PROPOSED WATER FEE AND EXPEXTED MNTHLY FEE REVENUE

Commune Name	Secteur Name	FAMILY 2000	O/M COST(FRW) O/M Unit	Repair	Total	/Fmly	Proposed Fee (FRW/F)	Total (FRW)
RUKARA	GAHINI	638	9,568	15,240	24,808	38.9	40	25,520
	KIYENZI	586	8,778	7,620	16,398	28.0	30	17,580
	NYAKABUNGO	391	5,863	6,350	12,213	31.2	35	13,685
	NYAWERA	671	10,060	10,160	20,220	30.1	35	23,485
	RUKARA	1,113	16,693	15,240	31,933	28.7	30	33,390
	RWIMISHINYA	599	8,985	7,620	16,605	27.7	30	17,970
	RYAMANYONI	575	8,625	17,780	26,405	45.9	50	28,750
	TOTAL	4,573	68,570	80,010	148,580	32.5		160,380
MUGESERA	CYIZIHIRA	700	10,498	10,160	20,658	29.5	30	21,000
	GATARE	719	10,778	11,430	22,208	30.9	35	25,165
	KAGASHI	857	12,843	13,970	26,813	31.3	35	29,995
	KAREMBO	103	1,535	1,270	2,805	27.2	30	3,090
	KIBARE	816	12,230	12,700	24,930	30.6	35	28,560
	KIBILIZI-1,	862	12,923	11,430	24,353	28.3	30	25,860
	KIRAMBO	598	8,960	8,890	17,850	29.8	30	17,940
	KUKABUYE	490	7,340	6,350	13,690	27.9	30	14,700
	MATONGO	621	9,315	8,890	18,205	29.3	30	18,630
	NGARA	658	9,860	8,890	18,750	28.5	30	19,740
	NYANGE	518	7,763	10,160	17,923	34.6	35	18,130
	SANGAZA	699	10,475	11,430	21,905	31.3	35	24,465
	SHYWA	656	9,828	10,160	19,988	30.5	35	22,960
	ZAZA	344	5,160	16,510	21,670	63.0	65	22,360
	TOTAL	8,641	129,505	142,240	271,745	31.4		292,595
SAKE	MBUYE	335	5,025	5,080	10,105	30.2	35	11,725
	MURWA	945	14,165	16,510	30,675	32.5	35	33,075
	RUKUMBERI	1,010	15,145	16,510	31,655	31.3	35	35,350
	SHOLI	921	13,803	15,240	29,043	31.5	35	32,235
	TOTAL	3,211	48,138	53,340	101,478	31.6		112,385
KAYONZA	GASOGI	437	6,543	6,350	12,893	29.5	30	13,110
	MBURABUTURO	322	4,830	3,810	8,640	26.8	30	9,660
	MUSUMBA	246	3,678	3,810	7,488	30.4	35	8,610
	NYAMIRAMA	548	8,213	7,620	15,833	28.9	30	16,440
	RUTARE	545	8,168	7,620	15,788	29.0	30	16,350
	RWINKWAVU	75	1,120	2,540	3,660	48.8	50	3,750
	SHYOGO	234	3,508	3,810	7,318	31.3	35	8,190
	TOTAL	2,407	36,058	35,560	71,618	29.8		76,110
RUTONDE	KADUHA	224	3,348	3,810	7,158	32.0	35	7,840
	RUTONDE	555	8,315	7,620	15,935	28.7	30	16,650
	RWERU	155	2,325	2,540	4,865	31.4	35	5,425
	SOVU	541	8,110	7,620	15,730	29.1	30	16,230
	TOTAL	1,475	22,098	21,590	43,688	29.6		46,145
KABARONDO	BISENGA	371	5,558	5,080	10,638	28.7	30	11,130
	MURAMA	157	2,353	2,540	4,893	31.2	35	5,495
	NKAMBA	156	2,335	2,540	4,875	31.3	35	5,460
	RURAMIRA	319	4,785	5,080	9,865	30.9	35	11,165
	RUSERA	360	5,398	5,080	10,478	29.1	30	10,800
	RUYONZA	186	2,788	2,540	5,328	28.6	30	5,580
	SHYANDA	148	2,218	2,540	4,758	32.1	35	5,180
	TOTAL	1,697	25,433	25,400	50,833	30.0		54,810

(continue)

PROPOSED WATER FEE AND EXPEXTED MNTHLY FEE REVENUE

Commune Name	Secteur Name	FAMILY 2000	O/M COST(FRW) O/M Unit	Repair	Total	/Fmly	Proposed Fee (FRW/F)	Total (FRW)
KIGARAMA	GASETSA	116	1,740	3,810	5,550	47.8	50	5,800
	GASHANDA	388	5,815	6,350	12,165	31.4	35	13,580
	KABARE-1	252	3,768	5,080	8,848	35.1	40	10,080
	KABARE-2	562	8,425	12,700	21,125	37.6	40	22,480
	KABERANGWE	286	4,285	3,810	8,095	28.3	30	8,580
	KANSANA	400	5,988	6,350	12,338	30.8	35	14,000
	REMERA	292	4,370	5,080	9,450	32.4	35	10,220
	RUBONA	1,019	15,275	13,970	29,245	28.7	30	30,570
	RURENGE	321	4,810	5,080	9,890	30.8	35	11,235
	VUMWE	741	11,103	10,160	21,263	28.7	30	22,230
	TOTAL	4,377	65,578	72,390	137,968	31.5		148,775
RUKIRA	GASIRU	289	4,333	5,080	9,413	32.6	35	10,115
	GITWE	343	5,140	5,080	10,220	29.8	30	10,290
	MUSHIKILI	298	4,465	5,080	9,545	32.0	35	10,430
	NTARUKA	38	560	1,270	1,830	48.2	50	1,900
	RUGARAMA	314	4,708	3,810	8,518	27.1	30	9,420
	TOTAL	1,282	19,205	20,320	39,525	30.8		42,155
BIRENGA	BARE	207	3,093	3,810	6,903	33.3	35	7,245
	BIRENGA	226	3,378	3,810	7,188	31.8	35	7,910
	GAHARA	619	9,273	8,890	18,163	29.3	30	18,570
	GAHULIRE	252	3,780	3,810	7,590	30.1	35	8,820
	GASHONGORA	372	5,578	5,080	10,658	28.6	30	11,160
	KIBAYA	595	8,925	7,620	16,545	27.8	30	17,850
	KIBIMBA	254	3,805	3,810	7,615	30.0	30	7,620
	SAKARA	352	5,275	5,080	10,355	29.4	30	10,560
	TOTAL	2,877	43,105	41,910	85,015	29.5		89,735
RUSUMO	GATORE	548	8,213	7,620	15,833	28.9	30	16,440
	KANKOBWA	808	12,118	38,100	50,218	62.2	65	52,520
	KIGARAMA	561	8,403	7,620	16,023	28.6	30	16,830
	KIGINA	973	14,595	13,970	28,565	29.4	30	29,190
	KIREHE	359	5,373	5,080	10,453	29.1	30	10,770
	MUSAZA	1,163	17,445	13,970	31,415	27.0	30	34,890
	NYABITARE	863	12,943	11,430	24,373	28.2	30	25,890
	NYAMUGALI	280	4,198	6,350	10,548	37.7	40	11,200
	NYARUBUYE	576	8,638	8,890	17,528	30.4	35	20,160
	TOTAL	6,131	91,923	113,030	204,953	33.4		217,890
TOTAL		36,671	549,610	605,790	1,155,400	31.5		1,290,588

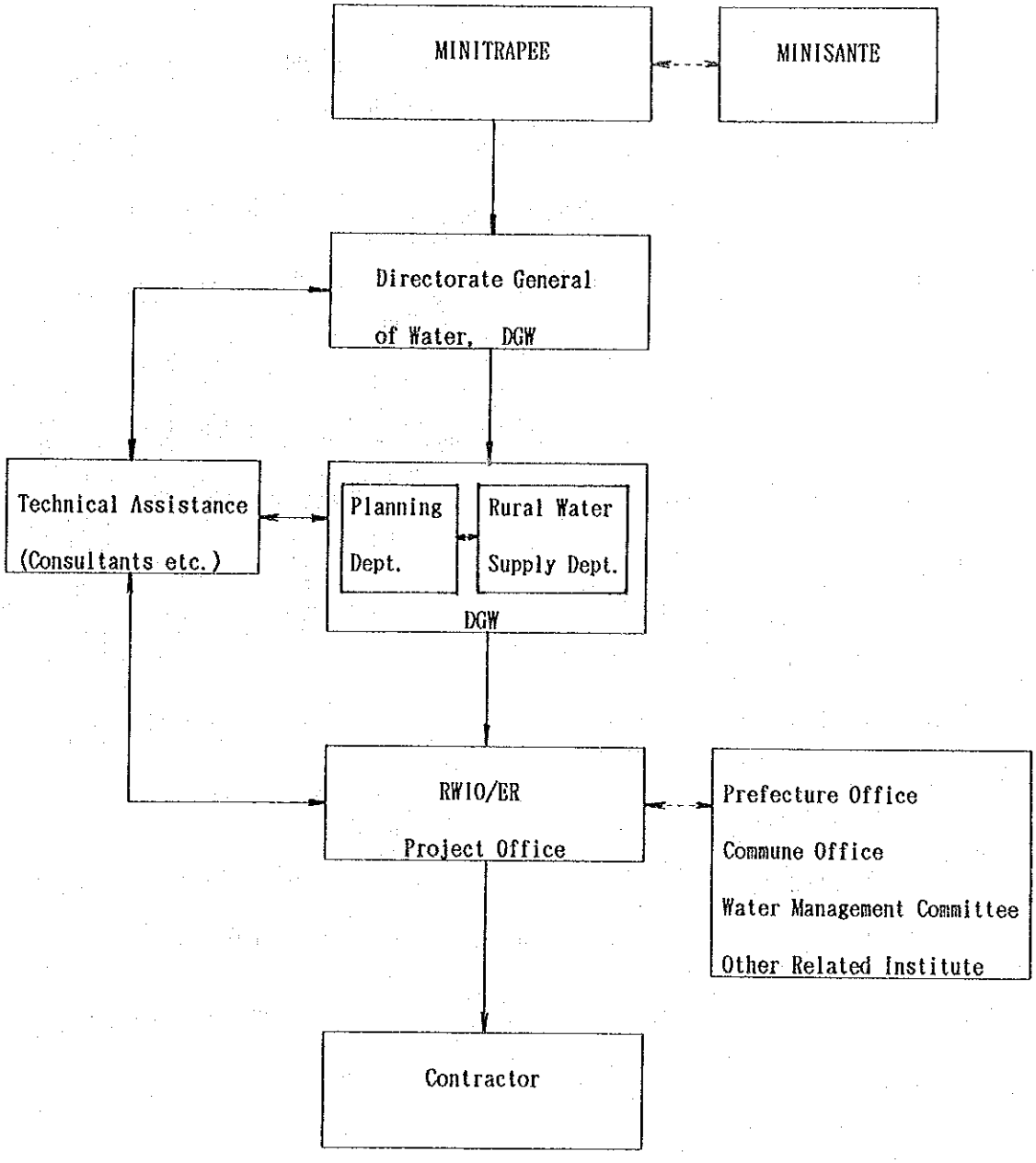
BALANCE BETWEEN WATER FEE AND O/M COST

Unit: FRW

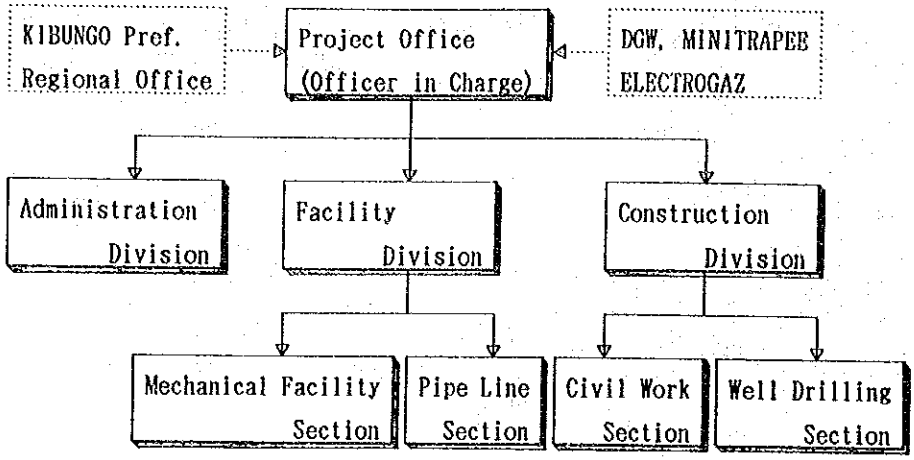
COMMUNE	SYSTEM 1		SYSTEM 2		SYSTEM 3		SYSTEM 4	TOTAL	
	Fee	O/M Cost	Fee	O/M Cost	Fee	O/M Cost	Fee	Fee	O/M Cost
BIRENGA		0	1,166,100	8,501,508	89,735	85,015	(9,660)	1,265,495	8,586,523
KABARONDO		0	1,938,300	1,102,644	54,810	50,833	(12,735)	2,005,845	1,153,477
KAYONZA		0	2,562,300	1,583,664	76,110	71,618	(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)

