tor will be required during the construction works.

2) Gas

Most of the people use liquefied petroleum gas (LPG) as the fuel for household use.

3) Telephone and Telecommunication

The telephone condition is not so good, in that telephones are provided only in the local offices of the central government, factories, hotels etc. and are not prevelant in most houses. Even the Scheme Office does not have a telephone.

3.3.4 Outline of Facilities and Equipment

The facilities and equipment involved in the Project are summarized in Tables 3.13 and 3.14.

3.3.5 Operation and Maintenance Plan

The items to be undertaken during the implementation of the Project and the operation and maintenance cost to be borne after the completion of the Project by the Kenyan side are indicated below:

(1) Before and During the Execution of the Project

a. land acquisition for construction of facilities
b. land acquisition for construction of maintenance roads
c. compensation to private land which may be accompanied with the installation works of rising and distribution mains
d. water supply service to consumers with tank lorries during the water interruption which will occur during the connection works to existing distribution pipes
e. flushing to clean the distribution pipes after the connection works to existing distribution pipes

Table 3.13 Outline of Major Facilities and Equipment

Intake Facilities	
Intake Weir	Concrete, Gravity Type H 2.2 m x W 30.4 m
Intake Pipe	Steel Pipe for Water Supply ϕ 300 mm x l 20 m
Grit Chamber	Concrete H 2.0 m x W 6.0 m x D 1.5 m x 2 units
Intake Pump Station	One-story 5.0 m x 8.0 m x 1 unit (A 40 m^2)
Intake Pump	Horizontal Single Suction Volute Pump Q 1.53 m^3/min x H 11.0 m x P 5.5 kw x 3 units
Transmission Pipe	Steel Pipe for Water Supply ϕ 300 mm x l 670 m
Maintenance Road	Gravel laid W 4.0 m x l 985 m
Water Treatment Plant	
Receiving Well	Concrete W 2.0 m x L 2.0 m x D 1.5 m x 1 unit
Rapid Mixing Chamber	Concrete, Mechanically Mixed W 2.0 m x L 1.5 m x D 1.5 m x 1 unit
Flocculation Basin	Concrete, Horizontally Baffled Flow W 4.0 m x L 5.1 m x D 1.5 m x 2 units
Sedimentation Basin	Concrete, Horizontal Flow W 4.0 m x L 23.0 m x D 3.0 m x 2 units
Rapid Filter	Concrete, Gravity Type W 3.0 m x L 3.5 m
Clear Water Reservoir	Concrete W 5.0 m x L 12.0 m x D 2.0 m x 2 units
Clear Water Pump Station	One-story 5.0 m x 8.0 m (40 m^2)
clear Water Pump	Horizontal Single Suction Multistage Volute Pump Q 1.53 m^3/min x H 112.0 m x P 55 kw x 3 units
Sludge Drying Bed	Concrete W 7.0 m x L 16.0 m x D 1.0 m x 5 units

Table 3.13 Outline of Major Facilities and Equipment (Cont'd)

Elevated Tank	Steel W 5.0 m x L 5.0 m x D 3.0 m (H 15.0 m) x 1 unit
Administrative Building	One-story 10.0 m x 21.0 m x 1 unit (A 210 m^2)
Electrical Equipment	lump sum
Chemical Building	One-story W 6.0 m x L 12.0 m x 1 unit (A 72 m^2)
Chemical Dosing Equipment	lump sum
Staff House	One-story (2 households per unit) W 22.0 m x L 4.0 m x 7 units (A 88.0 m^2)
Inplant Piping	Steel Pipe for Water Supply, etc. ϕ 100 - 300 mm
Inplant Road	Asphalt Pavement W 4.0 m x l 519 m W 3.0 m x l 147 m
Outdoor Lighting	lump sum
Transmission Facilities	
Maintenance Road	Asphalt Pavement W 4.0 m x l 210 m
Aqueduct	Truss-reinforced Type ϕ 300 mm x l 40 m
Rising Main No.1	Steel Pipe for Water Supply ϕ 300 mm x l 2,000 m
Booster Pump Station	One-story 6.0 m x 10.0 m x 1 unit (A 60 m^2)
Booster Pump	Horizontal Single Suction Multistage Volute Pump Q 1.39 m^3/min x H 112.0 m x P 55 kw x 3 units
Rising Main No.2	Steel Pipe for Water Supply ϕ 300 mm x l 7,408 m
Distribution Facilities	
Ground Reservoir No.1	concrete W 12.0 m x L 33.2 m x D 2.0 m

Table 3.13 Outline of Major Facilities and Equipment (Cont'd)

Elevated Tank No.1	Steel W 7.0 m x L 7.0 m x D 3.0 m (H 15.0 m)
Lift Pump Station No.1	One-story 5.0 m x 8.0 m x 1 unit (A 40 m^2)
Lift Pump No.1	Horizontal Single Suction Volute Pump Q 2.21 m^3/min x H 22.0 m x P 15 kw x 3 units
Ground Reservoir No.2	Concrete W 8.4 m x L 12.8 m x D 2.0 m
Elevated Tank No.2	Steel W 4.0 m x L 4.0 m x D 2.0 m (H 15.0 m)
Lift Pump Station No.2	One-story 4.0 m x 5.0 m x 1 unit (A 40 m^2)
Lift Pump No.2	Horizontal Single Suction Volute Pump Q 1.15 m^3/min x H 22.0 m x P 7.5 kw x 2 units
Distribution Main for Highland	Steel Pipe for Water Supply ϕ 300 mm x 1 189 m ϕ 250 mm x 1 492 m ϕ 200 mm x 1 802 m ϕ 150 mm x 1 3,049 m
Distribution Main for Lowland	Steel Pipe for Water Supply ϕ 200 mm x 1 623 m ϕ 150 mm x 1 1,482 m

Table 3.14 Outline of Equipment Supply

Water Meter	Direct Reading ϕ 12 mm x 700 units
Laboratory Instrument	
For Residual Chlorine	
No. of Units	2 units
Specifications	Color Comparator Test Kit
Chemicals	DPD (Tablets)
Measuring Method	Colorimetric Method
Measuring Range	0.1 - 2.0
For pH	
No. of Units	2 units
Specifications	Color Comparator Test Kit
Measuring Method	Colorimetric Method
Chemicals	Phenolred (Tablets)
Measuring Range	6.8 - 8.4
For Turbidity	
No. of Units	2 units
Specifications	Color Comparator Test Kit (JIS K0101)
Measuring Method	Colorimetric Method
For Alkalinity	
For Coagulation Effectiveness (Jar Tester Apparatus)	
No. of Units	1 unit
Specifications	Stirring Machine with 5 Paddles and a Variable-Speed Drive
Analytical Balance	
No. of Units	1 unit
Specifications	Double-Pan Balance
Measuring Range	10mg - 500g
Workshop Tool	
General Tool	
Spanner	2 units
Prier	2 units
Wrench	2 units
Driver	2 units
Hammer	2 units
Tool for Piping	
Pipe Wrench	2 units
Chaintongu	2 units
Pipe Cutter	2 units

Table 3.14 Outline of Equipment Supply (Cont'd)

Spare Parts		
	For Pump	
		Impeller Shaft Sleeve Bearing, Gland Packing O Ring Liner Ring
	For Motor	
		Bearing
	For Valve	
	Sluice Valve	1 unit
	Air Valve	1 unit
	For Chemical Feeding Equipment	
	Water Level Control Unit	1 unit
	Flow Control Unit	1 unit
	For Electrical Panel	
		Various Parts in the Panel
	For Flow Meter	
	Flow Meter	1 unit for Each Size
	For Water Level	
	Water Level	1 unit for Ground Reservoirs 1 unit for Elevated Tanks

f. power supply from KPLC to the Project sites
g. rehabilitation of existing distribution pipes for leakage control
h. expansion of distribution pipes
i. installation of water meters which will be supplied by the Japanese side
j. custom duties on imported equipment and materials, if necessary.
k. setting-up of an organization for the implementation of the Project.

The Kenyan side shall estimate the above cost and assure the requisite budget. Out of the above, the special budget to be provided by the Kenyan side during the construction works is shown in Table 4.7.

(2) After Completion of the Project

1) Personnel Expenses

It will be necessary to increase the operators by at least 10 persons for proper operation and maintenance, and quantity and quality control activities. Sludge removal and disposal can be entrusted to an outside contractor. In addition, the increase in number of staff for administration and distribution of budgetary matters will be required incidental to the scale of expansion.

2) Operational cost

Table 3.15 shows the power and chemical expenses required for the operation of pumps, chemical dosing equipment, etc. The budget should be assured for proper chemical dosing based on the estimation.

3) Maintenance cost

As for maintenance costs, the following should be considered in budgeting for proper operation and maintenance:

Table 3.15 Operation Cost

Facility Name	Before the Project	After the Project
1. Power Consumption		
(1) Intake/Treatment Facilities	430,174 KShs./yr	1,540,659 KShs./yr
(2) Booster Pump Station		882,774 KShs./yr
(3) Reservoir(Scheme Office)		249,738 KShs./yr
(4) Reservoir (Bible Col. Sch.)		68,618 KShs./yr
	Total 430,174 KShs./yr	Total 2,741,789 KShs./yr
2. Chemical Consumption	Quantity × Feeding Rate = Consumption (m^3/day) (ppm) (kg/day)	Quantity × Feeding Rate = Consumption (m^3/day) (ppm) (kg/day)
(1) Alum	1,000 45 45	4,400 45 198
	45 kg/day x 365 day/yr x 10.8 KShs./kg =177,400 KShs./yr	198 kg/day x 365 day/yr x 10.8 KShs./kg =780,500 KShs./yr
(2) Soda Ash	1,000 12 12	4,400 12 52.8
	12 kg/day x 365 day/yr x 2.9 KShs./kg = 12,700 KShs./yr	52.8 kg/day x 365 day/yr x 2.9 KShs./kg = 55,900 KShs./yr
(3) Bleaching Powder	1,000 2.5 2.5	4,400 2.5 11
	2.5 kg/day x 365 day/yr x 35 KShs./kg = 31,900 KShs./yr	11 kg/day x 365 day/yr x 35 KShs./kg =140,500 KShs./yr
	Total 222,000 KShs./yr	Total 976,900 KShs./yr

- Periodical inspection and repair of mechanical and electrical equipment: assumed at 0.5% of the initial equipment cost per year for the first 5 years and at 1% per year after that.
- Sludge removal and disposal from sludge drying beds: estimate a necessary expense for entrusting (about 5 times per year) x (approximately 15 m^3 sludge per time) x (unit cost per m^3)
- Other expense required for periodical inspection

The operation and maintenance cost estimated in terms of the above is presented in Table 4.8.

3.4 Technical Cooperation

Matters of great importance after the completion of the Project are whether the facilities will be operated and maintained as expected and whether the existing distribution pipes will be rehabilitated to prevent the leakage and their extension as planned.

At present, the World Bank is engaged in the formulation of the training program as well as the improvement of the NWCPC organization. Although the training in plant operation and maintenance will be probably included in this program, the time for implementation and so on are unknown at this moment. Therefore, as described in 3.2.6, it is considered that on-the-job training by the consultant using the actual facilities has the advantage of good timing.

CHAPTER 4

BASIC DESIGN

CHAPTER 4 BASIC DESIGN

4.1 Design Policies

The basic design shall be made based on the following policies:

a. The treated water shall meet the Kenyan Drinking Water Standard.
b. The treatment process and the operation system equipment shall be decided upon in consideration of their ease of the operation and maintenance.
c. The water treatment plant shall be operated continuously except during power interruptions.
d. The design flow for a water supply system in the sewerage service shall be within the capacity of the sewage treatment plant.
e. The standard shall conform to the Japanese Industrial Standard (JIS), the Japan Electrical Manufacturer's Association (JEM) the Standard of Japanese Electrotechnical Committee (JEC), or the equivalence to.

4.2 Examination of Design Conditions

4.2.1 Design Target Year

The design target years shall be 2012 for the ultimate plan and 2002 for Phase 1 (see in more detail in "4.2.4 Design Flow").

4.2.2 Design Service Area

The design service area for the ultimate plan shall be Kapsabet Town and its surrounding area (Zones 1 to 10 and 29 to 36) as shown in Figure 3.1.

The design service area for Phase 1 shall be Kapsabet Town and its surrounding area (Zones 1 to 10, 29, 30 and a part of zones 31, 32, 33, 35 and 36).

4.2.3 Design Population

The projected population in the Feasibility Study Report prepared by the NWCPC and the 1989 census population are indicated in Table 2.1 for com-

parison. Although the area of Kamobo is large, most of its residents live in the neighborhood of the national road and the town and the projected population is deemed reasonable. Hence, the projected population in the Feasibility Study Report shall be adopted in this Study as is.

Table 4.1 Comparison of Projected Population

Area	Zone	F/S (1990)	1989 Census
Town	11-28	10,114	10,000
Kamobo	1,5,29-36	7,800	6,500
Kiminda	2,4,6,9	1,939	7,100
Kiptune	10	300	2,700
Total		20,153	

Table 4.2 Design Served Population by Water Supply

	1997	2002	2012
Pop. in the Design Service Area	26,521	32,266	47,762
Served Pop. by Water Supply	22,378	30,249	47,762
Percentage**	(50%)	(80%)	(100%)

** Percentage that the population in Zones 31, 32, 33, 35 and 36 is involved in the design service area.

4.2.4 Design Flow

The design flow indicated in the Feasibility Study Report was revised based on the Kenyan Water Supply Design Manual. Major changes in its contents are as follows:

a. Zones 31, 32, 33, 35 and 36 shall not be 100% served by water supply in Phase 1, but will be 100% served in 2012 -- assuming that the service coverage will be improved every year.

1992 50%
1997 50%
2002 80%
2012 100%

b. The surrounding area shall not be 100% served by house connections. The coexistence of house connections and communal faucets is assumed as described in the Kenyan Water Supply Design Manual. The percentage of house connections versus communal faucets shall be 80:20 in 2012.

1992	50% : 50%
1997	50% : 50%
2002	60% : 40%
2012	80% : 20%

c. The per capita daily design flow shall be as indicated below based on the Kenyan Water Supply Design Manual, which, however, includes 20% for unaccounted-for water. As the unaccounted-for water is considered separately, the per capita daily design flow below deducts such contributions.

