I5.4.2 Sludge Drying Bed

The sludge drying bed is designed basically depending on the sewage generation volume and interval of desludging works at the anaerobic ponds. As same as the Njoro STW, it is proposed that the desludging works are to be carried out at intervals of 6 months.

(1)	Volume of raw sludge	:	6.6 m^3/day x 180 days = 1,188 m^3
(2)	Assumed raw sludge thickness on bed	:	30 cm
(3)	Proposed depth of bed	:	1.2 m
(4)	Proposed dimension of bed		
	Cross-sectional shape	:	Trapezoidal
	Bottom area	:	3,460 m^2, 40.8 m x 84.8 m
	Surface area	:	4,416 m^2, 48.0 x 92.0 m
	Storage capacity	:	4,726 m^3
	Slope of bed	:	5 %

The preliminary design of the sludge dry bed is presented in DWG. T - 6.

I5.5 Building Works

A control office and staff houses are proposed to be newly constructed at the Town STW as follows:

(1) Control office

At present, there is no appropriate office space in the Town STW although the Sewage Works Superintendent has a small space in a building annexed to the digester tank. This building was constructed in 1956 but has been seriously deteriorated. Especially its roof has no effect in waterproofing and it is supposed that reinforcement bars in roof slab might be in a state of serious corrosion.

It is therefore proposed to demolish the existing building and build a new office to ensure safe and proper operation and maintenance of the sewage treatment works. It is proposed to be sited within compound of the Town STW and to be composed of

office, workshop, spare part storage, lavatory and kitchen. Total floor area is 120 m^2. Its structural components are as follows:

Column, beam	:	Reinforced concrete
Roof	:	Steel
Wall	:	Concrete blocks

(2) Staff houses

There is no staff accommodation in the Town STW at all so that no operating staff stations at the site between PM 6:00 and AM 6:00. In order to properly operate and maintain the sewage treatment works day and night, it is proposed to construct adequate number of staff accommodations.

As same as the Njoro STW, Type D is required. The required number is 10.

The preliminary designs of the office and the staff house are shown in DWGs. B - 4 and B- 2 respectively.

I5.6 Mechanical and Electrical Works

(1) Electrical works

With construction of the new control office, existing electric power supply system within the yard needs to be rearranged. The existing main board will be accommodated in the new office and will be connected to the KPLC distribution line. DWG T - 12 shows the single line diagram for the electrical works.

(2) Mechanical works

Timeworn parts of the existing mechanical equipment in the 3,400 m^3/day line will be replaced with the new ones as assessed in Supporting Report C.

The following is the summary of the mechanical and electrical works required :

Table I - 1 Major Mechanical and Electrical Works

	Work Items	Unit	Quantity
(1)	Mechanical works		
	Drain pumps, 50 mm dia., H = 12 m, with mercury level switch	set	3
	Inlet gate, cast iron	set	1
	Coarse screen, SUS, at inlet	set	1
	Fine screen, SUS, at inlet	set	1
(2)	Electrical works		
	Main distribution board	set	1
	Distribution panel at grit chamber	set	1
	Control cabinet at deep well p/s	set	1
	Control cabinet at recirculation p/s	set	1
	Control cabinet at sludge dry bed p/s	set	1

(Data source : Study Team)

I5.7 Land Requirement

The land of the Town STW is required to be expanded to 55.3 ha for construction of the new and additional sewage treatment facilities, stormwater retention pond and sludge drying bed. The existing compound area covers only 13.3 ha so that the additional requirements is 42.0 ha.

I6. PRELIMINARY DESIGN OF STORMWATER RETENTION POND

I6.1 Introduction

During storm garbage, debris, oil and other materials accumulating in the town area flush down to Lake Nakuru through the drainage channels, resulting in anaethenic conditions. In Nakuru, Town Stormwater Drainage drains the central part of Nakuru Municipality of 374 ha as shown in Fig. I - 6. Pollutant load in terms of BOD through the Stormwater Drainage is estimated at 161 ton BOD/year constituting about 11% of the total BOD load. Stormwater flushing occurs about 80 times a year .

Most immediate concern with the Town Stormwater Drainage Channel is to prevent garbage/debris, oil and sediments reaching the lake during storm and a stormwater retention pond is proposed to remove those matters. Removal is effected by retention. Removal of oil, garbage/debris and part of sediments will also reduce pollutant loads to a certain extent although quantitative estimate is not provided.

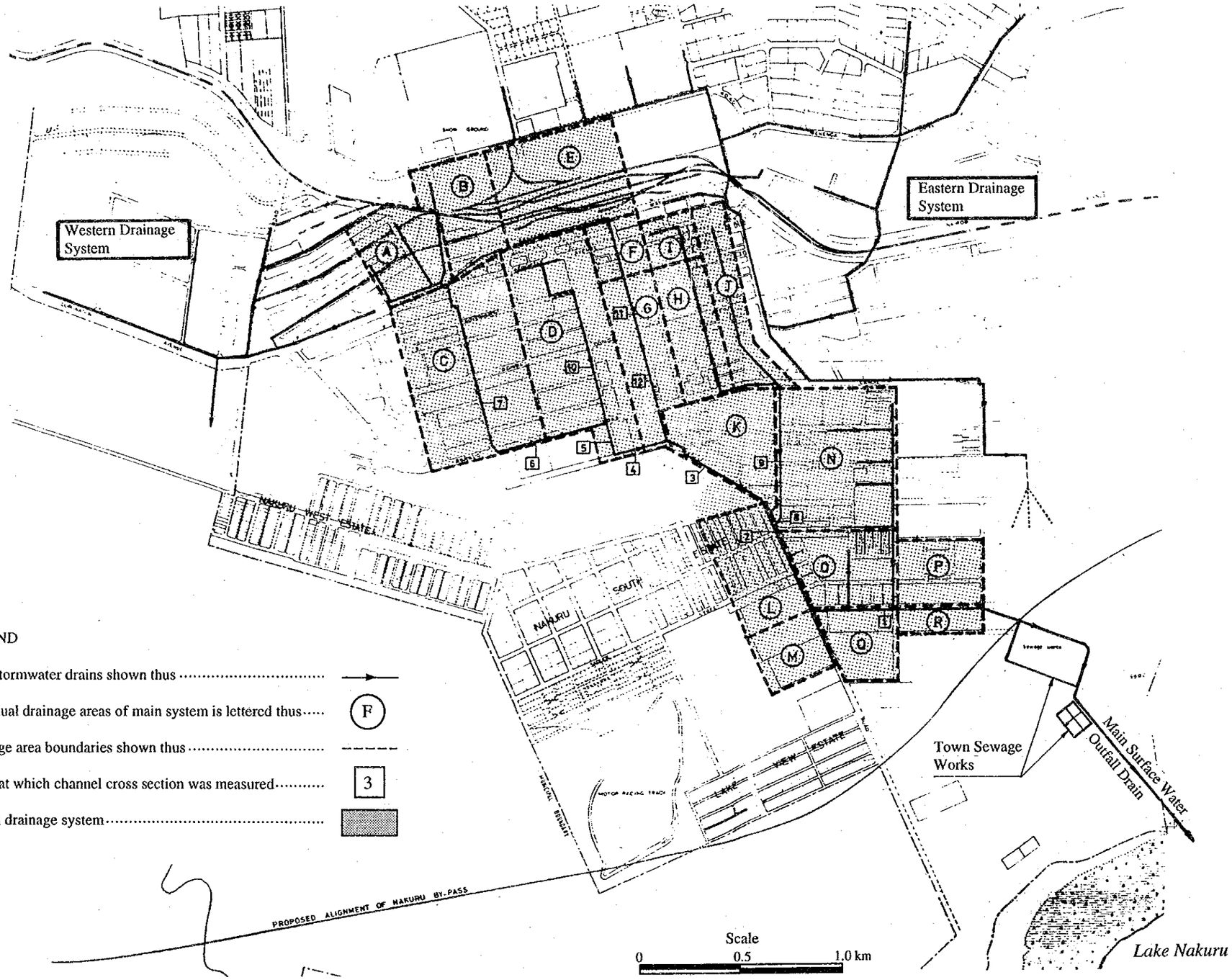
I6.2 Design Conditions and Criteria

I6.2.1 Storm Runoff

Detailed hydrological analysis on the first lush phenomenon for the Town Stormwater Drainage Channel is found on "The Preliminary Design Report on Sewage Treatment Works (Town Site), June 1978" prepared for NMC and MOLRRWD. From the field survey it was found that the basic conditions employed in the said report are still applicable and adopted for the stormwater volume to be used for design. A brief description of the basic conditions employed is made here.

Rational Method was used for estimating the run-off. Drainage area is divided into eighteen (18) smaller districts and appropriate run-off coefficients as shown in Table I - 2 are used. Time of concentration for the remotest district was calculated to be 46 minutes.

Fig. I-6



LEGEND

Main stormwater drains shown thus ····· →

Individual drainage areas of main system is lettered thus ····· (F)

Drainage area boundaries shown thus ····· ----

Points at which channel cross section was measured ····· 3

Central drainage system ····· ▒

[Source : **Preliminary Design Report on Sewage Treatment Works (Town Site), 1978]**

THE REPUBLIC OF KENYA	THE STUDY ON THE NAKURU SEWAGE WORKS REHABILTION AND EXPANSION PROJECT	TITLE
MINISTRY OF LOCAL GOVERNMENT	JAPAN INTERNATIONAL COOPERATION AGENCY	GENERAL LAYOUT OF STORMWATER DRAINAGE NETWORK

Table I - 2 Run-off Coefficients for Use in Nakuru

	Drainage Area	Run-off coefficient
1.	Town Centre	0.40
2.	Industrial Area	0.40
3a.	Residential, medium density	0.30
3b.	Residential, high density	0.30
4.	Kenya Railways Yard	0.10

(Source: NMC & MOWD)

Depth-duration-frequency relationship used in the said report is shown in Table I - 3 and compared with in the "Rainfall Frequency Atlas of Kenya by the Director of Water development".

Table I - 3 Comparison of Rainfall Intensity

			Return Period (year)		
			2	5	10
Preliminary Design of Sewage Treatment Works	Formula		$\frac{46.06}{(t+0.33)^{0.97}}$	$\frac{60.63}{(t+0.33)^{0.99}}$	$\frac{71.21}{(t+0.33)^{0.99}}$
	Rainfall Intensity, mm/h	Duration 60 min	35	46	54
		Duration 10 min	91	121	142
Rainfall Atlas of Kenya	Formula		-	$\frac{62.66}{(t+0.417)}$	$\frac{71.83}{(t+0.40)}$
	Rainfall Intensity, mm/h	Duration 60 min	-	44	51
		Duration 10 min	-	107	124

Note: Rainfall duration t is in hours
(Data Source: Study Team)

Rainfall intensities for sixty minutes and ten (10) minutes duration are also shown for return periods of 2, 5 and 10 year. Rainfall Atlas recommends a slightly lower rainfall intensity than that used for the drainage system. For safety, those values used for the design of drainage system will be adopted.

Return period for the design storm was 5 years and its duration was 46 minutes (i.e. which reaches from the remotest location in the drainage system) is considered for screening/oil removal/sedimentation in the Stormwater Retention Pond. Corresponding rainfall intensity is 42 mm/h and the stormwater volume reaching near Town STW for the first 46 minutes is 14,200 m^3.

I6.2.2 Sediment Deposit

No appropriate data is available to quantitatively estimate the sediment yield from the Town area. According to the Study on Construction of Dam in Malewa River System for Greater Nakuru Water Supply Project, the average annual suspended loads transport is estimated at 0.04 mm/km^2 for the Malewa river, which is also located in the Rift Valley. By applying this figure the annual sediment transport by the town stormwater drain is estimated at 150 m^3 per year.

I6.3 Preliminary Design

I6.3.1 Stormwater Drainage Channel

The existing stormwater drain should be relocated owing to the construction of the new 3,200 m^3/day line and additional treatment facilities. It carries not only the stormwater collected from its catchment area but also the treated sewage from the Town STW into Lake Nakuru. The new alignment is shown in DWG. T - 1.

The drain is designed with the same dimensions as the existing one so as not cause the adverse effect due to relocation. It is basically of trapezoidal cross-sectional shape and lined with concrete. The longitudinal profile and typical cross section are shown in DWG. S - 1.

I6.3.2 Stormwater Retention Pond

The pond is designed to be capable of absorbing a whole of the estimated stormwater volume and is proposed to be located close to the APs as shown in DWG. T - 1. Details of the pond and its ancillary structures are as shown in DWG. S - 2.

The pond is directly connected to the stormwater drain through a culvert with 1.5 m square. The dimensions of the pond is as summarized below :

Full Water Level	:	El. 1,777.0 m
Bottom level	:	El. 1,775.5 m
Dimensions		
Bottom area	:	8,568 m^2, 68 m x 126 m
Area at FWL	:	10,395 m^2, 77 m x 135 m
Water depth	:	1.5 m
Storage capacity	:	14,222 m^3
Side slope	:	1.0 : 3.0

The pond will be constructed by the same method as the WSPs.

At the inlet of the pond, an oil trap is sited, while an outlet with an overflow pit is provided at the southern corner of the ponds. The water retained have to be drained out into either the stormwater drain and the FPs through a drainage pipe.

I7. GUIDELINES FOR OPERATION AND MAINTENANCE

I7.1 Guidelines for Operation and Maintenance

I7.1.1 Sewerage System

It is identified through the pollution load estimate study that the sewage treatment works are the main source of pollution into Lake Nakuru. The rehabilitation and expansion of the sewage works have been planned aiming at reducing the pollution load. It is therefore keenly required to operate and maintain the sewage treatment works efficiently and functionally as long as possible in order to achieve the objective of the Project.

On the basis of evaluation of the existing facilities and design of the new and additional facilities, the Study Team elaborated a basic guideline for operation and maintenance of the respective component of the sewerage system for reference to WSD. The operation and maintenance works will be classified into daily routine works and a periodical works.

(1) Sewer network

(a) Daily routine work

- Removal of sewer blocking
- Cleansing of sewers
- Leakage detection and protection

WSD has been putting much effort on the daily routine works under the management of a Sewer Superintendent. Such efforts are expected to be continued.

(b) Periodical works

- Cleansing of all sewers block by block, preferably one in 5 years

The sewered area is divided into a number of blocks. It is necessary to wash out the sediment, sludge and other deposits. The periodical works could be executed directly by the WSD by using the maintenance equipment proposed.

(2) Sewage pump station

(a) Daily routine works

- Monitoring of sewage inflow and pump operation for 24 hours
- Removal of grit and sediment
- Lubrication of the mechanical equipment

(b) Periodical works

- Maintenance and repair of mechanical and electrical works
- Painting of steel work

The pumping equipment needs to be replaced periodically. A careful monitoring is indispensable in order to facilitate the budgeting for new equipment.

(3) Sewage treatment works

(a) Overall daily routine works

- Removal of grit, scum, rubbish and other foreign materials at inlets by man-power
- Monitoring of quantity and quality of influent and effluent
- Removal of scum, floating grass, etc. at waste stabilization ponds
- Lubrication of mechanical equipment
- Grass cutting and erosion control on slopes of waste stabilization ponds
- Minor repair of mechanical and electrical equipment at workshop
- Grass cutting at grass plots as required.

All the above routine works can be accomplished directly by the WSD staff.

Apart from the above, it is suggested to amend the operation method of recirculation pumps of the existing 3,400 m^3/day line at Town STW as follows: This focuses to operate the trickling filter during a 24-hour in order to ensure the quality of effluent from the plant and to maintain the function of the trickling filter.

Time	Operation Mode
AM 6:00 - PM 9:00	Full operation
PM 9:00 - AM 6:00	10 minutes for every three hours

It is required to make operative the recirculation pump accordingly.

(b) Periodical work

(i) Anaerobic ponds

- Desludging preferably at intervals of 6 months by using mud pumps to be executed directly by the WSD.

(ii) Waste stabilization ponds

- Desludging works
- Repair of pond outlets and inlets as required

In general the waste stabilization ponds does not require frequent desludging works. A timing of desludging should be judged through a careful monitoring of sludge accumulation condition during the routine works. It is foreseeable that there will be needs for mobilization of adequate construction equipment for such desludging work, since ponds are large in area and desludging volume is huge. Accordingly it would be imperative to procure an appropriate contractor for such desluding work.

(iii) Rock filter

- Washing of rock fragments, preferably every 3 months, and drying up them for about one-month period.
- Removal of sludge at the same time with the above.

These periodical works are expected to be executed by the WSD by using the same equipment as required for the desludging at the APs.

(iv) Grass plots

- Adjustment of grading and filling up water courses with earth material and grass.

These works is preferred to be carried out frequently to avoid short cut flow.

(v) Rock filter drain pit

- Pumping the water up from the drain pit to the nearest pond to accelerate sludge drying
- Disposal of sludge by the same method as that from sludge drying bed.

I7.1.2 Guidelines for Sludge Treatment and Disposal

There will be two different types of sludge treatment facilities as summarized below:

Table I-4 Sludge Treatment Method

Sewage Treatment Works	Sewage Volume	Sludge Treatment Facilities
Njoro	9,600 m^3/day	Sludge drying bed (new)
Town		
Existing line	3,400 m^3/day	Digester + sludge drying bed (existing)
New line	3,200 m^3/day	Sludge drying bed (new)

The design of the new sludge drying beds are reported in Chapters 4 and 6 of this report.

The existing digester is evaluated to be capable of treating the sludge generating only from the sewage amounting to 3,400 m^3/day and is expected to be operated continuously. Thus the sludge treatment method is mentioned only for the new facilities:

(1) Sludge removal from anaerobic pond

It is deemed appropriate to use mud pump to remove the sludge out from the anaerobic pond. The proposed pump is capable of discharging 1.2 m^3/min at a rated head of 10 m. The anaerobic ponds are proposed to be emptied at intervals of 6 months. It is desirable to execute the desludging work in such way that the incoming sewage is diverted into the facultative ponds and sludge to the drying bed.