BALANCE BETWEEN O/M COST AND REVENE FEE

	Fee	O/M Cost	Balance
SYSTEM 1			
MUHAZI	8,452,290	6,863,040	1,589,250
SAKE	13,046,880	9,259,932	3,786,948
SYSTEM 2			
KAYONZA-1	1,421,550	850,716	570,834
KAYONZA-2	1,140,750	732,948	407,802
KABARONDO	1,938,300	1,102,644	835,656
RUTONDE	1,209,000	4,915,032	-3,706,032
BIRENGA	1,166,100	8,501,508	-7,335,408
RUSUMO-1	2,375,100	16,069,776	-13,694,676
RUSUMO-2	2,694,900	21,004,284	-18,309,384
RUSUMO-3	2,365,350	16,040,940	-13,675,590



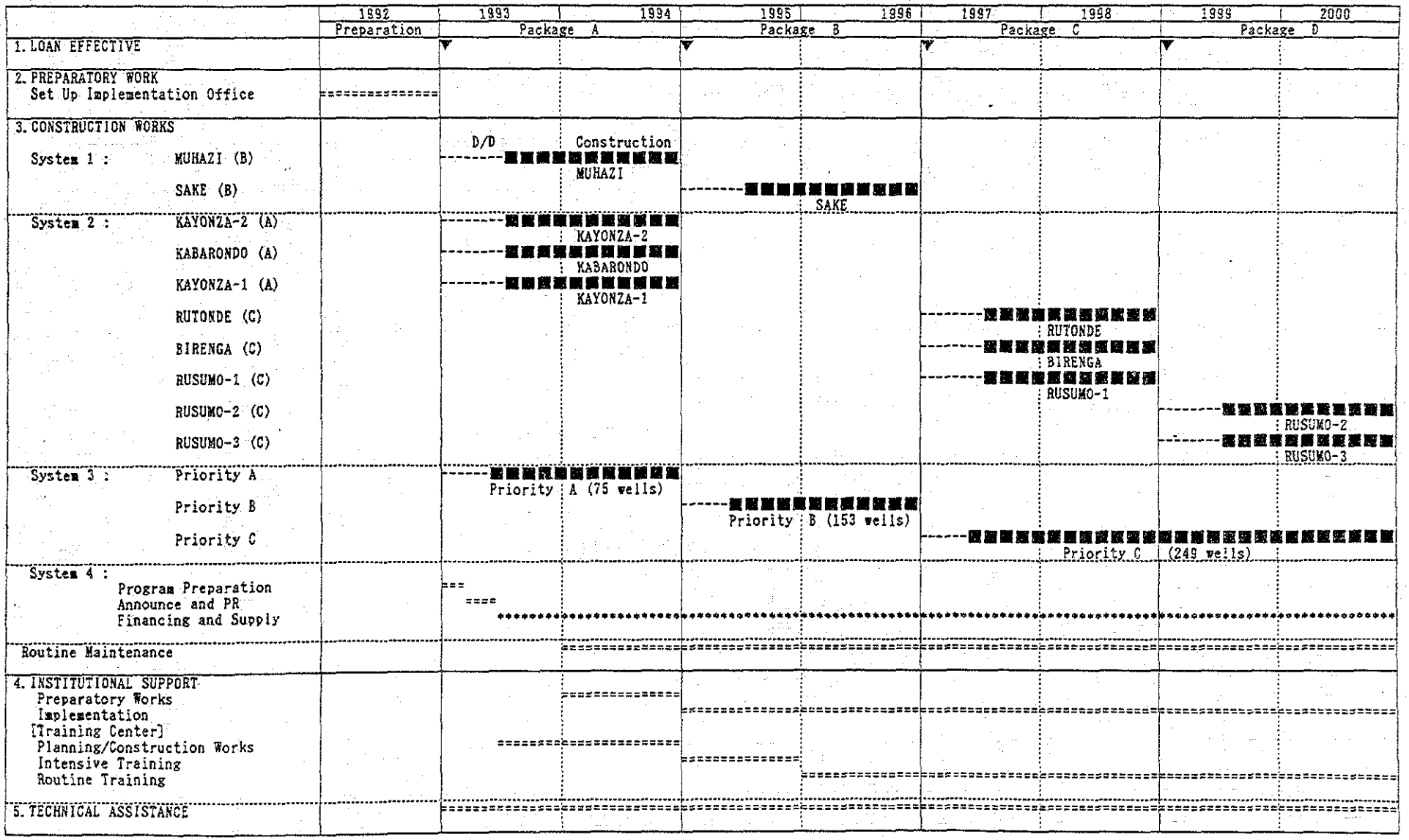
Project Implementation Organization



Project Implementation Office

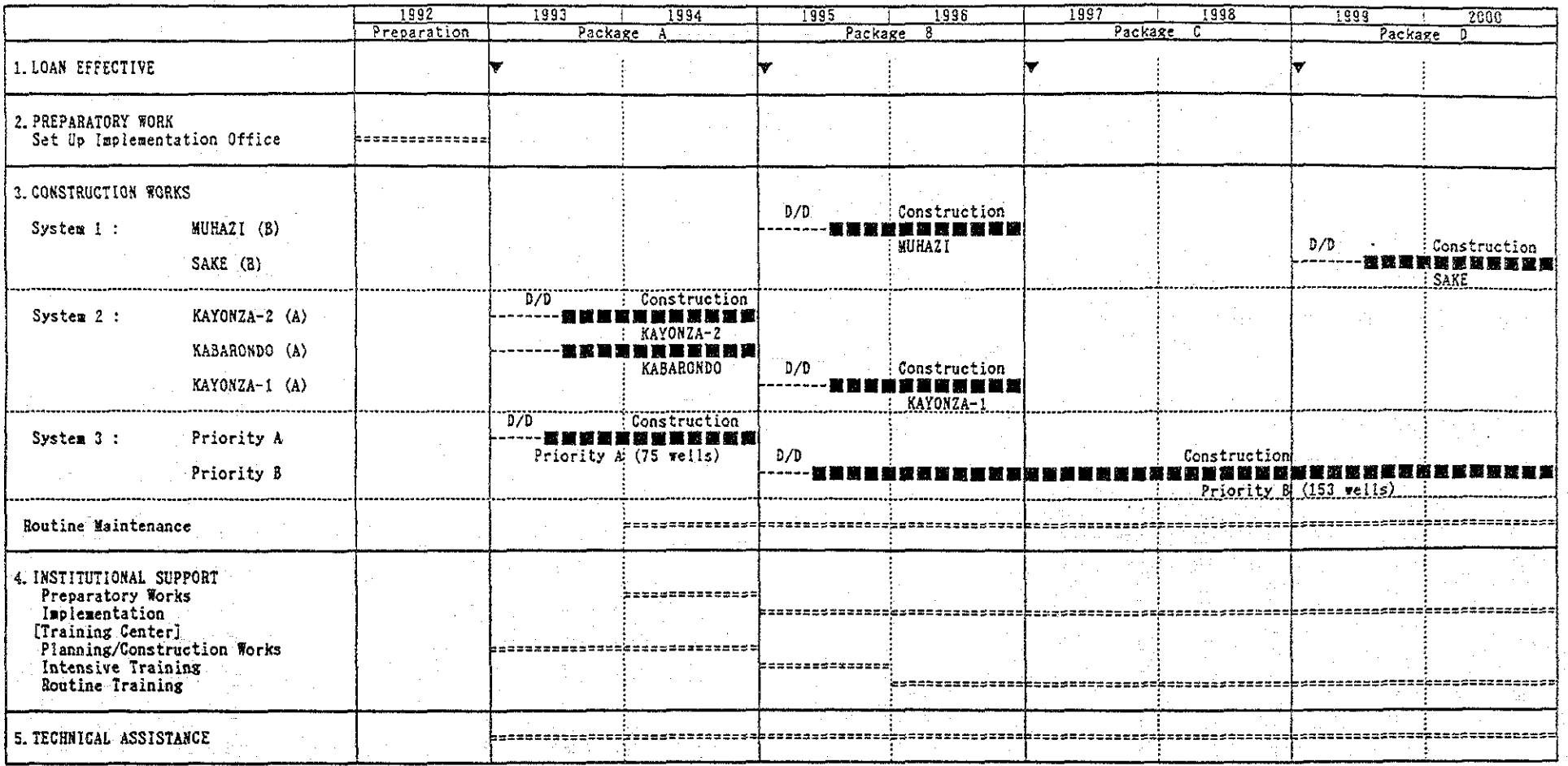
- Officer in Charge	1	Overall supervision and management
- Civil/Water supply Engineer	1	Engneering and supervision of civil works
- Facilities Engineer	1	Engneering and supervision
- Asst. Engineer	2	For well construction and water supply facilities
- Secretary	1	
- Driver	2	

Implementation Schedule for the Basic Plan

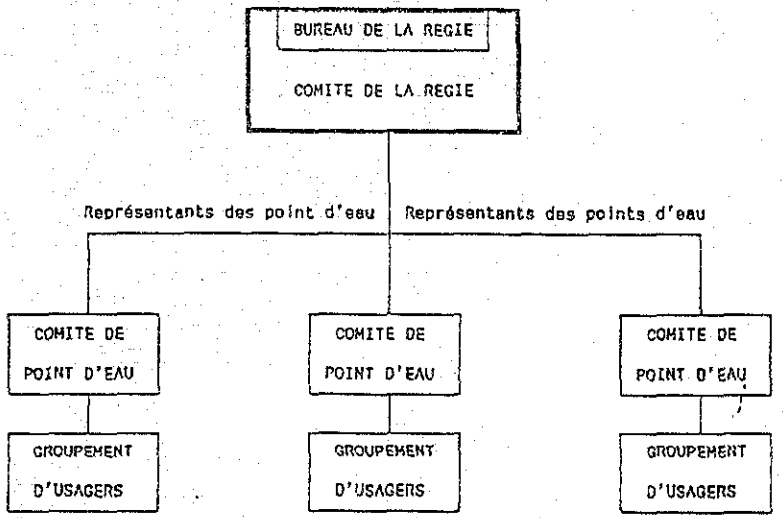


Implementation Schedule for the Basic Plan

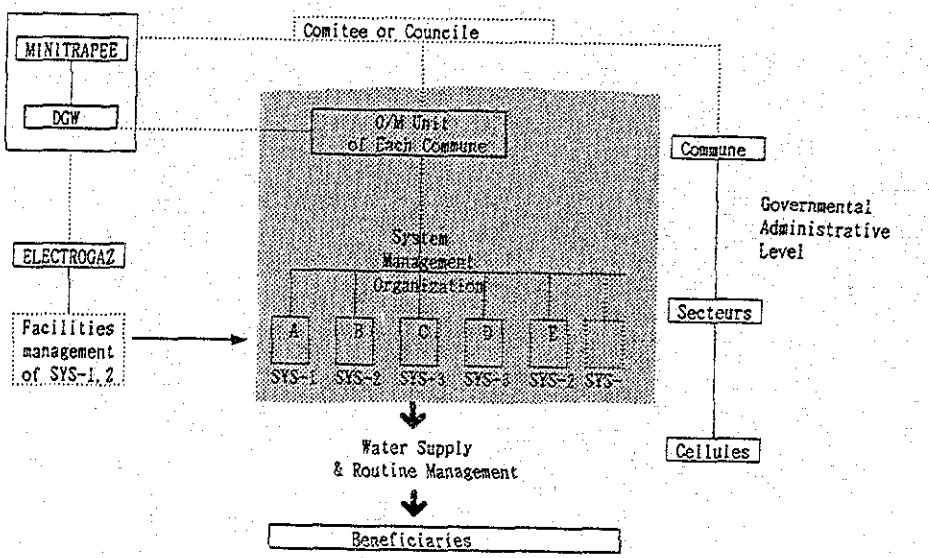
Implementation Schedule for the Possible Project Scheme



