4.2 Socioeconomic, Water Supply and Sanitation Conditions

4.2.1 Socio-economy and Gender Issue

(1) History and population

The history of Dekemhare goes back to 1932 where the Italians developed it to be the industrial base of Eritrea and as the main logistic center for the war they waged on Ethiopia. During the last three decades it was at the center of armed conflict and consequently its well developed infrastructure was totally devastated, and even after liberation it is only during the last two years that it is showing some sign of revival. Dekemhare is the largest and relatively more developed of the seven towns under study in terms of population size, existing infrastructures, number and variety of establishments and area.

Presently, it is administered by an executive who is assisted by different organs in charge of various municipal tasks. Several large villages in its surrounding have been incorporated into the town administration.

The present population of the town is 21,675 with 47.5% males and 52.5% females. Data on age structure for 1994 reveal that 37.6% of the population are below 14 years of age and those over 65 years are only 4.6%, the remaining 57.8% are of working age group suggesting that there is an inflow of young people in search of employment opportunities from the surrounding villages. In terms of ethnic composition, 74.0% are from Tigrigna ethnic group while that of Saho and Tigre are 13.0% each. About 23 % of the residents of the town are Moslems and 77 % Christians.

(2) Economic conditions

Most of inhabitants are traders and daily laborers. The farming community are very few in number. The daily laborers work in the backyard gardens and orchards which are quite numerous, as well as in construction sites. According to the administrator, there many skilled workers who could not find gainful employment in the town. The traders and shop-owners include those who reside in the town and not those ones that live in the surrounding villages and other towns but who have shops in the town. Dekemhare has 1167 licensed micro and small-scale enterprises classified as manufacturing (102); trade and distribution (606); hotels, restaurants, tea rooms, etc. (116); service establishments (156); local breweries (61); and 126 licensees given to building contractors, import and export trade, and the like. Most of these are one person establishments even though medium and large scale enterprises are cropping up. Besides, there are 28 line ministry and parastate and 11 non-government office. Every day except Sunday, it is market day even though Saturday is the most popular market day when traders and people from the surrounding area come in large number.

Available sources indicate that Dekemhare has the highest illiteracy rate of over 80% as compared to other towns. An estimated 28.2% of the inhabitants of the town are illiterate, and the rest are primary school completors and above. This could suggest that there is good deal of skilled and educated unemployment in the town. There are 14 educational institutions (4 kindergarten, 6 primary, 3 junior and 1 senior secondary school) enrolling a total of 7,905 students with 150 teaching staff. The percentage distribution of enrollment in these levels of education amounts to 4.8%, 46.3%, 22.8% and 26.1% respectively.

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

a) Household characteristics

The average household size for the town of Dekemhare is 5.2 with female head of households comprising about 39%. In terms of ethnic composition, the great majority are from the Tigrigna ethnic group who profess the Christian faith. Muslims comprise 7% of the residents and there are very few Saho and Tigre ethnic groups in the town (Appendix A, Table 4.1).

b) Occupation

Almost one third of the sampled households of this town derive their livelihood from trade and commerce, in which an equal number of women and men household heads are preoccupied. The next major source of employment is Government followed by industry. The share of males and females in occupational structure reveal that they are more or less equal save for Government employment where men and women account for 23% and 8% respectively. In Dekemhare, the jobless constitute (21%) out of the sampled households of which female heads account for 37% (Appendix A, Table 4.2).

c) Agriculture and land

The sample survey did not cover the original villagers that own agricultural land, but of the reported lees than 1% owning the average size is 1 hectare. However, as is indicated in Appendix A, Table 4.3, of the interviewed households, only 9% of the household heads own livestock that comprise 28 chicken. The few large chicken farms may have contributed to raising the average size.

d) Household income and expenditure

The average income of a typical household in Dekemhare is Nfa 917 per month. Indeed, this is the highest of the average income reported of all towns. Females earn a little more than two thirds of the income of that of males. In terms of household income by occupation, earnings from animal husbandry seems to be the most lucrative one (probably as result of the few dairy farm owners), followed by commerce, others, Government and construction. Similar to the condition in other towns, the category of other occupation seems to be highly paying and could include activities like quarrying and non-formal sector activities. The reported earning of unemployed (Nfa 794) is quite high as compared to, say, other sectors like agriculture construction and industry. This forces one to question the validity of the rate of unemployment that is indicated in Table 4.2 above, and/or the need to further explore the source of income of the unemployed. The Saho household ethnic group's average income is a little higher than the majority Tigrigna ethnic group (Appendix A, Table 4.4).

The composition of households by income group and the percentage share of expenditure on some basic household items is indicated in Appendix A, Table 4.5. About 5% of the households are reportedly earning less than Nfa 299 per month. The majority of the households (41%) earn between Nfa 600 – 999, and those who earn Nfa 300 – 599 (23%) are also quite numerous. Overall, it is reported that those who are within the income bracket of Nfa 600-999 are about 41%. The expenditure reveals that 42% of the income of households is spent on food and beverages, followed by rent and repayment and savings (11% each) and electricity (10%). The share in the household expenditure of water and social services is low.

c) Education status

With regards to the education status of the households, there is a reported 100% attendance of school age children of households and a high literacy rate of 80%. The educational status of the head of households reveal that 46% have completed six years of schooling (primary level), 12% completed eight years of schooling (junior secondary level) and 18% senior secondary school. This rather high percentage may be the result of the abnormal situation in the prior years. That is those who had missed schooling in the early years of independence could have attended classes even if they were over-aged. Those who attended some sort of non-formal education are 16% and there are only 8% college education and above (Appendix A, Table 4.6).

f) Women status and participation in communal activities

Considering the percentage of women's and girls' daily activity in the sample households, shows that a slightly less percentage of women are engaged in housekeeping as compared to the other towns. The major source of gainful employment for women is in commerce (15%), followed by cottage industry (10%). Women practice little daily labor in Dekemhare. About 4% of the women household heads are employed in Government. Looking at girls' activities, 53% of young girls attend school, out of which 47% also assist in housekeeping. As much as 5% of the girls are engaged in commerce (Appendix A, Table 4.7).

Sessions on sanitation, childcare, family planning and water use are the major events participated by the women in the sampled group. Among the women folk only 15% do not participate in any educational sessions. Those who participate in water use and family planning sessions are only 44% and 51% respectively, an aspect that indicates a healthy trend and should be sustained. Unlike the other towns, there is a relatively high participation (11%) in literacy sessions in this town (Appendix A, Table 4.8).

In Dekemhare, there seems to be a very high participation (80%) of sampled households in community organizations, such as communal water points and toilet, cottage industry, commercial activities, social and cultural, savings associations and the like. The majority (72%) are members of national organizations like the Peoples' Front for Democracy and Justice (PFDJ) and National Union of Eritrean Women (NUEW). Only 22% of the household heads are members of traditional socio-cultural organizations like (Ekub - traditional savings association, Maheber - traditional social welfare organization, etc.). Like in the other towns, there is no participation in management of communal water points, communal toilets and cottage industry (Appendix A, Table 4.9).

If we examine the participation of adult women in communal activities, such as, communal water points and toilets, public works/buildings, crop harvest, etc., all of the adult household women reported that they do participate in any of the listed ones. As many as 95% of the women responded that they participate in community meetings. Those who participate in soil and water conservation activities and in other activities such as cleaning streets are 32% and 30% respectively. These percentage figures the earlier assertion that there is no participation in voluntary communal water point or communal toilet management. Despite the fact that it is reported that a very sizeable number of them participate in sanitation and water education sessions (Appendix A, Table 4.8), it is indicated that actual participation in sanitation related activities is nil (Appendix A, Table 4.10).

The survey result shows women's participants in formal or national organizations/group is quite high. However, their participation even in traditional organizations such ekub and mahber is minimal,

suggesting that such traditional organizations are dominated by men.

g) Water related and other problems

Shortage of income (51%) seems to be the major source of households' response to the type of problem they face, and it is more pronounced on women rather than men. The next ranked problem is shortage of water (40%) where men seem to feel the pressure more than females (probably because they need water for construction and other occupation related activities), followed by lack of sanitation. Most respondents said that they are satisfied with the electricity, health and school services provided in the town (Appendix A, Table 4.11).

Ranking of the first three household's responses to the problem or conditions related with the existing water supply facility show that water stoppage and quality of water are first and second. Shortage of water (28%) and long queues (22%) are also mentioned as big problems (Appendix A, Table 4.12).

h) Affordability

In terms of affordability for piped water, 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 could afford to pay less than Nfa 5 per month and another 6% Nfa 10-14 per month. A total of 49% from all income groups could afford to pay between Nfa 10-14 (Appendix A, Table 4.14).

When we see the community's willingness and affordability to pay for communal toilets, the response of the less income group, is that they can ill afford to pay for community toilet. However, a total of 38% from all income groups could afford to pay between Nfa 2-3 per month. The results of the survey as presented in Appendix A, Table 4.15 is interesting because it shoes that the higher income group not interested in communal toilets, and secondly that the middle income group do want the services of community toilet. However, if given the choice, it could be safely assumed that these middle income group would be prefer private latrines rather than communal ones. The implication is that given a small credit they would be ready to construct one.

4.2.2 Water Supply Conditions

Dekemhare is relatively economically fast-growing town. A lot of capitalists are interested to invest in Dekemhare. Due to these big and small scale investments, the population is Like-wise increasing. On the other hand little is done in upgrading major public facilities such as water supply, sewerage system etc. Very old public facilities without major rehabilitation can not satisfy high demand of investors.

