6.2 PROPOSED WATER SUPPLY SYSTEM

6.2.1 System 1

(1) General

System 1 would be installed in those areas having populations greater than 21,000 where the installation of System 3 (handpump type) would be difficult and where the infrastructure, such as roads and electricity supply facilities, were well developed.

(2) Population Served and Water Demand

System 1 would be introduced in the Muhazi and Sake area. The outline of the project in these area is shown below.

Table 6.3 Water demand(System 3)

Name of area	Served area (km2)	Population 2000	Density 2000 (persons/km2)	Water demand (m3/day)
MUHAZI	39.9	21,944	550	518.2
SAKE	54.1	33,865	626	774.9
Total	94.0	55,809	594	1,293.1

Note) Water demand = Average daily water consumption

(3) Water Source

Being difficult to utilize groundwater, it would be necessary to take water from the Muhazi and Sake lakes for both areas. Thus, water purification facilities would be installed in both areas.

In the Sake area, 200 m3/day of water would be taken from a spring. The water supply system of the Sake area would be a type that combines the use of spring water and lake water.

(4) System Component

The water supply system of System 1 was composed of the following 4 facilities.

- Intake Facilities
- Purification Facilities
- Transmission Facilities
- Distribution Facilities

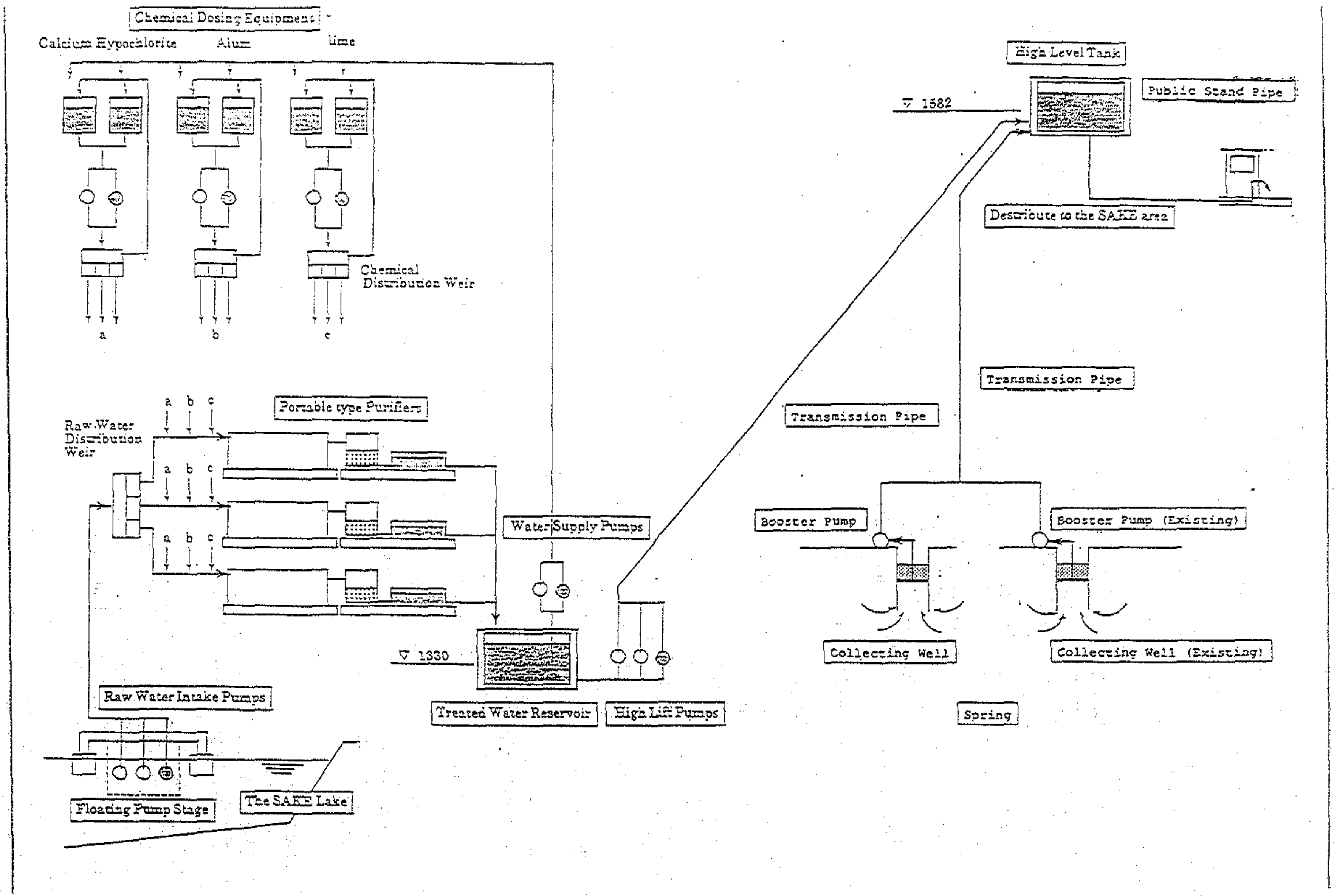


Fig. 6.1 Flow Diagram of Muhazi Area

Spring collecting facilities would be adopted as intake facilities in the Sake Area in addition to an intake from Lake Sake.

(5) Intake Facilities

1) Design Discharge of Intake Water

The design discharges of intake water were established as shown below taking into account the washing water of filtration materials.

(Unit: m3/day)

Water source	MUHAZI	SAKE
Lake water	660	760
Spring water	0	200
Total	660	960

2) Intake Method

The shores of lakes Muhazi and Sake were significantly contaminated by decomposed aquatic plants and algae. Therefore, floating-type intake facilities were to be used. Uncontaminated water would be taken: approximately 100 m off the shorelines.

The dimensions of floating type intakes were tabulated in the following table.

	MUHAZI	SAKE
Floating		
Pump:	4.0mx3.0mx1 set	4.0mx3.0mx1 set
Pump capa.:	0.23m3/mmx15mx1.5kw	0.27m3/minx15mx1.5kw
No. of pumps:	2 + 1 Reserve	2 + 1 Reserve

The spring collecting facilities of 100 m3/day capacity would be introduced in addition to the existing facilities having 100 m3/day capacity.

(6) Purification Facilities

1) Design Discharge of Purified Water

The design discharge of purified water were tabulated below:

(Unit:m3/day)

	MUHAZI	SAKE
Design Discharge of Purified Water	600	690

2) **Water Purification Method**

Since the water qualities in both areas were as shown below, it would be inappropriate to treat water by the slow sand filtration method. The rapid sand filtration method would be adopted.

- Turbidity was high.
- Contents of coliform group (100 ml MPN) were more than 1,000.
- Water contained a large amount of suspended particles of decomposed aquatic plants and algae.

3) **Type of Purification Facilities**

Portable-type purifiers having the following merits would be adopted. The features of the purifiers were summarized in Appendix M of Volume III.

- Functions of large scale water purification plant
- Easily installed
- Could be used in remote areas
- Simple operation
- Prompt delivery with low initial cost
- Low cost maintenance
- Automatic washing of filtration tank

4) **Component of Purification Facilities**

Purification facilities were composed of the following equipment.

- Raw water distribution tank
- Chemical dosing equipment (Al, CaOCl and Lime)
- Mixing tank (rapid and slow)
- Sedimentation tank with baffle board
- Rapid filtration equipment
- Washing water tank
- Treated water reservoir
- Pump facilities
- Treated water reservoir

Size, structure and dimensions of the equipment were presented in Appendix M of Volume III and the Drawings of Volume IV.

(7) Transmission Facilities

Transmission facilities were composed of high lift pumps and transmission pipes, the locations and alignments of which were shown on the Drawings of Volume IV.

1) High Lift Pump

A pump would be used to deliver water from the purification facilities to the distribution reservoir. A turbine pump suitable for high water heads would be installed.

The dimensions of pumps are shown below:

Water Resource	Item	MUHAZI	SAKE
Lake	Design discharge	600 m3/day	690 m3/day
	Pump capacity	0.21m3/min x 250m x 18.5kw	0.24m3/min x 300m x 30kw
	Number of pumps	2+1 Reserve	2+1 Reserve
Spring	Design discharge		200 m3/day
	Pump capacity		0.07m3/min x 100m
	Number of pumps		2

2) Transmission Pipe

Water hammer would occur in the pipeline due to the sudden stopping of the pump or by the quick closing or opening of the valve and the pipeline would be subjected to a strong instantaneous dynamic hydraulic pressure. Thus, piping material would be tough enough to resist the hydraulic pressures. For this reason, ductile cast iron pipe, that is strong, easy to install, and anticorrosive, would be used.

(8) Distribution Facilities

Distribution facilities were composed of the following 3 equipment.

- Distribution Reservoir
- Distribution Pipe
- Public Standpipe

1) Distribution Reservoir (High level tank)

It was proposed to convey water from the distribution reservoir to the public standpipes by gravity. Thus, the reservoir would be constructed at a high elevation. By taking into account the serving time (6:00 to 18:00) of the public standpipes, the reservoir would be capable of storing one half of the maximum daily supply amount. The design capacities of the reservoir were as given below:

	MUHAZI	SAKE
Design capacity	300 m3	Using existing facilities 350 m3

Rubble concrete type reservoirs would be employed, the locations, structures and dimensions of which were shown on the DRAWINGS of Volume IV.

2) Distribution Pipe

Polyvinyl chloride (PVC) pipe was economical and easy to install. It could be obtained in Rwanda and used for the distribution pipeline.

3) Public Standpipe

The service level of water distribution would be the public standpipe. So as to facilitate collection of a water fee, kiosks with public standpipes would be installed.

(9) Outline of Water Supply Facilities

Water Supply facilities of System 1 were outlined as the following.

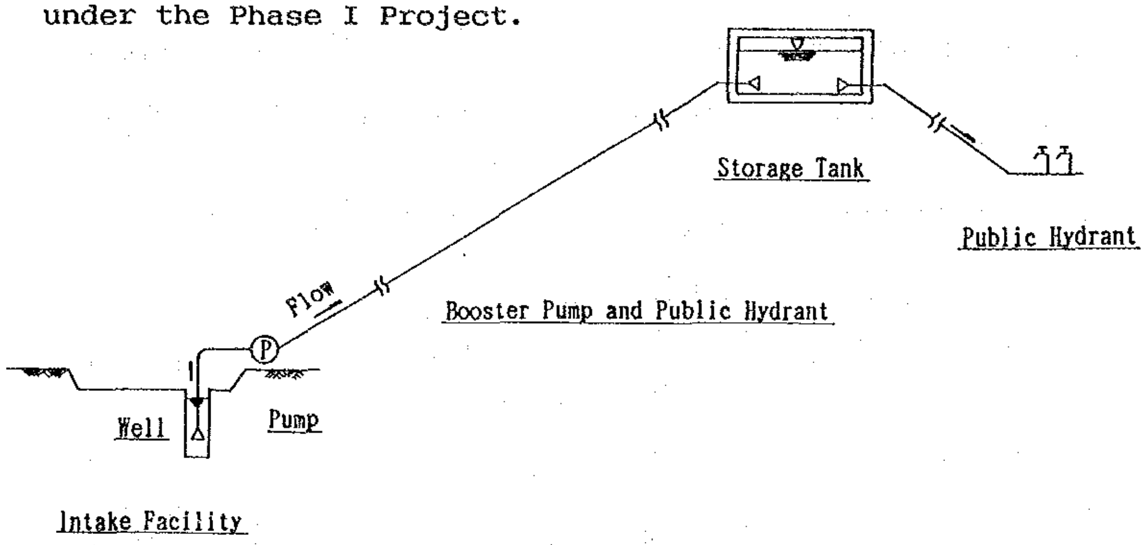
Table 6.4 Outline of Proposed Facilities(System 1)

	Muhazi	Sake	Total
Treatment Plant:	200 m3/d x 3 unit	250 m3/d x 3 unit	6 unit
Transmission Pipe:	DCIP 150 dia. 11,000 m	DCIP 150 dia. 7,000 m	DCIP 150 dia. 18,000 m
Reservoir:	300 m3 x 1	Existing	2
Distribution Pipe:	PVC 50-150 dia. 27,500 m	PVC 50-150 dia. 43,500 m	PVC 50-150 dia. 71,000 m
T.M. Line:	100 m	4,000 m	4,100 m

6.2.2 System 2

(1) General

System 2 was designed to utilize high quality spring water and pumped up groundwater without treatment. This System would be installed in highly populated areas where handpump installation (System 3) is difficult. This was the same type of system that was installed in Nyankora under the Phase I Project.



