Since the existing mixers are provisional ones, new mixers are to be provided to meet the replaced solution tanks.

Type:	Propeller type
Material:	SS
Motor:	1.5kW, 400V, 50Hz
Quantity:	3 sets

5) Lime Dosing Pump:

Since the existing pumps are worn-out and thus not possible to continue to use, they are to be replaced by new ones.

Type:	Manually operated stroke controlled diaphragm type
Capacity:	1.6 l/min to 16 l/min x 40m
Material:	SUS 304 for wetted part
Motor:	2.2kW, 400V, 50Hz
Quantity:	2 sets (1 for stand-by)

6) Pump for Washing

Pumps are newly provided for the durable function of lime feeding equipment. Pumps will wash out slurries attached to the inner surfaces of solution tanks, dosing pumps, pipes, valves etc.

Type:	Single suction volute pump
Capacity:	$0.2m^3$/min x 20m
Dimension:	50mmφ
Material:	Casing; FC
	Impeller; FC
	Shaft; SUS 304
Motor:	1.5kW, 50Hz
Quantity:	1 set

7) Pipes and Valves

Lime Solution Tank -- Dosing Pump-- Dosing Point

SGPW 1 lot

4.3.3. Transmission Facilities

There are two main transmission facilities, i.e., the transmission pump stations at the Kafue Water Treatment Plant and the Chilanga

Booster Pump Station in the water supply system. The objective of the project is the recovery of the capacity of each pump station from the existing 84,000m^3/day to 110,000m^3/day (76.4m^3/min) by means of necessary improvement of the existing equipment. However, the existing transmission main (nominal diameter = ϕ900mm) will be utilized in this project.

The conditions of the existing pump stations are as follows and the improvement will be done based thereon:

	Kafue Transmission Pump Station	Chilanga Booster Pump Station
Transmission Pump	.Two out of the four existing pumps are operable but are worn out .Impellers are damaged by cavitation and corrosion	.Three out of the four existing pumps are operable but are worn out .Same as noted on the left
Motor for Transmission Pump	.Since synchronous motors are used, maintenance and management thereof are fairly difficult. And mis-operation due to this difficulty is causing the breakdown of the equipment	.Same as noted on the left
Delivery Valve of Transmission Pump	.Delivery valves have been replaced by new ones every 3 to 4 years due to cavitation and the existing valves are also damaged by cavitation.	.Same as noted on the left
Others	.Ventilation of the pump room is very poor	.Same as noted on the left

(1) Design Criteria

- Friction Loss Coefficient for Transmission Main: C = 120
- Amount of Water to be Transmitted: 110,000m^3/day (76.4m^3/min)
- Amount of Water to be Pumped: 76.5m^3/min
- Basic Water Level and Head

Items	Kafue Pump Station	Chilanga Pump Station
Water Level on the Suction Side	3298'8"	3789'
Water Level on the Delivery Side	3789'	4298'2"
Total Head		
Gross Pump Head	490'5" 149.5m	509'2" 155.2m
Head Loss in Transmission Main	84.81m	84.17m
Loss of Pumps	2.0m	2.0m
Total Pump Head	236.3m → 242m	241.37m → 242m

(Note) Although the total pump heads at the Kafue Pump Station and the Chilanga Pump Station show 5m difference, the total pump head for the pumps at both pump stations is set to 242m taking the exchangeability of pumps between these pump stations.

(2) Pump

Only two out of the four pumps at the Kafue Transmission Pump Station (No. 1 high-lift pump station) and three out of the four pumps at Chilanga Booster Pump Station (No. 2 high-lift pump station) are currently working and neither pump station has the capacity of transmitting 110,000m^3/day. Moreover, neither of the two pump stations has any stand-by pumps and even the operable pumps at both stations are severely deteriorated. From the point of view of maintainance and

management, therefore, all of the eight pumps at both stations are to be replaced by new ones in this project.

Considering that 110,000m^3/day water to be transmitted is delivered by three pumps in action and that one stand-by pump is provided at each pump station, the capacity of the pump is computed as follows:

Capacity of the pump = 110,000m^3/day ÷ 3 sets
= 25.5m^3/min/set

Although the existing pumps are of two-stage volute type, multi-stage volute pumps are adopted for the Project because of easy maintenance and management thereof and of simplicity of pipings. Considering durability, stainless cast steel which has high strength is used as the material for the impeller of the pumps. This material is more resistant against corrosion due to cavitation than BC which is the material of the impellers of the existing pumps.

Type:	Horizontal shaft, double suction, multi-stage volute pump
Diameter:	ϕ450mm x ϕ250mm
Delivery Amount:	25.5m^3/min
Total Head:	242m
Pump Efficiency:	86% or more
Material:	Impeller; Stainless cast steel
	Shaft; Stainless steel
	Body; Cast iron
Quantity:	4setsat Kafue
	4 sets at Chilanga
	8 sets in total

(3) Motor for Pump

In order to solve the current problem, the type of motor is changed from the existing synchronous induction type to open drip-proof squirrel cage induction type. Since a starting resistance box and a generator are not necessary for a squirrel cage motor, the simplification of operation and maintenance thereof and sturdiness of the equipment are achieved (refer to Table 4.5).

Table 4.5 Comparison Table of Motor

	SQUIRREL CAGE INDUCTION MOTOR	WOUND ROTOR INDUCTION MOTOR
PRINCIPLE	An AC motor in which currents in the primary winding (connected to the supply) set up a flux which causes currents to be induced in the secondary winding (usually the rotor); these current interact with the flux to produce rotation.	
ROTOR	• A squirrel-cage induction motor is an induction motor whose secondary winding consists of conducting bars put in slots and end rings which short-circuit these bars at both sides of the iron core	• A wound-rotor induction motor is an induction motor whose secondary winding consist of polyphase coil windings, usually, the leads of the secondary windings are connected to external terminals of the machine through collector rings
CHARACTERISTICS	• Starting torque is small as compared with wound rotor motor • Direct-on-line starting current is 600 %	• It is possible to increase starting torque and restrict starting current in accordance with increasing secondary resistance • It is possible to control speed of motor by changing secondary resistance when motor is operating
MAINTENANCE	• Almost maintenance free because of no rubbing contact	• Regular inspection of slip-ring is required with occassional replacement necessary due to the rubbing contact of the slip-ring • Regular inspection for secondary resistant equipment is required • Maintenance is difficult as compared with squirrel cage motor
CONSTRUCTION PRICE	• Construction simple • Low price	• Construction complicated • High price
APPLICATION	• In case of constant speed • When ease of maintenance is required	• In case of speed control • In case it is required to reduce starting current

In order to abate the starting current for the squirrel cage motor, a reactor starting method is employed. In addition, a condenser for power factor improvement is provided in order to improve the power factor of the circuit.

Type:	Horizontal shaft open drip-proof squirrel cage type
Voltage:	3,300V
Output:	1,350kW
Quantity:	4 sets at Kafue
	4 sets at Chilanga
	8 sets in total

(4) Delivery Valve for Pump

A survey of the site indicates that the impellers of the existing pumps and the existing delivery valves for the pumps are severely damaged by cavitation. Excessive amounts of discharge when only one or two pumps are operating is causing this problem. Although throttling the delivery valve is taken as a countermeasure, it is considered that this countermeasure is not working effectively because sufficient throttling is not being done since the existing delivery valve is not for flow control.

Thus, it is necessary to select delivery valves which will not cause cavitation of the pump in case only one pump is operating. Based on this idea, electrically operated cone valves, which have high controllability, are provided.

Type:	Electrically operated cone valve
Diameter:	ϕ400mm
Output:	1.5kW x 400V
Quantity:	4 sets at kafue
	4 sets at Chilanga
	8 sets in Total
Open/Close time:	Approx. 110 seconds

Table 4.6(1) Comparison List for Discharge Valve

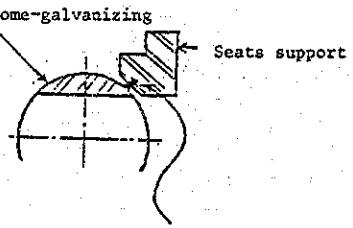
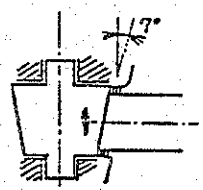
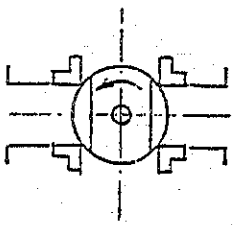
	ROTO VALVE	BALL VALVE	EXPLANATION
Construction of valve seat	Build-up welding 	Chrome-galvanizing  Seats support Valve seat is inserted	Build-up welding is the most reliable method for valve seat construction. Small bore ball valves do not require seat supports as elastic seat can be fixed directly onto valve body.
Rubbing distance of valve seat	 Short	 Long	Durability of valve will be larger if the rubbing distance is short, however, durability depends upon the type of seat material used. Metal seat is good for the valve seat.
Corrosion resistance of valve seat	Good	Using seal supported parts ----- poor Small bore valve ----- good	Large size ball valves are used mainly for oil and gaseous fluid, however, when it is used to handle water, careful attention must be ensured in selecting the appropriate material to avoid corrosion.
Durability of valve seat	Best	Not good	
Valve characteristics	Ease of control for 0 to 80 % flow range	Ease of flow control	Both Roto and Ball Valves are most suitable for flow control purposes.

Table 4.6(2) Comparison List for Discharge Valve

	ROTO VALVE	BALL VALVE	EXPLANATION
Cavitation coefficient	1.5	1.5	Incipient cavitation coefficient shown is at approx 40 % of valve opening for practical use.
Application of flow control	most suitable	Suitable, but not suitable in case where frequent opening and closing of valve is requried.	Ball valve is not suitable when the valve stay in the partial opened position for long duration of time.
Effects of flow with slurry liquid (at full open)	Bast	Bast	Both the roto and ball valves offer a straight way passage through its ports in the full open position with a mininum of turbulance thereby making them suitable for handling slurry and sewage water.
ditto (at a half open)	Good	Good	
Applicable maximum pressure	Bore diameter: 200 ϕ ----- 200 Kgf/cm^2 2000 ϕ ----- 20 Kgf/cm^2	Suitable for high pressure. (Usually employed for pressure ratings of 200 Kgf/cm^2)	
Durability of packing	Best	Best	
Revolution of hand-wheel and force at full shut	- 180 rev. - 40 Kgf	- 350 rev. - 40 Kgf	The data indicated in the column are based on the following assumptions: (i) Handwheel diameter is 600 mm (ii) Differential pressure of valve at 100 % closed is 10 Kgf/cm^2 (iii) Valve bore diameter is 800 mm

Table 4.6(3) Comparison List for Discharge Valve

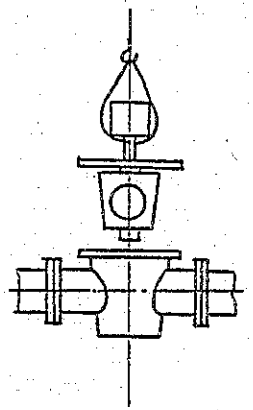
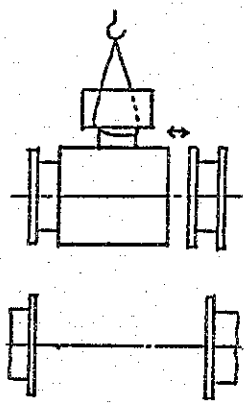
	ROTO VALVE	BALL VALVE	EXPLANATION
Inspection point of valve's internal parts, and difficulties in carrying out inspection.	 • Inspection for wear of bearing • Disassembly of valve from pipe is not necessary • Ease of maintenance	 • Inspection for bearing, valve seat and valve plug • Disassembly is necessary for inspection • Difficlty of maintenance	Most ball valves are required to be detached from the piping for maintenance purposes. However, for special ball valves detachment from the piping for maintenance are not required.
Approx. valve bore diameter (based on constant friction loss)	250 mm (7.7 m/s)	250 mm (7.7 m/s)	The bore size indicated in the column are based on the 400 mm diameter bore size butterly valve with a flow velocity of 3 m/S. (velocity flow)
Energy loss at full open	0.9 kW	0.9 kW	The figure shown are based on the assumption that the 800 mm and velocity flow is 5 m/sec.

Table 4.6(4) Comparison List for Discharge Valve

	ROTO VALVE	BALL VALVE	EXPLANATION
Application	Roto valve is widely used for water works, agricultural and industrial water, oil and gas as stop valve and flow control valve. For sewage works, it is used as stop valves mainly.	Large bore ball valves are used mainly for oil and gaseous fluid. Small bore ball valves are used mainly for water, chemical, and instrumentation application.	
Conclusion	• Roto valve is the most suitable for automatic control and flow control because it has good rigidity, durability and ease for maintenance. • Roto valve is more suitable for stop valve application as compared to sluice valve because of the following: – good sealing performance – easy to operate – low head loss at full opened position – compact in size	• Selection of seat material is important to ensure durability of the ball. • Small bore ball valves is suitable for handling water because anti-corrosion materials is used. • Ball valve 15 indispensable to high pressure gas and oil because valve seats is made of elastic material, giving good posibility of sealing. • Ball valves should not be used where frequent opening and closing of valve is required.	Each valve has its individual characteristics, so it is important when selecting the appropriate valves to consider its purpose of use, durability, inspection and maintenance, reliability and cost (initial cost and running cost, auxiliary facility cost) and etc.

(5) Others

.A duct is provided between the outlet of the cooling fan for the pump motors and the outdoors as ventilation in order not to raise the pump room temperature.

Ventilation duct : 1 lot, steel

.Portable floor drain pump is provided.

Specification: ϕ50mm x 0.1m3/min. x 10m x 0.4kW x 4 sets

.Pipings are arranged in connection with the replacement of pumps, delivery valves etc. while the existing header pipes are to be utilized. In addition, existing check valves are to be replaced by new ones.

.Check Valve

Type : quick closed type
Diameter : 450mm
Number : 4 at Kafue
4 at Chilanga
8 in total

.Pipings

Suction pipe : SGP JIS10kg flange
Discharge pipe: STPY JIS20kg flange
Other pipes : SGPW

(6) Device for Alleviating Water Hammer

Water hammer is expected to occur by the improvement of pumps according to hydraulic analysis (refer to Appendix 11). As a result of analysis, when flywheels are provided to pumps, water hammer is reduced to a safe degree coupled with the ventilation works of the existing air valves in the case of the Kafue pumps. On the other hand, in the case of the Chilanga pumps two one-way surge tanks are necessary in addition to the existing air valves and newly provided flywheels to the pumps. Specifications of each piece of equipment are shown below.

Table 4.7 Specifications of Water Hammer Devices

Items	Unit	Kafue Pumps	Chilanga Pumps	
Flywheel				
GD^2 value ($kg.m^2$)		1,000	1,000	
Type		Coupling	Coupling	
One-way Surge Tank (Reinforced concrete)			No.1	No.2
Location (distance from the pumping station)				
	(m)		12,011.2	13,535.2
Base level	(m)		1,293.98	1,304.40
Water level	(m)		1,295.86	1,306.86
Dimension	(m)		3x3.5x3	7x7x4
Pipe Diameter	(mm)		250	400

4.3.4 Electrical Equipment

The following improvements on electrical equipment are required in association with the improvements of the pumps both at the Kafue treatment plant and the Chilanga booster pumping station. In addition, power lines from the Kafue substation of ZESCO to the Kafue treatment plant are also included in the project because this line is frequently broken down.

(1) Kafue Treatment Plant

1) Substation Facilitiy

1. 33/3.3kV Main Transformer --- 7.5MVA x 2 sets

(installation work will be conducted by ZESCO).

The existing 2 sets of 5 MVA transformers are to be replaced by 2 new sets with an increased capacity of 7.5 MVA in order to meet the increased starting capacity of the pumps due to their replacement both at the treatment plant in this project and at the intake plant, granted by the Government of West Germany. The determination of 7.5 MVA is explained in the Appendix.

2. 3.3kV Metal-Enclosed Switchgear --- 13 panels

The existing secondary distribution switchgears of the transformers and starter switchgears for the pumps are to be replaced by new ones, in accordance with the changed starting method of the pumps.

