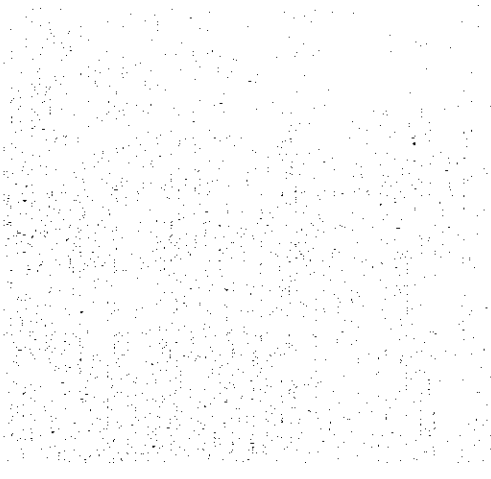
BASIC DESIGN STUDY REPORT
ON
REHABILITATION PROJECT OF TREATMENT PLANTS
AT KALATUWAWA AND LABUGAMA
IN
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

SEPTEMBER, 1984

JAPAN INTERNATIONAL COOPERATION AGENCY



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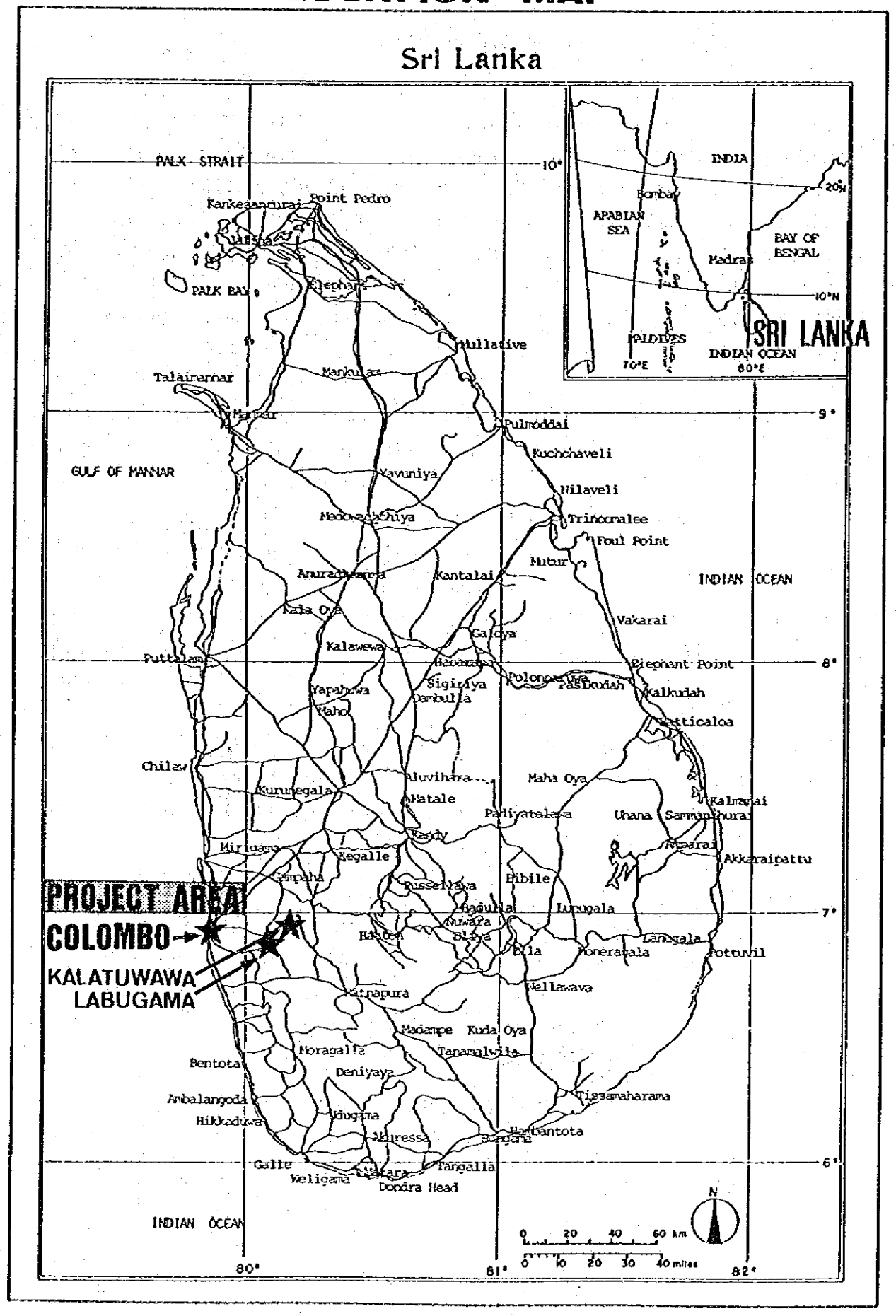
LOCATION MAP



PREFACE

In response to the request of the Government of the Democratic Socialist Republic of Sri Lanka, the Government of Japan decided to conduct a survey on the Rehabilitation Project of Treatment Plants at Kalatuwawa and Labugama and entrusted the survey to the Japan International Cooperation Agency. The J.I.C.A. sent to Sri Lanka, a survey team headed by Mr. Yoshihiro Tamai, the Director of Water Supply Department, Bureau of Waterworks, Osaka City, from May 20th to June 9th, 1984.

The team had discussions with the officials concerned of the Government of Sri Lanka and conducted a field survey in the Colombo area.

After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

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

September, 1984

Keisuke Arita, President
JAPAN INTERNATIONAL COOPERATION AGENCY

SUMMARY

Based on the Master Plan for South West Coast Area (S.W.C.A.) prepared by WHO in 1972, and the International Drinking Water Supply and Sanitation Decade Plan being executed by the United Nations, the implementation plan for water supply systems in Sri Lanka is currently being executed.

The Master Plan contains the water and sewerage system implementation plans of the south-west coastal area of Sri Lanka including Greater Colombo, and the International Water Decade Plan covers the plans of the rural cities, plantation areas and agricultural areas. The present status of the water service ratio at 65% in the cities and 18% in the suburbs shows the importance of urgent implementation of the systems to improve the standard of living. Over 10 countries are assisting through financial and technical cooperation projects.

The National Water Supply and Drainage Board (NWSDB) in Sri Lanka has the overall responsibility for planning, construction, and operation and maintenance of water systems throughout the country.

The Greater Colombo Project, described in the Master Plan, delineates the water system implementation plan in the Greater Colombo Area for the target year 2000 and is now being implemented.

Although the average served population in the Greater Colombo Area in 1981 was 76.4%; south of Colombo was 78.4%, the City of Colombo was 100%, and north of Colombo was zero, the plan aims to supply water to 100% of the 2,598,000, population, by the target year 2000 at the rate of 605,000 m3/d.

At present, 340,000 m3/d of treated water is distributed to the Greater Colombo Area from two water resources including 135,000 m3/d from two impounded reservoirs, and 205,000 m3/d directly from the river.

Although with the finance of IBRD/IDA, the Ambatale Water Treatment Plant which treats river water, was successfully constructed and expanded based on the Master Plan, the two existing treatment plants at the Kalatawawa and Labugama impounded reservoirs have not been functioning properly. This has been due to the lack of proper maintenance mainly on mechanical and electrical equipment which was installed many years ago, resulting in serious problems to the people in Colombo. In order to accomplish the 2000 year aims of the Master Plan, this situation must be remedied. The proposed Project is therefore very important for successful completion of the Master Plan.

The Project includes the rehabilitation of the two treatment plants consisting primarily of replacement of mechanical and electrical equipment as listed on the following page.

For the completion of the Project, NWSDB will take full responsibility for construction management. The construction will be carried out by a Japanese contractor who will be selected by NWSDB based on tendering competition. Japanese consultants will undertake the detailed design, assisting NWSDB on tendering procedures for the selection of a contractor, and supervision of the construction.

Upon completion of the construction, NWSDB will undertake the responsibility of operation and maintenance for both treatment plants.

The Consultant will undertake a staff training program during the test operation period, and this will ensure the smooth and successful operation and maintenance of the rehabilitated and upgraded plants. Although past records have showed a negative financial benefit from the operation of the existing water systems, revenue collection from water tariffs is following an upward trend. Based on the International Water Decade Plan, the national Government budget includes operation and maintenance costs. Therefore the operation of the plants should be smoothly carried out without financial constraint.

By supplying a good quality and ample quantity of water from the two treatment plants upon completion of the Project, the consumers of Greater Colombo will all benefit thus achieving the purpose of the Master Plan.

Rehabilitation Plan of Kalatuwawa Treatment Plant

Facilities/Equipment	Improvment	Existing State
Intake Facilities	Installation of new floating type surface water intake facility	none
Aeration Facilities	Expansion	ineffective
Sedimentation Basin	Floculation and multiple inclined plates installation and modification	horizontal flow
Generator and Electrical Facilities	Replacement of electrical equipment and modification of electrical system, DC to AC power supply	defective
Mechanical	Replacement and rehabilitation of pumps, valves, gates and other appurtenances of sedimentation basins, filtration tanks, back wash tank, and sludge treatment facilities	poor operation
Dosing Facilities	Replacement of dosing equipment for chlorination facilities	defective
Flow Measurement System	Flow meter replacement	poor operation

Facilities/Equipment	Improvement	Existing State
Filtration Media	Replacement of sand and gravel	contaminated
Operation Control System	Rehabilitation	poor operation
others	Installation of roof for backwash tank, etc.	

Rehabilitation Plan of Labugama Treatment Plant

Facilities/Equipment	Improvement	Existing State
Intake Facilities	Installation of new floating type surface water intake facility	none
Aeration Facilities	New construction	none
Sedimentation Basin	Flocculation and muptiple inclined plates installation and modification	horizontal flow
Filtration Tank	Replacement of valves, strainers and collector pipes, and rehabilitation of rakes	deteriorated

Facilities/Equipment	Improvement	Existing State
Filtration Media	Replacement of sand and gravel	contaminated
Dosing Facility	Replacement of dosing equipment and rehabilitation of tank	deteriorated
Flow Measurement	Replacement	poor operation
Diesel Generator	Installation	none
Others	Installation of roof for back wash tank, etc.	

THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

REPORT ON
BASIC DESIGN STUDY FOR

REHABILITATION PROJECT OF
TREATMENT PLANTS AT KALATUWAWA AND LABUGAMA

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1. INTRODUCTION

The Greater Colombo Water Supply System is fed by three water treatment plants, namely, the Ambatale Plant treating 205,000 m3/day of Kelani Ganga River water and the Kalatuwawa and Labugama Plants treating 91,000 m3/day and 59,000 m3/day respectively from impounded reservoirs. The system is being developed based on the Master Plan for Water Supply Systems in Sri Lanka prepared by WHO in 1972 and the International Drinking Water Supply and Sanitation Decade Plan prepared by the United Nations.

Through financing of IBRD/IDA, the Ambatale Plant is successfully being expanded, but the other two plants treating impounded water are not functioning properly. This is due to the obsolescence of the facilities and the lack of proper maintenance on the equipment which was installed many years ago. Many problems result including the supply of inadequately treated water to the consumers. Also there is a quantity limitation of these two sources because of the deficiencies.

In need of external financing, the Government of Sri Lanka requested Japanese Grant-aid assistance on the Kalatuwawa and Labugama Treatment Plants Rehabilitation Project. In response, the Japanese Government dispatched a survey mission to Sri Lanka through the Japan International Cooperation Agency (JICA). The purpose of the mission was to study Sri Lanka's request by undertaking a field investigation including meetings with local officials, culminating in preparation of a basic design concept for the Rehabilitation Project.

Headed by Yoshihiro Tamai, Director of the Water Supply Service Department, Osaka City Waterworks Bureau, Japan, the JICA Mission Study Team for this Rehabilitation Project were on site for 21 days from 20 May to 9 June 1984. Details on the survey members and their schedule are described in Appendices 1 and 2. In order to be familiarized with the project conditions and problems, the team undertook surveys of the existing water supply systems in both urban and rural areas including the Ambatale treatment plant and its intake facility. The Mission however concentrated its efforts on the performance of the treatment plants at Kalatuwawa and Labugama as well as the reservoir water quality and operation.

Based on discussions with officials of the National Water Supply and Drainage Board (NWSDB), and review of all data collected from the Urban Development Agency, the Ceylon Chamber of Commerce, JETRO, and other relevant agencies, an agreement on the project scope was reached and minutes was prepared and signed by representatives of both national governments which forms Appendix 3. Upon returning to Japan the Mission Team concluded their study and analyses to define more explicitly the design and operational changes needed for the Rehabilitation Project.

This report addresses the existing conditions of the National and Colombo Area Water Supply Systems, their future expansion plans, and the specific Rehabilitation Project at Kalatuwawa and Labugama including the following subjects.

(1) Materials and equipment for replacement and modification
(2) Treatment processes to be modified
(3) Suitable construction methods
(4) Local construction material and importing material/equipment
(5) Construction management method
(6) Project implementation schedules etc.

2. BACKGROUND

2.1 NATIONAL LEVEL

(1) RELEVANT DEVELOPMENT PROJECTS

Under the Five Year Plan for development projects in Sri Lanka, the public investment committed to the fields of agriculture, industry, housing, and water supply are shown in Table 1 which follows. The projected public investment for 1984 - 1988 amounts to 106 billion rupees. By sector, the highest priority based on the investment amounts is given to agricultural development and secondly to social economic infrastructures including transportation and electricity. Also, a considerable amount of investment is budgeted for housing and water supply projects.

The investment programme has been carried out on the basis of making annual reviews of investment and adjusting to the financial needs as considered appropriate.

The major development projects which the Government has launched, are the Mahaweli Development Project, the Free Trade Zone Development Project, Urban Renewal, and a Housing Programme. The implementation of these projects will result in increased employment opportunities and upgrading of living conditions. The largest two projects are summarized as follows;

Mahaweli Development Project

The dry zone along the Mahaweli River basin will be developed to increase the agricultural land and hydraulic power resources which will encourage new settlers.

Free Trade Zone Development Project

To increase the investment volume by foreign firms, a Free Trade Zone was developed in the northern part towards Colombo City, particularly the establishment of an Investment Promotion Zone adjacent to the Katunayake International Airport. There were 155 investment cases in the Free Trade Zone since 1981.

Table 1. Allocation of Government Capital Expenditure 1984-1988

	LOCAL	TOTAL	FOREIGN AID
Total Public Investment All Sectors	-	106307	-
SECTOR SUMMARY			
(1) Agriculture	19344	36330	24245
a. Mahaweli	9325	21187	15370
b. Other Irrigation	1670	2750	1841
c. Plantations	3756	5057	3624
d. Others	4593	7336	3410
(2) Industry	172	280	51
(3) Housing, Water Supply & Urban Development	5038	7796	1730
a. Housing	2325	2925	14
b. Other Construction	1101	1563	91
c. Water Supply	1612	3306	1625
(4) Economic Overheads	13077	29700	13366
a. Transport	3029	5505	395
b. Power	2046	9037	8726
c. Posts & Telecom	705	2471	1065
d. I.R.D. & Others M/P&I	1525	2256	1761
e. Other Programmes	4556	7883	1419
f. Administrative	1216	2549	979
(5) Social Overheads	3477	5894	979
a. Education	1872	3046	454
b. Health	1296	2304	322
c. Others	309	544	203
(6) HD. Miscellaneous (M/F & P)	11026	11149	123
(7) New Projects (Unidentified)	-	18261	-

(Unit: million Rs)

Source : Public Investment
National Planning Division May, 1984

(2) PRESENT CONDITION OF WATER SUPPLIES

The Democratic Socialist Republic of Sri Lanka is a small island with a total land area of 65,610 km2 and a current population of about 15 millions. The climate is tropical with very little variation. The rainfall on the island is mainly governed by the monsoons but it varies somewhat by geological districts. The island can be roughly divided into a dry zone with an average annual rainfall of about 650 - 1,800 mm and a wet zone with about 1,800 - 5,500 mm.

Development of water resources relies heavily on annual rainfall. Groundwater and surface water are widely used for domestic purposes but for drinking, groundwater is more extensively used. According to survey results on water usage in 1982, 33.7 % of the population were supplied with drinking water and 80 % of the served population relied on groundwater.

About 65 % of the land is in the dry zone, where deep wells are developed. However in the northern sections and coastal areas shallow wells are developed. In some areas of the coastal belt, the shallow wells often suffer from saline water intrusion which has been caused by uncontrolled "mining" of the groundwater resources. Free from such trouble are shallow wells which have been located a suitable distance from the shoreline and then the water from the wells is distributed by a piping system.

In the high land areas of Kandy and Nuwara Elyiya, there are many small springs producing good quality water. In these areas small sized piped water systems have been developed which operate on gravity flow from the springs.

The population served by piped water systems in 1980 and 1982 is given in Table 2. It can be seen that the percentage of population served in 1982 was 75.8 % in urban areas, 61.1 % in estate areas and 18.9 % in rural areas. As for supplied systems in urban and estate areas it is assumed that they are piped systems. The figures for rural areas are classified as either piped or well supplies.

TABLE 2 STATUS OF WATER SUPPLY SYSTEMS

DESCRIPTION	1980	1982
Total population (x 1,000,000)	15.2	15.3
Urban area		
Population	3.8	3.3
Population Served	2.47	2.5
Percentage	65.0 %	75.8 %
Rural area		
Population	10.6	11.1
Population served	1.8	2.1
Piped supply	1.5	1.6
Wells	0.3	0.5
Percentage	17.0 %	18.9 %
Estate		
Population	0.8	0.9
Population served	0.52	0.55
Percentage	65.6 %	61.1 %
Total population served by water supply	4.79	5.15
Percentage of population served	31.5 %	33.7 %

Source: Review of the Sri Lanka "Water Supply and Sanitation Programme for the International Drinking Water Supply and Sanitation Decade ; Nov. 1983.

(3) INSTITUTIONAL ASPECTS OF WATER WORKS ADMINISTRATION

Responsibilities for water works lies with a number of Government Ministries, Departments, Corporations and Boards. The functional relationships are shown in Figure 1. In this Figure, the solid connected line between authorities represents a direct involvement in water works management. A dotted line shows an indirect relationship. The above authorities share the responsibility of planning, project selection, design and implementation with each major sector management field.

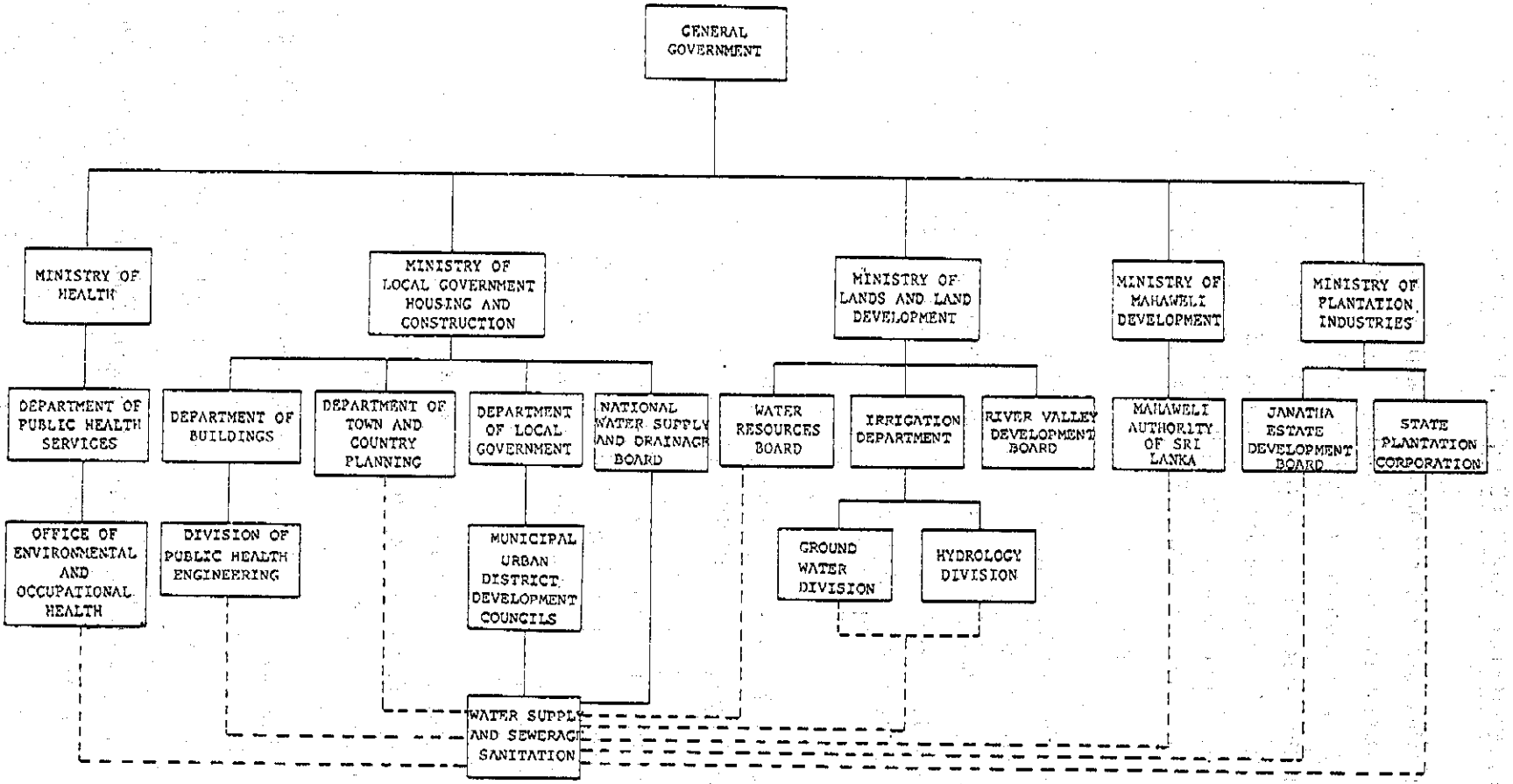
The most important organizations for water supplies are National Water Supply and Drainage Board, the Department of Local Government, (Ministry of Local Government, Housing and Construction), and the Municipal Urban District Development Council. The authorities concerned and their responsibilities on water works are summarized as follows:

A National Water Supply and Drainage Board, Ministry of Local Government, Housing and Construction (NWSDB)

NWSDB was formed in 1975 out of the Ministry of Local Government Housing and Construction and is now an autonomous organization. NWSDB is responsible for water works as follows:

- Planning, design and implementation, maintenance and operation of piped water supplies in urban and large communities.
- Planning, design and implementation of smaller schemes.
- Deep well drilling programme in rural areas.
- Protected well developing programmes with hand pumps and piped water systems.

Table 2. Institutions Involved in the Water Supply and Sanitation Programme



Source: Review of the Sri Lanka Water Supply and Sanitation Programme for the International Drinking Water Supply and Sanitation Decade, The Government of Sri Lanka: WHO & UNICEF, Nov. 1983

- Staff training for water works.

An organization chart of NWSDB is given in Figure 2 which follows.

B Department of Local Government, Ministry of Local Government Housing and Construction

This department gives administrative and technical assistance on water supply schemes for authorities and carries out implementation and maintenance of shallow wells in rural areas.

C Local Authorities

Local authorities including District Development Councils and Municipal and Urban Councils are charged with the regulations, control and administration of all matters related to public health and public utility services including water works.

Local authorities coordinate and help in design and implementation of smaller scale piped water systems by NWSDB. Operation and maintenance of non-piped systems are also the Local Authorities responsibility.

D Department of Public Health, Ministry of Health

This department has some responsibilities for health education in support of water works development and water quality monitoring in the Districts.

