PART 2

PRE-FEASIBILITY STUDY

SUMMARY

1. INTRODUCTION

1.1 FUNDAMENTALS

A part of work components (Phase-1) proposed in the Master Plan was selected as "priority project". The object of this feasibility study is the priority project. Fundamentals for the planning of the priority project are as follows:

1.1.1 Target Year

The target year for the feasibility study was set at 2010, which is the intermediate year to the year 2020, the target year of the Master Plan.

1.1.2 Water Demand

Table 1.1 shows the projected service population, service ratio and water demand up to the target year. Target service ratio was set by 60 %.

Table 1.1 Water Demand

Items	Year	2010
Total Population	Persons	4,955,000
Service Ratio	%	60
Served Population	Persons	2,973,000
Daily Average Use	m^3/day	733,000
Leakage (Ratio)	%	40
(Amount)	m^3/day	488,700
Daily Average Demand	m^3/day	1,221,700
Daily Maximum Demand	m^3/day	1,466,000

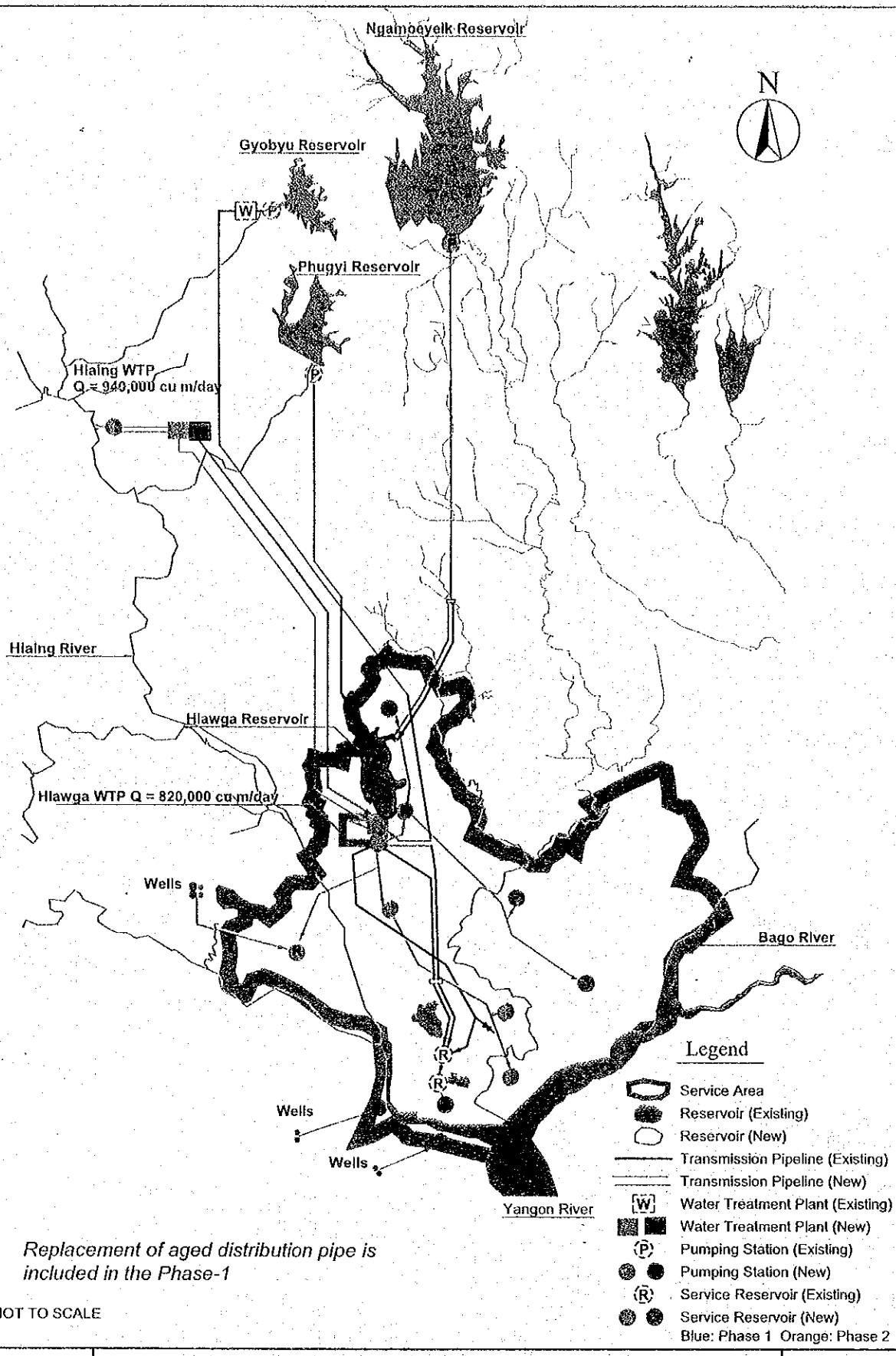
1.1.3 Planned Water Supply Amount

Table 1.2 shows the planned water supply amount generated by the existing and proposed facilities. Total water supply amount is 1,449,900 m^3/day corresponding to 99% of water demand in 2010.

Table 1.2 Planned Water Supply Amount

Items	Year	2010
Reservoirs		
Gyobyu	m^3/day	118,200
Phugyi	m^3/day	245,400
Hlawga	m^3/day	75,000
Ngamoeyeik	m^3/day	409,000
Groundwater	m^3/day	132,300
Hlaing WTP	m^3/day	470,000
Total of Available Water	m^3/day	1,449,900

Water supply facilities proposed in Phase-1 are shown in Figure 1.1.



JICA	THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR	FIG 1.1
	PROPOSED FACILITIES BY PROJECT PHASE	

2. DESIGN OF FACILITIES

2.1 INTAKE FACILITIES

2.1.1 Reservoir Water Intake Facilities

Ngamoeyeik Reservoir was included in the scope of work in Phase-1. Intake tower for water supply use was completed in 1995 and outlet main with diameter of 1,600 mm was also implemented up to the culvert access shaft. Proposed pumping station to convey reservoir water to Hlawga reservoir will be constructed next to this culvert access shaft.

2.1.2 River Water Intake Facilities

River water intake facility for Hlaing WTP was selected to be included in the scope of work in Phase-1. Based on the saline water intrusion survey composed of EC value measurement and interview to the villagers living nearby and field survey on topographic status of Hlaing River, Gwedanshe was selected as the site for intake facility.

Type of intake facility was also examined based on the criteria of 1) Construction condition, 2) Possible intake water amount, 3) Necessary O&M activities, and 4) Construction cost. Intake Gate type was selected as the optimum intake facility.

River water will be sent to grit chamber by gravity through transmission box culvert (3,000 x 3,000 mm x double) and then pumped to Water Treatment Plant about 7 km away through transmission pipeline (Dia. 2,500 mm x double).

2.1.3 Groundwater Intake Facilities

(1) Main System

There are 204 YCDC owned tube wells in the left bank area of Hlaing River. These wells were divided into two groups, namely;

- Pipeline Network Wells (104 wells): Wells connected to the existing pipelines
- Independent Wells (100 wells): Wells having there own independent pipelines

Out of 104 pipeline network wells, 75 wells were selected as "Regular Wells", and 10 independent wells were chosen as "Stand by Wells" out of 100 wells. Remaining 119 wells will be abandoned. Evaluation criteria for the settlement of tube wells are as follows;

(a) Water Quality: low Cl ion<200mg/l and low Fe concentration<1.0mg/l
(b) Structure: tube well diameter>100A (4") for pump replacement
(c) Yield: discharge>300l/min. (annual discharge>0.1MCM/Y)

The following rehabilitation work will be implemented on the regular and the stand by wells;

- Procurement of submersible pumps (20 units) for replacement of deteriorated pumps
- Replacement of Air-lift Pump by Submergible Pump (they can be replaced by adequate submergible pump installed in wells to be abandoned or can be replaced by new one.)
- Replacement of inadequate submersible pump with low pump head (Since 15 m was adopted as design head of distribution pipe network, remaining pump head must be larger than 15 m. Existing pumps shall be fully utilized)
- Installation of direct connection pipe to the distribution pipe
- Installation of well cap and concrete basement

(2) *Hlaingthaya System*

1) Outline of Hlaingthaya System

New well construction work (59 wells) will be carried out in Hlaingthaya T/S during Phase-1 period. Five or six wells will form a "well group", and each group has one intake reservoir and one stand by pump. Groundwater pumped by submergible pumps will be poured into intake reservoir and then pumped to proposed West Block North Service Reservoir. The following is the outline of the system;

Table 2.1 Outline of Hlaingthaya System

Tube Well	59 units (53 units = Regular, 6 units = Stand by) 10 well groups following
Intake Reservoir	10 units (W 10 m x L 13.5 m x D 3.5 m) Supply Pump: 30 units (20 units = Regular, 10 units = Stand by) 4.5 m^3/min x 20 m x 22 kW
Transmission Pipeline	Dia. 400 mm x 3,400 m Dia. 500 mm x 1,700m Dia. 600 mm x 850 m Dia. 700 mm x 1,700 m Dia. 800 mm x 1,700 m Dia. 1,200 mm x 3,300 m Dia. 1,500 mm x 2,950 m Dia. 1,800 mm x 7,130 m

