364
Capital Works	0	714	3572	3572	0	0	13	13	0	0
Payment of Principal	10	80	150	151	153	154	156	158	159	161
Working Capital	155	106	57	93	128	204	191	191	204	204
Applications	165	900	3779	3816	281	358	360	361	363	364
Loan Liabilities	3256	3299	3692	4088	3947	3805	3661	3516	3369	3221
Cash Balance	1767	1873	1930	2023	2151	2355	2546	2737	2941	3144

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	659	659	659	659	659	659	659	659	659	659
Operation and Maintenance	273	273	273	273	273	273	273	273	273	273
Depreciation	119	119	119	119	119	119	119	119	119	119
Payment of Interest	19	19	23	27	25	23	20	18	16	13
Expenditure	412	411	416	419	417	415	413	410	408	406
Profit before Tax	247	247	243	239	241	244	246	248	251	253
Tax	0	0	0	0	0	0	0	0	0	0
Profit after Tax	247	247	243	239	241	244	246	248	251	253
Funds Statement										
Profit after Tax	247	247	243	239	241	244	246	248	251	253
Loans	0	0	0	0	0	0	0	0	0	0
Subsidies	0	0	0	0	0	0	0	0	0	0
Depreciation	119	119	119	119	119	119	119	119	119	119
Sources	366	366	362	358	360	363	365	367	370	372
Capital Works	0	0	0	0	0	0	0	0	0	0
Payment of Principal	162	169	198	227	229	231	234	236	238	241
Working Capital	204	197	164	131	131	131	131	131	131	131
Applications	366	366	362	358	360	363	365	367	370	372
Loan Liabilities	3071	2913	2721	2494	2265	2034	1800	1564	1326	1085
Cash Balance	3348	3545	3709	3840	3972	4103	4235	4366	4497	4629

Source: JICA

Chapter 5 Improvement of Health and Sanitation

5.1 Plan for Sanitary Facilities

The sanitation situation in Dejen 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.

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

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

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

Item	HC			YC			PF		
	1995	2005	2010	1995	2005	2010	1995	2005	2010
• Water demand (lpcd)	5	58	63	17	34	37	5	18	20
• Waste water generation rate (%)	60	74	75	64	67	68	60	63	64
• Waste water production (lpcd)	3	43	47	11	23	25	3	11	13

5.1.1 Plan of Toilet Facilities

The sanitary technologies planned for Dejen 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 sanitary 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 Dejen, 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 parts 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

In order to stop the present indiscriminate dumping of refuse and to prevent both environmental pollution and water contamination, two strategic sites just outside the skirt of the town on the south are proposed for preparing proper refuse dumping sites.

Refuse collecting bins should be placed at strategic locations within the community so that people dump their refuse. Then refuse collecting and disposing truck or animal-drawn cart should empty the bins to transport the refuse to the prepared dumping sites. This work has to be administered by close relationship of the community, the Kebele and the Municipality. The refuse at the dumping site should be burnt under close supervision of the Municipality in coordination with WSS.

(3) Drainage

Two types of drainage are considered here. The first is the use of drainage field channels for the areas where the soakaway pits have become ineffective due to excess of sullage or waste water. The sizes and numbers of the drainage field channels depend on the quantity of waste water to be drained after close follow up of the working of the soakaway pits. The second type of drainage is draining is draining the storm water. Most of the drainage facilities that were prepared during the construction of the main roads have been blocked by outside rubbishes that have been dumped on them. The first action required is to open-up the blocked drainage facilities and maintain them regularly to remain open. This would considerably help to reduce the formation of stagnant water, and there by reducing or eliminating the sources for breeding of insects and flies. There are roads within Dejen that do not have any means of drainage facilities. These roads should have side ditches and cross drainages to drain the water whenever storm(rainfall) occurs.