E Janatha Estate Development Board, State Plantation Corporation, Ministry of Plantation and Industries

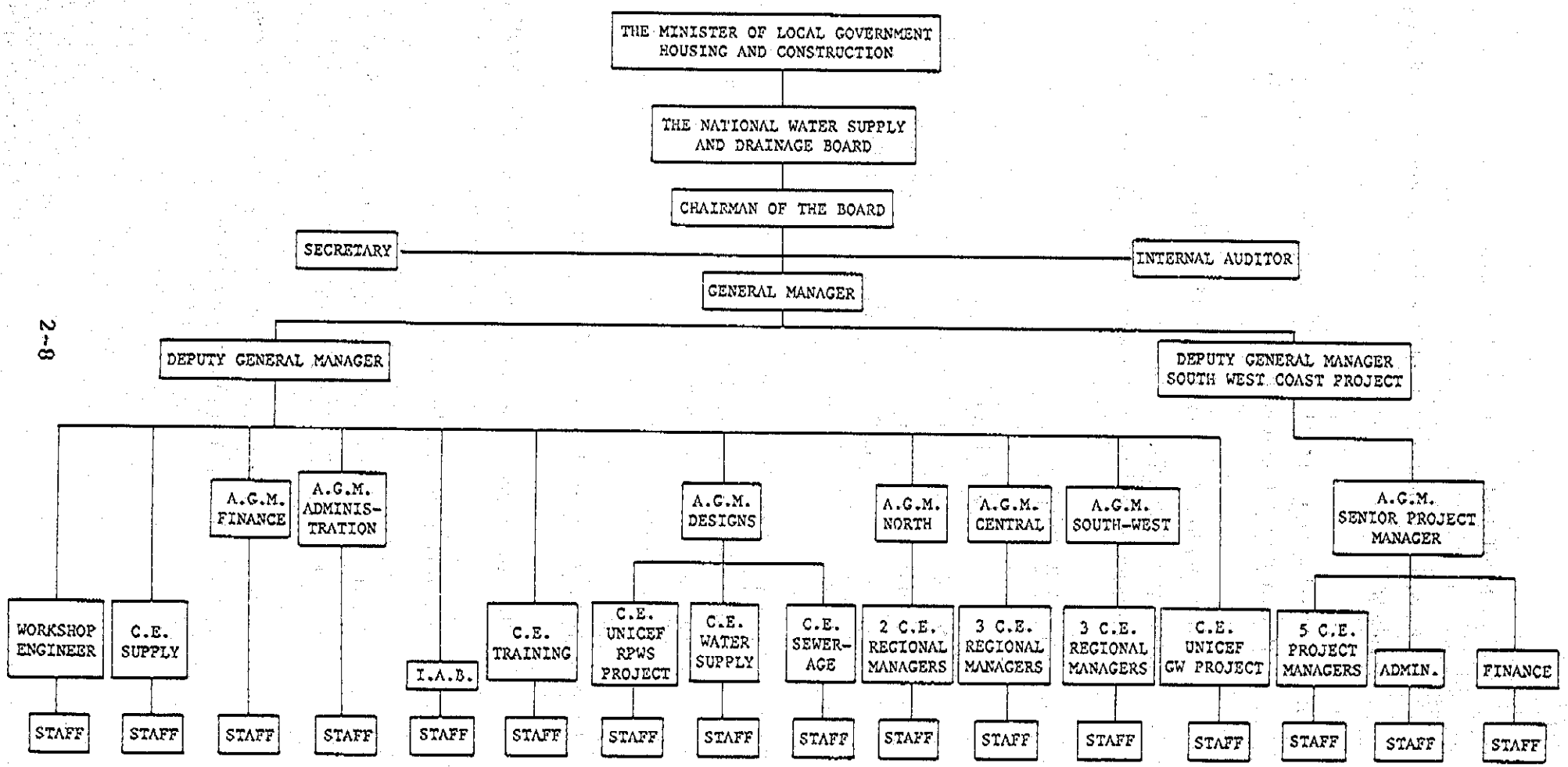
This authority is responsible for implementation and maintenance within the estate areas.

Figure - 2 SRI LANKA

WATER SUPPLY AND SANITATION SECTOR STUDY

NATIONAL WATER SUPPLY AND DRAINAGE BOARD

ORGANIZATION CHART



Note: A.G.M. - Assistant General Manager; C.E. - Chief Engineer; RPWS - Rural Piped Water Supply; GW - Groundwater

F Mahaweli Authority of Sri Lanka, Ministry of Mahaweli Development

This authority is responsible for agricultural development and resettlement in the dry zone. Water Supply schemes have been undertaken with assistance of UNICEF, NWSDB, and the Ministry of Health.

G Water Resource Board, Ministry of Land and Land Development

The Board is responsible for all matters concerning the country's water resources studies including investigation and exploitation of ground water, and watershed management.

H Department of Building, Ministry of Local Government Housing and Construction

This department is responsibe for design and construction of water supplies and sewerage schemes required for hospitals and other Government offices and buildings.

A review of the sector institutions according to functions is given in Table 3 following. From this Table, it can be seen that the NWSDB has responsibility for water supplies from the planning stage through to operation and maintenance.

TABLE 3 SRI LANKA
WATER SUPPLY AND SANITATION SECTOR STUDY

SECTOR INSTITUTIONS ACCORDING TO FUNCTIONS

Activity	Urban	Rural
Planning, Macro and Sector	Ministry of Local Government Housing and Construction	Ministry of Local Government Housing and Construction
	National Water Supply & Drsinage Board	National Water Supply & Drainage Board
	Ministry of Plan Implementation	Ministry of Plan Implementation
Project Generation	Ministry of Local Govt. Housing & Construction, Department of Local Government	The District Political Authority or District Minister in addition to the institutions as for Urban Schemes
	National Water Supply & Drainage Board	
Project Selection	Department of Local Government	Department of Local Government
	National Water Supply & Drainage Board	National Water Supply & Drainage Board
		The District Political Authority or District Minister
Project Design	National Water Supply & Drainage Board	National Water Supply & Drainage Board
Project Execution	National Water Supply & Drainage Board	National Water Supply & Drainage Board
Project Supervision	National Water Supply & Drainage Board	National Water Supply & Drainage Board
Operation and Maintenance	Major schemes - Headworks by NWSDB Distribution System by Local Authority or NWSDB	The Local Authority (initial period of operation by NWSDB)

(4) PROGRESS OF WATER SUPPLY PROGRAMMES

A. Long Range Programme

The long range plan for water supplies at the national level has been covered under "The International Drinking Water Supply and Sanitation Decade 1981 - 1990" referred to as the Decade Plan and under the Master Plan of the South West Coastal Area Water Supply and Sewerage Project.

a) Decade Plan

The Sri Lanka National Decade Plan was formulated when the UN declared "The International Drinking Water Supply and Sanitation Decade, 1981 - 1990". The plan has been developing with technical assistance and financial support from foreign countries. The design criteria stipulates a daily allowance of 40 lcd for standpipes, 80 - 120 lcd in rural areas, and 120 - 200 lcd in urban areas for house connections. The year 1990, water demand for the decade plan will be based on per capita demand and the estimated population served. The decade goal for water supply coverage is 67 % by 1990 and 100 % by 1995. The estimated funding required is 106.9 billion rupees at current prices.

Per capita Water Demand by Piped Water System

House Connection System		Stand Pipe System
Urban Area	Rural Area	Non - specified
120 - 200 lcd	80 0 120 lcd	40 lcd

Note ; lcd, litre per capita per day

b) South West Coast Master Plan

The Master Plan for water supply and sewerage projects was prepared by WHO in 1972 covering the project area of the south west coast. Some people living within this area will not be served by piped water in the master plan. However, they will be served by a water system under the decade plan.

B. Programmes and Progress

Following are the ditails of "Decade Plan" for water supply systems "South West Coast Master Plan" which are currently progressing.

a) "Decade Plan" for water supply systems

Outline of the plan is described in Tables 4, 5, 6, 7, 8 and Figure 3. The investment programme by districts for the Decade Plan is given amounting to 1.35 billion rupees for water supply systems as shown in Table 4. International donors are represented by many countries and organizations such as USA, Japan, Denmark, Finland, UNICEF etc.

Table 5 shows the total investment cost and system facilities for rural water supply programmes by Districts including a classification of piped, shallow or deep wells to be upgraded, or new wells to be installed.

Table 6 shows the piped water supply projects by NWSDB. The figures given in Table 6 show projects by Districts for planning, design, construction and maintenance. The total number of projects in 1981 by domestic funds was 263.

Table 7 shows the well drilling programme to the rural population.

Table 8 shows water supply projects for town schemes by foreign aid.

Figure 3 shows water supply projects by foreign aid based on Tables 7 and 8.

The District, Batticaloa, Nuwara Eliya and Ratnapura, developed water supply projects without foreign aid. At present, 5 projects have been implemented out of 9 projects which are undergoing or have reached the feasibility study stage for town water supply schemes supported by foreign aid since 1981.

It can be seen that development of water supply projects in Sri Lanka has been supported with foreign funding for about 73 % of the cases.

Since 1981, the Government has been facing financial constraint, and even the projects funded by foreign aid are behind schedule up to one year. Some projects funded domestically have been suspended or postponed.

b) South West Coastal Area Water Supply Master Plan

The project area given in Figure 4 is 150 km from south to north and 3.2 to 22.5 km wide at Greater Colombo.

Following is an outline of the Master Plan for S.W.C.A. provisions prepared by WHO in 1972 and described in a later section of this report.

Target year	2000
Estimated population in project area	4.334 million
Population served ratio	73 percent
Number of population served	3.156 million
- Greater Colombo	2.598 million
- Others	0.558 million

The Master Plan for S.W.C.A. includes the Greater Colombo Project, the Kalutala Project and the Ambalancoda Project. These projects were implemented with assistance from the Saudi Fund and IBRD.

Table - 4 PROPOSED WATER SUPPLY AND SANITATION PROGRAME

List of Districts and Estimated Costs

(Rupee, Million)

	District	Estimated Cost: Water Supply	Sanitation	Total	Note
1.	Amparai	72,9	28,4	101,3	
2.	Anuradhapura	Assistance by UNICEF			
3.	Badulla	106,2	9,2	115,4	
4.	Batticaloa	47,2	26,6	73,8	
6.	Colombo	46,6	2,2	48,8	
6.	Galle	64,8	13,4	78,2	
7.	Gampaha	117,3	13,4	130,7	
8.	Hambantota	Assistance by NORAD			
9.	Jaffna	Assistance by USAID			
10.	Kalutara	68,7	13,4	82,1	
11.	Kandy	151,2	9,2	160,4	Part assistance by FINNIDA
12.	Kegalle	64,1	6,8	70,9	
13.	Kurunegalla	197,4	25,8	223,8	
14.	Mannar	21,8	6,1	27,9	
15.	Matale	Assistance by DANIDA			
16.	Matara	58,2	8,0	66,2	
17.	Moneragala	57,3	11,3	68,6	
18.	Mullaitivu	Assistance by GTZ			
19.	Nuwara Eliya	54,6	4,3	58,9	
20.	Polonnaruwa	Assistance by DANIDA			
21.	Puttalam	84,9	26,6	111,5	
22.	Ratnapura	102,6	13,4	116,0	
23.	Trincomalee	24,4	11,3	45,7	
24.	Vavuniya	Assistance by GTZ			
	TOTAL	1,350,2	229,4	1,579,6	

Data Source: Sri Lanka Rural Water Supply & Sanitation Program Identification Report (copy) from NWSDB June, 1984.

Table - 5 PROPOSED RURAL WATER SUPPLY AND SANITATION PROGRAME

District	Summary of Estimated Cost (Rupees million)						Summary of Facilities				
	Piped systems		Shallow wells		Deep boreholes	Total water Supply	Piped systems		Shallow wells		Deep boreholes New wells (No.)
	To be upgraded	New systems	To be upgraded	New wells	New wells		To be upgraded (No. of persons)	New systems	To be upgraded (No. of wells)	New wells	
Amparal	11,5	10,0	1,8	3,5	46,1	72,9	23,000	5,000	150	192	1,325
Batticalon	1,5	6,0	1,6	2,4	35,7	47,2	3,000	3,000	133	132	1,025
Kurunegaln	6,5	26,0	6,7	10,0	148,2	197,4	13,000	13,000	558	558	4,258
Mannar	8,0	2,0	0,7	1,1	10,0	21,8	16,000	1,000	58	58	292
Moneragala	5,5	8,0	1,9	2,8	39,1	57,3	11,000	4,000	158	158	1,125
Puttalam	8,5	12,0	2,8	4,2	57,4	84,9	17,000	6,000	233	233	1,650
Irincomnlee	1,0	4,0	1,2	1,8	26,4	34,4	2,000	2,000	100	100	758
Badulla	44,5	44,0	4,5	6,8	6,4	106,2	89,000	22,000	375	375	183
Galle	3,5	14,0	10,3	30,9	6,3	64,8	7,000	7,000	858	1,717	175
Gampaha	23,5	24,0	17,4	52,4	-	117,3	47,000	12,000	1,450	2,908	-
Kalutura	3,5	14,0	10,1	25,4	15,7	68,7	7,000	7,000	842	1,408	450
Kandy	52,0	52,0	8,7	26,0	12,5	151,2	104,000	26,000	725	1,442	358
Kegalle	12,0	12,0	9,0	22,4	8,7	64,1	24,000	6,000	750	1,242	250
Matara	9,0	12,0	9,0	22,5	5,7	58,2	18,000	6,000	750	1,250	250
Nuwuru Eliya	25,0	26,0	0,9	2,7	-	54,6	50,000	13,000	75	150	-
Ratnapura	29,0	30,0	11,0	21,9	10,7	102,6	58,000	15,000	917	1,217	308
Colombo	5,0	10,0	7,2	21,9	2,9	46,6	10,000	5,000	600	1,192	83
TOTAL	249,5	306,0	104,8	258,3	431,6	1,350,2	499,000	153,000	8,732	14,333	12,490

Data Source: Sri Lanka Rural Water Supply & Sanitation Program Identification Report (copy) from NWSDB, June, 1984

Table - 6 PIPED WATER SUPPLY PROJECTS BY NWSDB

	District/Project	Total Nos.	Design	Const.	Maintenance	Expansion	Remarks
1.	Colombo District	5	-	1	4	-	
2.	Gampaha District	16	3	5	8	-	
3.	Kalutara District	3	2	1	-	-	
4.	Matale District	9	3	2	4	-	
5.	Kandy District	23	4	2	18	3	(4)
6	Nuwara-Eliya District	13	1	1	11	-	
7.	Galle District	5	2	3	-	-	
8.	Matara District	7	-	2	6	-	(1)
9.	Hambantota District	18	4	6	12	-	(4)
10.	Jaffna District	18	-	7	12	2	(3)
11.	Hannar District	9	-	4	8	-	(3)
12.	Vavuniya District	2	-	2	-	-	
13.	Mullativu District	1	-	-	1	-	
14.	Trincomalle District	7	-	3	4	-	
15.	Batticaloa District	4	1	1	4	-	(2)
16.	Ampara District	10	1	3	8	-	(2)
17.	Puttalam District	11	-	2	9	-	
18.	Kurunegala District	16	4	9	9	-	(6)
19.	Anuradhapura District	16	4	5	7	-	
20.	Polonnaruwa District	4	2	1	3	-	(2)
21.	Badulia District	24	5	4	17	-	(2)
22.	Monaragala District	5	1	1	4	-	(1)
23.	Kegalle District	14	4	5	7	-	(2)
24.	Ratunapura District	14	1	2	14	-	(3)
25.	South-West Coastal Project	7	-	5	2	-	
26.	Trincomalee Water Supply Project	1	-	1	-	-	
27	Matara Combined Water Supply Project	1	-	1	-	-	

Source: Statistical Data General and Technical on Pipe-Borae Water Supply Schemes in Sri Lanka, NWSDB, Oct., 1981

Table - 7 Well Drilling Programme

- Minimum Water Service to the Rural Population -

	Project Name	Scale	Year	Aid Country
1.	Pilot Ground Water Programme	1,000 deepwells in the dry zone	1983	UNICEF
2.	Pilot Ground Water Programme	1,500 deep wells	1984-1988	UNICEF
3.	Rural Water Supply Programmes	Wells with hand pumps and piped water Matale and Polonnaruwa District	-	Denmark Government
4.	Rural Water Supply Programme	Wells with hand pumps Vavuniya and Mullaitivu Districts	-	Financial support by the Government of the Federal Republic of Germany
5.	Programme of Water Supply	Wells with hand pumps and piped water Mostly rural for Harispattuwa	-	Finnish Government
6.	Water Supply Programme	Groundwater mapping and 2 market towns piped water Jaffna Peninsula	-	USAID
7.	Water Supply	Wells with hand pumps mostly Hambantota District	-	NORAD
8.	Mannar Water Supply Scheme	Piped groundwater	-	Netherlands Government
9.	IRDP Programmes		-	IBRD Dutch Government & Belgium Government

Sources: NWSDB, June, 1984

Table - 8 LIST OF TOWN SCHEMES TAKEN UP BY THE OTHER FOREIGN AGENCIES

Project Description	Agency	Feasibility Study Start	Construction Start	Construction Completion
1. Planning of Water Supply and Sanitation Programme in Matale and Polonnaruwa District	Denish Aid Denmark Government	January 81	July 83	December 85
2. Water Supply Facilities for Ampara Group of Towns	Japan International	January 82	Only a feasibility study	
3. Harispattura Electrite Water Supply & Sanitation Project	Department for International Development Corporation. Finland	November 80	January 83	December 85
4. Market Town Water Supply Jaffna Project	U.S. Aid	January 80	December 84	December 85
5. Matara Water Supply Project	British Overseas Development Administration. U.K.	January 79	January 80	December 84
6. Chilaw Water Supply Augmentation Scheme	Chinese Government	July 84		
7. Negombo Water Supply Augmentation Scheme Trincomalee Water Supply Project Kandy Water Supply Improvement	French Government	January 81	April 84	June 86
8. Polonnaruwa Town Water Supply	Chinese Aid	January 85		
9. Puttalum Augmentation Scheme	Chinese Aid	January 85		

Data Source: NWSDB, June, 84

Under construction except two.

Figure - 3 WATER SUPPLY PROJECT BY FOREIGN AID AND DISTRICTS

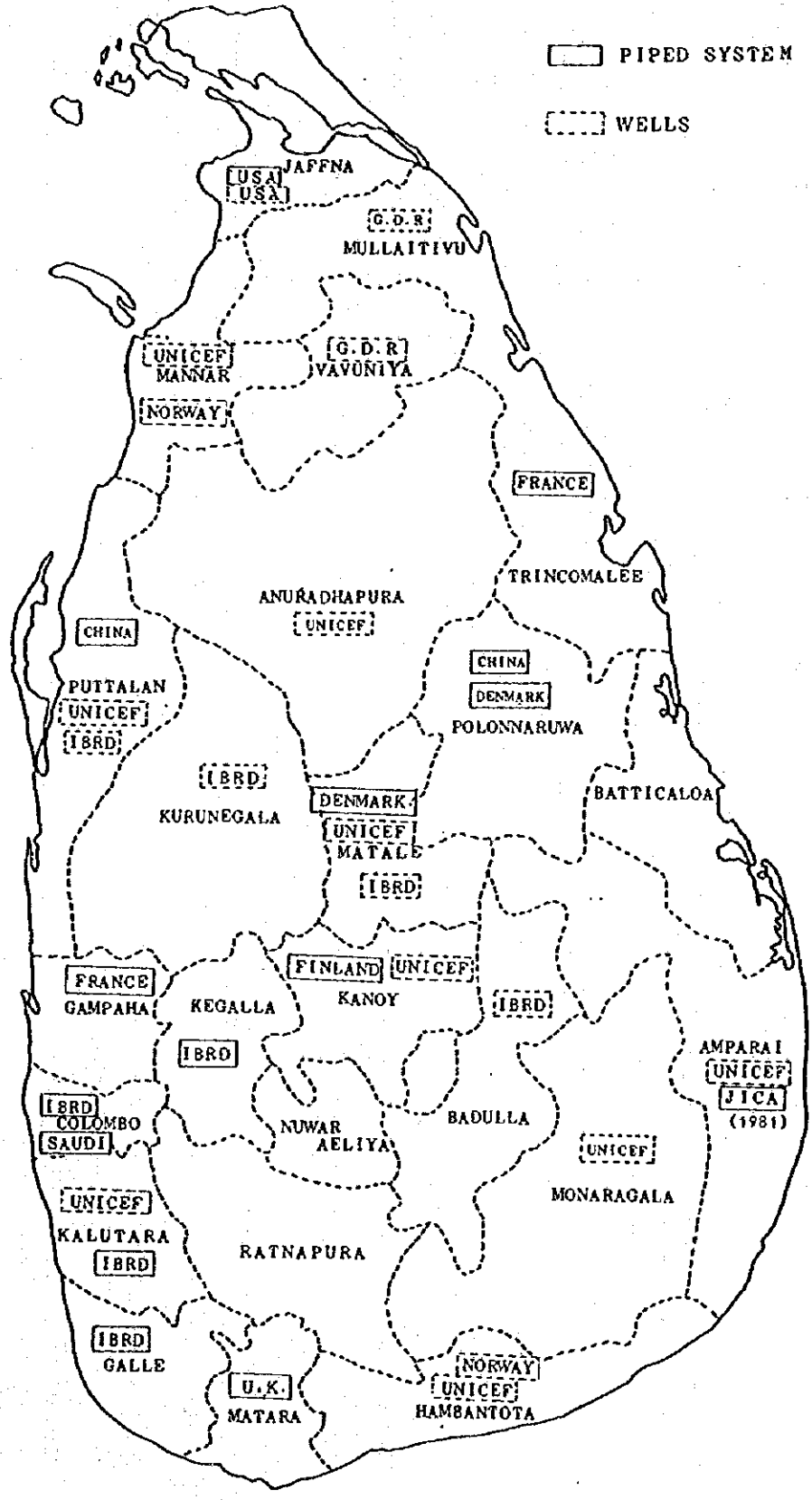


Figure - 4 MASTER PLAN FOR SOUTH WEST COAST AREA

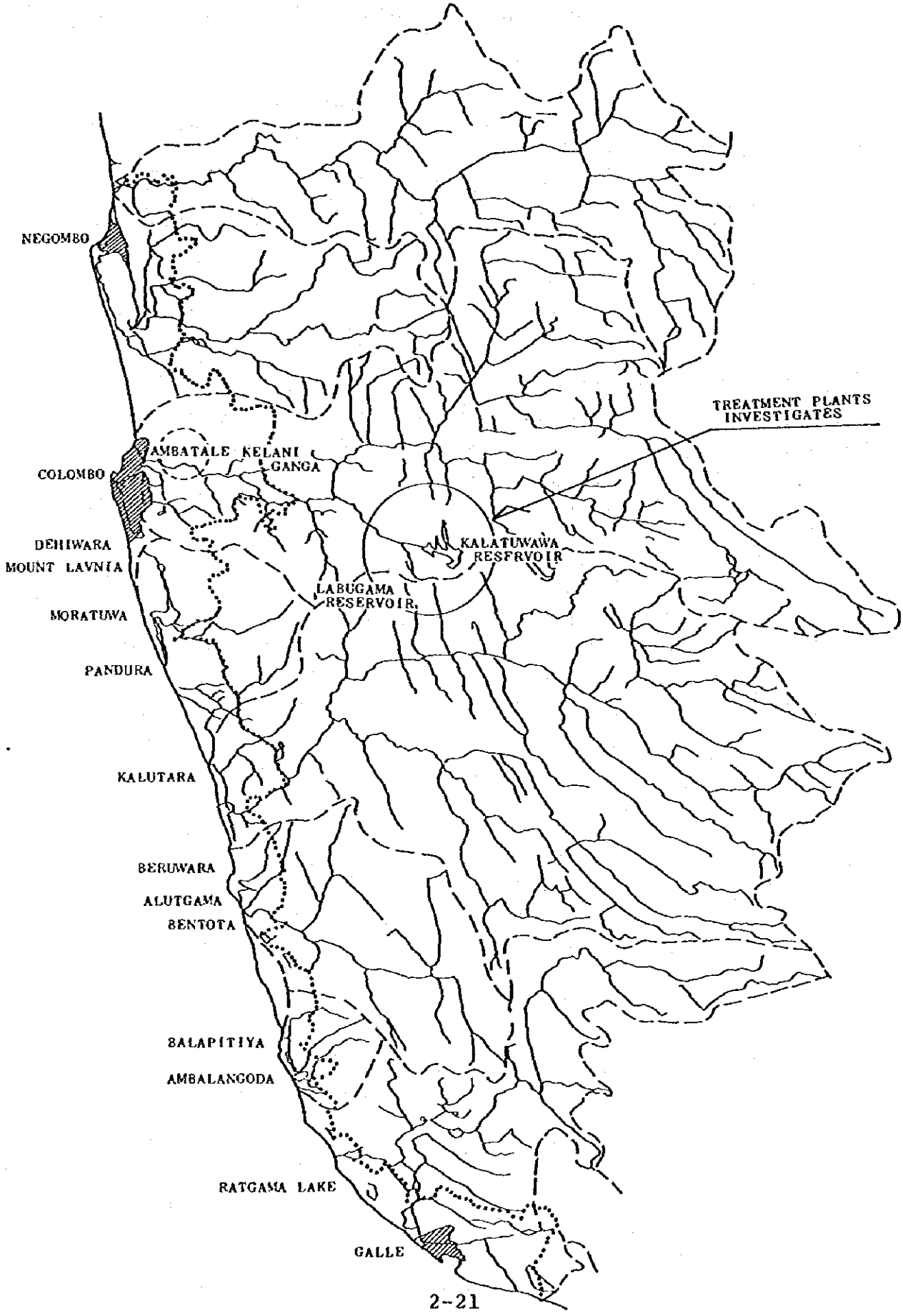


Table - 9 MASTER PLAN FOR SOUTH WEST COAST AREA WATER SUPPLY SYSTEM

Area	Proejct Population	Population Served	Population Served Ratio	House Connection Ratio	Stand Pipe Ratio
Project Area	4,334.0	3,156.0	73	60	40
Greater Colombo	2,598.0	2,598.0	100	64	36
Colombo Municipality	838.0	838.7	100	83	17
Colombo South	1,062.0	1,062.0	100	59	41
Colombo North	697.0	697.0	100	48	52
Negombo	162.2	162.2	100	46	56
Kalutara	62.0	62.0	100	45	55
Ambalangada	53.6	53.6	100	40	60
Gale	170.4	107.4	100	40	60
Rural Area	110.0	110.0	100	36	64
Others	1,178.0	-	-	-	-

(5) SOCIO-ECONOMIC CONDITIONS

A. General

The Democratic Socialist Republic of Sri Lanka is a small island located south east of the Indian Sub-Continent, and is approximately 65,610 km2 in area including about 959 km2 of inland waters.

