CHAPTER 6

KALU GANGA WATER SOURCE

6 KALU GANGA WATER SOURCE

6.1 Need for Kalu Ganga Development as Water Source

With commissioning of the 40 mgd new Ambatale treatment plant in January 1994, the maximum treatment capacity of the Ambatale plant is now augmented to 103 mgd (469,000 m^3/d). With the increased treatment capacity, salinity intrusion in the Kelani Ganga is becoming a major concern since the Ambatale plant has experienced stoppages of water intake due to salinity in 1991 drought period. It is feared that salinity intrusion will occur more frequently when the 103 mgd plant will be in full operation.

As shown in the water demand projection in Chapter 4, the existing system will not be able to satisfy the demand for 2005 which includes the demand for the scheduled expansion at east, south and north of Greater Colombo. Water shortage will likely occur sometime after 2000.

Increasing the existing capacity of the Ambatale plant in substantial amount will however not be likely considering the salinity problem. At Kalatuwawa and Labugama, the water production capacity will not be increased above the present level due to the limitation in the capacity of the impounding reservoirs. Under the present circumstances and for achieving the stable water supply meeting the future demand, it is inevitable that new water sources stable both in quantity and quality be planned and developed.

The Kalu Ganga is the most probable option as a new water source for the Greater Colombo water supply from the aspects such as safe yield, water quality and location. Not only as an additional water source, having two sources will bring the water supply system a great advantage in terms of safety for emergency. By provision of inter connected transmission system, either of sources will be able to supply water in case the other sources will be shut down or will face a lack of raw water.

From these points of view, the Kalu Ganga water is proposed as an additional water source for the Greater Colombo Water Supply System.

6.2 General Description of the Kalu Ganga

6.2.1 Basin and River

The Kalu Ganga is located in Kalutara and Ratnapura districts in the southern-western part of Sri Lanka. The catchment area is estimated at 2719 km^2. The Kalu Ganga originates from Adams Peak and flows through Ratnapura. Length of the river is about 124 km with the elevation difference of 450 m between the river-shed and the river-mouth.

6.2.2 Rainfall

In and around the basin of the Kalu Ganga, there are more than 30 rainfall gauging stations. Among them, daily rainfall records for the period of 1983 to 1992 at five rainfall gauging stations under the management of the Department of Meteorology are collected. The mean annual rainfall in the period of 1982 to 1992 at these stations are as follows:

Clyde Estate	2,850 mm
Horagoda	3,419 mm
Rayigama	4,270 mm
Wellandura	2,562 mm
Ratnapura	3,659 mm

6.2.3 Present Use of River Water

The present use of river water of the Kalu Ganga in the reaches downstream of the proposed intake site is o.35 m^3/s including some planning figure in the near future. These are industrial water use and water supply by Kalutara intake. According to the Department of Irrigation, there is no irrigation scheme along the Kalu Ganga.

6.2.4 Existing Development Plans for the Kalu Ganga

(1) Gem Mining Project

An Presidential Committee was formed on 1st December 1993 and recommended a ban on mechanized gem mining until detailed studies have proved that no damage to the environment will be caused by such activities. It also recommended that the pilot scheme should be banned in the present socio-political context. The President, D.B.Wijetunga is reported to have told the Committee that their recommendations would be implemented on obtaining Cabinet approval. Cabinet approval was announced on 19th January 1994.

(2) Kukule Ganga Hydropower Project

The Kukule Ganga Hydropower Project site is located south-east of Colombo at about 70 km air-distance in Karawana division of the Ratunapura district. The project is set up on the Kukule Ganga which is a tributary of the Kalu Ganga with an annual mean flow of 30.4 m^3/s and an average annual rainfall of 3,750 mm at the project site.

An implementation schedule for the construction has been proposed with the commencement at early month of 1995 and commissioning in the beginning of 2000.

It is envisaged that the water use for the hydropower purpose conducting run-of-river type will not bring about any water shortage to the down reaches so far as the quantity is concerned.

(3) Other Projects Planned for the Kalu Ganga

Presently no development is proposed by the related agencies except for ones described above. The Department of Industry is said to have a plan to move the industrial zone from the Colombo area to the Kalutara area near the river-mouth of the Kalu Ganga. But no definite plan is established yet.

6.3 Extent of Salinity Intrusion

(1) Saline Water Measurement

Saline water measurement along the Kalu Ganga was conducted by the Study Team on 31 January, 9 February, and 4 March, 1994. The results are shown in Figure 6.1.

(2) River Profile

The river profile of the Kalu Ganga is prepared based on the topographical map around the river surveyed in 1970's now being kept at the Department of Survey, longitudinal and cross-sectional profiles of the Kalu Ganga surveyed in 1989 by Irrigation Department, and the results of water depth measurement on the occasion of salinity measurement by the Study Team in 1994. The river profile is shown with the result of saline water intrusion analysis.

(3) Tide at the River-Mouth

The tide at the river-mouth of the Kalu Ganga has the same elevation with that at the Colombo Port.

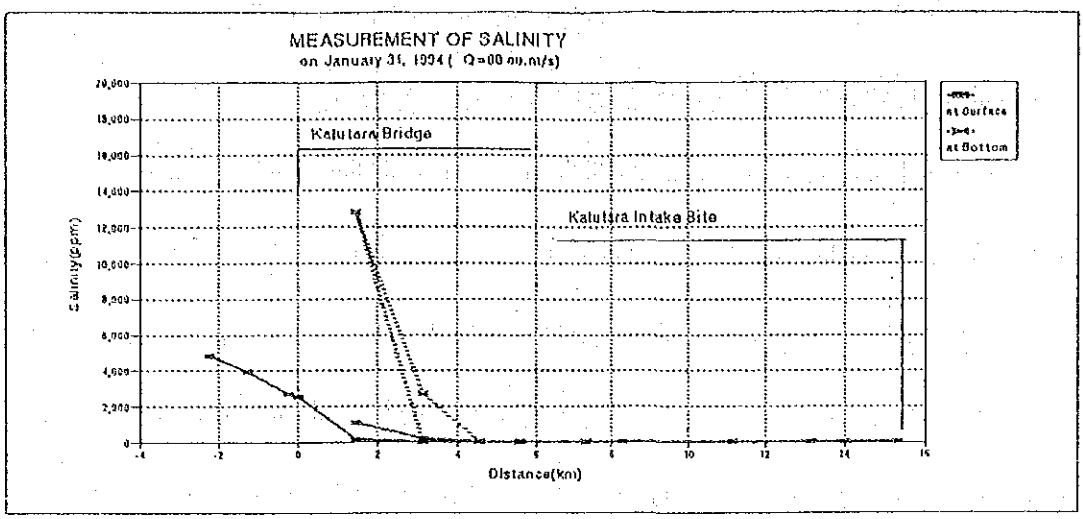
(4) Saline Water Intrusion

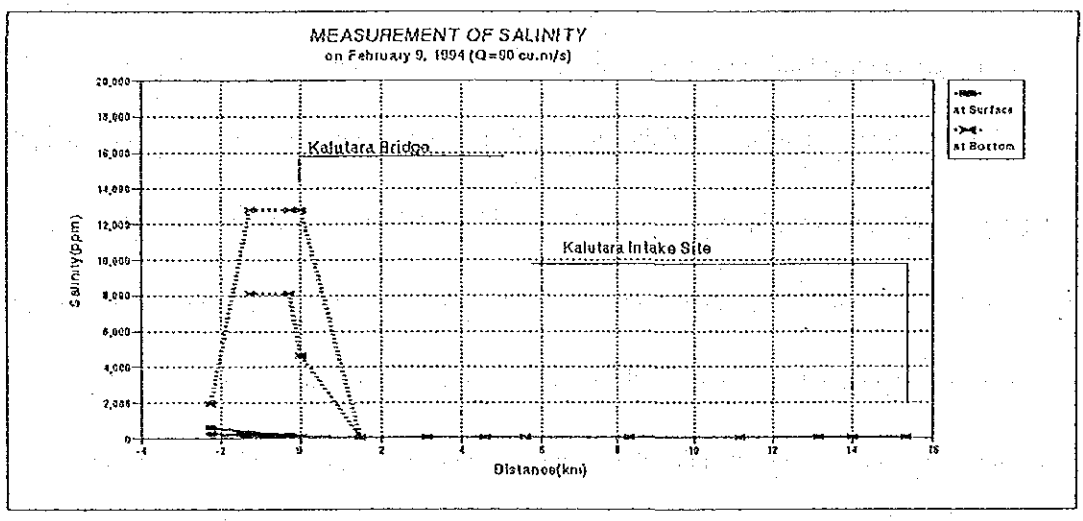
The analysis of sea water intrusion for the occasion of design drought of the river has been conducted on the basis of the presently available data and by using the "Farmer-Morgan" formula. The profiles of salt wedge are calculated for the following three cases of discharges and two cases of tide (high tide and low tide);

$Q_1 = 14.4\ m^3/s$ (Q_1 = 10 year drought without water intake for the Project)
$Q_2 = 12.2\ m^3/s$ ($Q_2 = Q_1$ – water intake for the 2010 demand)
$Q_3 = 10.0\ m^3/s$ ($Q_3 = Q_1$ – water intake for the 2020 demand)

high tide : elevation of tide = 0.32 m MSL
low tide : elevation of tide = – 0.18 m MSL

The profiles are shown in Figure 6.2. As seen in this Figure, the salt wedge reaches more upstream of the proposed water intake site for the case of high tide and the discharge of 10.0 m^3/s. For the other cases the saline water intrusion seems to be interrupted by the rather high river-bed in the reaches upstream of the Kalutara Intake Station.





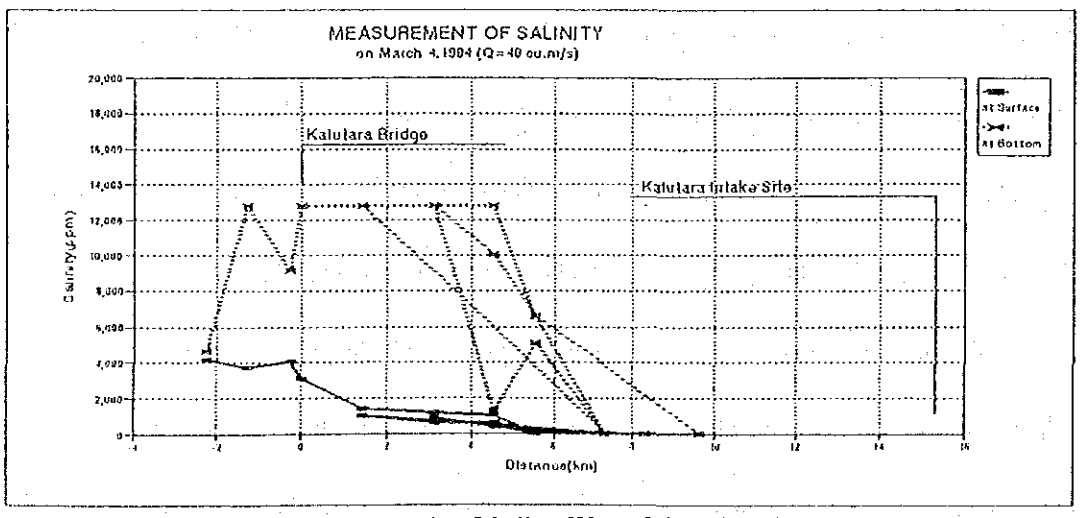
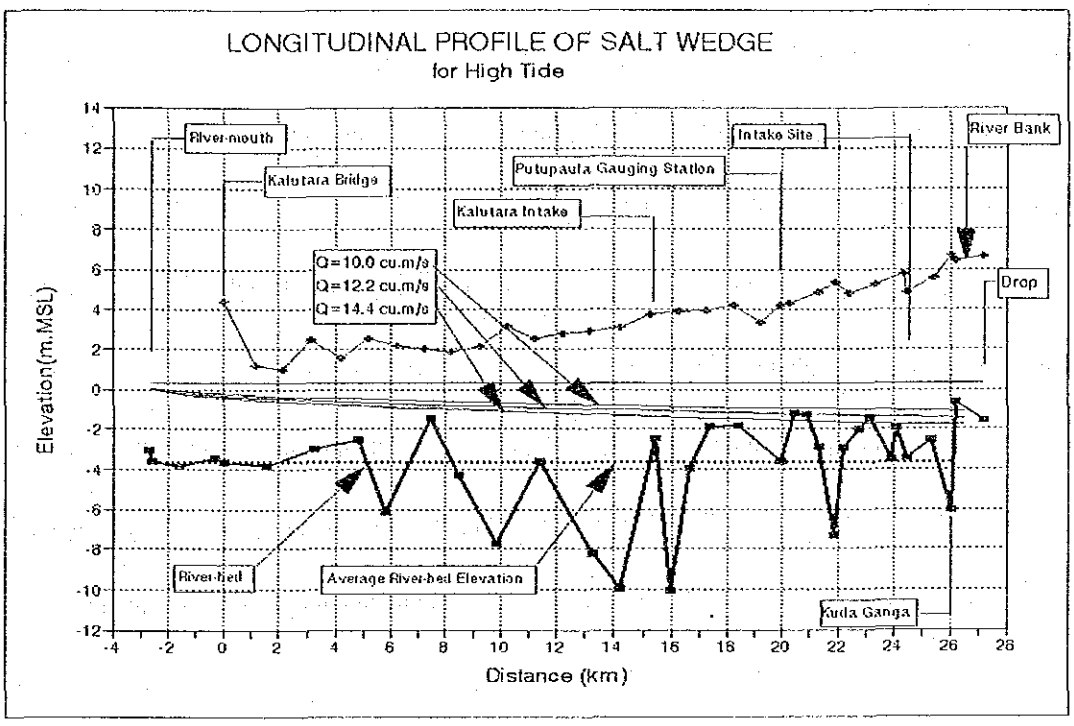


Figure 6.1 Result of Saline Water Measurement



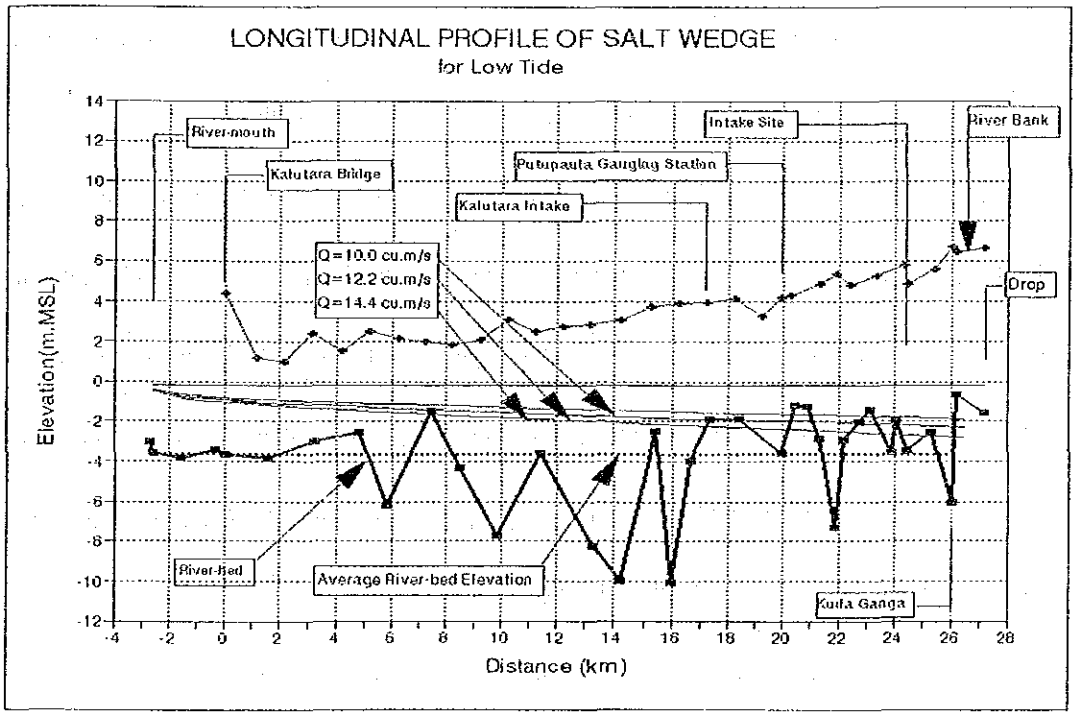


Figure 6.2 Longitudinal Profile of Salt Wedge

According to the present analysis on the saline water intrusion, the saline water at the proposed intake site will be about 63 percent of the total depth of 3.75 m for the case of high tide and water withdrawal of 4.4 m^3/s for the 2020 demand. In other words, the fresh water depth at the proposed intake site will be about 37 percent (1.4 m) of the total depth.

6.4 Safe Yield

6.4.1 Probable Annual Minimum Flow at Putupaula

Probability analysis on the annual minimum flow at Putupaula is made by using the log-normal method and Gumbel method. And it is concluded that Gumbel method should be adopted for the past records. The result is presented in Table 6.1.

Table 6.1 Probable Annual Minimum River Flow

Return Period (year)	Probable Annual Minimum Flow by Gumbel Method (m^3/s)
5	16.7
10	14.4
20	12.7
30	11.9

6.4.2 Existing Water Use

Existing water use along the Kalu Ganga in the objective reaches are the industrial use rather than water supply. The total amount is estimated at about 0.35 m^3/s.

Other than these, in the reaches downstream of the Narthupana bridge, the water transport seems active as many ferry facilities are found. The other use is not presently observed. No major future use of the river water is proposed other than the Kukulegama Power Generation Project as discussed in the previous section.

6.4.3 River Maintenance Flow

For any development plan of river water use, the river maintenance flow should be taken into consideration. At present, no river law nor any regulation on river maintenance flow other than the environmental acts are in force.

River maintenance flow generally should be determined based on the factors such as water transport, fishery, natural view, protection of saline water intrusion, protection of river-mouth closure, protection

of river facilities, maintenance of underground water-table, protection of flora and fauna, maintenance of water quality, existing water use, etc.

Regarding the water transport in the downstream reaches, the main factor of the river water-level during low flow period seems to be the tide, not the discharge itself.

One of major factors for the river maintenance flow is an issue of river-mouth closure. This is the combined phenomena due to the low discharge of the river and the littoral drift along the sea shore. Presently the river-mouth of the Kalu Ganga is much influenced by the littoral drift. The river-mouth, in the dry season, is rather small even though the basin is wide. Even now the river-mouth of the Kalu Ganga is excavated by the Department of Irrigation before rainy season.

The other factor for the river maintenance flow is the maintenance of water quality of the river from the view point of environment and the maintenance of flora and fauna. Presently there is no standard on the water quality of the river defined in the form of a regulation or the law.

6.4.4 Available Water of the Kalu Ganga

Regarding the quantity, the discharge of the Kalu Ganga is estimated at 14.4 m^3/s for the drought of 10 year return period. The return period of a drought on which the water supply plan should be based on, may need to be discussed in consideration of the social welfare situation and from the view point of social service.

At the proposed intake site, the depth of a layer of fresh water is estimated at approximately 1.4 m on the saline water wedge with the river discharge of 10.0 m^3/s after the water intake (14.4 m^3/s minus 4.4 m^3/s withdrawal for 2020 demand) and at the time of the high tide. This may suggest that the proposed water withdrawal at the proposed intake site be still possible without such serious influence of saline water.

In consideration of various unknown mechanism and factors on the functions of river maintenance flow of the Kalu Ganga at present, it may be suggested that the water withdrawal in the downstream reaches be tentatively limited within the range that the minimum flow after water withdrawal for the return period of 10 years is more than the past minimum flow of 11 m^3/s. This can be understood that the plan would not worsen the situation in the past natural situation.

