4.2 Socioeconomic, Water Supply and Sanitation Conditions

4.2.1 Socio-economy and Gender Issue

(1) History and population

Debarwa is an ancient town established during the 16th century and used to be the center of the kings of the then rulers of this part of Eritrea. The Italians used it as a garrison town and developed some rudimentary infrastructures including water supply facility but not sewerage.

The town is divided into two zones the first encompassing the original village and the second made up of the rather modern part with old and dilapidated buildings. A master plan has been completed and approved and presently many buildings and manufacturing enterprises have been established forcing the already poorly developed town utilities to be over-stretched. In fact, Debarwa does not yet have electricity supply.

The population figure for Debarwa for 1997 is 4831 comprising of 49 percent males and 51 percent females. More than 60% of the population are of working age and only about 31% are below the age of 15. All the inhabitants of the town are of the Tigrigna ethnic group and almost all the residents are Coptic Christians.

(2) Economic conditions

The majority of Debarwa residents are original inhabitants of the area and as such they derive their livelihood from agriculture. They grow cereals, pulses and vegetables for sale in Asmara. The rest are shop owners, daily laborers and local beer brewers. There are many female headed households who work as daily laborers in farms and some of the few modern establishments. In Debarwa there are 311 licensed micro, small-scale and big modern enterprises classified into manufacturing (39); trade and distribution (103); hotels, restaurants, tea rooms, etc. (73); service establishments (30); local drink brewers (85) and others (1). Those modern enterprises that employ more than 20 workers are 8 in number with a total capital of Birr 119.4 million. Total employment in these 8 enterprises is 836 and they are industries that are engaged in textile, food processing, plastic products, and aluminum works. There also 7 small scale enterprise producing cement products, metal and wood and bakeries with a total capital of Nfa 2.1 million and employment of 142 workers. They all consume a lot of water.

With regards to education, there are 4 schools (1 kindergarten, 1 primary, 1 junior and 1 senior secondary school) enrolling a total of 3228 students with 54 teachers. The percentage distribution of enrollment in these levels of education amounts to 4.0%, 55.6%, 15.9% and 24.5% respectively.

(3) Social and gender issues: Analysis of the result of the survey

a) Household characteristics

The average sampled household size for the town of Debarwa is 5.06. Female head households comprise about 39%. In terms of ethnic composition, all of the households are from the Tigrigna ethnic group who profess the Christian faith, amongst whom could be found a small minority of the followers of Islam (Appendix A, Table 4.1).

b) Occupation

The major source of employment for heads of household is commerce (33%) followed by government (25%) and agriculture (22%). When male and female heads of households are looked separately, female headed households' main source of employment is agriculture (29%), followed by commerce and daily labor. The numerous small commercial farms to the south of the town on the Mendefera road are the main source of job providers for women in Debarwa. The major sources of job provider for male headed households, on the other hand are commerce, Government and agriculture respectively (Appendix A, Table 4.2).

c) Agriculture and land

Of those households that derive their livelihood from agriculture, the vegetable growers seem to be better in small scale commercial farming. On the average, they produce 17 quintals of vegetable and consume 37% of it, probably contributing to their better nutritional standards. Whatever little grain they produce, however, is mainly consumed (Appendix A, Table 4.3).

From the total households of Debarwa town, about 25% own an average 0.7 hectare of farm land. It could be fairly estimated that these are the original residents of the town since by tradition only the villagers could be entitled to farm land. Another 17% of the households own livestock, with sheep/goats comprising the largest share (28%) followed by cow/ox. The average ownership of chicken is only 2 per household which is surprisingly low when seen from the relative ease of raising poultry in a semi-rural setting (Appendix A, Table 4.4).

d) Household income and expenditure

The average income of a typical household in Debarwa is Nfa 675 per month. It is reported that females earn almost half of that of their counter parts. Those households that are engaged in animal husbandry, earn an average income of Nfa 1336 per month, followed by those who are engaged in commerce, others and Government. The category of other occupation is the third highest earner to household income and is believed to include activities like private quarrying and non-formal sector activities. The reported earning of unemployed (Nfa 588) is also quite high as compared to say one of the major employers like agriculture. When income is compared with ethnic and religion background, one finds that Muslims earn higher income than their Christian counterparts (Appendix A, Table 4.5).

The composition of the town's households by income group and the percentage share of expenditure on some basic items of household expenditures reveal that about 20% percent of the households are reportedly earning less than Nfa 299 per month. The majority of the households (28%) earn between Nfa 300 – 599; those who earn Nfa 600 – 999 (12%) are also quite numerous for a small town like Debarwa. Looking at the expenditure column of the table reveals that almost half of the income of households is spent on food and beverages, followed by electricity and energy (14%). The fact that almost equal amount of expenditure is allocated for clothes and footwear, and travel/culture is somewhat puzzling because one expects an increase in the allocation of expenses for the former item. Additionally, the share of water in the expenditure schedule is rather small (Appendix A, Table 4.6).

e) Household level of education

With regards to the education status of the households, there is a reported 100% student attendance of

school age children of households and a 58% literacy rate. The educational status of the head of households reveal that 52% have completed six years of schooling (primary level), and 24% completed eight years of schooling (junior secondary level). Another 14% have attended some sort of non-formal education. There are no college level educated households (Appendix A, Table 4.7).

f) Women's status and participation in communal activities

On the average, one woman per household participates in women's organizations or groups. However, all of the women in the households are engaged in housekeeping, about 25% in trade and few (8%) as daily laborers. The percentage engaged in Government jobs and factories are insignificant. Almost 42% of young girls in Debarwa go to school. In accordance to tradition, most of these (31%) also help their mothers in housekeeping. Some 3% of young girls are also reportedly engaged in trade (Appendix A, Table 4.8). To the extent that girls' schooling is crucial to the development of the family and the society, girls preoccupation in non-scholastic activities need to be discouraged so that they may equally compete with boys for academic achievement.

About half of the adult women in Debarwa participate in educational session of social services. More specifically, 72 % attend child care and family planning sessions and another 47 % in sanitation sessions. Those who participate in water use sessions are only 25%, an aspect that requires the attention of the concerned officials in view of the need to efficiently and economically utilize water. Of the interviewed households, none reported that they attend literacy sessions (Appendix A, Table 4.9).

Overall, 78% of households reported that they are members of some sort of community organizations. The clear majority of them (89%) are members of national organizations like the Peoples' Front for Democracy and Justice (PFDJ) and National Union of Eritrean Women (NUEW). Another 77% are members of traditional socio-cultural organizations like (Ekub - traditional savings association, Maheber - traditional social welfare organization, etc.). No participation in management of communal water points, communal toilets, cottage industry, commercial activities and micro-finance institutions is reported (Appendix A, Table 4.10).

The participation of adult women in communal activities, such as, road building, public water point and toilet, crop harvest, etc., is very low. However, 56% of them participate in one kind of meeting or the other and another 33% in soil and water conservation activities and a small percentage of 8% in road building. To the extent that road building and soil and water conservation activities are not voluntary activities, but are part of the national cash-for-work programs it is difficult to categorize these activities as communal activities. This is to say that the survey result for the town of Debarwa does not indicate that there is active participation in communal water point or communal toilet management; despite the reported 47% women participation in sanitation education sessions (Appendix A, Table 4.9 and 4.11).

The survey result also indicates that the percentage of women participants in women's formal or national organizations/group is quite high. However, their participation in traditional organizations such ekub and mahber is minimal, despite the fact that 77% of household members belong to traditional socio-cultural organization, suggesting that such traditional organizations are dominated by men.

g) Water related and other problems

Households' response to the type of problem they face seems to be solely confined to the lack or

inadequacy of utilities. Naturally, a large majority of them responded that shortage of income (44%) as their major problem. The shortage affects women more than men. Shortage of utilities (water and electricity) is reported to be the next big problems facing households in Debarwa. Men feel the shortage more than females because they want the water for irrigation purposes rather than for domestic use (Appendix A, Table 4.12). There seems to be no apparent problem with regards to transport, family relations, sanitation and housing.

Ranking of the first three household's responses to the problem or conditions related with the existing water supply facility show that distance to water source is first followed by poor quality of water and high water tariff. They also reported that water is not adequate, there is long queuing and of deteriorating water facilities. Even though the first complaint is distance from water source, none of the households reported that hired labor for fetching water is a problem (Appendix A, Table 4.13).

h) Affordability and willingness to pay for community toilets

Of the sampled households, those group whose income is less than Nfa 299 can afford to pay up to Nfa 10-14 per month. Within this income group, 9% responded that they can afford to pay less than Nfa 5 per month only. The household that are within the income group of up to Nfa 1499 responded similarly. However, about 50% of the households can afford to pay up to Nfa 14 per month. A small percentage of 3% of all the income groups are willing to pay more than Nfa 40 per month (Appendix A, Table 4.15). On the whole, the higher the income the more willingness to pay higher tariff for water. This has clear implications in setting water tariff.

With regards to communal toilets, the lower income group showed no willingness to pay for communal toilets. On the other hand, the middle income group of Nfa 300-999 are willing to pay for communal toilet ranging from Nfa 2 or 3 to up to Nfa 25 per month (Appendix A, Table 4.16). Experience shows that once these group get a chance to have their own latrines, they would abandon the communal toilet. Therefore, some sort of credit facility should be made available for these group to build their own latrines; but until then it is these group that should be persuaded to join in the management of communal toilets and health sanitation committees of the town.

i) Communal water points

Those households of the town that travel less than 90 m to the nearest communal water point account for only 6.7% of the respondents, and an equal percentage travel more than 400 m. However, the majority of the respondents (47%) travel between 100-199 m only, while another 40% travel 200-399 m to the nearest water point. In Debarwa, men do not fetch water. The burden lies on women who fetch 11.4 times a week and more on girls who go up to 16 times per week. The share of boys is only 7%. A large percentage of the respondents (80%) reported that they are not satisfied with the existing communal water point. When asked about their preference, 58% of these unsatisfied household respondents said that they prefer house connection. Those who said yard connection amount to 42%. All of the unsatisfied respondents do not want communal water point (Appendix A, Table 4.17).

4.2.2 Water Supply Conditions

In Debarwa the only source of potable water is a drilled well. The other main source in terms of quantity is an unprotected spring tapped pond. In addition, there are four private well owners who sell water mainly to factories.

Water supply condition of the town is very poor and the proportion of water supply by pipes and water vender is nearly 43 % and 28 % respectively. Five communal water points and 15 house connections out of 1224 households in the town are connected to distribution pipes.

The house connection users are only 1.3% of the population. The present average per capita domestic consumption from the drilled well by private connections is about 25 liters. 42% of the total supply from the well is consumed by community tap users. The average per capita daily demand of water from the communal water point is about 9 liters. Almost equivalent amount is consumed directly from river/spring water.

Greater amount of water is consumed from water supplied home by tanker, water vender and rain water. The reason for lessor consumption of transported water from communal water points, public well and river/spring is clearly justified by the labor and time incurred to the family to fetch water from distant points. For water from communal water point more than 86% travel 100 to 400 m distance and for river/spring water about 60% travel 500-1000 m. About 80% of the communal water point users expressed their dissatisfaction on the mode of supply. Among them 58% prefer and say they can afford house connection and the remaining 42% prefer to have yard connection. All users of river/spring water reported they utilize the water for washing purpose only.

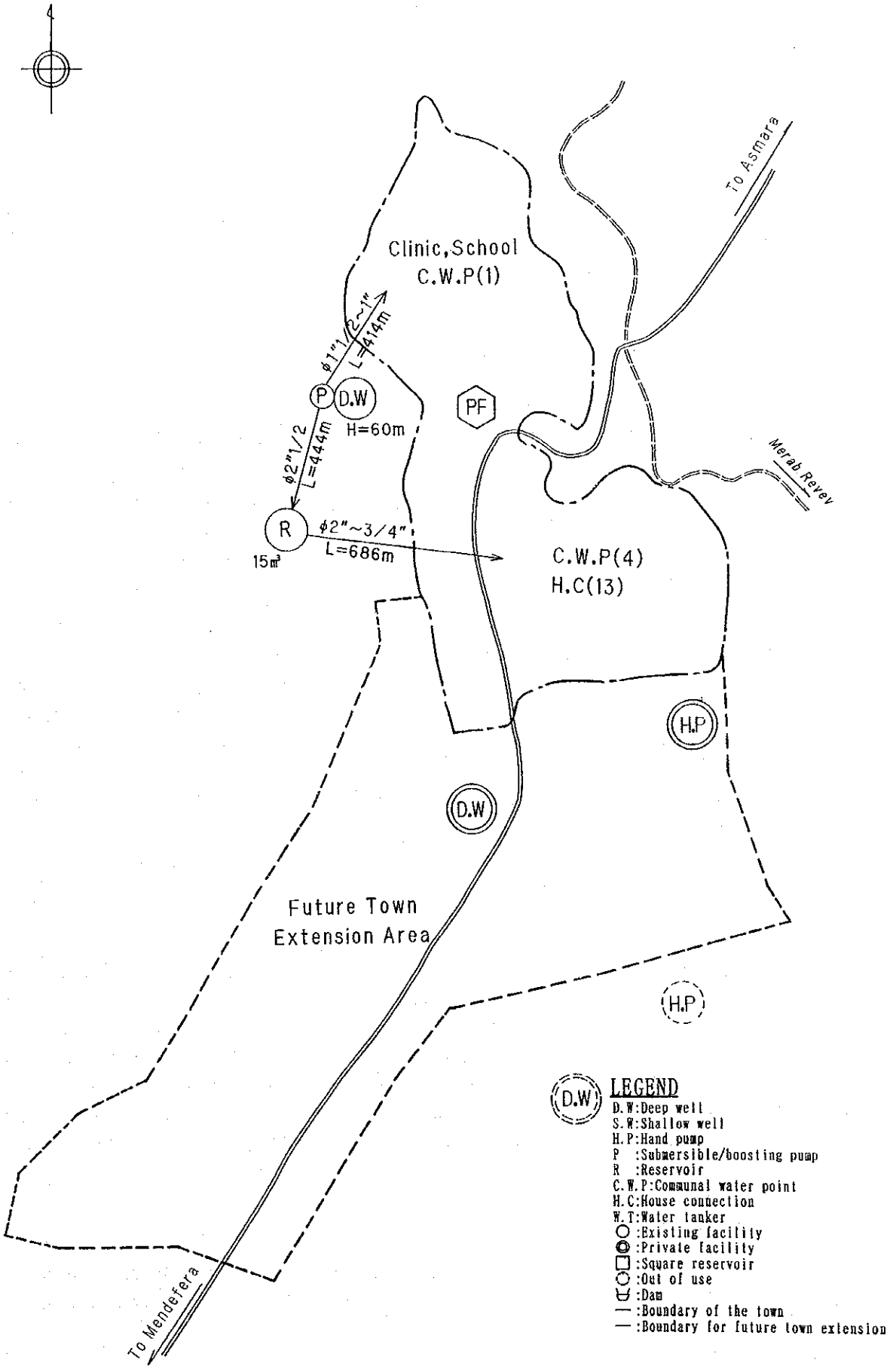
Some effort have been made by the Town administration to promote the town planning. The new master plan of the town have been completed with the expense of the Town administration. With regard to water, in 1995 the Municipality bought a generator for Nfa 62,000/- which after 7 months of operation, ceased functioning. Due to this reason, the town's water was interrupted for 4 months, until the spare part was purchased from abroad. Moreover, some private connections have been made since the establishment of the new town administration. However, due to inadequate quantity of water supply per day, the limited coverage of the existing pipeline network and the enormous amount of budget requirement for planned extensions, the Town administration cannot grant connections to all requesters. According to them, the main problem of water at present is not the inadequacy of the well's potential yield but rather the capacity of the generator. The town administrator is obliged to request the communities to participate in contributing money to alleviate the critical shortage of water in the town.

At times, when the water is scarce or when the spring tapped pond is dry, women are forced to fetch water from the River Mereb which is about 2 km from town.

Main water source of the town is one well located in 300 m far from the administration office of the town. Water from water source is directly transmitted to a school, a clinic and one communal water point in Geza Lamza, northern part of the town, and to the reservoir (15 m^3 in capacity) located on the top of the mountain. The borehole pump of the main well is connected to 2"1/2 diameter of galvanized steel pipe. The pump is operated for 2.5 hours per time and two times per day. Water of the reservoir is distributed to 5 communal water points and 15 households in the main town by gravity.

On the other hand, most of the inhabitants in the town and water vendors by donkey draw water from a public fountain well located in the north and 200 m far from the administration office. This public fountain is also a very important water source for the town even its water quality is doubtful. These situations of water supply are illustratively summarized as in Figure 4.2.1.

Figure 4.2.1 Outline of Water Supply Facility



Major problems of the existing water supply facility are limited service area, small capacity of reservoir, insufficient diameter and damage of pipes, water quality by copper mining industry.

4.2.3 Sanitary and Health Conditions

(1) Public sanitation

Refuse is dumped in 5 pits located in the different areas of the town. There is no refuse collecting truck in the town. The town conducts cleaning campaigns every three month to clear the pits. 30-40 dump-truck owner of the town participate in the campaign free of charge. Moreover, there is no sewerage system nor public latrines. According to the socio-economic survey conducted the kind of latrine hotels and restaurants have is flush type. For most of the existing retail shops do not have latrine facilities. A new regulation already is implemented which oblige all bars, restaurants, hotels etc. to have latrines facilities and, as to their cleanliness, daily follow-up is made by the Town administration.

Another big responsibility of the Town administration is the management of the factories. One aspect of management is to assess the environmental impact awareness of the factory owners and follow up their waste management practices. Factories such as textile, plastic and leather industries are examples of those producing hazardous waste. Some industries have already been established with no clear idea with respect to the ultimate disposal of their wastes.