The landscape of the island can be described as a compact area with a central mountainous region with peaks as high as 2,524 m. A number of rivers rise in these mountain peaks and flow towards the sea, creating fast moving rivers and waterfalls and have an economic importance as a source of generating hydro-electric power. About 20 % of the land is forest, and forest reserves, and 25 % is used for agricultural cultivation purposes. The remaining land consists of built up areas, grass lands, scrub growth, and non-arable lands.

Sri Lanka being close to the equator and lying between Latitude 6 and 10 north, has a mean temperature over the lands ranging from 26 to 28 C°. Rain brought by the monsoons results in recorded monthly totals of 1,250 to 1,500 mm while little rain falls in the dry zones. This relatively small island has a wide variation in rainfall.

The four distinguishable rainfall seasons are:

Mid-May to September	South-west monsoon
October to November	Intermonsoon period
December to February	North-east monsoon
March to Mid-May	Intermonsoon period

B. Socio-Economic Conditions

The GDP annual growth rate averaged over 6 % during 1978 to 1982, and the unemployment rate dropped to 13.4 % in 1982 from a high of 25.9 % in 1977. A variety of daily commodities has appeared on the market. Because of increasing imports, under the free trade policy, the trade balance resulted in a deficit of 9.8 billion dollars in 1982. The nation's economy appears to be falling into a recession. Moreover, events in July influenced the economic activity and light industries remained at a flat level. The GDP fell to 4.9 % in 1983. Under these financial difficulties, Government project investment slowed down in 1983. Income and expenditures for 75 local administrations in 1982 were as follows:

	Colombo Municipality (12)	Urban Areas (39)	Local Councils (24)	Total Local Administrations (75)
Income (Rs. x 1,000)	366,181.8	215,715.3	266,211.6	808,108.7
Expenditures (Rs. x 1,000)	354,883.4	194,581.3	218,875.1	768,339.8

Table 9 which follows shows general information on the Sri Lanka economy, financial balance between 1978 and 1982, total and per capita products at current and constant prices, and foreign assistance.

2-2 REGIONAL LEVEL

(1) CLIMATE

The Climate is tropical with high temperatures and high humidity throughout the year. The average monthly temperature is 27 C°, and only slightly cooler from December to February. Over the 30 year period from 1931 to 1961, the maximum and minimum temperatures were 30 C° and 23.9 C° respectively.

The average rainfall for the same 30 year period was 2,395 mm/year. Recent precipitation records for 1981 and 1982 showed the annual average rainfall as 2,078.1 mm and 2,005.5 mm/year respectively.

From a review of the monthly rainfall records, it was observed that the least rainfall occurs between December and March. At the Kalatuwawa and Labugama mountainous areas, the rainfall is about 4,000 mm per year or twice as much as recorded in the Colombo area. The water levels and rainfall records for Kalatuwawa and Labugama utilized in this study are included in Appendix 11.

(2) GEOGRAPHY

Colombo City is located in the south-western flat area of Sri Lanka. Along the sea, the City covers an area, 13 km in the north-south direction and 4 km in the east-west direction with an elevation range from 7 m to 20 m. Although many waterways are used for surface water drainage, there are also many marshy areas in the City. Next to the Fort region of the old town, Beira Lake is being used as a multi purpose reservoir. Out of 695 km2 of the Greater Colombo Area, 42 km2 is covered by water.

(3) REGIONAL DEVELOPMENT SCHEME

Including the City of Colombo, Greater Colombo has been developed as the center of economic, social and government activities. Most of the urban area has been developed so new development schemes are occurring in the rural areas. Under the Department of Town and Country Planning, the Ministry of Local Government, Housing, and Construction has responsibility for undertaking the development schemes through the Nation, and the Committee also has responsibility for the Greater Colombo Development Schemes based on the Greater Colombo Economic Commission Act No. 4 dated 1978. These schemes were prepared for increasing employment opportunities with commercial and light industrial development and also for improvement of the road network system necessary for development. For the development scheme of Greater Colombo, the Department of Town and Country Planning, the Ministry of Local Government Housing and Construction has prepared the Development Scheme of Colombo Master Plan (D.S.C.M.P.) for this Capital district for the target year 2001. The D.S.C. Master plan covers the Colombo area and surrounding area, between Negombo in the north to Alutguma in the south, 90 km long by 40 km wide, and covers approxinately 3,000 km2 containing 5,000,000 population.

The Committee, has mainly prepared development plans for residential, commercial and industrial areas at Katunayake Region the south-east side of Negombo, and the Biyagama area on the west side of the Kelani River. In the Kotte district located on the east side of Colombo, the new capital, Sri Jayewardenupure Kotte, has been developed with construction of the new capital building, city hall, cultural center, schools, hospitals, residential buildings, and parks etc.

Although the population in 1981 was 186,292 in the new capital area of 4,277 ha, the future population is planned to be 270,000 by the target year 2001.

(4) PRESENT STATE OF WATER SUPPLY

A. Summary of Treatment Plants

At present approximately 1.2 million people in Colombo City and its urban area are supplied 340,000 m3/day of water from three sources:

a) Kalatuwawa Treatment Plant
- . Capacity : 91,000 m3/day
- . purification process;
  aeration - sedimentation - rapid filtration - chlorination
- . source; Kalatuwawa Reservoir
  capacity: 15.4 million m3
- . conveyance ; gravity
- . construction; 1954

b) Labugama Treatment Plant
- . capacity ; 59,150 m3/day
- . purification process;
  sedimentation - rapid filtration - chlorination
- . source ; Labugama Reservoir
  capacity : 8.9 million m3
- . conveyance ; gravity
- . construction ; 1886

c) Ambatale Treatment Plant
- . capacity ; 205,000 m3/day
- . purification process;
  aeration - sedimentation - rapid filtration - chlorination
- . source : Kelani Ganga River
  intake capacity ; 5.5 m3/sec (475,200 m3/d)
- . conveyance ; pump - elevated tank
- . construction ; 1966

The Ambatale treatment plant is undergoing an expansion schedule of 182,000 m3/d in 1982, 273,000 m3/d in 1990, 364,000 m3/d in 1994 and 455,000 m3/d in 2000 forming the Greater Colombo Project commenced in 1980.

B. Present Condition of Water Supplies

The water treated from the impounded reservoirs is supplied to the northern area of Colombo City and Peri-urban Colombo South. Also the water treated directly from the river source is supplied to Colombo City and Peri-urban Colombo South. The distribution pipes for the Peri-urban Colombo North are now under construction and water service is not yet available. The present condition of water supply for each area is as follows;

a) Peri-urban Colombo South
population : 679,125
population served; 532,410
service ratio : 78.4 %

b) Colombo City
population : 585,776
population served : 585,776
service ratio : 100 %

c) Peri-urban Colombo North
population : 198,260
population served ; nil

The total population served is 1,188,186 out of 1,463,161 at an overall service ratio of 76.4 % in the Greater Colombo area which includes all the above three areas. Water is delivered to the consumers via house connections and public standpipes. In 1984 the number of public standpipes in Colombo City was 1,500 and 2,164 in the Peri-urban Colombo South.

The average water consumption in the supplied area is 300 lcd and 225 lcd net in consideration of 25 % leakage. Twenty four hours water supply is the objective in Greater Colombo but is difficult to maintain due to insufficient maintenance and obsollescence of the treatment plant facilities at Kalatuwawa and Labugama.

The quality of purified water from the Ambatale treatment plant meets the standards of WHO, but the water quality from Kelatuwawa and Labugama often deteriorates due to insufficient purification of the poorer quality raw water when the reservoir water level is low in the dry season.

(5) WATER SUPPLY PROJECT

The World Health Organization (WHO) made a Master Plan of the South-West Coastal Area Water Supply, Sewerage and Drainage Project in 1972, which included Greater Colombo, Negombo and the Galle areas with a target year of 2000. Also the Preliminary Engineering and Feasibility Study for water supply was completed by WHO in 1972. The Master Plan for S.W.C.A. is being implemented through the First and Second Sri Lanka Water Supply Project. The first project is finished and the second project is under implementation.

A. Summary of the Master Plan for South West Coast Area

This master plan for S.W.C.A. covers an area of 160 km in the north-south direction from Negombo to Galle and 3.2 km to 22.5 km in the east-west direction. The area planned consists of the following five regions as sub-areas.

a) Negombo Urban
b) Greater Colombo
    Colombo Municipality
    Peri-urban Colombo South
    Peri-urban Colombo North
c) Karutara Urban
d) Ambalangoda Urban
e) Galle Urban

The Master Plan for S.W.C.A. has projected a total population of 4,334,000 in the study area by 2000 and 3,156,000 will be served with water supply facilities, or a 73 % service ratio.

The percentage of population to be served in Greater Colombo is projected as 100 % or 2,598,000 people. This degree of servicing will be accomplished by direct house connections in 83 % of Colombo Municipality, in 59 % of Peri-urban Colombo South, in 48 % of Peri-urban Colombo North and the balance of the population will be served by public standpipes. The projected quantity of water supply is 32 to 57 lcd for public standpipes, 182 to 273 lcd for full-plumbing premises and 91 to 136 lcd for part-plumbing premises.

The plan is summarized below;

population in 2000	4,334,000
percentage of population served	73 %
population served	3,156,000
estimated water supply capacity	608,300 m3/d
Greater Colombo	100 % or 2,598,000
Other Urban Areas	32 % or 588,000

Figure 5 shows the population growth, daily water demand and expansion of the treatment plants in the master plan for the Greater Colombo area. In this plan, the Ambatale treatment plant is projected to expand from 91,000 m3/d to 455,000 m3/d by 2000 through a four stage expansion program, but Kalatuwawa and Labugama's present capacities of 91,000 m3/d and 59,150 m3/d respectively are to be maintained constant.

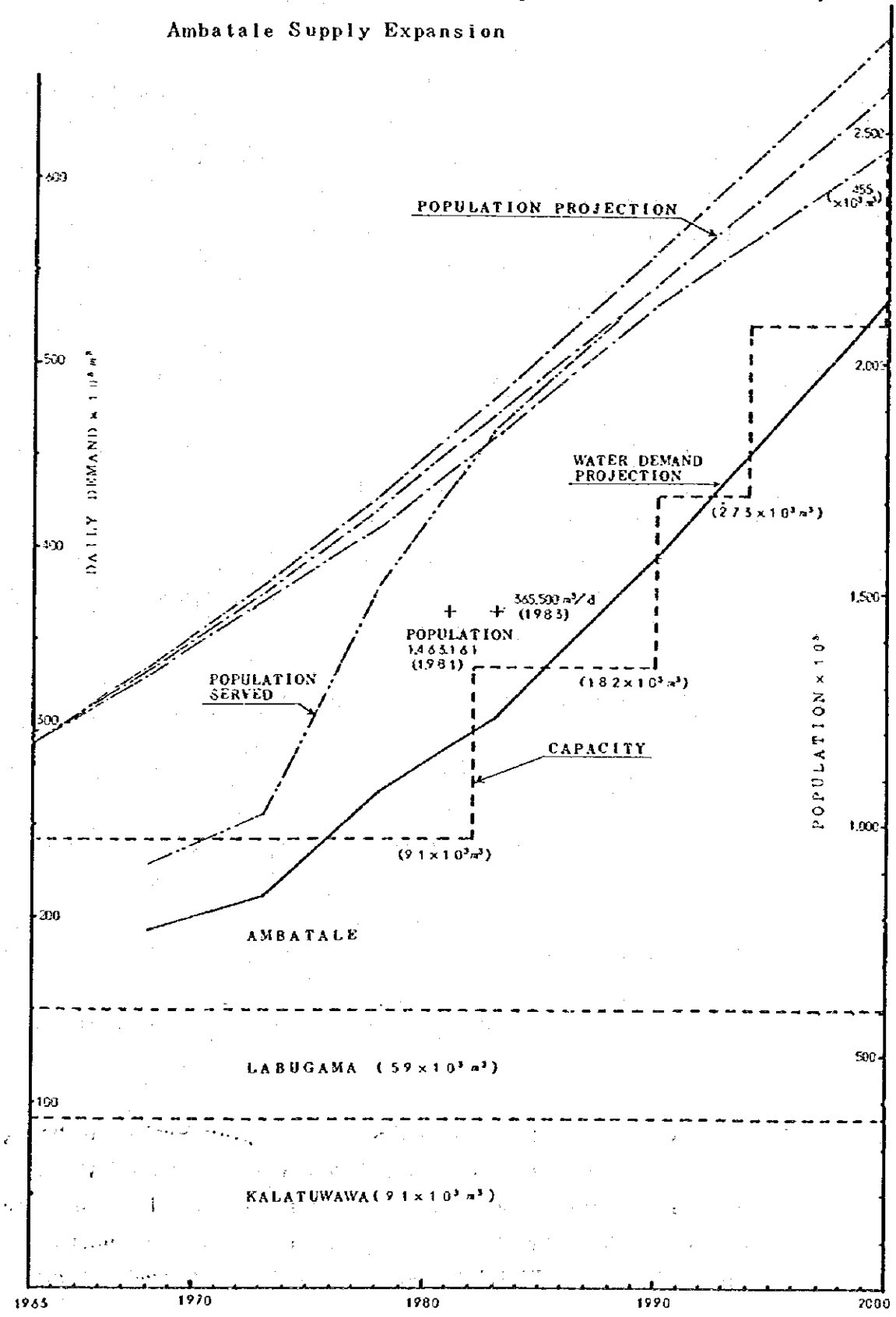
B. Other Projects

Other related water supply projects which are proceeding separately in the area but are excluded from the Master Plan for S.W.C.A. are as follows:

a) Katunayake Investment Promotion Zone

This zone includes an area of 182 ha consisting of improved roads, electricity and water supply facilities projected by the Greater Colombo Economic Committee in 1981.

Figure – 5 Masterplan Forecasts of Population, Water Demend, and Ambatale Supply Expansion



b) Kotte Area

The development of the Kotte area, the new capital, is being carried out by the Urban Development Authority, Ministry of Local Government, Housing, and Construction. The water demand in this area is estimated at 17,500 m3/d in 1986 and 30,000 m3/d in 2001. Another pipeline from Ambatale to the Kotte area is necessary to improve water supply transmission and is estimated by the National Water Supply and Drainage Board to cost 151 million rupees.

c) Water Supply Project at Rural Area in Colombo District

This project aims at water supply for 239,000 people or 5 % of the population in the rural area by 1990 and consists of establishing and improving piping for 15,000 people, establishing 1,192 new shallow wells, improving 600 existing shallow wells for 215,000 people and also to establish 83 deep wells for 10,000 more people.

d) Colombo Municipality Water Distribution Project

This project was undertaken by WHO in 1972 for the distribution system in Colombo City and was aimed at improving the pipline network through the investigation of pipe corrosion and water demand throughout the city area.

C. Implementation of the Master Plan

The Master Plan for S.W.C.A. has been implementing by the phasing.

At present the Second Sri Lanka Water Supply Project is being carried out which had a high priority in the Feasibility Study which immediately followed the Master Plan. In 1981, 15 projects in Gampaha District, 3 projects in Kalutara District, 5 projects in Galle District and 5 projects in Colombo District were carried out.

The First and Second Sri Lanka Water Supply Projects are as follows;

a) The First Sri Lanka Water Supply Project

project year ; 1978 - 1983

capital investment ; 203 million rupees for the project

. construction of reservoirs

Jubilee	4,546.5 m3
Moratura	4,546.5 m3
Maligakanda	13,639.5 m3
Church Hill	18,186 m3

Kirillapona elevated tank

. construction of distribution mains

Ambatale - Jubilee Main to Attidiya

. construction of booster pump at Kotte and Kirillapona

. Repair of existing pipeline network in Greater Colombo

. procurement of pump machinary at Ambatale

. installation of water meters

. installation of new distribution mains in the northern area of Towns North of Colombo

b) Second Sri Lanka Water Supply Project

project year : 1982 - 1985

capital investment : 507 million rupees

for the project

. construction of new intake and pumps at Ambatale

. installation of raw water pumps at Ambatale

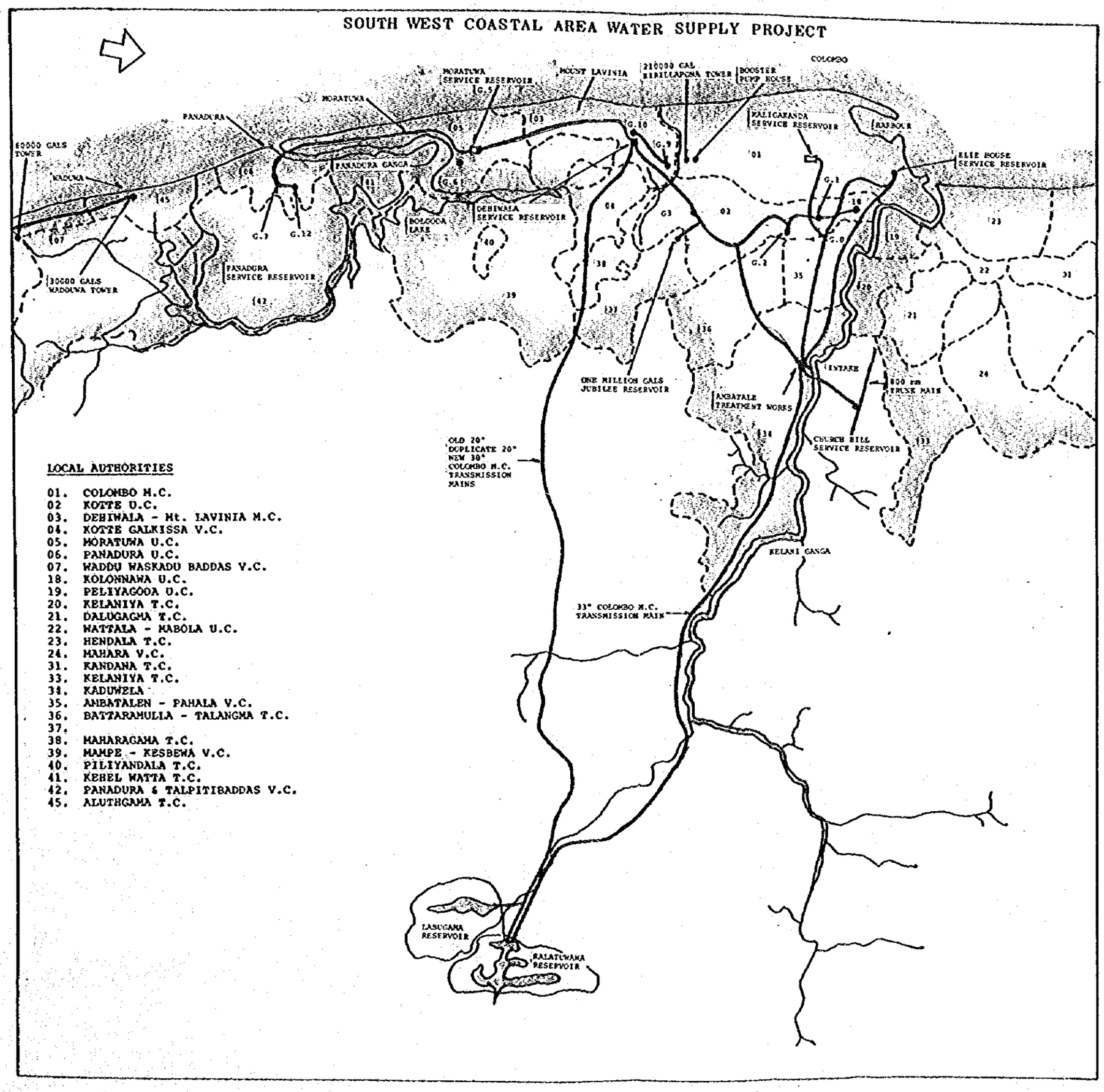
. construction of distribution mains

. construction of two coagulation tanks of 61,378 m3/d at Ambatale

. improvement of chemical dosing system at Ambatale

. modification from existing single media to dual media for 12 filters at Ambatale

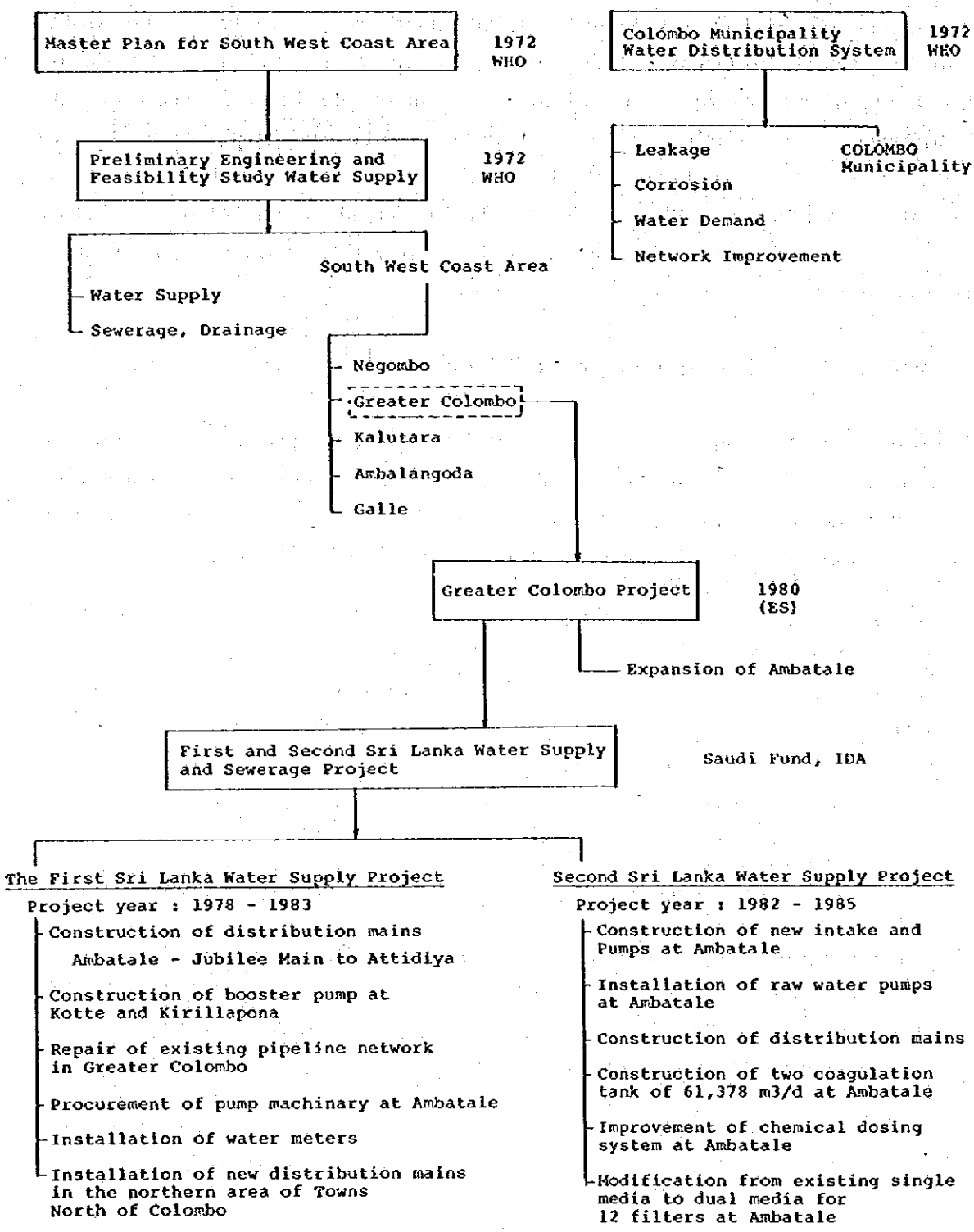
SOUTH WEST COASTAL AREA WATER SUPPLY PROJECT



LOCAL AUTHORITIES

01. COLOMBO M.C.
02 KOTTE U.C.
03. DEHIWALA - Mt. LAVINIA M.C.
04. KOTTE GALKISSA V.C.
05. MORATUWA U.C.
06. PANADURA U.C.
07. WADDU WASKADU BADDAS V.C.
18. KOLONNAWA U.C.
19. PELIYAGODA U.C.
20. KELANIYA T.C.
21. DALUGAGMA T.C.
22. WATTALA - MABOLA U.C.
23. HENDALA T.C.
24. MAHARA V.C.
31. KANDANA T.C.
33. KELANIYA T.C.
34. KADUWELA
35. AMBATALEN - PAHALA V.C.
36. BATTARAMULLA - TALANGMA T.C.
37.
38. MAHARAGAMA T.C.
39. MAMPE - KESBEWA V.C.
40. PILIYANDALA T.C.
41. KEHEL WATTA T.C.
42. PANADURA & TALPITIBADDAS V.C.
45. ALUTHGAMA T.C.