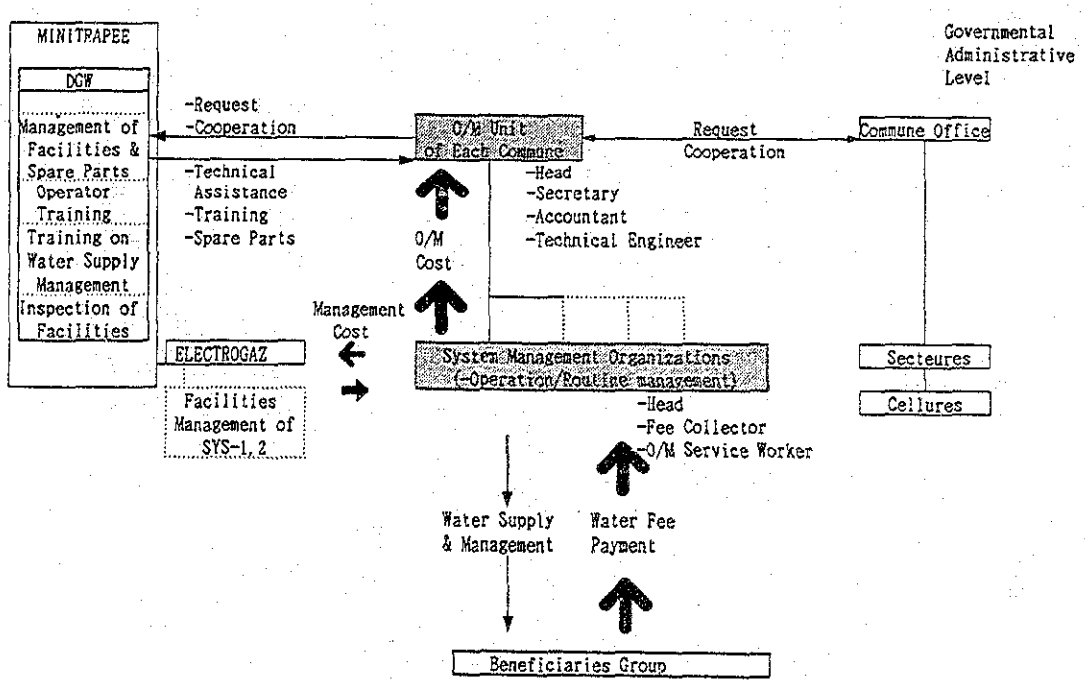
Implementation Schedule of the Possible Project Scheme



Proposed Organization by MINITRAPEE



Basic Structure for proposed O/M System in Each Commune



Schematic Flow-chart of Proposed O/M System

Proposed Operation and Maintenance System

Fig. P.5

APPENDIX Q

COST ESTIMATE

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COST ESTIMATE

1. GENERAL

Only small amounts of construction materials are produced domestically in Rwanda -- most materials are imported. Since Rwanda is a landlocked country, the imported materials come through Kenya, Uganda, and/or Tanzania. Hence, the construction costs of water supply projects, such as the Phase III Project, are normally estimated based on international prices of construction materials.

Rwanda's currency was devaluated in November, 1991. Furthermore, the domestic inflation rate has been significant.

Under these circumstances, a careful investigation should be made when estimating Project construction costs.

During the field study period, the following information was obtained:

- MINITRAPEE's Unit Construction Price List, 1988
- MINITRAPEE's Unit Construction Price List, 1989
- MINITRAPEE's Unit Construction Price List, 1990
- ELECTROGAZ's Unit Construction Price List, 1989
- HYDRO BAT's Report on Water Supply Plan in Rukara Commune, 1984
- HYDRO BAT's Report on Water Supply Plan in Rukara Commune, 1986
- FURISA's Report on Kigali's 200 Year Plan, 1990
- Kigali Commercial Bank's Exchange Rate List (1990-1991), 1991

2. ASSUMPTION ON COST ESTIMATE

The Project cost has been estimated on the following assumptions.

2.1 MEANS OF EXECUTION

Civil engineering work will be executed by the contract entered into between the promoter and the contractor. The machinery and equipment required for construction works will be provided by the contractors.

2.2 BASIC UNIT PRICE

No comparatively large construction work has been undertaken since the devaluation of the Rwanda Franc in 1990. For estimating the construction costs of the Project, the basic unit prices of construction work items in 1990 were multiplied by the inflation rates to obtain the August 1, 1991 unit prices.

(1) Basic 1990 Unit Prices

Based on gathered information, the basic unit prices of construction work items prior to the currency devaluation were obtained. The unit prices listed in MINITRAPEE's Unit Construction Price List of 1990 were adopted. Prices not contained in the Price List were obtained from other sources.

(2) Basic August 1, 1991 Unit Prices

The Foreign exchange rates of Rwanda's Franc before and after the currency devaluation were as follows:

Price to devaluation(1990)	:	1 US$ = 80 FRW
After devaluation(1991)	:	1 US$ = 128 FRW

The foreign exchange rate increased 160% as a result of the currency devaluation(see Table Q.1).

Compared to the foreign exchange rate increase, the price indexes with domestic currency, after the currency devaluation changed little as shown below:

Wages of common workers	:	120%
Gravel	:	115%
Sand	:	100%
Cement	:	123%
Reinforcing bars	:	133%
Gasoline	:	179%
Diesel oil	:	179%

By taking into account the above rates, the basic unit prices of construction work items were obtained by multiplying 1990 prices by the following inflation rates:

. Imported materials and equipment	:	160%
. Domestically procurable materials, such as pipes	:	133%
. Earth work	:	120%
. Concrete work	:	123%
. Other work	:	115%

The basic rate of labor, material and construction equipment is estimated i the prevailing rate in Rwanda. Detailed basic rate is shown in Table Q.2.

2.3 CONSTRUCTION COST

The construction cost is divided into the foreign and local currency portion. The local currency portion is estimated on the basis of the current price in the Rwanda as of August, 1991 and the foreign currency portion is estimated on the CIF price at Kigali. Construction cost is estimated based on unit cost for individual working items.

2.4 OVERHEAD AND PROFIT

Overhead and profit, which equal to 20% of the direct cost in total is included in each unit price.

2.5 EXCHANGE RATE

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

2.6 INDIRECT COST

Indirect cost is consisted engineering and administration costs.

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

The administration cost is shown in Table Q.3. The cost of engineering service is calculated applying 10% of the Construction Cost.

Required personals for the engineering service is outlined as below:

Design phase:
- Team Leader
- Hydrogeologist
- Water Supply Planning Engineer
- Design Engineer
- Mechanical/Facilities Engineer
- Structural Engineer
- Soil Mechanic Engineer and Geologist
- Topo Surveyor
- Construction Planning Engineer
- Technical Specification Engineer
- O/M Specialist and others

Construction phase: Team Leader
Construction Engineer
O/M Specialist
Others

2.7 PHYSICAL CONTINGENCY

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

2.8 PRICE CONTINGENCY

The price escalation is assumed as 4 % for foreign currency portion and local currency portion, referring to inflation rate of developed countries and consumer price index in Kigali between 1982 and 1987.

3. PROJECT COST

3.1 CONSTRUCTION COST

Civil work is composed of each proposed system as below:

- System 1
- System 2
- System 3
- System 4

The construction cost are given in Table Q.4 and Q.8 and its breakdown are as shown in DATA BOOK of Volume V.

In addition, the portions for the voluntary service activities by residents(Umuganda) are estimated in Table Q.9.

The activities are strongly recommended during the construction period as a participation of the beneficiaries, at this Stage.

3.2 PROJECT COST

The estimated project cost of the Basic Plan and the Possible Project Scheme are shown in Table Q.5.

3.3 ANNUAL DISBURSEMENT SCHEDULE

The annual disbursement schedule for the Basic Plan and the Possible Project Scheme are estimated on the basis of the project implementation schedule, and the outlines are shown in Table Q.6 AND Q.7.

4. OPERATION AND MAINTENANCE COST

At this study stage, different structures of O/M costs are recommended between piped water supply system and non-piped system(refer to Appendix P).

Piped water supply system(System 1 and 2):
Direct O/M cost + investment cost of O/M unit.

Non-piped water system(System 3 and System 4):
Maintenance cost + investment cost of O/M unit.

4.1 DIRECT O/M COST

Direct cost consist of following cost to operate the system:

Power Cost

Procurement of power is estimated, where the present unit prices is as follows;

Electric Power --- 8.5 RWF/KW/hr
Fuel of Engine --- 120 RWF/lit.
(lubricant:10% of fuel cost counted)

For the estimation of the energy cost, actual water consumption rate which was surveyed by the Study is taken into consideration(see Appendix F) and 75 % of design volume of System 1 and 2 will be considered to be supplied. Thus, energy cost should be estimated taking into account of 75 % design operation hour.

Chemical Input

Required volume of chemical input for treatment facilities of System-1 is estimated as given in Appendix M. Cost of the chemical input is considered to be as below:

Al2(SO4)3	90 FRW/kg
Ca(ClO)2	400FRW/kg
Ca(OH)2	25 FRW/kg

Repair Cost

The required cost to maintain a stable and continuous operation of the facilities is calculated by the below criteria.

Intake Pump, Submergible Pump, Booster Pump, Generator, Electric Facilities, Treatment Facilities:

The equipment/facilities are considered to have useful life of 10 years.

Therefore, 20% of total machinery cost is required which can allow maintenance for around 3 years. About 7 % p.a. of total machinery cost deposit is needed. The cost range from 12,000 FRW to 260,000 FRW per one(1) unit p.a., is estimated.

Pipelines, Valves, Fountains

Annually 0.5 % of non-machinery costs should be considered as the repair cost. the cost is estimated as 2,000 to 4,500 FRW/m of both distribution and transmission pipes.

Other,i.e. Machinery House, Storage Tank, Well etc.

The costs will not be considered, because the maintenances are covered by daily O/M.

Salaries of Operators/Workers

Water supply systems of piped water system of small and medium scale are required a salary payment to operators/workers. According to the field survey of the study, the monthly salary is 8,000 RWF/month, though depending on factors such as age and experience. In case of non-piped water supply systems, a few designated workers maintain the facilities in shifts and without pay.

The water seller at KIOSK shall be a part-time worker and his income of specific charge is planned to be 7 FRW/m3.

4.2 INVESTMENT COST OF O/M UNIT

Proper organization; operation and maintenance(O/M) unit, would be newly proposed to execute the operation and maintenance of water supply system and to conduct the collection works of water fee charge. The monthly cost for the investment per person is estimated as 2.5 FRW/month. The estimation is given in Table Q.10.

The main O/M costs are operator's salaries, power costs, repair costs and investment of proposed O/M unit. These are generally paid by beneficiaries as mentioned above and the estimation is given in Tables Q.11, Q.12 and Q.13.

Exchange Rate (FRW/US$)

Date		Exchange Rate (FRW/US$)
1990	Mar.	79.17
	May	77.69
	Jul.	75.67
	Aug.	74.22
	Sep.	73.81
	8, Nov.	71.79
	12, Nov.	118.70
	Des.	121.12
1991	Mar.	127.67
	May.	127.79
	Jul.	127.81
	1, Aug.	127.92

* 66.6% of devaluation on 11, Oct. 1990

UNIT PRICE OF LABOUER

ITEM	DESCRIPTION	UNIT PRICE (FRW/D)	(FRW/M)
Manager		-	20,000
Supervisor		-	17,000
Driver	Trailer	691	17,000
Driver	W>10T	518	13,000
Driver	FR4to10T	480	12,000
Driver	Vehicle	450	10,000
Assistant Diver		270	6,500
Site Supervisor		691	
Mason	Cheif	518	
Mason		480	
Plumber		480	
Asst. Engineer/Survey		480	12,000
Welder		480	
Carpenter		480	
Painter		450	
Secretary/Assitant		330	8,000
Labour		150	
Watchman		210	

UNIT PRICE OF CONSTRUCTION AND MATERIALS

ITEM	DESCRIPTION	UNIT	UNIT PRICE (RWF)
PVC Pipe	ϕ40x33.6	m	395
- do -	ϕ50x44.8	m	415
- do -	ϕ63x56.6	m	642
- do -	ϕ75x68.6	m	661
- do -	ϕ90x83.6	m	935
- do -	ϕ110x102.8	m	1,285
- do -	ϕ125x116	m	1,741
- do -	ϕ140x130	m	2,257
- do -	ϕ160x152.6	m	1,942
- do -	ϕ200x193.6	m	2,434
CON.Pipe	ϕ10cm	m	819
- do -	ϕ15cm	m	952
- do -	ϕ20cm	m	1,186
- do -	ϕ25cm	m	1,539
- do -	ϕ30cm	m	2,014
- do -	ϕ80cm	m	13,828
- do -	ϕ80cm(RE)	m	15,988
- do -	ϕ100cm	m	19,816
- do -	ϕ100cm(RE)	m	22,041
G.S.Pipe	ϕ3/8"	m	318
- do -	ϕ1/2"	m	462
- do -	ϕ3/4"	m	636
- do -	ϕ1"	m	847
- do -	ϕ1 1/4"	m	975
- do -	ϕ1 1/2"	m	1,254
- do -	ϕ2"	m	1,581
- do -	ϕ2 1/2"	m	2,397
- do -	ϕ3"	m	2,834
- do -	ϕ4"	m	3,450
(for construction)			
Cement		Ton	320,000
Re-Bar		Ton	150,080
Sand		m3	500
Graval		m3	1,150
Brick		pc	5
Common worker		Day	120
Paint(EP)		Lt	530
Glass t=3mm		m2	1,800
Gasolin		Lt	125
Diesel		Lt	120