(2) Private sanitation

Household latrine coverage of the town is only 11%. The type of latrines used are septic tank and dry pit latrine. The existing latrine conditions as observed by the numerators of the socio-economic survey is not bad. However, about 28% of the households are satisfied with the type of latrine they are having. Though most of the population do not have latrine due to main reason of money constraint they seem to be aware to the need for private latrine. If a credit system for latrine construction is introduced in the town about 64% of the households at the average repayment of 28Nfa per month are in favor of it. About 65% of the communities prefer septic tank (flush) latrines. With regard to their hygienic practices people mainly use paper and stone for anal cleansing. A minority of them mainly the Muslim society use water for anal cleansing (Appendix E, Table 4.4).

The Town administration is promoting private latrines by imposing new regulation which oblige new house builders to include latrine in their house. A committee is said setup to follow the implementation of this regulation. However, to some new house constructors money is still a constraint.

With regard to the communities waste disposal practices the inhabitants also believe their practice is not hygienic, but they put the blame on the Town administration for not providing them with public facilities. From the socio economic survey about 44% throw their refuse to their surrounding and 50% use open pit and all of them admit they dispose their wastewater either in their compound or to the surrounding area (Appendix E, Table 4.5).

(3) School sanitation

There are two government and one non-government schools in Debarwa. The government schools have not been given due attention with regard to sanitation facilities. Both government schools have a

common but non-functional water supply and latrine facilities. Once the existing latrines are out of order due to misuse, the school administrations do not maintain them. According to the administration, the main constraints for an improved sanitation are:

- budget - the students pay only 12 to 13 Nfa per annum for the school administrative expenses;
- most of the students are not accustomed to latrines, hence do not know how to use latrine properly.
- students play with taps and continually break them;
- schools do not have fences, hence external people improperly latrines.

For details of schools sanitation condition see Appendix E, Table 4.6.

(4) Hygiene/health condition

Debarwa has a health center with 20 beds and 4 pharmacies, 8 dressers and 4 pharmacists. The health center's annual statistical data show about 20% of the population diagnosed in hospital for water and poor sanitation related diseases (Appendix E, Table 4.7). On the other hand the house to house survey result indicate an average of 3 person per household were sick of diarrhea and 6 people per household were sick of Malaria for the last six month from the time the survey was conducted. Cases of infant death is at an average of 1.2 person per 10 years from the time of survey. The communities (about 94%) normally visit physician for treatment. The medical cost is an average of 5Nfa per case for diarrhea and 8.5 Nfa for Malaria (Appendix E, Table 4.8).

The enormous cases of water related and poor sanitation related diseases may not necessarily be due to lack of facilities, but it could also be as a result of poor hygienic practices and behaviors of the people. From the survey conducted about 60% of the population have the habit of washing hands with soap after defecation, 80% of them wash with water only before cooking and about 55% do not wash hands after cleaning and disposal of infants stool (Appendix E, Table 4.9).

With respect to the communities awareness to sanitation and related issues, about 94% said they participate in community sanitation work and 92% have the knowledge of ORS.

4.2.4 Financial Condition of WSS

Water Supply Service (WSS) of Debarwa earned 45,756 Nfa in 1996, while the expenditures incurred amounted to 25,412 Nfa, or a profit ratio of 44.5%. This ratio is considered an excellent financial performance.

Water sales by cash accounted for 78.7% of incomes and salaries occupied 70.8% of expenditures.

Numbers of water supply facilities are 15 for house connections, 5 for communal water points, 1 for water tanker, 1 for the public well and 1 for the private well. It is noticed that the number of house connections is very small.

Water tariffs per cubic meter are 3 Nfa for house connection users, 7.5 Nfa for communal water point users, 10 Nfa for users of water from the water tanker and 16 to 40 Nfa for users of water from water vendors. These tariffs are considered high among the seven towns.

WSS has 10 workers. Each worker earns an income of 4,576 Nfa, which is low among the 7 towns.

The average monthly salary per worker is calculated at 731 Nfa, which is on the high side.

The per capita per day consumption of water is 19.4 liters according to the results of the socio-economic survey. This per capita consumption is high.

(1) Population: 4,831

(2) Financial performance in 1996

Unit: Nfa

Revenues		Expenditures	
Item	Amount	Item	Amount
Water sales by meter	9,300	Salaries	18,000
Water sales by cash	36,000	Per diem	0
Rental charge of meters	456	Electricity	0
Service charge	0	Fuel	3,812
Others	0	Supply materials	0
Total	**45,756**	Repairs	0
		Office supply	3,600
		Others	358
		Total	**25,412**

(3) Water tariffs

Unit: Nfa/m^3

House connection	Communal water point	Water tanker	Water vendor	Public well
3-3.5*	7.5	10	16-40	0

Note: *3.5 Nfa/m^3 is for establishments/institutions.

(4) Number of water supply facilities

House connection	Communal water point	Water tanker	Public well	Private well
15	5	1	1	1

(5) Number of personnel

Division	Functions	Male	Female	Total	Perm.*	C./T.**	Total
Head		1		1	1		1
Administrative	Head	1		1	1		1
	Clerk		1	1	1		1
	Guard	1		1	1		1
Financial	Head	1		1	1		1
	Cashier		1	1		1	1
	Water seller	1	1	2		2	2
Technical	Motor operator	1		1	1		1
	Surveyor	1		1		1	1
	Total	7	3	10	6	4	10

Note: *=Permanent, **=Contract/Temporary

(6) Production and consumption of water in 1996 (m^3): 9,582 and 8,624.

(7) Average monthly salary: 731 Nfa.

(8) Per capita per day water consumption: 19.4 liters.

CHAPTER 5 STRATEGY ON PLANNING

5.1 Basic Strategy on the Planning

(1) Target year

The project for water resource development, water supply and sanitation improvement is to be formulated as a phased plan to the year 2015. A preliminary assumption would be that the project would comprise 3 phases, with phase horizons of 2005, 2010, and 2015, respectively. Although the 2010~2015 period would comprise mid~long term planning, the subject project formulation would include preliminary facility design and funding plan for this stage as well. With regard to the first phase (priority project with a target date of around 2005) of the project, facility design and costing would be to the feasibility study level.

(2) Water resources development plan

The water resources development plan would focus primarily on groundwater and underflow. This would include study of the feasibility of tapping shallow groundwater in the Quaternary formation and weathered rock zone in and around the target towns, and deep groundwater in rock formations.
Although the water source development plan will focus primarily on groundwater, discharge measurement will be carried out for Mereb river as a candidate, long term water source for Mendefera.

(3) Water use

Water supply would give priority to domestic water, however, industrial water use would also be considered with special attention to future demand trend in this regard in the case of towns such as Debarwa and Dekemhare which are pursuing programs to attract industrial enterprises.

(4) Water supply and sanitation plan

Water supply and sanitation plan would comprise a) facility plan with appropriate attention to natural and socio-economic condition, b) project cost estimation, c) O&M plan for sustainability of facilities, d) institutional strengthening plan, e) examination of the financial feasibility of the project and f) project implementation schedule.

(5) Sustainability of the project

Water supply project for rural towns lies with the municipal government of the concerned town with the aim to achieve budgetary independence. Specific recommendations on an operating structure for water supply systems which is sustainable under independent budget will be done. This would include an examination of factors such as O&M costs, replacement of main equipment after depreciation, etc. Also, in cases where the capacity of beneficiaries to pay water fees is too low to achieve independent budget viability, specific recommendations are to be made with regard to ways to compensate for this gap.

5.2 Population Projection

5.2.1 Population as of 1997

According to figures made available from the Ministry of Local Government, the total population of the seven towns as of 1997 amounts to 89,660 of which 53% are females and 47% males (see Table 5.2.1 below). The figures include the population of the surrounding villages which were incorporated within the town administrations by the MoLG. The population of the surrounding villages amounts to about 11%.

Table 5.2.1 Present Population and Household Size of the Seven Towns

Town	Population
Debarwa	4,831
Mendefera	20,371
Adiquala	9,488
Dekemhare	21,675
Segeneiti	6,146
Adi Keyih	14,215
Senafe	12,934
Total	89,660

Source: Ministry of Local Government,
Town Administration Department, 1997

5.2.2 Basic Assumptions Adopted for Population Projection

Base population data (1997) for all towns is taken from the data provided by the Town Planning Department of the Ministry of Local Government.

It is assumed that during the development plan period, the population of these seven towns will grow very rapidly due to the following reasons:

- the fact that the climate in all these areas is conducive for human settlement,
- that present demand for urban land is quite high as attested by the number of applications received by the town administrations,
- due to the high influx of rural people in search of better employment opportunities, and in search of better public amenities like schooling, health, water, etc.
- the fact that these towns are market centers which attract potential investors in trade and other service and manufacturing activities
- the various infrastructure (road, electricity, telephone, market places, et.) planned to be implemented by the government in the very near future.

5.2.3 Projected Population

Despite the fact that there will be rapid population growth rates in the coming years, it cannot be assumed that all the seven towns will experience uniform growth rate. Therefore, for the present planning

purpose, the seven towns have been categorized into two: those that will likely experience very rapid population growth and those that are likely to have lower growth rates. Following is elaboration on this:

(1) Category One: Mendefera, Dekemhare and Debarwa

These towns are envisaged to undergo a rather fast population growth rate due to the planned economic development program envisaged to be under-taken by the government and the expected private sector investment to follow in, in and around these towns.

Thus, the growth rate for these towns will be:

- at 5% per annum from the years 1998 – 2005, and
- from the year 2006 until the year 2015 they will experience a slower growth rate of 4.5% due to the general expectation of declining population growth.

The number of returnees assumed to settle in these towns is assumed to increase up to the year 2010 and slightly decrease from the year 2011 onwards.

Therefore, the number of returnees assumed to inflow to these towns are:

- from 1997 to 2000 a total inflow of 900,
- from 2001 to 2005 a total inflow of 1200,
- from 2006 to 2010 a total inflow of 1200, and
- from 2011 to 2015 a total inflow of 1000.

(2) Category Two: Adiquala, Segeneity, Adi Keyih and Senafe

The growth rate adopted for these towns is 4.5% up to the year 2005 and a slightly lower one of 3.5% until the year 2015.

The number of returnees assumed to settle in these towns is assumed to increase up to the year 2010 and slightly decrease from the year 2011 onwards.

Therefore, the number of returnees assumed to inflow to these towns are:

- from 1997 to 2000 a total inflow of 750,
- from 2001 to 2005 a total inflow of 1000,
- from 2006 to 2010 a total inflow of 1000, and
- from 2011 to 2015 a total inflow of 750.

5.3 Water Demand Projection

5.3.1 Present Domestic Water Consumption

According to the social economic survey report, present water consumption is expected as follows;

There are many water supply modes in the towns. Main modes are individual connection like house

connection and yard connection, communal water point, water wagon and water vender by donkey. Present supply mode and its water consumption is shown in Table 5.3.1.

This table shows that the house connection is the highest consumption and it is more than 20 l/s/d in five towns. Water wagon supply is the second and its consumption is about 15 – 16 l/s/d. Communal water point is lowest consumption. It means that water wagon supply is very important in seven towns at present.

The average consumption of each mode of service for seven towns is estimated 20.8 l/s/d in house connection, 11.3 l/s/d in yard connection, 11.0 l/s/d in communal water point and 14.1 l/s/d in water wagon.

5.3.2 Approach on Domestic Water Demand

The average domestic water demand and percentage of consumers for each mode of service for the seven towns is estimated based on the following consideration:

(1) Hygiene

The hygienic behaviors are influenced by the availability of adequate water. Hence the estimated water demand need to be adequate enough to keep personal and household hygiene.

(2) Available infrastructure

The infrastructures taken into account are availability of sewerage systems, cistern flush and pour flush latrines, shower and kitchen sink which have great effect on domestic water demand. At present Mendefera, Dekemhare and Adiquala have sewerage system. The town administrations of these towns realized the need and developed plans to rehabilitate and expand the system. In each town the only constraint to its implementation is budget. Moreover, with the implementation of the prospective water supply development project, lack of proper sewerage system will be aggravated.

With regard to present household latrine availability, Dekemhare, Mendefera and Adi Keyih are categorized #1, with 60%, 54% and 47.5% coverage respectively. Senafe and Adiquala are categorized #2, with coverage of 40% and 36.7% respectively, and Segeneiti and Debarwa are categorized # 3 with only 25.4% and 11.1% respectively.

(3) Economic potential

The present economic potential of the people has a direct implication with the available infrastructures. The future economic development growth is difficult to tell but with the development of water supply system it is envisaged that other economic activities will also accelerate accordingly. Hence the present situation is taken into consideration in this approach.

(4) Water resources potential

The water resources potential in these towns are limited in general. Therefore, demand on water supply may also be conditioned in accordance with the water resources potential, if there is no other choice.

Table 5.3.1 Present Supply Mode and Water Consumption

Name of Town	Mode of Supply	Consumers Percentage	Consumption (l/s/d)	Remarks
Debarwa	H.C.	1.25	25.0	
	Y.C.	-	-	
	C.W.	41.7	8.56	
	W.W.	27.8	15.61	
Mendefera	H.C.	10.94	24.11	
	Y.C.	6.56	14.95	
	C.W.	29.2	10.13	
	W.W.	53.3	16.39	
Adiquala	H.C.	13.86	20.45	
	Y.C.	6.14	12.07	
	C.W.	63.6	14.31	
	W.W.	-	-	
Dekemhare	H.C.	5.67	25.59	
	Y.C.	8.67	15.67	
	C.W.	-	-	
	W.W.	78.1	16.51	
Segeneity	H.C.	3.0	11.66	
	Y.C.	5.0	5.94	
	C.W.	90.5	8.79	
	W.W.	-	5.59	
Adi Keyih	H.C.	4.95	28.73	
	Y.C.	10.64	12.64	
	C.W.	13.94	16.45	
	W.W.	78.86	-	
Senafe	H.C.	7.78	10.3	
	Y.C.	6.62	6.8	
	C.W.	83.8	8.04	
	W.W.	1.82	16.49	
Total / Average	H.C.	7.5	20.8	
	Y.C.	7.2	11.3	
	C.W.	36.1	11.0	
	W.W.	45.3	14.1	

- "H.C." means house connection.
- "Y.C." means yard connection.
- "C.W." means communal water point.
- "W.W." means water wagon including water vender by donkey.
- The sums of consumers are not 100% because of multiple answers and neglected other sources.

(5) The government policy

The government policy do not favor subsidy for the services. While determining the water tariff, all expenses including the cost of investment on the system, production cost, and expansion cost are believed to be covered by the consumers. Hence, it is inevitable that people's affordability will limit them from consuming more water.

(6) Population

Population has great impact on water supply and sanitation. With the increase in the population the environment caused by sanitation loses its absorbing capacity and the economic development of the town accordingly increases. Hence development of infrastructures is a pressing demand of the town. At present Adi Keyih, Mendefera and Dekemhare having high populations are categorized #1, Senafe in second level and Segeneiti, Adiquala and Debarwa are placed third level.

(7) Current water demand trend

In all towns the water demand trend for water supplied home is high and for human transported water is vise versa.

Therefore, the towns based on the above listed factor are categorized, and basic factors for water demand are estimated based on the present water supply condition, as follows (refer to Table 5.3.2).

- Category 1 - Mendefera, Dekemhare and Adi Keyih
  - Consumers % of population (in 2000) => HC:YC:CW= 25:30:45
  - Demand rate in 2000 => 30, 20, 15 lcd for HC, YC, and CW
  - Annual growth rate of supply modes => 3% (HC), 2% (YC, only 2005)
  - Annual growth rate of demand by mode => 3% (HC), 2% (YC)
- Category 2 - Senafe and Adiquala
  - Consumers % of population (in 2000) => HC:YC:CW= 20:30:50
  - Demand in 2000 => 25, 20, 15 lcd for HC, YC, and CW
  - Annual growth rate of supply modes => 3% (HC), 2% (YC, to 2010)
  - Annual growth rate of demand by mode => 3% (HC), 2% (YC)
- Category 3 - Debarwa and Segeneiti
  - Consumers % of population => HC:YC:CW= 15:20:65
  - Demand in 2000 => 25, 20, 15 lcd for HC, YC, and CW
  - Annual growth rate of consumers => 3% (HC), 2% (YC, to 2010)
  - Annual growth rate of demand by mode => 2% (HC), 2% (YC)

Note) HC: House Connection, YC: Yard Connection, CW: Communal Water point.

Average domestic water demand based on Table 5.3.2 is shown in Table 5.3.3.