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 Dejen are too low to justify the installation of conventional sewerage system in Dejen. On account of this, the sanitary facilities proposed for Dejen are on-site sanitary technologies.
- Those households that do not have any toilet facilities in Dejen 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 Dejen 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 Dejen.
- 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 Dejen 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 Dejen for Target Years of 2005 & 2010 by Type of Water Services

Target Year	Households		
	HC	YC	PF
• 2005	210	760	910
• 2010	460	920	800

5.2.2 Estimate of Costs

(1) Capital Costs per Unit

For each type of toilet facility that is considered appropriate for Dejen 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 Dejen by the Year 2005 and 2010

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

- By the year 2005

  - All schools in Dejen will have, at least, VIP collective toilets.
  - The Dejen Hospital toilet facilities will be rehabilitated; and the clinic and possibly a health center will have VIP collective toilets.
  - Dejen 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 Dejen 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 Dejen for Year 2005

Facilities	No	Unit Cost (birr)	Total Cost (1,000 Birr)
• VIP collective toilets for schools	12	65,000	780
• VIP collective toilets for clinics and health centers	2	65,000	130
• VIP public toilet for market area and bus terminal	4	95,000	380
• 100% households with HC to have PF toilets	210	7,500	1,575*
• 75% households with YC to have VIP shared toilets or higher	570	15,000	8,500*
• 75% households with PF to have VIP toilets	683	2,000	1,366*
• Vacuum truck	1	250,000	250
• Refuse disposal truck	1	180,000	180
• Sludge dumping site	1	10,000	10
• Refuse disposing site	2	6,500	13
• Refuse collecting bins	40	250	10
Total			13,244
Excluding Households' (*)			1,753

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

Facilities	No	Unit Cost (birr)	Total Cost (1,000 Birr)
• 50% of households in Dejen with HC to have flush toilets	230	7,500	1,725*
• 50% of Dejen households with YC to have VIP toilets or higher	460	3,000	1,380*
• 100% of Dejen households with PF to have VIP toilets	800	2,000	1,600*
• Replacement of vacuum truck	1	250,000	250
• Replacement of refuse disposal truck	1	180,000	180
• Replacement of refuse collecting bin	40	250	10
Total			5,145
Excluding Households' (*)			440

(5) Total Operating and Maintenance Cost

Indicative operating and maintenance costs for sanitary facilities for Dejen 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	12	800	9.60
• VIP collective toilets for clinics and health centers	2	800	1.60
• VIP public toilet for market area and bus terminal	4	3,000	12.00
• 100% households with HC to have PF toilets	210	1,250	262.50*
• 75% households with YC to have VIP shared or higher toilets	570	400	228.00*
• 75% households with PF to have VIP toilets	683	300	204.90*
• Vacuum truck	1	7,500	7.50
• Refuse disposal truck	1	8,500	8.50
• Sludge dumping site	1	2,000	2.00
• Refuse disposing site	2	2,500	5.00
• Refuse collecting bins	40	50	2.00
Total			743.60
Excluding Households' (*)			48.20

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	230	1,250	287.50*
• VIP or higher toilets for households with YC	460	1,000	460.00*
• VIP toilets for households using PF	800	300	240.00*
• Vacuum truck	1	7,500	7.50
• Replacement disposal truck	1	8,500	8.50
• Replacement collecting bins	40	50	2.00
Total			1,005.50
Excluding Households' (*)			18.00

(6) Summary of Costs

- Capital Costs

Year	Cost in 1,000 Birr (Total)	Excluding Households'
2005	13,244	1,753
2010	5,145	440
Total	18,389	2,193

- Annual Operating & Maintenance Costs

Year	Cost in 1,000 Birr (Total)	Excluding Households'
2005	743.60	48.20
2010	1,005.50	18.00
Total	1,749.10	66.20

5.3 Application of Sanitary Education Program

In line with the approach detailed in the Main Report, this section and Chart contain specific suggestions made for sanitary education in Dejen. They take into consideration specific conditions found in Dejen during the field survey period.

Despite the very low level of access to health education and the low level of diarrheal disease control awareness reported in the household survey, the level of sanitary behaviors seemed to be similar to many of the other towns in the Study.

To improve the situation in Dejen, support for existing health education must be provided and assistance given to widen it's remit to include sanitary education through the Churches and Mosques. The Health Committee needs strengthening with representation of the Churches and Mosques on the Committee and to give support for them in their potential roles as health education facilitators as part of the community level health education program. The provision of budget for sanitary education work in the town is also required, including budget for the sanitarians.