	Adopted	Manual	
House Connection (high class)	200 l	(250 l)	
(middle class)	120 l	(150 l)	
(low class)	60 l	(75 l)	
Communal Faucet	16 l	(20 l)	
Boarding School (student)	40 l	(50 l)	
(teacher)	60 l	(75 l)	
(staff)	60 l	(75 l)	
Day School (student)	20 l	(25 l)	
(teacher)	20 l	(25 l)	
Hospital without beds	20 l	(25 l)	
Hospital with beds	160 l	(200 l)	note:per bed
Prisoner	40 l	(50 l)	

As for the surrounding area where the house connections and communal faucets coexist, the per capita daily design flow shall be as indicated below, taking into account each share and unit design flow which is 60 l for house connection and 16 l for communal faucet, respectively.

1992	38.0 l/day (= 60x0.5 + 16x0.5)
1997	38.0 l/day (= 60x0.5 + 16x0.5)
2002	42.4 l/day (= 60x0.6 + 16x0.4)
2012	51.2 l/day (= 60x0.8 + 16x0.2)

d. The unaccounted-for water ratio shall be 35% in 1997 and 20% in 2012, since the value of 10% adopted in the Feasibility Study Report does not reflect the actual status and is underestimated.

1992	35%
1997	35%
2002	25%
2012	20%

e. The annual growth rate of population shall be 4%.

f. The annual growth rate of the boarding school, hospital, prison and commercial uses shall be 4% for 1992 to 2002 and 2% for 2002 to 2010.

The design flow for water supply by year shall be summarized in Table 4.3.

Table 4.3 Summary of Design Flow for Water Supply

Year	1990	1997	2002	2012
Population	20,153	26,521	32,266	47,762
High Class	1,026	1,350	1,643	2,432
Middle Class	1,787	2,352	2,861	5,420
Low Class	15,360	20,214	24,592	35,217
Students etc.	1,980	2,605	3,170	4,693
Water Demand (cu.m/d)				
Residential	1,022	1,344	1,801	2,966
Institutional	210	277	336	446
Commercial	22	102	124	151
Industrial	242	319	387	473
Fire	266	317	360	440
Sub-Total	1,762	2,357	3,008	4,476
Unaccounted-for Water	949 (35%)	1,270 (35%)	1,003 (25%)	1,199 (20%)
Total	2,711	3,629	4,011	5,595
Values in F/S by MWD	3,277		5,235	7,238

According to the agreement, the design flow for water supply in the service area by sewerage is decided based on the final treatment capacity of the sewage treatment plant. Therefore, by calculating the design flow for water supply by year, the target year for Phase 1 will be the year

when the design flow for water supply is closest to the allowable water supply volume to be decided based on the final treatment capacity of the sewage treatment plant in the service area by sewerage.

As described in "2.5.2 Outline of the Project", the final treatment capacity after the completion of the construction works for Phase 2 is 1,820 m^3/day. The conversion rate of water to sewage by source is defined as follows:

Residential (high class)	0.75
(middle class)	0.80
(low class)	0.80
Industrial	0.80
Commercial	0.85
Institutional (schools, etc.)	0.80

The average conversion rate is 0.80, therefore the allowable water supply volume is 2,275 m^3/day by the following calculation:

$$1,820/0.80 = 2,275 \ m^3/day$$

While the design flow fir water supply in the service area by sewerage is as shown in Table 4.4. The design flow for water supply in 2002 is within the allowable water supply volume of 2,275 m^3/day and closest thereto. *Consequently, the target year for Phase 1 shall be the year of 2002.*

Table 4.4 Design Flow by Year in the Served Area by Sewerage

Zone No.	Percentage Involved within the Service Area by Sewerage	Design Flow (m^3/day)		
		1998	2000	2002
2-8	100	286	297	334
11-29,37	100	1,567	1,675	1,833
30	20	6	7	6
31	30	24	27	31
32	50	24	27	31
35	10	13	14	16
		1,920	2,047	2,253

4.3 Basic Design

4.3.1 Composition of the System

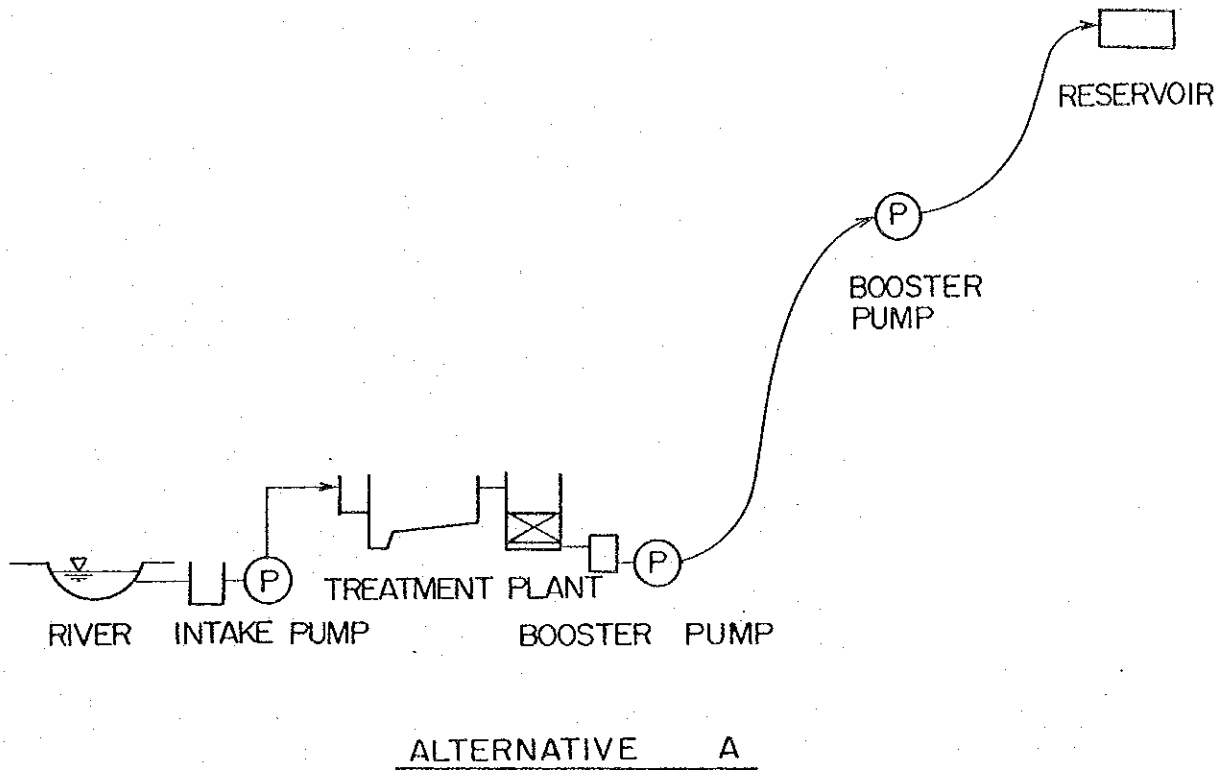
The raw water taken from the Kimondi River with a sufficient flow is pumped to the water treatment plant after passing through the grit chamber.

Regarding the location of the water treatment plant, there are two alternatives. The government-owned land along the Kimondi River is proposed in Alternative A, while the privately owned land with an higher elevation than that of the site in Alternative A along the national road is proposed in Alternative B. Figures 4.1 and 4.2 show the schematic water supply system and general layout of the water supply facilities, respectively.

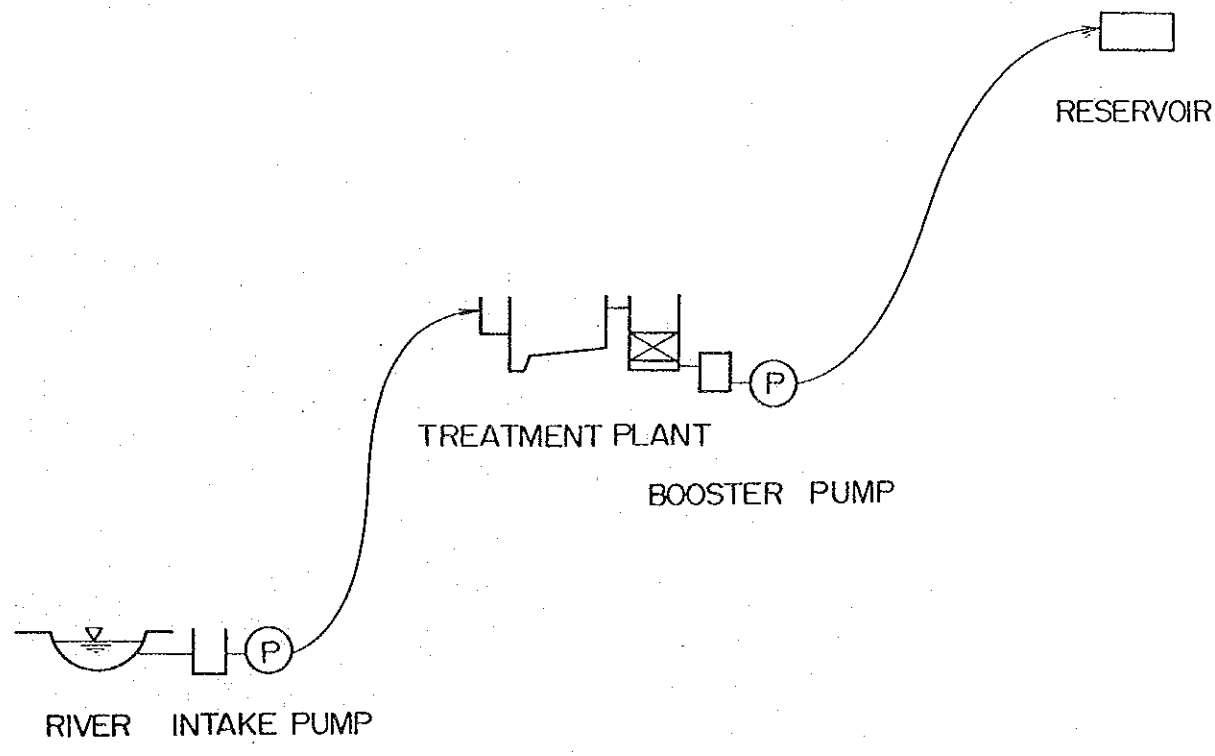
In case of Alternative A, the construction of a booster pump station is necessary to alleviate the heavy water hammer effects derived from the topographic conditions of the route of the rising main. As a result the pumps are used at three stages, namely the raw water intake, the clear water transmission and the clear water boosting as shown in Figure 4.1. In case of Alternative B, the pumps are used at two stages, since the site for the booster pump station in Alternative A has also enough space for a water treatment plant.

The site for the water treatment plant in Alternative A includes the swamp and partially exposed rocks, while that in Alternative B is well situated on a hill which would provide good working conditions. Alternative B is better in consideration of it ease of maintenance and construction cost.

However, the site for Alternative B is on private land and there is some uncertainty as to whether the land will be acquired by the time of the commencement of the construction work. Although the NWCPC already held a meeting on this matter with the landowner who has showed a willingness to sell the land at present, both could not enter into the further definite talks, since the NWCPC could not present the conditions for land purchase, such as the amount and the time due to the unknown time schedule of the Project. While the site in Alternative A is available at any time



ALTERNATIVE A



ALTERNATIVE B

Figure 4.1 Composition of Proposed Water Supply System Alternatives

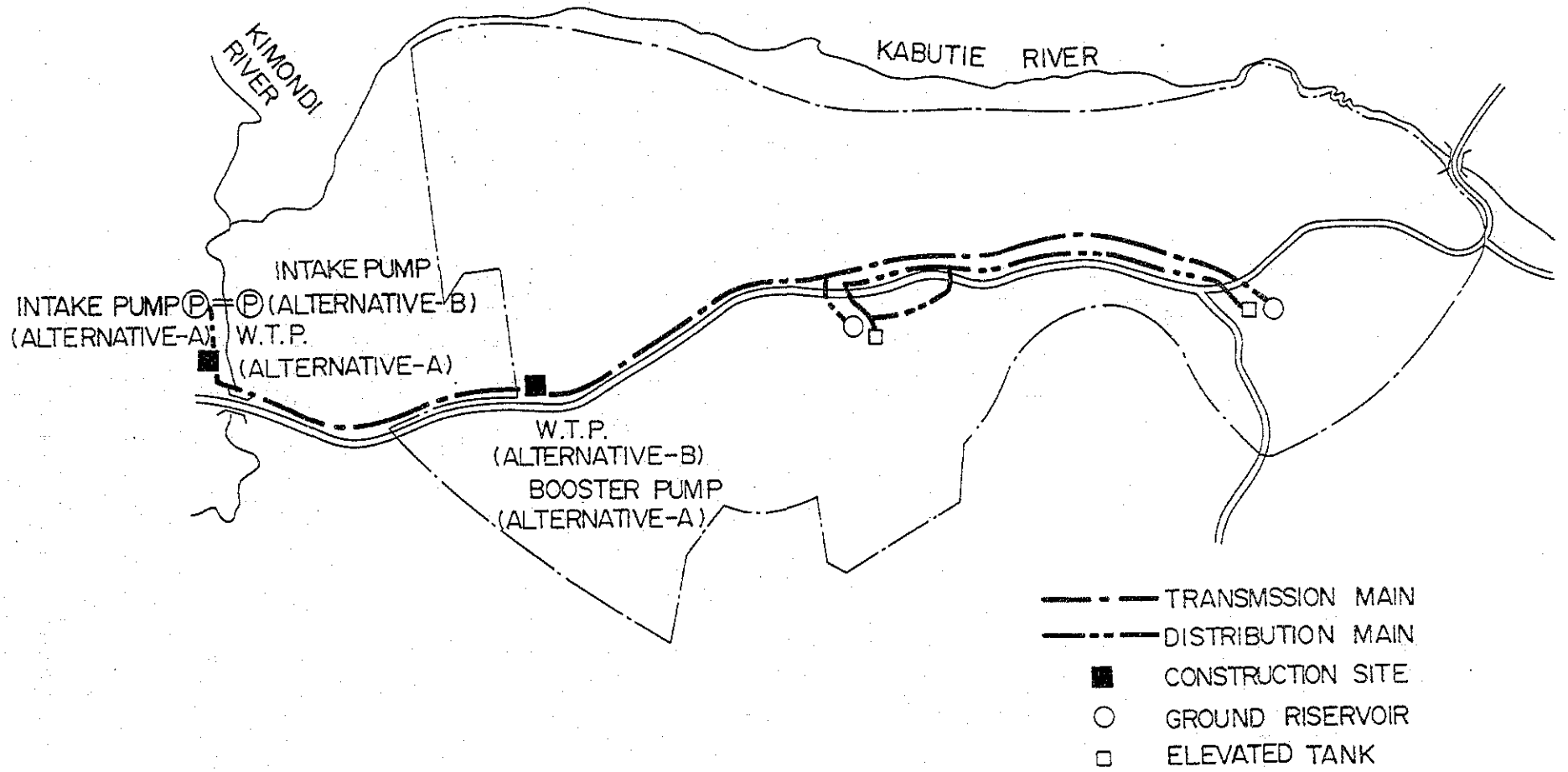


Figure 4.2 General Plan of Proposed Water Supply System Alternatives

due to the fact that it is government-owned land.