Table 5.3.2 Water Consumption

Name of town	Present water consumption pattern			Expected water demand											
	Mode of supply	Consumption l/c/d	Consumers % of household 1)	Year 2000-2005				Year 2005-2010				Year 2010-2015			
				Consumers (% of hld)		Ave. Consumption (l/c/d)		Consumers (% of hld)		Ave. Consumption (l/c/d)		Consumers (% of hld)		Ave. Consumption (l/c/d)	
				2000	**2005**	2000	**2005**	2005	**2010**	2005	**2010**	2010	**2015**	2010	**2015**
Debarwa	House connection	25	1. 25	15	17	25	28	17	19	28	30	19	22	30	35
	Yard connection	–	–	20	22	20	22	22	24	22	24	24	27	24	27
	Communal water point	8. 56	41. 7	65	61	15	15	61	56	15	15	56	51	15	15
	Water tanker	15. 61	27. 8												
Mendefera	House connection	24. 11	10. 94	25	29	30	35	29	34	35	40	34	39	40	47
	Yard connection	14. 95	6. 56	30	33	20	22	33	66	22	24	66	61	24	27
	Communal water point	10. 13	29. 2	45	38	15	15	38	0	15	15	0	0	15	15
	Water tanker	16. 39	53. 3												
Adiquala	House connection	20. 45	13. 86	20	23	25	29	23	27	29	34	27	31	34	39
	Yard connection	12. 07	6. 14	30	33	20	22	33	37	22	24	37	69	24	27
	Communal water point	14. 31	63. 6	50	44	15	15	44	37	15	15	37	0	15	15
	Water tanker	–	–												
Dekemhare	House connection	25. 59	5. 67	25	29	30	35	29	34	35	40	34	39	40	47
	Yard connection	15. 67	8. 67	30	33	20	22	33	66	22	24	66	61	24	27
	Communal water point	–	–	45	38	15	15	38	0	15	15	0	0	15	15
	Water tanker	16. 51	78. 1												
Segeneiti	House connection	11. 66	3	15	17	25	28	17	19	28	30	19	22	30	35
	Yard connection	5. 94	5	20	22	20	22	22	24	22	24	24	27	24	27
	Communal water point	8. 79	90. 5	65	61	15	15	61	56	15	15	56	51	15	15
	Water tanker	5. 59	–												
Adi Keyih	House connection	28. 73	4. 95	25	29	30	35	29	34	35	40	34	39	40	47
	Yard connection	12. 64	10. 64	30	33	20	22	33	66	22	24	66	61	24	27
	Communal water point	16. 45	13. 94	45	38	15	15	38	0	15	15	0	0	15	15
	Water tanker	–	78. 86												
Senafe	House connection	10. 3	7. 78	20	23	25	29	23	27	29	34	27	31	34	39
	Yard connection	6. 8	6. 62	30	33	20	22	33	37	22	24	37	69	24	27
	Communal water point	8. 04	83. 8	50	44	15	15	44	37	15	15	37	0	15	15
	Water tanker	16. 49	1. 82												

1): The sums aren't necessarily 100% because of multiple answers and neglected other sources.

Table 5.3.3 Domestic Water Demand

(l/c/d)

Name of the Town	In 2005	In 2010	In 2015
Debarwa	18.8	19.9	22.6
Mendefera	23.1	29.4	34.8
Adiquala	20.5	23.6	30.7
Dekemhare	23.1	29.4	34.8
Segeneity	18.8	19.9	22.6
Adi Keyih	23.1	29.4	34.8
Senafe	20.5	23.6	30.7

5.3.3 Other Water Demand

Total water demand consists of the domestic water demand and non-domestic water demands such as governmental, institutional, commercial and industrial demands. There are no standard figures of these non-domestic water consumption in Eritrea.

As a result of the field survey, the following non-domestic water consumption is obtained.

Table 5.3.4 Non-domestic Water Consumption by Field Survey

Item	Number	Water consumption	
		m^3/d	l/shop/d
Hotel	12	2.65	221
Restaurant	12	2.51	209
Shop	12	2.41	201
Factory	12	11.95	996

On the other hand, there are standard figures of these demands in the similar country, as follows.

School	5 lit/pupil
Hospital, Clinic	100 lit/bed
Hotel	100 lit/bed
Bar, Tea shop, Restaurant	200 lit/shop
Church, Mosque	5 lit/visitor
Office	5 lit/person
Industry (dry)	5,500 lit/ha
Industry (wet)	22,000 lit/ha

Water consumption of 5 lit/person as shown above is considered the basic figure for drinking only. As for water consumption of industry, it is planned for industry area in Debarwa, Mendefera and Dekemhare. Light industry is planned in Mendefera but it is unclear what kind of industry is planned in the remaining two towns.

Finally, non domestic water demand adopted is as follows, based on the field survey, discussion with engineers concerned in Water Resources Department and the standard figures of the similar countries.

Table 5.3.5 Non-Domestic Water Demand

Item	Water Demand
School	5 l/pupil
Hospital, Clinic	100 l/bed
Hotel, Bar, Tea shop, Restaurant	210 l/shop
Church, Mosque	5 l/visitor
Office	5 l/person
Factory	1,000 l/factory
Light industry	5,500 l/ha
Other Industry	15,000 l/ha

Non-domestic water demand except for light industry and other industry is assumed to increase in a geometric ratio of population growth rate. Water demands of light industry and other industry planned for future extension are separated and estimated per hectare based on the town planning data. Therefore, non-domestic water demands in each target year employed the same figure as above, and added the following population growth rate.

Table 5.3.6 Increasing Rate per Year for Non-domestic Water Demand

Unit: %

Name of Town	1997-2005	2006-2010	2011-2015
Debarwa	8.80	7.93	7.32
Mendefera	5.99	5.65	5.44
Adiquala	6.27	5.62	5.22
Dekemhare	5.93	5.60	5.40
Segeneiti	7.15	6.35	5.81
Adi Keyih	5.70	5.15	4.82
Senafe	5.81	5.25	4.90

5.3.4 Loss and Peak Demand

(1) Physical loss

Physical losses caused by water leakage and waste from pipes, reservoirs and taps, illicit connections, etc., are put at 15 %, assuming that the new facilities will be constructed by the target year.

(2) Max. daily and peak hour water demand

Fluctuations of the maximum daily water demand and weekly or daily variations for peak hour water demand due to seasonal or monthly climatic conditions, are taken into consideration. It is found by the field survey that water consumption in rainy season is higher by 22 % than that in dry season. Rainwater is very important source during the rainy season for washing (95%) and drinking (5%).

It is very difficult to investigate the peak hour water demand because of insufficient water source and

obsolete water supply facilities. Well pumps are operated 3~12 hours daily to meet the reservoir capacity, and communal water points are used 2~3 times per day at present. However, water supply condition will be developed under this project, and as a result, communal water points will be decreased, while individual connections (house connections and yard connections) will be increased in future.

These factors, for example, employed for Keren-city Water Supply Project for an approx. 70,000 population are 1.2 for max. daily water demand and 1.5 for peak hourly water demand.

Finally, max. daily water demand and peak hourly water demand are worked out by assuming the following coefficient based on the field survey and the standard figures in Eritrea.

Max. daily water demand = C1 x Average daily water demand
Peak hour water demand = C2 x Max. daily water demand
Coefficient of C1 = 1.2
Coefficient of C2 = 1.5

5.4 Water Supply System

5.4.1 Water Supply System

Existing water sources of six towns except Segeneity are located far from and/or lower than the town. Therefore, water is transmitted from the water sources to the reservoir by pumps and is distributed from the reservoir to customers by gravity. Well pumps are operated daily for 2.5 hours in Debarwa, 4.0 hours in Senafe and 7 - 12 hours in the remaining towns at present. In case water source is far form the town such as Mendefera and Dekemhare, water is directly supplied to the customers by water wagons.

The project plan for the water supply system employs the same system with the existing one as a rule. Water sources are to be groundwater because it is the cheapest source and the water can directly used for drinking without treatment. In case groundwater is insufficient to satisfy the demand and/or located extremely far from the town, surface water will be planned. New water sources and the existing water sources to be used in the project are connected to the reservoir by pipelines, not by water wagons. The reasons are a) there are a few water wagons and these wagons have frequent breakdowns, and b) pipeline systems are more safe and steady than the water wagons. Water of the transmission line from water source to reservoir is supplied by pump and the distribution line from reservoir to water taps is by gravity. The transmission line has no direct connection to the distribution line.

5.4.2 Water Supplied Area

Seven towns under the project have each administrative district and the administrative district consists of sub zones in the town and/or some villages. There are schools, hospitals, shops, hotels, churches, mosques, etc., in the sub zones and villages. The center of the town is divided into some sub zones and many inhabitants are living in these sub zones at present.

Each town has their future town plan and future town extension area beside the center of the town. Almost all villages are close and/or near to the town center and are included in the future town extension areas. However, a few villages are far from the town center and there is no future town plan for such

villages at present.

Under the circumstances, water service areas are divided into following three areas under the project in accordance with the present town and water supply conditions, population, future town plan, topographical features and so on. Finally, the administrative districts including all villages are planned for the water supply facilities under the project.

a) Water service area in the project target year 2005 : the areas are center of the town and essential for rehabilitation and improvement of the existing water supply facilities,

b) Water service area in the project target year 2010 : the areas are close to the town center of. These areas are for the future town extension plan, and water of these areas are supplied by water wagons or water venders at present.

c) Water service area in the project target year 2015 : the areas are far from the town center but in the administration district.

5.4.3 Facility Plan

(1) General

Existing water supply facilities are mostly replaced under the project because of following reasons. However, the existing wells counted as the water sources in the project will be used continuously, and only well pumps will be replaced after developing the existing wells. Reservoirs having enough capacity will be used after rehabilitation.

a) Yield from wells is insufficient to cover the future water demand,

b) Well pumps are obsolete and have breakdowns,

c) Reservoirs have small capacity and insufficient water level,

d) Pipelines are also obsolete, insufficient diameter to distribute the future water demand, not standable to the future increasing pressure, unknown position, etc., and

e) Communal water points are damaged.

(2) Target years for pipeline

Water supply facilities have two types, namely, one is pipeline type which is difficult to expand the system to meet the future water demand such like transmission pipeline and main distribution pipeline, while another is easy to expand such like wells pumps, reservoirs, etc.

The facilities for easy expansion are constructed and enlarged to meet the water demand in the target year. However, in case that expanded capacity is as small as $10m^3$ or less and not economical for construction, the facilities are to be constructed to meet the future demand.

The pipe diameters of the transmission line and main distribution line are enlarged to meet the water demand in the target year; for example, the pipe diameter of 100mm in 2005 is replaced by 125mm in 2010 and by 150mm in 2015 in the same line. Therefore, construction of these pipelines shall consider the future water demand.

The diameters of the transmission pipeline and main distribution pipeline are planned for the water demand in the target year 2010 under the project. The transmission pipeline and main distribution pipeline in the target year 2015 will be equipped with another one line to meet the water demand in the target year 2015. The reasons to employ these diameters are a) it is difficult to expand the facilities to meet the water demand, b) the facilities covering the water demand in the target year 2010 is nearly 20 % increase from those in 2005, and is cheaper than construction of another one line (refer to Appendix D), c) the facilities covering water demand in the final target year 2015 are nearly 40 % increase from those in 2005, and the final future plan is still unclear at present.

(3) Pipe material

Water pressure, soil characteristics and topographical configuration are very important to select pipe material for the transmission pipeline and the distribution pipeline.

Water pressure depends on given topographical configuration and total length of the pipelines, especially for transmission pipelines. Some transmission pipelines are expected durable to more than 100m of dynamic water head, while the distribution pipelines are expected to less than 75m. Soil characteristics in the project areas vary in one town to another. The ground bed of each town consists of the following lithologies and it will be difficult to select different pipe material to meet the lithologies.

Debarwa:	unconsolidated soil and weathered laterite,
Mendefera:	soil and weathered crack rich basalt,
Adiquala:	soil and mostly hard fresh basalt including rock fragments,
Dekemhare:	alluvial deposits
Segeneity:	soil and heavily weathered granite,
Adi Keyih:	clayey soil including fine to coarse gravel,
Senafe:	soil and coarse sand including sand stone gravel.

Under these circumstances, following pipe materials are recommendable.

Ductile cast iron pipe for transmission pipeline:
the transmission line is very important and the maximum pressure of the line including water hammer is nearly 1961 kPa (20kgf/cm^2),

PVC pipe for distribution pipeline:
the maximum pressure of the distribution line including water hammer is less than 981 kPa (10 kgf/cm^2).

(4) Power supply

There are main diesel power plants at Mendefera, Dekemhare and Adi Keyih in Debub Region. Electricity in six towns except Debarwa is supplied by these diesel power plants at present.

There is a network plan to connect these diesel power plants with Asmara power plant, and Debarwa will be supplied with electricity by 2000. Therefore, power supply for new water supply facilities in all seven towns will served by these diesel power plant through the network.

(5) Major water supply facility

The following major water supply facilities are planned in the project.

- Intake facility: deep well, shallow well, well pump,
- Transmission facility: transmission pipeline, booster pump, pump pit,
- Distribution facility: reservoir, distribution pipeline,
- Water service facility: individual connection, communal water point,
- Electricity facility: power supply, generator,
- Others: pump house, valves, flow meter.

Basic items of new water supply facilities are planned below.

a) Well

- Diameters of well casing are 150 mm (6 inches) for the yield capacity of 10 lit/s or less, and 200 mm (8 inches) for the capacity exceeding 10 lit/s.
- Material for casing and screen are both PVC pipe.
- Existing wells to be used in the project will be developed.

b) Well pump

- Well pump operation 24 hours daily.
- Type of well pumps are submersible.
- Well pumps for the existing wells for use in the project to be newly replaced.
- One stand-by pump provided in the town.

c) Transmission pipeline

- Pipeline for new installation
- Diameters of pipe in the target year 2005 will be for max. daily water demand in the target year 2010.
- Additional line will be constructed for the water demand in the target year 2015
- Material is ductile cast iron pipe.

d) Booster pump

- Booster pump at less than 130 m head.
- Stand-by pump not planned in the project.
- Type of booster pump is centrifugal.

e) Pump pit

- Pump pit in suction pit for boosting pump.
- Capacity is 30-minutes pumping capacity.
- Min. capacity of the pit as $15m^3$.
- Tank is of reinforced concrete made.

f) Reservoir

- Capacity for grand type is 8-hour max. daily water demand, while that for elevated type is 1-hour demand.

- The reservoirs are reinforced concrete made for ground type and fiberglass reinforced plastics (FRP) made for elevated type.

g) Distribution pipeline
- Pipeline for new installation.
- Diameters of pipe in the target year in 2005 for the max. daily water demand in the target year of 2010.
- An additional line will be installed for the water demand in the target year 2015
- Min. pressure is 7 m.
- Material is PVC pipe.
- Minimum diameter of pipe is 50 mm.

h) Individual connection
- Diameter of pipe is 13 mm.
- Material is polyethylene pipe.
- Flow meter is equipped.

i) Communal water point
- There are 8 taps per communal water point.
- Communal water points for coverage of a radius of 150 m
- Communal water point is made of concrete.

j) Power supply
- Electricity is a main power source for pumps
- No generator planed under the project.

k) Pump house
- Pump house planned for pump panels, the booster pump and generator.
- Pump house is brick made.

l) Others
- Valves (stop valve, air valve, wash out valve, pressure reducing valve, etc.) are installed at the proper position.
- The chlorinating facility is installed on the reservoir.
- Flow meters are installed at the outlet of pumps and reservoirs and at inlet of communal water points and individual connections.

5.5 Sanitation Improvement

5.5.1 Objective and Scope of the Program

The main objective of the Sanitation improvement program is to reduce the water and poor sanitation related diseases and create a healthy and productive society. Ultimately a healthy and productive society will have self sustained economy and a happy family.

This program particularly focus on public and private sanitation facilities improvement and hygienic practices. Hence the scope of the study includes the following areas of sanitation improvement:

- improve public sanitation facilities such as:
  - provision of wastewater and soil waste disposal system
  - provision of solid waste disposal system
  - provision of public and community toilets
  - improve schools, hospitals etc. sanitation facilities
- improve private toilets
- develop sanitation/hygiene educational program
- develop a management structure for sanitation improvement program

5.5.2 General Approach

The general approach of this study on sanitation improvement formulation program is based on the following steps.

a) The first step for the sanitation improvement program formulation is getting a clear picture of the current sanitation and health condition of the town with regard to facilities and practices. Therefore all pertinent information from the grass root to higher official level was gathered by approaching relevant people, referring documents and from socio-economic survey. The type of information collected are on the existing public and private sanitation facilities, economic condition of the town in general and household in particular, sanitation practices and behaviors of the community are assessed.

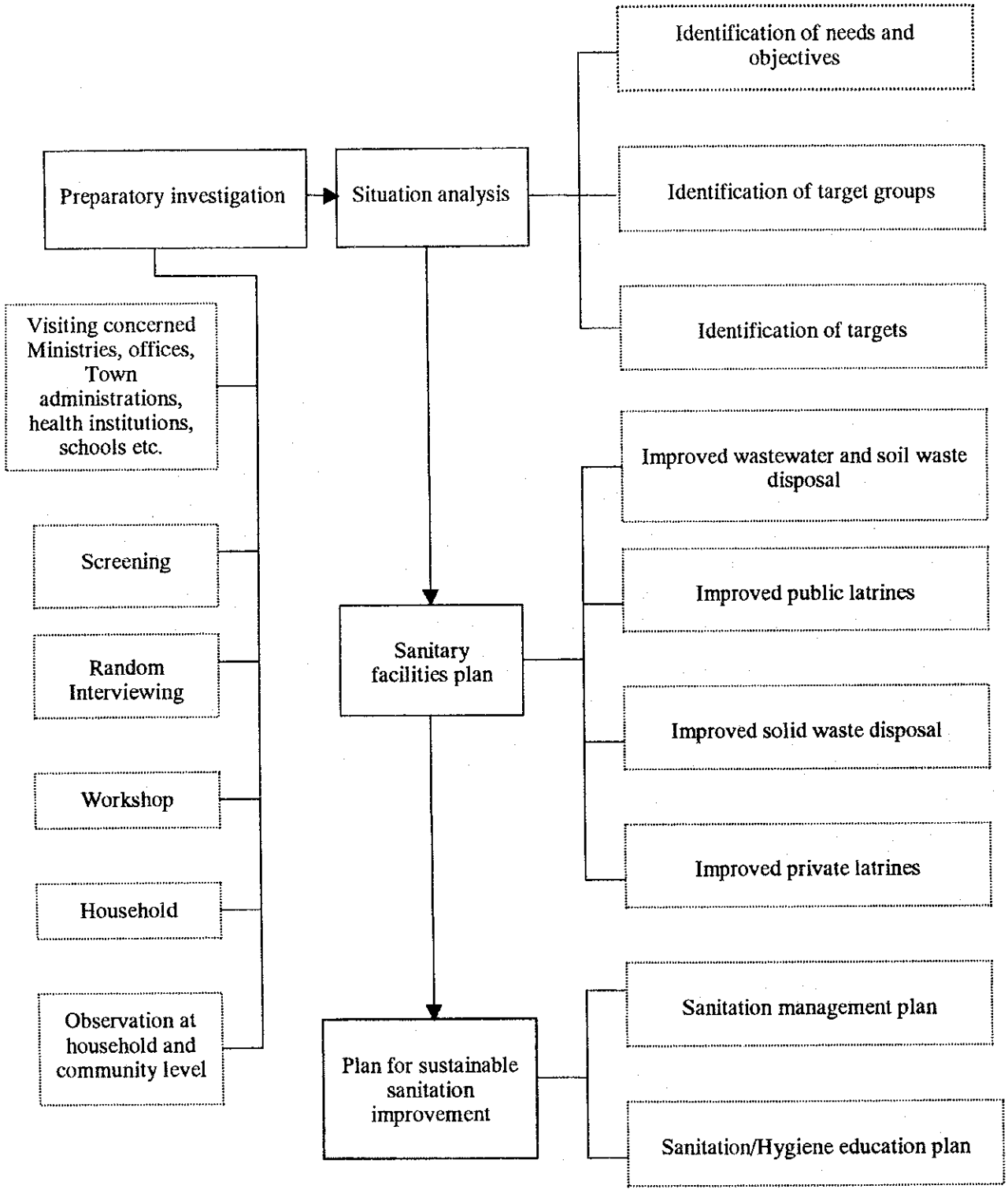
b) Following to the information collection process the situation is analyzed and needs and objectives, the specific targets and the specific target groups are identified.

c) Having a clear picture of the current condition on sanitation, social, cultural, economic etc. aspects the potential developments are foreseen and future plans for improved sanitation facilities program are formulated for three consecutive phases (year 2000-2005, year 2005-2010, and year 2010-2015).

d) Further in this study management and educational plans for effective and sustainable improved sanitation program is proposed.