6.5 Water Quality

Comparison of the water quality data with the proposed Sri Lankan Water Quality Standards for Different Uses shows that the Kalu Ganga water complies with the criteria for 'Drinking Water, Conventional Treatment'.

The water quality data characterizes the Kalu Ganga water as having low to medium turbidity and color, soft, with low alkalinity, chlorides and dissolved solids. No heavy metals were found to be present. The nitrate and phosphate figures are high enough to support algal growth, though this will not be a problem provided the raw water is fed directly from the intake facility to the treatment works process stages. Some filamentous algae may appear on the side walls of channels etc. but regular cleaning will prevent any problems from occurring.

Comparison with analytical data from the Kelani Ganga shows the two rivers to be broadly similar but the Kelani salinity figures indicate the presence of saline intrusion on occasions.

CHAPTER 7

PROPOSED LONG TERM DEVELOPMENT PLAN

7. PROPOSED LONG TERM DEVELOPMENT PLAN

7.1 Balance in Water Demand and Supply

Figures 7.1 and 7.2 show a proposed allocation of water demand and source to supply and the transmission diagrams proposed for the water demands in 2010 and 2020, respectively.

7.2 Kalu Ganga Water Supply System Recommended

7.2.1 Outline of the System Recommended

The raw water will be taken from the Kalu Ganga at the intake station to be constructed at Udugammana Village, Madurawala, approximately 1.6 km downstream of the confluence of the Kalu Ganga and the Kuda Ganga. The raw water will then be pumped to the proposed water treatment plant after screening and grit removal.

The proposed water treatment plant will be constructed on a mount to be graded at an elevation of +11.0 m MSL along the road branched from the road B157 and going to the Horana Intake station. The raw water will have treatment of chemical coagulation, sedimentation and rapid sand filtration. The sludge settled in the sedimentation basins will be withdrawn and pumped to the sludge lagoon. Backwash drain from the filters will be returned to the receiving well to minimize the discharge to the nearby watercourse. The treated clear water will be lifted up to the proposed high level reservoir to be constructed on the hill with an elevation of about +100 m MSL and approximately 3.0 km northwest of the water treatment plant.

The clear water will be directly transmitted by gravity from the proposed high level reservoir to the existing Dehiwala Reservoir (G4), the existing Moratuwa Reservoir (G5), and the existing Panadura Reservoir (G7) and Panadura Tower (G12). Proposed Piliyandala Tower and the existing Bandaragama Tower will be tapped from the proposed transmission main at Piliyandala and Bandaragama, respectively.

7.2.2 Intake Facilities

The location and layout of the intake station are shown in Figures 7.3 and 7.4.

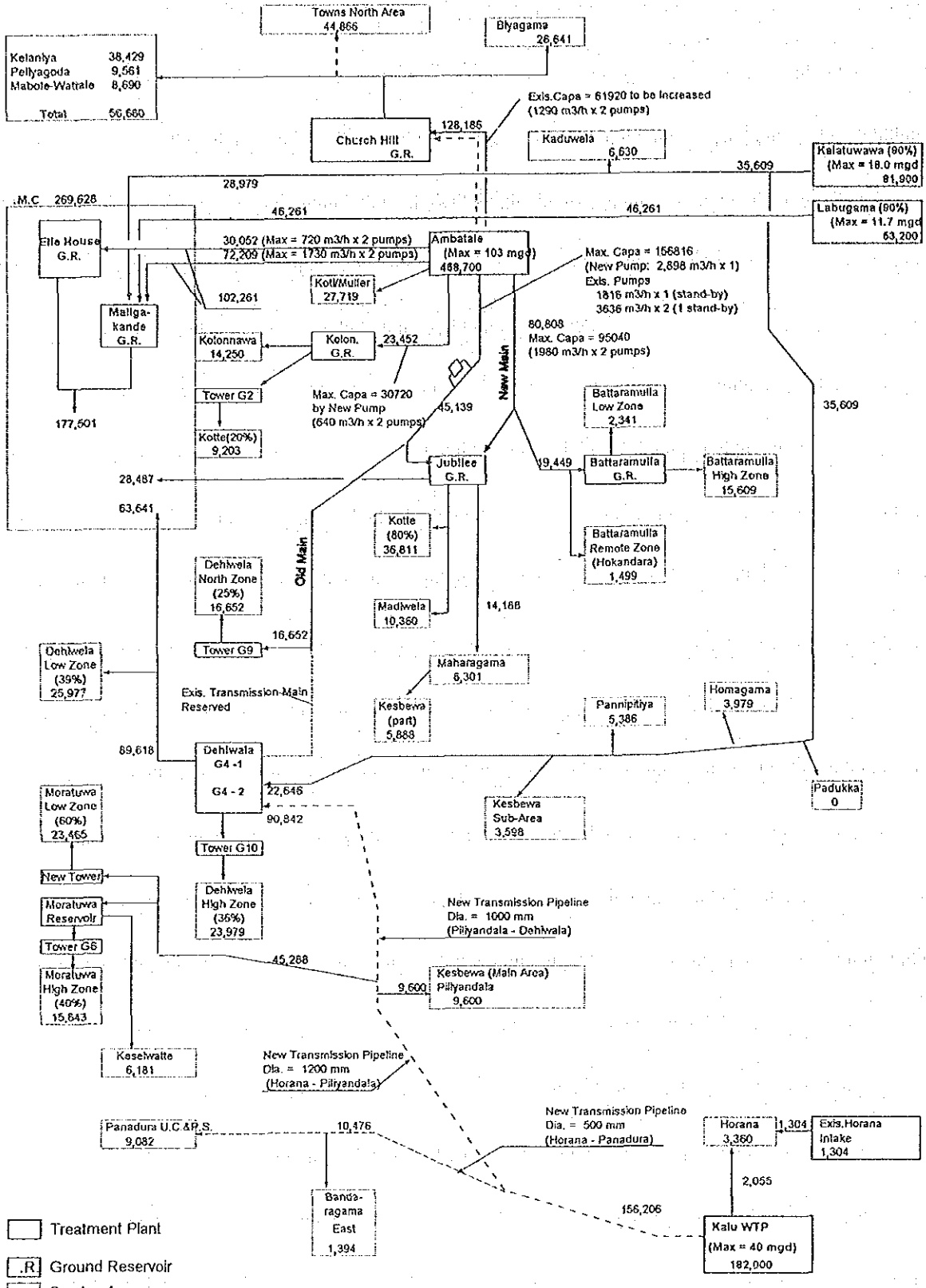


Figure 7.1 Transmission Diagram for 2010 Demand

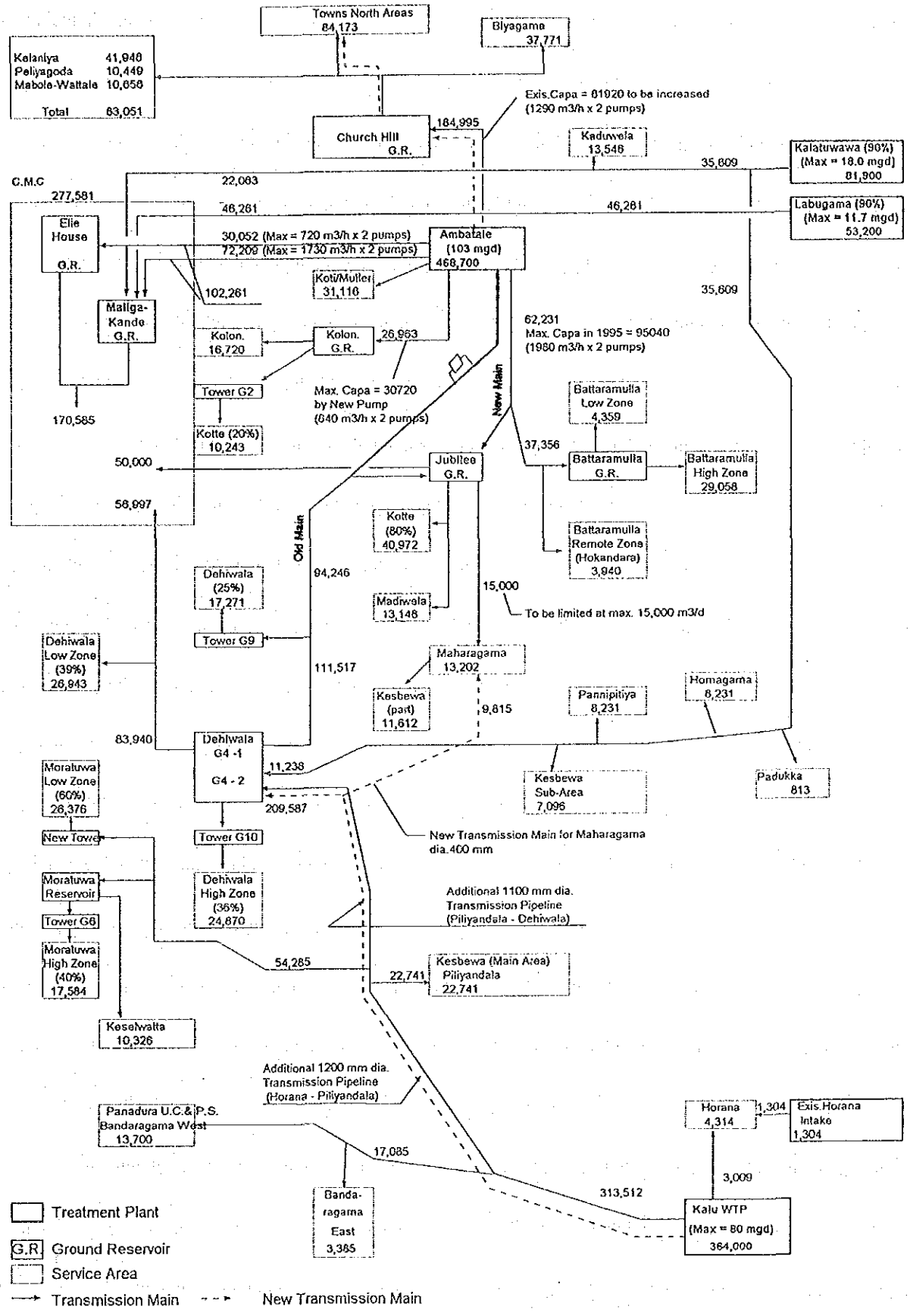


Figure 7.2 Transmission Diagram for 2020 Demand

The raw water will be normally taken from the Kalu Ganga through the intake mouth with a bottom elevation of -0.900 m MSL. The stop log will be provided with the intake mouth so as to raise the bottom elevation of the intake mouth to -0.900 m MSL at the time of salinity intrusion of which the water level is estimated at -1.06 m MSL at the location of the intake mouth under the condition of an annual minimum river flow of 14.4 m^3/sec with a return period of 10 years and the intake amount of 4.0 m^3/sec (382,000 m^3/d) for 2020 water demand at the high tide.

The raw water will be introduced through the screen and intake gate the grit chamber which will be covered with concrete and soil for safety and prevention of the leaves from entering. The inlet and outlet gates will be provided with each chamber.

The raw water will be then pumped up to the water treatment plant after grit removal. In the intake pumping station the pump motors and electrical equipment will be installed on the first floor with an elevation of +10.00 m MSL against the flood.

7.2.3 Treatment Facilities

Design parameters and capacity of the facilities together with required area computed are summarized in Table 7.1. For determining design capacity, 5 percent of allowance and, in like manner, 20-50 percent for the required area, are taken into consideration. The required area for a water treatment plant resulted in approximately 10 ha in total.

Table 7.1 Design Parameters of Water Treatment Plant

Facility	Design Parameter	
Receiving Well	Retention Time	2 min
Mixing Chamber	Type	Hydraulic Mixing
	Mixing Time	2 sec
	Retention time	2 min
Flocculation Basin	Type	Baffled Channel
	Retention Time	25 min
	GT	50,000
Sedimentation Time	Type	Horizontal Flow
	Retention Time	2.5 hours
	Surface Loading	25 mm/min
	Depth	4 m
	Overflow Rate	500 m3/m/d
Rapid Sand Filter	Type	Rising-level, Constant Rate
	Filter Media	Sand
	Filtration Rate	120 m/d
	Filter Wash	Self-backwash plus Surface Wash
Chlorination Chamber	Retention Time	2 min
Clear Water Reservoir	Retention Time	1 hour

Figure 7.5 shows a layout of the proposed treatment plant.

7.2.4 Transmission Facilities

Layout and system diagram of the transmission system required for the development of the Kalu Ganga Water Supply Project are shown in Figures 7.6 and 7.7.

7.2.5 Distribution Facilities

(1) Dehiwala Service Area

Most of the land in the Dehiwala service area lies below 15 m MSL. It will be possible to serve most of the area directly from the ground reservoir and provide satisfactory pressures. If this modification is made, it will help reduce leakage by reducing supply pressure as well as reducing pumping cost.

This recommendation follows the study named as "Operation and System Control of the Greater Colombo Water Supply System" prepared by Engineering-Science and Resources Development Consultants in 1988.

With this zoning, Dehiwala area is divided into three zones as follows:

North Zone :	Area north of Dehiwala canal. To be supplied from water tower G9.
Low Zone :	Area to be supplied from Dehiwala Ground Reservoir G4. A new distribution main is proposed to be laid as shown in distribution pipeline layout.
High Zone :	Area to be supplied from water tower G10. This zone stretches south along Galle Road.

(2) Moratuwa Service Area

As well as Dehiwala, most of the land in the Moratuwa service area lies below 15 m MSL. It will then be possible to divide the area into two zones according to elevation.

This recommendation also follows the study of "Operation and System Control of the Greater Colombo Water Supply System" as well as for Dehiwala.

With this zoning, Moratuwa area is divided into two zones as follows:

Low Zone :	Area to be supplied from the new water tower.
High Zone :	Area to be supplied from water tower G6. This zone also covers the southern area stretching to Panadura.