For this reason, the basic design shall be made for Alternative A.

The treatment process shall be chemical sedimentation followed by filtration and a receiving well, rapid mixing chamber, flocculation basin, plane sedimentation tank, rapid sand filter, clear water reservoir and so on will be constructed in the water treatment plant. A clear water pump will be also equipped therein.

Transmission facilities will be composed of a rising main and a booster pump station to be constructed on the path of the rising main to supply to the water to two ground reservoirs in the town.

Two pairs of ground reservoir and elevated tank shall be constructed at the center and the east of the service area, respectively. The water will be distributed to the lowland service area from the ground reservoir and to the highland service area from the elevated tank which will also supply the water to the lowland service area after reducing the pressure. Distribution mains will be installed so as to connect two elevated tanks and surround the center of the town with a big water consumption.

The comparison between Alternatives A and B is summarized as shown in Table 4.5.

4.3.2 Facility Planning

(1) Intake Facilities (Intake Weir)

- The location which will take water from the river shall be the point which has no bend or imbalance in the flow of the Kimondi River.
- The water depth is not enough to construct the intake tower, since it is little over 1 m at the deepest point, therefore, the water level for the intake shall be maintained by constructing an intake weir.
- As there will be some affect on the upstream by the backwater resulting from the construction of the intake tower, such a point

Table 4.5 Comparison of Water Supply System Alternatives

Facility Name	Alternative A	Alternative B
Intake Facility Intake Weir Grit Chamber & Intake Pump Station	• It is constructed on the exposed rocks about 620m up-stream from the proposed site in Alternative A. • The facilities are on the right bank near the intake weir. • The pump head is low.	• Same as the left • On the right bank • The pump head is higher than that in Alternative A.
Raw Water Transmission Facility	• The length of transmission pipes is short (0.6m) • The aqueduct is required for crossing the Kimondi River.	• The length of transmission pipes is longer than that in Alternative A. • No river crossing.
Water Treatment Plant	• It is on the left bank • The treatment process is the combination of chemical sedimentation and rapid filtration.	• It is on the hill along the national road halfway of the rising main. • Same as the left
Clear Water Transmission Facilities	• The length of the rising mains is longer by the difference in the length of raw water transmission pipes. • The booster pump is necessary to alleviate the effect by water hammer • The number of pump stations is one more than that in Alternative B with troublesome maintenance.	• The length of the rising pipes is more or less than that in Alternative A. • The effect by water hammer is less than that in Alternative A due to the construction of a booster pump station. • The number of pump stations is one less than that in Alternative A.
Distribution Facilities	• A pair of a ground reservoir and a elevated tank is constructed at two places • The design service area is divided into three: (a) lowland service area where the water is supplied from the ground reservoir by gravity (b) highland service area where the water is supplied from the elevated tank by pumps (c) lowland service area where the water is supplied from by the elevated tank by gravity after pressure release • Distribution mains is so installed as to connect two ele-vated tanks and to surround the center of the Town	• Same as the left • Same as the left • Same as the left

which has less affect upstream due to a steep slope of the river bed shall be selected.

- A point with exposed rocks shall be selected for water intake to fix the intake weir thereto for structural stabilization.
- The intake facilities shall have a capacity great enough to cope with the design flow in 2012.

Taking into account the above selection criteria, the location of the intake weir shall be approximately 1 km upstream from the national road across the Kimondi River, or approximately 0.62 km upstream from the proposed site of the water treatment plant. This point is situated farthest downstream on a 20 to 30 m long stretch of exposed rocks which the river flow crosses at almost a right angle. There are exposed rocks on the right banks but swamps on the left bank, therefore, the intake weir shall be so constructed as to cut deeply into the left bank.

(2) Intake facilities (Grit Chamber and Intake Pumps)

- In Alternative A, intake pumps will be required, since the water cannot be gravitated to the water treatment plant due to the low water level at the intake point.
- Likewise, in Alternative B, intake pumps will be required.
- Intake pumps for clear water shall be used, but a grit chamber is necessary to protect the pumps from wearing.
- As the difference in water level of the Kimondi River between the intake point and the upstream end of the proposed site for the water treatment plant in Alternative A is only approximately 60 cm, it is impossible to construct a grit chamber at such a location as to drain discharge from the grit chamber by gravity. Therefore, it shall be constructed near the intake weir and the drain therefrom shall be discharged by a pump.
- According to the experience of the residents, the flood water level was 2.0 m above the present water level measured during the basic design study. Therefore, the depth of the grit chamber will be about 6 m. The ground elevation after site grading to construct the grit chamber will be 2.5 to 3.0 above the water level.

- As the grit chamber will be difficult to expand in the future, its capacity shall be large enough for the water demand in 2012.
- The capacity of the intake pumps shall correspond to the amount of water intake which includes the 10% loss in the water treatment plant to the amount of water supply.
- The location of the raw water transmission pipes is on the right bank of the Kimondi River, the same as the water treatment plant due to no available site for the plant on the left bank in Alternative A but on the left bank due to no land requirement for the plant in Alternative B. Alternative A accompanies the aqueduct across the Kimondi River aside the Kimondi River.

(3) Treatment Facilities

- The amount of water treatment shall be that of water supply plus the 10% loss at the water treatment plant.
- The treatment process shall be the combination of chemical coagulation and rapid sand filtration. The following facilities is involved
  - receiving well, rapid mixing chamber, flocculation basin, plane sedimentation basin and rapid sand filter
  - clear water reservoir, clear water pump station and clear water pumps
  - sludge drying bed
  - chemical building, chemical dosing equipment
  - administrative Building
  - staff house

The site for the sewage treatment plant shall include that for future expansion.

(4) Transmission Facilities

- The clear water pumps need some measures for water hammer which also affect on the type, size and the thickness of the rising main. The steel pipe is expected to be used.
- The size of the rising main shall meet the design flow in 2002.
- The routes of the rising main shall be as shown in Figure 4.2.

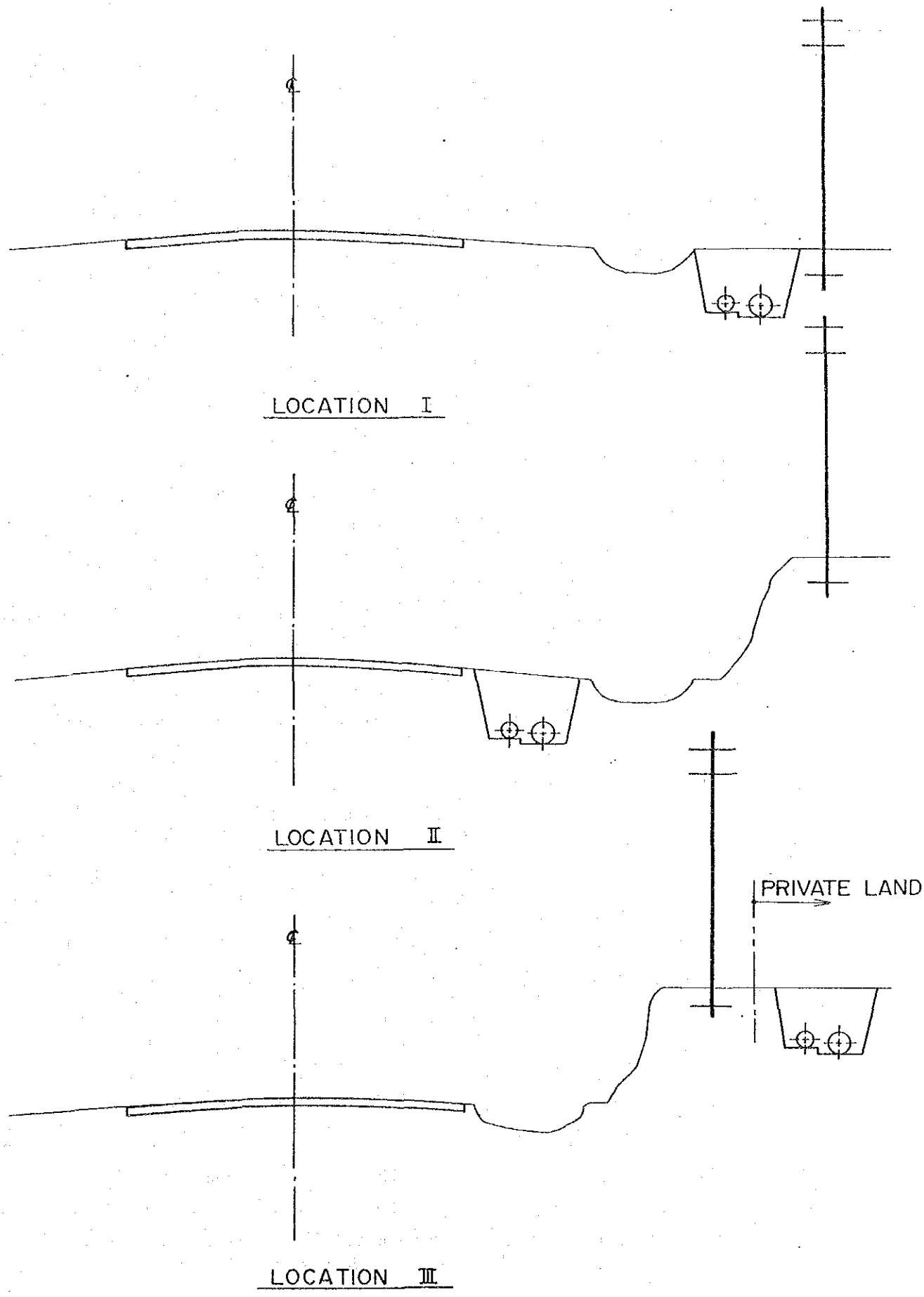


Figure 4.3 Location of Pipe Installation

- The location of the pipes to be installed shall follow the rules below.

  - The pipe shall be installed at Location I as a rule.
  - When Location I is narrow or on the elevation, the pipe shall be installed at Location II.
  - Location III is privately owned and may have a fence, trees, shed, sewers or manholes. The installation work at Location III may involve restoration work and the occurrence of monetary trouble caused by lease of private land and additional construction work.
  - In case of Location I or III, the base portion of electric poles may be excavated with some risks. In addition, as the use of heavy constructional equipment may be limited, there may be some problems in the safety of construction works and the time involved in the construction period.
  - When the existing pipes are installed at Location III, manual excavation will be required to install the new pipes.

    As mentioned above, the pipe installation at Location III may involve a lengthening of the construction period and there might be difficulty in assuring safety, therefore, it is not recommendable to install pipes at Location III.

    The pipes to be installed in the Project will form the frames of the Kapsabet Town water supply system and should be installed on the public; land namely on the road reservations for easy maintenance but not on the private land. Some pipes may be installed under the road pavement.
  - When Location I is on a elevation higher than the road level, it is impossible to install the pipes thereon with the reasons: (a) possibility of the slope being destroyed due to a lack of slope protection, (b) the loss of slope stability by tree roots since the existing trees will be cut at the time of pipe installation, (c) the possible lengthening of the construction period using manual labor, (d) the rising main; the tight time frame of the Kapsabet Town water supply system will not permit the rising main to be installed on such unstable lands.

(5) Distribution Facitlies

- A pair of the ground reservoir and elevated tank shall be constructed at the Scheme office and Bible College School, respectively.
- From the ground reservoirs receiving the clear water, the water will be distributed to the lowland service area by gravity.
- Some water in the ground reservoir will be lifted to the elevated tank by a lift pump.
- From the elevated tank the water is distributed to the highland service area and after releasing the pressure to the lowland service area.
- Distribution mains, as shown in Figure 4.2, will be installed by the Japanese side and connected to the existing distribution pipes.
- To divide the design service area into four parts, isolation valves will be installed on the existing and new pipes.
- The location for pipe installations shall conform to (4) as above. There are some sections of double pipe installation. In this case, the range of excavation must be extended.
- The distribution pipe outgoing from the ground reservoir shall be connected to the existing one near the reservoir at two points per reservoir.
- Other connections with the existing distribution pipes shall be undertaken by the Kenyan side.
- Out of two existing ground reservoirs at the Scheme Office, the big one will be demolished due to the fact that it is no longer functioning, however, the small one will be used upon completion of the construction work for Phase 1, but not used and left as is, because of the difference in water level between the old and new reservoirs will cause a complicated operation and the old one has only one tenth of the capacity of the new one.
- The existing ground reservoir at Namgoi is approximately 45 years old and has big cracks between the top slab and the wall which results in leakage problems and has the possibility to pollute the reservoir through the intrusion of storm water from the outside.
- The existing elevated tank at Namgoi was built 15 years ago and

is still in usable condition. However, it does not have enough elevation to transmit the water to the elevated tank at the Bible College School. A booster pump is currently used to take the water from the ground reservoir this purpose. When a new elevated tank is constructed at the Bible College School, it will have a higher water level than that of the existing one 300 m away. It will be difficult to control the water supply level from two elevated tanks with different water levels without control instrumentation. In consideration of the difficulty in coping with the trouble in instrumentation equipment, it will be necessary to make a stable supply of good water possible by simplifying the whole of the water supply system and by facilitating its operation.

For this purpose, it is not a good idea to involve the old and small elevated tank in the new water supply system since such a system would complicate operation and maintenance and increase the facilities to be maintained. Therefore, all the existing reservoirs including the elevated tank at the Scheme Office and at Namgoi shall not be used when the new ground reservoirs and elevated tanks are constructed.

(6) Electrical Equipment

1) Condition of the Power Distribution System and Scope of the Project

The power distribution system in Kapsabet Municipality is composed of the Nandihills Line and the Tindiret Line outgoing from the Nandi substation (33/11kV, 50,000 kVA) of the Kenya Power and Lighting Company Ltd. (KPLC). Each line is a wooden pole type distribution line with a three phase-three wire system, 11 kV and a single line, and at the important points of main feeders and branch feeders, sectioning switches for maintenance and automatic voltage regulator for constant voltage distribution are equipped.