For details of flow of the study approach please refer Figure 5.5.1.

Figure 5.5.1 Details of the Sanitation Improvement Program Formulation Approach



5.5.3 Areas of Focus and Basic Considerations

The needs and objectives, specific targets of the study and target groups for the sanitation development program are greatly influenced by socio-economic condition of the town and anticipated water demand. Hence the socio-economic study, water demand projections and water supply plans of this study are background for the sanitation improvement program formulation.

Moreover, explicit studies are carried out in areas of:

- Public, institutional and private sanitary facilities with respect to availability, coverage and conditions.
- Communities practice in using sanitary facilities.
- Social, economic, religious and cultural influences on sanitation facilities and usage.
- Availability of common water-born diseases, range of cases of sickness and death.
- Treatment practices for water-born disease.
- Sanitation behaviors in hand washing, utensil keeping, food and water storage, water drawing, infant excreta handling etc.
- Educational programs on sanitation, hygiene and health.
- Community management experiences.
- Community attitude on sanitation improvement programs and willingness to participate
- Government policy and programs on sanitation improvement.
- Existing management structure on sanitation.

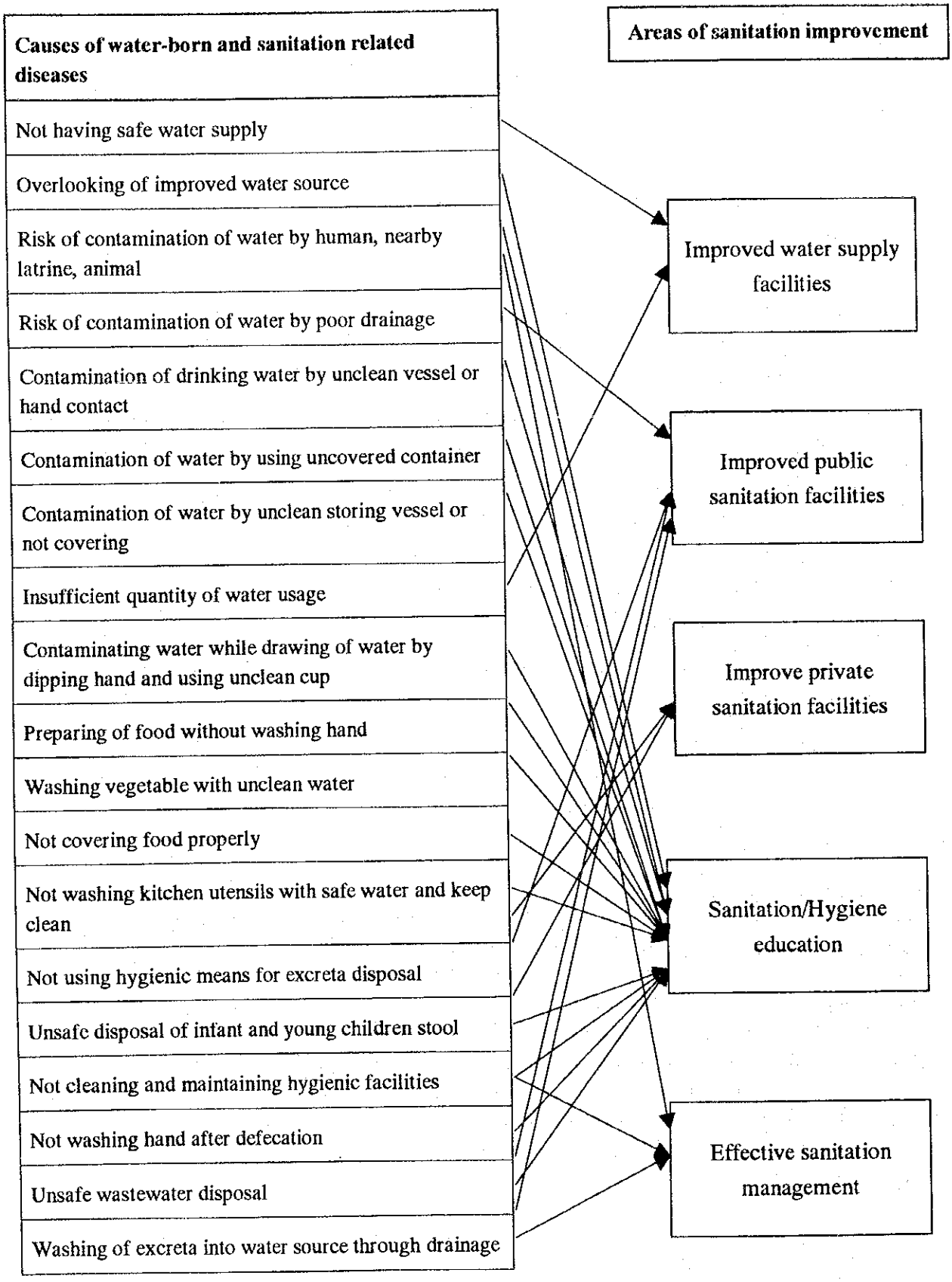
The sanitation facilities plans are developed ensuring the economic and technical feasibility and social and cultural appropriateness in the society. The basic factors considered are:

- make life easier and solve felt problems.
- functionally appropriate, easy to operate and maintain.
- affordable and materials easily available;
- in line with the cultural value and behavioral of the users;

The management plan formulated effectively address the operation and maintenance, staff strengthening, evaluation and monitoring aspect of the solid waste, wastewater and soil waste disposal, public and private latrines and sanitation/hygiene educational management.

To maximize the potential benefits of water supply and sanitation improvement programs on health, facilities need to be used and related behavioral risks reduced. Therefore, the sanitation improvement program is coupled with sanitation/hygiene education programs with the objective of establishing links between water and sanitation facilities on one hand and human practices on the other hand, especially with regard to the use, care, and maintenance of the facilities; the preservation of water safety and its use in sufficient quantities; and the safe disposal of wastewater , human and other solid waste.

Figure 5.5.2 Causes of Water-born and Sanitation Related Diseases and Areas of Sanitation Improvement



5.6 Financial and Economic Analysis

5.6.1 Water Prices and Revenues

(1) Determination of water prices

Water prices will be determined by category of customers and by target year based on:

a) Average monthly household income.

b) Distribution of household income by category of customers.

c) Willingness-to-pay for water.

d) The World Bank's recommendation of 4% of household income as the maximum limit of the payment for water.

e) The richer you are, the more you pay per unit volume of water: unit price for water point users < that for yard connection users < that for house connection owners and commerce/industry/institutions.

f) The more you consume, the more you pay per unit volume of water: the same as immediately above.

g) Future growth of household income.

h) Financial sustainability of water supply facilities to be constructed, i.e. sufficient revenues from water charge to cover the O & M and depreciation costs of the facilities.

(2) Projection of revenues

Revenue from water charges will be projected from:

a) No. of households by year and by category of customers

b) Annual water consumption per household by year and by category of customers

c) Water price by year and by category of customers

d) Bill collection rate, of which 95% is proposed

Another revenue source is the revenue from technical service charge. This revenue will be added on the purchase and transportation cost of connections.

The third revenue source is the revenue from meter rent.

Other revenues are the revenues from the sales of materials, contract fee, connection fee, fines, etc. These revenues were not taken into account as they are of minor importance, irregular and unpredictable.

5.6.2 Financial Analysis

Before financial analysis is carried out, the values will be determined based on the following factors (figures in parenthesis are proposed):

a) Project life (20 years for F/S projects; 30 years for M/P projects)

b) Discount rate (10%)

c) Financing conditions for the initial cost, i.e. subsidy or loan (subsidy)

d) Cost bearing by town people, i.e. the type(s) of cost to be borne by them:

i) O & M cost (yes)

ii) Replacement cost of all equipment and facilities (yes)

e) Durable life of equipment and facilities:

i) Pumps and other electro-mechanical equipment (15 years)

ii) Facilities including boreholes, reservoirs, pipes, communal water points,

iii) pumping stations and treatment plants (50 years)

f) Corporate income tax (free)

The initial cost, O&M cost and revenues will be estimated over a period of years, taking into account the above information and conditions.

Financial analysis comprises two forms of criteria: projection of financial statements and estimation of financial criteria.

(1) Projection of financial statements

Income statement, fund statement and balance sheet will be projected annually up to the last year of project life.

At the same time, major financial indicators such as cost revenue ratio, net profit ratio, the ratio of working capital to revenues and the ratio of net profits to total assets will be calculated based on those financial statements.

Financial feasibility of the project will also be evaluated based on the above statements and indicators.

(2) Estimation of financial criteria

Using cost benefit (revenue) streams, financial criteria including NPV, B/C and FIRR will be estimated.

Evaluation based on the values of the above criteria will be made regarding financial feasibility of the project.

5.6.3 Economic Analysis

(1) Estimation of benefits

a) Economic value of water

The major benefits accruing from the implementation of the Project are the reduction of water related diseases and general improvement of the town people on one hand, and the saving of water fetching time on the other.

Such benefits can be reflected in the price of water. Generally, water charge is controlled by the government to the level by far below the real economic value of water. The real economic value of water is usually clarified by the price at which the public is forced to buy water during its extreme scarcity. People in the 7 towns are forced to buy water from the water tank when there is no other alternative. Water cost is at 10 Nfa per cubic meter, which is 2 to 5 times higher than the water directly secured from the individual connection or the communal water point. In case even this alternative is not available, they buy water from the vendor at an exorbitant rate. In Debarwa, where water situation is more acute than in other towns concerned, such water is bought at 16 to 40 Nfa per cubic meter.

From the foregoing, it will be assumed that the level of the real economic value of water is at least 20 Nfa per cubic meter.

b) lcd and population growth in the "without" the project

Population in a town is projected to grow at the average annual rate of 5 percent. This projection has been made possible on the assumption that enough water will be available in future to cater for the rapidly growing population. Supposing water situation were as severe as at present in future, the growth of population would be much less.

It will be assumed in the "without project" case that the per capita per day consumption of water will not improve in the future and also that the growth rate of population will be half compared with the "with project" case.

(2) Economic cost

To carry out economic analysis of the Project, cost at the market prices shall be converted into economic terms.

The standard conversion factor will be assumed as 0.9, which will be applied to the local components of the capital cost.

(3) Economic analysis

Taking the above-mentioned matters into consideration, economic analysis will be performed for the Project in each town after preparing cost benefit streams for the project life period.

Through the economic analysis, the economic parameters such as NPV. B/C and EIRR will be calculated. In starting such analysis the preconditions adopted in the financial analysis will also be applied.

CHAPTER 6 DEVELOPMENT PROGRAM

The development programs for water resource, water supply and sanitation improvement are to be formulated as a phased plan to the year 2015,based on the strategy on planning examined in the previous chapter. A preliminary assumption would be that the project comprises 3 phases, with phase horizons of 2005, 2010, and 2015, respectively.

6.1 Population and Water Demand Projection

Based on the population in 1997, informed by the Ministry of Local Government, the population in each target year are projected as marked as Table 6.1.1.

Administration of Debarwa has two sub zones and one village, namely, zone 1 and zone 2 of Debarwa and Geza Lamza. Future town extension area is planned in the southern part of the town. Although most of inhabitants live in two sub zones and one village and a few live in the future town extension area at present, population will increase especially in the future extension area.

Water service area in the target year 2015 is planned as follows and illustrated in Figure 6.1.1.

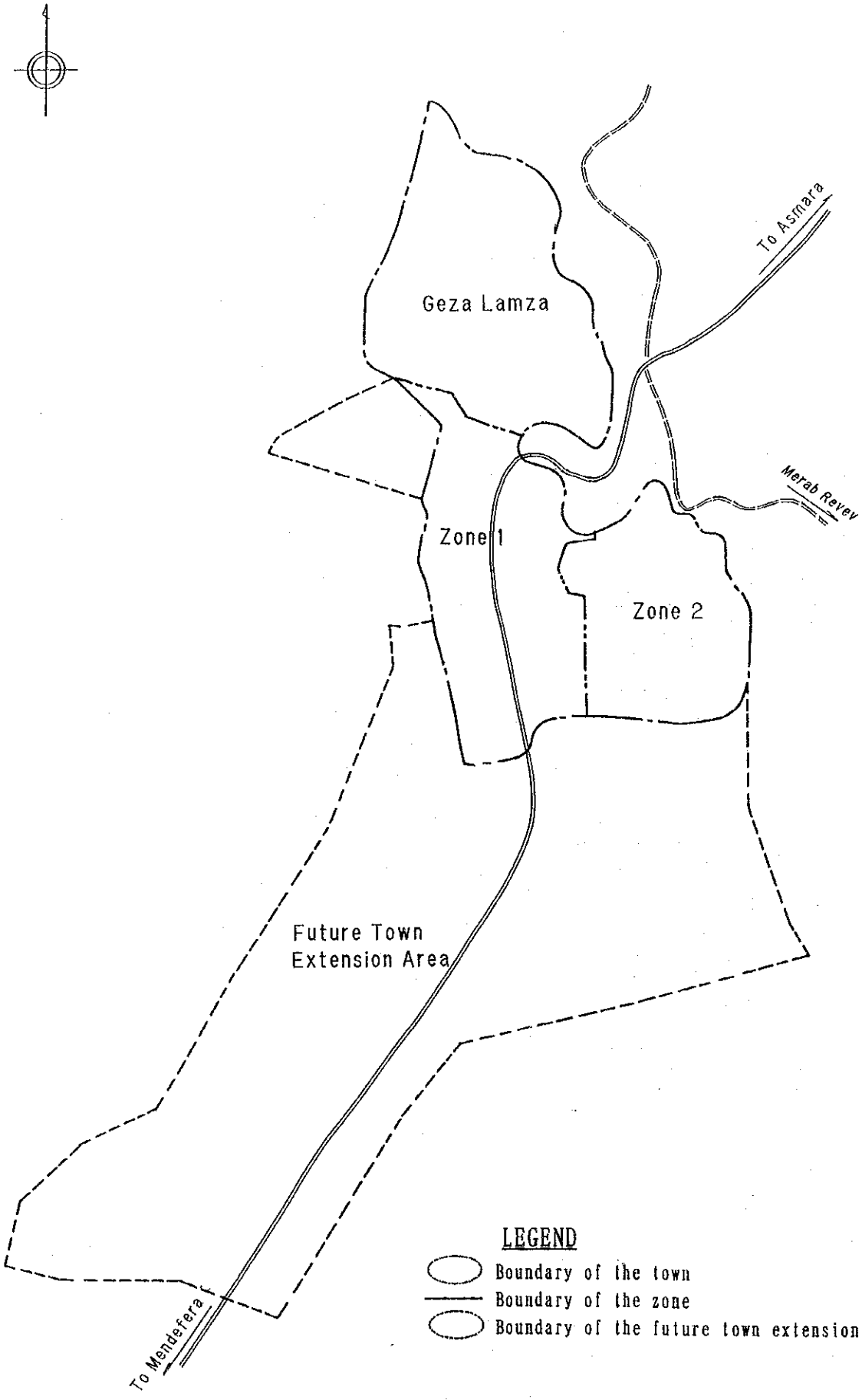
- Target year 2005: Zone 1 and zone 2 of Debarwa, Geza Lamza,
- Target year 2010: Approx. 50% of future town extension area,
- Target year 2015: Remaining 50% of future town extension area.

Water demands are estimated from the projected population of the water service area and other factors (refer to Section 5.3.4.). Detailed estimation is shown in Appendix D.

