4.2 Socioeconomic, Water Supply and Sanitation Conditions

4.2.1 Socio-economy and Gender Issue

(1) History and population

Located in the South-Eastern part of the country, Senafe is the last main town before one enters the Ethiopian border. It is one of the most ancient settlements and the town itself and its environs are reputed to be of rich archeological site giving rise to potential tourist attraction. Like other towns it is divided into two zones the first encompassing the original village and the second made up of the rather modern part with old and dilapidated buildings. A master plan has been completed and approved and presently many buildings are being erected forcing the already inadequate water and other utilities to be over-stretched.

Senafe has a population of 11,042 as of 1996. The ratio of males to females is 48.5% to 51.5%. The under 14 age group comprise of 48.9% while that of above 50 are 8.4%, again revealing that there are quite a large dependent population.

(2) Economic conditions

The same sources also indicate that about 38% of the town dwellers are traders and shop owners, 31% laborers, 7% other workers engaged in all sorts of occupation like masonry, stone quarrying, and vendors, etc., 16% farmers and 8% civil servants. The original inhabitants of the town are the farming community. The traders/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. Senafe has 364 licensed micro and small-scale establishments classified into manufacturing (43); trade and distribution (217); hotels, restaurants, tea rooms, etc. (76); service establishments (22); and others (6). During market day more than 30 villages (about 10,000 people) come to the market. The number is reportedly high during harvest period and holidays where people come to sell their livestock and buy necessities. Most of the establishments and shop owners are of one man entities. In the town, there are 14 line ministry offices.

Data for town residents' literacy and educational levels is not available. However, there are 5 educational institutions (1 kindergarten, 3 primary, 1 junior and 1 senior secondary school) enrolling a total of 3649 students with 60 teachers. The percentage distribution of enrollment in these levels of education is 3.8%, 59%, 20.1% and 17.2% respectively.

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

a) Household characteristics

The average family size of Senafe is 6.5 putting it in the top rank from among the seven towns under study. Female head of households comprise 40%. The Saho ethnic group has a major presence in this town (32%). Christians who comprise 66% of the sampled households predominate in this town (Appendix A, Table 4.1).

b) Occupation

The occupational structure of the respondents seems to be more disbursed in Senafe than in the other

towns because people seem to try to be occupied in as many activities as possible. For example, agriculture, industry, Government and commerce provide employment for 12%, 12%, 9% and 6% respectively. Agriculture, commerce and construction reportedly provide employment for both women and men equally, whereas in Government women are much less represented. It is also surprising to see that of those engaged in industry women constitute 15% while men are only 10%. Among the 18% jobless, women represent 26% (Appendix A, Table 4.2).

c) Agriculture and land

Only 8% of the respondent households own land for agriculture with an average size of a little less than half hectare (Appendix A, Table 4.4). Overall, production of crop is minimal and almost all that is produced is for self-consumption (Appendix A, Table 4.3).

Only 11% of the sampled households own livestock. On average sampled households own 13 sheep/goats and 3 cow/oxen. Chicken ownership is low when considered at the relative ease of raising them (Appendix A, Table 4.4).

d) Household income and expenditure

The average monthly income for a household in Senafe is shown as Nfa 743 per month. Women's income of Nfa 885 is higher than that of men as attested by the relatively good occupation they hold. Cross correlation between income and ethnic background reveal that income of other ethnic groups (Ethiopians) is much higher compared to those of the citizens (Appendix A, Table 4.5).

Table 4.6 presents composition of the town's sample households by income group and the major items of household expenditures. About 12% of the sample households earn less than Nfa 299 per month. Another 44% and 26% earn between Nfa 300-599 and 600-999 in a month. Those that reportedly earn more than Nfa 3000 per month are about 2%. In terms of the expenditure pattern, the table provides that 42% of an average household expenditure is on food, followed by saving and repayment 16% and electricity and energy 12%. Like in the other towns, monthly expenditure on water is low, but the residents' expenditure pattern on travel and culture 3% is less than that of the other towns (Appendix A, Table 4.6).

e) Household status of education

Like in the other towns, almost all school-age children in the sampled households attend schools. Looking at the education status of the respondents, Appendix A, Table 4.7, indicates that 73% are literate, and those who completed primary, junior and senior secondary comprise 32%, 26% and 29% respectively. College and above respondents are 2% and those who attend non-formal schooling 11%.

f) Women status and participation in communal activities

In similar pattern, with the other towns, one woman per household participates in women's organizations or groups. But unlike other towns where all women are engaged in house keeping, the figure for Senafe is less. Besides, 20% are active in commerce and 14% in industry and small percentage are employed in Government. With regards to the activities of girls, even though 64% are going to school, 52% of them said that they help their mothers in household chores. The percentage of young girls that are engaged in commerce are only 9% (Appendix A, Table 4.8).

The participation of women in educational sessions of social services is similar to that of Adi Keyih and looks better to that of other towns Firstly, there are fewer respondents who do not participate in such sessions. Secondly, participation most of the activities seems much higher for water use, sanitation, childcare and family planning. There is also literacy session with 15% participation (Appendix A, Table 4.9).

On the average, 1.4 woman per household participate in women's organizations or groups in the town of Senafe. Of the sampled households, none reported that they participate in communal water points or community toilets. Their participation in socio-cultural activities (22%) is even lower than in other towns. There is a savings association where 5% of the respondents belong to. Additionally, most women participate in formal national organizations like PFDJ and NUEW.

In this town 51% and 56% of the households responded that they belong to communal water point and communal toilet. The participation of adult women of the sample households in attending meetings related with these activities is however minimal with 1% each. Participation in soil and water conservation, and for roads seems to be good with 62% and 15% respectively. Nevertheless, their participation in communal water points and toilets management is nil, but participation in national and traditional community meetings is high (Appendix A, Table 4.11).

g) Household problems

In a larger magnitude than the other towns, the major household problems seem to be shortage of income where 75% of the household respondents and 77% of the women responded said they face shortage. Very few said there is no problem. By the low percentage of response to the other categories, they could be saying that if shortage of income is solved everything else will be solved (Appendix A, Table 4.12).

When existing problems related with the present water supply condition are analyzed, long queuing (69%), high water tariff (39%) and inadequate quantity of water (18%) and distance is mentioned in order of importance (Appendix A, Table 4.13).

h) Affordability for water and sanitation facilities

The sampled households of all income group responded that they can afford to pay for water. Within the lower income group those who responded are only 12% and the majority of them can afford to pay up to Nfa 5-9. However, 12% of all income group said less than Nfa5, 23% from Nfa 5-9 and a large 49% can afford Nfa 10-15 per month (Appendix A, Table 4.15).

With regards to payment for communal toilets, the sampled households of Senafe are, unlike other towns, ready to use and pay for communal toilets. In the first place, a larger percentage of the lowest income group gave response. However, a total of all income group, expressed their willingness to pay up to Nfa 4-6 in a month. Secondly, the cumulative response of the total group is even more encouraging, because 35% said they can afford a reasonable payment of less than Nfa 2 a month, another 30% said Nfa 2-3 a month. This means that all in all, 43% of all income group will be willing to contribute less than Nfa 4 a month (Appendix A, Table 4.16).

i) Communal water points

Communal water points seem to be better located in Senafe as compare to other towns. The majority of

the respondents (34%) walk less than 90m; even though those that travel more than 400m are about 30%. As in Adi Keyih men also share the burden of carrying water with women. Of the 64% unsatisfied respondents, 67% favor house connections and another 27% yard connections (Appendix A, Table 4.17).

4.2.2 Water Supply Conditions

In Senafe though the system is limited, it has a piped water supply from a groundwater source. It is observed from the socio-economic survey conducted house to house that the consumers from house connection, yard connection and communal water point are 8%, 7% and 84% respectively and the consumption rate is 10l/c/d, 7l/c/d and 8l/c/d respectively (Appendix E, Table 4.2). The consumption from water tanker (16l/c/d) is even higher than the consumption by house connection users.

The communal water point users for about 30% are traveling more than 400m distance to fetch water (Appendix E, Table 4.3). Among the communal water point users 64% are not satisfied by the service they are getting. From those who are not satisfied about 67% of the households prefer and afford house connection and 27% afford yard connection. The remaining 7% say they afford communal water point only.

With regard to the communal water point management, so far WSS is the responsible authority. However, 41% of the households are favoring for the community based management of the communal water point systems.