2.2 RAW WATER RANSMISSION FACILITIES

2.2.1 Gyobyu Pumping Station

Three units of deteriorated transmission pumps in Gyobyu P/S will be replaced to secure stable raw water supply to Terminal Reservoir. Pump specification is as follows;

3,310 m^3/hr x 184 kW x 13.7 m x 3 units

2.2.2 Phugyi Pumping Station

To cope with increase in intake amount (50 to 54 MGD) and to secure stable raw water transmission to Hlawga reservoir, one additional pump shall be installed. Pump specification is as follows;

5,160 m^3/hr x 450 kW x 24 m x 1 unit

2.2.3 Ngamoeyeik Pumping Station

To convey Ngamoeyeik reservoir water to Hlawga reservoir, pumping station shall be constructed at the downstream of the existing culvert access shaft. The following is the outline of Ngamoeyeik P/S:

Pump House: RC made, 1 story

Pump Specification: 71.0 m^3/min x 1,200 kW x 78 m x 5 units (1 unit stand-by)

2.2.4 Ngamoeyeik Transmission Pipeline

One pipeline will be constructed to convey raw water of Ngamoeyeik Reservoir to Hlawga Reservoir. The following is the specifications;

Design Flow: 409,050 m^3/day (90 MGD)

Diameter: 1,800 mm and 1,100 mm

Length: 30,750 m (Dia. 1,800 mm), 13,280 m (Dia. 1,100 mm)

2.3 WATER TREATMENT PLANT

Construction of Hlaing WTP is included in Phase-1 works. Hlaing WTP will be partially constructed in Phase-1 stage and its capacity equivalents to 50% of the design capacity. Therefore, plant capacity will be; 940,000 m^3/day x 0.5 = 470,000 m^3/day

The following is the dimensions of major facilities.

Table 2.2 Major Facilities of Proposed Hlaing WTP

Facilities	Dimension
Grit Chamber	^{L} 42.0 m x ^{W} 14.0 m x ^{D} 3.0 m (LWL) x 4 channels
Intake Pump	115 m^3/min x 750 kW x 55 m x 4 units (1 Stand-by)
Receiving Well	^{L} 10.0 m x ^{W} 6.0 m x ^{D} 6.0 m x 1 unit
Flocculation Basin	^{W} 1.3 m x L 22.0 m x ^{D} 3.3 m x 2 channels
	^{W} 1.8 m x ^{L} 22.0 m x ^{D} 3.3 m x 2 channels
	^{W} 2.4 m x ^{L} 22.0 m x ^{D} 3.3 m x 2 channels
Sedimentation Basin	^{L} 80.0 m x ^{W} 22.0 m x ^{D} 3.8 m x 12 units
Rapid Sand Filter	^{L} 14.8 m x ^{W} 5.8 m x 44 units (4 units stand by)
Chlorination Channel	^{L} 36.0 m x ^{W} 6.0 m x ^{D} 3.0 m x 2 channels
Clear Water Reservoir	^{L} 84.0 m x ^{W} 42.0 m x ^{D} 3.0 m x 2 units
Backwash Wastewater Storage Tank	^{L} 36.0 m x ^{W} 12.0 m x ^{D} 3.0 m x 2 units (1 unit stand by)
Sludge Lagoon	^{L} 180.0 m x ^{W} 46.0 m x ^{D} 3.0 m x 3 units

2.4 CLEAR WATER TRANSMISSION FACILITIES

2.4.1 Hlaing WTP to Terminal Reservoir

In Phase-1, one clear water transmission pipeline will be installed from Hlaing WTP to Terminal Reservoir to convey clear water. The specifications of transmission pumps and pipeline are shown below;

Transmission Pump: 85 m^3/min x 55 m x 1,150 kW x 5 units (1 unit stand by)
Transmission Pipeline: Dia. 2,000 mm x 33.3 km

2.4.2 Terminal Reservoir System

Terminal Reservoir will receive treated water from Hlaing WTP, Gyobyu reservoir water and will intake Hlawga reservoir water together with pumped Phugyi and Ngamoeyeik reservoir water. Dimensions of proposed Intake Tower, Receiving Wells are as follows;

Intake Tower	: W5.0 m x L 15.0 m x H 18.8 m
Receiving Well (A)	: Dia. 36.0 m x D 11.0 m
Receiving Well (B)	: W 14.2 m x L 30.4 m x D 6.6 m

Terminal Reservoir will transmit clear water to the following existing and proposed service reservoirs through transmission pipeline.

Table 2.3 Outline of Terminal Reservoir Distribution Pumping Station

Pumped to	Transmission Pump	Transmission Pipeline
Kokine S. R.	80 m^3/min x 79 m x 1,150 m x 5 units (1 unit stand by)	Connection to the existing pipeline; To Gyobyu Pipeline : Dia. 1,400 mm x 4.2 km To Hlawga No.1 Pipeline : Dia. 1,650 mm x 1.0 km To Hlawga No.2 Pipeline : Dia. 1,100 mm x 1.3 km
CB Hlawga S. R.	80 m^3/min x 38 m x 640 m x 6 units (1 unit stand by)	Dia. 2,200 mm x 3.9 km
CB West S. R.	80 m^3/min x 38 m x 640 m x 8 units (1 unit stand by)	Dia. 2,700 mm x 7.5 km

Note) S. R. = Service Reservoir

Total volume of Terminal Reservoir, 80,000 m^3 is divided into eight units with 10,000 m^3 each. Six units will be implemented during Phase-1 work. Dimension of Terminal Reservoir is:

W 42.0 m x L 84.0 m x D 3.0 m x N 6 units

Upon completion of these P/S and transmission pipelines, the existing Yegu P/S will be abolished.

2.4.3 Service Reservoirs

The following clear water transmission pipelines will be installed to convey received treated water to another service reservoir located in downstream;

Table 2.4 Transmission Pipelines between Service Reservoirs

From	To	Transmission Pipeline
CB West Service Reservoir	CB DT East Service Reservoir	Dia. 1,800 mm x 12.2 km
CB DT East Service Reservoir	EB South Service Reservoir	Dia. 1,200 mm x 7.6 km

2.4.4 Other Connection Pipeline

The RC pipeline, which is now under construction, was also planned to be connected with Hlawga No.1 P/S by new connection pipeline to serve water to CB North (Zone 5), EB North (Zone 8) and EB Central (Zone 7).

Connection Pipeline: Dia. 1,200 mm x 2.0 km

2.5 SERVICE RESERVOIRS

The following Service Reservoirs will be implemented during Phase-1;

Table 2.5 List of Proposed Service Reservoirs

Name of Service Reservoir	Necessary Capacity in 2010	Transmission Pipelines	Distribution Method
CB West SR	50,000 m^3	Included in "TR"	Gravity
CB Hlawga SR	50,000 m^3	Ditto	Gravity
CB DT East SR	50,000 m^3	Dia. 1,800 mm x 12.2 km	Pump
EB South SR	25,000 m^3	Dia. 1.200 mm x 7.6 km	Pump
WB North SP	30,000 m^3	None (Phase-2)	Pump

Note) TR = Terminal Reservoir

2.6 DISTRIBUTION FACILITIES

2.6.1 Rehabilitation of Aged Pipelines

Since the first distribution pipeline construction in Yangon City was launched in 1879, most of them have already heavily deteriorated and been causing large volume of water leakage. Along with water source development, such water leakage must be eliminated as soon as possible. In this connection, aged pipelines mainly installed in downtown areas will be replaced.

The target T/S was screened by age of their existing pipelines. T/Ss having pipeline with average age of over 50 years was selected to be included in the scope of work. Aged pipelines in the following 14 T/Ss will be replaced;

Average Pipe Age	Name of T/S
Over 80 Years	Ahlone, Botataung, Kyauktada, Kyeemyindaing, Lanmadaw, Latha, Pabedan, Pazundaung, Tamwe (9 T/Ss)
50 to 80 Years	Sanchaung, Mingalartaungyunt, Dagon, Bahan Yankin (5 T/Ss)

2.6.2 Primary Mains

Distribution pipelines were classified into two categories by pipe diameter as follows;

Primary Mains: Dia. 300 mm to 1,500 mm
Secondary Mains: Dia. 75 mm to 250 mm

Based on the pipeline network analysis, necessary diameter and length of proposed new primary mains were determined.

Table 2.6 Pipeline List of Proposed Primary Mains

Dia. (mm)	300	250	400	500	600	700	800	900
Length (m)	6,310	1,090	10,810	17,920	10,540	8,800	11,450	3,760
Dia. (mm)	1,000	1,100	1,200	1,350	1,400	1,500		Total
Length (m)	6,750	1,260	2,410	5,260	1,230	80		87,670

2.6.2 Secondary Distribution Mains

As same as primary mains, necessary diameter and length of proposed new secondary mains were determined.