Table 6.1.1 Population and Water Demand

Target Year	2005	2010	2015
Population Projection	9,490	13,020	17,230
Service Population	7,990	12,460	17,230
Service ratio (%)	84.2	95.7	100
Average Water Consumption (l/c/d)	42.8	50.5	63.7
Average Daily Demand (m^3/d)	342	629	1,098
Max daily demand (m^3/d)	411	754	1,318
Peak hour demand (m^3/hour)	25.7	47.2	82.3

Figure 6.1.1 Outline of the Service Area



6.2 Water Resources Development Plan

6.2.1 Current Water Resources

In the town, only one borehole (BH-12) drilled along the Ruba Abuna Tatios is utilized as a water source of pipe-born water supply system. The borehole is said to yield around 3 lit/sec of groundwater. Then, a dug-well (DW-11), also existing along the stream, is served as a public water resource but equipped with no mechanical pump. For a private sector, there are 4 boreholes and 8 dug-wells near around the town. Most of the boreholes are utilized for a domestic water use through any mechanical pump, and most of the dug-wells are served for irrigation purpose installed by a motor pump. Most of dug-wells are said not to be perennially available excepting those dug just near the Mereb main flow.

Besides the groundwater resources, many small surface dams (called as micro dam) are constructed in this area, for mainly irrigation and/or livestock water uses. These are, however, severely silted already, and only a few dams are still available for their purpose reportedly.

6.2.2 Potential of Water Resources

(1) Introduction

In general, to evaluate a potential for water resources development, especially for groundwater resources, on a certain area is quite difficult except for the area where has complete hydrological data such as rainfall, surface runoff, groundwater hydrograph, evaporation, etc., recorded for long enough period. Besides those, the properties of controlling aquifer of the area, such as thickness, extension, transmissivity, storage coefficient, etc. shall be required to evaluate the groundwater potential on a certain groundwater basin. Conversely, a water resources potential of an area can be estimated substantially, if such hydrological/hydrogeological data on the area were available. In this case, many water balance equations can be utilized, and a simulation study which is the most reliable way to estimate a water resources development potential can be applied.

Unfortunately, most of such data on around the town are not available at the moment, except for rainfall data. Measurements on surface runoff (the Mereb River) and groundwater level at Test Well (DEB-1) are just started. Pan evaporation has been measuring at Mendefera Station. Thus, the circumstances to evaluate a water resources potential exactly shall be established in near future. Right now, however, the water potential must be evaluated based on several suppositions.

(2) Potential of water resources

Basically, an origin of all water in a certain basin is rainfall. Considerable part of rainwater evaporates out before surface runoff or percolating through ground. And a part of remaining rainwater flows out through a river, then, only the last remaining part can percolate through ground recharging a groundwater. The maximum groundwater development potential, steadily available as water resources, is to be the volume of yearly recharging. Thus, the groundwater resources potential, the surface water potential as well, can be estimated as follows:

a) Rainfall – (effective) Evapotranspiration = Effective rain (mm)
b) Effective rain x catchment area = Total water source (m^3)

c) Total water source – Surface runoff = Groundwater recharge (m^3)

For Debarwa, monthly mean rainfalls are available (refer to 4.1.2). Usually, there is no evapo-transpiration data because of difficulty of direct measurement. Evapotranspiration value used to be converted from Pan Evaporation value, as its 60 to 80%. In this Study, 70% of the converting rate from Pan Evaporation to Evapotranspiration is to be adopted as an average. Normally, a rainfall minus 70% of evaporation shall be an effective rain, and thus, only July and August have an effective rain. However, the river flow of the Mereb starts from June and lasts in October in most of the year, so 10% or 20% of monthly rainfalls at the beginning and the ending of a rainy season are intentionally counted as an effective rainfall.

Then, the effective rainwater must be shared between a surface runoff and a groundwater recharging. In Debub region, there is quite a few runoff observation data; those are only one month measuring data on the Mereb at Debarwa Bridge. Although the data indicated that the runoff coefficient of the Mereb was less than 8%, the monthly rainfall for the data (1997) was almost a half of the mean monthly volume. Runoff coefficient varies in accordance with a rainfall, and so about 16% of mean annual runoff coefficient is supposed for the area. In this case, the final effective rainwater is to be shared between runoff and percolation by 6:4, and the ratio shall be adopted at all of the target areas. Thus, the yearly groundwater recharge amount, that means the maximum available groundwater potential, is estimated as shown in Table 6.2.1.

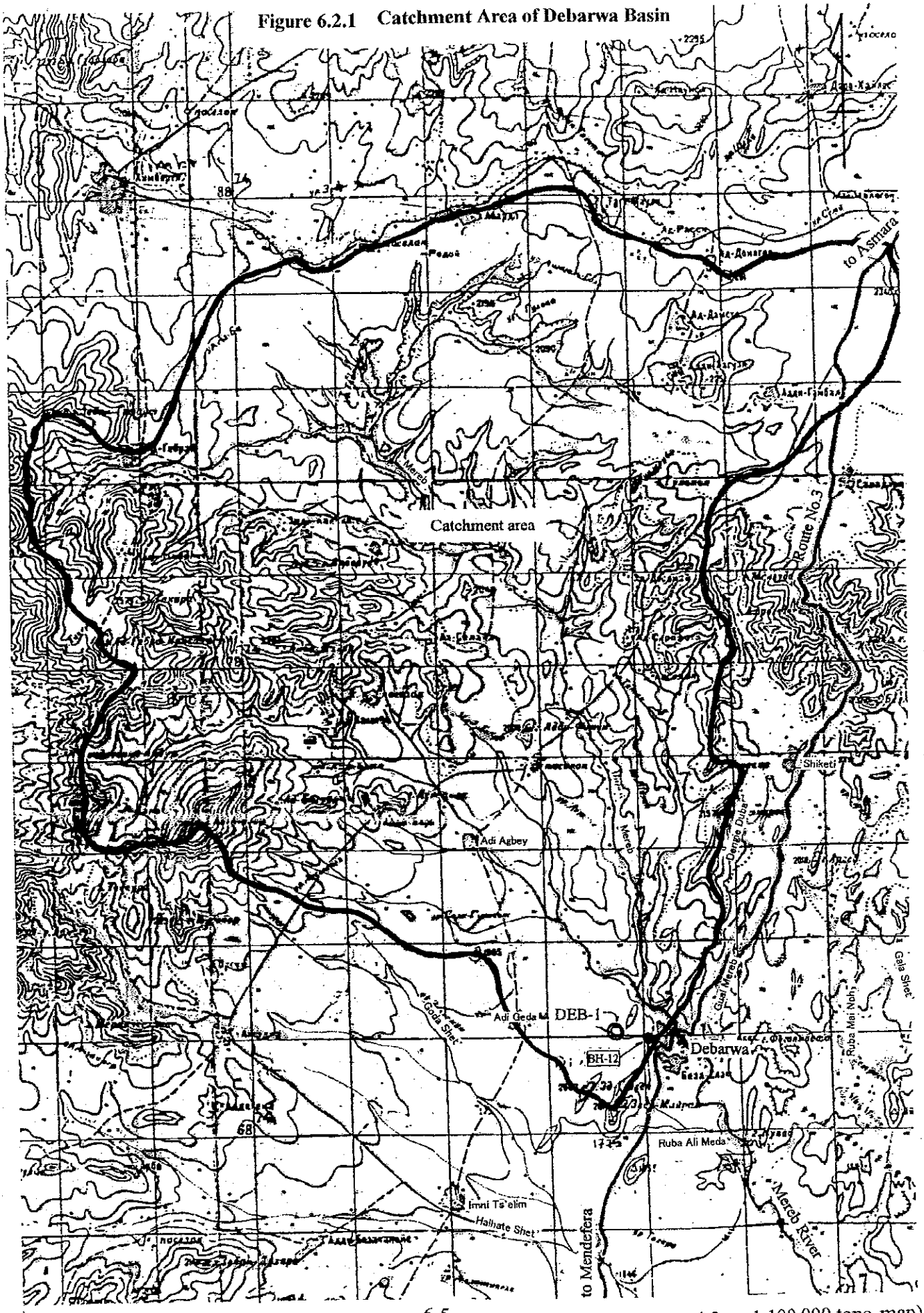
Table 6.2.1 Estimation of Groundwater Recharge

Debarwa	Jun	Jul	Aug	Sep	Oct	Annual (mm)	Vol. (m^3/a)	(%)
Rainfall (mm/m)	65.7	171.1	213.5	41.9	17.0	658.5	128,407,500	100.0%
P.E (mm/d)	5.4	5.6	4.6	5.1	5.0	2,107.9		100.0%
E. Evapotr.(-"-)	117.2	121.5	99.8	110.7	108.5	1,503.8		70.0%
E. Rain (mm/m)	6.6	49.6	113.7	8.4	1.7	179.9	35,082,450	27.3%
Runoff (-"-)	3.9	29.7	68.2	5.0	1.0	107.9	21,049,470	16.4%
Recharge (-"-)	2.6	19.8	45.5	3.4	0.7	72.0	14,032,980	10.9%
Act. E.T. (-"-)	59.1	121.52	99.82	33.5	15.3	478.6	93,325,050	72.7%

Note 1) P.E: Pan Evaporation, E.: Effective, E.T.: Evapotranspiration
Note 2) There are no effective rain during Nov.~May.

As shown in the table, the averaged yearly groundwater recharge is estimated as 72 mm/a, which is about 11% of the total rainfall. Catchment area of the groundwater basin including DEB-1 is not only the surface catchment of Ruba Abana Tatios but extended widely to NE direction through the major structural lines in the direction, involving the catchments of Ruba Enda Baulino and the main Mereb too. The total catchment area of the basin is measured as around 195 km^2 based on the 1:100,000 topo-map (Figure 6.2.1), resulted the groundwater recharge volume is around 14 MCM/a, quite enough volume for future water demand of Debarwa town.

Figure 6.2.1 Catchment Area of Debarwa Basin



(93% reduced from 1:100,000 topo-map)

Finally, a safety groundwater development volume must be considered, because such ground-water recharge occurs during rainy season, mostly within only two months, but water demand continues throughout a year in almost same level. Such situation usually prevents a full-use of the maximum water resources potential, in particular in the area where groundwater flows out quickly. In such a case, from one-third to one-tenth of the yearly recharge volume shall be taken as a criterion on the maximum groundwater development, of course depending upon the local condition. Favorably in Debarwa area, it looks like the groundwater flow is extremely slow and the aquifer has quite high storativity, as explained in section 4.1.1, and the situation may allow almost full groundwater development.

Table 6.2.1 indicates the surface water potential too, around 21 MCM/a as renewable water sources. Then, the water resources potential of the Mereb underflow was also investigated at the upstream of Debarwa Bridge, but the result was quite discouraged, almost no potential (refer to Field Investigation Report).

(3) Water quality

Water qualities of existing water supply system including some water sources were good for drinking, except for one dud-well which was contaminated by coliform bacteria, as explained in the section 4.1.4 and shown in Figure 4.1.5.

For the new water source, groundwater extracted from DEB-1 was analyzed in the laboratory of WRD. The result of analysis is attached in Appendix and shown as Figure 6.2.2, and the data indicate that the water quality of DEB-1 is also good for potable water.

6.2.3 Water Resources Development Plan

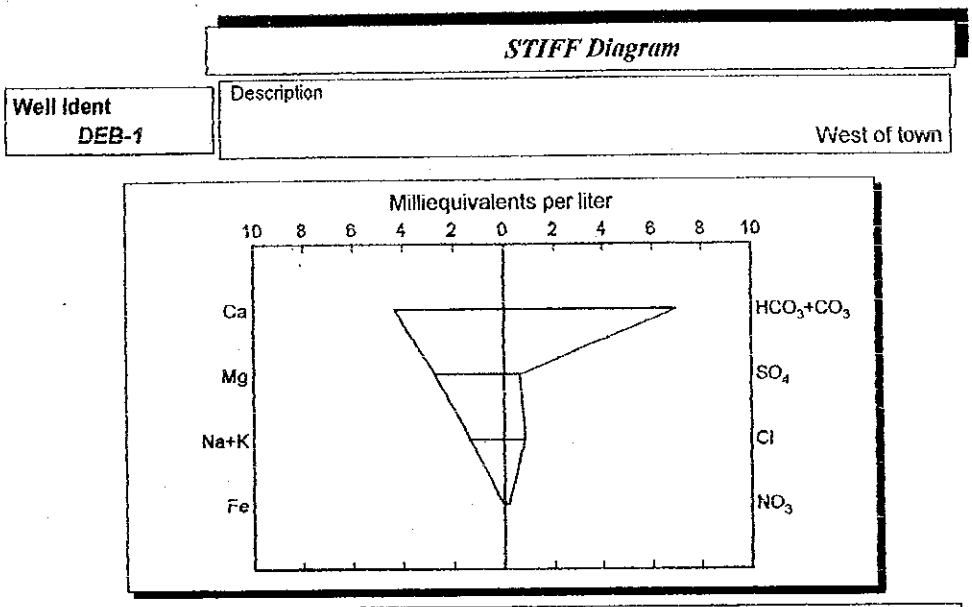
(1) Increasing of water demand

Water demand projection was already discussed in the previous section (6.1). And the Study projected out the water demands of Debarwa in 2005, 2010, and 2015 are 411, 754, and 1318 m^3/day respectively. The increasing rate of water demand in the future is illustrated in Figure 6.2.3. As shown in the figure, the water demand shall increase drastically from 2010 to 2015, because of an industrial water demand.

(2) Water resources development plan

Fortunately in Debarwa, the major aquifer is quite thick, wide, and has high storativity. And Test Well DEB-1 showed excellent yield of 15.0 lit/sec in its pumping test, even though the well diameter was 6". Normally, the largest pump can be installed in 6" well is so-called #65 pump (65 mm of suction diameter with 140 mm of flange diameter), and it can deliver around 9.0 lit/sec of water at maximum. Therefore, the design yield of the well is to be set as 9.0 lit/sec at maximum, in spite of very high yield in the pumping test. Otherwise, the well must be re-drilled and completed as 8" well, so that it can yield fully 15 lit/sec.

Figure 6.2.2 Water Quality of DEB-1



Cations					
	Ca	*Mg*	*Na*	*K*	*Fe*
Milliequivalents per liter	4.2914	2.6981	1.3398	0.01279	0.0021
Milligrams per liter	86.00	32.80	30.80	0.50	0.04

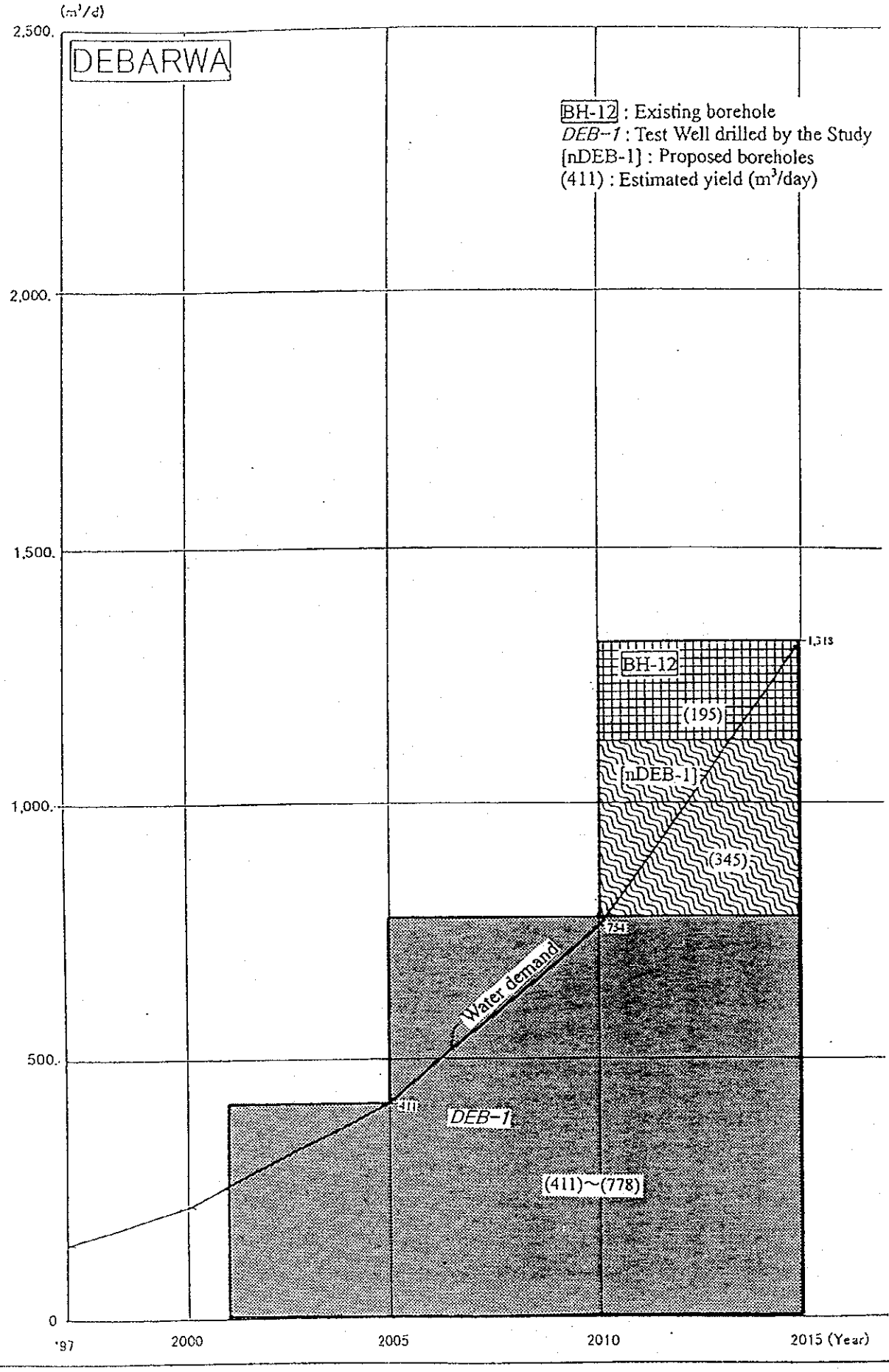
Anions					
	HCO3	*CO3*	*SO4*	*Cl*	*NO3*
Milliequivalents per liter	6.99853		0.66624	0.84630	0.17098
Milligrams per liter	427.00		32.00	30.00	10.60

Mn	NO2	PO4	F	B	SiO2
0.0000	0.00043		0.0095		
TDS	Hardness	Alkalinity	Conductivity	pH	SAR
	19.6		762.00	7.46	0.7167

Water Type	Cations (epm)	Anions (epm)
Calcium Bicarbonate	8.3	8.7

Error Balance
2.04

Figure 6.2.3. WATER DEMAND AND RESOURCES PLAN



The yield of 9.0 lit/sec becomes 777.6 m^3/day, which is just enough to cover the water demand in 2010. And the existing borehole of BH-12 which is the current public water resources has around 207.4 m^3/day of groundwater yield. Thus, the actual water supply potential in Debarwa, already confirmed and without re-drilling, is total around 985.0 m^3/day. While, the projected water demand in 2015 is 1318 m^3/day, it can not be covered by the said two wells only. It means, another well is required to drill till the last target year of 2015. The additional well can be drilled beside the DEB-1, by the same dimension. The situation, both projected water demands and resource plan, is shown in Figure 6.2.3.