Lack of adequate and efficient water supply is the top most constraint for any development program in the town. The Town administration of Dekemhare and the Water Resources Department of Eritrea drilled two wells since Liberation. The first drilled well is fitted with a submersible pump but is not connected to the distribution network system. Hence this well serves in filling the water tankers. The second well is fitted with a pump by the Town administration and is due to give service. According to the socio-economic survey conducted the dominant mode of supply of the town is water tanker which covers about 78% of the population with an average daily per capita consumption amount of 17 liters. Though limited in scope the other mode of supply is house connection and yard connection, which covers 6% and 9% of the residents respectively. The water supply for private connections is however intermittent hence, the users still depend on supplementary supply from water tanker. The average

consumption rate from the house connection and yard connection is 26 l/c and 16 l/c respectively (Appendix E, Table 4.2). Moreover, there are 30 unprotected private hand dug wells and 6 drilled private wells fitted with hand pumps, though presently only 2 are working. The present water consumption pattern by mode of service is shown in the Appendix E, Table 4.1.

The distribution network which is developed during the Italian colony does not cover the industrial zone area. The only mode of supply for this area is water tanker. Many of them specially building material production plants are complaining about the lack of water. The production of the factories due to lack of water supply is not to their capacity and does not the satisfy the pressing demand of the society

There are 431 house connections supplied by the pipes but no communal water point in the town. The proportion of water supply by pipes is estimated about 14 percent.

Outlines of water supply system in the town is illustrated as in Figure 4.2.1, and is shown in the figure, there were five wells to supply water to the reservoir (340 m^3 in capacity) located in the eastern part of the town. However, two out of five are very old and constructed by Italian. These two cannot be used and one of the remaining three is dried up at present. Two boreholes can be used for the main water source of the town. One is located in the southern part of and 380m far from the reservoir and another is in the western part of and 1.3 km far from the reservoir. Well pumps are operated 8 - 10 hours per day for one and 10 - 12 hours per day for another, and the capacity of theses pumps is 1.4 litter per day. Water is distributed from the reservoir to 431 households of the town by gravity. However, the distribution pipelines is almost out of function.

There is no communal water point in the town, but there are five water wagons; one of them is government-owned for supply to the inhabitants. Water sources of water wagons are three boreholes. They are located in the southern part of the town and approx. 3.0, 1.7 and 7.0 km far from the town respectively.

Major problems of the existing water supply facilities are low potential wells, obsolete motors, small capacity and leakage of the reservoir, leakage from distribution pipes, etc.

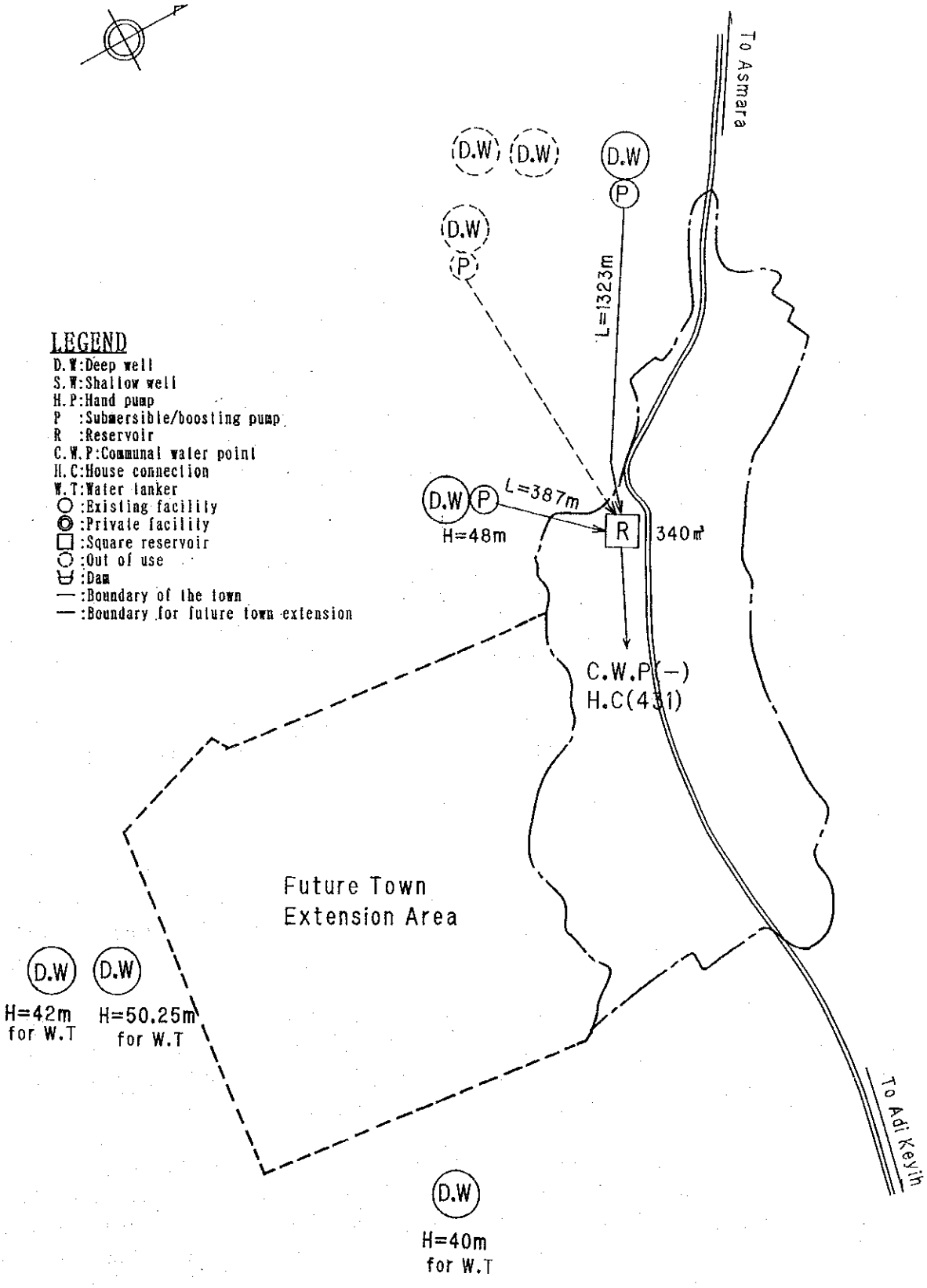
4.2.3 Sanitary and Health Condition

(1) Public sanitation

The Town administration has providing a dump truck for refuse disposal. The truck works three times a day for two to four days in a week. The disposal area is 3 km from the town. The service coverage is about 95% while the remaining 5% of the town area is not getting the service due to inaccessibility for truck.

There is no sewerage system in the town only a storm drainage system exist for the limited areas at the center of the town. Moreover, there is no vacuum truck in the town. When ever the need for vacuum truck arises the Town administration gets one on request from to Asmara Municipality.

Figure 4.2.1 Outline of Water Supply Facility



With regard to public latrines, there is an old latrine which is in use. The latrine is provided with water and an attendant who follow up its cleanliness. Another two latrines, with the men's, and ladies' sections each having 2 units has been newly constructed at two market places. These latrines, according to the Mayor, shall be open for public use after the provision of water and the necessary personnel who will attend only.

Big and small enterprises in many cases have latrine facilities. The kind of latrines in use by such establishments are flush with septic tank. On the other hand retail shops do not have latrines.

The Town administration has plans to promote sanitation. Among its plans The Town administration since recently introduced a new regulations which oblige all big to small establishments to include latrine facilities. The town administration has a sanitary section but with limited human resources capacity. At present, this section's task mostly focuses on the commercial and public services. The Municipality is trying to enhance its capacity in order to be able to implement all the regulations with respect to the sanitation of the town. Limited budget, both with respect to facility provision and staff capacity building are said the main constraint of the Town's administration in improving the sanitation conditions.

There is also in national and local level program for cleaning campaigns. The program is conducted every three month. To make such program though the necessary tools are bought by the Town administration and for to conduct for the whole town at the same time a committee and 20-30 trucks are required which makes it a difficult task that incur quite a lot of expense. Hence, such a campaign is currently conducted section by section in areas needed.

In spite of lack of proper water supply and sanitation facilities the town's sanitation condition, according to the Mayor, is relatively not very bad.

(2) Private sanitation

In Dekemhare private latrines coverage is only 60%. Surprisingly some people are converting their latrine unit to ordinary rooms due to the pressing housing problem of the town. The type of latrines exist in the town are either septic tank/cesspool or pit latrine at the rate of 46% and 13% respectively (Appendix E, Table 4.3).

The lack of private latrines issue with the growing population and development became serious with respect to environmental pollution and its public health impact. This issue has been realized by the Town administration and to improve the situation a new regulation is introduced which oblige new house builders to include latrine and kitchen in their housing units.

Dekemhare town does not have a vacuum truck facility for disludging septic tanks. For this reason houses with latrine type of septic tank/cesspool do not get immediate service when their septic tank is full. The vacuum truck when needed and quite a number of them request, the service is provided by requesting the Municipality of Asmara. The frequency of the vacuum truck visits is 4-6 months.

With regard to sanitation condition and related behaviors, the cleanliness aspect of the existing private latrines as observed is not very bad, but still need improvement. Among the households who have latrine about 39% are not satisfied with the type of latrine they have. The preferences of these households is flush (septic tank) type but more than 40% said they can afford either pit latrine or

community latrine. According to the socio-economic survey most of the residents are aware for the need of latrine. About 34% of the population are favoring credit system, if introduced, at the average repayment rate of 27Nfa/month (Appendix E, Table 4.3).