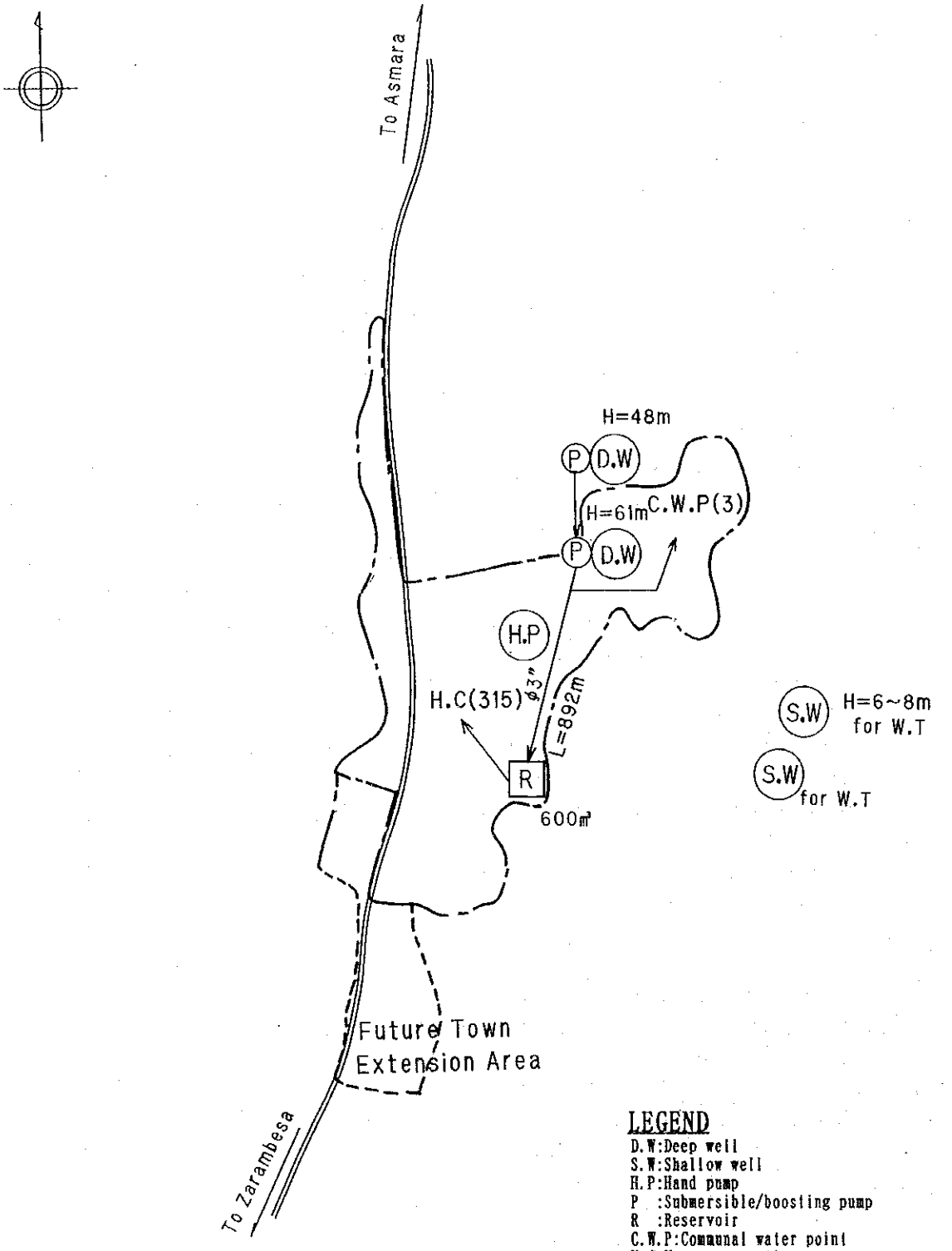
Some of the community of Senafe also use river/spring water (1% of households) as supplementary source for which all the users informed the water is used for washing purpose only (Appendix E, Table 4.2). They travel 500 to 1000m to the river (Appendix E, Table 4.3).

Outlines of the water supply system in this town are illustrated as Figure 4.2.1. Main water sources of the town are three boreholes located outside the old town, that is the northern part of and 1.0 km far from the municipality. Two of them are working but the remained one is out of order at present. Well pumps are operated for four hours per day and water from the wells is fed to the reservoir beside the municipality by the transmission pipeline of 3 inches in diameter. The reservoir is ground type, built by Italians and approx. 600 m^3 (300 m^3 x 2 units) in capacity. Water is supplied from the reservoir to 315 house connections by gravity but three communal water points are served directly from one of well pumps.

As for another water sources for the town, there are one hand-pump-equipped borehole in the new town and two dug wells for a water tanker at Afoma valley in the east of the town.

Most of facilities were built by Italians, and therefore they are obsolete except one well of recent installation. The transmission pipes were laid without earth cover and exposed on the houses. The reservoir is obsolete and there is some leakage. Total water leakage is estimated at approximately 50 percent.

Figure 4.2.1 Outline of Water Supply Facility



4.2.3 Sanitary and Health Condition

(1) Public sanitation

The town has no sewerage system. For refuse disposal, the Town administration has provided a dump truck which at present gives service twice a week. Though the coverage is 100% each house gets service only once in a week. There is no other garbage collection system. The communities have to dump directly into the truck. The refuse disposal site is only one and half kilometer from the town and the refuse is neither buried nor burned.

With regard to public latrines, one latrine has been constructed by the Town administration at the bus terminal, which serves both for males and females. The latrine is pour-flush and has an attendant who watches and cleans. For this operation and maintenance, the users pay 5 cents per visit. Moreover, small retail shops including sewa houses do not have latrine facilities. Bars and restaurant are reported to have latrine facilities in the survey. The Town administration with this regard has imposed a new regulation which force the owners to provide latrine n their house.

Like most other towns, the Town administration has a sanitary section to follow up the implementation of the sanitation regulations. So far 15-20 bars, sewa houses and restaurants have been closed due to lack of latrines. The responsibilities of the Sanitary section are not limited to the inspection of bars and restaurants only, but also to go round the town and control the illegal dumping of refuse in the public area and to check the cleanliness of household latrines, too. However, the staff capacity for this job is limited.

There is no regular cleaning campaigns. Whenever the town needs to be cleaned, the Town administration makes arrangements for a campaign irregularly, in addition to the national cleaning campaign.

(2) Private sanitation

According to the socio-economic survey result the private household latrines coverage is only 40%. The type of latrines exist are flush and dry pit latrines, both at equal ratio (19% coverage each). The cleanliness of the latrine is also one area which requires improvement. Among houses who have latrine 53% are not satisfied. Those who are not satisfied by their latrine 49% of them said they prefer and afford flush latrine and 18% sad they afford pit latrine and 33% afford community toilet. If a credit system is introduced, 51% of the residents said they favor it and afford to repay at 30 Nfa per month rate (Appendix E, Table 4.4).

The Town administration having realized the impact of lack of household latrines on the environment introduced a new regulation which oblige new house builders to include latrine n their house. In its implementation unless the house has a latrine the Town administration will not issue an ownership license to the owner. The new houses are located upstream of the well-field. For this reason, a pit latrine without a proper stone masonry water tight-wall and concrete flooring, is not permitted. The house builders are complaining about budget constraints in the construction of such latrines.

In Senafe stone, water and paper are used for anal cleansing at the rate of 32%, 31% and 67% (Appendix E, Table 4.4). With regard to waste disposal practices, solid waste in general by 99% of the population

use the Town administration refuse truck and wastewater by 78% is disposed to open field in their surrounding. Animal waste is use for fuel and fertilizer only by 25% of the owners. Infant excreta is also improperly handled by 64% of the family with infants (Appendix E, Table 4.5).

(3) School sanitation

In Senafe there are five schools. Among these schools one does not have water facility and two schools never had latrine and one school had but the latrine is blocked and out of use. The main problem of the schools with regard to water and latrine facilities is money constraint. Mismanagement in operation and maintenance and lack of sanitation education is also another factor which contribute to the poor facilities condition. For details of the schools sanitation facilities refer Appendix E, Table 4.6).

(4) Hygiene/health condition

In Senafe, there is a hospital with 26 beds, a clinic and 3 pharmacies with a physician, 4 nurses, 8 dressers. The hospital's statistical data show the occurrences of water and poor sanitation related diseases affecting less than 10% of the population annually (Appendix E, Table 4.7). Further studies on sanitation and health aspect was made by conducting socio-economic survey. From this study diarrhea, dysentery and malaria cases are reported 12, 8 and 7 persons respectively in six months from the date of survey. The average medical cost is Nfa 17.67, 11.95 and 19.58 per case for diarrhea, dysentery and malaria respectively. About 92% are believed to visit physician when they are sick. The infant death rate from the survey is 1.69 infant per 10 years (Appendix E, Table 4.8).

As part of sanitation practice the hygienic behaviors are studied. The hand washing with soap after defecation, before cooking, before eating, after disposal of children stool and after handling animal dung is at the rate of 41%, 37%, 24%, 40% and 0% respectively (Appendix E, Table 4.9). The food handling practice relatively is better. About 99% of the people wash vegetable before eating and 81% cover leftover food (Appendix E, Table 4.10).

With regard to the knowledge on sanitation, about 82% had attended health/hygiene education sessions. About 78% of the residents know how to preparation of ORS. The residents also participate in community sanitation work. About 98% of the community participated in cash, material and labor contributions in the community work.

4.2.4 Financial Condition of WSS

Water Supply Service (WSS) of Senafe earned 126,545 Nfa from Jan. to Aug. in 1997, while the expenditures incurred amounted to 83,900 Nfa, or a profit ratio of 33.7%. This ratio is considered an excellent financial performance.

Water sales by meter and cash accounted for 54.8% and 11.2% of incomes respectively, totaling 66.0%. Salaries and electricity occupied 55.3% and 37.6% of expenditures, respectively, totaling 92.9%.

Numbers of water supply facilities are 315 for house connections, 3 for communal water points, 1 for the water tanker and 1 for the public well.

Water tariffs per cubic meter are 2.5 Nfa for house connection users, 5 Nfa for communal water point users and 10 Nfa for users of water from the water tanker. These tariffs are considered an average level.

WSS has 14 workers. Each worker earns an income of 12,052 Nfa, which is medium among the 7 towns. The average monthly salary per worker is calculated at 483 Nfa.

The per capita per day consumption of water is 9.4 liters according to the results of the socio-economic survey. This per capita consumption is low.

(1) Population in 1997: 12,934

(2) Financial Performance in 1997 (from Jan. to Aug.)

Unit: Nfa

Revenues		Expenditures	
Item	Amount	Item	Amount
Water sales by meter	69,408	Salaries	46,393
Water sales by cash	14,133	Per diem	0
Rental charge of meter	-*	Electricity	31,554
Service charge	43,004	Fuel	5,400
Others	0	Supply materials	0
Total	126,545	Repairs	0
		Office supply	0
		Others	553
		Total	83,900

Note: * included in "Water sales by meter".

(3) Water tariffs

Unit: Nfa/m^3

House connection	Communal water point	Water tanker	Water vendor	Public well
2.5	5	10	-	0

(4) Number of water supply facilities

House connection	Communal water point	Water tanker	Public well	Private well
315	3	1	1	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
	Store keeper	2		2	2		2
	Driver	1		1	1		1
	Driver's assistant	1		1	1		1
Financial	Head	1		1	1		1
	Water seller	3	1	4		4	4
Technical	Motor operator	1		1	1		1
	Plumber	2		2	2		2
	Total	13	1	14	9	5	14

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

(6) Production and consumption of water in 1996 (m^3): 63,130 and 31,565.