3. 3.3kV/400V Transformer --- 300kVA x 2 sets

Since the existing two transformers are worn-out, one of which is completely nonoperational, the old two ones are to be replaced by new ones.

4. 400V Main Low Tension Control Panel ---- 2 panels

The old ones are to be replaced by new ones.

2) Power Supply System Facilities

1. Power Control Panel ---------- 11 panels
   - .for Auxiliary Equipment of the Transmission Pump
   - .for Flash Mixer
   - .for Alum Feeding System
   - .for Lime Feeding System
   - .for Auxiliary Equipment of the Upwash Pump

3) Monitoring and Instrumentation Equipment

1. Level Meter for Reservoir (floating type)---- 1
2. Flowmeter (Orifice) ---------- 1
3. Monitoring and Control Panel ---------- 1

Since discharge and water level of the reservoir need to be monitored, the existing worn-out meters are to be replaced by new ones.

4) Transmission Line

The power source of the treatment plant comes from the Kafue substation of ZESCO through two aerial lines. The section of the existing lines (500 meters) starting at the Kafue substation are liable to power failure due to poor insulation caused by dust from the nitrogen plant nearby. Hence, in this project, two-500m lines are laid underground to guarantee a stable power source for the Kafue treatment plant. Hence the following are granted and installed by ZESCO.

1. 33kV polyethylene cable 250mmsq - 3 core 1,200m (including 200m allowance)
2. Cable head ------- 4 sets

(2) Chilanga Booster Pumping Station

1) Substation Facility

1. 3.3kV Metal-Enclosed Switchgear -------- 12

The existing switchgears are to be replaced by new ones in accordance with the change of starting

method of the pumps

2. 3.3kV/400V Transformer ---------- 75kVA x 1 set
Replaced by new ones as appurtenances of the pumps.

2) Power Supply System Facilities

1. Power Control Panel (as appurtenances of the pumps)
---------- 3 panels

3) Monitoring and Instrumentation Equipment

1. Level meter for reservoir(floating type) --- 1
2. Flowmeter(orifice) ---------- 1
3. Monitoring and Control Panel ---------- 1

Since discharge and water level need to be monitored, the existing worn-out meters are to be replaced by new ones.

4.3.5 Equipment for Operation and Maintenance

(1) Communication Equipment

A communication system between the Kafue treatment plant - the Chilanga pumping station - and the Lusaka water works was provided for the following purposes:

1 Communications between the three stations
2 Transmission of the water level records of the receiving reservoirs to the transmission pumping stations i.e., from Lusaka to Chilanga and from Chilanga to Kafue.
3 Transmission of the water level records and discharge records of pumps for monitoring.

However, it was damaged and has long been inoperable, mainly due to lightning surge. Therefore, the public telephone system is used instead but it is usually overloaded or not working properly. As a result, overflow of reservoirs is taking place. To solve this problem, the following improvements are made:

Communication Method: 400MHz, simplex system

Equipment composition: radio equipment, 3 stations
(Kafue treatment plant, Chilanga pumping Lusaka water works)

Spare parts such as lightning arresters and print plates are also provided while existing antennae are utilised.

(2) Vehicle

Transportation in Lusaka relies heavily on vehicles which are mostly imported. The allocated two vehicles in the Water and Sewerage Department are out of order due to lack of spare parts and poor maintenance while the following number is considered the total number necessary for management of the water works.

.2 to 4 ton trucks for transportation of chemicals, pipes etc. ---------- 2 units

.4- wheeled wagon for transportation of staff and maintenance of various facilities ------- 4

.Pickup truck for short-distance transportation of various goods -------- 4

.Water supply wagon ---------- 4

.2 ton crane truck ---------- 1

Of this number, for the operation and maintenance of the Kafue system one 3-ton truck and two 4-wheeled wagons are considered the minimum necessary, and the following vehicles are provided:

1. 3ton truck x 1 vehicle
   Type : double type, high deck, standard body with wood
   Maximum load capacity: 3 tons
   Engine power: 100HP
   Fuel : gas oil

2. 4-wheeled wagon x 2 vehicles
   Type : 7-passenger wagon
   Engine power: 2,600cc
   Fuel : gasoline

3. Spare parts for 1 truck and two wagons for three years

4.4 Equipment List to be Granted

4.4.1 Water Treatment Equipment

Equipment	Items	Description	Quantity
Alum Feeding	Alum Solution Tank	.Line the inner surface of the existing concrete tanks with stainless steel plate	3
	Mixer for Solution Tank	.Replace the existing mixer with new vertical type mixers	3
	Meshed Basket for Alum Solution	.Provide and install a new stainless steel meshed basket	1
	Alum Circulation Pump	.Replace the existing pumps with new volute pumps	2
	Alum Dosing Pump	.Replace the existing pumps with new variable constant feed pumps	3
	Flash Mixer	.Remove the pumps, pipes and valves of the existing mixers and install new flash mixers	2
	Pipes and Valves	.Replace the existing pipes and valves from the alum saturation tank to the alum solution tank and the pipes for circulation with new ones	1 lot
		.Replace the existing pipes and values from the alum solution tank to the dosing point at the mixing basin with new ones	1 lot
Equipment for Sedimentation Basin	Sludge Cones	.Provide and install new anti-corrosive sludge cones	30
	Cone Suspension	.Provide and install new manual cone suspension equipment	30
	Pipes and Valves	.Provide and install new pipes and valves for draining sludge	30 lots
Rapid Filter Basin Equipment	Filter Media	.Remove the existing filter media, and wash and sort it. Then, install it after supplementing it with new media, if necessary	for 20 basins
	Sand Washing Equipment	.Provide new sand washing equipment for maintenance and management	1 lot
	Underdrain Equipment	.Check the underdrain equipment and repair it if necessary	for 20 basins
	Drain Trough	.Provide and install new drain troughs (5 sets per basin)	for 20 basins
	Flow Control Valve	.Remove the existing flow control valves and venturi-flumes and provide and install new mechanically operated flow control valves	20
	Valves, Gates, Etc.	.Remove the existing air cylinders of the pneumatically operated valves and gates and provide and install new hand operators	for 20 basins
		(Control gates for inflow and discharge)	
		(Valves for washing water and pneumatic backwash valves)	
	Air Wash Blower	.Replace existing blowers with new ones	2
	Backwash Pump	.Replace the existing pumps with new ones	4
Lime Feeding Equipment	Lime Solution Tank	.Replace the existing tanks with new ones	3
	Mixer for Lime Solution	.Replace the existing mixers with new ones	3
	Lime Dosing Pump	.Replace the existing pumps with new ones	2
	Pump for Washing	.Provide a new pump for washing	1
	Pipes and Valves	.Remove the existing pipes and valves from the lime solution tanks to the dosing points and provide and install new ones	1 lot

4.4.2 Transmission Equipment

Equipment	Items	Description	Quantity Kafue	Quantity Chilanga
Pump Facilities	Pump	.Replace the existing horizontal shaft two-stage pumps with new ones	4	4
	Motor	.Replace the existing wound rotor induction motors with new squirrel cage induction motors	4	4
	Delivery Valves	.Replace the exisiting sluice valves with new electrically operated cone valves	4	4
	Ventilation Duct	.Provide and install new ducts for the exhaust heat from the motors	4 lots	4 lots
	Floor Drain Pump	.Provide new portable type floor drain pumps	2	2
	Check Valves	.Replace the existing valves with new ones	4	4
	Pipes	.Remove the existing pipes on the pump for transmission, suction and discharge with new pipes	4 lots	4 lots
		.Provide and install a new floor drain pipe	1 lot	1 lot
	Countermeasures Against Water Hammer	.Provide and install a new flywheel	4 lots	4 lots
		.Provide and install new one-way surge tanks	-	2 lots

4.4.3 Electrical and Instrumental Equipment

Equipment	Items	Description	Quantity Kafue	Quantity Chilanga
Substation Facilities	Main Transformer	.Replace the existing 5MVA transformers with new 7.5MVA ones	2	-
	3.3kV Secondary Switchgear	.Replace the existing panels with new ones	2	2
	Bus Tie Switchgear	.Replace the existing panel with a new one	1	1
	Main Pump Panel	.Replace the exisiting panels with new ones	4	4
	Reactor Panel	.Provide and install new reactor panels for starting pumps for transmission	4	4
	Transformer Primary Panel for Auxiliary Equipment for Transformer	.Replace the existing panel with a new one	1	1
	Feeder Panel for Intake Pump	.Ditto	1	1
	Auxiliary Equipment for Transformer	.Replace the existing auxiliary equipment with new equipment	2	1
	Main Low Tension Control Panel	.Replace the existing panels with new ones	6	-

Equipment	Items	Description	Quantity Kafue	Quantity Chilanga
Power System Facilities				
	Power Control Panel for Auxiliary Equipment of the Transmission Pump	.Replace the existing panel with a new one	3	3
	Power Control Panel for Flash Mixer	.Ditto	1	-
	Power Control Panel for Alum Feeding system	.Ditto	3	-
	Power Control Panel for Lime Feeding System	.Ditto	2	-
	Power Control Panel for Auxiliary Equipment of the Backwash Pump	.Ditto	2	-
	Local Control Panel for Transmission Pump	.Ditto	1	
Monitoring and Instrumental Equipment	Level Meter	.Replace the existing meter with a new one	1	1
	Float Switch	.Replace the existing switches with new ones	2	2
	Flowmeter for Transmission	.Replace the existing flowmeter with a new one	1	1
	Monitoring and Control Panel	.Replace the existing panel with a new one	1	1

4.4.4 Equipment for Operation and Maintenance

Equipment	Items	Description	Quantity
Communication Equipment	Wireless Telephone System Equipment	.Provide and install new wireless telephones .The existing antenas are to be used	3 stations
Vehicles	Truck	.Provide a new truck of 3-ton maximum loading capacity	1
	Wagon	.Provide new seven-passenger wagons	2

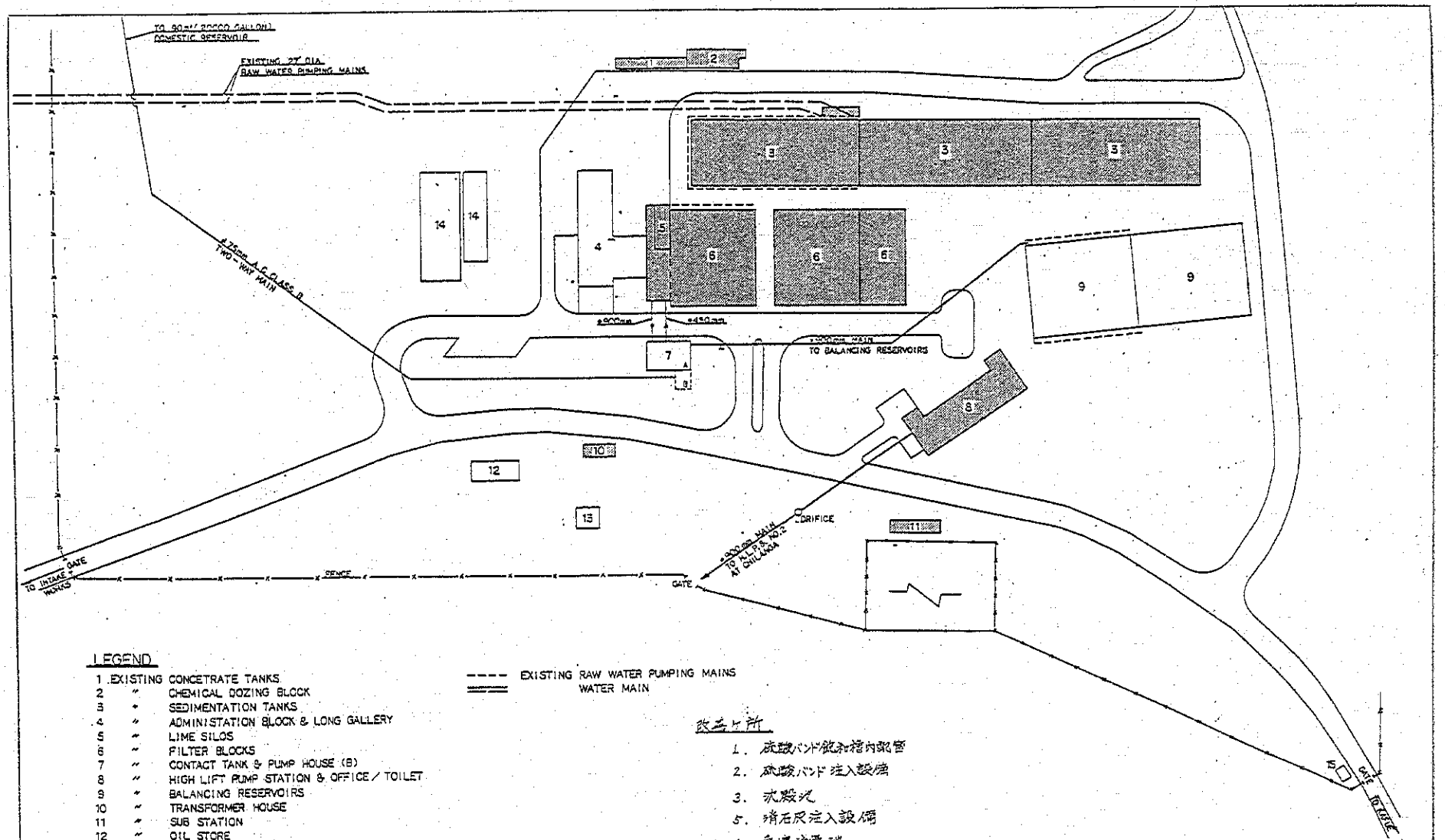
4.5 Drawings

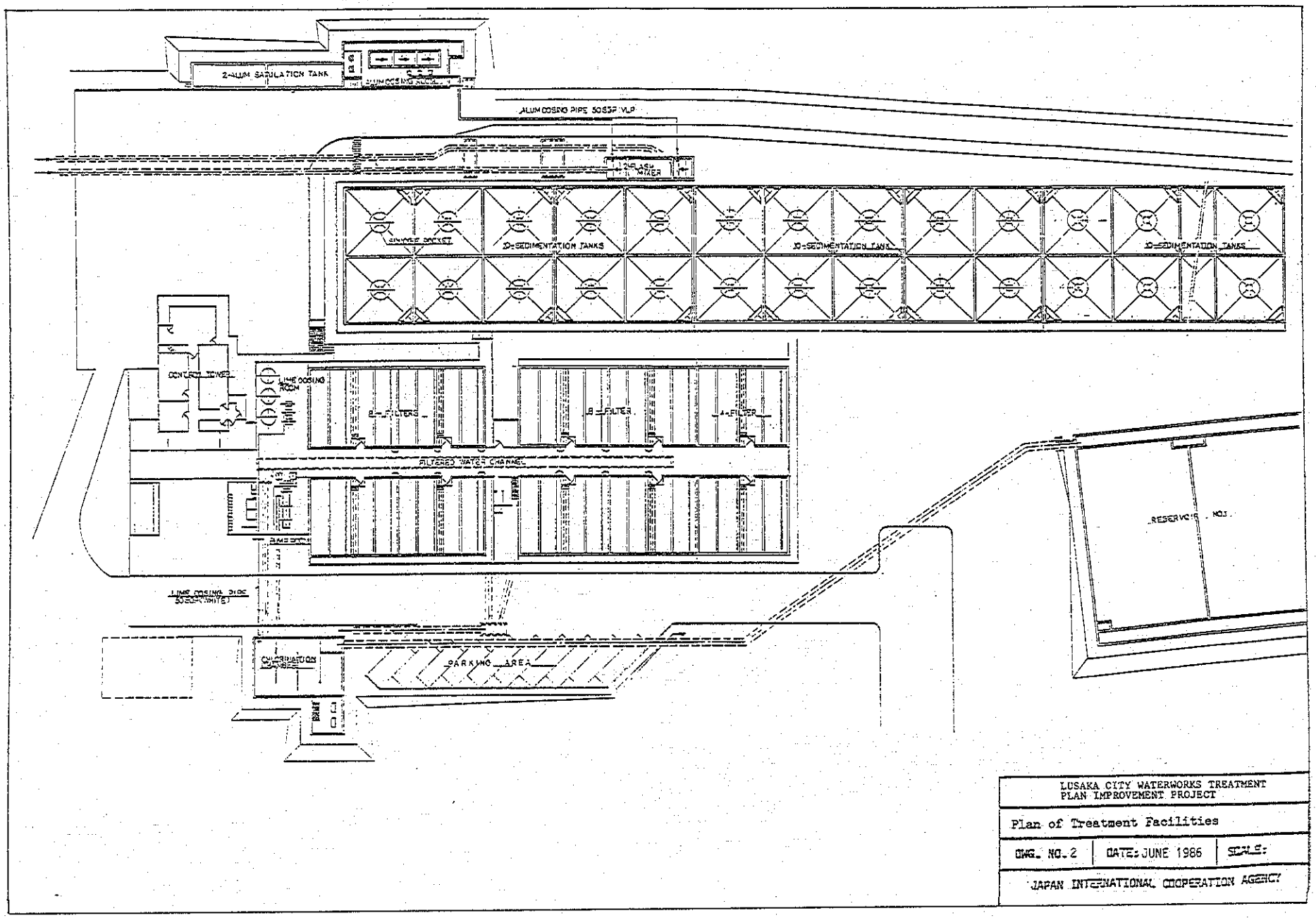
DWG.NO.	Title of Drawings
1.	General Plan of Kafue Treatment Plant
2.	Plan of Treatment Facilities
3.	Plan and Section of Flash Mixer
4.	Plan and Section of Sedimentation Basin
5.	Plan and Section of Filter
6.	Flow Diagram of Alum Feeding Equipment
7.	Flow Diagram of Lime Feeding Equipment
8.	General Plan of Chilanga Puming Station
9.	Plan and Section of Pump
10.	Section of Pump
11.	Power Supply System Diagram
12.	Skelton Diagram (1)
13.	Skelton Diagram (2)
14.	Skelton Diagram (3)
15.	Skelton Diagram (4)
16.	Plan and Section of Electrical Room