With respect to waste disposal practices, 85% of the population use the Town refuse truck facility, while the remaining 15% which probably is the inaccessible area residents dump garbage either in the open field or open pit. And wastewater is disposed by 82% of the population in their surrounding area. Only 5% of the population are using the existing sewerage system. Animal waste is used as fuel or fertilizer by more than 63% of the owners. Infant excreta is not properly handled by about 40% of the population (Appendix E, Table 4.4).

(3) School sanitation

In Dekemhare there are ten schools. Among which five are non governmental. In general the schools specially the government schools are not given due attention for the basic sanitation facilities. Four schools never had water supply facility. With regard to latrines five schools never had a latrine and one school had one but now it is blocked and out of use. The schools administration is aware to the need of this basic sanitation facilities but at present is not capable financially to provide to all the schools.

(4) Hygiene/health condition

Dekemhare has a health center with 23 beds, a clinic, 4 pharmacies and an ambulance with a physician, 3 nurses and 5 dressers. The hospital's statistical data show the occurrence of water and poor sanitation related diseases in Dekemhare. From 1995 up to 1997 data 14 to 21% of the population per annum is affected by water and poor sanitation diseases and 3 to 12% by malaria. The dominating water and poor sanitation related diseases however, are diarrhea, amebic dysentery giadiasis and bacillary dysentery (Appendix E, Table 4.6).

The socio-economic survey conducted house to house also indicate that the water and poor sanitation related diseases are high in the town. From the survey diarrhea, dysentery and malaria are reported at an average rate of 8, 7 and 11 person per household relatively in six months period from the time of survey. For 93% of the population believe in medical treatment by consulting physician. The medical cost is an average of Nfa 15.13, 28.92 and 39.94 per case for diarrhea, dysentery and malaria respectively. Infant death is also reported an average of 1.17 per for the last 10 years (Appendix E, Table 4.7).

The hygienic practices being considered as one factor that contribute a great deal to the water and poor sanitation related diseases such behaviors of the communities in Dekemhare have been assessed. From the socio economic survey conducted as part of this study it is realized that the hand washing practices with water and soap after defecation, before cooking, before eating, after disposal of children stool and after handling animal dung being at the rate of 57%, 31%, 26%, 63% and 75% are not qualified good (Appendix E, Table 4.8). Food handling practice is not bad but still need improvement (Appendix E, Table 4.9).

The residents knowledge on child immunization program is high (94%) (Appendix E, Table 4.7). On the other hand in spite of having a high percentage of water and poor sanitation disease cases the comminutes knowledge on ORS preparation is limited (77%) (Appendix E, Table 4.10).

4.2.4 Financial Condition of WSS

Water Supply Service (WSS) of Dekemhare earned 270,180 Nfa in 1996, while the expenditures incurred amounted to 209,944 Nfa, or a profit ratio of 22.3%. This ratio is considered an excellent financial performance.

Water sales by cash and meter accounted for 58.7% and 24.9% of incomes respectively, totaling 83.6%. Salaries and fuel occupied 37.2% and 19.7% of expenditures, respectively, totaling 56.9%.

Numbers of water supply facilities are 431 for house connections and 5 for water tankers. There is no communal water point. Provision of these facilities in Dekemhare is considered better as compared to the other 6 towns.

Water tariffs per cubic meter are 2 Nfa for house connection users and 10 Nfa for users of water from water tankers. These tariffs are considered an average level.

Based on the foregoing figures, the water supply conditions in Dekemhare are better as compared to the other 6 towns.

WSS has 17 workers. Each worker earns an income of 15,893 Nfa, which is medium among the 7 towns. The average monthly salary per worker is calculated at 678 Nfa.

The per capita per day consumption of water is 14.6 liters according to the results of the socio-economic survey. This per capita consumption is at the average level.

In conclusion, the per capita consumption of water is at an average level and financial management of WSS is fine. One thing is to be noticed: water tariff of water tankers is 5 times that of house connections. Water consumption must be drastically increased especially in view of the fact that the town is the biggest in terms of population and also that it occupies a strategic location for future economic development of the surrounding areas.

(1) Population in 1997: 21,675

(2) Financial Performance in 1996

Unit: Nfa

Revenues		Expenditures	
Item	Amount	Item	Amount
Water sales by meter	67,180	Salaries	78,139
Water sales by cash	158,649	Per diem	3,679
Rental charge of meters	6,581	Electricity	4,662
Service charge	2,941	Fuel	41,336
Others	34,829	Supply materials	8,255
Total	270,180	Repairs	31,910
		Office supply	1,226
		Others	40,737
		Total	209,944

(3) Water tariffs

Unit: Nfa/m^3

House connection	Communal water point	Water tanker	Water vendor	Public well
2	-	10	-	-

(4) Number of water supply facilities

House connection	Communal water point	Water tanker	Public well	Private well
431	0	5	0	0

(5) Number of personnel

Division	Functions	Male	Female	Total	Perm.*	C./T.**	Total
Head		1		1	1		1
Administrative	Customer relations	1		1	1		1
	Guard	3		3		3	3
	Store keeper	1		1		1	1
	Driver	1		1	1		1
	Assistant driver	1		1		1	1
Financial	Accountant		1	1	1		1
	Cashier		1	1	1		1
Technical	Motor operator	4		4		4	4
	Plumber	3		3	3		3
	Total	15	2	17	8	9	17

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

(6) Production and consumption of water in 1996 (m^3): 106,213 and 82,315.

(7) Average monthly salary: 678 Nfa.

(8) Per capita per day water consumption: 14.6 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.

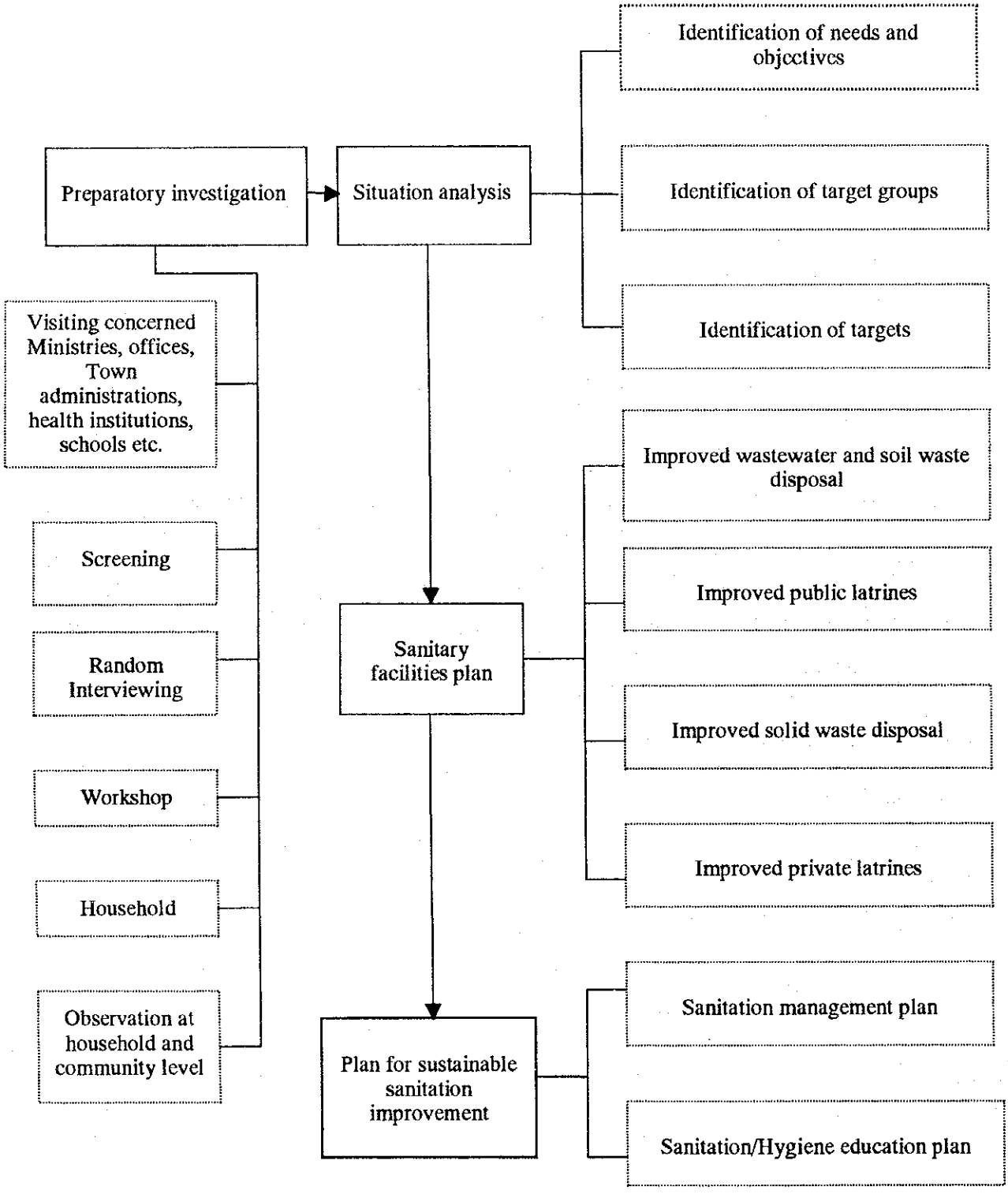
b) Following to the information collection process the situation is analyzed and needs and objectives, the specific targets and the specific target groups are identified.

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.