(7) Average monthly salary: 483 Nfa.

(8) Per capita per day water consumption: 9.4 liters

CHAPTER 5 STRATEGY ON PLANNING

5.1 Basic Strategy on the Planning

(1) Target year

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

(2) Water resources development plan

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

(3) Water use

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

(4) Water supply and sanitation plan

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

(5) Sustainability of the project

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

5.2 Population Projection

5.2.1 Population as of 1997

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

Table 5.2.1 Present Population and Household Size of the Seven Towns

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

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

5.2.2 Basic Assumptions Adopted for Population Projection

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

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

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

5.2.3 Projected Population

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

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

(1) Category One: Mendefera, Dekemhare and Debarwa

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

Thus, the growth rate for these towns will be:

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

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

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

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

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

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

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

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

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

5.3 Water Demand Projection

5.3.1 Present Domestic Water Consumption

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

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

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

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

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

5.3.2 Approach on Domestic Water Demand

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

(1) Hygiene

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

(2) Available infrastructure

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

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

(3) Economic potential

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

(4) Water resources potential

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

Table 5.3.1 Present Supply Mode and Water Consumption

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

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

(5) The government policy

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

(6) Population

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

(7) Current water demand trend

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

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

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

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

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

Table 5.3.2 Water Consumption

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

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

Table 5.3.3 Domestic Water Demand

(l/c/d)

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

5.3.3 Other Water Demand

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

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

Table 5.3.4 Non-domestic Water Consumption by Field Survey

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

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

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

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

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

Table 5.3.5 Non-Domestic Water Demand

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

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

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

Unit: %

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

5.3.4 Loss and Peak Demand

(1) Physical loss

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

(2) Max. daily and peak hour water demand

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

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

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

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

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

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

5.4 Water Supply System

5.4.1 Water Supply System

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

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

5.4.2 Water Supplied Area

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

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

villages at present.

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

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

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

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

5.4.3 Facility Plan

(1) General

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

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

b) Well pumps are obsolete and have breakdowns,

c) Reservoirs have small capacity and insufficient water level,

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

e) Communal water points are damaged.

(2) Target years for pipeline

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

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

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

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

(3) Pipe material

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

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

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

Under these circumstances, following pipe materials are recommendable.

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

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

(4) Power supply

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

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

(5) Major water supply facility

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

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

Basic items of new water supply facilities are planned below.

a) Well

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

b) Well pump

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

c) Transmission pipeline

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

d) Booster pump

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

e) Pump pit

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

f) Reservoir

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

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

g) Distribution pipeline

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

h) Individual connection

- Diameter of pipe is 13 mm.
- Material is polyethylene pipe.
- Flow meter is equipped.

i) Communal water point

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

j) Power supply

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

k) Pump house

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

l) Others

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

5.5 Sanitation Improvement

5.5.1 Objective and Scope of the Program

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

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

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

5.5.2 General Approach

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

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

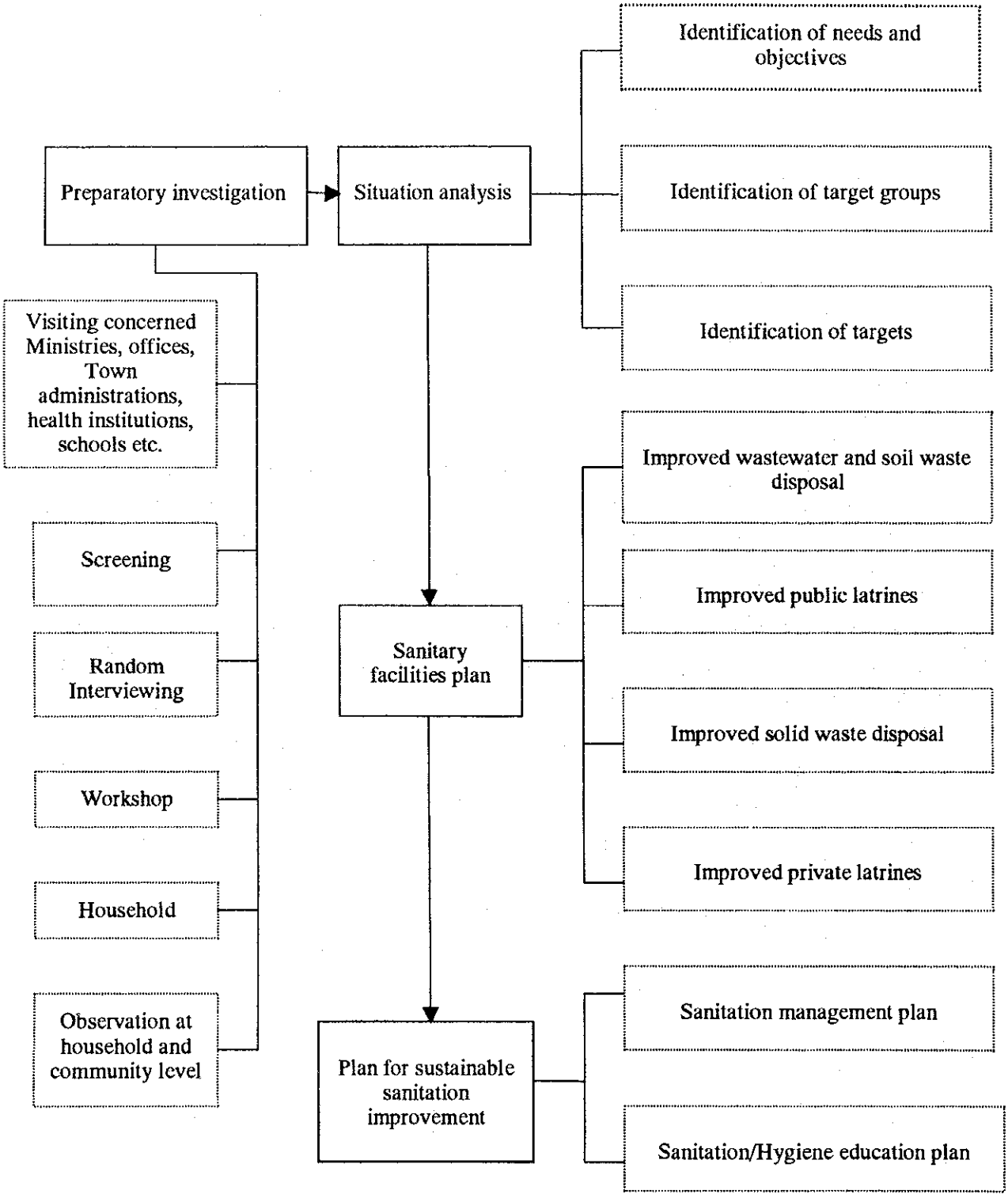
b) Following to the information collection process the situation is analyzed and needs and objectives, the specific targets and the specific target groups are identified.

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

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

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

Figure 5.5.1 Details of the Sanitation Improvement Program Formulation Approach



5.5.3 Areas of Focus and Basic Considerations

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

Moreover, explicit studies are carried out in areas of:

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

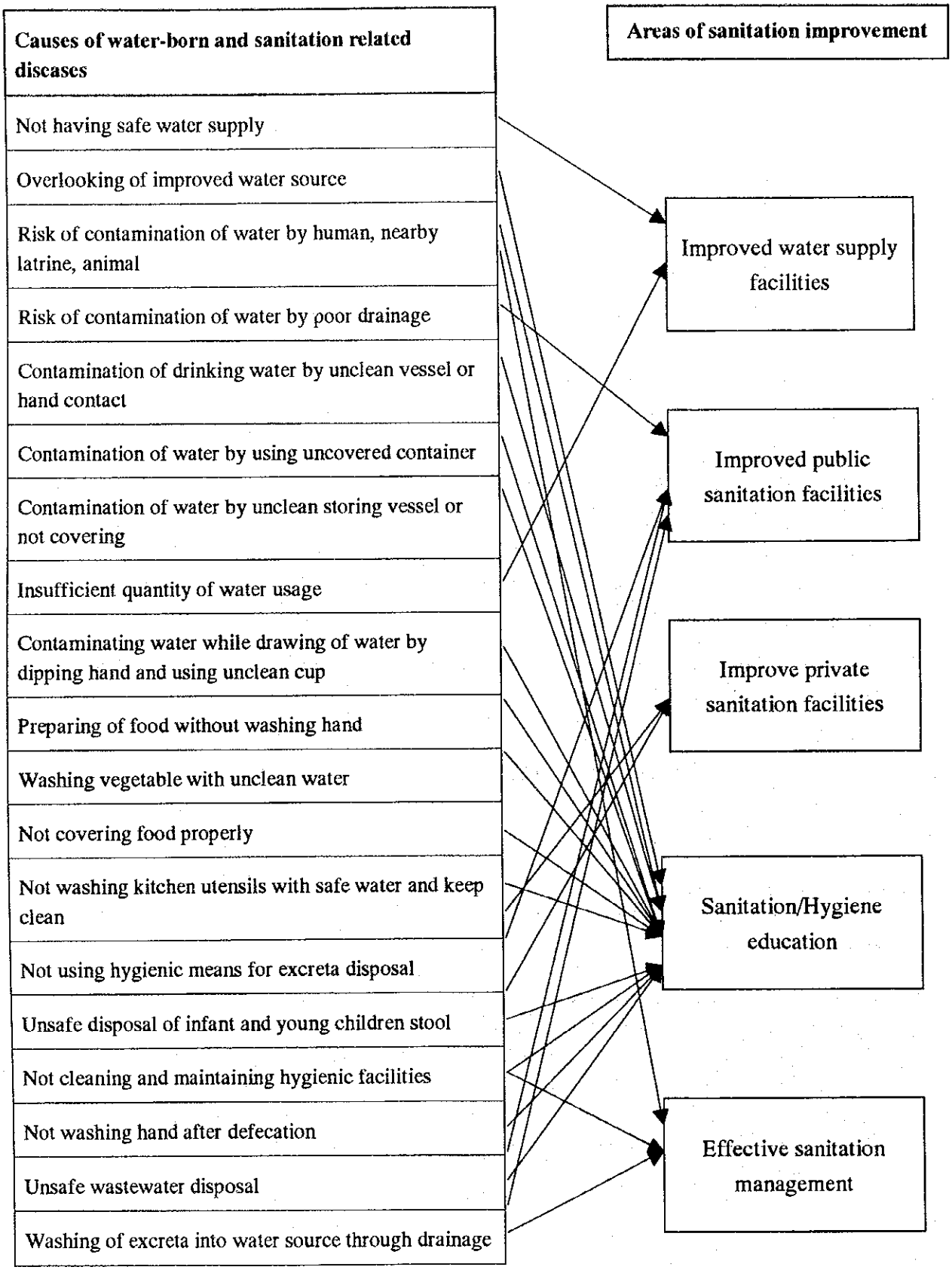
The sanitation facilities plans are developed ensuring the economic and technical feasibility and social and cultural appropriateness in the society. The basic factors considered are:

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

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

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

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



5.6 Financial and Economic Analysis

5.6.1 Water Prices and Revenues

(1) Determination of water prices

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

a) Average monthly household income.

b) Distribution of household income by category of customers.

c) Willingness-to-pay for water.

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

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

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

g) Future growth of household income.

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

(2) Projection of revenues

Revenue from water charges will be projected from:

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

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

c) Water price by year and by category of customers

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

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

The third revenue source is the revenue from meter rent.

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

5.6.2 Financial Analysis

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

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

b) Discount rate (10%)

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

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

i) O & M cost (yes)

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

e) Durable life of equipment and facilities:

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

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

iii) pumping stations and treatment plants (50 years)

f) Corporate income tax (free)

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

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

(1) Projection of financial statements

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

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

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

(2) Estimation of financial criteria

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

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

5.6.3 Economic Analysis

(1) Estimation of benefits

a) Economic value of water

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

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

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

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

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

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

(2) Economic cost

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

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

(3) Economic analysis

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

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

CHAPTER 6 DEVELOPMENT PROGRAM

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.

The administration of Senafe has two sub zones and five villages; namely, zone 1 and zone 2 of Senafe, Wetera, Awle, Hahahile, Tisha and Afema. There are 3 blocks each in zone 1 and zone2. As Wetera, Awle, Hahahile and Tisha are close to the center of the town, only Afema is located in the southeastern part of and approx. 2km far from the municipality. Zone 1 is the old town and zone 2 is the new town. Zone 2 and Wetera are the center of the town.

Future town extension area is planed in the southern part of the town beside Wetera.

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

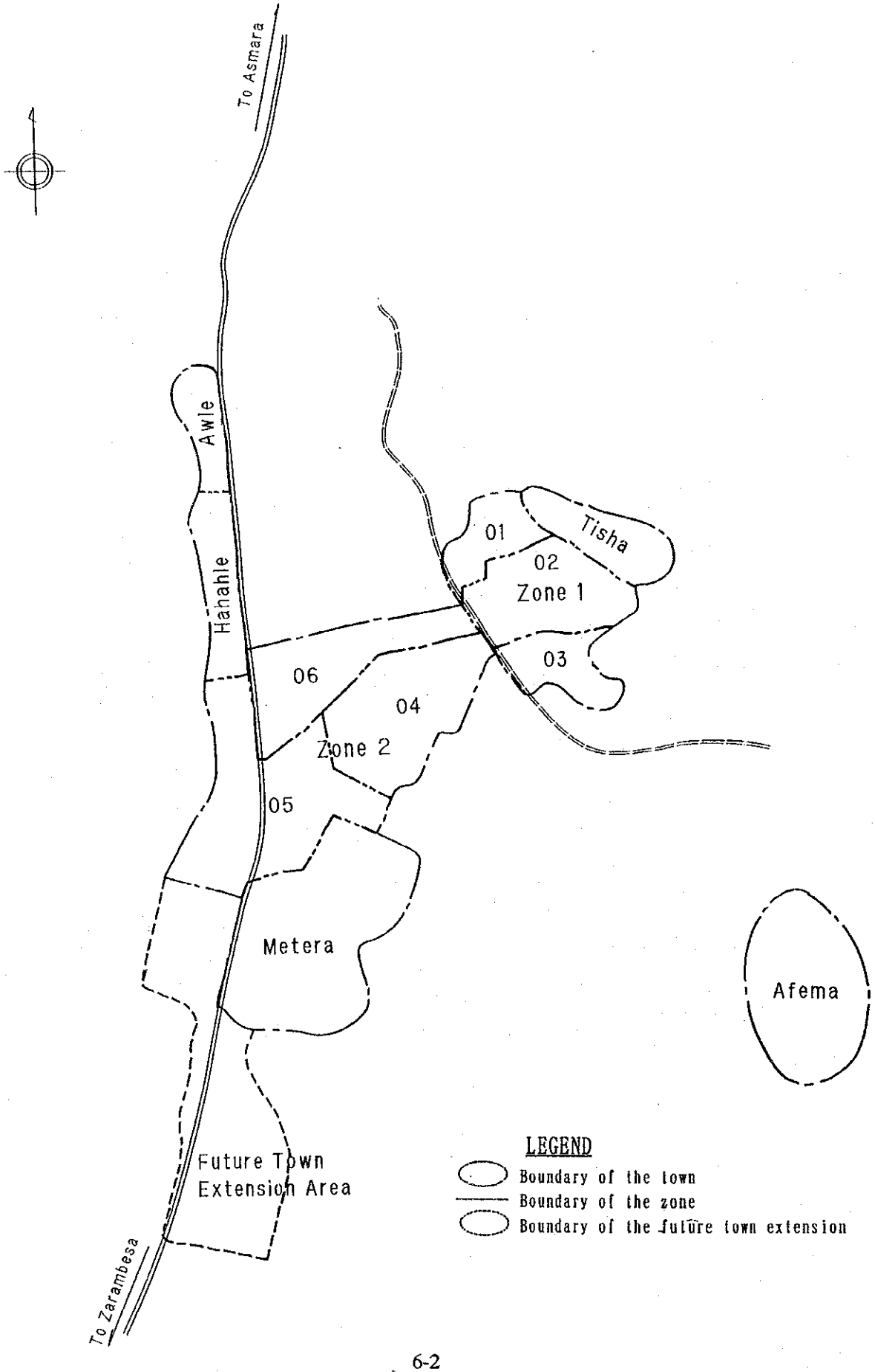
- Target year 2005: zone 1 and zone 2 of Senafe, Wetera,
- Target year 2010: future town extension area,
- Target year 2015: Awle, Hahahile, Tisha and Afema

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

Table 6.1.1 Population and Water Demand

Target Year	2005	2010	2015
Population Projected	20,330	25,140	30,610
Supplied Population	15,620	21,810	30,610
Service ratio (%)	76.8	86.8	100.0
Average Water Consumption (l/c/d)	37.2	39.4	46.2
Average Daily Demand (m^3/d)	582	859	1,414
Max daily demand (m^3/d)	698	1,030	1,697
Peak hour demand (m^3/hour)	43.6	64.4	106.0

Figure 6.1.1 Outline of the Service Area



6.2 Water Resources Development Plan

6.2.1 Current Water Resources

The public water sources of the town are two boreholes: BH-9 and BH-10. Both of the wells are installed by a submersible pump, sending water to the reservoir tank with a capacity of around 600 m^3. Besides the said public water sources, 3 boreholes with a hand-pump and 7 dug-wells are functioning for domestic, irrigation, or livestock water sources. Then, two boreholes (BH-8 and 14) drilled by WRD are left untouched but capped.

Besides the groundwater resources, there are five surface dams including the Afoma Dam, in this sub-region for agricultural/livestock purposes. Almost all of these dams are suffering from sedimentation problem and dry up in some years.

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 periods. 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 (at the Mereb River) and groundwater level at Test Well (SEN-1) 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 Senafe, 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

Senafe	Jun	Jul	Aug	Sep	Oct	Annual (mm)	(%)
Rainfall (mm/m)	29.6	170.4	145.2	21.7	7.9	528.1	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)	3.0	48.9	45.4	4.3	0.8	102.4	19.4%
Runoff (-"-)	1.8	29.3	27.2	2.6	0.5	61.4	11.6%
Recharge (-"-)	1.2	19.6	18.2	1.7	0.3	40.9	7.8%
Act. E.T. (-"-)	26.6	121.5	99.8	17.4	7.1	425.8	80.6%

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 small as 40.9 mm/a, which is about 7.8% of the total rainfall.

The area near around the town is divided into some small sub-basins. The town itself is included into the Ruba Ribis basin, which neighbors upon the Enda Abune Anbesa basin on the south. Both of them are pouring into the Red Sea finally. While, the west of the town beyond the characteristic rocky mountains is a deep valley connecting to the Mereb River. The areas of the sub-basins are 18.1, and 53.8 km^2 for the Ruba Ribis, and Enda Abune Anbesa sub-basins, respectively (refer to the Figure 6.2.1). Those areas are measured on the 1:50,000 aerial map. Each sub-basin area is extending to downstream more, in an exact saying, but cut short into the meaningful area from a view point of actual groundwater development, e.g. the Enda Abune Anbesa sub-basin is enclosed at the conjunction with southern tributary. The upstream of the Ruba Ribis basin is, however, deemed to be connected with the southern neighboring basin hydrogeologically, so that, actual recharging area of the Ruba Ribis basin is to be counted as 27.4 km^2. Based on the area and effective rain, the yearly groundwater recharge on each sub-basin is calculated as 1.12 and 1.82 MCM/a, for the said basins respectively.

