CHAPTER 13 PRIORITY PROJECT OF SEWERAGE SYSTEM PLAN

13.1 Identification of the Priority Project

The Master Plan Area consists of Nuwara Eliya-city center in Nanu Oya catchment and hospital/brewery area in Barrack Plains catchment. From the viewpoint of the considerations such as large-scale commercial and high population density areas, large-scale facilities, conservation of the natural environment and topography etc which are the same as the Master Plan, the priority area will be determined.

Detailed data on population, commercial activities, etc by these sub-areas are not available, and the evaluation was made by a series of discussions with the Municipality officers concerned and from field observations.

13.2 Planing Fundamentals

The priority project area for the Feasibility Study for Nuwara Eliya includes the city center and the surrounding commercial and residential areas as far north as the Saint Andrew Hotel and along the Nanu Oya as far south as the south end of Victoria Park. The project area also includes a separate area around the Base Hospital and Brewery and along Uda Pussellawa Road in front of these vicinities. Although the trunk sewers will continue further to the south to the proposed treatment plant site as described elsewhere above, additional areas will not be served by incoming sewers into side streets. The trunk sewers will be designed to receive this additional flow in the future under Phase 2. Large-scale developments such as the Grand Hotel, will however be served.

The priority project area is shown on Figure 13.1.

Table 13.1 Priority Project Area in Nuwara Eliya

Planning value	2005
Area (ha)	84
Population	1,830
Daily Average Sewage Flow (m^3/day)	1,200
Daily Maximum Sewage Flow (m^3/day)	1,400
Hourly Maximum Sewage Flow (m^3/day)	2,400

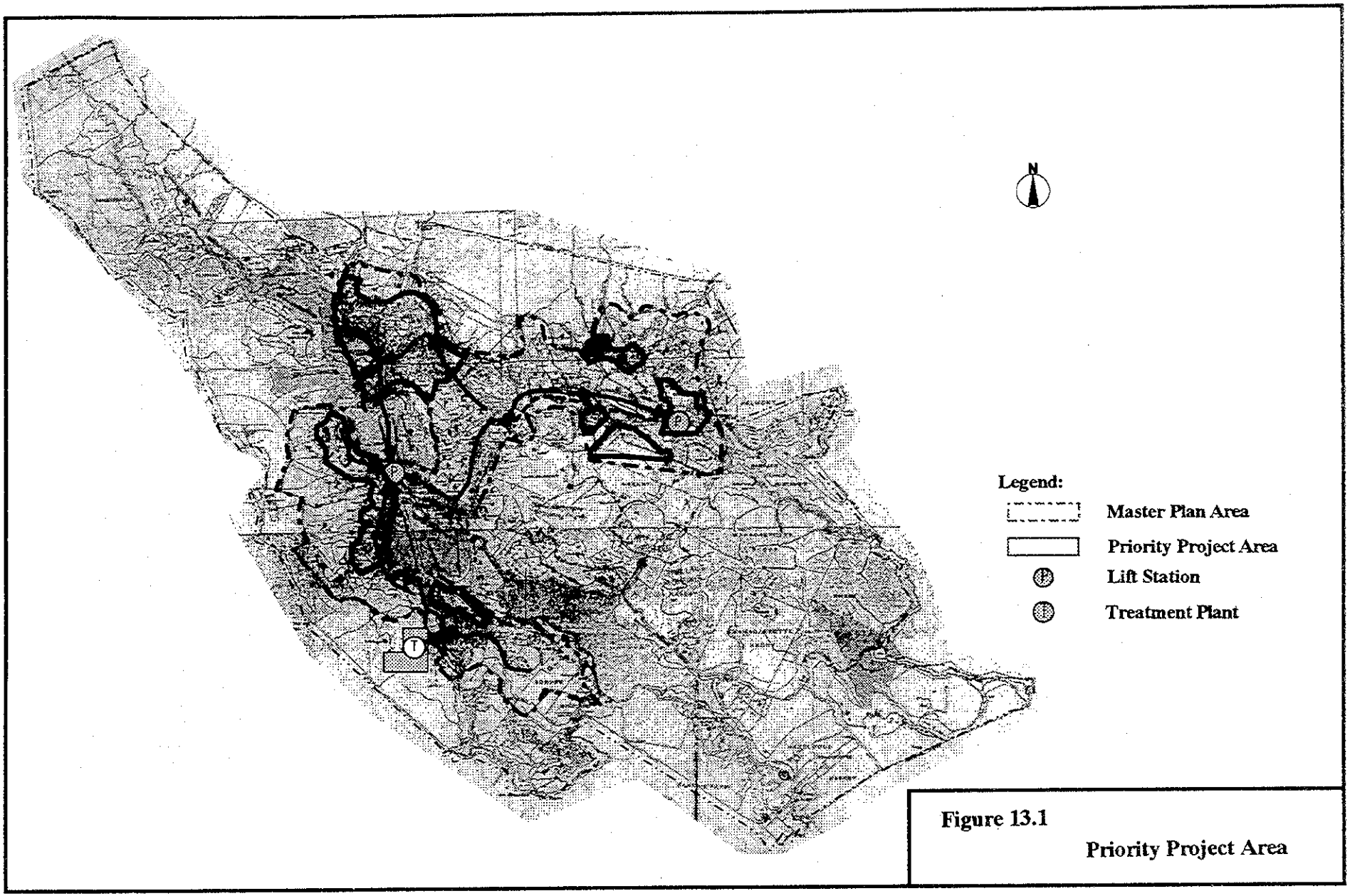


Figure 13.1
Priority Project Area

13.3 Preliminary Design of Sewerage System

Design Consideration

One of the proposed pumping station sites is located at the northeast of the municipality along Uda Pussellawa Road. The site is now used to accommodate Municipality employees. The elevation is 1,863m with dimensions of 35 m long and 10 to 25 m wide. The near surface soft peat bed is present down to a depth of 1.40m. Below the peat bed are soft clays and plastic clays giving low SPT 'N' values. If shallow foundations are considered long-term settlements can be expected, Foundations below 3.00m depth may not be practical with a ground water table at 1.90m. Therefore shallow R.C. driven piles can be considered which will achieve the set within the dense weathered rock. The boulder recorded from 3.80m to 4.20m may be considered an isolated occurrence. The required pile load set can be achieved at a depth of around 8.00m within the granular dense weathered rock.

Another proposed pumping station site is located at Victoria Park is at an elevation of 1,877m and is 20 m square. The subsurface peat bed down to 1.85m depth is soft and not load bearing material. However, the sand bed and a gravel bed below 1.85m depth are moderately dense. Independent footings or a raft type foundation can be considered at a depth of 1.85m. Below this depth are sands and granular bedrock with an average S.P.T. N value of 17. The safe load bearing capacity will be 150 kN/m^2 at 1.85m depth. No long-term settlements are expected in granular sands below 1.85m depth. Dewatering and shuttering will be required during construction because of the shallow ground water table at 1.00m depth.

The proposed site of the sewage treatment plant in the valley area cultivated for tea plantation along London Road. The elevation varies from 1,852m at the bottom of valley to 1871m at the road. The finished ground level for the sewage treatment plant will be at an elevation of 1855m and 1884m for the complete mixing aeration lagoons.

At the time of discussion on the draft final report (December 1998), alternative site for the treatment plant was proposed because of difficulty of land acquisition, i.e. opposition of the tea plantation laborers working in the proposed site. The newly proposed site is located in the private farmland upstream of the site planned initially. Since the land is owned by one person, the staff of the municipality judged that acquisition of the land is not difficult. Because of the constraints of time, topographical survey and soil investigation were not conducted on the new site. However, it may be judged by observation that the size and slope of the site is more suitable than the initial site. It is possible to construct the plant on the new

site as planned initially, and required costs for construction and operation & maintenance would be less than those for initial plan. Therefore, it was judged that the examination of the plant might be conducted using the initial plan.

Sewage Collection System

Sewage collection method is separate system and the piping materials are:

Diameter of 100 mm : PVC - Type 600 (service connection)
Diameter of 150 to 600mm : Vitrified Clay Pipe
Diameter of more than 600mm : Reinforced Concrete Pipe with Anti-corrosion Coating

The diameters and lengths for the sewer system to be designed are summarized in the following tables.

Table 13.2 Summary of Sewer Plan

Item	Diameter (mm)	Length (m)
Clay Pipe – Lateral	150	4,000
Clay Pipe – Sewer Main	150 to 400	8,190
DI Pipe	100	2,020
Service Connection	units	750

Table 13.3 Summary of Special Sewer Works

Item	Sewer I.D. No.	Diameter (mm)	Length (m)	Location
River Crossing (Inverted Siphon)	8-1	150 x 2	20	Bus Terminal (Nanu Oya)

Design hourly maximum sewage flow is used for designing the pumping station, the submersible pump should be used for the pump with numbers of more than two including the standby pump.

Table 13.4 Summary of Pumping Station Plan

Location	Specification
Nuwara Eliya - 1	Submersible Pump, 0.89 m^3/min, 39 m, 11 kW, 2 sets
Nuwara Eliya - 2	Submersible Pump, 2.82 m^3/min, 24 m, 22 kW, 2 sets

Sewage Treatment System

The preliminary design for the sewage treatment plant was prepared with the following capacity. In this study, the plant is designed with a capacity of 1,400 m^3/day at this stage, with a final capacity of 2,800 m^3/day, being borne in mind.

Location	Treatment Method	2005	2015
Nuwara Eliya	Aerated Lagoon	1,400 m^3/day	2,800 m^3/day

Specifications of the sewage treatment plant with numbers, dimensions and design parameters for each facility are given in Table 13.5.

Table 13.5 Specifications of Sewage Treatment Plant

Facilities	Specifications
1. Grit Chamber and Screen	
Type	Parallel Flow Type
Dimension	0.5 m W x 2.7 m L x 0.3 m D
Water Surface Load	1,778 m^3/m^2/day
Average Velocity	0.15m/sec
Number of Basin	2 basins (including 1 stand-by)
2. Complete Mixing Aerated Lagoon	
Type	Rectangular Type
Dimension	14.0 m W x 25.0 m L x 3.0 m D
Aeration Power Level	13 kW
Retention Time	1.5 days
Number of Basin	2 basins
3. Partial Mixing Aerated Lagoon	
Type	Rectangular Type
Dimension (Cell)	12.0 m W x 16.0 m L x 4.0 m D
Aeration Power Level	6 kW
Retention Time	2.0 days
Number of Basin	3 cells x 2 basins
4. Disinfection Tank	
Type	Rectangular Type
Dimension	1.0 m W x 15.0 m L x 1.0 m D
Retention Time	15.4 min
Number of Basin	1 basins

13.4 Project Cost

Total cost of the proposed project is estimated in Sri Lankan Rs. as follows:

Table 13.6 Project Cost of Priority Project

Unit: Thousand Sri Lankan Rs.