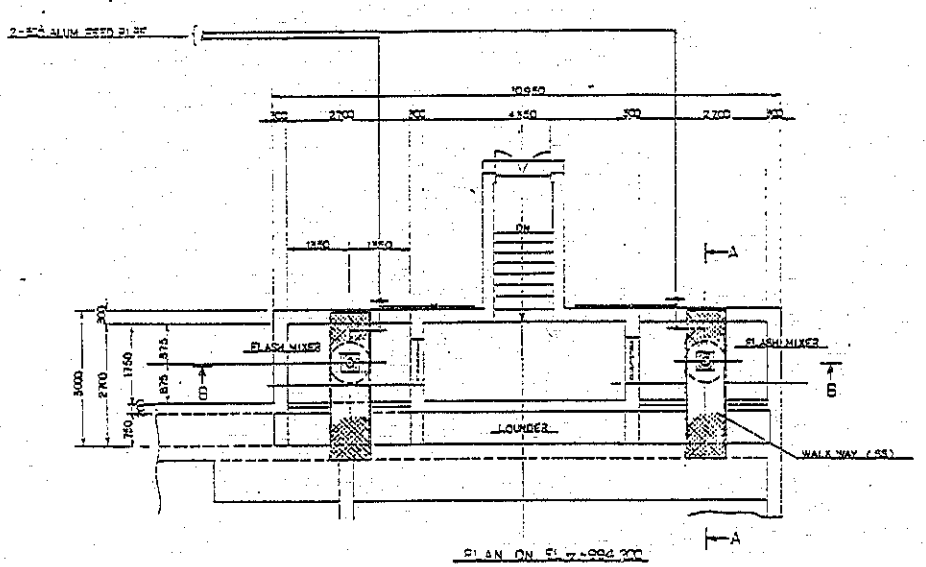
4.6 Project Cost to be born by Government of Zambia

The Project cost to be born by the Government of Zambia consists of the replacement costs of transformers and transmission cables.

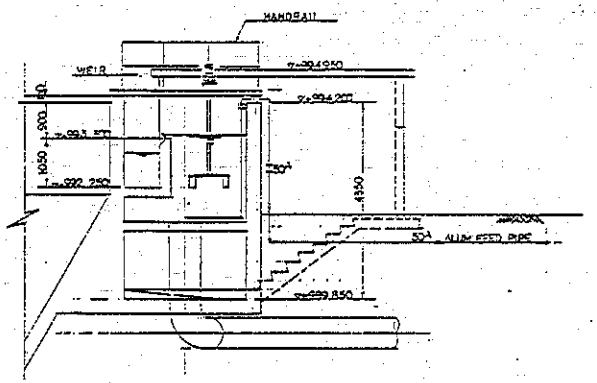
1) Replacement cost of transformers : 8,000kwacha
2) Replacement cost of transmission cables : 10,000kwacha


TO 90m³ (20000 GALLON) DOMESTIC RESERVOIR
EXISTING 27" DIA. RAW WATER PUMPING MAINS
2
3
3
3
14
14
4
5
6
6
6
9
9
Φ750mm A.C CLASS B TWO-WAY MAIN
Φ900mm
Φ450mm
Φ1000mm MAIN TO BALANCING RESERVOIRS
7
8
8
10
12
13
11
Φ300mm MAIN TO K.I.P.& NO.2 AT CHILANGA
ORIFICE
TO INTAKE WORKS
GATE
FENCE
GATE
15
GATE TO TOWN
LEGEND
1 .EXISTING CONCETRATE TANKS
2 〃 CHEMICAL DOZING BLOCK
3 〃 SEDIMENTATION TANKS
4 〃 ADMINISTATION BLOCK & LONG GALLERY
5 〃 LIME SILOS
6 〃 FILTER BLOCKS
7 〃 CONTACT TANK & PUMP HOUSE (B)
8 〃 HIGH LIFT PUMP STATION & OFFICE / TOILET
9 〃 BALANCING RESERVOIRS
10 〃 TRANSFORMER HOUSE
11 〃 SUB STATION
12 〃 OIL STORE
13 〃 CARPENTER SHOP
14 〃 CHEMICAL STORES / TEMPORARY /
15 〃 SECURITY OFFICE
EXISTING RAW WATER PUMPING MAINS
WATER MAIN
改善ヶ所
1. 硫酸バンド貯蔵槽内設置
2. 硫酸バンド注入設備
3. 次亜塩素注入設備
5. 消石灰注入設備
6. 急速攪拌池
8. カフエ送水ポンプ室
10. 電気室
11. 受電所電気室.
LUSAKA CITY WATERWORKS TREATMENT PLAN IMPROVEMENT PROJECT
General Plan of Kafue Treatment Plant
DWG. NO.1
DATE: JUNE 1986
SCALE:
JAPAN INTERNATIONAL COOPERATION AGENCY

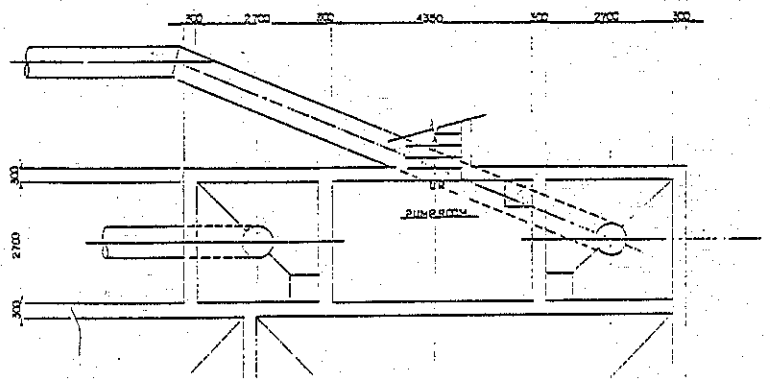

2-ALUM SARULATION TANK
ALUM DOSING PIPE
FLASH MIXER
SINGLE SOCKET
10m SEDIMENTATION TANKS
10m SEDIMENTATION TANKS
10m SEDIMENTATION TANKS
CONTROL TOWER
LIME DOSING ROOM
FILTERED WATER CHANNEL
RESERVOIR NO.1
PARKING AREA
LUSAKA CITY WATERWORKS TREATMENT PLAN IMPROVEMENT PROJECT
Plan of Treatment Facilities
DWG. NO. 2
DATE: JUNE 1986
SCALE:
JAPAN INTERNATIONAL COOPERATION AGENCY



PLAN ON EL +994.200



SECTION A-A



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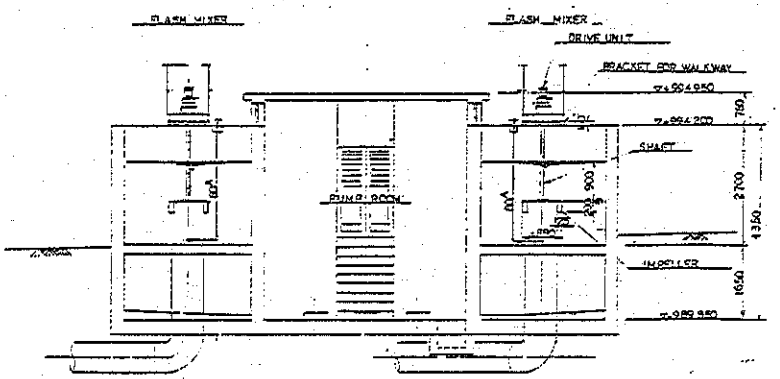
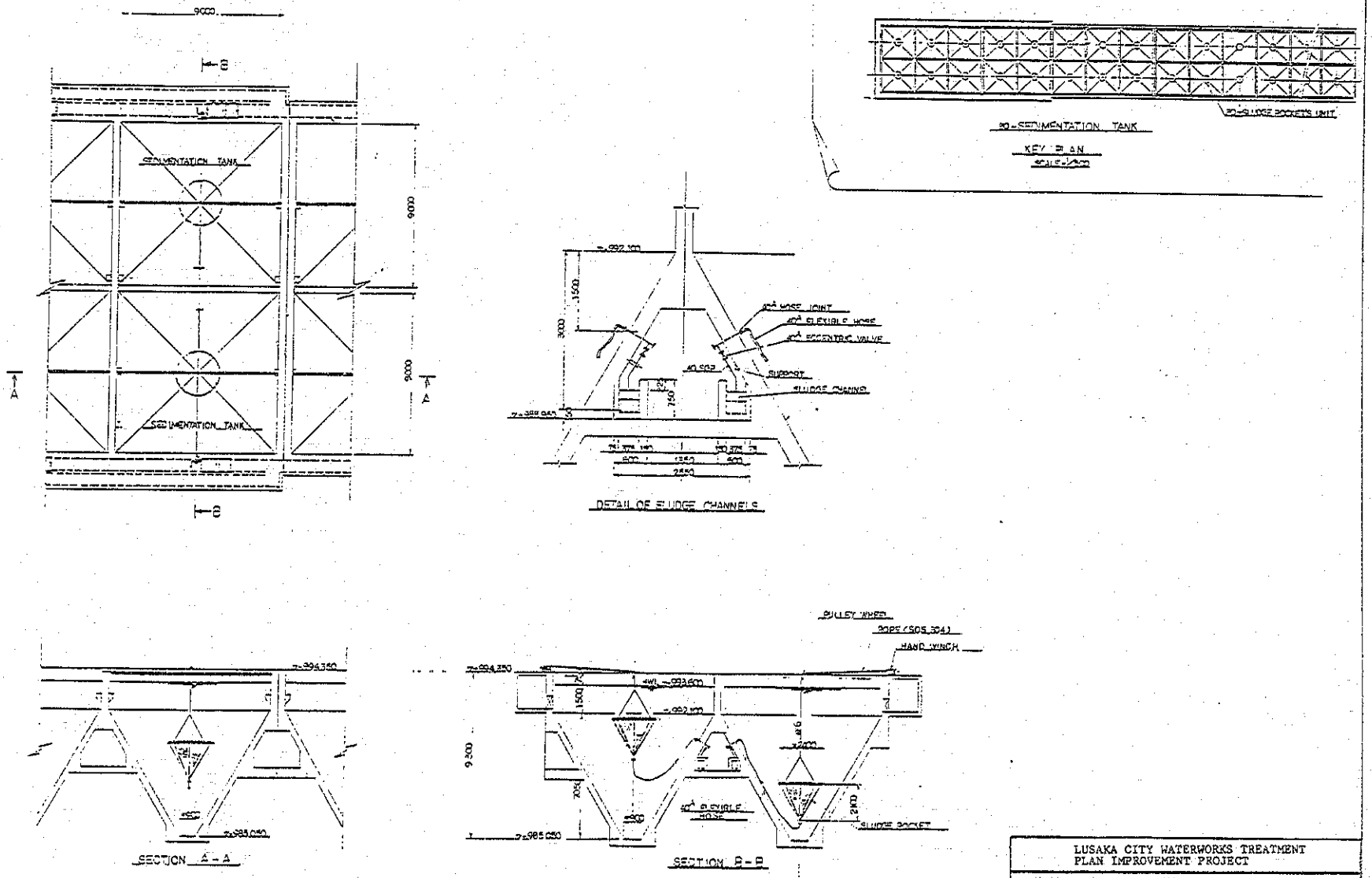
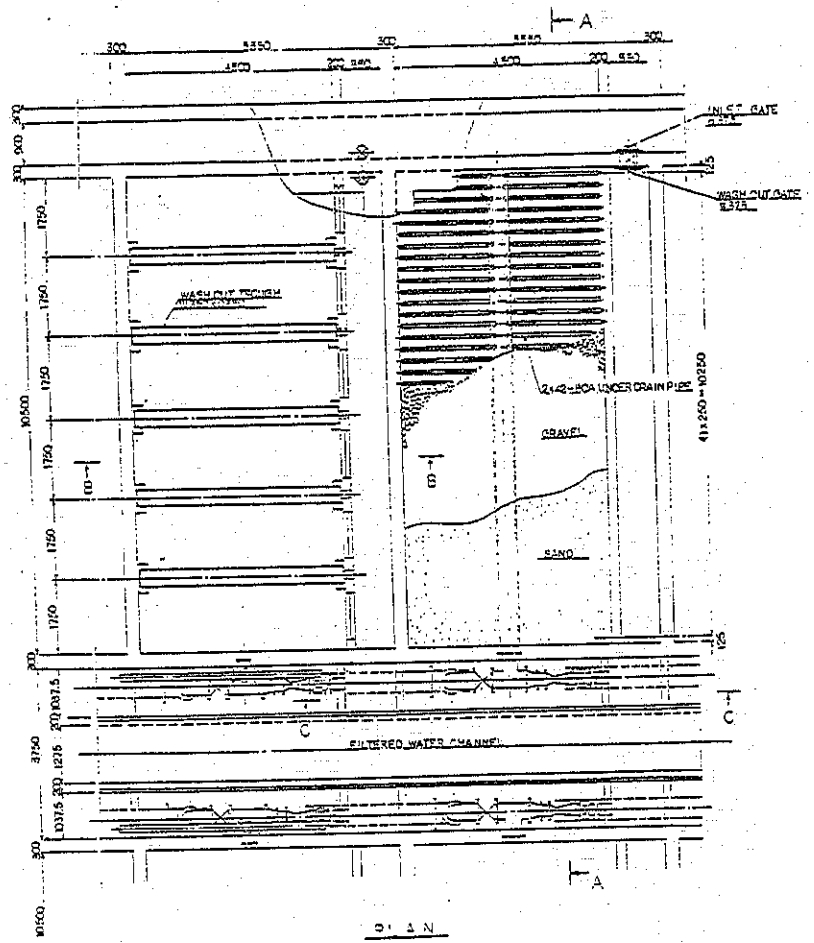