6.3 Water Supply and Sanitary Facility Plan

6.3.1 Water Supply Facility Plan

(1) General

The elevation of test borehole of DEB-1 is 1850m. On the other hand, the service area including the future extension area is at around 1875m to 1830m of elevation and its topographical feature inclines gently from west to east. The existing town composed of zone 1, zone 2 and Geza Lamza is slightly higher than the future extension area. There is an existing reservoir on a mountain in the western part of zone 1 ,and its elevation is approx. 1900m. Therefore, a new reservoir is planed at the higher place near the existing reservoir and water will be distributed to the service area by gravity.

As mentioned in "6.2.3. Water Resources Development Plan", the existing borehole of BH-12 can be used. However, other existing water supply facilities could not be used because of following reasons.

- Well pump is obsolete and has breakdowns,
- Reservoir has a small capacity and some leakage,
- Pipelines is obsolete with insufficient diameter to cover the future water demand, unknown location, etc., and
- Communal water points are damaged.

Therefore, all water supply facilities except the existing borehole of BH-12 are newly planned under the project.

(2) Facility plan

Water supply facilities of this project consist of intake facilities (borehole and well pump), transmission facilities (transmission pipeline, pump pit and booster pump), distribution facilities (reservoir and distribution pipeline), service facilities (individual connections and communal water points) and others (power supply and control house). These facilities are planed and summarized herein, and detailed calculations for the facilities are shown in Appendix D.

a) Intake facilities

The test borehole DEB-1 was drilled in the west of the Debarwa and approx. 0.7 km far from the town. This borehole can be used until the target year of 2010 and another new borehole will be drilled for the water demand in 2015.

Number of the borehole and specifications of well pumps in each target year are as follows:

Target year 2005: One borehole of DEB-1 to be used.
Spec. of pump at DEB-1: Q=0.288m^3/m, H=73.3m

Target year 2010: No plan of new borehole but the well pump of DEB-1to be replaced to meet water demand.
Spec. of pump at DEB-1: Q=0.522m^3/m, H=82.8m

Target year 2015: Additional one new borehole of DEB-1' and existing boerehole of BH-12 to be used.
Spec. of new pump at DEB-1': Q=0.258m^3/m, H=79.9m
Spec. of existing pump at BH-12: Q=0.138m^3/m, H=75.7m

b) Transmission facilities

Two new transmission pipelines from DEB-1 to the new reservoir and from DEB-1' to the new reservoir shall be planned. The existing transmission pipeline from BH-12 to the new reservoir shall be replaced. The transmission facility plan for each target year are as follows:

Target year 2005: New pipeline from DEB-1 to the new reservoir.
Diameter and total length of the pipe
D=100mm, L=690m

Target year 2010: No plan of new pipeline.

Target year 2015: Additional one new pipeline from DEB-1' to new reservoir and existing but replaced pipeline to be used.
Diameter and total length of pipe
D=80 to 60mm, L=1,170m

c) Distribution facilities

A new reservoir is planned beside the existing reservoir. The reservoir will be expanded to meet the water demand in each target year.

Distribution pipeline is also newly laid and extended to meet the water demand in the target year. The distribution facility plan for each target year is as follows:

Target year 2005: Capacity and type of new reservoir
V=140m^3, ground type
Diameter and total length of pipe
D=125mm ~ 50mm, L=20,658m

Target year 2010: Capacity and type of additional reservoir
V=120m^3, ground type
Diameter and total length of expansile pipe
D=75mm ~ 50mm, L=15,052m

Target year 2015: Capacity and type of additional reservoir
V=180m^3, ground type
Diameter and total length of expansile pipe
D=100mm ~ 50mm, L=23,348m

d) Service facilities

Number of individual connections is estimated from the percentage of consumers in each target year. Communal water points are planned close to the area of low income houses and the vicinity. Communal water points are arranged to cover up the area by approx. 150m-radius circles. Service facility plan for each target year is as follows:

Target year 2005:	Number of individual connections	409 sets
	Number of communal water points	12 sets
Target year 2010:	Number of additional individual connections	218 sets
	Number of additional communal water points	6 sets
Target year 2015:	Number of additional individual connections	334 sets
	Number of additional communal water points	6 sets

e) Others

Power supply for pumps is planed to use the network from diesel power plant in the region to the town. Control houses are planed for the panel for pump, booster pump, generator for future plan, etc. Type A and B of the control house are for well pump, and type C and D are for booster pump. There is a generator room in the Type B and D. Number of control house is as follows:

Target year 2005:	Number and type of control house	
	Type B	1 set
Target year 2010:	No additional control house.	
Target year 2015:	Number and type of additional control house	
	Type A	1 set

Table 6.3.1 Number of Facility

Item		Unit	Year		
Facility	Description		2005	2010	2015
Intake Facility	New borehole	sets			
	Existing borehole	sets			1
	Observation borehole	sets	1		1
	Dam	sets			
	(Sub-total)	sets	1	0	2
Well Pump Facility	Submersible pump		DEB-1, 0.288m3/min 73.3m, 1set	DEB-1, 0.522m3/min 82.8m, 1set	DEB-1, 0.258m3/min 79.9m, 1set
					BH-12, 0.138m3/min 75.7m, 1set
	(Sub-total)	sets	1	1	2
Transmission Pipeline	DCIP 200mm	m			
	ditto 150mm	m			
	ditto 125mm	m			
	ditto 100mm	m	690.0		
	ditto 80mm	m			690.0
	ditto 60mm	m			480.0
	(Sub-total)	m	690.0	0.0	1,170.0
Booster Pump Facility	Centrifugal pump				
	(Sub-total)	sets	0	0	0
Pump Pit	Made of RC				
	(Sub-total)	sets	0	0	0
Reservoir	Made of RC		140m3	120m3	180m3
	Made of F R P				
	Existing				
	(Sub-total)	sets	1	1	1
Distrbution Pipeline	P V C 300mm	m			
	ditto 250mm	m			
	ditto 200mm	m			
	ditto 150mm	m			
	ditto 125mm	m	365.0		
	ditto 100mm	m			2,242.0
	ditto 75mm	m	1,513.0	174.0	2,195.0
	ditto 50mm	m	18,780.0	14,878.0	18,911.0
	(Sub-total)	m	20,658.0	15,052.0	23,348.0
Control House		sets	1	0	1
Communal Water Point		sets	12	6	6
Individual Connection		sets	409	218	334
Tempolaty Road	Width 3.0m	m	700	0	500

6.3.2 Sanitary Facility Plan

(1) School sanitation facilities

In Debarwa the sanitation condition in general is very poor condition. For most of the schools do not have proper sanitation facilities. In order to come up with a radical change in sanitation practices within the society one approach of sanitation promotion should be through schools.

Therefore, the main target group in this sanitation improvement program are students. By targeting students the advantages are both in economic aspect and effectiveness in behavioral change. The economic advantages are achieved by using existing institution, teachers, organized students by age and level of understanding. The effectiveness of the program in schools is proved in some other town in Eritrea. Students learn easily and accordingly change their hygienic behaviors. Follow up to their hygiene/sanitation practice in school is an easy task. On the other hand students` changed perception is believed to influence in particular their family and will also have a compounded effect result in the society.

The school sanitation facilities development program along with hygiene education program is envisaged to bring about an improved sanitation facility, hygienic behavioral changes and environmental conditions.

The type of latrine recommended is taking into consideration the cultural, economic, operation and maintenance aspects. The constraints pointed out by the schools for having poor condition latrines and latrines which are out of use are also addressed in this latrine promotion program.

(2) Public sanitation facilities

Provision of public facilities for solid waste, wastewater and storm water drainage, sludge removal and latrines are crucial for environmental sanitation and community public health promotion. Debarwa at present is lacking all these public facilities. Provision of all the necessary public facilities at the first phase of the project may not be economically feasible. However, required improvement of public facilities is discussed bellow.

a) Wastewater and storm water drainage

It is well understood that water supply coverage without parallel improvement of sanitation increases environmental pollution and causes public health problem. Trying to correct the imbalance between the water supply and sanitation on the other hand will create a financial burden to the town. In Debarwa the economic or development level of the people for instance does not allow for a conventional sewerage system provision. Moreover, from the technical point of view the wastewater flow in a sewerage system shall be too low due to anticipated low consumption rate. A very low flow rate results in poor self cleansing of the sewerage system. Debarwa's projected water consumption rate and wastewater generation rate is shown below.

Debarwa's estimated quantity of wastewater is:

- house connection users - 90% of the water demand
- yard connection users - 70% of the water demand

- community water point users - 60% of the water demand

Table 6.3.2 Water Demand and Wastewater Generation Projection

	Consumers (% of hld)			Water demand (l/c/d)			Wastewater generation (l/c/d)		
Mode of supply	2005	2010	2015	2005	2010	2015	2005	2010	2015
HC	17	19	22	28	30	35	25.2	27	31.5
YC	22	24	27	22	24	27	15.4	16.8	18.9
CWP	61	56	51	15	15	15	9	9	9

From the above table in Debarwa in none of the target year the technical requirement for the conventional sewerage system provision is satisfied. Therefore, an on-site drainage system is proposed for Debarwa.

The type of drainage techniques recommended are soak-away pit and drainage field channels for sludge removal and road side and cross road trenches for storm water drainage.

b) Public latrine

In Debarwa lack of public latrines is one area which contribute to the environmental degradation and poor public health. In this study public facilities under direct responsibility of the town administration are areas under consideration. Hence, from the public health point of view public areas such as market places, bus terminals, stadium etc. are proposed to be provided with public toilets.

c) Refuse disposal

The town administration of Debarwa never had refuse truck. As part of sanitation safe refuse collection and disposal is essential to improved public health. The present situation of Debarwa does not provide these basic services. In this study it is anticipated that Debarwa during the target year 2000-2005 need to have at least one refuse truck to go round and collect garbage and dispose at environmentally safe place outside the town at a reasonable distant place. During target year 2005-2010 and 2010-2015 provision of refuse containers in all areas of the town is proposed.

(3) Private sanitation facilities

The awareness for an improved public health condition should basically be created within the family. Therefore, efforts made to promote private sanitation facilities have great effect to improve environmental sanitation conditions. For small towns such as Debarwa where conventional sewerage systems are not introduced or can not be introduced due to economic and technical aspect, the inhabitants are advised to have appropriate household latrine and on-site wastewater disposal systems.

Debarwa having very low coverage of household latrine, open field defecation is a major factor to the present poor sanitation condition of the town. Having unhygienic latrine in a house also causes health problem. If actions are not taken in due time the pollution and health problems due to lack of household latrines and unhygienic latrine usage will be aggravated with increase in population.

The action taken by the town administration by introducing rules and regulations for the new house builders with regard to provision of family latrine in their house is highly appreciated and its impact on sanitation improvement is inevitable. However, economic constraint of the owners (builders) is still an obstacle to implement the town administration's new regulations. In socio-economic survey the residents expressed their awareness to the need for private latrine but some of them due to money constraint said they can afford only community latrine only. Hence this study proposes latrines for various groups of the society including those with very low income status.

The kind of latrines recommended are in line with the type of water supply facilities provision. The coverage anticipated is proportional to the water supply facilities coverage. The type of latrines already in use are flush latrine and dry pit latrine only. Therefore, in this project it is recommended to enhance the quality of the toilets in use taking into consideration the economic, social and cultural aspects of the society.

Basically three types of toilet for three modes of water services are recommended as tabulated below. In this study communal latrines are not recommended for the very reason of anticipated difficulty in its management. It is rather recommended shared latrines for up to four families.

Table 6.3.3 Recommended Household Latrines

Mode of water service	Recommended household latrine
House connection users	Cistern flush latrine (CFL)
Yard connection users	Pour flush latrine (PFL)
Communal water point users	Ventilated improved pit latrine (VIP)

Table 6.3.4 Anticipated Coverage of Latrines in Debarwa

Target year	CFL	PFL	VIP
2000-2005	17%	15.4%	24.4%
2005-2010	19%	19.2%	33.6%
2010-2015	22%	21.6%	40.8%

Pit latrines are designed in double pits considering the non availability of vacuum trucks in the town and the inconvenience and unaffordable rates of the truck borrowed from Asmara. The pits are 4 m^3 capacity each. Assuming 0.5 liters per day excreta per person for an average household size of five, 915 liters of excreta is disposed annually. Hence a single pit may serve for four years for a family. When one pit is full the family shift the vent pipe and squatting hole to the second pit and put lid on both squatting and vent holes. The height and the area of the latrines are sized just for economic purpose.

The double pit VIP latrine if used by three or four families it will be affordable for even very low income group. Hence the town administration should encourage the low income group families to built common VIP latrine. For four families of 20 members a single pit will last for a year and the decomposed matter

shall be removed every two years.

The flush latrines are recommended to have a septic tank with dry masonry wall for soak-away purpose in order to solve the problem of frequent vacuum truck requirement to some degree. If soak-away is not possible due to impermeable ground formation, the town shall rely on Asmara vacuum truck during the 1st phase of the project up to year 2005.

(4) Number of facilities

The facility plan is derived on the basis of development program. Accordingly the following assumption are considered in the facility plan:

- All existing schools with out proper latrine provision need to have latrine by the target year 2000-2005.
- At least one new school establishment is assumed in five years period for financial projection.
- All existing public places under the town administration such as market places, bus terminal and stadium to be provided public latrine by target year 2000-2005.
- The household latrine provision is based on demand, coverage and mode of water service development program for the three target years.
- Every five years replacement of vacuum and refuse truck is assumed.

Table 6.3.5 Number of Latrines

	Year 2005	Year 2010	Year 2015
School Latrine - PFL	2	1	1
Public Latrine - CFL	3	1	1
Household Latrine - CFL	323	172	263
Household Latrine - PFL	292	208	244
Household Latrine - VIP	463	412	530

Table 6.3.6 Number of Public Facilities

	Year 2005	Year 2010	Year 2015
Refuse truck (compactor)	1	1	1
Vacuum truck (3,000 liters)	-	1	1
Refuse collecting bins	100	100	100
Refuse collecting container (8 m^3)	-	25	25

6.4 Institutional Strengthening Plan

6.4.1 Existing Situation

Water and sanitation typically require multisectoral intervention and collaboration in their planning, implementation and management stages. At the central level, the main focal ministries for water and sanitation related affairs are the Ministry of Land, Water and Environment, the Ministry of Local Government and the Ministry of Health. In Debarwa, the town administrations, proposed Water and Sanitation Committee (WSC) as a Board, the former WSS and new WSA and the communal water point and toilet management committees are directly involved.

In this chapter, the national level institutional set-up of the above institutions will be described and recommendations forwarded for strengthening them. This will be followed by the description and recommendation for strengthening water related institutions in Debarwa. This is important because institutional building starts from the top and goes down to the bottom rather than the other way round.

6.4.2 The Ministry of Land, Water and Environment

The Government's decision behind the establishment of the Ministry of Land, Water and Environment (MoLWE) lies in its desire to ensure that its strategic resources of land, water and environment are managed and utilized through appropriate study, documentation and proper upkeep. The MoLWE has three Departments, one each for water, land and environment.

The former Water Resource Department (WRD) has been reorganized within the new MoLWE. It is now called Water Department (WD) and has two divisions under it: the Water Use Management Division (WUMD) and the Water Resource Assessment Division (WRAD) (Appendix A, Chart 6.1).

(1) Staffing pattern of the WD

Presently, there are 13 experts assigned for the WD and it has not been decided yet in which one of the Units of the WD they will be assigned.

(2) Functions of Water Use Management Division (WUMD)

This Division is responsible for drawing up policies and guidelines and for drafting water laws and regulations for the development and management of the country's water resources. There are two Units under this Division: the Water Law Unit (WLU) and the Water Resources Development Unit (WRDU). The former is responsible for drafting laws and regulatory guidelines on water resource utilization. It also issues permits for water related works and renders legal and advisory service to the other Units. The WRDU is responsible for the provision of policy and implementation guidelines for those involved in water resource development and management activities, studies new water basins and catchment areas and supervises national projects that cut across regions or that serve more than one region.

(3) Functions of Water Resource Assessment Division (WRAD)

The responsibilities of this Division are to collect, process and store data on the quality and quantity of available water resources for the efficient planning and implementation of the sector's program. There three units under this Division, namely the Hydrometeorological Information Service Unit (HMSU), the

Water Quality and Pollution Unit (WQPU) and the Water Resource Information Unit (WRIU). As the name suggests, the first Unit is responsible to undertake hydrometeorological works related to both ground and surface water resources, supervises and monitors the conservation of protection of these resources, and submits collected data and information to the data base center. The investigation of the quality of water collected by the HMSU is the responsibility of the WQPU, and additionally, it measures and monitors pollution levels in collaboration with the Department of Environment and passes on water pollution information to concerned bodies. The responsibilities of the WRIU is to enter, process and analyze data and information secured from the two units, and in collaboration with the Department of Land and Environment and concerned sectors, prepares written materials and maps concerning the quality and quantity of water resources.