(1) Construction cost		
1) Collection System		145,085
Trunk/MainSewer		
Sewer Lateral		
2) Pumping Station		10,617
Civil Work	2,462	
Mechanical/Electrical Work	8,155	

3) Sewage Treatment Plant		82,026
Civil Work	41,910	
Mechanical/Electrical Work	40,116	
4) Administration cost		12,272
Sub-Total		**250,000**
(2) Procurement of maintenance equipment		**25,000**
(3) Engineering cost		
1) Detailed design	18,525	
2) Construction supervision	9,500	
Sub-Total		**20,500**
(4) Common expenses		
1) General and administration expenses	4,000	
2) Land acquisition	24,000	
Sub-Total		**28,000**
(5) Contingency		**48,500**
(6) GST (12.5%)		**46,000**
Total		**418,000**

Note: Exchange rate: SL Rs. 1.00 = Japanese Yen 1.80 (as of November, 1998)

13.5 Financial Evaluation of Priority Project

The results of the financial analysis on the priority project is as follows (refer to Chapter 17 for details):

Following conditions were assumed for the analysis.

(1) Costs

- Project cost presented in Table 13.6 (418 million Rupees).
- Operation and Maintenance cost presented in Table 14.4 (3,297 thousand Rupees per annum)
- Overhead equivalent to 10% of sales amount

(2) Income

- Sewerage tariff is set taking account willingness to pay and affordability of the residents (2.0 Rs./m^3 in 2004) Annual tariff increase of 1% in real terms is assumed.
- Non-domestic user will pay four or five times of unit sewerage tariff than the domestic user.
- Hundred (100) percent or 90 percent of total project cost is covered by subsidy of the government. Remaining will be borrowed with a policy of 10% annual interest, 24 years payback including 2 years grace period.

(3) Depreciation period is considered as 50 years for civil structures, 15 years for mechanical and electrical equipment, and 15 years for vehicles. Salvage values at 20% of initial cost is considered for mech./elec. equipment, and vehicles.

Table 13.7 shows the results of computation.

Table 13.7 FIRRs by Different Grant Coverage for Sewerage Priority Project

Item	unit	Case 1	Case 2
Grant Coverage for the Investment	%	100	90
Starting Tariff for Domestic Users	Rs./m^3	2.00	2.00
Non-Dom. Tariff Multiplier against Dom.	Times	4	5
Annual Tariff Increase Rate	%	1.00	1.00
FIRR for F/S	%	9.30	1.47

As presented in the above tables, the priority project show good financial performance, though annual water tariff increase of 1% in real terms is assumed. It is viable financially. Cash flow analysis on the priority project assuming 10% annual inflation rate shows that operating fund is in short by 2009. If required operating fund can be borrowed with 10% annual interest rate, cumulative deficit can be recovered in 2017. However, if 10% of project cost shall be shouldered by the project operation entity, financial situation will be worse seriously.

13.6 Implementation Schedule

The priority project, which is the phase 1 of the long-term development plan, expected to be completed by the end of 2003.

Phase 1	(1999 to 2003)	- Priority Project
	1999 -2001	Preparation of project
	2001 - 02	Detailed design and bidding
	2002	Commencement of construction
	2002 - 03	Construction
	2004	Commencement of operation

CHAPTER 14 OPERATION AND MAINTENANCE PROGRAM FOR SEWERAGE SYSTEM

14.1 General

The appropriate operation and maintenance (O & M) of the sewerage facilities is vital not only to maintain the performance of the system, but also to prolong its service life. The minimum requirements necessary to attain satisfactory levels of O & M practice is described and the further development of O & M activities will be subject to the progress of human resource development in this particular field.

14.2 Work Program for Operation and Maintenance

There are four main O & M procedures namely, daily inspection, site investigation, pipe cleaning and rehabilitation of damaged sewers.

Table 14.1 Work Items by Type of O & M of Sewer

O & M Type	Working Items
Daily inspection	- Operation of pumping facilities - Operation of electrical facilities
Site investigation	- Identification of damage and blockage location - Identification of the percolation point of groundwater - Investigation of the overflow point at manhole - Measurement of the volume of settled soil at the sewer bottom
Pipe cleaning	- Removal of settled soil, silt and foreign matter
Rehabilitation	- Replacement/repair of damaged sewer

In order to perform the above activities, it is proposed that the following vehicles and equipment be purchased. The vehicles and equipment are a high-pressure cleaning car, a sludge vacuum car, high-pressure cleaning device, and a dump a truck and a pickup truck.

The pipe cleaning operation for a complete sewage collection system should be performed to a comprehensive maintenance schedule. The pipe cleaning crew should record the volume and quality of the removed sediment, the method of cleaning and cleaning time in order to make improvements in future O&M activities.

An annual pipe rehabilitation schedule, based upon the results of the investigation survey should be prepared. The rehabilitation work should be prioritized such that the sewers in most urgent need of repair are rehabilitated first.

The proposed method of sewage treatment to be used at the sewage treatment plant is the use of an Aerated Lagoon. This requires relatively simple technology and less manpower for operation and maintenance. Proper operation and maintenance is however indispensable in order to realize the full performance of the equipment and meet the design life of the equipment.

The O & M for the pump station is classified into two items, daily and periodical working. The working items by O & M types are shown in Table 14.2.

Table 14.2 Work Items of Sewage Treatment Plant by O & M Types

O & M Work	Working Items
Daily work	- Measurement of sewage flow - Removal of screenings at screen - Inspection of operation of aerators - Inspection of operation of sludge collection - Inspection of operation of chlorination facilities - Inspection of operation of electrical facilities - Removal and transfer to the sludge drying beds - Removal of dried sludge
Periodical work	- Removal of grit and sediments at grit chamber (monthly) - Inspection/repair of mechanical/electrical facilities (annually) - Overhaul of mechanical/electrical facilities (every 5 to 10 years)

The sewage treatment plant will discharge the treated water into Meda Ela, but the treated water will have to comply with strict effluent regulations. Because the quality of the treated water will need to be checked immediately on demand, a laboratory will be facilitated within the plant, staffed by a chemist. Complicated water quality analysis will, however, be conducted by a specialist outside company under contract to the treatment plant. Some major items for sewage, such as temperature, pH, BOD, COD, SS, number of coliform bacteria group, total colonies etc., and temperature, pH and moisture content should be measured at the treatment plant.

14.3 Organization for Operation and Maintenance

The proposed staffing for operation and maintenance personnel is 8 persons for Phase 1 and 12 persons for Phase 2, as shown in Table 14.3

Table 14.3 Required Number of Staff for O&M of Sewerage System

(unit: persons)

Field & Position		Phase 1	Phase 2	Duty
Manager		1	1	Responsible for sewage system
Sewer and Pumping Station				
Sewer	Engineer	-	1	Responsible for cleaning of sewers
	Foreman	1	1	Responsible for site works
	Worker	1	1	1 workers/team
	Driver	-	1	1 workers/team
Vehicle Maintenance*	Mechanic	-	-	Maintenance of vehicles/equipment
Sewage Treatment Plant				
Operation	Engineer	1	1	Responsible for technical matters
	Foreman	1	1	Responsible for operation of each shift
	Operator	1	2	1 operator/shift
Maintenance	Technician	1	1	Responsible for site works
	Worker	-	1	Cleaning
Water Analysis	Chemist	1	1	Water quality control
Total		8	12	

* Vehicle maintenance shall be done by the Municipality workshop.

14.4 Operation and Maintenance Cost

The operation and maintenance program, as stipulated in the preceding sections, requires the following items and annual funds for proper operation of the sewage collection system and the sewage treatment plant.

Table 14.4 Operation and Maintenance Cost

(Unit: Thousand Rs/year)

Item	Phase 1	Phase 2
- Personnel Expenses	840	1,176
- Electricity Cost	1,947	2,504
- Chemical Cost	27	51
- Repair Cost	483	871
Total	3,297	4,602

PART IV ENVIRONMENTAL, INSTITUTIONAL AND FINANCIAL ASPECTS, AND CONCLUSION

CHAPTER 15 ENVIRONMENTAL IMPACT ASSESSMENT

15.1 Environmental Studies carried out under the JICA's Development Study and Needs of EIA

The Environmental Studies carried out under the present project include:

(1) An Initial Environmental Examination (IEE), carried out by the JICA mission team during the first project phase (February - April 1998);

(2) An Environmental Impact Assessment (EIA), executed with the help of a subcontracted local consultant Company, during the second stage of the project, between August and November 1998;

(3) A water, sewerage and sludge quality survey, carried out by means of two separate field campaign, respectively performed during the dry season (February - March, 1998), and during the rainy season (July - August, 1998).

The IEE, completed in April 1998, was submitted for approval to the NWSDB, and the Central Environmental Authority (CEA) of Sri Lanka, who is the Government Agency, entitled for environmental licensing in the Country.

The CEA, after reviewing the IEE and considering the size and the characteristics of the different project's components, had initially categorized this project as a *"not prescribed"*, meaning that the project implementing agency (NWSDB) has no obligations to submit an EIA to the Central Environmental Authority (CEA) for the licensing of the present project.

Nevertheless, CEA gave a certain number of recommendations which imposed a deeper environmental analysis, and the NWSDB officially requested the JICA Study Team to execute a full scale EIA, as initially planned.

15.2 Critical environmental Aspects Considered under the EIA

The project is in general beneficial for the environment, giving a substantial contribution to the water quality improvement in the Nuwara Eliya project area, with all consequent positive effects on public health, general socioeconomic development, and visual impact.

Although no permanent negative effects are expected, the project nevertheless presents some critical environmental aspects which will deserve an attentive environmental management

since the very beginning, to avoid public nuisance either during construction or during operation, and eventual delays during the implementation stage.

These aspects are reported and briefly commented in Table 15.1.

Table 15.1 Summary of Project Impacts

Impact	Degree of Importance
(a) Land acquisition and compensation to entitled persons or agencies or institutions for the water supply and wastewater treatment plants in Nuwara Eliya;	Critical. Attentive management is required
(b) Impact on traffic and transportation during construction in central areas of Nuwara Eliya;	Critical but temporary. Attentive management is required
(c) Possible negative impact on alternative water uses from groundwater extraction in Nuwara Eliya	Important but not critical. Monitoring is essential.
(d) Transport and disposal of sludge, wastes and excavated materials during construction;	Temporary. Important but not critical.
(e) Noise during construction	Temporary. Critical in sensitive areas.
(f) Offensive odors at wastewater treatment plant sites;	Critical because of people nuisance. Attentive management is required.

Other than this, the following environmental aspects were also developed under the EIA:

(1) Assessment of water quality and balance of contamination in the major surface water bodies of the Nuwara Eliya project areas;

(2) General guidelines for the Environmental Monitoring and Auditing during construction and during operation, with special reference to permanent monitoring of wastewater treatment plants;

(3) Environmental organization and institutional setting of the NWSDB, at central and peripheral level.

15.3 Specific Impacts and Recommended Mitigation Measures

15.3.1 Socio-Economic Impacts

(1) Proposed dam sites

Jayalanka reservoir site

The proposed project area is located quite close to the Kandapola - Nuwara-Eliya road.