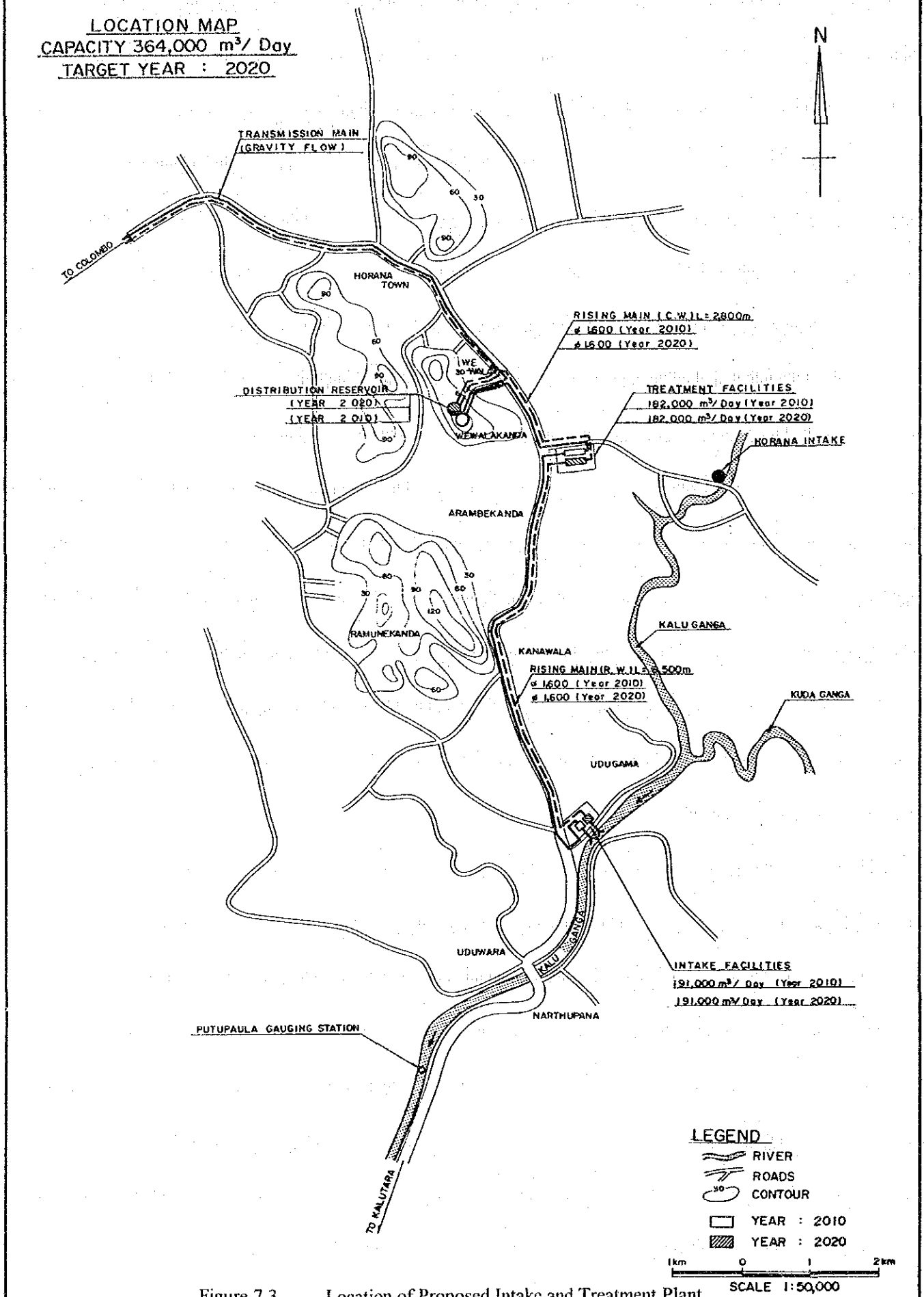


Figure 7.3 Location of Proposed Intake and Treatment Plant

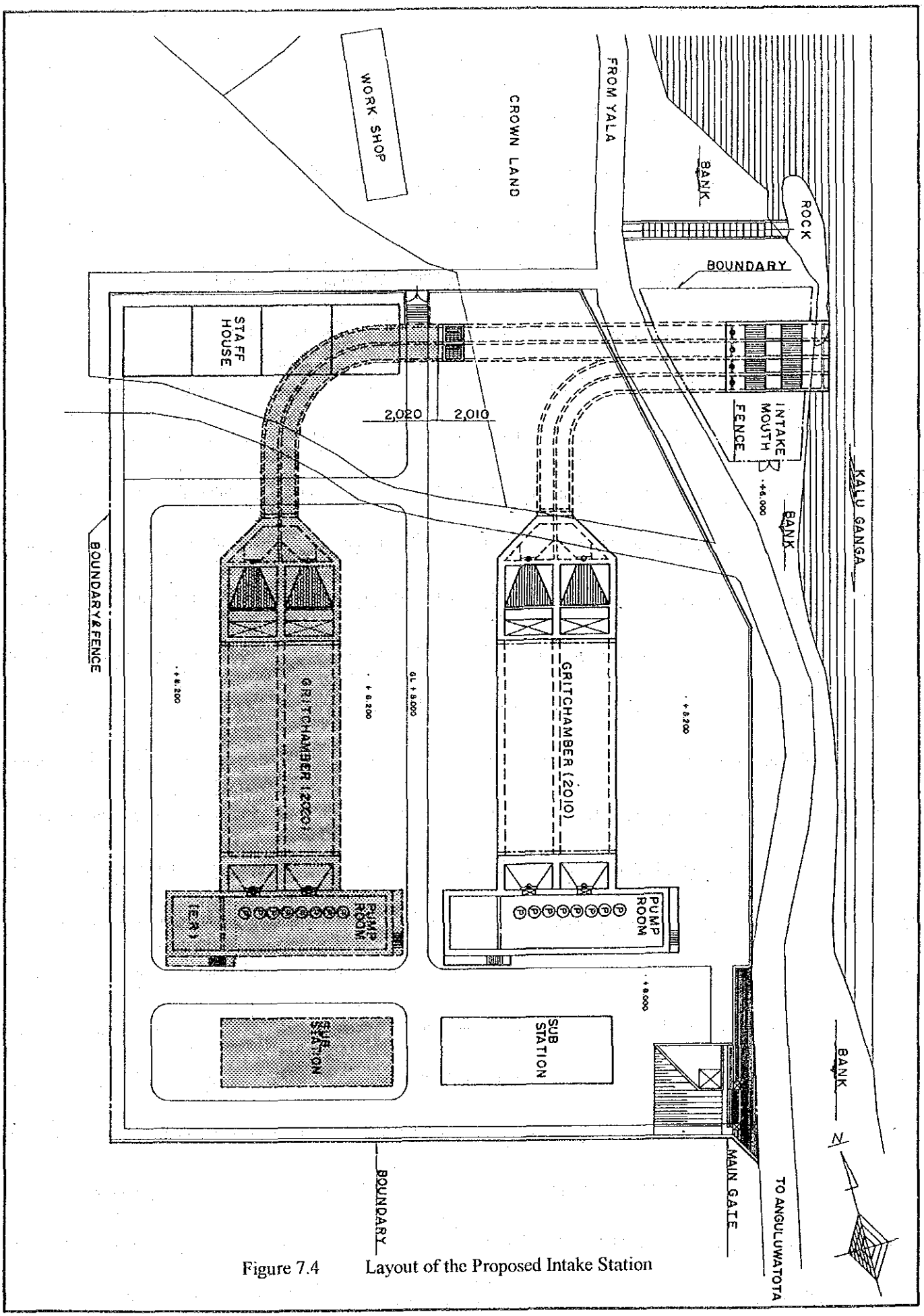


Figure 7.4 Layout of the Proposed Intake Station

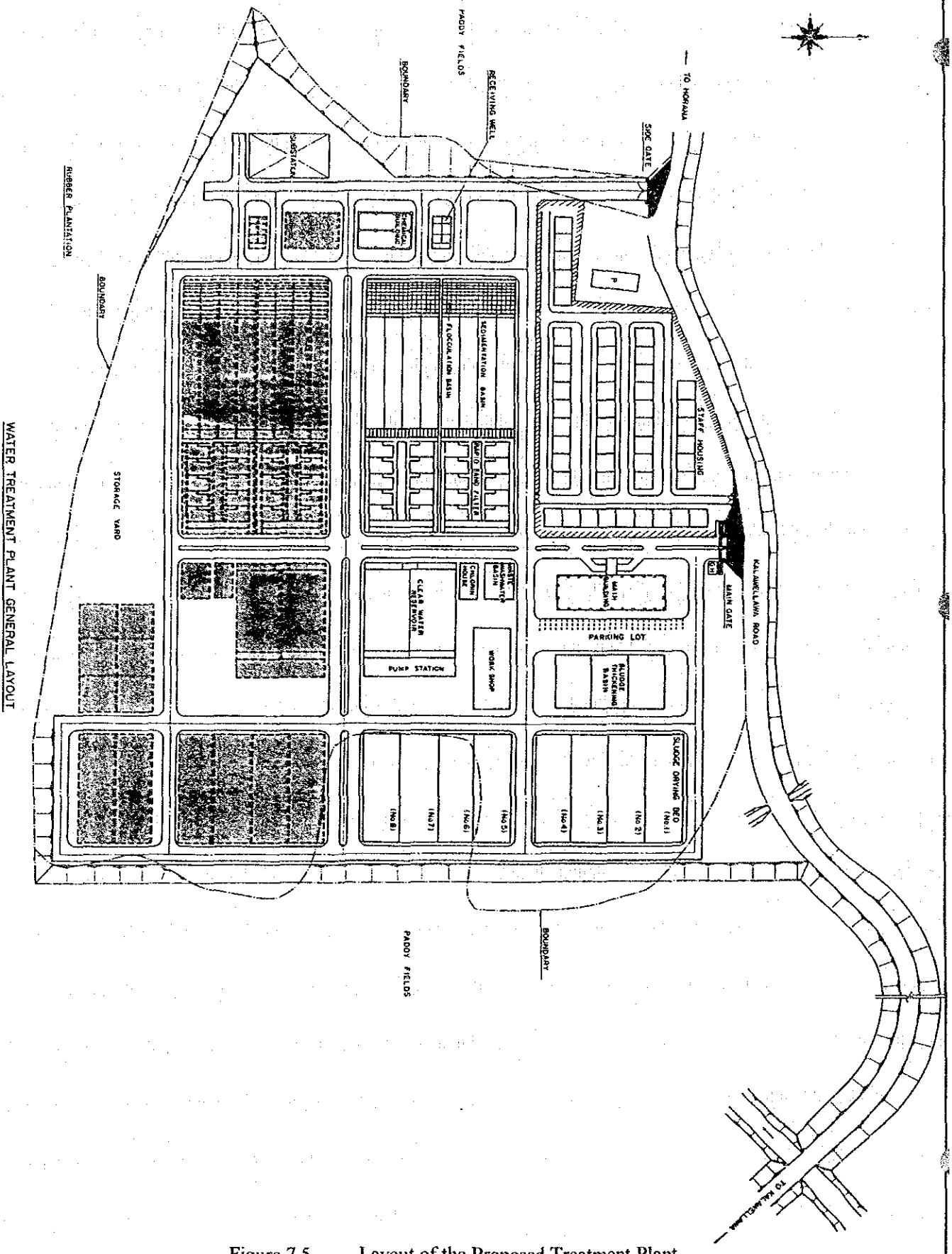


Figure 7.5 Layout of the Proposed Treatment Plant
(to be newly added A3 or A4?)

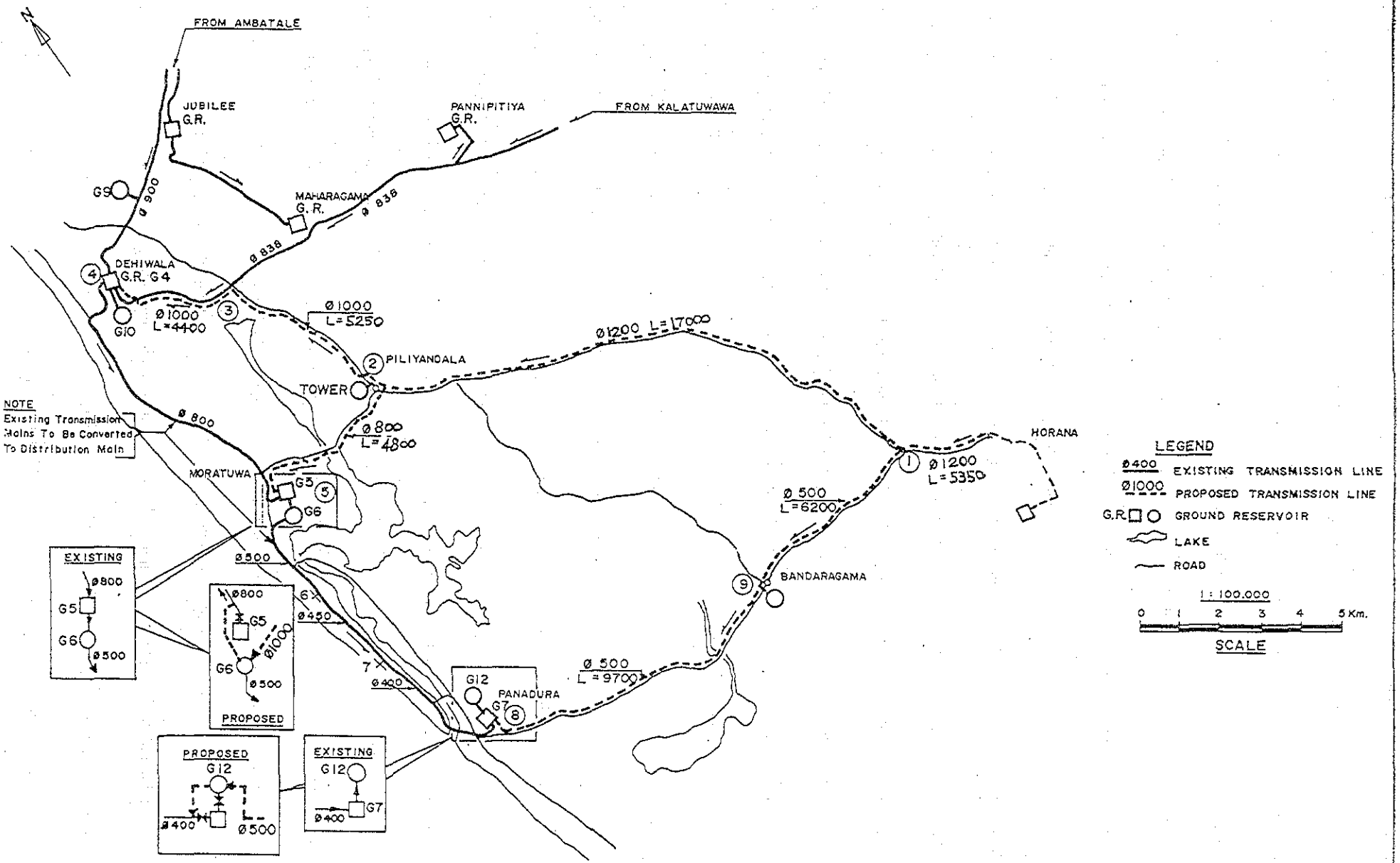


Figure 7.6 Proposed Clear Water Transmission Pipeline

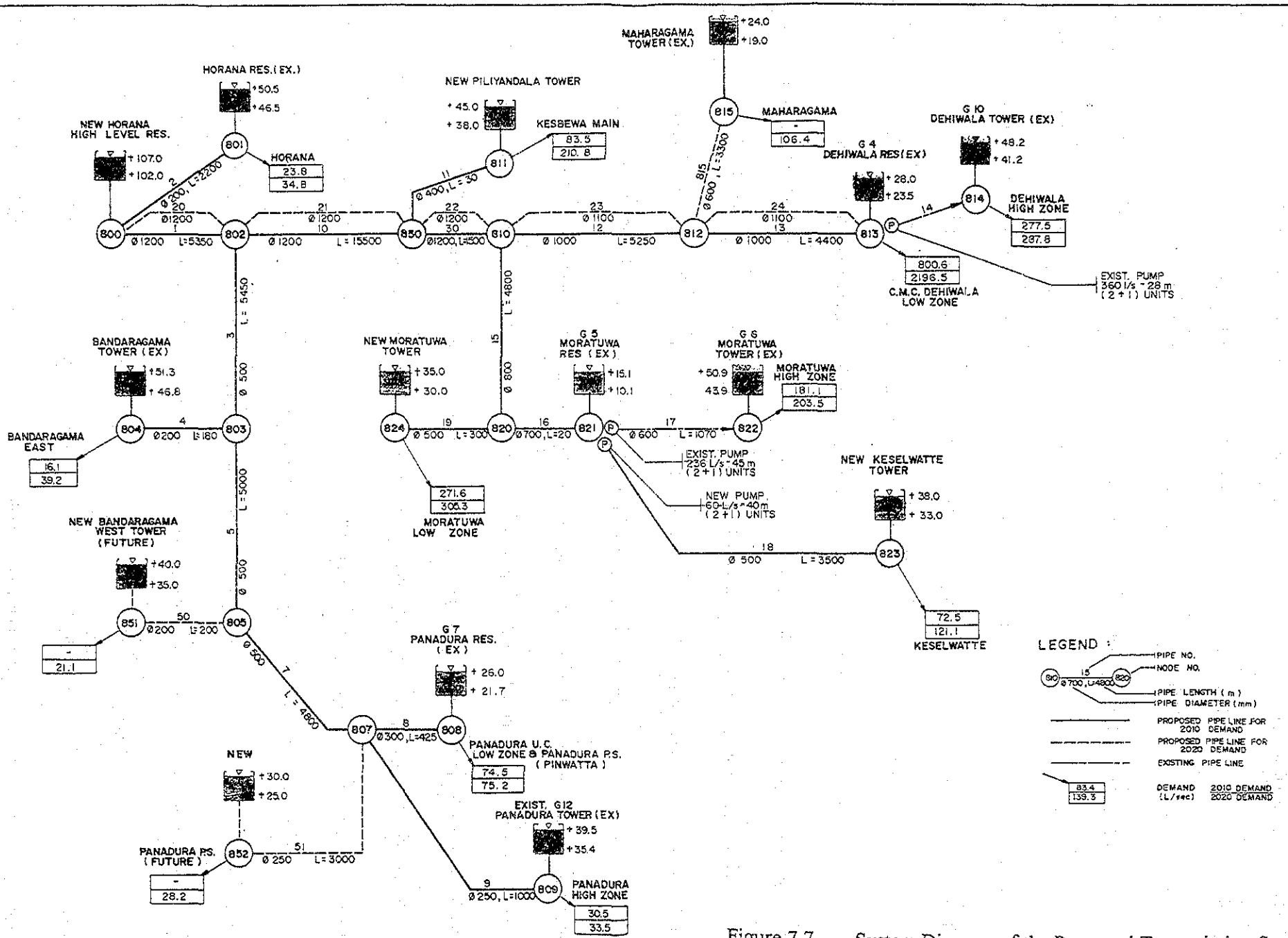


Figure 7.7 System Diagram of the Proposed Transmission System

(3) Panadura Service Area

Panadura service area covers entire Panadura U.C. At present, Panadura area is divided into two pressure zones by elevation. A northern part of Panadura is supplied from water tower G12 which is supplied water from Panadura reservoir G7 by pumping. Reservoir G7 also directly supply the rest of Panadura U.C. by gravity.

The existing zoning is recommended to be used in future distribution.

(4) Kesbewa Service Area

This service area is the area scheduled to be implemented under the Towns South Project under OECF finance.

The area is divided into two sub-areas considering the topography as listed below:

Main Area : Area along Piliyandala road and its surrounding. To be supplied from the proposed new transmission main from the new treatment plant at Horana. It is proposed to construct a water tower which will directly receive water from the new transmission main.

Sub Area : Area located north-eastern. This area is located close to High Level Road so that it is proposed to be supplied water from the Kalatuwawa-Dehiwala transmission main which is running under High Level Road.

(5) Keselwatte Service Area

This area will also be implemented under the OECF financed Towns South Project. This area has a narrow shape along old Galle Road. It is proposed to build a water tower for gravity supply therefrom. Water will be transmitted to the water tower from Moratuwa reservoir by new pumping station.

(6) Homagama Service Area

This area will also be implemented under the OECF financed Towns South Project as well as Keselwatte. Homagama service area covers a central area of Homagama P.S. Treated water is planned to be supplied to a new ground reservoir from the existing Kalatuwawa - Dehiwala main. A high level reservoir is proposed at the elevation of +40m MSL to receive water by pumping from the ground reservoir and distribute it to the service area.

(7) Bandaragama Service Area

There is an existing distribution system at the town center of Bandaragama consisting of deep well, water tower and distribution pipelines. In the future development plan, the water tower is proposed to be supplied water from the proposed transmission main laid from Horana along the national road A8. Some expansion to meet the 2010 demand is proposed to be implemented.

(8) Horana Service Area

The existing Horana water supply system covers the entire Horana U.C. Water taken from Kalu Ganga is conveyed to the high level ground reservoir located at the hill side north of Horana town center. Water is then distributed to the service area by gravity. The existing distribution pipelines will be used for future with necessary reinforcement by constructing additional pipes. There will be no expansion of the service area to outside of Horana U.C. area.

7.3 Phased Implementation Plan

7.3.1 General

The design target years for the Kalu Ganga Water Supply System are set at 2010 for the Feasibility Study and at 2020 for the long term development plan. Based on these design target years, the implementation plan is divided into two Phases: 1) Phase 1 from present to 2010, and 2) Phase 2 from 2011 to 2020. Each phase is further deivided into two stages to reduce the investment in each of the implementation. Staging plan is schematically presnted in Figure 7.9.

Facilities constructed in each stage are summarized in Table 7.2 below.

Table 7.2 Stage Construction Plan

Facilities	Phase 1 (2010)		Phase 2 (2020)	
	Stage 1	Stage 2	Stage 1	Stage 2
Intake Station				
* intake mouth	1/1	-	-	-
* grit chamber	1/2	-	1/2	-
* intake pump	1/4	1/4	1/4	1/4
* pump station	1/2	-	1/2	-
Raw Water Transmission	1 line	-	1 line	-
Treatment Plant				
* major treatment facilities	1/4	1/4	1/4	1/4
* major pump equipment	1/4	1/4	1/4	1/4
* power receiving system	1/1	-	-	-
* major building	1/1	-	-	-
Clear water transmission	to Panadura	to Dehiwala	duplicate to Dehiwala	-
Distribution facilities	Moratuwa	Other areas	reinforcement in each area	

Note: The figures show the rate of facilities to be constructed in the particular stage to the full facilities in 2020.

