JAPAN INTERNATIONAL COOPERATION AGENCY
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

THE FEASIBILITY STUDY
ON
THE KALU GANGA WATER SUPPLY PROJECT
FOR
GREATER COLOMBO

VOLUME I

SUMMARY REPORT

NOVEMBER 1994

NIPPON JOGESUIDO SEKKEI CO., LTD.
NIPPON KOEI CO., LTD.

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PREFACE

In response to a request from the Government of the Democratic Socialist Republic of Sri Lanka, the Government of Japan decided to conduct a feasibility study on the Kalu Ganga Water Supply Project for Greater Colombo and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Sri Lanka a study team headed by Mr. Ikuo Miwa, Nippon Jogesuido Sekkei, Co., Ltd. and composed of members from Nippon Jogesuido Sekkei, Co., Ltd. and Nippon Koei Co., Ltd., three times between December 1993 and October 1994.

The team held discussions with the officials concerned of the Government of Sri Lanka and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Sri Lanka for their close cooperation extended to the team.

November 1994

Kimio Fujita
President
Japan International Cooperation Agency

November 1994

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Japan

Dear Sir,

Letter of Transmittal

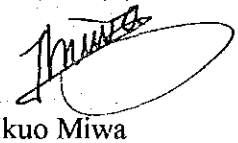
We are pleased to submit herewith the final report for the Feasibility Study on the Kalu Ganga Water Supply Project for Greater Colombo.

The Study was completed through the discussions with the Sri Lankan Government officials and the field investigation during three visits from December 1993 to October 1994 and the home work thereafter.

The Final Report consists of five volumes consolidating the progress report and the interim report: Volume I - Summary Report which succinctly describes the study and recommendations; Volume II - Main Report which covers the long-term development plan for the Greater Colombo Water Supply System, clarifies the position of the Kalu Ganga Water Supply System and describes the details of the first phase project through the Feasibility Study; Volume III - Supporting Report including detailed engineering analysis and relevant information; Volume IV - Data Report compiling collected data, and Volume V - Drawings showing the design of facilities involved in the proposed Project.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and the Ministry of Health and Welfare. We also would like to show our appreciation to the officials of the National Water Supply and Drainage Board, the JICA Sri Lanka Office, and the Embassy of Japan in Sri Lanka for their kind cooperation and assistance throughout our field survey.

Very truly yours,



Ikuo Miwa
Team Leader
The Feasibility Study on
the Kalu Ganga Water Supply Project
for Greater Colombo

EXECUTIVE SUMMARY

The Feasibility Study on the Kalu Ganga Water Supply Project for Greater Colombo

Period of Study : December 1993-November 1994
Counterpart Organization : National Water Supply and Drainage Board (NWSDB)

EXECUTIVE SUMMARY

1. BACKGROUND

The existing water supply system for Greater Colombo is at present serving population of about 1.4 million. Water production facilities which have a maximum production capacity of 136 mgd (618,800 m^3/d) rely on the Kelani Ganga (river) system for its source. Considering the population growth, development of residential and commercial areas, and expansion of the water supply service area, the Greater Colombo area is expected to have a shortage in water production capacity after the year 2000. The Kelani Ganga, however, has a limited capacity of raw water intake over the existing level. Thus, development of new water source and necessary production and transmission facilities is required before such a shortage occurs in near future.

2. OBJECTIVES

Objectives of this study are to prepare a long-term development plan to satisfy the water demand projected for 2020, and to prepare the first phase implementation plan for the demand in 2010. The scale of the project and the water demand are tabulated in Table 1.

Table 1 Water Demand Projection and Required Size of the Project

Item	Year 2010	Year 2020
Total Water Demand in Greater Colombo (daily average demand)	684,700 m^3/d	842,400 m^3/d
Required Size of the Project (Water production capacity)	182,000 m^3/d (40 mgd)	364,000 m^3/d (80 mgd)

For detailed calculation of the requried project size, see Table 4.7 in page 4-10.

3. STUDY AREA

The study will take into full consideration, water demand in the entire Greater Colombo area. The study area for the new water supply expansion or the reinforcement of the existing system will include eight divisions in the south of Colombo; namely, Dehiwala, Moratuwa, Panadura, Keselwatte, Kesbewa, Homagama, Bandaragama, and Horana. The study area covers approximately 23,000 ha out of 73,900 ha of the entire Greater Colombo area.

The expansion plan of the Greater Colombo water supply is shown in Figure 1.

4. PROPOSED PROJECT

4.1 CONCEPT IN ESTABLISHMENT OF THE PROJECT

As the existing water sources and production facilities will not be able to satisfy the future demand sometime in between 2000 and 2005, new water sources and related water supply facilities need to be developed. The Kalu Ganga is proposed as the new water source considering the existing constraints in water intake capacity from the Kelani Ganga source.

4.2 PROJECT COMPONENTS

The project component will consist of the facilities as listed in Table 2. Layout of the project component is shown in Figure 2.

Table 2 Project Component and Capacity

Facility	Phase 1 (for 2010 demand)		Phase 2 (for 2020 demand)
	Stage 1	Stage 2	
Water Intake	Intake capacity 191,100 m^3/d	-	Intake capacity 191,100 m^3/d
Raw Water Transmission Pipeline	dia.1500 mm L = 7,670 m	-	dia.1500 mm, L = 7,670 m
Treatment Plant	91,000 m^3/d	91,000 m^3/d	182,000 m^3/d
High Level Reservoir	30,000 m^3	-	30,000 m^3
Clear Water Transmission Pipeline	dia.1650-400mm L = 25,010 m	dia.1200-200mm L = 28,960 m	dia. 1650 - 200 mm L = 37,130 m
Distribution Facilities (incl. branch pipes)	dia.600 - 90 mm L = 179,380 m	-	dia. 700 - 90 mm L = 192,200 m

5. PROJECT COST

The project cost is estimated in June 1994 price with the consideration on the past construction costs under international tendering in Sri Lanka as much as possible. The exchange rates used are as follows:

Price level : June 1994

Exchange rates : US$1.0 = Rs.49.0 = Japanese ¥106.0

The summary of the cost estimates for Phase 1 is shown in Table 3.

Table 3 Summary of Cost Estimates for Phase 1 (2010 demand)

unit : million

Stage	F.C. Portion (¥)	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

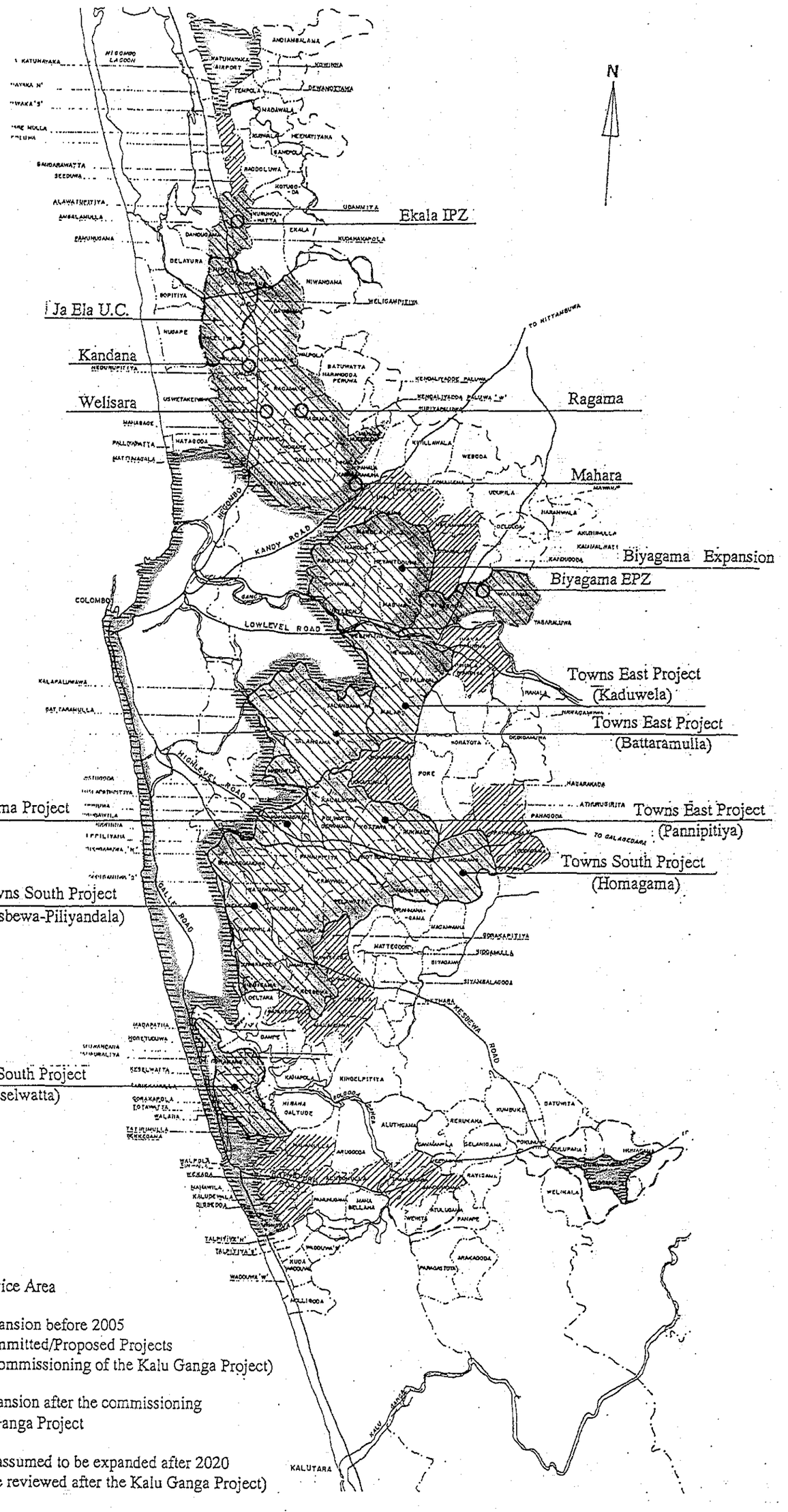


Figure 1 Planned Water Supply Expansion

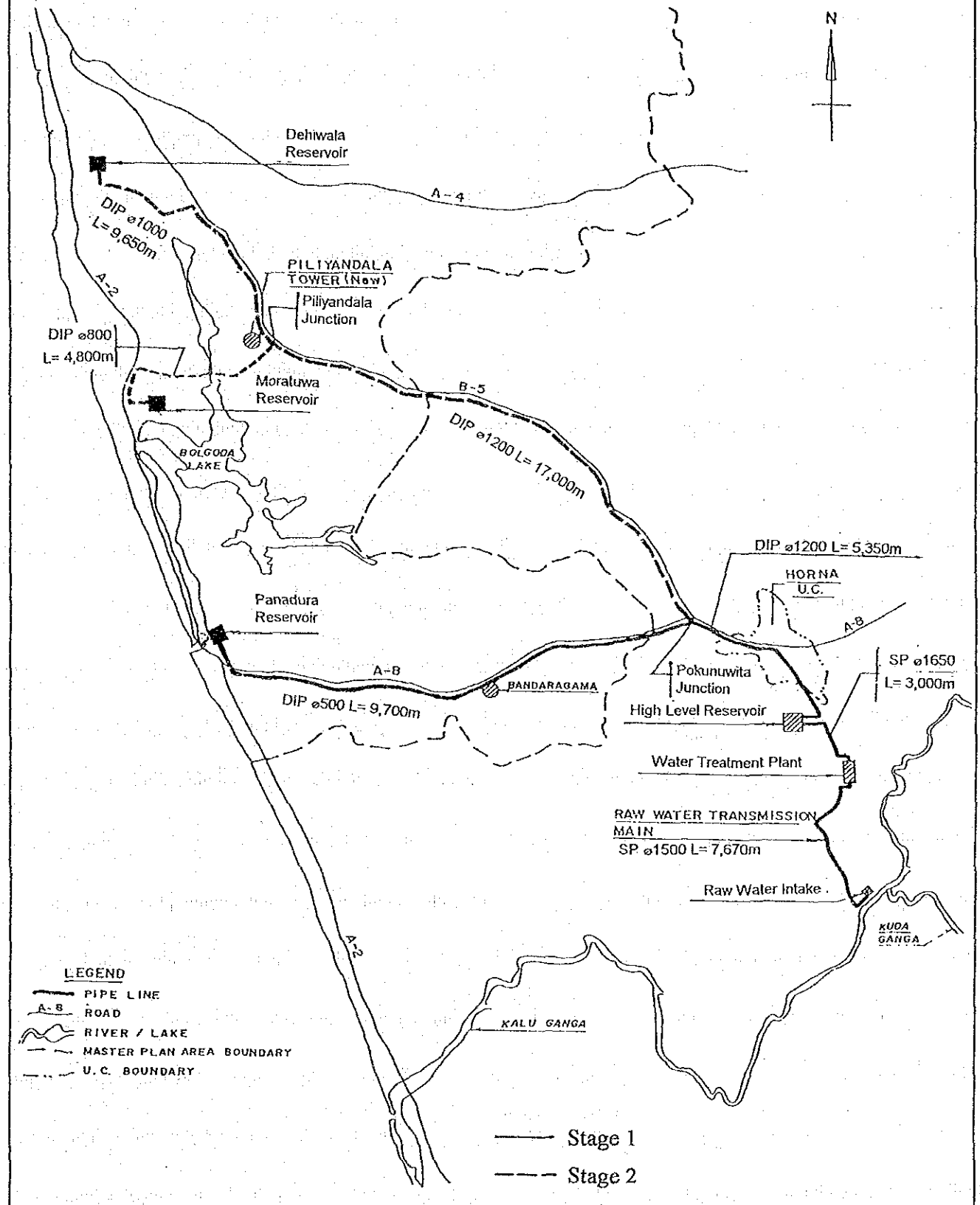


Figure 2 Layout of the Project Component

6. EVALUATION

6.1 CONCLUSION

The proposed project is evaluated as feasible from the view points of the technical, financial, socio-economical, and environmental aspects provided that the reasonable tariff structure be developed.