Three major types of land uses are found in the catchment area: forest, tea, and vegetable cultivation. Vegetable cultivation is intensive and at least three crops per year are harvested. The total number of families in the catchment area is about 281, with a dwelling population counted in 1,617 people in 3 clusters in the upper catchment. Scattered houses are present in mid slope and the lower valley.

The envisaged dam construction will flood about 20 ha of fertile and almost flat land, while the total required land will be of about 40 ha, involving relocation of some 200 families. Considering the extremely high price of land (up to Rs. 40 million per ha have been reported), the difficulties and cost of resettlement (no similar land is available), it can be concluded the project is not feasible under present social and environmental conditions.

Bambarakele reservoir site

The Dam site is located below the settlement area and above the plantation settlements. Less than 10 ha will be flooded and no evacuation will take place. Only the sheds of the Inland Fisheries Department, plus one small hut not occupied permanently, need to be removed. The lower segment of the proposed reservoir site includes tea-cultivated land. According to the estimations one ha of tea land is worth about Rs. 4,800,000 ($ 73,000), while the upper part of the reservoir area is under forest vegetation.

Bambarakele dam, opposite of Jayalanka, present a positive socioeconomic feasibility. If technically feasible, the project could also help the local economic development. Impoundment area is reduced, land can be easily acquired at convenient prices, and there is no opposition to the project. The reservoir could be conveniently utilized for fish breeding, an activity already developed at small scale by the Fishery Department. Compensations to affected people should nevertheless be considered, in monetary or non-monetary form (recommended). According to the socioeconomic survey conducted in the area, these should at least include a) improvement of waste management, and b) training on soil conservation.

(2) Sewage treatment plant (Nanu Oya road)

The project site is located in a minor valley closer to the Nuwara Eliya - Nanu Oya road. Land is owned by a tea plantation. Total affected population has been counted in 102 persons (September 1998) who will need to be considered for compensation. Land acquisition will be necessary, but no household relocation is needed.

The price of one hectare of tea land in this area is about Rs. 12,000,000 (about $ 185,000). Unpleasant odors of the sewerage plant are considered as a main threat by resident people, expecting unavoidable problems such as headache, psychological disturbances due to sludge management, etc. A proper information campaign is therefore essential to explain real dangers and threats for human health expected from plant operation.

In Nuwara Eliya, the authority for land acquisition is the Divisional Secretary of the Municipality.

15.3.2 Groundwater Balance

Nuwara Eliya water supply project includes a proposal to extract ground water from the valley of Upper Nanu Oya. Expected negative impacts from groundwater extraction are the following:

(1) Lowering of shallow layers, with possible impairment of present water uses (tea crops, gardening, agriculture, and animal grazing);
(2 Reduction of soil moisture for the survival of the natural vegetation;
(3) Possible loss of biodiversity.

The study area is represented by the Upper Nanu Oya or Gregory Lake hydrological catchment, covering about 1,450 ha with predominant land use of natural forest. To quantify the limiting hydrologic yield of the aquifer, a hydrological simulation model has been used choosing a model already tested for a similar catchment. Primary field study information was also used to validate the model outputs. The modified water balance model provided the daily outputs of hydrological processes, such as evapotranspiration, runoff, ground water recharge, and soil moisture depletion in the root zone for different land use types within the Upper Nanu Oya catchment.

The percentage of rainfall, which contributes to evapotranspiration, runoff and recharge is calculated at 46.4%, 45.2% and 8.3%, respectively. The average daily ground water recharge over a period of 30 years is about 7,184 m^3/d, slightly over the designed abstraction value of 7,000 m^3/d.

The above analysis indicated that ground water can be considered as a reliable source for water supply at Nuwara Eliya, since designed abstraction is less than the long-term recharge. However, the model shows a potential lowering of water table due to ground water over-

abstraction: this will produce negative impacts on natural vegetation, due to accelerated soil moisture depletion rate, generating conflicts with alternative water users.

Relying only on ground water to provide the required projected demand for year 2015 could therefore be risky especially during dry years. However, proposed groundwater resource to be developed exists in deep aquifer consisting of fractures in the shear zone which continues 120km long beyond the Nuwara Eliya area and its actual mechanism is not identified yet. Therefore it is strongly recommended that intensive groundwater development study be conducted by the foreign experienced specialists to clarify the available yield of groundwater in the area.

15.3.3 Water Quality Assessment and Balance of Contamination in the Major Surface Water Bodies in the Nuwara Eliya Project Area

(1) Water quality survey

Raw water quality

Acid pH of raw water has been shown in Brewery and Gemunupura intakes during dry weather. Nitrate and phosphorus concentrations are also very high in surface water intakes. All surface water intakes in Nuwara Eliya have been contaminated with Fecal coliform. The analytical results also show high concentrations of iron in surface intakes of Nuwara Eliya during rainy season.

Groundwater quality

Underground water also shows clear signs of contamination. Acidic pH has been reported in some investigated bereholes, wile others (Palladium bore hole) showed extremely high concentration of free ammonia. Nitrite and nitrate are unbelievably high in the same borehole, while phosphorus is exceeding the limits almost all over during the rainy season (agricultural runoff). Fecal contamination had been reported in all boreholes except in Galway forest bore hole. In addition, high concentration of Mn and Fe was found in several sites. The highest concentration of iron has been reported in the Palladium borehole.

Surface water quality

Surface water in Nuwara Eliya was extremely acidic during the dry weather compared to the rainy season. Extremely high BOD_5 has been determined for the water samples collected upstream of the Hospital Stream and Inflow to the Barrack Plains Reservoir. The Barrack Plains Reservoir also showed high BOD_5 values during the rainy season. Dis-

solved oxygen in surface water samples is usually very low. Total nitrogen and total phosphorus are also remarkably high in the surface water analyzed during the rainy season. In addition to fecal contamination, surface water samples also show relatively high concentrations of Mn and Zn ions.

(2) Balance of contaminants and assessment of project impacts on water quality

A water quality model has been developed for Nuwara Eliya, in order to assess potential impacts and predict water quality evolution in the area.

The following water bodies have been analyzed:

1) Nanu Oya: 3.3 km, from upstream to its inflow to the Lake Gregory;
2) Hospital Stream: 3.0 km, from upstream to its inflow to the Barrack Plains Reservoir;
3) Lake Gregory: considered as well mixing surface water body;
4) Barrack Plains Reservoir: at present this area is converted into a swamp, therefore only contaminant loads are computed but water quality modeling was not attempted.

Three scenarios, corresponding to the different project development phases, have been investigated:

1) Phase 0: present status;
2) Phase 1: 30% of the population connected to the sewer system;
3) Phase 2: 90% of population connected to the sewer system.

Concentrations of BOD_5, DO, T-N and T-P were computed using one-dimensional modeling approach for the Nanu Oya and Hospital stream, and complete mixed system approach for Lake Gregory.

The following results have been achieved:

Nanu Oya

The steam will be rehabilitated with the implementation of the water supply system and sewage treatment facility, since it will totally reduce the direct discharge of sewage and domestic water into the stream system. However, nitrogen and phosphorus concentrations may remain at higher levels, because of agricultural run-off.

Hospital Stream

There will be greater improvement of the water quality of hospital stream, assuming that discharge of untreated hospital waste and brewery effluent to the stream will be dismissed

after project implementation.

Lake Gregory

According to the model, water quality improvement of Gregory Lake will be relatively minor. A similar situation has been already discussed for the Kandy Lake, and is mainly due to the fact that the model considers the lake as well mixing, with a small retention time. Real water quality improvement, after the implementation of Phase 2, is likely to be more important than shown by model results.

15.3.4 Impact on Traffic and Transportation during Construction

In Nuwara Eliya, negative effects of construction activities on traffic and transportation will be minor. Rearrangement of traffic moving directions along principal roads will anyhow be necessary.

Not all selected roads are presently in condition to absorb the new traffic load, and should therefore be improved to ease transit of vehicles.

The most important areas of intervention are:

(1) Lady Mccullums drive ('B' class road; to be widened);
(2) Jayathilaka Mawatha (surface upgrading);
(3) Moonpalace road (surface upgrading).

In addition this, a few car parks areas should be improved to move roadside parking during construction (Cargill's ground, new market car parks, parking space on park road opposite old Kachcheri building).

Road-by-road details on traffic management are given in the Vol. IV, Chapter 15, and the principal EIA report.

15.3.5 Other Environmental Impacts

Other environmental impacts will mainly concern offensive odors, high noise levels during construction, collection and disposal of solid material during construction, and collection and disposal of sludge during the wastewater treatment plant operation.

Description of impacts and recommended mitigation measures are essentially the same already discussed in the previous paragraph, even if the expected intensity in Nuwara Eliya will be low.

15.4 Environmental Auditing and Monitoring

In the case of water supply or wastewater treatment plants, environmental auditing and monitoring are essential activities either during construction or during operation stage. Responsibilities are shared between the NWSDB (environmental monitoring and reporting) and the CEA or the entitled Project Approving Agency (environmental auditing).

Environmental auditing and monitoring is expected to be of particular importance for the wastewater treatment plants, because of the nature of the plant themselves, and because of the lack of experience existing in the Country. Furthermore, treated wastewater derived from the treatment plant should meet the relevant CEA standards as stipulated in Gazette Extra Ordinary No.595/16 of 2nd February 1990.

A general monitoring and reporting program should be agreed in written between the NSWDB and the CEA. The following activities should be considered:

(1) General Monitoring and Reporting Provisions. This includes: 1) procedures for collection of samples and measurements; 2) procedures for flow measurement; 3) devices and methods to be applied; 4) analyses to be performed, detection methods, list of certified laboratories; 5) frequency of monitoring; 6) reporting methodology and frequency of reporting.

(2) Influent sampling and analysis required. This will include: parameter, units, sample type, sample frequency, report frequency;

(3) Sludge monitoring requirements. This will include: 1) sludge removal, handling, storage, use or disposal; 2) sludge management practices; 3) sludge operation and maintenance facilities; 4) sampling, testing for pollutants and sludge quality analysis; 4) notification and reporting;

(4) Effluent Monitoring. This will include: 1) location of effluent sampling stations; 2) periods of monitoring; 3) effluent sampling and analysis requirements.

A proposal for a "Wastewater Treatment Plant Monitoring and Reporting Program" suitable for application to the Nuwara Eliya sewerage project, is given in Appendix 15.

15.5 Institutional Setting

The NWSDB does not have, at the date, an internal environmental organization, able to perform all environmental activities usually requested to correctly engineer, build and operate all production, transmission and distribution facilities owned by the Board.

For the accomplishment of the environmental tasks requested under the present project, the CEA asks the NWSDB to set up the following environmental units:

(1) A Project Environmental Unit (PEU), in charge for environmental management, monitoring and reporting, as above specified;

(2) An Environmental Auditing Commission (EAC), in charge for the Environmental Auditing,.

These units, to operate correctly, need to be inserted in an organized institutional scheme, where tasks, responsibilities and hierarchical dependencies are clearly defined. A general Environmental Setting is therefore proposed for the NWSDB, to be implemented taking advantage of the present project.