SECTION B-B

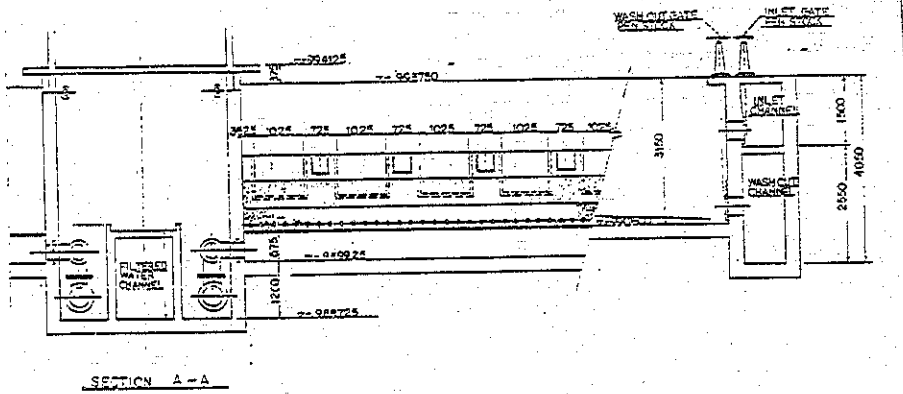
LUSAKA CITY WATERWORKS TREATMENT PLAN IMPROVEMENT PROJECT		
Plan and Section of Flash Mixer		
DWG. NO.3	DATE: JUNE 1986	SCALE:
JAPAN INTERNATIONAL COOPERATION AGENCY		



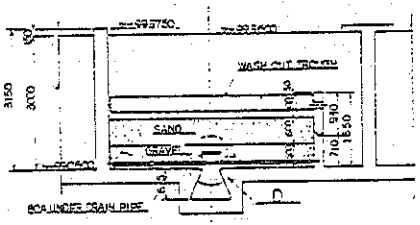
LUSAKA CITY WATERWORKS TREATMENT PLAN IMPROVEMENT PROJECT		
Plan and Section of Sedimentation Basin		
DWG. NO.4	DATE: JUNE 1986	SCALE:
JAPAN INTERNATIONAL COOPERATION AGENCY		



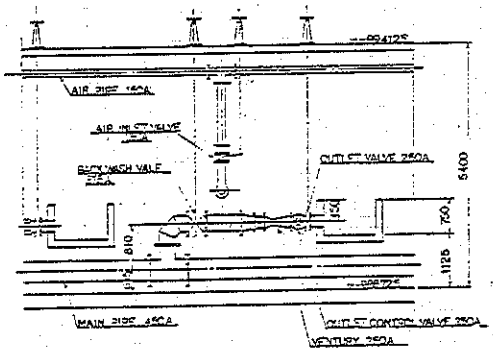
PLAN



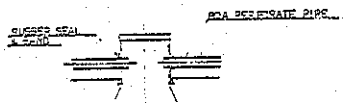
SECTION A-A



SECTION B-B

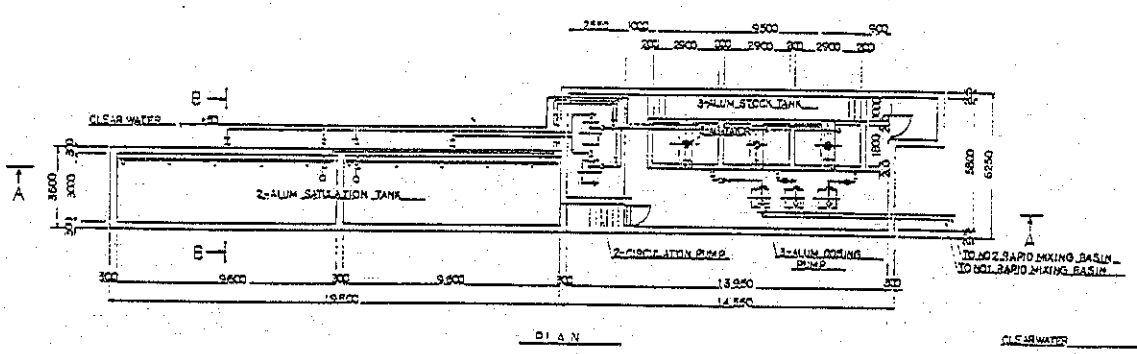


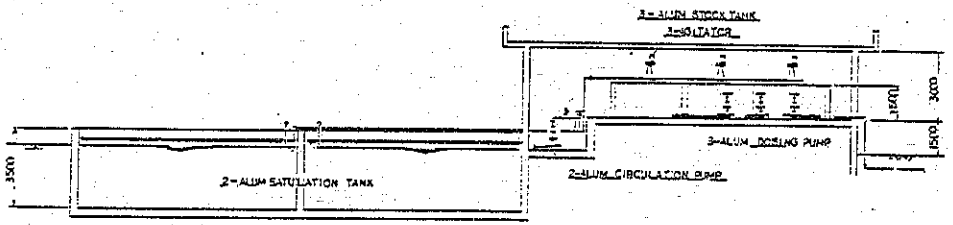
SECTION C-C

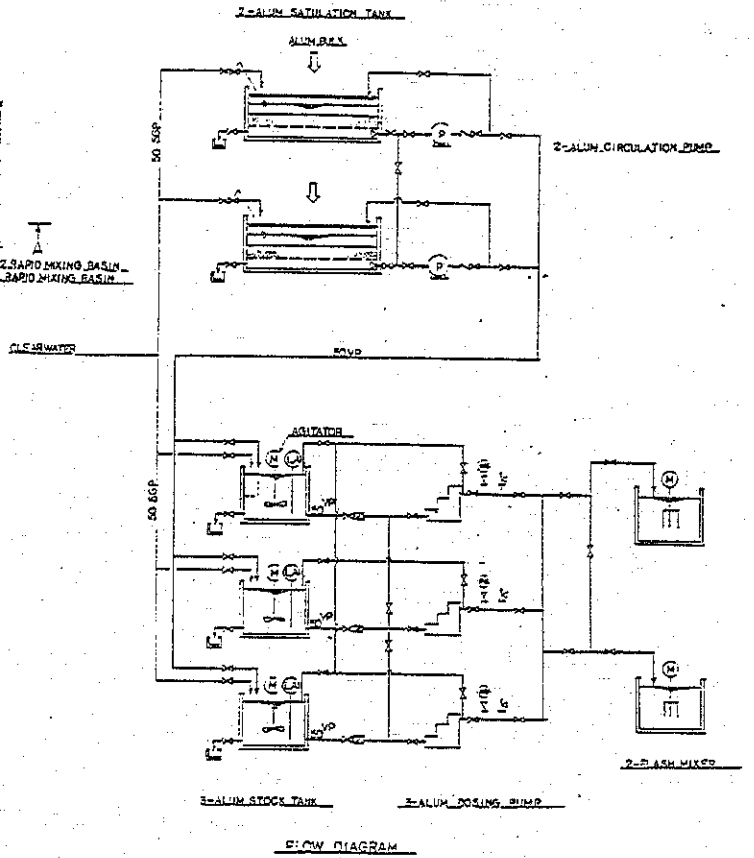


DETAIL OF D
S=1/20

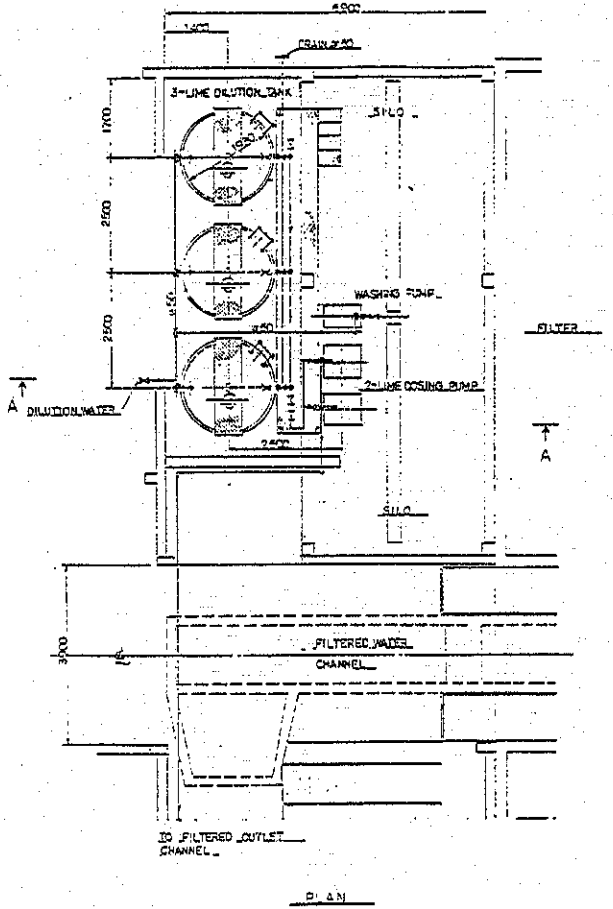
LUSAKA CITY WATERWORKS TREATMENT PLAN IMPROVEMENT PROJECT		
Plan and Section of Filter		
DWG. NO. 5	DATE: JUNE 1986	SCALE:
JAPAN INTERNATIONAL COOPERATION AGENCY		



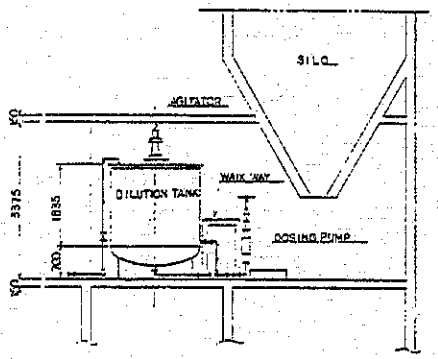




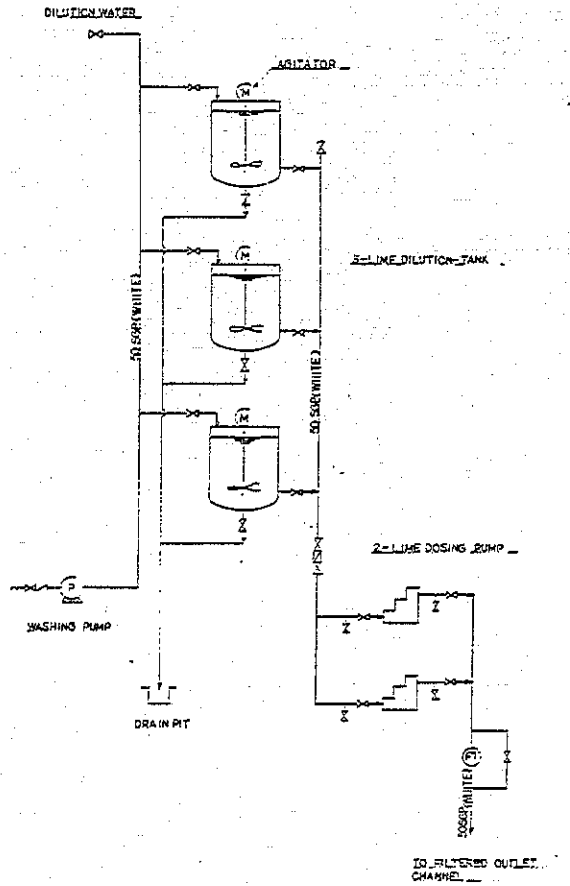
LUSAKA CITY WATERWORKS TREATMENT PLAN IMPROVEMENT PROJECT		
Flow Diagram of Alum Feeding Equipment		
DWG. NO.6	DATE: JUNE 1986	SCALE:
JAPAN INTERNATIONAL COOPERATION AGENCY		