6.2 TECHNICAL EVALUATION

The proposed project plan was prepared with due consideration for various points of view for technical and economical aspects and evaluated feasible for implementation.

6.3 FINANCIAL EVALUATION

In light of this financial situation concerning the debt burden and the depressed tariff structure, the reasonable tariff revision should be indispensable to satisfactorily accomplish the corporate targets for the year 2000. The tariff revision should be implemented after 2000 within a reasonable range in due consideration of affordability. The Project will be viable in terms of Financial Internal Rate of Return (FIRR) provided that the tariff rate be allowed to increase within a reasonable level as shown below:

Incremental rate of tariff	FIRR
8 % (Base case)	10.0 %
10 %	12.3 %
12 %	14.6 %

Note: Incremental rate of tariff means actual value including an inflation factor.

6.4 SOCIO-ECONOMIC EVALUATION

Economic advantages brought about by the project will include improvement of sanitary and hygienic conditions, development in commercial and industrial activities in the project area, and increase in land value etc.

6.5 ENVIRONMENTAL CONSIDERATION

In general it may be concluded that the results of the Environmental Impact Assessment show that the project will not cause significant or lasting harm to the environment provided practical countermeasures are taken. Consequently environmental considerations should not rule out the implementation of the Project.

7. IMPLEMENTATION PROGRAM

Expansion of the water supply facilities in relation with the water demand projection is shown in Figure 3. Figure 4 shows the implementation program of the proposed Project.

8. RECOMMENDATIONS

1) Taking necessary measures for ensuring the financial viability of the project scheme (debt service management, inventory monitoring and fixed assets management, cost containment strategy, increase in water tariff etc.)

2) Improvement of Non-Revenue Water (NRW)

3) Protection of Water Source

4) Role of the Greater Colombo Regional Support Center

5) Conduct of detailed analysis on salinity intrusion

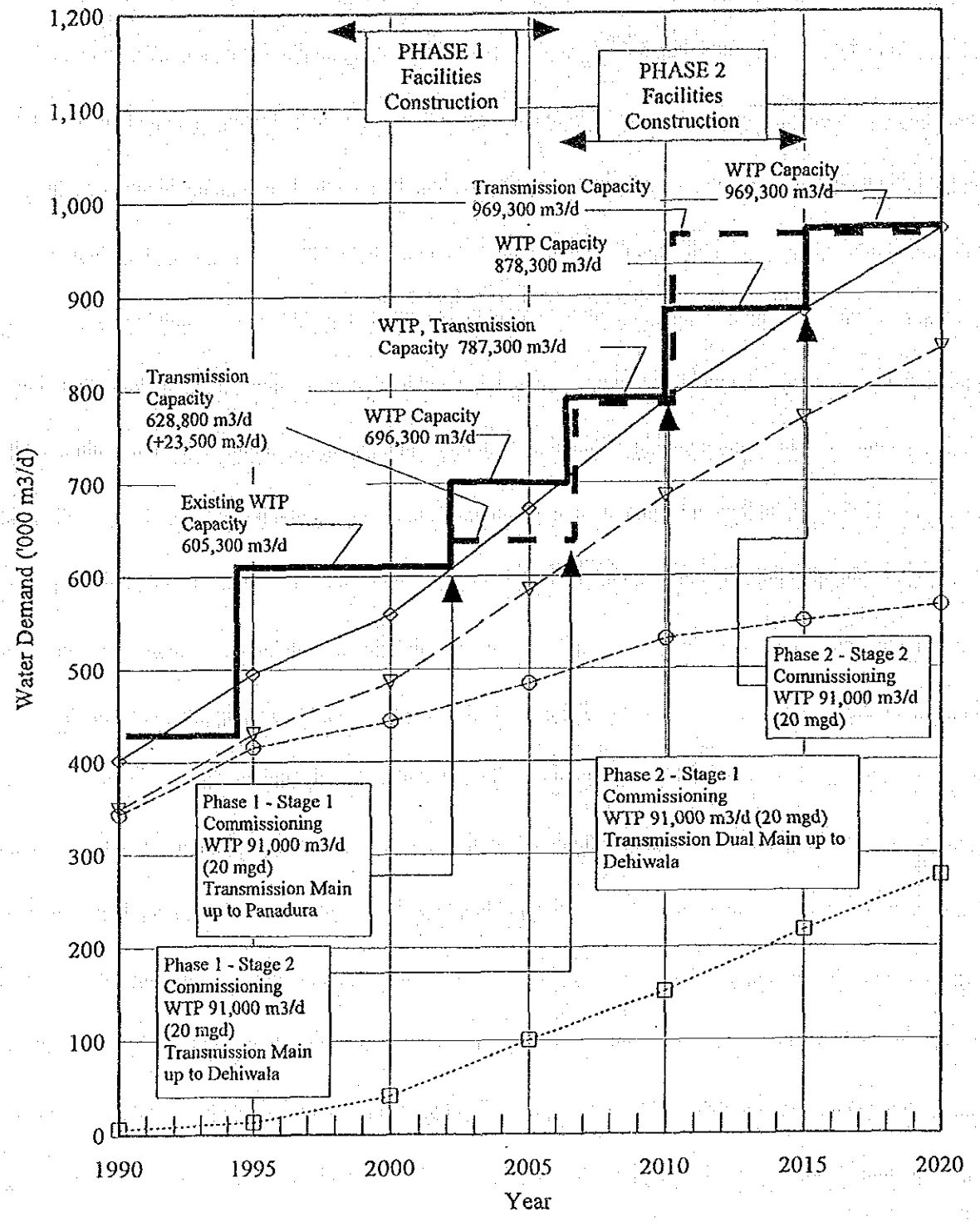
6) Establishment of salinity intrusion monitoring system

7) Timely Review of the Feasibility Study Prior to the Implementation

8) Establishment of water quality monitoring system for the Kalu Ganga

9) Kalutara Water Supply System in Future

10) Provision of sewerage services



◈ Daily Max. Demand ▽ Daily Ave. Demand

⊖ Existing Area Demand ⊡ New Area Demand

Figure 3 Implementation of the Project and Water Demand Projection

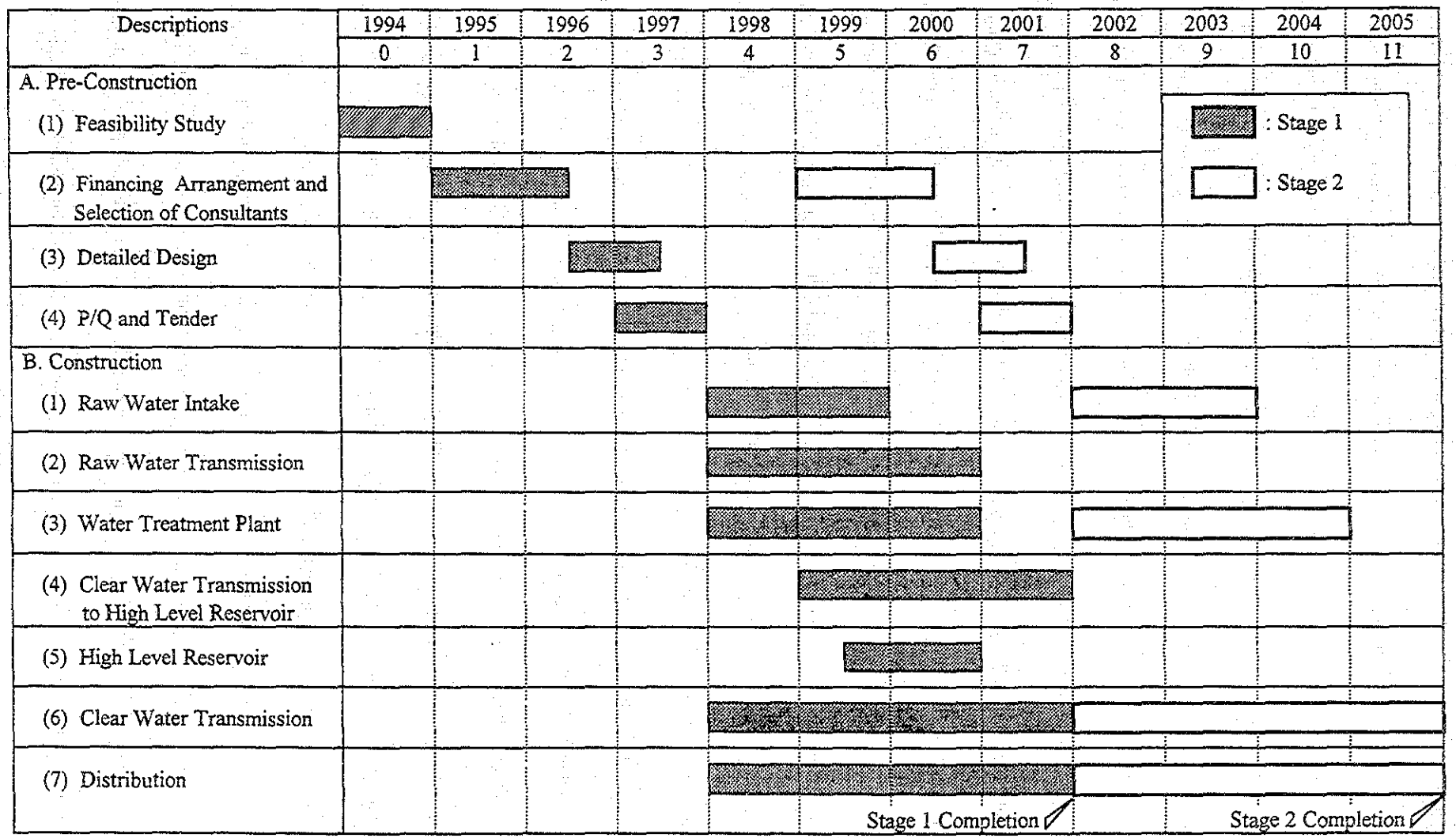


Figure 4 Implementation Schedule

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5. WATER DEMAND FOR THE KALU GANGA BY OTHER PROJECTS

6. KALU GANGA WATER SOURCE

7. PROPOSED LONG TERM DEVELOPMENT PLAN

PART II FEASIBILITY STUDY

8. SCOPE OF WORK FOR THE FEASIBILITY STUDY

9. DESIGN OF FACILITIES

10. OPERATION AND MAINTENANCE PROGRAM

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LIST OF ACRONYMS

ADB	Asian Development Bank
AGM	Assistance General Manager, NWSDB
B.W.L.	Bottom Water Level
CEB	Ceylon Electricity Board
C.M.C.	Colombo Municipal Council
DCS	Department of Census and Statistics
DGM	Deputy General Manager, NWSDB
EPZ	Export Processing Zones
ES	Engineering-Science, Inc.
GM	General Manager, NWSDB
GOS	Government of Sri Lanka
G.S.	Gramasevaka Division (local administrative unit)
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
JICA	Japan International Cooperation Agency
MSL	Mean Sea Level
MHCUD	Ministry of Housing, Construction and Urban development
NHDA	National Housing Development Authority
NJS	Nippon Jogesuido Sekkei Co.,Ltd.
NK	Nippon Koei Co., Ltd.
NRW	Non-revenue Water
NWSDB	National Water Supply and Drainage Board
OECF	Overseas Economic Cooperation Fund of Japan
O.I.C	Officers-in-Charge
P.S.	Pradeshiya Sabha (local administrative unit)
RDA	Road Development Authority
RSC	Regional Support Center, NWSDB
T.W.L	Top Water Level
UDA	Urban Development Council
UFW	Unaccounted for Water
WB	World Bank

LIST OF UNITS AND ABBREVIATIONS

cm	centimeter
cu m, m^3	cubic meter
cu m/d, m^3/d	cubic meter per day
cu m/min, m^3/min	cubic meter per minute
cu m/s, m^3/s	cubic meter per second
dia.	diameter
ft	feet
gal	Imperial gallon (= 4.546 litters)
ha	hectare
hr	hour
Kg	kilogram
Km	kilometer
Kw	kilowatt
KwH	kilowatt Hours
L/cap/d	liter per capita per day
L/s	liter per second
m	meter
mgd	million gallons per day
mm	millimeter
MPa	megapascal
Rs.	Sri Lankan Rupee
sq km, km^2	square kilometer
sq m, m^2	square meter
V	volt
y	year

EXCHANGE RATE (As of June 1994)

US$1.0 = Rs.49.0 = Yen 106.0

CHAPTER 1

INTRODUCTION

1. INTRODUCTION

1.1 Authorization

On the basis of the Scope of Work agreed upon between the National Water Supply and Drainage Board (hereinafter referred to as the "NWSDB") and the Japan International Cooperation Agency (hereinafter referred to as "JICA") on 30 August 1993 in Colombo, JICA made a contract with the joint venture of Nippon Jogesuido Sekkei Co., Ltd. and Nippon Koei Co., Ltd. on 6 December 1993 to conduct a feasibility study on the Kalu Ganga Water Supply Project for Greater Colombo (hereinafter referred to as the "Study").

JICA, the official agency responsible for the implementation of technical cooperation programs of the Government of Japan, undertook the Study in accordance with the relevant laws and regulations in force in Japan and in close cooperation with the authorities of the Government of the Democratic Socialist Republic of Sri Lanka. The NWSDB acted as a counterpart agency to the Japanese Study Team and as a coordinating body in relation to other relevant organizations for the smooth implementation of the Study.