ADMINISTRATION COST

	Unit	Q'ty	Unit Rate F/C	Unit Rate L/C (FRW)	Total	
Project Office	l.s	1			3,000,000	aprox. 150m2
Office Equipment & Facilities	l.s	1			2,000,000	
Sub-total					5,000,000	
Sararies						
Officer in Charge	M/M	108		20,000	2,160,000	12mx9years
Civil/Water Supply Engineer	M/M	108		17,000	1,836,000	- do -
Facilities Engineer	M/M	108		17,000	1,836,000	- do -
Assistant Engineers	M/M	216		12,000	2,592,000	12mx9yearsx2
Secretary	M/M	108		8,000	864,000	12mx9years
Driver	M/M	216		10,000	2,160,000	12mx9yearsx2
Sub-total					11,448,000	
Operation						
Vehicle	M	108		20,000	2,160,000	
Fuels	M	108		30,000	3,240,000	
Office Supplies	an	9		240,000	2,160,000	
Field Equipment	an	9		120,000	1,080,000	
Others	an	9		100,000	900,000	
Sub-total					9,540,000	
GRAND TOTAL					25,988,000	

Table PRELIMINARY COST ESTIMATION
(TOTAL CONSTRUCTION COST)

Unit:1,000 RWF

COMMUNE	SYSTEM 1	SYSTEM 2	SYSTEM 3	SYSTEM 4	TOTAL
BIRENGA	0	53,163	178,245	(7,674)	231,408
KABARONDO	0	69,881	104,311	(10,113)	174,192
KAYONZA	0	130,791	163,047	(8,840)	293,838
KIGARAMA	0	0	299,068	(7,209)	299,068
MUGESERA	0	0	624,588	(0)	624,588
MUHAZI	404,875	0	0	(0)	404,875
RUKARA	0	0	328,793	(17,014)	328,793
RUKIRA	0	0	89,795	(7,889)	89,795
RUSUMO	0	294,020	448,995	(38,826)	743,015
RUTONDE	0	35,374	94,400	(1,796)	129,774
SAKE	441,716	0	239,663	(0)	681,379
TOTAL COST	846,591	583,229	2,570,905	(99,361)	4,000,725 = 31.26 million US$
					(4,100,086)
Design Population	55,809	44,016	215,112	(49,931)	314,937
Design Demand(m3/day)	1,293	1,013	3,680	(-)	5,987
COST/PERSON	15,169	13,250	11,951	(1,990)	12,703
COST/DEMAND(m3)	654,699	575,687	698,559	(-)	668,291

PROJECT COST OF THE BASIC PLAN

(Unit: million 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) x 15%	680.4
Total		5,216.5

PROJECT COST OF POSSIBLE PROJECT SCHEME

(Unit : million FRW)

Item	Prep'n Work (1992)	Package A (93-94)	Package B (95-96)	Package C (97-98)	Package D (99-00)	Total
1.Construction Work						
System 1	0.0	0.0	404.9	0.0	441.7	846.6
System 2	0.0	146.7	54.0	0.0	0.0	200.7
System 3	0.0	376.3	263.8	263.8	263.8	1,167.7
	0.0	523.0	722.7	263.8	705.5	2,215.0
2.Administration Cost	7.3	4.7	4.7	4.7	4.6	26.0
3.Engineering Service (10% of 1)	0.0	52.3	72.3	26.4	70.5	221.5
4.Base Cost (1+2+3)	7.3	580.0	799.7	294.9	780.6	2,462.5
5 Physical Contingency (15% of 4)	1.1	87.0	120.0	44.2	117.0	369.3
6.Total (4+5)	8.4	667.0	919.7	339.1	897.6	2,831.8

Basic Plan

SUMMARY OF COST ESTIMATION FOR BASIC PLAN

(Unit : 1000 FRW)

Measures		Prepa.	Package A		Package B		Package C		Package D		Total
		1,992	1,993	1,994	1,995	1,996	1,997	1,998	1,999	2,000	
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	
8. Grand Total (6+7)		8,769	608,756	805,443	868,526	1,039,234	918,236	777,969	658,238	761,114	6,446,285

Possible Project Scheme

SUMMARY OF COST ESTIMATION FOR POSSIBLE PROJECT SCHEME

(Unit : 1000 FRW)

Measures		Prepa.	Package A		Package B		Package C		Package D		Total
		1992	0	1994	1995	1996	1997	1998	1999	2000	
1. Construction Cost(C/C)											
System 1	MUHAZI			80,975	161,950	161,950					404,875
	SAKE							88,344	176,686	176,686	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	357,155	315,433	326,230	131,889	220,233	308,575	308,575	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	35,716	31,543	32,623	13,189	22,023	30,858	30,858	221,493
4. Total Base Cost(B/C) 1+2+3		7,332	273,856	395,203	349,308	361,185	147,410	244,588	341,765	341,765	2,462,411
5. Physical Contingency(15% of B/C)		1,100	41,078	59,280	52,396	54,178	22,111	36,688	51,265	51,265	369,362
6. Total (4+5)		8,432	314,934	454,483	401,705	415,363	169,521	281,277	393,029	393,029	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 (6*8)		8,769	340,633	511,231	469,938	505,352	214,499	370,141	537,888	559,403	3,517,853

Table Q.7

NO.	DESCRIPTION	UNIT	QUANTITY	Unit Rate			Amount			REMARKS
				F/C (RWF)	L/C (RWF)	Total (RWF)	F/C (RWF)	L/C (RWF)	Total (RWF)	
	Water Supply Faciliyies of System-1									
1	Muhazi						215,934,000	188,941,000	404,875,000	
2	Sake						221,020,000	220,696,000	441,716,000	
	Total						436,954,000	409,637,000	846,591,000	

NO.	DESCRIPTION	UNIT	QUANTITY	Unit Rate			Amount			REMARKS
				F/C (RWF)	L/C (RWF)	Total (RWF)	F/C (RWF)	L/C (RWF)	Total (RWF)	
	Water Supply Faciliyies of System-2									
1	Kayonza-1	L.S.					28,674,000	48,132,000	76,806,000	
2	Kayonza-2	L.S.					23,845,000	30,140,000	53,985,000	
3	Rutonde	L.S.					17,836,000	17,538,000	35,374,000	
4	kabaronda	L.S.					34,728,000	35,153,000	69,881,000	
5	Birnga	L.S.					25,598,000	27,565,000	53,163,000	
6	Rusumo-1	L.S.					35,442,000	46,017,000	81,459,000	
7	Rusumo-2	L.S.					47,459,000	60,352,000	107,811,000	
8	Rusumo-3	L.S.					34,189,000	70,561,000	104,750,000	
	Total						247,771,000	335,458,000	583,229,000	

NO.	DESCRIPTION	UNIT	QUANTITY	Unit Rate			Amount			REMARKS
				F/C (RWF)	L/C (RWF)	Total (RWF)	F/C (RWF)	L/C (RWF)	Total (RWF)	
	Water Supply Faciliyies of System-3									
1	RUKARA	L.S.					193,496,000	135,297,000	328,793,000	
2	MUGESERA	L.S.					368,033,000	256,555,000	624,588,000	
3	SAKE	L.S.					141,278,000	98,385,000	239,663,000	
4	KAYONZA	L.S.					96,148,000	66,899,000	163,047,000	
5	RUTONDE	L.S.					55,620,000	38,780,000	94,400,000	
6	KABARONDO	L.S.					61,387,000	42,924,000	104,311,000	
7	KIGARAMA	L.S.					176,021,000	123,047,000	299,068,000	
8	RUKIRA	L.S.					52,917,000	36,878,000	89,795,000	
9	BIRENGA	L.S.					104,967,000	73,278,000	178,245,000	
10	RUSUMO	L.S.					264,057,000	184,938,000	448,995,000	
	TOTAL						1,513,924,000	1,056,981,000	2,570,905,000	

Table Q.8 (3)

NO.	DESCRIPTION	UNIT	QUANTITY	Unit Rate			Amount			REMARKS
				F/C (RWF)	L/C (RWF)	Total (RWF)	F/C (RWF)	L/C (RWF)	Total (RWF)	
	Water Supply Faciliyies of System-4									
1	Rukara Ryamanyoni	unit	40.00		11,900	11,900		476,000	476,000	
2	Rukara Ryamanyoni	unit	39.00		11,900	11,900		464,100	464,100	
3	Rukara Nyakabungo	unit	283.00		11,900	11,900		3,367,700	3,367,700	
4	Rukara Rwimishiny	unit	375.00		11,900	11,900		4,462,500	4,462,500	
5	Rukara Rukara	unit	154.00		11,900	11,900		1,832,600	1,832,600	
6	Rukara Kiyenzi	unit	251.00		11,900	11,900		2,986,900	2,986,900	
7	Rukara Niyawera	unit	288.00		11,900	11,900		3,427,200	3,427,200	
8	Kayonza Gasogi,Mburabutur	unit	325.00		11,900	11,900		3,867,500	3,867,500	
9	Kayonza Musuba	unit	306.00		11,900	11,900		3,641,400	3,641,400	
10	Kabarondo Rusera	unit	178.00		11,900	11,900		2,118,200	2,118,200	
11	Rutonde Kaduha	unit	151.00		11,900	11,900		1,796,900	1,796,900	
12	Kigurama Remera	unit	134.00		11,900	11,900		1,594,600	1,594,600	
13	Kayonza Rwinkwavu	unit	112.00		11,900	11,900		1,332,800	1,332,800	
14	Kabarondo Shyanda	unit	251.00		11,900	11,900		2,986,900	2,986,900	
15	Kabarondo Bisenga,Murama	unit	421.00		11,900	11,900		5,009,900	5,009,900	
16	Kigurma Rubona	unit	191.00		11,900	11,900		2,272,900	2,272,900	
17	Birenga Birenga	unit	301.00		11,900	11,900		3,581,900	3,581,900	
18	Birenga Gahara	unit	344.00		11,900	11,900		4,093,600	4,093,600	
19	Kigarama Kabare-2	unit	281.00		11,900	11,900		3,343,900	3,343,900	
20	Rukira Gasiru,Gituku,Rugarama	unit	426.00		11,900	11,900		5,069,400	5,069,400	
21	Rukira Mushikili,Ntaruka	unit	237.00		11,900	11,900		2,820,300	2,820,300	

NO.	DESCRIPTION	UNIT	QUANTITY	Unit Rate			Amount			REMARKS
				F/C (RWF)	L/C (RWF)	Total (RWF)	F/C (RWF)	L/C (RWF)	Total (RWF)	
	Water Supply of System-4 (2)									
22	Rusumo Nyarubuye	unit	115.00		11,900	11,900		1,368,500	1,368,500	
23	Rusumo Kankobwa, Kigarama	unit	2,026.00		11,900	11,900		24,109,400	24,109,400	
24	Rusumo Nyabitare	unit	144.00		11,900	11,900		1,713,600	1,713,600	
25	Rusumo Kigina	unit	122.00		11,900	11,900		1,451,800	1,451,800	
26	Rusumo Musaza	unit	582.00		11,900	11,900		6,925,800	6,925,800	
27	Rusumo Gatore	unit	274.00		11,900	11,900		3,260,600	3,260,600	
	Total							99,376,900	99,376,900	
								99,376,000	99,376,000	

NO.	DESCRIPTION	Amount			Umuganda		REMARKS
		F/C (RWF)	L/C (RWF)	Total (RWF)	L/C (RWF)	Total (RWF)	
	Water Supply Facilities						
1	System-1	451,256,000	411,226,000	862,482,000	334,304,000	771,939,000	
2	System-2	247,771,000	335,458,000	583,229,000	293,610,000	541,362,000	
3	System-3	1,513,924,000	1,056,981,000	2,570,905,000	986,732,000	2,500,656,000	
4	System-4	0	99,376,000	99,376,000	99,376,000	99,376,000	
		2,212,951,000	1,903,041,000	4,115,992,000	1,714,022,000	3,913,333,000	

Table Q.9 (1)

PAGE

NO.	DESCRIPTION	Amount			Umuganda		REMARKS
		F/C (RWF)	L/C (RWF)	Total (RWF)	L/C (RWF)	Total (RWF)	
	Water Supply Faciliyies of System-1						
1	Muhazi	230,236,000	190,530,000	420,766,000	149,806,000	366,421,000	
2	Sake	221,020,000	220,696,000	441,716,000	184,498,000	405,518,000	
	Total	451,256,000	411,226,000	862,482,000	334,304,000	771,939,000	