The recommended environmental organization is based on the following operating units.

(1) A Central Environmental Division (CED), to be created in Colombo, as a staff function to Additional General Management office.

(2) A Regional Environmental Unit (REU), to be established in the World Bank regional office in Kandy, in charge for the general coordination of all environmental activities directly or indirectly concerning the NWSDB Getambe Regional Office.

(3) A Project Environmental Unit (PEU), to be established in Nuwara Eliya, in charge for the Environmental Management and Monitoring of the specific projects. This Unit will operate local laboratories for routinely water quality and sludge quality analysis.

(4) An Environmental Auditing Commission, formally not belonging to the NWSDB, but formed as an independent institution, or - as recommended by the CEA - within the Municipality of Nuwara Eliya. This Commission will be tentatively composed by 5 mem-

bers, and namely: 1) the Municipal Council; 2) the NWSDB; 3) the Mahaweli Authority; 4) the CEA - Local Office or Central Office; 5) a CEA nominated independent consultant.

CHAPTER 16 INSTITUTIONAL ARRANGEMENTS AND CAPACITY BUILDING STRATEGY

16.1 Sector Policy Issues Options and Recommendations

(1) Review the sector regulatory framework and NWSDB role with respect to the framework. In the interim, a Board of Regulators can be established for each of the MC's.

(2) Enact demand-based, revenue-raising mechanisms, through surcharges on local property taxes or business taxes, to reduce the impact on increased user charges and expected financial deficits.

(3) Review cost recovery and central financing policies for projects with direct environmental alleviation projects, like sewerage, to improve affordability.

(4) Review and renegotiate the bulk service contracts between NWSDB and PS/UC's. Areas for re-negotiation may include:

- Protecting NWSDB from financial defaults through payment guarantees, bank guarantees, phased takeovers and pre-contract capacity audits;
- Protecting "bulk dealers" from non-delivery of water by NWSDB. If the NWSDB is unable to supply an agreed minimum volume of water during the month, the dealers should be entitled to claim for damages or discounts on the bulk price;
- NWSDB bulk pricing issues;
- Basis for allocation of water supply among bulk dealers when supply is short;
- Regulatory control over "retailers", e.g., tariff review;
- Service standards for "retailers";
- Provision of regular training, technical assistance and management advisory services to the "retailers"
- Extension of wastewater services, where applicable.

(5) Private sector participation, in the form of concessions or joint ventures, is a workable approach for increasing resource mobilization and operating efficiencies. However, the scope of this study is limited from exploring the issue with more depth. Several major policy decisions on financing, institutional arrangements and incentives must precede any serious privatization initiative. The following recommendations are offered:

- Establish the basic ground rules, timetables and procedures and incentives (with official approvals at the highest levels).

- Appoint of a private sector participation advisor to help guide the process.
- Establish appropriate regulatory arrangements and tariff adjustment process.
- Wider dialogue and discussion with affected MC's and PS/UC's, consumers, government, potential local and foreign investors and current staff.
- Ensure that the employment security issues and concerns are amply discussed.

Once a decision to increase private sector participation is arrived at and the service area is identified, a thorough study should be implemented to establish:

- the basic technical description of the proposed area;
- who the contracting parties representing the owners of the assets are;
- scope and form of privatization to be adopted, including a draft of the contract itself;
- policies to protect the tenure of employees;
- incentives and government guarantees, if any; and
- the bidding procedures, evaluation criteria and award procedures and timetable.

16.2 Project Implementation Organizational Plan

(1) Establish the Project Management Office PMO under the RSC/C. A Project Management Office (PMO), headed by a full-time Project Director (PD), will be organized to coordinate all the activities related to this Project. The PMO shall bear planning and design, construction management, capacity building and social marketing responsibilities. The PMO should plan and coordinate a large-scale public information and social marketing program together with the respective municipal councils. The Project consultants will, inter alia, supervise the detailed design and construction of the new facilities; prepare the tender documents and guide the selection of contractors; and transfer technology.

(2) Establish Institutional Development Services Office (IDSO). At the completion of Phase 1, the PMO will become a regular office to be called the IDSO under the DGM of RSC/C. The main function is to provide management advisory and technical assistance and training services to the bulk dealers. The PMO will comprise the core of the IDSO so that the capabilities developed during this Phase will not be dissipated.

16.3 Facilities Start-up, Operation and Maintenance Organizational Plan

(1) Upgrade the respective waterworks office of KMC and NEMC into water and sanitation offices (WSO's). The WSO should lead towards establishing a full-scale water and

wastewater public utility within the municipal administration by re-structuring the existing organizational set-up initially to improve accountability for technical and commercial performance, ultimately leading to increased financial autonomy.

(2) Negotiate and agree on the inter-agency contract between NWSDB and the respective MC's regarding the initial operation and maintain the treatment plants and sewage pumping stations and turnover the responsibilities to the MC's over a 6-8 year period. Cost sharing will have to be negotiated and agreed upon. NWSDB will assign Interim Operations Teams to operate and maintain the new facilities are properly operated and maintained with additional staffing from the MC's.

(3) Adopt appropriate operating policies for sewerage, including

- Incentives for promoting and encouraging sewer service applications through revolving funds;
- Integrated billing and collection system for water and wastewater services;
- Influent standards policy for acceptance of wastewater into the sewerage system;
- Service extension policy;
- Mandatory sewer connection policy for customers with high consumption;
- Incentive policy for sewerage field staff; and
- Sanitation, septic tanks and septage collection.

16.4 Institutional Capacity Building Strategy

(1) The emerging human resources development and training strategy for this Project focuses on three (3) main elements:

- Direct provision of training through formal workshops, participation in local seminars and overseas training, on facilities construction and O&M, on reduction of non-revenue water and on improved management control systems. Over 200 key staff and operators will participate in the sewerage O&M-biased training plan.
- Strengthening capacity of the Manpower Training Division of NWSDB and the RSC/C Training Unit for sewerage facilities O&M training.
- Organizing formal and on-job training on treatment plant and pumping stations operations (both water and wastewater) for operators from the MC's.

(2) The introduction of sewerage management functions will additionally require an revisions and expansion of existing planning, management and monitoring systems, including:

- Performance accountability;
- Operation and maintenance guidelines and standards;
- Performance monitoring; and
- Cost accounting procedures and controls.

16.5 Social Marketing Strategy and Public Information

Plan and launch a sustained social marketing and public information program in Nuwara Eliya and Greater Kandy.

16.6 Resource Requirements

Rs 6,300,000 (about US$ 96,920) during the Phase 1 period is required for this institutional package, in addition to advisory services which will be included in the overall engineering services budget.

CHAPTER 17 FINANCIAL ANALYSIS

17.1 Conditions and Constraints on Financial Study

Incremental portion added by the project was dealt in the analysis. That is, an appropriate "hypothetical business entity" in each project, which is associated with new investment, was assumed for the analysis.

In the water supply project of the Greater Kandy Area, this "hypothetical business entity" covers whole newly added water supply activities of the NWSDB, the KMC and other local authorities in the Greater Kandy Area.

As discussed later, Rs. 13.36 per cubic meter in 1998 was assumed to be a standard tariff for the financial analysis, which is 90% of current average water rate of the NWSDB. This is the retail price. As for the water produced by the proposed plan, a part of water will be sold directly to customers, while the remaining portion will be sold to final users through the KMC or other local authorities. The sales from the NWSDB to the KMC or the local authorities were considered as "internal transaction" in our "hypothetical entity". It was assumed that the retail prices of the NWSDB, the KMC, and other local authorities are the same level, that is Rs. 13.36 per m^3.

The retail distributors such as the KMC and other local authorities have to be compensated their distribution costs from the total revenue of the sales amount with the retail price of Rs.13.36 /m^3. In case of the NWSDB, the total expenditure other than the water production costs is covered by the name of the overhead, which was assumed as the 15 % of water sales. There was some expansion of the concept of "overhead as accounting term". Therefore, in case of bulk supply from the NWSDB to retailers, some portion of this "overhead" has to be given to the retailers as "so-called retail fee". The bulk price is the retail price minus retail fee. This price has to be decided as fair price.

In every project, early stage of the project period suffers cash deficit. In order to keep operation, in addition to construct cost, the working capital must be supplied. For reference, the working capital burden is estimated under the assumption of the cash availability with 10 % interest. Interest payment and cumulative figure is shown on the respective table.

The depreciation period was assumed as follows.

Civil Works including engineering fee etc.: 50-year life and no salvage value.

Machinery and Electrical equipment: 15-year life and with 20 % salvage value.

Vehicles: 15-year life and no salvage value.

The salvage value at the year of 2050 was assumed to be converted to cash at the book value for the estimation of FIRR.

Annual inflation rate will be constant at the rate of 10% until 2050.

The loan condition by the government is 10 % interest rate and 24 years with two-year grace period, which is same as the current government policy.

While NWSDB's financial forecast uses 94 % as water tariff collection rate, we applied same number after examining the collection performance of the NWSDB in central province and the KMC.

In sewerage projects, 100 % percent subsidy from government for capital investments was assumed. But as the government grants may not cover whole capital investments, 90 % subsidy case was also computed for reference. As to operation and maintenance costs, while current government policy assumes free service, a policy that the O&M cost recovery from the tariff shall be established was employed. Sewerage tariff was assumed to be Rs.2.0/m^3 taking account the affordability of the domestic users. Sewerage tariff of non-domestic users was set at three to five times of domestic tariff.

17.2 Financial Analysis

17.2.1 Financial Evaluation of Water Supply Project

Tables 17.1 and 17.2 present the summary of financial analysis for the project.

Table 17.1 FIRRs by Different Tariff Increase Rate of Water Supply System

Tariff Increase Rate	0.0%	0.5%	**1.0%**	1.5%	2.0%
FIRR for M/P	5.16%	6.21%	**7.20%**	8.15%	9.07%
FIRR for F/S	4.26%	5.39%	**6.43%**	7.42%	8.36%

Note: Bold Faces are the recommended Cases.

Table 17.2 Results of Sensitivity Analysis on Water Supply Project

Case	Annual Tariff Increase	Variance of Capital Investment and O&M Cost			
		-5%	0%	+5%	+10%
FIRR for M/P	1.0%	7.76%	**7.20%**	6.67%	6.17%
FIRR for F/S	1.0%	7.02%	**6.43%**	5.88%	5.36%

(1) Nuwara Eliya Water Supply Project (Master Plan)

FIRR of this case is remarkable 7.2 % as an ordinal infrastructure development project. When we see the project from longer point of view, this project is surely financially rewarded and attractive. But annual fund flow becomes positive in 2010, while the cumulative deficit will disappear in 2016.

(2) Nuwara Eliya Water Supply Project (Feasibility Study)

The financial feasibility for the master plan and the F/S are showing the common behaviors. Because the most part of the project will be covered in Phase 1. Therefore in substance the M/P and F/S are almost identical.