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 Senafe area, the main aquifer is the fissured aquifer type of the basement metamorphic rocks, usually showing fair to good yield. And the secondary aquifer is the fissured type aquifer of Adigrat sandstone overlying the basement. It is located at the downstream of the Afoma Dam though, the groundwater hydrograph of SEN-1 suggests that the lowest groundwater level, at the end of dry season, is only about 4.1 m bgl and the groundwater flow is not so smooth. Such local condition can mitigate the limitation of safety groundwater development somewhat.

(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. It was reported that the water quality, in particular chemical properties, of this sub-region is generally good. However, the results of the analyses show that most of the samples, as much as nine samples out of ten, were found contaminated with *faecal coliform bacteria*. Although the report noted such contamination might be occurred by unusual rainfall and flooding, checking of the water quality must be repeated periodically.

For the new water source, groundwater extracted from the Observation Well SEN-1 was 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 chemical property of the water is almost good excepting high manganese content, however, it is again found to contain bacteria, indicators of faecal pollution. Thus, the utmost care must be paid on the structure of the production wells to prevent a faecal pollution, and then, the water quality of the sources and the supply system must be checked periodically.

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 increasing water demands of Senafe as 698, 1030, and 1697 m^3/day in the year of 2005, 2010, and 2015, respectively. Increasing ratio of the water demand is fairly high in comparison with the other target towns. The situation of such increasing water demand is illustrated in Figure 6.2.3, together with actual water resources development plan explaining in this section.

Figure 6.2.1 Catchment Area of Senafe Basin

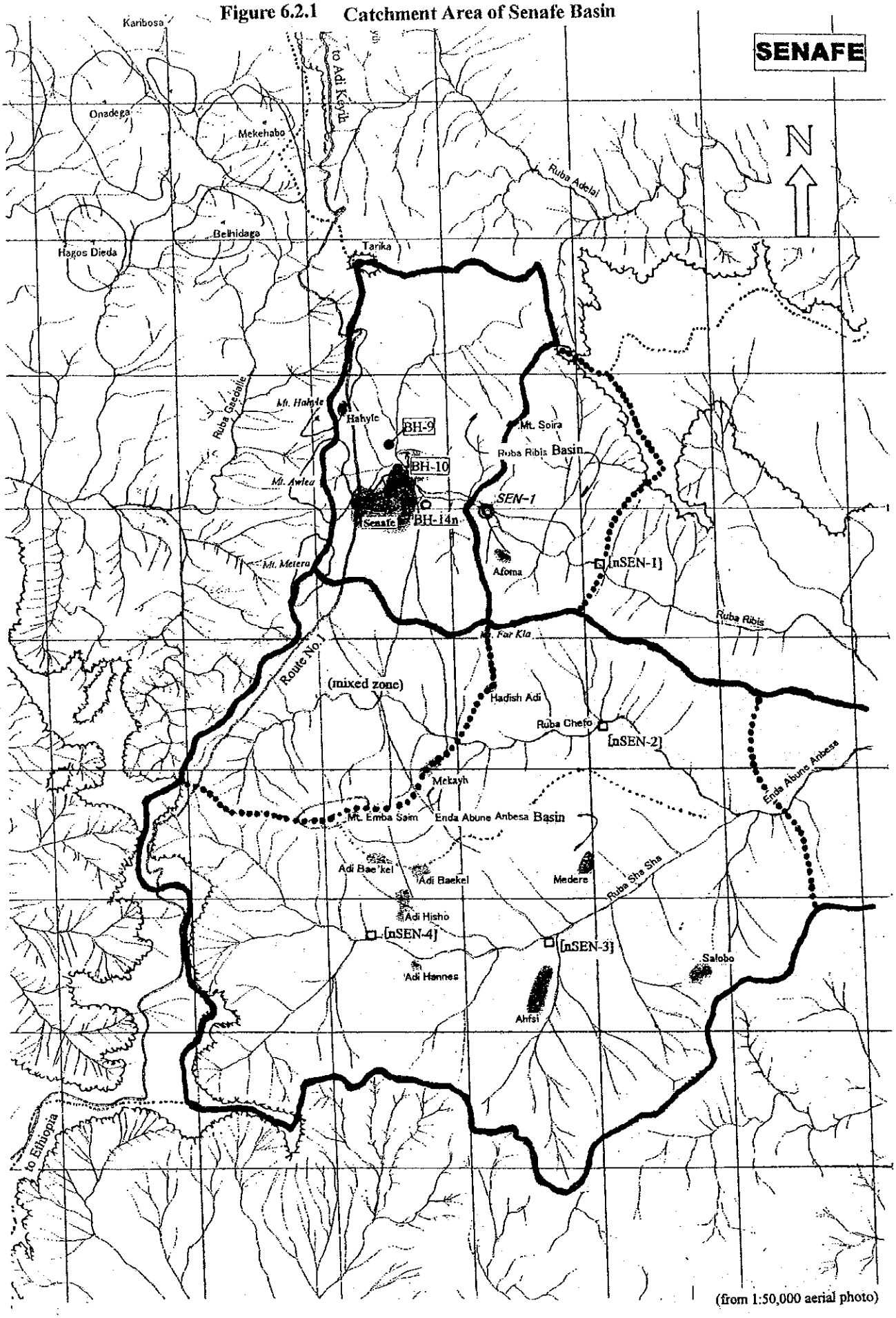
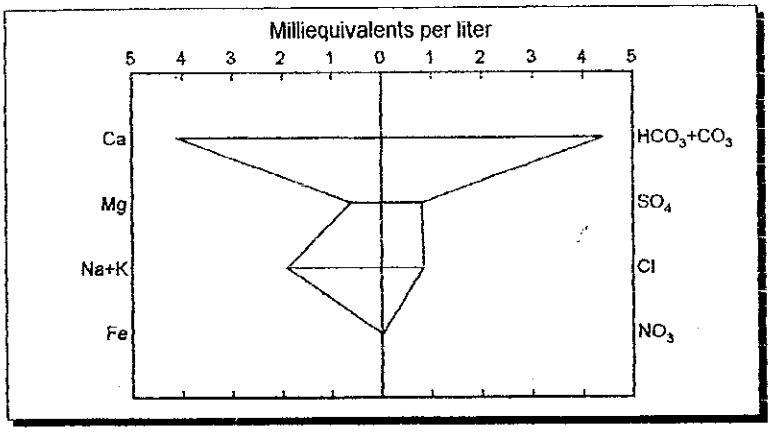


Figure 6.2.2 Water Quality of SEN-1

STIFF Diagram

Well Ident	Description
SEN-1	Observation Wel



Cations

	Ca	*Mg*	*Na*	*K*	*Fe*
Milliequivalents per liter	4.0918	0.6005	1.7705	0.11507	0.0016
Milligrams per liter	82.00	7.30	40.70	4.50	0.03

Anions

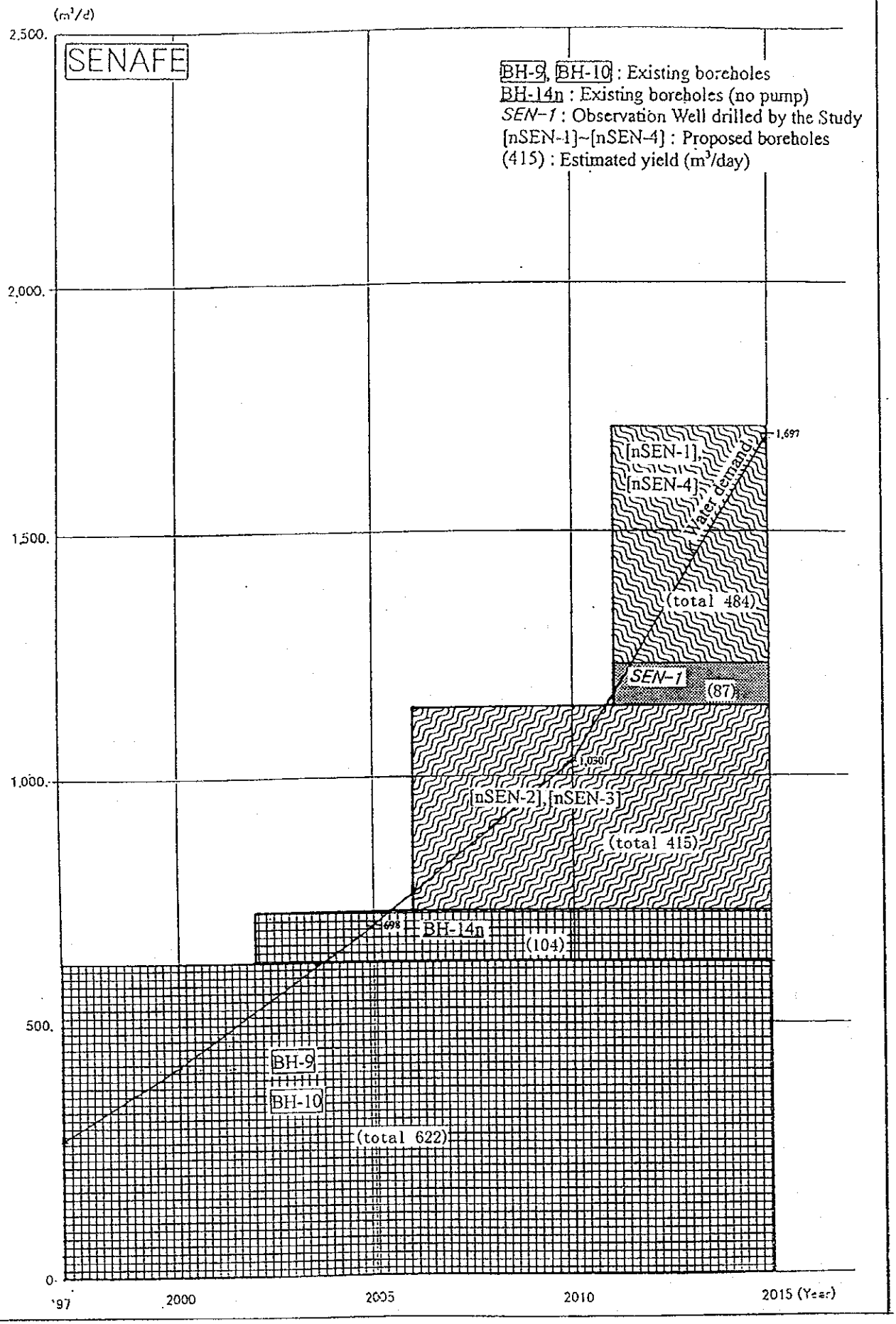
	HCO3	*CO3*	*SO4*	*Cl*	*NO3*
Milliequivalents per liter	4.39908		0.81198	0.84630	0.04355
Milligrams per liter	268.40		39.00	30.00	2.70