NO.	DESCRIPTION	Amount			Umuganda		REMARKS
		F/C (RWF)	L/C (RWF)	Total (RWF)	L/C (RWF)	Total (RWF)	
	Water Supply Faciliyies of System-2						
1	Kayonza-1	28,674,000	48,132,000	76,806,000	42,786,000	71,460,000	
2	Kayonza-2	23,845,000	30,140,000	53,985,000	26,746,000	50,591,000	
3	Rutonde	17,836,000	17,538,000	35,374,000	14,855,000	32,691,000	
4	kabarondo	34,728,000	35,153,000	69,881,000	31,057,000	65,766,000	
5	Birnga	25,598,000	27,565,000	53,163,000	23,528,000	49,126,000	
6	Rusumo-1	35,442,000	46,017,000	81,459,000	39,709,000	75,151,000	
7	Rusumo-2	47,459,000	60,352,000	107,811,000	52,556,000	100,015,000	
8	Rusumo-3	34,189,000	70,561,000	104,750,000	62,373,000	96,562,000	
	Total	247,771,000	335,458,000	583,229,000	293,610,000	541,362,000	

PAGE

NO.	DESCRIPTION	Amount F/C (RWF)	Amount L/C (RWF)	Amount Total (RWF)	Umuganda L/C (RWF)	Umuganda Total (RWF)	REMARKS
	Water Supply Faciliyies of System-3						
1	RUKARA	193,496,000	135,297,000	328,793,000	126,127,000	319,623,000	
2	MUGESERA	368,033,000	256,555,000	624,588,000	239,851,000	607,884,000	
3	SAKE	141,278,000	98,385,000	239,663,000	92,067,000	233,345,000	
4	KAYONZA	96,148,000	66,899,000	163,047,000	62,653,000	158,801,000	
5	RUTONDE	55,620,000	38,780,000	94,400,000	36,249,000	91,869,000	
6	KABARONDO	61,387,000	42,924,000	104,311,000	40,014,000	101,401,000	
7	KIGARAMA	176,021,000	123,047,000	299,068,000	114,734,000	290,755,000	
8	RUKIRA	52,917,000	36,878,000	89,795,000	34,486,000	87,403,000	
9	BIRENGA	104,967,000	73,278,000	178,245,000	68,414,000	173,381,000	
10	RUSUMO	264,057,000	184,938,000	448,995,000	172,137,000	436,194,000	
	TOTAL	1,513,924,000	1,056,981,000	2,570,905,000	986,732,000	2,500,656,000	

Annual Cost Table of O/M Unit

	unit cost (RWF)	Quantity	Base Cost	
Investment Cost				
Operation &Management				
Allowance				
Head	12,000	12 mm	144,000	
Accountant	10,000	12 mm	120,000	
O/M Manager	10,000	12 mm	120,000	
O/M Service Worker & Collector	8,000	24 mm	192,000	
Administrator	8,000	12 mm	96,000	
Office Keeper	4,000	12 mm	48,000	
Equipment O/M	200,000	1 LS	200,000	
Office O/M	100,000	1 LS	100,000	
Fuel	130	2,000 km	260,000	
Equipment				
Vehicle(4WD)	250,000	1 no.	250,000	
Office Supplies	100,000	1 LS	100,000	cost
Field equipment	100,000	1 LS	100,000	per month
TOTAL			1,730,000	144,167

[Note] The cost of equipments is estimated as depreciations.
Infrastructure cost, such as office construction is not included.
Cost per person is calculated as a follow:

Cost/person = (monthly cost x 11 comunes)/ total population of Kibungo Prefecture(in 2000)

144,167 x 11 / 653,511
= 2.4 RWF

Table Q.11

OPERATION AND MAINTENANCE COSTS OF SYSTEM 1 [MUHAZI]

						Monthly Cost [RWF]
Direct O/M Cost						
Power Cost	unit cnsmp.	ope. hour	total cnsmp.	unit cost	daily cost	
	50	18	900	8.5	7,650	229,500
	[Kwh]		[Kwh]	[RWF]	[RWF]	
Repair Cost of Machine Parts	Total Machinary investment x 7% / 12 = O/M cost p.m.					
	29,428,000 RWF/unit			1 no x 7% /12 =		171,663
Pipeline/Faucets Repair Cost	Total investment of pipelines, valunes & fountains x 0.5% / 12 = O/M cost p.m.					
	164,694,000 RWF x 0.5%/12 =					68,623
Chemical Input	daily cnsmp. (kg)	x	unit cost [RWF]	daily cost [RWF]		
Al2(SO4)3[50mg/l]	22.5		90	2,025		60,750
Ca(ClO)2 [7mg/l]	3.2		400	1,260		37,800
Ca(OH)2 [25mg/l]	11.3		25	281		8,438
Operator/Worker's Salary	salary p.m.	x	No. of operatores			
	8,000 RWF/m x		1 =			8,000
Water Seller(KIOSK Manager)	(660m3/d x 0.75) x 7FRW x30 days		(16 persons)			103,950
					subtotal	688,723
Monthly Investment Cost for O/M Unit						
(Cost per Person) 2.5 RWF/psn						
(Design Populations & Families) 21,944 psns 3,659 fmls						
				Total Investment Cost/month		54,860
TOTAL O/M COST						743,583
				O/M Cost per Family	(Level 3) =	203 (1.59 US$)
					(Level 2) =	156 (1.22 US$)
					(Level 1) =	138 (1.07 US$)

Note: Required Power(kW/hr) = (Intake, 1.5kWx2+Dosing, 5kW+High Lift, 18.5kWx2)x1.1

OPERATION AND MAINTENANCE COSTS OF SYSTEM 1 [SAKE]

						Monthly Cost [RWF]
Direct O/M Cost						
Power Cost	unit cnsmp.	ope. hour	total cnsmp.	unit cost	daily cost	
	75	18	1,350	8.5	11,475	344,250
	[Kwh]		[Kwh]	[RWF]	[RWF]	
Repair Cost of Machine Parts	Total Machinary investment x 7% / 12 = O/M cost p.m.					
	44,597,800 RWF/unit			1 no x 7% /12 =		260,154
Pipeline/Faucets Repair Cost	Total investment of pipelines, valunes & fountains x 0.5% / 12 = O/M cost p.m.					
	145,879,200 RWF x 0.5%/12 =					60,783
Chemical Input	daily cnsmp. (kg)	x	unit cost [RWF]	daily cost [RWF]		
Al2(SO4)3[50mg/l]	25.9		90	2,329		69,863
Ca(ClO)2 [7mg/l]	3.6		400	1,440		43,200
Ca(OH)2 [25mg/l]	12.9		25	323		9,703
Operator/Worker's Salary	salary p.m.	x	No. of operatores			
	8,000 RWF/m x		1 =			8,000
Water Seller(KIOSK Manager)	(960m3/d x 0.75) x 7FRW x30 days		(26 persons)			151,200
					subtotal	947,152
Monthly Investment Cost for O/M Unit						
(Cost per Person) 2.5 RWF/psn						
(Design Populations & Families) 33,865 psns 5,648 fmls						
				Total Investment Cost/month		84,663
TOTAL O/M COST						1,031,815
				O/M Cost per Family	(Level 3) =	183 (1.43 US$)
					(Level 2) =	137 (1.07 US$)
					(Level 1) =	126 (0.98 US$)

Note: Required Power(kW/hr) = (Intake, 1.5kWx2+Dosing, 5kW+High Lift, 30.0kWx2)x1.1

OPERATION AND MAINTENANCE COSTS OF SYSTEM 2 [KAYONZA-1]

							Monthly Cost [RWF]
Direct O/M Cost							
Power Cost	unit cnsmp.	ope. hour	total cnsmp.	unit cost	daily cost		
(7.5kWx19.2hrx75 %)	7.5 [Kwh]	14.4	108 [Kwh]	8.5 [RWF]	918 [RWF]		27,540
Repair Cost of Machine Parts	Total Machinary investment x 7% / 12 = O/M cost p.m.		2,127,520 RWF/unit		1 no x 7% /12	=	12,411
Pipeline/Faucets Repair Cost	Total investment of pipelines, valunes & fountains x 0.5% / 12 = O/M cost p.m.		20,654,040 RWF/m x	0.5%/12		=	8,606
Operator/Worker's Salary	salary p.m.	x	No. of operatores 8,000 RWF/m x	1	=		8,000
Water Seller(KIOSK Manager)	(10.4m3/d x 0.75)x 7FRW x30 days			(6 persons)			15,813
					subtotal		72,369
Monthly Investment Cost for O/M Unit							
(Cost per Person) 2.5 RWF/psn							
(Design Populations & Families) 4,374 psns 729 fmls							
			Total Investment Cost/month				10,935
TOTAL O/M COST							83,304
				O/M Cost per Family (RWF)	(Level 1) =		114 (0.89 US$)
					(Level 2) =		97 (0.76 US$)
					(Level 3) =		85 (0.67 US$)

OPERATION AND MAINTENANCE COSTS OF SYSTEM 2 [KAYONZA-2]

							Monthly Cost [RWF]
Direct O/M Cost							
Power Cost	unit cnsmp.	ope. hour	total cnsmp.	unit cost	daily cost		
(11kWx12.8hrx75 %)	11 [Kwh]	9.6	105.6 [Kwh]	8.5 [RWF]	897.6 [RWF]		26,928
Repair Cost of Machine Parts	Total Machinary investment x 7% / 12 = O/M cost p.m.		4,255,040 RWF/unit		1 no x 7% /12	=	24,821
Pipeline/Faucets Repair Cost	Total investment of pipelines, valunes & fountains x 0.5% / 12 = O/M cost p.m.		11,360,640 RWF/m x	0.5%/12		=	4,734
Operator/Worker's Salary	salary p.m.	x	No. of operatores 8,000 RWF/m x	1	=		8,000
Water Seller(KIOSK Manager)	(80.3m3/d x 0.75)x 7FRW x30 days			(5 persons)			12,647
					subtotal		77,130
Monthly Investment Cost for O/M Unit							
(Cost per Person) 2.5 RWF/psn							
(Design Populations & Families) 3,508 psns 585 fmls							
			Total Investment Cost/month				8,770
TOTAL O/M COST							85,900
				O/M Cost per Family (RWF)	(Level 1) =		147 (1.15 US$)
					(Level 2) =		104 (0.82 US$)
					(Level 3) =		96 (0.75 US$)

OPERATION AND MAINTENANCE COSTS OF SYSTEM 2 [RUTONDE]

							Monthly Cost [RWF]
Direct O/M Cost							
Power Cost	unit cnsmp.	ope. hour	total cnsmp.		unit cost	daily cost	
(5.5kWx15.5hrx75 %)	9.0	11.6	104.3	5.2	120.0	12521.5	375,646
(5.5kWx1.36x1.2 PS)	[PS]		[PSh]	x 0.051/PSh	[RWF]	[RWF]	
Repair Cost of Machine Parts	Total Machinary investment x 7% / 12 = O/M cost p.m.						
			4,000,960 RWF/unit		1 no x 7% /12	=	23,339
Pipeline/Faucets Repair Cost	Total investment of pipelines, valunes & fountains x 0.5% / 12 = O/M cost p.m.						
			9,432,000 RWF/m x		0.5%/12	=	3,930
Operator/Worker's Salary	salary p.m.	x	No. of operatores				
			8,000 RWF/m x		1	=	8,000
Water Seller(KIOSK Manager)	(80.7m3/d x 0.75)x 7FRW x30 days				(5 persons)		12,710
						subtotal	423,625
Monthly Investment Cost for O/M Unit							
(Cost per Person) 2.5 RWF/psn							
(Design Populations & Families) 3,720 psns 620 fmls							
				Total Investment Cost/month			9,300
TOTAL O/M COST							432,925
				O/M Cost per Family (RWF)	(Level 1) =		698 (5.46 US$)
					(Level 2) =		661 (5.16 US$)
					(Level 3) =		654 (5.11 US$)

OPERATION AND MAINTENANCE COSTS OF SYSTEM 2 [KABARONDO]