The distribution method is a radial system which is generally

used in many systems and the transformers are arranged as required. The Project will be supplied the power from the Nandihills Line but requires a 5 km extension from the existing 11 kV distribution line to the proposed site of the sewage treatment plant due to there being no line at present.

According to the KPLC, the extension of the 11kV distribution line work require four months to complete and the cost must be borne by the NWCPC, since it is out of the scope of the Japanese side's responsibilities.

2) Condition of the Power Source

The Nandi Substation receives the power with 33 kV, double lines and distributes the 11kV power by two three phase 25,000 kVA transformers.

The present loading condition is 13,510 kVA and still has sufficient capacity for the Project. On the Nandihills Line, the size of wires is mainly 50 mm^2, although it also includes 25 mm^2 and 75 mm^2 wires. However, as the capacity of the distribution line will allow for the Project, power supply is possible only by extension of the 11kV distribution line.

There is no data on the Kenyan Side regarding the frequency of the power interruptions, although experience has shown that they occur around three times per month in the worst case, but the durations are generally short. Two to three hour power failures are caused by trees falling down during heavy rains and a scheduled power failure for maintenance totals 10 hours every three years. As the Project can cope with a power failure by increasing the reservoirs' storage capacity, a power generator shall not be used in the Project.

3) Power Receiving Scheme

a. Power Receiving Voltage

The receiving voltage of the intake facilities/water treatment plant, booster pump station and distribution facilities are decided based on the Methods of Charge (KPLC) Bylaws. Each facility receives electricity in three phases, 415 V and for lighting with single phase, 240V.

b. Power Receiving System

The power receiving system of each facility is a three phase-four wire system, 415/240V, 50Hz, single line based on the Methods of Charge (KPLC) Bylaws. The KPLC provides a distribution transformer, meter and service cable and undertakes the installation work of the equipment and the wiring works of the service cable.

As for the water treatment plant the power will be received by a receiving panel in the electrical room of the administrative building and distributed to the intake pump station, clear water pump station and the chemical building.

As for the booster pump station and the lift pump station at the ground reservoirs, power will be received by a control panel.

c. Power-Factor Improvement

The KPLC requires its customers to retain a power factor of 90% in the Methods of Charge (KPLC) Bylaws and to pay a 1% surcharge per percent of a power factor below 90%.

The overall power factor of the facilities will be over 90% and a capacitor will be installed on each load to improve the power factor.

4) Operation Equipment Scheme

a. Operation method by Facility

Each piece of equipment will be directly operated by a manual on-off switch, since the NWCPC has confirmed that each piece of equipment would be operated under a 24-hour system under the supervision of at least one operator.

b. Starting Method of Electric Motor

Based on the loading characteristics and power source capacity of each electric motor, the starting method shall be a star-delta starting for the clear water pumps and the total voltage starting method for other pumps.

c. Method of Protection

A distribution system shall be protected from a short-circuit fault by a molded case circuit breaker and from a ground fault by a residual current circuit breaker. A medium voltage circuit shall be protected from both short-circuit faults and ground faults by a leakage circuit breaker , and from overcurrent by the combination of a magnetic contactor and a thermal overload relay. The lift pumps at the reservoirs shall be protected from idling through the use of a level switch, which will detect low water levels.

d. Type of Voltage

The voltage to be used for each facility shall be as follows:

For power	three phase, 415V
For control	single phase, 110V
For instrumentation	single phase, 110V

e. Selection of Equipment

The form of the switch gear used for receiving and distribution and the control gear uses for operation shall be the indoor medium voltage closed switch gear, in conformity with JEM 1265. The field panel shall be a stand-type switch gear.

5) Instrumentation Equipment Scheme

The instrumentation for each facility shall be shown below. Each instrument will be directly read and no instrumentation panel will be provided.

a. Intake Facility and Water Treatment Plant

Intake	amount of water intake	Weir
Clear Water Reservoir	amount of water transmission	Water meter

b. Distribution Facilities

Ground Reservoir	amount of water supply low water level	Water Meter Level Switch
Elevated Tank	amount of water supply water level	Water Meter Gauge

c. Power Receiving Equipment

voltage, current, power, power factor

6) Telecommunication Equipment

To control the amount of water transmission to the two ground reservoirs from the water treatment plant, there are two methods in a telecommunication system: (1) a radio system and (2) a wire telecommunication system. The results of the survey at the Kenyan Post and Telecommunication Company (KPTC) shows that both systems can be provided easily. The proposed site for each facility is located near wiring for the telephone service and a telephone for a wire telecommunication system is provided and maintained by the KPTC for short peri-

ods. Therefore, a wire telecommunication system shall adopted in the Project and KPTC telephones shall be provided for the water treatment plant, the booster pump station and the two lift pump stations at the ground reservoirs.

This work shall be undertaken by the Kenyan side.

7) Lighting Equipment

Power will be distributed to lights and receptacles of each facility from the lighting panel with single phase, 240V.

The illuminance shall conform to the Illuminance Criteria of the Japanese Industrial Standard (JIS Z9110) as shown in Table 4.6.

Table 4.6 Illuminance Criteria (JIS Z9110)

Place	Range of Illuminance (lx)	Standard Illuminance (lx)
Administrative Room	150 - 300	200
Laboratory	150 - 300	200
Electrical Room	150 - 300	200
Workshop, Corridor, etc.	75 - 150	100
Store Room	30 - 75	50
Pump Station, Chemical Bldg.	75 - 150	100
Outdoor for Road and Implant Precaution	10 - 30	20

The lighting equipment shall be of the fluorescent lamp and incandescent lamp type for indoors and the mercury lamp and incandescent lamp types for outdoor use.

8) Other Equipment

a. The distribution line for power and instrumentation shall be cable wired to metal pipes and cable pits or cable trays shall be provided as required. The wiring for indoor lighting shall use electrical wire which will be embedded or encased by the exposed metal pipes. Outdoor lighting will use cable and be the underground line.

b. The earth works shall be done in conformity with the Kenyan Standards and the IEE.

4.3.3 Equipment Supply Plan

Other than the civil and architectural structures and the mechanical and electrical equipment to be equipped with the Project, the following are supplied to the Kenyan side as The Goods.

- water meter
- laboratory instruments
- workshop tools
- spare parts for mechanical and electrical equipment

(1) Water Meter

As described in "2.4.3 Condition of Water supply", as of June 1993, the water is supplied to 931 households, including offices. Of this number, meters of 46 households are out of order and 165 households are use a flat rate without a water meter. In 1990, trouble with water meters was frequent and the assessment amount of water has reached to 36.5% of the total amount of water. However, through the implementation of the Project, the number of the people who will apply for water supply will increase markedly due to the realization of the stable water supply. By meeting such requests, the revenue of the Scheme Office will increase and improve its current financial condition. Therefore, the supply of water meters is considered reasonable.

The service population of the area is estimated to be 30,249 in 2002 and has the following breakdown:

Houses inside the Town	13,923	
Houses outside the Town		
House connection	1,249	
Coexistence of H.C. & C.F.	11,350	┌ H.C. 6,810 (60%) └ C.F. 4,540 (40%)
Students in boarding schools	2,446	

Prisoners	1,281
Total	30,249

The houses inside Kapsabet Town shall be given priority for installation of water meters. The number of the average family members is 3.5 persons per household in the town, while the average is 5 persons in the countryside. As the average of the town is affected by the existence of boarding schools, the average of the countryside shall be used for the calculation of the number of necessary water meters, which is approximately, 2,780 units. The water consumption rate of less than 30 m^3/month is applied at the same rate as the flat rate and its percentage is 67% according to the interview survey. This is expected to go down through the realization of a stable water supply and is assumed to be 50%. Therefore, the number of necessary water meters for the users with a water consumption of more than 30m^3/month is about 1,390, from which the number of water meters in current use is deducted:

1,390 - (931 - 46 - 105) = 670 say 700 units

Consequently, 700 units of water meters shall be supplied to the Kenyan side.

(2) Laboratory Instruments

The analytical instruments to measure the parameters which are required to be recorded in the Water Supply Operation Chart of the NWCPC and the testing instruments used to determine the proper chemical dosing rate will be supplied to the Kenyan side.

1) Parameters to Be Measured

- residual chlorine
- turbidity
- pH
- alkalinity

2) Testing Instruments

- jar tester
- analytical balance

(3) Workshop Tools

General tools necessary for overhauling pumps, etc., and piping tools for installing water meters and repairing the leakage points on the distribution pipes shall be supplied to the Kenyan side except for complex equipment such as a lathe and the like.

1) General Tools

spanner, plier, wrench, driver, hammer, electric welder, etc.

2) Piping Tools

pipe wrench, chain pipe wrench, pipe cutter, etc.

(4) Spare Parts

Spare parts are necessary to maintain the mechanical and electrical equipment to be provided in the Project, but difficult for the Kenyan side to procure due to its poor financial condition. Therefore, spare parts required for a 2-year maintenance plan shall be supplied in the Project.

- for pumps — impeller, shaft sleeve, bearing, grand packing, O ring, liner ring
- for motors — bearing
- for valves — sluice gate, air valve (one unit for the size to be mostly used in the Project)
- for chemical doing units — water level control unit, flow control unit

- for panels breaker, relay, switch, indication lump
- flow meter one unit for each size
- water level meter
  each one unit for ground reservoirs and elevated tanks with electric poles

4.3.4 Basic Design Drawings

The following basic design drawings are shown in Appendix attached hereto.

No. 1 Site Plan
No. 2 Flow Diagram
No. 3 Hydraulic Profile
No. 4 Intake Facilities - Plot Plan
No. 5 Intake Weir
No. 6 Intake Gate (Intake Structure)
No. 7 Grit Chamber & Intake Pump Station (1)
No. 8 Grit Chamber & Intake Pump Station (2)
No. 9 Transmission Pipe
No.10 Water Treatment Plant - Plot Plan
No.11 Coagulation & Sedimentation Basin (1)
No.12 Coagulation & Sedimentation Basin (2)
No.13 Coagulation & Sedimentation Basin (3)
No.14 Rapid Sand Filter (1)
No.15 Rapid Sand Filter (2)
No.16 Rapid Sand Filter (3)
No.17 Rapid Sand Filter (4)
No.18 Clear Water Reservoir & Pump Station
No.19 Sludge Drying Bed (1)
No.20 Sludge Drying Bed (2)
No.21 Administration Building
No.22 Chemical Building
No.23 Staff House
No.24 Booster Pump Station
No.25 No.1 Rising Pipe (1)

No.26 No.1 Rising Pipe (2)
No.27 No.1 Rising Pipe (3)
No.28 No.1 Rising Pipe (4)
No.29 No.1 Rising Pipe (5)
No.30 Aqueduct
No.31 No.2 Rising Pipe (1)
No.32 No.2 Rising Pipe (2)
No.33 No.1 Ground Reservoir & Elevated Tank (1)
No.34 No.1 Ground Reservoir & Elevated Tank (2)
No.35 No.2 Ground Reservoir & Elevated Tank (1)
No.36 No.2 Ground Reservoir & Elevated Tank (2)
No.37 Distribution Main (1)
No.38 Distribution Main (2)
No.39 Electrical Single Line Diagram
No.40 Electrical Panel (1)
No.41 Electrical Panel (2)

4.4 Implementation Plan

4.4.1 Policy for construction

The Japanese consultant is responsible for the detailed design, bidding and construction supervision to ensure that the Project proceeds smoothly and to complete the Project within the given period. For this purpose, The consultant will send a resident engineer to the Project site for construction supervision as an agent of the NWCPC.

The Japanese contractor will undertake the construction work and send a resident engineers to supervise and direct the work. Also engineers who will be sent as required and will give instructions regarding the installation of equipment as well as the test runs needed for adjustment of the water treatment system in accordance with the progress of the mechanical and electrical works including pumps, valves, operation panels, instrumentation, etc.

Training in plant operation at the time the Plant's turning-over to the Kenyan side will be involved in the construction period to clarify the relationship between the facilities supplied and the water treatment

technology and to help make the technology transfer systematically.

Unless all the facilities for intake, treatment, transmission and distribution are completed, the water supply system will not be able to be its fully operational. The integration of the existing and new water supply systems will not be attained until the new system is connected to the existing one. Therefore, even though the construction period is divided into stages, it is difficult to expect the effect of the Project to be shown in any one stage. As a result, the construction work will be contracted as one package.

4.4.2 Construction Conditions

In Kenya, water supply piping work is commonly done. However, the construction of water treatment plants and sewage treatment plants for urban areas have only been done under technical and economical assistance from foreign countries.

In the Project, as the intake facilities, water treatment plant, booster pump station and reservoirs with elevated tanks will be constructed at the new sites regardless of the existing facilities, these new sites are in good condition for construction work. There is enough space in each site to construct a Project office and storage area for the construction materials and equipment.

The rising pipes and distribution mains shall be installed, in principle, outside the storm drain along the national road due to an absence of permission to install the pipes under the paved roads. In case that the pipes have to be installed on private land, it has been confirmed that such lease fees and compensation would be borne by the Kenyan side.

The following are notes of interest regarding the construction work:

a. As the construction sites for the intake facilities, water treatment plant and booster pump station are outside the existing power supply area of the KPLC, power generators will be required for construction work.

b. Likewise, as the construction sites for the intake facilities, water treatment plant and booster pump station are outside the existing water supply area, it will be necessary for the contractor to install a storage tank at each site and carry water purchased at the Scheme Office with tank lorries

c. As a large volume of water will be required for the leakage test and for flushing after the installation of pipes, the contractor should arrange the time of water purchase and water volume with the Scheme Office beforehand.

d. As the Kimondi River has plenty of water and a rapid flow, it will be dangerous to construct the intake weir by closing half of the river flow. For this reason, by excavating the detoured watercourse on the left bank beforehand, the intake weir should be completed in a single stroke during the period from November to March, which has less rainfall.

e. As the rising pipes and distribution mains will be mostly installed along the national road, the contractor will be required to pay full attention to safety measures and to avoid traffic stoppages on the national road resulting from the construction work as much as possible.

f. As there is no concrete plant in Kapsabet Town, on-site concrete mixers with large capacities will be necessary

g. The contractor will be required to arrange for a telephone in an before the construction work begins.

4.4.3 Construction and Supervisory Plan and Technical Guidance for Plant Operation

(1) Detailed Design

The detailed design will proceed after the E/N between the Government of Japan and the Government of the Republic of Kenya and after the verification of the consultant contract by the Government of

Japan. Such a detailed design for the Project will be prepared based on the basic design. The detailed design drawings and tendering documents prepared by the consultant will be approved by the NWCPC to enter the bidding.