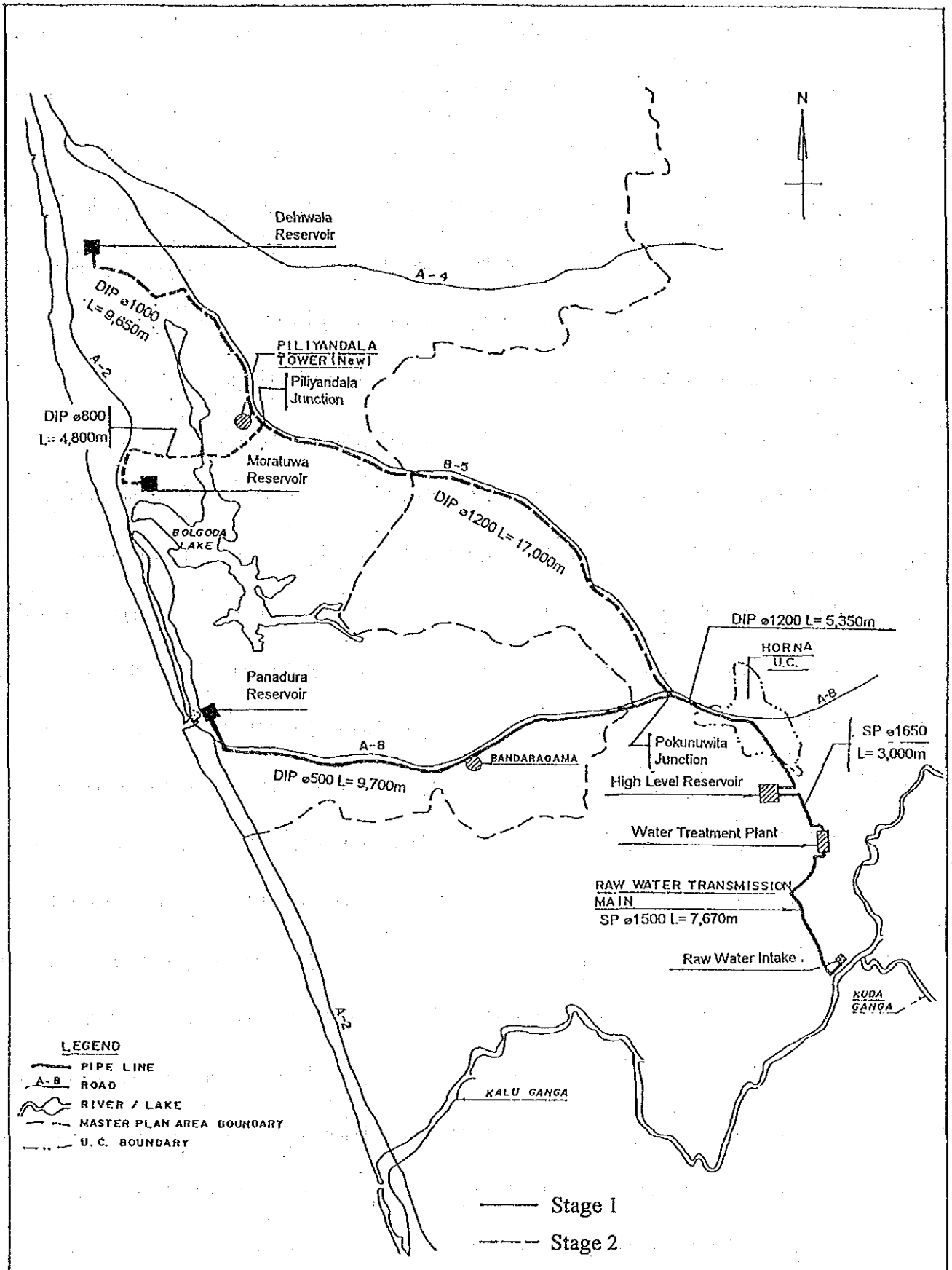
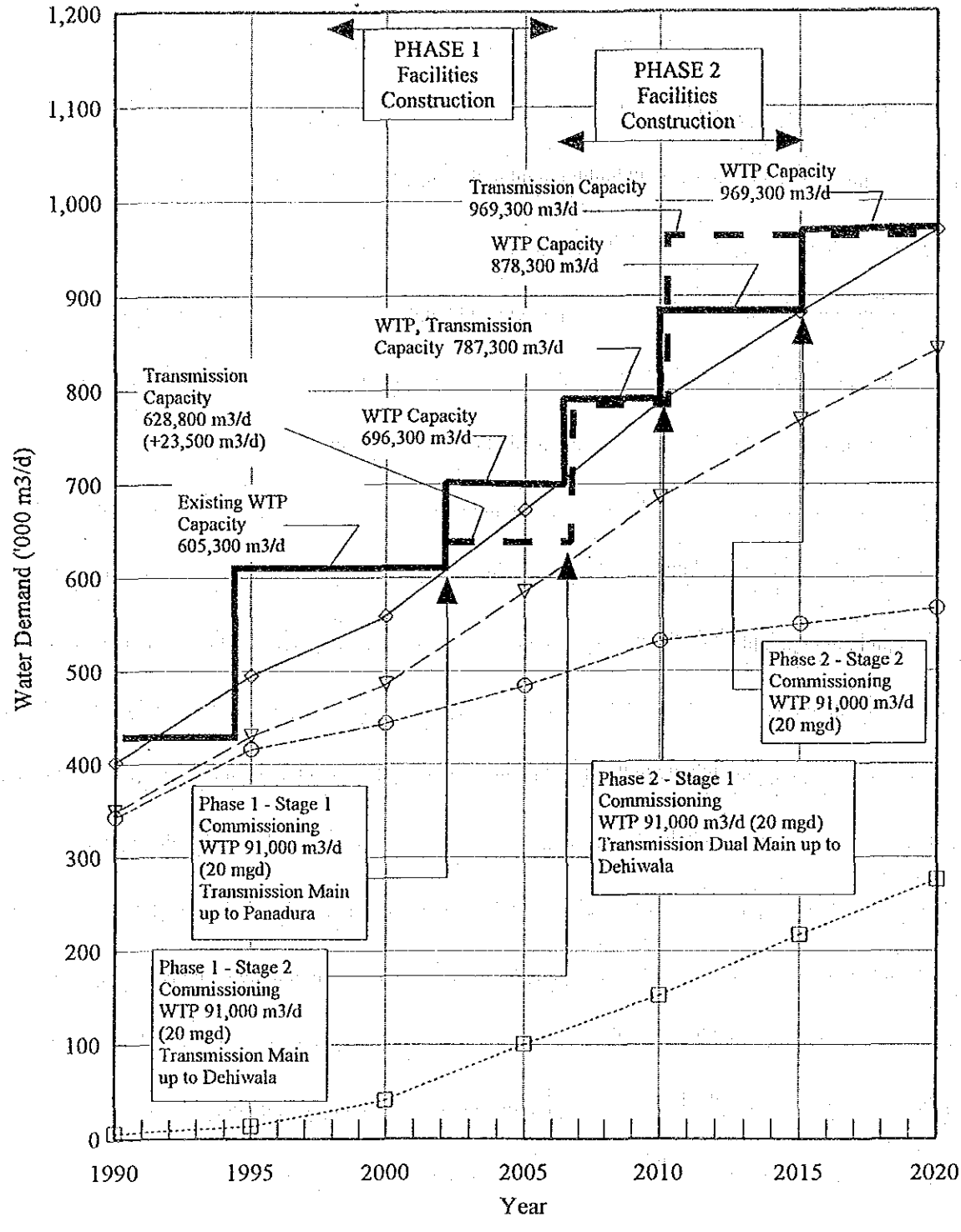


Figure 7.8 Layout of the Kalu Ganga Water Supply System



◈ Daily Max. Demand ▽ Daily Ave. Demand

⊖ Existing Area Demand ⊡ New Area Demand

Figure 7.9 Water Demand Projection and Phased Implementation

7.3.2 Intake Facility

Entire part of the intake mouth for the 2020 demand will be constructed in the first stage. Grit chamber and pumping station will be constructed for the 2010 demand only. Future expansion of grit chamber and pumping station for the 2020 demand will be made in the adjacent site as shown in the layout. Pumps for 2010 demand will be installed in two stages.

7.3.3 Raw Water Transmission Pipeline

Raw water transmission will be carried out by a single pipeline for the 2010 demand and by an additional pipeline to meet the 2020 demand. The first pipeline of a diameter of 1500 mm for the 2010 demand will be constructed in the first stage.

7.3.4 Water Treatment Plant

The treatment plant for the 2010 demand will have a capacity of 40 mgd (182,000 m^3/d). Facilities expanded for the 2020 demand will be constructed in later phase although the layout plan of the plane should consider the entire facilities for the 2020 demand.

For the facilities for Phase 1 (2010 demand), it is proposed to construct 20 mgd of treatment capacity in the first stage and another 20 mgd in the second stage. Buildings which are difficult to divide in two stages will be constructed in the first stage.

Phasing for Phase 2 for the 2020 water demand will likely be implemented in the same manner as the Phase 1 implementation.

7.3.5 Clear Water Transmission Facility

Clear water transmission pipeline is a major part of facility which will need large investment. It is financially effective to divide the pipeline construction into two stages as well as the treatment plant. To avoid a large amount of investment in Stage 1, the following expansion is recommended.

- Extend the 500 mm main from Pokunuwita Junction to Panadura
- Branch line from Piliyandala to Moratuwa is assumed to be constructed in the Towns South Project.
- Extension of the 1200 mm main for Piliyandala and the 1000 mm main for Dehiwala will be made in stage 2.

7.3.6 Distribution Facility

Expansion of distribution system will be made in stage including the Towns South Project which is presently ongoing under the OECF finance and will likely be completed prior to the commencement of the Kalu Ganga Project.

These service areas under the OECF project are all new area as follows:

- Kesbewa Area
- Homagama Area
- Keselwatte Area

Areas other than the scope of the OECF project already have the existing water supply facilities as described in the other part of this report. The scope proposed in the Kalu Ganga Water Supply Project is considered as reinforcement or modification of the existing distribution system to meet the future demand. Such area will be:

- Dehiwala Area
- Moratuwa Area
- Panadura Area
- Bandaragama Area
- Horana Area

Of these areas, Moratuwa area is given high priority for reinforcement of the distribution system since there are fewer pipes in the area compared with the other area and the demand for water supply is high. Moratuwa area is therefore recommended to be included in the first stage implementation while the other areas will be implemented in the second stage.

7.4 Relationship with Other Projects

The Kalu Ganga project is proposed to augment the water production and water supply capacity of the Greater Colombo water supply system. It will provide an additional water source so that the Greater Colombo water supply system will be able to cope with the increasing water demand and proceed with the expansion of the service area.

Along with the need for the Kalu Ganga Water Supply Project, several projects are ongoing in Greater Colombo for the expansion of water supply. Relationship between the Kalu Ganga project and the other projects, particularly the service area expansion projects, is discussed in this section.

(1) Towns East of Colombo Water Supply Project - OECF financed

The service area for this project consists of three areas such as : Battaramulla, Pannipitiya and Kaduwela. Battaramulla service area will be supplied water from Ambatale treatment plant via the new 1100 mm Ambatale-Jubilee transmission main. Pannipitiya and Kaduwela will receive water from

Kalatuwawa - Dehiwala and Kalatuwawa - Maligakande transmission mains, respectively. Therefore, this project will have no direct relation with the Kalu Ganga.

(2) Greater Colombo Water Supply System - Coverage of Southern Urban Areas (Towns South Project) - OECF financed

Under this project, expansion of three service areas will be implemented consisting of Kesbewa, Keselwatte and Homagama. The detailed design for the project is scheduled to commence in 1994. Construction of the distribution facilities is scheduled to be commenced in 1996 and be completed in 1997.

Out of the three service areas, Homagama service area is planned to receive water from the Kalatuwawa - Dehiwala transmission main so that there will be no direct relation with the Kalu Ganga project. Keselwatte is planned to be supplied water from Moratuwa either by pumping from the ground reservoir G5 or by gravity from the water tower G6 depending on the detailed analysis in the detailed design.

Kesbewa is divided in two zones as described in Section 7.2.5. Kesbewa sub-area will be supplied water from the Kalatuwawa-Dehiwala transmission main.

Kesbewa main area was planned, in the Master Plan Update, to be supplied from new Jubilee reservoir via a 700 mm new transmission main since there was no other source considered to obtain water at the time of the preparation of the feasibility study for the Tows South Project. This area is however proposed in the Kalu Ganga Project to receive water from the new Kalu Ganga system via the new transmission main connecting Horana and Dehiwala. This scheme is contradicted from the original transmission plan for Kesbewa which proposed the 700 mm transmission main to be constructed. Water transmission for Kesbewa from the Kalu Ganga system is however more economical and technically reasonable if the Kalu Ganga Project is to be implemented.

The original scheme (Jubilee to Kesbewa) was proposed before the commencement of this feasibility study on the Kalu Ganga Project so that it does not suit the development planning of the Kalu Ganga Project.

As an alternative, water transmission from Maharagama reservoir to Kesbewa shows the minimum cost. Although this plan will need construction of a pipeline for temporary transmission from Maharagama to Piliyandala, this pipeline may be able to transfer to distribution main when the Kalu Ganga water will be supplied to Kesbewa. With this water transmission, the two existing transmission

mains to Dehiwala reservoir (from Ambatale and from Kalatuwawa) will be used as it is presently used without increase in transmission amount for Kesbewa or Keselwatte.

This alternative transmission plan is therefore recommended to be implemented in the Towns South Project from a view point of economical investment.

CHAPTER 8

SCOPE OF WORK FOR THE FEASIBILITY STUDY

8. SCOPE OF WORK FOR THE FEASIBILITY STUDY

8.1 Service Area

Areas to be covered in the Feasibility Study are as follows:

Dehiwala-Mt. Lavinia M.C.
Moratuwa U.C.
Panadura U.C.
Kesbewa P.S.
Panadura P.S. (including Keselwatte)
Homagama P.S.
Bandaragama P.S.
Horana U.C.

8.2 Population Served by the Project

Served population which will receive direct benefit from the Kalu Ganga Water Supply System is projected as follows:

Service area	Year		
	2005	2010	2020
C.M.C.	0	134,311	450,131
Dehiwala M.C.	11,426	160,779	243,750
Moratuwa U.C.	168,171	175,950	182,610
Panadura U.C.	38,600	38,600	39,300
Kesbewa P.S.	26,226	43,169	91,388
Panadura P.S. (including Keselwatte)	23,508	34,084	59,460
Bandaragama P.S.	2,908	5,546	19,426
Horana U.C.	12,298	13,552	16,290
Total (rounded)	283,000	606,000	1,102,000

Note: Populations of C.M.C. and Dehiwala are projected from the proportion of water demand to be supplied from the Kalu System.
Homagama is excluded from the served population projection since it will be supplied from Kalatuwawa.

8.3 Water Demand

The water demand for the Kalu Ganga Water Supply System is projected at:

67,000 m^3/d (14.7 mgd) for 2005
182,000 m^3/d (40 mgd) for 2010

8.4 Facilities to be Involved

The facilities to be examined in the Feasibility Study shall be as follows:

1) Intake Facilities

Intake station with a intake capacity of 191,100 m^3/d for the 2010 water demand

2) Raw Water Transmission Facilities

Pipeline dia. 1,500 mm x approx. 7,670 m

3) Treatment Facilities

Water treatment plant with a treatment capacity of 182,000 m^3/d for the 2010 water demand

4) Clear Water Transmission Facilities

	From	To
1.	Water Treatment Plant	High Level Reservoir
2.	High Level Reservoir	Pokunuwita Junction
3.	Pokunuwita Junction	Piliyandala
4.	Piliyandala	Dehiwala
5.	Piliyandala	Moratuwa
6.	Pokunuwita Junction	Panadura

5) Storage Facilities

High level reservoir
Tower for Moratuwa low zone
Tower for Kesbewa main area
Ground reservoir and tower for Kesbewa sub area with pumping station
Ground Reservoir and high level reservoir for Homagama with pumping station
Tower for Keselwatte

6) Distribution Facilities

CHAPTER 9

DESIGN OF FACILITIES

9. DESIGN OF FACILITIES

9.1 Intake Facilities

Major facilities and equipment at the intake station for the 2010 intake amount is as shown in Table 9.1.

Table 9.1 Major Facilities and Equipment at the Intake Station

Name	Dimensions/Spec.	No. of Unit	Remarks
Intake Mouth	3.0mW x 10.1mH x 14.6mL x 4 lanes	1	w/ stop logs and screens v = 27 cm/s
Intake Box Culvert	box culvert 3.0mW x 2.4mH x 26.9mL x 2 lanes	1	v = 27 cm/s
Grit Chamber	parallel flow, rectangular 7.0mW x 7.0mH x 54.7mL	2	v = 5.3 cm/s
Pump Well	30.8mW x 13.4mH x 8.0mL	1	
Pumping Station	32.0mW x 9.2mD x 7.5mH	1	
Intake Pump	Vertical mixed flow pump 22.1 m^3/min, H = 29 m	8	Motor 160 kw, 6kV
Power Receiving Equip.		1	

W : width H : height D : depth L : length v : velocity

9.2 Raw Water Transmission Facilities

One pipeline will be constructed for convey the amount of 2010 demand.

Pipeline Details

Number of pipeline	:	1 line
Diameter	:	1500 mm
Length	:	7,670 m
Pipe material	:	Mild steel (welding joint)
Flow	:	Pumping from the raw water intake
Maximum velocity	:	1.3 m/sec

9.3 Treatment Facilities

Major facilities and equipment of the treatment plant for Phase 1 (2010 demand) are summarized in Table 9.2.

Table 9.2 Major Facilities and Equipment of Treatment Plant (Phase 1)

Facility	Dimension/Spec.	No. of Unit	Remark
Receiving Well	3.0mW x 2.0mL x 4.0mD	1	
Hydraulic Rapid Mixer	1.0mW x 5.0mL x 1.1mD	2	
Flow Splitting Chamber	4.45W x 4.65mL x 1.5mD	1	
Hydraulic Flocculation Basin	Vertical flow type 10.0mW x 13.8mL x 3.5mD		mean velocity = 15 - 30 cm/s
Sedimentation Basin	Horizontal Flow 10mW x 68mL x 4.5mD	8	with mechanical sludge scraper
Rapid Sand Filters	constant rate, variable head, self-backwashing type	20	filtering rate = 120 m/d = 5.0 m/h
Clear Water Basin	46.5mW x 60.5 mL x 4.0mD	1	
Sludge Thickening Basin	20mW x 30mL x 3.0mD	3	
Sludge Drying Bed	20mW x 60mL x 2.0mD	8	
Main Building	1000 m^2	1	
Chemical House	600 m^2	1	
Chlorine House	200 m^2	1	
Transmission Pump	Horizontal centrifugal pump 21.1 m^3/min, H=104m	8	Motor 560 kw, 6kV

9.4 Clear Water Transmission

One pipeline will be constructed for convey the amount of 2010 demand.

Pipeline Details

1) Treatment Plant to High Level Reservoir

Number of pipeline	:	1 line
Diameter	:	1650 mm
Length	:	3,000 m
Pipe material	:	Mild steel (welding joint)
Flow	:	Pumping from the treatment plant
Maximum velocity	:	0.99 m/sec

2) After High Level Reservoir

All routes will be one line and will be of ductile iron. Other details are summarized in Table 9.3 below:

Table 9.3 Summary of Proposed Transmission Pipeline Details
(After High Level Reservoir)

Route	Dia. (mm)	Length (m)	Flow	Max. Velocity (m/sec)
H.L.R. to Pokunuwita Junc.	1200	6,680	Gravity	1.84
Pokunuwita Junc. to Piliyandala	1200	17,000	Gravity	1.74
Piliyandala to Dehiwala	1000	9,580	Gravity	1.66
Piliyandala to Moratuwa	800	4,800	Gravity	1.44
Pokunuwita Junc. to Panadura	500	15,250	Gravity	1.15
Branch Connection to Moratuwa New Tower from 800 mm main	500	50	Gravity	1.55
Branch Connection to Piliyandala New Tower from 1200 mm main	400	800	Gravity	1.68
Branch Connection to Homagama New G.R. from Kalatuwawa main	400	200	Gravity	0.87
Moratuwa Res. to Keselwatte Tower	350	3,500	Pumping	1.26
Branch Connection to Kesbewa Sub Area G.R. from Kalatuwawa main	300	1,000	Gravity	1.34
Branch Connection to Bandaragama Tower from 500 mm main	200	180	Gravity	1.25
Branch Connection to Horana G.R. from 1200 mm main	200	2,200	Gravity	1.11

9.5 Storage Facilities

Table 9.4 shows a summary of storage facility proposed for the project.

Table 9.4 Summary of Proposed Storage Facility

Area	Facility	Capacity	Water Level T.W.L. B.W.L.	Retention Time for 2010 demand for 2020 demand
High Level Reservoir	Ground Reservoir	30,000 m^3	+107.0 m +102.0 m	4.0 hours 4.0 hours
Dehiwala	-	-		
Moratuwa Low Zone	Tower	2,000 m^3	+35.0 m +30.0 m	2.0 hours**) 1.8 hours**)
High Zone	-	-		
Panadura	-	-		

Table 9.4 Summary of Proposed Storage Facility (cont'd)

Area	Facility	Capacity	Water Level T.W.L. B.W.L.	Retention Time for 2010 demand for 2020 demand
Kesbewa Main Area	Tower	2,000 m^3	+45.0 m +40.0 m	6.6 hours**) 2.6 hours**)
Sub Area	Ground Reservoir	2,000 m^3	+20.0 m +15.0 m	13.3 hours 6.8 hours
	Pumping Station	40 l/sec h = 30 m n = 3 units		
	Tower	1,000 m^3	+43.0 m +38.0 m	26.6 hours 13.6 hours
Homagama	Ground Reservoir	1,500 m^3	+30.0 m +25.0 m	9.0 hours 4.4 hours
	Pumping Station	30 l/sec h = 25 m n = 3 units		
	High Level Reservoir	1,500 m^3	+47.0 m +42.0 m	9.0 hours 4.4 hours
Keselwatte	Tower	2,000 m^3	+38.0 m +33.0 m	7.7 hours**) 4.6 hours**)

Note: Effective retention time marked **) should be added 4.0 hours for the retention in the High Level Reservoir at Horana.
Facilities for Kesbewa, Homagama and Keselwatte will be constructed under the Towns South Project.

9.6 Distribution Facilities

Distribution facilities required for development along with the Kalu Ganga Water Supply Project is summarized as shown in Table 9.5.