17.2.2 Financial Evaluation of Sewerage Project

Table 17.3 presents the summary of financial evaluation for the project.

Table 17.3 FIRRs by Different Grant Coverage for Sewerage Project

Item	unit	Case 1	Case 2
Grant Coverage for the Investment	%	100	90
Starting Tariff for Domestic Users	Rs./m^3	2.00	2.00
Non-Dom. Tariff Multiplier against Dom.	times	4	5
Annual Tariff Increase Rate	%	1.00	1.00
FIRR for M/P	%	13.18	2.07
FIRR for F/S	%	9.30	1.47

(1) Nuwara Eliya Water Supply Project (Master Plan)

One-percent (1%) annual tariff increase in real terms was assumed. It is the same rate with the Master Plan. FIRR was at 13.18%. If 10% of the capital investment is required to be recovered with monthly fee in addition to the requirement of O&M cost recovery, the financial projection will be worse. Non-domestic customers were assumed to pay

five times of unit rate of domestic customers.

(2) Nuwara Eliya Sewerage Project (Feasibility Study)

In the Nuwara Eliya Sewerage Project (F/S), the financial performance projection for the feasibility study becomes worse than the above master plan (FIRR: 9.30%).

In case of 10% capital cost requirement, the result is much worse than the case of the master plan.

17.3 Financial Status of NWSDB

The whole financial situation and the financial capability of the NWSDB were examined. As the water supply business requires substantial fixed assets, the ROA (return on total assets) is low. However, several projects have been proceeded because of subsidy and loan from the government. The largest problem with the financial structure of the NWSDB is debt service.

In near future, new financing scheme such as BOT or PSP might become one option of the infrastructure construction but time will be required before these schemes become practically available, although there is the indication of moving to new financing scheme especially in water supply sector.

CHAPTER 18 PROJECT EVALUATION

18.1 General

The proposed projects for the improvement of the water supply system and for the development of new sewerage system in Nuwara Eliya were evaluated from the viewpoints of the expected benefits and appropriateness/feasibility. The composition of the evaluation items was composed of the following aspects: financial, socio-economic, technical, institutional, and environmental.

18.2 Water Supply Project

18.2.1 Financial Aspect

(1) Nuwara Eliya Water Supply (Master Plan)

FIRR for this case is 7.2%. The financial feasibility for the whole period through 2050 is strongly confirmed even it takes time for the cash balance to become positive.

(2) Nuwara Eliya Water Supply (F/S)

The financial perspective is almost same as the master plan because the F/S covers the most part of the whole master plan remaining only marginal works to the later phase.

18.2.2 Socio-Economic Aspect

The implementation of the Project will bring to the society the following socio-economic benefits other than tangible benefits such as expansion of the area to be served and steady supply of safe water;

- Increase of employment opportunity
- Increase in consumer's satisfaction
- Mitigation of fire damages
- Increase in income of the business sectors
- Increase in value-added of the land

The implementation of the Project aiming to augment the capacity of water supply to cope with development of other infrastructures, will be vital to secure an envisaged steady growth of economy.

18.2.3 Technical Aspect

In the course of planning the Nuwara Eliya Water Supply System, a various kinds of comparative studies with possible alternatives as to the location of facilities, structure of the system, construction method, material, process and so on were made to establish the optimum plan of the system. The outcome of the Study is aiming at energy- and cost-saving, easy operation and maintenance of the system and minimization of the impact on the surrounding environment during and after construction based on the appropriate technology in due consideration of the current practice in Sri Lanka. The Project is therefore considered feasible from the technical point of view.

18.2.4 Institutional Aspect

Although due consideration be given to the NEMC which is the agency that will be in charge of the Nuwara Eliya Water Supply Project after its implementation, the NWSDB has the capability enough to cope with implementation of the Project during construction stage with some addition to the existing organization. After construction, the NWSDB should assist operation and maintenance under the agreement between the NWSDB and the NEMC until the staff of the NEMC will be well trained. On condition that those arrangements will be made, the Project is considered institutionally sound.

18.2.5 Environmental Aspect

Environmental Impact Assessment (EIA) of the proposed project was carried out during the course of the Study. Results of this EIA study have raised certain possibility of environmental impacts by implementation of the project. Preventive measures and relevant legislative arrangements are thereby considered to mitigate the anticipated environmental impacts.

As a whole, the proposed project including the said preventive measures is determined to have minimal and tolerable impacts to the environment.

Among others, the following preventive measures are included in the scope of the proposed project:

(1) By employing the groundwater source development, construction of a dam with vast impoundment, which will make large impact on the environment, can be avoided.

(2) Effective improvement of transmission system will decrease the energy requirement during rainy season by transmitting the surface water effectively.

18.3 Sewerage Project

18.3.1 Financial Aspect

(1) Nuwara Eliya Sewerage Project (Master Plan)

Case 1

The FIRR is 13.18 % for this case. With the moderate supply of the working capital, the project is financially feasible and recommendable.

Case 2

This is the case that is required a partial sharing of the capital investment to the local side for several reasons. Under the current assumption, the FIRR is 2.07 % and is marginal.

(2) Nuwara Eliya Sewerage Project (F/S)

Case 1

The FIRR is 9.30 %. If the increase of the starting tariff for domestic users or the annual increase rate on the tariff is accepted, the FIRR will be improved further.

Case 2

This is the case that is required the participation to the cost sharing for the capital investment. Under the assumptions specified for this case, the FIRR is 1.47%. Though this scheme can be implemented financially, but financial condition will be very critical.

18.3.2 Socio-Economic Aspect

Safe drinking water and the sanitary disposal of waste have long been recognized as basic needs of society, as both of them function to safeguard human health and enable a more productive life. Health and environmental problems caused by inadequate water supply and poor waste disposal have been exacerbated by continued population growth and the high concentration of that population in urban areas.

While it is a given that advanced sewer systems help to alleviate these issues, the positive effects of sewer systems can be broken down into two categories. The first of these is direct effects, i.e., the direct contributions that sewer projects make to those individuals who discharge waste into the sewer system. The other of these is indirect effects, i.e., the indirect contributions a sewerage system makes to those individuals who are not connected to the system, as well as those contributions the system makes to future generations. In economic terms, such indirect benefits are called external economics, in which production or consumption yields positive benefits to even those who are not paying for said service directly. The following is a series of examples of such benefits.

(1) Improved public health
(2) Infrastructure as a basis for economic development
(3) Construction's short-term effects on the local economy
(4) Construction's long-term effects on the local economy
(5) Using construction to acquire technology

18.3.3 Technical Aspect

In the course of planning the Nuwara Eliya Sewerage System, a various kinds of comparative studies with possible alternatives as to the location of facilities, structure of the system, construction method, material, process and so on were made to establish the optimum plan of the system. The outcome of the Study is aiming at energy- and cost-saving, easy operation and maintenance of the system and minimization of the impact on the surrounding environment during and after construction based on the appropriate technology in due consideration of the current practice in Sri Lanka. The Project is therefore considered feasible from the technical point of view.

18.3.4 Institutional Aspect

Although due consideration be given to the NEMC which is obviously the most appropriate agency that will be in charge of the Nuwara Eliya Sewerage Project after its implementation, the NWSDB has the capability enough to cope with implementation of the Project during construction stage with some addition to the existing organization. After construction, the NWSDB should play main roll for operation and maintenance under the agreement between the NWSDB and the NEMC until the staff of the NEMC will be well trained. On condition that those arrangements will be made, the Project is considered institutionally sound.

18.3.5 Environmental Aspect

Environmental Impact Assessment (EIA) of the proposed project was carried out during the course of the Study. Results of this EIA study has raised certain possibility of environmental impacts by implementation of the project. Preventive measures and relevant legislative arrangements are thereby considered to mitigate the anticipated environmental impacts.

As a whole, the proposed project including the said preventive measures is determined to have minimal and tolerable impacts to the environment.

Among others, the following preventive measures are included in the scope of the proposed project:

(1) Sludge treatment will be minimal by employing the aerated lagoon method.
(2) The sludge discharged from septic tanks which presently discharged directly to environment will be treated at the treatment plant.

CHAPTER 19 CONCLUSION AND RECOMMENDATIONS

19.1 Water Supply Project

19.1.1 Conclusion

The financial viability of the Nuwara Eliya water supply project is much dependent on the tariff rate. The current tariff rate is regarded to be under the proper level in terms of the affordability and in comparison with other public utility charges. The results of the case study with a parameter of incremental rate of tariff, taking into account the current depressed tariff structure, indicates that the Project will be viable if the tariff rate is allowed to be increased at 1 percent per annum for whole phases of the long-term development plan. Even if the project stop after implementation of the Phase 1, which is the subject of the feasibility study as the priority project, requirement to tariff increase is not different from the master plan because most of the facilities will be constructed in Phase 1 and the increase of water demand though the future is not large because due to expecting NRW reduction.

19.1.2 Recommendations

Recommendations towards the implementation of the Project are summarized in accordance with their importance and priorities as follows:

(1) Taking necessary measures for ensuring the feasibility and financial viability of the Project

For the debt service management along with the implementation of the proposed projects and for clearing up the accumulated deficit, the routine efforts in the water supply management such as reduction in NRW, and implementation of the cost containment strategy will not be sufficient. The present water tariff system will therefore need to be reviewed to set up a higher level of tariff structure at reasonable level considering the affordability of the consumers in the study area. The viability of the proposed project will then be assured with such measures to be taken.

(2) Improvement of Non-Revenue Water (NRW)

Reduction of non-revenue water (unaccounted-for water) is a major subject to tackle in the management of the Nuwara Eliya water supply system. It will, if successfully implemented,

result in increase in the revenue and reduction in the operation cost.

Most efficient and economical measures for reduction in NRW may be recommended as follows:

- Leak detection and repair or replace of valves, pipes, service connections, and reservoirs
- Replace "bundles" of service connection lines with appropriately sized distribution main extension pipes
- Provision of water meters to every consumer, repairing the defective water meters, and calibration of reading error.
- Conducting efficient meter reading and billing collection
- Controlling the illegal connection and unbilled legal connections
- Provision or repair of the bulk flow meters to monitor the amount of supply.

(3) Protection of Water Source

It is necessary for the municipality to establish a policy for protection of the surface water sources in terms of quality and quantity of the raw water. For water quality, in particular, the following possible sources of contamination must be paid attention:

a) Cultivation and/or dwelling in the catchment area of surface water sources.
b) Contamination by detergent and soap originating from washing and bathing upstream of intake facilities

For quantity of the water sources, a control system of groundwater utilization in the study area must be established.

(4) Role of the Regional Support Center (Central) and the NEMC

The Central Regional Support Center of the NWSDB is considered as the obvious and most appropriate agency that will be in charge of the Project during its implementation. After completion of the Phase 1 of the project, the NEMC, on the other hand, should play main role for operation and maintenance of the system. The involvement of the RSC (C) and the NEMC, therefore, from the initial stage of the planning and design of the Project is quite significant to reflect the real needs and problems experienced by the RSC the (C) and the NEMC.