PLAN

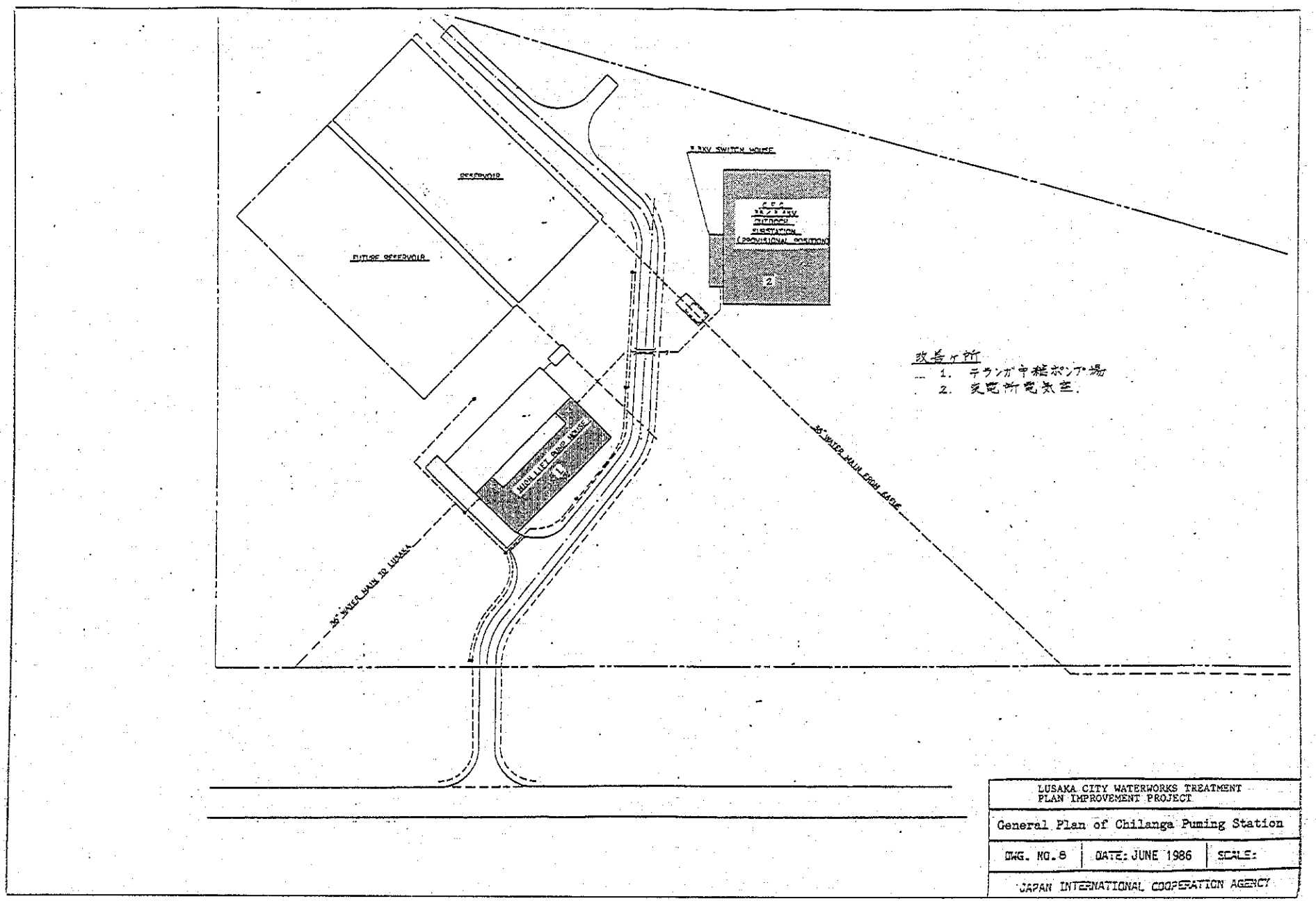


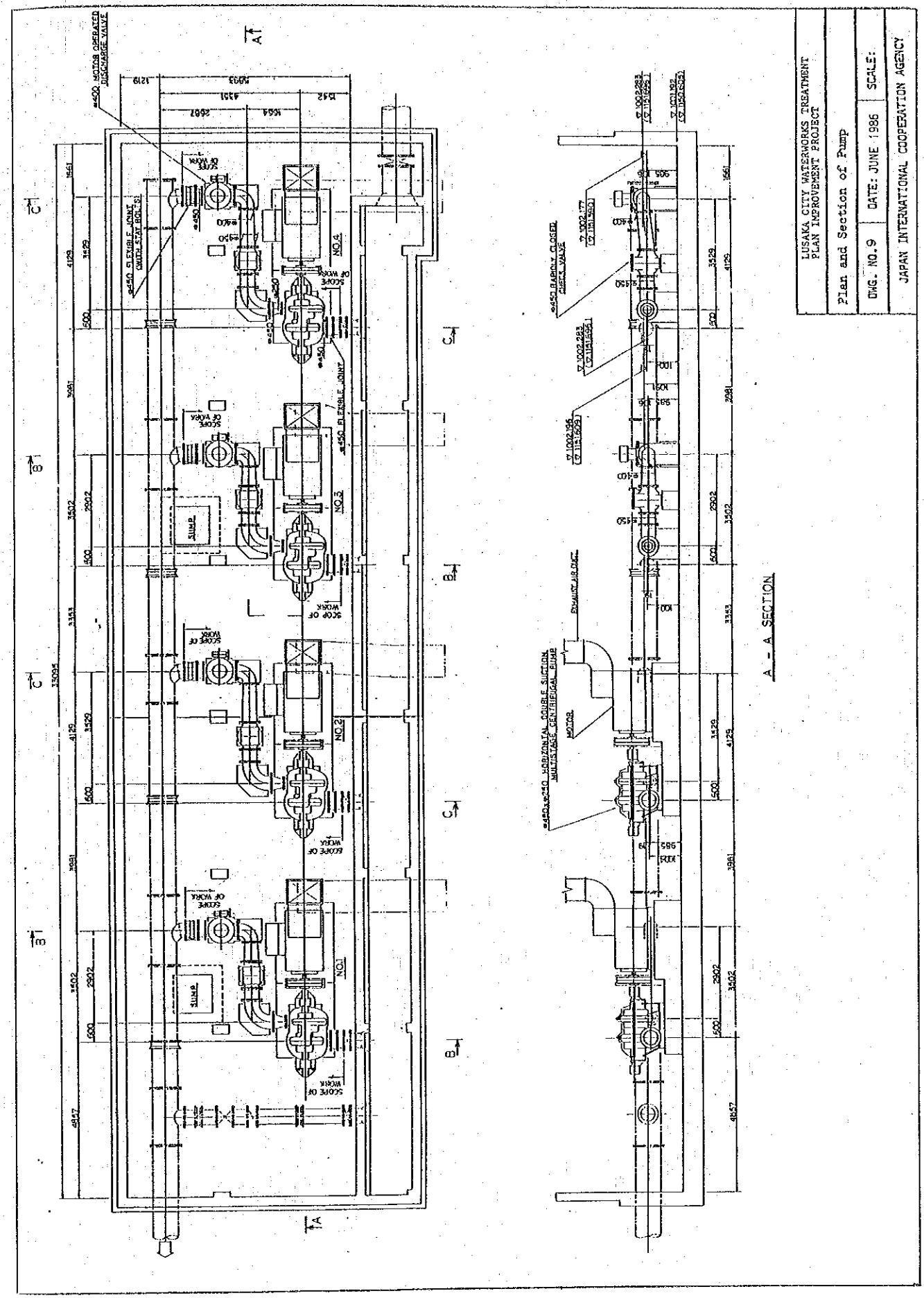
SECTION A - A

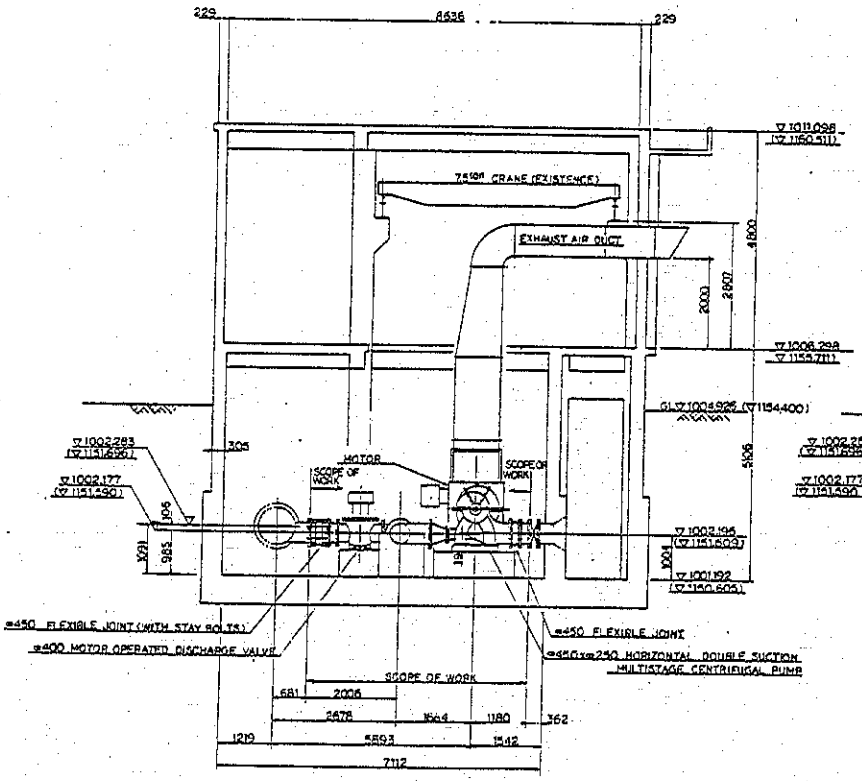


FLOW DIAGRAM

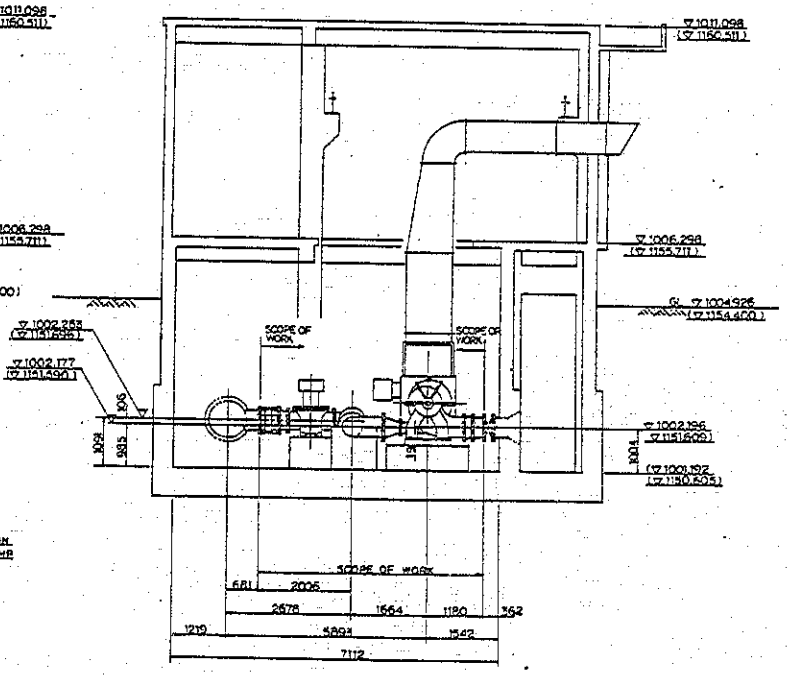
LUSAKA CITY WATERWORKS TREATMENT PLAN IMPROVEMENT PROJECT		
Flow Diagram of Lime Feeding Equipment		
DWG. NO.7	DATE: JUNE 1986	SCALE:
JAPAN INTERNATIONAL COOPERATION AGENCY		


RESERVOIR
FUTURE RESERVOIR
2
改善ヶ所
1. チランガ中継ポンプ場
2. 受電所電気室.
35" WATER MAIN FROM KAFUE
35" WATER MAIN TO LUSAKA
LUSAKA CITY WATERWORKS TREATMENT PLAN IMPROVEMENT PROJECT
General Plan of Chilanga Puming Station
DWG. NO. 8
DATE: JUNE 1986
SCALE:
JAPAN INTERNATIONAL COOPERATION AGENCY


LUSAKA CITY WATERWORKS TREATMENT PLAN IMPROVEMENT PROJECT
Plan and Section of Pump
DWG. NO.9
DATE: JUNE 1986
SCALE:
JAPAN INTERNATIONAL COOPERATION AGENCY
A - A SECTION
NO.4
NO.3
NO.2
NO.1
SCOPE OF WORK

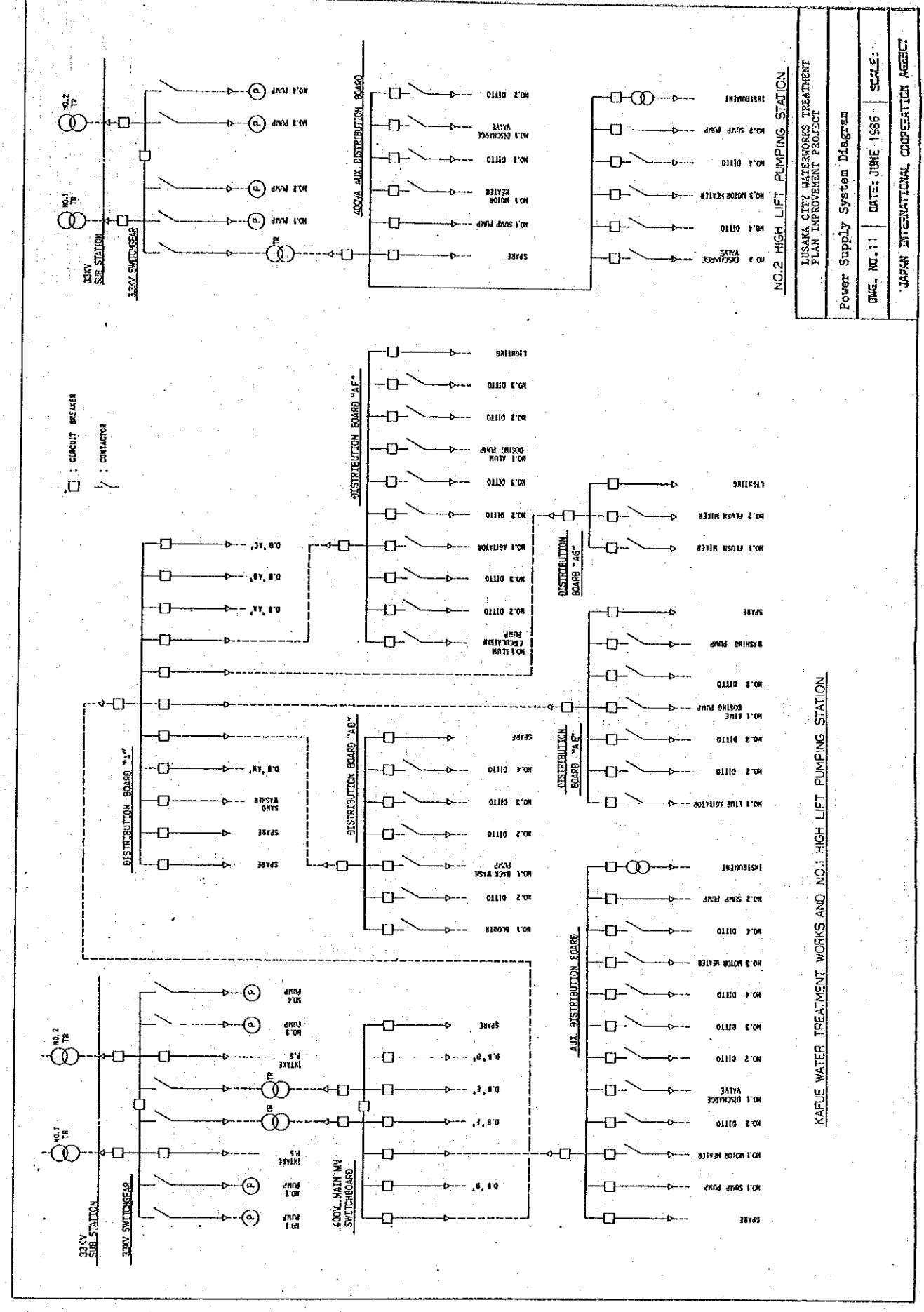


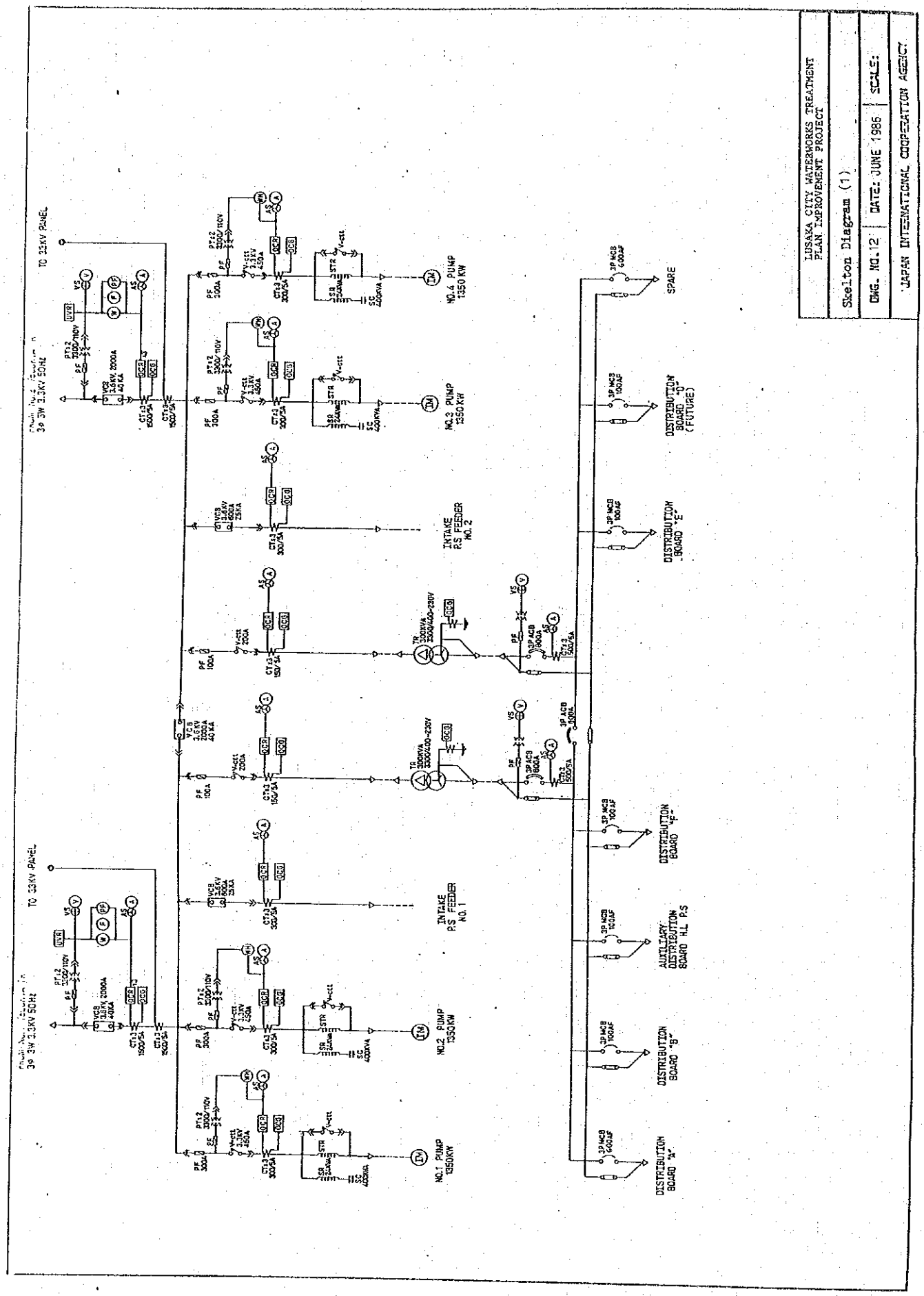
B - B SECTION

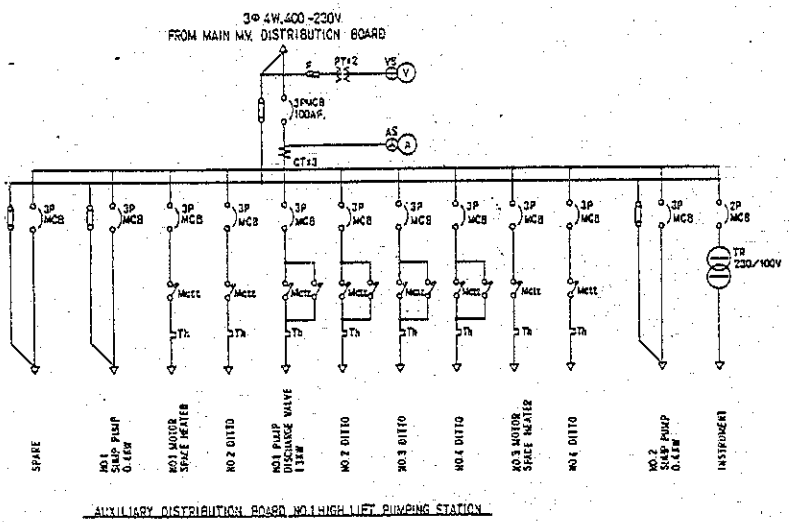


C - C SECTION

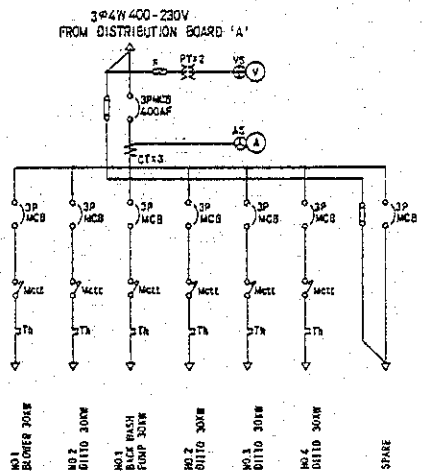
LUSAKA CITY WATERWORKS TREATMENT PLAN IMPROVEMENT PROJECT		
Section of Pump		
DWG. NO.10	DATE: JUNE 1986	SCALE:
JAPAN INTERNATIONAL COOPERATION AGENCY		