Table 9.5 Summary of Distribution Pipeline

Service Area	dia. (mm)	material	length (m)
Dehiwala M.C.			
High Zone	300 - 250	DI	750
	200 - 110	PVC	2,680
	90*)	PVC	22,500
Low Zone	700 - 250	DI	7,140
	200 - 110	PVC	4,020
	90*)	PVC	33,500
North Zone	250	DI	360
	200 - 150	PVC	4,210
	90*)	PVC	20,000

Table 9.5 Summary of Distribution Pipeline (cont'd)

Service Area	dia. (mm)	material	length (m)
Moratuwa U.C.			
High Zone	250	DI	650
	200 - 110	PVC	7,340
	90*)	PVC	71,000
Low Zone	600 - 250	DI	6,840
	200 - 150	PVC	8,550
	90*)	PVC	85,000
Panadura U.C.			
High Zone	200 - 110	PVC	2,590
	90*)	PVC	22,000
Low Zone	400 - 250	DI	940
	200 - 110	PVC	3,040
	90*)	PVC	43,000
Kesbewa			
Main Area	600 - 250	DI	4,200
	200 - 110	PVC	19,450
	90*)	PVC	125,000
Sub Area	300 - 250	DI	2,850
	200 - 110	PVC	9,340
	90*)	PVC	41,300
Keselwatte	600 - 250	DI	5,550
	200	PVC	9,550
	90*)	PVC	90,000
Homagama	450 - 250	DI	1,910
	200 - 110	PVC	20,610
	90*)	PVC	93,000
Bandaragama	110	PVC	1,340
	90*)	PVC	12,250
	63**)	PVC	3,340
Horana	150 - 110	PVC	3,540
	90*)	PVC	5,000

*) PVC pipe dia. 90 mm is provided for branch pipe (in provisional quantity)

**) PVC pipe dia. 63 mm for Bandaragama is taken from the design by NWSDB.

CHAPTER 10

OPERATION AND MAINTENANCE PROGRAM

10. OPERATION AND MAINTENANCE PROGRAM

10.1 Operation and Maintenance of Facilities

The water supply facilities should be kept such conditions through proper operation and maintenance as to show the given function at any time, namely as to supply enough good water for water demand with pressures required.

Any omission or negligence of such proper operation and maintenance may lead to the unexpected damage to not only the users but also the water supply facilities and may take much time and money for their restoration.

The facility maintenance to keep the function of each facility and equipment is mainly composed of patrol/inspection and maintenance. Patrol/inspection is done to check the normality of the function, working condition, etc. of each facility and equipment, while maintenance is conducted to keep the normal function of each facility and equipment through cleaning, overhaul and preventive measures.

Detailed operation and maintenance program for intake and treatment plant is presented in Volume II, Main Report.

10.2 Operation and Maintenance in Emergency

10.2.1 Against Flood

As the intake station and water treatment plant are located in the flood area, the proposed designs take account of the 100 year maximum flood level for preventing the important facilities from inundation by raising the elevation of structural walls and floor level of the buildings for the intake station and filling the ground for the water treatment plant.

10.2.2 Against Salinity Intrusion

The preliminary salinity intrusion analysis shows that the upper level of the salinity wedge is -1.06 m MSL under the conditions of an annual minimum river flow of 14.4 m^3/s for a return period of ten years and an annual mean high tide of +0.32 m MSL. At this time the fresh water depth is approximately 1.4 m. The key location to identify the salinity wedge is a wide area of shallow bed immediately downstream of the Narthupana Bridge as shown in Figure 6.2 in Chapter 6. This area is expected to act as a natural barrier against the salinity intrusion.

When the water level of the Kalu Ganga near the intake point drops below +1.0 m MSL during the drought and the salinity wedge goes upstream over this point, there may be a possibility that saline water wedge will reach the intake point. It is recommended that the river water should be sampled

frequently at the several depths near the Narthupana Bridge and at the intake mouth to check the movement of the salinity wedge. Although the level of the intake mouth is planned to prevent the salt water intrusion, if the level of the saline wedge is observed higher than expected, the stop logs may be used to raise the bottom elevation of the intake mouth. Such a preventive system should be kept until the water depth near the intake point will rise above +1 m MSL.

10.3 Water Quality Control

The objective of water quality control in water supply is to keep the water to be supplied in a clean and safe condition. The water quality of the effluent of each facility is a good indicator to know whether the particular facility is properly operated and maintained. A water quality surveillance program is presented in Volume II, Main Report.

10.4 Staff Requirement

The proposed Kalu Ganga Water Supply System is composed of the following facilities:

1) Intake station (new)
2) Raw water transmission main (new)
3) Water treatment plant (new)
4) Clear water transmission main 1 (new)
5) High level reservoir (new)
6) Clear water transmission main 2 (existing and new)
7) Distribution reservoir (new)
8) Distribution pipes (existing and new)

The construction of the Kalu Ganga Water Supply System will take long years from the commencement to the completion and the staff requirement for the Project implementation varies depending its phase such as before, during and after construction. As the NWSDB itself has a number of engineers and also the consulting engineers are expected to be hired in the course of the implementation of such a big Project, the staff to be newly recruited is considered to be mainly those who will be engaged in the operation and maintenance of the system.

The staff requirement is determined based on the comprehensive consideration for the structure of the overall system, layout of facilities, scale of the plant, composition of treatment processes, management system, working custom and so on. The facilities which require the stationed engineers/ operators/workers are the intake station, water treatment plant, high level reservoir and distribution reservoirs. As for the transmission and distribution pipelines, the existing organization concerned of the NWSDB is considered to cope with them.

The proposed organization for the Kalu Ganga Water Supply System under the Regional Support Center (Greater Colombo) is shown in Figure 10.1.

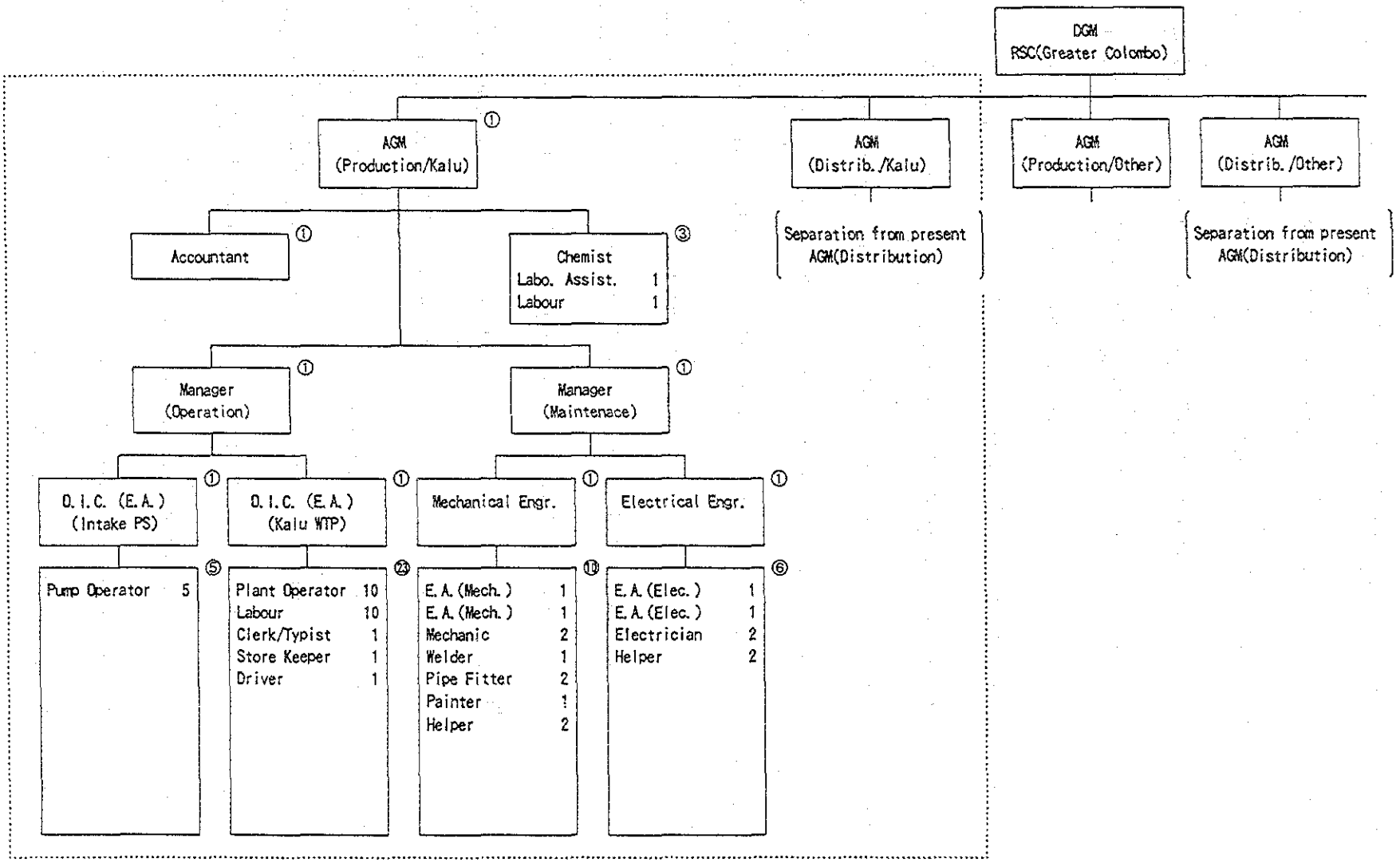


Figure 10.1 Proposed Organization for Kalu Ganga Water Supply System

CHAPTER 11

IMPLEMENTATION PLAN

11 IMPLEMENTATION PLAN

11.1 Implementation Plan and Schedule

The project is planned to be implemented divided into two phases on the basis of the design target years of 2010 for the Feasibility Study and of 2020 for the long term development plan with the following size of requirement.

Phase 1 (2010) : 182,000 m^3/day (40.0 mgd)
Raw water intake, 2.1 m^3/s

Phase 2 (2020) : 364,000 m^3/day (80.0 mgd)
Raw water intake, 4.2 m^3/s

Further, it is planned to construct most facilities in four stages by dividing each phase into two stages so that the initial investment will be almost leveled in each stage. Implementation periods of one stage is assumed at seven years including its design and tender processes. The proposed staging plan is summarized in Table 11.1 and shown in Figure 11.1.

Table 11.1 Staging Plan

Facilities	Phase 1 (2010)	
	Stage 1	Stage 2
Intake facilities		
* intake mouth	4/4	-
* grit chamber	2/4	-
* intake pump	4/16	4/16
* pump station	1/2	-
Raw water transmission	1 line	-
Treatment facilities		
* receiving well	1/2	-
* sedimentation basin	4/16	4/16
* filter	10/40	10/40
* clear water reservoir	1/2	-
* high lift pump	4/16	4/16
* sludge drying bed	4/16	4/16
* chemical building	1/2	-
* administrative building	1/1	-
* storehouse/workshop	1/1	-
* staff housing	45/56	11/56
* power receiving system	1/1	-
Clear water transmission	to Panadura	to Dehiwala
Distribution facilities	Moratuwa	Other areas

Note: numerator no. of units to be constructed/equipped in the particular stage
denominator no. of units in the year of 2020

The proposed implementation schedule of stage 1 and 2 of phase 1 is presented in Figure 11.2, having basic consideration of 1) required water demand and project size, 2) commissioning time of other water

supply projects, 3) construction period in each stage, 4) investment cost in each stage, and 5) loan repayment projection of the NWSDB.

11.2 Mode of Implementation

The fund required for the project implementation will be provided by the Government national budget of Sri Lanka and/or supporting loan from donor country/ies and/or other agency/ies. The construction works of stage 1 of phase 1 will be conducted by selected contractor/s through prequalification of bidders and international competitive bidding (ICB) and be divided into the following contract packages taking into account the advantages in technical and economical aspects, in terms of nature of works, size of contract, to avoid less attractive to the international construction companies and other factors affecting.

Package A : Intake station, raw water transmission main and clear water transmission main to the high level reservoir.

Package B : Water treatment plant and high level reservoir.

Package C : Clear water transmission main from the high level reservoir to the Panadura reservoir and distribution facilities.

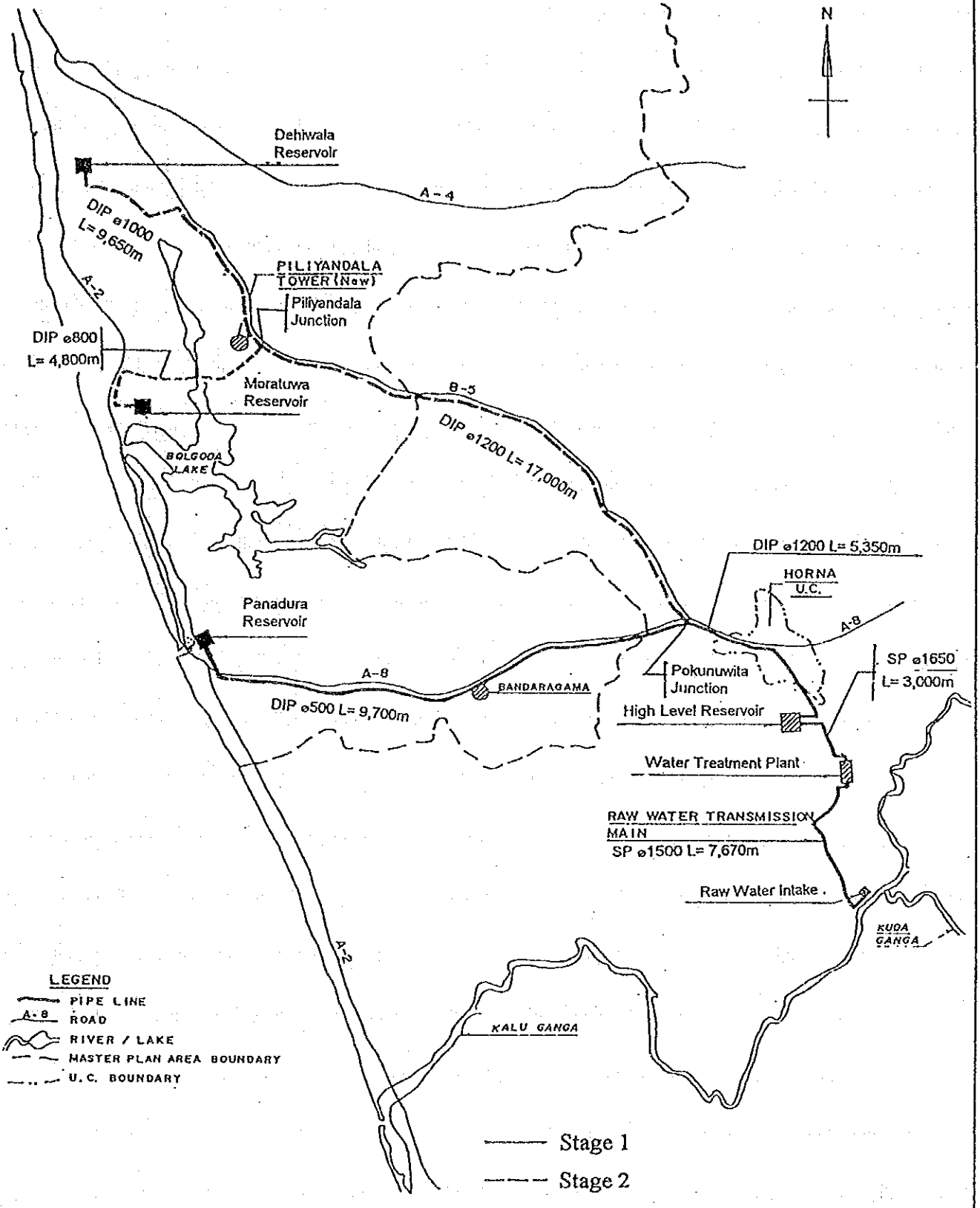


Figure 11.1 Staging Plan for Transmission Mains

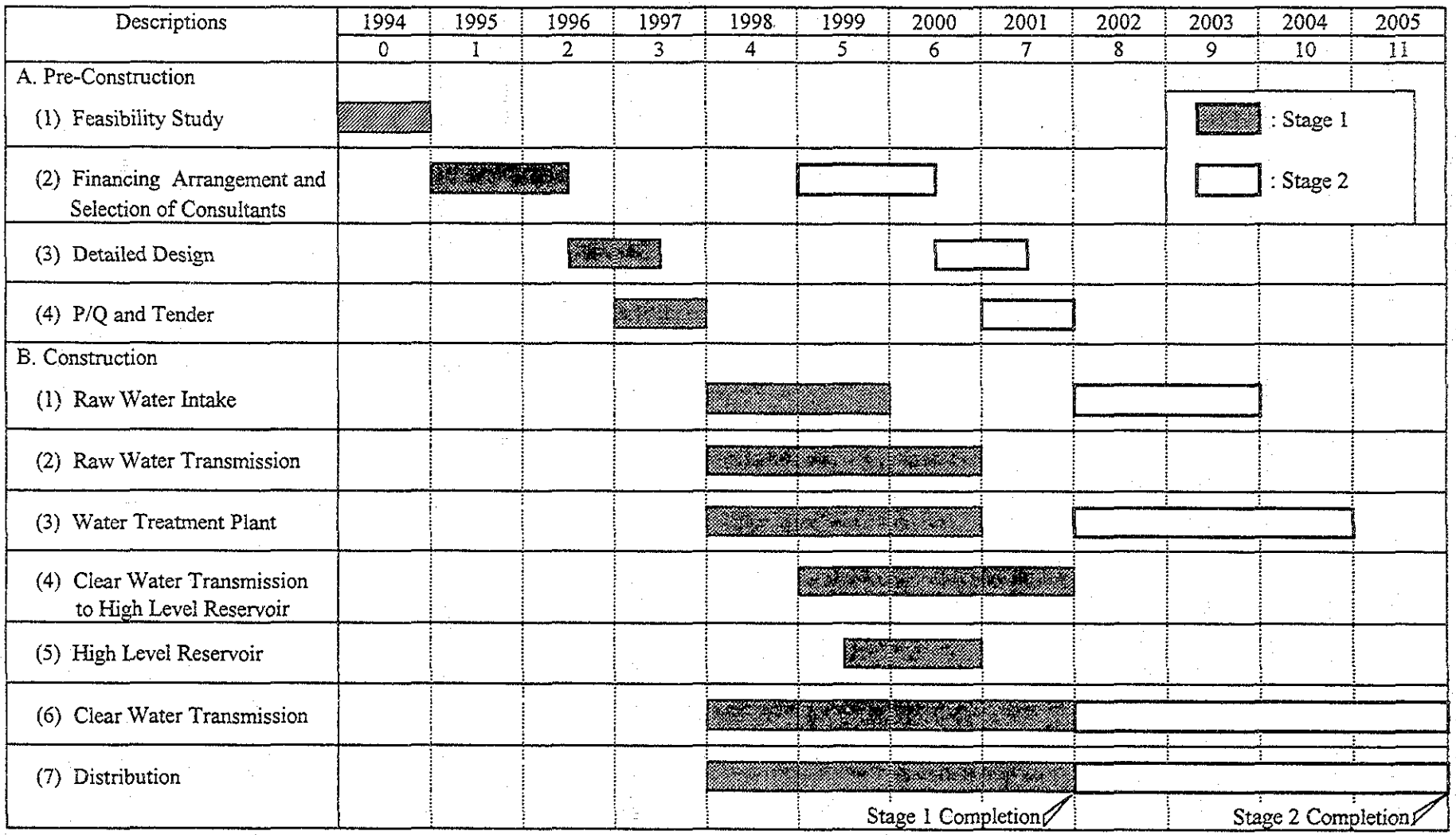


Figure 11.2 Implementation Schedule, Phase 1 (2010 Demand)

CHAPTER 12

PROJECT COST ESTIMATES

12 PROJECT COST ESTIMATES

12.1 Composition of Project Cost

The project cost comprises the following cost items.