Table 2.7 Pipeline List of Proposed Secondary Distribution Mains

Dia. (mm)	75	100	150	200	250	Total
Length (m)	20,500	40,900	198,300	14,600	17,400	291,700

3. UNACCOUNTED FOR WATER (UFW)

3.1 CONTEXT

This is a brief summary of the Plan for UFW reduction & control prepared as part of the study for the water supply system in Yangon. Given the lack of any previous experience of this type of activity, short explanations are given to answer the four questions:

- What is meant by UFW?
- What is the situation for UFW in Yangon Now?
- What is the overall strategy to implement until 2020?
- What are the first actions to put into effect towards this strategy?

3.1 UFW

The definition of unaccounted for water is:

UFW = Production - Consumption (that is measured &/ or known)

So UFW is all water that is produced but not included in consumption. This includes such things as:

- The water that leaks from pipes
- Trunk & Distribution Mains
- Customer Service Pipes
- Water used but not known or reported
- Public use for gardens, municipal operations etc
- Free supplies that are not recorded
- Water Supply Operations & Maintenance
- Illegal connections
- Unregistered Connections
- Mistakes & errors caused by
- Missing customers
- Metering inaccuracy
- Incorrect estimates

So UFW is easy to define but difficult to quantify and to calculate properly requires a lot of data.

Water that is supplied but it is not known where it ends up is costing money because it cost money to produce and transport (pumping costs) and lost money because no-one paid for it.

3.2 PRESENT SITUATION IN YANGON

The key point to make for the present situation in Yangon is that no good estimate of UFW can be made with any confidence because there is little or no information on which to base any assessment.

There is none of the normally required data, because:

- There is no flow measurement at any level in the network
- Customer metering is less than 25%
- Operational information is not regularly collected and analysed
- Few records are kept

However, reasonable estimates of the severity of the situation can be made based on observation and experience and an attempt made to quantify the level of UFW approximately. UfW is considered to be high in Yangon and is in the order of 65 – 70 %.

It is not surprising that the level is high, given that the network suffers from:

- Old pipes & poor installation practice
- Lack of operational maintenance & investment
- Large numbers of leaks visible on mains and services
- No UfW control action is in place
- Leaks increase with time if no action is taken, so it will get worse if left unattended.

Also, the level of UfW makes the situation worse in the present situation with:

- Low network pressure
- Poor service
- Low coverage

3.3 STRATEGY UP TO 2020

First and most importantly, it is necessary to recognise the problem and then decide to do something about it seriously. This is the starting point for the strategy that will need to be implemented in order to achieve the ambitious targets required to meet the needs of the overall Master Plan to match Supply & Demand by 2020.

The target for UFW levels is to progressively reduce these losses as:

Present level	> 65 %	to	2020	30 % total	
Of which	Leaks	25 %,	Other losses		5 %

The principles of the directions to be followed to achieve this target are:

- Find & Repair the leakage to reduce these losses
- Meter all customers
- Pay special attention to large use customers
- Get maps, network data, customer information & records all in good order and kept up-to-date
- Investigate & rectify problems identified
- Divide the network up into metered areas to provide information and enable Leak detection work to be prioritised to areas with high leakage

As well as:

- Major programme of rehabilitation and new works to reduce and avoid recurrence of leaks by:
- Specification of good Materials
- Specification of good installation standards
- Best practice design and network layout

- Policy reviews and action to create the right conditions including:
- Tariff structure to encourage saving and waste reduction
- Byelaws, regulations & standards for customer connections
- Rapid achievement of Universal customer metering

3.4 ACTION PLAN FOR EARLY STAGE

The first stages in putting this long term strategy in place are as follows:

3.4.1 Operational

- Implement UFW control measures for
- Leakage (physical losses)
- 'lost' water use (Non-physical losses)
- SO Create a special UFW team for this work
- Improve the mapping system & network data
- Actively search for leaks
- Improve pipe repairs
- Divide the network into zones & districts

3.4.2 Metering & Billing

- Prepare & Implement a plan to achieve universal customer metering
- Review & modify tariff policy

3.4.3 New Works

- Pipe replacement & reinforcement in critical areas
- Divide the network into zones & districts

3.4.4 Working Areas

The following areas will be where leak detection activities will be implemented. The order & extent of work of each township will be decided by the results of initial investigation when the project starts.

Table 3.1 Areas for Leak Detection Activities

Existing Service Area Townships with No rehabilitation work planned	Supply & Pressure	Second Level of Priority for rehabilitation work	Supply & Pressure
Mayangone	X	Bahan	X
Insein	X	Dagon	X
Kamayut		Yankin	X
South Okkalapa	X		
Thingangyun			
Mingaladon	X		
North Okkalapa	X		

X denotes relatively good level of supply & pressure according to the initial pressure survey carried out by the study team in 2001. Further pressure survey work is required for detail.

4. INSTITUTIONAL & ORGANIZATIONAL DEVELOPMENT PLAN

The institutional and organizational development plan of the Feasibility Study (FS) envisages strengthening of the Water Supply and Sanitation (Engineering) department through organizational development, capacity enhancement and, skills development. The organizational development is aimed at improvement of the output of the department through the creation of appropriate structures within. The capacity of the staff is to be developed through a comprehensive plan for human resources development, strengthening and institutionalising effective work arrangements involving work planning, co-ordination and continuous monitoring of every task as well as timely provision of materials, parts and supplies of quality standards. On the other hand, staff performance is to be developed through design, implementation and continuous monitoring of work-oriented training.

The feasibility study (FS) recommends that the three components namely, organizational development, capacity enhancement and skills development are all to be treated as an integrated package.

The FS study is based on the proposals in the Master Plan formulated in 2001.

Organizational development The FS recommends four organizational changes. Firstly, it recommends the overall structure of the department is retained with appropriate arrangements to enable this institution to function in a proactive manner. The main arrangements recommended in this connection are the department to (a) ensure a desirable degree of financial authority over its revenue (b) be able to undertake co-ordination of the water sector activities including those of other ministries and agencies (c) improve its capacity to procure needed supplies at its own discretion (d) develop its capacity to develop human resources through its own actions.

Secondly, it is recommended that a division for planning, co-ordination & monitoring is created to function under the chief engineer. This division will provide leadership in sectoral planning, co-ordination both within and without the department, plan and implement a continuous monitoring programme, initiating, implementing and evaluation of training, and water quality assessment. This division will incorporate the current water quality assessment section and create three separate sections for planning and co-ordination, monitoring and, training.

Thirdly, the FS recommends re-organization of two divisions (water distribution and reservoir) and store section. The reservoir division be named as "Water Resources division" with three sections namely, water resources planning, management of reservoirs, and management of river and groundwater. The water distribution division will be re-named "Water Supply" which will carryout its designated role through 4 technical sections of customer and client service, operation and

maintenance, districts, planning and design, and unaccounted for water control unit. The administration section will support other sections. The store section will be re-named "Procurement and Stores" section and functions expanded. It will now operate under a deputy chief engineer (DCE).

Accordingly, several new roles and functions will be developed so are job descriptions that would be one of the important activities to be launched as a matter of priority.

One DCE will be in-charge of Water Resources, Water Supply and Electrical and Mechanical divisions while the other DCE will supervise Administration and Finance, Sewage, Pipeplant divisions and the Procurement and Stores section.

Finally, several organizational arrangements such as co-ordination meetings, reporting procedures, regular workshops, reports (prepared using reliable and accurate data collected through continuous monitoring programmes), etc. are proposed. One of the main recommendations is the creation of an inter-ministerial co-ordination committee for water resources chaired by a senior staff member of the Ministry of Construction.

The capacity improvement of each of the six operational areas namely, facilities O&M and repair, supply of materials, parts, tools and instruments, water quality assessment, headworks construction, installation of service lines and meters, and billing and revenue collection are proposed to be undertaken through (a) upgrading and refurbishment of workshops, (b) re-organization of stores, (c) instituting a job-oriented and practical training programmes, (d) effective planning, co-ordination and reporting arrangements, (e) the utilization of accurate, reliable and up-to-date data generated on a continuous basis, (f) formulation of water supply management byelaws and regulations, and (g) utilization of technical assistance (TA) as proposed in the FS. The improvement of human resources will be a bonus for capacity improvement.

As a positive step in strengthening O&M of newly established facilities, the FS recommends that appropriate clauses in contractor documents are inserted so that the contractor has an obligation to explain and train the relevant staff before the facilities are turned over to the department for O&M.

The FS strongly recommends that TA is provided to the department in 7 areas namely, planning, monitoring, training, human resources development, O&M, customer and client relations and, evaluation.

Considering the important role of communal water supply facilities such as communal tanks and ponds within the larger City landscape and the low-income families which depend on this source,

the FS proposes that a detailed study be planned to determine investments including appropriate management strategies needed in these areas.

The FS recommends that the main water supply activity areas of the department are further supported by instituting new arrangements such as plumbing quality control, production of information, education and communication materials aimed at both customers and clients, more productive and effective customer education focussed in particular on water waste reduction and O&M of service lines, and the utilization of local community and non-governmental organization resources through partnership arrangements.

Strengthening the human resources of the department is a main focus of the FS. It recommends a package of human resources management strategies such as increasing the number and quality of staff, increased understanding of jobs, productive professional development and instituting training throughout the department. Development of staff training facility within the department itself is one of the crucial proposals of the FS. A recommendation is made to conduct a training needs assessment and thereby to prepare a training MP to cover the period 2003 to 2020.