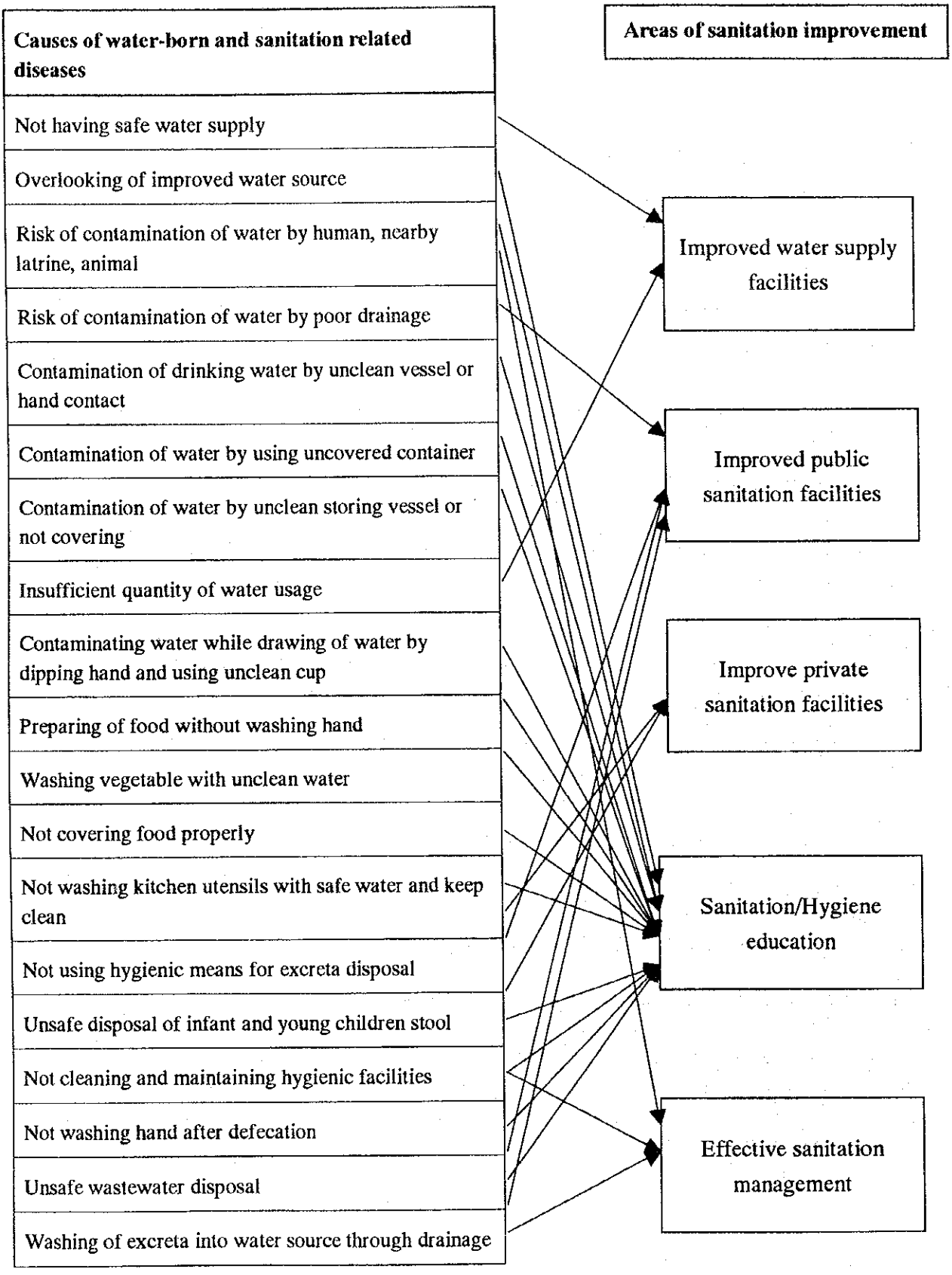
The sanitation facilities plans are developed ensuring the economic and technical feasibility and social and cultural appropriateness in the society. The basic factors considered are:

- 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

Based on the strategy on planning mentioned in the previous chapter, development programs are formulated as a phased plan to the year 2015, with target years of 2005, 2010, and 2015.

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 in Table 6.1.1.

Administration of Dekemhare has two sub zones and three villages; namely, zone 1 and zone 2 of Dekemhare, Hadamu, Metsalu and Amhare. Zone 1 and zone 2 are divided into 5 and 4 blocks respectively. Hadamu is located in the northwestern part of and close to the center of the town. However, Metsalu is located in the northeastern part of and approx. 1.5 km far from the town. Amhare is located in the southwestern part of and approx. 2.0 km far from the town. Future town extension area is planned to the south of the town. There are two blocks; one for residential area and another for industrial area.

Water service area until the target year 2015 is planned as follows (refer to Figure 6.1.1).

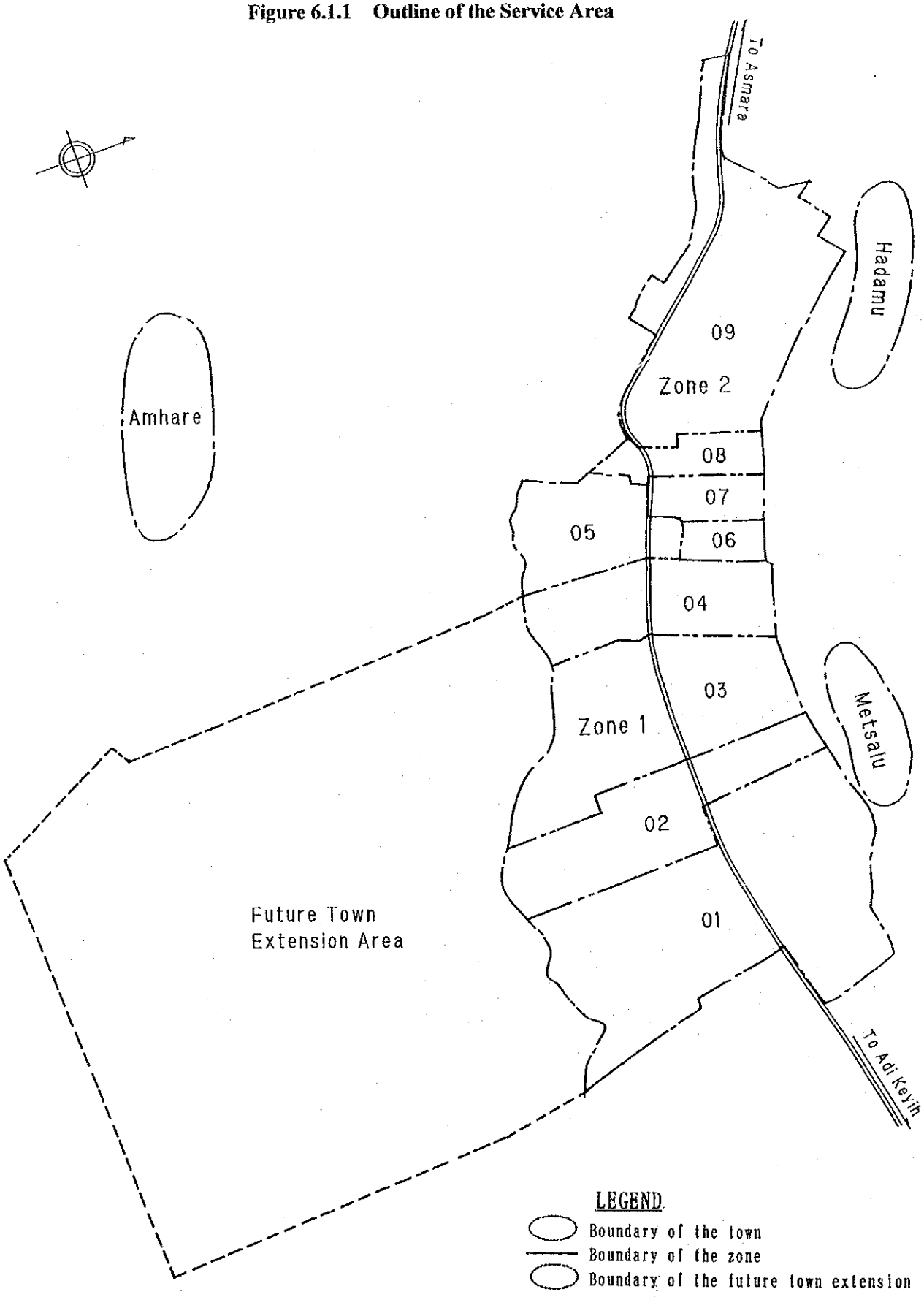
- Target year 2005: zone 1 and zone 2,
- Target year 2010: future town extension area for residential area, and
- Target year 2015: other future town extension area and Hadamu, Metsalu, Amhare.

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

Table 6.1.1 Water Demand

Target Year	2005	2010	2015
Population Projection	34,370	44,030	55,880
Supplied Population	26,610	37,950	55,880
Service ratio (%)	77.4	86.2	100.0
Average Water Consumption (l/c/d)	41.3	53.9	74.0
Average Daily Demand (m^3/d)	1,100	2,044	4,135
Max daily demand (m^3/d)	1,320	2,452	4,962
Peak hour demand (m^3/hour)	82.5	153.3	310.1

Figure 6.1.1 Outline of the Service Area



6.2 Water Resources Development Plan

6.2.1 Current Water Resources

In the town, there are two groups of public water resources. One group is consisted of three boreholes (BH-4, 8, and 10) drilled at the western part of the town, and directly connected to the reservoir tank to deliver the pipe-born water to the town. Another group consisted of two boreholes, drilled in the southern wide alluvial plain, has motor pump installed but no supply pipes, utilizing through water tankers. Besides of the said public water sources, 8 of boreholes and 3 of dug-wells are functioning as private water sources.

In Dekemhare area, there are about 9 micro dams mainly used for livestock and irrigation. As same as the other areas of the region, most of the dams are suffering from sedimentation problem.