(4) Establishment of the Water and Sanitation Authority (WSA)

It is mentioned in Chapter 2 that the draft Water and Sanitation Law, envisages the establishment of Water and Sanitation Authority (WSA) whose mandate will be to manage water and sanitation facilities and thus ensure the provision of water supply and sanitation services to both urban and rural areas of the country. One of the most important task or program of the WD will be to see the quick establishment of the WSA.

6.4.3 The Ministry of Local Government

The Proclamation to decentralize regional administrations was out in 1996. However, the process of complete empowering and building the capacities of these regional administrations should be seen as a long term goal. Accordingly, the primary mandate of the Ministry of Local Government (MoLG) is to act as the main coordinating and facilitating body for the regions in their dealings and relationships with the ministries at central level.

MoLG has four Departments: Regional Affairs Department, Administration Department, Council, Municipal and Cooperatives Affairs Department and the Research Department.

(1) Regional affairs department

The Department which is entrusted with water projects implementations is the Regional Affairs Department (RAD/MoLG). Its functions include coordinating and assisting in the preparation and implementation of economic, social and infrastructure development projects. RAD's tasks would be to facilitate the implementation of regional projects that involve high level expertise at the central level. Examples of such activities include: procurement, bidding/contracting, project implementation, evaluation and follow-up. In the structural organization of RAD, therefore, similar structure exists as in the regions, viz., Economic Development, Social Services and Infrastructure Services Divisions

The Units under these three divisions and the staffing pattern is indicated in Appendix A, Chart 6.2. The Infrastructure Services Division and the Engineering and Project Management Unit under it are responsible for the planning, implementation and follow-up of water projects on behalf of the regions. There are six experts composed of engineers and economists in this Unit.

(2) Establishment of the project management unit (PMU)

When there is a major water project to be implemented the RAD/MoLG establishes a project management

unit (PMU) which would assume direct responsibility for the implementation of the project. There are five of such PMUs at present for water projects financed by the World Bank, EU, GTZ, KFW and SDR.

For the implementation of the water and sanitation project in the seven towns in Debub Region, a Project Management Unit (PMU) will be established under RAD in the MoLG. It is proposed that the PMU be headed by an expatriate technical expert, one national counter part and three national experts: two engineers in charge of supervision works and one for community organization.

6.4.4 The Ministry of Health

The MoH has three main Departments under it: the Health Service Department, the Pharmacy Department and the Research and Human Resources Department. Environmental Health and Sanitation Unit is one of the Units under the Health Service Department (Appendix A, Chart no.6.3). It is responsible for developing and revising legislation, policies, standards and guidelines concerning environmental health and sanitation. Additionally it is involved in training of personnel, research and evaluation and rendering technical advise to regions. There are five experts under the Environmental Health and Sanitation Unit each responsible for environmental health, environmental sanitation, quarantine of food, drinks and beverages at airports, environmental pollution and work hazards. The first three experts in particular are responsible for ensuring the safety and adequacy of water, personal, food and environmental hygiene and environmental sanitation concerned with latrines and dry and liquid waste disposal.

6.4.5 Proposal for Institutional Strengthening Plan

1) The WD in MoLWE will need additional manpower during the periods under considerations if it is to dispense its mandate properly. On the assumption that its staff number will increase by 10 percent every five years, the number will be 14, 15 and 17 by the years 2005, 2010 and 2015 respectively. Additionally, in order to enhance the level of skills of the experts, training for a second degree will be needed at least for five experts, and short term overseas for all the 17 experts within the period of the development program. Possible areas of training could be information collection and analysis, supervision/monitoring and evaluation in underground and surface water resources.

2) A Project Management Unit (PMU) in MoLG should be established to see the implementation of the water and sanitation projects for the seven towns under study. The PMU will be under RAD/Infrastructure Service Division. There should be one expatriate staff who will head the PMU assisted by one counterpart staff and three experts under them. He and his staff will all be paid by the project. Additionally, it is suggested that training, in procurement, water facility design, design evaluation, etc. will be needed for the staff of the Engineering and Project Management Unit under the Infrastructure Service Division under RAD.

3) To facilitate the task of the head of the PMU, the three suggested experts to be employed will be: two assistant engineers and one expert on people's participation and community organization/management. While the latter will be responsible for the software aspect of the project, the two engineers will help to supervise the construction work of the water supply and sanitation facilities in the seven towns.

4) A 'Water and Sanitation Authority of Eritrea (WSA) should be established as an autonomous body charged with management of all water and sewerage/sanitation facilities in the country. The

establishment of WSA is envisaged in the draft 'Water and Sanitation Law'. It is proposed that the national level WSA should be overseen by a Board whose members should be from the main focal ministries and other interest group in the country. The Board will report to the Minister of the MoLWE. The manager with his support staff will run the office efficiently and in a coast effective manner. It is important to have two main departments under the organizational set-up of WSA: one for urban and another for rural and it is proposed that these two main departments ought to have separate divisions for water supply and for sanitation. Under these two divisions, there will be six units one for each six regions of the country. Towards this end, WSA will have to be vested with ownership and control of all towns' water supply and sanitation assets including infrastructure facilities. It is proposed that each town's WSA management become an autonomous unit with its separate cost center, possibly retaining its won income for maintenance and repair works. In order to minimize costs, WSA should operate with minimum staff. The number of staff in town WSA will be determined as per the requirement of the facilities and number of beneficiaries. The details of the management structure, including maintenance and tariff collection system will have to be worked out in the course of the project implementation.

5) In the wake of the approval for the establishment of WSA, it would be appropriate that it assists central level and Debub Regions to dispense their respective responsibilities as per the spirit of the Water Law, Water Policy and the Proclamation which allows the establishment of regional administration. For example, it could coordinate all local training of accountants, plumbers and fitters, motor and water meter technicians, electricians, etc.

6) In the MoH the Environmental Health and Sanitation Unit will be strengthened both at the national and region level, by training 6 sanitation specialists for first degree and 30 assistant sanitarians for diploma to be stationed at the regions and sub-regions.

7) Most importantly, the functional relationship between regional administration and central level ministries need further refinement and strengthening.

In Table 6.4.1 at the next page is presented a tentative proposal for institutional strengthening plan for the entire period under study. The expected outcome of this proposed management and strengthening plan of the will be dealt in Chapter Seven.

Table 6.4.1 Summary of Proposals for Institutional Strengthening Plan (2005, 2010, 2015): A Summary

Institution	Recommendation
1. MoLWE (Water Department)	**1. Capacity Building** - Office equipment and supplies - Hydrological, meteorological, survey, geological, and related equipment **2. Training** - Long Term Overseas (BA) for a second degree for 6 experts, including one in water sector planning - Short-term training for 17 experts
2. MoLG (RAD/PMU)	**1. Capacity building** - Technical Assistance for one expatriate - Technical Assistance for three engineers and one community organization experts – all nationals. - Office equipment and supplies - Vehicles **2. Training** - Long term training in facility design for 2 experts - Short terms training for three experts in the water infrastructure services?
3. MoH (Environmental Health and Sanitation Unit)	**1. Capacity building** - Office equipment and supplies for region sanitation offices **2. Training** - Long term training for 6 sanitatrians (BA) - Short term (6months) training for 30 assistant sanitarians
4. Water Supply and Sanitation Authority (WSA)	**1. Capacity Building** - Office equipment, supplies and facilities - Transport vehicles - Technical assistance for engineers and community organization experts - Debarwa WSA office building - HQ building, and stores - Seed money for Debarwa sanitation credit program **2. Training** - Short term training of plumbers, fitters, recorders (water meters and generators, pumps, etc.), in Debarwa at community level. - Short term training for bookkeepers of community level water and sanitation committees.
5. Other Public Institutions: Schools, health institutions, Churches, Mosques, public places, etc.	**1. Capacity Building:** - Establishment of water and sanitation groups in these public institutions and construct latrines and piped water sources by the end of the plan period. Its finance will be jointly from institutions themselves, parents, community, etc.

6.5 Project Cost

6.5.1 Project Cost for Water Supply

Project cost consists of the following main facilities and items.

a) Construction cost

- Intake facilities (borehole, well pump, etc.)
- Transmission facilities (booster pump, pump pit, transmission pipeline, etc.)
- Distribution facilities (reservoir, distribution pipeline, etc.),
- Service facilities (individual connection, communal water point, etc.)
- Electric facilities (control house, power supply, etc.), and
- Others (temporary road etc.)

b) Engineering fee,

c) Administration cost

d) Physical contingencies, and

e) Price contingencies

Project costs for local currency component consists of earth works, concrete works, pipe laying works, installation of mechanical and electrical facilities, temporary works, etc., while for foreign currency component consists of materials and equipment, such as pipes and its fittings, valves, pumps control panels, etc..

To the construction cost, percentages for engineering fee and administration cost are assumed as 10% and 2% respectively. Physical contingencies are assumed as 10% of the sum of the construction cost, engineering fee and administration cost. Finally, price contingencies also assume 6% per year. Project costs of each target year are estimated following tables.

Table 6.5.1 Project Cost in 2005

(Nakfa)

Description	Local C.	Foreign C.	Total	Remarks
1. Construction cost				
Borehole	0	0	0	
Well pump	10,625	193,486	204,111	
Transmission pipeline	143,041	400,613	543,654	
Booster pump	0	0	0	
Pump pit	0	0	0	
Reservoir	341,400	188,160	529,560	
Distribution pipeline	2,649,049	1,251,514	3,900,564	
Individual connection	0	0	0	
Communal water point	216,234	82,397	298,630	
Control house	195,387	10,233	205,620	
Temporary road	207,900	0	207,900	
Sub total	**3,763,636**	**2,126,403**	**5,890,039**	
2. Engineering fee	-	589,004	589,004	
3. Administration cost	117,801	-	117,801	
4. Physical contingencies	388,144	271,541	659,684	
Total	**4,269,580**	**2,986,948**	**7,256,528**	
5. Price contingencies	527,720	369,187	896,907	
Ground total	**4,797,300**	**3,356,135**	**8,153,435**	

Table 6.5.2 Project Cost in 2010

(Nakfa)

Description	Local C.	Foreign C.	Total	Remarks
1. Construction cost				
Borehole	0	0	0	
Well pump	10,727	190,008	200,735	
Transmission pipeline	0	0	0	
Booster pump	0	0	0	
Pump pit	0	0	0	
Reservoir	310,073	180,990	491,062	
Distribution pipeline	1,906,410	822,996	2,729,407	
Individual connection	0	0	0	
Communal water point	108,117	41,198	149,315	
Control house	0	0	0	
Temporary road	0	0	0	
Sub total	**2,335,327**	**1,235,193**	**3,570,520**	
2. Engineering fee	-	357,052	357,052	
3. Administration cost	71,410	-	71,410	
4. Physical contingencies	240,674	159,224	399,898	
Total	**2,647,411**	**1,751,469**	**4,398,880**	
5. Price contingencies	1,107,992	733,023	1,841,015	
Ground total	**3,755,403**	**2,484,493**	**6,239,896**	

Table 6.5.3 Project Cost in 2015

(Nakfa)

Description	Local C.	Foreign C.	Total	Remarks
1. Construction cost				
Borehole	22,504	358,595	381,099	
Well pump	21,130	331,435	352,565	
Transmission pipeline	239,082	533,715	772,797	
Booster pump	0	0	0	
Pump pit	0	0	0	
Reservoir	406,428	202,989	609,417	
Distribution pipeline	3,047,158	1,605,927	4,653,085	
Individual connection	0	0	0	
Communal water point	108,117	41,198	149,315	
Control house	137,822	9,993	147,815	
Temporary road	148,500	0	148,500	
Sub total	**4,130,741**	**3,083,852**	**7,214,593**	
2. Engineering fee	-	721,459	721,459	
3. Administration cost	144,292	-	144,292	
4. Physical contingencies	427,503	380,531	808,034	
Total	**4,702,536**	**4,185,842**	**8,888,378**	
5. Price contingencies	4,224,281	3,760,136	7,984,417	
Ground total	**8,926,818**	**7,945,978**	**16,872,795**	

6.5.2 Project Cost for Sanitation

Table 6.5.4 Cost Estimation of Latrines

(Nakfa)

Description		Year 2005	Year 2010	Year 2015
School Latrine - PFL	Construction cost	373,628	74,725	74,725
	Price contingencies	46,180	37,635	75,638
	Total	**419,808**	**112,360**	**150,363**
Public Latrine - CFL	Construction cost	323,627	74,725	74,725
	Price contingencies	96,181	37,635	75,638
	Total	**419,808**	**112,360**	**150,363**
Ground total		**839,616**	**224,720**	**300,726**

6.6 Sustainability of Water Supply Facilities

6.6.1 Capacity Building for WSA

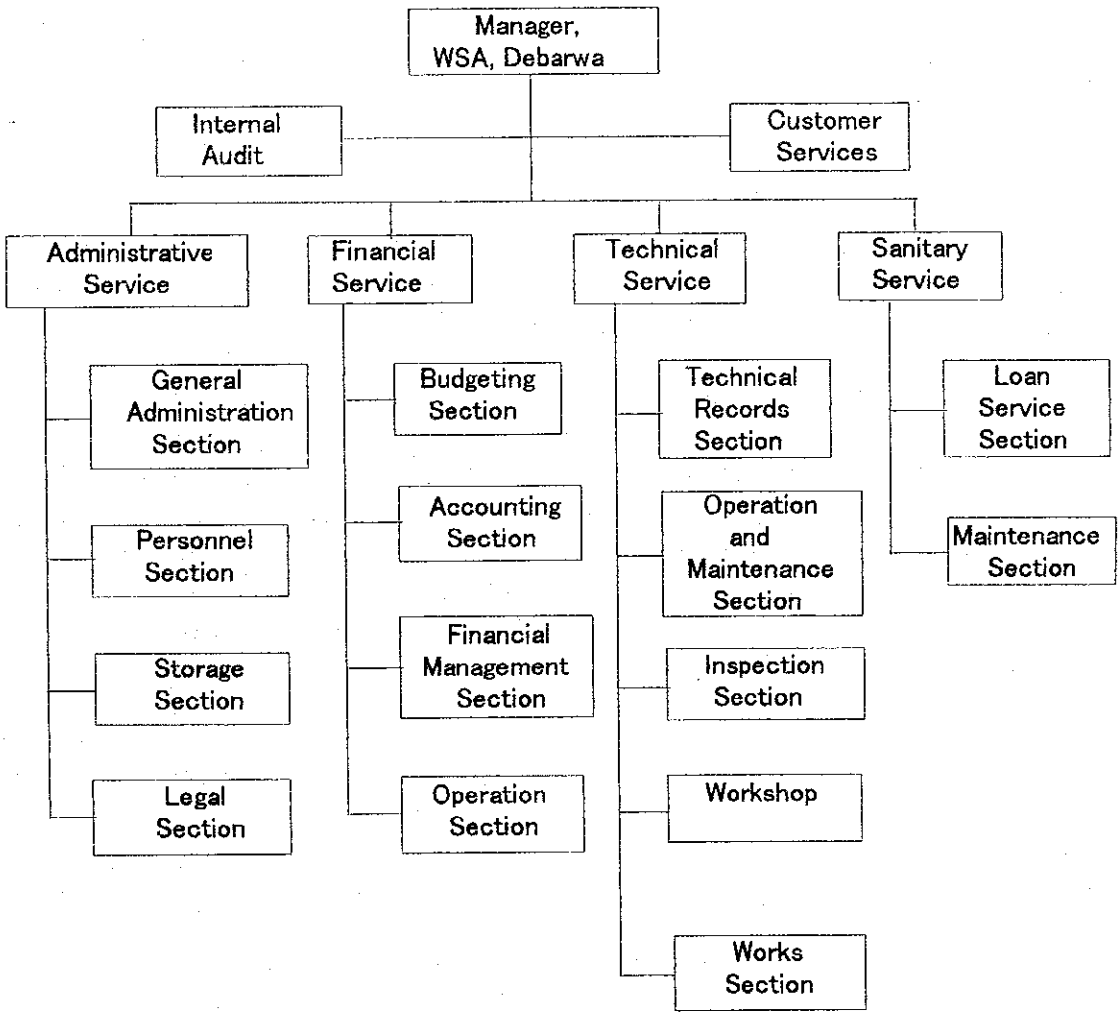
The smooth and successful implementation of the water supply project being envisaged depends on how

competent and capable the manpower of WSA Debarwa will be in both qualitative and quantitative terms.

Therefore, personnel planning in functions and numbers of personnel to be required in the future target years is of paramount importance.

The primary objective of WSA Debarwa is to supply clean and safe water in a sufficient, sustainable and efficient manner. To achieve this, the WSA shall be fully competent technically, financially and legally. Figure 6.6.1 shows the ultimate organizational set-up of the WSA.

Figure 6.6.1 Proposed Organizational Set-Up of WSA, Debarwa (2015)



Organizationally, WSA Debarwa will ultimately be composed of Manager, Customer Services, Internal Audit, Administration Service, Financial Service, Technical Service and Sanitary Service.

The Manager is responsible for the stable and successful management of WSA Debarwa and represents the WSA in dealing with the committees, the town municipality and National WSA. Customer Service functions as a window or opening for communications with the consumers in general. Internal Audit is essential for a strict observance of rules and regulations in financial management.

Administration Service is composed of General Administration, Personnel, Storage and Legal sections. General Administration Section is in charge of secretarial/clerical work. Guards and sweepers also belong to this section. Personnel Section is in charge of recruitment, assignment and training of personnel, and remuneration. The National WSA is proposed be to be basically responsible for the training of personnel. However, it is proposed also that a town WSA can re-train or newly train personnel as need arises, using its own fund. Storekeeping and procurement of materials/supplies are done by Storage Section. Such matters as complaints, lawsuits and penalties are taken care of by the Legal Section.