The FS proposes an investment in the order of dollars 6 million for the implementation of the institutional and organizational development plan. It is finally recommended that the dividends resulting from institutional and organizational development will be significantly high enough to make a commitment for the proposed investments.

5. IMPLEMENTATION PLAN AND COST ESTIMATE

5.1 IMPLEMENTATION PLAN

5.1.1 Implementation Plan

The project is planned to implement in two stages aiming the target year of 2010. Stage 1 works will be conducted from 2004 to 2006, while stage 2 works will be carried out from 2007 up to 2010. In 2003, the detailed design, Pre-qualification and tendering is anticipated. Implementation plan was formulated based on the following major work items;

Table 5.1 Major Work Items

No.	Work Items	Work Contents
1	Rehabilitation	Replacement of the existing aged pipeline
		1.1 Pipelines with average age over 80 years
		1.2 Pipelines with average age from 50 to 80 years
2	Development of Reservoir System	2.1 Ngamoeyeik Reservoir System (Installation of transmission pipeline and pumping station)
		2.2 Strengthening of Existing Reservoir System (Replacement of Gyobyu pumps, 1 additional pump to Phugyi P/S)
3	Hlaing River System	3.1 Intake Facility
		3.2 Hlaing River System (Raw water mains, P/S, WTP, transmission main)
4	Terminal Reservoir	4.1 Connection pipelines
		4.2 Terminal Reservoir
		4.3 Transmission P/S
5	Transmission and Distribution System	Transmission Pipeline, Service Reservoir and Distribution Network
		5.1 CB Downtown (Zone 1)
		5.2 CB Downtown East (Zone 2)
		5.3 CB West (Zone 3)
		5.4 CB Hlawga (Zone 4)
		5.5 CB North (Zone 5)
		5.6 EB South (Zone 6)
		5.7 EB Central (Zone 7)
		5.8 EB North (Zone 8)
		5.11 WB North (Zone 11) (including groundwater development)
6	Connections	Other connection pipeline installation works
7	Groundwater Management in Main System	Groundwater management in the left bank of Hlaing River

5.1.2 Implementation Schedule

Implementation schedule was prepared based on the aforementioned major work items and shown in Table 5.2.

Table 5.2 Project Implementation Schedule

No.	Facility	Dimension	Phase 1 Stage 1 2003	2004	2005	2006	Phase 1 Stage 2 2007	2008	2009	2010
1	**Rehabilitation**	Dia. 75 to 450 mm, L = 368,900 m								
1.1	Replacement of aged distribution pipe < 60 years old									
1.1.1	Botataung, Kyauktada, Lanmadaw, Latha, Pabedan, Pazundaung									
1.1.2	Tamwe									
1.1.3	Ahlone, Kyeemyindaing									
1.2	Replacement of aged distribution pipe < 60 and > 50 years old									
1.2.1	Sanchaung									
1.2.2	Mingalartaungnyunt									
1.2.3	Dagon, Bahan, Yankin									
2	**Development of Reservoir System**									
2.1	Ngamoeyeik reservoir System									
2.1.1	Transmission line	Dia.1800 x 30.75 km								
2.1.2	Pumping station	409,000 m3/d								
2.1.3	Duplication of dia.1100 mm line	Dia.1100 x 13.28 km								
2.2	Strengthen of existing reservoir system									
2.2.1	Gyobyu pump rehabilitation (3 pumps)	9,930 m3/hr								
2.2.2	Phugyi additional 1 pump	5,160 m3/hr								
3	**Hlaing River System**									
3.1	Intake facility									
3.1.1	Intake facilities									
3.2	Hlaing river system (1/2)									
3.2.1	Raw water main	Dia.2500 x 7 km								
3.2.2	Pumping station	491,000 m3/d								
3.2.3	Water treatment plant	470,000 m3/d								
3.2.4	Transmission pumping station	470,000 m3/d								
3.2.5	Transmission main	Dia.2000 x 33.3 km								
4	**Terminal System**									
4.1	Connections									
4.1.1	Intake facilities and raw water main									
4.1.2	Gyobyu connection pipe	Dia.1400 x 4.2 km								
4.1.3	Connection to existing transmissions	Dia.1650 x1.0 km, Dia. 1100 x 1.3 km								
4.2	**Terminal reservoir (TR)**									
4.2.1	TR (2/4)	40,000 m3								
4.2.2	TR (1/4)	20,000 m3								
4.2.3	TR (1/4)	20,000 m3								
4.3	**Transmission pumping station**									
4.3.1	PS for Downtown	400 m3/min								
4.3.2	PS for Central West, DT East, East South	480 m3/min								
4.3.3	PS for Central North, Hlawga and East North and Central	640 m3/min								
5	**Transmission and Distribution System**									
5.1	Downtown (Zone 1)									
5.1.1	Strengthening of transmission line	Dia. 1400 x 1.35 km								
5.1.2	Rehabilitation of central reservoir	45,450 m3 (10 MG)								
5.1.3	Distribution network									
5.2	Downtown East (Zone 2)									
5.2.1	Transmission line (from Central West SR)	Dia. 1800 x 12.2 km								
5.2.2	Service reservoir	50,000 m3					(1/2)			
5.2.3	Distribution pumping station	474 m3/min								
5.2.4	Distribution network									
5.3	Central West (Zone 3)									
5.3.1	Transmission line (From TR)	Dia. 2700 x 7.5 km								
5.3.2	Service reservoir	50,000 m3				(1/2)				
5.3.3	Distribution network									
5.4	Hlawga zone (Zone 4)									
5.4.1	Transmission line (From TR)	Dia. 2200 x 3.9 km								
5.4.2	Service reservoir	50,000 m3						(1/2)		
5.4.3	Distribution network									
5.5	Central North (Zone 5)									
5.5.1	Transmission line (From TR)									
5.5.2	Service reservoir									
5.5.3	Distribution network									
5.6	East South (Zone 6)									
5.6.1	Transmission line (From DT East)	Dia. 1200 x 7.6 km								
5.6.2	Service reservoir	25,000 m3						(1/2)		
5.6.3	Distribution pumping station	210 m3/min								
5.6.4	Distribution network									
5.7	East Central (Zone 7)									
5.7.1	Transmission line (From East North)									
5.7.2	Service reservoir									
5.7.3	Distribution pumping station									
5.7.4	Distribution network									
5.8	East North (Zone 8)									
5.8.1	Transmission line (From TR)									
5.8.2	Service reservoir									
5.8.3	Distribution pumping station									
5.8.4	Distribution network									
5.11	West North (Zone 11) - Hlaingtheya									
5.11.1	Groundwater development									
5.11.2	Transmission line for groundwater									
5.11.3	Transmission line from central system									
5.11.4	Service reservoir	30,000 m3								
5.11.5	Distribution pumping station	186 m3/min								
5.11.6	Distribution network									
6	**Connections**									
6.1	Connection to Hlawga No1 PS to 36 inch pipe now under construction for Dagon Myothit area	Dia. 1200 x 2.0 km								
7	Groundwater management in Central Block									
	Annual Construction Cost (million US$)	**Total 781 million $**		34	36	134	92	177	136	172

5.2 COST ESTIMATE

5.2.1 Cost Estimate Condition

(1) Price Level

The price level is March 2002 at the starting time of Pre Feasibility Study.

(2) Foreign Exchange Rates

The exchange rates were set as follows;

US$ 1.0 = Yen 130 = Kyat 500

(3) Procurement of Construction Materials and Equipment

Most of mechanical and electrical equipment is assumed to procure from abroad. Likewise, ductile cast iron pipe and steel pipe will be imported. In case of PVC pipe and RC pipe, domestic products are available.

As to construction materials, domestic sand, brick and gravel is available but cement and re-bar is imported from Thailand.

After the completion of this project, chemicals needed for the O&M of facilities will be procured both from domestic and abroad market. The following chemicals are needed;

Solid Alum	: Imported from India or Thailand
Liquid Chlorine	: Imported from Thailand
Liquid Sodium Hypochlorite	: Domestic or imported from Thailand

(4) Foreign and Local Currency Portions

The project cost estimate was divided into the Foreign Currency portion (F/C) and Local Currency portion (L/C) assuming foreign fund to the F/C portion.

F/C and L/C ratio assumed as follows according to the work categories;

Work Categories	L/C	F/C
Civil Works	20 %	80 %
Pipe Laying Works	5 %	95 %
Electric and Mechanical Works	5 %	95 %

5.2.2 Project Cost

The project cost of Phase-1 work is summarized in Table 5.3.