LUSAKA CITY WATERWORKS TREATMENT PLAN IMPROVEMENT PROJECT
Power Supply System Diagram
DWG. NO.11
DATE: JUNE 1986
SCALE:
JAPAN INTERNATIONAL COOPERATION AGENCY
NO.2 HIGH LIFT PUMPING STATION
KAFUE WATER TREATMENT WORKS AND NO.1 HIGH LIFT PUMPING STATION
33KV SUB STATION
33KV SWITCHGEAR
NO.1 TR
NO.2 TR
400V AUX. DISTRIBUTION BOARD
400V MAIN MV SWITCHBOARD
AUX. DISTRIBUTION BOARD
DISTRIBUTION BOARD "A"
DISTRIBUTION BOARD "AA"
DISTRIBUTION BOARD "AB"
DISTRIBUTION BOARD "AC"
DISTRIBUTION BOARD "AE"
DISTRIBUTION BOARD "AF"
: CIRCUIT BREAKER
: CONTACTOR

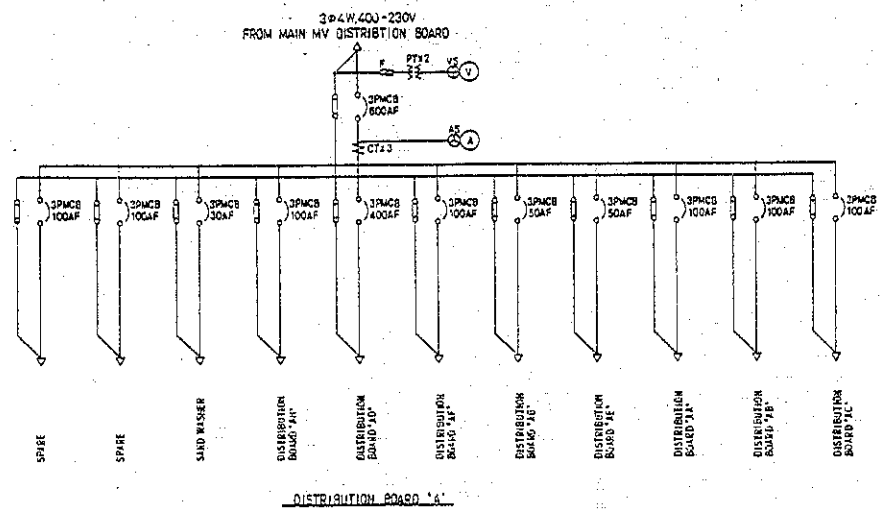

LUSAKA CITY WATERWORKS TREATMENT PLAN IMPROVEMENT PROJECT
Skelton Diagram (1)
DWG. NO.12
DATE: JUNE 1986
SCALE:
JAPAN INTERNATIONAL COOPERATION AGENCY
TO 33KV PANEL
3φ 3W 3.3KV 50Hz
NO.1 PUMP 1350KW
NO.2 PUMP 1350KW
NO.3 PUMP 1350 KW
NO.4 PUMP 1350 KW
INTAKE P.S FEEDER NO.1
INTAKE P.S FEEDER NO.2
SPARE
DISTRIBUTION BOARD "A"
DISTRIBUTION BOARD "B"
AUXILIARY DISTRIBUTION BOARD H.L P.S
DISTRIBUTION BOARD "F"
DISTRIBUTION BOARD "E"
DISTRIBUTION BOARD "D" (FUTURE)



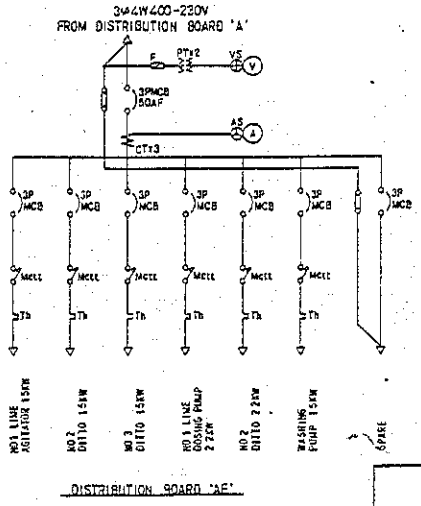
AUXILIARY DISTRIBUTION BOARD NO.1 HIGH LIFT PUMPING STATION



DISTRIBUTION BOARD 'AD'

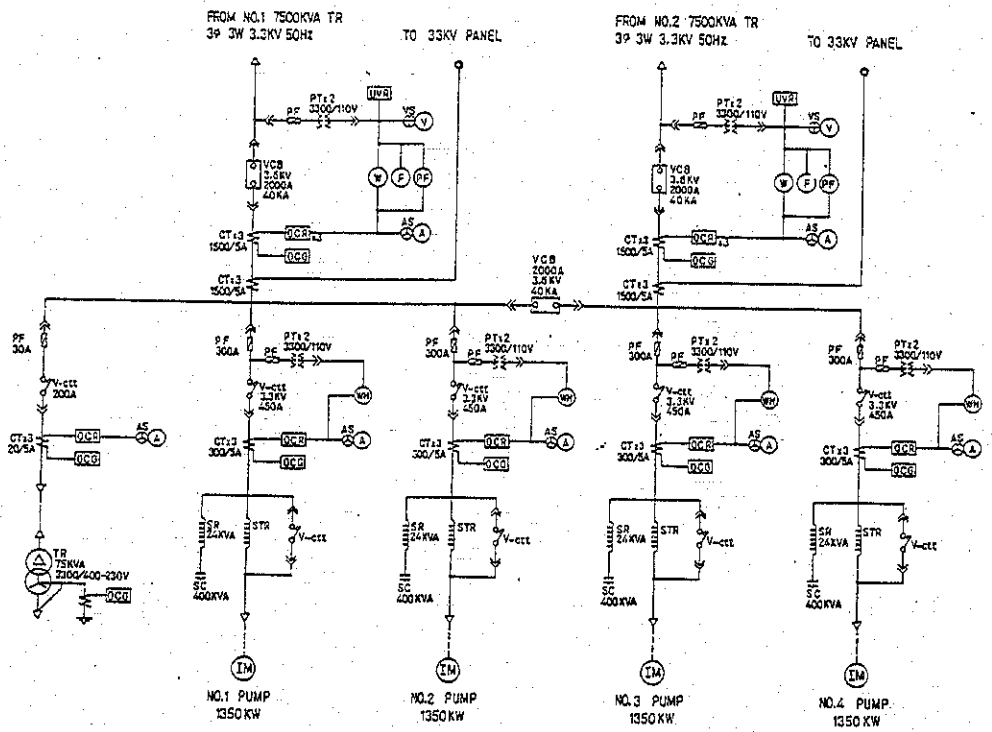


DISTRIBUTION BOARD 'A'

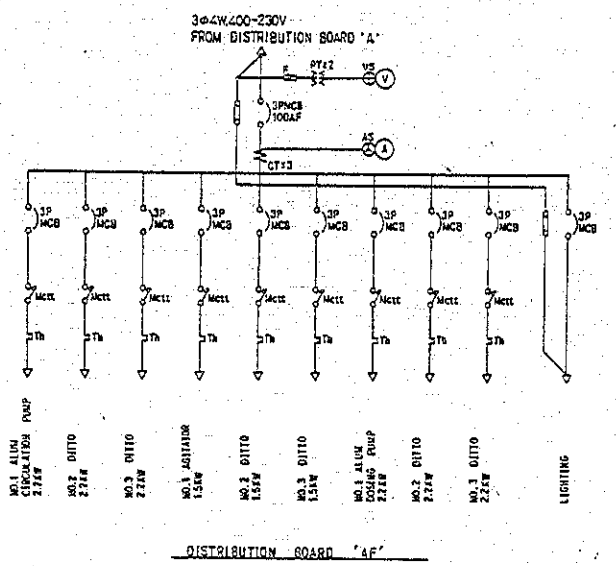


DISTRIBUTION BOARD 'AE'

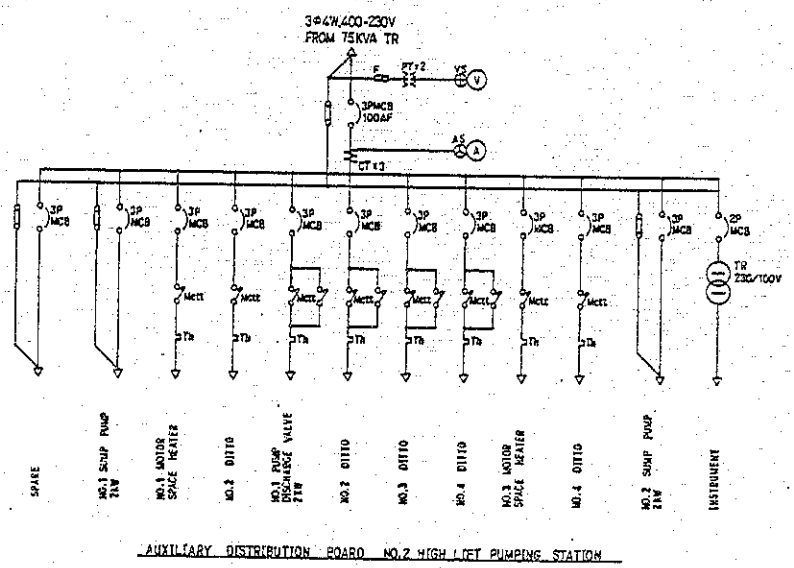
LUSAKA CITY WATERWORKS TREATMENT PLAN IMPROVEMENT PROJECT		
Skelton Diagram (2)		
DWG. NO.13	DATE: JUNE 1986	SCALE:
JAPAN INTERNATIONAL COOPERATION AGENCY		



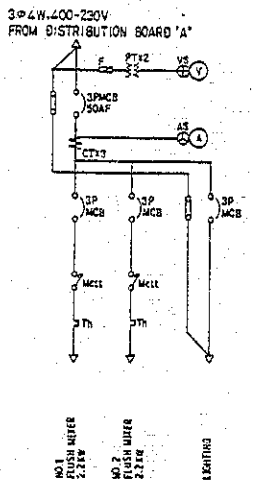
LUSAKA CITY WATERWORKS TREATMENT PLAN IMPROVEMENT PROJECT		
Skelton Diagram (3)		
DWG. NO.14	DATE: JUNE 1986	SCALE:
JAPAN INTERNATIONAL COOPERATION AGENCY		



DISTRIBUTION BOARD 'AF'

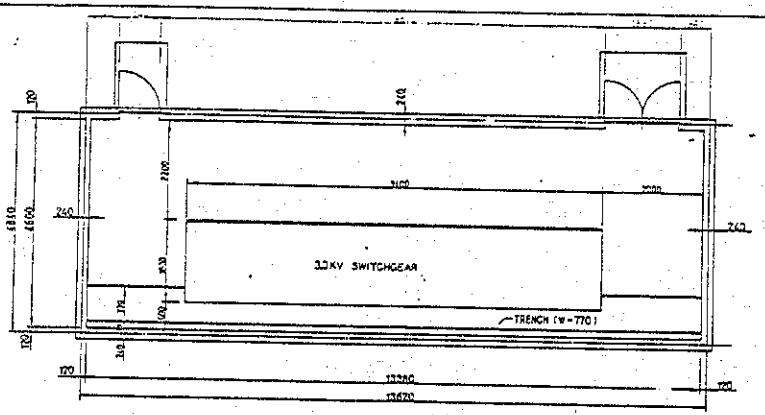


AUXILIARY DISTRIBUTION BOARD NO.2 HIGH LIFT PUMPING STATION

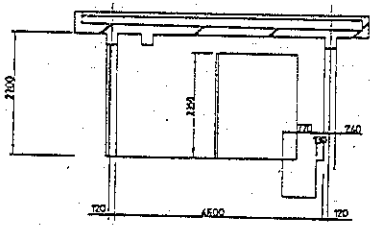


DISTRIBUTION BOARD 'AG'

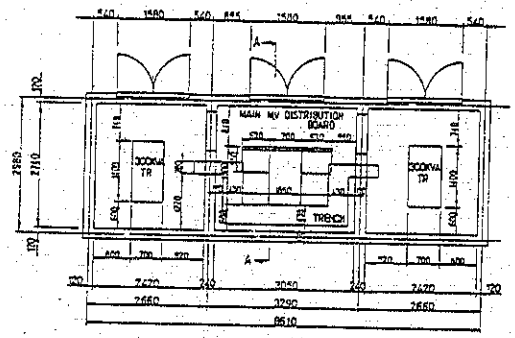
LUSAKA CITY WATERWORKS TREATMENT PLAN IMPROVEMENT PROJECT		
Skelton Diagram (4)		
DWG. NO.15	DATE: JUNE 1986	SCALE:
JAPAN INTERNATIONAL COOPERATION AGENCY		



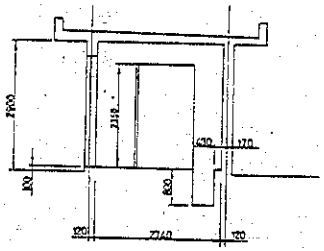
3.3kV SWITCH HOUSE KAFUE WATER TREATMENT WORKS



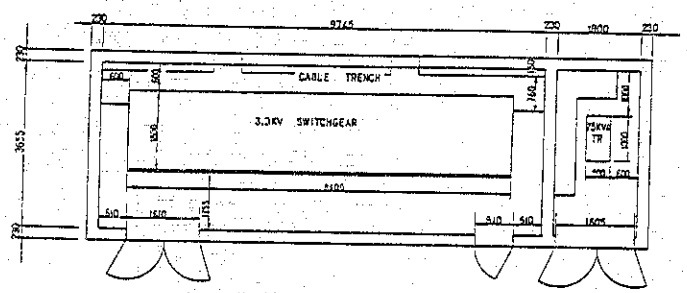
S = 1/50



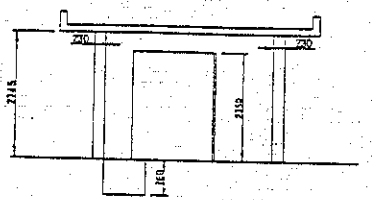
TRANSFORMER HOUSE KAFUE WATER TREATMENT WORKS



SECTION A-A (S = 1/50)



3.3kV SWITCH HOUSE NO.2 HIGH LIFT PUMPING STATION



S = 1/50

LUSAKA CITY WATERWORKS TREATMENT PLAN IMPROVEMENT PROJECT		
Plan and Section of Electrical Room		
DWG. NO.16	DATE: JUNE 1986	SCALE:
JAPAN INTERNATIONAL COOPERATION AGENCY		

Chapter 5 PROJECT IMPLEMENTATION PROGRAM

CHAPTER 5 PROJECT IMPLEMENTATION PROGRAM

5.1 Project Implementation

The agency responsible for Project implementation is the Water and Sewerage Department of the Lusaka Urban District Council which is under the control of the Ministry of Decentralization (MOD). After the Exchange of Notes between the Government of Zambia and the Government of Japan, MOD will contract a Japanese consulting firm for design and tender documentation, after which it will proceed to the tender procedures regarding procurement of equipment and materials and their installation.