							Monthly Cost [RWF]
Direct O/M Cost							
Power Cost	unit cnsmp.	ope. hour	total cnsmp.		unit cost	daily cost	
(7.5kWx2x15.0hr x75 %)	15.0	11.3	168.8		8.5	1434.4	43,031
	[Kwh]		[Kwh]		[RWF]	[RWF]	
Repair Cost of Machine Parts	Total Machinary investment x 7% / 12 = O/M cost p.m.						
			2,127,520 RWF/unit		2 no x 7% /12	=	24,821
Pipeline/Faucets Repair Cost	Total investment of pipelines, valunes & fountains x 0.5% / 12 = O/M cost p.m.						
			11,929,200 RWR/m x		0.5%/12	=	4,971
Operator/Worker's Salary	salary p.m.	x	No. of operatores				
			8,000 RWR/m x		1	=	8,000
Water Seller(KIOSK Manager)	(133.3m3/d x 0.75)x 7FRW x30 day				(7 persons)		20,995
						subtotal	101,818
Monthly Investment Cost for O/M Unit							
(Cost per Person) 2.5 RWF/psn							
(Design Populations & Families) 5,956 psns 994 fmls							
				Total Investment Cost/month			14,890
TOTAL O/M COST							116,708
				O/M Cost per Family (RWF)	(Level 1) =		117 (0.92 US$)
					(Level 2) =		92 (0.72 US$)
					(Level 3) =		87 (0.68 US$)

OPERATION AND MAINTENANCE COSTS OF SYSTEM 2 [BIRENGA]

							Monthly Cost [RWF]
Direct O/M Cost							
Power Cost	unit cnsmp.	ope. hour	total cnsmp.		unit cost	daily cost	
(11kWx13.0hrx75 %)	18.0	9.8	175.0	8.8	120.0	21003.8	630,115
(11kWx1.36x1.2 PS)	[PS]		[PSh] x 0.051/PSh		[RWF]	[RWF]	
Repair Cost of Machine Parts	Total Machinary investment x 7% / 12 = O/M cost p.m. 8,160,000 RWF/unit				1 no x 7% /12 =		47,600
Pipeline/Faucets Repair Cost	Total investment of pipelines, valunes & fountains x 0.5% / 12 = O/M cost p.m. 15,072,600 RWF/m x 0.5%/12 =						6,280
Operator/Worker's Salary	salary p.m. x No. of operatores 8,000 RWF/m x 1 =						8,000
Water Seller(KIOSK Manager)	(77.8m3/d x 0.75)x 7FRW x30 days (6 persons)						12,254
						subtotal	704,249
Monthly Investment Cost for O/M Unit							
(Cost per Person) 2.5 RWF/psn							
(Design Populations & Families) 3,588 psns 598 fmls							
				Total Investment Cost/month			8,970
TOTAL O/M COST							713,219
				O/M Cost per Family (RWF)	(Level 1) =		1,193 (9.32 US$)
					(Level 2) =		1,113 (8.70 US$)
					(Level 3) =		1,103 (8.61 US$)

OPERATION AND MAINTENANCE COSTS OF SYSTEM 2 [RUSUMO-1]

							Monthly Cost [RWF]
Direct O/M Cost							
Power Cost	unit cnsmp.	ope. hour	total cnsmp.		unit cost	daily cost	
(7.5kWx2x19.3hx75%)	24.5	14.5	354.3	17.7	120.0	42521.8	1,275,653
(7.5kWx1.36x1.2 PS)	[PS]		[PSh] x 0.051/PSh		[RWF]	[RWF]	
Repair Cost of Machine Parts	Total Machinary investment x 7% / 12 = O/M cost p.m. 4,448,480 RWF/unit				2 no x 7% /12 =		51,899
Pipeline/Faucets Repair Cost	Total investment of pipelines, valunes & fountains x 0.5% / 12 = O/M cost p.m. 24,297,480 RWF/m x 0.5%/12 =						10,124
Operator/Worker's Salary	salary p.m. x No. of operatores 8,000 RWF/m x 1 =						8,000
Water Seller(KIOSK Manager)	(172.2m3/d x 0.75)x 7FRW x30 day (8 persons)						27,122
						subtotal	1,372,797
Monthly Investment Cost for O/M Unit							
(Cost per Person) 2.5 RWF/psn							
(Design Populations & Families) 7,300 psns 1,218 fmls							
				Total Investment Cost/month			18,250
TOTAL O/M COST							1,391,047
				O/M Cost per Family (RWF)	(Level 1) =		1,142 (8.92 US$)
					(Level 2) =		1,099 (8.59 US$)
					(Level 3) =		1,091 (8.52 US$)

OPERATION AND MAINTENANCE COSTS OF SYSTEM 2 [RUSUMO-2]

							Monthly Cost [RWF]
Direct O/M Cost							
Power Cost	unit cnsmp.	ope. hour	total cnsmp.	unit cost	daily cost		
(11kWx2x17.3hx75 %)	35.9	13.0	465.9	23.3	120.0	55902.5	1,677,076
(11kWx1.36x1.2 PS)	[PS]		[PSh] x 0.051/PSh		[RWF]	[RWF]	
Repair Cost of Machine Parts	Total Machinary investment x 7% / 12 = O/M cost p.m.						
	8,161,200 RWF/unit x 2 no x 7% /12 =						95,214
Pipeline/Faucets Repair Cost	Total investment of pipelines, valunes & fountains x 0.5% / 12 = O/M cost p.m.						
	31,701,600 RWF/m x 0.5%/12 =						13,209
Operator/Worker's Salary	salary p.m. x No. of operatores						
	8,000 RWF/m x 1 =						8,000
Water Seller(KIOSK Manager)	(199m3/d x 0.75)x 7FRW x30 days				(11 persons)		31,343
						subtotal	1,824,841
Monthly Investment Cost for O/M Unit							
(Cost per Person) 2.5 RWF/psn							
(Design Populations & Families) 8,292 psns 1,382 fmls							
				Total Investment Cost/month			20,730
TOTAL O/M COST							1,845,571
O/M Cost per Family (RWF)					(Level 1) =		1,335 (10.43 US$)
					(Level 2) =		1,267 (9.89 US$)
					(Level 3) =		1,257 (9.82 US$)

OPERATION AND MAINTENANCE COSTS OF SYSTEM 2 [RUSUMO-3]

							Monthly Cost [RWF]
Direct O/M Cost							
Power Cost	unit cnsmp.	ope. hour	total cnsmp.	unit cost	daily cost		
(7.5kWx2x19.2hx75 %	24.5	14.4	352.5	17.6	120.0	42301.4	1,269,043
(7.5kWx1.36x1.2 PS)	[PS]		[PSh] x 0.051/PSh		[RWF]	[RWF]	
Repair Cost of Machine Parts	Total Machinary investment x 7% / 12 = O/M cost p.m.						
	4,448,480 RWF/unit x 2 no x 7% /12 =						51,899
Pipeline/Faucets Repair Cost	Total investment of pipelines, valunes & fountains x 0.5% / 12 = O/M cost p.m.						
	35,167,800 RWF/m x 0.5%/12 =						14,653
Operator/Worker's Salary	salary p.m. x No. of operatores						
	8,000 RWF/m x 1 =						8,000
Water Seller(KIOSK Manager)	(170.5m3/d x 0.75)x 7FRW x30 day				(17 persons)		26,854
						subtotal	1,370,449
Monthly Investment Cost for O/M Unit							
(Cost per Person) 2.5 RWF/psn							
(Design Populations & Families) 7,278 psns 1,213 fmls							
				Total Investment Cost/month			18,195
TOTAL O/M COST							1,388,644
O/M Cost per Family (RWF)					(Level 1) =		1,145 (8.94 US$)
					(Level 2) =		1,102 (8.61 US$)
					(Level 3) =		1,090 (8.52 US$)

ESTIMATIONS OF WATER FEE AND O/M COST OF SYSTEM-3

Commune Name	Secteur Name	Population 2000	FAMILY 2000	Water Demand (m3/day)	No. of Well	O/M Unit	Repair	Total	/Fmly (unit:RWF)	(US$)
RUKARA	GAHINI	3,827	638	111.4	12	9,568	15,240	24,808	38.9	0.30
	KIYENZI	3,511	586	56.8	6	8,778	7,620	16,398	28.0	0.22
	NYAKABUNGO	2,345	391	38.1	5	5,863	6,350	12,213	31.2	0.24
	NYAWERA	4,024	671	62.6	8	10,060	10,160	20,220	30.1	0.24
	RUKARA	6,677	1,113	119.9	12	16,693	15,240	31,933	28.7	0.22
	RWIMISHINYA	3,594	599	58.0	6	8,985	7,620	16,605	27.7	0.22
	RYAMANYONI	3,450	575	60.2	14	8,625	17,780	26,405	45.9	0.36
	TOTAL	27,428	4,573	507.0	63	68,570	80,010	148,580	32.5	0.25
MUGESERA	CYIZIHIRA	4,199	700	63.1	8	10,498	10,160	20,658	29.5	0.23
	GATARE	4,311	719	69.6	9	10,778	11,430	22,208	30.9	0.24
	KAGASHI	5,137	857	81.3	11	12,843	13,970	26,813	31.3	0.24
	KAREMBO	614	103	9.4	1	1,535	1,270	2,805	27.2	0.21
	KIBARE	4,892	816	75.8	10	12,230	12,700	24,930	30.6	0.24
	KIBILIZI-1,	5,169	862	83.2	9	12,923	11,430	24,353	28.3	0.22
	KIRAMBO	3,584	598	53.9	7	8,960	8,890	17,850	29.8	0.23
	KUKABUYE	2,936	490	45.2	5	7,340	6,350	13,690	27.9	0.22
	MATONGO	3,726	621	56.0	7	9,315	8,890	18,205	29.3	0.23
	NGARA	3,944	658	62.0	7	9,860	8,890	18,750	28.5	0.22
	NYANGE	3,105	518	57.8	8	7,763	10,160	17,923	34.6	0.27
	SANGAZA	4,190	699	67.6	9	10,475	11,430	21,905	31.3	0.24
	SHYWA	3,931	656	62.4	8	9,828	10,160	19,988	30.5	0.24
	ZAZA	2,064	344	99.6	13	5,160	16,510	21,670	63.0	0.49
	TOTAL	51,802	8,641	886.9	112	129,505	142,240	271,745	31.4	0.25
SAKE	MBUYE	2,010	335	31.0	4	5,025	5,080	10,105	30.2	0.24
	MURWA	5,666	945	100.3	13	14,165	16,510	30,675	32.5	0.25
	RUKUMBERI	6,058	1,010	99.5	13	15,145	16,510	31,655	31.3	0.24
	SHOLI	5,521	921	89.3	12	13,803	15,240	29,043	31.5	0.25
	TOTAL	19,255	3,211	320.1	42	48,138	53,340	101,478	31.6	0.25
KAYONZA	GASOGI	2,617	437	41.5	5	6,543	6,350	12,893	29.5	0.23
	MBURABUTURO	1,932	322	29.1	3	4,830	3,810	8,640	26.8	0.21
	MUSUMBA	1,471	246	24.2	3	3,678	3,810	7,488	30.4	0.24
	NYAMIRAMA	3,285	548	53.8	6	8,213	7,620	15,833	28.9	0.23
	RUTARE	3,267	545	51.6	6	8,168	7,620	15,788	29.0	0.23
	RWINKWAVU	448	75	9.1	2	1,120	2,540	3,660	48.8	0.38
	SHYOGO	1,403	234	22.7	3	3,508	3,810	7,318	31.3	0.24
	TOTAL	14,423	2,407	232.0	28	36,058	35,560	71,618	29.8	0.23
RUTONDE	KADUHA	1,339	224	20.3	3	3,348	3,810	7,158	32.0	0.25
	RUTONDE	3,326	555	54.6	6	8,315	7,620	15,935	28.7	0.22
	RWERU	930	155	14.0	2	2,325	2,540	4,865	31.4	0.25
	SOVU	3,244	541	52.0	6	8,110	7,620	15,730	29.1	0.23
	TOTAL	8,839	1,475	140.9	17	22,098	21,590	43,688	29.6	0.23
KABARONDO	BISENGA	2,223	371	36.5	4	5,558	5,080	10,638	28.7	0.22
	MURAMA	941	157	15.0	2	2,353	2,540	4,893	31.2	0.24
	NKAMBA	934	156	14.1	2	2,335	2,540	4,875	31.3	0.24
	RURAMIRA	1,914	319	32.5	4	4,785	5,080	9,865	30.9	0.24
	RUSERA	2,159	360	32.5	4	5,398	5,080	10,478	29.1	0.23
	RUYONZA	1,115	186	16.7	2	2,788	2,540	5,328	28.6	0.22
	SHYANDA	887	148	14.2	2	2,218	2,540	4,758	32.1	0.25
	TOTAL	10,173	1,697	161.5	20	25,433	25,400	50,833	30.0	0.23