Table 5.3 Summary of Project Cost

(Unit : US$)

	L/C	F/C	Total
Phase-1	108,096,000	673,120,000	781,215,000

5.2.3 Operation and Maintenance Cost

Operation and maintenance cost for the completed water supply facilities is comprised of the following cost categories;

Salaries
Electricity
Chemicals
Repair Cost

(1) Salaries

Total salaries of the O&M personnel were calculated based on the annual personnel allotment and their basic monthly salaries. The followings are the basic salaries by job types;

Engineer, Other Professionals, Technicians : 8,000 Ks/month
Supporting Staff : 5,500 Ks/month

(2) Electricity

Electric consumption was calculated according to the pump motor output and operation hours. Since the construction of new facilities was planned as shown in implementation schedule, total motor output was varied year by year. The following electric tariff was adopted;

0.50 Ks/kWH (for Department)

(3) Chemicals

Chemical consumption was estimated based on the treated water amount and chemical dosage rate. The following dosage rate was adopted;

Alum (Water Treatment Plant) : 50 mg/L
Chlorine (Water Treatment Plant) : 1.5 mg/L
Sodium Hypochlorite (Service Reservoir) : 1.0 mg/L

(4) Repair Cost

Repair cost was accounted based on the purchase cost of equipment. 5 % of equipment cost was summed up every 4 years.

6. ECONOMIC AND FINANCIAL EVALUATION OF PHASE-1 WORKS

6.1 ECONOMIC EVALUATION

Following table shows a summary of water volume to be supplied and economic benefit of potable water supply (the economic benefit derived from saving the cost for alternative water resources, namely the cost of private tube well) due to completion of the works in each stage of Phase-1 Works of the Project.

Table 6.1 Water Volume to be Supplied and Economic Benefits of Water Sources

Phase	Stage	Year	Water volume to be supplied due to the completion of the works (m^3/day)	Incremental water volume to be supplied due to the completion of the works (m^3/day)	Leaked volume to be improved (m^3/day)	Total	Incremental annual water volume to be supplied (m^3/annum)	Annual economic benefit	
								(Million Kyats)	(Equivalent to US$1,000)
		2003	219,700					0	0
Phase-1	Stage-1	2004	232,900	13,200	150,145	163,345	59,620,938	4,352	8,705
		2005	277,900	58,200	160,063	218,263	79,666,047	5,816	11,631
		2006	512,000	292,300	169,976	462,276	168,730,851	12,317	24,635
	Stage-2	2007	521,100	301,400	179,885	481,285	175,668,851	12,824	25,648
		2008	530,200	310,500	189,788	500,288	182,605,050	13,330	26,660
		2009	539,400	319,700	199,686	519,386	189,575,950	13,839	27,678
		2010	823,000	603,300	209,580	812,880	296,701,051	21,659	43,318

(Note 1) Unit value of benefit: 73 (*Kyats/m^3*)
(Note 2) Exchange rate: 500 Kyats = US$1.00

In addition to the above indicated benefit in case of Phase-1 Works, following benefits are taken into account due to the improvement of water environment, namely, (a) saving of medical expenditure due to decrease of water borne diseases of people living in Yangon City, and (b) saving of income loss of working members of households also due to decrease of water borne diseases:

Table 6.2 Saving of Medical Expenditure

(Figures are incremental ones and after completion of works of each phase)

Stage	Water volume to be supplied due to the completion of the works (m3/day)	Annual volume to be supplied (m3/annum)	Service population (persons)	Number of patients*		Medical expenditure by water borne diseases (Million Kyats)	Annual saving amount of medical expenditure	
				Overall diseases	Water borne diseases		(Million Kyats)	(Eqyuvalent to US$1,000)
Stage-1	512,000	186,880,000	2,560,000	332,544	24,076	27	4	8
Stage-2	311,000	113,515,000	1,555,000	201,995	14,624	16	2	5

(Note 1) Average volume of water consumption 140 (l/day)
(Note 1) Share rate of water consumption of domestic suctome 70% (of the total water volume to be supplied)
(Note 2) Suffering rate of overall diseases 12.99% (to the total population)
(Note 3) Suffering rate of water borne diseases: 7.24% (to the overall diseases)
(Note 4) Unit value of medical expenditure: 1,104 (Kyats/patient per year)
(Note 5) Contribution rate of the Project to water borne disease 15.00% (to the total water borne diseases)
(Remarks) * Number of patients consist of outpatients and inpatients.

Table 6.3 Saving of Income Losses

(Figures are incremental ones and after completion of works of each phase)

Stage	Water volume to be supplied due to the completion of the works (m3/day)	Annual volume to be supplied (m3/annum)	Service population (persons)	Working population (persons)	Number of inpatients*		Number of outpatients*		Income loss in total (Million Kyats/annum)			Annual saving amount of income loss	
					Overall diseases	Water borne diseases	Overall diseases	Water borne diseases	In-patients	Out-patients	Total	(Million Kyats)	(Equivalent to US$1,000)
Stage-1	512,000	186,880,000	2,560,000	831,197	53,502	3,874	54,470	3,944	32	10	41	6	12
Stage-2	311,000	113,515,000	1,555,000	504,887	32,498	2,353	33,086	2,395	19	6	25	4	7

(Note 1) Average volume of water consumption: 140 (l/day)
(Note 2) Suffering rate of overall diseases: 12.99% (to the total population)
(Note 3) Average number of inpatients per year: 237,573 (persons/annum)
(Note 4) Average number of outpatients per year: 241,871 (persons/annum)
(Note 5) Suffering rate of water borne diseases: 7.24% (to the overall diseases)
(Note 6) Unit value of income: 1,017 (Kyats/day per capita)
(Note 7) Contribution rate of the Project to water b: 15.00% (to the total water borne diseases)
(Note 8) Number of days to be needed to visit hospitals for outpatients: 2.38 (days/annum)
(Note 9) Average duration to stay in hospitals for inpations: 8.01 (days/annum)
(Remarks) * Number of patients consist of outpatients and inpatients.

The estimated annual economic costs for construction together with its financial costs in case of Phase-1 are summarized as below:

Table 6.4 Annual Economic Cost for Construction and its Financial Cost

(US$1,000)

Phase	Stage	Year	Overall Project	
			Financial	Economic
Phase-1	Stage-1	2003	0	0
		2004	33,585	29,293
		2005	35,264	30,594
		2006	129,892	111,774
	Stage-2	2007	97,844	84,967
		2008	187,693	157,302
		2009	144,989	121,934
		2010	183,101	154,949
Phase-1 total			812,366	690,813

Economic cost for operation/maintenance (OM cost) is summarized as shown in the following table during the construction period, and this cost will be a burden to the Project (namely, YCDC) until the end of the project life of 50 years after completion of the works.

Furthermore, it is assumed that replacement works will be made every 20 years interval after completion of each facility.

Table 6.5 Economic Cost for Operation and Maintenance

(US$1,000)

OM work items	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Personal cost	5	5	5	5	6	6	6	6	6	6	6	6	6	6	6	6	6
Electricity cost	10	10	199	337	415	415	487	487	487	487	487	487	487	487	487	487	487
Chemical cost	192	192	600	600	928	928	8,666	8,666	8,666	8,666	8,666	8,666	8,666	8,666	8,666	8,666	8,666
Inspection/repairing cost					791		0		1,076				1,076				1,076
Financial total	207	207	804	943	2,140	1,349	9,159	9,159	10,234	9,159	9,159	9,159	10,234	9,159	9,159	9,159	10,234
Economic cost	104	104	403	472	1,072	676	4,587	4,587	5,125	4,587	4,587	4,587	5,125	4,587	4,587	4,587	5,125

(US$1,000)

OM work items	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Personal cost	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Electricity cost	487	487	487	487	487	487	487	487	487	487	487	487	487	487	487	487	487
Chemical cost	8,666	8,666	8,666	8,666	8,666	8,666	8,666	8,666	8,666	8,666	8,666	8,666	8,666	8,666	8,666	8,666	8,666
Inspection/repairing cost				1,076				1,076				1,076				1,076	
Financial total	9,159	9,159	9,159	10,234	9,159	9,159	9,159	10,234	9,159	9,159	9,159	10,234	9,159	9,159	9,159	10,234	9,159
Economic cost	4,587	4,587	4,587	5,125	4,587	4,587	4,587	5,125	4,587	4,587	4,587	5,125	4,587	4,587	4,587	5,125	4,587

The economic evaluation is made using cash flows based on the above benefit and cost.

Generally, EIRR of the project under study should be higher than the applied discount rate as an opportunity cost of capital. The resulted EIRR is slightly higher than the said discount rate in overall works of Phase-1 as 5.03 %. And, it indicates that the EIRR of Stage-1 is quite high as 16.62 %. It may be reflected in the subject of the works of Stage-1. The subject of the Stage-1 mainly includes the rehabilitation works for existing facilities, so it can be expected high effect with low cost.

As suggested by such international institutions as the World Bank, an EIRR is expected to at least be cleared a hurdle of 5.0 % of EIRR from a viewpoint of basic human needs even such a project in developing countries. From this viewpoint, the resulted EIRR is cleared the said hurdle is in the case of entire works of Phase-1 with 5.03 % of EIRR. Namely, the Project is economically sound from the viewpoint of basic human needs in case of executing entire works of Phase-1.

6.2 FINANCIAL EVALUATION

Based on the recommended unit price of water to be supplied as shown in the following table and using the above mentioned financial cost of Phase-1 of the Project, the financial evaluation is made.