Table I-5 Required Day for Desludge at Anaerobic Ponds

Sewage Treatment Works	Number of APs	Volume of Each AP	Pump/1 Capacity	Required Day for Empty
Njoro	2	6,777 m^3	1,224 m^3/day	5.5 days
	2	9,605 m^3	1,224 m^3/day	7.8 days
Town	2	6,099 m^3	1,224 m^3/day	5.0 days

(Data source: Study Team)
/1 : 12 hours operation/day

The sludge pumped should be discharged into the sludge drying bed through a drain horse. The sludge removal work should be carried out by the WSD operation and maintenance staff.

(2) Sludge volume and drying

The daily raw and dried sludge volumes are estimated as follows:

Table I-6 Raw and Dried Sludge Volumes

Sewage Treatment Works	Daily Sludge Production		Annual Sludge Production	
	Raw (m^3/d)	Dried (m^3/d)	Raw (m^3/d)	Dried (m^3/d)
Njoro	20.0	4.0	7,300	1,460
Town	6.6	1.3	2,410	475

(Data source: Study Team)

The raw sludge is assumed to be spread over the sludge drying bed with a thickness of 30 cm in order to accelerate percolation and evaporation of water.

(3) Disposal of dried sludge

According to the sludge quality investigation, toxic and heavy metals are detected, although their concentration are not exceeding the standard values set forth by the other countries as Germany and Japan. However there exist a number of industries in the Njoro Sewerage District, producing various toxic and heavy metals. This implies that there may be possibility of accumulation of such materials until proper pre-treatment of industrial wastewater.

Although it is desirable to dose the dried sludge on the cultivated lands, quality of the sludge must carefully be monitored for the reasons mentioned above. It is therefore tentatively proposed that the dried sludge will be hauled and disposed to the dumping site with adequate precautions.

NMC should identify the dumping site in and around the Study Area and adopt the safe dumping method.

I7.1.3 Stormwater Retention Pond

The operation and maintenance work in the stormwater retention pond is also classified into daily routine and periodical works as follows:

(1) Daily routine works

- To remove rubbish, oil and other foreign materials at oil trap by the WSD staff at Town STW.

- To make the pond empty as soon as cease of storm rainfall by operating outlet gate/drain valve.

- Grass cutting and maintenance of embankment

(2) Periodical work

- Removal of sediment deposit, probably once two-three years, by using the same equipment for sludge removal by the WSD.

I7.2 Proposed Operation and Maintenance Equipment

For successful and effective performance of operation and maintenance works, it is proposed to strengthen the operation and maintenance equipment. The existing equipment have been surveyed and as a result, it is proposed that the WSD be provided with the operation and maintenance equipment listed up in Table I-7.

Table I-7 List of Operation and Maintenance Equipment

Item No.	Items	Unit	Quantity
A.	**Workshop Equipment**		
(1)	Tool box with assorted tools	lot	1
(2)	Electric angle grinder, 8 inch	set	1
(3)	Drill bits, 2 to 12 mm dia. with stand	set	1
(4)	Portable electric blower, 50 cm dia..	set	1
(5)	Gear puller	set	1
(6)	Tap and dies. M2 to M12 fine thread	set	1
(7)	Gas welding set	set	1
(8)	Electric welder, 100A	set	1
(9)	Electric tool box with assorted tolls	lot	1
(10)	Drilling machine	set	1
(11)	Air compressor	set	1
(12)	Vice	set	1
(13)	Chain block	set	1
(14)	Hydraulic jack	set	1
(15)	Shelf with rack	set	1
(16)	Gate crane, movable type	set	1
B.	**Operation and Maintenance Equipment**		
(1)	Mud pump, Dia. 100 mm, 1.2 m^3/min., H=10 m	set	3
(2)	Generator for the above, 8 KVA	set	2
(3)	Truck with 1 ton crane	unit	1
(4)	High pressure sewer cleaner, 4 ton vehicle	unit	1
(5)	High pressure sewer cleaner, vacuum car, 4 ton	unit	1
(6)	High pressure sewer cleaner, water tanker, 4 ton	unit	1
(7)	Plug for water stop, 225, 300, 375 mm, 2 each	nos.	6
(8)	Pick up truck, 1 ton	unit	2
(9)	Tractor shovel with back-hoe attachment, 0.4 m^3	unit	1
(10)	Dump truck, 6 ton	unit	2
(11)	Gas mask	set	6
C.	**Testing Apparatus for Existing Njoro Laboratory**		
(1)	Low temperature incubator	no.	1
(2)	Drying oven	no.	1
(3)	Aspirator	no.	1
(4)	Air pump	no.	1
(5)	Portable pH meter	no.	1
(6)	Portable DO meter	no.	1
(7)	Portable conductivity meter	no.	1
(8)	Portable ORP meter	no.	1
(9)	Balance	no.	1
(10)	Analytical balance	no.	1
(11)	Automatic sampler	no.	1
(12)	Sampling bottles	set	1
(13)	Glassware & other accessories	lot	1

(Data source : Study Team)

I7.3 Re-use of Treated Sewage

Water is a precious resources in the arid zone like the Study Area. The sewage could also be used for various purpose after proper treatment meeting the purpose under consideration. The project applies the waste stabilization pond method for sewage treatment, which would makes possible to use the treated water technically for irrigated agriculture and aquaculture. The relevant issues are discussed below:

(1) Irrigated agriculture

The quality of the irrigation water shall meet the "Microbiological Quality Guideline for Treated Wastewater Used for Irrigation (for the Protection of Human Health, WHO" and "Physicochemical Quality Guideline; FAO". The former sets forth that the fecal coliforms shall be less than 1,000 MPN/100 mL for unrestricted irrigation. The effluent quality of the project would meet this requirement.

The supply of irrigation water will however result in increasing crop intensity, which would induce to apply more fertilizer and agro-chemical to increase the crop yield. Drainage from irrigated land would contain a certain amount of residual fertilizer and agro-chemical and eventually runs down into Lake Nakuru, owing to the topographic condition, probably causing adverse effect on the lake ecology.

(2) Aquaculture

It may be possible to breed fish in the maturation ponds, where the BOD concentration is expected to be less than 50 mg/L. This is being realized at the Kericho STW.

The primary purpose of the project is to reduce the pollution load into Lake Nakuru through rehabilitation and expansion of sewage treatment works. The re-use of the treated water means the increased water supply, resulting in creating additional pollution loads, and accordingly contravenes the primary purpose of the project. It is more important to constrain the water consumption in the lake catchment area by means of such measures as controls of population increase, industrialization, land use, urban development, etc.

J : PROJECT COST ESTIMATE

J: PROJECT COST ESTIMATE

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

J1. INTRODUCTION

This is the sector report of construction plan and cost estimate for the study on the Nakuru sewage works rehabilitation and expansion project. The report aims to estimate the project financial cost according to the project implementation schedule on the basis of the feasibility design.

Major works of the project consist of (1) the rehabilitation and expansion of town sewage treatment works, (2) the rehabilitation of Njoro sewage treatment works, (3) the rehabilitation of Mwariki sewage pumping station, (4) the construction of water quality testing laboratory, and (5) the supply of operation and maintenance equipment.

The project financial cost has been estimated on the price level of November 1993, according to (1) the survey and investigation for availability of construction materials, equipment and labour force and those unit prices in Kenya at September 1993, conditions of contractor's force, infrastructures and others affecting the project execution, (2) the proposed construction plan and schedule, and (3) the bill of quantities for construction works.

J2. CONSTRUCTION PLAN AND SCHEDULE

J2.1 General Description of the Project

The Nakuru Sewage Works Rehabilitation and Expansion Project, hereinafter said the Project, aims to improve effluents condition of sewer to the lake Nakuru by rehabilitation and expansion of existing Town and Njoro Sewer Treatment Works.

The project site is located in the Nakuru municipality which is situated about 177 km northwest of Nairobi, capital of Kenya. The industrial and commercial development has been geared mainly to the agricultural potential of the area. While there are many garages and workshops concerned with the distribution and repair of agricultural machinery and vehicles. Nakuru is also main depot of the Kenya Railways, being on the main Kenya - Uganda rail link. The town lies on the shores of lake Nakuru which is a major tourist attraction in Kenya. The altitude of the municipal area varies widely from around EL.1950 m to EL.2100 m.

The monthly mean maximum and minimum temperatures are 25.4 and 10.8 centigrade degrees respectively. Temperature is high during the period from January to March and in September. The annual rainfall is 1019 mm in an average ranging from 756 mm to 1236 mm during 5 years of 1988 to 1992. The driest months are December to February, while wetest months are those of long rains, March, April and May of the annual rainfall nearly 40%. The amount of rainfall varies largely from year to year.

The Lake Nakuru has no outlet. Five major river systems, Njoro, Lamudiak, Ngosur, Makalia and Enderit, flow in the lake. The lake level fluctuates only by a balance of inflow such as runoffs of the rivers, precipitation on the lake and sewage from the municipality. Most of the rivers have small catchments, being less than 300 km^2, and their catchment areas are mostly covered by secondary grasslands, upland acacia wood lands, savanna and bushland and upland evergreen and semi-deciduous bushland.

The project site is covered by sedimentary soil formed as a result of sedimentation of Menengai crater or Old Lake Nakuru. The upper sedimentary foundation is made up of a complex mixture of silt, sand, volcanic ash and pumice layers. These sedimentary soil layers are under exceedingly consolidated condition. The lower layer are composed of tuff or lava that were deposited from Menengai Crater during the period from Pliocene to Pleistocene. The tuff or lava that constitutes the foundation of the area has the upper layer of weathered soil with a thickness of 0.5 to 1.0 m and the lower layer in fresh condition.

J2.2 Principal Features of the Project

The proposed design inflow rate of Town and Njoro sewage treatment works are as tabulated in Table J-1.

Table J-1 Design Inflow Rate

Town STW :	Rehabilitation of existing	3,400 m^3/day
	Expansion	3,200 m^3/day
	Total	6,600 m^3/day
Njoro STW :	Rehabilitation of existing	3,600 m^3/day
	Nakuru Sewerage Project	6,000 m^3/day
	Total	9,600 m^3/day
	Total, Town and Njoro	16,200 m^3/day

The respective component of rehabilitation and expansion works of the project are summarized as below.

(1) Mwariki sewage pumping station

(a)	Submersible pumps with appurtenants	7.5 kW x 3 sets
(b)	Control house	31 m^2 x 1 house
(c)	Lifting equipment	1.0 ton x 1 set

(2) Njoro sewage treatment works

(a)	First flush pond	1-pond, 45 m x 78 m x D 3.5 m
(b)	Anaerobic pond	2-pond, 45 m x 78 m x D 3.5 m
(c)	Facultative pond	2-pond, 154 m x 266 m x D2.0 m
(d)	First maturation pond	2-pond, 100 m x 170 m x D2.0 m
(e)	Second maturation pond	2-pond, 30 m x 170 m x D2.0 m
(f)	Third maturation pond	2-pond, 30 m x 170 m x D2.0 m
(g)	Rock filter	2-line, 30 m x 110 m x H2.0 m, and 4-line, 30 m x 92 m x H4.0 m for 6000 m^3/day
(h)	Grass plots	1.8 ha x 2-bed 1.5 ha x 4-bed for 6000 m^3/day
(i)	Sludge drying bed	1 place

(3) Town sewage treatment works

(a)	Stormwater retention pond	1-pond, 60 m x 188 m x D2.0 m
(b)	Anaerobic pond	2-pond, 44 m x 73 m x D3.5 m
(c)	First flush pond	1-pond, 44 m x 73 m x D1.0 m
(d)	Facultative pond	4-pond, 93 m x 281 m x D2.5 m x 2, and 115 m x 326 m x D2.5m x 2
(e)	First maturation pond	4-pond, 70 m x 176 m x D2.0 m x 2, and 88 m x 175 m x D2.0 m x 2
(f)	Second maturation pond	4-pond, 42 m x 108 m x D2.0 m x 2, and 40 m x 106 m x D2.0 m x 2
(g)	Third maturation pond	4-pond, 42 m x 108 m x D2.0 m x 2, and 40 m x 110 m x D2.0 m x 2
(h)	Rock filter	2-line, 30 m x 104 m x H2.1 m x 2, and 30 m x 98 m x H 2.1 m x 2
(i)	Grass plots	1.7 ha x 2, and 1.6 ha x 2
(j)	Control house	120 m^2 x 1
(k)	Mechanical and electrical equipment for existing STW	1 lot
(l)	Workshop equipment and tools	1 lot
(m)	Staff houses	10 x 40 m^2 approx.
(n)	Sludge drying bed	1 place

(4) Water quality testing laboratory

(a)	Building	350 m^2 x 1
(b)	Testing equipment and tools	1 lot
(c)	Operation guidance for laboratory and testing apparatus	lump sum

(5) Procurement of operation and maintenance equipment

(a)	Workshop equipment, Town STW	1 lot
(b)	Operation and maintenance equipment	1 lot

J2.3 Implementation Plan

J2.3.1 Implementation Schedule

The proposed implementation schedule for the project are shown in Fig. J-1. The project implementation will be about two (2) years, which is consisted of the financial arrangement, detailed design including additional survey and investigation, and construction work as summarized below.

(1)	Financial arrangement	3.0 months
(2)	Detailed design	3.5 months
(3)	Tender/contract	2.5 months
(4)	Construction works	
	- Mwariki SPS	3.0 months
	- Town STW	16.0 months
	- Njoro STW	16.0 months
	- Laboratory	6.0 months

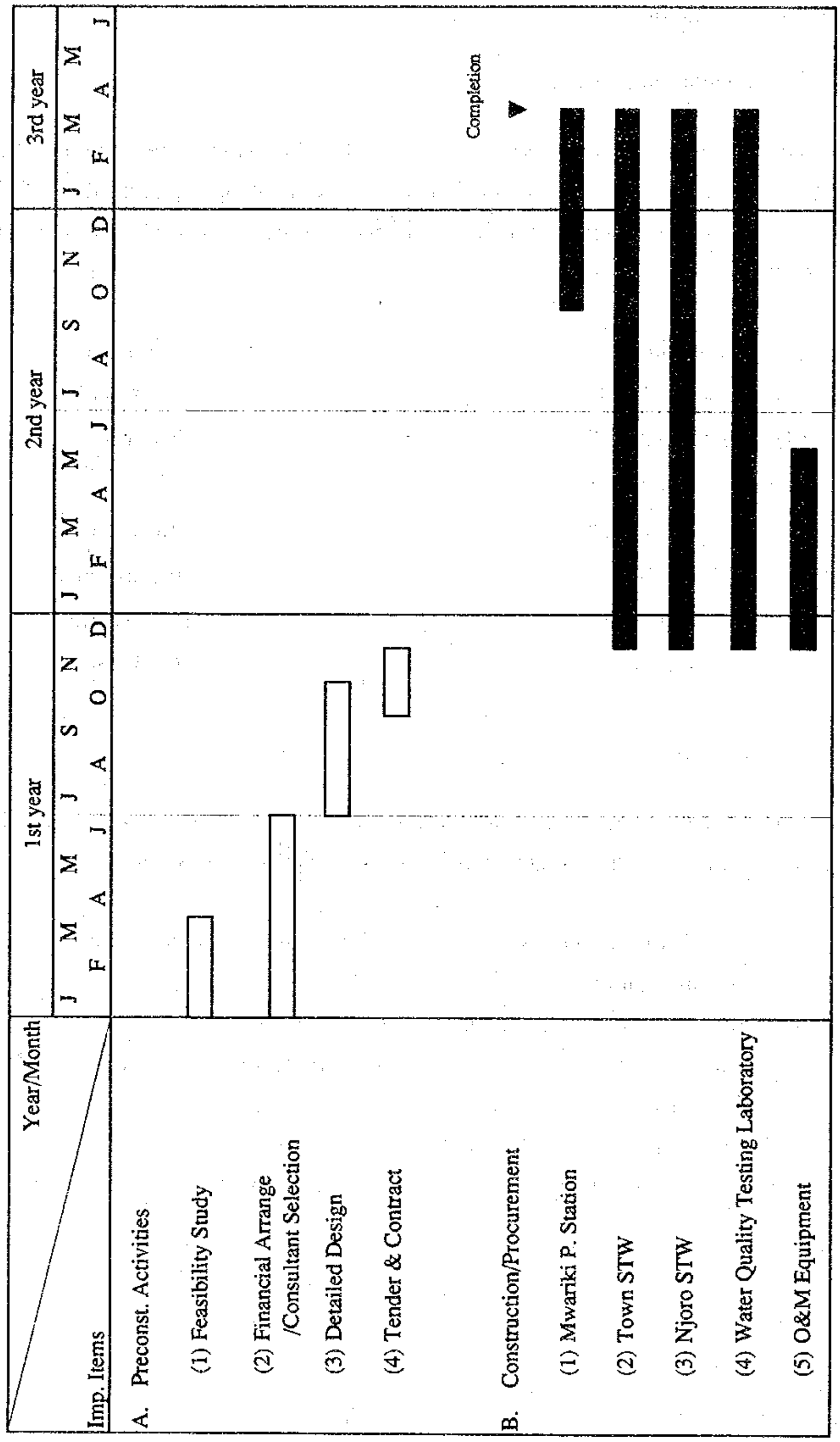
J2.3.2 Financial Resource

The finance for the project implementation will be provided by Kenyan Governmental budget and other supporting finance for the following project components.

- Rehabilitation and expansion for Town and Njoro STWs and Mwariki sewage pumping station,
- Construction of water quality testing laboratory,
- Testing apparatus for the water quality testing laboratory and Njoro existing laboratory,
- Procurement of O&M equipment, and
- Engineering services for detailed design & construction supervision.