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 (DEK-2) are already started. Pan Evaporation has been measuring at the Mendefera Station. Thus, the circumstances to evaluate a water resources potential, in detail, 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 Dekemhare, monthly mean rainfalls are available (refer to section 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

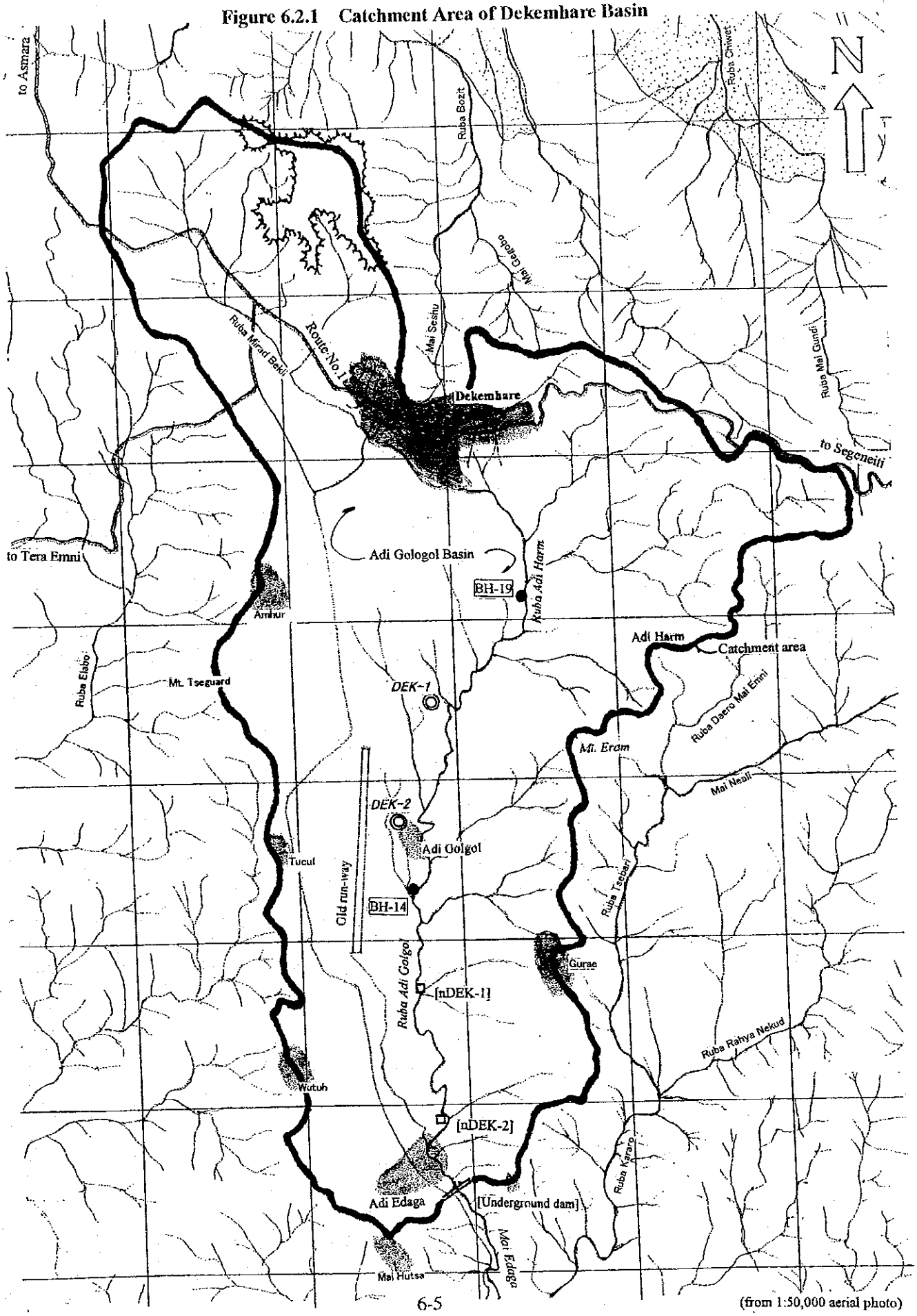
Dekemhare	Jun	Jul	Aug	Sep	Oct	Annual (mm)	(%)
Rainfall (mm/m)	43.7	195.1	156.0	27.3	3.3	528.6	100.0%
P.E (mm/d)	5.4	5.6	4.6	5.1	5.0	2,107.9	100.0%
E. Evapotr.(-"-)	117.2	121.5	99.8	110.7	108.5	1,503.8	70.0%
E. Rain (mm/m)	4.4	73.6	56.2	5.5	0.3	139.9	26.7%
Runoff (-"-)	2.6	44.1	33.7	3.3	0.2	84.0	16.0%
Recharge (-"-)	1.7	29.4	22.5	2.2	0.1	56.0	10.7%
Act. E.T. (-"-)	39.3	121.5	99.8	21.8	3.0	383.7	73.3%

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 56.0 mm/a, which is about 10.7% of the total rainfall.

The flat and wide alluvial plain extending at the south of Dekemhare town, and almost all of town area, are included into one catchment areas of the Ruba Adi Golgol, and this is the main groundwater basin in this area. Total area of the basin is around 47.6 km^2 based on the 1:50,000 aerial map (refer to Figure 6.2.1), so that, the yearly groundwater recharge volume of the basin is calculated as around 2.67 MCM/a.

Figure 6.2.1 Catchment Area of Dekemhare Basin



(from 1:50,000 aerial photo)

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. The situation usually prevents a full-use of the maximum water resources potential, in particular in the area where groundwater flows out easily. In the region where has clear rainy and dry seasons, from one-third to one-tenth of the yearly recharge volume shall be taken as a criterion on the maximum groundwater development, depending upon the local condition though. For this Dekemhare area, the main aquifer is a combination with the alluvial deposits type aquifer and the fissured aquifer type of granite underlying. The alluvial deposits is said as lake deposits having not so much excellent aquifer property, but the granitic aquifer shows good yield. And then, the groundwater hydrograph indicates the groundwater in the plain is not flowing out easily, rather enclosed at the southern end of the basin, like a natural underground dam. Such local condition can mitigate the limitation of safety groundwater development drastically, in particular the situation of natural underground dam like basin structure may allow almost full groundwater development in the basin.

(3) Water quality

Water qualities of ten samples taken from the existing water supply system, inclusive of some water sources, were analyzed in the laboratory of WRD. The results said almost all of water in the area have good water quality for drinking, excepting was one borehole drilled near at the village of Adi Golgol which was contaminated by bacteria. However, it was noted that the contamination might be occurred by unusual rainfall at the sampling period. Then, two water sources indicated rather high EC value of more than 1000 μS/cm, but not so troublesome as a potable water.

For the new water sources, groundwater extracted from Test Wells DEK-1 and 2 were analyzed in the same laboratory. The result of analysis is attached in Appendix and shown as Figure 6.2.2. The data indicate that the water quality of the borehole is also good for potable water, only a little salty as the EC values suggest.

6.2.3 Water Resources Development Plan

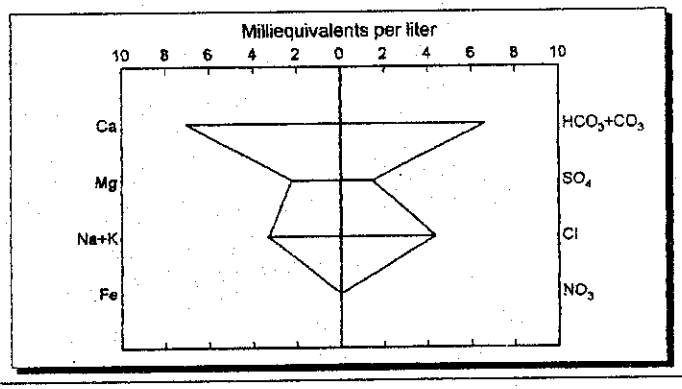
(1) Increasing of water demand

Water demand projection was already discussed in the previous section (6.1). And the Study projected out the skyrocketing water demands of Dekemhare as 1320, 2452, and as much as 4962 m^3/day in the year of 2005, 2010, and 2015, respectively. The skyrocketing water demand is caused not only by increasing population but increasing industrial water use. Such situation of water demand increasing is illustrated in Figure 6.1.3, together with actual water resources development plan explaining in this section.