MASTER PLAN FOR SOUTH WEST COAST AREA AND GREATER COLOMBO PROJECT



(6) POSITION OF THE BASIC DESIGN STUDY

As shown in Figure 5 Ambatale is projected to expand to 455,000 m3/d but Kalatuwawa and Labugama are projected to maintain their present capacities of 91,000 m3/d and 59,150 m3/d respectively. The water supply project in Greater Colombo within the Master Plan was made on the basis of proper operation of both treatment plants at Kalatuwawa and Labugama. The reliable delivery of good quality and ample quantities of water from both treatment plants is therefore essential and critical to sustain this project. The water supply to Colombo, capital of Sri Lanka will face a dangerous limitation if the operating capabilities of both treatment plants is not restored quickly.

Therefore this rehabilitation project should proceed without delay.

Furthermore this rehabilitation project has special significance because it is now the policy of waterworks management to concentrate on improving and upgrading existing facilities rather than proceeding with new construction because of current national budget constraints.

3. SUMMARY OF THE TREATMENT PLANTS INVESTIGATED

3-1 KALATUWAWA

(1) SUMMARY OF THE SYSTEM

This treatment plant was constructed in 1954 at a capacity of 91,000 m3/day. The source of raw water is from the 15.4 million m3 impounded reservoir controlled by a gravity type concrete and masonry dam and treatment consists of aeration, sedimentation, filtration and chlorine disinfection. The purified water is supplied to Colombo City by gravity through one 30 inch and two 33 inch diameter conveyance pipes approximately 50 km in length.

The treatment process consists of cascade type aerator, sedimentation tanks with ascending bottoms, ten rapid gravity filters and a waste recovery system.

The unique characteristic of this plant is the in-plant electric power generation. The electric power generated by the turbine generators which are using raw water from the reservoir provides the energy for water treatment. Also several diesel engine driven generators have been installed for back up to the turbine generators. The gravity water transmission system results in energy savings and improved reliability of the waterworks system.

(2) PRESENT CONDITION OF THE SYSTEM

At present this treatment plant is not working satisfactory because of obsolescence of many of the mechanical and electrical components. The critically limiting factor for filtration is insuficient backwashing capability due to defects in the valving and penstock mechanisms.

Figure－6 Kalatuwawa

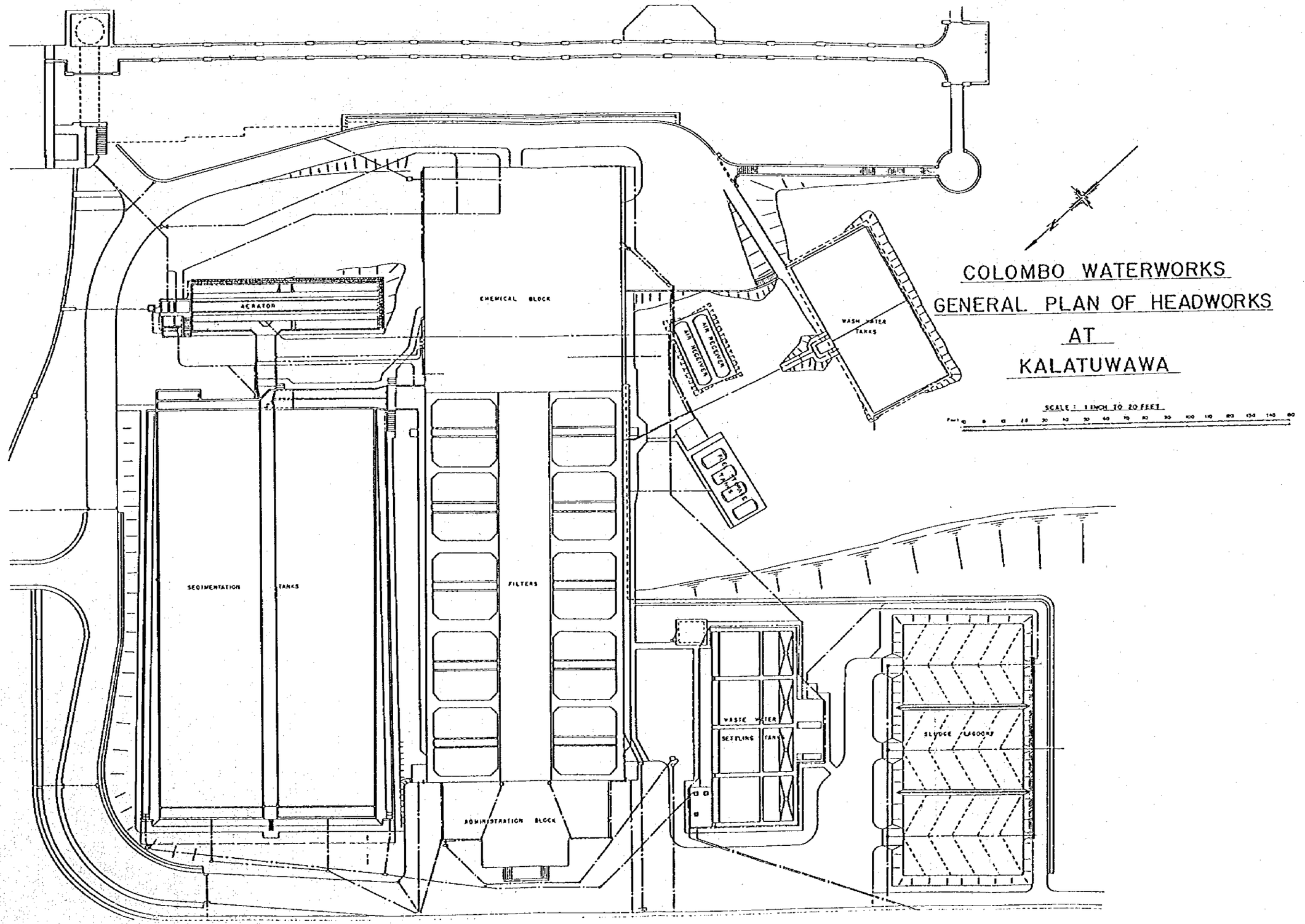
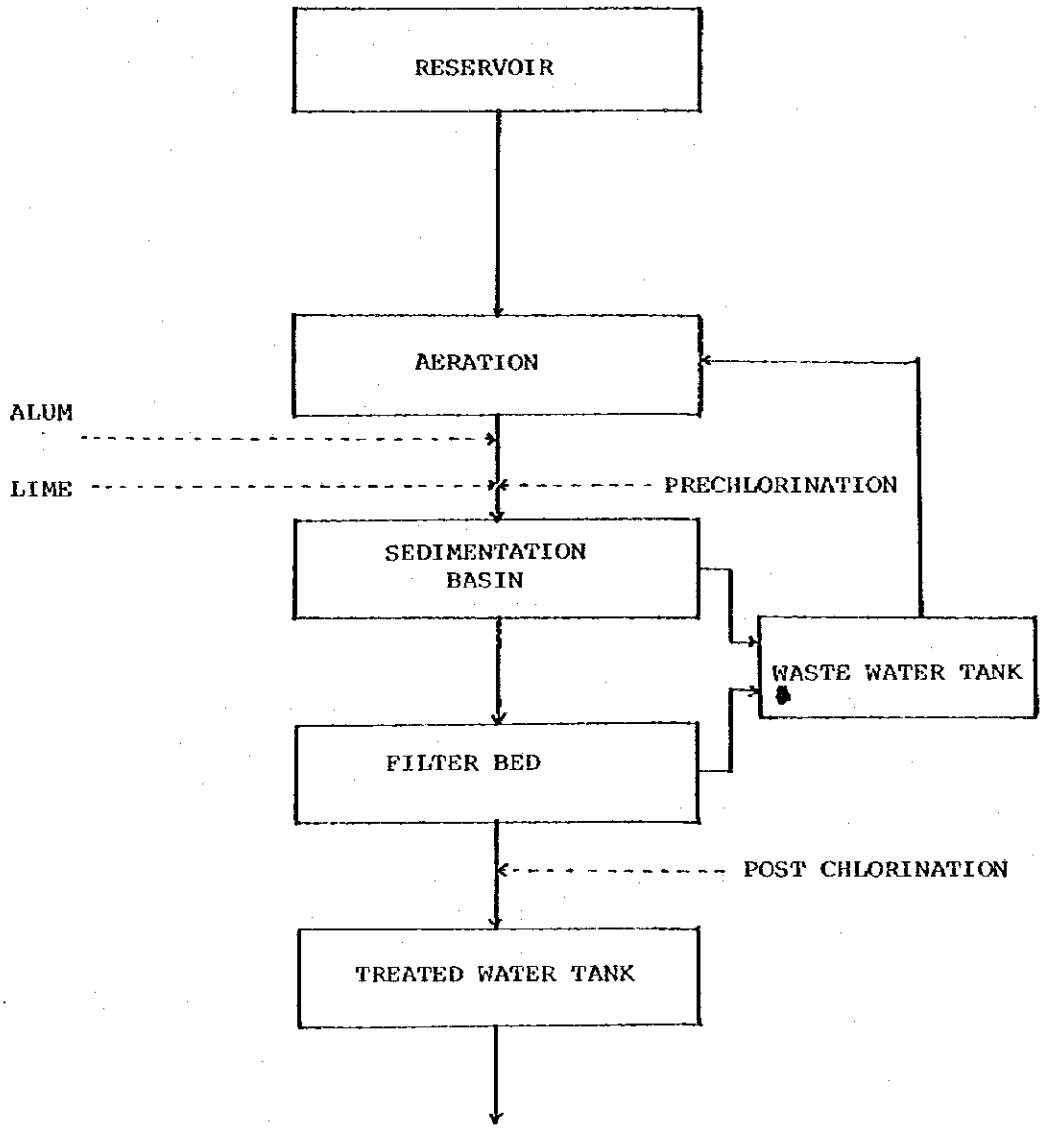
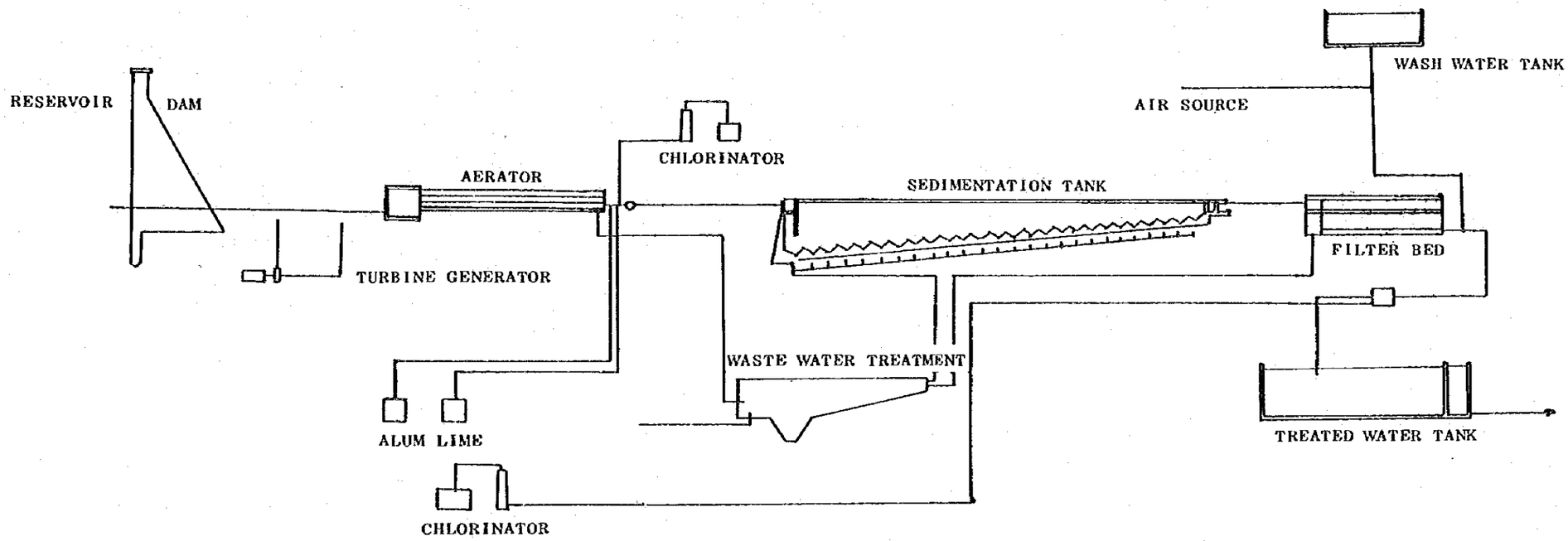


Figure - 7 FLOW CHART OF KALATUWAWA WATER TREATMENT PLANT



Figure－8　KALATUWAWA HEADWORKS
SCHEMATIC LAYOUT



Aeration and sedimentation processes are also ineffective. The capacity of the sedimentation tank is too small to treat the present raw water flows resulting in insufficiently settled water overloading the filters. The floc is retained in the filter media and has accumulated forming mud balls thus frequently interupting and restricting the filter operation.

Figures 6,7 and 8 are shown the present system.

3-2. LABUGAMA

(1) SUMMARY OF THE SYSTEM

This treatment plant has a capacity of 59,150 m3/day. The source of raw water is from the 8.9 million m3 impounded reservoir controlled by an earth dam. Treatment consists of sedimentation, filtration, and chlorine disinfection.

The purified water is supplied to Colombo City by gravity through two 20 inch and one 30 inch diameter conveyance pipes approximately 45 km in length. The treatment process consists of a covered sedimentation tank and rapid gravity sand filters. The unique characteristic of this plant is the use of Jewell Filters constructed in 1886.

(2) PRESENT CONDITION OF THE SYSTEM

The Jewell Filters have not been working since 1977 and the only treatment provided at present is chlorination.

The filter system is inoperative because of the obsolescence of the valves, water collecting mains, strainers, and agitating mechanisms for backwashing.

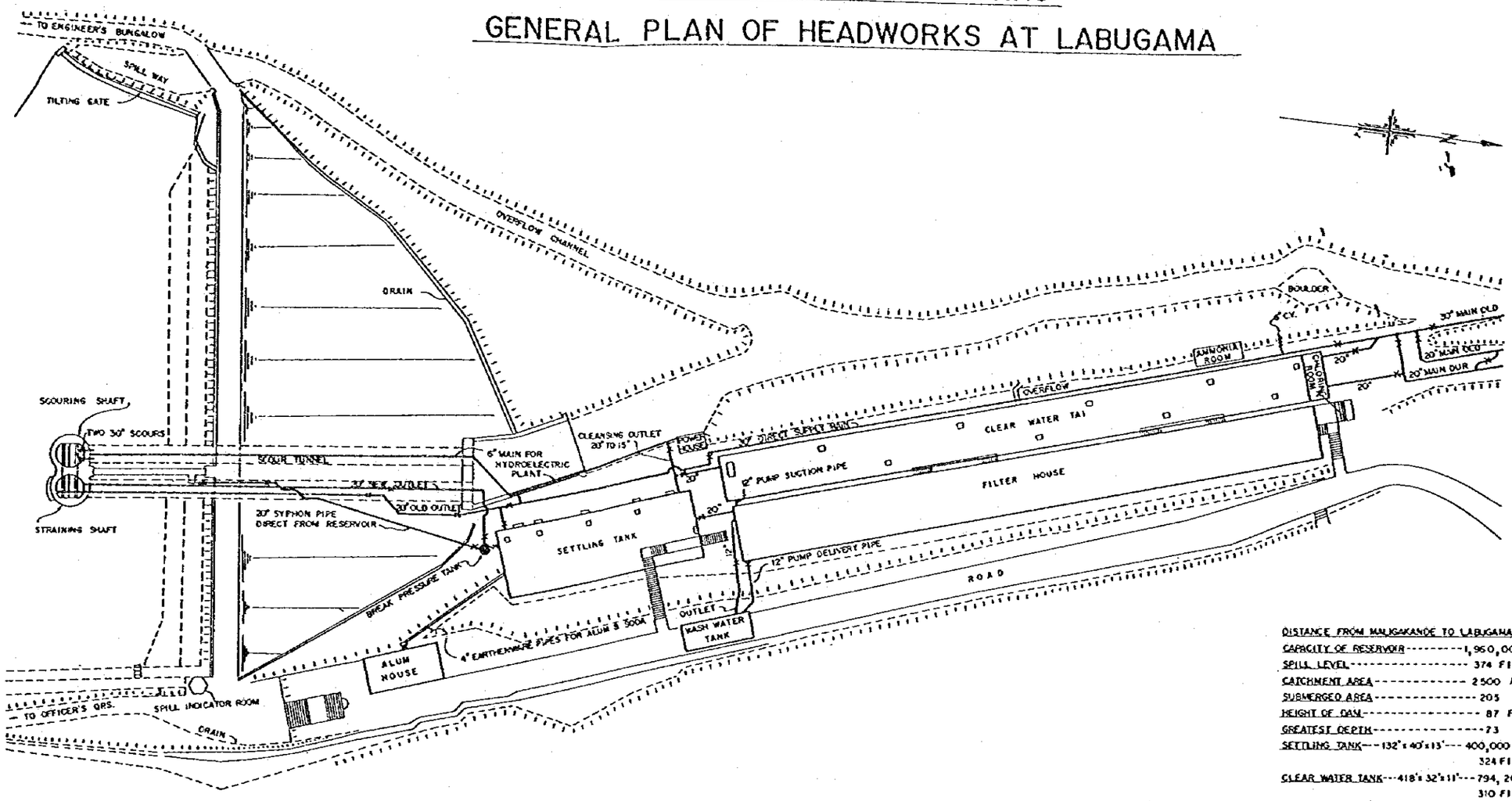
Also the sedimentation process is ineffective because of the small capacity and resulting short detention time.

Figures 9, 10 and 11 are shown the present system.

Figure - 9 Labugama

COLOMBO WATERWORKS

GENERAL PLAN OF HEADWORKS AT LABUGAMA



DISTANCE FROM MALIGAKANDE TO LABUGAMA 25 1/8 MILES
CAPACITY OF RESERVOIR ---------1,960,000,000 GALS.
SPILL LEVEL ---------- 374 FI ABOVE M.S.L.
CATCHMENT AREA ---------- 2500 ACRES
SUBMERGED AREA ---------- 205 "
HEIGHT OF DAM ---------- 87 FEET
GREATEST DEPTH ---------- 73 "
SETTLING TANK---132'x 40'x 13'--- 400,000 GALS.
324 FI ABOVE M.S.L.
CLEAR WATER TANK---418'x 32'x 11'---794, 200 GALS.
310 FI ABOVE M.S.L.
FILTER HOUSE 390'x 35' GROUND---311 FI " "
TOP ---323 FI " "
15 "JEWEL GRAVITY" TYPE FILTERS
EACH 21'-0" DIA
MAX : DELIVERY OF EACH 850,000 GALS.
2 ALUM VATS ---8' DIA EACH ---------- 5,000 "
1 SODA VAT -----8' DIA ---------- 2,500 "
WASH TANK ---------- 25,000 "

NOT TO SCALE

Figure - 10 FLOW CHART OF LABUGAMA WATER TREATMENT PLANT

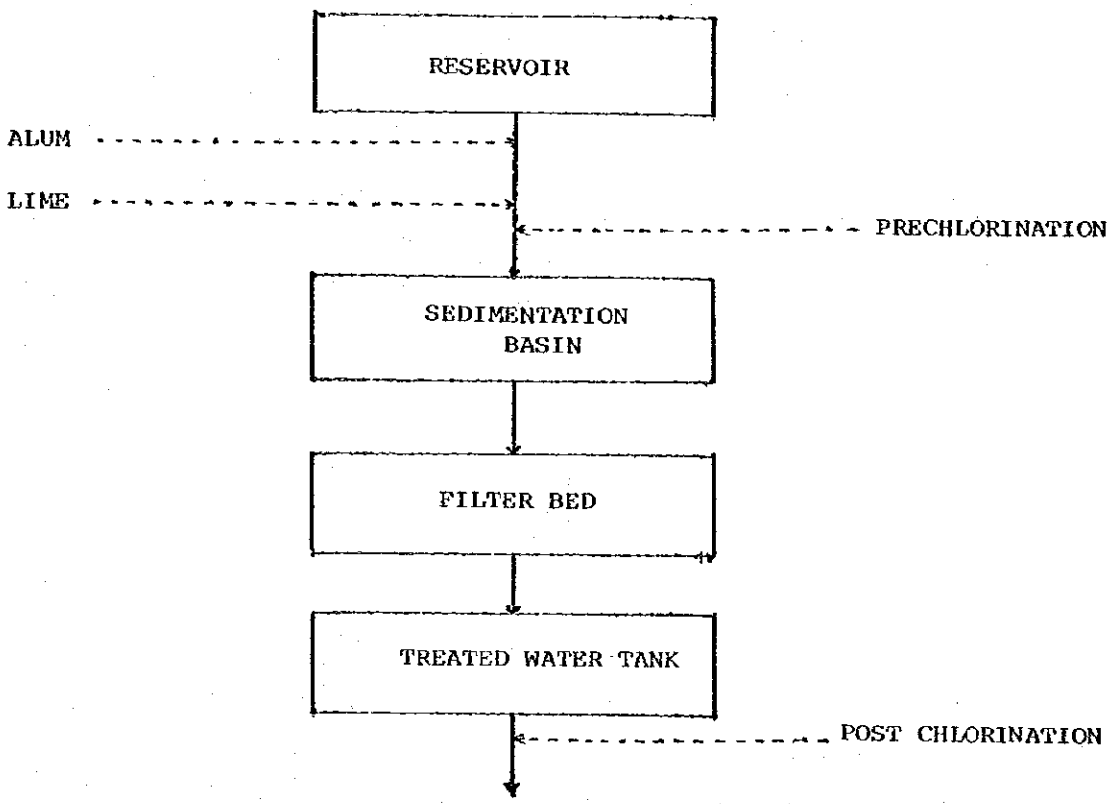
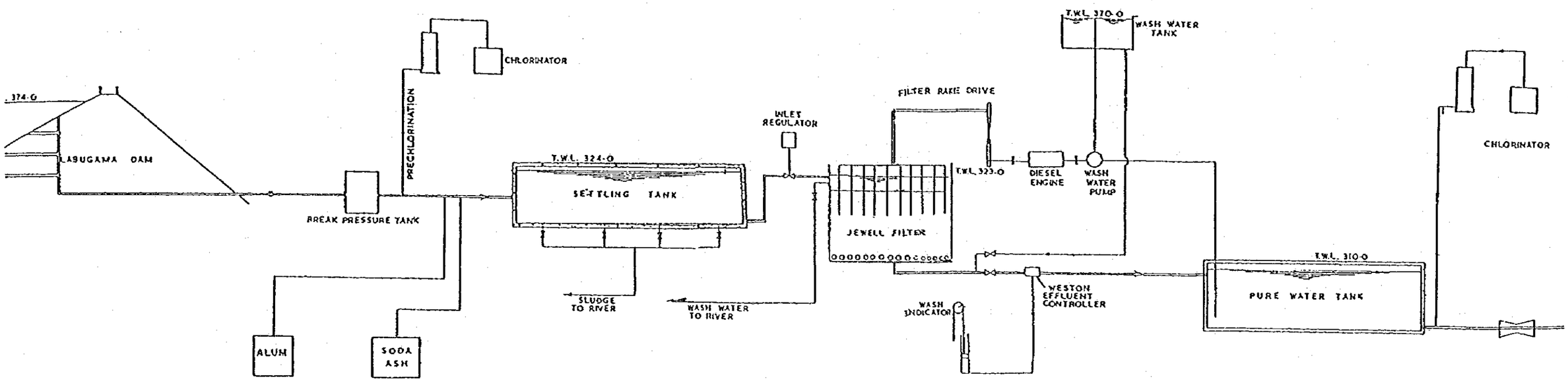


Figure – 11 LABUGAMA



LABUGAMA HEADWORKS
SCHEMATIC LAYOUT

3-3. PRESENT WATER QUALITY

(1) RAW WATER

The results of physical-chemical analyses are shown below:

	Kalatuwawa				Labugama	
	1983		1984		1983	1984
Year/Month	July	Aug.	Nov.	May*	Aug.	May*
pH	6.5	6.8	6.1	6.1	6.6	5.8
Turbidity (J.T.U)	12.5	18	2.8	6.6	8	10
Colour	20	80	10	25	25	45
Alkalinity (ppm)	6	16	6	6	36	8
Iron (ppm)	2.6	1.4	0.2	ND	0.5	0.25
No. of samples	4				2	

* Denotes tested by the Team, other data presented by NWSDB

Regarding the biological examination of the raw water conducted by the Survey Team, the most common algal species at both reservoirs were Rhizosolenia, a member of the Diatoms, followed by Elaktothrix, one of the blue-green algae. The total number of these algae were about 1,500 - 2,000 counts/ml respectively. The results were average for reservoirs in warm climates.