Fig. J-1

Fig. J-1 Implementation Schedule



THE REPUBLIC OF KENYA MINISTRY OF LOCAL GOVERNMENT	THE STUDY ON THE NAKURU SEWAGE WORKS REHABILITATION AND EXPANSION PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE IMPLEMENTATION SCHEDULE

J2.3.3 Mode of Construction

The project construction works will be carried out by selected contractor/s in the method of competitive bid through the prequalification tender.

J2.3.4 Implementation Organization

The proposed implementation organization is as shown in Fig. J-2. The construction works will be administrated by the project office organized under the Urban Development Department.

J2.4 Construction Works

J2.4.1 General

The construction works for Nakuru sewage works rehabilitation and expansion project are categorized as the following work components.

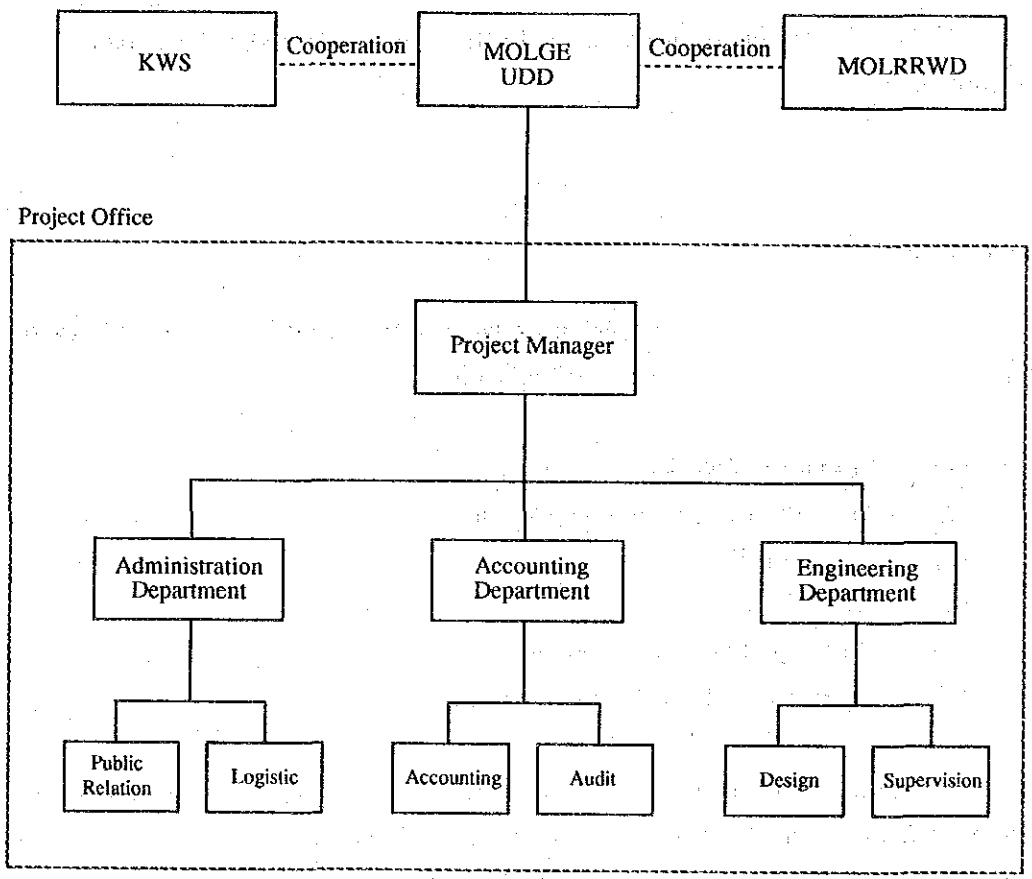
(1) Preparatory works
(2) Mwariki sewage pumping station
(3) Town STW
(4) Njoro STW
(5) Water quality testing laboratory
(6) Operation and maintenance equipment

Among the items above, major works are the construction of Town and Njoro Sewage Treatment Works. The procurement of operation and maintenance equipment and laboratory apparatus are included in the components of project's construction works.

Total construction period is scheduled sixteen (16) months to complete the project.

The construction works of Town and Njoro STWs are planned to conduct concurrently on the basis of the construction work volume and overall work period of 16 months. Work schedule for the respective work component are planned as follows in consideration of work volume, weather condition, delivery period of construction material and equipment, and other factors affecting the construction execution.

Fig. J-2



MOLG : Ministry of Local Government
UDD : Urban Development Department
KWS : Kenya Wildlife Service
MOLRRWD : Ministry of Land Reclamation Regional and Water Development

THE REPUBLIC OF KENYA MINISTRY OF LOCAL GOVERNMENT	THE STUDY ON THE NAKURU SEWAGE WORKS REHABILITATION AND EXPANSION PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE ORGANIZATION CHART OF PROJECT OFFICE

- Preparatory works : 1 to 2 months
- Town STW : 16 months, 8 months for 2 expansion lines of 3,200 m^3/day and 8 months for 2 rehabilitation lines
- Njoro STW : 16 months
- Mwariki Pumping Station : 6 months at later stage
- Water Quality Testing Laboratory : 16 months including testing equipment procurement, installation and guidance for handling.

It is planned that the handing over of the following facilities will be made partially to meet the requirement of effluent condition in an early stage.

- 3,200 m^3/day expansion line of Town STW
- 6,000 m^3/day expansion line upon completion of rock filter and grass plots

Conditions and assumptions for implementation of this project are referred in clause J2.

J2.4.2 Preparatory Works

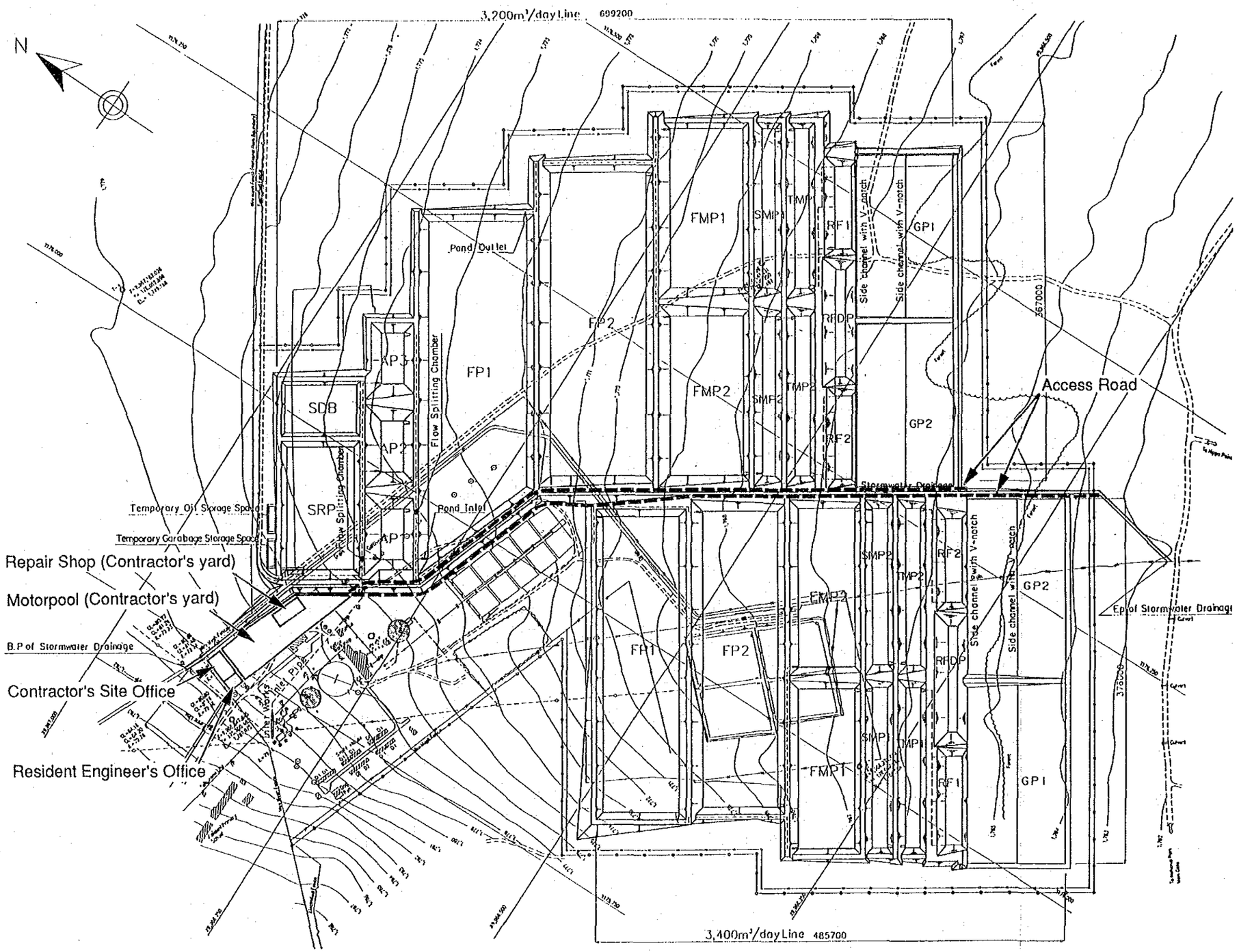
Following preparatory works are to be provided at initial stage of construction, so that the main construction works could start timely and smoothly.

(1) Access road

All construction site is accessible and close to Nakuru downtown, therefore no special off-site work is taken for mobilization by the contractor.

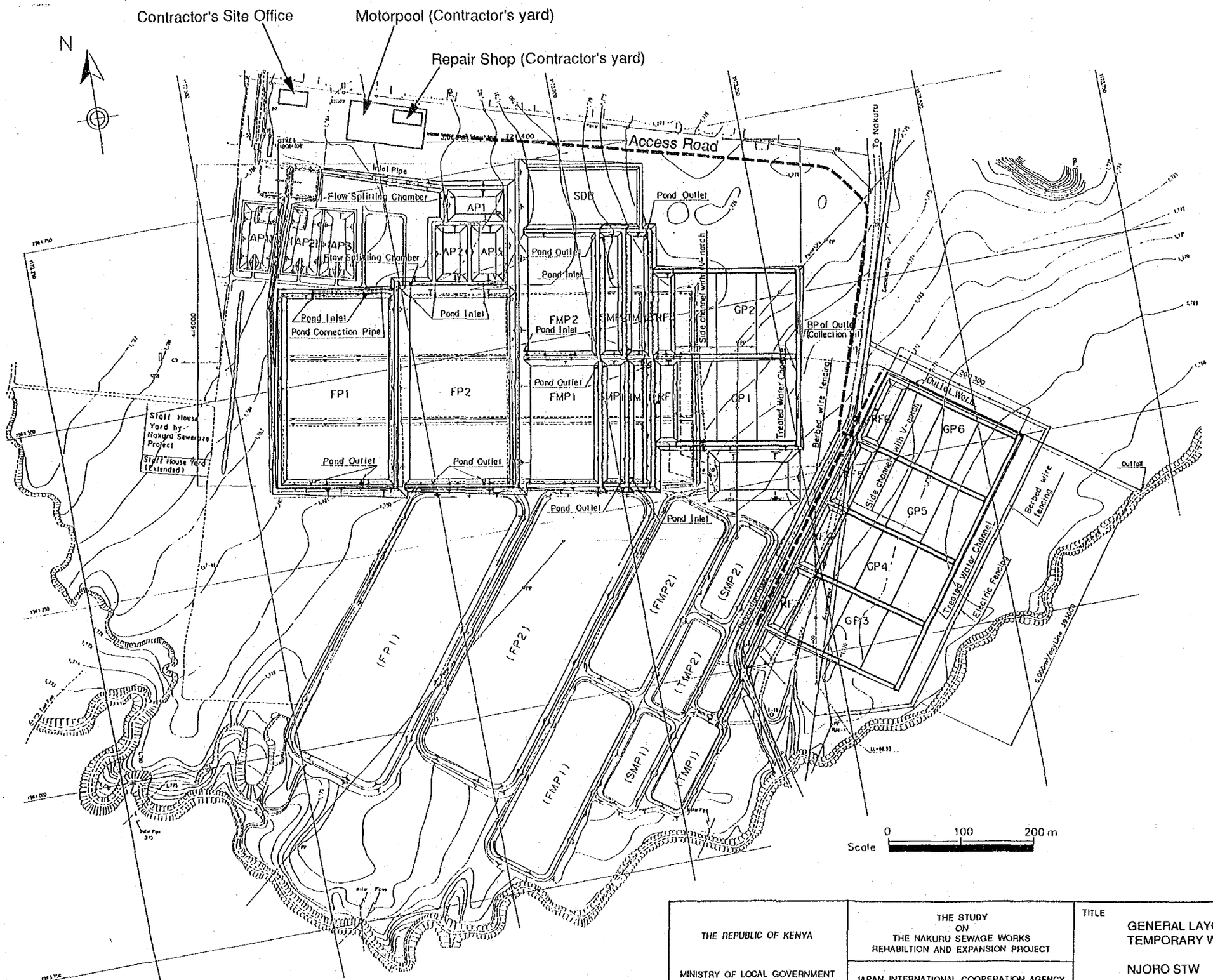
Only inner access road in Town and Njoro STWs will be necessary for the construction works. A route is proposed as shown in Fig. J-3 and J-4 of general layout for both Town and Njoro STW. Total length of inner access will be 1,600 m for Town STW and 1,500 m for Njoro STW, and macadam type with 3 to 4 m effective width.

Fig. J-3



THE REPUBLIC OF KENYA MINISTRY OF LOCAL GOVERNMENT	THE STUDY ON THE NAKURU SEWAGE WORKS REHABILTION AND EXPANSION PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE GENERAL LAYOUT FOR TEMPORARY WORKS TOWN STW

Fig. J-4



THE REPUBLIC OF KENYA MINISTRY OF LOCAL GOVERNMENT	THE STUDY ON THE NAKURU SEWAGE WORKS REHABILTION AND EXPANSION PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE GENERAL LAYOUT FOR TEMPORARY WORKS NJORO STW

(2) Power supply

Required electric power for mechanical and electrical works will be supplied by existing line of 220 V at Town STW, Njoro STW and Mwariki pumping station since ready serving the electricity. A distribution line will be expanded from existing control office at main gate of Nakuru National Park for the construction of water quality testing laboratory, which will be located adjacent to the Education Center of KWS. Consultation is necessary to the Kenya Power and Lighting Company on the demand of the permanent facilities provided under this project.

(3) Water supply

Town and Njoro site are served a piped water from the municipal water supply. Site offices, workshops, concrete works and others will be able to obtain a water from this line upon consultation with municipality.

Water for embankment work will be planned to obtain from the rivers by pump up system, and transport to the work site by water tanker.

(4) Resident engineer's office

One (1) resident engineer's office will be provided at Town STW having 30 m^2 approximately as shown in Fig. J-3.

(5) Contractor's site office

Contractor's site office will be provided at both Town and Njoro STW having 200 m^2 in floor area respectively as shown in Fig. J-3 and J-4. The offices are to be removed after completion of the project.

(6) Motor pool, repair shop and warehouse

A motor pool and repair shop are planned to provide at Town and Njoro STW for pool, maintenance and repair of construction equipment. Site warehouse will be also provided at both Town and Njoro with adequate floor space.

(7) Quarter for resident engineer

One (1) resident engineer's quarter will be provided in Nakuru city.

(8) Quarter for contractor's staff

Quarter/s for contractor will also be provided at Nakuru city.

(9) Communication

Public telephone system is connected to Town and Njoro STW which could be expanded to the site offices.

(10) Laboratory for construction work

A small scale laboratory will be necessary either the site of Town or Njoro during construction period to enable routine tests for earthwork. Concrete and other quality control tests will be carried out at the Ministry of Public Works laboratory in Nakuru or Nairobi.

J2.4.3 Mwariki Sewage Pumping Station

(1) General

The Mwariki pumping station was constructed in 1986 for pumping up the sewage collected from Langa housing estate into the 600 mm trunk sewers. The actual flow rate is 1000 m^3/day approximately. The pumping station is equipped with 3 sets of submersible pump with capacity 1.5 m^3/min respectively in the sump pit, and one set of 18.25 kVA, 240 V generator in the control house. This pumping station is planned to rehabilitate the pumps with its appurtenants having same capacity and to construct a new control house adjacent to the pumps.

(2) Building works

A new control house of 31 m^2 floor area comprised control room and office will be constructed by reinforced concrete. The existing control house will be used as a ware-house.

Since small scale house, the construction works will be carried out by man power with some supporting equipment such as truck for materials transportation. The works is scheduled about two (2) months in the later stage after the construction of Town control house.

(3) Mechanical and electrical works

The 3 units of existing sewer pump with a capacity of 7.5 kW, 1.5 m^3/min are planned to be replaced due to wear and tear. The new pumps are to be a blade with cutter type and controlled by automatic operation system. A set of lifting apparatus is also planned to be replaced, which is equipped with the existing steel frame for maintenance work. The works cover the procurement, delivery and installation of equipment.

J2.4.4 Town STW

(1) General

The Town STW was initially completed in 1956 and once rehabilitated in 1986. It is conventional type comprising of 1) a primary clarifier, 2) a trickling filter, 3) secondary and final clarifier, and 4) four maturation ponds. The four (4) maturation ponds in total capacity of 450 m^3 each were constructed in 1986 while the other facilities were completed in 1956 with a treatment capacity of 3,400 m^3/day. This sewage treatment works receives 3,790 m^3/day of sewage volume currently and the treated sewage discharges to the lake Nakuru through open channel. This Town STW is planned to rehabilitate the existing, two (2) treatment process lines with a capacity of 3,400 m^3/day and expand two (2) lines with a capacity of 3,200 m^3/day.

The construction and procurement works required for the rehabilitation and expansion of Town STW are;

- To construct ponds with related structures,
- To build houses,
- To replace mechanical and electrical components of existing STW partially, and
- To procure workshop equipment.