Figure 6.2.2 Water Quality of DEK-1 and 2

STIFF Diagram

Well Ident	Description
DEK-1	Upstream side



Cations

	Ca	Mg	Na	K	Fe
Milliequivalents per liter	7.0459	2.2375	3.2625	0.02301	0.0048
Milligrams per liter	141.20	27.20	75.00	0.90	0.09

Anions

	HCO3	CO3	SO4	Cl	NO3
Milliequivalents per liter	6.59861		1.45740	4.37255	0.10001
Milligrams per liter	402.60		70.00	155.00	6.20

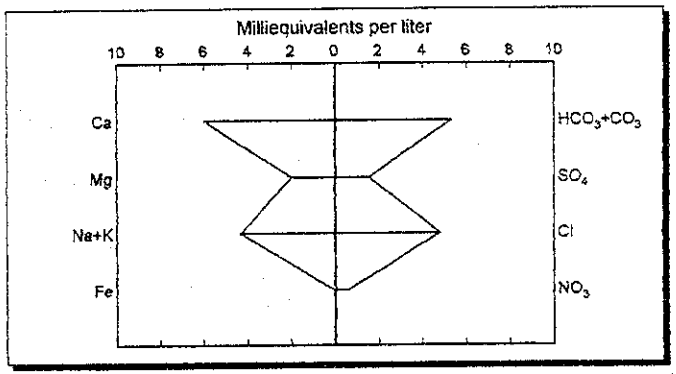
Mn	NO2	PO4	F	B	SiO2
0.0036	0.01130		0.0274		
TDS	Hardness	Alkalinity	Conductivity	pH	SAR
	26.0		1247.00	7.10	1.5143

Water Type	Cations (epm)	Anions (epm)
Calcium Bicarbonate	12.6	12.6

Error Balance: 0.09

STIFF Diagram

Well Ident	Description
DEK-2	Downstream side



Cations

	Ca	Mg	Na	K	Fe
Milliequivalents per liter	5.9880	1.9989	4.2630	0.03068	0.0011
Milligrams per liter	120.00	24.30	98.00	1.20	0.02

Anions

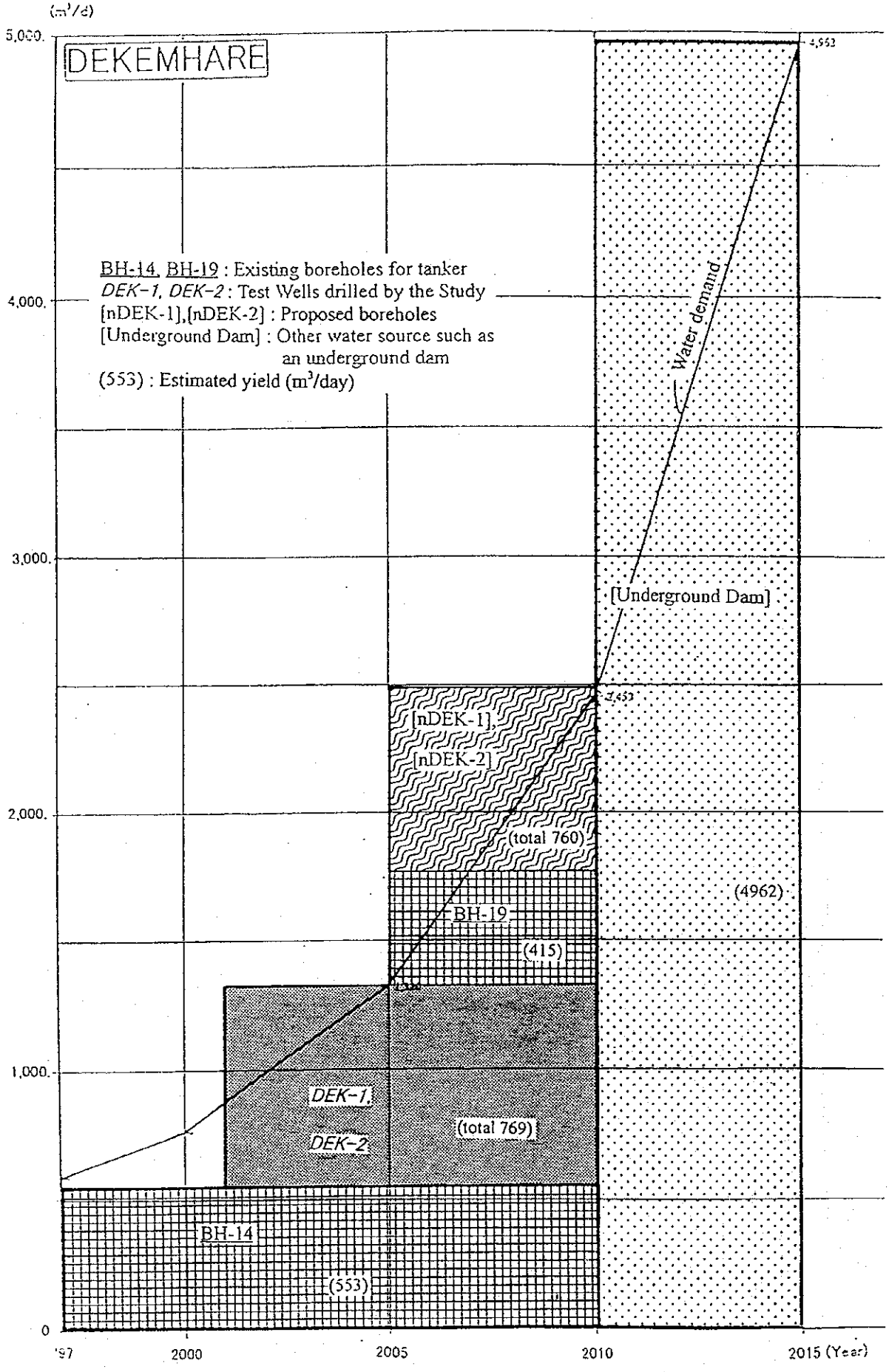
	HCO3	CO3	SO4	Cl	NO3
Milliequivalents per liter	5.29889		1.56150	4.79570	0.58552
Milligrams per liter	323.30		75.00	170.00	36.30

Mn	NO2	PO4	F	B	SiO2
0.0036	0.00739		0.0232		
TDS	Hardness	Alkalinity	Conductivity	pH	SAR
	22.4		1184.00	6.91	2.1332

Water Type	Cations (epm)	Anions (epm)
Calcium Bicarbonate	12.3	12.3

Error Balance: 0.08

Figure 6.2.3. WATER DEMAND AND RESOURCES PLAN



(2) Water resources development plan

In Dekemhare, there are two water resources groups, having total around 1200 m^3/day of yield, not enough for the water demand in 2005. Among them, the water resources facilities of the western group are rather time-wounded and not reliable for long time use from a viewpoint of water resources potential, because they are located at near around the upstream end of the catchment area. While, the two boreholes (BH-14 and 19) belonging to the southern resources group were drilled recently in the wide alluvial plain, and show rather excellent yields. Thus, only the southern water resources group shall be involved into the new water supply system to make a reliable and simple water resources facility. The old borehole group shall be retired or kept as a spare water source.

The safety yields of the said two existing boreholes are estimated as 967.7, and two Test Wells drilled under the Study yield 768.9 m^3/day (as 80% of the tested yield). The total of them comes around 1737 m^3/day. This volume is enough to cover the water demand in 2005 but for 2010. To cover the water demand in 2005, there are two combinations of water sources, "two existing boreholes + DEK-2" and "two Test Wells + BH-14." Then, the wells of the later group locate near each together at around the village of Adi Golgol, while, BH-19 of the former group locates near the Dekemhare town, far from the other two and inconvenient to make a simple water supply line. Thus, the combination of three wells of the later group shall be utilized as water resources of the town for 2005.

To satisfy the water demand for 2010, another two of new boreholes shall be drilled in the same basin, which expectedly yield around 760.4 m^3/day in total. Then, the existing borehole of BH-19 shall be involved into the water supply system in this stage. BH-19 has a safety yield of about 414.7 m^3/day, and thus, total 1175 m^3/day of water source shall be added. It results the total water supply amount of 2497 m^3/day, just enough to cover the water demand in 2010. While, the potential of groundwater development in this basin is far rich than the amount, so that the groundwater can be steadily developed in this period. The recommended drilling sites for the new production wells of nDEK-1 and nDEK-2 are shown in Figure 6.1.1 together with Test Wells and existing water sources, however, further detail and systematic siting works to identify the exact drilling points shall be required.

In 2015, the water demand in Dekemhare shall be increased drastically, to the volume of 4962 m^3/day, which may exceed the limit of groundwater development through a borehole. While, the major groundwater basin in Dekemhare area looks like forming a natural under-ground dam as discussed before. It means, the basin can easily be developed through actual underground dam scheme, making a cutoff wall at the southern end of the basin, just down-stream of Adi Edaga village (refer to Figure 6.1.1), of course, it needs further investigation though. The recharging water in the basin shall be stored in the underground dam, if the basin could be closed properly, and in this case, almost all of the recharged water can be utilized because it is a renewable water source every year. As discussed above, the yearly recharging volume in the basin is around 2.67 MCM/a, converted into about 7300 m^3/day, which is roughly 1.5 times of the total water demand in 2015.

6.3 Water Supply and Sanitary Facility Plan

6.3.1 Water Supply Facility Plan

(1) General

Altitude of water service area is around 2040m to 2000m of elevation and slopes gently inclines from north to south. The future town extension area is nearly flat and its elevation is around 2020m. The location in the eastern side of the town is favorable for reservoir.

Water is supplied by water wagons at present, and field investigation shows the percentage of households using water from water tanker is 78%. Water is transmitted by pipes to the town under the project even the water sources are far away from the town.

Existing water supply facilities could not be used because of following reasons.

- Yield from the existing borehole in the town is insufficient to cover the future demand,
- Well pump is obsolete and has breakdowns,
- Reservoir is obsolete and insufficient pressure, and
- Pipelines is also obsolete with insufficient diameter to cover the future demand, unknown locations and diameters, etc.

All water supply facilities except the existing wells along Mai Edaga 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 of each facilities are shown in Appendix D.

a) Intake facilities

The existing boreholes in or besides the town are obsolete and have insufficient water source potential. The existing boreholes and test boreholes in the southern area of the town are planned for future water demand. An underground dam will finally be constructed to cover the water demand in 2015.