(5) Conduct of vigorous investigation on groundwater potentiality.

The groundwater potentiality investigation conducted in this study is based on the presently available data and information. As a result of the investigation, it was found that the study area has high potentiality of groundwater development. Because of constraints of time and budget, identification of the site to be developed and available yield were not finalized. However, it is obvious that if the safe groundwater source can be developed with sufficient quantity, cost for water supply system will be kept at feasible level. Development of surface water sources will cost very high and the project becomes infeasible. In this regard it is strongly recommended that the hydrogeological survey with test well drilling and pumping tests shall be conducted continuously by the NWSDB with support of experienced foreign specialists before implementation of the project.

(6) Provision of Sewerage Services

The augmentation of the water supply capacity will bring the increase in the sewage to be discharged in the service area. At present, on-site sewage treatment systems are working at the hospital, large hotels and factories though most of them were not functioning well. Other remaining areas are served by the on-site facilities, which mainly treat excreta and do not treat other wastewater. The pollution load to be discharged into watercourses will accordingly increase in the area steadily if no countermeasure will be provided. In addition, although the maintenance of those facilities is left to the responsibility of owners, their neglect of proper maintenance of those facilities will lead to the pollution of the surface water and groundwater. The wastewater from the town center of the NEMC, which is the major pollutant discharge area, is discharge to midstream of the Nanu Oya river. It flows down to the Gregory Lake via the Victoria Park. Both of them are the one of major resources for tourism industry. In this regard, high priority should be given to the provision of a proposed sewerage system.

19.2 Sewerage Project

19.2.1 Conclusion

The current water supply service in the NEMC will be improved upon completion of the water supply project by the end of 2004. The increased water consumption will, on the other hand, further accelerate deterioration of urban environment and water pollution in rivers and lakes especially during dry season.

The proposed sewerage project for the NEMC is prepared to mitigate the above mentioned existing and foreseeable problems by the target year of 2005. Likewise, the necessity and appropriateness as well as urgency of the proposed project is substantially acknowledged and justified for betterment of public hygiene and environmental conservation in the NEMC.

As stated in the previous discussions, the sewage tariff to be introduced after implementation of the project will be the critical issue for operation of the project. In order to enable the project financially feasible, at least capital investment shall be granted by the central government. In addition, utmost effort shall be made to increase the number of connections in the service area. In the initial stage, people should pay the high cost for the service connection including the modification of plumbing in private premises. In this regard, financial incentives shall be given to the users in order to ease the burden for the payment such as the special loan services for the people.

It may be concluded that the scope and scale of investment of the project appear appropriate, and effects of the investment seem satisfactory. Because both the NWSDB and the NEMC do not have experience of introduction of the sewerage system with treatment plant, institutional arrangement should be made in both authorities with close relationship each other.

It is quite difficult to recover costs of the investment without substantial financial complements through the central government's financial subsidies even on condition that the tariff increases annually. As a result, it should be assured that the special considerations be made for the financial scheme which can fund the initial capital investment fully.

19.2.2 Recommendations

Recommendations towards the implementation of the Project are summarized in accordance with their importance and priorities as follows:

(1) Taking necessary measures for ensuring the feasibility and financial viability of the Project

Securing the fund for the project through the government's grant is the indispensable for viability of the proposed project.

(2) Establishment of legislative set-up for the sewerage services.

Sewerage service with tariff system is the new concept for the public in built-up area. In order to proceed the project, to promote the service connection and to secure the tariff for its operation and maintenance, legislative set-up is needed.

(3) Establishment of tariff system

Affordable tariff system shall be established through consultation with the officials of the NEMC.

(4) Monitoring of the trade effluent.

The sewerage system was designed for ordinary quality of sewage. If the quality of wastewater from big user is become worse than the expected quality, its influence cannot be ignored. In this regard, establishment of the quality standard of wastewater to be discharged to sewer system is indispensable together with establishment of effective monitoring system.

(5) Role of the Regional Support Center (Central) and NEMC

The Central Regional Support Center of the NWSDB is considered as the obvious and most appropriate agency that will be in charge of the Project during and after its implementation. After implementation of the Phase 1 of the Project, the RSC (C) should play main role in operation and maintenance of the system until the staff members of the NEMC become trained well. The involvement of the RSC (C) and the NEMC, therefore, from the initial stage of the planning and design of the Project is quite significant to reflect the real needs and problems experienced by the RSC (C) and NEMC.

(6) Timely Review of the Feasibility Study prior to the Implementation

This Feasibility Study is prepared on the basis of the presently available data and information and most reasonable projection made from such information. In future, there may be more development or changes in socio-economic or natural conditions in the project area, which are now unforeseeable but might affect, if they occur, the recommendations pre-

sented in the study. It is therefore recommended that the Feasibility Study be timely reviewed in future to take into account the situation at the time of the implementation of the Project.

Figure 3.2

Block Diagram of Existing Water Supply Facilities
(extraction from FINNIDA M/P)

HARISPATTUWA AKURANA/ PUJAPITIYA

DISTRIBUTION 2500 m³/d
GALHINNA 746 M.S.L
11G
DISTRIBUTION 2600 m³/d
12
5300 m³/d
ϕ 280 mm PVC L = 3.90 km
ϕ 225 mm PVC & ϕ 200 mm D.I L = 5.60 km
2700 m³/d
8
BOKKAWELA 580 M.S.L
11S
2700 m³/d
ϕ 225 mm PVC & ϕ 200 mm D.I L = 3.40 km
8
8
GODAHENA Booster sump 650 M.S.L
11
PUJAPITIYA 570 M.S.L
DISTRIBUTION HEEDEMIYA 1000 m³/d
DISTRIBUTION 1500 m³/d
7200 m³/d
MADEDENIYA EXIST 584 M.S.L
16
ϕ 225 mm PVC L = 5.20 km
RAJAPIHILLA EXIST 532 M.S.L
1800 m³/d
8
15
3000 m³/d
ϕ 280 mm PVC L = 2.30 km
DISTRIBUTION RAJAPIHILLA 1000 m³/d
8
UDUWAWALA 510 M.S.L
13
5000 m³/d
14'
ϕ 315 mm PVC L = 5.0 km
DISTRIBUTION RAJAPIHILLA 1900 m³/d
10,200 m³/d
POLGOLLA NADAWALA
DISTRIBUTION HEDENIYA 1600 m³/d
N
17
NUGAWELA 545 N.S.L
DISTRIBUTION KULUGANMANA 2900 m³/d
14
KULUGANMANA EXIST 523 M.S.L
DISTRIBUTION 1500 m³/d
DISTRIBUTION 2900 m³/d
65
GOHAGODA 526 N.S.L.
3800 m³/d
DISTRIBUTION 150 m³/d
DISTRIBUTION 1000 m³/d
700 m³/d
EXISTING DISTRIBUTION 1200 m³/d
GOHAGODA EXIST 526 N.S.L
65
EXISTING ϕ 1600 PVC TYPE 1000
BOGAHAKANDA 562 M.S.L
BOGAHAKANDA Booster Sump 550 M.S.L
YATIHALAGALA 512 M.S.L
64
DISTRIBUTION 1300 m³/d
KMC GOHAGODA
8400 m/d
EXISTING
DISTRIBUTION ALAWATUGODA 2100 m³/d
HEEPITIYA 615 M.S.L
9
ALAWATUGODA BALANCING TANK 2100 m³/d
5000 m³/d
ϕ 315 mm PVC L = 3.76 km
POLGOLLA KAHAWATTA
KURUGODA 571 M.S.L
8
7
DISTRIBUTION ALAWATUGODA 2100 m³/d
DISTRIBUTION AKURANA (UPPER) 500 m³/d
EXIST AKURANA 514 M.S.L
10
2700 m³/d
8100 m/d
350 m³/d
ϕ 110 PVC L = 1.00 km
8
TELAMBUGAHAWATTA 570 M.S.L
DISTRIBUTION 2500 m³/d
DISTRIBUTION 800 m³/d
ϕ 225 mm PVC L = 1.40 km
840 m³/d
ϕ 400 mm DI L = 3.65 km
KAHAWATTA 520 M.S.L
8
6
8
ϕ 350 mm DI L = 6.15 km
DISTRIBUTION AKURANA (LOWER) 5700 m³/d
26,400 m³/d
PHASE I – ϕ 450 mm DI
PHASE II – ϕ 450 mm D.I – YEAR 2000
L = 6.75 km
ϕ 450 mm DI L = 2.3 km
DISTPIBUTION 2500 m³/d
3700 m³/d ϕ 160 PVC EXISTING
EXISTING ϕ 160 mm PVC
EXISTING ϕ 160 mm PVC
1600 m/d ϕ 160 mm PVC
8
5
1
8
ϕ 225 mm PVC, L = 1.65 km YEAR - 2005
KONDADENIYA 535 M.S.L
14900 m³/d
ϕ 450 mm DI ; L = 4.20 km
PROPOSED TREATMENT PLANT
POLGOLLA TREATMENT PLANT (PROPOSED) 450 N.S.L 118,100 m³/d
DISTRIBUTION 675 m³/d
4
JAMBUGAHAPITIYA 565 M.S.L
900 m³/d
ϕ 160 mm PVC L = 2.70 km
UDATALAWINNA 575 M.S.L
DISTRIBUTION 675 m³/d
4
9
DISTRIBUTION 1300 m³/d
3
KAHALLA 500 M.S.L
ϕ 225 mm PVC L = 0.60 km
1500 m³/d
ϕ 225 mm PVC L = 1.50 km
1500 m³/d
L = 2.6 km
1
8
6
BALANAGALA EXIST 513 M.S.L
1800 m³/d 225 mm PVC
DISTRIBUTION 1500 m³/d
3400 m³/d
ϕ 280 mm PVC L = 3.00 km
9900 m³/d
DISTRIBUTION 1200 m³/d
26
8
3700 m³/d
ϕ 280 mm PVC L = 1.30
BANGALAWATTA 523 M.S.L
ϕ 315 mm PVC L = 1.30 km
5100 m³/d
4800 m³/d
ϕ 450 mm DI L = 2.00 km
L = 2.4
ϕ 300 mm L = 0.60 km
PIHILL 525
PO
63,100 m/d ϕ 900 mm DI
L = 2.1 km
39,000 m³/d
L = 1.25 km
KANDY MUNICIPAL COUNCIL
DISTRIBUTION 22 000 m³/d
17
UPLANDS 545 M.S.L
2600 m³/d ϕ 400 mm DI
ϕ 160 PVC
L = 0.4 km
37,100 m³/d ϕ 600 mm DI
DISTRIBUTION 1150 m³/d
30
DAMBARAWA 517 N.S.L
ϕ 225 mm PVC L = 1.35 km
1700 m³/d
POLGOLL
1
8
0.7 km
3800 m³/d
29
DISTRIBUTION 3200 m³/d