The construction of Town STW will be critical path work of the project, and it's major work is the construction of various kind of ponds with related structures.

(2) *Topography and site geology*

The Town STW site is at the ground elevation range from 1,764 m to 1,787 m and flat land with a gradient of 1:70 to 1:50. Proposed expansion area is mostly occupied by the Nakuru national park and covered by bush and small shrubs.

Soil type of Town STW site is shown in Table J-2.

Table J-2 Soil Type of Town STW

Borehole no.	Depth (GL.m)	Elevation (m)	Soil type
1	- 5.0	1762	silt
	-10.0	1757	silt
	-15.0	1752	pozzolanic ash
2	- 5.0	1773	sand
	-10.0	1768	silt
	-15.0	1763	tuff

The sub-surface geological condition of Town STW work site is broadly sedimented up to a depth of 3 m with volcanic silt. Each sedimentary layer is considered to be well compacted or tight form as indicating N value of 10 to 20. The permeability coefficient is 1 x 10^{-4} to 10^{-3} cm/sec in silt layer and 1 x 10^{-6} cm/sec in pozzolanic ash layer. It is judged that the site is suitable for the construction of the contemplated ponds and the excavated soil are usable for the embankment material with appropriate compaction. However, sandy soil layer with N value of 4 to 5 exists partially at the depth of 3 m below the ground surface and it has a comparatively high permeability coefficient of the order of 1 x 10^{-3} cm/sec. Resulting from assessment of soil properties, the silt in the Town STW site could be used as embankment material.

(3) Civil works

(a) General

Major civil work is the construction of 1) one (1) stormwater retention pond, 2) one (1) first flush pond, 3) two (2) anaerobic ponds, 4) four (4) facultative ponds, 5) two (2) each of first, second and third maturation pond, 6) four (4) rock filters, 7) four (4) grass plots, 8) one (1) sludge drying bed , and 9) one sludge digesting pond.

Required major work items and quantities are;

- Land clearing and stripping of 66,000 m^3 in bank measure,
- Excavation for various ponds of 209,000 m^3 in bank measure,
- Embankment of 205,000 m^3 of bank measure,
- Related structures to the ponds,

- Stormwater drainage channel,
- Dredging for existing ponds of 6,100 m^3 in wet condition or 1,525 m^3 in dry condition,
- Inner road, and
- Relocation of electrified wiremesh fences.

The construction works for Town STW will be divided by two (2) stages that the two (2) treatment process lines with a capacity of 3,200 m^3/day is carried out firstly due to no suspense of effluent treatment by Town STW and the rehabilitation of existing two (2) lines with a capacity of 3,400 m^3/day is followed.

The stormwater drainage channel is planned to construct for 7 months and to complete at the same time of the expansion.

It is basic concept that the work volume of excavation and embankment in the Town work site is planned to balance under a minimum hauling distance of materials as far as possible.

Number of equipment is calculated by loose measure of work volume based on the hauling work.

(b) Site clearing and stripping

The proposed area for ponds expansion is mostly under Nakuru national park covered with bush and small shrubs and the unoccupied ground in the existing STW is cultivated vegetables by people in the vicinity.

The land clearing and stripping of 66,000 m^3 with 15 cm depth will be carried out by 21 tons-class bulldozer. The stripping work is scheduled to complete for one and half months work period and provide 3 units of bulldozer. The stripped material is planned to use for the embankment material as practicable as possible.

(c) Excavation

The site is suitable for excavation works because of comparatively hard and flat with a few mild inclination. Total excavation volume is estimated 209,000 m^3 of common soil. The excavation depth is less than 4.0 m from the existing

ground levels respectively of 1,766 to 1,776 m. The excavated soil will be utilized mostly as for the embankment materials. The excavation work will be carried out at the wide spreading area of respective pond upto the design bottom level after the stripping and it will be transported to the place for embankment by 11 tons-class dump truck loaded by 1.8 m^3 class crawler loader. The excavation and embankment works will be scheduled to complete for 1,300 hours work period and a standard progress is estimated by loose measure (209,000 x 1.2 = 250,800 m^3) as below.

250,800 m^3/1300 hours = 193 m^3/hr --> 195 m^3/hr

Required major fleet will be planned as follows.

Bulldozer for excavation, dozing and hauling, 21 t
(195 m^3/h) / (77 m^3/h) = 2.5 --> 3 units
Crawler loader for loading, 1.8 m3
(195 m^3/h x 0.8) / (85 m^3/h) = 1.8 --> 2 units
Dump truck for hauling, 11 t
(195 m^3/h x 0.8) / (25 m^3/h) = 6.2 --> 8 units
(1 unit as spare)

Rock breaker with air compressor and ripper equipped with bulldozer will be considered to apply according to a further detailed geological investigation.

(d) Embankment

The land levels of various ponds are set out carefully to balance the cut and backfill volume. The embankment work of 205,000 m^3 in total volume will be carried out in parallel with the excavation work as practicable as possible without temporary stock of embankment materials to avoid its double handling from economical point of view. Direct embankment method is to be applied using bulldozers in case that its hauling distance is less than 60 m. Maximum embankment height is approximately 4.0 m. This work could also be conducted at wide working area. The embankment material would be obtained from the excavated soil of ponds within the Town work site. The balance is as follows.

Embankment	209,000 m^3 bank measure
Excavation	205,000 m^3 bank measure
Balance	+ 4,000 m^3

A excessive volume of 4,000 m^3 and unsuitable material from the stripping and or excavation will be utilized for land reclamation.

The dumped materials will be spreaded and compacted by using 11 tons-class bulldozer and 10 tons-class vibratory roller. Towed type tamping roller will also be planned due to the soil characteristics as described above in site geology. It is confirmed that the dry density of more than 95% is expected when the silt with natural moisture contents (Wn = 50%) is compacted at an appropriate compaction degree. Thus it is considered the most appropriate to compact the soil under the natural moisture content, but the subsidence of embankment is subject to flood water. Hence, to avoid the such problem it will be required to provide a 8 tons-class water tanker to spray water while executing compaction. The passage number of compaction equipment is tentatively planned six (6) times per one layer of 30 cm, which is to be decided by embankment test in later stage.

Standard progress of embankment will be 190 m^3/hour (205,000 x 1.2 m^3/1,300 hour), and the required major fleet for this work will be planned as follows.

Bulldozer for spreading and compaction, 11 t
(190 m^3/hr)/(74 m^3/hr) = 2.6 --> 3 units

Vibratory roller, tandem type, 10 t
(190 m^3/hr)/(45 m^3/hr) = 4.2 --> 5 units

Tamping roller, 7.5 t, towed type by 21 t bulldozer
as supporting equipment --> 1 unit

Water tanker, for spraying water to adjust moisture content
6 kl, one unit for 2 vibratory roler --> 2 units

(e) Related structures to the ponds

Required major works related to the stabilization ponds are summarized in Table J-3.

Table J-3 Required Major Works of Stabilization Ponds

Work Item	Work Quantity
- PC slab	9,200 m
- Pond inlet work	23 places
- Pond outlet work	19 places
- U type inlet work to grass plots	700 m
- Rock filter	16,000 m^3
- Grass plots	6.6 ha
- Sod facing	119,000 m^2
- Precast concrete pipes for ponds connection	4,400 m (300 mm, 450 mm)

Concrete works in the ponds will be carried out after the construction of embankment is completed. Concrete works for the storm water drainage channel will be carried out concurrently with the ponds construction by using concrete mixer, agitator truck and concrete vibrator. It will be necessary to provide a reusable shuttering which could be moved quickly for the form work in consideration of the tight construction schedule.

Precast concrete slabs is provided to protect the ponds water-line. Production of slabs at site is to be met the embankment schedule of the ponds.

These works will be conducted in parallel with the excavation and embankment of the ponds. The foundation excavation will be carried out by combination of equipment and man power. Required equipment will be planned as follows.

- Backhoe, 0.6 m^3 for structure foundation excavation,
- Crawler loader, 1.8 m^3 for rock materials handling for rock filters,
- Dump truck, 11 t for material transportation, and
- Portable concrete mixer, 0.3 - 0.5 m^3 for concrete production.

Rock filter materials will be planned to purchase from rock supplier in Nakuru on the site delivery basis, which is required the size of 10 to 20 cm. According

to the materials investigation, the quarried rock is being producted in Nakuru of the distance of 5 km from Town STW. The rock transported to the site will be put by using 1.8 m^3-class crawler loader.

Grasses (Kikuyu grass) for grass plots will be obtained from farmers or material suppliers, and transported by 11 tons dump truck. Source of Kikuyu grasses will be in and around Nakuru municipality, which distance from the Town STW site varies 3 to 50 km according to the site survey. The works of grass plots will be carried out in rainy season as much as possible.

Sod facing in the ponds to protect from soil erosion will also be carried out in rainy season upon embankment formation level have been achieved.

(f) Stormwater drainage channel

The Town stormwater drainage channel is planned to construct 1,200 m in total length between stormwater retention pond and outlet. The channel is designed trapezoid open channel having 3.0 m of bottom width and 1:1.2 of slope. The construction works is scheduled for 6 months work period.

The channel excavation will be carried out by 0.6 m^3-class back hoe and the excavated soil is hauled by 11 ton dump truck as for the embankment material or other effective usage.

(g) Dredging/disposal of sedimented sludge

No dredging of existing ponds is done since commencement of operation at Town STW. Total sedimentation volume is estimated 6,100 m^3 in wet condition or 1,500 m^3 in dry condition in four (4) ponds. Dredging and disposal of sludge are planned to conduct at the time of the Town STW rehabilitation and expansion works in dry season. This works are planned to carried out by two (2) steps provided temporary and small scale ring dike as for the drying bed of dredged sludge 1.5 m^3/min-class mud pump will be applied for dredging and pumping sedimented sludge into the temporary ring dike. A 11 tons dump truck will be applied for transportation and disposal to the existing municipal's spoil area in 8 km hauling distance, after drying the dredged sludge.

(h) Inner road

Inner road of 1,600 m with macadam type will be constructed in an early construction stage so that the road could be used as access and construction road. A bulldozer, backhoe, roller and motor grader will mainly be used for the inner road construction.

(4) Building works

Two (2) kinds of building construction works are required.

- Control house, 120 m^2 x 1 unit
- Staff houses, 39.76 m^2 x 6 units and 38.22 m^2 x 4 units

A reinforced concrete type control house composes an office, workshop, warehouse, kitchen and laboratory with 20 m x 6 m width. This house will be constructed in using local producted materials.

The construction works are scheduled to conduct for with 6 months work period in dry season. A lot of workshop equipment are installed upon delivery to the site in this control house.

(5) Mechanical and electrical works

Mechanical and electrical works in the Town STW are summarized as follows;

- Procurement and installation of machinery which is to be rehabilitated such as drain pumps, control cabinets and others,
- Supply of spare parts,
- Rehabilitation of steel hatch cover,
- Setting the electrical power cables and distribution board at the control and staff houses, and
- Other minor mechanical and electrical works.

Several items of machinery will have to be procured from abroads for the sewage treatment plant which was manufactured by foreign company. Import arrangement for the item/s is required in early stage of construction works by the contractor since the proposed replacement items are listed up due to wear and tear or less or none function. The mechanical and electrical works will be conducted in parallel with the civil works, especially the building works.

J2.4.5 Njoro STW

(1) General

The Njoro STW is stabilization pond type and constructed in 1973 on the left bank of the Njoro river. It consists of anaerobic pond and three lines of stabilization ponds which each line comprising of facultative pond, first maturation pond, second maturation pond and third maturation pond. It was originally designed for a daily treatment capacity of 3,600 m^3/day. The treated sewage discharges to the Njoro river, which eventually discharges into lake Nakuru. The Njoro STW has however been operating under a severe over-loading condition for many years, receiving more than 5,400 m^3/day.

The existing treatment capacity of Njoro STW is 3,600 m^3/day. The expansion is proposed the additional treatment facilities and anaerobic ponds to improve the final effluent quality of existing ponds. Two (2) sewage treatment process lines are planned comprising anaerobic ponds, facultative ponds, maturation ponds, rock filter and grass plots.

The stabilization ponds of Njoro STW with treatment capacity of 6,000 m^3/day will be completed after sixteen (16) months from the commencement of the works. The final treatment capacity of Njoro STW becomes 9,600 m^3/day.

Major works of Njoro STW are as follows.

- To construct ponds with related structures,
- To relocate none paved rural road, electrified fence wire mesh fence and telephone line, and
- To procure laboratory testing equipment.

It is advisable that 1) the diversion of existing flow should be carried out before commencement of this rehabilitation and expansion works in order to do under dry condition in the site, and 2) the construction of rock filter and grass plots to be connected to 6,000 m^3/day process line are carried out in an early stage to improve effluent conditions.

(2) Topography and site geology

The construction site is at 1,768 to 1,784 m from sea level and flat land of very gentle slope. The distance from Town STW is about 3 km. The unpaved road crosses the proposed construction site.

The sub-surface geological condition is quite similar to the Town sewage work site. Soil type of Njoro STW site is shown in Table J-4.

Table J-4 Soil Type of Njoro STW

Borehole No.	Depth (EL m)	Elevation (m)	Soil Type
3	- 5.0	1,776	silt
	-10.0	1,771	silt
	-15.0	1,766	sandy silt
4	- 5.0	1,766	silt
	-10.0	1,761	pozolanic ash
	-15.0	1,756	silty sand
5	- 5.0	1,763	sand
	-10.0	1,758	sand
	-15.0	1,753	sand

N value of sedimentary layer is 5 to 15 and permeability coefficient is 1×10^{-4} to 10^{-6} cm/sec in silt layer. A comparatively loose sand layer as the Town site is also identified at the depth of 2.4 m from the ground surface. This layer is made up of volcanic sand composed uniformly of case grains having a weak cementation capacity and comparatively high permeability coefficient, 1×10^{-3} to 10^{-5} cm/sec. Attention is directed to prevent of seepage as same as the Town site. It is assessed that silt available at Njoro the site can be used as embankment material from soil property test.

(3) Civil works

Major civil works of Njoro STW are;

- Land clearing and stripping of 33,000 m^3 in bank ,
- Excavation of ponds of 173,000 m^3 in bank,
- Embankment of 162,000 m^3 in bank,
- Related structures to the ponds,

- Relocate of rural road of 500 = m, electrified fence wire mesh fence and telephone line,
- Dredging of existing ponds of 34,800 m^3 in wet condition or 8,700 m^3 in dry condition (25%),
- Inner road, and
- Approach road.

A work sequence will be as follows:

- To construct rock filter and grass plots to be connected 6,000 m^3/day stabilization ponds which will be complete in middle 1994, within 5 to 6 months from the starting time,
- To conduct earthwork other than existing ponds area from initial stage in parallel with the construction of rock filter and grass plots,
- To divert the flow to 6000 m^3/day line after completion of rock filter and grass plots, and
- To continue earth work at existing ponds area.

The proposed construction method for Town STW is applied principally for the Njoro STW works because of similar topography, geological condition and kind of works.

(a) Site clearing and stripping

The construction site of existing Njoro STW is under Nakuru national park and covered by bushes and grasses. Required stripping works will be carried out for about one and half month work period by same type of equipment for Town STW with following number of unit.

33,000 m^3/210 hrs approx. = 157 m^3/hr --> 160 m^3/hr
(160 m^3/hr)/(77 m^3/hr) = 2.0 --> 2 units

(b) Excavation

The excavation site is very gentle slope. Total excavation volume is 173,000 m3 in bank measure and it is common soil. The excavated soil is planned to utilize as for the embankment material as practicable as possible. The excavation and embankment works are to be carried out concurrently so that direct embankment could be achieved. The excavation and embankment works is scheduled for 14 months work period and/or 1300 hours working hours.

Standard progress for excavation estimates by loose measure (173,000 x 1.2 = 207,600 m^3) as;

207,600 m^3/1,300 hrs = 159 m^3/hr --> 160 m^3/hr

The same type of fleet for Town STW will be planned. Required number of equipment is estimated as follows.

Bulldozer for excavation, dozing and hauling within 60 m, 21 tons
(160 m^3/hr)/(77 m^3/hr) = 2.0 --> 2 units

Crawler loader for loading, 1.8 m3
(160 m^3/hr x 0.8)/(85 m^3/hr) = 1.5 --> 2 units

Dump truck for hauling, 11 t
(160 m^3/hr x 0.8)/(25 m^3/hr) = 5.1 --> 7 units (1 unit spare)

(c) Embankment

Required embankment volume is estimated 162,000 m3 in bank measure. The embankment material could be obtained from the ponds excavation in Njoro STW and its balance is as follows.

excavation	: 173,000 m^3 bank measure
embankment	: 162,000 m^3 bank measure
balance	: +11,000 m^3

Basically, same construction method for Town STW have to be applied since similar topography and geology.

N value of the sedimentary layer in Njoro STW site is 10 to 20 it is judged reliable foundation with sufficient bearing capacity for the embankment. Same kind of fleet for Town STW work is also planned to apply for Njoro STW embankment work. Required standard progress of embankment work is estimated by loose measure (162,000 x 1.2 = 194,400 m^3) as;

194,400 m^3 / 1300 hr = 149 m^3/hr --> 150 m^3/hr

Fleet for Njoro STW embankment work

Bulldozer, 11 t
(150 m^3/hr)/(74 m^3/hr) = 2.0 --> 2 units

Vibratory roller, 10 t
(150 m^3/hr)/(45 m^3/hr) = 3.3 --> 3 units
Tamping roller, 7.5 t towed by 21 t bulldozer --> 1 unit

Water tanker, 6 kl --> 1 unit

(d) Related structures to the ponds

Required major works related to the stabilization ponds are summarized in Table J-5. Also, same construction method to the Town STW will be applied and provided the gang ang equipment separately.