Mn	NO2	PO4	F	B	SIO2
0.0109	0.00870		0.0553		
TDS	Hardness	Alkalinity	Conductivity	pH	SAR
	13.1		734.00	6.68	1.1559

Water Type	Cations (epm)	Anions (epm)
Calcium Bicarbonate	6.6	6.2

Error Balance
3.41

Figure 6.2.3. WATER DEMAND AND RESOURCES PLAN



(2) Water resources development plan

The existing water sources, BH-9 and 10, have a total yield of around 622.1 m^3/day, slightly short to cover the water demand in 2005. Under the Study, the existing BH-14 which was kept capped was confirmed to yield 103.7 m^3/day constantly. And the yield is enough to cover the shortage of water in 2005, therefore, the well shall be completed as one of the production wells until 2005. At this stage, total groundwater development volume is less than one-fourth of the yearly recharging volume, and it can be considered as enough safety from the total hydro-geological situation.

To satisfy the water demand for 2010, new water source must be developed. In this case, the southern neighboring basin is to be developed, because the water supply service area shall be extended mainly towards south. Besides the said three boreholes, two boreholes newly drilled along the Ruba Chefa and its southern tributary (named nSEN-2 and 3) shall be enough to cover the water demand in 2010. The Enda Abune Anbesa basin has rather wide catchment area, and the groundwater extraction through the two new boreholes is around 415 m^3/day, thus the safety ratio of groundwater development (extraction/yearly recharge) in this basin is very high as around 12.0.

For the final target year of 2015, around 560 m^3/day of new water source must be developed, in addition to the above mentioned water sources. In the stage, Observation Well SEN-1 is to be involved into the water supply system, because the Afoma zone shall be included in the service area. SEN-1 can yield around 86.4 m^3/day, and to cover the remaining shortage, another two production wells shall be drilled: one is at the downstream of the Ruba Ribis and another is at the upstream of the southern neighboring basin (along the Ruba Sha Sha). These are temporary named as nSEN-1 and nSEN-4, as shown in Figure 6.2.3. The safety ratios, in this stage, are around 3.0 in the Ruba Ribis and around 7.2 in the Enda Abune Anbesa basin, both of them deems to be reasonable. The recommended sites of the new production wells, mentioned above and presented in Figure 6.2.1, are to be reconfirmed through systematic siting works in or prior to each implementation stage.

6.3 Water Supply and Sanitary Facility Plan

6.3.1 Water Supply Facility Plan

(1) General

Topographical feature of the town undulates. Ruba Shanbko, which consists of separated two zones, is lower and its elevation is 2350m. Southern part of zone 1 and western part of zone 2 are higher than Ruba Shanbko and these elevations are 2365m and 2375m respectively. Wetera and Hahahile close to zone 2 are nearly at the same elevation as zone 2 but Awle and Tisha are far from the center of the town and these elevations are approx. 10m higher than zone 2.

The existing facilities except boreholes and the reservoir are replaced because of following condition.

- Yield from the existing boreholes including unused wells is used to cover the future demand,
- One well pump is replaced because of obsoleteness and breakdowns,
- Reservoir is rehabilitated because of insufficient capacity,
- Pipelines is replaced because of obsoleteness, insufficient diameters to cover the future demand,

unknown location and diameter, etc., and

- Communal water points are planned to supply stable water.

(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 the facilities are shown in Appendix D.

a) Intake facilities

As mentioned in "6.2.3. Water resources Development Plan", the existing boreholes can cover the water demand in 2005, but new boreholes shall be added for future water demand.

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

Target year 2005: Three existing boreholes of BH-9, BH-10 and BH-14 to be planned and existing well pumps to be replaced.
Spec. of pump at BH-9: Q=0.288m^3/m, H=63.1m
Spec. of pump at BH-10: Q=0.144m^3/m, H=64.3m
Spec. of pump at BH-14: Q=0.072m^3/m, H=71.2m

Target year 2010: Two new boreholes to be added.
Spec. of pump at nSEN-3: Q=0.144m^3/m, H=109.8m
Spec. of pump at nSEN-4: Q=0.144m^3/m, H=60.5m

Target year 2015: Two new boreholes and one test borehole to be added. Well pumps of nSEN-3and nSEN-4 to be replaced to meet water demand.
Spec. of pump at SEN-1: Q=0.060m^3/m, H=17.9m
Spec. of pump at nSEN-1: Q=0.144m^3/m, H=90.9m
Spec. of pump at nSEN-2: Q=0.144m^3/m, H=125.3m
Spec. of pump at nSEN-3: Q=0.144m^3/m, H=117.1m
Spec. of pump at nSEN-4: Q=0.192m^3/m, H=79.0m

b) Transmission facilities

Three new transmission pipelines are planned and one existing pipeline shall be replaced. The transmission pipelines will be extended to meet the water demand. Booster pumps shall be planned because of the long distance and difference of elevations. The transmission facility plan for each target year is as follows:

Target year 2005: New pipeline from BH-9 and BH-10 to existing reservoir to be planned and another new pipeline from BH-14 to existing reservoir to be replaced.
Diameter and total length of pipe:
D=100 to 60mm, L=2,126m

Target year 2010: New pipeline from nSEN-3 and nSEN-4 to existing reservoir to be added.
Diameter and total length of pipe:
D=125 to 80mm, L=8,800m

Spec. of new booster pump at BP1: Q=0.288m^3/m, H=92.1m
Number and capacity of pump pit for booster pump:
15m^3 1set

Target year 2015: One new pipeline from nSAN-2 to the pump pit of BP1 and another pipeline from SEN-1 and nSEN-1 to new reservoir 2 to be added. Booster pump of BP1 to be replaced to meet water demand.
Diameter and total length of the pipe
D=80 to 60mm, L=6,100m
Spec. of new booster pump at BP1: Q=0.480m^3/m, H=102.6m
Spec. of new booster pump at BP2: Q=0.204m^3/m, H=70.0m
Number and capacity of pump pit for booster pump:
15m^3 1set

c) Distribution facilities

The existing reservoir (reservoir 1) can be used because there are two pits and its elevation can cover the almost of the service areas. Also a new reservoir (reservoir 2) shall be planned for Afema village for the target year in 2015.

A 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: Diameter and total length of pipe
D=150 to 50mm, L=17,139m

Target year 2010: Diameter and total length of expansile pipe
D=100 to 50mm, L=8,645m

Target year 2015: Capacity and type of new reservoir 2
V=110m^3, ground type for Afema village
Diameter and total length of expansile pipe
D=125 to 50mm, L=2,320m

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 connections	1,480 sets
	Number of communal water points	8 sets
Target year 2010:	Number of additional individual connections	668 sets
	Number of additional communal water points	3 sets
Target year 2015:	Number of additional individual connections	811 sets
	Number of additional communal water points	4 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,
Target year 2010:	Number and type of additional control house Type A: 1set, Type B: 1set, Type C: 1set,
Target year 2015:	Number and type of additional control house Type A: 2sets, Type B: 1set, Type D: 1set,

6.3.2 Sanitary Facility Plan

(1) School sanitation facilities

In Senafe 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. Senafe at present is lacking all these public facilities. Provision of all the necessary public facilities at the first phase of the project may not be economically feasible. However, required improvement of public facilities is discussed bellow.

Table 6.3.1 Number of Facilities

Item		Unit	Year		
Facility	Description		2005	2010	2015
Intake Facility	New borehole	sets		2	2
	Existing borehole	sets	3		
	Observation borehole	sets			1
	Dam	sets			
	(Sub-total)	sets	3	2	3
Well Pump Facility	Submersible pump		BH-14, 0.072m3/min 71.2m, 1set	nSEN-3, 0.144m3/min 109.8m, 1set	SEN-1, 0.060m3/min 17.9m, 1set
			BH-10, 0.144m3/min 64.3m, 1set	nSEN-4, 0.144m3/min 60.5m, 1set	nSEN-3, 0.144m3/min 117.1m, 1set
			BH-9, 0.288m3/min 63.1m, 1set		nSEN-2, 0.144m3/min 125.3m, 1set
					nSEN-1, 0.144m3/min 90.9m, 1set
					nSEN-4, 0.192m3/min 79.0m, 1set
	(Sub-total)	sets	3	2	5
Transmission Pipeline	DCIP 200mm	m			
	ditto 150mm	m			
	ditto 125mm	m		2,900.0	
	ditto 100mm	m	1,164.0	3,200.0	
	ditto 80mm	m			900.0
	ditto 60mm	m	962.0	2,700.0	5,200.0
	(Sub-total)	m	2,126.0	8,800.0	6,100.0
Booster Pump Facility	Centrifugal pump			BP.1, 0.288m3/min 92.1m, 1台	BP.1, 0.480m3/min 102.6m, 1set
					BP.2, 0.204m3/min 70.0m, 1set
	(Sub-total)	sets	0	1	2
Pump Pit	Made of RC			15m3	15m3
	(Sub-total)	sets	0	1	1
Reservoir	Made of RC				110m3
	Made of FRP				
	Existing		1		
	(Sub-total)	sets	1	0	1
Distrbution Pipeline	PVC 300mm	m			
	ditto 250mm	m			
	ditto 200mm	m			
	ditto 150mm	m	318.0		
	ditto 125mm	m	254.0		120.0
	ditto 100mm	m	1,270.0	316.0	0.0
	ditto 75mm	m	774.0	644.0	1,606.0
	ditto 50mm	m	14,523.0	7,685.0	594.0
	(Sub-total)	m	17,139.0	8,645.0	2,320.0
Control House		sets	3	3	4
Communal Water Point		sets	8	3	4
Individual Connection		sets	1,480	668	811
Tempolaty Road	Width 3.0m	m	500	3,000	4,000

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 Senafe the economic or development level of the people for instance does not allow for a conventional sewerage system provision. Moreover, from the technical point of view the wastewater flow in a sewerage system shall be too low due to anticipated low consumption rate. A very low flow rate results in poor self cleansing of the sewerage system. Senafe's projected water consumption rate and wastewater generation rate is shown below.