(2) Population Served and Water Demand

System 2 would be employed in the following eight (8) service blocks. Population served and water demand were tabulated in the following table:

Table 6.5 Water Demand (System 2)

Block Name	Served Area (km2)	Population 2000	Density 2000	Water Demand (m3/day)
KAYONZA-1	12.9	4,374	339	100.4
KAYONZA-2	8.2	3,508	428	80.3
RUTONDE	6.0	3,720	620	80.7
KABARONDO	15.7	5,956	379	133.3
BIRENGA	9.3	3,588	386	77.8
RUSUMO-1	15.0	7,300	487	172.2
RUSUMO-2	13.8	8,292	601	199.0
RUSUMO-3	21.3	7,278	342	170.5
Total	102.2	44,016	431	1,013.1
Average	12.8	5,500	430	127.0

Note) Water Demand = Average daily water consumption

(3) **Water Source**

The water source for System 2 would be mainly good quality groundwater with stable quantities.

In the Rusumo-3 Block, a spring (30 m3/day) used for an existing water supply system would be utilized as the water source. A 60 m deep, 8 inch diameter tube-well was planned to supply 166.1 m3/day of groundwater.

(4) **System Components**

The water supply systems of System 2 were composed of the following:

. Wells
. Pumping facilities
. Transmission pipes
. Distribution reservoir
. Public standpipes

(5) **Well**

1) **Location**

The potential areas to be developed were presented in "Classification of Groundwater Development Potential".

However, the drilling locations of wells would be determined at the most prospective points selected from the field geological survey including geophysical prospecting, at the implementation stage of the Basic Plan.

2) **Well Structure**

The hydrogeological condition at the shallow groundwater development areas was that unconfined groundwater was expected in the upper subsurface portion consisting of alluvium (20 m) and underlying weathered rock (40 m). The groundwater table was estimated at 20 m-GL and design drawdown at pumping duration was considered to be 10 m.

Thus, 60 m of well depth was recommended. Through the unconfined aquifer to a depth of 60 m, a well diameter of 6" (150 mm) was considered suitable due to the size of the installed pumping facilities and capacity of the drilling rig.

Since a filter thickness (gravel pack) would be required, over 40 mm, the drilling diameter would be more than 230 mm (9 1/2").

In addition, as groundwater in the upper subsurface of 20 - 30 m may be contaminated by surface water, the upper portion of the wells would be sealed by complete cementation.

The well structure was presented in the DRAWINGS of Volume IV.

(6) Pumping Facilities

Submersible motor pumps would be installed as the pumping facilities for System 2. The required head and discharge capacity were as given in Appendix M of Volume III.

Based on the results of the economic studies, it was decided to utilize electricity for the pumps in areas where the power supply extension from existing lines was less than 3.4 km. In areas where the power supply extension was more than 3.4 km, generator units would be used.

The pump selection procedure was presented in Appendix M of Volume III and the location, structure and dimensions of the pump facilities were presented in DRAWINGS of Volume IV.

(7) Other Facilities

Other facilities such as transmission pipes, distribution reservoirs and public standpipes were designed to a similar idea as System 1. The location, structure and dimensions were presented in DRAWINGS of Volume IV.

(8) Outline of Water Supply Facilities

Water supply facilities of System 2 were outlined in Table 6.6.

Table 6.6 Outline of System-2

Item	Unit	KAYONZA-1	KAYONZA-2	RUTONDE	KABARONDO	BIRENGA	RUSUMO-1	RUSUMO-2	RUSUMO-3	TOTAL
Maximum Daily Water Demand	m3/day	115.4	92.3	92.8	153.3	89.5	196.8	228.9	196.1	1,165.1
Discharge Capacity	l/min	80.1	64.1	64.4	106.5	62.1	136.7	159.0	136.2	-
Well Facilities	set	1	1	1	2	1	2	2	2	12
Number of Pumps	set	1	1	1	2	1	2	2	2	12
Total Head	m	180	220	125	185	220	180	250	185	-
Design Pumping Rate	l/min	100	120	100	85	115	85	110	85	-
Pump Load	kw	7.5	11	5.5	7.5	11	7.5	11	7.5	-
Power Sourse	nos	T.M.Line 1,800 m	T.M.Line 1,200 m	Generator 5.5kwx1	T.M.Line 1,800 m	Generator 11kwx1	Generator 7.5kwx2	Generator 11kwx2	Generator 11kwx2	T.M.L 4,800m Generator x8
Transmission Pipe	m	DCIP φ75 500	DCIP φ75 250	DCIP φ75 200	DCIP φ75 600	DCIP φ75 950	DCIP φ75 1,300	DCIP φ75 1,400	DCIP φ75 700	5,900
Reservoir Tank	unit	60m3x1	60m3x1	60m3x1	80m3x1	60m3x1	100m3x1	120m3x1	100m3x1	8 unit
Distribution Pipe (PVC)	m	φ30-75 9,620	φ30-50 8,050	φ30-50 3,730	φ30-75 6,780	φ30-50 7,600	φ30-75 13,100	φ30-100 18,200	φ30-100 23,650	90,730
Public Standpipe	nos	6	5	5	7	6	8	11	17	65

6.2.3 System 3

(1) General

System 3 was a handpump installation type. Its per capita capital cost and per household O/M cost would be less than those of Systems 1 and 2. Among the Systems that satisfied the basic development policy for the Basic Plan of the Project, System 3 was the most economical.

System 3 would be applied to all areas where shallow well construction was suitable.

(2) Population Served and Water Demand

System 3 would be applied to the following ten (10) communes. Population served and water demand in communes were as given below:

Table 6.7 Water Demand (System 3)

Commune	Service Area (km2)	Population 2000	Density 2000	Water Demand (m3/day)
RUKARA	158.4	27,428	173	507.0
MUHAZI	0	0	0	0
MUGESERA	127.4	51,802	407	886.9
SAKE	68.2	19,255	282	320.1
KAYONZA	63.1	14,423	229	232.0
RUTONDE	24.1	8,839	367	140.9
KABARONDO	33.7	10,173	302	161.5
KIGARAMA	142.9	26,231	184	470.4
RUKIRA	48.5	7,682	158	123.2
BIRENGA	78.4	17,242	220	287.6
RUSUMO	265.2	36,769	139	605.3
Total	1,009.9	219,844	218	3,734.9

(3) Well

1) Hydrogeological Classifications of Well Condition

Wells for System 3 would be drilled in suitable shallow groundwater development areas. These areas were classified, in view of hydrogeological condition, into the following groups (see the classification map of groundwater development potential):

Sa:	Suitable for a shallow groundwater development with lower limitations of both quantity and quality
Sb:	Moderately suitable for a shallow groundwater development with a low limitation of quantity but high limitation of quality
Sc:	Moderately suitable for a shallow groundwater development with a high limitation of drilling work
Sd:	Marginally suitable for a shallow groundwater development with limitations of quantity

Table M.8 of Appendix M (Volume III) listed the well conditions summarized for each sector of which the total of Phase III Basic Plan is shown below:

Well condition	Number of wells
Sa	194
Sb	87
Sc	45
Sd	151
Total	477

2) Well Type

The following 2 types of well would be adopted for System 3 based on the hydrogeological study, condition of existing wells and results of test drilling.

Well type	Well condition	Borehole depth	Static water level	Dynamic water level
I	Sa,Sc,Sd	50 m	GL-20.0 m	GL-27.5 m
II	Sb	60 m	Gl-20.0 m	GL-30.0 m

3) Well Structure

A diameter of 4" (100 mm) of well casing was proposed on account of the size of pumping facilities. As a filter thickness (gravel pack) was required, more than 30 mm, the drilling diameter would be over 160 mm (6 2/5").

According to the same conditions of groundwater contamination in the upper subsurface, as for System 2 motor pump wells, the upper portion of the wells would be sealed by complete cementation.

The well structure was given in the DRAWINGS of Volume IV.

(4) Manual Pump

1) Type of Pump

Bellows type handpumps which had the following advantage, would be adopted as the manual pump for System 3.

- The head in the standard specification is to be 30 meters and 50 meters maximum.
- Since the pump head is covered with a cap, it can be protected against the intrusion of foul materials any troubles caused by like children's mischief.
- In order to reduce labor, it uses oilless metals at the frictionable parts and the power transmission adopts the cable, so that even woman or child can easily operate in case of considerable low water level.
- The pedestal of pump head is designed to be able to install not only onto small diameter tube well, but also onto large diameter hand dug well.

2) Design Pumping Rate

The smaller figure of the well safe yield and the pumping rate of a manual pump were adopted as the design pumping rate of this project.

(Unit: m3/day)

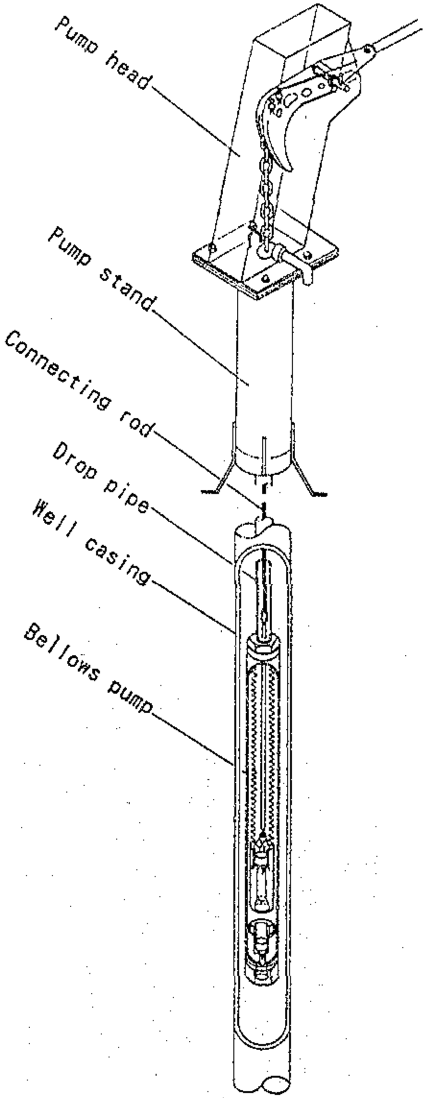
Well condition	Safe yield of well	Pumping rate of manual pump	Design pumping rate
Sa,Sb,Sc	77	10	10
Sd	8	10	8

The pumping rate of a pump is:

1,400 l/hr x 12 hr x 60% = 10 m3/day

(5) Ancillary Facilities

The ancillary facilities would be composed of a wash area around the well, drainage ditch, planks and so on. The structure was presented in DRAWINGS of Volume IV.



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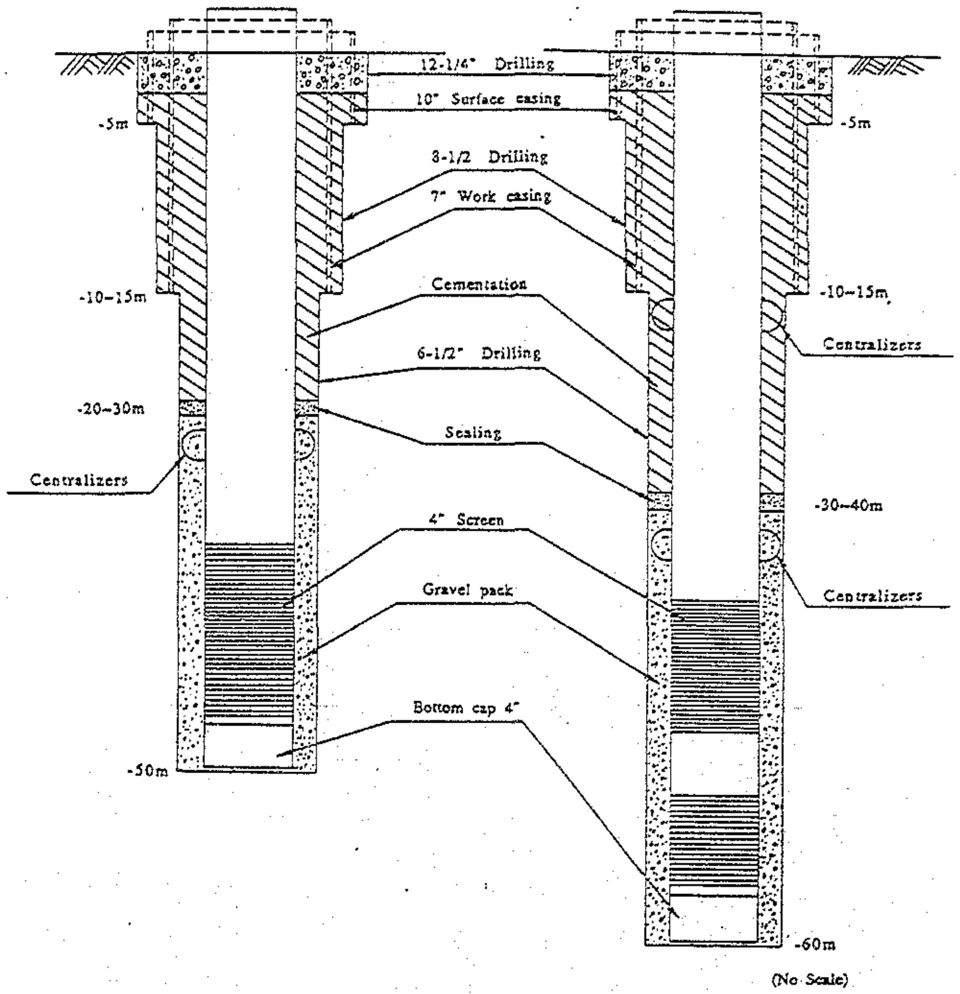


Well Structure

For "Sa", "Sb" and "Sc" For "Sd"

Fig. 6.2 Typical Section of Water Well

(6) **Outline of Water Supply Facilities**

The water supply facilities of System 3 were outlined as the following.