Table J-5 Required Major Works of Njoro STW Ponds

Work Item	Work Quantity
- PC slab	6,700 m
- Pond inlet work	17 places
- Pond outlet work	11 places
- U type inlet to grass plots	800 m
- Rock filter	25,000 m^3
- Grass plots	9.6 ha
- Precast concrete pipes for ponds connection	2,700 m (D300, 375, 450, 675 mm)

The construction of rock filter and grass plots for expansion to 6,000 m^3/day process line will be carried out from initial stage of construction works, since these facilities are connected to the third maturation ponds, and be completed for 6 months approximately.

(e) Relocation of road, fences and telephone line

An existing rural road and telephone line of 500 m are planned to relocate as shown in the drawing. The electrified wire mesh fences are constructed according to the expansion of the project. Relocation works are carried out in an

early stage of construction works by man power. No affect is to be given to public activities with regard this works.

(f) Dredging/disposal for sedimented sludge

No dredging for existing stabilization ponds has been carried out since commencement of the operation. Sedimented sludge volume is estimated 34,800 m^3 in wet condition or 8,700 m^3 in dry condition (25%). The dredging work is required to carry out at initial stage for 3 months work period in dry season. Mud type pump with generator will be planned to apply for this dredging work. After drying the dredged sludge at the temporary ring dike in Njoro STW, it will be loaded by 1.8 m^3-class tractor shovel and transported to the existing municipality's disposal site by 11 tons-class dump truck.

(g) Inner and approach road

Inner and approach road will be constructed at the initial stage of construction works by using bulldozer, motor grader, backhoe and dump truck for about one month work period.

(4) Procurement of testing apparatus for existing Njoro laboratory

A lot of testing apparatus, listed in the bill of quantities, is planned to procure in this project. The arrangement of procurement and delivery is to be taken in an early stage after the contract award.

J2.4.6 Water Quality Testing Laboratory

(1) Building works

One water quality testing laboratory is planned to construct adjacent to the existing main gate and office of KWS in Nakuru national park, which is a reinforced concrete made having 350 m^2 in floor area.

The building works will be carried out mainly by using local product materials at the initial stage of construction works and be completed for 6 months work period.

(2) Procurement of laboratory instruments

A lot of laboratory instruments are planned to procure for this laboratory as listed in the bill of quantities. The procurement and delivery will be carried out during the building

construction. The training of a handling for these instruments including the laboratory operation system is necessary to provide.

J2.4.7 Operation and Maintenance Equipment

To achieve the proposed effluent for Town and Njoro STWs, a lot of operation and maintenance equipment are proposed to supply in this project. Detailed list is given in the bill of quantities dividing into the O&M equipment for Town workshop and general purpose.

The purpose of workshop's equipment is to repair and maintenance of mechanical and electrical components for Town and Njoro STWs, vehicles, construction equipment and others, especially for emergency repair.

The proposed O&M equipment are for repair and maintenance of the sewage facilities as general purpose.

The delivery of the equipment expected after 6 months from the contract award.

J2.4.8 Major Construction Equipment

Major equipment for the project construction works are supposed in the proposed method statement in respective clause and summarized in Table J-6.

Table J-6 Major Construction Equipment

Equipment/Capacity	Town	Njoro	Others/ Common Use	Total
- Bulldozer, 21 t class	3	2	0	5
- Bulldozer, 11 t class	3	2	0	5
- Crawler loader, 1.8 m3 class	3	3	0	6
- Excavator(backhoe), 0.6 m^3 class	2	2	0	4
- Dump truck, 11 t class	10	10	1	21
- Tamping roller, 10 t class	1	1	0	2
- Vibration roller, 10 t class	5	3	0	8
- Tamper, 60 kg class	5	5	2	12
- Concrete mixer, 0.3-0.5 m^3 class	2	1	1	4
- Agitator truck, 3 m3 class	1	1	0	2
- Concrete vibrator, 10 kg class	5	2	1	8
- Ordinary truck, 6 t class	1	1	1	3
- Motor grader, 3.1 m class	-	-	2	2
- Truck crane, 10 t class	1	1	1	3
- Breaker, 30 kg class	2	0	0	2
- Mud pump, 1.5 m^3/min. class	1	2	0	3
- Submersible pump, 1.5 m^3/min. class	1	1	0	2
- Welder, 100 A class	-	-	1	1
- Generator, 10-20 kVA class	1	2	0	3

J2.5 Construction Time Schedule

(1) Time schedule

A proposed construction schedule is shown in Fig. J-5. The schedule proposes taking the following factors into consideration.

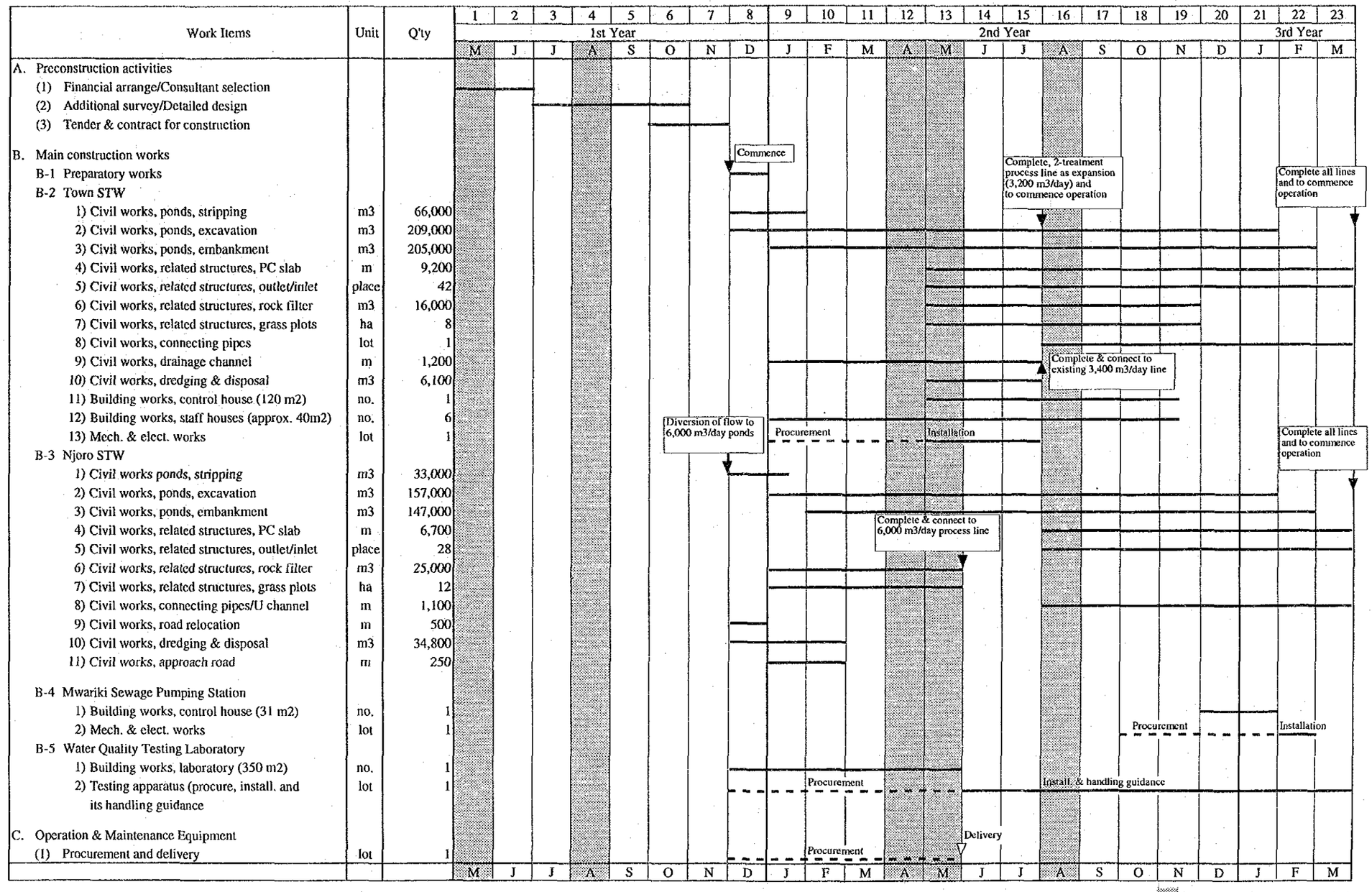
- To realize the proposed system in an early time to improve effluent condition
- To minimize the construction cost
- To conduct earthwork in dry season

The construction period of whole project works is sixteen (16) months and respective work components are summarized as below.

Fig. J-5

Construction Time Schedule for Nakuru Sewage Expansion & Rehabilitation Project

Work Items	Unit	Q'ty
A. Preconstruction activities		
(1) Financial arrange/Consultant selection		
(2) Additional survey/Detailed design		
(3) Tender & contract for construction		
B. Main construction works		
B-1 Preparatory works		
B-2 Town STW		
1) Civil works, ponds, stripping	m3	66,000
2) Civil works, ponds, excavation	m3	209,000
3) Civil works, ponds, embankment	m3	205,000
4) Civil works, related structures, PC slab	m	9,200
5) Civil works, related structures, outlet/inlet	place	42
6) Civil works, related structures, rock filter	m3	16,000
7) Civil works, related structures, grass plots	ha	8
8) Civil works, connecting pipes	lot	1
9) Civil works, drainage channel	m	1,200
10) Civil works, dredging & disposal	m3	6,100
11) Building works, control house (120 m2)	no.	1
12) Building works, staff houses (approx. 40m2)	no.	6
13) Mech. & elect. works	lot	1
B-3 Njoro STW		
1) Civil works ponds, stripping	m3	33,000
2) Civil works, ponds, excavation	m3	157,000
3) Civil works, ponds, embankment	m3	147,000
4) Civil works, related structures, PC slab	m	6,700
5) Civil works, related structures, outlet/inlet	place	28
6) Civil works, related structures, rock filter	m3	25,000
7) Civil works, related structures, grass plots	ha	12
8) Civil works, connecting pipes/U channel	m	1,100
9) Civil works, road relocation	m	500
10) Civil works, dredging & disposal	m3	34,800
11) Civil works, approach road	m	250
B-4 Mwariki Sewage Pumping Station		
1) Building works, control house (31 m2)	no.	1
2) Mech. & elect. works	lot	1
B-5 Water Quality Testing Laboratory		
1) Building works, laboratory (350 m2)	no.	1
2) Testing apparatus (procure, install. and its handling guidance	lot	1
C. Operation & Maintenance Equipment		
(1) Procurement and delivery	lot	1



Legends: Expected heavy rainy period

THE REPUBLIC OF KENYA MINISTRY OF LOCAL GOVERNMENT	THE STUDY ON THE NAKURU SEWAGE WORKS REHABILTION AND EXPANSION PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE CONSTRUCTION TIME SCHEDULE

Town STW	:	16 months
Njoro STW	:	16 months
Mwariki pumping station	:	5 months
Water quality testing laboratory	:	16 months
Procurement of O&M equipment	:	6 months

(2) Milestone

(a) Town STW

The rehabilitation and expansion works for Town STW is scheduled to be conducted by two (2) stages within 16 months.

An important milestone is the time for taking over of two (2) treatment processing lines having a capacity of 3,200 m^3/day as expansion and the works are scheduled to complete at after eight (8) months from commencement of the works. The remaining 2 treatment processing lines having capacity of 34,000 m^3/day as rehabilitation are scheduled to commence the construction after completion of the expansion.

The stormwater drainage channel is also scheduled to complete at after eight (8) months from commencement of the works in order to drain a effluent from existing Town STW for the rehabilitation of existing ponds under dry condition.

It is required that sedimented sludge of existing ponds should be treated before commencing the second stage of ponds construction.

The rehabilitation and expansion of Town STW including the test operation is scheduled to complete after sixteen (16) months from the commencement to the works.

(b) Njoro STW

The construction of stabilization ponds will be carried out through whole work period of 16 months. However, the following milestone is to be taken attention:

* To divert the effluent to 6,000 m^3/day ponds system by the commencement time of construction at latest,

* To complete the rock filter and grass plots after six (6) months from the commencement of the works, and
* To complete treatment work for existing sedimented sludge within 3 months from the commencement of construction.

Whole works of Njoro STW are scheduled to complete after sixteen (16) months from commencement of the works.

(c) Mwariki pumping station

The works are scheduled to conduct in later stage of whole schedule, and no special milestone is indicated.

(d)Water quality testing laboratory

A proposed laboratory building is scheduled to complete after six (6) months from commencement of the works.

A lot of testing apparatus is scheduled to deliver at site after six (6) months from commencement of the works, so that installation and handling guidance could conduct for about 10 months before the project completion time.

(e) O&M Equipment

It is recommend to deliver the proposed O&M equipment since insufficient of O&M work performance due mainly to shortage of these kind of equipment.

J2.6 Conditions for Construction Execution

This clause describes generally for its current and prevailing conditions for construction fields in Kenya which will affects the project's construction execution. A basic considerations for construction planning is also stipulated briefly referring the collected data and interview survey in Nairobi, Nakuru and Gilgil in September 1993.

J2.6.1 Construction Contractors

Construction contractor in Kenya will be broadly divided into foreign capital group and domestic capital group (mostly Indian). The number of construction contractor is 300 approximately under the member of Kenya Construction Contractors Association among the company/ies for general constructor, electrical works, installation and or erection, survey and

inspection works as of January 1992 according to the JETRO report. The contractors in Kenya has registered to the following Ministries respectively.

- Ministry of Works, Housing and Physical Planning
- Ministry of Transport and Communications
- Ministry of Water Development

The category of registration is classified according to contract amount as shown in Table J-7.

Table J-7 Category of Registration

(Unit: Million Kenya Pound)

Category	Contract Sum
A :	more than 1.5
B :	1.0 - 1.5
C :	0.5 - 1.0
D :	0.25 - 0.5
E :	0.125 - 0.25
F :	0.075 - 0.125
G :	0.0375 - 0.075
H :	less than 0.0375

Note : One (1) Kenya pound = 20 Kenya shilling

It seems to be reported that recently Kenyan civil engineering contractors show being active conditions by booming of construction of office buildings, housings and other public facilities due mainly to investment by domestic capitalists and foreign fund projects. Most of contractors in Kenya seems to conduct and implement middle to small scale projects.

J2.6.2 Labour Force

Required unskilled, semi-skilled and skilled laboures including heavy equipment operators could be acquired or employed from local personnel. However some specialized technician could be acquired from abroads.

J2.6.3 Construction Equipment

The following kind of equipment will be required to apply for execution of construction works of this project.

- Bulldozer
- Backhoe
- Tractor/Wheel Loader
- Dump Truck
- Compaction Roller
- Concrete Mixer
- Concrete Vibrator
- Motor Grader
- Ordinary Truck
- Truck Crane
- Concrete Breaker
- Mud/Submersible/Centrifugal Pump
- Generator

These types of construction equipment are not manufactured locally, therefore, most of them will be imported.

These kind of equipment which will be required for the project's construction works are available in Kenya with rental or lease basis through supplier's agent/s or civil engineering contractor/s. Generally, lease or rental cost is high due to insufficient market of mechanized construction including quick supply of spare parts, or less standardization of construction equipment resulting from the site survey and investigation in September 1993. The selected contractor/s will apply the equipment force upon cost comparison either from abroad or lease in domestically.

J2.6.4 Construction material

Major construction materials required for the project and its availability, source of material, are summarized in Table J-8 on the basis of the survey and investigation in September 1993.

Table J-8 Major Construction Materials

Material	Availability/Source
Portland Cement	Available at Nairobi/Mombasa - Product by 2 companies - Supply through 4 companies - Bulk or 50 kg bag - Kenya standard KS 02-21
Coase Aggregate	Available at Nakuru
Fine aggregate	Available at Homa Bay, Kisumu
Re-bar, Round	Available at Nairobi/Mombasa
Re-bar, Deformed	Available at Nairobi/Monbasa
Formed Steel	Available at Nairobi/Mombasa
Timber	Available at Nakuru
Precast Concrete Pipe	Available at Nairobi
Fuel	Available at Nakuru
Lubricants	Available at Nakuru/Nairobi
Bitumen	Available at Nairobi

There is no suitable sand and gravel deposit in the vicinity of the project site. It has been noted that fine aggregate was transported from Homa Bay in Kisumu 180 km west of Nakuru for construction of Grain Silo project and Nakuru water supply project.

J2.6.5 Transportation Plan

It is available local transport network by domestic and private agency using trucks or trailers, or Kenyan national railway system from Nairobi or Mombasa to Nakuru in daily basis. Mombasa port is famous and reliable port to handling the sea cargoes in east Africa. The project cargoes to be imported from abroads will be unloaded in this Mombasa port, and be transported to the site by truck or trailer and or railway. The distance to the site is as follows.

Nakuru - Nairobi : 157 km
Nakuru - Mombasa : 650 km

J2.6.6 Annual Workable Day and Working Hour

(1) Workable day

Workable days and hours for the project construction works has been estimated at 325 day and 2,288 hours respectively for 16 months construction period started with December 1st year to March 3rd year. While annual workable day and hours were estimated at 232 days and 1,592 hours based on the following conditions and assumptions.

(a) Sunday and national holiday

Sunday : 12 month x 4 days/month = 48 days
National holiday ;

January	: January 1st	1 day new year day
March or April :		5 days Easter
May	: May 1st	1 day labour day
June	: June 1st	1 day Madaraka day
October	: Oct. 10th	1 day Moi day
October	: Oct. 20th	1 day Kenyatta day
December	: Dec. 12th	1 day Independence day
December	:	7 days Christmas day, and by Kenyan custom
amount		18 days

Annual: 66 days
Total for this project: 79 day (16 months, from December 1st year to March 3rd year)

(b) Idling time (day) due to rainfall

The mechanized construction works by equipment force will be suspended due to the rainfall, and its idling time was estimated as shown in Table J-9 on the basis of the rainfall data and the following criteria for daily rainfall.