1) Direct construction cost
   - preliminary and general
   - direct construction cost
   - Business Turnover Tax (B.T.T.)
2) Land acquisition and compensation costs
3) Government's administration expenses
4) Engineering services expenses
5) Staff training cost
6) Price contingency
7) Physical contingency

12.2 Conditions and Assumptions for Cost Estimate

1) Price level : June 1994
2) Foreign exchange : US$ 1.0 = Rs 49.0 = Y 106.0
3) Devaluation : 5.4 % (average of 1990-1993)
4) Foreign and local currency portions ;

   The project cost was estimated divided into the foreign currency portion (F.C.) and local currency portion (L.C.) categorizing the fund by foreign donor/s into the foreign currency portion. The unit construction cost were divided into the F.C and L.C with certain ratio of it which was assumed taking into account the following factors and other projects being implemented currently.

   - availability of skilled and common labours
   - productivity and availability of construction materials in domestic market
   - productivity and availability of construction plant and equipment

5) Custom duty : 20 %
6) Interest during construction : not accounted
7) Land acquisition and compensation costs

   The land acquisition cost was estimated by unit cost basis refering cost data from the NWSDB, and compensation cost was estimated by lump sum basis.

8) Government's administration expenses

   15 % of the local direct construction cost

9) Engineering services expenses

   10 % of the direct construction cost

10) Staff training cost

    1 % of the direct construction cost

11) Price contingency

F.C : 2.1 %/year
L.C : 7.4 %/year

12) Physical contingency

10 % of the direct construction cost

12.3 Project Cost

The project cost in phase 1 was worked out as summarized in Table 12.1, and tabulated in Table 12.2 and 12.3 for Stage 1 and Stage 2, respectively.

Table 12.1 Summary of Project Cost, Phase 1 (for 2010 demand)

unit : million

Stage	F.C. Portion (yen)	L.C. Portion (Rs.)	Total (Rs. equivalent)
Stage 1	10,797	3,508	8,499
Stage 2	7,148	3,110	6,414
Total of Phase 1	17,945	6,618	14,913

Among the project financial cost, the direct construction cost was estimated at equivalent Rs.5,620 million for Stage 1 and Rs. 3,556 million for Stage 2, respectively.

12.4 Disbursement Schedule

A disbursement schedule was provided following to the proposed implementation schedule as tabulated in Table 12.4 and 12.5 for Stage 1 and Stage 2, respectively.

Table 12.2 Project Cost for Stage 1 of Phase 1 (2010)

(unit : thousand)

Code	Cost Item	F.C. Portion (yen)	L.C. Portion (Rs.)	Total (Rs. equiv.)
100	Direct Construction Cost			
101	General	183,200	181,000	265,687
102	Intake Facilities	895,457	101,971	515,909
103	Raw Water Transmission Main	1,388,385	303,855	945,656
104	Treatment Facilities	2,797,623	379,410	1,672,651
105	Clear Water Transmission Main from WTP to HLR	628,956	137,652	428,396
105	High Level Reservoir	623,070	133,974	421,997
106	Clear Water Transmission Main from HLR to the Service Area	1,210,706	264,970	824,636
107	Distribution Facilities	247,537	166,089	280,516
	Total of 101 to 107	7,974,934	1,668,921	5,355,447
108	B.T.T. (5%)	0	264,695	264,695
100	Total of Direct Construction Cost	7,974,934	1,933,616	5,620,142
200	Land Acquisition and Compensation	0	58,685	58,685
300	Administrative Expenses	0	290,042	290,042
400	Engineering Services	972,628	112,403	562,014
450	Staff Training Cost	97,263	11,240	56,201
	Subtotal	9,044,825	2,405,986	6,587,084
500	Price Contingency	771,094	782,903	1,139,363
600	Physical Contingency	981,592	318,889	772,657
	Total Project Cost	10,797,511	3,507,778	8,499,231

Table 12.3 Project Cost for Stage 2 of Phase 1 (2010)

(unit : thousand)

Code	Cost Item	F.C. Portion (yen)	L.C.Portion (Rs.)	Total (Rs. equiv.)
100	Direct Construction Cost			
101	General	130,000	43,600	103,694
102	Intake Facilities	188,770	9,530	96,792
103	Raw Water Transmission Main	0	0	0
104	Treatment Facilities	1,198,739	98,540	652,674
105	Clear Water Transmission Main from WTP to HLR	0	0	0
105	High Level Reservoir	0	0	0
106	Clear Water Transmission Main from HLR to the Service Area	3,038,052	664,901	2,069,284
107	Distribution Facilities	276,977	338,368	466,405
	Total of 101 to 107	4,832,538	1,154,939	3,388,848
108	B.T.T. (5%)	0	167,577	167,577
100	Total of Direct Construction Cost	4,832,538	1,322,516	3,556,425
200	Land Acquisition and Compensation	0	0	0
300	Administrative Expenses	0	198,377	198,377
400	Engineering Services	615,479	71,129	355,643
450	Staff Training Cost	61,548	7,113	35,564
	Subtotal	5,509,565	1,599,135	4,146,009
500	Price Contingency	988,594	1,227,872	1,684,877
600	Physical Contingency	649,816	282,701	583,097
	Total Project Cost	7,147,975	3,109,975	6,414,060

Table 12.4 Disbursement Schedule, Stage 1 of Phase 1 (2010)

unit: million

Code	Cost Item	Total		1996		1997		1998		1999		2000		2001	
		F.C (yen)	L.C (Rs.)	F.C (yen)	L.C (Rs.)	F.C (yen)	L.C (Rs.)	F.C (yen)	L.C (Rs.)	F.C (yen)	L.C (Rs.)	F.C (yen)	L.C (Rs.)	F.C (yen)	L.C (Rs.)
100	Direct Construction Cost	7,975	1,934	0	0	0	0	3,190	773	2,392	580	1,595	387	797	193
200	Land Acquisition and Compensation Cost	0	59	0	29	0	29	0	0	0	0	0	0	0	0
300	Government's Administrative Expenses	0	290	0	29	0	29	0	58	0	58	0	58	0	58
400	Engineering Service	973	112	292	34	97	11	146	17	146	17	146	17	146	17
450	Staff Training Cost	97	11	0	0	0	0	24	3	24	3	24	3	24	3
	Sub-Total	9,045	2,406	292	92	97	70	3,360	851	2,563	658	1,765	464	968	271
500	Price Contingency	771	783	6	7	4	11	215	203	223	218	194	199	129	145
600	Physical Contingency	981	319	30	10	10	8	357	105	279	87	196	66	110	42
	Grand Total	10,798	3,508	328	109	111	88	3,933	1,160	3,064	963	2,155	730	1,206	458

Table 12.5 Disbursement Schedule, Stage 2 of Phase 1 (2010)

unit: million

Code	Cost Item	Total		2000		2001		2002		2003		2004		2005	
		F.C (yen)	L.C (Rs.)	F.C (yen)	L.C (Rs.)	F.C (yen)	L.C (Rs.)	F.C (yen)	L.C (Rs.)	F.C (yen)	L.C (Rs.)	F.C (yen)	L.C (Rs.)	F.C (yen)	L.C (Rs.)
100	Direct Construction Cost	4,833	1,323	0	0	0	0	1,933	529	1,450	397	967	265	483	132
200	Land Acquisition and Compensation Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0
300	Government's Administrative Expenses	0	198	0	20	0	19	0	40	0	40	0	40	0	40
400	Engineering Service	615	71	185	21	62	7	92	3	92	11	92	11	92	11
450	Staff Training Cost	61	7	0	0	0	0	15	2	15	2	15	2	15	2
	Sub-Total	5,510	1,599	185	41	62	27	2,040	574	1,557	449	1,074	316	591	184
500	Price Contingency	989	1,228	20	18	8	14	320	372	282	346	221	285	136	192
600	Physical Contingency	650	283	20	6	7	4	236	95	184	79	130	60	73	37
	Grand Total	7,148	3,110	225	65	77	46	2,597	1,041	2,023	874	1,425	662	800	414

12.5 Operation and Maintenance Cost

Annual operation and maintenance cost was estimated at Rs.190 million as shown in Table 12.6 to meet the requirement of 182,000 m^3/day in 2010.

Table 12.6 Annual Operation & Maintenance Cost

O & M cost items	O & M cost (Rs.million/year)	Ratio (%)
- wage & salaries	6.4	3.4
- occasional workers cost	3.6	1.9
- power cost	153.5	81.1
- chemical cost	10.6	5.6
- other (materials/ equipment/facilities)	10.2	5.4
- repairs	5.0	2.6
Total	189.3	100.0

CHAPTER 13

INSTITUTIONAL AND MANAGERIAL CONSIDERATIONS

13. INSTITUTIONAL AND MANAGERIAL CONSIDERATIONS

13.1 History and Background of Institutional Development of the NWSDB

The NWSDB, as a public corporation catering to a commercially-oriented consumer service, was essentially required to lay its primary emphasis on operation and maintenance and consumer billing, with supporting emphasis laid on financial management, public relations, corporate planning, human resources development, community participation, groundwater development, and planning, design, construction relating to rehabilitation or new schemes. However, the NWSDB was institutionally not capable to realize its new roles as a public corporation, and was functioning without any operational targets of performance indicators other than those related to the disbursement of capital budget on new schemes.

In 1984, with technical assistance from the USAID, an Institutional Development (ID) Project was launched for comprehensive institutional building of the NWSDB. Major activities under the ID Project ended in 1991, bringing in a major transformation to the NWSDB, which has then become commercially oriented with new emphasis on operations and maintenance, financial viability and decentralization of decision making. Since then, the NWSDB is endeavoring in continued institutional strengthening activities with a view to ensure sustenance of the gains made from the ID Project and to achieve additional improvements.

In July 1993, the USAID conducted an impact evaluation in order to determine the level of institutional development and the degree of sustainability that has been achieved in the two years since major full time ID Project activities had ceased, The general conclusion of the evaluation was that in many areas the NWSDB had demonstrated a capacity to replicate and build on end of project accomplishment whereas the major gains in institutional strengthening made over the life of the ID Project had been maintained over the two years following completion of the Project.

The NWSDB, based on the recommendations of the above evaluation, has prepared an institutional strengthening (IS) plan catering to identified needs in specific areas on which emphasis is laid after assessing IS needs for the next five years. This Plan is included among the project proposals of the World Bank assisted Water Supply and Sanitation Project IV and the NWSDB is seeking funding assistance from the IDA, ADB and other sources.

13.2 Current Problems and Constraints

Some of the major problems and constraints confronting the functions of the NWSDB have been identified during the impact evaluation of the ID Project and also by the NWSDB in its proposed IS Plan, also suggesting recommendations how to overcome them. Considering the importance from the

point of organizational and management considerations, some of the problems and constraints that were pointed out and laid emphasis by the managerial staff of the NWSDB who were interviewed during the study are summarized in Table 13.1.

13.3 Organization for Project Implementation

13.3.1 Role of the Greater Colombo Regional Support Center

The Project which is to be implemented by the NWSDB is aimed at meeting the increased water demand in the Greater Colombo Area. Therefore, the present RSC (GC), or any future authority succeeding it, is considered as the obvious and most appropriate agency that will be in charge of the Project during and after its implementation.

The RSC(GC) is now the largest RSC in terms of the number of service connections and the share of revenue to the NWSDB. But it remains one of the weakest centers in terms of organizational and managerial capability because it has not received due attention in the earlier institutional development activities. After the Project implementation, water supply capacity in the Greater Colombo area will be doubled and the RSC (GC) should be fully geared to meet the increased roles, functions and activities it will be charged with. Whether or not the RSC (GC) will be charged with additional functions in the sanitation sector with the proposed taking over of sewerage management and the creation of a Greater Colombo Water Supply and Sewerage Authority (GCWSSA) is also important in considering future organizational needs.

13.3.2 Organization Planning

In making suggestions on the organizational arrangements for project implementation, it is however presumed here that the current programs and plans already proposed or being implemented by the NWSDB for continued institutional strengthening of the NWSDB will be successfully conducted in the mean time.

Organizational requirements for the project implementation are divided into three stages; namely, 1) Pre-Construction Stage, 2) Construction Stage and 3) Post Construction Stage. The NWSDB will be responsible for execution of the Project implementation including the following works;

- Detailed design of Project facilities
- Planning and supervision of the construction works
- Land acquisition and other required preliminary works
- Procurement of and supply of the materials and equipment
- Procurement and furnishing of funds

Table 13.1 Some Current Problems and Constraints of the NWSDB

1) **Commercial aspects**

Collection systems need to be efficiently devised with effective use of existing facilities like post offices, banks, retail shops, etc. as collection centers.

Customer complaints, though reduced, are still attended by senior level managers.

2) **Planning, Design and Coordinating**

Planning and implementation of minor to medium schemes are sometimes rushed under political pressure without proper environmental economic studies.

Real needs and problems experienced by the RSCs who eventually takes over a scheme are not well reflected in the plans and designs done at Head Office.

3) **Construction Supervision**

Sharing of responsibility of the NWSDB and the foreign consultants in major foreign funded projects sometimes leads to problems in cost and quality of work.

Quality of work suffers due to high turnover of young engineers at construction sites.

4) **Production**

O&M costs are generally high due to poor performance of old facilities and poor operation of pumps etc.

Staff at treatment plants are not adequately trained to improve their knowledge, skill, and consciousness on the control of cost and quality of water and their obligations to the consumers.

5) **Distribution System:**

UFW ratio in Colombo is very high and is attributed to illegal connections, stealth, leakage etc.

Skilled workers are not adequate to attend to maintenance and repair of old pipelines in the C.M.C. area.

Pipeline maps are not readily available for regular maintenance

Repair and maintenance crews are not sufficiently equipped with required facilities.

6) **Operation and Maintenance**

To make preventive maintenance successful, beside training, field level staff also need to be motivated and suitably compensated.

7) **Water quality testing and monitoring:**

There is no proper system of coordination between the plants and the NWSDB Central Laboratory so that information on water quality could not be available to higher managerial levels for emergency decision making.

Competence of the staff responsible for the most important water quality control and regulation of treatment operations is not necessarily adequate to carry out their mission.

There is no systematic water quality monitoring program to check deterioration of the quality of raw water due to pollution, salt intrusion etc..

8) **Training:**

Benefits of training and education program are not fully achieved due to a lack of competent training staff and resources, inadequate training materials, inability to release staff for training over long periods.

9) **Human resources:**

At present the functions and duties of the staff are not clearly defined and often performed by staff at a higher rank. Delegation and supervision are lacking.

10) **Public education/awareness:**

Attempts taken to educate and create awareness among the public on proper use of water are not adequate.

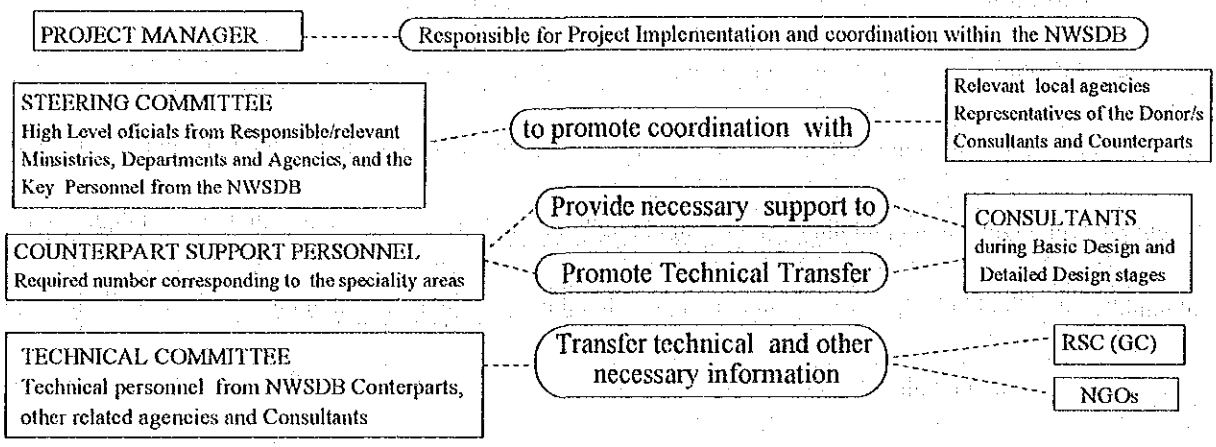
Willingness to pay for water need to be promoted.

11) **Legal aspects and policy matters:**

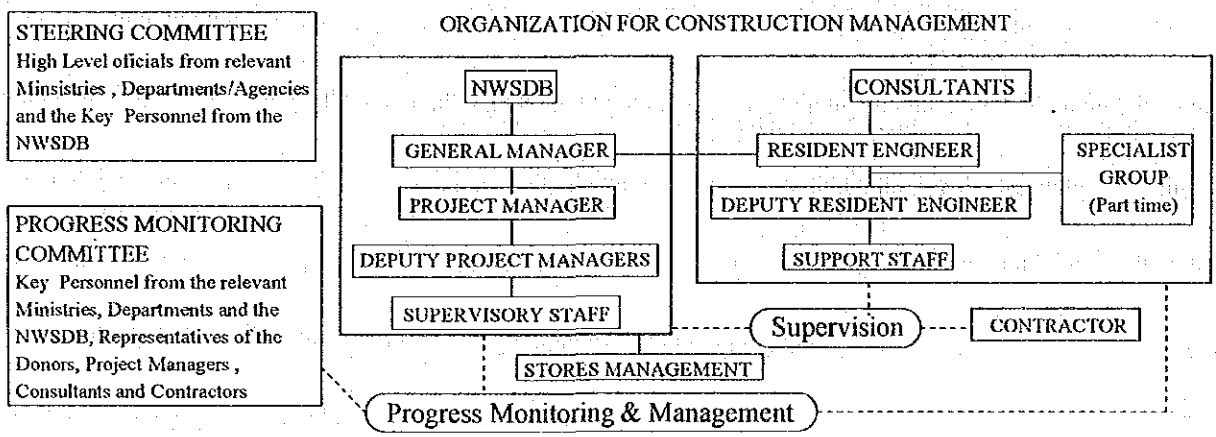
The NWSDB though legally qualified, is not practically controlling C.M.C.'s activities in providing standposts and bathing places on political requests. Considering the high loss of revenue to the NWSDB and higher wastage of water supplied free of charge, a policy decision is necessary to remedy situation.

Water supply in the Greater Colombo Area are likely to be brought under a separate new authority; Greater Colombo Water Supply and Sanitation Authority. Improving the relation between the NWSDB and the C.M.C. and other relevant local government agencies and strengthening of organizational, managerial and operational capacity of the RSC (GC), not only in the water supply sector but also in the sanitation sector, need urgent attention.