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

Target year 2005: One existing borehole of BH-14 and two test boreholes of DEK-1 and DEK-2 to be planned.
Spec. of pump at BH-14: Q=0.384m^3/m, H=56.1m
Spec. of pump at DEK-1: Q=0.198m^3/m, H=28.1m
Spec. of pump at DEK-2: Q=0.336m^3/m, H=39.5m

Target year 2010: One existing borehole of BH-19 and two new boreholes of nDEK-1 and nDEK-2 to be added. Well pumps of BH-14 and DEK-2 to be replaced because of increasing loss head.
Spec. of pump at BH-14: Q=0.384m^3/m, H=61.1m
Spec. of pump at BH-19: Q=0.288m^3/m, H=129.3m
Spec. of pump at DEK-2: Q=0.336m^3/m, H=44.6m
Spec. of pump at nDEK-1: Q=0.264m^3/m, H=85.2m
Spec. of pump at nDEK-2: Q=0.264m^3/m, H=120.9m

Target year 2015: New underground dam to be added.
Spec. of pump at U-DAM: Q=1.746m^3/m, H=120.6m

b) Transmission facilities

Three new transmission pipelines are planned and extended to meet the water demand. Booster pumps shall be planned because of the long distance and difference of elevation. Another booster pump from reservoir 1 to the elevated tank beside the reservoir 1 is planned. The transmission facility plan for each target year is as follows:

Target year 2005: New pipeline from BH-14, DEK-1 and DEK-24 to new reservoir 1 to be planned
Diameter and total length of the pipe:
D=200mm~80mm, L=7,767m
Spec. of new booster pump at BP1: Q=0.918m^3/m, H=100.8m
Spec. of new booster pump of BP1' for elevated tank
Q=0.218m^3/m, H=15.0m
Number and capacity of pump pit for booster pump:
30m^3 1sets

Target year 2010: Pipeline from nDEK-2and nDEK-1 to connection of BH-14 and DEK-2, and new pipeline from BH-19 to new reservoir 1 to be added.
Diameter and total length of the total pipe:
D=125mm~80mm, L=8,100m
Spec. of new booster pump at BP1
Q=1.446/m, H=111.1m
Spec. of new two booster pumps of BP1' for elevated tank
Q=0.287m^3/m, H=15.0m
Number and capacity of additional pump pit for booster pump:
15m^3 1set

Target year 2015: One new pipeline from new underground dam to new reservoir 1 to be added.
Diameter and total length of the pipe: D=200mm, L=11,200m
Spec. of new two booster pumps of BP1' for elevated tank
Q=0.310m^3/m, H=15.0m
Spec. of new booster pump at BP2
Q=1.746m^3/m, H=120.6m
Number and capacity of pump pit for booster pump:
55m^3 1set

c) Distribution facilities

New reservoir is planned at the highest position in the northern part of the existing reservoir. The elevation of new reservoir is estimated around 2050m. However, this water level is insufficient to supply some western areas. Therefore, an elevated reservoir shall be planned besides new ground type reservoir. Moreover, two new reservoirs shall be planned for two villages in the target year 2015. 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 each target year. The distribution facility plan for each target year is as follows:

Target year 2005: Capacity and type of new reservoir
$V=440m^3$, ground type for reservoir
$V=15m^3$, H=12m elevated type
Diameter and total length of the pipe
D=250mm~50mm, L=43,774m

Target year 2010: Capacity and type of additional reservoir 1
$V=380m^3$, ground type
Diameter and total length of expansile pipe
D=125mm~50mm, L=16,693m

Target year 2015: Capacity and type of one additional reservoir and three new reservoirs
$V=720m^3$, ground type for additional reservoir
$V=50m^3$, ground type for Hadamu
$V=50m^3$, ground type for Amhare
$V=30m^3$, ground type for Metsalu
Diameter and total length of expansile pipe
D=200mm~50mm, L=47,892m

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 circles of 150m-radius Service facility plan for each target year is as follows:

Target year 2005:	Number of individual connection	2,676 sets
	Number of communal water points	20 sets
Target year 2010:	Number of additional individual connection	1,343 sets
	Number of additional communal water points	9 sets
Target year 2015:	Number of additional individual connection	1,832 sets
	Number of additional communal water points	22 sets

e) Others

Power supply for pumps is planed to use the network from diesel power plant in the region. 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 A: 2sets, Type B: 1set, Type C: 1set, Type D: 1set,
Target year 2010:	Number and type of additional control house Type A: 2sets, Type B: 1set,
Target year 2015:	Number and type of additional control house Type A: 1set, Type C: 1set,

6.3.2 Sanitary Facility Plan

(1) School Sanitation Facilities

In Dekemhare 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 study 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.

In this study 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. Dekemhare at present is lacking appropriate public facilities. Required improvement of public facilities are discussed below. For phased programs and budget requirement refer 'Financial Plan' of this section.

Table 6.3.1 Number of Facilities

Item		Unit	Year		
Facility	Description		2005	2010	2015
Intake Facility	New borehole	sets		2	1
	Existing borehole	sets	1	1	
	Observation borehole	sets	2		
	Dam	sets			
	(Sub-total)	sets	3	3	1
Well Pump Facility	Submersible pump		DEK-1, 0.198m3/min 28.1m, 1set	nDEK-2, 0.264m3/min 120.9m, 1set	DAM, 1.746m3/min 120.6m, 1set
			DEK-2, 0.336m3/min 39.5m, 1set	nDEK-1, 0.264m3/min 85.2m, 1set	
			BH-14, 0.384m3/min 56.1m, 1set	BH-19, 0.288m3/min 129.3m, 1set	
				DEK-2, 0.336m3/min 44.6m, 1set	
				BH-14, 0.384m3/min 61.1m, 1set	
	(Sub-total)	sets	3	5	1
Transmission Pipeline	DCIP 200mm	m	6,191.0		11,200.0
	ditto 150mm	m			
	ditto 125mm	m		2,100.0	
	ditto 100mm	m	948.0	3,500.0	
	ditto 80mm	m	628.0	2,500.0	
	ditto 60mm	m			
	(Sub-total)	m	7,767.0	8,100.0	11,200.0
Booster Pump Facility	Centrifugal pump		BP.1, 0.918m3/min 100.8m, 1set	BP.1, 1.446m3/min 111.1m, 1set	BP.2, 1.746m3/min 120.6m, 1set
			BP.1', 0.218m3/min 15.0m, 1set	BP.1', 0.287m3/min 15.0m, 1set	BP.1', 0.310m3/min 15.0m, 1set
	(Sub-total)	sets	2	2	2
Pump Pit	Made of RC		30m3, 1set	15m3	55m3
	(Sub-total)	sets	1	1	1
Reservoir	Made of RC		440m3	380m3	720m3 50m3, 2set 30m3
	Made of F R P		15m3, h=12m		
	Existing				
	(Sub-total)	sets	2	1	4
Distrbution Pipeline	P V C 300mm	m			
	ditto 250mm	m	133.0		
	ditto 200mm	m	205.0		71.0
	ditto 150mm	m	940.0		2,336.0
	ditto 125mm	m	1,486.0	510.0	2,695.0
	ditto 100mm	m	2,599.0	566.0	3,489.0
	ditto 75mm	m	1,275.0	1,921.0	5,379.0
	ditto 50mm	m	37,136.0	13,696.0	33,922.0
	(Sub-total)	m	43,774.0	16,693.0	47,892.0
Control House		sets	5	3	2
Communal Water Point		sets	20	9	22
Individual Connection		sets	2,676	1,343	1,832
Tempolaty Road	Width 3.0m	m	200		

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 Dekemhare the economic or development level of the people for instance does not allow for 100% coverage 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. Dekemhare though is limited in scope has a sewerage system which is developed during Italian colony. Therefore, it is recommended to rehabilitate and expand the existing system at least covering 1/3rd area by the year 2000-2005, 2/3 area by the year 2005-2010 and complete coverage by the year 2010-2015. Dekemhare's projected water consumption rate and wastewater generation rate is shown below.

Dekemhare'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	29	34	39	35	40	47	31.5	36	42.3
YC	33	66	61	22	24	27	15.4	16.8	18.9
CWP	38	0	0	15	15	15	9	9	9

The areas were the sewerage system does not coverage an on-site drainage system is proposed.

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 Dekemhare 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 Dekemhare never had refuse truck. As part of sanitation safe refuse collection and disposal is essential to improved public health. The present situation of Dekemhare does

not provide these basic services. In this study it is anticipated that Dekemhare during the target year 2000-2005 need to have at least two refuse truck with compaction to go round and collect garbage and dispose at environmentally safe place outside the town at a reasonable distant place. During the three target years provision of refuse containers for 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 has great effect to improve environmental sanitation conditions. For small towns such as Dekemhare where coverage of conventional sewerage system is limited the inhabitants are advised to have appropriate household latrine and on-site wastewater disposal systems.

Dekemhare 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 Dekemhare

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 cubic meter 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	6	1	1
Public Latrine - CFL	5	1	1
Household Latrine - CFL	1,993	1,001	1,365
Household Latrine - PFL	1,361	2,707	2,727
Household Latrine - VIP	1,045	880	484

Table 6.3.6 Number of Public Facilities

	Year 2005	Year 2010	Year 2015
Refuse truck (compactor)	2	1	2
Vacuum truck (3,000 liters)	1	2	1
Refuse collecting bins	150	100	100
Refuse collecting container ($8m^3$)	20	25	10

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 Dekemhare, the town administrations, the former WSS or the new WSA, the town's Water and Sanitation Committee as a Board, and the communal water point toilet 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 Dekemhare. 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 ands it has not been decided yet, in which of the Units in 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 section 2.3.6, 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 Departments 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 I the preparation and implementation of economic and social development in the region. More specifically, 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 of the Departments in the regions, viz., Economic Development, Social Services and Infrastructure Services Divisions

The Units under these three divisions and the staffing pattern is as 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.

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 Services Department (Appendix A, Chart 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 the MoH 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 summary of the institutional strengthening plan for the entire period under study. The expected outcome of the proposed management and strengthening plan of the towns will be dealt in chapter seven.

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 in Table 6.5.1 – 6.5.3.