The water quality test results utilized in this study are included in Appendix 8.

Characteristics of the reservoir water quality are summarized as follows:

1. Weak acidity
2. Low turbidity, 18 degrees at maximum and often less than 5 degrees
3. High colour, 80 degrees at maximum and 10 degrees at minimum
4. Low alkalinity, 36 ppm at maximum but mostly less than 10 ppm
5. High iron, 2.6 ppm at maximum and often less than 0.5 ppm and occasionally undetected
6. Presence of plankton

(2) TREATED WATER AND TAP WATER

Bacteriological Examinations

The results of bacteriological examinations of the treated water at the plants were that one of 23 samples tested was unsatisfactory at Kalatuwawa and one of 24 samples tested at Labugama was unsatisfactory. Nineteen samples from public taps were acceptable and conformed to the drinking water standards of Sri Lanka shown in Appendix 13

Physical-Chemical Analyses

The water quality at the plants is summarized as follows;

	Sri Lanka Standard		Kalatuwawa				Labugama	
			Jul.	Aug.	Nov.	May	Aug.	May
	Desirable	Allowable	'83	'83	'83	'84	'83	'84
pH	7.0-8.5	6.5-9.0	6.1	6.4	6.0	5.9	6.4	5.7
Turbidity JTU	2	8	2	7.0	3.0	4.6	14	9
Color degrees	5	30	15	5	10	20	30	45
Total Iron mg/l	0.3	1.0	0.4	0.32	0.08	ND	1.4	0.25

Most of the quality tests proved satisfactory for a public water supply, even though the concentration of some components exceeded the limits of the Sri Lanka Drinking Water Standards. Higher concentrations of pH, turbidity, colour and iron are not harmful to human health but they create poor taste, odors and unpalatable appearance.

(3) TREATMENT METHOD CONSIDERATIONS

From the results of water quality analyses, the chemical and physical characteristics of both raw water supplies can be modified to meet the Sri Lanka Drinking Water Standards through the present treatment processes. Effectiveness of the treatment method is often influenced by the forms of iron and manganese in solution together with the existence of other substances in the water. The notable characteristics of the raw water are high colour, weak acid and high concentrations of iron. The high iron may create difficulties in the purification process when combined with humic acid.

Jar tests are an essential laboratory method to decide optimum chemical dosing rates which will produce the best quality of treated water.

Although both reservoirs at Kalatuwawa and Labugama have common physical characteristics it is difficult to recommend a practical reservoir operation procedure for flushing the bottom layer of anaerobic water and selection of intake depth without essential limnological data on currents, flows, stratification and plankton.

3-4. RESERVOIR SUPPLY CAPACITY CONSIDERATIONS

Records for the 14 year period from 1968 - 1982 on the Kalatuwawa and Labugama reservoirs have been studied to determine the frequency of minimum available quantities over a ten year cycle.

Table 11 which follows shows the yearly minimum low water levels and minimum storage capacity in the reservoirs.

This data was then plotted on a probability graph as a Thomas plot and is shown on Figure 12 and 13. From this Figure the minimum water storage over a 10 year cycle at Kalatuwawa was estimated at 1,300 x 1,000 m3 and at Labugama was estimated at 1,120 x 1,000 m3.

These minimum volumes are 8.5 and 12.6 % respectively of the total effective reservoir capacity. This can also be seen on Figure 12 and 13. Labugama appears to be slightly better than Kalatuwawa for capacity, but nominally, a reduction to one tenth of the effective capacity would occur once in 10 years for both reservoirs.

The frequency distribution of water levels for both reservoirs are given in Figure 14. Again Labugama appears to be slightly better, but both have sufficient capacity during the predictable dry season conditions.

Table 11-1 Annual Minimum Water Level and Minimum Storage Water

	Year	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Water Level (m)	KALATUWAWA	105.3	106.9	107.1	105.7	105.1	109.6	105.5	103.3	101.8	103.1	105.3	101.7	106.5	105.6	102.3	103.1	103.0	100.7
	LABUGAMA	104.9	103.1	106.7	106.6	105.5	110.4	106.5	102.5	102.4	101.9	103.9	100.1	107.7	108.7	105.0	104.8	109.9	103.4
Volume $\times 10^6$ (m^3)	KALATUWAWA	3.97	5.64	5.87	4.37	3.80	9.27	4.14	2.42	1.38	2.29	3.97	1.30	5.18	4.26	1.76	2.29	2.23	0.53
	LABUGAMA	2.48	1.58	3.49	3.43	2.82	6.05	3.37	1.35	1.31	1.11	1.93	0.40	4.15	4.83	2.53	2.42	5.04	1.70

Table 11-2 Calculated Annual Minimum Volume by Thomas Plot Method

Order	n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	$\frac{n}{N+1}$	0.053	0.105	0.158	0.211	0.263	0.316	0.368	0.421	0.474	0.526	0.579	0.632	0.684	0.737	0.789	0.842	0.895	0.847
Volume $\times 10^6$ (m^3)	KALATUWAWA	0.53	1.30	1.38	1.76	2.23	2.29	2.29	2.42	3.80	3.97	3.97	4.14	4.26	4.37	5.18	5.64	5.87	9.27
	LABUGAMA	0.40	1.11	1.31	1.35	1.58	1.70	1.93	2.42	2.48	2.53	2.82	3.37	3.43	3.49	4.15	4.83	5.04	6.05

Probable frequency would be occured smaller volume less than minimum volume observed on the record in every year.

where; N : Total number of data
n : Order from smallest to bigger in water level and volume

Figure 12

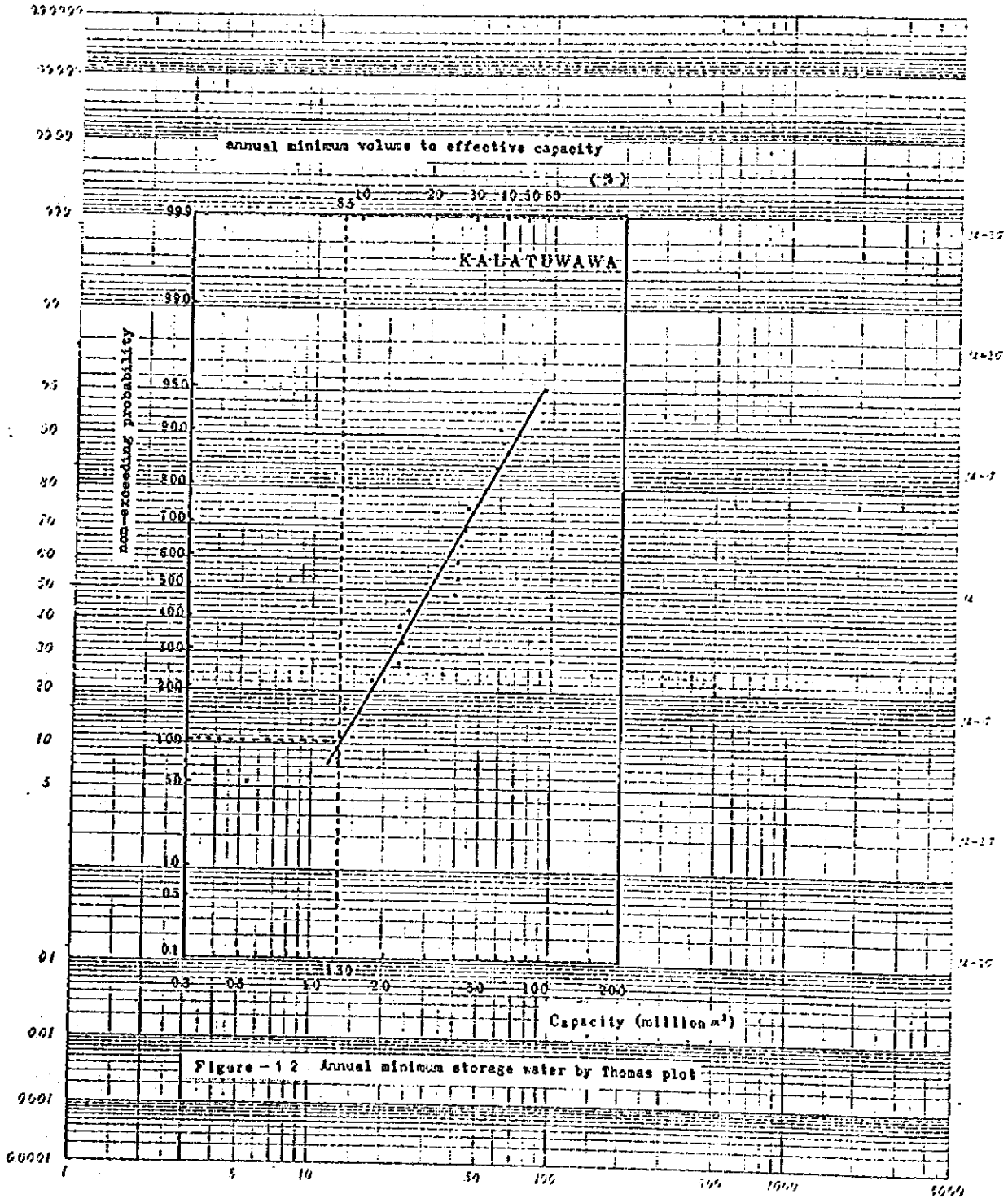


Figure – 1 2 Annual minimum storage water by Thomas plot

Figure 13

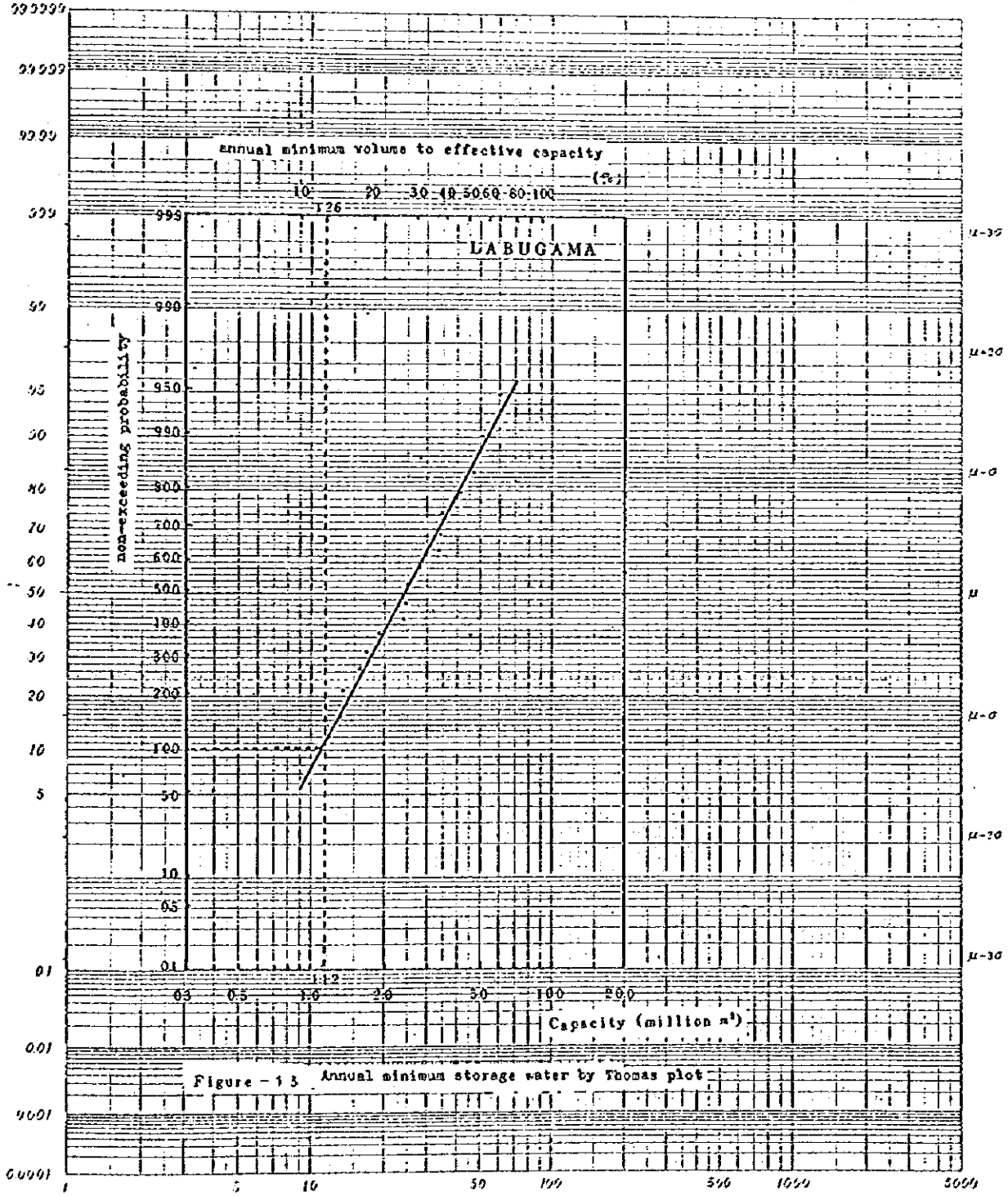
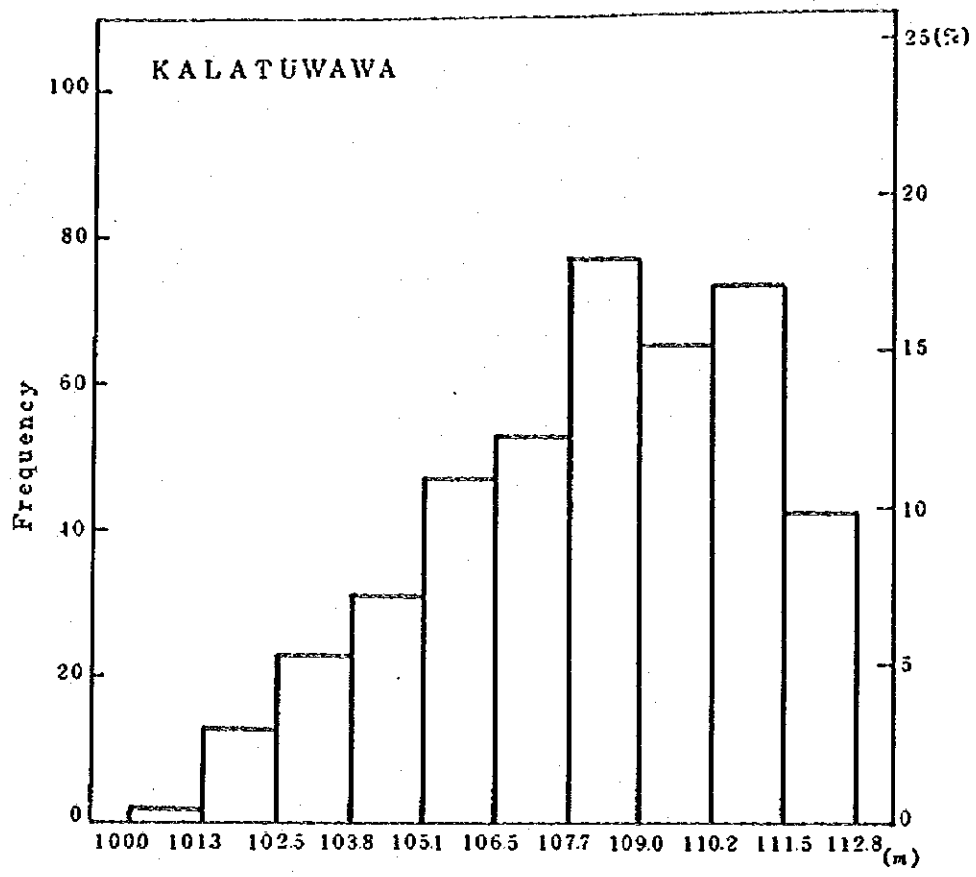
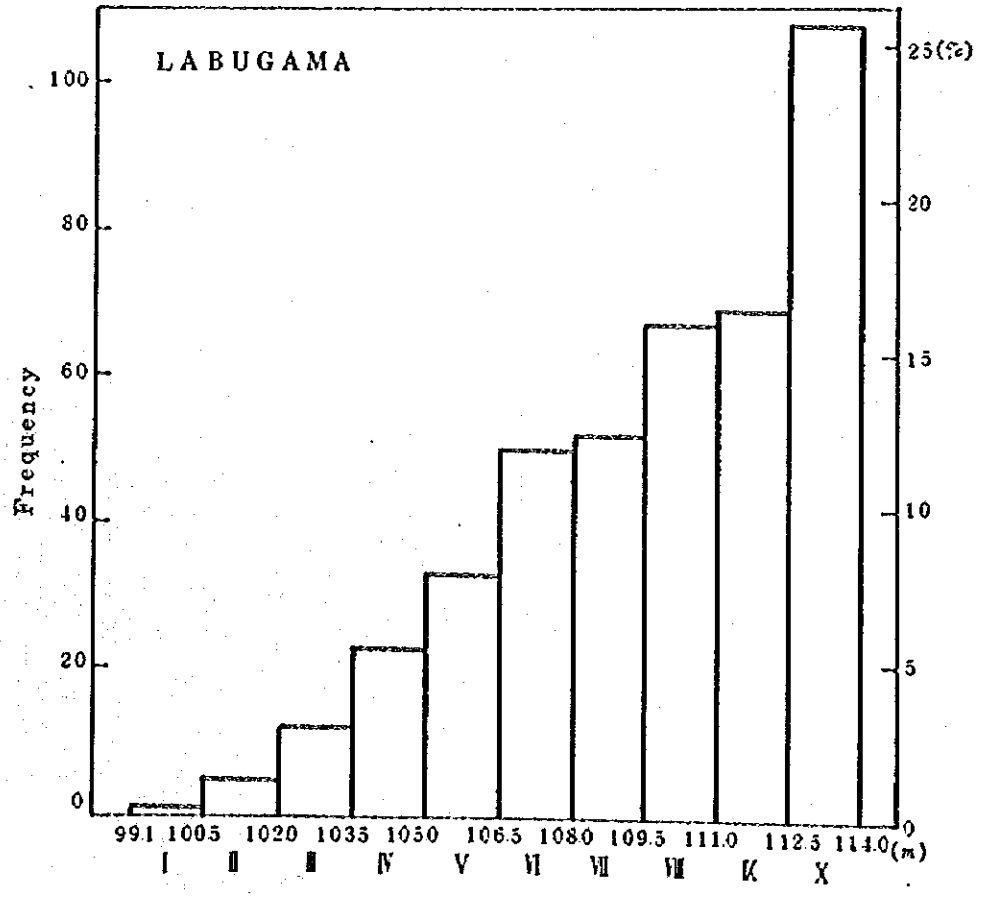


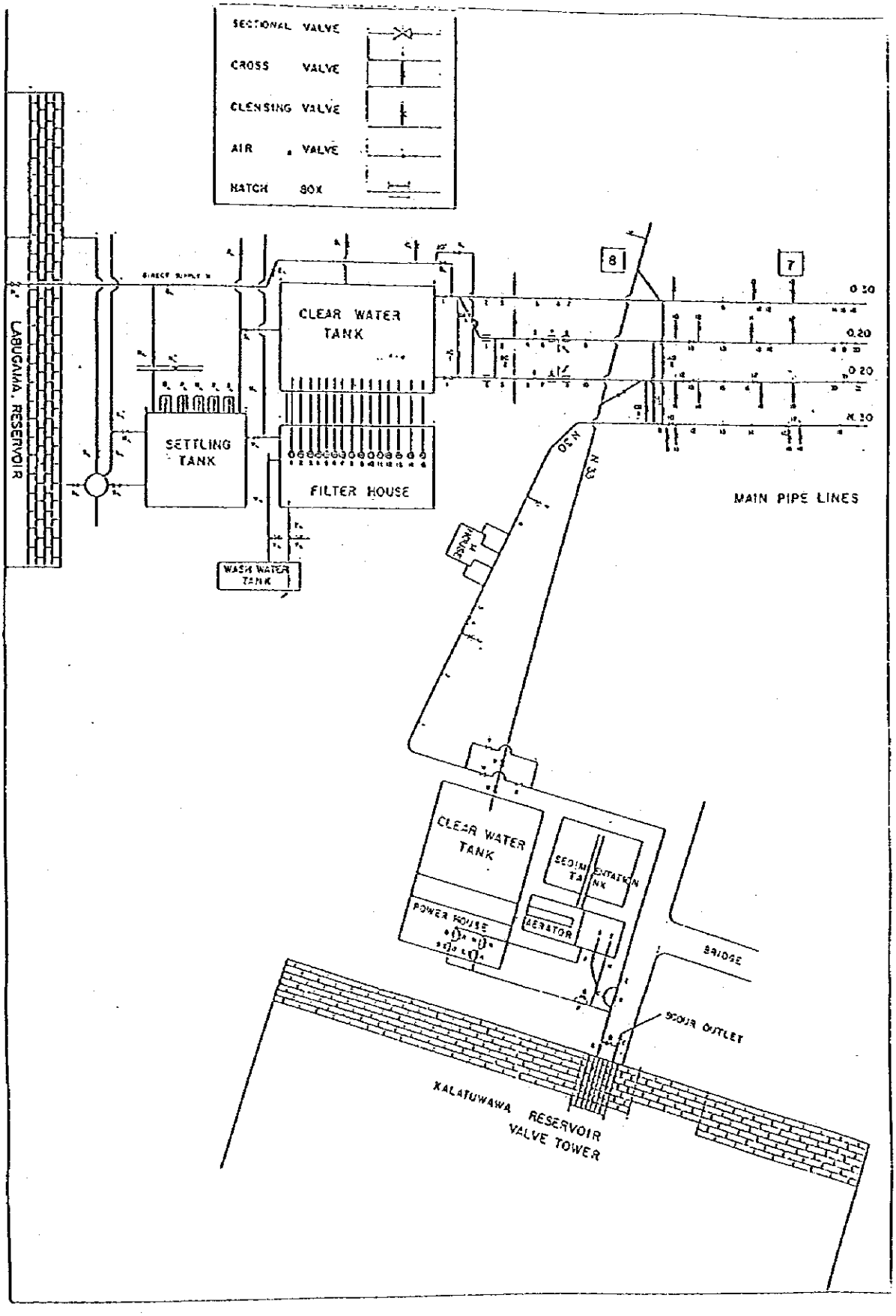
Figure – 13 Annual minimum storage water by Thomas plot

Figure－14 Frequency Distribution Graph of Water Level





Figure－15 WATER SYSTEM



4. PROJECT SCOPE

4-1 PURPOSE AND SCOPE

The primary aim of this project is the rehabilitation and upgrading of the treatment plants at Kalatuwawa and Labugama which are now suffering from numerous process deficiencies, and inoperative and obsolete equipment, poor treatment efficiency and unacceptable water quality supplied to the consumers. Future rehabilitation will consist of repair and/or replacement of most mechanical/electrical devices associated with the sedimentation tanks, filters and waste water recovery facilities. Also, the aeration and sedimentation processes require major improvement.