1.2 Background

The Greater Colombo area is located in the southwest quarter of the Island of Sri Lanka. The total population of this area is approximately 2,837,000 persons consisting of 1,616,000 persons living in the existing service area and 1,271,000 persons in an outlying area extending from Katunayake in the north to the Kalu Ganga in the south. The NWSDB currently provides service to the population residing in the existing service area which measures 194 km^2.

The existing water supply depends upon the impounding reservoirs at Kalatuwawa and Labugama, the river intake at Ambatale on Kelani Ganga, and a minor pumped supply from the Kalu Ganga providing a total supply capacity of about 136 mgd (618,800 m^3/day) after completion of the new Ambatale Water Treatment Plant on January 1994.

The first water supply master plan for Greater Colombo was prepared in 1972 by Howard Humphreys & Sons under the UNDP assistance. Since then, the implementation of the water supply development has been conducted in line with the recommendations in this master plan. In 1991, a study was undertaken to update the original master plan by Engineering-Science under USAID assistance to prepare "Greater Colombo Water Supply System Master Plan Update (hereinafter called as the Master Plan Update 1991)". This study was further updated in 1993 as Addendum for the Master Plan Update 1991 to incorporate the most recent development in the service area.

In accordance with the development plan presented in the Master Plan Update 1991 to meet the growing water demand for the expanding population in both the existing service area and in the outlying area by 1995, the Jubilee and Maharagama system and the "Towns East" scheme are in progress. The development of the Kalu Ganga Water Supply System as a new water source is one of the recommendations in the Master Plan Update 1991.

Sometime in between 2000 and 2005, it is necessary to serve the existing service areas of the towns south and the areas south of Dehiwala/Mt.Lavinia with a new water supply system from the Kalu Ganga due to the limited water supply from the Kelani Ganga. The number of population served by the new water supply from the Kalu Ganga will be 634,000 persons in the above area by the year 2010. This scheme will provide more flexibility to respond to the uncertain courses of future development in the area.

In light of this background, it was proposed to undertake the Feasibility Study for the Kalu Ganga Water Supply Project as a program of technical assistance by JICA.

1.3 Objective of the Study

The objective of the Study is to formulate a long-term plan for the expansion of the Greater Colombo Water Supply System with an intake from the Kalu Ganga to meet the water demand up to the year 2020 and to conduct the Feasibility Study for the Phase 1 Project of the long-term development plan.

1.4 Study Area

The Study shall cover the existing and proposed service areas of the Greater Colombo Water Supply System and the Kalu Ganga basin.

The areas proposed to be tentatively covered under the Study are Horana, Bandaragama, Panadura, Keselwatte, Kesbewa, Homagama, Moratuwa, and Dehiwala/Mt.Lavinia.

However, due consideration shall be given to the entire Greater Colombo area in order to realize the coordinated development of water supply in the area and to demarcate the service area in the most feasible way to be served by the two major sources, i.e. the Kelani Ganga and the Kalu Ganga.

1.5 Design Year

"Greater Colombo Water Supply System Master Plan Update" projected the water demand in the Greater Colombo area by 2020 and shows the facility plan by 2000. Taking into account the fact that the population projection is made on the basis of 1981 census data, it seems inappropriate in accuracy

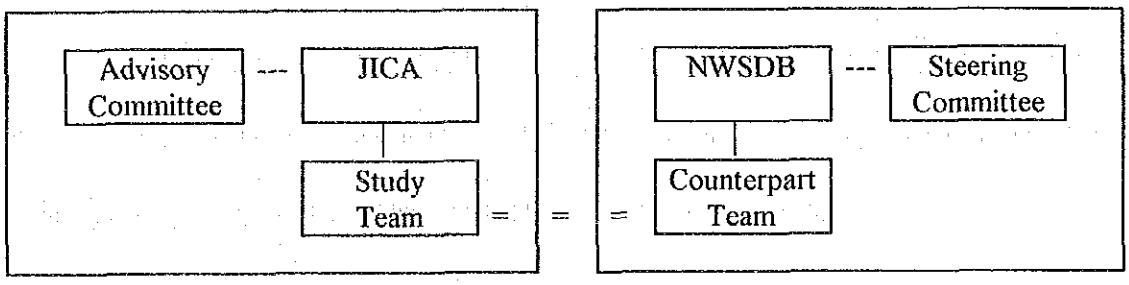
to extend the design year beyond 2020, hence a design year for the Master Plan in the Study shall be the same year of 2020 as that in the said Master Plan Update.

As for the design year for the Feasibility Study shall be set at the year 2010 in consideration of the construction period of the new water supply system including the time period needed for detailed design and project processing.

1.6 Study Organization

1.6.1 General

The general organization for the Study is as shown below



1.6.2 Japanese Organization

The Japanese organization consist of the Study Team under JICA headquarters and the Advisory Committee set up at the JICA headquarters.

The members of the Study Team are as follows:

Mr. Ikuo Miwa	Team Leader/Water Supply Planning
Mr. Keisuke Okazaki	Facility Planning
Mr. Kuniaki Onishi	Distribution Planning and Water Demand
Mr. Masao Fujiwara	Water Intake Planning and Geology
Mr. Toshikatsu Imai	Hydrology and Water Source
Mr. Malcolm Patrick Hyde	Water Quality and Environment
Mr. Shin-ichi Osaka	Equipment Planning
Mr. Kiyohito Yamazaki	Implementation Planning and Cost Estimation
Mr. Kirthi Sri Senanayake	Organization and Operation
Mr. Shin-ichi Isoda	Financial Planning and Project Evaluation

The members of the Advisory Committee are as follows:

Mr. Katsuyoshi Tomono	Leader/Water Supply Planning Senior Researcher, Japan Water Works Association
Ms. Keiko Yamamoto	Facility Planning

Mr. Tomio Iwamoto	Senior International Cooperation Specialist, Japan Water Works Association Finance Assistant Manager, Engineering Department, Osaka Municipal Waterworks Bureau

1.6.3 Sri Lankan Organization

The Sri Lankan organization consists of the NWSDB Counterpart Team, and Steering Committee composed of the representatives of the organizations concerned with the Kalu Ganga Water Supply Project in coordination with the NWSDB.

The principal members of the NWSDB Counterpart Team and the NWSDB are as follows:

Mr. T. B. Madugalle	Chairman
Mr. A. P. Chandraratne	General Manager
Mr. M. Wickramage	Addl. General Manager (Corporate Planning)
Mr. P. M. R. Pathiraja	Addl. General Manager (Operations)
Mr. P. U. Gunasinghe	Deputy General Manager (P&D)
Mr. S. K. H. Perera	Deputy General Manager (RSC-GC)
Mr. K. M. N. S. Fernando	Deputy General Manager (IDA)
Mr. T. M. M. Mediwaka	Deputy General Manager (Financial)
Mr. S. J. P. Wijegoonewardene	Assistant General Manager (P&D I)
Mr. D. N. J. Ferdinando	Assistant General Manager (RSC-GC)
Mr. A. H. C. Silva	Assistant General Manager (UFW)
Mr. L. S. P. J. de Silva	Assistant General Manager (Service)
Mr. R. H. Ruvinis	Chief Engineer (P&D)
Mr. Anura Jayasinghe	Chief Engineer (Corporate Planning)
Mr. Nimal Padamsiri	Chief Chemist
Mr. Asoka Perera	Geologist
Mr. G. B. N. Wimalasooriya	Senior Engineer (P&D)
Mr. W. A. Samarakoon	Engineering Assistant
Ms. P. Sangarapillai	Engineering Assistant

The members of the Steering Committee are as follows:

Mr. K. A. H. Ranaweera	Secretary to the Minister for Housing
Mr. T. B. Madugalle	Chairman, NWSDB
Ms. D. D. J. Kudaligama	Director, External Resources Department
Mr. P. Sumanapala	Deputy Director, National Planning Department
Mr. D. G. D. C. Wijeratne	Addl. General Manager (Planning), CEB
Mr. K. G. D. Bandaratilake	Deputy Director General (Technical), CEA
Mr. K. G. S. Lankatilake	Addl. Director (Technical), UDA
Mr. G. T. Dharmasena	Deputy Director(Hydrology), Irrigation Department
Mr. Lionel Wijendra	Addl. Director, Policy and Planning, Ministry of Housing, Construction and Public Utilities

1.7 Organization of Report

The Study Reports prepared are as follows:

Summary Report	(Volume I)
Main Report	(Volume II)
Supporting Report	(Volume III)
Data Report	(Volume IV)
Drawings	(Volume V)

The Summary Report presents the essential results of the whole Study which is extracted from the Main Report. It consists of two parts ; Part I "Development Plan" and Part II "Feasibility Study".

Part I describes the natural conditions, socio-economic conditions and land use of the Greater Colombo area as well as the Study area, the outline of the existing waterworks including the organization concerned, water supply system, population served, water use, and on-going and planned water supply projects. Based on the results of the review on the Master Plan Update prepared in 1991 and population and water demand projection, and the study on the water demand for the Kalu Ganga by other projects and the safe yield of the Kalu Ganga water source, the long-term development plan of the Kalu Ganga Water Supply System which is an integral part of the Greater Colombo Water Supply System is presented.

Part II defines first the scope of work for the Feasibility Study of the Kalu Ganga Water Supply System and describes the design of facilities, operation and maintenance program, implementation plan, project cost estimates, institutional and managerial considerations, financial performance of the NWSDB, project evaluation and the environmental protection considerations.

CHAPTER 2

GENERAL DESCRIPTION OF THE GREATER COLOMBO AREA

2. GENERAL DESCRIPTION OF THE GREATER COLOMBO AREA

2.1 Natural Conditions

2.1.1 Meteorology

The mean monthly temperature at Colombo ranges from 26.8°C to 28.7°C. The highest temperature in a year appears in May and the lowest appears in November. The mean monthly temperature of daily maximum temperature at Colombo are around 32°C in April and 22°C in January, respectively.

2.1.2 Hydrology

Annual rainfall at Colombo ranges from around 1,500 mm to 2,500 mm and the average of annual rainfall is 2,153 mm. The monthly rainfall at Colombo has peaks of 319 mm in May and 278 mm in November. The lows are 57 mm in February and 106 mm in August at Colombo.

Tide at the Colombo port has generally two high tides every day. The mean amplitude of tide is 0.51 m and the mean tide is +0.08 m MSL.

2.2 Socio-Economic Conditions

2.2.1 Economic Condition

The data available for understanding the economic condition of the Greater Colombo area, especially the income level of the people is very limited. "Greater Colombo Water Supply System Master Plan Update" prepared in 1991 presents the 1989 Colombo household income developed with such limited data which is reproduced in Tables 2.1 and 2.2.

Table 2.1 Colombo Household Income (1989)

Income Receiver Quintile	Household Income (Rs./month)
Lowest 20%	630
Second 20%	2,090
Third 20%	3,677
Fourth 20%	5,326
Highest 20%	19,217

Table 2.2 Colombo Household Income Level (1989)

Percent of Household	Receive Income (Rs./month)
20%	619
30%	1,700
40%	2,785
50%	4,640

2.2.2 Education

The ratio of pupils to teachers are in general satisfactory for each primary, secondary and maha vidyalayas level. The problems schools have been facing are the early school leavers and the lack of educational facilities.

The shortage of educational requirements includes the teachers, school furniture, school accessories (i.e. teachers' tables and chairs, black boards, cupboards, students' desks and chairs, science tables, home science unit, aesthetic unit, etc.), and other requirements (play grounds, buildings, floor space, science room, library, water, electricity, latrines, etc.). In Homagama, for example, 24 schools out of 45 schools need sufficient buildings, floor space and other requirements.

2.2.3 Public Hygiene

The Provincial Director of Health Services (PDHS), the Deputy Provincial Director of Health Services (DPDHS) and the Medical Officers of Health (MOH) are responsible for sanitation, general preventive services, epidemiological and health education at each level of province, district and area of the Divisional Secretary (former Assistant Government Agent). The administrative area of the MOH almost coincide with that of the Divisional Secretary but not exactly.

Per 100,000 persons morbidity of the water and sanitation related/associated diseases are 17,215 in ill-defined intestinal infection, 3,303 in shigellosis and 2,596 in malaria, respectively, in order of magnitude. Ill defined intestinal infections and shigellosis are attributable to poor sanitation and undesirable health behavior, while malaria is mainly due to poor drainage leaving stagnant pools of water and indiscriminate disposal of water containing materials in which vectors breed.

2.2.4 Sanitation and Sewerage

In the Greater Colombo area, the sanitation and sewerage facilities are used for excreta and wastewater management as of 1992 as listed in Table 2.3.

The existing sewerage system covers only the C.M.C. area. Although sanitary sewers have been constructed in a northern coastal part of Dehiwala M.C., no house connection has been provided due to no operation of two pumping stations to convey sewage within the area.

Table 2.3 Sanitation Facilities in Greater Colombo

	Population	%
Served by sewers	550,000	19
Served by on-site facilities	1,700,000	59
No service or service grossly inadequate	650,000	22
Total	2,900,000	100

2.2.5 Environmental Problems

(1) Water Pollution

Sewage pollution has been reduced since completion of a sea outfall pipe at Mutwal in 1987. Previously some 90,000 m^3 of untreated sewage was pumped into the river from the northern sewerage zone each day. A second outfall was constructed at the same time to serve the Southern sewerage zone, discharging untreated sewage at a point 1.4 km from the coast at Wellawatta. In theory the northern outfall is some 2.0 km in length but unofficial sources suggest the pipeline has been severed about 1.0 km from the shore. High levels of sewage pollution are frequently found in the harbor area and it is quite likely that significant pollution drifts inshore from both outfalls.

More than 50 percent of the population live in poor housing and discharge their sewage directly or indirectly to surface waters. Septic tanks and pit latrines are used extensively but are often constructed without any regard to location or ground conditions. In consequence significant groundwater contamination occurs. This is cause for great concern as many areas of Greater Colombo rely on wells for their potable water supplies. A survey of an area in the Ratmalana/Moratuwa district showed 95 percent of the well waters to have faecal contamination.