Table 5.3.1 Sanitary Education Priorities in Dejen

Priority level	Type of Behavior	Blocks to Improved Practice
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).
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-High	Water scoop kept off the floor	Domestic hygiene (women) although facilitated by shelf or similar available in kitchen to keep utensils on (women/ men) Construction of such shelves to be promoted (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	Handwashing with soap after handling children's stools*	Personal hygiene (women and girls roles) made easier by improving access to water and soap/ ash nearer to latrine (women) and improving the status of such behavior (all)
Medium-High	Kitchen utensils kept off the floor	Domestic hygiene (women) although facilitated by shelf or similar available in kitchen to keep utensils on (women/men) Construction of such shelves to be promoted (CPP)
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 and girls role) must be encouraged and status of latrine users promoted (CPP/all))
Medium-Low	Fly Control	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-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)
	* High Priority for low income households	
	~ Not a priority for PC Users	

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 131 m^3/day in 1995 to 363 m^3/day in 2000, 545 m^3/day in 2005 and 839 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 17 in 1995 to 22 in 2000, 23 in 2005 and 29 in 2010.

The organizational structure will get enlarged and more diversified. The ultimate organizational structure of WSS 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 20, 20 and 25 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, 3 and 4 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)	131	363	545	839
2. Water Production per Worker (m^3/day/worker)	7.7	20	30	40
3. Coefficient	1	1.1	1.1	1.2
4. No. of Personnel	17	20	20	25
5. Additional Personnel for Sanitation	0	2	3	4
6. Final No. of Personnel	17	22	23	29

2. Breakdown of Personnel by Position/Function

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

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

Positions/Functions	1995	2000	2005	2010
5. Financial Service				
1) Head	0	0	0	1
2) Budgeting Section	0	0	0	0
3) Accounting Section				
Accountants	1	1	1	1
Cashiers/Treasurers	1	0	0	0
Sub-Total	2	1	1	1
4) Financial Management Section				
Financial Analysts	0	0	0	0
5) Operation Section				
Meter Readers	0	1	1	1
Bill Distributors/Collectors	0	0	0	0
Water Sellers	5	5	5	5
Sub-Total	5	6	6	6
Total	7	7	7	8
6. Technical Service				
1) Head	0	0	0	1
2) Technical Records Section	0	0	0	0
3) Operation and Maintenance Section				
Mechanics	0	0	0	0
Electricians	0	0	0	0
Motor Operators	0	4	4	4
Plumbers	2	1	1	2
Sub-Total	2	5	5	6
4) Inspection Section				
Water Meter Technicians	0	1	1	1
Leakage Detectors	0	0	0	0
Water Quality Analysts	0	0	0	0
Sub-Total	0	1	1	1
5) Workshop	0	0	0	0
6) Works Section				
Contracting	0	0	0	0
Designing/Drafting	0	0	0	0
Sub-Total	0	0	0	0
Total	2	6	6	8
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	0	1
Drivers	0	0	1	1
Sub-Total	0	0	1	2
Total	0	2	3	4
Grand-Total	17	22	23	29