5 mm or less	:	No suspend
5 mm to 10 mm	:	0.5 day suspend only in rainy day
10 to 30 mm	:	Rainy day plus 1 day suspend
30 mm or more	:	Rainy day plus 2 day suspend

Table J-9 Idling Time Due to Rainfall

Month	Rainy Days (days)	Rainfall (mm/month)	Rainfall <1 (mm/day)	Suspend (days)
January	5	31	6.2	3
February	6	35	5.8	3
March	8	55	6.9	4
April	16	123	7.7	8
May	13	103	7.9	7
June	9	71	7.9	5
July	12	76	6.3	6
August	13	100	7.7	7
September	11	75	6.9	6
October	14	85	6.1	7
November	13	84	6.5	7
December	7	45	6.4	4
total				67 days

(Data source : Nakuru Lanet Airfield Met. Station, 1957-1962
The study on the national water master plan, JICA, July 1992)

Note <1 : Daily mean rainfall is estimated with monthly rainfall divided by rainy days due to unavailable of daily rainfall data.

Annual : 67 days

Total for this project : 81 days (16 months from Dec. 1st year to March 3rd year)

(2) Workable hour

Annual working hour was estimated as follows at normal working hours of 8.0 hours/day from Monday to Friday and 5.0 hours in Saturday.

232 days - 48 days (Saturday) x 8 hours/day = 1,472 hrs
48 days x 5 hours/day = 240 hrs
1,472 hrs + 240 hrs = 1,712 hours

Total workable hour of this project assumes as follows by 16 months construction period from December 1st year to March 3rd year.

325 days - 64 days (Saturday) x 8 hours/day = 2,088 hrs
64 days x 5 hours/day = 320 hrs
2,088 hrs + 320 hrs = 2,408 hours

J2.6.7 Swell and Shrinkage Factors of Material

Hourly production rate of construction equipment and manpower will be estimated to meet with the site conditions according to the following swell and shrinkage factors as shown in Table J-10.

Table J-10 Swell and Shrinkage Factors of Material

Material	Loose/Bank	Compacted/Bank
Common soil	1.20	0.90
Sand	1.20	0.95
Weathered Rock	1.30	1.15
Hard Rock	1.60	1.25
Dredged Material at Existing Ponds	wet condition	1.0
	dried	0.25

J2.6.8 Hourly production Rate of Construction Equipment

An hourly production rate of equipment is tabulated in Table J-11, however actual number and type of equipment will be decided by selected contractor/s.

Table J-11 Production Rate of Construction Equipment

Equipment	Production Rate	Work
Bulldozer, 21 ton	77 m^3/hr	Excavation
Backhoe, 0.6 m^3	46 m^3/hr	Excavation/Loading
Crawler Loader, 18 m^3	85 m^3/hr	Excavation/Loading
Dump Truck, 11 ton (loading by 1.8 m^3 crawler loader)	25 m^3	Hauling
Dump Truck, 11 ton (loading by 0.6 m^3 backhoe)	18 m^3	Hauling
Bulldozer, 11 ton	74 m^3/hr	Compaction
Vibratory Roller, 10 ton	45 m^3/hr	Compaction

(1) Excavation by Bulldozer for Common soil

$Q = (60 * q * E) / Cm$

where, Q : Hourly production rate (m^3/hr)
q : Excavation and hauling volume per one cycle (m^3)
E : Work efficiency
Cm : Cycle time (min.)
Cm = 0.038 l + 0.2
l : Distance for excavation, dozing and hauling in average (m)

equipment	q	E	Cm	l	Q
bulldozer, 21 t	2.85	0.6	1.34	30	77

(2) Excavation and loading by backhoe for common soil

$Q = (3{,}600 * q * E) / Cm$

where, Q : Hourly production rate (m^3/hr)
q : Excavation and loading volume per one cycle (m^3)
q = 0.98 q1
q1 : Bucket capacity = 0.6 m^3
E : Work efficiency
Cm : Cycle time (sec)Cm : cycle time (sec)
Cm = 28 sec by 90 degree turn

equipment	q	E	Cm	Q
backhoe 0.6 m^3	0.59	0.6	28	46
crawler loader 1.8 m^3	1.76	0.6	45	85

(3) Hauling

$Q = (60 * q * E) / Cm$

where, Q : Hourly hauling volume (m^3)
q : Loading volume per one unit (m^3)
E : *Work efficiency*
Cm : Cycle time (min)
Cm = xL + y

x : coefficient by hauling, 4.6
L : hauling distance, 400 m
y : coefficient by loading
13 by crawler loader
18 by backhoe

equipment	q	E	Cm	Q
dump truck, 11 t (loading by 1.8 m^3 crawler loader)	6.1	0.9	13	25
dump truck, 11 t (loading by 0.6 m^3 backhoe)	6.1	0.9	18	18

(4) Compaction

$Q = (V * W * D * E) / N$

where, Q : Hourly production rate (m^3/hr)
V : Compaction speed (m/hr)
W : Effective compaction width per one time (m)
D : Thickness after compaction (m)
E : Work efficiency
N : Number of passage of compaction per layer

equipment	V	W	D	E	N	Q
bulldozer, 11 t	3,500	0.7	0.3	0.6	6	74
vibratory roller, 10 t	1,000	1.8	0.3	0.5	6	45

J3. COST ESTIMATE

J3.1 Project Financial Cost

The project financial cost has been worked out as tabulated in Table J-12.

Table J-12 Project Financial Cost

(Unit: US$10^3)

Cost items	F.C.	L.C.	Total
1. Direct cost	8,188	8,196	16,384
2. Land acquisition and compensation cost	0	16	16
3. Administration expenses for Gov. agency <1	0	820	820
4. Engineering services expenses <2	1,571	748	2,319
sub total	9,759	9,781	19,539
5. Physical contingency <3	976	978	1,954
6. Price contingency <4	466	871	1,337
Total	11,201	11,629	22,830

Notes:
- <1 5% of direct cost
- <2 12% of direct cost, at the ratio of 80% for F.C. and 20% for L.C., plus VAT of 18%.
- <3 10% of total 1 to 4
- <4 2.3% per annum for foreign portion and 4.2% per annum for local portion

J3.2 Conditions and Assumptions for Cost Estimate

The following conditions and assumptions has been applied for the project financial cost estimate.

(1) Price level : September 1993

This is the time of data collection and site investigation for project cost estimate at Kenya.

(2) Exchange rate

US$ 1.0 = Yen 109.50
US$ 1.0 = KShs 62.40
KShs 1.0 = Yen 1.75

The above exchange rate is averaged TTS rate of 122 days from Mar-20th 1993 to September 15th 1993, and data source by Bank of Tokyo, and Bank of America.

(3) The financial cost of the project was estimated with foreign (Japanese Yen) and local currency (Kenya Shillings) respectively. The ratio of foreign and local portions are divided on the basis of the following factors.

(a) Direct cost

* Productivity of construction materials in Kenya:
  The material cost is local portion which being product in Kenya.
* Availability of labourers, materials, and equipment in Kenya (available but none production):
  These cost are divided into foreign and local portions following its availability in Kenya, for example;
  - Labour cost is local portion,
  - Depreciation cost of construction equipment is foreign portion, but operator's cost is local portion, and
  - Laboratory instruments cost is foreign portion.

(b) Indirect cost

* Land acquisition and compensation costs is to be born by Kenyan Government
* Government administration cost is also to be born by Kenyan Government

(4) Unit labour wage is estimated at daily basis in 8 hours from Monday to Friday and 5 hours for Saturday.

(5) Unit price of construction materials and daily basis equipment cost are estimated on condition that it is available to procure its almost everything in Kenya.

(6) The estimate cost expresses by Yen for foreign currency and KShs for local currency respectively.

(7) The project implementation period is proposed 24 months from April 1994 upon completion of feasibility study to March 1996.

(8) The construction period is proposed at 16 months from December 1994 to March 1996.

(9) Kenyan Value Added Tax (VAT) of 18 % is incorporated into the local currency portion of project financial cost.

J3.3 Constitution of the Project Financial Cost

The project financial cost constitutes of the following five (5) cost elements.

(1) Direct construction cost
- Preliminary and general items
- Construction cost
- Procurement and installation cost

(2) Land acquisition and compensation cost

(3) Administration expenses

(4) Engineering services expenses

(5) Contingency
- Physical contingency
- Price contingency

J3.4 Estimate Approach

(1) Direct construction cost

The direct construction cost is consisted of preliminary and general items, construction cost for Mwariki P.S, Town STW, Njoro STW, water quality testing laboratory and O&M equipment, and summarized as shown in Table J-13.

Table J-13 Summary of Direct construction Cost

(Unit: US$10^3)

No.	Cost Item	Foreign C	Local C.	Total
1.	Preparatory works	45	652	697
2.	Mwariki pumping station	116	35	151
	2.1 Building works	3	30	33
	2.2 Mechanical and electrical works	105	2	107
	2.3 Miscellaneous & minor works	8	2	10
3.	Town STW	3,898	2,723	6,621
	3.1 Civil works	3,370	2,167	5,537
	3.2 Building works	66	371	436
	3.3 Mechanical and electrical works	207	8	215
	3.4 Miscellaneous & minor works	255	178	433
4.	Njoro STW	3,099	1,996	5,095
	4.1 Civil works	2,840	1,865	4,705
	4.2 Testing apparatus for existing Njoro laboratory	49	1	50
	4.3 Spare parts for existing Njoro STW	7	0	7
	4.4 Miscellaneous & minor works	203	131	333
5.	Water quality testing laboratory	464	276	740
	5.1 Laboratory building	33	268	301
	5.2 Laboratory instruments	431	8	439
6.	Operation and maintenance equipment	566	11	577
	Total	8,188	5,693	13,881
	VAT, 18% (FC + LC, added to LC)		2,503	2,503
	G. Total	8,188	8,196	16,384

(a) Preparatory works

Preparatory works are to cover the charge for performance bond, insurance of works and contractor's equipment, third party insurance, insurance against accident to workmen, contractor's camp, offices, temporary access road, setting out of the works, signboards and other incidentals.

General items are to cover the resident engineer's office, staff houses, transportation of engineers, overseas training if necessary, security, temporary bridges, repair of existing bridges and other incidentals.

Preliminary and general items are estimated on lump sum basis.

(b) Construction cost

Direct construction cost for civil works including the building works are estimated with unit cost multiplied by the work quantity for respective work item, which was worked out by feasibility design. The unit cost for respective work item was determined upon review and analysis of collected data and survey/investigation at Nakuru, Nairobi and Kisume.

(i) Labour cost

The labour wage rate applied for this cost estimate is settled on the basis of quotations from civil engineering company in September 1993 and data of "the regulation of wages and conditions of employment act" (order 1993). The basic minimum daily and hourly rates are accorded to the first schedule of Kenya Gazette Supplement No. 26 dated 30th April 1993. The basic labour wage is as shown in Table J-14.

Table J-14 Basic Labour Wage

No.	Kind of Labour	Labour Wage (per day)	
		(KShs)	(US$ equivalent)
1.	Foreman	1,800	(29)
2.	Assistant foreman	1,200	(19)
3.	Carpenter	480	(8)
4.	Re-bar fixer	480	(8)
5.	Operator	480	(8)
6.	Driver	480	(8)
7.	Welder	640	(10)
8.	Concretor	450	(7)
9.	Mason	450	(7)
10.	Form Worker	450	(7)
11.	Painter	450	(7)
12.	Common labour	300	(5)
13.	Plumber	450	(7)
14.	Powderman	600	(10)
15.	Mechanician	600	(10)
16.	Electrician	600	(10)

(ii) Material cost

Unit price of construction materials is settled on the basis of quotations from civil engineering company, manufacturers, suppliers and agents in Kenya, and data by investigation in/around Nakuru, Gilgil, Nairobi and Kisumu in September 1993. The unit price of construction materials is as shown in Table J-15.

Table J-15(1/2) Unit Price of Construction Materials

No.	Cost Items	Unit	Unit Price (KShs)	Unit Price (US$ equivalent)
1.	Portland Cement Type I (BS 12)	ton	9,920	(159)
2.	Portland Cement Type V (BS 4027)	ton	11,000	(176)
3.	Reinforcement Bar			
	1) Mild steel bar	ton	42,000	(673)
	2) Deformed bar	ton	45,000	(721)
	3) High tensioned deformed bar	ton	45,000	(721)
4.	Structural Steel			
	1) Shaped steel	ton	92,500	(1,482)
	2) Steel plate	ton	92,500	(1,482)
	3) Fabrication	ton	30,000	(481)
5.	Coarse Aggregate	m^3	1,200	(19)
6.	Fine Aggregate	m^3	3,000	(48)
7.	Crushed Stone	m^3	1,200	(19)
8.	Colgated Iron Sheet	m^2	700	(11)
9.	Timber for Formwork	m^3	12,000	(192)
10.	Timber for Structure	m^3	35,000	(561)
11.	Plywood	m^2	1,100	(18)
12.	Welding Rod	kg	300	(5)
13.	Gasoline	litre	28	(0.4)
14.	Kerosene	litre	20	(0.3)
15.	Diesel Oil	litre	24	(0.4)
16.	Lubricant (1-cyl. = 6.3 m^3)	litre	200	(3)
17.	Acetylene	cyl.	3,075	(49)
18.	Oxygen (1-cyl.= 8.5 m^3)	cyl.	540	(9)
19.	LPG (12 kg)	cyl.	560	(9)
20.	Concrete Hollow Block			
	1) 200 x 200 x 400 mm (min. 1,000 pcs.)	pc	49	(0.8)
	2) 100 x 200 x 400 mm	pc	35	(0.6)
21.	Riprap Stone	m^2	650	(10)
22.	Backfill Sand	m^3	2,200	(35)
23.	Turfing	m^2	70	(1)

(Conditions: Site Delivery Basis)

Table J-15(2/2) Unit Price of Construction Materials

No.	Cost Items	Unit	Unit Price (KShs)	Unit Price (US$ equivalent)
24.	Concrete Pipe with Rubber Ring (spigot & Socket for flex.)			
	1) 300 D x 1.2 m	pc	1,800	(29)
	2) 375 D x 1.2 m	pc	2,300	(37)
	3) 450 D x 1.5 m	pc	5,000	(80)
	4) 525 D x 1.5 m	pc	6,000	(96)
	5) 600 D x 1.5 m	pc	7,500	(120)
25.	Brick, 230 x 50 x 75 mm (min. 1,000 pcs)	pc	11	(0.2)
26.	Barbed Wire, 12.5 mg/kg	kg	106	(1.7)
27.	Barbed Wire, 16 m/kg	kg	120	(1.9)
28.	Nail, 1" to 6"	kg	95	(1.5)
29.	Explosive, Dinamite	kg	900	(14)
30.	Explosive, Ammonium, Nitrate	kg	600	(10)
31.	Electric Detonator w/ 4 m leg wire	pc	450	(7)
32.	Asphalt Emulsion, MC3000	litre	70	(1)
33.	Bitumen, 80/100	kg	40	(0.6)
34.	PVC pipe			
35.	Steel Pipe			
36.	Cast Iron Manhole Cover, 600 mm dia.	pc	8,000	(128)
37.	Water Stop, 9 mm synthetic rubber	m	1,800	(29)
38.	Bituminous Paint	litre	260	(4)
39.	Gravel for Road (murram)	m^3	1,200	(19)
40.	Concrete Post for Fence, 5"x5"x125"	pc	615	(10)
41.	Metric IT 5,686x3,000	pc	1,800	(29)
42.	Mesh Reinforcement, 200x200x2.2 kg•m	ton	90,000	(1,442)
43.	Epoxy Resin Paint	litre	700	(11)
44.	Galvanized Steel Pipe, 1"	m	280	(5)
45.	Galvanized Steel Pipe, 3/4"	m	220	(4)
46.	Electric Charge			
	1) Fixed charge	LS		
	2) Consumption rate	kWh		
	3) On Demand	kVA		
47.	Water Charge	m^3		

(Conditions: Site Delivery Basis)

(iii) Equipment cost

Equipment cost is settled on the basis of the quotations from civil engineering companies and other data from manufacturer's agents in Nairobi. The equipment cost is as shown in Table J-16.

(c) Mechanical and electrical works

The cost estimate for mechanical and electrical works is made according to the current market price in Kenya and Japan.

(d) Procurement cost

Procurement cost for various kind of equipment and instruments is estimated with quotations from manufacturers, suppliers and agents in Kenya and Japan.

(2) Land acquisition and compensation cost

No land acquisition cost was estimated since the proposed construction site is a part of national park belonging to the Government. However, compensation cost to farmers is estimated for their plantation on the lump sum basis and incorporated into the local currency portion.

(3) Administration expenses

Administration expenses for Government agencies are estimated with applying 5% of direct construction cost and incorporated into the local currency portion.