Storm waters and industrial effluents flow into the streams and canal networks in the Colombo area, most finally entering the Kelani Ganga at the St. Sebastian Canal North Lock. At high water the effluent flows are diverted South and West to be discharged to sea at Dehiwatta and Wellawatta. Combined with domestic sewage, these inflows have caused the vast majority of such watercourses to become open sewers.

(2) Air Pollution

Air pollution problems in the Greater Colombo area are relatively few compared with industrialized regions in other countries. However it is believed to have the highest air pollution levels of Sri

Lanka as it accounts for 60 percent of manufacturing industries, 60 percent of registered vehicles and diesel driven power stations.

(3) Solid Waste Pollution

An estimated 1200 tons per day of domestic refuse were produced in the Colombo urban area in 1990, a figure which is set to rise by another 21 percent by the year 2010. About 90 percent of this solid waste in the Colombo Municipality is brought to temporary collection sites where it remains for unacceptably long periods of time. In some of the smaller Urban Local Authorities only 5 percent is collected.

The net result is that very large quantities are dumped in low lying areas, much of which eventually finds its way into the drains, watercourses, lakes and lagoons. This causes severe water pollution, blockage of channels promoting flooding and offensive odors.

Solid waste from industry is small compared to their discharge of liquid effluents.

2.3 Land Use in the Project Area

The Project area comprises seven Divisional Secretary's Divisions. The followings are the brief summaries of current configurations of land use in the Project area.

1) Dehiwala

The land extent of this division is approximately 20 km^2. Approximately 90 percent of the land is utilized for the urban facilities and utilities. The land for agricultural use occupies only 1.1 percent and the remaining potential land for cultivation is very less. This division is currently functioning as a satellite town of the city of Colombo.

2) Moratuwa

This division is located at the western and southern end of the boundaries of the Colombo district with demarcated boundaries on the west by sea coast line of approximately 10 km, on the east and south by the Bolgoda river and on the north by Ratmalana division in Colombo district.

The total land of this division is 23.6 km^2, and of them 90 percent is occupied by houses, industrial and commercial buildings, roads and other public facilities.

3) Panadura

The area of this division is approximately 58 km^2. More than 90 percent is covered with agricultural, natural and water logged areas. Keselwatte is included in this division.

4) Kesbewa

This division is located in the coastal plain with the extent of approximately 60 km^2. According to the data obtained, the land use pattern indicates that an approximately half of the land is home gardens and the main crop is coconut. These characteristics of home gardens spread from urban to rural areas.

5) Homagama

Except for the mountain called Kuragala Kanda which rises to a height of 350 feet, this region is mainly a plain, 30 to 75 m above the sea level. The north and eastern parts of the region are fed Kelani Ganga and its tributaries, while the western and southern parts are by Maha-Oya and its tributaries.

About 80 percent of the total extent of lands is highlands and 20 percent are paddy lands. Out of 125.8 km^2 of arable lands 1.6 km^2 are still to be cultivated.

6) Bandaragama

The map prepared by the Survey Department on land use in Colombo and Kalutara districts during 1981-1984 reveals that the extent of Bandaragama division is 84.8 km^2. Out of that 0.1 km^2 is developed land, 83.3 km^2 which corresponds to 98 percent is agricultural land, 1.3 km^2 is swamps and 0.1 km^2 is barren land.

7) Horana

Horana division is situated in Kalutara district and bordered on Colombo district to the north, Madurawala and Bulathsinhala divisions to the south, Ratunapura district to the east and Bandaragama division to the west. Horana is the second largest Divisional Secretary's Division in the district.

CHAPTER 3

EXISTING WATER SUPPLY

3. EXISTING WATER SUPPLY

3.1 Organization and Activities of the NWSDB

3.1.1 Legislation

The NWSDB is a public authority established under the National Water Supply and Drainage Board Law No.2 of 1974 of the National State Assembly. The NWSDB was formed out of the Department of Water Supply and Drainage in January 1975 and now is an autonomous body under the Ministry of Housing, Construction and Public Utilities (MHCPU). The NWSDB has its main responsibilities in developing, providing, operating and controlling public water supply facilities to distribute water for public, domestic or non-domestic including industrial and commercial purposes and to charge for the water so supplied.

Before the formation of the NWSDB, local authorities in the respective areas supplied water to their consumers and this practice is continued in some areas even now. The proposed service area under the Kalu Ganga Water Supply Project includes three kinds of administrative units; 1) Municipal Council, 2) Urban Council, and 3) Pradeshiya Sabha. Their powers as to public utility services are specified in the Governmental Ordinances gazetted under Chapter 252, Municipal Councils of August 15, 1947 and Chapter 577, Urban Councils of January 1, 1940. According to these ordinances, the Municipal and Urban Councils are empowered to establish and maintain water supply services, public baths, bathing places, laundries and places for washing animals etc. among other public services.

3.1.2 Organization and Staffing of the NWSDB

(1) Organization

The updated organizational structures of the MHCPU and the NWSDB are shown in Figures 3.1 and 3.2, respectively.

The NWSDB operates through five Regional Support Centers (RSCs): the Central RSC, Greater Colombo RSC, North Eastern RSC, Southern RSC, and Western RSC. With such an organizational set up, the NWSDB maintain about 50 percent of a total of nearly 500 water supply schemes currently in operation throughout the country. However, only skeleton services are maintained in the Northern Provinces due to security situation there.

The 248 schemes under the purview of the NWSDB have produced 310 million m^3 of water in 1993. The total number of connections under these schemes was 260,996. A population of 2.1 million had received 24 hour water supply while 3.2 million were benefited with a service less than 24 hours. Of

the total population, 68.8 percent in the urban area and 31.4 percent in the rural area has drinking water primarily from safe sources. The key facts and figures are summarized in Table 3.1.

Table 3.1 Number of Water Supply Schemes in Sri Lanka

year	Total Schemes	NWSDB maintained schemes	% of NWSDB's Schemes
1991	476	231	48.5
1992	491	245	49.8
1993	494	248	50.2

Source : Annual Reports of the NWSDB 1992 and 1993.

(2) Staff

The number of employees deployed by location (Head Office and RSCs) as of May 1993 is tabulated in Table 3.2.

Table 3.2 Staff Deployment of the NWSDB by location

Location	Permanent	Casual	Total	(%)
Head Office	1,453	94	1,547	23.1
Greater Colombo RSC	1,042	51	1,093	16.4
Kalutara Region	185	1	186	2.8
Ratmalana Region	407	20	427	6.4
Kurunegala Region	595	15	610	9.1
Matara Region	551	2	553	8.3
Hambantota Region	321	6	327	4.9
Kandy Region	631	41	672	10.1
Anuradhapura Region	407	25	432	6.5
Bandarawela Region	321	35	356	5.3
Ampara Region	150	2	152	2.3
Jaffna Region	115	1	116	1.7
North East RSC	131	11	142	2.1
No Pay Leave/Scholarships abroad	70		70	1.0
Total	6,379	304	6,683	100.0

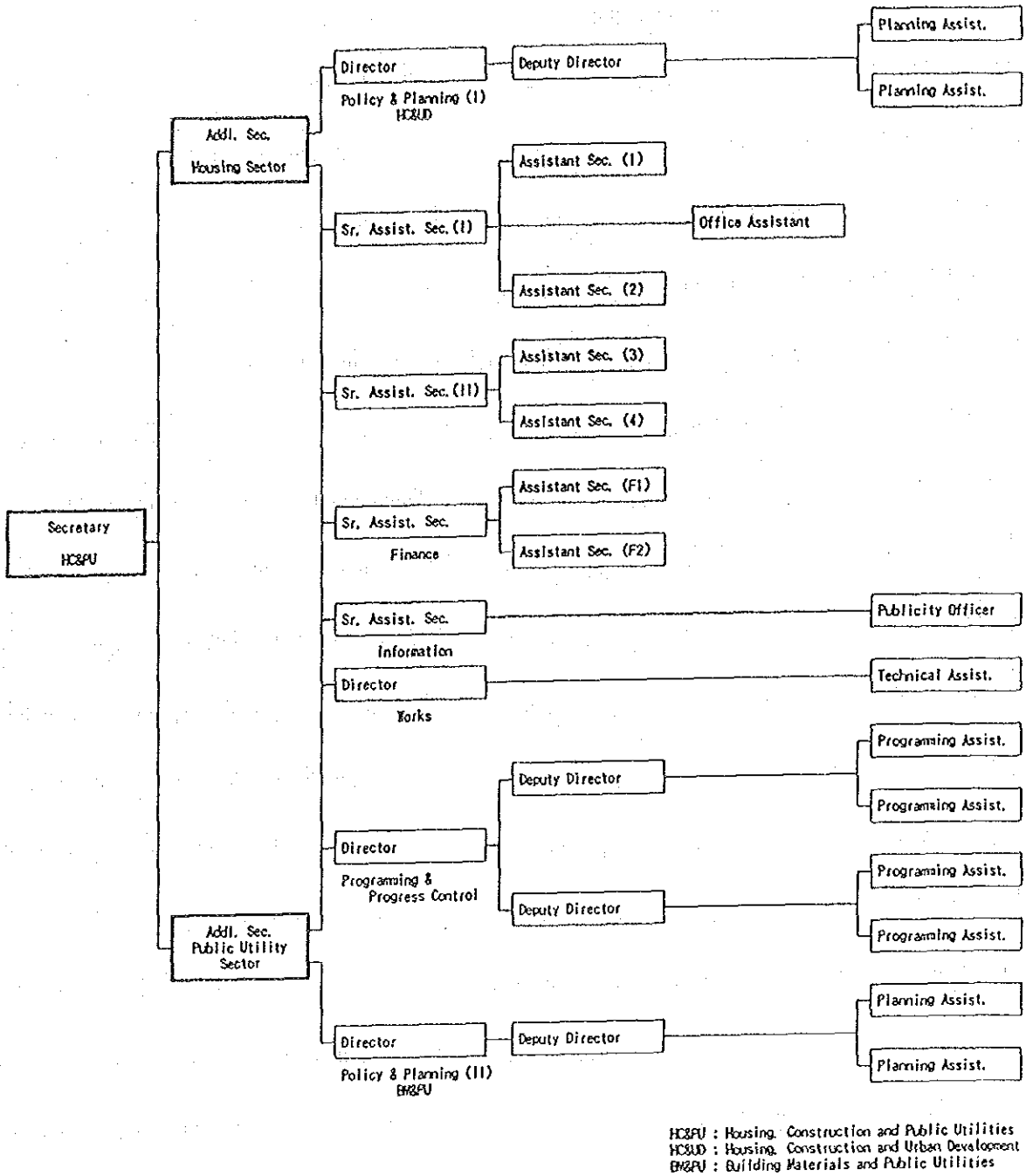


Figure 3.1 Organization Chart of Ministry of Housing, Construction and Public Utilities

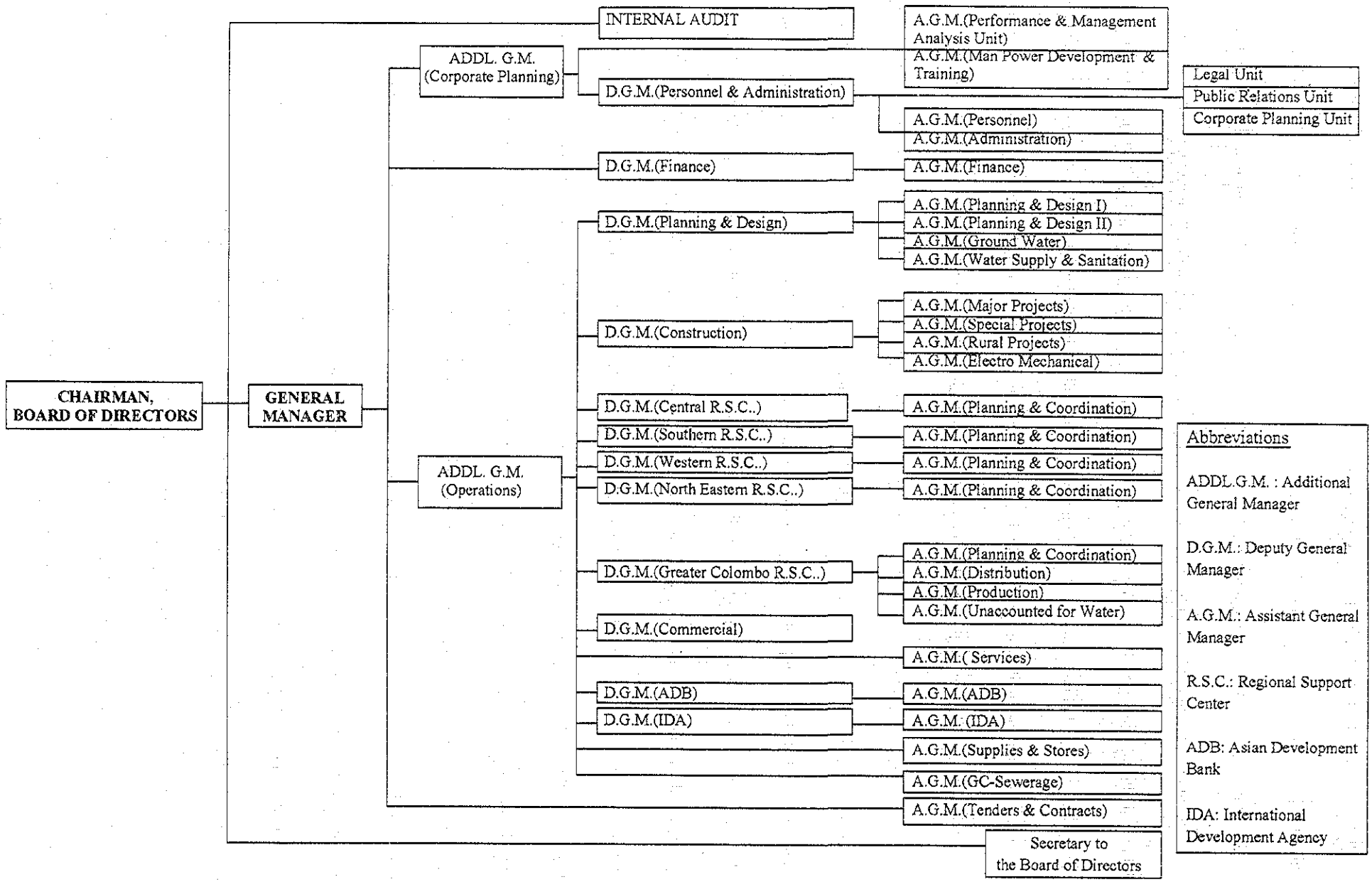


Figure 3.2 Organization Chart of the NWSDB

3.2 Financial Status of the NWSDB

During the last four years, there has been significant progress in the financial performance of the NWSDB as shown on Table 3.3. This significant progress is mainly attributable to improvement in institutional management and rate of the tariff increase which has been allowed to take place annually to meet the increased operational cost in cope with the general inflation.