(2) Tendering

Contract documents for the Project which will be prepared by the consultant will be approved by the NWCPC. The consultant will assist the NWCPC in making the tender announcement, distributing the tender application form to tenderers, receiving the tender application from tenderers, prequalifying tenderers and distributing the bidding documents to prequalified tenderers. The bidding will be made one month after the tender announcement and bidding documents will be evaluated immediately after the bidding. The lowest bidder will be selected as the successful contractor and the NWCPC will enter into a contract agreement with the contractor.

(3) Construction Supervision

The consultant will evaluate and approve the shop drawings submitted after bidding by the contractor, witness for the shipment of Project material and equipment to be transported to the Project site, and will hold a series of meetings with the NWCPC officials and the contractor prior to the commencement of construction works to advise both parties.

The Project includes civil and architectural works, installation works of mechanical and electrical equipment, piping works and the test run after the completion of the construction works. The consultant will send one resident civil engineer and one each civil engineer and architect to operate on an on-the-spot basis for construction supervision, and one each mechanical and electrical engineer for equipment installation supervision, quality control and guidance of the test run at the time of interim and completion of the construction works

As the construction site proposed for the intake facilities, water

treatment plant, booster pump station, reservoirs, rising pipes and distribution mains is scattered in the town and its surrounding area, a few local engineers will be hired to support the Japanese engineers.

(4) Technical Guidance of Plant Operation

For the operation and maintenance of the water treatment plant by the Kenyan side after the facilities are turned over to the Kenyan side, the consultant (or JICA expert, if possible) will provide short-term technical guidance to the plant operators. Such technical guidance will include chemical dosing corresponding to the change in the raw water quality, operation of plant equipment, and removal and disposal of the settled sludge. For this purpose, the engineer who will be sent from Japan shall be familiar with the technology of water treatment and the plant operation and will stay in Kenya for three months.

4.4.4 Procurement Plan

The materials necessary for the Project will be procured from Kenya as much as possible, however, those which are not available in Kenya, does not conform to the quality or specifications required in the Project, or cannot be procured stably in the aspect of quantity or cost will be procured from Japan, taking into account the construction period.

(1) Major Materials to Be Procured from Kenya

The following are procurable in the local market.

1) Major Construction Materials

cement, sand, gravel, steel bar, brick, filter sand, wood for form construction, steel pipe for water supply (SGP), polyvinyl chloride pipe (PVC), form material for elevated tank

2) Chemicals for Test Run

alum, soda ash, bleaching powder

(2) Construction Materials to Be Procured from Japan

1) Major Construction Materials

pump, valve and gate, piping joint, water treatment equipment (underdrain system, surface wash pipe, chemical dosing equipment, chlorinator, mixer), electrical equipment (mercury lump, low voltage panel, control panel), instrumental equipment, laboratory equipment

2) Constructional Machine

crane, backhoe, giant breaker, vehicle, power generator, compressor, submergible pump, concrete cutter, bar cutter, welder, general, tool

4.4.5 Implementation Plan

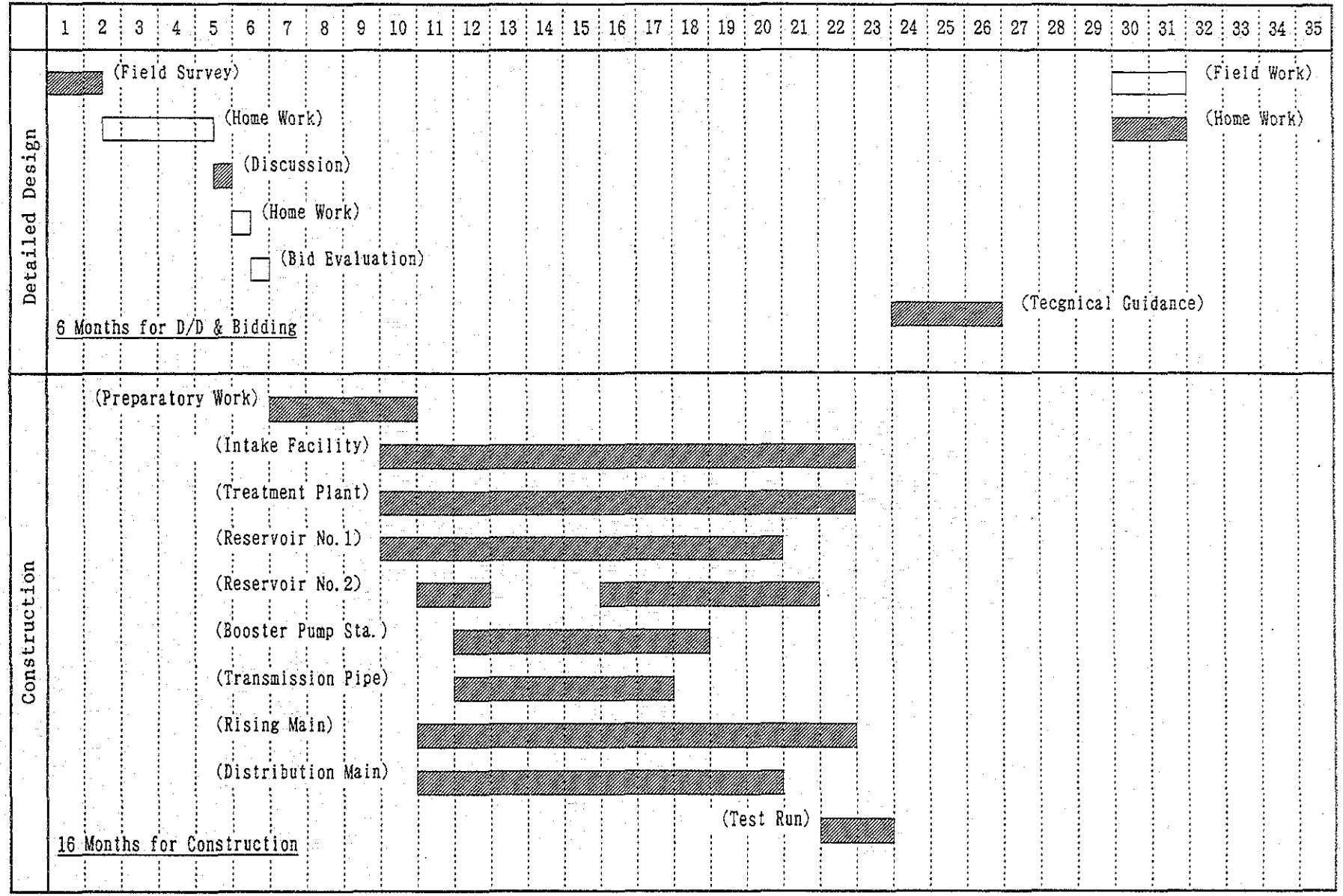
(1) Implementation Plan

To progress the construction works economically and efficiently, the implementation plan is defined as shown in Figure 4.4, taking into account the rainy season from November to March.

(2) Scope of Work to Be Undertaken by Each Side

The scope of work to be undertaken by the Japanese side are the detail design and construction supervision for intake, treatment, transmission and distribution facilities and the technical guidance of plant operation by the consultant as well as the construction works for civil and architectural structures and mechanical and electrical equipment including pipe installation works by the contractor.

Figure 4.4 Implementation Plan of the Project



The scope of work to be undertaken by the Kenyan side are the land acquisition for facilities and roads, provision of relevant infrastructure, repair for leakage control and extension of the existing distribution pipes and operation and maintenance of the water supply system after the completion of the Project.

The scope of work to be carried out by each side is as follows:

1) Scope of Work to Be Undertaken by the Japanese Side

a. Water Intake Facilities (Including Civil, Mechanical and Electrical Works)

a) intake weir and intake water pipes
b) grit chamber
c) intake pump station and intake pumps
d) transmission pipes
e) maintenance road between the intake pump station and water treatment plant

b. Water Treatment Facilities (Including Civil, Mechanical and Electrical Works)

a) receiving well, rapid mixing chamber and flocculation basin
b) sedimentation basin
c) rapid sand filter
d) clear water reservoir
e) clear pump station and clear water pumps
f) chemical building and chemical feeding equipment
g) sludge drying bed
h) elevated tank
i) administration building (office, control room, electrical room, laboratory , workshop and stock room) and electrical equipment
j) inplant piping
k) inplant maintenance road

l) inplant outdoor lighting

m) staff houses

c. Transmission Facilities (Including Civil, Mechanical and Electrical Works)

a) rising pipes (including the restoration works of roads)

b) regulation basin

c) booster pump station and booster pumps

d) aqueduct across the Kimondi River

e) maintenance road between the water treatment plant and national road

d. Distribution Facilities (Including Civil, Mechanical and Electrical Works)

a) ground reservoir

b) elevated tank

c) lift pump station and lift pumps

d. distribution mains (including the restoration works of roads)

e. Temporary Work for Construction

a) project site office and stockyard

b) consumables such as power and water for construction works

c) chemicals for test operation of the water treatment plant (for two months)

2) Scope of Work to be undertaken by the Kenyan Side

a. For Construction Works

a) land acquisition for water intake facilities

b) land acquisition for a water treatment plant

c) land acquisition for a booster pump station

d) land acquisition for ground reservoirs and elevated tanks
e) land acquisition for access roads
f) lease fee and compensation for private land use necessary for pipe installation and compensation for rehabilitation of things removed during the construction works
g) removal of things remained in the construction sites which are unnecessary for the Project

b. Power Supply and Provision of Relevant Infrastructure

a) power supply to water intake pump station, water treatment plant, booster pump station and lift pump stations for elevated tanks
b) installation of telephone sets composed of a telephone and a protective unit at the intake facilities, water treatment plant, booster pump station and lift pump stations

c. Rehabilitation and Extension of Existing Distribution Pipes

a) extension of existing distribution pipes
b) maintenance and repair of existing distribution pipes for leakage control
c) installation of water meters to be supplied by the Japanese side
d) water supply service to consumers during the water interruption which will occur during the connection works to existing distribution pipes
e) flushing for cleaning of distribution pipes after connection works to existing distribution pipes
f) operation and maintenance of the completed water supply facilities

4.4.6 Expenses to Be Borne by the Kenyan Side

The expenses necessary for the implementation of the scope of work undertaken by the Kenyan side are shown in Tables 4.7 and 4.8. The detail of

the scope of work and operation cost is given in "3.3.5 Operation and Maintenance Plan".

However, the expenses for land acquisition, compensation for private land lease and restoration, cost for removal of things the remain in the proposed construction sites, cost for repair and extension of existing distribution pipes, and the expense for meter installation shall be estimated by the Kenyan side for necessary budgeting.

Table 4.7 Incidental Expenses for Implementation of the Project to Be Borne by the Kenyan Side

1. Personnel expense for counterparts 3 prs. x @ KShs. 60,000 /MM x 19 MM	= KShs. 342,000
2. Expense for power supply	= KShs. 6,500,000
3. Expense for telephone	= KShs. 100,000
4. Expense for water supply service consumer with tank lorries	= KShs. 18,000
5. Expense for flushing for cleaning of distribution pipes	= KShs. 50,000

Table 4.8 Operation and Maintenance Cost

(Unit:1,000KShs./yr)

Item	Current	After Expansion
1. Personnel	630 (15 prs. x @3.5/MM x 12)	1,488 (31 prs. x @4.0/MM x 12)
2. Power	430	2,742
3. Chemical	220	977
4. Repair	-	375 (0.5% of equipment cost)
5. Sludge removal and disposal	-	100 (5 times/yr x @20/time)
	1,280	5,682

CHAPTER 5

PROJECT EVALUATION AND CONCLUSION

CHAPTER 5 PROJECT EVALUATION AND CONCLUSION

5.1 Effects

The implementation of the Project is expected to bring the following effects (see Table 5.1):

(1) The production volume at the water treatment plant will increase from 1,040 m^3/day to 4,011 m^3/day, four times the present production volume and the beneficiaries will number approximately 30,200 in 2002. The realization of a 24 hour stable water supply will make it possible to cancel the time limitation for water supply and to supply the possible users who have now depended on the alternative water sources. The water supply problem, which is the greatest problem of Kapsabet, will be solved by the implementation of the Project and it is no exaggeration to say that the town will find a chance for further development.

(2) The present water supply is operated by giving priority to quantity rather than quality and sufficient attention has not been necessarily given to the assurance of the water quality. Through the implementation of the Project, the water supply facilities will be renewed, including the chemical feeding equipment for proper chemical dosing, which will lead to the provision of clean and safe water which meet the Kenyan drinking water quality standard (if the system is properly operated and maintained) and assure the health of the people who previously have depended on unsanitary alternative water sources.

(3) The realization of a stable water supply will bring the increase in water consumption, which will contribute to the increase in revenue. Also, complaints of inadequate water supply will be swept away, which will make the collection of water charge smoother and will have a favorable effect on the increase in revenue.

5.2 Conclusion

The initial water supply system of Kapsabet was built in 1948 and thereaf-

ter expanded in 1960 and 1980 to a total capacity of 820 m^3/day. At present, however, the first treatment system is no longer functional and the other treatment facilities are time-worn. Equipment with a relatively short lifespan has not been replaced or repaired due to financial constraints, The system is now in an only partially operational state and cannot carry out its mission to supply potable water. In addition, the present water supply system is using only one pump without any stand-by and the rising main has frequent bursts. The current system could easily cease to operate at any moment. However, the NWCPC cannot take necessary measures against the Kapsabet water supply system's crisis due to its tight financial situation and lack of profitability.

The Project meets the goal of the national development plan, benefits approximately 30,200 people living in Kapsabet and its surrounding area and will significantly contribute to the future development of Kapsabet. Furthermore, taking into account the critical situation of the present water supply system, it is considered that the Project has an emergency priority.

The Project deserved to be implemented under the grant aid assistance of the Government of Japan due to it massive potential contribution to the improvement of the resident's living standards and the public health.