Table 6.8 Outline of System 3

Commune Name	Area	50m depth well	60m depth well	Manual pump
Rukara	160 km2	51	12	63
Mugesera	130 km2	103	9	112
Sake	70 km2	38	4	42
Kayonza	70 km2	11	17	28
Rutonde	25 km2	9	8	17
Kabarondo	35 km2	14	6	20
Kigarama	145 km2	39	18	57
Rukira	50 km2	16	-	16
Birenga	80 km2	20	13	33
Rusumo	265 km2	89	-	89
Total	1,030 km2	390	87	477

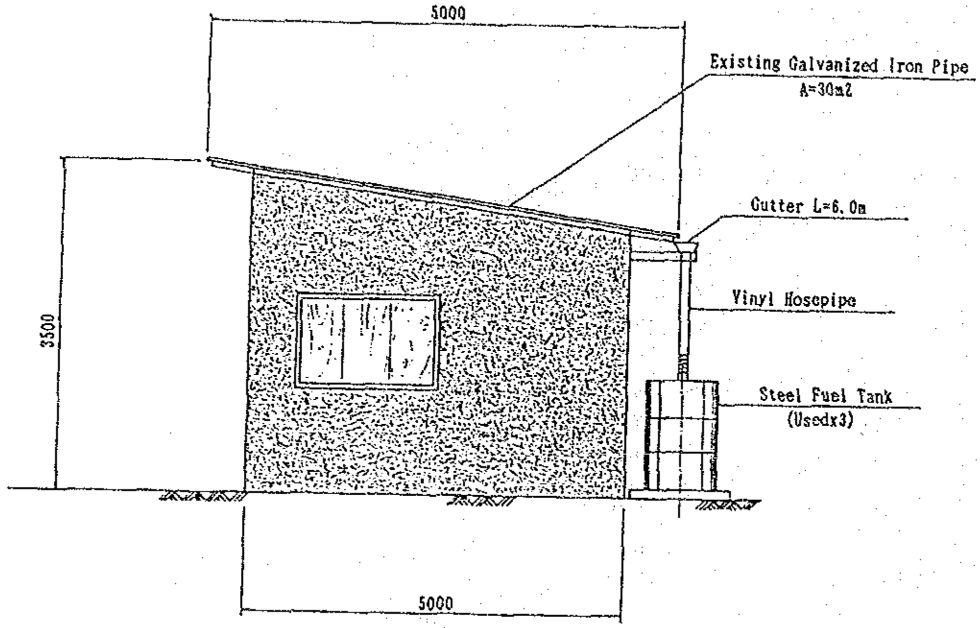
6.2.4 System 4

(1) **General**

System 4 was a rainwater harvesting system employing the roof catchment method. This System would be installed in sparsely populated hilly areas where the installation of System 3 (handpump type) would be difficult.

If more than 30 m2 of roof area was available, it would be possible, except during the dry season (June through August), to obtain 80 liters/household/day of water which satisfied the basic development policy. To satisfy the policy during the dry season, it would be necessary to install large capacity reservoir tanks and provide measures for retaining the water quality. The cost of such an installation would be too high.

In view of the above background, the reservoir tank capacity was decided upon by setting the per capita water supply amount at 3 liters/person/day which was considered as the minimum demand to secure human life. As System 4 facilities would be installed at each household, the rainwater harvesting method would be adopted.



Proposed Rainwater Harvesting System

(2) Service Area and Population Served

The outline of the project in the area where System 4 would be installed was as shown below:

Table 6.9 Service Area and Population (System 4)

Commune	Service Area (km2)	Population 2000	Number of family 2000
RUKARA	47.4	8,566	1,430
MUHAZI	0.0	0	0
MUGESERA	0.0	0	0
SAKE	0.0	0	0
KAYONZA	96.9	4,453	743
RUTONDE	3.1	902	151
KABARONDO	40.0	5,092	850
KIGARAMA	30.2	3,632	606
RUKIRA	41.1	3,959	663
BIRENGA	26.3	3,862	645
RUSUMO	202.0	19,564	3,263
Total	487.0	50,030	8,351

(3) **Water Balance of Standard System**

The typical house in the Study Area had an average roof area of 30 m2. The water balance of rainwater harvesting on a roof was as shown in the following Table. To secure a minimum of 3 liters/person/day of water during the dry season, it would be necessary to install a 600 liter capacity tank at each household.

Table 6.10 Water Balance for System 4

Month	Monthly precipi-tation (mm)	Average discharge collected water (l/day)	Minimum Water demand per family during the dry season (June-Aug.) (l/day/f)	Amount of water shortage during the dry season (June-Aug.) (l/day/f)	Required capacity of reservoir tank
1	84.5	74			
2	72.5	70			
3	152.3	133			
4	160.9	145			
5	79.8	70			
6	10.5	9	18	9	270
7	9.2	8	18	10	310
8	20.6	18	18		
9	49.6	45			
10	78.3	68			
11	149.8	135			
12	80.3	70			
Total	948.3	70.4			580

Note: - Roof area was 30 m2 which was the average of the dwellings in Kibungo Prefecture
- Harvest rate = 0.9

(4) **Extension Program**

The material cost of System 4 for a standard family was as shown below:

Material	Quantity	Amount (FRW)
Steel fuel tank (used)	3 unit	6,000
Collection pipe	5 m	5,000
Gutter	3 m	900
Total		11,900

Taking account of the water supply costs to be borne by the residents and the residents' awareness of the water supply system, the extension program of water supply systems was proposed as follows:

1) The residents would bear one half of the material costs and engage in the installation work.

2) The Government would bear the remaining half of the material costs and provide the residents with the technical guidance necessary for system installation.

3) By considering the income levels of the residents, they would pay the following costs:

   . For the first month after system installation : 1,200 FRW

   . From the 2nd month through the 25th month : 200 FRW

4) The Government would select the number of households for system installation that could be financed by its available budgetary fund.

(5) **Outline of Water Supply Facilities**

Water supply facilities of System 4 were outlined as the following.

Table 6.11 Outline of System 4

Commune Name	Area	Rainwater harvesting facility
Rukara	50 km2	1,430
Kayonza	100 km2	743
Rutonde	5 km2	151
Kabarondo	40 km2	850
Kigarama	30 km2	606
Rukira	40 km2	663
Birenga	25 km2	645
Rusumo	200 km2	3,263
Total	490 km2	8,351

CHAPTER 7

IDENTIFICATION OF POSSIBLE PROJECT SCHEME

7.1. GENERAL

Although the Government of Rwanda had a basic policy that aimed at complete supply of drinking water for all of the people within this century, it would seem difficult, in view of the financial conditions, to complete all projects of the Basic Plan by the year 2000.

Even if sufficient funding for the Basic Plan was raised, it would not be feasible from the viewpoint of Governmental policy to invest it during a nine (9) year period only on the Kibungo Prefecture's water supply project.

Thus, in view of the country's overall water supply improvement plan, it was considered to be more realistic to select the higher priority projects that were proposed in the Basic Plan and implement them according to their order of priority.

7.2. FINANCIAL LIMITATION FOR PROJECT IMPLEMENTATION

7.2.1 Reasonable Project Cost

In general, if the construction costs of water supply projects in a developing country had to be compensated by fees collected from water recipients, clean water would never be supplied to the residents, due to their low incomes and inability to pay. Therefore, the construction costs would be borne either by the Government or by financial aid provided by developed countries.

According to the Evaluation Report for the Third National Development Plan (MINIPLAN), the investment amount for the field of rural water supply during the plan period was as shown in Table 7.1. The mean annual increase rate of the investment amount was 16 percent and that between 1984 and 1986 was 12 percent.

Table 7.1 Invested Money For Rural Water Supply Field

(unit : million FRW)

	1982	1983	1984	1985	1986	Total
Invested Amount	341.5	256.3	554.0	339.2	664.6	2,155.6
Price Index	110.9	127.8	134.7	135.1	128.3	
Invested Amount in Real Value	284.8	200.5	411.3	251.1	518.0	1,665.7
Annual Increase rate			20.2%		12.2%	16.1%

Note: Price index for 1980 was 100.

According to the data above, it is adequate to consider in the Study, for the period after 1986, an inflation rate of investment for rural water supply field as 10%.

Based on the 1986 investment amount of 664.6 million FRW and by assuming an annual increase rate of investment after that year as being "10 percent", the total investment amount for the Rural Water Supply Project in the Eastern Region during Phase III Project period (1992 - 2000) was estimated to be around 16,000 million FRW as shown in Table 7.2.

Table 7.2 Estimate of Investment Amount for the Rural Water Supply Field during the Project Period

(Unit: million FRW)

Year	Base Cost	Growth Index	Investment Amount	Accumulated Investment Amount
1986	664.6	1.000		
1992		1.772	1,177.7	1,177.7
1993		1.949	1,295.3	2,473.0
1994		2.144	1,424.9	3,897.9
1995		2,358	1,567.1	5,465.0
1996		2.594	1,724.0	7,189.0
1997		2.853	1,896.1	9,085.1
1998		3.138	2,085.5	11,170.6
1999		3.452	2,294.2	13,464.8
2000		3,797	2,523.5	15,988.3

The population which should be provided with new rural water supply was obtained as in Table 7.3 and that in Kibungo Prefecture was estimated as 17.9% (224,700) of the whole country.

In view of Rwanda's financial situation, the upper limit of the investment amount for the Rural Water Supply Project (Phase III), in the Eastern Region, was calculated by taking into consideration the delay of the rural water supply development in Kibungo Prefecture. Considering the population in need of rural water supply, the investment amount for the entire country's rural water supply during the Phase III Project period obtained in Table 7.2 (16 billion FRW) was divided. Upper limit of the investment amount for the Phase III Project in Kibungo Prefecture is estimated as below:

16,000 million FRW x 17.9% = 2,864 million FRW
= 2.9 billion FRW

Table 7.3 Rural Water Supply Rate and Population to be provided with Rural Water Supply in Each Prefecture

Name of Prefecture	Population	Water Supply Rate(%)	No Water Supply Rate(%)	Number of People to be provided with New Water Supply Facilities
Butare	746,600	78	22	164,300 (13.1%)
Byumba	590,200	79	21	123,900 (9.9%)
Cyangugu	407,200	73	27	109,900 (8.8%)
Gikongoro	460,000	83	17	78,200 (6.2%)
Gisenyi	584,000	77	23	134,300 (10.7%)
Gitarama	731,300	76	24	175,500 (14.0%)
Kibungo	416,200	46	54	224,700 (17.9%)
Kibuye	372,700	78	22	82,000 (6.5%)
Ruhengeri	667,000	76	24	160,000 (12.8%)
Total	4,975,200			1,252,800 (100 %)

Notes: 1) Population figures are based on MINAGRI's Data
2) Water supply rates are based on MINITRPEE's DATA
3) Kigali Prefecture, where urbanization had progressed considerably, was excluded from the investment area for rural water supplies.

7.2.2 Maximum Cost for Each Project

The Basic Plan would consist of many independent projects. Thus, by assuming the case that each of the independent projects would be implemented as a slight project, the reasonable maximum cost of a single project was to be established.

Major water supply projects in Rwanda were implemented with financial aid provided by developed countries and international organizations. The costs of recently completed water supply projects were as shown in Appendix O of Volume III(Supporting Report).

Except for the project in Kigali, the cost of each project was less than US$5 million. Of all the rural water supply projects, the largest was the Phase I Project implemented with grant aid cooperation from the Government of Japan -- the cost was US$4.14 million.