PATHA DUMBARA

DISTRIBUTION ALAWATUGODA 2100 m³/d

HEEPITIYA 615 M.S.L

POLGOLLA

KAHAWATTA

KURUGODA 571 M.S.L

DISTRIBUTION AKURANA (UPPER) 500 m³/d

TELAMBUGAHAWATTA 570 M.S.L

DISTRIBUTION 600 m³/d

AKURANA 514 M.S.L

KAHAWATTA 380 M.S.L

DISTRIBUTION AKURANA (LOWER) 5700 m³/d

UDUWAWALA 610 M.S.L

DISTRIBUTION RAJAPHILLA 1900 m³/d

DISTRIBUTION 2600 m³/d

KONDADENIYA 533 M.S.L

ULUGANNANA EXIST 523 M.S.L

DISTRIBUTION 1600 m³/d

DISTRIBUTION 1000 m³/d

GOHAGODA EXIST 528 M.S.L

KMC GOHAGODA

KANDY MUNICIPAL COUNCIL

DISTRIBUTION 675 m³/d

JAMBUGAHAPITIYA 565 M.S.L

UDATALAWINNA 575 M.S.L

DISTRIBUTION 675 m³/d

DISTRIBUTION 1300 m³/d

KAHALLA 500 M.S.L

BALANAGALA EXIST 513 M.S.L

DISTRIBUTION 1500 m³/d

PROPOSED TREATMENT PLANT

POLGOLLA TREATMENT PLANT (PROPOSED) 450 M.S.L 118,100 m³/d

DISTRIBUTION 1700 m³/d

WATTEGAMA 557 M.S.L

WATTEGAMA EXIST. INTAKE 1400 m³/d

DISTRIBUTION 1200 m³/d

BANGALAWATTA 523 M.S.L

PITIYEGEDARA 530 M.S.L

DISTRIBUTION PETIYEGEDARA 1450 m³/d

POLGOLLA, MADAWALA, MANIKHINNA

DISTRIBUTION 500 m³/d

NAPANA 502 M.S.L

PIHILLADENIYA 523 M.S.L

DISTRIBUTION 1000 m³/d

MENIKHINNA 534 M.S.L

DISTRIBUTION 2600 m³/d

KUNDASALE

POLGOLLA KUNDESALE

DAMBARAWA TOWER 517 M.S.L

DISTRIBUTION 1450 m³/d

EXIST FARM SCHOOL

DISTRIBUTION 22 000 m³/d

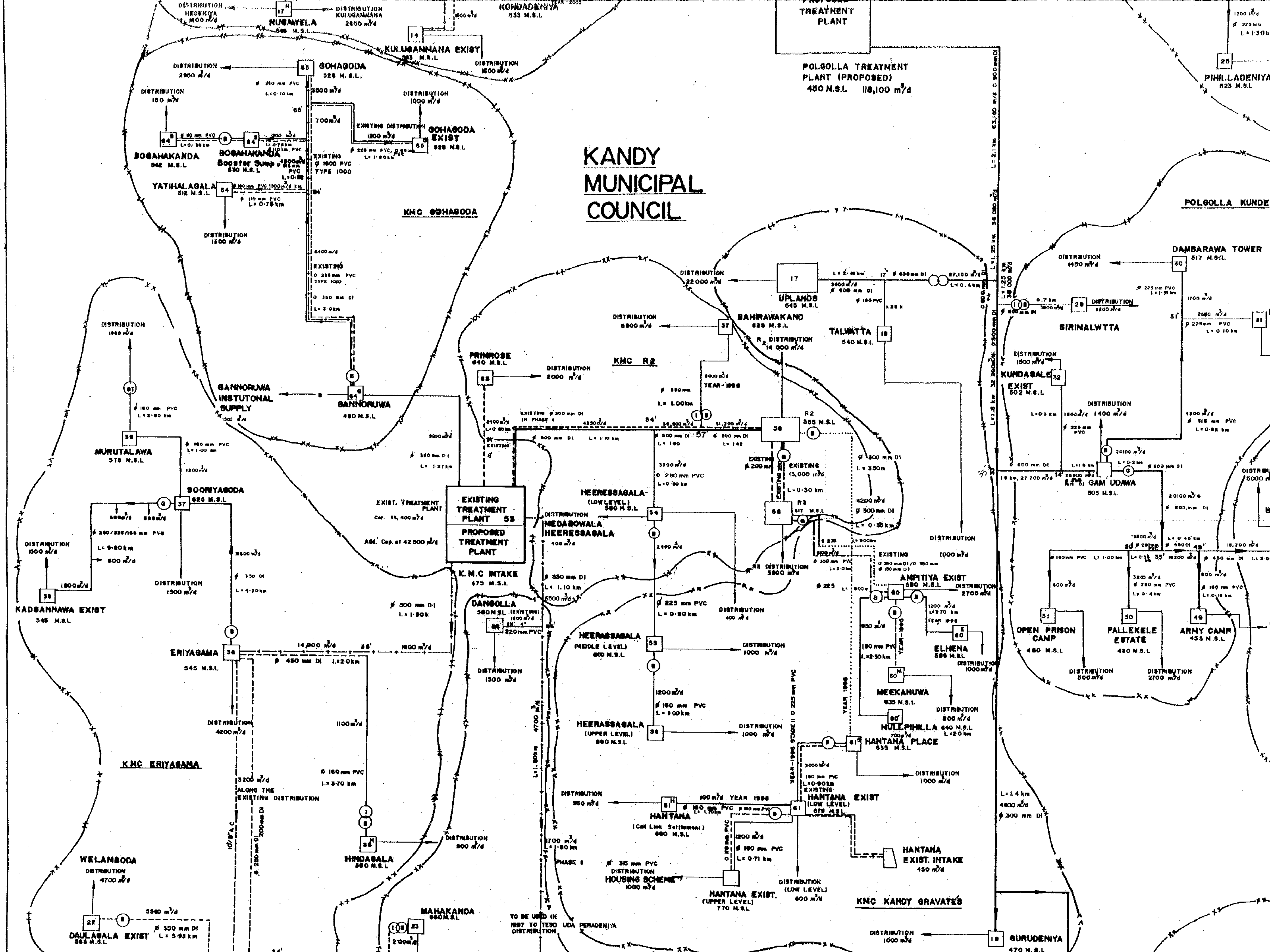
UPLANDS 548 M.S.L

AHASPOKUNA 508 M.S.L

DISTRIBUTION 500 m³/d

MAHABERIY-TENNA

DISTRIBUTION 250 m³/d


KANDY
MUNICIPAL
COUNCIL
POLGOLLA TREATMENT
PLANT (PROPOSED)
450 M.S.L 118,100 m³/d
TREATMENT
PLANT
KONDADENIYA
NUGAWELA
KULUGANNANA EXIST
GOHAGODA
526 M.S.L.
GOHAGODA
EXIST
528 M.S.L
BOGAHAKANDA
BOGAHAKANDA
Booster Sump
YATIHALAGALA
KMC GOHAGODA
GANNORUWA
INSTUTONAL
SUPPLY
GANNORUWA
480 M.S.L
MURUTALAWA
575 M.S.L
SOORIYAGODA
625 M.S.L
KADGANNAWA EXIST
546 M.S.L
ERIYAGAMA
545 M.S.L
KMC ERIYAGAMA
WELAMBODA
DAULAGALA EXIST
HINDAGALA
MAHAKANDA
PRIMROSE
640 M.S.L
KNC R2
UPLANDS
545 M.S.L
BAHIRAWAKAND
TALWATTA
540 M.S.L
EXISTING
TREATMENT
PLANT 55
PROPOSED
TREATMENT
PLANT
EXIST. TREATMENT PLANT
K.M.C INTAKE
475 M.S.L
DANGOLLA
HEERESSAGALA
(LOW LEVEL)
MEDABOWALA
HEERESSAGALA
HEERASSAGALA
(MIDDLE LEVEL)
600 M.S.L
HEERASSAGALA
(UPPER LEVEL)
660 M.S.L
HANTANA
HOUSING SCHEME
HANTANA EXIST.
(UPPER LEVEL)
770 M.S.L
HANTANA EXIST
(LOW LEVEL)
HANTANA
EXIST. INTAKE
450 m³/d
HANTANA PLACE
635 M.S.L
MEEKANUWA
635 M.S.L
HULLPIHILLA
ELHENA
AMPITIYA EXIST
580 M.S.L
KNC KANDY GRAVATES
GURUDENIYA
470 M.S.L
PIHILLADENIYA
523 M.S.L
POLGOLLA KUNDE
DAMBARAWA TOWER
517 M.S.L
SIRINALWTTA
KUNDASALE
EXIST
502 M.S.L
GAM UDAWA
505 M.S.L
OPEN PRISON
CAMP
480 M.S.L
PALLEKELE
ESTATE
480 M.S.L
ARMY CAMP
453 M.S.L
TO BE USED IN 1997 TO TEBO UDA PERADENIYA DISTRIBUTION