ESTIMATIONS OF WATER FEE AND O/M COST OF SYSTEM-3

Commune Name	Secteur Name	Population 2000	FAMILY 2000	Water Demand (m3/day)	No. of Well	O/M Unit	Repair	Total	/Fmly (unit:RWF)	(US$)
KIGARAMA	GASETSA	696	116	12.3	3	1,740	3,810	5,550	47.8	0.37
	GASHANDA	2,326	388	41.4	5	5,815	6,350	12,165	31.4	0.24
	KABARE-1	1,507	252	38.6	4	3,768	5,080	8,848	35.1	0.27
	KABARE-2	3,370	562	61.1	10	8,425	12,700	21,125	37.6	0.29
	KABERANGWE	1,714	286	28.9	3	4,285	3,810	8,095	28.3	0.22
	KANSANA	2,395	400	43.2	5	5,988	6,350	12,338	30.8	0.24
	REMERA	1,748	292	31.8	4	4,370	5,080	9,450	32.4	0.25
	RUBONA	6,110	1,019	107.7	11	15,275	13,970	29,245	28.7	0.22
	RURENGE	1,924	321	33.3	4	4,810	5,080	9,890	30.8	0.24
	VUMWE	4,441	741	72.1	8	11,103	10,160	21,263	28.7	0.22
	TOTAL	26,231	4,377	470.4	57	65,578	72,390	137,968	31.5	0.25
RUKIRA	GASIRU	1,733	289	27.4	4	4,333	5,080	9,413	32.6	0.25
	GITWE	2,056	343	34.2	4	5,140	5,080	10,220	29.8	0.23
	MUSHIKILI	1,786	298	28.1	4	4,465	5,080	9,545	32.0	0.25
	NTARUKA	224	38	3.9	1	560	1,270	1,830	48.2	0.38
	RUGARAMA	1,883	314	29.6	3	4,708	3,810	8,518	27.1	0.21
	TOTAL	7,682	1,282	123.2	16	19,205	20,320	39,525	30.8	0.24
BIRENGA	BARE	1,237	207	21.9	3	3,093	3,810	6,903	33.3	0.26
	BIRENGA	1,351	226	23.6	3	3,378	3,810	7,188	31.8	0.25
	GAHARA	3,709	619	62.6	7	9,273	8,890	18,163	29.3	0.23
	GAHULIRE	1,512	252	24.5	3	3,780	3,810	7,590	30.1	0.24
	GASHONGORA	2,231	372	35.4	4	5,578	5,080	10,658	28.6	0.22
	KIBAYA	3,570	595	58.8	6	8,925	7,620	16,545	27.8	0.22
	KIBIMBA	1,522	254	26.9	3	3,805	3,810	7,615	30.0	0.23
	SAKARA	2,110	352	33.9	4	5,275	5,080	10,355	29.4	0.23
	TOTAL	17,242	2,877	287.6	33	43,105	41,910	85,015	29.5	0.23
RUSUMO	GATORE	3,285	548	54.2	6	8,213	7,620	15,833	28.9	0.23
	KANKOBWA	4,847	808	79.5	30	12,118	38,100	50,218	62.2	0.49
	KIGARAMA	3,361	561	53.4	6	8,403	7,620	16,023	28.6	0.22
	KIGINA	5,838	973	102.9	11	14,595	13,970	28,565	29.4	0.23
	KIREHE	2,149	359	36.6	4	5,373	5,080	10,453	29.1	0.23
	MUSAZA	6,978	1,163	108.0	11	17,445	13,970	31,415	27.0	0.21
	NYABITARE	5,177	863	82.6	9	12,943	11,430	24,373	28.2	0.22
	NYAMUGALI	1,679	280	28.2	5	4,198	6,350	10,548	37.7	0.29
	NYARUBUYE	3,455	576	59.9	7	8,638	8,890	17,528	30.4	0.24
	TOTAL	36,769	6,131	605.3	89	91,923	113,030	204,953	33.4	0.26
TOTAL		219,844	36,671	3735	477	549,610	605,790	1,155,400	31.5	0.25

OPERATION AND MAINTENANCE COSTS OF SYSTEM 3

			Monthly Cost (RWF)
Direct O/M Cost			
Repair Cost	Total investment of manual-pump x 7.0 % / 12 = O/M cost p.m.	217,790 F/wellx 1 no. x 7.0%/12	1,270
		O/M Cost per well=	1,270
Monthly Investment Cost for O/M Unit			
(Cost per Person)	2.5 RWF/person (6persons/fmly)	O/M Cost per Family =	15

APPENDIX R

SUPPLEMENTARY STUDY

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SUPPLEMENTARY STUDY

Supplementary Studies which are requested from MINITRAPEE, are carried out to provide further examination results of Phase III Study.

The studies consist of three teams as below:

- Introduction of "Solar Energy Pump"
- Introduction of Piped-water Supply Facilities to the System-4 Areas
- Extension of Piped-water Supply Facilities in Rukara Area

1. POSSIBILITY OF INTRODUCING SOLAR ENERGY PUMPS

1.1 GENERAL

In General, the merits of a solar panel (photovoltaic power generating system) are as follows:

Based on the above merits, there is a high potential for using solar panels as power sources for the pumps used in domestic water supply projects. However, as a solar panel has the following demerits, there are technical and economic restrictions for its introduction:

. Initial cost for installation is high
. On cloudy days, its efficiency is low
. Pump head and discharge are restricted

1.2 OUTLINE OF SOLAR PUMPING SYSTEM

(1) System Selection

Solar pumping systems can be used with or without battery(see Fig. R.1). In a solar pumping system, usually batteries are employed to store the electrical energy from sunlight during the day for use at night. However, a pumping system without batteries is more advantageous. In a pumping system without batteries, solar radiation energy, which is converted into electricity by means of photovoltaic modules, is directly supplied to the pump and is transformed into potential energy for pumping water. A pumping system without storage battery has the following benefits:

- No need for maintenance
- High efficiency rate
- System configuration is simple with high reliability
- Inexpensiveness

In a pump system with storage battery, solar radiation energy is converted into electricity by means of photovoltaic modules and stored in the battery, which then drives the pump.

Such a pumping system has the following benefits:

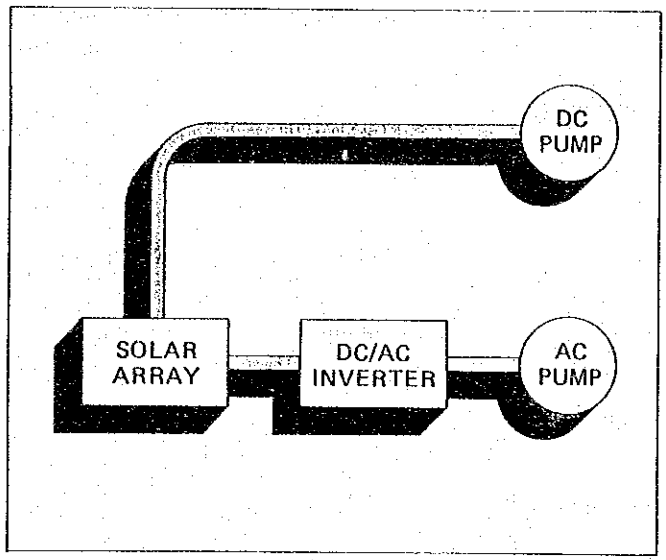
- Water can be pumped whenever it is needed
- A large volume of water can be pumped with a small capacity pump operating 24 hours a day.

(2) Pump Selection

Both DC and AC types of submersible pump can be provide for solar pumping system. The characteristics of the both types of pump are as below:

DC Submersible Pump:
The DC submersible pump is ideal in situations where the volume of water required is relatively moderate (less than 100 m3/day) with lifts (total head) less than 20 meters and is suitable for raw water supply from rivers, ponds, marshes or open wells. A DC submersible pump incorporates a DC motor which comes brush-less or with brush. Brush-less type requires no maintenance and is suitable for small capacity below 200 W. As for pumps over 200 W they are with-brush type because of economy, however, our pumps are of special design to enable replacement of brush even for submersible type.

AC Submersible Pump:
The AC submersible pump is ideal in situations where the volume of water required is moderate-to-high and is suitable for raw water or clean water supply from wells deeper than 20 meters.



(3) Capacity of Solar Pumping System

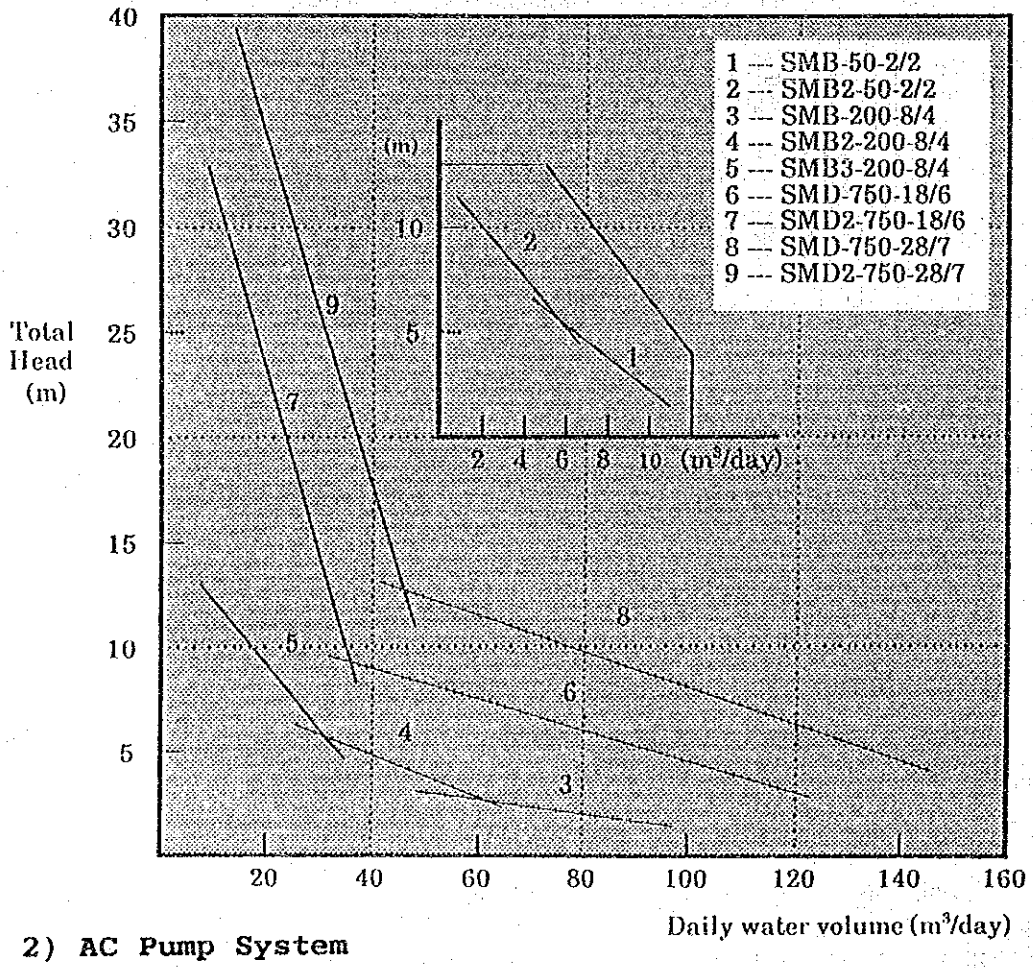
1) DC Pump System

DC pump systems have been standardized into the nine types listed in the graph below. The selection of the proper pump can be made by knowing the total head and the required volume of water on a fine day. For example, when the water requirement is 20 m3/day at a total head (static head) of 16 meters, a Type 7 can be utilized.

These DC pump systems have been manufactured for simplified use in pumping small amounts of water. These pumps are designed to be used without a storage battery, by direct connection with the photovoltaic modules.

Submersible pumps in the lower output DC pump systems come with brush-less DC motors. These motors require no maintenance work on the brushes and are easy to use. However, for economic reasons, submersible pumps in the larger capacity DC pumps system use DC motors with brushes. These motors require periodic maintenance or replacement of the brushes.