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, hydrometeorological, 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 - Dekemhare WSA office building - HQ building, and stores - Seed money for Dekemhare sanitation credit program **2. Training** - Short term training of plumbers, fitters, recorders (water meters and generators, pumps, etc.), in Dekemhare 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.

Table 6.5.1 Project Cost in 2005

(Nakfa)

Description	Local C.	Foreign C.	Total	Remarks
1. Construction cost				
Borehole	9,275	85,317	94,593	
Well pump	31,636	454,765	486,401	
Transmission pipeline	1,847,118	6,082,274	7,929,392	
Booster pump	4,440	317,985	322,425	
Pump pit	93,732	70,058	163,790	
Reservoir	719,127	888,100	1,607,227	
Distribution pipeline	5,776,698	3,404,226	9,180,924	
Individual connection	0	0	0	
Communal water point	360,389	137,328	497,717	
Control house	922,416	51,713	974,129	
Temporary road	59,400	0	59,400	
Sub total	**9,824,232**	**11,491,765**	**21,315,997**	
2. Engineering fee	-	2,131,600	2,131,600	
3. Administration cost	426,320	-	426,320	
4. Physical contingencies	1,025,055	1,362,336	2,387,392	
Total	**11,275,607**	**14,985,701**	**26,261,309**	
5. Price contingencies	1,393,665	1,852,233	3,245,898	
Ground total	**12,669,273**	**16,837,934**	**29,507,207**	

Table 6.5.2 Project Cost in 2010

(Nakfa)

Description	Local C.	Foreign C.	Total	Remarks
1. Construction cost				
Borehole	35,734	631,872	667,605	
Well pump	53,240	983,112	1,036,352	
Transmission pipeline	1,687,118	4,663,040	6,350,158	
Booster pump	4,111	370,984	375,095	
Pump pit	62,765	38,970	101,736	
Reservoir	628,332	251,164	879,495	
Distribution pipeline	2,078,554	1,123,646	3,202,200	
Individual connection	0	0	0	
Communal water point	162,175	61,798	223,973	
Control house	471,031	30,218	501,249	
Temporary road	0	0	0	
Sub total	**5,183,060**	**8,154,803**	**13,337,864**	
2. Engineering fee	-	1,333,786	1,333,786	
3. Administration cost	266,757	-	266,757	
4. Physical contingencies	544,982	948,859	1,493,841	
Total	**5,994,799**	**10,437,449**	**16,432,248**	
5. Price contingencies	2,508,938	4,368,272	6,877,210	
Ground total	**8,503,737**	**14,805,721**	**23,309,458**	

Table 6.5.3 Project Cost in 2015

(Nakfa)

Description	Local C.	Foreign C.	Total	Remarks
1. Construction cost				
Borehole	623,349	128,680	752,029	
Well pump	11,521	530,186	541,707	
Transmission pipeline	2,753,503	9,439,717	12,193,221	
Booster pump	5,222	652,507	657,728	
Pump pit	136,057	99,898	235,956	
Reservoir	1,495,892	769,311	2,265,204	
Distribution pipeline	6,476,029	4,273,241	10,749,271	
Individual connection	0	0	0	
Communal water point	396,428	151,061	547,489	
Control house	334,684	20,524	355,207	
Temporary road	0	0	0	
Sub total	**12,232,685**	**16,065,126**	**28,297,811**	
2. Engineering fee	-	2,829,781	2,829,781	
3. Administration cost	565,956	-	565,956	
4. Physical contingencies	1,279,864	1,889,491	3,169,355	
Total	**14,078,506**	**20,784,398**	**34,862,903**	
5. Price contingencies	12,646,701	18,670,595	31,317,296	
Ground total	**26,725,207**	**39,454,992**	**66,180,199**	

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	448,353	74,725	74,725
	Price contingencies	55,417	37,635	75,638
	Total	**503,770**	**112,360**	**150,363**
Public Latrine - CFL	Construction cost	373,627	74,725	74,725
	Price contingencies	46,181	37,635	75,638
	Total	**419,808**	**112,360**	**150,363**
Ground total		**923,578**	**224,720**	**300,726**

6.6 Sustainability of Water Supply Facilities

6.6.1 Capacity Building for WSA

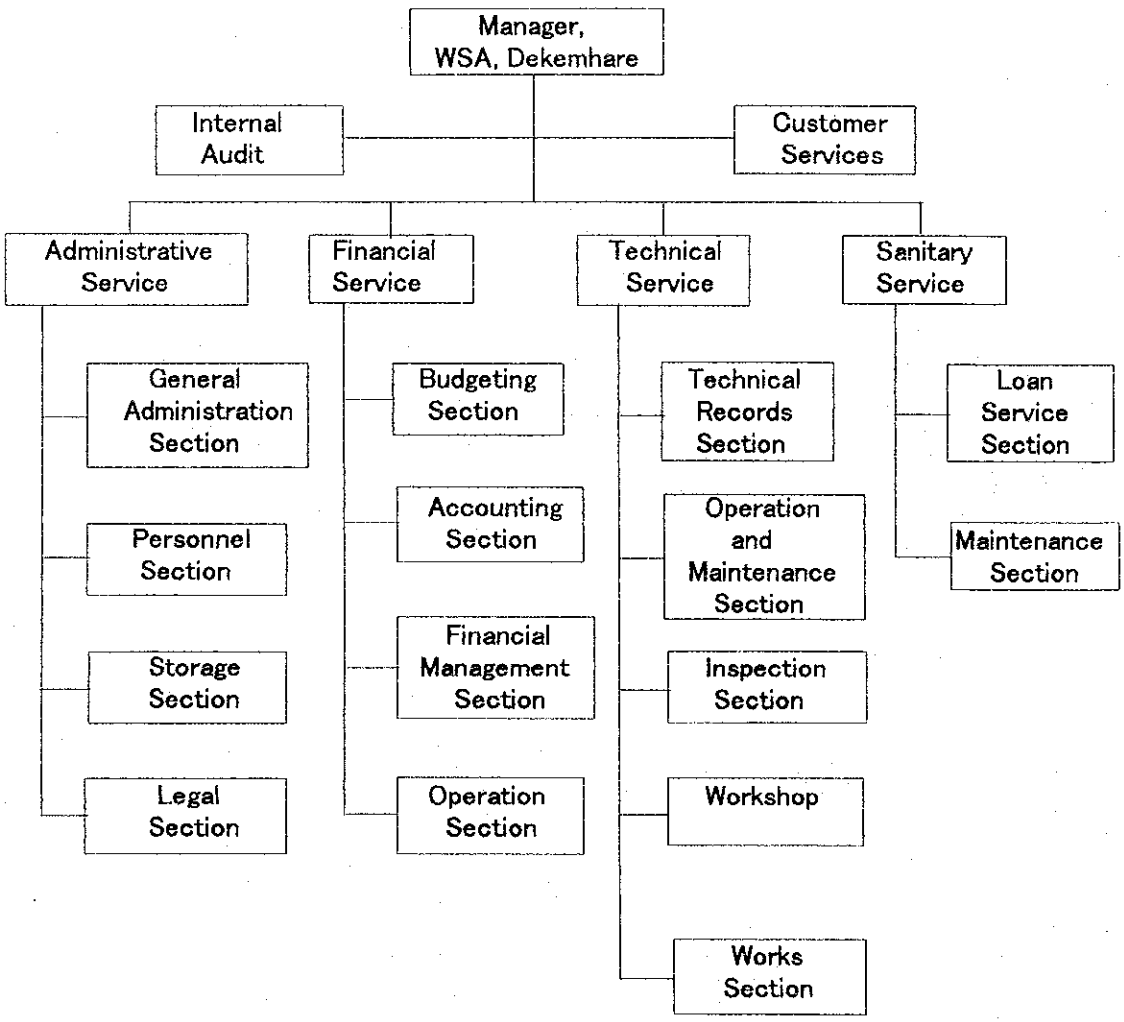
The smooth and successful implementation of the water supply project being envisaged depends on how competent and capable the manpower of WSA Dekemhare will be in both qualitative and quantitative terms.

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

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



Organizationally, WSA Dekemhare 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 Dekemhare 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 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 Dekemhare 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 Dekemhare 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 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 are operated mainly by electricity. Fuel is also required during 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 Dekemhare. 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 as Table 6.6.1.

Table 6.6.1 O&M Cost

(Unit: Nfa)

Item	Year 2005		Year 2010		Year 2015	
1. Personnel Cost	42 persons	393,287	63 persons	683,890	83 persons	1,044,504
2. Electricity and Fuel Cost	42.90 kwh/day	315,675	61.20 kwh/day	450,334	173.40 kwh/day	1,275,947
3. Chemical Cost	3,441 kg	22,369	6,393 kg	41,553	12,937 kg	84,088
4. Repairing Cost	Initial Cost for Pump 808,826 Nfa Initial Cost for Others 20,507,171 Nfa	121,687	Initial Cost for Pump 2,220,273 Nfa Initial Cost for Others 32,433,587 Nfa	202,808	Initial Cost for Pump 3,419,708 Nfa Initial Cost for Others 59,531,963 Nfa	365,043
5. Miscellaneous Cost		85,302		137,858		276,958
Total		**938,320**		**1,516,443**		**3,046,539**

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 felling 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 Dekemhare for the stipulated development program.

- 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.
- 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.
- Introduce and develop a viable management system for water and sanitation facilities that will be managed by the communities.
- 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 Dekemhare, 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 Dekemhare, 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 Dekemhare.

(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 Dekemhare 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 as observed is not only too much to manage but also ineffective.

Therefore, introduction of autonomous management systems are 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 Dekemhare 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 Dekemhare. 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 Dekemhare 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 Dekemhare 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 Dekemhare town administration

Dekemhare 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