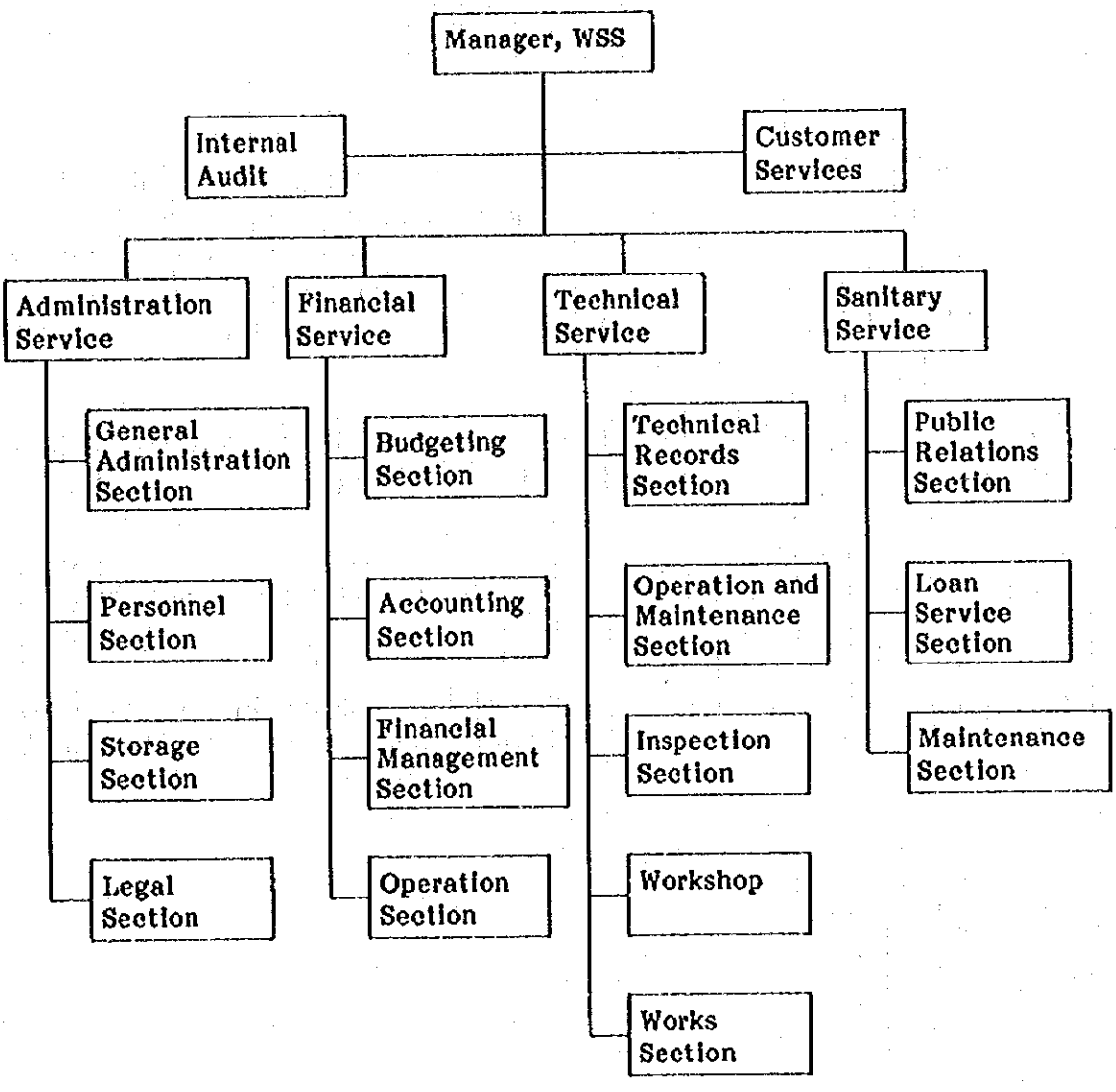


Figure 6.1.2 Proposed Model Organization Set-up of WSS

6.4 Community Building / Participation and WID

In line with the approach detailed in the Main Report, the findings of the field survey have been used to make these specific recommendations for community building and WID in Dejen:

- The water supply situation in Dejen was serious. This could be alleviated by making piped water available each day in adequate quantities at all water points and providing additional public fountains to be constructed in areas where the piped supply does not reach at present. These would have to be Government managed but could be constructed with community contributions of labor and money from the recipients. The community should also be involved in the final selection of locations and styles of water facilities. This would start to develop a sense of ownership by the community for the system and open the community development dialogue with them. Private connections with adequate service time should be provided for those who can afford them.

- Public latrines should be provided. These should be managed and maintained in a sanitary condition to encourage interest in sanitary facilities and this would have to be done by the authorities. If this is unlikely to happen, public latrines should not be constructed as poorly maintained latrines are already providing people in Dejen with a disincentive for latrines. It is unlikely that showers with these public latrines would be popular as the weather is very cool.

- Private latrine construction seems to be blocked mainly by lack of finance. Loans should be made available for people to construct simple private household latrines. It is important that these loans be taken up by those who need them most, rather than those who are aware of them first. Special attention needs to be given to approaching poor income groups. These tend to be female headed households and Christians.

- Sanitation program to be supported with some enforcement by the Authorities, particularly the Woreda to influence the Municipality to organize for the guarding and cleaning of the existing public latrines. Attention must be given not to discriminate against the poor when using enforcement. This issue must be handled with sensitivity.