Based on the above viewpoint, the reasonable maximum cost of a single project was thought to be US$ 4 million.

7.3. IDENTIFICATION OF THE POSSIBLE PROJECT SCHEME

7.3.1 Basic Concept for the Selection of the Possible Project Scheme

In general, a priority project was selected based on the following criteria:

I: In view of basic human needs, priority would be given to the development of the following areas where:

- the water source was contaminated and the occurrence rate of water-bone disease was very high.
- residents had to rely on a traditional type of water source.
- rural development was still in a primitive stage.

II: In view of the independent management capabilities of the residents, priority would be given to the development of the following areas where:

- the residents had a good understanding of the private and public water supply projects.
- residents had a willingness to participate in project implementation and management work.
- project facility O/M work would be easy and the costs low.

III: Priority would be given to a project that is economical and feasible.

- A project not having a high cost and where grant aid from an international institution could be expected.
- An area where the infrastructure was relatively well-developed and where it would be easy to carry out project construction.
- A project whose per capita construction cost and facility O/M cost were low.

For the water supply systems proposed in the Basic Plan, it would be difficult to adopt the same service level and the same water fee rate due to differences of water sources and area conditions. Therefore, when selecting a possible water supply project, it was necessary to examine the service level and water fee rate by placing emphasis on the above mentioned priority levels of "I", "II" and "III". The basic concept for project selection was as follows:

System 1 & 2 : Power and chemical cost were required and, as a result, the per household O/M cost would become high. Thus, the residents' awareness of the water supply system and their financial capability to pay the water fees would be a very important factor. For system selection, emphasis would be placed on "II" and, particularly, "III".

System 3 & 4 : The initial costs and the O/M costs for these systems were lower than for Systems 1 and 2. Thus, for system selection, emphasis would be placed on "I" and "II".

7.3.2 Examination of Project Priority

(1) Examination Basis and Procedures

For selection, the following items were examined for each water supply service block:

- The natural conditions of the area:
  Water quality, amount of available water, effects on construction work.
- Present water supply conditions:
  Type of existing water sources, spring distribution pattern, existing water supply systems' water supply rates.
- Social conditions:
  Existing health and hygiene related facilities, such as hospitals and health centers, and the area's development potential.
- Economy and ease of operations and maintenance:
  Per capita construction cost, operation and maintenance cost, and operation and maintenance organization.

Each item was classified into three levels: easy to difficult; high demand to very little demand; advantageous to disadvantageous(see Table 7.4). The examination results were given in Tables 7.5 and 7.6.

(2) Project Priority in Systems 1 and 2 Areas

In the Basic Plan, a total of 10 projects were proposed for System 1 and System 2 areas: 2 projects in System 1 areas; 8 projects in System 2 areas. These projects were classified into the following three categories according to their priority level:

A: Very high priority project that was desired to be implemented as soon as possible.

- Kayonza-1 (System 2)
- Kayonza-2 (System 2)
- Kabarondo (System 2)

B: High priority project that was desired to be implemented after "A".

- Muhazi (System 1)
- Sake (System 1)

Table 7.4(1) Evaluation Points for Priority Project Selection (System 1 and 2 Areas)

Check Item	Evaluation Point: a	Evaluation Point: b	Evaluation Point: c
1. Quality of Water Source	Shallow well suitable area categories Sa, Sc, and Sd	Shallow well suitable area category Sb	--
2. Quantity of Water Source	Shallow well suitable are categories Sa, Sb, and Sc	--	--
3. Electricity Service	Within 1.5 km from existing electricity supply lines	About 1.5 to 3.4 km from existing electricity supply lines	More than 3.4 km from existing electricity supply lines (generator use)
4. Access Road	High density of existing road network	Medium density of existing road network	Low density of existing road network
5. Existing Water Source	Surface water (lake, river)	Surface water and spring	Spring
6. Rate of Spring Yield	Less than 10 $m^3/day/km^2$	10 to 30 $m^3/day/km^2$	More than 30 $m^3/day/km^2$
7. Supply Rate of Safe Water	Less than 30%	30 to 60%	More than 60%
8. Number of Beneficiaries	More than 5,000	3,000 to 5,000	Less than 3,000
9. Hospital and Health Centre	A hospital or health centre exists	A nursery centre or DP exists	None
10. Community Potential	H, D, LT	V_{s1}, V_{s2}	V_f
11. Initial Cost per Capita	Less than US $100	US $100 to US $150	More than US $150
12. Per Household Operation & Maintenance (O/M) Cost	Less than US $1.0	US $1.0 to US $1.5	More than US $1.5
13. Participation of Area Residents	Area residents' willingness to participate in the project is high	Area residents' willingness to participate in the project is average	Area residents' willingness to participate in the project is low
14. O/M Organization	Easy to establish an O/M organization	Relatively easy to establish an O/M organization	Difficult to establish an O/M organization

Table 7.4(2) Evaluation Points for Priority Project Selection (System 3 Areas)

Check Item	Evaluation Point: a	Evaluation Point: b	Evaluation Point: c
1. Quality of Water Source	Shallow well suitable area categories Sa, Sc, and Sd	Shallow well suitable area category Sb	--
2. Quantity of Water Source	Shallow well suitable area categories Sa, Sb, and Sc	--	Shallow well suitable area category Sd
3. Drilling Conditions	Shallow well suitable area category Sa	Shallow well suitable area categories Sb and Sd	Shallow well suitable area category Sc
4. Access Road	Good road condition	Need to widen existing road	No access road exists
5. Existing Water Source	Surface water	Surface water and spring	Spring
6. Rate of Spring Yield	Less than 10 $m^3/day/km^2$	10 to 30 $m^3/day/km^2$	More than 30 $m^3/day/km^2$
7. Supply Rate of Safe Water	Less than 30%	30 to 60%	More than 60%
8. Hospital and Health Centre	A hospital exists	A health centre exists	None
9. Community Potential	H, D, LT, V_{s1}	V_{s2}	V_f
10. Initial Cost per Capita	Less than US $80	US $80 to US $150	More than US $150
11. Per Household Operation & Maintenance (O/M) Cost	Less than US $0.25	US $0.25 to US $0.30	More than US $0.30
12. Participation of Area Residents	Area residents willingness to participate in the project is high	Area residents' willingness to participate in the project is average	Area residents' willingness to participate in the project is low
13. O/M Organization	Commune has an O/M organization	Commune has a willingness to establish O/M organization	Low willingness to establish O/M organization

Table 7.5 Selection of Priority Block for Systems 1 and 2

Commune	Name of Service Block	Secteure	Natural and Construction Conditions					Needs of Safe Water (Existing Water Supply Conditions)				Social Conditions				Economy and O/M Conditions					Rank of Priority
			① Quality of Water Source	② Quantity of Water Source	③ Electrification	④ Access	Over-all Eva.	⑤ Existing Water Source	⑥ Density of Spring	⑦ Service Percentage of Safe Water	Over-all Eva.	⑧ Scale of Beneficiaries	⑨ Hospital Health Center	⑩ Development Potential	Over-all Eva.	⑪ Initial Cost per Capita	⑫ O/M Cost per Family	⑬ Participation of Local People	⑭ O/M Organization	Over-all Eva.	
System-1	MUHAZI				◎	◎	A	◎	◎	◎	A	◎	◎	◎	A	○	○	◎	◎	B	B
	SAKE				○	○	B	◎	◎	◎	A	◎	◎	◎	A	○	○	◎	◎	B	B
System-2	KAYONZA-1	Kyonza	◎	○	○	◎	A	◎	◎	◎	A	○	△	◎	B	○	◎	◎	◎	A	A
	KAYONZA-2	Nyamirama Syogo	◎	◎	◎	△	A	◎	◎	◎	A	○	△	◎	B	○	◎	◎	◎	A	A
	RUTONDE	Rweru	◎	◎	△	△	C	○	○	◎	B	○	△	△	C	◎	△	◎	◎	C	C
	KABARONDO	Nkamba Buramira Ruyonza	◎	◎	○	△	B	○	○	○	B	◎	△	○	B	◎	◎	◎	◎	A	A
	BIRENGA	Ndamira	◎	◎	△	◎	B	○	○	◎	B	○	△	○	B	○	△	◎	◎	C	C
	RUSUMO-1	Gatore Kirehe	◎	◎	△	△	C	◎	◎	△	B	◎	○	◎	A	◎	△	◎	○	C	C
	RUSUMO-2	Nyarubuye	◎	◎	△	△	C	◎	◎	○	A	◎	◎	◎	A	○	△	◎	○	C	C
	RUSUMO-3	Nyamugali	◎	◎	△	○	B	◎	◎	◎	A	◎	△	△	C	○	△	◎	○	C	C

Table 7.6(1) Selection of Priority Block for System 3 (2/1)

Commune	Secteure	Potential Class and No. of Well	Natural Conditions: Ground Water ① Quality	Natural Conditions: Ground Water ② Quantity	Natural Conditions: ③ Drilling Condition	Natural Conditions: ④ Access	Natural Conditions: Overall Eva.	Needs of Safe Water (Existing Water Supply Conditions): ⑤ Existing Water Source	Needs of Safe Water: ⑥ Density of Spring	Needs of Safe Water: ⑦ Service Percentage of Safe Water	Needs of Safe Water: Overall Eva.	Social Conditions: ⑧ Hospital Health Center	Social Conditions: ⑨ Development Potential	Social Conditions: Overall Eva.	Economic and O/M Conditions: ⑩ Initial Cost per Capita	Economic and O/M Conditions: ⑪ O/M Cost per Family	Economic and O/M Conditions: ⑫ Participation of Local People	Economic and O/M Conditions: ⑬ O/M Organization	Economic and O/M Conditions: Overall Eva.	Rank of Priority
RUKARA	GAHINI	Sa - 12	◎	◎	◎	△	C	◎	◎	△	C	◎	◎	A	○	○	◎	◎	B	C
	KIYENGI	Sa - 6	◎	◎	◎	△	C	◎	◎	◎	A	△	○	B	◎	◎	◎	◎	A	C
	NYAKABUNGO	Sa - 5	◎	◎	◎	○	A	○	◎	◎	B	△	△	C	◎	◎	○	◎	A	B
	NYWERA	Sa - 8	◎	◎	◎	◎	A	○	◎	◎	B	△	○	B	◎	◎	○	◎	A	A
	RUKARA	Sb - 12	○	◎	○	○	B	○	◎	○	B	◎	◎	A	○	◎	◎	◎	A	A
	RWIMISHINYA	Sa - 6	◎	◎	◎	◎	A	○	◎	◎	B	△	△	C	◎	◎	◎	◎	A	B
	RYAMANYONI	Sd - 14	◎	△	○	◎	C	○	◎	◎	B	△	○	B	△	△	◎	◎	C	C
MUGESERA	CTIZIHARA	Sd - 8	◎	△	○	◎	C	○	◎	◎	B	△	△	C	○	◎	○	◎	B	C
	GATARE	Sd - 9	◎	△	○	◎	C	◎	◎	◎	A	△	△	C	○	◎	◎	○	B	C
	KAGASHI	Sd - 11	◎	△	○	○	C	◎	◎	◎	A	△	△	C	○	◎	◎	○	B	C
	KAREMBO	Sa - 1	◎	◎	◎	△	C	○	△	△	C	△	◎	A	◎	◎	○	◎	A	C
	KIBARE	Sd - 10	◎	△	○	◎	C	○	○	◎	B	△	○	B	○	◎	○	◎	B	C
	KIBIUZI-L	Sb - 9	○	◎	○	◎	B	○	○	○	B	△	△	C	○	◎	○	◎	B	C
	KIRAMBO	Sd - 7	◎	△	○	○	C	◎	△	◎	C	△	○	B	○	◎	◎	◎	A	C
	KUKABUYE	Sa - 5	◎	◎	◎	◎	A	○	○	○	B	△	◎	A	◎	◎	○	◎	A	A
	MATONGO	Sd - 7	◎	△	○	◎	C	◎	◎	◎	A	△	○	B	○	◎	◎	◎	A	B
	NGARA	Sa - 7	◎	◎	◎	○	A	○	◎	◎	B	△	○	B	◎	◎	○	◎	A	A
	NYANGE	Sd - 8	◎	△	○	○	C	◎	◎	◎	A	○	○	A	○	○	◎	◎	B	B
	SANGAZA	Sd - 9	◎	△	○	◎	C	◎	◎	◎	A	△	○	B	○	◎	◎	◎	A	B
	SHYWA	Sd - 8	◎	△	○	○	C	○	△	○	C	△	△	C	○	◎	○	◎	B	C
	ZAZA	Sd - 13	◎	△	○	◎	C	○	△	◎	C	◎	◎	A	△	△	◎	◎	C	C
SAKE	MBUYE	Sb - 4	○	◎	○	○	B	◎	◎	△	C	△	○	B	○	◎	◎	◎	A	C
	MURWA	Sd - 13	◎	△	○	○	C	◎	○	◎	C	◎	◎	A	○	◎	◎	◎	A	B
	RUKUMBERI	Sd - 13	◎	△	○	○	C	◎	◎	◎	A	△	○	B	○	◎	◎	◎	A	B
	SHOLI	Sd - 12	◎	△	○	◎	C	◎	◎	◎	A	△	△	C	○	◎	◎	◎	A	B
KAYONZA	GASOGI	Sb - 5	○	◎	○	△	C	○	◎	◎	B	△	△	C	○	◎	○	○	B	C
	MBURABUTUR	Sb - 3	○	◎	○	○	B	○	◎	◎	B	△	△	C	◎	◎	○	○	B	C
	MUSUMBA	Sa - 3	◎	◎	◎	△	C	○	◎	◎	B	△	○	B	◎	◎	○	○	B	C
	NYAMIRAMA	Sa - 4	◎	◎	◎	△	C	○	◎	◎	B	△	◎	A	◎	◎	○	○	B	B
	RUTARE	Sb - 6	○	◎	○	◎	B	○	◎	◎	B	△	△	C	○	◎	○	○	B	C
	RWINKWAVU	Sa - 2	◎	◎	◎	◎	A	○	◎	◎	B	◎	◎	A	△	△	○	○	C	B
	SHYOGO	Sb - 3	○	◎	○	○	B	◎	◎	◎	A	△	◎	A	○	◎	○	○	B	A
RUTONDE	KADUHA	Sa - 3	◎	◎	◎	○	A	◎	△	○	C	△	△	C	○	◎	◎	◎	A	B
	RUTONDE	Sa - 6	◎	◎	◎	◎	A	◎	○	○	B	△	◎	A	◎	◎	◎	◎	A	A
	RWERU	Sb - 2	○	◎	○	◎	B	◎	○	◎	B	△	△	C	○	◎	◎	◎	A	C
	SOVU	Sb - 6	○	◎	○	◎	B	◎	△	○	C	△	△	C	○	◎	◎	◎	A	C