5.3 Matters to Be Undertaken by the Kenyan Side

To achieve the target of the Project and to maximize its effect as much as possible, it will be necessary for the Kenyan side to take the following necessary measures:

(1) Before the Construction of the Project

- to assure a budget for the tasks of the Kenyan side
- to secure full possession the land for the construction of the facilities proposed in the Project
- to organize a Project team for the smooth planning progress
- to prepare plans for leakage control and for the expansion of the existing distribution pipes

Table 5.1 Effect by the Project

Condition/Problem	Measures in the Project	Effect by the Project
• Water demand exceeding water supply	• Expansion of the capacity to be supplied from the present 620 m³/day to 4,011 m³/day	• 24−hour stable water supply • Improvement of service coverage from 45% to 94%
• Insufficient capacity of the present water source for futu	• Change of the water source from the Kabutie River to the Kimondi River	• Sufficient capacity for future water demand • Prospective of future development of the Town • No needs for unsanitary alternative source
• No allowance or standby for existing facilities	• Expansion of the capacity • Provision of the standby for major equipment	• No more overloaded operation • Rapid restart of operation by switching to the standby equipment
• Insufficient attention to water quality	• Expansion of the capacity • Provision of chemical dosing euqipment	• No more improper operation • Proper chemical dosing • Decrease in mortality of water−related decease by the supply of clean water
• Frequent rejection to pay the water charge	• 24−hour stable water supply	• Improvement of collection rate of water charge since the stable supply of clean water removes the complaints of the users
• Deficit management of water supply system	• Supply of water meters	• Increase in revenue from water charge collection caused by the increase in water consumption.

- to resume the suspended construction work on the sewerage facilities as soon as possible and to complete the work by the second phase.

(2) During the Construction of the Project

- to assign a Project engineer who will participate in the Project from the planning stage so as to understand the contents of the Project and to master the technology and whereupon will subsequently operate and maintain the system after the completion of the Project.

(3) After the Completion of the Project

- to budget for operation and maintenance of the system
- to budget for repair and extension of the existing distribution pipes
- to establish measures for ensuring the collection of water charges, which are the financial source for the operation and maintenance of the system
- to conduct a training program to raise the skill levels of the operators
- to carry out the preventive maintenance systematically to keep the system functioning normally
- to clarify the responsibility to manager each of each facility
- to adequately monitor the quality of the raw water so as to properly operate the system corresponding to any change
- to maintain an adequate supply of spare parts

APPENDICES

APPENDIX 1 MEMBER LIST OF SURVEY TEAM

(1) Basic Design Study

Yasuhiro Morimoto	Team leader	Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs, Government of Japan
Shuji Matsueda	Water Supply System	Planning Division, Water Supply and Environmental Sanitation Department, Environmental Sanitation Bureau, Ministry of Health and Welfare, Government of Japan
Ikuo Miwa	Water Supply System	Nippon Jogesuido Sekkei Co., Ltd.
Kenji Hori	Treatment Facilities	Nippon Jogesuido Sekkei Co., Ltd.
Sigeo Sawai	Distribution Facilities	Nippon Jogesuido Sekkei Co., Ltd.
Shinichi Osaka	Mechanical Equipment	Nippon Jogesuido Sekkei Co., Ltd.
Kiyoshi Amano	Electrical Equipment	Nippon Jogesuido Sekkei Co., Ltd.

(2) Explanation of Draft Final Report

Not sent due to no signing of the Minutes of Meeting

APPENDIX 2 SURVEY SCHEDULE

(1) Basic Design Study (June 15 to July 12, 1993)

1	June 13	Messrs. Matsueda, Miwa, Hori and Sawai - arrived in Paris
2	June 14	Mr. Morimoto - arrived in Nairobi Messrs. Matsueda, Miwa, Hori and Sawai - left Paris
3	June 15	Messrs. Matsueda, Miwa, Hori and Sawai - arrived in Nairobi Meeting with JICA Kenya Office Meeting with the Embassy of Japan Courtesy call to MWD
4	June 16	Courtesy call to NWCPC Meeting with NWCPC Courtesy call to MOF
5	June 17	Arrival in Eldoret Field survey in Kapsabet
6	June 18	Field survey in Kapsabet
7	June 19	Arrival in Nakuru Inspection of water and wastewater treatment plants in Nakuru Messrs. Morimoto, Matsueda and Miwa - arrival in Nairobi (Messrs. Hori and Sawai - arrival in Eldoret)
8	June 20	Inspection of Itanga water treatment plant (Messrs. Hori and Sawai - field survey in Kapsabet)
9	June 21	Meeting with NWCPC (Messrs. Hori and Sawai - field survey in Kapsabet)
10	June 22	Meeting with NWCPC (Messrs. Hori and Sawai - field survey in Kapsabet)
11	June 23	Meeting with NWCPC (Messrs. Hori and Sawai - field survey in Kapsabet)
12	June 24	Report of results to JICA Kenya Office Report of results to the Embassy of Japan Messrs. Morimoto and Matsueda - left Nairobi (Messrs. Hori and Sawai - field survey in Kapsabet)
13	June 25	Mr. Osaka - arrival in Nairobi

		Messrs. Miwa and Osaka - courtesy call to NWCPC
		Messrs. Miwa and Osaka - arrived in Eldoret
		(Messrs. Hori and Sawai - field survey in Kapsabet)
14	June 26	Field survey in Kapsabet
15	June 27	Internal meeting
16	June 28	Field survey in Kapsabet
17	June 29	Mr. Amano - arrived in Nairobi
		Messrs. Miwa, Hori, Sawai and Osaka - arrived in Nairobi
18	June 30	Meeting with NWCPC
		Request of unit price estimation
19	July 1	Request of unit price estimation
		Meeting with topo and soil surveying company
		(Mr. Hori - arrived in Eldoret and field survey in Kapsabet)
20	July 2	Messrs. Miwa, Sawai, Osaka and Amano - arrived in Nakuru
		Inspection of water treatment plant in Nakuru
		Messrs. Miwa, Sawai, Osaka and Amano - arrived in Eldoret
		(Mr. Hori - field survey in Kapsabet)
21	July 3	Field survey in Kapsabet
22	July 4	Internal meeting
23	July 5	Field survey in Kapsabet
24	July 6	Field survey in Kapsabet
25	July 7	Arrival in Nairobi
26	July 8	Meeting with NWCPC
27	July 9	Collection of unit price estimation
		Report of results to JICA Kenya Office
		Messrs. Osaka and Amano - left Nairobi
28	July 10	Data arrangement
29	July 11	Data arrangement
30	July 12	Meeting with NWCPC
		Report of results to the Embassy of Japan
		Messrs. Miwa, Hori and Sawai - left Nairobi
31	July 13	Messrs. Miwa, Hori and Sawai - arrived in Paris
32	July 14	Messrs. Miwa, Hori and Sawai - left Paris
33	July 15	Messrs. Miwa, Hori and Sawai - arrived at Narita

(2) Explanation of Draft Final Report

Not sent due to no signing of the Minutes of Meeting

APPENDIX 3 LIST OF PERSONNEL CONCERNED

(1) Kenyan Side

1) Ministry of Finance

Mr. C. I. Shakaba	Permanent Secretary

2) Ministry of Land Reclamation, Regional and Water Development

Eng. S. K. Kibunja	Deputy Director of Water Development
Mr. B. N. Muchungi	Engineer

3) National Water Conservation & Pipeline Corporation (NWCPC)

Eng. H. K. A. Rotich	Managing Director
Eng. M. M. Mahammud	Chief Development Services Manager
Mr. M. O. Ochieng	Deputy Chief Development Services Manager
Mr. E. S. Kelengwe	Acting Chief Corporate Services Manager
Mr. Saboket	Western Regional Office Manager
Mr. Simon Wanjara	Kapsabet Scheme Office Manager
Mr. Paul Kigose	Kapsabet Scheme Office Line Patroller

4) Kapsabet Town Council

Mr. James K. Tuikong	Kapsabet Town Clerk

5) Kapsabet District Council

Mr. Nalyanya Wasike	Kapsabet District Physical Planner

(2) Japanese Side

1) Embassy of Japan in Kenya

Mr. Kiyoshi Sakai	First Secretary

2) Kenya JICA Office

Mr. Toshikazu Nagashima	Resident Representative
Mr. Sumio Aoki	Deputy Resident Representative
Mr. Koji Makino	
Mr. Makoto Fujita	JICA Expert
Mr. Hiroyuki Morita	JICA Expert

Appendix 4 Minutes of Discussions

MINUTES OF DISCUSSIONS

BASIC DESIGN STUDY
ON
THE PROJECT FOR EXPANSION OF KAPSABET WATER SUPPLY SYSTEM
IN
THE REPUBLIC OF KENYA

Based on the results of the Preliminary Study on the Project for Expansion of Kapsabet Water Supply System (hereinafter referred to as "the Project"), the Japan International Cooperation Agency (JICA) sent to the Republic of Kenya a Basic Design Study Team on the Project (hereinafter referred to as "the JICA Team"), which is headed by Mr. Yasuhiro MORIMOTO, Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs, the Government of Japan, which is scheduled to stay in the country from 15th June, 1993 to 12th July, 1993.

The JICA Team held discussions with the officials concerned of the Government of Kenya and conducted a field survey at the study area.

In the course of discussions and field survey, both parties have confirmed the main items and the concerns described in the attached sheets. The JICA Team will proceed to further works and prepare a Basic Design Study Report.

Nairobi, 24th June, 1993

Mr. Yasuhiro MORIMOTO
Leader
Basic Design Study Team
JICA

Eng. H. K. A. ROTICH
Managing Director
National Water Conservation
and Pipeline Corporation
(NWCPC)

Mr. S. M. MBOVA
Permanent Secretary
Ministry of Land Reclamation,
Regional and Water Development

Dr. W. KOINANGE
Permanent Secretary
Ministry of Finance

ATTACHMENT

I. OUTLINE OF THE PROJECT

1. Objective of the Project

The objective of the Project is to establish a water supply system for improvement of the water supply situation in Kapsabet Town.

2. Project Sites

The Project site is located in Kapsabet Town as shown in ANNEX-I.

3. Executing Agency

The National Water Conservation and Pipeline Corporation (NWCPC) under the Ministry of Land Reclamation, Regional and Water Development is responsible for the administration and execution of the Project.

4. Items requested by the Government of Kenya

After discussions with the JICA Team, the following items were finally requested by the Kenyan side.

(1) Construction of water intake facilities
(2) Construction of water treatment plant
(3) Construction of water transmission facilities which may include the booster pumping station
(4) Construction of service reservoirs and distribution mains
(5) Supply of water meters

However, the final components of the Project will be decided after further studies.

5. Size of Facilities in the Project

For facilities which cannot be phased, the design flow will be based on the target year of 2012 and for those which can be phased, the design flow will be based on the capacity of the completed sewage treatment plant mentioned below in II. 1. (1).

6. Others

(1) Japan's Grant Aid System

The Kenyan side has understood the system of Japan's Grant Aid explained by the JICA Team.

(2) Schedule of the Study

(i) The Consultant members of the JICA Team will proceed with further studies in Kenya until 12th July, 1993.
(ii) JICA will prepare a Draft Final Basic Design Study Report in English around September, 1993.
(iii) In case that the contents of the report is accepted in principle by the Kenyan side, JICA will complete a Final Basic Design Study Report and send it to the Government of Kenya by November, 1993.

II. CONDITIONS FOR THE PROJECT

1. Prerequisite for the Implementation of the Project

As prerequisite to enter into the stage of appraisal and approval of the Project, the Japanese side shall confirm the following to be achieved by the Kenyan side:

(1) Completion of the Kapsabet Sewerage Project both in Phase I and Phase II with a total capacity of 1,820 cubic meter per day and confirmation of implementation of environmental conservation measures to be recommended in the Final Basic Design Study Report. NWCPC shall report the completion of the Project.
(2) Good achievement in implementation of "Corporate Development Plan" and "Implementation of Revenue Collection, Financial Management and Management Information Systems" and other related institutional support programs (hereinafter referred to as "the Institutional Support Programs"). To follow up the achievement in implementation of the Institutional Support Programs, NWCPC shall submit all final reports of the Institutional Support Programs and progress reports on Implementation of the Institutional Support Programs to JICA.

(3) Submission of the following plan and reports to JICA so as to evaluate measures to be taken by NWCPC for the Project to meet the requirements to be indicated in the Final Basic Design Study Report on the inquiry basis from the Japanese side. The base year to prepare the plan and reports will be given in that inquiry.

(i) The implementation plan for the rehabilitation work of and the extension work to the existing water reticulation system. Such a plan shall include the following items:

a. Length of pipe by size to be rehabilitated and extended yearly

b. construction cost of the above pipes and its budgetary allocation plan

c. Map showing the location of the above pipes

(ii) The report on estimated annual revenue from water sales and fund available for Kapsabet Scheme Office at least for five years after the new system will be in operation. Such a report shall include the following items:

a. No. of connections

b. Revenue by meter rents, services, water deposits and tariffs

c. fund for investment (rehabilitation and extension)

d. fund for operation and maintenance such as salary, electricity, chemicals, fuel and repair