Table J-16(1/2) Equipment Rental Cost

No.	Cost Items	(KShs)	(US$ equivalent)
1.	Backhoe, 1.0 m^3	42,000	(673)
2.	Backhoe, 0.6 m^3	32,000	(513)
3.	Backhoe, 0.35 m^3	28,000	(49)
4.	Bulldozer, 32 ton w/Ripper	80,000	(1,282)
5.	Bulldozer, 21 ton	60,000	(962)
6.	Bulldozer, 11 ton	35,000	(561)
7.	Dump Truck, 11 ton	15,000	(240)
8.	Dump Truck, 7 ton	12,000	(192)
9.	Dump Truck, 4 ton	7,000	(112)
10.	Flat Bed Truck, 10 ton	14,000	(224)
11.	Flat Bed Truck, 8 ton	11,000	(176)
12.	Flat Bed Truck, 4 ton	7,000	(112)
13.	Cargo Truck w/Crane, 8 ton	12,000	(192)
14.	Cargo Truck w/Crane, 4 ton	9,000	(144)
15.	Truck Mixer, 4.5 m^3	20,000	(321)
16.	Truck Mixer, 1.6 m^3	13,000	(208)
17.	Truck Crane, 30 ton	51,000	(817)
18.	Truck Crane, 25 ton	44,000	(705)
19.	Truck Crane, 15 ton	30,000	(481)
20.	Crawler Crane, 40 ton	83,000	(1,330)
21.	Crawler Crane, 35 ton	70,000	(1,122)
22.	Trailer, 30 ton	34,000	(545)
23.	Trailer, 20 ton	28,000	(449)
24.	Trailer, 12 ton	25,000	(401)
25.	D. Generator, 125/150 kVA	15,000	(240)
26.	D. Generator, 100/125 kVA	13,000	(208)
27.	D. Generator, 65/75 kVA	10,000	(160)
28.	D. Generator, 10/12.5 kVA	4,000	(64)
29.	Vibration Roller, 2.5 ton	3,000	(48)
30.	Vibration Roller, 10 ton	60,000	(962)
31.	Plate Compactor, 80 - 100 kg	1,000	(16)
32.	Type Roller, 8 - 20 ton	17,000	(272)
33.	Macadam Roller, 10 - 12 ton	17,000	(272)
34.	Pad-foot Roller, 10 - 20 ton	18,000	(288)
35.	Motor Grader, 2.4 - 3.1 m	28,000	(449)

Conditions: Cost per day (8 hours) excluding operator & fuel, lubricants and maintenance/repair cost

Table J-16(2/2) Equipment Cost

No.	Cost Items	(KShs)	(US$ equivalent)
36.	Tractor Shovel, 1.8 m^3	40,000	(641)
37.	Tractor Shovel, 1.2 m^3	35,000	(561)
38.	Wheel Loader, 1.8 m^3	35,000	(561)
39.	Wheel Loader, 1.2 m^3	27,000	(433)
40.	Submersible Pump, 4" x 15 m	1,800	(29)
41.	Submersible, 3" x 15 m	1,200	(19)
42.	Submersible, 2" x 15 m	800	(13)
43.	Concrete Mixer, 0.3 m^3	4,700	(75)
44.	Re-Bar Bender, 30 mm	2,500	(40)
45.	Air Compressor, 5 m^3/min	6,000	(96)
46.	Air Compressor, 7.5 m^3/min	8,000	(128)
47.	Crawler Drill, 4 ton	25,000	(401)
48.	Fuel Lorry, 6 kl	12,000	(192)
49.	Fuel Lorry, 2 kl	8,000	(128)
50.	Water Tanker, 6 kl	12,000	(192)
51.	Fuel Storage Tank, 24,000 litre	30,000	(481)
52.	Vehicle, 4 x 4	4,500	(72)
53.	Welder, 250 A, Engine	4,000	(64)
54.	Pile Driver, 100 ton, Tripod	200,000	(3,205)
55.	Vibro Hammer, 60 kW	30,000	(481)
56.	Diesel Pile Hammer, 2 ton	35,000	(561)
57.	Transformer, 50 kVA	3,300	(53)
58.	Clamshell Bucket, 0.6 m^3	2,000	(32)
59.	Electronic Distance Meter Complete Set	3,000	(48)
60.	Theodolite w/Tripod	1,200	(19)
61.	Auto Level w/Tripod	1,200	(19)
62.	Cement Silo, 100 ton	5,000	(80)
63.	Hand Breaker, 30 kg	800	(13)
64.	Pick Hammer, 8 kg	500	(8)
65.	Concrete Bucket, 1.0 m^3	1,600	(26)
66.	Concrete Batching Plant, 30 m^3/h	48,000	(769)
67.	Concrete Pump Truck, 65 m^3/h	-	-
68.	Asphalt Sprayer, 20 - 30 litre/min	1,800	(29)
69.	Pick-up Truck, 1 ton	3,000	(48)
70.	Concrete Cutter, 30 cm	-	-
71.	Bulldozer, 15 ton	40,000	(641)
72.	Air Breaker w/Backhoe, 1,300 kg	18,000	(288)

Conditions: Cost per day (8 hours) excluding operator & fuel, lubricants and maintenance/repair cost

(4) Engineering services expenses

Engineering services expenses for detailed design and construction supervision is estimated on the condition of 12% of the direct construction cost plus value added tax of 18%. The 12% of the direct construction cost is allotted 80% for foreign currency and 20% for local currency portion.

(5) Contingency

(a) physical contingency

Physical contingency is considered 10% of the direct construction cost to cope with the unforeseen physical conditions.

(b) price contingency

The price escalation rate has been estimated with incorporating devaluation factors of Shilling to US dollar on the basis of data in Kenya such as cost index of civil engineering and consumer price index, and divided into the foreign and local currency portions respectively as below.

Foreign currency portion : 2.3% per annum
Local currency portion: 4.2% per annum

(i) Foreign currency portion (Yen)

Table J-17 Price Escalation Rate of Foreign Currency

Year	CPI	Increased Rate
1985	100	
1989	103.7	2.3%
1990	106.9	3.1%
1991	110.4	3.3%
1992	112.3	1.7%
1993	NA	1.1% (January to June)
		Average 2.3% (weighted)

CPI : consumer prices index
(Data Source : International Financial Statistics Yearbook 1993)

(ii) Local currency portion (KShs)

(ii.a) Consumer price index

Increased rate of consumer price index is obtained by the 2 data sources as shown in Table J-18.

Table J-18 Increased Rate of Consumer Price

A		B		
1987/88	8.7%	1985	100.0	
1988/89	12.3%	1986	103.9	3.9
1989/90	13.3%	1987	111.9	8.0
1990/91	15.8%	1988	124.4	12.5
1991/92	19.6% (tentative)	1989	140.5	16.1
		1990	162.4	21.9
average	13.94%	1991	194.6	32.2
		1992	N.A	
		1993	N.A	
		average		15.77
(A+B) / 2 = (13.94 + 15.77) / 2 = 14.855 --> 15%				

(Data source A : Economic Survey 1992,
Ministry of Planning and National Development)
(Data source B : International Financial Statistics Yearbook 1993)

(ii.b) Exchange rate (KShs/US$)

Table J-19 Variation of Exchange Rate

	1985	1986	1987	1988	1989	1990	1991	1992	1993
KShs/US$	16.4	16.2	16.5	17.7	20.6	22.9	27.5	32.2	NA
Variation	+0.2	-0.3	-1.2	-2.9	-2.3	-4.6	-4.7		
Rate	+1.2	-1.9	-7.3	-16.4	-11.2	-20.1	-17.1		
Average	10.4%								

(Data source : International Financial Statistics Yearbook 1993)

(ii.c) Escalation rate : Re

$$ER = [\{(1+PI)/100\}/\{(1+RE)/100\}]-1]*100$$
$$= [\{(1+15)/100\}/\{(1+10.4/100\}]-1]*100$$
$$= 4.2\%$$

where,

ER : Escalation Rate
PI : Price Index
RE : Rate of Exchange

No increased rate is taken into consideration as "special factor" though devaluation rate of 1993 assumes at 94% up to September 15 as follows.

Average exchange rate US$ 1.0 = KShs 62.4
62.4 - 32.2 (1992) = 30.2
30.2/32.2 * 100 = 94%

J3.5 Disbursement Schedule

Annual disbursement schedule is estimated with a certain percent of respective item as shown in Table J-20.

Table J-20 Ratio of Annual Disbursement

Cost Items	Ratio of annual disbursement (%)		
	1994	1995	1996
- Construction works	20	70	10
- Compensation	100	0	0
- Gov. administration	30	50	20
- Engineering services	40	50	10

Annual disbursement schedule is tabulated in Table J-21.

Table J-21 Annual Disbursement Schedule

(Unit: US$10^3)

Cost Item	Total		First Year		Second Year		Third Year	
	FC	LC	FC	LC	FC	LC	FC	LC
1. Direct cost	8,188	8,196	1,638	1,639	5,731	5,737	819	820
2. Land acquisition	0	16	0	16	0	0	0	0
3. Gov. administration	0	820	0	246	0	410	0	164
4. Engineering services	1,571	748	628	299	785	374	157	75
Sub total, 1 to 4	9,759	9,781	2,266	2,201	6,517	6,522	976	1,058
5. Physical contingency 10% for FC & LC	976	978	227	220	652	652	98	106
Sub total 1 to 5	10,734	10,759	2,492	2,421	7,168	7,174	1,073	1,164
6. Price contingency FC: 2.3% p.a. LC: 4.2% p.a.	467	870	57	102	334	615	76	153
Total, 1 to 6	11,201	11,629	2,550	2,523	7,502	7,789	1,149	1,317

J3.6 Operation and Maintenance Cost

Operation and maintenance (O&M) cost has to be estimated on the annual basis for (1) sewers, (2) Mwariki pumping station, (3) Town STW with repair shop, and 4) Njoro STW with laboratory. Annual operation and maintenance cost is worked out at KShs 6.4 million as shown down below.

Table J-22 Annual Operation and Maintenance Cost

Items		Amount	
		KShs million	(US$ equivalent 10^3)
1) Sewers	:	3.53	(57)
2) Mwariki pumping station	:	0.10	(2)
3) Town STW	:	1.92	(31)
4) Njoro STW	:	0.85	(14)
Total		6.40	(103)

Cost estimate for operation and maintenance is made according to the following conditions.

(1) Sewers

- Sewer length: 87 km
- Cleaning of sewers: one (1) time per five (5) years
- Length: 100 m/day
- Life of cleaning equipment: 15 years
- Cleaning crew: 5 persons/team
- Operation and maintenance cost of cleaning equipment: 5% of purchase cost
- Sewer repair cost: 0.5% of construction cost
- Annual working day: 250 days
- Annual pay: 30,000 KShs per one labour
- Equipment purchase cost: KShs 16 million
- Cleaning length: 17,400 m/year (87,000 m/5 year)
- Number of cleaning team: one (1) (17,400 m/{100 m*250 days})
- Fuel cost: KShs 23.5/litre
- Cost for managing staffs: excluded

Table J-23 O&M Cost for Sewers

(Unit: KShs)

Item	Annual Cost
Equipment	
Depreciation (16,000,000/15)	1,070,000
Maintenance (16,000,000*0.05)	800,000
Sewer repair	550,000
(87,000 m/1.2 m)*(KShs 1,500/1.2 m)*0.005	360,000
Material	
(Fuel, KShs 23.5*50 lit/day*250 days)	
(Lubricants, 20% of fuel)	
Labour	750,000
(5 labourers for equipment cleaning crew * KShs 30,000/person) + (20 labourers for manual cleaning crew * KShs 30,000/person)	
Total	3,530,000 (US$56,571)

(2) Mwariki pumping station

- Operation: done by one operator

- Operation hour: 9 hrs/day
- Electrical charge: KShs 3.24/kWh
- Equipment life: 15 years
- Repair and maintenance cost of equipment: 5% of purchase cost

Table J-24 O&M Cost for Mwariki PS

(Unit: KShs)

Item	Annual Cost
Equipment, depreciation (KShs 900,000/15 years)	6,000
Repair/maintenance (KShs 900,000*0.05)	4,500
Electricity charge (5.5 kWh/set*9 hr/day*365 days*KShs3.24/kwh)	60,000
Labourer (1 * KShs 30,000)	30,000
Total	100,500 (US$1,611)

(3) Town STW & Njoro STW

- Number of staffs for O&M works

Table J-25 Staffs for O&M Works

	Town	Njoro	Total
Forman	1	1	2
Mech. Engineer	1	1	2
Labo. Technician	1	1	2
Assist. Forman	2	2	4
Labour	4	6	10
Driver	1	1	2
Watchman	3	5	8
Total	13	17	30

Note: Number of staff is based on "Design Manual for Eastern Africa" issued by the Overseas Development Administration (ODA).

- Electrical charge: KShs 3.24/kWh
- Fuel cost: KShs 23.5/litre
- Initial cost of Town STW plant: KShs 50 million
- Repair & maintenance of STW plant: 2%

Table J-26 O&M Cost for Town STW & Njoro STW

(Unit: KShs)

Item	Annual Cost		
	Town	Njoro	Total
Electricity charge	400,000 (10,000 kwh for pump/lighting)	160,000 (4,000 kwh for lighting)	560,000
Fuel	21,000	31,000	52,000
Plant, depreciation	0	0	0
repair and maintenance	1,000,000	59,000	1,059,000
Total	1,921,000 (US$30,785)	850,000 (US$13,622)	2,771,000 (US$44,407)

K : INSTITUTIONAL STUDY

K: INSTIUTIONAL STUDY

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

K1. INTRODUCTION

Nakuru Municipality is the fourth largest urban centre in Kenya and is the Provincial Headquarters for the Rift Valley Province. The municipality has been subjected to a rapid population increase in recent years, more than 14 % per annum per year on the average during the period 1969 to 1987 and the current population is estimated at about 361,000. Nakuru is an industrial town covering a wide range of products for domestic and export markets.

In the southern rim of the municipality is located Lake Nakuru National Park around Lake Nakuru. Lake Nakuru is world-wide famous for millions of flamingoes. It is the home of 420 species of birds, although the lesser flamingoes (Phoeniconias Minor) predominate in numbers. It is one of the conservation areas registered under the Convention on Wetlands of International Importance especially as Waterfowl Habitat (the Ramsar Convention).

Rapid population increase and expansion of various human activities in the catchment area of the lake has resulted in increasing pollutants such as sewage, industrial wastewater and agro-chemicals. The pollutants are likely to affect the delicate ecological balance of the closed lake. The pollutants are likely to affect the nutrient ratios plus lowering the productivity of the lake and imminient disappearance of the flamingoes, hence loss of value of the lake as a tourist attraction.

In 1991, the then Ministry of Water Development (now the Ministry of Land Reclamation Regional and Water Development), through the National Water Conservation and Pipeline Corporation (NWCPC) completed the Greater Nakuru Water Supply Project, Eastern Division, Stage 1 aiming at supplying potable water amounting to 13,300 m^3/day to Nakuru Municipality. However, there has been concern that there may be some adverse effect on the ecology of the lake due to increasing sewage derived from the augmented potable water supply. The Government of Kenya (GOK) requested the Government of Japan (GOJ) for assistance for (1) Augmentation and expansion of the existing sewerage facilities and (2) Master Plan Study for the entire sewage disposal in Nakuru Municipality.

After exchange of diplomatic notes between GOK and GOJ, the Scope of Work for the Study, on the Nakuru Sewage Works Rehabilitation and Expansion Project (the Study) was concluded between the Japanese International Cooperation Agency (JICA) representing GOJ and the Ministry of Local Government (MOLG) representing GOK, in January 27th 1993. The objective of the Study is to carry out a feasibility study of sewage works

rehabilitation and expansion which is one of the urgent measures to cope with the increasing sewage.

The objective of this Institutional Study was to review the existing institutions, legislation and regulations related to water supply, sewerage, health and solid waste disposal and to make recommendations on improvements and strengthening of such institutions, legislations and regulations in view of reduction of pollutants within the Lake Nakuru catchment area and a sustained operation of the completed project.

K2. EXISTING INSTITUTIONS CONCERNED WITH ENVIRONMENTAL MANAGEMENT

K2.1 The National Environment Secretariat (NES)

The central focus of environmental management in Kenya is the MOER. The MOER has the overall responsibility of advising on rational utilization of forestry and mineral resources. Within the MOER is the NES which was created in 1972 after the United Nations Conference on Human Environment held in Stockholm. The organization of the NES is shown in Fig. K-1.

The main functions of the NES is to promote the integration of environmental policies and to advise the GOK and other institutes on matters related to the state of the environment and especially in connection with the monitoring, assessing and evaluating the impact of development activities on the environment. NES is the link between the GOK and the international organization dealing with environmental matters mainly the UNEP.