PRECONSTRUCTION STAGE



CONSTRUCTION STAGE



POSTCONSTRUCTION STAGE

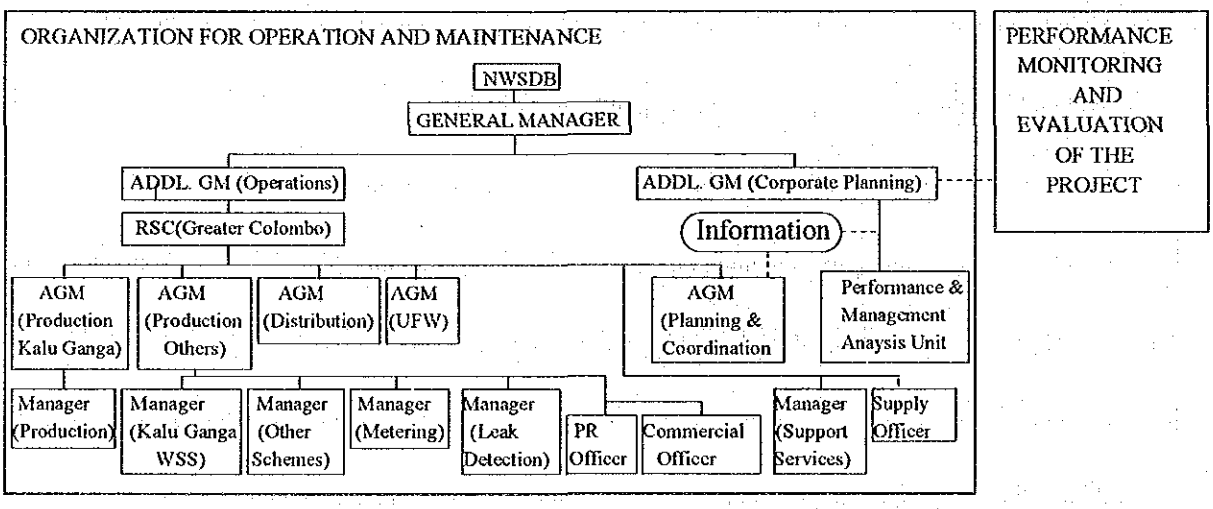


Figure 13.1 Organization for Project Implementation

It is proposed that planning and design, tender document preparation, selection of contractors etc., and supervision of implementation be carried out through consultant engineering services. In the event the Project is accepted for implementation with foreign assistance, a foreign consultants will usually be appointed to provide above engineering services.

Major activities and organizational requirements in each stage are considered below. A schematic diagram of the organization for Project Implementation is shown in Figure 13.12.

13.3.3 Pre-Construction Stage

Activities in this stage involves comprehensive activities such as, basic design, detailed surveys and investigations, and detailed design of the recommended plan derived from the feasibility study, also including engineering services for tendering procedures.

1) Project Manager

For overall execution, the NWSDB will appoint new DGM (Kalu Ganga Water Supply Project), or other designation as appropriate to the NWSDB under the General Manager. The appointed new DGM will be directly responsible for implementation of the Project and for coordinating the activities of all the sections within the NWSDB concerned with implementation of the Project.

2) Steering Committee

The Project involves and requires assistance and cooperation from a number of ministries, local governments and other agencies and in order to promote coordination necessary for the study, organizing of a steering committee consisting of higher level officials from the NWSDB and relevant Ministries/agencies is recommended.

3) Counterpart Personnel

Counterpart support to the foreign consultant would be essential for smooth and effective execution of these activities. Direct association of counterpart personnel during this stage will not only help in effective transfer but also in efficient gathering and exchange of vital information and data required for effective planning and design of facilities.

4) Technical Committee

Specially during the basic planning and design, major technical decisions have to be made taking into consideration of inter-related matters that affect the future performance of the water supply scheme. These include, future river development plans, water use plans including future water supply schemes

in neighboring areas, environmental problems related to water quality and quantity etc. Formation of a technical committee consisting of technical personnel from the NWSDB and other relevant agencies is recommended.

5) Participation of RSC (Planning and Coordination)

Considering the present and future role of RSC (GC) who will eventually be in charge of operation and maintenance of this water supply scheme, its participation in the Project from the early stages of implementation is recommended. Similarly, the participation of RSC (Western) in the planning process is beneficial as this RSC is responsible for the areas adjoining Greater Colombo.

6) NGO Participation

In order to sort out any problems or issues that may crop up at later stages in connection with land acquisition, environmental and consumer related matters, public opinion may be heard by involving NGOs when necessary. This coordination may be handled by the Public Relations unit of the NWSDB.

13.3.4 Construction Stage

Construction stage involves all activities of the Project implementation from awarding of the contract to the commissioning of facilities constructed.

1) Organization for Construction Management

As an established practice, the Construction Division of the NWSDB provides major projects implemented with foreign assistance with the necessary engineering support services in construction management right from the awarding of contract up to the handling over of completed facilities. This division which has accumulated experience in construction management will act as the consultant to the NWSDB for construction supervision while foreign consultants will be in charge of total project management. A special project team needs to be organized under a Senior Project Manager. In this stage, it is important to have emphasized involvement and participation of the RSC (GC).

Construction activities will be spread over several distant locations simultaneously and therefore, construction site offices need to be suitably located and coordinated from a central location, for example from a Project Office at the site of treatment plant where activities will be extensive.

2) Steering Committee

To promote coordination necessary during construction stage among the various agencies involved, continued guidance and direction by the steering committee would be required.

3) Stores Management

For proper control of storage and flow of various equipment and materials and any other items procured and supplied for the Project and handed over to the custody of the NWSDB during the construction period, it would be necessary to organize a suitable stores management system and necessary security measures.

4) Progress Monitoring Committee

A committee for monitoring the progress of project implementation need to be organized. This committee may consist of the key personnel from the NWSDB, funding agencies, consultants responsible for construction supervision and project management, contractor and any others as required.

13.3.5 Post Construction Stage

After the facilities constructed under the Project are commissioned and taken over by the NWSDB the Kalu Ganga Water Supply System will be managed by the RSC (GC) which is considered the most appropriate organization fit to do so.

Water supplied in the Greater Colombo Area will eventually be almost doubled by year 2020. This implies that the RSC (GC) has not only to be strengthened institutionally, but also its organization has to be restructured in time to come. However, since the Project is to be implemented in stages, the organizational changes may also be done in stages. In the first phase, rather than creating a separate RSC responsible for the Kalu Ganga System and any other future schemes in the southern parts of Greater Colombo, it would be appropriate to develop new AGM offices under the RSC (GC) who will be responsible for the facilities constructed in the first phase. Whether to set up a separate RSC for Greater Colombo South, or separate DGM offices for the northern and southern areas under the existing RSC (GC) will only be a matter for later consideration and depends not only on the operation and management performance of the organization set up for the first phase, but also on the status with regards to the proposed GCWSSA.

Therefore suggestions on organization planning are made here presuming that the RSC (GC) will be strengthened with additional staff under existing or new AGM offices. The basic areas considered under the "after construction" stage are as follows:

1) Organization for Intake, Production and Transmission facilities

Management, operation and maintenance of these facilities may be brought under the responsibility of a new AGM assigned for this purpose with his office located near the proposed treatment plant. Basic organization is as shown in Figure 13.1.

2) Water Quality Testing, Monitoring and Control

All activities from sampling to testing required to ensure production and supplying of safe and high quality water will be handled by a plant laboratory headed by a Chemist reporting to the AGM. The tests include physical, chemical, bacteriological and those for unit operations.

In addition, this laboratory will assist in a water quality monitoring program which should be systematically planned and preferably implemented by the Central Laboratory of the NWSDB with a view to take timely corrective measures against any future deterioration of the quality of the Kalu Ganga water source.

3) Distribution Facilities

The existing AGM (Distribution) section need to be strengthened with additional Area Manager/s assigned to take charge of the service areas newly introduced under the Kalu Ganga System. Staff under other supporting sections for metering, leak detection, commercial and public relations also need to be increased in proportionate with the additional load on their functions.

4) Reduction of Non-Revenue Water (NRW)

As a project has only been just launched for this purpose of reducing non revenue water, the organization requirements under the AGM (UFW) are yet to be defined. The AGM (UFW) will assist AGM (Distribution) through the latter's staff in NRW reduction efforts.

5) Operation and Maintenance

Operation and maintenance of facilities under the Kalu Ganga System will be handled by the AGMs who are respectively in charge of the facilities. A program for operations and maintenance of major facilities is recommended in Chapter 10. Preventive maintenance is strongly recommended and detailed schedules for this purpose need to be prepared in consultation with manufacturers and suppliers.

6) Billing and Collections

The existing system of meter reading, billing and collection may be continued with necessary modifications. Particularly with regards to the developing towns away from the city center, collection

mechanism needs to be improved, for example by popularizing payments through retail shops, post offices etc., considering consumers' convenience.

7) Store Management

For proper control of storage and flow of various items required for routine operations and maintenance, an improved stores management system that links with the accounting system must be introduced.

8) Performance Evaluation of the Project

To ensure that the investment on the Project is effectively utilized and the system is maintained to provide a safe and stable water supply, it is necessary to monitor and evaluate the performance of the system regularly and throughout all components of the system so that necessary and timely measures could be taken. Items of monitoring and evaluation shall include not merely the mechanical performance of facilities, but also organizational and management performance. These will include the performance indicators already identified for the management information system. This activities may be implemented b the Performance and Management Analysis Unit under the Addl. GM (Corporate Planning) with the support of RSC (GC).

CHAPTER 14

FINANCIAL PLAN FOR THE NWSDB

14. FINANCIAL PLAN FOR THE NWSDB

14.1 Financial Performance of the NWSDB

Taking into account the characteristics of water supply sector in the developing countries such as Sri Lanka, where the water demand/suppressed demand will continue to be above the supply capacity, the revenues could be expected to accrue at a steady growth as far as the water facilities be expanded in a proper manner.

The current financial position of the NWSDB is represented by Table 14.1 which shows a whole image of the latest financial status with major financial indicators such as total assets, long-term liabilities, shareholders' equity, retained earnings (deficit), revenues, etc.

14.1.1 Unitary Tariff Rate and Operation Cost

The unitary tariff rate by group has been set up based on the current tariff structure to make simplified the projection of future revenues.

The unitary tariff is classified into the following five groups in due consideration of current tariff rate, user's characteristics, assumption volume, etc. as shown in Table 14.2.

Group	Category
1) Domestic	Domestic, Yard taps, Religious institutions
2) Non-domestic	Commercial, Government sector
3) Others	Hotels, Industries
4) STD/Post	Standposts
5) Bulk	Bulk to local governments

14.1.2 Present Financial Situation related to Debt Service

The debt service coverage ratio indicated for these years is rather strong, averaging about 3 or 4 to 1, in spite of a low level of total asset turnover (revenue divided by total assets). This is notably attributable to the strong financial support of the Government in a form of capital grant. However, the implication of long-term liabilities' management is cause for concern.

The outstanding of the long-term liabilities represented by "Foreign Loan through Treasury" is Rs.3,564 million in the balance sheet as of 31 December 1993. On the other hand, the debt outstanding as of 31 December 1993 is estimated at Rs.2,240 million according to "Repayment Schedule". The difference of Rs.1,324 million is said to be transferred from "A/C of Long-term Liabilities" to "Capital Grants-Central Government", the journal entry of which is considered to be as follows:

Cash		1,324	
	Capital Grants - Central Government		1,324
Long-term Liabilities		1,324	
	Cash		1,324

The timing of this transfer is said to be discussed among the authorities concerned. Unless this kind of transfer to mitigate the debt burden of the NWSDB be applied, the profit after depreciation and interest for 1993 would have gone into the red. Even so the debt service coverage ratio could be secured to be more than 1.2.

The financial management of the NWSDB is reported to have improved in several aspects such as billing and collection and general ledger functions, resulting in a high level of financial consciousness among NWSDB managers. However, the financial management is recommended to be further strengthened, first of all, focusing on the debt service management.

The NWSDB is advised to make further efforts in cost reduction and in inventory and fixed assets management in pursuit of sound financial management, in order to become a self-sustainable and financially independent utility entity less free of the Government support/participation.

14.1.3 Loan Repayment Schedule

The projection of the loan repayment schedule is presented in Table 3.7 in Chapter 3 consisting of the following data for the projects assisted by the foreign financing agencies;

- Disbursed and disbursement schedule by year (projects proposed for outside Greater Colombo area are included).
- Debt outstanding
- Debt service projection (interest and repayment)

14.2 Projection of Financial Plan of the NWSDB up to 2000

To realize the objectives set out in the Corporate Plan (1991-1995), the positive support of the major external financial agencies and the Government for cost containment programs, collection improvement strategies and tariff revisions enabled a series of measures designed to improve the overall financial viability of the institution, to have been carried out, resulting in the good performance for the past three years (1991-1993) with a strong financial support of the Government

14.2.1 Corporate Financial Targets

The following corporate financial targets are set up through frequent discussion with the staff concerned to make the NWSDB an independent and sustainable public utility organization less free of

the government support by year 2000, when the accumulated deficit amounting to Rs.1,330 million as of 31 December 1993 be cleared up.

1) The revenues should cover its operating cost, depreciation and loan interest.
2) Debt service coverage ratio (Profit before interest and depreciation/Debt services) is maintained at more than 1.5 to 2.0
3) The increase in average unitary tariff should be kept within an inflation rate
4) Account Receivable (Debtors), amounting to Rs.650,525,742 as of 31 December 1993, should be, in part, written off over a reasonable period, say, 10 years.
5) The net surplus for the year, that is, net profit after interest and depreciation, should be around 2 percent on the net fixed assets (no revaluation of fixed assets in place is taken into account over the period up to 2000).
6) The accumulated deficit should be cleared up by 2000 (after the accumulated deficit having been cleared up, it should be considered whether a dividend holiday be lifted up or maintained further).

The following three measures described in the Corporate Plan (1991-1995) will be indispensable as well to accomplish the above corporate financial targets, designed to improve the overall financial viability of the NWSDB.

1) Cost containment programs
2) Collection improvement strategies
3) Tariff revisions

14.2.2 Pre-conditions of Financial Management

The pre-conditions for preparation of the future revenue and cash-flow projection are presented below:

1) Production Capacity of the NWSDB up to 2000 and operating rate

1.	Production capacity	715,000 m^3/day
2.	Capacity utilization	90 %
3.	Water served	228,000,000 m^3/year

2) Non-Revenue Water (NRW)

45% in 1993
40% in 2000

3) Allocation of Water Served

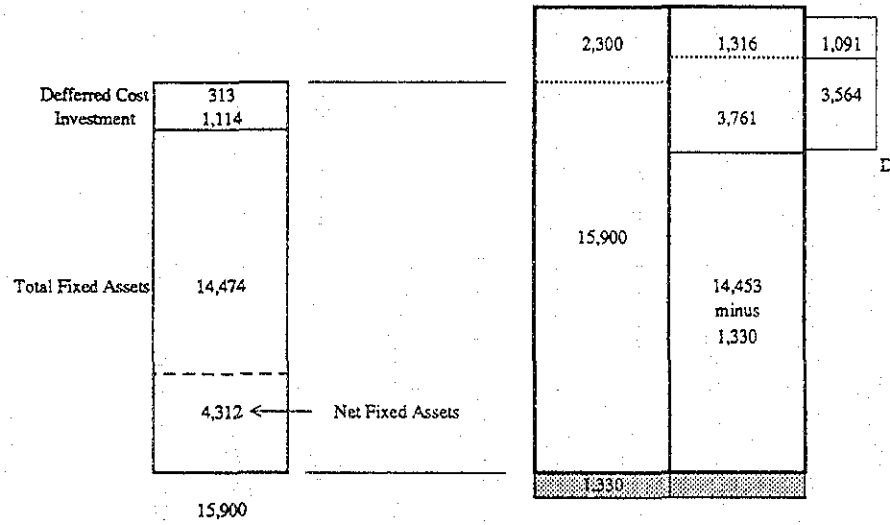
		Allocation of water served for Total Region
1.	Domestic	48 %
2.	Non-domestic	27 %
3.	Others	3 %
4.	STD/POST	13 %
5.	Bulk	9 %

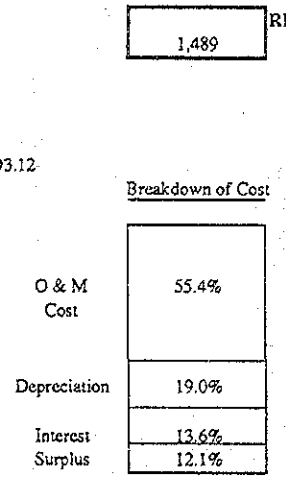
Table 14.1 Current Financial Status of NWSDB

FINANCIAL STATEMENTS 1993.12.31 (Unit : Million Rs.)

Total Current Assets	13%	2,300	1,316	7%	Total Current Liabilities
Deferred Cost	2%	313	3,761	21%	Long-term Liabilities
Investment	6%	1,114	14,453	79%	Shareholders'equity
Total Fixed Assets	80%	14,474	-1,330	-7%	Retained Earnings/(Deficit)
TOTAL ASSETS	100%	18,200	18,200	100%	Total Liabilities & Equity

Loan Interest Payable	579	
Loan Capital Payable	512	
Foreign Loan Thr. Treasury	3,564	
Capital Grants-Central Govern.	9,834	68%
Capital Grants-Foreign Agencies	3,711	26%
Equity to Total Assets	72%	





Profit bef. depreciation & interest	665
Depreciation,etc.	283
Loan interest	202
Surplus for the year	180
Capital Repayment	34
Loan Interest	202
Debt Services	236
Debt Services Coverage Ratio (Profit bef. depre. & interest) / Debt Services	2.82
Turnover ratio of Revenues to Total Assets	8.2%
Investments for 1993	407
(% of debt services	173%)
Return on Net Fixed Assets	4.2%

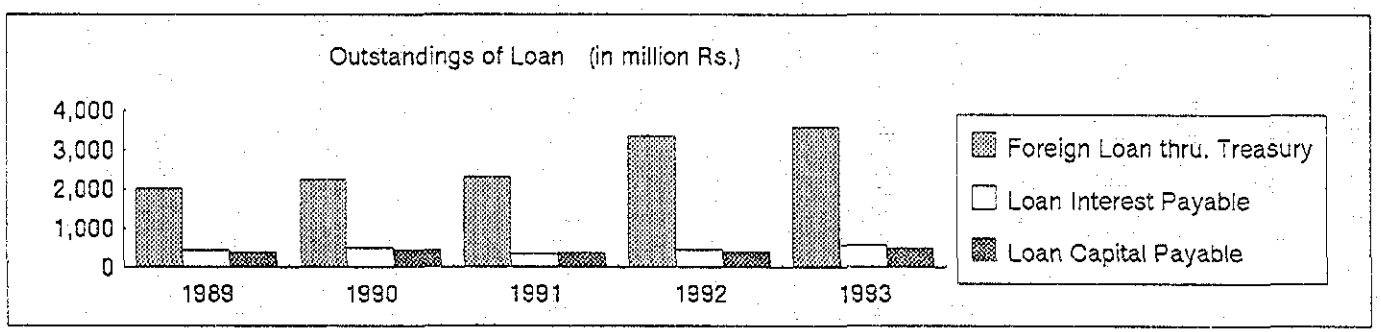


Table 14.2 Billing Collection (1993)

1993 Billing & Collection		Water Consumed (m3/year)		Water Sales (Rs.)		Collection (Rs.)	Collection rate	No. of Connections	Monthly Water Served per connection	Unitary Rate (Rs./m3)	Consumption per Connection
1 DOMESTIC											
	Domestic	57,304,937		255,499,092		252,264,495	99%	228,680	20.9	4.46	251
	Religious Institutions	1,559,544		2,997,595		2,644,736	88%	1,867	69.6	1.92	835
	Sub-total	58,864,481	47.0%	258,496,687	22.6%	254,909,231	99%	230,547	21.3	4.39	255
Service charges											
Rs./month per connection		6		1,383,282							
2 NON-DOMESTIC											
	Government School	1,265,590		23,985,131		26,214,395	109%	915	115.3	18.95	1,383
	Government Quarters	812,004		4,889,671		3,316,787	68%	4,405	15.4	6.02	184
	Government	15,411,647		324,874,453		307,840,983	95%	3,820	336.2	21.08	4,034
	Commercial	12,497,177		266,371,613		247,164,230	93%	19,253	54.1	21.31	649
	GECE	3,286,753		52,598,488		55,091,870	105%	4	68474.0	16.00	821,688
	Institutions	708,709		14,214,527		9,618,006	68%	629	93.9	20.06	1,127
	Board Premise	107,752		748,552		406,077	54%	130	69.1	6.95	829
	Sub-Total	34,089,632	27.2%	687,682,435	60.1%	649,652,348	94%	29,156	97.4	20.17	1,169
Service charges											
Rs./month per connection		10		291,560							
3 OTHERS											
	Tourist Hotels	1,494,806		40,216,821		38,444,426	96%	226	551.2	26.90	6,614
	Industries	2,279,554		57,140,163		56,685,452	99%	725	262.0	25.07	3,144
	Shipping	250,589		20,045,790		20,387,758	102%	8	2610.3	79.99	31,324
	Sub-Total	4,024,949	3.2%	117,402,774	10.3%	115,517,636	98%	959	349.8	29.17	4,197
Service charges											
Rs./month per connection		10		9,590							
4 CMC STD/POST(G.C.)		11,143,910		16,595,865		16,595,865	100%	2,753	337.3	1.49	4,048
STD/POST(REGIONS)		5,337,343		8,130,142		4,665,116	57%	4,556	97.6	1.52	1,171
	Sub-total	16,481,253	13.2%	24,726,007	2.2%	21,260,981	86%	7,309	187.9	1.50	2,255
5 BULK BILLING		11,708,000	9.4%	56,199,000	4.9%	46,798,000	83%			4.80	
	TOTAL	125,168,315	100.0%	1,144,506,903	100.0%	1,088,138,196	95%	260,662	40.0	9.14	480

(MIS TOTAL Regional Area)

* The service charges are assumed to be included in the water sales bill.