Table 6.6 Recommended Unit Price of Water

Water Price to Be Applied (US¢/m³)

Sector	2005	2010	2015	2020	Share rate
Domestic sector	8.47	12.65	15.62	17.92	70%
Public sector	5.65	8.43	10.41	11.95	10%
Industrial/commercial sector	38.11	56.93	70.29	80.65	20%

Resulted FIRR is lower than the applied discount rate (10 %) in overall works of Phase-1. But, it indicates that the FIRR of Stage-1 is quite high as 17.62 %. It may be reflected in the subject of the works of Stage-1. The subject of the Stage-1 mainly includes the rehabilitation works for existing facilities as already mentioned above, so it can be expected to keep healthy financial operation in YCDC for Stage-1 Works.

From the viewpoint of suggestion of such international institutions as the World Bank as mentioned above, an FIRR is also expected to at least be cleared a hurdle of 5.0 % of FIRR from a viewpoint of basic human needs even such a project is in developing countries. From this viewpoint, the resulted FIRR for overall works of Phase-1 is cleared the said hurdle with enough rooms as 8.27 %. Namely, it may be totally said that the Project is sound from the viewpoint of basic human needs in case of executing entire works of Phase-1.

6.3 AFFORDABILITY OF PEOPLE TO PAY FOR WATER

Following table and figure show relationships between income and expenditure for water of the households applying the above mentioned water price as a water tariff revision schedule in case of households belonging to the minimum income level according to the Consumer Survey:

Table 6.7 Relationship Between Income and Expenditure for Water

		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
A. Household income*1											
(1) Minimum level	Kyats/HH/month	13,844	15,228	16,751	18,426	20,269	22,295	24,525	26,978	29,675	32,643
(2) Maximum level	Kyats/HH/month	85,464	94,010	103,411	113,752	125,127	137,640	151,404	166,544	183,199	201,519
(3) Average	Kyats/HH/month	39,260	43,186	47,505	52,255	57,481	63,229	69,552	76,507	84,158	92,574
B. Water consumption	m^3/HH/month	29	29	29	29	29	29	29	29	29	29
	gallons/HH/month	6,467	6,467	6,467	6,467	6,467	6,467	6,467	6,467	6,467	6,467
C. Water tariff	US¢/m^3	1.32	1.32	1.32	1.32	8.47	8.47	8.47	8.47	8.47	12.65
	Kyats/m^3	6.60	6.60	6.60	6.60	42.35	42.35	42.35	42.35	42.35	63.26
	Kyats/10^3 gallon	30	30	30	30	193	193	193	193	193	288
Revised rate						541.71%					49.38%
D. Expenditure for wat	US¢/HH.month	38.80	38.80	38.80	38.80	249.01	249.01	249.01	249.01	249.01	371.97
(4)	Kyats/HH.month	194	194	194	194	1,245	1,245	1,245	1,245	1,245	1,860
Expenditure share rate: (4)/(1)		1.40%	1.27%	1.16%	1.05%	6.14%	5.58%	5.08%	4.62%	4.20%	5.70%
		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
A. Household income*1											
(1) Minimum level	Kyats/HH/month	35,907	39,498	43,448	47,792	52,572	57,829	63,612	69,973	76,970	84,667
(2) Maximum level	Kyats/HH/month	221,671	243,838	268,222	295,044	324,548	357,003	392,703	431,973	475,171	522,688
(3) Average	Kyats/HH/month	101,831	112,014	123,216	135,537	149,091	164,000	180,400	198,440	218,284	240,113
B. Water consumption	m^3/HH/month	29	29	29	29	29	29	29	29	29	29
	gallons/HH/month	6,467	6,467	6,467	6,467	6,467	6,467	6,467	6,467	6,467	6,467
C. Water tariff	US¢/m^3	12.65	12.65	12.65	12.65	15.62	15.62	15.62	15.62	15.62	17.92
	Kyats/m^3	63.26	63.26	63.26	63.26	78.10	78.10	78.10	78.10	78.10	89.61
	Kyats/10^3 gallon	288	288	288	288	355	355	355	355	355	407
Revised rate						23.45%					14.74%
D. Expenditure for wat	US¢/HH.month	371.97	371.97	371.97	371.97	459.21	459.21	459.21	459.21	459.21	526.88
(4)	Kyats/HH.month	1,860	1,860	1,860	1,860	2,296	2,296	2,296	2,296	2,296	2,634
Expenditure share rate: (4)/(1)		5.18%	4.71%	4.28%	3.89%	4.37%	3.97%	3.61%	3.28%	2.98%	3.11%

*1 Increasing ratios of income level is assumed at 10 % based on CPI taking moderate case into account comparing with per capita GDP increasing ratio. The base income level is based on the Consumer Survey as shown in Appendix M.1.

*2 Per capita water consumption: 140 l/day.capita
Average family size: 7 /HH
Conversion rate: 4.546 l/gallon

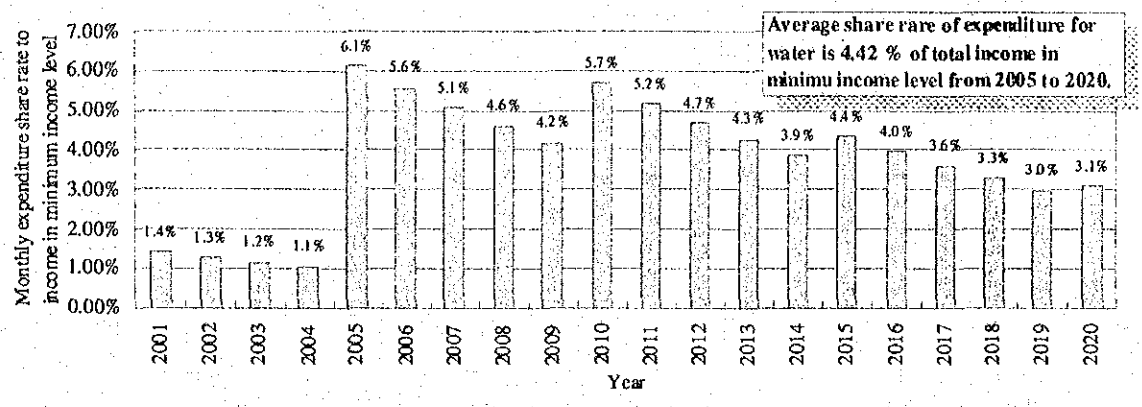


Figure 6.1 Relationship Between Income and Expenditure for Water

Five (5) % of total income is the upper limit of affordability of people to pay for water according to the suggestion of international financing institution as the World Bank and Asian Development Bank. As indicated in the above table and figure, monthly share rates of expenditure for water against monthly income level exceed the 5 % at 5 times in 2005 (5.95 %), 2006 (5.40 %), 2007 (5.1 %), 2010 (5.7 %) and 2011 (5.2 %) in case of minimum income level. However, the average share rate during the period from 2005 to 2020 is lower than 5 % as 4.42 %. It means that said recommended tariff system is within safety side of the affordability of people to pay for water.

In this case, it is assumed that the people's income level will be increased by 10 % every year over the future taking consumer price index and increasing ratio of per capita GDP.

6.4 REPAYMENT ABILITY OF THE PROJECT

In this Project, the price escalation rates are applied as 1.0 % per annum for FC portion and specified rate of 0.5 % per annum for LC portion tentatively according to the similar projects in developing countries in south-east Asia. An amount of annual equal payment including interest and principal is calculated at US$ 43,064 $\times 10^3$ with an interest rate of 1.30 % per annum and 30 years of repayment period including 10 years of grace period. Following table shows the repayment schedule of entire works of Phase-1.

Table 6.8 Repayment Schedule for the Works of Phase-1

(US$1,000) (US$1,000)

Year in order	Year	Outflow: Construction cost: Loan portion	Outflow: Construction cost: Local portion	Outflow: Foreign borrow: Interest	Outflow: Foreign borrow: Principal	Outflow: OM cost	Outflow: Total	In flow: Foreign borrow	In flow: Revenue in total	In flow: In flow in total	Cash balance	Subsidy to the Project from YCDC or Central Government of Myanmar
-1	2001	0	0	0	0	0	0	0	0	0	0	0
0	2002	0	0	0	0	0	0	0	0	0	0	0
1	2003	0	0	0	0	0	0	0	0	0	0	0
2	2004	31,875	2,361	0	0	207	34,444	31,875	1,312	33,186	-1,257	1,257
3	2005	33,380	2,908	414	0	207	36,910	33,380	11,246	44,626	7,716	
4	2006	121,799	13,105	848	0	804	136,556	121,799	23,818	145,617	9,061	
5	2007	94,693	7,943	2,432	0	943	106,010	94,693	24,797	119,490	13,480	
6	2008	168,339	29,994	3,663	0	2,140	204,136	168,339	25,777	194,115	-10,020	10,020
7	2009	132,470	22,193	5,851	0	1,349	161,863	132,470	26,761	159,230	-2,633	2,633
8	2010	171,576	25,656	7,573	0	9,159	213,964	171,576	62,564	234,140	20,176	
9	2011			9,804	0	9,159	18,962		62,564	62,564	43,602	
10	2012			9,804	0	10,234	20,038		62,564	62,564	42,526	
11	2013			9,804	33,260	9,159	52,222		62,564	62,564	10,342	
12	2014			9,371	33,692	9,159	52,222		62,564	62,564	10,342	
13	2015			8,933	34,130	9,159	52,222		77,238	77,238	25,016	
26	2028			2,693	40,371	10,234	53,298		88,620	88,620	35,322	
27	2029			2,168	40,895	9,159	52,222		88,620	88,620	36,398	
28	2030			1,637	41,427	9,159	52,222		88,620	88,620	36,398	
29	2031			1,098	41,966	9,159	52,222		88,620	88,620	36,398	
30	2032			553	42,511	10,234	53,298		88,620	88,620	35,322	
31	2033					9,159	9,159		88,620	88,620	79,462	
Total		754,131						754,131				

(Note)
(1) Interest rate of foreign loan: 1.30%
(2) Equal annual repayment amount of capital for foreign loan (US$1,000)): 43,064

As indicated in the above, a subsidy to the Project from General Account of YCDC or from the central Government of Myanmar (or some domestic financing sources) will be needed at the early stage of execution of construction works and at the time to be needed large scale of construction cost to invest. However, when the water charge is collected smoothly, YCDC can caver such deficit by the water charge in any case as mentioned hereunder for accounting projection.