Table 7.6(2) Selection of Priority Block for System 3 (2/2)

Commune	Secteure	Potential Class and No. of Well	Natural Conditions: Ground Water ① Quality	Natural Conditions: Ground Water ② Quantity	③ Drilling Condition	④ Access	Over-all Eva.	Needs of Safe Water (Existing Water Supply Conditions): ⑤ Existing Water Source	⑥ Density of Spring	⑦ Service Percentage of Safe Water	Over-all Eva.	Social Conditions: ⑧ Hospital Health Center	⑨ Develop-ment Potential	Over-all Eva.	Economic and O/M Conditions: ⑩ Initial Cost per Capita	⑪ O/M Cost per Family	⑫ Participation of Local People	⑬ O/M Organi-zation	Over-all Eva.	Rank of Priority
KABARONDO	BISENGA	Sa - 4	◎	◎	◎	△	C	◎	◎	◎	A	△	○	B	◎	◎	◎	○	A	B
	MURAMA	Sa - 2	◎	◎	◎	○	A	◎	◎	◎	A	△	○	B	◎	◎	◎	○	A	A
	NKAMBA	Sa - 2	◎	◎	◎	◎	A	○	○	○	B	△	◎	A	◎	◎	○	○	B	A
	RURAMIRA	Sb - 4	○	◎	○	△	C	○	◎	◎	B	△	◎	A	○	◎	○	○	B	C
	RUSERA	Sa - 4	◎	◎	◎	△	C	○	○	◎	B	△	○	B	◎	◎	○	○	B	C
	RUYONZA	Sa - 2	◎	◎	◎	△	C	○	○	◎	B	△	△	C	◎	◎	○	○	B	C
	SHYANDA	Sb - 2	○	◎	○	○	B	◎	◎	○	B	△	△	C	○	◎	◎	○	B	C
KIGARAMA	GASETSA	Sa - 3	◎	◎	◎	△	C	◎	◎	△	C	△	△	C	△	△	○	○	C	C
	GASHANDA	Sa - 5	◎	◎	◎	○	A	◎	◎	○	B	△	○	B	◎	◎	◎	○	A	A
	KABARE-1	Sa - 4	◎	◎	◎	△	C	○	○	○	B	◎	◎	A	○	○	○	◎	B	C
	KABARE-2	Sa - 10	◎	◎	◎	◎	A	◎	◎	◎	A	△	○	B	○	○	○	○	B	A
	KABERANGWE	Sb - 3	○	◎	○	○	B	◎	◎	△	C	△	△	C	○	◎	◎	○	B	C
	KANSANA	Sa - 5	◎	◎	◎	△	C	○	○	○	B	△	○	B	◎	◎	○	○	B	C
	REMERA	Sb - 4	○	◎	○	△	C	◎	◎	◎	A	△	◎	A	○	◎	◎	○	B	B
	RUBONA	Sb - 11	○	◎	○	△	C	◎	◎	◎	A	△	△	C	○	◎	○	○	B	C
	RURENGE	Sa - 4	◎	◎	◎	△	C	◎	◎	△	C	△	△	C	◎	◎	◎	○	A	C
	VUMWE	Sa - 8	◎	◎	◎	△	C	◎	◎	◎	A	△	△	C	◎	◎	○	○	B	C
RUKIRA	GASIRU	Sd - 4	◎	△	○	◎	C	○	◎	○	B	○	○	A	○	◎	○	○	B	B
	GITWE	Sc - 4	◎	◎	△	◎	B	○	◎	△	C	△	◎	A	○	◎	◎	○	B	C
	MUSHIKILI	Sc - 4	◎	◎	△	△	C	○	◎	○	B	△	△	C	○	◎	○	○	B	C
	NTARUKA	Sc - 1	◎	◎	△	◎	B	○	◎	△	C	△	△	C	△	△	○	○	C	C
	RUGARAMA	Sc - 3	◎	◎	△	△	C	○	○	◎	B	△	△	C	◎	◎	○	○	B	C
BIRENGA	BARE	Sa - 3	◎	◎	◎	◎	A	○	○	△	C	○	◎	A	○	○	◎	◎	B	B
	BIRENGA	Sa - 3	◎	◎	◎	△	C	○	◎	◎	B	△	○	B	○	◎	◎	◎	A	C
	GAHARA	Sb - 7	○	◎	○	△	C	◎	◎	○	B	○	○	A	○	◎	○	○	B	C
	GAHULIRE	Sa - 3	◎	◎	◎	○	A	○	○	△	C	△	◎	A	◎	◎	○	◎	A	B
	GASHONGORA	Sa - 4	◎	◎	◎	○	A	◎	◎	△	C	△	△	C	◎	◎	○	○	B	C
	KIBAYA	Sb - 6	○	◎	○	△	C	○	△	◎	C	△	◎	A	○	◎	○	○	B	C
	KIBIMBA	Sa - 3	◎	◎	◎	△	C	◎	○	○	B	△	△	C	◎	◎	○	○	B	C
	SAKARA	Sa - 4	◎	◎	◎	○	A	○	○	△	C	△	◎	A	◎	◎	○	○	B	B
RUSUMO	GATORE	Sc - 6	◎	◎	△	◎	B	◎	◎	○	B	△	○	B	○	◎	○	○	B	C
	KANKOBWA	Sa - 30	◎	◎	◎	○	A	◎	◎	◎	B	△	△	C	△	△	◎	○	C	B
	KIGARAMA	Sa - 6	◎	◎	◎	◎	A	◎	◎	○	B	△	○	B	◎	◎	○	○	B	B
	KIGINA	Sa - 11	◎	◎	◎	○	A	○	◎	○	B	◎	◎	A	◎	◎	◎	○	A	A
	KIREHE	Sa - 4	◎	◎	◎	○	A	○	◎	○	B	○	◎	A	◎	◎	◎	○	A	A
	MUSAZA	Sc - 11	◎	◎	△	◎	B	○	◎	○	B	△	○	B	◎	◎	◎	○	A	B
	NYABITARE	Sc - 9	◎	◎	△	△	C	○	◎	◎	B	△	△	C	◎	◎	○	○	B	C
	NYAMUGALI	Sd - 5	◎	△	○	△	C	◎	◎	◎	A	△	○	B	○	○	◎	○	B	C
	NYARUBUYE	Sc - 7	◎	◎	△	△	C	○	◎	◎	B	△	◎	A	○	◎	○	○	B	C

C: A project requiring the installation of generator units. Facility operation and maintenance costs would be high, and it was desirable to implement the project after completing the electrical facility development.

. Rutonde (System 2)
. Birenga (System 2)
. Rusumo-1 (System 2)
. Rusumo-2 (System 2)
. Rusumo-3 (System 2)

(3) Priority Projects in System 3 Areas

The priority projects in System 3 areas were classified into the same three categories as for the Systems 1 and 2 areas. The categories were as follows:

A: Very high priority project that was desired to be implemented as soon as possible.
B: High priority project that was desired to be implemented after "A".
C: Project for which construction would possibly present some difficulties.

Priority	Number of Wells
A	75
B	153
C	249
Total	477

7.3.3 SELECTION OF POSSIBLE PROJECT SCHEMES

The possible project schemes were selected by taking into account the upper limit of their total construction costs from the high priority projects (Priority A and/or B) examined in Section 7.3.2. They were listed as Table 7.7.

Table 7.7 List of Possible Project Scheme

System	Project/ Area Name	Area (km2)	Served Population	Note
1	MUHAZI	39.9	21,944	Priority B
	SAKE	54.1	33,865	" B
	sub-total	**94.0**	**55,809**	
2	KAYONZA-1	12.9	4,374	Priority A
	KAYONZA-2	8.2	3,508	" A
	KABARONDO	15.7	5,956	" A
	sub-total	**36.8**	**13,838**	
3	Well of Priority A	168.9	37,868	75 wells
	Well of Priority B	359.6	65,026	153 wells
	sub-total	**528.5**	**102,894**	**228 wells**
	Total	**659.3**	**172,541**	

CHAPTER 8

IMPLEMENTATION PROGRAM AND COST ESTIMATE

8. IMPLEMENTATION PROGRAM AND COST ESTIMATE

8.1 EXECUTING AGENCY

The Directorate General of Water (DGW), The Ministry of Public Works, Energy and Water (MINITRAPPE), would be the executing agency for implementation of the project and it was proposed that an Implementation Office (RWI/ER Office) of Rural Water Supply Project in Eastern Region (RWSP/ER) would be established under the administration of the DGW for the smooth and effective execution of The Basic Plan.

The RWI/ER Office will have three(3) divisions at full development stage and the necessary works would be conducted by six(6) staff members, as shown in the Figure below:

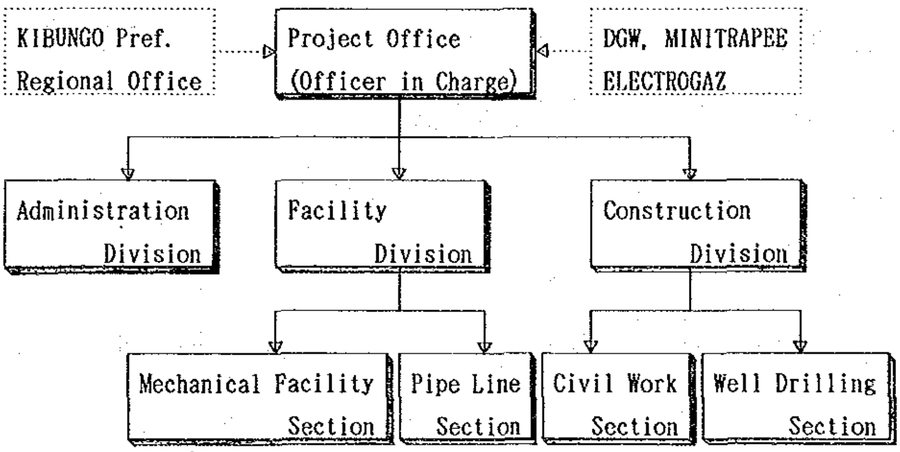


Fig. 8.1 Project Implementation Office

- Officer in Charge	1	Overall supervision and management
- Civil/Water Supply Engineer	1	Engineering and supervision of civil works
- Facilities Engineer	1	Engineering and supervision
- Asst. Engineer	2	For well construction and water supply facilities
- Secretary	1	
(- Driver)	(2)	

8.2 FINANCING

The foreign currency portion and some parts of local currency of the Basic Plan would be financed by the international financing institutions. While, 40 to 60% of the local currency portion would be provided by the Government of Rwanda.