4-2 BASIC POLICY

Improvement and rehabilitation of the treatment plants desirably should meet the following policy objectives:

(1) To achieve minimum annual operating and maintenance costs through adoption of energy saving devices where possible.

(2) The treatment processes and control systems should be simple to operate.

(3) The treatment plant operation should not deviate appreciably from the methods presently employed.

(4) To ensure reliability of continuous and adequate water treatment especially by improving the normal service and standby power systems.

(5) To ensure that the overall treatment process will not be interrupted or harmfully affected by inspection, maintenance and repair procedures on each sub system of plant operation.

(6) To ensure utilization of locally available materials in Sri Lanka as much as possible and selection of working methods and materials for rehabilitation which will allow continuous water purification.

(7) To prepare a new and complete operating and maintenance manual for the rehabilitated plants plus an appropriate training program for the technicial staff responsible for operation and maintenance.

(8) To provide an inventory of sufficient spare parts for regular maintenance and operation procedures.

4-3 KALATUWAWA

(1) NEED FOR REHABILITATION PROJECT

It has been observed that there is a noticeable change in the raw water quality at the inlet chamber depending on the water level of the reservoir. Therefore it is recommended that surface intake facilities be installed to rectify this situation. The aeration facilities need to be expanded to reduce color and odor in the raw water more effectively when the reservoir water level is low. The sedimentation tanks are less effective during periods of deteriorated raw water quality and the filters are also overloaded impairing the total purification process.

The installation of vertical baffle type flocculators and multiple inclined plates in the sedimentation tanks will dramatically increase the efficiency of the pre-treatment process.

The existing in-plant electric generators need to be replaced because they are antiquated and the electric power circuitry should be converted from D.C. to A.C. because the D.C. equipment and parts are difficult to purchase and are costly.

The total power supply system needs to be rearranged by supplying power from the outside including replacement of all obsolete and defective electrical equipment.

The general layout of the treatment facilities at Kalatuwawa is shown in Figure 16 which follows.

(2) REHABILITATION OF TREATMENT FACILITIES AND EQUIPMENT

A. Intake Inlet

The installation of surface water intake equipment is recommended to avoid drawing off poorer quality of raw water due to reductions in the reservoir water level. This equipment is capable of optimizing the selection of water quality using the existing intake gates and will contribute to consistently better quality raw water. (Figure 17)

B. Aeration Facilities

The existing aerator is ineffective for removing color and odor when the reservoir level is low and can be improved by expanding the aeration area. (Figure 18)

C. Sedimentation Tanks

The existing sedimentation tanks have a capacity of only 1.6 hours detention at the design flow of 91,000 m3/day. The retention time for this size and type of treatment plant is usually much higher at 3 to 5 hours. Therefore the flocculation and sedimentation processes are not effective. Expansion of sedimentation tank capacity would be the best way to improve this situation. However, insufficient space is available for expansion. Any expansion would occupy the existing access road and would be an insufficient increase only adding 20 minutes detention time. Therefore it was concluded to use the existing sedimentation tank structures more effectively.

The most practical option is to install multiple inclined plates and vertical baffle type flocculators in the existing sedimentation tanks which would be relatively easy to maintain. The flocculators of the vertical baffle type would have a 20 minute detention time. Also water gathering troughs with less than a 500 m3/d/m overflow rate should be added. (Figure 19, 20)

D. Inplant Power Generator and Electric Circuit

Two turbine generators using raw water from the reservoir, and the diesel engine generators are not working sufficiently due to their age. This seriously interferes with the purification especially for the backwashing cycle and for power supply for the balance of the treatment plant. The electric devices also have deteriorated due to their age. This condition combined with the scarcity and high cost of DC parts makes it necessary to undertake a comprehensive replacement program. Therefore the turbine and diesel engine generators and all ancillary works need to be replaced with A.C. units. The proposed upgraded power supply system will consist of turbine generators which will be employed when the reservoir water level in high, and the diesel engine generators when the level is low. Power will be received from the national distribution network. The power supply system rearranged in this manner will be substantially more reliable and easier to maintain than the present system.

E. Mechanical Facilities

Pumps, valves and penstocks belonging to the sedimentation tanks, filters, waste water tank and waste water recovery system are malfunctioning and in a deteriorated condition which seriously interferes with the treatment process, particularly the filter backwasing

operation. The various pumps, valves and other mechanical devices need to be replaced or repaired to restore the plant into a good operating condition.

F. Chemical Dosing Facilities

The alum and lime handling and dosing facilities are in need of repair and/or replacement. Also the chlorinators should be replaced.

G. Measurement Facilities

Flow meters, level controls and pressure recorders need to be replaced with equipment which operates on A.C. power supply.

H. Filter Media

The existing filter media consisting of sand and gravel should be removed and replaced. (Figure 21)

I. Control Mechanisms

Valves and penstocks for the filters are controlled hydraulically but these control mechanisms are not in good working condition. It is recommended that the hydraulic system be replaced with a pneumatic system to improve operation reliability.

J. Miscellaneous

Structural cracks in the building need repair, walls need to be painted, and the domestic water system plumbing and building wiring similarly need substantial repair and replacement.

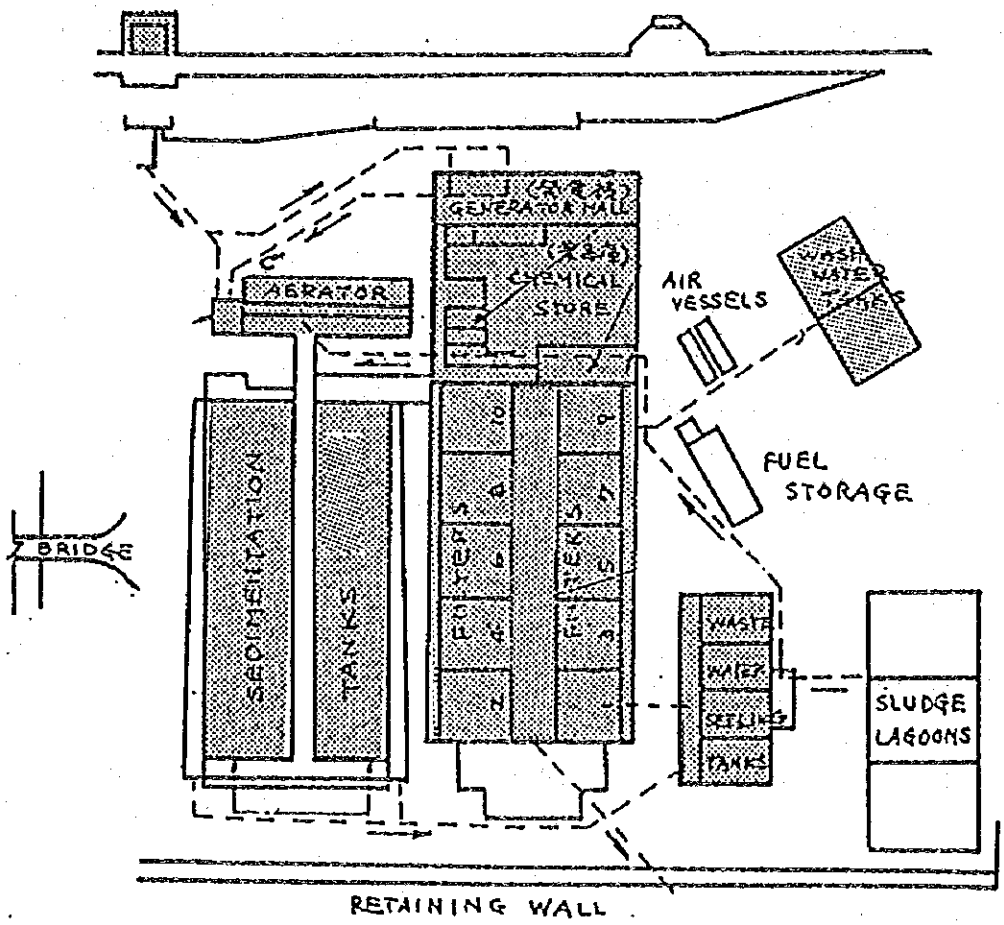
REQUIRED IMPROVEMENTS AT KALATUWAWA

FACILITIES/EQUIPMENT	QUANTITIES	IMPROVEMENT	EXISTING STATE
A. Intake			
surface water intake equipment	1	new additional	none
B. Inlet Valve Chamber			
float	2	replace	damaged
control structure	1	repair	damaged
27" sluice valve	1	replace	poor operation
12" sluice valve	1	replace	poor operation
C. Aerator	1	expansion	ineffective
D. Sedimentation Tanks			
flocculator	2	new additional (vertical baffle type)	horizontal flow
sedimentation tank	2	new additional (multiple inclined plates)	horizontal flow
8" sludge valve	46	replace	poor operation
water gathering trough	1 set	new additional	none
E. Filters			
building	1	painting, repair	crack
18" inflow penstack	10	replace	poor operation
24" inflow penstock	10	replace	poor operation
15" sluice valve	10	replace	poor operation
12" sluice valve	10	replace	poor operation
8" sluice valve	10	replace	poor operation
control panel	10	replace	poor operation
piping	1 set	new additional	none

FACILITIES/EQUIPMENT	QUANTITIES	IMPROVEMENT	EXISTING STATE
F. Booster Room			
water pressure pump	2	remove	defective
air compressor for valve control	2	new additional	none
air compressor for back wash	2	replace	defective
wash water pump	2	replace	defective
5" sluice valve	2	replace	poor operation
4" sluice valve	2	replace	poor operation
4" check valve	2	replace	poor operation
piping	1 set	new additional	none
G. Chemical Dosing Equipment			
lime slaker drive mechanism	1	repair	defective
lime feeding equipment	1	replace	defective
pre-chlorinator	2	replace	defective
H. Filter Gallery			
domestic water pump	1	replace	defective
post-chlorinator	2	replace	defective
sampling pump	1 set	replace	defective
residual chlorine meter	1	replace	defective
I. Waste Water Recovery			
recovery pump	1	replace	defective
8" sluice valve	4	replace	poor operation
8" check valve	2	replace	poor operation
piping for recovery pump	1 set	replace	deteriorated
sludge pump	2	replace	defective
4" sluice valve	4	replace	poor operation
4" check valve	2	replace	poor operation
piping for sludge pump	1 set	replace	deteriorated

FACILITIES/EQUIPMENT	QUANTITIES	IMPROVEMENT	EXISTING STATE
J. Power House			
hydraulic generator	2	replace	defective
diesel engine generator	2	replace	poor operation
diesel engine generator	2	remove	poor operation
power receiving panel	1	new additional	none
power distribution panel	1	replace	defective
control panel	2	replace	defective
regulator	1	replace	detective
K. Measurement Facilities			
raw water flow meter	1	replace	poor operation
filtered water flow meter	2	replace	poor operation
level meter of washing tank	1	replace	poor operation
level detector of filter	10	new additional	none
meter panel	1	replace	defective
L. Wiring in the Building	1 set	replace	deteriorated
M. Wash Water Tank			
roof	1	new additional	none
expansion	1 set	new additional	none
N. Filter Media			
filter sand and gravel	1193 m3	replace	contaminated

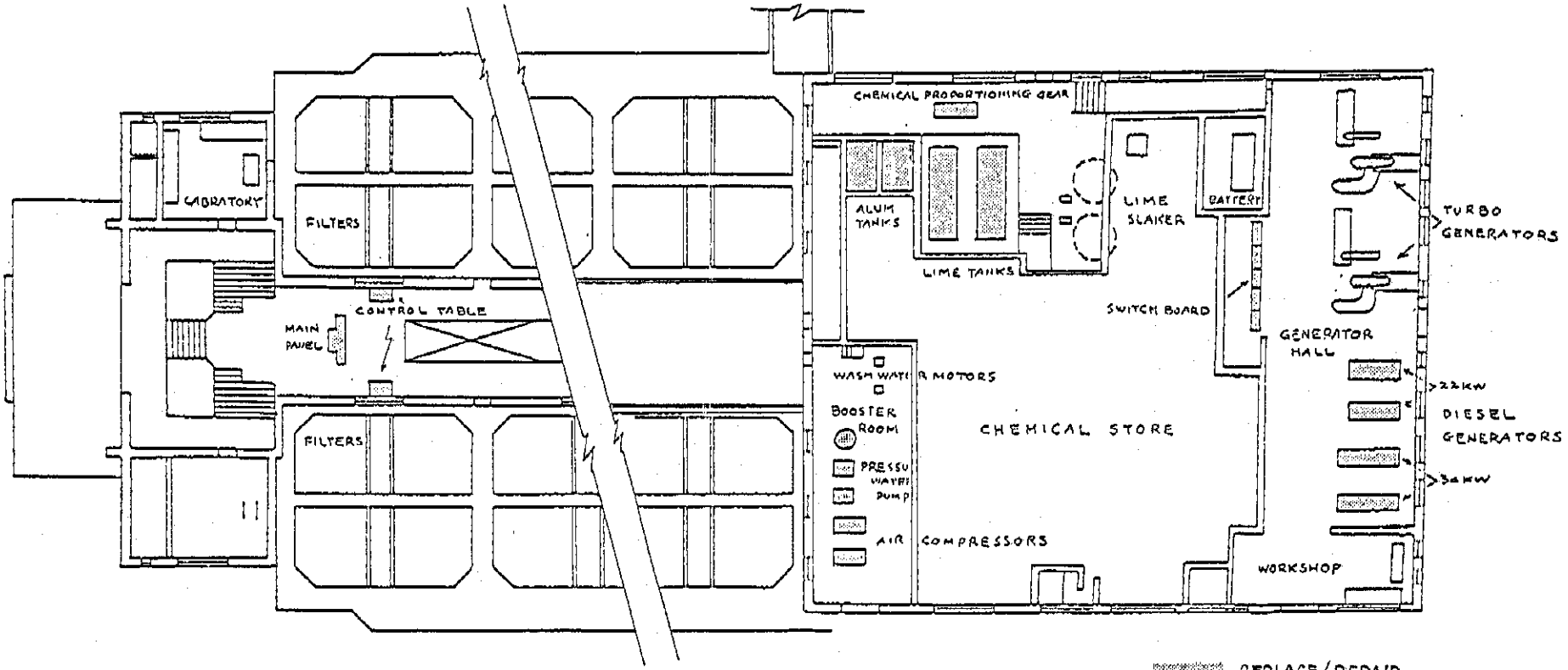
Figure－16－1 Kalatuwawa Improvement



GENERAL PLAN

IMPROVEMENT

Figure – 16 – 2



MAIN BUILDING PLAN

Figure－17 SURFACE WATAR INTAKE

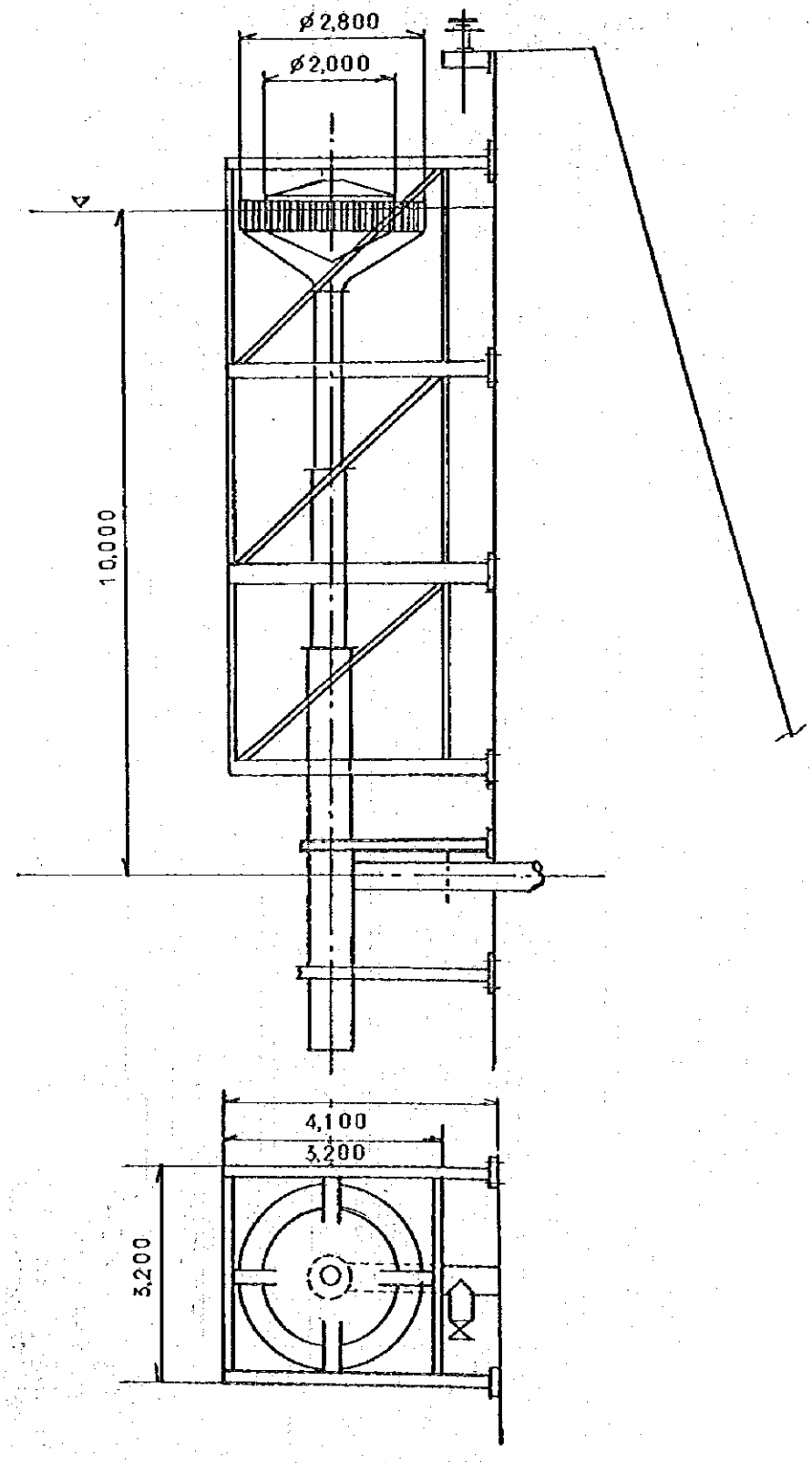


Figure – 18

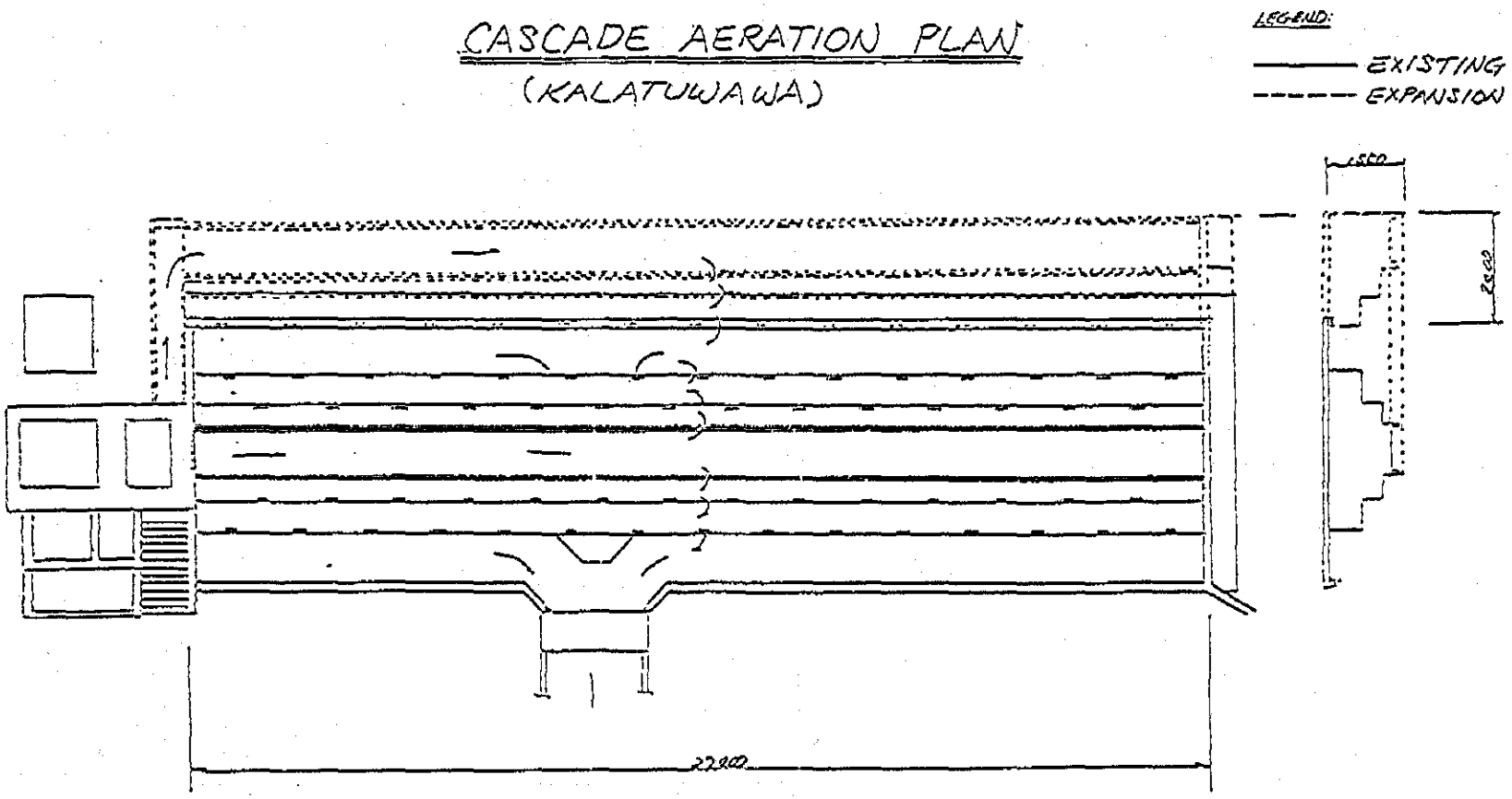
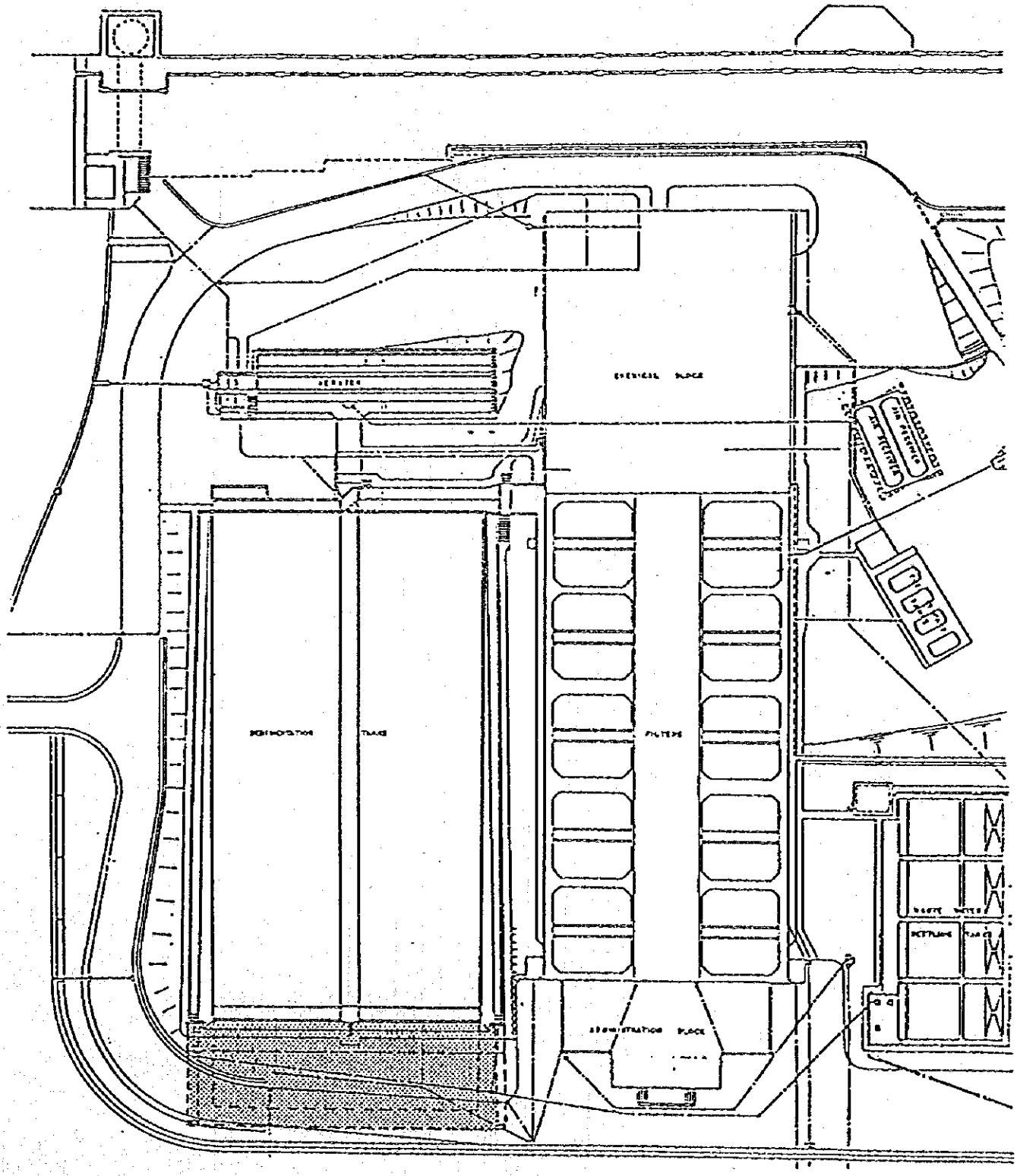