KANDY MUNICIPAL COUNCIL

KUNDASALE

POLGOLLA TREATMENT PLANT (PROPOSED) 450 M.S.L 118,100 m³/d

EXISTING TREATMENT PLANT 35

PROPOSED TREATMENT PLANT

K.M.C INTAKE 475 M.S.L

GOHAGODA EXIST 628 M.S.L

DANGOLLA 580 M.S.L (EXISTING) 1800 m³/d ES: 4" 220mm PVC

MAHAKANDA 660 M.S.L

PRIMROSE 640 M.S.L

KMC R2

DISTRIBUTION 2000 m³/d

DISTRIBUTION 6800 m³/d

DISTRIBUTION 22000 m³/d

DISTRIBUTION 14 000 m³/d

BAHIRAWAKAND 628 M.S.L

UPLANDS 545 M.S.L

TALWATTA 540 M.S.L

R2 555 M.S.L

HEERESSAGALA (LOW LEVEL) 560 M.S.L

HEERESSAGALA (MIDDLE LEVEL) 600 M.S.L

HEERASSAGALA (UPPER LEVEL) 660 M.S.L

MEDABOWALA HEERESSAGALA

R3 617 M.S.L

DISTRIBUTION 3800 m³/d

DISTRIBUTION 1000 m³/d

DISTRIBUTION 400 m³/d

DISTRIBUTION 1500 m³/d

DISTRIBUTION 900 m³/d

DISTRIBUTION 1000 m³/d

DISTRIBUTION 1000 m³/d

DISTRIBUTION 2700 m³/d

DISTRIBUTION 1000 m³/d

DISTRIBUTION 1000 m³/d

DISTRIBUTION 600 m³/d

DISTRIBUTION 950 m³/d

DISTRIBUTION 1000 m³/d

DISTRIBUTION 1000 m³/d

ANPITIYA EXIST 580 M.S.L

ELHENA 586 M.S.L

MEEKANUWA 635 M.S.L

MULLEPHILLA 640 M.S.L

HANTANA PLACE 635 M.S.L

HANTANA EXIST (LOW LEVEL) 679 M.S.L

HANTANA (Col Link Settlement) 660 M.S.L

HANTANA EXIST. (UPPER LEVEL) 770 M.S.L

HANTANA EXIST. INTAKE 450 m³/d

HOUSING SCHEME 1000 m³/d

TO BE USED IN 1997 TO TESD DISTRIBUTION

UDA PERADENIYA

GURUDENIYA 470 M.S.L

KNC KANDY GRAVATES

POLGOLLA KUNDESALE

DAMBARAWA TOWER 517 M.S.L

DISTRIBUTION 1450 m³/d

SIRINALWTTA

DISTRIBUTION 3200 m³/d

KUNDASALE EXIST 502 M.S.L

DISTRIBUTION 1500 m³/d

DISTRIBUTION 1400 m³/d

GAM UDAWA 505 M.S.L

EXIST FARM SCHOOL 516 M.S.L

DISTRIBUTION 2100 m³/d

KOLONGASWATTA 555 M.S.L

DISTRIBUTION 1500 m³/d

DISTRIBUTION 5000 m³/d

BALAGOLLA 492 M.S.L

PALLEKELE ESTATE 480 M.S.L

OPEN PRISON CAMP 480 M.S.L

ARMY CAMP 455 M.S.L

DISTRIBUTION 500 m³/d

DISTRIBUTION 2700 m³/d

DISTRIBUTION 500 m³/d

DISTRIBUTION 750 m³/d

I D B 456 m M.S.L 750 m³/d

TO BE CONSTRUCTED UNDER HULUGANGA PROJECT

PIHILLADENIYA 523 M.S.L

DISTRIBUTION 1000 m³/d

MENIKHINNA 534 M.S.L

DISTRIBUTION 2600 m³/d

AHASPOKUNA 608 M.S.L

DISTRIBUTION 500 m³/d

MAHABERIY-TENNA

DISTRIBUTION 250 m³/d

DISTRIBUTION 1200 m³/d

RAJAWELLA 540 M.S.L

VIJAYABRIGANA 550 M.S.L

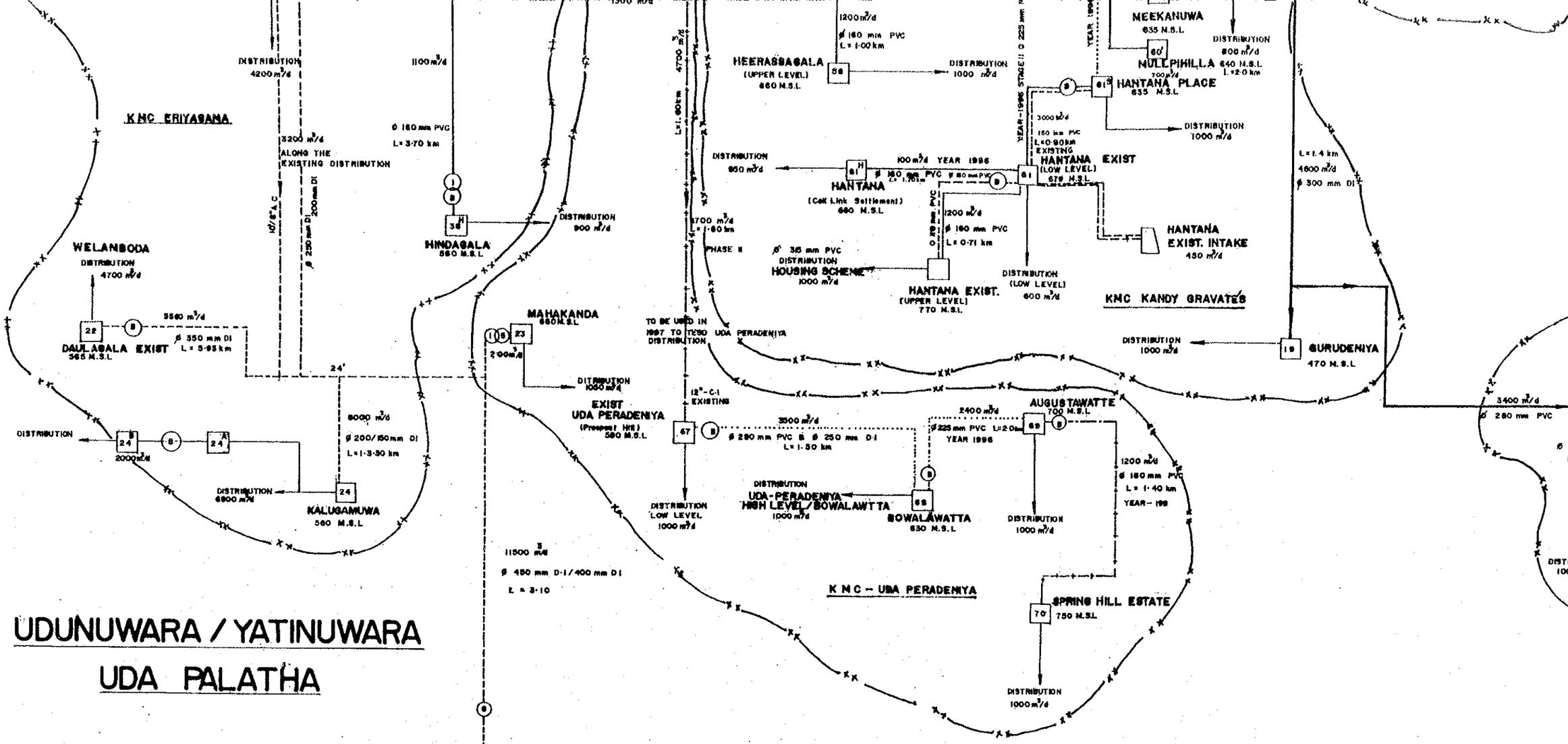
DISTRIBUTION RAJAWELLA/ KUMBUKKANDURA 1500 m³/d

DIGANA VILLAGE 573 M.S.L

DISTRIBUTION 1500 m³/d

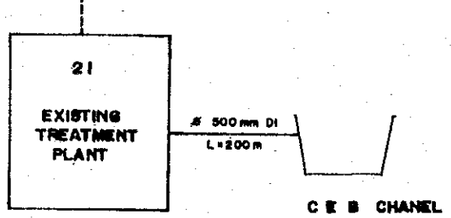
AMBAKOTE 540 M.S.L

DISTRIBUTION 100 m³/d



UDUNUWARA / YATINUWARA

UDA PALATHA



REFERENCE

- Immediate Rehabilitation
- Existing Distribution / Transmition
- Proposed Stage I
- Proposed Stage II
- Existing Reservoirs Location
- Off Line Booster
- Balancing Tank
- Gravity
- Under Implementation
- Proposed Reservior
- Inline Booster

NOTES

ALL RESERVOIRS MARKED 'EXIST' ARE EXISTING STRUCTURES.
ALL OTHER RESERVOIRS ARE PROPOSED OR AUGMENTED STRUCTURES.

RESERVOIRS MARKED BOOSTER SUMP ARE ONLY FOR BOOSTING.
ALL OTHER RESERVOIRS ARE FOR BOOSTING AS WELL AS DISTRIBUTION OR DISTRICT ONLY

THE FLOWS MARKED ALONG TRANSMISSON LINES ARE PEAK DAY FLOWS (AV. DEMAND x 1.18)

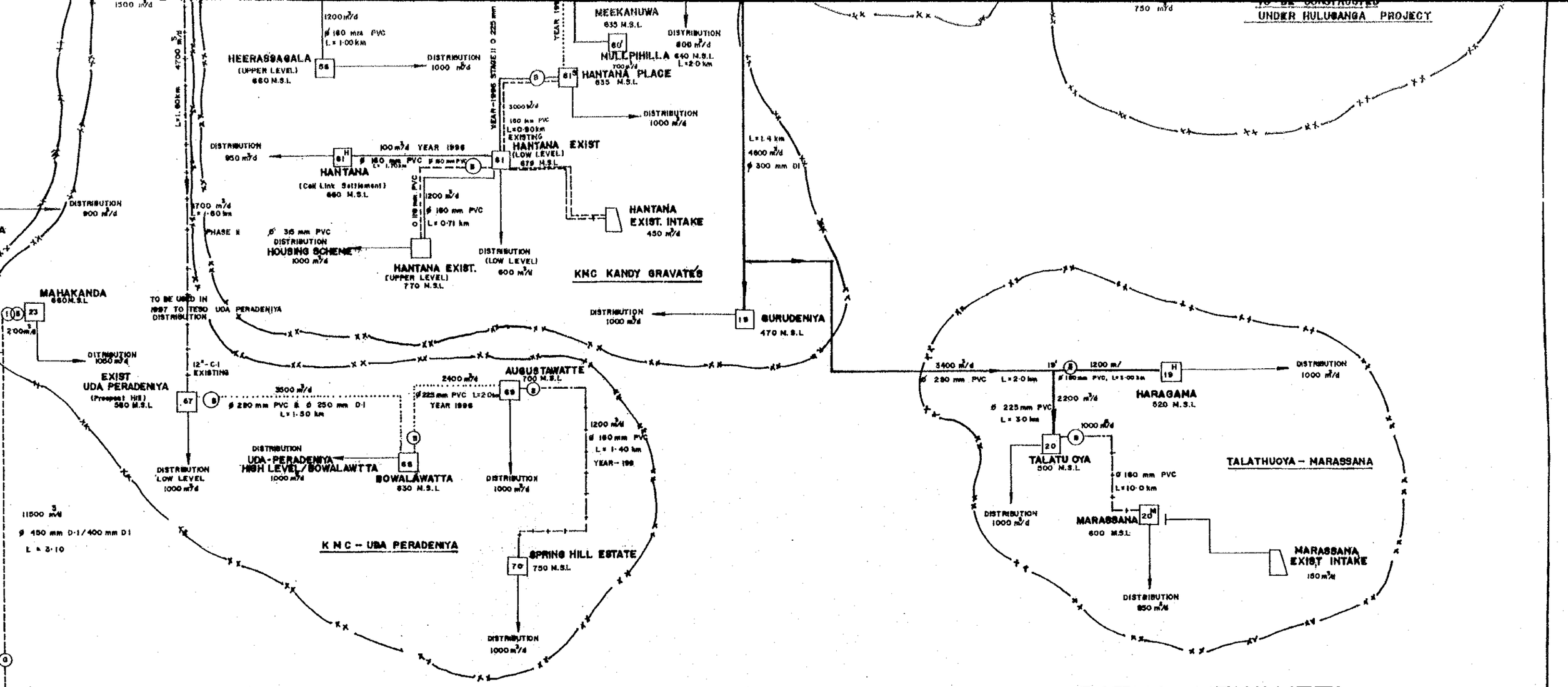
DIAMETERES ARE SELECTED TO MATCH THESE FLOWS.

KANDY & FOUR GRAVETS

WATER SUPPLY MASTER PLAN FOR GREATER KAND

BLOCK DIAGRAM - YEAR 2015

Fig
Bloc



WATER SUPPLY MASTER PLAN FOR GREATER KANDY
BLOCK DIAGRAM - YEAR 2015

Figure 3.2
Block Diagram of Existing Water Supply Facilities (extraction from FINNIDA M/P)