However, the NWSDB is still in an accumulated deficit, amounting to Rs.1,482 million as of the end of 1993 which are approximately equivalent to an approximate annual revenue.

The financial statements have been reviewed from several aspects representing the performance of the past several years. The major indicators are summarized in Table 3.3 which is constructed principally based on the data from the above financial statements.

Among them, major concerns are described below:

1) Inventory Turnover

Inventory turnover appears to be a prime concern for the utility operation entity, which is total sales divided by the total value of inventory. This ratio has been recognized to show an upward trend over these years, representing some improvement. This ratio of 1.80 as of 31 December 1993 appears to show still excessive level of inventory, amounting to the equivalent of 1 to 2 times worth of the annual operating expenses. These amounts may not represent real stocks. Even if so, an assessment of existing amount and values should be made and appropriate adjustments made to the book value. Anyhow, it should be noted that the low ratio indicates that too much money is still being tied up in inventory in relation to sales volume.

2) Collection Period (Arrears)

The next ratio is average collection period, which is the total of accounts receivable divided by sales per day. This ratio of 159 for the year of 1993 indicates that an average of 159 days is required to collect the receivable. This ratio has been recognized to show a downward trend over these years, representing some improvement. However, it is rather high in relation to the normal collection period of 30 days for the NWSDB. Since customers are still slow in paying the bills, the outstandings of the arrears are recognized to be still as high as Rs.595 million corresponding to about 40 percent of the annual revenue.

But the outstanding of the arrears have been kept at a constant level for these years, indicating recent good performance in collection from billings.

In the course of improving financial performance, it has become apparent that further improvement is required to sustain the sound financial management of the NWSDB, taking into account that the debt service tends to increase from now on, reaching the peak in around 2001 as shown in Figure 3.4.

The repayment schedule in Figure 3.4 is constructed on the basis of the amounts disbursed and to be disbursed for the externally-assisted projects.

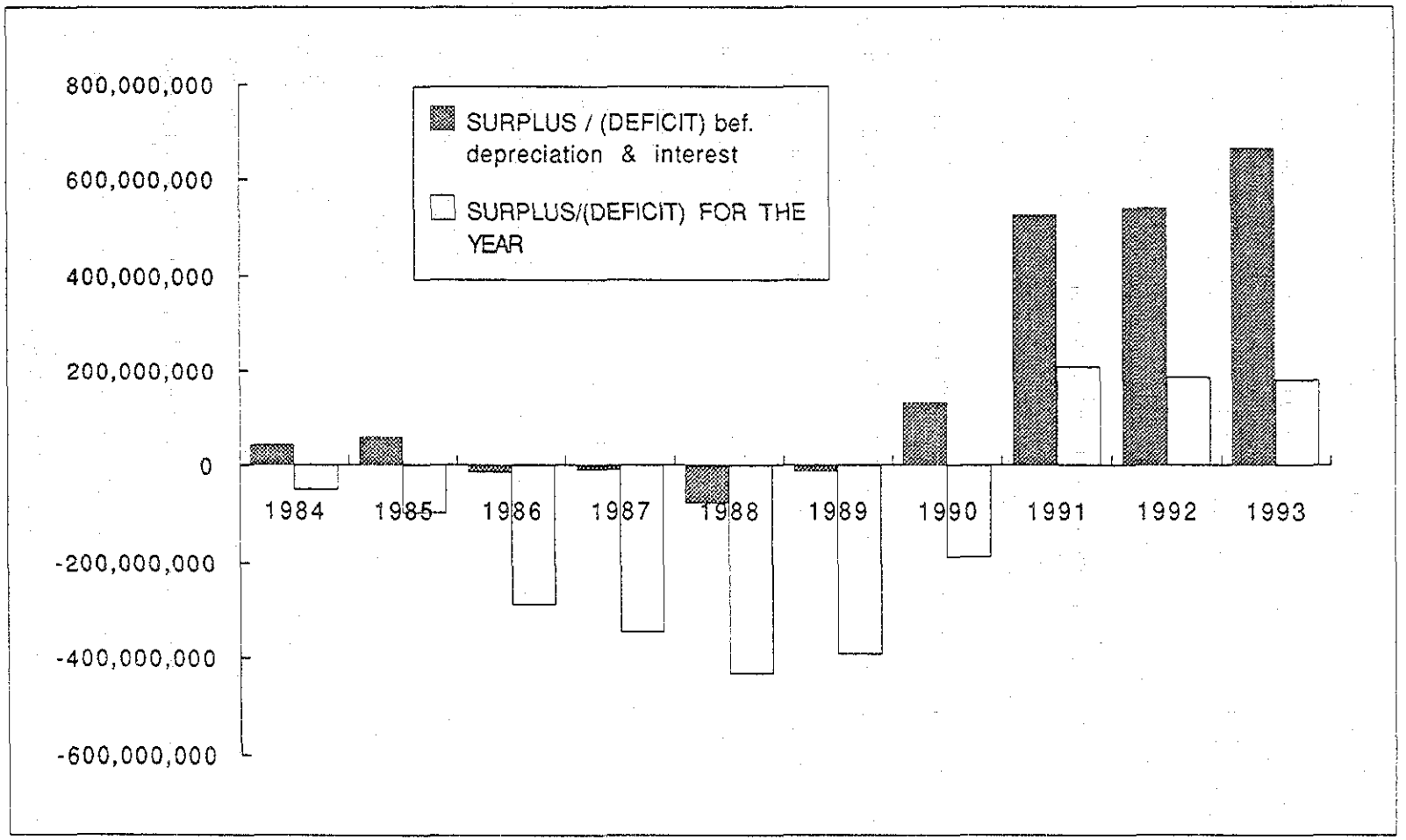


Figure 3.3 Financial Performance of the NWSDB

Table 3.3 Financial Highlights

unit: Rs.'000

	Year		
	1993	1992	1991
1. Revenue from Operation & others	1,488,926	1,211,723	1,100,491
Gross Revenue per cubic meter of water billed and sold (Rs./m^3)	11.90	10.25	9.68
2. Gross Operating Expenses (including administrative overheads)	814,491	670,305	574,288
Gross operation cost per cubic meter of water billed and sold (Rs./m^3)	6.51	5.67	5.05
3. Net Income	179,932	187,360	209,300
Rate of Return on	4.1%	4.9%	5.5%
Net Fixed Assets	4,431,560	3,776,659	3,795,789
4. Accumulated Deficit	-1,330,474	-1,482,056	-1,664,220
5. Cash Position (Cash at bank and investment)	1,291,000	875,000	521,000
6. Long-term Liabilities	3,761,393	3,534,216	2,510,993
7. Total Assets	18,200,197	15,658,941	12,758,561
8. Liquidity Ratio			
Current Ratio	1.75	1.93	1.93
Quick Ratio	1.12	1.23	1.28
9. Capital & Debt Structure			
Debt to Total Assets	0.21	0.23	0.20
Debt to Equity	0.29	0.32	0.28
10. Activity Ratio			
Inventory Turnover	1.80	1.57	1.51
Average Collection Period (days)	159	177	188
11. Debt Service Coverage Ratio	2.84	4.04	4.90

Water Billed and Sold (in '000 m^3)	125,168	118,274	113,650
Water Produced (in '000 m^3)	228,000	216,000	192,000
Percentage of Water Billed to Water Produced	54.9%	54.8%	59.2%

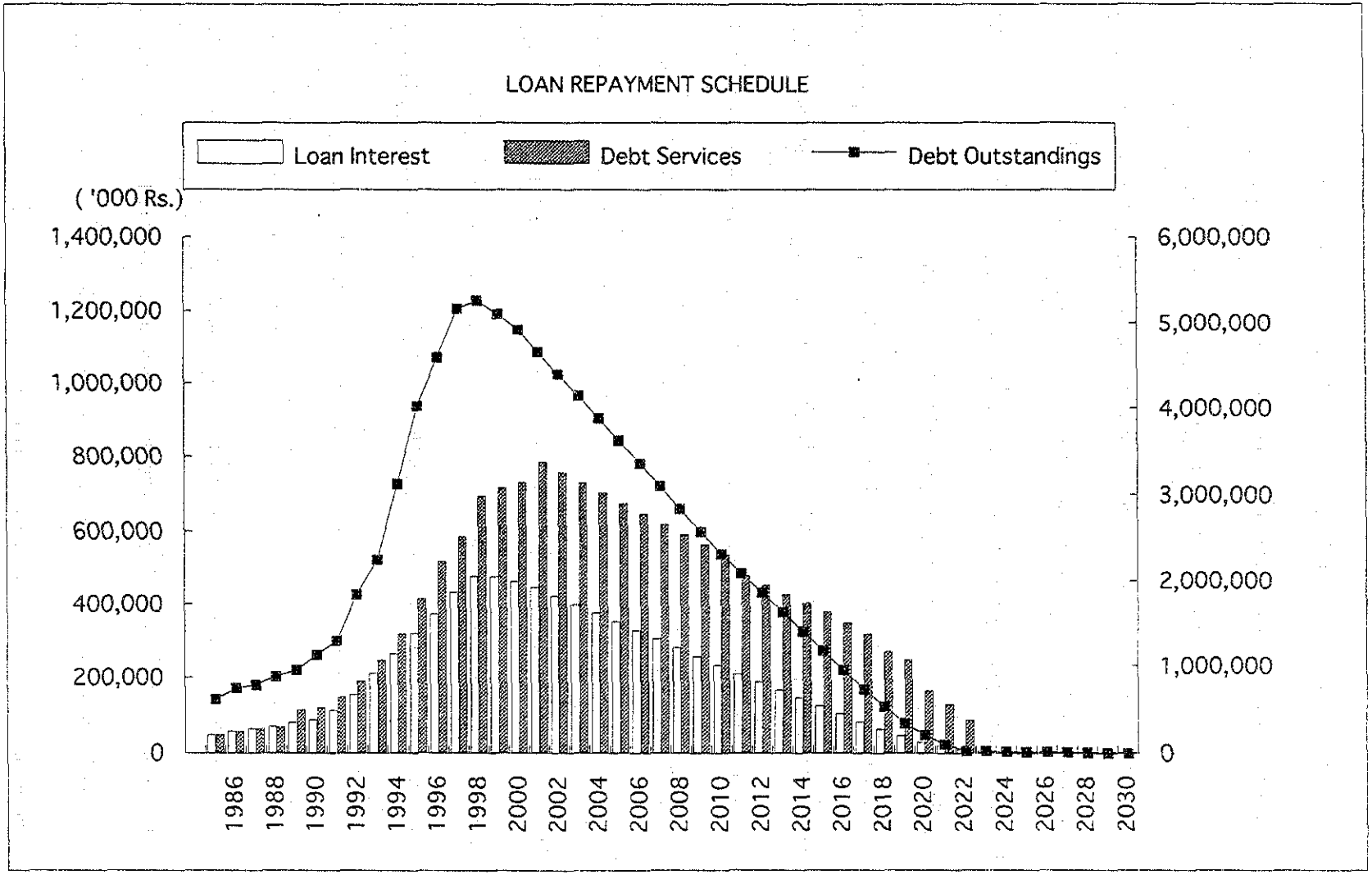


Figure 3.4 Loan Repayment Projection

3.3 Existing Water Supply System and Facilities

3.3.1 Water Sources

(1) Labugama and Kalatuwawa Reservoirs

The Master Plan Update utilized the following basic data given in Table 3.4 for the reservoir study. The reservoir operation was simulated for the period of October 1949 to September 1988.

Table 3.4 Reservoir Operation Study Data

Item	Kalatuwawa	Labugama
Nominal Design Capacity of Treatment Plant	20 mgd (91,000 m^3/d)	13 mgd (59,000 m^3/d)
Actual Capacity of Supply	18 mgd (81,900 m^3/d)	11.6 mgd (53,000 m^3/d)
Maximum Storage	15.4 million m^3	8.9 million m^3
Minimum Storage	1.6 million m^3	0.95 million m^3

Source: Greater Colombo Water Supply Master Plan Update (July 1991)

Appropriate adjustment was made during the reservoir simulation study to obtain the computed net yield of Labugama equivalent to the measured yield for the period 1978 - 1983 by increasing the runoff coefficient for the Labugama catchment. The final runoff coefficient for the Labugama was 0.70. The mean monthly safe yield at Kalatuwawa resulted as 1.97 million m^3 and that at Labugama as 0.96 million m^3.

(2) Kelani Ganga

The Kelani Ganga basin has a drainage area of 2,278 km^2 and an annual rainfall of 3,800 mm of which 64 percent is estimated to drain into the sea.