Senafe'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	23	27	31	29	34	39	26.1	30.6	35.1
YC	33	37	69	22	24	27	15.4	16.8	18.9
CWP	44	37	0	15	15	15	9	9	9

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

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

b) Public latrine

In Senafe 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 Senafe never had refuse truck. As part of sanitation safe refuse collection and disposal is essential to improved public health. The present situation of Senafe does not provide these basic services. In this study it is anticipated that Senafe during the target year 2000-2005 need to have at least one refuse truck to go round and collect garbage and dispose at environmentally safe place

outside the town at a reasonable distant place. During target year 2005-2010 and 2010-2015 provision of refuse containers in all areas of the town is proposed.

(3) Private sanitation facilities

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

Senafe 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 is 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 is 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 Senafe

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%

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

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

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

(4) Number of facilities

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

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

Table 6.3.5 Number of Latrines

	Year 2005	Year 2010	Year 2015
School Latrine - PFL	3	1	1
Public Latrine - CFL	3	1	1
Household Latrine - CFL	935	423	540
Household Latrine - PFL	805	497	1661
Household Latrine - VIP	716	214	337

Table 6.3.6 Number of Public Facilities

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

6.4 Institutional Strengthening Plan

6.4.1 Existing Situation

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

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

6.4.2 The Ministry of Land, Water and Environment

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

The former Water Resource Department (WRD) has been reorganized within the new MoLWE. It is now called Water Department (WD) and has two divisions under it: the Water Use Management Division

(WUMD) and the Water Resource Assessment Division (WRAD) (Appendix A, Chart 6.1).

(1) Staffing Pattern of the WD

Presently, there are 13 experts assigned for the WD, and it has not been decided yet, in which one of the Units 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 are three units under this Division, namely the Hydrometeorological Information Service Unit (HMSU), the Water Quality and Pollution Unit (WQPU) and the Water Resource Information Unit (WRIU). As the name suggests, the first Unit is responsible to undertake hydrometeorological works related to both ground and surface water resources, supervises and monitors the conservation of protection of these resources, and submits collected data and information to the data base center. The investigation of the quality of water collected by the HMSU is the responsibility of the WQPU, and additionally, it measures and monitors pollution levels in collaboration with the Department of Environment and passes on water pollution information to concerned bodies. The responsibilities of the WRIU is to enter, process and analyze data and information secured from the two units, and in collaboration with the Department of Land and Environment and concerned sectors, prepares written materials and maps concerning the quality and quantity of water resources.

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

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

6.4.3 The Ministry of Local Government

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

the ministries at central level.

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

(1) Regional affairs department

The Department which is entrusted with water projects implementations is the Regional Affairs Department (RAD/MoLG). Its functions include coordinating and assisting the tasks of the economic and social development of regions. 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 economic 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.

For the implementation of the water supply and sanitation project under study, it is suggested that a PMU with similar functions be established within RAD of the MoLG. It is proposed that the PMU be headed by an expatriate technical expert, one national counter part and three national experts: two engineers in charge of supervision works and one for community organization.

6.4.4 The Ministry of Health

The MoH has three main Departments under it: the health Service Department, the Pharmacy Department and the Research and Human Resources Department. Environmental Health and Sanitation Unit is one of the Units under the Health Service Department (Appendix A, Chart 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) RAD/MoLG: A Project Management Unit (PMU) in MoLG should be established to see the implementation of the water and sanitation projects for the seven towns under study. The PMU will be under RAD/Infrastructure Service Division. There should be one expatriate staff who will head the PMU assisted by one counterpart staff and three experts under them. He and his staff will all be paid by the project. Additionally, it is suggested that training, in procurement, water facility design, design evaluation, etc. will be needed for the staff of the Engineering and Project Management Unit under the Infrastructure Service Division under RAD.

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

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

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

fitters, motor and water meter technicians, electricians, etc.

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

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

In Table 6.4.1 at the next page is presented a 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 7.

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 - Senafe WSA office building - HQ building, and stores - Seed money for Senafe sanitation credit program **2. Training** - Short term training of plumbers, fitters, recorders (water meters and generators, pumps, etc.), in Senafe 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	27,826	255,952	283,779	
Well pump	31,615	433,982	465,597	
Transmission pipeline	437,408	1,054,265	1,491,673	
Booster pump	0	0	0	
Pump pit	0	0	0	
Reservoir	42,386	197,368	239,754	
Distribution pipeline	2,242,582	1,216,321	3,458,703	
Individual connection	0	0	0	
Communal water point	144,156	54,931	199,087	
Control house	471,031	30,218	501,249	
Temporary road	148,500	0	148,500	
Sub total	**3,545,303**	**3,243,038**	**6,788,341**	
2. Engineering fee	-	678,834	678,834	
3. Administration cost	135,767	-	135,767	
4. Physical contingencies	368,107	392,187	760,294	
Total	**4,049,177**	**4,314,060**	**8,363,237**	
5. Price contingencies	773,458	824,054	1,597,512	
Ground total	**4,822,635**	**5,138,114**	**9,960,749**	

Table 6.5.2 Project Cost in 2010

(Nakfa)

Description	Local C.	Foreign C.	Total	Remarks
1. Construction cost				
Borehole	26,458	546,554	573,012	
Well pump	21,088	308,171	329,259	
Transmission pipeline	1,834,967	4,827,686	6,662,653	
Booster pump	1,992	123,997	125,989	
Pump pit	62,765	38,970	101,736	
Reservoir	0	0	0	
Distribution pipeline	1,111,394	533,562	1,644,956	
Individual connection	0	0	0	
Communal water point	54,058	20,599	74,658	
Control house	530,070	30,757	560,827	
Temporary road	891,000	0	891,000	
Sub total	**4,533,793**	**6,430,296**	**10,964,090**	
2. Engineering fee	-	1,096,409	1,096,409	
3. Administration cost	219,282	-	219,282	
4. Physical contingencies	475,308	752,671	1,227,978	
Total	**5,228,383**	**8,279,376**	**13,507,759**	
5. Price contingencies	2,633,172	4,169,744	6,802,916	
Ground total	**7,861,554**	**12,449,120**	**20,310,675**	

Table 6.5.3 Project Cost in 2015

(Nakfa)

Description	Local C.	Foreign C.	Total	Remarks
1. Construction cost				
Borehole	26,458	546,554	573,012	
Well pump	52,760	764,053	816,812	
Transmission pipeline	1,244,238	2,495,512	3,739,750	
Booster pump	4,030	252,176	256,206	
Pump pit	62,765	38,970	101,736	
Reservoir	310,073	180,990	491,062	
Distribution pipeline	320,616	228,488	549,105	
Individual connection	0	0	0	
Communal water point	72,078	27,466	99,543	
Control house	725,555	41,182	766,737	
Temporary road	1,188,000	0	1,188,000	
Sub total	**4,006,573**	**4,575,391**	**8,581,964**	
2. Engineering fee	-	858,196	858,196	
3. Administration cost	171,639	-	171,639	
4. Physical contingencies	417,821	543,359	961,180	
Total	**4,596,034**	**5,976,946**	**10,572,979**	
5. Price contingencies	4,652,089	6,049,843	10,701,932	
Ground total	**9,248,123**	**12,026,789**	**21,274,912**	

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	224,177	74,726	74,726
	Price contingencies	18,472	37,634	75,638
	Total	**251,885**	**112,360**	**150,363**
Public Latrine - CFL	Construction cost	224,177	74,726	74,726
	Price contingencies	27,708	37,634	75,637
	Total	**251,885**	**112,360**	**150,363**
Ground total		**503,770**	**224,720**	**300,726**