The MOD will contract suppliers/manufacturers and the latter will commence preparation of materials and production of equipment and also their installation including their transportation to the sites under the supervision of Japanese consultants. The suppliers, after installation of the equipment, will execute a test run and adjust them, if necessary, under the supervision of the consultants who will transfer the whole facility to the Lusaka Urban District Council after satisfying themselves that it is functioning properly.

5.2 Undertaking of Works in the Project Implementation

The Project, including supply and installation of equipment, will be carried out by both the Japanese side and the Zambian side.

5.2.1 Undertaking of the Japanese Side in the Project

The Japanese side will undertake the supply, transportation, installation, test run and adjustment of the following equipment:

(1) Water Treatment Equipment

1) Alum Feeding Equipment
2) Equipment for Sedimentation Basin
3) Rapid Filter Basin Equipment
4) Lime Feeding Equipment

(2) Pump Facilities

(3) Electric and Instrumental Facilities

1) Substation Facilities

2) Power Control Panels for Water Treatment Equipment

3) Power Control Panels for Kafue Pumping Stations

4) Power Control Panels for Chilanga Pumping stations

5) Main Transformers for Water Treatment Equipment and Cables

(4) Equipment for Maintenance and Management

1) Communication Equipment

2) Vehicles

5.2.2 Undertaking of the Zambian Side in the Project

(1) General Items

The following will be undertaken by the Zambian side.

1) To ensure prompt unloading,customs clearance and tax exemption of the equipment and materials imported into Zambia for the Project.

2) To take the necessary procedures for exempting equipment and materials donated by the Japanese Government and any payment for services within Zambia by the Japanese consultant and suppliers/manufacturers from custom duties, internal taxes and other fiscal levies.

3) To take the necessary measures for the Banking Arrangement (B/A) and the payment of commisions for banking services based upon the B/A.

4) To provide necessary arrangements for Japanese nationals whose services may be required in connection with the Project, regarding their entry to and from Zambia and their stay therein for the performance of their work.

5) To take nessary measures if required,for approval of

the Government in connection with implementation of this project.

6) To assume operation and maintenance cost for managing and maintaining the equipment and materials for the Project.

(2) Installation of Electrical Facilities

The following electrical equipment, which will be given to the Lusaka Urban District Council, then to ZESCO, will be installed by ZESCO.

1) Main transformer for the Kafue water treatment plant
2) Electric Cables

(3) Land Acquisition for Surge Tank

(4) Road Improvement

The road connecting sites such as the surge tank and the Chilanga pumping station with the main road will be either improved or newly constructed.

(5) Electricity and Telephone System

The following facilities will be properly provided to support the installation work for equipment and materials.

1) Electricity
   - Distributing line to the site.
   - Drop wiring and internal wiring within the site.
   - Main circuit breaker and transformer.
2) Telephone system
   - Telephone trunk line to the main distribution frame/panel (MDF) of the site
   - MDF and the extension after the frame/panel.

5.3 Implementation Plan

It will take 21.5 months for the Project to be completed, as shown in Table 5.1, which time will be divided into the following stages:

(1) Preparatory Work

Any work required such as construction of the administration office and warehouse, together with acquisition of an open storage yard for equipment and materials, will be carried out.

(2) Installation Work for Pumps

The eight(8) old pumps, 4 at the Kafue treatment plant and 4 at the Chilanga pumping station, will be replaced by new ones. It will take 10.5 months to design and manufacture the pumps and transport them to the sites, while it will take 6.5 months to remove the old ones and install the new ones. Replacement work will be done one after another in order to minimize interruption of water services, considering the water shortage conditions in Lusaka City.

(3) Installation Work for Water Treatment Plant

9.5 months will be required to design and manufacture flash mixers, chemical feeders and valves including transportation to the site, while it will take ¼ months to install them. Their installation work will be done one after another so that only one unit will suspend service at a time out of 30 sedimentation basins and 20 filters.

(4) Electric Facilities and Others

It will take 9.5 months to design and manufacture electrical facilities and transport them to the site, while it will take 4 months to install them. A temporary power source must be provided during replacement of the electrical facilities in order not to interrupt water service.

5.4 Procurement of Equipment and Materials

(1) Procurement from Japan

The following equipment and materials will be procured from Japan:

- Water Treatment Equipment

- Pumping Equipment including pump, motor and associated appurtenances
- Electrical equipment including transformer, control panel, cable, wires, etc.

They will be unloaded at Dar Es Salaam port in Tanzania, which has eight berths with sufficient capacities to accomodate up to 35,000 ton vessels. After unloading, they will be transported by road to Zambia.

(2) Procurement in Zambia

The following materials will be procured in Zambia:

- Fine aggregate, sand
- Timber
- Petrol, gas oil

5.5 Detailed Design and Installation Supervision

(1) Design and Tender Documentation

Japanese consultants will execute detailed designing and prepare tender documents immediately after the Exchange of Notes. The tender call and evaluation of the tenders will follow upon due approval, on behalf of the Government of Zambia.

(2) Installation Supervision

1) Assistance for Contract Award

After the evaluaton of tenders, assistance will be extended to the Government of Zambia for contract award for supply and installation of equipment and materials

2) Management of Equipment and Materials

Detailed instruction and review of shop-drawings will be done with suppliers upon manufacturing and supply of the equipment and materials, and they will be inspected during manufacturing and upon completion.

3) Installation Supervision

Installation supervision will begin on the site from the time of first delivery of the equipment, with close coordination with the staff of the Lusaka Urban District Council.

4) Turn-Over of the Facilities

Careful supervision will be carried out in the case of the test run after all the equipment is installed, and any adjustments which are deemed necessary will be completed. After final confirmation of the facilities, the plant will be officially turned over to the Zambian Government.

5.6 Implementation Schedule

It will take 27.5 months after the signing of the Exchange of Notes (E/N) to complete the Project (Refer to Table 5.1). Each stage of the Project will take the following period:

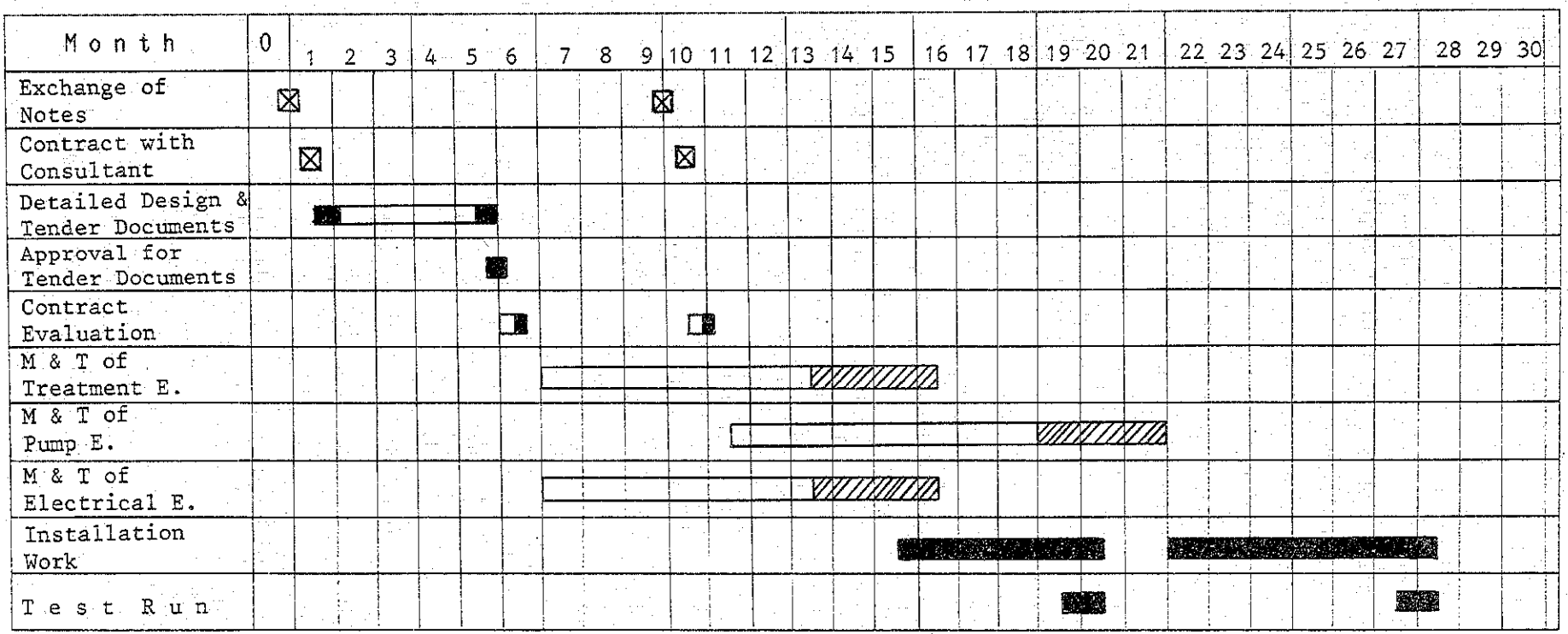
- Procedure for the contract between Government of Zambia and a Japanese consultant .....0.5 month
- Preparation of the detailed design and tender documents .....4.5 months
- Procedure of the contract between the Government of Zambia and suppliers .....1.0 month
- Manufacturing and transportation of equipment and materials .....15.0 months
- Installation work and test run of equipment and materials .....6.5 months

5.7 Operation and Maintenance Plan

5.7.1 Responsible Organization for Operation and Maintenance

The Water and Sewerage Department of the Lusaka Urban District Council is responsible for the improved/ rehabilitated facilities. The total number of the staff of the Department is 839, which is allocated into 8 sections as shown in Table 3.1, among which 7 sections are related to water works with the exception of the sewerage section. The Kafue water

Table 5.1 Implementation Schedule



LEGEND

	In Japan	M : Manufacturing
	Transportation	T : Transportation
	In Zambia	E : Equipment

supply system for which this project is planned is managed by the Kafue water works section. Its organizational chart is shown in Fig.3.3 and the allocated number of personnel is 129 persons, out of which 16 posts are not filled. Since this project is aiming at restoring the existing facilities, not constructing new facilities, it will not be necessary to change its structure nor to increase the number of staff. On the other hand, since the existing semi-automatically equipped facilities are planned in the Project to be replaced with manually operated facilities, the result will be easy but reliable operation. Nevertheless, it is necessary for operators to understand the functions of the equipment and carry them out.

5.7.2 Operation and Maintenance Costs

Operation and maintenance costs are estimated assuming that the improvement/rehabilitation works on the Kafue system will be completed. The estimated costs of the facilities related to this project.

(1) Personnel Costs

Personnel costs are estimated with consideration of a pay increase, not of an increase of operators as is described in the preceding sub-section.

(2) Electricity Charge

The electric load will increase in the following way by the implementation of the Project;

1) Flash Mixer 2.2kw x 2 sets
   Annual electric consumption
   4.4kw x 24hrs x 365days = 38,544 KWH
2) Mixer for Alum 1.5kw x 3 sets
   Annual electric consumption
   4.5kw x 24hrs x 365days = 39,420 KWH
3) Mixer for Lime 1.5kw x 3 sets
   Annual electric consumption
   4.5kw x 24hrs x 365days = 39,420 KWH
4) Pumps 1,350kw x 2 sets (increased only)

Annual electric consumption

2,700kw x 24hrs x 365days = 23,652,000 KWH

Hence, the increased annual electric fee of 1985 will be 332,800 kwacha (= 23,652,000 KWH x 1.4 Ngwee/KWH) as the 1985 price. Assuming a fee increase of 10 percent per annum, the increased annual electric fee of the 1988 will be 442,957 kwacha [= 332,800 x $(1+0.1)^3$].

(3) Chemicals Fee

Since the increased water amount of this project is 26,000 m3/day (= 110,000 - 84,000), the increased chemicals fee is calculated, using the 1985 price as follows:

1) Alum

26,000 m3/dayx40 mg/l x 365days = 380 tons

380 ton x 3,300 kwacha/ton = 1,254,000 kwacha

2) Lime

26,000 m3/day x 20 mg/l x 100/85(purity)

x 365 days = 224 tons

224 tons x 1,500 kwacha/ton = 336,000 kwacha

3) Chlorine

26,000 m3/day x 3 mg/l x 365 days = 29 tons

29 tons x 15,000 kwacha/ton = 435,000 kwacha

4) Annual increased chemicals fee

1) + 2) + 3) = 2,025,000 kwacha

Assuming a price increase of 10 percent per annum, the increased annual chemical fees in 1988 will be 2,695,275 kwacha [= 2,025,000 x (1+0.1)3]. As is calculated, since the increased operation and maintenance costs are only 3,138,232 kwacha for the electric fee and chemicals fee, unit cost of water will not increase so much. The cash balance for 1988 when the Project is planned to be completed will improve as revenues will increase as well.

Table 5.2 Estimated Cash Balance of the Department (1988)

[Unit: kwacha]

Items	1985 Accounts	1988 Accounts (Estimated)
Revenue : Water Tariffs	10,040,228	17,727,128
Expenditure		
Personnel Cost	2,697,417	4,569,424
Electric & Chemical Fees	5,370,840	8,509,078
Administration Fee	755,834	1,280,382
Debt Cost	765,000	765,000
Total	9,589,087	15,123,884
Balance of Payments	+ 451,141	+ 2,603,244

Note 1: Personnel costs and administration fees are assummed to increase 40% per annum in 1985 and 10% per annum thereafter.

Note 2: Water charge of 1988 is calculated as follows based on the water tariff of Table 3.4.:
As water consumption in tariffs 1 and 4 constitute 75% of total water consumption, the average water tariff is estimated below, averaging that of below 100 m3 in tariff 1 and that of below 40 m3 in tariff 4.

Tariff 1 (14.00 kwacha + (0.95 kwacha/m3 x 84 m3)) ÷ 100 m3
= 93.8 kwacha ÷ 100 m3
= 0.94 kwacha/m3

Tariff 4 (13.00 kwacha + (0.70 kwacha/m3 x 20 m3)) ÷ 40 m3
= 27.0 kwacha ÷ 40 m3
= 0.68 kwacha/m3

Average Water Tafiff
0.81 kwacha/m3

Increased Water Tafiffs between 1985 and 1988 due to the Project
26,000 m3/day x 365 days x 0.81 kwacha/m3
= 7,686,900 kwacha

Total Water Tariffs in 1988
Water Tariffs in 1985 + Increased Water Tariffs
= 17,727,128 kwacha

Chapter 6 PROJECT EVALUATION

CHAPTER 6 PROJECT EVALUATION

The Water and Sewerage Department of the Lusaka Urban District Council is faced with hardship in their management due to a lack of management-level officers and a lack of operation and maintenance funds. As a result, the existing facilities have not been operated and maintained properly, resulting in reduction of the rated capacity together with frequent breakdowns of the existing facilities. In order to cope with these problems, the following measures have been taken by the Department.

(1) Six experts from the Government of the Federal Republic of Germany have taken over the management positions as directors to deal with the lack of management-level officers. They also initiated training for Zambian candidates for the manager positions.

(2) Lack of funds for operation and maintenance has been caused by both the economic depression of the nation and inefficiency of revenue collection in the district council. Apart from the former, the latter has been improved upon by the above-mentioned experts as well. For example, the following measures have been taken:

- Repair house meters to read consumed water amount correctly, aiming at increasing revenue collection.
- Strengthen financial section of the Department, aiming to issue accurate invoice to each consumer
- stop water service to consumers who failed to pay water tariffs on time

As the above-mentioned measures -soft measures- have been successfully implemented, the Department has considered implementing hard measures in order to meet the increasing demand. Although it is recognized that expansion of facilities is crucial to meet demand, it is financially difficult. Under the condition where existing facilities are not fuctioning to rated capacity, it is logical to consider

rehabilitation of the existing facilities, which will be considerably more economical than new construction and yet increase the supply up to the rated capacity, resulting in better service to the consumers.

6.1 Benefits

(1) Direct Benefits

This project will restore the Kafue system, which decreased to 84,000m^3/day, to the rated capacity of 110,000m^3/day, an increase of 30%. As a result, the total supply capacity of Lusaka city, including groundwater sources, will increase to 220,000m^3/day from 194,000m^3/day. Further, as the water source of the Kafue system is the Kafue river, the discharge of which is abundant and stable while the extractable amount of groundwater decreases during the dry season, this project will contribute to stabilization in addition to the increase of the water supply in Lusaka City, although the served population and the served area will not differ from the existing ones. In addition, this project will improve treated water quality.