Furthermore, it was recommended that a few portions(10 to 20 %) of local currency would be covered by construction works of the beneficiaries' voluntary service.

8.3 IMPLEMENTATION SCHEDULE FOR THE BASIC PLAN

Since GOR had a basic policy which aimed at complete supply of drinking water for all of the people within this century, the implementation schedule of the Basic Plan would be made to complete all project components by the year 2000.

The implementation schedule was formulated on a target of completion within nine (9) years between 1992 and 2000; the first year for mainly preparatory work and four (4) Packages; Package A of 1993 to 1994, Package B of 1995 to 1996, Package C of 1997 to 1998 and Package D of 1999 to 2000, were proposed on account of the large project scale, long project period and smooth/effective execution.

The implementation schedule of the Basic Plan was given in Fig 8.2, and estimated populations served at each package of the Project were as presented in the table below.

	Package A	Package B	Package C	Package D	Total
System 1	21,944	33,865	0	0	55,809
System 2	13,838	0	14,608	15,570	44,016
System 3	37,868	65,026	58,475	58,475	219,844
System 4	12,507	12,507	12,507	12,509	50,030
Total	86,157	111,398	85,590	86,554	369,699

Implementation Schedule for the Basic Plan

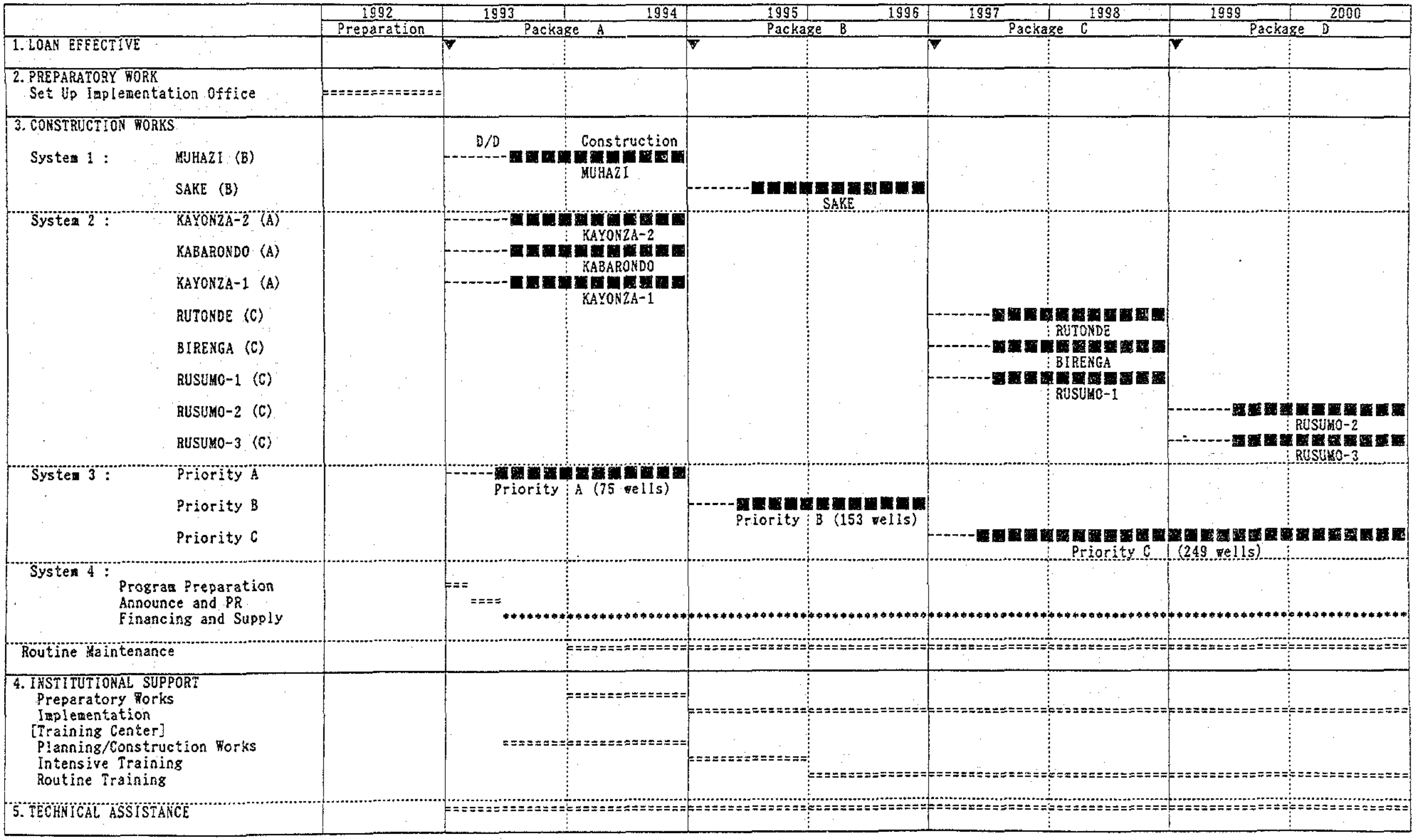


Fig. 8.2 Implementation Schedule for the Basic Plan

8.4 PROJECT COST OF THE BASIC PLAN

8.4.1 Conditions of Cost Estimate for the Basic Plan

For estimating the project costs of the Basic Plan, the basic unit prices of construction work items in 1990 were multiplied by the inflation rates to obtain the August 1, 1991 unit prices.

Construction Cost

Construction works would be carried out on a contract basis. Construction cost was estimated based on unit costs for individual working items. The L/C portion was estimated on the basis of the current price in Rwanda and the F/C portion estimated on the CIF price at Kigali.

Overheads and profits, which equaled 20% of the direct cost in total was included in each unit price.

Exchange Rate

US$1.00 equals to FRW 128 and to J.Yen 135 (the official exchange rate in August, 1991).

Indirect Cost

Engineering and administration costs were necessary expenditures for detailed design, preparation of tender documents, tendering, tender evaluation and construction works supervision.

Physical Contingency

The physical contingency related to the construction and indirect cost was set at 15% of the cost.

Price Contingency

The price escalation was assumed as 4% for both the foreign and local currency portions.

8.4.2 Project Cost of the Basic Plan

The project cost of the Basic Plan at current prices (August, 1991) was estimated at 5.2 billion FRW (41 million US$), excluding price contingency, the O/M cost and institutional supporting cost. The breakdown was given in Table 8.1 and Its disbursement schedule shown in Table 8.3.

Table 8.1 Project Cost of the Basic Plan

	(Unit: millon FRW)
1. Construction Cost	
System 1	846.6
System 2	583.2
System 3	2,570.9
System 4	99.4
Sub-total	4,100.1
2. Indirect Cost	
Administration	26.0
Engineering Service	410.0
sub-total	436.0
3. Physical Contingency (1+2)x15%	680.4
4. Total	5,216.5

The construction cost of each package was as given in Table 8.2.

Table 8.2 Construction Cost of Each Package

(Unit: 1000 FRW)

System	Package A	Package B	Package C	Package D	Total
1	404,875	441,716	0	0	846,591
2	200,672	0	169,996	212,561	583,229
3	376,333	791,334	841,942	561,296	2,570,905
4	24,840	24,840	24,840	24,841	99,361
Total	1,006,720	1,257,890	1,036,778	798,698	4,100,086

The construction cost of each system was:

System 1 -- 847 million FRW(6.6 million US$),
System 2 -- 583 million FRW(4.6 million US$) and
System 3 -- 2,571 million FRW(20.1 million US$)
(System 4 -- 99 million FRW).

Table 8.3 Disbursement Schedule of the Basic Plan

(Unit : 1000 FRW)

		Prep'n	Package A		Package B		Package C		Package D		Total
		1992	1993	1994	1995	1996	1997	1998	1999	2000	
1. Construction Cost(C/C)											
System 1	MUHAZI		161,950	242,925							404,875
	SAKE				176,686	265,030					441,716
System 2	KAYONZA-2		30,722	46,084							76,806
	KABARONDO		27,952	41,929							69,881
	KAYONZA-1		21,594	32,391							53,985
	RUTONDE						14,150	21,224			35,374
	BIRENGA						21,266	31,897			53,163
	RUSUMO-1						32,583	48,876			81,459
	RUSUMO-2								43,124	64,687	107,811
	RUSUMO-3								41,900	62,850	104,750
System 3	Priority A		188,166	188,167							376,333
	Priority B				395,667	395,667					791,334
	Priority C						491,133	350,809	280,648	280,648	1,403,238
System 4			12,420	12,420	12,420	12,420	12,420	12,420	12,420	12,421	99,361
Sub-total			442,804	563,916	584,773	673,117	571,552	465,226	378,092	420,606	4,100,086
2. Administration Cost		7,332	2,332	2,332	2,332	2,332	2,332	2,332	2,332	2,332	25,988
3. Engineering Service (10% of C/C)			44,280	56,392	58,477	67,312	57,155	46,523	37,809	42,061	410,009
4. Total Base Cost(B/C) 1+2+3		7,332	489,416	622,640	645,582	742,761	631,039	514,081	418,233	464,999	4,536,083
5. Physical Contingency(15% of B/C)		1,100	73,412	93,396	96,837	111,414	94,656	77,112	62,735	69,750	680,412
6. Total (4+5)		8,432	562,829	716,036	742,420	854,175	725,695	591,193	480,968	534,748	5,216,495
7. Price escaration ratio (%)		4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	
8. Accumurated ratio		1.0400	1.0816	1.1249	1.1699	1.2167	1.2653	1.3159	1.3686	1.4233	
9. Grand Total (6x8)		8,769	608,756	805,443	868,526	1,039,234	918,236	777,969	658,238	761,114	6,446,285

The construction cost per one person in each system was:

System 1 -- 15,169 FRW (119 US$),
System 2 -- 13,250 FRW (104 US$) and
System 3 -- 11,694 FRW (91 US$).

The development cost per water demand(m3) in each system was:

System 1 -- 654,700 FRW(5,115 US$),
System 2 -- 575,700 FRW(4,498 US$) and
System 3 -- 688,300 FRW(5,377 US$).

In addition, the portions for the voluntary service activities by residents was estimated in Appendix Q and outlined as below:

System 1 : 18 % of L/C(10 % of total cost)
System 2 : 12 % of L/C(7 % of total cost)
System 3 : 7 % of L/C(3 % of total cost)

8.5 IMPLEMENTATION PLAN OF THE POSSIBLE PROJECT SCHEME

It would not be realistic to complete all of the individual projects proposed in the Basic Plan for Phase III Project by the year 2000 from the viewpoints of project financing, and the operation and maintenance systems of the facilities. Therefore, a stagewise development would be recommended.

Thus, the implementation program of the overall project in the Basic Plan for the Phase III Project was to be conducted in the following five stages. The overall implementation program for stagewise development was planned as shown in Table 8.4.

Phase III-A : Initial Phase
Phase III-B : Consolidation I Phase
Phase III-C : Review Phase
Phase III-D : Consolidation II Phase
Phase III-E : Self-help Operation Phase (Completion Stage)

During the Phase III-A and III-B periods, the Possible Project Scheme would be implemented in order of priority and communications between the government offices and the area resident would be enhanced.

During Phase III-C, evaluation of the implemented Possible Project Scheme during Phase III-A and III-B periods would be carried out. During the Phase III-D period, deferred projects of the Basic Plan after the year 2000 would be implemented. Finally, Phase III-E was the completion stage of the Phase III Project.

Therefore, the schedule of the Possible Project Scheme was based on a target of completion within nine (9) years between 1992 and 2000, as given in Fig 8.3. The first year was mainly for preparatory work and the remaining years were divided into four (4) packages. Package A from 1993 to 1994, Package B from 1995 to 1996, Package C from 1997 to 1998 and Package D from 1999 to 2000.

-Package A: (1993-1994)
System 2 (Kayonza-2 and Kabarondo Blocks)
System 3 (Wells of Priority A)

-Package B: (1995-1996)
System 1 (Muhazi Block)
System 2 (Kayonza-1 Block)
System 3 (Wells of Priority B)

-Package C: System 3 (Wells of Priority B)
(1997-1998)

-Package D: System 1 (Sake Block)
System 3 (Wells of Priority B)

The implementation components of the possible sub-projects in the Area were as follows:

1) Preparatory Works
The preparatory works such as the establishment of the project organization (RWI/ER Office etc.) and setting up the facilities would be carried out.