6.6 Sustainability of Water Supply Facilities

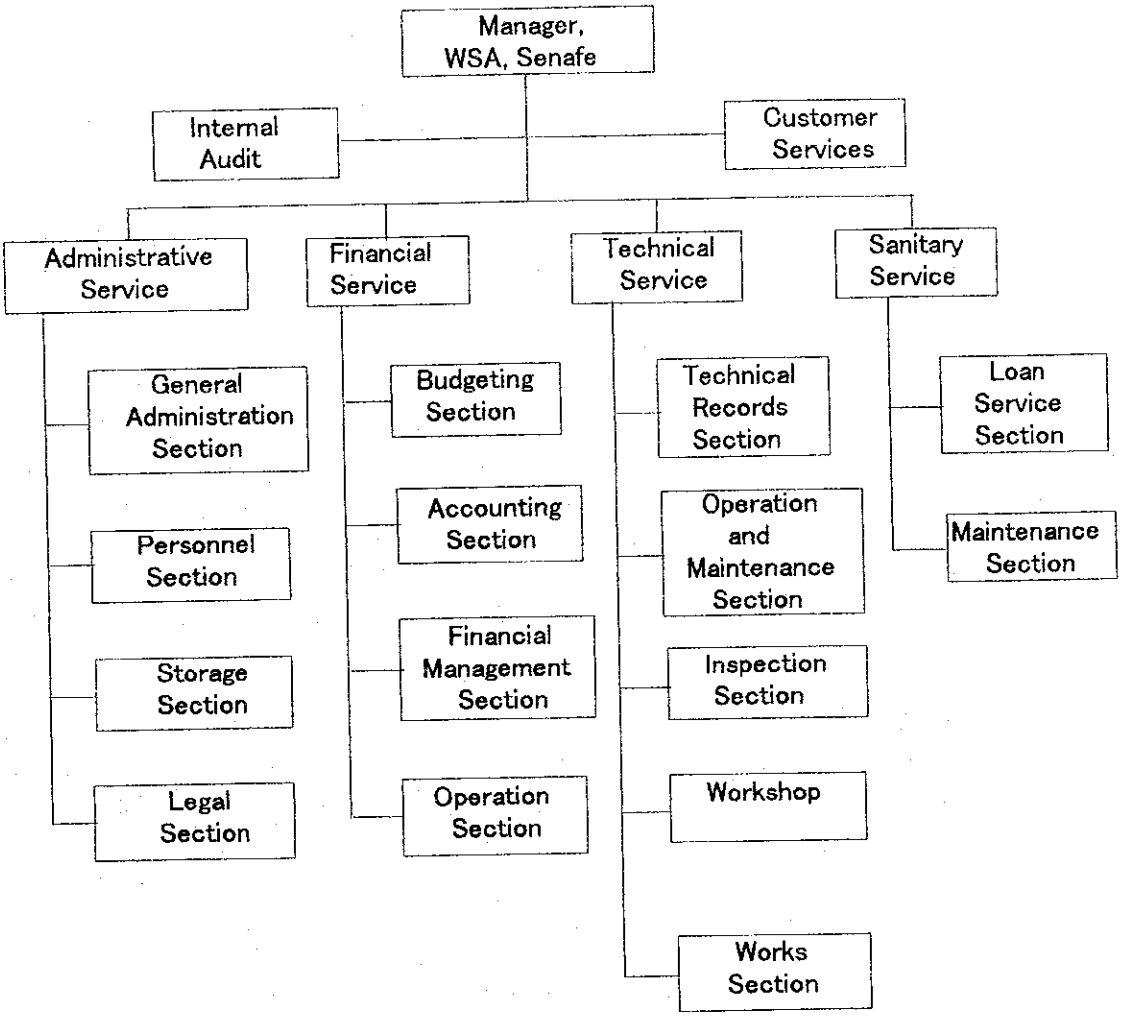
6.6.1 Capacity Building for WSA

The smooth and successful implementation of the water supply project being envisaged depends on how competent and capable the manpower of WSA Senafe 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 Senafe 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, Senafe (2015)



Organizationally, WSA Senafe 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 Senafe 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 Senafe 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 Senafe 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 Senafe. 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	32 persons	299,647	39 persons	423,361	53 persons	666,972
2. Electricity and Fuel Cost	10.40 kwh/day	76,527	29.60 kwh/day	217,809	51.85 kwh/day	381,533
3. Chemical Cost	1,820 kg	11,829	2,685 kg	17,455	4,424 kg	28,758
4. Repairing Cost	Initial Cost for Pump 465,597 Nfa Initial Cost for Others 6,322,745 Nfa	39,897	Initial Cost for Pump 920,846 Nfa Initial Cost for Others 16,831,586 Nfa	102,703	Initial Cost for Pump 1,993,864 Nfa Initial Cost for Others 24,340,532 Nfa	155,805
5. Miscellaneous Cost		42,790		76,133		123,307
Total		**470,690**		**837,460**		**1,356,375**

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 Senafe 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 Senafe, 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 Senafe, 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 Senafe.

(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 Senafe 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 Senafe 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's 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 Senafe. 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 Senafe 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 Senafe 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 Senafe town administration

Senafe 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

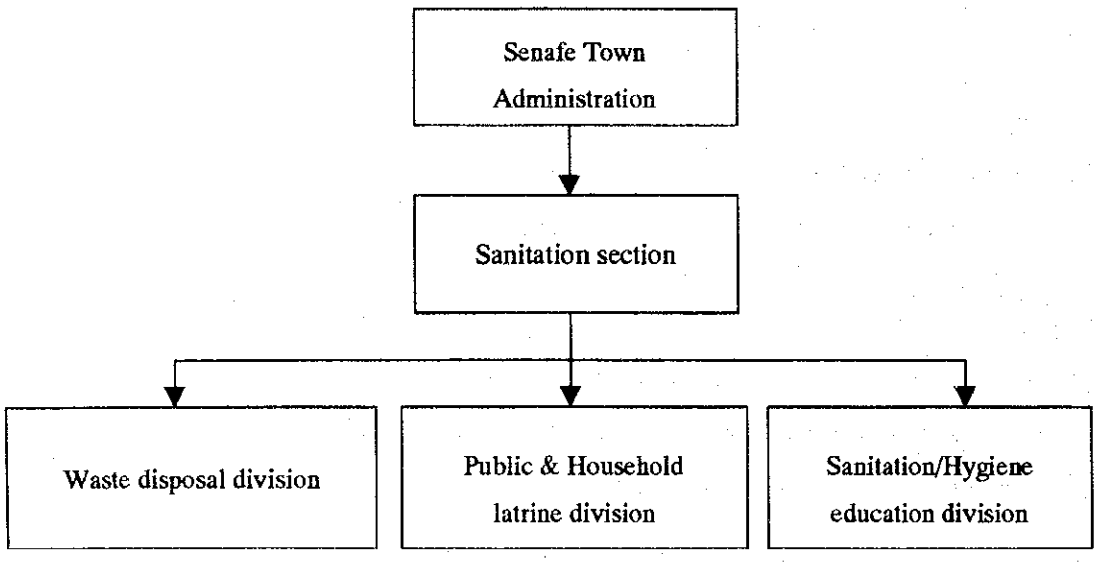
- Assess public and household latrine coverage.

- 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



6.7.2 Educational Program Development

An effective sanitation improvement program is achieved if and only if the provision of sanitation facilities and good management plans are backed by a hygiene education program. Compared to facility provision and management plan, developing and conducting an educational program is a difficult task.

The educational program developed should be able to address different groups of beneficiaries by age, sex, education, cultural and religious background. The educational program once developed does not mean the end of it. Every time the program shall be updated to fit to whom it is addressed and the type of teaching mechanism used.

Implementation of the educational programs is rather more difficult than that of developing the program. Choosing appropriate teaching mechanism to fit the addressed target group is very important. The following teaching mechanism can be used for hygiene/sanitation education programs.

Table 6.7.1 Teaching Mechanism and Media

Teaching mechanism	Teaching media
Audio	Radio
Visual	Posters
Audio visual	TV, video films
Communication	Face to face

Easy and less expensive means of conducting the hygiene/sanitation education program is to make use of existing institutions such as schools, churches, mosques, women association, youth association, radio and television stations etc.

School children can be given the education in the schools, and youth association. The hygiene/sanitation aspects need to be included in the students curriculum. In Eritrea organizations such as UNICEF are trying to incorporate the theoretical background of hygiene/sanitation program in the students curriculum. However, from similar project experience in Eritrea the most effective way of teaching children in sanitation and hygiene is to practically make them get used to clean latrine usage, develop hand washing habit after using latrine and cleaning latrine. These are simple norms a student can practice daily in the school, which in a short while expected to change his/her hygiene/sanitation perception and their changed perception is anticipated to be reflected in their family and their society. A latrine attendant or instructor shall be constantly around the toilet, observing and instructing the students to follow simple rules of using latrines. The rules may include only five points:

- To avoid blockage of latrine to make them use only water or paper not stone for anal cleansing
- To put paper used in the basket
- To pour water after using latrine
- To wash hands after using latrine
- To clean latrine by turn daily after class

Church and Mosque are places where elderly people have trust. These institutions if possibly be used to reach elderly people in hygiene/sanitation educational programs effective outcome can be envisaged.

The housewives in Eritrea in general are very tied up with routine home duties such as cleaning, cooking, washing, gardening, shopping etc. Moreover, the social obligation such as helping a relative or neighbor preparing food and drinks for a wedding ceremonies which takes many days, going to funeral which sometime takes place to far away village and visiting the family home for a consecutive days, going to associations, visiting sick person, delivered woman, relatives, going to church etc. are part of the cultural norms of women specially housewives which makes them busy. In addition for a small town like Senafe fetching water is another burden besides the busy daily life they have. For these reasons an independent hygiene/sanitation program schedule may not be effective and realistic. A more effective and easy way of addressing women might be through the existing radio educational programs which is broadcast during working hour while at the same time carrying out their home duties or through existing institution such as the Eritrean women association, community administration (Mimihidar), church or mosque. Women normally tend to listen the radio educational program, but for those who do not some encouragement by women association or community administration is vital.

In this study the hygiene/sanitation education program development is limited to the preparation of a general educational guideline manual and development of some basic illustrative posters.

The educational emphasis developed in the posters illustrate typical areas for the sanitation improvement of the town. The intended messages to be conveyed in the posters are:

- Explanation on risk of pathogens on health
- Keeping food and water safe from contamination.
- Responsibility of the society on protecting the environment and surface waters from pollution
- Devcloping habit of hand washing.
- Developing habit of latrine usage
- Demonstration of low cost, safe household latrine.
- Demonstration on household latrine handling.
- Responsibilities in public sanitation facilities usage.
- Risk of infant excreta.
- etc.

The sanitation and hygiene educational manual prepared gives a guideline how to communicate and convey the education to the community. The manual includes the following contents

- How to establish good relationship
- How to analyze the situation and identify community
- How to develop work-plan
- How to select appropriate methods
- How to develop educational method