(iii) The report on the staffing for Kapsabet Scheme Office after the commencement of the construction work to meet the man-power requirement. Such a report shall include the following items:

a. Schedule of staffing including deployment from other schemes of NWCPC

b. Qualification and estimated salary of each employee

c. Schedule and contents of training

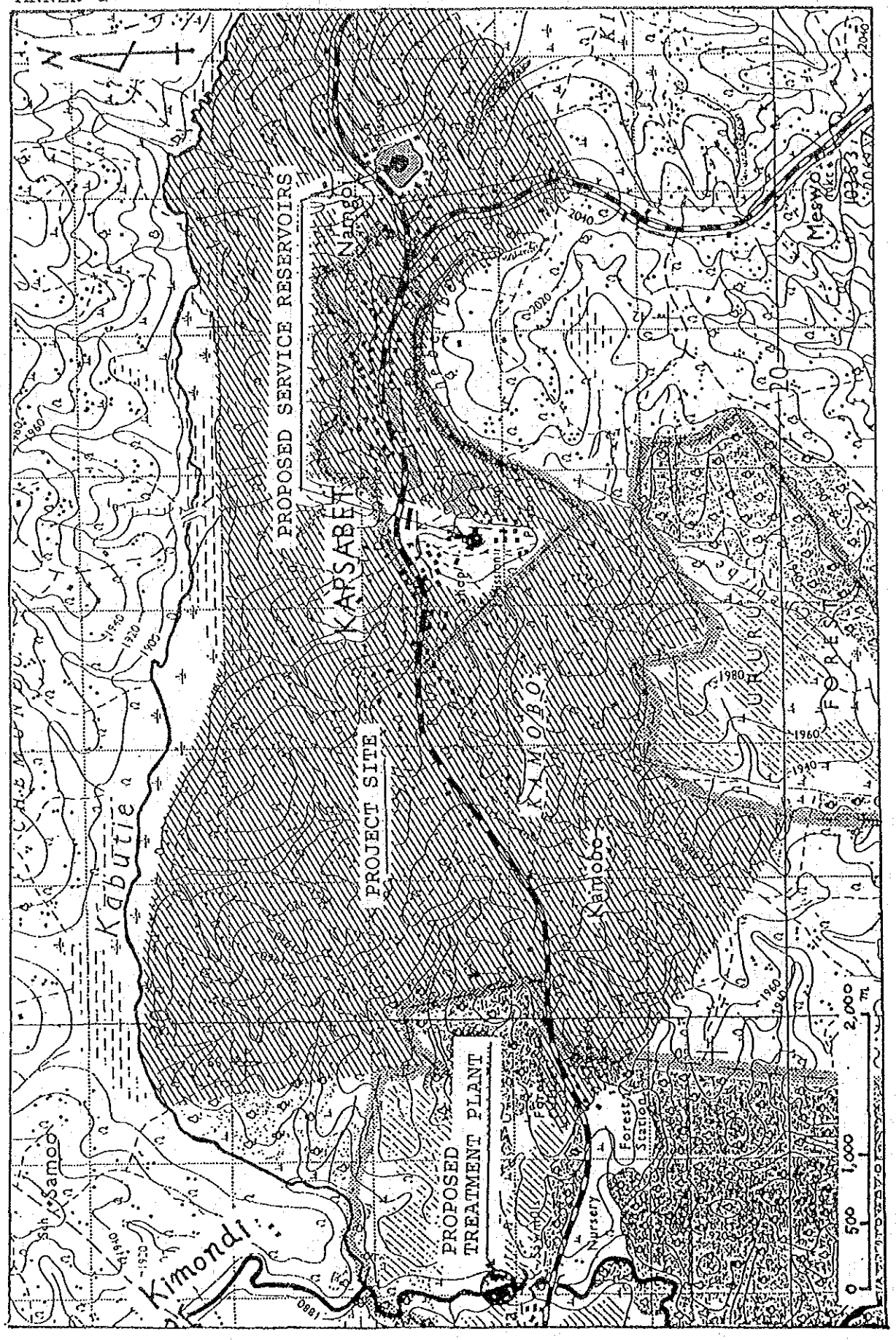
2. Environmental Consideration

Both parties have a great concern for environmental conservation in Kapsabet and the Government of Kenya shall take all necessary measures for environmental conservation in relation with the Project. However, in case established that the implementation of the Project will have an adverse effect on the environment, the Project might be suspended.

3. Undertakings by the Government of Kenya

The Government of Kenya will take necessary measures, described in Annex-II for smooth implementation of the Project, on condition that the Grant Aid Assistance by the Government of Japan will be extended to the Project.

ANNEX-I


PROPOSED SERVICE RESERVOIRS
PROJECT SITE
PROPOSED TREATMENT PLANT
KARSABET
KAMOBO
Kamobo
Nangoi
Kimondi
Kabutie
Samoo
Mesyo
FOREST
Forest Station
Nursery
0 500 1,000 2,000 m

ANNEX-II

Necessary measures to be taken by the Government of Kenya on condition that Japan's Grant Aid is extended.

(1) To secure the following sites, which will be indicated in the Final Basic Design Study Report, for construction of facilities and installation of pipes by the start of detailed design:
   a. site for water intake facilities
   b. site for raw water transmission pipe from the intake facilities to the water treatment plant
   c. site for water treatment plant
   d. site for treated water transmission pipe from the water treatment plant to the existing road, if necessary
   e. site for booster pumping station, if necessary
   f. site for service reservoir No. 1
   g. site for service reservoir No. 2
   h. any other sites that may be required

(2) a. To clear, level and reclaim the sites prior to commencement of the construction.
   b. To leave the disposal of those remaining within the proposed sites at the time of commencement of the construction work to the discretion of the Contractor.

(3) To construct gates and fences in and around the sites.

(4) To construct the access roads to the sites prior to commencement of the construction.

(5) To undertake the electrical work on the primary power distribution side from the existing power distribution end to the proposed sites for the intake facilities, treatment plant and, if necessary, the booster pumping station, by the commencement of construction work.

(6) To provide other incidental facilities, if necessary, in and around the sites.

(7) To bear the commissions to the Japanese foreign exchange bank for the banking services based upon the banking arrangement.

(8) To ensure tax exemption and custom clearance of the products at the port of disembarkation.

(9) 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 as may be necessary for their entity into Kenya and stay therein for the performance of their work.

(10) To exempt Japanese nationals from custom duties, internal taxes and other fiscal levies which may be imposed in Kenya with respect to the supply of the products and services under the verified contracts.

(11) To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant.

(12) 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 installation of the equipment.

(13) To assign the same engineer to the counterpart during the period of detailed design, the supervisor during the period of construction and the scheme manager of the Kapsabet Office after completion of the Project.

Appendix 5 Data

Data No.1 Water Sales and Production

Year	Month	Consumers			Water Sales				Water Production			Unacc.	Percent	Daily Average	
		Meter (Nos.)	Flat Rate (Nos.)	Total (Nos.)	Meter (cu.m)	Flat Rate (cu.m)	Asses. (cu.m)	Total (cu.m)	M. Meter (cu.m)	Waste W. (cu.m)	Avail. (cu.m)	(cu.m)	(%)	Produced (cu.m)	Sold (cu.m)
1989	7	589	75	664	21,692	1,350	5,250	28,492	30,486	725	29,761	1,269	4.2	983	919
	8	584	90	674	20,099	1,620	5,120	26,839	30,743	250	30,493	3,654	11.9	992	866
	9	591	85	676	17,354	1,530	5,630	24,514	29,008	290	28,718	4,204	14.5	967	817
	10	642	93	735	16,134	1,043	6,552	23,729	29,546	995	28,551	4,822	16.3	953	765
	11	585	101	686	19,354	1,618	7,328	28,500	32,908	675	32,233	3,733	11.3	1,097	950
	12	576	102	678	17,708	1,836	8,246	27,790	31,154	1,100	30,054	2,264	7.3	1,005	896
1990	1	594	93	687	20,836	1,674	7,250	29,760	31,449	350	31,099	1,339	4.3	1,014	960
	2	612	78	690	21,217	1,404	7,275	29,896	33,923	300	33,623	3,727	11.0	1,212	1,068
	3	626	72	698	17,762	1,296	7,200	26,258	33,072	540	32,532	6,274	19.0	1,067	847
	4	637	68	705	17,279	1,088	7,250	25,611	33,589	80	33,509	7,898	23.5	1,120	854
	5	678	22	700	18,951	1,260	7,150	27,361	33,271	180	33,091	5,730	17.2	1,073	883
	6	691	9	700	21,346	774	7,820	29,940	34,425	120	34,305	4,365	12.7	1,148	998
	Total				229,926	16,693	82,071	328,690	383,574	5,605	377,969	49,279	12.8	1,051	901
1990	7	650	44	704	17,933	792	7,350	26,075	33,681	200	33,481	7,406	22.0	1,086	841
	8	658	48	706	15,766	921	8,250	24,937	35,128	500	34,628	9,691	27.6	1,133	804
	9	658	50	708	21,740	900	6,525	29,165	33,014	450	32,564	3,399	10.3	1,100	972
	10	658	54	712	20,718	1,015	7,875	29,608	32,530	550	31,980	2,372	7.3	1,049	955
	11	680	50	730	18,500	957	7,323	26,780	33,614	330	33,284	6,504	19.3	1,120	893
	12	663	65	728	19,066	1,879	7,450	28,395	33,731	800	32,931	4,536	13.4	1,088	916
1991	1	663	65	728	22,135	1,223	5,885	29,243	31,878	675	31,203	1,960	6.1	1,026	943
	2	665	65	730	18,366	1,143	7,529	27,058	31,616	1,020	30,596	3,538	11.2	1,129	966
	3	699	65	764	15,432	1,271	8,925	25,628	29,735	1,230	28,505	2,877	9.7	959	827
	4	671	64	735	18,835	1,456	10,942	31,233	34,258	675	33,583	2,350	6.9	1,142	1,041
	5	671	64	735	15,675	1,364	9,785	26,824	32,616	1,875	30,741	3,917	12.0	1,052	865
	6	671	64	735	18,338	2,025	11,694	32,057	37,219	1,310	35,909	3,852	10.3	1,241	1,069
	Total				222,524	14,946	99,533	337,003	399,020	9,615	389,405	52,402	13.1	1,093	923
1991	7	666	65	731	17,588	2,067	8,243	27,898	32,713	900	31,813	3,915	12.0	1,055	900
	8	667	65	732	16,634	2,080	5,200	23,914	26,180	860	25,320	1,406	5.4	845	771
	9	666	65	731	17,943	3,060	6,580	27,583	30,247	900	29,347	1,764	5.8	1,008	919
	10	666	65	731	17,756	4,163	6,925	28,846	31,428	300	31,128	2,282	7.3	1,014	931
	11	666	65	731	16,741	4,189	6,704	27,634	29,988	300	29,688	2,054	6.8	1,000	921
	12	666	65	731	15,832	5,674	5,015	26,521	29,532	300	29,232	2,711	9.2	953	856
1992	1	666	65	731	15,608	7,123	4,957	27,688	30,209	600	29,609	1,921	6.4	974	893
	2	666	65	731	15,525	7,603	4,784	27,912	30,002	0	30,002	2,090	7.0	1,035	962
	3	666	65	731	15,325	5,789	3,640	24,754	25,718	0	25,718	964	3.7	830	799
	4	666	65	731	13,750	5,824	3,986	23,560	24,913	0	24,913	1,353	5.4	830	785
	5	666	65	731	13,725	6,013	2,947	22,685	27,065	300	26,765	4,080	15.1	873	732
	6	666	65	731	16,172	10,345	3,890	30,407	32,754	600	32,154	1,747	5.3	1,092	1,014
	Total				192,601	63,930	62,871	319,402	350,749	5,060	345,689	26,287	7.5	958	873
1992	7	666	65	731	15,237	9,045	3,615	27,897	28,926	0	28,926	1,029	3.6	933	900
	8	666	65	731	16,760	5,835	2,838	25,463	28,475	500	27,975	2,512	8.8	919	821
	9	666	65	731	15,940	5,632	2,113	23,685	26,162	600	25,562	1,877	7.2	872	790
	10	666	65	731	17,890	5,463	1,197	24,550	28,381	800	27,581	3,031	10.7	918	792
	11	660	65	731	10,545	3,456	2,748	24,749	26,936	700	26,236	1,487	5.5	898	825
	12	666	65	731	19,236	3,578	2,504	25,318	27,418	900	26,518	1,200	4.4	884	817
1993	1	666	65	731	21,385	4,790	1,667	27,842	30,505	900	29,605	1,763	5.8	984	898
	2	666	65	731	22,325	4,850	1,800	28,975	33,130	1,000	32,130	3,155	9.5	1,069	935
	3	675	256	931	16,975	3,640	1,385	22,000	24,700	700	24,000	2,000	8.1	797	710
	4	766	165	931	25,475	3,680	1,845	31,000	33,600	800	32,800	1,800	5.4	1,084	1,000
	5	766	165	931	24,537	3,570	1,673	29,980	32,400	900	31,500	1,500	4.6	1,045	967
	6	766	165	931	23,780	3,390	2,080	29,250	32,250	1,800	30,450	1,200	3.7	1,040	944
	Total				238,115	56,929	25,665	320,709	352,883	9,600	343,283	22,554	6.4	967	879

Note: The master meter was out of order on 29th December, 1992 and the figures in the colum of "M. Meter" has been estimated since that.

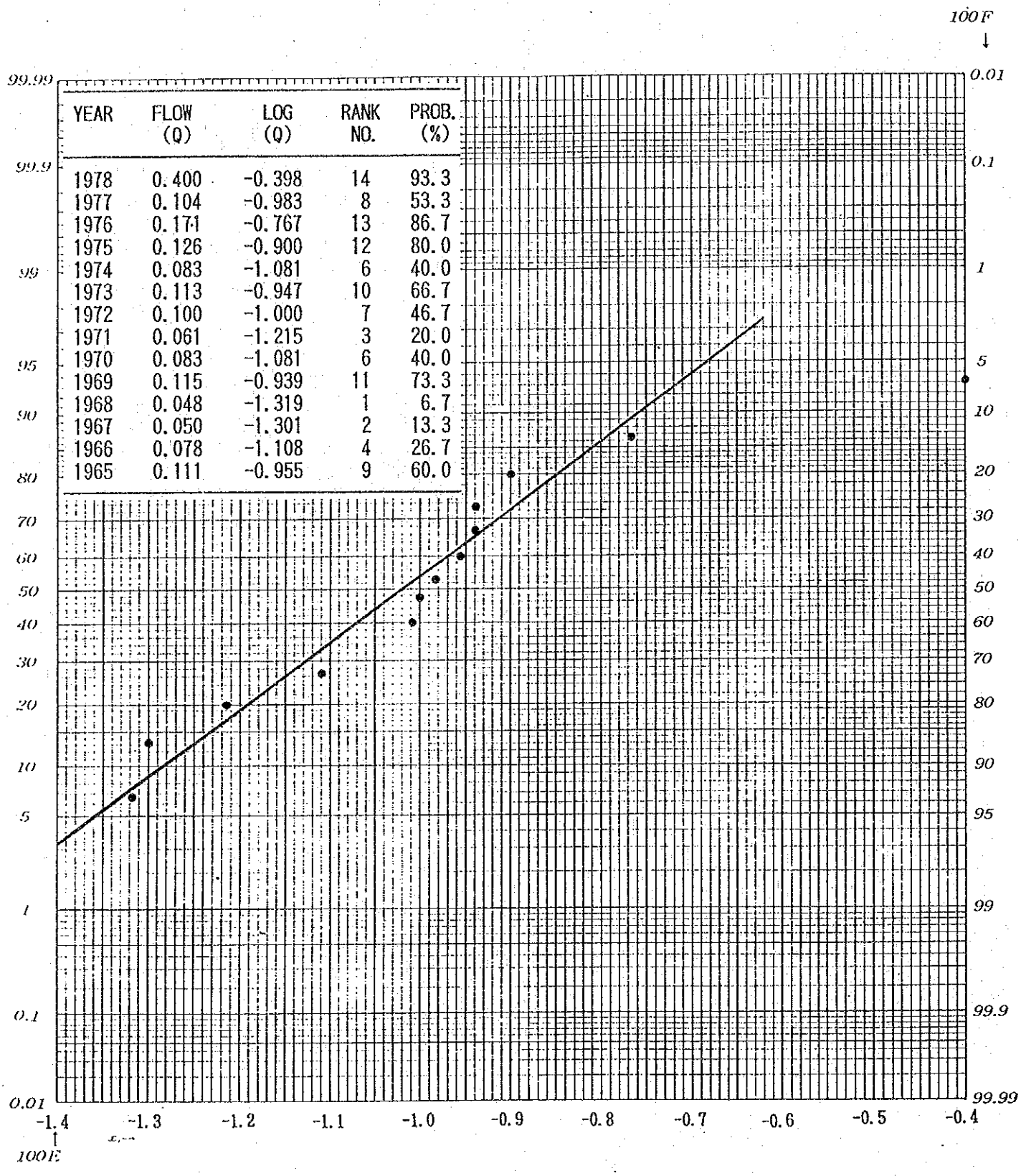
Data No.2 Meters Allocated to the Supply