2) Detailed Design/Basic Design Work

3) Construction Works and Supplying Program

4) Training
Training would be commenced after obtaining the loan/grant agreement for the second package

Table 8.4 Overall Implemetation Program for the Basic Plan

Phase	Phase III - A	Phase III - B	Phase III - C	Phase III - D	Phase III - E
	Initial Phase	Consolidation I Phase	Review Phase	Consolidation II Phase	Self-help Operation Phase
Objective and Target	1) Government and aiding organizations will gain residents' trust. 2) Stimulate area residents' aspirations. 3) Find out problems involved in the Plan as soon as possible 4) Accumulate field personnel's know-how and skills	1) Increase the number of experienced and skillful field personnel and organise them 2) Develop standard techniques and construction methods to be used in planned projects 3) Decide facilities' and equipment's technical standards	1) Review possible projects to be implemented by the year 2000 2) Review the social and economic changes by the year 2000 3) Based on 1) and 2) above, review the Basic Plan of the Phase III Project.	1) Unlike the Initial Phase and Consolidation II Phase, establish country level development policy 2) Prepare sufficient funds, manpower, and organizations 3) Make steady progress, even at slow speed.	1) Aim at area residents' self-supporting management 2) Develop operation and maintenance organization and expand the fields in which area residents can participate
Special Attention	1) Not to make oversized 2) Select appropriate areas 3) Well understand each area's major economic and social features 4) Promote acceleration campaign 5) Use simple techniques 6) Select field personnel having well-rounded personalities 7) Select convenient areas for transportation and communications	Select appropriate special attention items specified in the left column and develop appropriate development methods	1) Review and revise the development policy and the development level to suit the economic and social conditions in the year 2000 2) Adjust each concerned project to conform to other projects	1) Close cooperation between the Government organization and the aiding organization 2) If project implementation is carried out under the area residents' petition or political pressure, the Government may lose the residents' trust.	
Implementation Schedule	Implementation of Possible Projects (Phase III-A to III-B)		Evaluation of Possible Projects and Review of the Basic Plan	Implementation of Other Projects	Establishment of Area Residents' Self-supporting Management Organization
Related Program	Residents' Promotion Education Program (Phase III-A to III-D)				
	Training Program for Water Supply Technicians (Phase III-A to III-D)				
		Strengthening Program of Commune and Water Committee Organization (Phase III-B to III-E)			

Implementation Schedule for the Possible Project Scheme

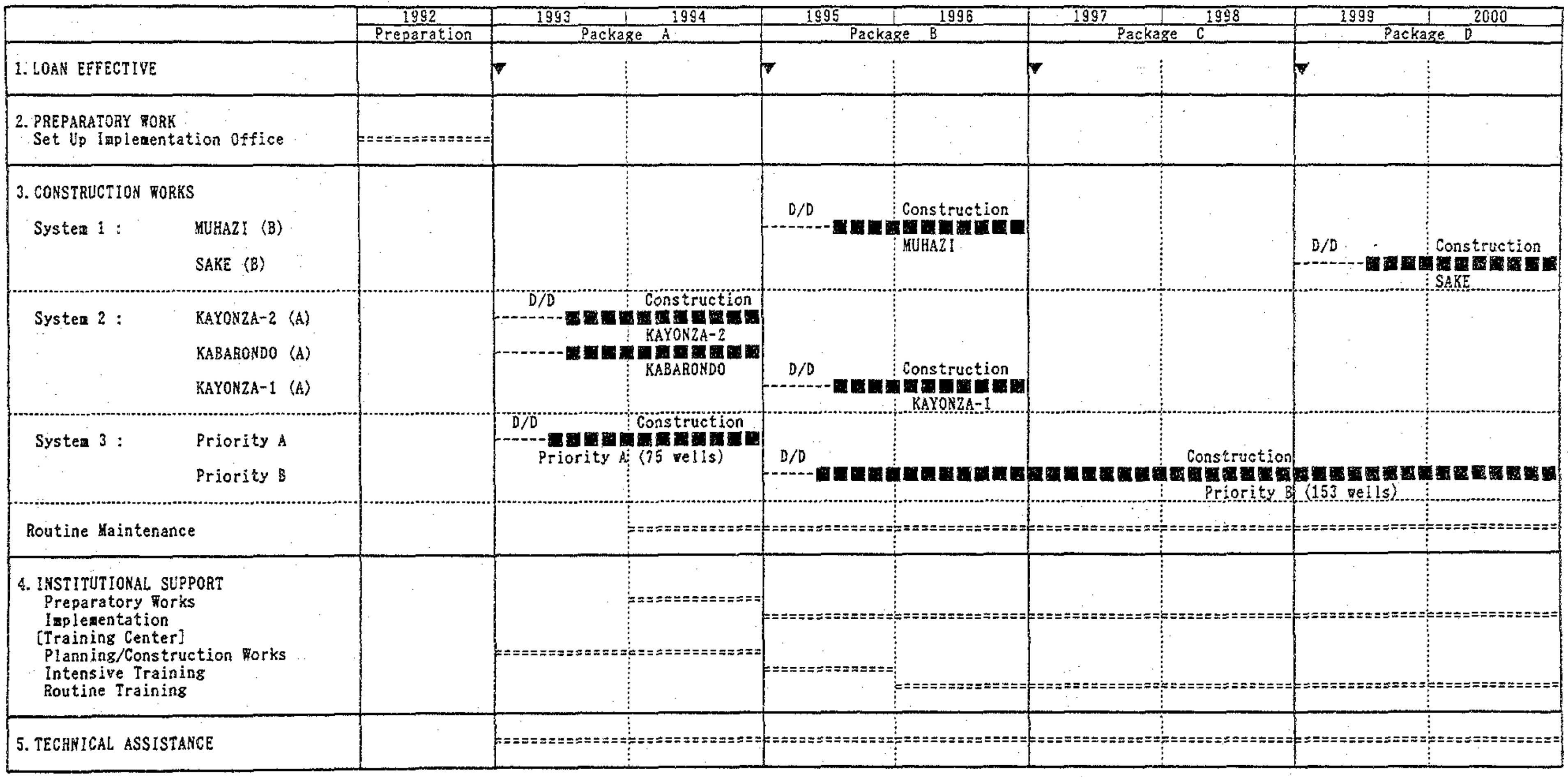


Fig. 8.3 Implementation Schedule of the Possible Project Scheme

8.6 PROJECT COST OF THE POSSIBLE PROJECT SCHEME

The project cost of the Possible Project Scheme at current prices excluding price contingency, was 2.83 billion FRW (22 million US$). This amount was lower than the estimated maximum investment cost for drinking water supply in the Kibungo Prefecture. Breakdown and disbursement schedule of the project cost were as given in Tables 8.5 and 8.7.

Table 8.5 Project Cost of the Possible Project Scheme
(unit: million FRW)

1. Construction Cost	
System 1	846.6
System 2	200.7
System 3	1,167.7
sub-total	**2,215.0**
2. Indirect Cost	
Administration Cost	26.0
Engineering Service	221.5
sub-total	**247.5**
3. Physical Contingency	
(1+2)x15%	369.3
4. Total	**2,831.8**

The construction cost of each package was as given in Table 8.7.

Table 8.6 Construction Cost of Each Package
(unit: 1000 FRW)

System	Package A	Package B	Package C	Package D	Total
1	0	404,875	0	441,716	846,591
2	146,687	53,985	0	0	200,672
3	376,333	263,778	263,778	263,778	1,167,667
Total	523,020	722,638	263,778	705,494	2,214,930

Table 8.7 Disbursement Schedule of the Possible Project Scheme

Possible Project Scheme (Unit : 1000 FRW)

		Prep'n	Package A		Package B		Package C		Package D		Total
		1992	1993	1994	1995	1996	1997	1998	1999	2000	
1. Construction Cost (C/C)											
System 1	MUHAZI				161,950	242,925					404,875
	SAKE								176,686	265,030	441,716
System 2	KAYONZA-2		30,722	46,084							76,806
	KABARONDO		27,952	41,929							69,881
	KAYONZA-1				21,594	32,391					53,985
System 3	Priority A		188,166	188,167							376,333
	Priority B				131,889	131,889	131,889	131,889	131,889	131,889	791,334
Sub-total			246,840	276,180	315,433	407,205	131,889	131,889	308,575	396,919	2,214,930
2. Administration Cost		7,332	2,332	2,332	2,332	2,332	2,332	2,332	2,332	2,332	25,988
3. Engineering Service (10% of C/C)			24,684	27,618	31,543	40,721	13,189	13,189	30,858	39,692	221,493
4. Total Base Cost (B/C) 1+2+3		7,332	273,856	306,130	349,308	450,258	147,410	147,410	341,765	438,943	2,462,411
5. Physical Contingency (15% of B/C)		1,100	41,078	45,920	52,396	67,539	22,111	22,111	51,265	65,841	369,362
6. Total (4+5)		8,432	314,934	352,050	401,705	517,796	169,521	169,521	393,029	504,784	2,831,773
7. Price escaration ratio (%)		4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	
8. Accumurated ratio		1.0400	1.0816	1.1249	1.1699	1.2167	1.2653	1.3159	1.3686	1.4233	
9. Grand Total (6x8)		8,769	340,633	396,008	469,938	629,978	214,499	223,079	537,888	718,466	3,539,256

8.7 OPERATION AND MAINTENANCE COST

(1) Estimate Condition

Operation and maintenance costs consisted of the following direct O/M cost and investment cost of O/M Unit, the latter Unit being a proposed supporting institution for Water Supply.

1) Direct O/M Cost

- Power Cost

For the estimation of the energy cost, actual water consumption rate at 75 % of the design volume of Systems 1 and 2 was considered to be supplied.

- Chemical Input

- Repair Cost

About 7% per each 3 years of total machinery cost deposits were needed and 0.5 % of non-machinery cost would be considered as the repair cost of pipelines/valves.

- Salaries of Operators/Workers

2) Investment Cost of O/M Unit

The monthly cost for the investment of O/M Unit per person was estimated as 2.5 FRW/month.

(2) Estimated Cost

According to the O/M cost classification of MINITRAPEE, the fee was thought to be composed of three levels as listed below:

- -Level 1: Costs required for the management, operation, and maintenance works
- -Level 2: Costs of Level 1 plus non-machinery costs
- -Level 3: Costs of Level 2 plus machinery costs

MINITRAPEE's policy was to collect water fees at least for Level 1 directly from the water supply recipients.

The O/M cost per each system and/or each well consisted of the direct operation/maintenance costs and the system management costs as follows:

	Cost for O/M Unit (FRW/M/Person)		System Management Cost(FRW/M/system)
System 1:	2.5		690,000 - 950,000
System 2:	2.5	Elec. power:	55,000 - 100,000
		Generator:	over 420,000
System 3:	2.5		1,270
System 4:	2.5		

The O/M costs for different water supply systems at Level 3(overall O/M cost) were outlined as below:

Table 8.8 Operation and Maintenance Costs

System	Level	O/M Cost FRW/Family(US$/Family)	Remark
1	3	185- 203 (1.4-1.6)	
	2	140- 155 (1.1-1.2)	
	1	125- 140 (1.0-1.1)	
2	3	120- 150 (0.9-1.1)	Electric power
	3	700-1,335 (5.5-10.4)	Generator
3	3	27- 63 (0.2- 0.5)	

8.8 OPERATION AND MAINTENANCE

8.8.1 Proposed Institutional Support

To achieve prospective water supply development, the introduction of institutional support systems would be needed first. MINITRAPEE also proposed a policy whereby water supply recipients would pay facility operation and maintenance costs (see Appendix F of Volume III).

At this Study stage, the O/M Unit at Commune level and the System Management Organization at service block level would take full responsibility for matters relevant to the subject of O/M and water fees.

(1) Organizational Structure

The organizational structure was proposed by referring to MINITRAPEE's recommendation for water supply facility operation and maintenance which had a basic unit at commune level (see Fig. 8.4).

The proposed Communal O/M Unit of Commune level organization was to be organized by representatives of the water supply recipients and commune office personnel. The System Management Organization of each water supply system which come under Communal O/M Unit, was also proposed for routine management and maintenance of each water supply system. O/M Unit and System Management Organizations would be operated by four and three persons, respectively. The details were given in Appendix P of Volume III.

In addition, it was strongly recommended that the technical management of piped systems (Systems 1 and 2) be directed by ELECTROGAZ.

The water selling rights of each KIOSK would be provided to the water sale-person and such a person would be appointed as a part-time worker. The specific charge of supplied water at the Kiosk would be his income.

In case of un-piped water supply systems, i.e. handpump shallow well water supply, it was also proposed that a few designated workers maintain the facilities in shifts and without pay, since the works are simple and short.