6.5 ACCOUNTING OPERATION

Following table shows a result of projection of Profit and Loss of WSS Department of YCDC until the 2010. In this case, it is assumed that total outstanding collections are to be most pessimistic case as 10 % consisting of (1) outstanding charge: 2.60 %, (2) free connection rate: 3.45 %, (3) non-billing rate: 1.80 % and (4) the rate of communal water tapping: 2.59 % in average.

Table 6.9 Projection of Profit and Losses from the Project until 2010

(US$1,000)

	(Note)	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
A. Revenue due to water charge collection		2,371	12,305	24,877	25,857	26,836	27,820	63,623
B Outstanding collection			1,286	2,600	2,702	2,804	2,907	6,649
Outstanding charge	2.60%		320	647	672	698	723	1,654
Free connection rate	3.45%		425	858	892	926	960	2,195
Non-billing rate	1.80%		221	448	465	483	501	1,145
Communal water tapping	2.60%		320	647	672	698	723	1,654
C. Governmental and/or YCDC cross subsidy		0	0	0	0	0	0	0
D. Subtotal (A -B + C)		2,371	11,019	22,277	23,155	24,031	24,912	56,975
E. OM cost for YCDC own operation		0	0	0	0	0	0	0
F. OM cost for the Project		207	207	804	943	2,140	1,349	9,159
G. Replacement cost		657	1,350	3,954	5,735	9,173	11,818	15,152
H. Depreciation		0	1,016	2,088	6,116	8,871	14,188	18,280
I. Subtotal (E+F+G+H)		864	2,573	6,846	12,794	20,184	27,355	42,591
J. Profit before Tax (D - I)		1,507	8,446	15,432	10,360	3,847	-2,443	14,384
K. Income tax		0	0	0	0	0	0	0
Net Profit (J - K)		1,507	8,446	15,432	10,360	3,847	-2,443	14,384

(Note)

- Communal water tapping is used by lowest income levels with share rate of 3.7 % of total households connected with YCDC Water Supply System.
- However, total domestic users shared at 70 % of total water volume to be supplied. So, it is assumed that the rate of communal water tapping users is to be 2.60 % of the water volume to be supplied (= 3.7 % * 70 %).

As indicated in the above table, there is only once to register a deficit in the fiscal year 2009/10 during the period to the year 2010 from the viewpoint of one-year-budget.

Based on the above projection of profit and loss of YCDC, a projection of fund flow of YCDC is made. This table indicates a situation of balance sheet in each year.

Table 6.10 Balance Sheet Situation

(US$1,000)

	2004	2005	2006	2007	2008	2009	2010
A. Source of Fund (B+E+F)	35,743	45,750	152,422	119,111	211,051	166,408	229,897
B. Internal fund generation (C+D)	1,507	9,462	17,519	16,476	12,718	11,745	32,664
C. Depreciation		1,016	2,088	6,116	8,871	14,188	18,280
D. Net profit	1,507	8,446	15,432	10,360	3,847	-2,443	14,384
E. Credit of International Financing Institution to the Project	31,875	33,380	121,799	94,693	168,339	132,470	171,576
F. Counterpart contribution by YCDC (Local currency portion)	2,361	2,908	13,105	7,943	29,994	22,193	25,656
G. Application of fund (I+J+K)	35,743	45,750	152,422	119,111	211,051	166,408	229,897
I. Investment for the Project	34,236	36,288	134,903	102,635	198,333	154,663	197,233
J. Debt retirement	0	414	848	2,432	3,663	5,851	7,573
1) Repayment of principal for Phase-1	0	0	0	0	0	0	0
2) Interest payment of loan amount for Phase-1	0	414	848	2,432	3,663	5,851	7,573
K. Working capital	1,507	9,047	16,671	14,044	9,056	5,894	25,091
Available cash	1,507	10,554	27,225	41,269	50,325	56,219	81,310

(US$1,000)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
A.	33,612	33,485	35,509	36,458	37,406	37,279	39,303	40,252	41,200	41,073	43,097	44,045	44,994
B.	33,612	33,485	35,509	36,458	37,406	37,279	39,303	40,252	41,200	41,073	43,097	44,045	44,994
C.	23,437	23,437	23,437	23,437	23,437	23,437	23,437	23,437	23,437	23,437	23,437	23,437	23,437
D.	10,176	10,049	12,073	13,021	13,970	13,842	15,867	16,815	17,763	17,636	19,660	20,609	21,557
E.	0	0	0	0	0	0	0	0	0	0	0	0	0
F.	0	0	0	0	0	0	0	0	0	0	0	0	0
G.	33,612	33,485	35,509	36,458	37,406	37,279	39,303	40,252	41,200	41,073	43,097	44,045	44,994
I.	0	0	0	0	0	0	0	0	0	0	0	0	0
J.	9,804	9,804	43,064	43,064	43,064	43,064	43,064	43,064	43,064	43,064	43,064	43,064	43,064
1)	0	0	33,260	33,692	34,130	34,574	35,024	35,479	35,940	36,407	36,881	37,360	37,846
2)	9,804	9,804	9,804	9,371	8,933	8,490	8,040	7,585	7,124	6,656	6,183	5,704	5,218
K.	23,809	23,681	-7,554	-6,606	-5,658	-5,785	-3,761	-2,812	-1,864	-1,991	33	982	1,930
Available cash	104,992	97,437	90,831	85,174	79,389	75,628	72,816	70,952	68,961	68,994	69,976	71,906	

As indicated in the above table, a deficit of net profit in 2009/10 may be covered by the accumulated available cash (disposable cash balance at the end of each year). Also, in the year 2013 and 2014, working capitals will be booked in credit side as indicated in the above table. They are caused by just starting time of repayment in these years. However, these are also balanced out by the accumulated available cash. Accordingly, YCDC can keep sound accounting until the year 2020 and thereafter.

6.6 RECOMMENDED TARIFF SYSTEM

Following table shows existing tariff system in Yangon City:

Table 6.11 Existing Tariff System in Yangon

Rate system	Domestic customers (Kyats)	Government offices (Kyats)	Commercial/ industries (Kyats)	Foreign customers (US$)	Remarks
Flat rate	120	80 to 107,000	405 to 25,000	25	Per month
Specific rate	30	20	135	*	Per 1,000 gallons

(Note) * US$ 2.00 for HH, and US$4.00 for commercial/industries.

Existing rate of water meter fitting is 22 % of the total customers who connected with existing YCDC water supply system according to a result of questionnaire survey made by JICA Study Team in 2001. Based on the above mentioned metered tariff revision schedule and taking the existing tariff system into account, following new tariff system may be recommended. In this case, it is assumed that the rate of water meter fitting is linearly increased until the year 2020 as the target year of 100 per cent fitting to be realized. The JICA Study Team recommends this Tariff System and Revision Schedule to YCDC.

Table 6.12 Recommended New Tariff System

As of 2005

Rate system	Domestic customers (Kyats)	Government offices (Kyats)	Commercial/ industries (Kyats)	Foreign customers (US$)	Remarks
Flat rate	1,262	*	*	*	Per month per customer
Specific rate	193	128	866	*	Per 1,000 gallons

As of 2010

Rate system	Domestic customers (Kyats)	Government offices (Kyats)	Commercial/ industries (Kyats)	Foreign customers (US$)	Remarks
Flat rate	1,886	*	*	*	Per month per customer
Specific rate	288	192	1,294	*	Per 1,000 gallons

As of 2015

Rate system	Domestic customers (Kyats)	Government offices (Kyats)	Commercial/ industries (Kyats)	Foreign customers (US$)	Remarks
Flat rate	2,328	*	*	*	Per month per customer
Specific rate	355	237	1,598	*	Per 1,000 gallons

As of 2020

Rate system	Domestic customers (Kyats)	Government offices (Kyats)	Commercial/ industries (Kyats)	Foreign customers (US$)	Remarks
Flat rate	No flat rate	*	*	*	Per month per customer
Specific rate	407	272	1,833	*	Per 1,000 gallons

(Note) * To be decided by YCDC itself based on domestic situation.