By the period of the previous Master Plan Study in 1972, the minimum flow condition observed during the January to March period was improved due to the regulation of flows from hydropower stations in the upper reaches of the river. A further improvement to the flows at Ambatale during low-flow periods was noticed after 1976, when the hydropower stations in the Mahaweli complex came into operation.

The sand mining activities since 1987 to date had a major influence on low water flows at Ambatale since the mining has resulted in a continuous lowering of the natural river bed level and enlargement of the river section in the lower reaches. Although the river flow at Ambatale is sufficient to withdraw 500,000 m^3/d during the low flow periods, low tide may cause the river water level to fall below the intake level, and high tides may bring in saline water.

(3) Kalu Ganga

The Kalu Ganga has a drainage area of 2,700 km^2 discharging 7,600 million m^3/year compared to 5,600 million m^3/year for the Kelani Ganga. However, due to the non-availability of regulating reservoirs in the basin, a greater variation of mean monthly flows can be observed over the course of the year.

The hydrological and hydraulic analysis of the Kalu Ganga are described in Chapter 6 of this report.

3.3.2 Water Treatment

After completion of the 40 mgd New Ambatale Water Treatment Plant the total nominal production capacity of the existing four water treatment plants except for the 0.33 mgd minor Horana Water Treatment Plant is 136 mgd (618,800 m^3/d) as follows:

Old Ambatale	63 mgd	(286,700 m^3/d)
New Ambatale	40 mgd	(182,000 m^3/d)
Kalatuwawa	20 mgd	(91,000 m^3/d)
Labugama	13 mgd	(59,000 m^3/d)
Horana	0.3 mgd	(1,500 m^3/d)

While, the water use in 1992 in the existing service area covered by the above four water treatment plant was 173,458 m^3/d on an average and was estimated at 199,500 m^3/d on the daily maximum basis taking into account the peak factor of 1.15.

(1) Labugama Water Treatment Plant

The Labugama Water Treatment Plant is supplied raw water from the impounding reservoir situated behind the treatment plant. The dam and reservoir were commissioned in 1886 and provided the first major source of piped water supply to the Colombo City. Initially, raw water was conveyed to the City; a treatment plant was commissioned in 1917 and, thereafter refurbished in 1985 and commissioned in the subsequent year 1986.

The design capacity after the refurbishment is 59,000 m^3/d, however, the supply quantity is regulated according to the instructions received from the Ambatale Water Treatment Plant taking into account the water levels in the reservoir and water level of the clear water reservoir. According to the water production records, the average throughput from this treatment plant is 43,000 m^3/d, maximum 83,000 m^3/d and minimum 23,000 m^3/d, respectively.

(2) Kalatuwawa Water Treatment Plant

The Kalatuwawa Water Treatment Plant was commissioned in 1958 and refurbished in 1985/86. The design output following renovation is 91,000 m^3/d. The raw water from the reservoir passes over an

aerator and is then given conventional treatment by coagulation, flocculation, sedimentation and filtration. The clear water reservoir has a capacity of 5,000 m^3. The facilities include a filter backwash water recycling system that is not in use.

(3) Ambatale Water Treatment Plant

The first phase of the plant was commissioned in 1966, the second phase was implemented from 1972 to 1979, and the third phase in 1987.

In the first phase, raw water intake capacity was 182,000 m^3/d (40 mgd) with an initial treatment capacity of 91,000 m^3/d (20 mgd). High level pumps are provided to deliver water to Ambatale Tower for supply to Kotte, Dehiwala, Moratuwa, and Panadura.

In the second phase, additional pumping units to increase the capacity of the intake up to 182,000 m^3/d was provided. High level pumps delivering water to Maligakande, Elie House and towns north of Colombo were provided.

In the third phase, a new raw water intake of 300,000 m^3/d capacity with an initial pumping capacity of 130,000 m^3/d was constructed. High level pumps were provided to deliver water to Kolonnawa.

The new Ambatale Water Treatment Plant project financed by the Government of France was completed in December 1993 and commissioned. The project increased a production capacity by 182,000 m^3/d (40 mgd).

3.3.3 Water Transmission and Distribution

(1) Transmission Mains

In the existing Greater Colombo water supply area, approximately 330 km of major transmission mains have been provided. The general plan of transmission and distribution system is given in Drawings (Volume V).

(2) Distribution System

An extensive network of distribution pipes ranges from 38 to around 800 mm. In general, pipes of 150 mm or less are PVC, while the larger pipes are cast iron. The existing condition of distribution network in and around the C.M.C., however, is not understood in detail since the network is partly installed fifty to one hundred years ago. Further, tap water on each house connection generally contains color due to rusting of old pipes.

3.4 Served Population

In the water supply operation of Greater Colombo, there is no record directly indicating the served population. Billing record shows the number of meters which are considered to be equivalent to the number of households connected. Population with direct connection can be estimated from these record. For the community taps, the Master Plan Update conducted the field survey to estimate the population on community tap, and resulted that about 200 people are using one community tap in average. Total served population was then estimated as shown in Table 3.5.

Table 3.5 Estimated Served Population

Service Area	No. of Domestic Connections (1)	Estimated persons per house			Metered Population ('000) (5) = (1) x (4)	No. of Indirect Connections (6)	Stand Pipe Population ('000) (7)	Total Served Population ('000) (8) = (5)+(7)
		1990 Population (2)	No. of Houses (3)	Persons per house (4) = (2)÷(3)				
Colombo M.C.	45,662	740,600	79,600	9.3	399.4	6,626	307.4	706.8
Dehiwala M.C.	18,104	218,600	29,308	7.6	140.3	341	68.2	208.5
Kotte U.C.	13,866	127,400	18,949	6.7	100.5	200	26.9	127.4
Kolonnawa U.C.	2,647	51,700	8,872	5.8	15.7	265	35.8	51.5
Moratuwa U.C.	11,613	169,900	28,959	5.9	70.6	262	52.4	123.0
Kotikawatta/ Mulleriyawa U.C.	2,003	88,700	14,883	6.0	14.9	10	2.0	16.9
Kelaniya U.C.	5,673	143,300	27,360	5.2	38.1	80	16.0	54.1
Panadura U.C.	3,541	38,000	6,552	5.8	21.8	201	16.1	37.8
Total	103,108	1,578,200	214,483	-	801.3	7,985	537.9	1,339.2

Source: Tables 4.12, 5.2 and 5.10, Data Base Report, Master Plan Update (1991)

3.5 Water Use

3.5.1 Water Use

Water consumption in the Greater Colombo Water Supply is counted from the billing which are issued every month. Billings are summarized by service area in Greater Colombo and category in use.

Water use in the existing water supply is classified in several categories by purpose of water use. In the Master Plan Update, water use are categorized as domestic and non-domestic use for the purpose of planning in which the non-domestic use consists of industrial, commercial and institutional uses.

Water use by service area are summarized in Table 3.6.

Table 3.6 Water Use by Service Area and Category

Service Area	Daily Average Water Use in 1992 (m^3/d)				
	Domestic	Industrial	Commercial	Institutional	Total
Colombo M.C.	39,199	2,551	22,612	17,813	82,175
Dehiwala M.C.	18,185	253	3,588	7,304	29,330
Kotte U.C.	14,705	10	1,324	2,230	18,269
Kolonnawa U.C.	359	7	536	201	1,103
Moratuwa U.C.	9,424	1,043	960	795	12,222
Kotikawatta/Mulleriyawa U.C.	2,283	545	853	3,777	7,458
Kelaniya U.C. 1)	9,144	5,358	2,002	2,965	19,469
Panadura U.C.	2,792	24	207	408	3,431
Total	96,090	9,791	32,083	35,494	173,458

Note: 1) Kelaniya U.C. includes the consumption in Peliyagoda U.C., Wattala-Mabole U.C. and Biyagama EPZ.

3.5.2 Unaccounted-for Water (UFW)

Production amount calculated from the records available, it was estimated that the daily average production in 1992 is approximately 380,000 m^3/d.

With these production (380,000 m^3/d) and consumption data (173,000 m^3/d), it is simply calculated the UFW ratio as 54 percent. However, the water consumption was summarized from the billing records, and therefore does not include consumption at public taps. The Master Plan Update estimated the amount of community tap water use to be about 28,000 m^3 in 1990. The Master Plan Update also considered water meter measurement error as about 5 percent. Adding these amount to the consumption, total water use is estimated as 209,700 m^3. From this figure, the UFW ratio is calculated as follows:

UFW Ratio = 100- {(173,000 x 1.05 + 28,000) / 380,000} = 45 percent.

3.6 Ongoing and Planned Water Supply Project

Ongoing and planned water supply projects by various donating agencies are listed below:

JICA Project

Ambatale Water Treatment Plant Improvement Project

OECF Projects

Towns East of Colombo Water Supply Project

Towns South of Colombo Water Supply Project

World Bank (IDA) Projects

Ambatale-Jubilee Water Conveyance and Maharagama Water Supply Scheme

Scraping and Cement Mortar Lining of Greater Colombo Area Transmission Mains and Distribution System

World Bank Assisted Water Supply and Sanitation Project IV

Third Sri Lanka Water Supply and Sanitation Rehabilitation Project

ADB Projects

Reduction of Unaccounted-for Water in Greater Colombo

CHAPTER 4

REVIEW OF THE MASTER PLAN UPDATE AND POPULATION AND WATER DEMAND PROJECTION

4. REVIEW OF THE MASTER PLAN UPDATE AND POPULATION AND WATER DEMAND PROJECTION

4.1 General

Review of the Master Plan Update 1991 (including Addendum 1993) was conducted reflecting the latest socio-economic conditions, and the status of development policy and various ongoing and planned projects. Major issues revised in this review are summarized as follows:

1) Determining the extent of service area expansion.
2) Introducing a progress factor of house connection
3) Introducing concept of "Water Loss" in the demand projection instead of the unaccounted-for water (UFW)

4.2 Project Horizon

Project horizon for implementation of the Kalu Ganga Water Supply Project for Greater Colombo is set as follows:

Long Term Development Plan for 2020

For this year, sizing of planned facilities will be identified as a long term development plan to meet the water demand projected. Safe yield at the proposed Kalu Ganga intake will also be reviewed for the demand. Requirements in land acquisition will be prepared for this long term development plan.

First Phase Implementation Plan for 2010

A preliminary design for the first phase implementation will be conducted to identify the details of planned facilities to meet the water demand. A feasibility study will then be conducted for the project.

4.3 Service Area

Extent of the entire service area of Greater Colombo Water Supply System has been defined in the original master plan. The Master Plan Update followed the same boundary of the area which covers major part of Colombo, Gampaha and Kalutara Districts and consist of two Municipal Councils, nine Urban Councils, and 15 Pradesiya Sabhas. Figure 4.1 shows a boundary of the planned service area. A total of the service area is about 73,900 ha. Out of this, the existing water supply service covers approximately 16,400 ha of the central urbanized area with C.M.C. at its center.

4.4 Population Projection

On the basis of the population projection carried out in the previous Greater Colombo Water Supply System Master Plan Update as well as the Wastewater and Sanitation Master Plan, the further update taking into account the amendment of projections by the Ministry of Policy Planning, UDA and DCS has been carried out in this study. The summary is given in Table 4.1.

4.5 Extent of Expansion

Figure 4.2 show the areas to be included in the development of water supply.