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	102	2.2	1.2
Springs/rivers	132	2.0	1.4

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 1% 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
312	6.8	16	0.0956

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 2,863 thousand birr and 4,560 thousand birr respectively. It means benefits are 159% 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 by 59% greater than the cumulative personnel cost of WSS at 0 opportunity cost.

It is to be noted that time benefit resulting from project implementation is substantial, considerably surpassing 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	235,822	22,542
2000	428,933	41,001
2001	569,976	54,483
2002	714,385	68,287
2003	862,261	82,422
2004	1,013,714	96,899
2005	1,168,967	111,740
2006	1,378,632	131,781
2007	1,590,962	152,077
2008	1,806,028	172,635
2009	2,023,900	193,461
2010	2,244,651	214,562
2011	2,244,651	214,562
2012	2,244,651	214,562
2013	2,244,651	214,562
2014	2,244,651	214,562
2015	2,244,651	214,562
2016	2,244,651	214,562
2017	2,244,651	214,562
2018	2,244,651	214,562
2019	2,244,651	214,562
2020	2,244,651	214,562
2021	2,244,651	214,562
2022	2,244,651	214,562
2023	2,244,651	214,562
2024	2,244,651	214,562
2025	2,244,651	214,562

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	76	76	23	-54
5	2000	0	82	82	41	-41
6	2001	0	82	82	54	-28
7	2002	0	83	83	68	-15
8	2003	0	84	84	82	-1
9	2004	0	85	85	97	12
10	2005	0	85	85	112	26
11	2006	0	92	92	132	40
12	2007	0	98	98	152	54
13	2008	0	105	105	173	68
14	2009	0	111	111	193	82
15	2010	0	117	117	215	97
16	2011	0	117	117	215	97
17	2012	0	117	117	215	97
18	2013	0	117	117	215	97
19	2014	0	117	117	215	97
20	2015	0	117	117	215	97
21	2016	0	117	117	215	97
22	2017	0	117	117	215	97
23	2018	0	117	117	215	97
24	2019	0	117	117	215	97
25	2020	0	117	117	215	97
26	2021	0	117	117	215	97
27	2022	0	117	117	215	97
28	2023	0	117	117	215	97
29	2024	0	117	117	215	97
30	2025	0	117	117	215	97

7.2 Financial Evaluation

7.2.1 Calculation of FIRR

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

(1) Initial Cost

It was assumed initially that the central government would provide subsidy to the Dejen 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 2.7%.

The value is judged to be rather on the low side.

After repeated simulation, it was finally decided that the subsidy ratio of initial cost would be 85%.

(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 4.2% was obtained.

The value exceeds 1%, which is the assumed interest rate of external loan by 3.2%. 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: 2.5%	-1.7%
2. Case 2	Initial Cost : +10%	FIRR: 3.5%	-0.7%
3. Case 3	Progress of : 1997=70% Construction 1998=30%	FIRR: 4.5%	+0.3%
4. Case 4	Progress of : 1998=70% Construction 1999=30%	FIRR: 3.4%	-0.8%

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 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, then, 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	209	69	277	70	-207
2	1997	1381	69	1450	71	-1379
3	1998	1381	70	1451	72	-1379
4	1999	0	200	200	170	-29
5	2000	0	211	211	268	57
6	2001	0	246	246	305	59
7	2002	0	251	251	336	84
8	2003	0	257	257	366	109
9	2004	0	262	262	396	134
10	2005	0	267	267	426	159
11	2006	0	316	316	484	168
12	2007	107	330	437	533	96
13	2008	536	344	880	583	-297
14	2009	536	358	893	632	-261
15	2010	0	371	371	682	310
16	2011	0	273	273	659	385
17	2012	13	273	286	659	373
18	2013	13	273	286	659	373
19	2014	0	273	273	659	385
20	2015	0	273	273	659	385
21	2016	0	273	273	659	385
22	2017	0	273	273	659	385
23	2018	0	273	273	659	385
24	2019	0	273	273	659	385
25	2020	0	273	273	659	385
26	2021	0	273	273	659	385
27	2022	0	273	273	659	385
28	2023	0	273	273	659	385
29	2024	0	273	273	659	385
30	2025	0	273	273	659	385