Financial Service must be qualitatively and quantitatively fully manned. Its functions encompass budgeting, accounting, financial management and operation. Annual and monthly budget of income and expenditures is prepared by Budgeting Section. Accounting Section prepares financial statements based on daily financial transactions. Financial Management Section analyzes and evaluates financial performances. Operation Section is in charge of meter reading, billing and collection, and cash water selling.

The communal water points are proposed to be managed by the communities themselves. The study team does not elaborate such a proposal in terms of financial and personnel needs. It is assumed that WSA Debarwa helps communities in the management of the facilities in some manner.

Technical Service must also be fully staffed in terms of the numbers and competence. It covers Technical Records, Operations and Maintenance, Inspection and Works sections, and Workshop. Records of equipment and supplies such as acquired date, numbers, plans, dimension, breakdowns and repairs are kept in Technical Records Section. Operation and maintenance of pumping stations, reservoirs, pipelines, communal water points are taken care of by the Operation and Maintenance Section. Inspection of the above-mentioned facilities is regularly carried out by the Inspection Section. Repairing and manufacturing belong to Workshop. Works Section is in charge of rehabilitation/ replacement/construction of facilities.

In addition to the organizations related to water supply, it is proposed that WSA Debarwa provide an intermediary services for the diffusion of sanitary facilities as well as sanitation services. Sanitary Service is composed of Loan Service and Maintenance sections. Loan Service Section provides loan/subsidy to clients for the installation of septic tank toilets, and keep related records. Maintenance Section regularly empties toilets with a vacuum truck, and regularly cleans and maintains drainages.

The total numbers of personnel are proposed to be 19, 28 and 40 in 2005, 2010 and 2015, respectively (Appendix G, Table-1). They were worked out based on the volume of water to be produced.

6.6.2 O&M Cost

(1) Personnel cost

The number of personnel to be required in each target year has been projected based on the volume of water to be produced in a year.

Personnel cost is calculated by multiplying the number of personnel by the average remuneration per employee. The average monthly remuneration in a target year is calculated to be Nfa 616, while the

estimated average yearly growth rate of salaries in real terms is 3%, taking into consideration the current average salary's of the Water Supply Service Office (WSSO).

The estimated number of personnel in the target years is shown in Table 6.6.1, and the average remuneration per employee is estimated at Nfa 9,364, Nfa 10,855 and Nfa 12,584 at 1997 prices in years 2005, 2010 and 2015, respectively.

(2) Electricity and fuel cost

All mechanical equipment is operated mainly by electricity. Fuel is also required in emergency. Electricity requirements are calculated based on the volume of water to be produced in each target year.

The electricity cost has been calculated by multiplying electricity requirements in kwh by the unit electricity charge, and by adding 5% of its cost for fuel, in each target year.

The estimated electricity requirements in kwh/day in the target years are shown in Table 6.6.1, and the electricity charge per kwh is Nfa 20.16.

(3) Chemical cost

The chemical, hypochlorite or bleaching powder for disinfection to be consumed in each target year has been projected from the volume of water to be produced in such a year.

The chemical cost is calculated by multiplying chemical requirements in kg in each target year by the unit price of the chemical.

The estimated chemical requirements in the target years are shown in Table 6.6.1, and the unit price of the chemical is Nfa 6.5.

(4) Repairing cost

Maintenance and minor repairing works such as replacement of spare parts for pumps and valves, fixing of water leaking locations, checking of water level in the reservoir, etc. are carried out by the staff in WSA Debarwa. Repairing needs are calculated based on the initial cost for mechanical and electrical works as well as on the initial cost for civil works including pipe laying works in a target year.

Repairing cost is estimated at 1% of the initial cost for mechanical and electrical works, and 0.5% of the initial cost for civil works including pipe laying works, in each target year.

(5) Miscellaneous cost

The miscellaneous cost is assumed at 10% of the sum of the preceding four types of costs.

The results of cost calculation are presented in Table 6.6.1.

Table 6.6.1 O&M Cost

(Unit: Nfa)

Item	Year 2005		Year 2010		Year 2015	
1. Personnel Cost	19 persons	177,915	28 persons	303,951	40 persons	503,375
2. Electricity and Fuel Cost	7.50 kwh/day	55,188	18.50 kwh/day	136,130	29.70 kwh/day	218,544
3. Chemical Cost	1,072 kg	6,965	1,966 kg	12,778	3,436 kg	22,335
4. Repairing Cost	Initial Cost for Pump 204,111 Nfa Initial Cost for Others 5,685,928 Nfa	33,518	Initial Cost for Pump 404,846 Nfa Initial Cost for Others 9,055,712 Nfa	54,260	Initial Cost for Pump 757,411 Nfa Initial Cost for Others 15,917,739 Nfa	95,879
5. Miscellaneous Cost		27,359		50,712		84,013
Total		**300,944**		**557,831**		**924,146**

6.6.3 People's Participation

(1) The path to development: self-reliance and people's participation

People's active participation and self-reliance constitute the main pillars of the Government's development policy. Participation is multi-faceted and may include, and involves almost all stages of the project cycle. For example, in the water sector, communities should be involved right from the planning stage up to the final hand-over/management stage, after the project is completed, if sustainability of community based projects is desired. The most important principle is the inculcation within the community thinking the feeling of ownership of the project.

Even today, self-reliance and people's participation, particularly through community organization, is still relevant in the economic and social transformation of Eritrea. Such a move will address the development needs of Eritrea which, cannot be achieved short of mobilizing the manpower and natural resources of Eritrea. However, self-reliance and popular participation cannot be replicated as in the days of the struggle. The EPLF was organized on a socialist ethos, where individuals were not paid for their services and owned nothing for that mater, and 'everything to the war front' was not a slogan but a survival strategy. Economic reconstruction of the country is much more complex and it will take place in an environment of liberal economy where the macro-economic policy of Eritrea paves the way for the private sector to play a leading role in the economic growth of the country. But the good news about Eritrea is that the new government works hard for self-reliance and popular participation of a kind compatible with market economies. Self-reliance should not be narrowly conceived to imply that everything is to be done by Eritreans only. Self-reliance is when the people take responsibility for their own future and map out strategies appropriate to their situation. Working towards organizing the people towards this endeavor is crucial to pull together people's resources.

(2) Reiteration of principles

In the broad context of this study, people's/community's participation simply refers to placing people at the center of urban water supply and sanitation development efforts. People based development is clearly enunciated in the Government's policy which is based on the five broad development principles

enumerated in Chapter 2 section 2.2. The implications of these five principles for people's participation are quite clear. But to reiterate, the following main points are elucidated:

- Ownership of policies and programs: Projects' sustainability could not be guaranteed unless community/people get a sense of ownership of the programs and projects built in and around their locality in particular and the country in the broader sense. Therefore, such sense of collective ownership need to be built as a culture within the people.
- Participatory politics: This policy principle implies that sustainability of projects becomes questionable if the people are excluded in all the stages of the project cycle, i.e., from the planning, to the implementation and latter on in the management of it. In the case of the project, 'Water Supply and Sanitation in Seven Towns of Debub', people's representative were briefed and their opinions sought right from the inception stage of the study, followed by a second meeting after the progress report was finalized. During these two meetings, extensive discussions were held and views exchanged in which the community representatives expressed their readiness to do whatever was expected of them.
- Good economic management: As the civil service is planned to be efficient, accountable and lean, in like manner, the management of projects including those that involve communities need to be lean, efficient and accountable to their constituencies if projects at these level are to be sustainable.
- Human Resources Development: At the macro level, this involves education and training to enhance the country's skilled manpower base. The implication for people's participation is that if communities are to effectively dispense their share in the planning, implementation and management of projects, they need to be trained and educated informally or formally as appropriate.

(3) Recommendations

Based on the implications drawn from the development principles elucidated above, the following recommendations are made to enhance people's participation, and therefore sustenance of projects in Debarwa for the stipulated development program.

a) Continuous sensitization and awareness creation program will need to be an in-built feature of the program for the development of water supply and sanitation in the seven towns.

b) The study team recommends on the broad strategy which the Government could follow in ensuring people's participation in the management and administration of water and sanitation facilities.

c) Introduce and develop a viable management system for water and sanitation facilities that will be managed by the communities.

d) Education and training need to be an in-built system of any program that seeks the active involvement of communities in project planning, implementation and management.

6.6.4 Community Based Management

In the spirit of the principles that govern people's participation as elucidated in section 6.6.3, community based management aims at placing communities at the center of the projects to be implemented, with true user ownership of facilities, including communal facilities. In Debarwa, community based management would, therefore, involve the following principles:

(1) Communities must own and manage the improved as well as unimproved or existing water points and sanitation facilities, with all that such ownership entails. This helps to understand the local values, knowledge and competencies which could eventually assist in the strengthening of community based management.

(2) Hardware and software components of the water supply and sanitation facilities need to be given equal attention. This is all the more important because, dealing with water and sanitation facilities involves managing resources which could be complex activities such as record-keeping, payment, excluding non-payers, punishing offenders, etc. For most communities failure will be common, and systems could fall into a stop and start manner, rather than move smoothly. Therefore, any intervention must recognize that software is not a straightforward task. Periodic failure could be common, even though failure itself needs to be considered as part of the learning process.

(3) The importance of linking hygiene and sanitation interventions with water supply infrastructures is indeed obvious. However, given the difficulties that water point committee members could face, a separate sanitation committee also needs to be established to manage community toilets and govern on the same principle as that of the water committees.

There exist various interest groups in Debarwa, such as those pertaining to age, sex, income, occupation, values and attitudes. It is important, therefore, not to rely solely on community elders but rather to bring various groups, notably women and young men into the process. The exclusion of these groups may understate important inputs that will consequently undermine management success of community based projects.

(4) Perhaps, one of the considerations often lost in community based management of water and sanitation facilities is that the beneficiaries of services are consumers, and therefore, they have all the right to demand quality service for the value of their money. Attitudes of service delivery agents, including especially private contractors, do often ignore and/or forget to take consumers' interest into account, particularly during the early stages of service delivery (e.g., public water point and public toilet design and location).

(5) Finally, despite uniform opinion and lessons learned regarding the need to have a strong software component to both water supply and sanitation programs, this is often not translated into the relevant commitment in terms of financing and personnel allocation during the project implementation stage. This could simply put the returns to investment of such projects into jeopardy. It is not intended here to suggest how much should be allocated for the software component even after the completion of the project but to stress that the issue of what the software component should deliver be given adequate consideration.

On the basis of the above principles, the following recommendations are given for community based management in Debarwa.

(1) Communities must actually own the improved water points, with all that such ownership entails. In addition, such ownership and management should eventually incorporate unimproved water points into the system.

(2) If community based management is to function in a sustainable manner, both hardware and software components need to be given equal attention. The complexity of the software tasks should not be underestimated nor the amount of time it takes.

(3) Failure should be recognized to be part of the process; and if there is failure somewhere in the line, it should be considered part of the learning curve in the water and sanitation sector.

(4) In community based management, activities should be focused specifically on building self-reliance, self-confidence, and technical and management skills, and helping to solve problems in such a way that water and sanitation facilities are effectively managed locally.

(5) Participatory appraisal techniques need to supplement committee meetings/contacts with opinion leaders, in the consideration for improvement of software delivery.

(6) Within the context of affordability, service delivery agents need to recognize that communities are consumers and would like to maximize the returns from the money they pay for the service required.

(7) The sustainability of community based management for water supply and sanitation facilities may require software interventions up to five year period with multiple visits and strengthening activities taking place over this period. The final measuring rod for empowerment of the community will therefore lie in the commitment of software fund over time, and not simply at the initial stages of service delivery.

6.7 Sustainable Sanitation Improvement

6.7.1 Sanitation Management Plan

While assessing the present public sanitation condition the very basic problem of Debarwa with respect to sanitation is not lack of facilities provision but misuse of facilities and lack of maintenance. The solution of this basic problem to some extent is addressed in the facilities design stage. The technology adapted are to the level of economy and knowledge of the people. Basic latrine design considerations for easy management are:

- The school and public latrines proposed are in a way which minimize water wastage and avoid frequent breakage of cisterns by replacing the cistern with a simple tap at low level for collecting water with jug and pour flush.
- Misuse of school and public latrines in the absence of attendant is addressed in the proposed latrine by providing iron bar mesh fence which will also provide access for inspection by the attendant while in use.
- The septic tank for the school and public latrines is proposed with dry masonry wall lining for soak-away purpose, to minimize the frequent requirement of vacuum track.
- The household latrines recommended for low income group are self manageable. The proposed type of latrine is a double pit ventilated latrine with exchangeable squatting holes and vent holes. The decomposed matter can be removed by family members from shallow depth pit and can be used as manure.

However, the other basic factor for a sustainable sanitary facility is management plan. At present the managing body for all public facilities is the town administration. The town administration having big duties and responsibilities, handling such petty jobs to the extent of managing public latrine is not only too much to manage but also ineffective.

Therefore, introduction of autonomous management systems is highly recommended. The town administrator remaining to be the overall inspector of the facilities with respect to the cleanliness and functionality, the management responsibility of public facilities shall be given either to an individual on contractual or rental basis or a community sanitary facilities committee which shall be formed to operate and manage the systems. The first option is preferable for the very reason that the responsibility lies on an individual only. Moreover, the contractual agreement for rent shall include performance bond for any damages and irresponsible acts of the tenant and clause for termination of the agreement.

The public latrines proposed incur minimum cost which is limited to monthly expenses of water, detergent and cleaning material and once in two to three years of de-sludging

For instance, if a latrine gives service for an average of 300 people per day for defecation and 25 cents is charged per visit, the monthly gross income shall amount 2250 Nfa. This amount of money after covering all the expenses provide a good earning for an individual. For Debarwa town administration Nfa 2,250/- is very trivial sum of money but the burden for an effective management is beyond capacity.

The school latrines do require an attendant who follow up the general condition of the latrines and practices of the students in handling and using the latrines. Cleaning and keeping the latrines in good condition however shall be the students responsibility for the very reason of creating hygienic perception and practical change in their behavior on sanitation and hygienic habits.

(1) Solid waste management

The solid waste management at present is the town administrations responsibility with a great deal of cooperation of the people. The cleaning campaign which is conducted once in a while has a good effect in creating sanitation awareness in the society and keeping the town clean. But for more effectiveness it is highly recommended to develop a plan which introduce a waste handling norm which involves the participation of all groups of the society in a day to day life. Such plan includes:

- Provision of refuse collection bins in the public areas and streets.
- Provision of garbage containers in all residential areas.
- Provision of refuse truck.
- Provision of vacuum truck

Provision of the above facilities and developing realistic work plan is the town administration` responsibility while appropriately using the facilities is duty and responsibility of each of the society member in day to day life.

Provision of garbage containers to all residential areas may not be at present economically feasible to Debarwa. In this case the refuse truck may go round to all the residential areas and collect garbage directly from the residents on fixed days and timing.

The management for solid waste which includes collection of refuse and ultimate disposal to an environmentally safe place outside the town shall be the responsibility of the town administration. However, wide range of cooperation by all groups of beneficiaries is vital for a successful sanitation improvement program.

(2) Wastewater and soil waste management

The kind of wastewater system proposed for Debarwa is on-site disposal. Therefore, the management of wastewater disposal is communities responsibility.

With regard to de-sludging of septic tanks, up to the year 2005 Debarwa town administration may have to rely on the vacuum truck from Asmara for anticipated few number of septic tanks. However, for effective operation private vacuum truck owners should be encouraged.

(3) Proposed sanitation management structure for Debarwa town administration

Debarwa town administration already has sanitation section. However, in this study it is recommended to redefine duties and responsibilities of the section and promote the technical staff know-how.

As shown in the chart below the sanitation section should include Waste disposal division, Public & Household latrine division and Sanitation/Hygiene education division. The duties and responsibilities of each division is defined as follow:

The sanitation section is responsible for pubic relations service and overall control of works and performance evaluation of the three divisions. In addition this section shall be responsible to the staff strengthening of the three divisions. Arranging training programs by looking for fund and institution to promote staff is vital duty of the section.

Duties and responsibilities of Waste disposal division

- Clean the town
- Collect household refuse by going round the town on schedule
- Arrange vacuum truck facility
- Develop monitoring and evaluation technique explicitly on sanitation improvement in the community.
- Monitoring the community solid and wastewater handling
- Follow up violation of regulation by the community such as solid waste disposal to their surrounding area and open field deification.
- Assess environmentally safe area for ultimate solid and soil waste disposal.
- Conduct periodical environmental impact assessment of the disposal area.
- Evaluate and monitor the waste disposal mechanism of factories and industries.
- Regularly clean and maintain drainage system.

Duties and responsibilities of Public & household latrine division

- Assess public and household latrine coverage.
- Assess public areas which require latrine
- Arrange fund for public latrines construction.
- Facilitate low interest and long repayment loan for low income group level household latrine construction.
- Facilitate tendering of public latrine rental contract.
- Evaluation and monitoring of the public and household latrines condition.
- Develop a monitoring and evaluation technique on sanitation improvement of the community with regard latrines.
- Training household latrine builders.
- Giving technical advise to household latrine builders.
- Follow up the repayment of loan.

Duties and responsibilities of sanitation/ hygiene education division

- Arrange educational program for communities.
- Correspond with different bodies with relative field of interest and who could possibly cooperate by giving fund or arrange an educational program such as ministry health, education, and other non-governmental organizations.
- Develop a monitoring and evaluation technique on sanitation improvement technique on sanitation improvement of the community with regard sanitation behavioral changes.
- Evaluate and monitor sanitation/hygiene behavioral changes of the community.

Figure 6.7.1 Sanitation Management Structure