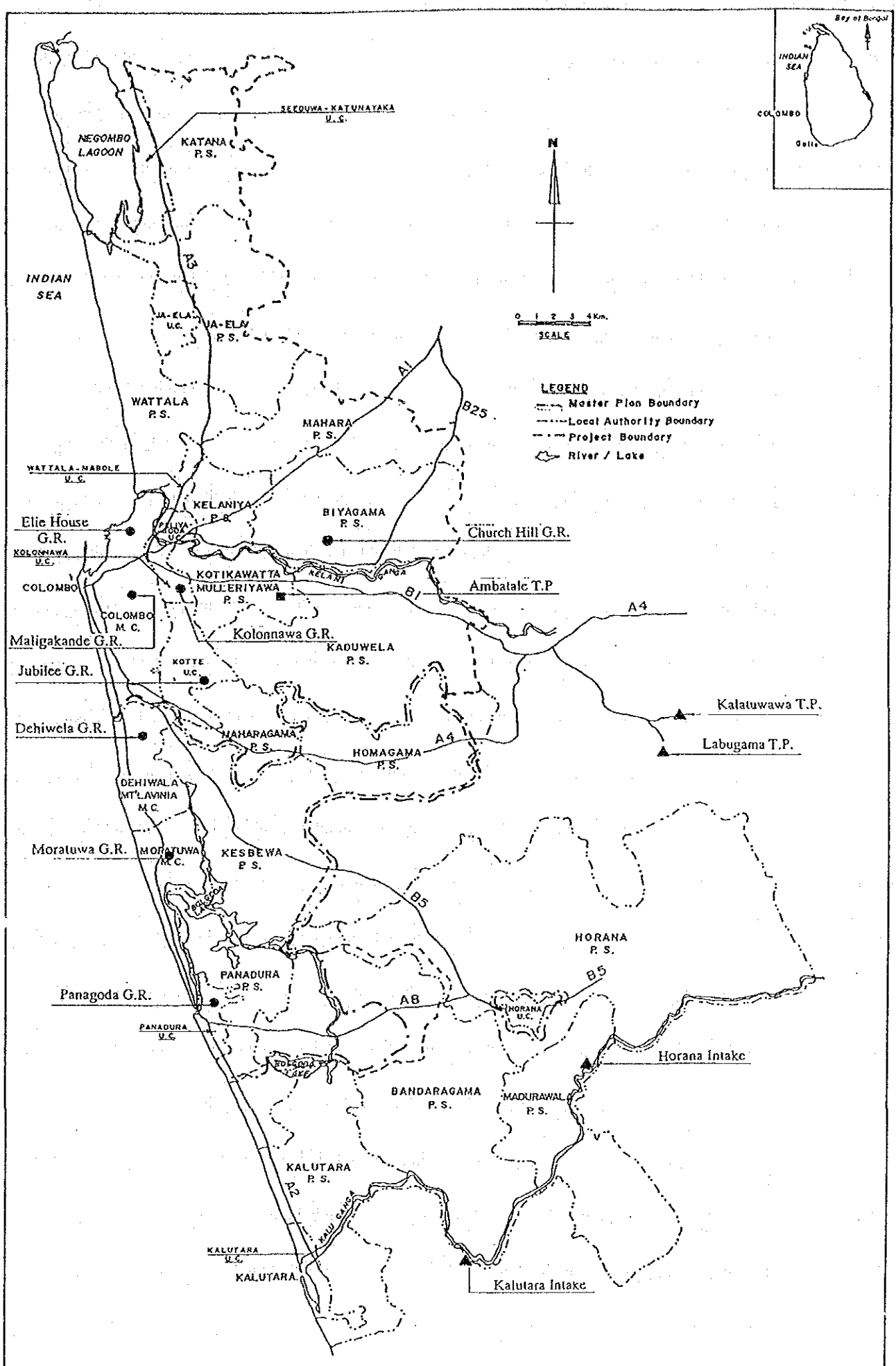


Figure 4.1 Greater Colombo Water Supply Master Plan Area

Table 4.1 Proposed Population Projections

Divisional	Administrative	Population					Growth Rate				Population Density					Land
Secretaries	Area	1990	1995	2000	2010	2020	1990	1995	2000	2010	1990	1995	2000	2010	2020	Area
Division		(x1000)	(x1000)	(x1000)	(x1000)	(x1000)	(%)	(%)	(%)	(%)	(Pers./ha)	(Pers./ha)	(Pers./ha)	(Pers./ha)	(Pers./ha)	(ha)
COLOMBO DISTRICT																
Colombo	Colombo M.C.	740.6	752.4	760.0	770.7	776.4	0.32	0.20	0.14	0.07	198.4	201.6	203.6	206.5	208.0	3,733
Ratmalana	Mt. Lavinia M.C.	218.6	232.1	242.4	243.6	243.9	1.21	0.87	0.05	0.01	103.8	110.2	115.1	115.7	115.8	2,106
Nugegoda	Kotte U.C.	114.0	135.9	141.4	152.0	160.9	3.58	0.80	0.73	0.57	67.5	80.4	83.7	89.9	95.2	1,690
Moratuwa	Moratuwa U.C.	172.7	176.2	179.4	183.5	190.4	0.40	0.36	0.23	0.37	73.1	74.6	76.0	77.7	80.6	2,361
Kolonnawa	Kolonnawa U.C.	51.7	56.0	59.6	60.0	60.1	1.61	1.25	0.07	0.02	105.3	114.1	121.4	122.2	122.4	491
	Kotikawatta-															
	Mulleriyawa P.S.	88.7	92.4	98.5	104.5	110.3	0.82	1.29	0.59	0.54	38.4	40.1	42.7	45.3	47.8	2,307
Kaduwela	Kaduwela P.S.	163.4	206.6	245.5	335.5	425.6	4.80	3.51	3.17	2.41	18.6	23.6	28.0	38.3	48.5	8,770
Maharagama	Maharagama P.S.	120.3	132.3	144.0	153.9	163.3	1.92	1.71	0.67	0.59	55.1	60.6	66.0	70.5	74.8	2,183
Piliyandara	Kesbewa P.S.	166.2	191.3	217.9	279.0	340.1	2.85	2.64	2.50	2.00	28.4	32.6	37.2	47.6	58.0	5,860
Homagama	Homagama P.S.	59.4	65.3	71.1	76.0	80.5	1.90	1.73	0.67	0.58	19.3	21.2	23.1	24.7	26.1	3,083
	Sub Total	1895.6	2040.5	2159.8	2358.7	2551.5	1.48	1.14	0.89	0.79	58.2	62.6	66.3	72.4	78.3	32,584
GAMPAHA DISTRICT																
Kelaniya	Peliyagoda U.C.	34.4	36.5	36.8	37.0	37.3	1.19	0.16	0.05	0.08	89.8	95.3	96.1	96.6	97.4	383
	Kelaniya P.S.	108.9	120.9	132.3	149.1	153.9	2.11	1.82	1.20	0.32	47.4	52.6	57.5	64.9	66.9	2,299
Mahara	Mahara P.S.	103.2	113.9	125.6	148.8	180.1	1.99	1.97	1.71	1.93	22.1	24.4	26.9	31.8	38.5	4,676
	Wattala Mabole															
	U.C.	27.0	27.8	28.9	30.0	31.6	0.59	0.78	0.37	0.52	71.2	73.4	76.3	79.2	83.4	379
	Wattala P.S.	116.1	139.1	159.9	204.4	223.1	3.68	2.83	2.49	0.88	15.1	18.1	20.8	26.6	29.0	7,685
Ja-Ela	Ja-Ela U.C.	33.0	35.9	38.6	46.0	54.6	1.70	1.46	1.77	1.73	36.4	39.6	42.6	50.8	60.3	906
	Ja-Ela P.S.	130.1	156.0	180.7	231.3	300.0	3.70	2.98	2.50	2.63	23.1	27.7	32.1	41.1	53.3	5,624
Biyagama	Biyagama P.S	120.1	132.1	142.9	165.2	195.4	1.92	1.58	1.46	1.69	20.3	22.4	24.2	28.0	33.1	5,910
Katana	Seeduwa-															
	Katunayake U.C.	42.5	44.0	45.8	50.3	51.2	0.70	0.81	0.94	0.18	41.0	42.5	44.2	48.6	49.4	1,036
	Katana P.S.	47.5	63.1	81.3	112.9	156.2	5.84	5.20	3.34	3.30	16.1	21.4	27.6	38.4	53.1	2,942
	Sub Total	762.8	869.3	972.8	1175.0	1383.4	2.65	2.28	1.91	1.65	24.0	27.3	30.6	36.9	43.4	31,840
KALUTARA DISTRICT																
Panadura	Panadura U.C.	38.0	38.0	38.6	38.6	39.3	0.00	0.31	0.00	0.18	65.3	65.3	66.3	66.3	67.5	582
	Panadura P.S.															
	(except Wadduwa)	107.3	109.8	112.4	117.6	124.0	0.46	0.47	0.45	0.53	46.0	47.1	48.2	50.4	53.2	2,332
Horana	Horana U.C.	10.8	12.1	13.2	15.4	18.1	2.30	1.76	1.55	1.63	32.0	35.8	39.1	45.6	53.6	338
	Horana P.S.	20.5	27.8	33.9	46.0	56.6	6.28	4.05	3.10	2.10	8.7	11.7	14.3	19.4	23.9	2,368
Bandaragama	Bandaragama P.S.	51.6	62.4	72.4	92.3	112.5	3.87	3.02	2.46	2.00	12.8	15.4	17.9	22.8	27.8	4,041
	Sub Total	228.2	250.1	270.5	309.9	350.5	1.85	1.58	1.37	1.24	23.6	25.9	28.0	32.1	36.3	9,661
TOTAL		2886.6	3159.9	3403.1	3843.6	4285.4	-	-	-	-	39.0	42.7	45.9	51.9	57.8	74,085

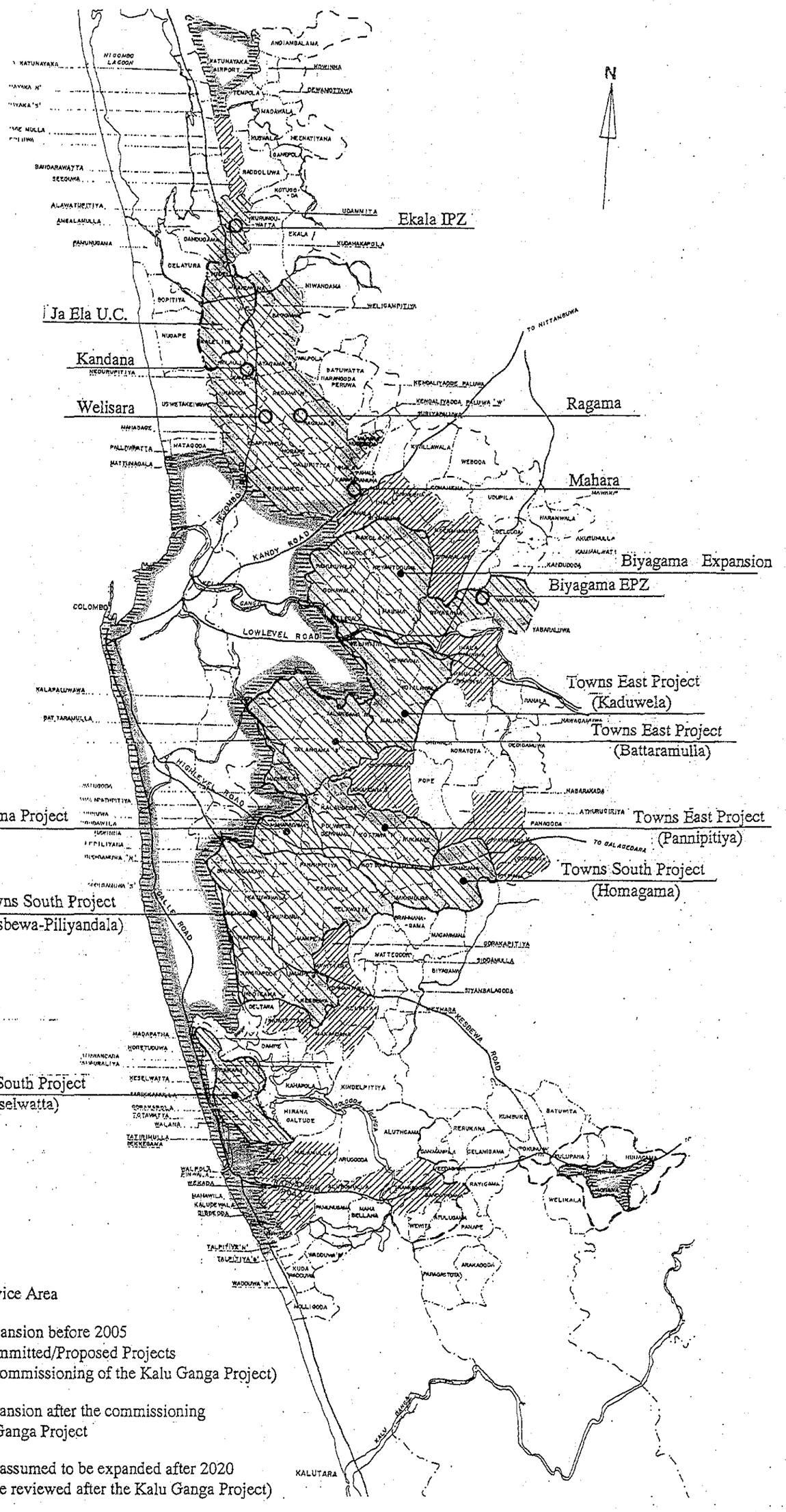


Figure 4.2 Planned Water Supply Expansion

4.6 Water Demand Projection

4.6.1 Served Population

Served population are projected as shown in Table 4.2.

Table 4.2 Served Population Projection

Service Area	Served Population ('000)			
	1995	2000	2010	2020
COLOMBO DISTRICT				
Colombo M.C.	746.8	760.0	770.7	776.4
Dehiwala M.C.	224.4	242.4	243.6	243.9
Kotte U.C.	131.5	141.4	152.0	160.9
Moratuwa U.C.	161.0	162.4	176.0	182.6
Kolonnawa U.C.	55.7	59.6	60.0	60.1
Koti/Mulleriyawa P.S.	61.9	76.6	99.3	104.8
Homagama P.S. (part)	0	9.0	24.8	40.7
Kaduwela P.S.	0	30.2	106.7	195.6
Kesbewa P.S.	0	14.9	85.8	166.6
Maharagama P.S.	35.1	57.4	94.4	121.6
GAMPAHA DISTRICT				
Ja Ela U.C.	0	1.5	26.3	37.1
Peliyagoda U.C.	26.2	27.9	31.5	33.6
Seeduwa Katunayake U.C.	0	0	0	0
Wattala Mabole U.C.	19.6	21.6	25.5	28.4
Biyagama P.S.	6.3	26.0	63.8	103.0
Ja Ela P.S.	0	5.1	58.0	99.3
Katana P.S. (part)	0	0.3	7.7	17.4
Kelaniya P.S.	87.7	100.1	126.7	137.5
Mahara P.S. (part)	0	1.7	22.8	44.6
Sithawaka P.S. (Padukka)	0	0		2.7
Watala P.S.	0	4.2	69.0	97.8
KALUTARA DISTRICT				
Horana U.C.	10.0	10.8	13.6	16.3
Panadura U.C.	37.0	38.6	38.6	39.3
Bandaragama P.S.(part)	0	0	5.5	19.4
Horana P.S. (part)	0	0	0	0
Panadura P.S.	2.3	9.1	34.1	59.5
Total	1,605.4	1,800.2	2,350.8	2,811.2

4.6.2 Special Demands

Aside from the water demand calculated from the criteria which define for basic water use, some special water demands should be taken into account due to the development scheme of industrial estates. Special industrial demands to be added to the projected demands are therefore summarized as shown in Table 4.3 below.