Status	Size (mm)	1989 Dec.	1990 Jul.	1990 Dec.	1991 Jul.	1991 Dec.	1992 Jul.	1992 Dec.	1993 Jul.
On water supply	12								
	20								
	25								
	35	1	1	1	1	1			
	150	1	1	1	1	1	1	1	1
	Total	2	2	2	2	2	1	1	1
On connections	12	544	631	627	635	630	630	630	630
	20	25	29	25	25	25	25	25	25
	25	5	6	6	6	6	6	6	6
	35	2	5	5	5	5	5	5	5
	150								
	Total	576	671	663	671	666	666	666	666
Serviceable in Store	12	202							
	20								
	25		10	9	9	9	9	9	
	35								
	150								
	Total	202	10	9	9	9	9	9	0
Unserviceable	12		84	39	39	39	39	39	39
	20		2	2	2	2	2	2	2
	25		4	4	4	4	4	4	4
	35						1	1	1
	150	1	1	1	1	1			
	Total	1	91	46	46	46	46	46	46
Sent to Repair	12	165	165	210	210	210	210	210	210
	20								
	25								
	35								
	150						1	1	1
	Total	165	165	210	210	210	211	211	211
Total	12	911	880	876	884	879	879	879	879
	20	25	31	27	27	27	27	27	27
	25	5	20	19	19	19	19	19	10
	35	3	6	6	6	6	6	6	6
	150	2	2	2	2	2	2	2	2
	Total	946	939	930	938	933	933	933	924

Data No.3 Monthly Consumption by Bulk Consumers with Less than 1" Meter

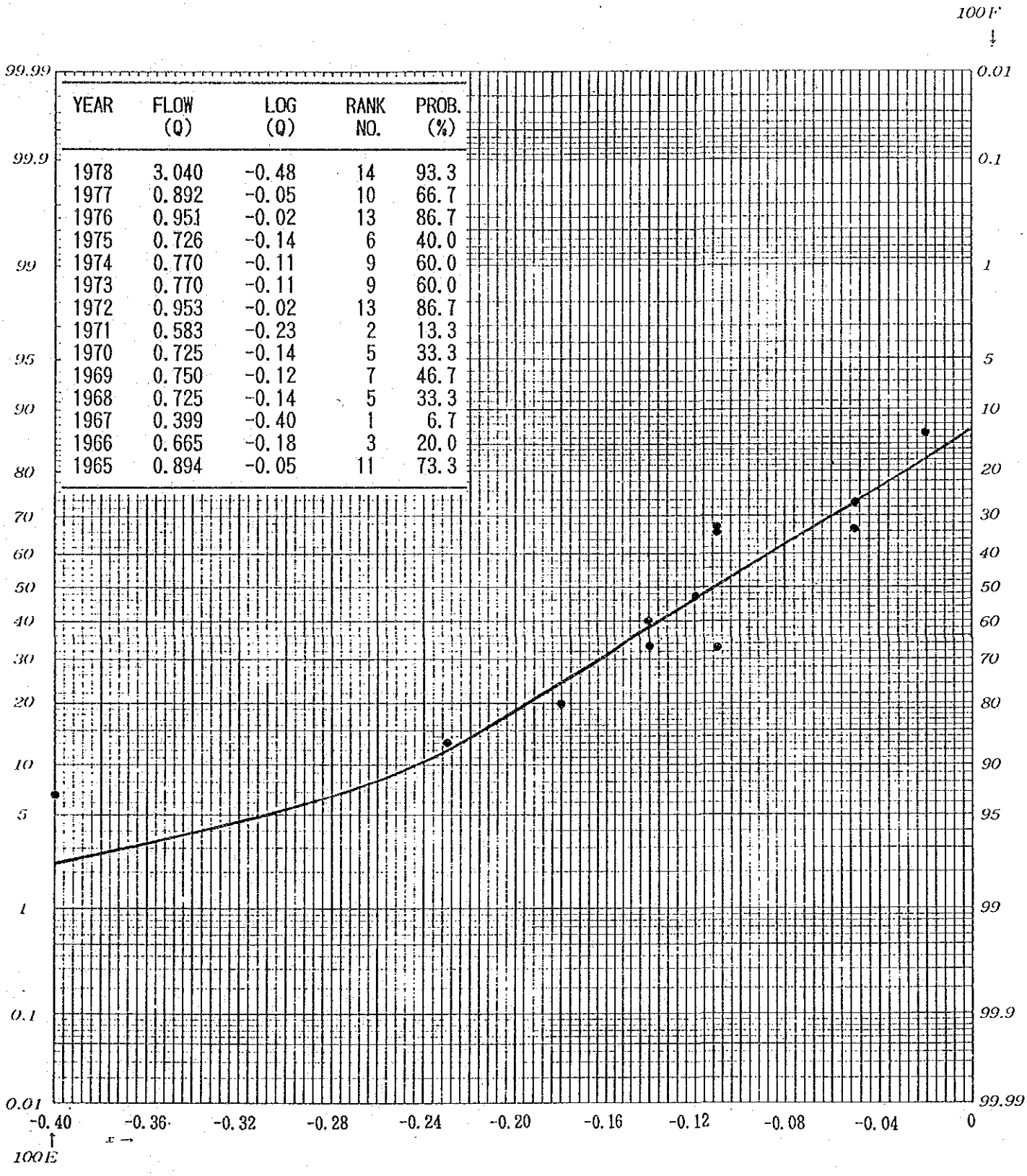
Name of Client	Meter Size	1992 Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	1993 Jan.	Feb.	Mar.	Apr.	May	Jun.	Total	Daily Average
District Hospital	1"	175	175	218	175	175	175	175	117	115	115	117	120	1,852	5.1
District Water Engineer Office	1"	29	20	129	64	77	77	75		4	9			484	1.3
Kapsabet Girls High School	1"	37	37		98	37	37	37	37	37	37	37	37	488	1.3
Chebut Tea Factory	1"	800	800	800	800	800	800							4,800	26.1
Christian Intermediate Technology Center	1"	224	279	291	182	214		200	162	61	220	313	264	2,410	6.6
D.C. Government Quarters	1"			Change to Flat Rate											
Kapsabet Town Council (Slaughter House)	1"	25	25	25	25	25	25	25	25	25	25	25	25	300	0.8
Intex Construction	1"			Not in Use at Present											
Kenya Commercial Bank	1"	119	101	93	93	93	93	93	93	93	93	93	93	1,150	3.2
Government of Kenya Kapsabet Prison	1-1/2"	138	138	138	138	138	138	138	138	138	138	138	138	1,656	4.5
Ministry of Health (Hospital)	2"	144	144	144	144	144	144	144	144	144	144	144	144	1,728	4.7
Ministry of Health (Hospital)	2"	466	431	534	501	253	424	569	211	299	295	397	438	4,818	13.2
Kenya Cooperative Creamery	2"	128	110	235	298	368	250	222	463	304	481	520	377	3,754	10.3
Kapsabet High School	2"	982	502	446	918	960	219	114	902	703	499	704	990	7,939	21.8

Data No.4 Provable Low-Water Flow of the Kabutie River



YEAR	FLOW (Q)	LOG (Q)	RANK NO.	PROB. (%)
1978	0.400	-0.398	14	93.3
1977	0.104	-0.983	8	53.3
1976	0.171	-0.767	13	86.7
1975	0.126	-0.900	12	80.0
1974	0.083	-1.081	6	40.0
1973	0.113	-0.947	10	66.7
1972	0.100	-1.000	7	46.7
1971	0.061	-1.215	3	20.0
1970	0.083	-1.081	6	40.0
1969	0.115	-0.939	11	73.3
1968	0.048	-1.319	1	6.7
1967	0.050	-1.301	2	13.3
1966	0.078	-1.108	4	26.7
1965	0.111	-0.955	9	60.0

Provable Low-Water Flow of the Kimondi River



YEAR	FLOW (Q)	LOG (Q)	RANK NO.	PROB. (%)
1978	3.040	-0.48	14	93.3
1977	0.892	-0.05	10	66.7
1976	0.951	-0.02	13	86.7
1975	0.726	-0.14	6	40.0
1974	0.770	-0.11	9	60.0
1973	0.770	-0.11	9	60.0
1972	0.953	-0.02	13	86.7
1971	0.583	-0.23	2	13.3
1970	0.725	-0.14	5	33.3
1969	0.750	-0.12	7	46.7
1968	0.725	-0.14	5	33.3
1967	0.399	-0.40	1	6.7
1966	0.665	-0.18	3	20.0
1965	0.894	-0.05	11	73.3

Data No.5 Water Quality of Possible Water Sources

Sampling Date		June 13,1993				June 26,1993	
		Kabutie	Kimondi Before Joining	Kimondi After Joining	Mokong	Kabutie	Kimondi
pH		6.50	6.60	6.62	6.60	6.80	6.75
TDS	mg/l	109.0	25.0	129.0	283.0	34.0	56.5
SS	mg/l						29.5
COD	mg/l						113.31
Total Hardness	mg/l	24.0	28.0	30.0	48.0	28.0	54.0
Nitrate	mg/l					5.297	4.397
Fluoride	mg/l					0.050	0.093
Chloride	mg/l					9.955	8.250
Sulphate	mg/l					3.492	3.492
Na	mg/l					540.0	610.0
Phenolic Substance	mg/l					1.247	1.415
CN	mg/l					0.155	0.153
As	mg/l					N.D.	N.D.
Cd	mg/l					N.D.	N.D.
Pb	mg/l					N.D.	N.D.
Se	mg/l					N.D.	N.D.
Cr	mg/l					N.D.	N.D.
Ba	mg/l					N.D.	N.D.
Al	mg/l					3.0	5.0
Cu	mg/l					N.D.	N.D.
Fe	mg/l	0.88	1.26	1.08	0.66	1.72	2.30
Mn	mg/l	N.D.	N.D.	N.D.	N.D.	0.01	0.01
Zn	mg/l					N.D.	N.D.
Mg	mg/l					0.09	0.12
Hg	mg/l					N.D.	N.D.
Conductivity	*1	62.0	51.0	54.0	105.0		
Alkalinity	mg/l	69.0	69.0	47.0	76.0		
NH3-N	mg/l	0.127	0.148	0.157	0.021		
NO2-N	mg/l	0.066	0.061	0.060	0.290		
NO3-N	mg/l	3.341	1.047	1.008	1.734		

N.D. Not detected

*1 micromhos/cm

Data No.6 Consumption of Chemicals, Fuels and Electricity

Year	Nonth	Chemicals			Fuel			Electric.
		Alum (kg)	Soda Ash (kg)	Bleaching (kg)	Diesel (l)	Lub. Oil (l)	Petrol (l)	(Units)
1989	7	1,578.0	118.5	84.631				19,478
	8	1,746.0	284.0	91.404				19,581
	9	1,560.0	832.0	90.560				18,292
	10	1,637.0	137.0	90.329				18,858
	11	1,713.0	500.0	100.936				20,257
	12	1,431.0		83.036				19,315
1990	1	1,732.0	200.0	81.925				19,523
	2	1,367.0	629.0	77.427				19,541
	3	1,635.0	618.0	75.417				18,398
	4	1,650.0	654.0	72.068	50.0			18,867
	5	1,691.0	630.0	67.142	18.0			19,343
	6	1,813.0	1,089.0	73.165	16.0			19,490
	Total	19,553.0	5,691.5	988.040	84.0	0.0	0.0	230,943
1990	7	2,138.0	801.0	84.552	16.0	1.0		19,427
	8	1,807.0	442.0	85.004				19,126
	9	1,791.0	516.0	80.595				18,557
	10	1,509.0	508.0	79.356				18,251
	11	1,604.0	532.0	82.880	50.0	1.0		18,833
	12	1,627.0	531.0	95.677				18,603
1991	1	1,536.0	534.0	75.972				17,164
	2	1,432.0	502.0	76.940				18,459
	3	1,278.0	435.0	73.350				17,144
	4	1,358.0	537.0	81.675				18,887
	5	1,266.0	328.0	75.505				19,095
	6	1,943.0	600.0	87.850				20,401
	Total	19,289.0	6,266.0	979.356	66.0	2.0	0.0	223,947
1991	7	1,970.0	512.0	79.120				18,775
	8	1,731.0	590.0	64.881				16,154
	9	1,963.0	596.0	96.537				18,206
	10	1,806.0	515.0	96.500				18,314
	11	1,166.0	437.0	72.000				19,815
	12	960.0	409.0	64.750				20,446
1992	1	1,085.0	435.0	73.000				20,503
	2	1,014.0	309.0	70.500				20,688
	3	890.0	60.0	68.000				19,050
	4	982.0	305.0	61.500				18,030
	5	1,085.0	334.0	63.000				16,959
	6	1,491.0	66.0	87.500				19,912
	Total	16,143.0	4,568.0	897.288	0.0	0.0	0.0	226,852
1992	7	1,260.0	291.0	51.900				17,900
	8	1,450.0	357.0	51.500				17,864
	9	1,305.0	332.0	91.500				16,581
	10	1,290.0	304.0	78.000				17,489
	11	1,183.0	321.0	62.400				18,394
	12	1,255.0	308.0	72.000				16,442
1993	1	1,200.0	299.0	84.500				18,563
	2	1,250.0	280.0	81.500				19,785
	3	1,155.0	246.0	75.500				19,895
	4	1,320.0	282.0	87.000				20,246
	5	1,310.0	290.0	86.000				19,141
	6	1,370.0	307.0	85.000				19,350
	Total	15,348.0	3,617.0	906.800	0.0	0.0	0.0	221,650