(2) Indirect Benefits

Revenue collection is expected to improve because water consumers will have greater confidence in the supply service of the City due to the increased amount of stabilized supply, resulting in greater willingness to pay. Further, achievement of a higher standard of living in Lusaka city cannot be overlooked as a result of social and environmental improvement due to the implementation of the Project.

6.2 Justification

(1) Technical Aspect

The basic consideration in undertaking the Project is to note the

fact that automatically controlled treatment equipment could not be operated and maintained properly, because they are too sophisticated and funds for spare parts are not available. Consequently, the equipment planned are to be simply designed to the extent possible with emphasis on easy operation and maintenance by operators, considering the current operators' level of skills. Considering this will ensure reliable operation of the facilities and also assure easier replacement of parts whenever necessary, the plan is considered to be reasonable in approach and feasible technically. It should also be noted that when the operators' skill level is improved as a result of technical training by experts, etc., equipment for automatic control can easily be considered.

(2) Financial Aspect

While the 30% increase in supply capacity resulting from this project will inevitably increase operation and maintenance costs by 15 - 20%, mainly for the increased electricity charges and chemical feeding costs, increased sales of water due to the greater amount of supply will offset the cost easily. Since collection of bills is expected to improve, as stated earlier, as a result of implementation of the Project, it is confidentially assumed that the Project will contribute greatly to the improvement of the financial condition of the supply services of the City.

(3) Operation and Management Aspect

Besides the improved facilities with emphasis on easy operation, the operators' skill level is also expected to improve as a result of technical training in the Department. In addition, the improved facilities can be sufficiently run by the operators, as they will be trained by supplier/contractor during the test run. It shoud also be noted that the operators' number need not be increased because this Project is not an expansion, but rather limited to rehabilitation of the existing facilities.

Chapter 7 CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

Lusaka is continuously faced with water shortages. In order to solve this problem, it is necessary to expand water supply facilities. However, in reality, it is difficult to commence the expansion due to financial constraints etc. Further, the existing facilities are not functioning to full rated capacity. Accordingly, it is logical and reasonable to consider the improvement/rehabilitation of the existing facilities, as the first step toward alleviation of the current water deficit.

Ideally almost all existing facilities which are old and not functioning up to par should be improved. These facilities consist of, in terms of their function, intake, transmission, treatment (purification) and distribution, and in terms of water source, the Kafue river and 49 boreholes. However, realistically, and as one of the first measures, improvement of the treatment and transmission facilities of the Kafue system (water source is the Kafue river) is targeted in this project. Since the Project is expected to increase and stabilize the water supply, it is justified and worthwhile for the Government of Japan to cooperate in this project as a grant aid programme.

7.2 Recommendations

The following matters should be considered in order to facilitate the improvement of facilities of the Kafue system effectively and efficiently to the maximum extent possible.

(1) Organization for Operation and Maintenance

It is very important to properly operate and maintain water supply facilities in order to regularly supply water of adeguate quality to the citizens. To ensure proper operation and maintenance, due consideration should be given not only to strengthening and reinforcing organization but also to guaranteeing sufficient operation and maintenance costs. Fortunately, as improvements on them are progressing due to the efforts

of the Water and Sewerage Department, it is hoped these efforts can be maintained with the aid of a firm revenue collection system.

(2) Technical Training

Besides the training by supplier/contractor at the time of project completion, it is necessary to raise the technical level of operators for proper equipment operation and maintenance. Fortunately, the training of operators has already been undertaken by the Water and Sewerage Department through the technical assistance of the Government of West Germany. The effort has to be followed up with a firm programme of implementation by designating the personnel in charge.

(3) Distribution Management Plan

Distribution facilities, among others, are very complicated and difficult to comprehend. However, these distribution facilities, particularly the distribution pipes, are the things connecting the water supply installations to the users. Therefore, although hard measures --- expansion and rehabilitation measures for them, are necessary, even soft measures --- proper management of distributing facilities, will improve the water supply situation. As one example it is being considered to divert some water from the relatively well supplied areas to areas with severe shortages. To make this measure possible, it is firstly necessary to grasp the water supply situation (distribted amount, distributed pressure, distributed direction etc.) at present and in the past and to estimate the distribution pattern of the supplied amount with due consideration given to areal distribution of commerce, industry and population. Since the basic data as mentioned above is not reliable due to many breakdowns of flow meters and house meters, the old ones should be replaced and, if necessary, new ones installed.

(4) Completion of the "Immediate Improvement Projects"

Although this project is the keynote of the "Immediate Improvement Project", improvements of other facilities other than those included in the Project should follow immediately after completion of the Project. Particularly, the distribution facilities should be improved, aiming at

reduction of much of the leakage. Citizens of Lusaka will enjoy a steady supply of clean water only when all the Immediate Improvement Measures are implemented. Their contents are repeated below;

1) Rehabilitation of the existing Kafue pipeline
2) Rehabilitation of the reservoirs and booster stations located in Lusaka
3) Rehabilitation/replacement of all flow metering equipment, including individual meters and recording flow meters
4) Replacement of various diameter steel mains which have heavy water losses due to leaks
5) Replacement of old leaking pipes, particularly on the plots of the Army, Airport, UTH(University Teaching Hospital)
6) Rehabilitation/replacement of pumps and equipment presently used in the boreholes
7) Repair /replacement of leaking valves and lines throughout the system
8) Construction of proper workshops with provision of proper tools

(5) Preparation of Master Plan

Since water shortages in Lusaka City are expected to continue even though they will be somewhat alleviated by the implementation of this project, extension of water supply facilities should be considered as soon as possible taking into account possible future development. Master planning possibly covering 20 years should immediately be prepared.

APPENDICIES

APPENDICIES

Appendix-1
資料－1

MINUTES OF DISCUSSION
ON
THE IMPROVEMENT PROJECT OF LUSAKA CITY TREATMENT PLANT
IN
THE REPUBLIC OF ZAMBIA

In response to the request of the Government of the Republic of Zambia, the Government of Japan decided to conduct a Basic Design study on the Improvement Project of Lusaka City Treatment Plant and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Zambia the study team headed by Mr. Mikio Nakamura, Deputy Director of First Basic Design Study Division, Grant Aid Planning and Survey Department, JICA from March 9th to 31st 1986.

The team had a series of discussions on the Project with the officials concerned of the Government of the Republic of Zambia headed by Mr. Silumelume Mubukwanu, Permanent Secretary Ministry of Decentralisation and conducted a field survey in Lusaka area.

As a result of the study, both parties agreed to recommend to their respective Governments that the major points of understanding reached between them, attached herewith, should be examined towards the realization of the Project.

March 20th, 1986

Mikio NAKAMURA
Leader
Japanese Study Team

Silumelume MUBUKWANU
Permanent Secretary
Ministry of Decentralization

ATTACHMENT

1. The objective of the Project is to rehabilitate the treatment plant of Kafue Water Supply System in order to ensure the water supply from the System to the people of Lusaka City, as in Annex 1.

2. The Japanese Survey Team will convey the Government of Japan the desire of the Government of the Republic of Zambia that the former takes measures to cooperate in implementing the project and bears the cost of the items requested by the latter shown in Annex. 1 within the scope of Japanese economic cooperation programme in grant form.

3. The Government of the Republic of Zambia will take necessary measures listed in Annex II under the condition that the grant aid assistance by the Government of Japan is extended to the Project.

4. Both parties confirmed that the Survey Team explained Japan's grant aid programme and the Zambia side has understood it.

ANNEX 1

THE FOLLOWING ITEMS ARE REQUESTED BY THE GOVERNMENT OF THE REPUBLIC OF ZAMBIA AS GRANT AID ASSISTANCE

1. Rehabilitation/Upgrading the high lift stations at Kafue and Chilanga.

2. Rehabilitation/Upgrading of the existing treatment facilities at Kafue.

3. Rehabilitation of telecommunication system between Kafue - Chilanga - Lusaka Water Works.

4. Vehicle(s) for between Kafue, Chilanga and Lusaka Waterworks.

Annex II

Following arrangements are requested to be undertaken by the Government of the Republic of Zambia.

No.	Items	To be covered by Recipient Side	To be covered by Grant Aid
1.	To secure a lot of land when needed	o	
2.	To clear, level and reclame the site when needed	o	
3.	To construct the gate and fence in and around the site when needed	o	
4.	To construct the road for the construction when needed		
	1) Within the site		o
	2) Outside the site	o	
5.	To provide facilities for distribution of electricity and other incidental facilities		
	1) Electricity		
	a. The distributing line to the site	o	
	b. The drop wiring and internal wiring within the site		o
	c. The main circuit breaker and transformer		o
	2) Telephone System		
	a. The telephone trank line to the main distribution frame/panel (MDF) of the building	o	
	b. The MDF and the extension after the frame/panel		o
6.	To bear the following commissions to the Japanese foreign exchange bank for the banking services based upon the B/A		
	1) Advising commission of A/P	o	
	2) Payment commission	o	
7.	To ensure unloading and customs clearance at port of disembarkation in recipient country		
	1) Marine (Air) transportation of the products from Japan to the recipient country		o
	2) Tax exemption and custom clearance of the products at the port of disembarkation	o	

	3) Internal transportation from the port of disembarkation to the project site		o
8.	To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contract such facilities as may be necessary for their entry into recipient country and stay therein for the performance of their work	o	
9.	To maintain and use properly and effectively that the facilities constructed and equipment purchased under the Grant	o	
10.	To bear all the expenses other than those to be borne by the Grant, necessary for construction of the facilities as well as for the transportation and the installation of the equipment	o	

(P)

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APPENDIX 2. MEMBER LIST OF THE SURVEY TEAM

Position	Name	Firm
Team Leader	Mikio NAKAMURA	Deputy Head, First Basic Design Study Division, Grant Aid Planning and Survey Department, Japan International Cooperation Agency (JICA)
Water Works Planner	Hideo HIGUCHI	Senior Water Supply Engineer, Environmental Sanitation Division, Bureau of Public Health, Tokyo Metropolitan Government
Water Works Planner	Kazufumi MOMOSE	Tokyo Engineering Consultants Co., Ltd. (TEC)
Mechanical & Electrical Planner	Takashi SUZUKI	Tokyo Engineering Consultants Co., Ltd. (TEC)

APPENDIX 3. LIST OF INTERVIEWEES

(1) National Comission for Development and Planning (NCDP)

Mr. Casunga

(2) Ministry of Decentralization

Mr. S. K. Mubukwanu	Permanent Secretary
Mr. J. K. Bahal	Assistant Secretary (Local Government Finance)
Mr. A. K. Kaweza	Principal Local Government Auditor (Loans and Investments)

(3) Ministry of Agriculture and Water Development

Mr. Kayombo	Director (Water Affairs Department)

(4) Lusaka Urban District Concil

Mr. N. J. Mapala	District Executive Secretary
Mr. T. D. Nsenje	Administrative Section
Mr. F. A. Din	Legal Secretary
Mr. M. Sinikolongo	Development Section
Mr. I. Khan	Deputy City Engineering Department
Mr. J. E. Hendrich	Director, Water and Sewerage Department
Mr. Elwin Pahlke	Director, Development and Planning section
Mr. A. S. Marwood	Assistant Director, Water Services Section
Mr. L. Kashinga	Technical Superintendent, Kafue Water Works
Mr. B. C. Salati	Assistant Technical Superintendent, Kafue Water Works
Mr. T. A. Ngoma	Administration Superintendent, Kafue Water Works
Mr. Kachana	Senior Engineer Assistant, Chilanga High Lift Station
Mr. Sindandumuna	Foreman, Chilanga High Lift Station
Mr. Bhowmick	Lusaka Water Works

(5) Zambia Electricity Supply Corporation (ZESCO)

Mr. E. A. Moyo	Planning Engineer, Headquarter
Mr. Moffat C. Mulenga	Kafue District Engineer

(6) Nicholas O'Dwyer & Partners (Consulting Engineers)

Mr. Thomas Niall McDermott	Project Manager
Mr. Andrew G. Flanagan	Project Manager

(7) Japanese Embassy

Mr. Masatoshi OHTA	Ambassador
Mr. Kyohei ISHIDA	Second Secretary
Mr. Yukio KITAMURA	Second Secretary

(8) Japan International Cooperation Agency

Mr. Kohji YAMAGUCHI	Resident Representative, Japan Overseas Cooperation Volunteers

APPENDIX 4. SCHEDULE OF THE FIELD SURVEY

Date	Day	Place	Work
Mar. 11	Tue	Japanese Embassy	1. Courtesy call 2.Explanation of study schedule
12	Wed	Lusaka Urban District Council (LUDC)	1. Explanation of Inception Report 2. Request for data collection
		Ministry of Decentralization (MOD)	. Ditto
		Central Statistical Office	. Data collection
		Government Printer	. Data collection
		Japan Overseas Cooperation Volunteers (JOCV), JICA	. Courtesy call
13	Thu	Kafue Water Treatment Plant & Chilanga High Lift Pumping station	. Site investigation
14	Fri	LUDC	. Discussion
		NicholasO'Dwyer	. Request for data collection
		Lusaka Water Works	. Site investigation
		Stuart Park Reservoir	. Ditto
		Distribution Pipe	. Ditto
15	Sat	Hotel	. Arrangement of documents collected
16	Sun	Hotel	. Arrangement of documents collected
17	Mon	Nicholas O'Dwyer	. Data collection
		Water Affairs Department	. Explanation of Inception Report
18	Tue	LUDC	1. Data collection 2. Discussion for "Minutes of Discussion"
		Nicholas O'Dwyer	. Data collection
		Central Statistical Office	. Data collection
		School of Veterinary Medicine	. Site investigation

Date	Day	Place	Work
Mar. 19	Wed	LUDC	1. Data collection 2.Preparation of draft "Minutes of Discussion"
		Water Affairs Department	. Presentation of draft "Minutes of Discussion"
		Japanese Embassy	. Presentation of draft "Minutes of Discussion"
		Ministry of Decentralization	. Ditto
20	Thu	Ministry of Decentralization	. Signing of "Minutes of Discussion"
		Survey Department	. Data collection
21	Fri	Kafue Water Treatment Plant & Chilanga High Lift Pumping Station	. Site investigation
		Kafue Transformer Substation, Zambia Electricity Supply Corporation Limited (ZESCO)	. Site investigation
22	Sat	Distribution Reservoirs	. Site investigation
		Lusaka City	. Site investigation
23	Sun	Hotel	. Arrangement of documents collected
24	Mon	LUDC	. Data collection
25	Tue	Head Quarter, ZESCO	. Data collection
26	Wed	Kafue Water Treatment Plant & Chilanga High Lift Pumping Station	1. Water quality analysis 2. Site investigation
27	Thu	LUDC	. Data collection
		ZESCO	. Data collection
		Japanese Embassy	. Ditto
		JOCV	. Ditto
		MOD	. Ditto
		MOF	. Ditto
		Water Affairs Department	. Ditto
28	Fri	Hotel	. Arrangement of documents collected

APPENDIX 5 LIST OF DATA COLLECTED

1. General Information for Zambia
   - Monthly Digest of statistics
   - Annual Report for the year ended 1980
   - Country Profile Zambia 1984
   - Migration Statistics
   - Economic Indices
   - Map

2. Water Affairs
   - Zambia Water Wastage Study (African Development Bank) 1977
   - International Drinking Water Supply and Sanitation Decade 1981-1990
   - Lusaka Groundwater Supply Scheme Pre-Appraised Report 1979
   - Management Advice for the Establishment of the Agreed Water & Sewerage Department 1980-1981
   - Project Identification Report 1985
   - Emergency Measures
   - Water Reticulation System Map (LUDC)

3. Existing Water Supply Facilities
   - Tender Document (Conditions of Contract, Specification, B/Q)
   - AsBuilt Drawings(Civil,Architect,Mechanical, Electrical)
   - Water Quality Analysis

4. Price, Cost
   - Analysis of Rates for Items f Sanitary & Water Supply Works
   - Price List (Ministry of Works and Supply)

5. Charge
   - Water Tariff
   - Electricity charge

6. Others
   - Specification for Transformer, ZESCO