Table 4.3 Special Industrial Demands

unit : m^3/day

	1995	2000	2005	2010	2020
Biyagama EPZ (Biyagama P.S.)	6000	11,100	13,650	13,650	13,650
Katunayake IPZ (Phase 4) (Katana P.S.)	0	0	9,100	9,100	9,100

4.6.3 Water Loss

To clearly define the concept of consumption and other loss, use of the terminology of "Water Loss" is introduced instead of "Unaccounted-for Water (UFW)". In the future water demand projection, all the components of consumption are included in the estimates so that the water consumption, as defined as domestic, commercial, industrial, and institutional use, is estimated as a total amount of water possibly to be used regardless of whether the consumption is metered or not (including free water and illegal connection). "Water Loss" will therefore consist of the parts which will not be included in the consumption as defined in Table 4.4. Table 4.5 shows a summary of water loss ratio projection.

Table 4.4 Definition of Unaccounted-for Water

Definition in Present Water Use Record	Item	Definition in Water Demand Projection
Water accounted for	Consumption metered and billed	**Amount projected as Consumption**
	Consumption unmetered including standpost use (billed on estimated amount)	
Unaccounted-for Water	Consumption unmetered (not billed)	
	Meter under-reading	
	Illegal connection use	
	Public use not to be billed (firefighting, water/sewer pipe flushing etc.)	**Water Loss**
	Leakage in transmission and distribution system	

Table 4.5 Projected Water Loss Ratio

Service Area	1995	2000	2005	2010	2020
Existing Service Area					
Colombo M.C.	** 40 %	35 %	35 %	35 %	30 %
Other Areas	** 30 %	25 %	25 %	25 %	20 %
New Service Area	As initial ratio = 10 % increase in straight interpolation				20 %

** Estimated higher side water loss at present level.

4.6.4 Future Water Demands

Future water demand defined as the connected demand is calculated from the full development demand multiplied by the progress percentage from the year assumed for commissioning and the special demands added.

Tables 4.6 and Figure 4.3 show the result of the water demand projection including water loss.

4.6.5 Set up of Peak Factor

Water supply facilities should be designed to satisfy everyday water demand at least until the target year. In order to meet this requirement, the maximum day demand is used for determining the capacity of water supply facilities. The maximum day demand is generally computed by conducting 'Peak Factor' which is defined as the ratio of the maximum day demand to the average day demand.

In this study, water production records at Labugama, Kalatuwawa and Ambatale water treatment works together with the bulk meter reading on the transmission mains previously collected in the Master Plan Update have been analyzed.

As a result, peak factor of 1.15 is adopted for the maximum daily demand.

4.7 Required Size of the Kalu Ganga Project

A required capacity of the proposed Kalu Ganga Project is calculated from the total peak demand and the capacity of the existing treatment facilities.

Demand exceeding the existing capacity should be supplied by the Kalu Ganga Project as shown in Table 4.7. From this table, the size of the Kalu Ganga Project to be planned is recommended as:

For 2010 182,000 m^3/d (40.0 mgd) as treatment production capacity

For 2020 364,000 m^3/d (80.0 mgd) as treatment production capacity

Table 4.6 Projected Water Demand (Daily Average)

Service Area	Total Water Demand (m^3/d) (Consumption + Loss)			
	1995	2000	2010	2020
COLOMBO DISTRICT				
Colombo M.C.	220,605	230,585	269,628	277,581
Dehiwala M.C.	54,972	60,133	66,609	69,084
Kotte U.C.	35,414	37,668	46,014	51,215
Moratuwa U.C.	30,240	30,839	39,108	43,959
Kolonnawa U.C.	9,846	11,115	14,250	16,720
Koti/Mulleriyawa P.S.	18,198	21,049	27,719	31,116
Homagama P.S. (part)	0	3,241	10,127	17,565
Kaduwela P.S.	0	6,582	24,580	48,627
Kesbewa P.S.	0	2,940	19,085	41,449
Maharagama P.S.	6,340	10,838	19,398	27,523
GAMPAHA DISTRICT				
Ja Ela U.C.	0	277	5,337	8,339
Peliyagoda U.C.	8,410	8,503	9,561	10,449
Seeduwa Katunayake U.C.	0	0	0	0
Wattala Mabole U.C.	5,866	6,588	8,690	10,656
Biyagama P.S. (incl. Biyagama EPZ)	7,210	13,871	26,641	37,771
Ja Ela P.S.	0	955	17,345	28,978
Katana P.S. (incl. Katunayake EPZ)	0	180	3,149	13,690
Kelaniya P.S.	23,576	27,416	38,429	41,946
Mahara P.S. (part)	0	485	6,629	13,427
Sithawaka P.S. (Padukka)	0	0	0	813
Watala P.S.	0	697	12,406	19,739
KALUTARA DISTRICT				
Horana U.C.	2,261	2,374	3,360	4,314
Panadura U.C.	6,540	7,407	8,562	9,395
Bandaragama P.S.(part)	0	0	1,394	5,207
Horana P.S. (part)	0	0	0	0
Panadura P.S.	403	1,653	6,701	12,808
Total	429,879	485,395	684,718	842,372

Table 4.7 Connected Demand and Required Water Production Capacity

Service Area	Division	Node No.	Connected Water Demand (m^3/d) 1995	2000	2005	2010	2015	2020
Towns East Area	Kaduwela	281	0	1,775	4,138	6,630	9,985	13,546
	Panagoda	402	0	0	0	0	0	0
	Pannipitiya	411	0	1,733	3,657	5,386	6,859	8,231
	Madiwela/Kotte	528	1,905	2,349	2,722	3,097	3,501	3,926
	Madiwela/Kotte	529	4,435	5,485	6,374	7,263	8,218	9,222
	Maharagama	552	0	2,759	5,716	8,301	10,790	13,202
	Battaramulla (High)	563	0	4,180	9,743	15,609	22,075	29,058
	Battaramulla (Low)	568	0	627	1,461	2,341	3,311	4,359
	Batta. (Remote)	574	0	480	1,015	1,499	2,744	3,940
	Total Towns East		6,340	19,387	34,827	50,125	67,483	85,484
Towns South Area	Homagama	498	0	1,273	2,695	3,979	6,270	8,231
	Panadura (Keselwatte)	496	0	1,214	3,959	6,181	8,353	10,326
	Kesbewa (Exis. Maharagama)	529-A	0	907	3,377	5,888	8,701	11,612
	Kesbewa (Main Area)	542	0	1,557	5,801	10,112	16,874	23,751
	Kesbewa (Sub Area)	552	0	475	1,770	3,085	4,560	6,085
	Panadura P.S.	494	403	440	478	520	1,587	2,483
	Total Towns South		403	5,866	18,081	29,765	46,343	62,488
Towns North Area	Wattala South	122	0	748	6,937	11,995	16,311	20,353
	Mahara South	132	0	0	0	0	612	1,163
	Mahara North	141	0	260	2,068	3,547	5,138	6,562
	Ragama	145	0	325	3,823	6,239	7,957	10,015
	Welisala, kandana	156	0	513	5,821	9,643	12,312	15,355
	Ja Ela U.C.	161	0	492	5,325	8,843	11,636	14,717
	Wattala North	165	0	256	2,900	4,594	5,682	6,970
	Katana P.S. (South)	166	0	0	0	0	929	1,759
	Katunayake EPZ	170	0	0	0	0	7,280	7,280
	Katunayake U.C. North	174	0	0	0	0	0	0
	Katana P.S. (North)	183	0	0	0	0	0	0
	Total Towns North		0	2,594	26,876	44,866	67,856	84,173
Biyagama	Biyagama (include. EPZ)	127	7,210	9,979	12,745	15,532	15,832	16,165
	Biyagama	121	0	3,263	6,262	9,312	13,113	16,953
	Biyagama	132	0	629	1,208	1,796	3,250	4,653
	Total Biyagama		7,210	13,871	20,215	26,641	32,195	37,771
Area far South	Sitawaka (Padduka Town)	428	0	0	0	0	413	813
	Bandaragama P.S. (West)	494	0	0	0	0	944	1,823
	Bandaragama P.S. (East)	497	0	0	714	1,394	2,338	3,385
	Horana P.S.	1000	0	0	0	0	0	0
	Total Area far South		0	0	714	1,394	3,695	6,020
Total of New Area			13,952	41,719	100,712	152,791	217,572	275,935
Total of Existing Area Demand			415,900	443,600	483,600	531,900	549,800	566,400
Total Day Average Demand			429,800	485,400	584,300	684,700	767,400	842,300
Total Daily Maximum Demand (Peak factor = 1.15)			494,300	558,200	672,000	787,300	882,300	968,700
Water Production Capacity	(Max.)							
Ambatale (Old)	63 mgd		286,700	286,700	286,700	286,700	286,700	286,700
Ambatale (New)	40 mgd		182,000	182,000	182,000	182,000	182,000	182,000
Kalatuwawa (90% of Max.)	18 mgd		81,900	81,900	81,900	81,900	81,900	81,900
Labugama (90% of Max.)	11.75 mgd		53,200	53,200	53,200	53,200	53,200	53,200
Horana	0.33 mgd		1,500	1,500	1,500	1,500	1,500	1,500
Total Production Capacity			605,300	605,300	605,300	605,300	605,300	605,300
Requried Additional Production Capacity for Daily Maximum Demand			0	0	**66,700** (15 mgd)	**182,000** (40 mgd)	**277,000** (61 mgd)	**364,000** (80 mgd)

Node Nos. are referred to from the Transmission Models presented in the Master Plan Update 1991.

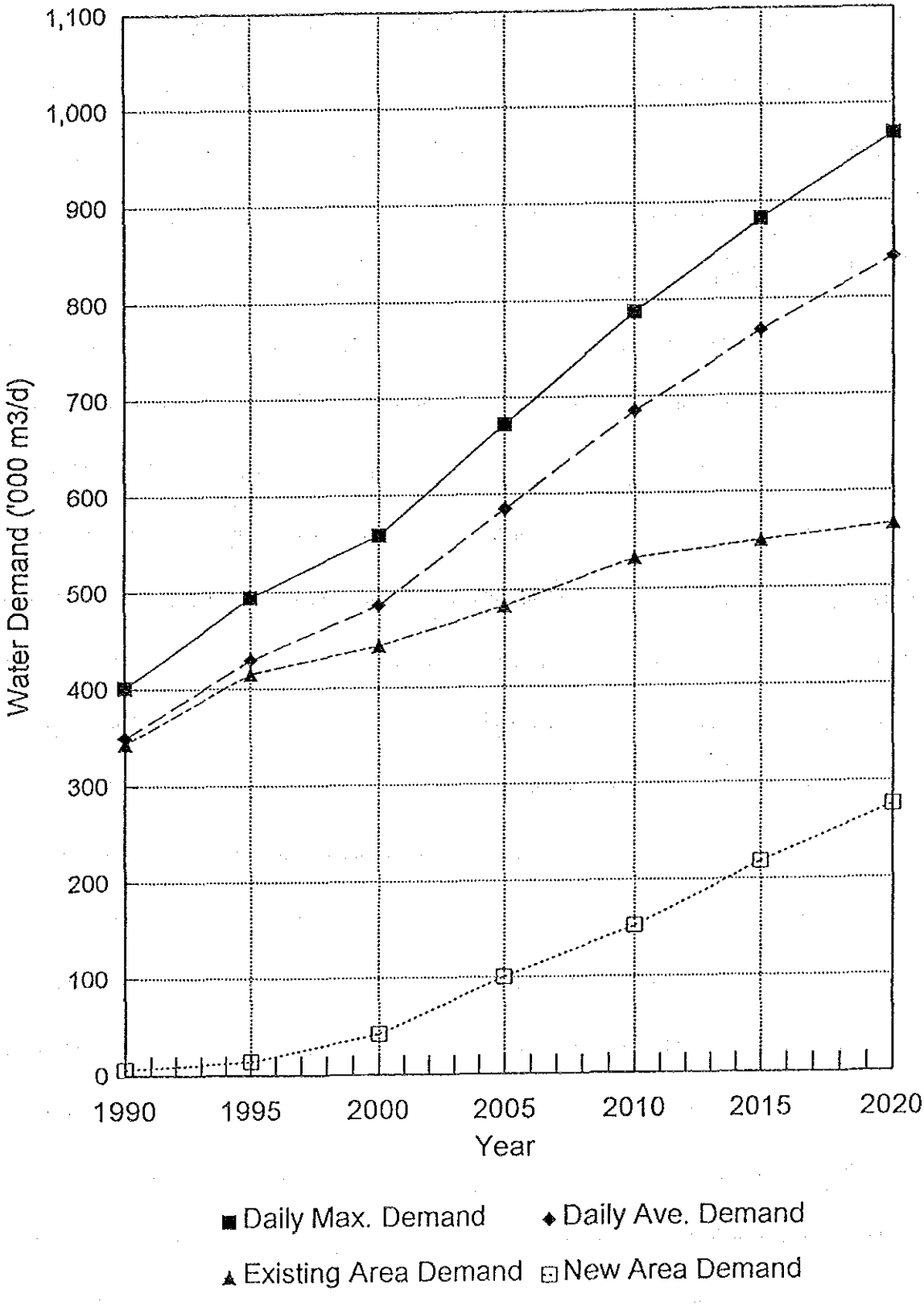


Figure 4.3 Water Demand Projection

CHAPTER 5

WATER DEMAND FOR THE KALU GANGA BY OTHER PROJECTS

5. WATER DEMAND FOR THE KALU GANGA BY OTHER PROJECTS

The total water demand to be taken from the Kalu Ganga in the area south of Greater Colombo is estimated as follows:

Table 5.1 Estimated Water Demand in the Area South of Greater Colombo

Year	Kalutara Water Supply Scheme	Industrial Estate		Total
		(Scheduled)	(Recommended)	
	(m^3/d)	(m^3/d)	(m^3/d)	(m^3/d)
2010	55,000	7,900	25,000	80,000
2020	68,000	7,900	25,000	93,000

For the purpose of studying the safe yield of the Kalu Ganga, it may be practical to say that approximately 100,000 m^3/d (1.2 m^3/s) of water be reserved for areas of Dodangoda, Bulathseinhala, Madurawala, and the service area of Kalutara Water Supply Scheme.