CASCADE AERATION PLAN
(KALATUWAWA)
LEGEND:
EXISTING
EXPANSION
5000
2500
22000

Figure -19 CONSIDERATION OF EXPANSION OF SEDIMENTATION



EXPANSION CONSIDERATED

Figure－20 BASIC CONCEPT OF KALATUWAWA

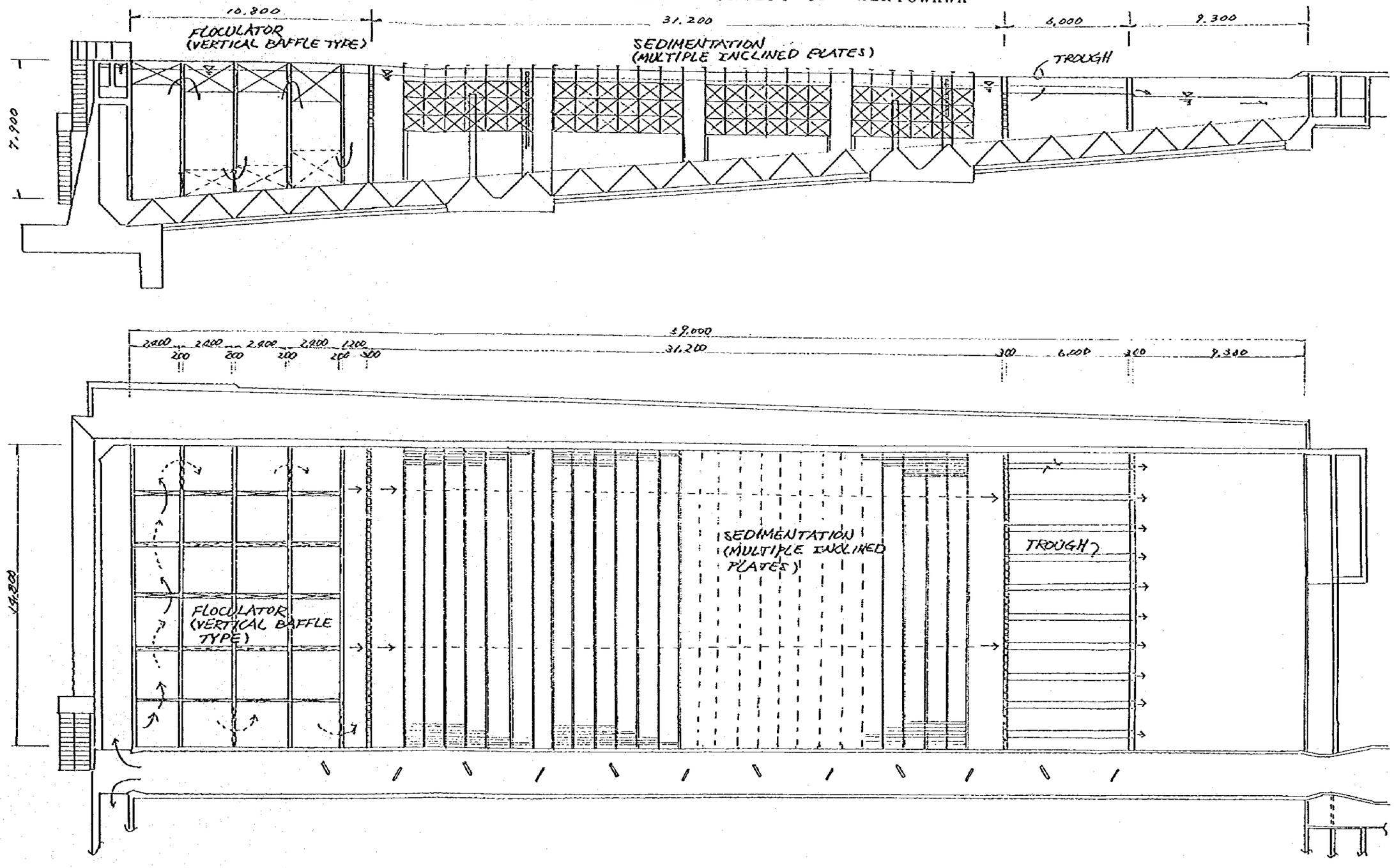
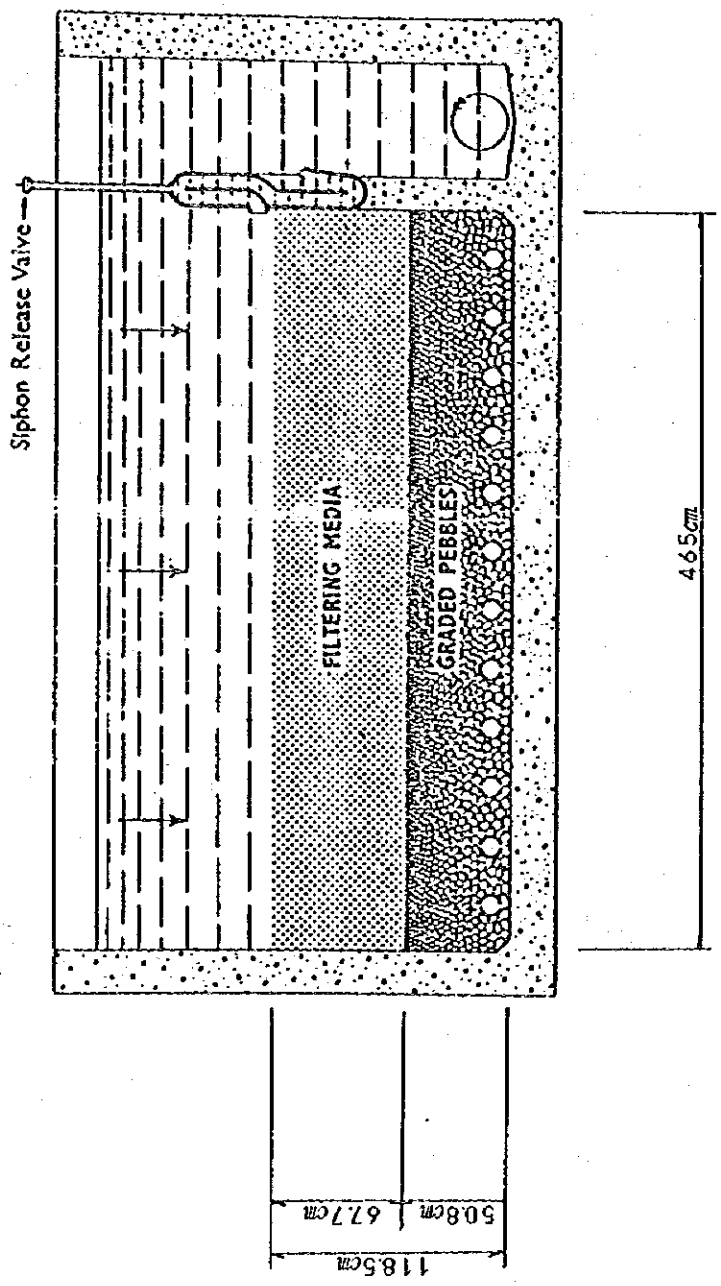


Figure-2: FILTER MEDIA



4-1 LABUGAMA

(1) NEED FOR REHABILITATION PROJECT

Aerator facilities are needed to remove color and odor when the reservoir water level is low. The existing sedimentation tanks are ineffective and lacking in capacity. Insufficient space is available for expansion and it was concluded to use the existing structures more effectively. It is recommended that flocculators of the vertical baffle type be provided. Also the existing sedimentation tanks can be augmented with multiple inclined plates. The combined effect will substantially improve the flocculation and sedimentation processes. The valves and strainers of filters have deteriorated with age and the driving rakes for the back washing cycle need repairing. A diesel engine generator for the wash water pump and the driving rakes should be provided as a standby for the existing electric motor drive. Other mechanical/electrical devices need replacing due to the plant's overall deteriorated condition.

The general layout of the treatment facilities at Labugama is shown on Figures 22 and 23 which follow.

(2) REHABILITATION OF TREATMENT FACILITIES AND EQUIPMENT

A. Intake

The installation of surface water intake equipment is recommended.

B. Aerator

Aeration facilities are recommended to be installed to remove color and odor from the raw water. (Figures 24)

C. Sedimentation Tank

The existing sedimentation tanks have only 0.7 hours retention for the design flow of 59,150 m3/day, and function ineffectively. Therefore flocculators and sedimentation equipment are needed in the existing sedimentation tanks to improve the overall treatment efficiency.

Flocculators of the vertical baffle type with more than 20 minutes retention time and sedimentation equipment consisting of multiple inclined plates with more than 20 minutes retention time are recommended. To accomplish this it will be necessary to increase the height of the existing sedimentation tanks. Also water gathering troughs with less than 500 m3/d/m overflow rate is required. (Figure 25)

D. Filters

The filters have not been working for about the past ten years. This is because of the inoperability of the valves, backwashing mechanisms and water collection mains. (Figure 26)

E. Filter Media

The filter media of sand and gravel needs replacing.

F. Chemical Dosing Facilties

The chemical feeding equipment and accessories are in need of repair and the chlorinators which are used for disinfection and removal of iron and manganese should be replaced.

G. Measurement Facilities

The flow meters are not working properly, need replacing and recorders should be provided.

H. Diesel Engine Generator

A diesel engine generator is required for the backwash pump and mechanisms.

I. Others

Rearrangement and replacement of electric circuitry and roofing of the wash water tank should be carried out.

REQUIRED IMPROVEMENTS AT LABUGAMA

FACILITIES/EQUIPMENT	QUANTITIES	IMPROVEMENT	EXISTING STATE
A. Intake			
surface water intake equipment	1	new additional	none
B. Aerator	1	new additional	none
C. Sedimentation Tank			
flocculator	2	new additional (vertical baffle type)	horizontal flow
sedimentation tank	2	new additional (multiple inclined plates)	horizontal flow
water gathering trough	1 set	new additional	none

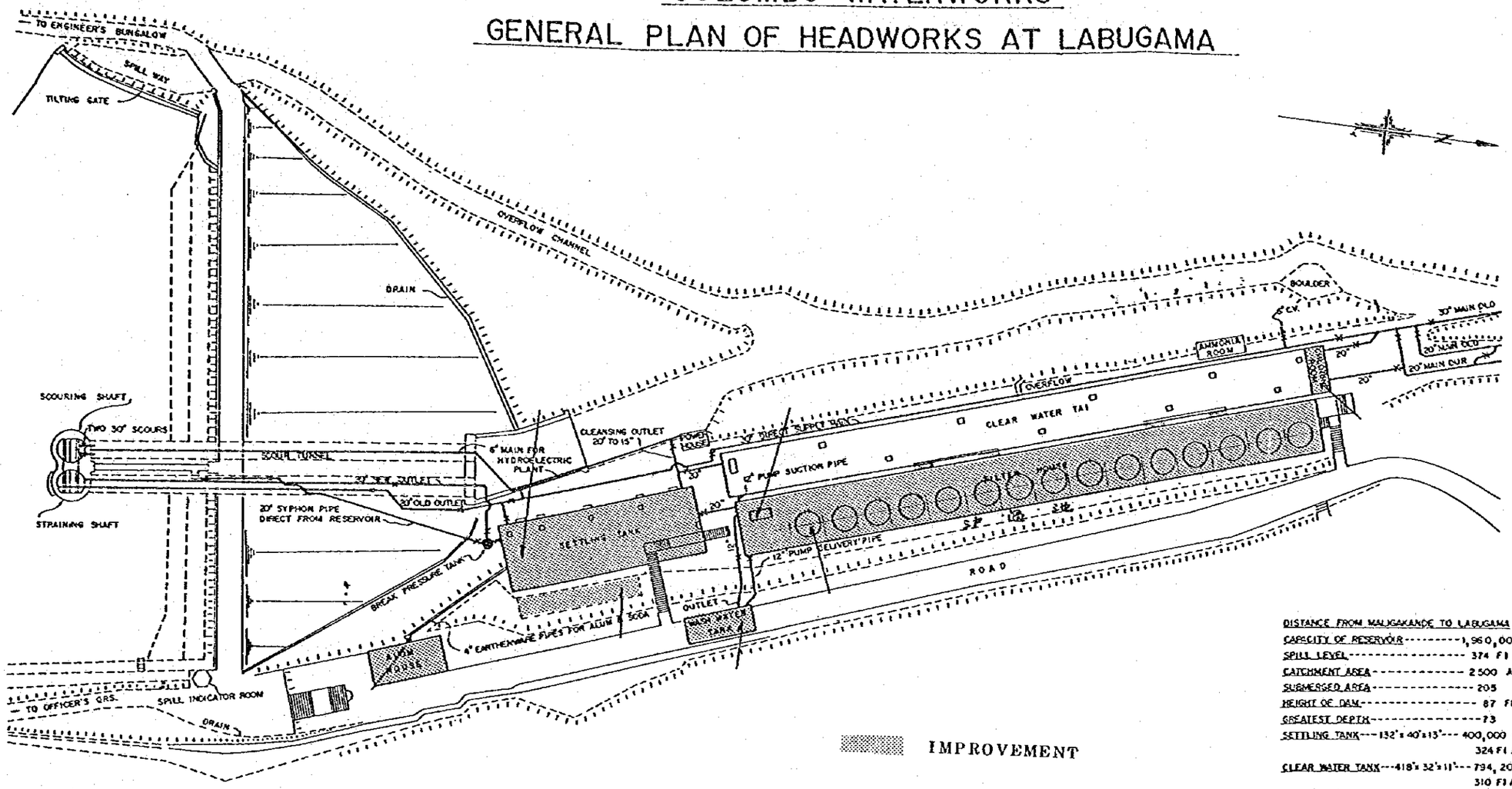
REQUIRED IMPROVEMENTS AT LABUGAMA (CONT'D)

FACILITIES/EQUIPMENT	QUANTITIES	IMPROVEMENT	EXISTING STATE
D. Chemical Dosing Facilities			
alum storage	1	repair	deteriorated
lime storage	1	repair	deteriorated
E. Filters			
back wash mechanism	1 set	repair	deteriorated
ϕ 350 mm valve	60	replace	poor operation
water gathering main	15	replace	deteriorated
strainers	20,580	replace	deteriorated
piping	1 set	replace	deteriorated
filter media	513	replace	deteriorated
F. Chlorinator	2	replace	deteriorated
G. Diesel Engine Generator	1	new additional	none
H. Power Supply Panel	1	new additional	none
I. Flow Meters	3	replace	poor operation
J. Wash Water Tank Roof	1	new additional	none
K. Wiring In The Building	1 set	new additional	none

Figure – 22

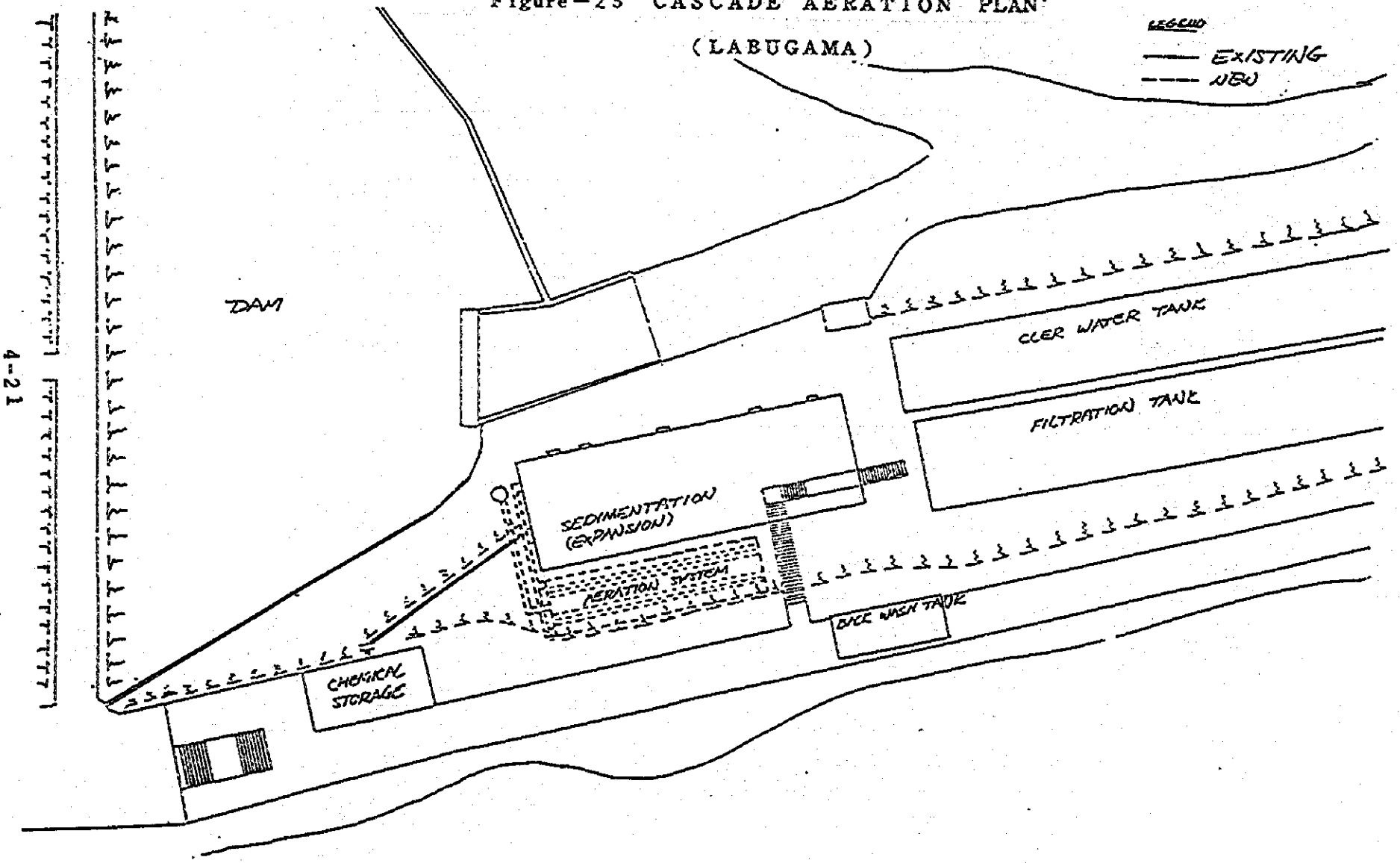
COLOMBO WATERWORKS

GENERAL PLAN OF HEADWORKS AT LABUGAMA



DISTANCE FROM MALIGAKANDE TO LABUGAMA	25 ¼ MILES
CAPACITY OF RESERVOIR	1,960,000,000 GALS.
SPILL LEVEL	374 FI ABOVE M.S.L.
CATCHMENT AREA	2500 ACRES
SUBMERGED AREA	205 "
HEIGHT OF DAM	87 FEET
GREATEST DEPTH	73 "
SETTLING TANK	132'x 40'x13' --- 400,000 GALS.
	324 FI ABOVE M.S.L.
CLEAR WATER TANK	418'x 32'x11' --- 794,200 GALS.
	310 FI ABOVE M.S.L.
FILTER HOUSE	390'x 35' GROUND --- 311 FI " "
	TOP --- 323 FI " "
	15 "JEWEL GRAVITY" TYPE FILTERS
	EACH 21'-0" DIA
	MAX : DELIVERY OF EACH 650,000 GALS.
2 ALUM VATS	8' DIA EACH --- 5,000 "
1 SODA VAT	8' DIA --- 2,500 "
WASH TANK	25,000 "

Figure－23 CASCADE AERATION PLAN
(LABUGAMA)