(2) **Activities**

Main activities of both proposed organizations were outlined as follows:

O/M Unit
- Control O/M services
- Guidance and extension of O/M techniques to operator/worker at site level
- Coordination, account and administration of water fee management
- Purchasing O/M supplies and O/M equipments
- Storage O/M supplies and O/M equipments
- Promoting O/M groups at Sectors level

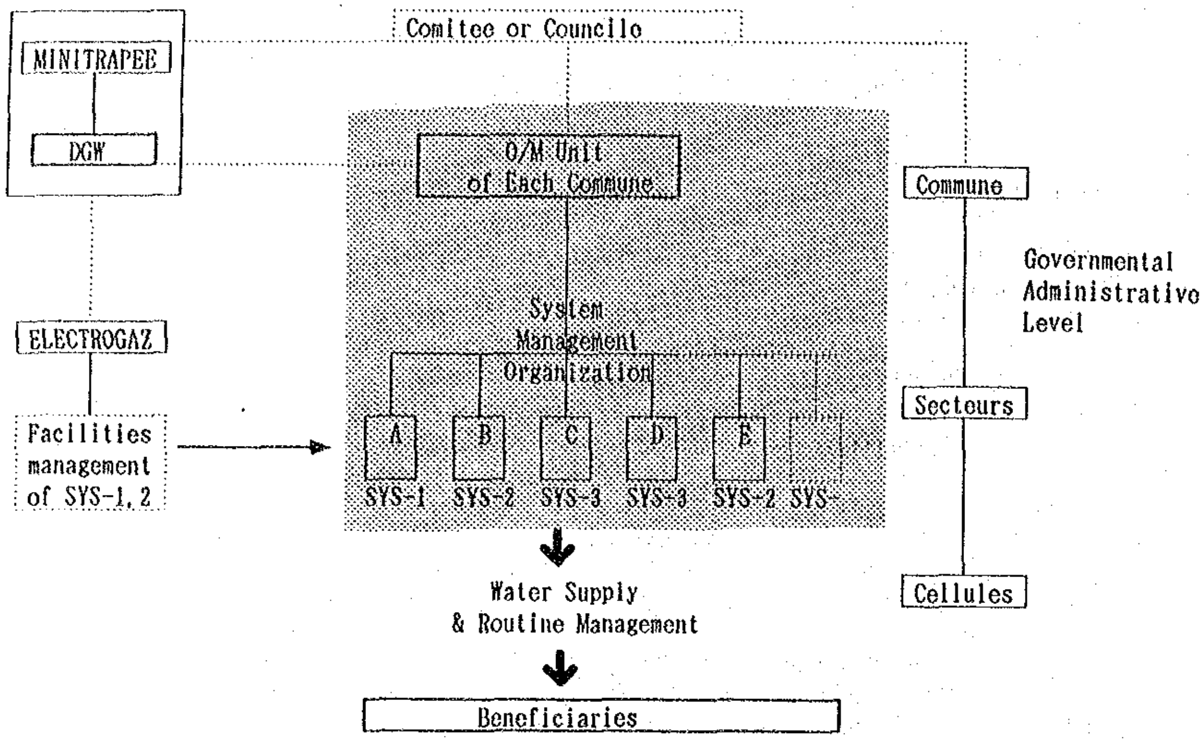
System Management Organization
- Providing O/M services (supported by ELECTROGAZ)
- Guidance and extension of O/M techniques to user groups of the System and also general health matters
- Water fee collection
- Water supply works

(3) **Training**

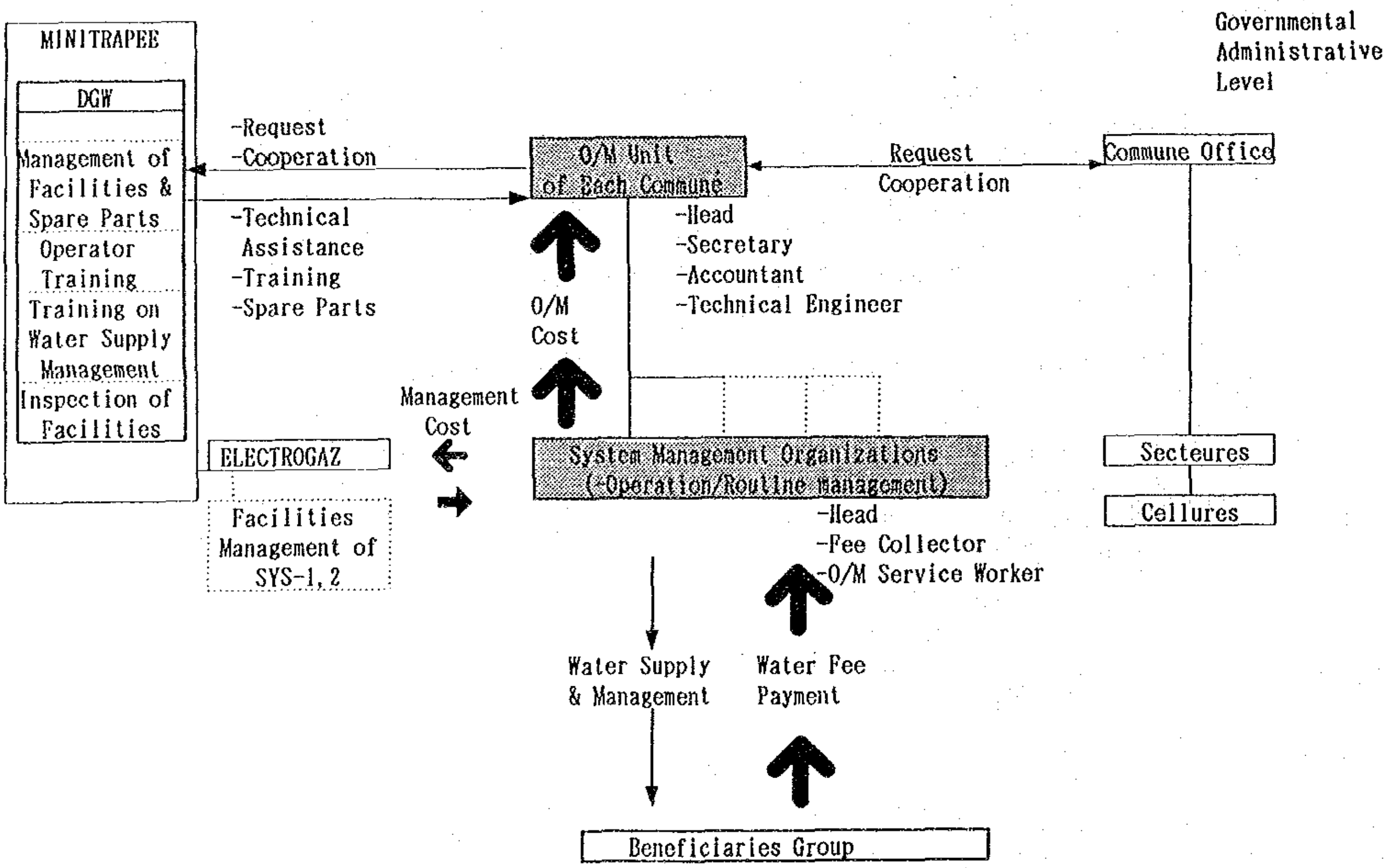
At this stage, it was strongly required, for sustainable development of "The Rural Water Supply Project in The Eastern Region (Phase III)", that the following training programs would be considered in order to promote the O/M and water fee charge systems efficiently and effectively.

- Training courses for O/M workers at site level
- Training for O/M managers and O/M service workers of O/M Unit
- Courses for accountants, administrators and collectors of O/M Unit

According to the Government policy, since it was proposed that CCDFP would be newly established in each commune, CCDFP should extend water supply knowledge to the residents and provide training for the personnel in charge of public health matters.



Basic Structure for proposed O/M System in Each Commune



Schematic Flow-chart of Proposed O/M System

Fig. 8.4 Proposed Operation and Maintenance System

8.8.2 Water Fee Collection System

(1) Consideration of Water Fee System

A water fee would be collected for each water supply block. Therefore, the water fee rate to cover the O/M costs would vary according to the size and service level of each water supply block.

Based on the estimated O/M costs and by taking into account the financial capability of the residents, it was proposed that the water fee collection system adopted for the Basic Plan should be the fixed fee rate and the meter rate methods. At the stage, it was recommended that the water fees at Level 2 of MINITRAPEE should be collected from the water supply recipients.

(2) Water Supply Method

By taking into account the water fee system mentioned above, the Kiosk method was thought to be the most appropriate for Systems 1 and 2.

The water supply manager of the Kiosk would be a part-time employee of the System Management Organization. The manager would be paid according to the amount of water he sells (about 7 FRW per cubic meter).

(3) Water Fee Rate

The water fee rate for each water supply system was to be established as follows:

System 1:

-Basic Fixed Fee Rate:	100 FRW/household/month
-Meter Fee Rate:	No charge up to 2.0 m3/month. 2.0 FRW/20 liters or 100 FRW/m3 in excess of 2.0 m3/month.

System 2:

-Basic Fixed Fee:	70 FRW/household/month
-Meter Fee Rate:	No charge up to 2.0 m3/month. 2.0 FRW/20 liters or 100 FRW/m3 in excess of 2.0 m3/month.

System 3:

Water fee rates would vary according to the number of wells and the population in each "Secteur". Based on the O/M cost, the water fee rate would be 30 to 65 FRW (0.25-0.5 US$)/family/month.

System 4:
A decision was made to collect 15 FRW/household/month for each commune as a form of water supply administration fee that was necessary for the O/M Unit.

8.8.3 Balance between O/M Cost and Water Fee

System 1:

The annual costs of Level 2 would be 6,863,040 FRW in Muhazi and 9,259,932 FRW in Sake, while the annual water fee revenue would be 8,452,290 FRW and 13,046,880 FRW, respectively.

In reality, 645,000 FRW would be needed every three years in Muhazi, and 780,000 FRW in Sake for machinery repairs.

System 2:

The highest annual O/M cost would be for Rusumo-2 with 21 million FRW, whilst its water fee revenue would be 1.5 million FRW per year and the lowest annual O/M cost would be for Kayonza-1 with 850,716 FRW, whilst its water fee revenue would be 118,462 FRW per year.

The facilities would need from 40,000 to 75,000 FRW for supplying the electric power system and 75,000 to 300,000 FRW every three years for repair costs of engine generator systems.

System 3:

The water fee revenue and the operation and maintenance cost would be balanced within each commune and the annual scale would range from 45,000 to 300,000 FRW (350-2,350 US$).

Table 8.9 Balance between Water Fee and O/M Cost

Unit: FRW

COMMUNE	SYSTEM 1		SYSTEM 2		SYSTEM 3		SYSTEM 4	TOTAL	
	Fee	O/M Cost	Fee	O/M Cost	Fee	O/M Cost	Fee	Fee	O/M Cost
BIRENGA		0	1,166,100	8,501,508	89,735	85,015	(9,660)	1,265,495	8,586,523
KABARONDO		0	1,938,300	1,102,644	54,810	50,833	(12,735)	2,005,845	1,153,477
KAYONZA		0	2,562,300	1,583,664	76,110	71,618	(14,655)	2,653,065	1,655,282
KIGARAMA		0		0	148,775	137,968	(9,090)	157,865	137,968
MUGESERA		0		0	292,595	271,745	(0)	292,595	271,745
MUHAZI	8,452,290	6,863,040		0	0	0	(0)	8,452,290	6,863,040
RUKARA		0		0	160,380	148,580	(17,655)	178,035	148,580
RUKIRA		0		0	42,155	39,525	(9,900)	52,055	39,525
RUSUMO		0	7,435,350	53,115,000	217,890	204,953	(48,915)	7,702,155	53,319,953
RUTONDE		0	1,209,000	4,915,032	46,145	43,688	(2,265)	1,257,410	4,958,720
SAKE	13,046,880	9,259,932		0	112,385	101,478	(0)	13,159,265	9,361,410
TOTAL COST	21,499,170	16,122,972	14,311,050	69,217,848	1,240,980	1,155,403	(124,875)	122,392,020	102,048,253
									(102,173,128)

8.8.4 Financial Management

Based on MINITRAPEE's proposal, CCDR of CID would be the main office for handling the financial management of the Basic Plan's water supply systems.

The total water fee revenue from the Basic Plan's water supply systems in Kibungo Prefecture would be 102 million FRW per year.

Sake Commune would have the largest budget with a yearly revenue of 13.16 million FRW whilst its expenditure would reach 9.36 million FRW per year. Rukira Commune would have the smallest budget with an annual revenue of 52,000 FRW and annual expenditures of 39,525 FRW.