7. ENVIRONMENTAL IMPACT ASSESSMENT

7.1 DESCRIPTION OF PRIORITY PROJECT

7.1.1 Stage 1 (2004-2006)

Ngamoeyeik Reservoir System (Transmission & Pumping Station (P/S)

The project of concern is the secure water source that corresponds to the current demand as designated in the Master Plan.

There is no water treatment plant with sedimentation, flocculation, filtration and disinfection processes. One transmission pipe has already been completed. Replacement of Aged Distribution Pipes

The project categorized into 2 components by an installation age. CB Hlawga Service Reservoir will be installed near Terminal Reservoir covering Hlawga area (Zone 4). Simultaneously, it was planned that CB North Service Reservoir that is joined with Hlawga Service Reservoir makes up for distribution of Central North area (Zone 5).

7.1.2 STAGE 2 (2007-2010)

Hlaing Water Treatment Plant and Supplemental Facilities

Presently, Gyobyu Water Treatment Plant (WTP) is only equipped treatment facility under jurisdiction of YCDC. In the Master Plan study, construction of two water treatment plants was proposed. The priority project consists in introducing the modernized treatment plant. About 33 km of one transmission pipeline with 1,900 mm diameter will be laid from Hlaing WTP to Terminal Reservoir by each project phase.

Rehabilitation of Regular Well, Well Construction and Service Reservoir

2 service reservoirs preparing 100,000 m^3 of design capacity will be constructed in the Central Block (CB), named CB West Service Reservoir and CB Downtown East Service Reservoir.

7.2 STATE OF ENVIRONMENT OF PROJECT SITES

7.2.1 General Presentation

The study team has engaged social environmental impact survey to local staff in charge of hearing about both potential and expected impacts of social aspect for establishment of the state of environment of project sites.

Social survey has consisted into a survey about communities living close to the service reservoir and transmission pipeline sites and a survey about urban communities in several roads and

streets concerned by the distribution network improvement projects. The detailed description of the state of environment of priority project sites can be referred to in Appendix L.

7.2.2 New Transmission And Distribution Pipes & Replacement Of Aged Pipe Project Site And Service Reservoirs

The priority project of network systems of distribution pipelines covers most townships of Yangon City either urban, peripheral or satellite community. It is known that the about 60% population of Yangon doesn't enjoy piped water. Even though the area where already covered piped water supply system, those people are also suffering poor water supply conditions all the time.

The project site can be divided into 3 areas.

Satellite townships

Living Environment

Proposed service reservoir sites both Central Block Downtown East and East Block South are located relatively close to residential and commercial quarters. Women

Women in development is very sensitive issue of social environment aspect not only water supply project but other basic human needs one. After completion of this project, most resident will be able to get water thorough the pipe fairly.

Proposed plan of priority projects, there is no significant infringe such a cultural properties. If the religious lot is located on proposed project sites, it will be obliged to make alternations in consideration of mitigation of impacts.

7.2.3 Hlaing Water Treatment Plant And Supplemental Facilities

The project of Hlaing Water Treatment Plant and supplemental facilities will be constructed nearby Gwedanshe village. Proposed Water Treatment Plant will be planned installation along the main road from Yangon and intake facilities are located at riverside. River water was recommended as raw water source by investigating of both quantity and quality aspects on Master Plan study. Living Environment

The proposed project site is a typical remote country place and there is nothing but some small communities. By virtue of project installation, living environment of concerned area may be slightly changed for employment conditions because job opportunity related with water treatment plant will be expected both construction phase and operation phase.

Natural Environment

Impacts are not very troublesome as well as other project such as an agricultural development.

7.3 IMPACTS OF THE PROJECT ON ENVIRONMENT

The range of possible impacts of the project on environment is large because of the many components of projects, variety of issues and various intensities of impacts.

Potential impacts

Expected impacts

Definition of Main Impacts

Table 7.1 Checklist for Evaluating Environmental Impact

Grouping	Items
1. Social life & living environment	(1) Resettlement (2) Livelihood (3) Quality of the living environment (4) Life style and social behaviour (5) Community life and social conflicts (6) Change of economic activity and employment (7) Protection of sensitive groups and promotion of women
2. Public health	(8) Public health (9) Occupational health and sanitation
3. Pollution and nuisances	(10) Water quality (11) Air pollution and offensive odour (12) Urban nuisances and risks (traffic, accidents, noise) (13) Wastes
4. Natural patrimony	(14) Habitats, fauna and flora species (15) Conservation of river banks and prevention of sanding (16) Conservation of soil (17) Conservation of groundwater (18) Disaster
5. Cultural patrimony	(19) Landscape, amenities, aesthetic values (20) Remains and assets

Main potential impacts are those impacts that would certainly occur if no measure was taken at the project design level, but that can be avoided through technical measures adopted with execution of the project. Main expected impacts are those impacts that will necessarily occur with execution of the project without possibility of mitigation through technical design of the project. Main impacts are summarised in the Table 7.2 below, according to projects.

Table 7.2 Relevance of Main Impacts According to Project

Items	Stage 1	Stage 2
Main Potential Impacts		
Worsening of the living environment	X	X
Main Expected Impacts		
Improvement of sanitation and health	X	X
Exposure to pollution and nuisance	X	X
Loss of environmental asset	X	X
Improvement of tap water quality	X	X
Livelihood	X±	X±

Table 7.3 Statements of Social Impacts In Project Sites

	Stage 1	Stage 2
Indicators of sensitivity		
Size of population directly exposed to impacts	2	1
Cultural roots with the place of living	0	1
Scoring A	2	2
Main expected negative impacts		
Exposure to pollution and nuisance	2	2
Loss of environment asset	1	1
Loss of livelihood	1	1
Scoring B	4	4
Total scoring A×B	8	8
Comprehensive Qualification Rate	Negligible	Negligible

Ranking order in most optimistic alternative: 0 negligible; 1 moderate; 2 important; 3 very important;

Impacts on the Natural Environment

The study has shown that there are almost nothing potential impacts and expected impacts both stages. On the whole, components of all projects have few impacts on the natural environment.

Impacts on the Social Environment

Reconsideration of social environmental aspect for the priority project will be necessary based on examination of field survey result.

The global impact of the project on environment is basically positive for the welfare and quality of life of people in Yangon City. The negative impacts of the project are raised for the local communities living in the project sites.

Since the environmental benefit of the project for public health of Yangon population is not questionable, few measures to solve the problems identified have been proposed.

7.3.1 Main Potential Impacts

Worsening of the Living Environment

The installation of the distribution network in the priority zones has both positive and negative impacts on the living environment. Positive impacts are the improvement of sanitation conditions.

Countermeasures of sewerage collection / treatment would induce a definitively positive impact on the living environment.

Clean and sanitary environment of living.

7.3.2 Main Expected Impacts

All priority projects that will be taken in Phase-1 will contribute to improve the sanitary conditions of populated areas of Yangon City. Population living around the targeted areas is already seriously suffered with terrible water supply conditions. The implementation / rehabilitation of water supply facilities have to sweep away water shortage issue.

In case of aged pipe rehabilitation site, residents are living in the site jostling each other. Loss of Environmental Asset

Especially, proposed sites of Central Block West reservoir, Hlawga reservoir and Terminal reservoir are located on the outskirts of Yangon with an abundance of forest resources. Improvement of Tap Water Quality

Improvement of water quality will be a synergic effect of better management of water treatment plant and installation of pipeline network.

The impact of the project on the livelihood and income of inhabitants results from the loss of farm land housing and grazing fields at the construction sites (service reservoir treatment plant and pipelines, etc.). Loss of livelihood, namely a market gardening, is insignificant impact in the case of construction for large facility building, such as water treatment plant and service reservoir.

7.4 ENVIRONMENT MANAGEMENT PLAN

7.4.1 Proposed Management Activities For Phase-1 Projects

Plan of Environmental Measures During Construction

The construction of service reservoirs, water treatment plant and pipe laying are certainly part of water supply project. The pipelines and reservoir construction sites must be cleaned from all construction materials when the works have been done. Employment of local people for construction works is strongly recommended.

Prevention of Inadequate Project Site

Preventing the formation of inadequate project site is possible at the stage of planning of the project.

Table 7.4 Plan of Measures for Phase-1

	Social life and living environment	Public health	Pollution, nuisances	Natural environment	Landscape, amenities
Prevention measures					
(1) Plan of measures during construction	X		X		X
(2) Prevention of inadequate project site		X	X		X
(3) Environmental monitoring			X	X	
Mitigation and remediation measures					
(4) Settling a greenery buffer zone	X		X	X	X
(5) Plan of social reinsertion	X				
(6) Community participation	X				
Sustainability measures					
(7) Sanitary use of dried sludge		X			
(8) Collection of domestic wastewater		X			

Environmental Monitoring

A monitoring plan of groundwater quality should be set up, with sampling in water wells around the site.

Plan of Social Reinsertion

Community Participation

7.4.2 Conditions of Implementation of Measures

The institutional capacity to manage environment is a key issue for implementation of measures and environment management plan within the scope of the project. Public participation needs to be promoted and supported for the environmental plan of the project.