Figure－24 AERATOR

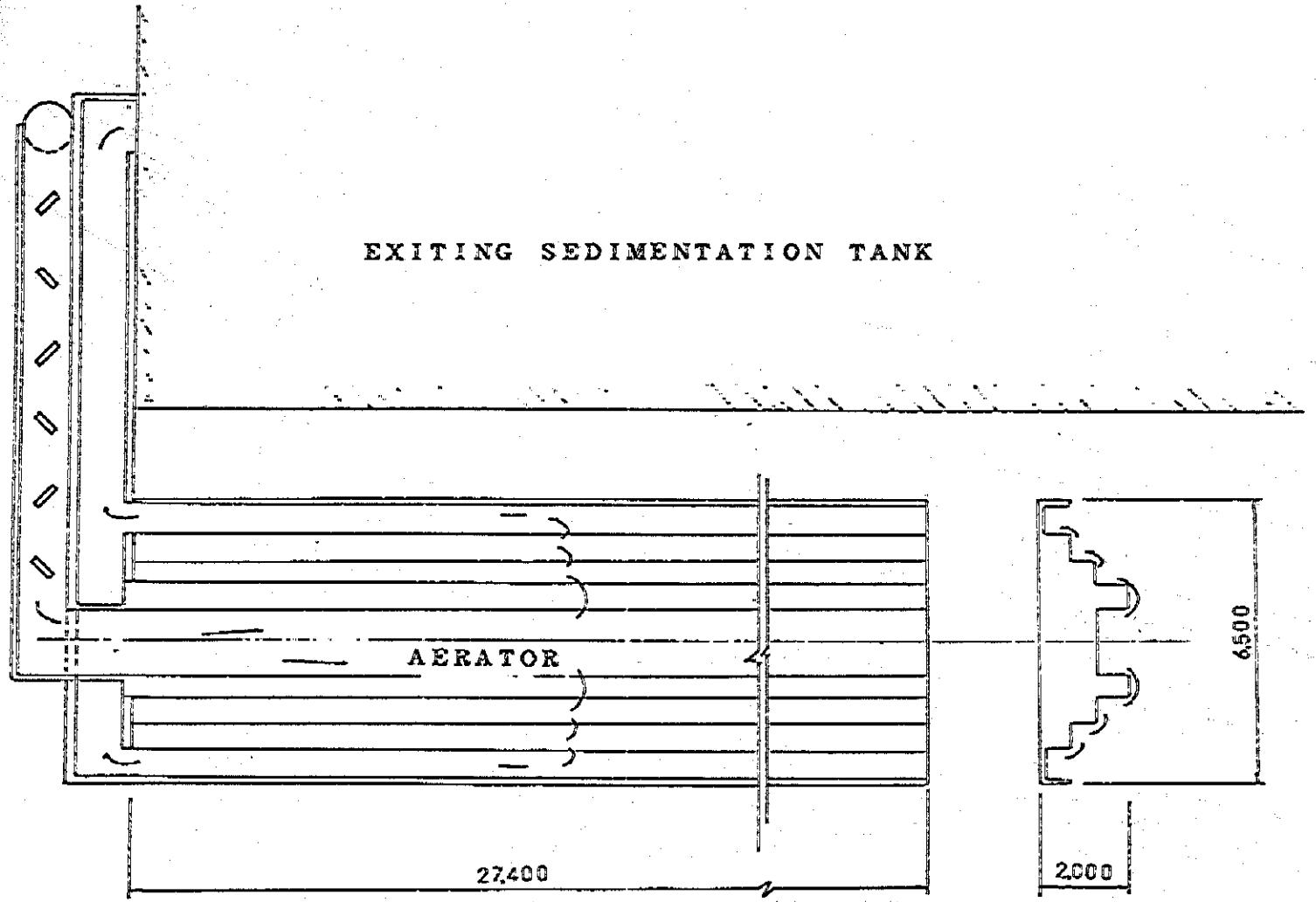
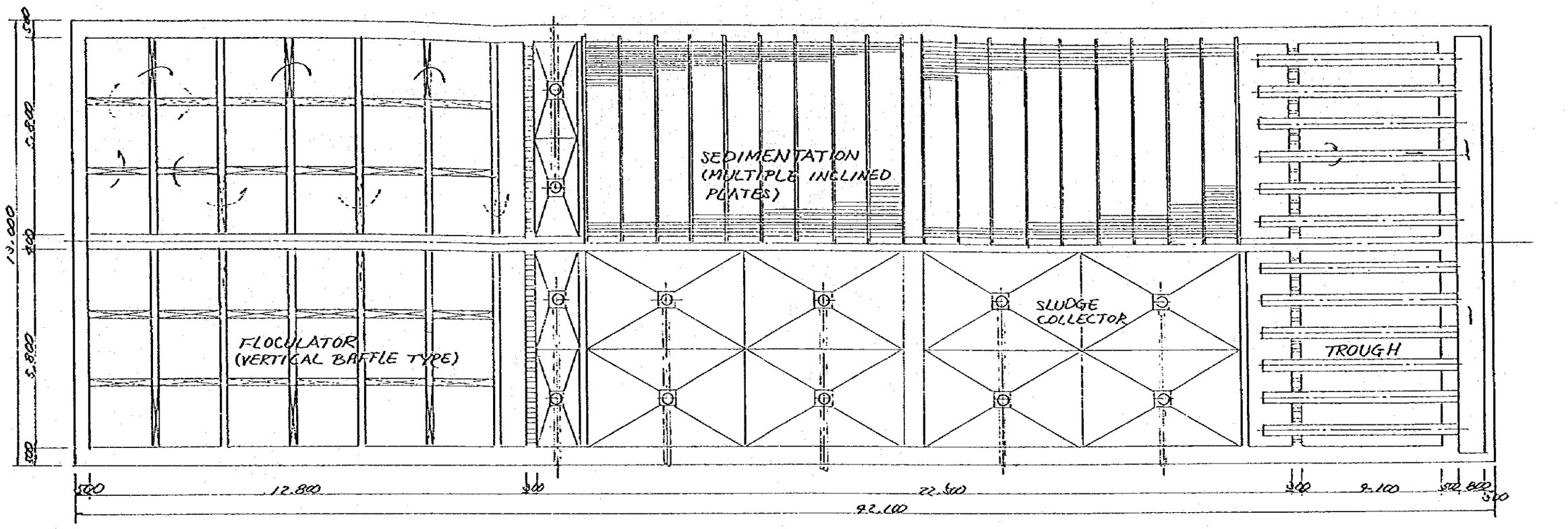
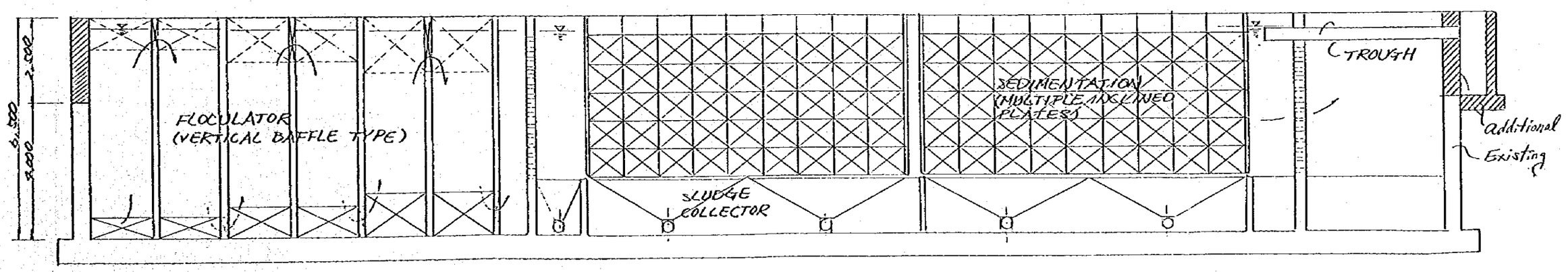
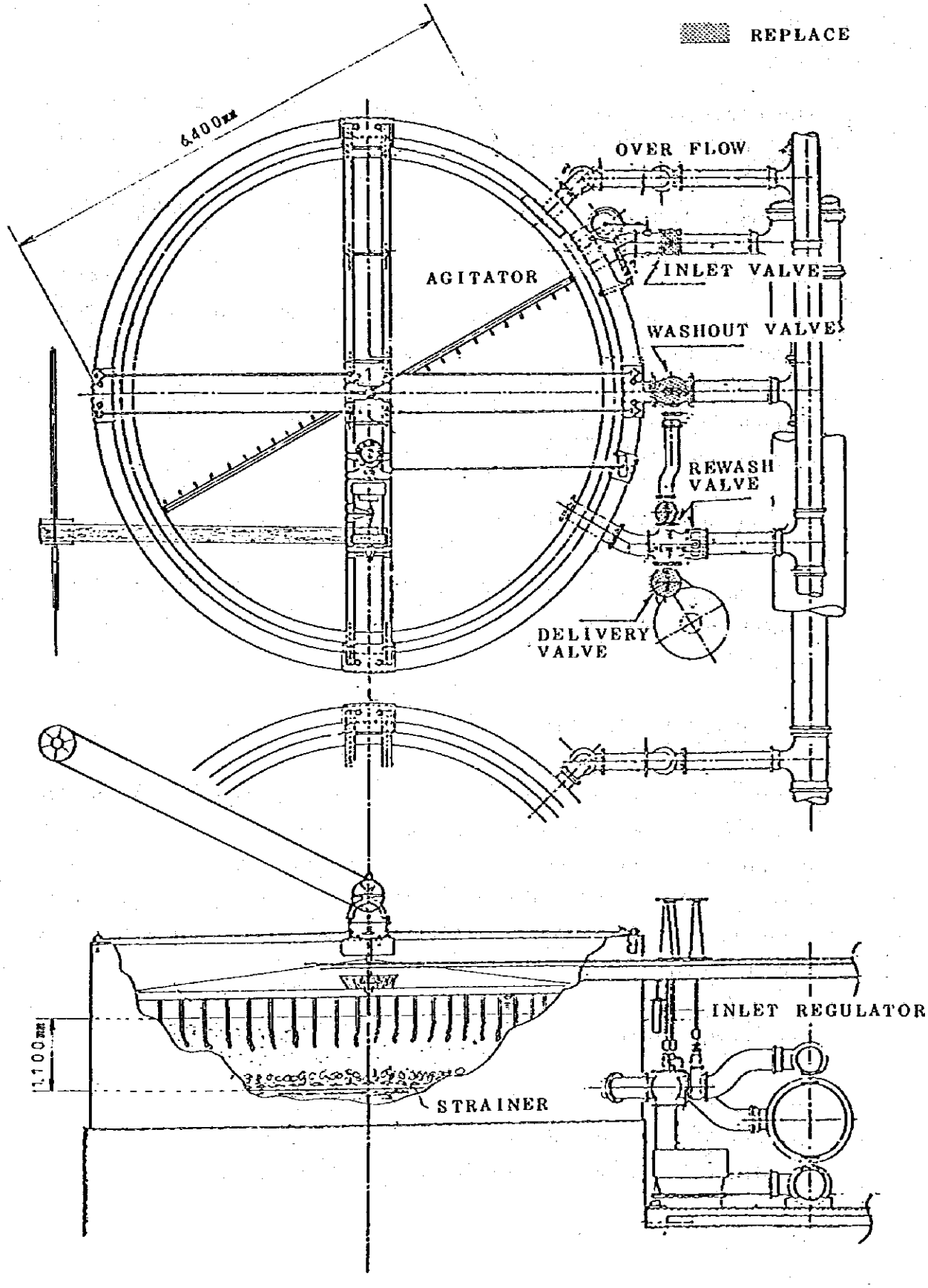


Figure – 25 BASIC CONCEPT OF LABUGAMA





Figure－26 FILTER (Labugama)



5. PROJECT EXECUTION

5-1 OWNER

The owner responsible for execution of the Project is NWSDB who also has overall responsibility for the design, construction, operation and management of water supply systems throughout the country. Except for the water supply system in Colombo City which is operated and maintained by the municipality on behalf of NWSDB, all water treatment and supply systems in the Greater Colombo area including the three treatment plants and their supply sources are operated and maintained by NWSDB. For the execution of the Project, the relevant departments of NWSDB will be responsible for construction, operation and maintenance of all improvements recommended in this Rehabilitation Project.

5-2 PROJECT ORGANIZATION

The following procedures will be adopted for the execution of the Project to comply with procedures for Japanese Grant-aid cooperation.

(1) DETAILED DESIGN

A future contract will be prepared between the Governemnt of Sri Lanka and a Japanese Consultant Engineering firm for the detailed design and construction supervision services. The Consultant will carry out the detailed design including all site investigations and preparation of drawings and contract documents for tendering and construction.

(2) TENDERING

Based on the tender documents prepared by the Japanese Consultant, NWSDB will proceed with international tendering for construction. Tendering will involve the following steps:

1. Pre-qualification of contractors
2. Tender preparation
3. Evaluation of contractor and tendered documents
4. Negotiation with the first ranked contractor, generally the lowest tenderer
5. Contract award and signing of the contract

(3) CONSTRUCTION

The following procedures will be adopted for the construction phase of the work:

1. Contract drawings and specifications approval
2. Material procurement and construction of civil works
3. Mechanical and electrical equipment manufacturing
4. Shipping (Japan - Sri Lanka - Project Sites)
5. Installation and modification of equipment
6. Test operation
7. Commissioning
8. Staff training for operation/maintenance

5-3 CONSTRUCTION SUPERVISION

For the tendering procedure and construction supervision of the Project, the Consultant will provide the following services:

(1) TENDERING ASSISTANCE

1. Preparation of necessary tender documents
2. Tendering assistance
3. Tender evaluation and contract award assistance

(2) CONSTRUCTION SUPERVISION

1. Appraisal of manufacturing and shipping schedules of equipment and materials
2. Materials and equipment test approvals
3. Construction schedule including manning and procurement of materials
4. Construction and installation management
5. Commissioning and start up advice
6. Staff training

5-4 PROCUREMENT

It is desirable to use local products for the construction as much as possible, however for this project almost all electrical and mechanical equipment will have to be imported. Materials such as cement, gravel, sand, paint and other materials for civil and architectural work are locally available in Sri Lanka. Any materials and equipment which are not procured locally will be supplied from Japan. Also, particular attention should be given in the procurement plan for spare parts and maintenance tools etc. to ensure reliable and continuous future operation.

5-5 UNDERTAKINGS OF THE GOVERNMENT OF SIR LANKA

For smooth Project execution, the Government of Sri Lanka shall undertake the following:

(1) To provide exemptions on taxes, duties, fees and other changes imposed on equipment and materials brought into Sri Lanka for the Project.

(2) To permit all personnel relating to the Project execution to enter, leave and sojourn in Sri Lanka, supplied with all necessary visas, permits etc. at no cost.

(3) To provide all necessary data and information deemed necessary for the Project execution.

(4) To provide offices, storage facilities etc. necessary for the Project execution.

(5) To install electric power supply facilities at the Kalatuwawa Treatment Plant site.

(6) To provide electricity and water at sites for construction.

(7) To ensure well maintained access roads to all project areas.

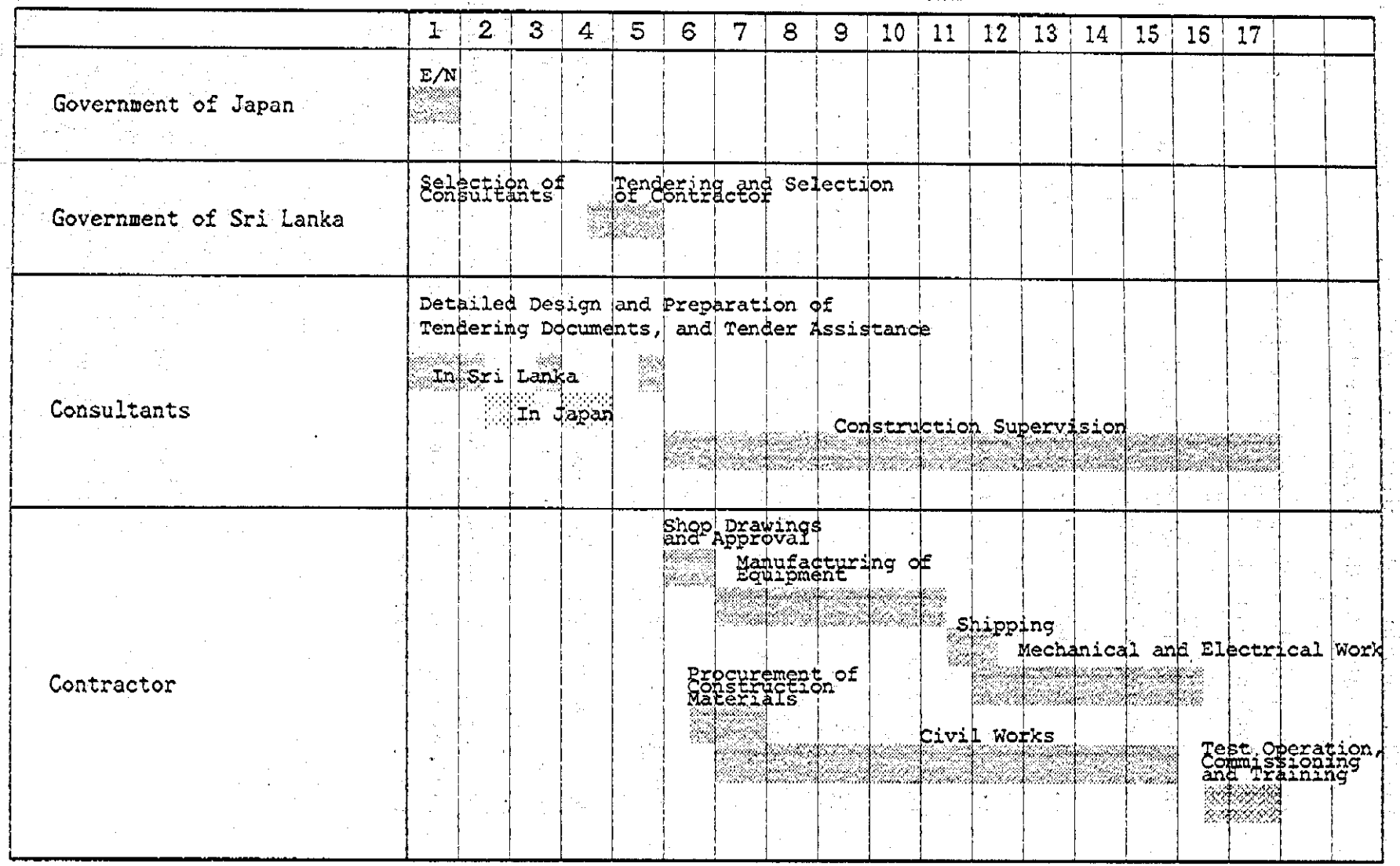
(9) To follow the necessary procedures for contract payments.

(10) To pay all costs for operation and maintenance of the Kalatuwawa and Labugama water treatment plants during and after the construction period.

5-6 PROJECT SCHEDULE

As shown in Figure 27, Project Implementation Schedule, no special problems are envisaged on construction management of the mechanical and electrical works. However, during the rainy season, the construction schedule of civil works shall be carefully monitored and kept flexible as this work is affected and delayed by wet wether conditions.

FIGURE 27 PROJECT IMPLEMENTATION SCHEDULE



5-7 OPERATION AND MAINTENANCE SCHEME

Under the present organization there is a scheme for operation and maintenance. Accordingly, for the modified two plants' operation and maintenance system, no particular recommendation on reorganization will be made. However, since new types of electrical and mechanical equipment will be installed on this Project, the following comments are considered important for a smooth operation in the future.

(1) Sufficient chemicals etc. for coagulation and disinfection shall be adequately stored.

(2) Operation and maintenance shall be strictly followed according to the system and schedule to be established. All records for operation and maintenance shall be kept in an orderly manner.

(3) With respect to modification of the sedimentation basins cleaning and desludging shall be performed much more frequently than before, probably at a frequency of once a month.

At this point in our study assessment, it seems unnecessary to recommend additional operation and maintenance staff for the rehabilitated plants.

Operation & Maintenance Cost Estimate

The approximate future annual costs for operation and maintenance of the two rehabilitated plants are estimated as follows.

Kalatuwawa Plant	Total	8,133,000 Rs
1. Chemical feeding		6,819,000
2. Electric power		180,000
3. Staff salaries and benefits		859,000
4. Repairs		5,000
5. Fuel etc.		270,000

Labugama Plant	Total	5,602,375 Rs
1. Chemical feeding		4,432,375
2. Electric power		90,000
3. Staff salaries and benefits		977,000
4. Repairs		3,000
5. Fuel etc.		100,000

The above estimated figures for the annual operation and maintenance costs of the Kalatuwawa and Labugama Plants are about double the present figures.

6. PROJECT EVALUATION

The Project consists of all the necessary rehabilitation work at the Kalatuwawa and Labugama Water Treatment Plants, including replacing of mechanical and electrical equipment and modifying the aerator, sedimentation basin, filters and other facilities. These two plants are handling about 40 % of the water demand in central Greater Colombo. In recent years, however, the two treatment plants have not been functioning properly and are unable to supply water continously for 24 hours. This has been due to the age of the plants, and the lack of proper maintenance on mechanical and electrical equipment. This problem has been compounded with the dilemna of treating contaminated water during drought conditions. The Master Plan for water supply systems (S.W.C.A.) in the Greater Colombo Area prepared in 1972, was prepared based on the assumption that all treatment systems were in good operating condition. If these plants continue to malfunction, the Master Plan can not be effective.

For the supply of abundant, good quality water to the people in the Greater Colombo area, and to successfully follow the Master Plan, Project execution is urgently required.

As recommended later, if the water quality control management of the watersheds upstream of the dams is effective, the two plants could treat a better raw water quality free from contamination. However water quality control management of the watershed and reservoirs has not been effective. This has contributed largely to the inefficiencies of the treatment processes. It is recommended that water quality control shall be properly managed upon the completion of the Project.

As a result of this evaluation, project execution is essential for the health and well being of the Sri Lanka citizens to ensure an abundant supply of potable water at all times.

7. CONCLUSIONS AND RECOMMENDATIONS

7-1 GENERAL

The Project is defined as rehabilitation of the Kalatuwawa and Labugama water treatment plants which currently supply water to the Greater Colombo area, including Colombo City and the north and south sectors of Colombo. The Greater Colombo water system has three water treatment plants but only the two older plants are included in this project.

The existing Master Plan for water system development was based on supplies and water treatment facilities performing satisfactorily. Therefore, it is essential that these malfunctioning plants which are creating a potential health hazard, shall be rehabilitated and consistently well operated and maintained. The Government of Sri Lanka recognizing these critical conditions and the urgency has a strong desire to complete the Project as quickly as possible.

The Government of Sri Lanka under financial constraint has sought external aid from the Government of Japan. Instead of developing new water supply facilities the Government has concentrating on upgrading the existing water supply facilities. In addition to the physical rehabilitation programme at both plants, the following recommendations are proposed to enhance the projects successful implementation.

1. PROBLEMS

Following items are to be settled in near future.

a. Water Source Management

It is anticipated that eutrophication of raw water in reservoirs will occure in couple of years after filling water in reservoirs and then will cause growing algae and planeton. And sometimes bottom layer

of reservoirs become anaerobic state, caused by putrefacation of sediments of organic matters which is accelerated under higher temperature, especially in tropical countries. As the result odor, iron, manganese may be dissolved and found in reservoirs. It is essential to keep measurement and check on currents, stratification, and water quality in reservoirs in order to utilize and obtain appropriate quality of raw water for water supply use from the reservoirs.

b. Purification Management

1. Owing to lack of knowledge for coagulation, sedimentation process is not worked properly and effectively, consequently filters are working with overload.

2. Ineffective back wash accumulated contamination of filter media, consequently filters are working ineffectively.

3. Water quality management for coagulation, sedimentation and filteration is insufficient.

c. Leakage

It is necessary to make appropriate investigation on leakage at piping network in order to be able to make further frame work for leakage abatement if necessary.

d. Quality of Tape Water

Water from tap of hotels and residences has often color.
It seems that receiving tank and aged piping in the building mainly contaminates water.

2. STAFF TRAINING

Following rehabilitation of the plants, the middle class engineers positioned between managers and labourers should receive special training outlined as follows:

a. Electrical and Mechanical Equipment

In order to properly operate mechanical and electrical equipment to be installed at the two plants, staff training is necessary to acquaint operating personnel with the functioning, make up, and special features of these mechanisms. This training shall include analysis of the equipment, maintenance, replacement of parts, and methods for periodic spot checks.

b. Water Quality Control Management of Reservoirs

Treating impounded river water has some inherent technical problems. In order to treat impounded water of dams properly, the biological water quality and reservoir bottom characteristics should be analysed and interpreteted. For this reason, staff training for water quality analyses including algae and plankton identification, and water treatment theory are necessary. This training programme may be held in Japan inspecting sample systems, and in Sri Lanka, conducting on site analyses and interpretation of the results.

7-2 WATER QUALITY TESTS OF RESERVOIR WATER

No data was available on biological water quality and reservoir bottom conditions for accumulated deposits at the Kalatuwawa and Labugama reservoirs. For safe and smooth operation of both plants, water quality analyses need to be conducted for periods of time in both the rainy and dry seasons to determine quality variations during both seasons.

The water quality tests should include bacteriological, chemical and biological analyses including algae identification etc, and identification of the characteristics of reservoir bottom deposits.