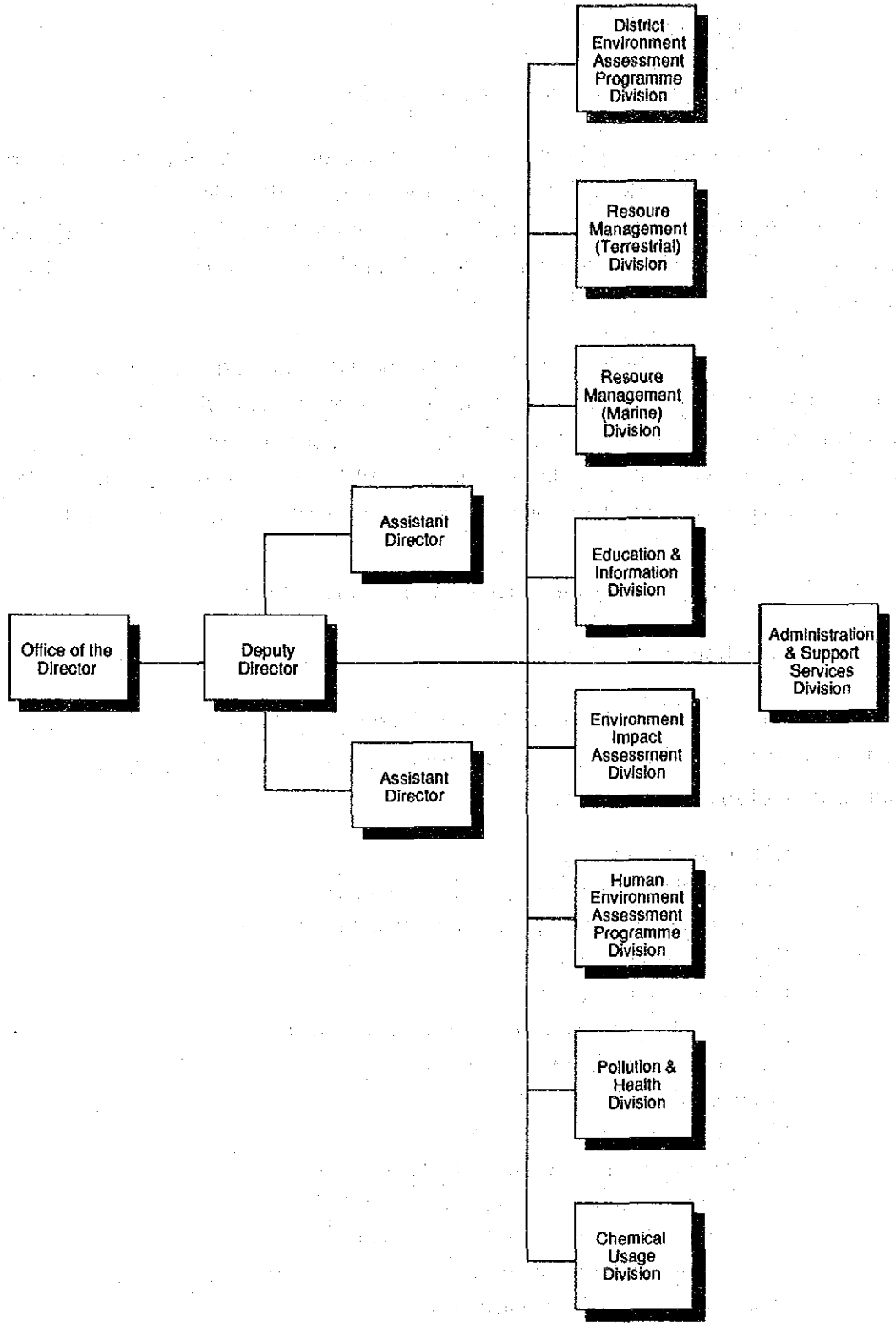
K2.2 The Inter Ministerial Committee on Environment (IMCE)

K2.2.1 Composition of IMCE

The coordination role of the NES is done through the IMCE which is composed of ministries, departments, universities, teacher training colleges and porastatals of GOK. The composition of the IMCE is given below.

- Office of the President
- National Environment Secretarial - Chairman
- National Council for Science and Technology (NCST)
- Kenya Mission to UNEP
- Kenya Mission to Habitat
- Ministry of Labour and Manpower Development (Factory Inspectorate Department)
- Ministry of Health (MOH)
- Ministry of Agriculture (MOA)
- Ministry of Local Government (MOLG)
- Ministry of Commerce and Industry (MOC & I)
- Ministry of Tourism and Wildlife (Fisheries Department)
- Ministry of Land Reclamation, Regional and Water Development (Water Development Department)
- Attorney Generals Chambers
- Kenyatta University
- Kenya Science Teachers College (KSTC)

Fig. K-1



THE REPUBLIC OF KENYA	THE STUDY ON THE NAKURU SEWAGE WORKS REHABILITATION AND EXPANSION PROJECT	TITLE
MINISTRY OF LOCAL GOVERNMENT	JAPAN INTERNATIONAL COOPERATION AGENCY	NATIONAL ENVIRONMENT SECRETARIAT (NES) ORGANIZATION CHART

K2.2.2 Functions of IMCE

The IMCE is established by the MOENR and has no actual legal status. It is however, mandated to coordinate issues regarding :

(1) UNEP

The UNEP Governing Council deals with UNEP programmes. The Council meets on a two year basis to give direction to the UNEP secretariat on the programmes to be executed including budgetary issues. Kenya is a member of the council.

(2) United Nations Conference on Environment and Development (UNICED)

The IMCE prepared Kenya's contribution to the UNICED held in June 1992 in Rio De Janeiro whose major outcome is the AGENDA 21 which is a plan of action to guide world nations on sustainable use of natural resources in harmony with environmental conservation. The IMCE is coordinating the implementation of the AGENDA 21 in Kenya.

(3) National Environment Action Plan (NEAP)

The IMCE is coordinating the strategies for the NEAP. A recent workshop organized by NES and spearheaded by IMCE proposed the organization for the implementation of the Plan. The activities of the NEAP have commenced with the appointment of a coordinator and establishment of task forces to handle various environmental issues.

(4) Ad hoc committees on Environment

The IMCE forms Ad hoc Committee on Environment to tackle specific problems regarding environmental conservation. Such Committee have dealt with issues of pollution from specific industrial, wetlands management, drought environmental legislation, biodiversity and others. The IMCE endorses the reports of the Ad hoc Committees and follows the implementation of the recommended action by the relevant agencies.

The IMCE has no budgetary provisions and relies on the budget lines in the member institutions. This is a major constraint in the operation of the committee. Acquisition of a legislative clout for the IMCE through enactment of the proposed National Environmental Bill (NEB) is strongly recommended by this Study.

K2.3 The Inter-ministerial Working Group (IWG)

IWG was organized in 1992 and has representatives from the following institutions:

- Office of the President
- Ministry of Finance
- Ministry of Lands and Settlement
- Ministry of Environment and Natural Resources
- Ministry of Local Government
- Ministry of Land Reclamation and Water Development
- Ministry of Commerce and Industry
- The National Water Conservation and Pipeline Corporation (NWCPC)
- Kenya Wildlife Services (KWS)

As specified by the then Office of the Vice-President and Ministry of Finance, the Terms of Reference (TOR) of the IWG are stipulated as follows:

(1) To address policy issues geared to harmonizing the development and environment of Nakuru Town and its environment.

(2) To give guidance and advise to the implementing agency on the proposed Nakuru Sewage Works to ensure that the international and national importance of preserving the precious ecology of Lake Nakuru is maintained as much as possible.

(3) To oversee that restrictive utilization measures of the Greater Nakuru Water Supply Project in accordance with the progress of the sewage works expansion programme is implemented.

(4) To ensure that there is full cooperation and assistance between GOK and GOJ.

(5) To ensure that proper measures are taken to control and restrict the Nakuru urban area.

The Director of Water Development Department of the MOLRRWD is the Chairman of the IWG.

The IWG has deliberated upon the development plan for the Nakuru area and advocates controlled development at the DDC level. Political good will is seen as an important ingredient for environmental conservation of the Lake Nakuru catchment area. In principal ,new industries should be allotted sufficient land to allow for wastewater pre-treatment for those discharging into public sewers and full effluent treatment for those discharging into water courses. EIA should be undertaken for development projects at the planning stage and DDC should ensure that practicable recommendations for mitigate of adverse environmental impacts are implemented.

It is therefore fitting that the Nakuru DDC becomes a member of the IWG through representation by the District Environmental Officer who is also under the Office of the President. The IWG should then undertake the due role of coordination and supervision of activities that are necessary for the conservation and protection of Lake Nakuru catchment. It is recommended that the IWG ultimately reports to the Office of the President.

K2.4 *The District Development Committee (DDC)*

Each district has a DDC under the chairmanship of the District Commissioner who is under the administration of the Office of the President.

The functions of the DDC can be seen in the light of the District Focus Strategy for Rural Development which was introduced in July 1983. The aims and objectives of this strategy were ;

(1) Involve the beneficiaries of development projects in the identification, planning, implementation, operation and evaluation of the projects within their area.

(2) Coordinate the activities of different organizations with similar goals in the District.

(3) To enable the local communities to select their priorities due to limited resources available.

(4) Mobilization of locally available resources mainly labour and materials to enhance development in line with the Government's Policy of cost sharing.

(5) Create the need for atsans within the community instead of importing semi-skilled labour from without the community.

(6) Create a sense of ownership for the projects so implemented within the community.

The Strategy of District Focus for Rural Development is therefore based on the principle of Ministries and Districts having complementary responsibilities. Responsibility for the operational aspects of rural development has been delegated to the Districts while the responsibility for broad policy and planning and implementation of multi-district and national projects has remained with the Ministries.

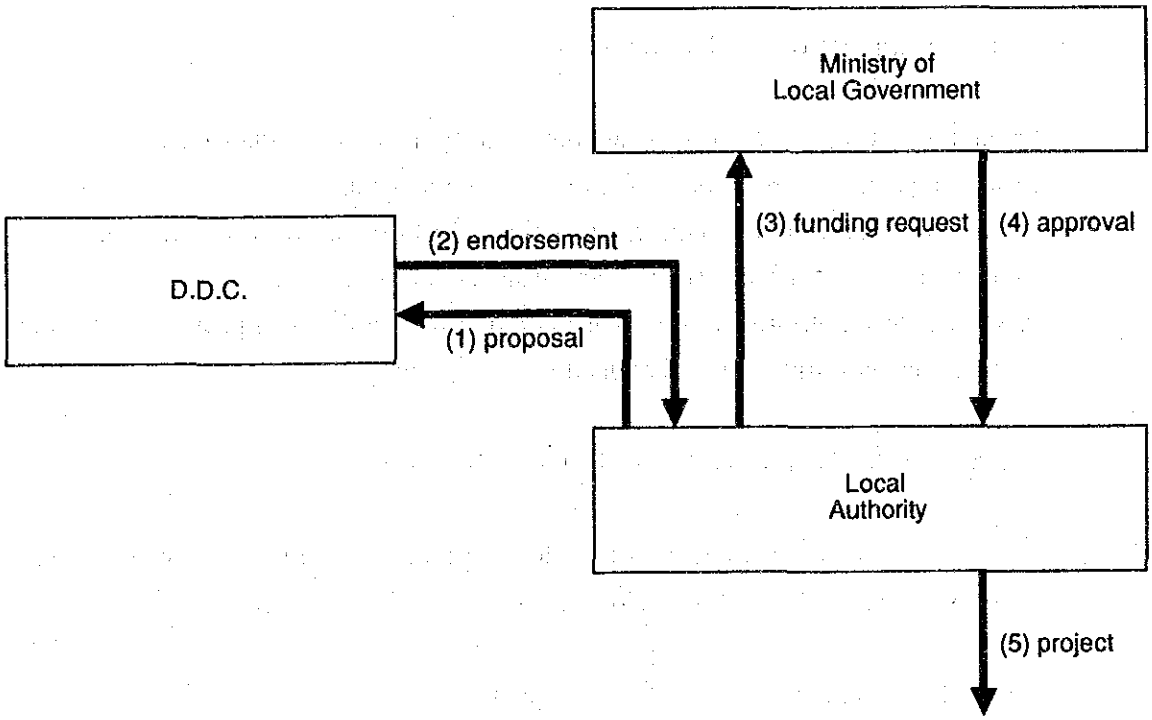
The membership of the DDC include the following :

- District Commissioner (Chairman)
- District Development Officer (Secretary)
- District Environment Officer
- District Department Heads of Development - Related ministries
- Members of Parliament from the District
- Chairmen of Local Authorities within the District
- Clerks of Local Authorities within the District
- Chairmen of Divisional Development Committee
- Representative of Development - Related Parastatals such as commercial Banks
- Invited Representatives of NGOs

The DDC encompasses many perspectives on the development needs of the district and its approval of project proposal represents a strong mandate of local support. The relationship between the DDC and the Local Authorities is shown in Fig. K-2

Harmonization of development and environment of Nakuru Municipality and the entire Lake Nakuru catchment basin, in view of conservation and protection of Lake Nakuru is a national project and cannot therefore be under the supervision of the Nakuru DDC, thus the IWG has been established to supervise and coordinate the activities.

Fig. K-2



THE REPUBLIC OF KENYA	THE STUDY ON THE NAKURU SEWAGE WORKS REHABILITATION AND EXPANSION PROJECT	TITLE
MINISTRY OF LOCAL GOVERNMENT	JAPAN INTERNATIONAL COOPERATION AGENCY	RELATIONSHIP BETWEEN DDC AND *LOCAL AUTHORITIES*

K2.5 Ministry of Local Government

K2.5.1 Ministry of Local Government

The MOLG administers the Local Government Act (Cap. 265). The functions of this Ministry in relationship to environmental management rests on:

- Local Government By-laws
- Urban Planning and Development

The stated main functions of the MOLG are:

- Promoting sound local government administration by local authorities,
- Promoting sound management of resources by local authorities,
- Providing technical assistance to local authorities in the planning and implementation of urban development projects and programmes,
- Assisting local authorities to discharge their responsibilities to providing services to their local communities and expand their capacity.

K2.5.2 The Urban Development Department (UDD) of MOLG

For logical institutionalization of urban development co-ordination the UDD was created in 1991 within the MOLG. The exclusive function of the UDD are:

- Strengthen local authorities technical capacity
- Strengthen local authority capacity for socio-economic development
- Strengthen local authority capacity for operation and maintenance of infrastructural system
- Contribute to training of local authority staff
- Improve local authority management and financial competence
- Guide local authorities on consultancy and contractual matters
- Prepare policy and legal framework
- Promote research activities
- Co-ordinate donor agencies
- Train UDD staff
- Provide information and documentation
- Assist in recruitment of UDD staff

Execution of work is by the local authorities and not by the UDD.

The new UDD consists of two divisions and five sections, thus:

(1) Divisions

- Technical Services Division
- Development Planning Division

(2) Sections

- Economic Planning
- Development Planning and Research
- Community Development
- Roads and Transport
- Buildings
- Water and Sanitation
- Administration Section

Fig. K-3 shows the organization chart of the UDD.

The most relevant Section within the UDD regarding this Study is the Water and Sanitation Section which has the following responsibilities:

(1) Regulating and coordinating consultancy services for water and sanitation projects in the local authorities

(2) Contract administration for water and sanitation project in local authorities

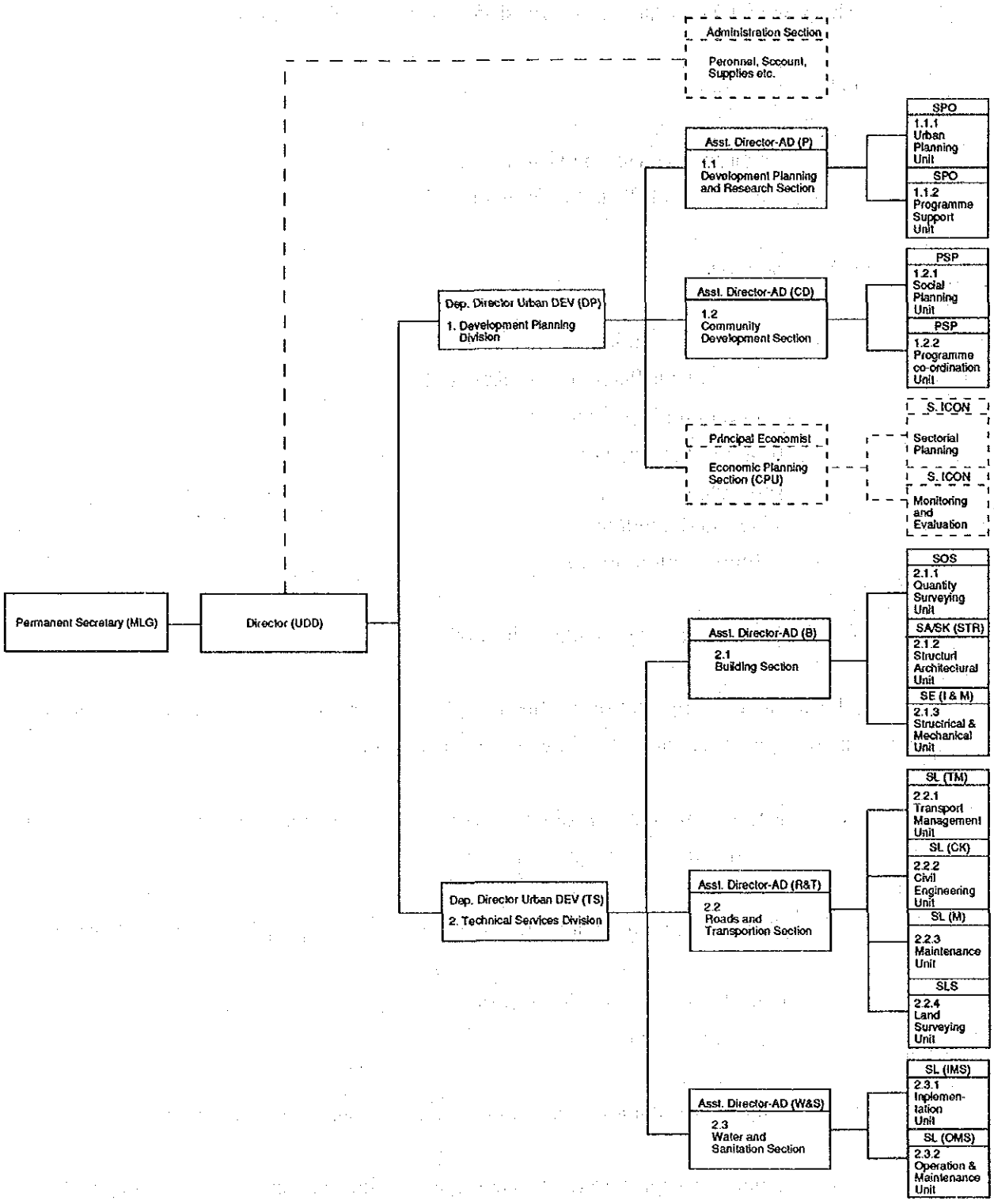
(3) Coordination of on-site training for operation and maintenance of water and sanitation systems

(4) Guiding local authorities on planning for water and sanitation projects

(5) Ensuring professionally acceptable design and construction standards for water and sanitation projects

(6) Prepare TOR for studies and design for water and sanitation projects

Fig. K-3



As prepared by the organizational workshop, Nyeri Feb. 1992

THE REPUBLIC OF KENYA MINISTRY OF LOCAL GOVERNMENT	THE STUDY ON THE NAKURU SEWAGE WORKS REHABILITATION AND EXPANSION PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE MINISTRY OF LOCAL GOVERNMENT URBAN DEVELOPMENT DEPARTMENT