Average Allocation Water Served for the last 3 years		
Domestic	158,632,349	44.4%
Non-domestic	94,810,629	26.6%
Others	13,770,876	3.9%
STD/Post	47,496,775	13.3%
Bulk Billing	42,382,000	11.9%
TOTAL	357,092,629	

UNITARY TARIFF RATE For 1993			
	CATEGORY	Unitary Rate (Rs./m3)	Allocation of Water Served %
1	Domestic	4.39	47.0%
2	Non-domestic	20.17	27.2%
3	Others	29.17	3.2%
4	STD/Post	1.50	13.2%
5	Bulk Billing	4.80	9.4%
	Average	9.14	

4) Bill Collection Rate

95%

5) Operation and Maintenance Costs

Rs.3.6/m^3

6) Average Tariff

1.	Domestic	Rs. 4.4/m^3
2.	Non-domestic	Rs. 20.2/m^3
3.	Others	Rs. 29.2/m^3
4.	STD/POST	Rs. 1.50/m^3
5.	Bulk	Rs. 4.80/m^3

14.2.3 Projected Financial Plan

The tariff revision for the major categories/groups which will be required to meet the corporate financial targets, its resultant net income, and its cashflow, etc. are presented in Table 14.3. And based on those data and the actual financial statements of 1993 (base year), the financial plan up to 2000 has been established as shown on Table 14.4.

14.2.4 Implications of Financial Management

The forecasts of revenues and cashflows in the previous section include that the NWSDB will be able to make substantial contributions to solving the accumulated deficit problem by 2000, eventually resulting in raising a part of funds required to implement its capital programs from internally generated funds.

The NWSDB, however, is clearly capable of undertaking the full investment program as envisaged, under the stated assumptions. In any event, further strengthening of the NWSDB's institutional development inclusive of inter-departmental management information system under the initiative of the Corporate Planning Unit and decentralization of RSCs., and financial improvement programs will be needed to reach the levels of financial performance indicated in these forecasts.

Furthermore, it is important to expand and institutionalize the operation and the financial management so that it fully covers all regional operating activities. To achieve this objective, it is indispensable that Corporate Planning Division, Commercial Division and Finance Division cooperate closely each other with intermittent advise from Operation Division and prepare the Key Management Information Report, representing the accepted performance review document of the NWSDB for the top management.

Table 14.3 Summary of Revenue and Cashflow Projection

(Unit: '000 Rs.)

	1993	1994	1995	1996	1997	1998	1999	2000	Average growth rate 1993-2000
1. Revenues	1,488,926	1,718,011	1,948,650	2,202,903	2,455,590	2,740,388	2,935,285	3,144,198	11.3%
2. Net income	151,581	163,225	136,541	148,759	190,489	272,388	324,336	396,050	14.7%
3. Net income on net fixed assets	4.1%	2.9%	2.6%	2.0%	2.3%	3.5%	2.9%	3.8%	
4. Debt services									
Interest	201,891	280,579	368,344	447,338	516,123	561,594	560,879	544,003	
Repayment	33,865	39,318	46,412	71,154	71,154	133,630	156,061	187,965	
5. Net cashflow	336,381	549,960	593,181	643,657	714,388	756,810	841,627	942,268	15.9%
6. Balance of C/F	Δ1,330,475	Δ1,167,250	Δ1,030,709	Δ881,950	Δ691,461	Δ419,073	Δ94,737	301,313	
Main Parameters									
A. Domestic (Rs/m^3)	4.39	4.5	4.8	5.2	5.6	5.9	6.2	6.5	
Incremental rate to the previous year (%)		2.0%	8.0%	8.0%	7.0%	6.0%	5.0%	5.0%	5.8%
B. Non-domestic (Rs/m^3)	20.17	22.2	24.4	26.6	28.5	30.2	31.7	33.3	
Incremental rate to the previous year (%)		10.0%	10.0%	9.0%	7.0%	6.0%	5.0%	5.0%	7.4%
C. Total (Rs/m^3)	9.1	9.9	10.8	11.8	12.6	13.4	14.1	14.9	
Incremental rate to the previous year (%)		8.3%	9.2%	8.6%	7.2%	6.4%	5.6%	5.6%	7.3%

Table 14.4 Financial Plan for the NWSDB up to 2000

Revenues Projection		1993	1994	1995	1996	1997	1998	1999	2000	Rate of Growth
		Base year								
Production Capacity(m3/day)		715,021	751,421	788,173	825,305	866,447	916,189	929,531	942,521	4.0%
NRW(%)		45.1% 45%	44.0%	43.0%	42.0%	41.5%	41.0%	40.5%	40.0%	
Water Consumed ('000 m3)		125,168	136,338	145,560	155,091	164,226	175,139	179,195	183,226	5.6%
Sales ('000 Rs.)		1,128,899	1,350,641	1,574,791	1,822,434	2,068,387	2,346,325	2,534,235	2,736,030	13.5%
Average Tariff (Rs./m3)		9.1	9.9	10.8	11.8	12.6	13.4	14.1	14.9	7.3%
Total Revenues from Operation		1,489,899	1,718,011	1,948,650	2,202,903	2,455,590	2,740,388	2,935,285	3,144,198	11.3%
Income Statements		**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	Rate of Growth
Revenues		1,488,926	1,718,011	1,948,650	2,202,903	2,455,590	2,740,388	2,935,285	3,144,198	11.3%
Total Expenses	5%	814,491	913,207	1,005,765	1,105,806	1,218,977	1,353,406	1,441,771	1,535,015	9.5%
Depreciation,etc.		282,939	361,000	438,000	501,000	530,000	553,000	608,300	669,130	13.1%
Interest		201,891	280,579	368,344	447,338	516,123	561,594	560,879	544,003	15.2%
Net profit		151,581	163,225	136,541	148,759	190,489	272,388	324,336	396,050	14.7%
Profit on Net Assets		(Adjustment included)	2.9%	2.6%	2.0%	2.3%	3.5%	2.9%	3.8%	
Cash-Flow Statements		**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	
Net profit from operation		151,581	163,225	136,541	148,759	190,489	272,388	324,336	396,050	
Depreciation		282,939	361,000	438,000	501,000	530,000	553,000	608,300	669,130	
Repayment		33,865	39,318	46,412	71,154	71,154	133,630	156,061	187,965	
Decrease in A/C receivables		-64,274	65,053	65,053	65,053	65,053	65,053	65,053	65,053	
Debtor at end of the year		650,526	662,888	672,170	692,670	724,114	768,369	820,056	880,945	
Net Cash-flow		336,381	549,960	593,181	643,657	714,388	756,810	841,627	942,268	
Expected Cash Generation		336,381	615,012	673,717	726,674	800,144	845,303	933,229	1,035,978	
TOTAL FUND FROM OPERATION		400,655	484,907	528,129	578,605	649,335	691,758	776,575	877,215	
Accumulated generated funds		1,242,602	1,727,509	2,255,638	2,834,243	3,483,578	4,175,336	4,951,911	5,829,126	
BALANCE SHEETS		**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	
Fixed Assets		4,431,560	5,692,160	5,315,160	7,625,594	8,330,751	7,853,751	11,097,522	10,520,352	
Work in Progress		10,041,990	10,824,656	13,042,603	12,022,702	12,581,012	13,189,279	9,420,808	9,420,808	
TOTAL FIXED ASSETS		14,473,550	16,516,817	18,357,763	19,648,297	20,911,763	21,043,030	20,518,330	19,941,160	
DEFERRED COST		312,681	258,681	197,681	128,681	54,681	0	0	0	
INVESTMENTS		1,113,543	1,513,543	1,913,543	2,313,543	2,713,543	3,113,543	3,513,543	3,913,543	
TOTAL CURRENT ASSETS		2,300,423	2,400,423	2,500,423	2,600,423	2,700,423	2,800,423	2,900,423	3,000,423	
TOTAL ASSETS		18,200,197	20,689,464	22,969,410	24,690,944	26,380,410	26,956,996	26,932,296	26,855,126	
TOTAL CURRENT LIABILITIES		1,316,090	1,416,090	1,516,090	1,616,090	1,716,090	1,816,090	1,916,090	2,016,090	
LONG-TERM LIABILITIES		3,761,393	4,603,425	5,388,743	5,963,539	6,537,185	6,631,655	6,475,594	6,287,629	
SHAREHOLDERS'EQUITY		14,453,189	15,922,106	17,308,323	18,384,906	19,459,573	19,839,739	19,839,739	19,839,739	
RETAINED EARNINGS		-1,330,475	-1,167,250	-1,030,709	-881,950	-691,461	-419,073	-94,737	301,313	
Adjustment			-84,907	-213,036	-391,641	-640,976	-911,414	-1,204,389	-1,589,645	
LIABILITIES & SHAREHOLDERS'EQUITY		18,200,197	20,689,464	22,969,410	24,690,944	26,380,411	26,956,997	26,932,297	26,855,126	
BALANCE C/F		-1,330,475	-1,167,250	-1,030,709	-881,950	-691,461	-419,073	-94,737	301,313	

14.3 Water Tariff Consideration

14.3.1 General

The tariff revisions implemented for the recent years have had a major impact on the financial improvement of the NWSDB as discussed in the previous chapter, and have resulted in satisfactory levels of cash generation to permit the NWSDB to cover the operating costs and the debt service for these three years.

14.3.2 Present Level of Water Tariff

The historical tariff structure is presented in Table 14.5. The consumers are classified into several categories, the tariff rate of which is established in due consideration of cross subsidies among the categories. The tariff is based on metered consumption, having a unified system across the country.

Especially, there is a significant cross-subsidies among the domestic consumers, that is, users with low consumption pay a low tariff rate while users with high level of consumption pay higher tariff rate. This scheme will also encourage the poor household to make an application for connecting to the water system. This will meet "the social objectives" represented by philosophy "some for all, rather than more for some".

14.3.3 Future Water Tariff Consideration

To meet the corporate financial targets, the tariff revision in addition to the cost containment programs and collection sustainable strategy, will be advised to be made as shown on Table 14.3. According to the study result, the incremental rate of each tariff group over a period of (1994-2000) may be ranged within the expected inflation level.

Group	Average incremental rate over a period of 1994-2000
Domestic	5.8%
Non-domestic	7.4%
Total	7.3%

The unitary tariff for each category is estimated based on that discussed in the previous chapter and an incremental rate of tariff. The unitary tariff is summarized as follows.

Future Unitary Tariff (Rs./m^3)

Category/Group	1993 (Actual)	2000	2002 (Commissioning year the Kalu Ganga)
Domestic	4.4	6.5	7.6
Non-domestic	20.2	33.3	38.8
Others	29.2	56.8	66.3

14.3.4 Affordability

The average income for the middle 20 percent (3rd 20 percent quintile) is estimated to be Rs.3,677/month in 1989. The income in 1994 can be deduced at Rs.4,262/month with a conservative assumption that the incremental rate is 3 percent per annum. Generally the affordability for water charge is said to be around 3 percent of the household income.

$$\text{3 \% of monthly household income} = 4{,}262 \times \frac{3}{100} = \text{Rs.}127.9$$

$$\text{Average monthly billing per household as of 1994} = \text{Rs.}51.5/\text{month}$$

The scheme is sufficiently affordable.

At present the tariff rates appear to be affordable compared with the water tariff in other countries as shown on Table 14.6. Future increases may necessitate further cross-sector subsidies from the high water users in the domestic sector and from the non-domestic sector, however, such increased cross sector subsidies may be more difficult to justify so that the tariff revision will be necessary to be made independently and flexibly for the respective category in cope with the future debt service, and its social and economical requirement.

14.4 Financial Plan for Implementation of the Kalu Ganga Project up to 2010

A precise review of the financial performance of the NWSDB was carried out in the previous section, to assist in preparing in future tariff revision based on the revenue projection and the debt service obligation and in assessing its capacity for undertaking future major investments.

The unitary tariff and other major parameters applied for the financial analysis are as follows:

1) Unitary tariff rate by category (as of 2000)

1.	Domestic	Rs. 6.5 /m^3
2.	Non-domestic (Commercial)	Rs. 33.3/m^3
3.	Others (Industries)	Rs. 56.8/m^3

2) Average water production unit cost (as of 1993) Rs. 3.0/m^3

The unit production cost for operation and maintenance is estimated based on the engineering estimation for the Project.

The major assumptions are as follows;

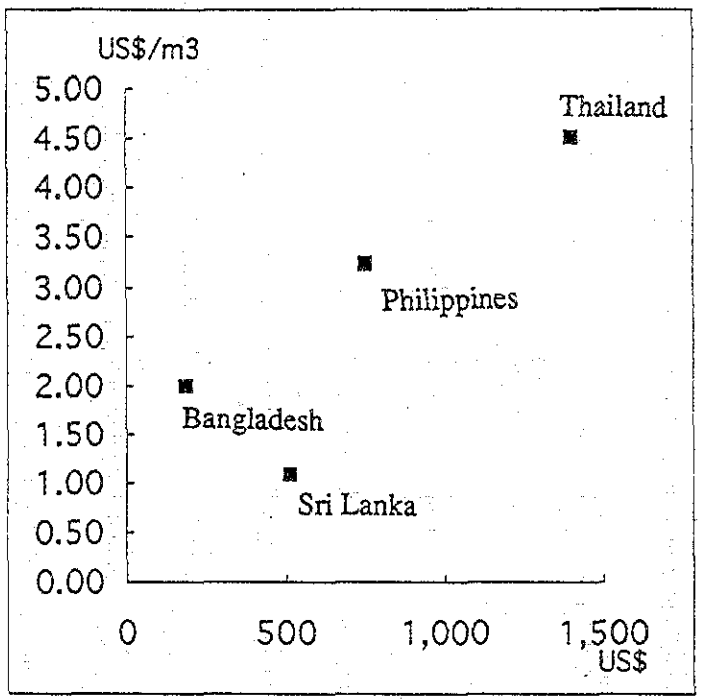
1)	Incremental rate of tariff	8% per annum
2)	Incremental rate of production cost	5% per annum

Table 14.5 Water Tariff Structure

Category	1984-1989	1990 Aug.	1991 Jan.	1992 Jan.	1993 Jan.	1994 Jan.
Direct Billing (Rs./month)						
Service Charge						
All consumers	0	5.00	5.00	5.00		
Domestic					6.00	6.00
Non-Domestic					10.00	10.00
Domestic (Rs./m^3)						
0-10 m^3	Free	Free	1.00	0.65	0.75	0.75
10-20 m^3	1.00	1.00	1.50	1.10	1.20	1.30
20-30 m^3	3.00	3.00	4.50	4.00	4.50	4.80
30-40 m^3	5.50	5.50	8.00	7.50	8.50	9.40
40-50 m^3	5.50	5.50	8.00	7.50	8.50	12.00
Over 50 m^3	5.50	11.00	19.50	20.00	25.00	25.00
Standpost	0.80	0.80	1.00	1.25	1.50	1.75
Non-Domestic (Rs./m^3)						
Government, institutions and Commercial	5.60	11.00	19.50	20.00	21.00	22.00
Tourist Hotels	9.00	16.50	25.00	27.00	27.00	27.00
Industries	9.00	16.50	25.00	27.00	25.00	25.00
Shipping	50.00	50.00	75.00	80.00	80.00	80.00
Religious Institutions	same as Domestic					
Unmetered Flat Rate (Rs./month)						
Domestic	30.00	100.00	100.00	100.00	150.00	150.00
Non-Domestic	40.00	500.00	500.00	750.00	1,000.00	1,500.00
Bulk Billing (Rs./m^3)						
without Electricity	NA	1.75	2.50	2.70	-	3.40
with Electricity	NA	NA	4.00	4.00	4.45	4.90

Table 14.6 Comparison of Water Charges in Asian Countries

Country	Water Charges	GDP per capita
Thailand	115.00 Bharts	1,402 US$
	= 4.51 US$	(1990)
	US$= 25.50 Bharts	
Philippines	82.75 Peso	750 US$
	= 3.24 US$	(1992)
	US$= 25.51 Peso	
	(1992)	
Bangladesh	69.00 TK	190 US$
	= 2.00 US$	(1991)
	US$= 34.57 TK	
	(1990)	
Sri Lanka	50.50 Rs.	512 US$
	= 1.10 US$	(1991)
	US$= 46.00 Rs.	
	(1994)	



Water charges are calculated for the average monthly consumption per household,being 25 m3/month.

14.4.1 Financing for the Proposed Project

Conditions for finance of the project are assumed as follows taking into account the usual practice of the government:

1)	Project Cost (1994 price)	Table 14.7
2)	15% of the Project Cost	Government grant
3)	85% of the Project Cost	External loan
	50% of the external loan	Government grant
	50% of the external loan	Re-lending to the NWSDB
4)	The debt burden of the NWSDB	42.5% of the project cost
5)	Conditions of re-lending to the NWSDB	
	Interest	12%
	Repayment period (including a grace period of 2 years)	24 years

14.4.2 Projection of Financial Statement up to 2010

The revenue and the cashflow have been projected using the unitary tariff by category in the previous section and the water demand projection in Chapter 4.

The forecast financial statements consisting of revenue projection, repayment schedule and cash flow projection, are presented in Table 14.8 (1) where the following cashflow projections are shown:

1) Cashflow for the NWSDB without the Kalu Ganga Project
2) Financing for the Kalu Ganga Project
3) Cashflow to Proceed from the Kalu Ganga Project
4) Integrated Cashflow for the NWSDB with the Kalu Ganga Project

The integrated balance sheets up to 2010 are presented in Table 14.9.

The major assumptions for this purpose are as follows;

1) Water allocation

Domestic	60%
Non-domestic	35%
Others	5%

2) Water supply and water consumption (m^3/day)

	2002	2003	2004	2005	2006	2007	2008	2009	2010 onward
Water supply	2,116	20,867	39,617	58,368	78,338	98,308	118,278	138,247	158,217
Water consumption	1,438	14,176	26,914	39,653	53,220	66,787	80,354	93,920	107,517

3) Funds shortage

The shortage of money which will occur due to loan interest in the initial stage of construction, will be made up for by the NWSDB's own funds. These funds are included in equity portion.