Expected daily flow rate at 600mWh/cm²-day Irradiance
(Data based on actual field test results in Japan)



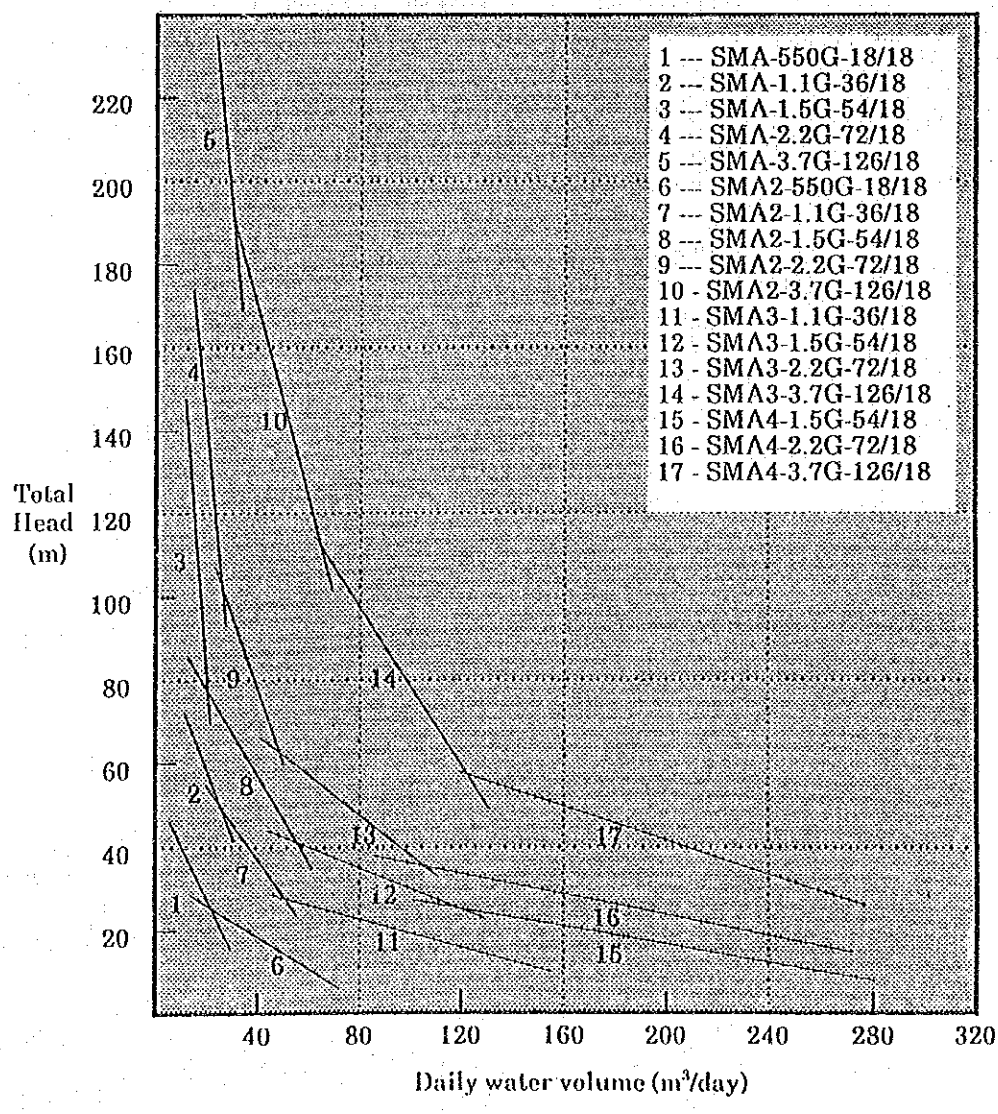
2) AC Pump System

AC pump systems have been standardized into the over 15 types as listed in the graph below. These AC pump systems have been manufactured in series for use in full-scale water supply systems

All of these AC pump systems can be used in direct connection with photovoltaic modules and an invertor and do not need batteries in order to operate efficiently. The invertor incorporates a MPPT control which ensures maximum efficiency of the photovoltaic modules in respect to variations in solar radiation. It also has other functions required for automatic operation without using a storage battery.

Besides the submersible AC pumps listed in the graph, almost all 3-phase AC pumps can be used in combination with photovoltaic modules and an invertor. When a self-priming pump or mixed-flow pump is required. Note that when a pump system of smaller capacity than those listed in the graph is required, a DC pump system can be used. If, on the other hand, a pump system of larger capacity than those listed in the graph is required, several pump units can be utilized in parallel operation.

Expected daily flow rate at 600mWh/cm²-day Irradiance
(Data based on actual field test results in Japan)



(4) Examination of the Possibility of Introducing Solar Energy

Pump into the Phase III Project

There are two possible cases for introducing solar energy pumps into the Phase III Project, they are:

Case 1: Introduction into a System 2 area (small-scale piped water supply system) employing a diesel engine operated pump.

Case 2: Introduction in a System 4 area (roof catchment system) to install a piped system.

The design water supply amount and pump head in the above two case areas are listed in Table R.2 and Fig. R.2.

When the solar energy pump is used for more than 120 m of lift, the daily pumping amount will be restricted to less than 30 m3. Therefore, the only possible area to introduce a solar energy pump would be the R-22 Area (System 4).

By lowering the water distribution tanks by approximately 50 m, it would be possible to introduce solar energy pumping systems in the following three areas:

R-1 Area (System 4)
R-2 Area (System 4)
R-5 Area (System 4)

(5) **System Component and Its Cost**

R-1, R-2, R-5 and R-22 areas are considered to have a possibility of solar energy pump facilities (SMA-3.7G-126/8) installation (see Table R.2). The system components and its costs are estimated as below:

unit:FRW

Item	Quantity	Unit Cost	System Cost
.Solar battery panel	126	160,00	20,160,000
.Supporting facilities	21	72,000	1,512,000
.Invertor	1	1,426,000	1,426,000
.Pump	1	1,890,000	1,890,000
.Accessories	1		1,000,000
Sub-total			25,988,000
Construction work			2,012,000
TOTAL			28,000,000

* The cost is CIF at Kigali

(6) **Conclusion**

The introduction of solar energy pump to the Study Area is considered to be unsuitable on account of following reasons:

- Higher cost compare with generator system
- Requirement of high maintenance technique
- Unstable workability during rainy season

2. ALTERNATIVE STUDY FOR INTRODUCTION OF PIPED WATER SUPPLY FACILITIES TO SYSTEM 4 AREAS

2.1 GENERAL

System 4 (rainwater harvesting system) is designed based on the assumption that it is no need to satisfy the basic development policy in dry season because of the economical reason. Thus, to secure a safe and stable water supply to satisfy above policy even in dry season, it is necessary to introduce System 2 (piped supply system with groundwater development) instead of System 4 in the area where System 4 is planned to install in this project.

The alternative study was made to examine the possibility of installing System 2 in System 4 installation area and the result of the study is given as the followings.

2.2 STUDY OF INTRODUCING SERVICE BLOCK

The project area installed System 2 instead of System 4 could be divided to 27 Service Block in consideration of hydrogeological conditions, topographic condition, boundary of administrations and so on. The divided Service Blocks are presented in Fig. R.3.

2.3 POPULATION SERVED AND WATER DEMAND

The population served and water demand of service blocks are presented in Table M.10.

2.4 WATER SUPPLY FACILITIES

The specification and quantity take off of water supply facilities are tabulated by each service block in Table R.4 and the outline arrangement are shown in DATA BOOK of Volume V.

2.5 CONSTRUCTION COST

The construction cost of the alternative plan (installing System 2 in System 4 installation area) is 2,097 million FRW, which is tabulated by each service block in Table R.3.

3. STUDY FOR EXTENSION POSSIBILITY OF RUKARA PIPED WATER SUPPLY FACILITIES

Some portions in Rukara Area is and will be covered by piped water supply System as shown in Fig. R.4. The extension possibility from the System is examined in the Section.

Basically, the extension development is not proposed at this project stage because of the low potentiality of existing water source and the high development cost per capita.

3.1 DEVELOPMENT POTENTIALITY OF WATER RESOURCE

Existing and planned water sources for the Rukara water supply block are springs as below:

		Discharge
Chatkue-1	:	0.65 liter/sec
Chatkue-2	:	0.77 liter/sec
Gajarama	:	1.80 liter/sec

The total amount of 278.2 m3/day is considered to be a maximum capacity for the system.

Based on the spring water yields and unit water demand(130 liter/family), possible capacity of supplied population is estimated as a follow:

$$\frac{278.2\ m3/d}{0.13\ m3/d} = 2,140 \text{ families } (= 12,840 \text{ persons})$$

3.2 EXAMINATION OF EXTENSION POSSIBILITY

The population which will be covered by the existing and/or planned water supply system, is estimated around 11,000 person in 1991. Therefore, no surplus of existing water source for further extension is expected.

In addition, according to the supply plan of MINITRAPEE, since the facilities are designed using the water source capacity of 278.2 m3/day, it is estimated that the water supply facilities have few room of extension possibility.

Thus, it is proposed that new water resource should be developed when the extension of the system will be planned.

(1) Study for Extension to Surrounding Area of the System

The condition to extend piped facilities to neighboring areas is discussed in Section 7 of Appendix L and

extending cost to an area of 4 km2 of 210,000 US$ is estimated. If per capita cost of construction is empoied as given in Appendix L, the piped facilities will be installed in the areas whose the population density of over 350 persons/km2 is considered to be suitable to extend.

The population of the surrounding area is below 300 persons/km2 in 2000 as given in Appendix D. Therefore, extension proposal from the system is not recommended, at this Study Stage.

(2) Case Study of Extension Plan

In addition, extension plan to Karamba was examined as a case study. The plan is given in Fig. R.5 nd design capacities/estimated costs are as below:

	Cost(Million FRW)
.1 Well(new water source)(D = 60 m)	7.9
.Transmission Pipeline(dia.75 mm x 2,200 m)	22.7
.Distribution Pipe(dia.30-50 mm x 11,200 m)	20.2
.Electric transmission line(2,000 m)	19.8
.Other related facilities	9.7
Total	80.3

The population of the served area in 2000 is estimated as around 3,100 persons. Therefore, the construction cost per person is;

25,900 FRW(202 US$)/person

and the cost is not suitable to proposed that the extension of piped supply facilities.

As the conclusion, the extension plan of the existing /planned water supply system in Rukara to the surrounding areas which have less than 300 persons/km2 of population density, is not satisfied on account of high construction cost per capita.

System model No.		SMB-50-2/2	SMB2-50-2/2	SMB-200-8/4	SMB2-200-8/4	SMB3-200-8/4	SMD-750-18/6	SMD-750-28/7	SMD2-750-18/6	SMD2-750-28/7
*Solar array	Maximum output	96.0 W		384.0 W			864.0 W	1344 W	864.0 W	1344 W
	Optimum voltage	33.4 V		66.8 V			100.2 V	116.9 V	100.2 V	116.9 V
	Connection of modules	2 series 1 parallel of 48.0 W modules		4 series 2 parallel of 48.0 W modules			6 series 3 parallel of 48.0W modules	7 series 4 parallel of 48.0W modules	6 series 3 parallel of 48.0W modules	7 series 4 parallel of 48.0W modules
Pump and motor	Model No.	SMB-50	SMB2-50	SMB-200	SMB2-200	SMB3-200	SMD-750		SMD2-750	
	Type	Submersible pump incorporating brushless DC motor					Submersible pump incorporating brush DC motor			
	Rated output	50 W		200 W			750 W			
	Discharge size	19 mm		40 mm			50 mm		40 mm	
	Net weight	6 kg		20 kg	35 kg		32 kg		28 kg	
Accessories		Hose (10m) Rope (10m) Tool set		Hose (10m) Rope (10m) Tool set			Hose (15m) Rope (15m) Spare parts Tool set		Hose (20m) Rope (20m) Spare parts Tool set	
Weight and measurement		Weight : 40kg Measurement : 0.35m^3		Weight : 180kg Measurement : 1.2m^3			For SMD-750-18/6 & SMD2-750-18/6 Weight : 245kg Measurement : 2.2m^3 For SMD-750-28/7 & SMD2-750-28/7 Weight : 400kg Measurement : 2.9m^3			

* The electrical characteristics are mean values based on measurements made at Standard Test Conditions which are : Irradiance of 100mW/cm^2, AM1.5 and cell temperature of 25°C

(continue)

Table R.1 (1)

System model No.		SMA-550G-18/18 SMA2-550G-18/18	SMA-1.1G-36/18 SMA2-1.1G-36/18 SMA3-1.1G-36/18	SMA-1.5G-54/18 SMA2-1.5G-54/18 SMA3-1.5G-54/18 SMA4-1.5G-54/18	SMA-2.2G-72/18 SMA2-2.2G-72/18 SMA3-2.2G-72/18 SMA4-2.2G-72/18	SMA-3.7G-126/18 SMA2-3.7G-126/18 SMA3-3.7G-126/18 SMA4-3.7G-126/18
*Solar array	Maximum output	864.0 Wp	1728.0 Wp	2592.0 Wp	3456.0 Wp	6048.0 Wp
	Optimum voltage	300.6 V				
	Connection of modules	18 series 1 parallel of 48.0 W modules	18 series 2 parallel of 48.0 W modules	18 series 3 parallel of 48.0 W modules	18 series 4 parallel of 48.0 W modules	18 series 7 parallel of 48.0 W modules
Invert-er	Model No.	SPI-1		SPI-2		
	Type	VVVF type				
	Capacity	1.5kVA		5.5kVA		
	Output voltage	AC0~200V (0~60Hz)				
Pump and motor	Rated output	0.55 kW	1.1 kW	1.5 kW	2.2 kW	3.7 kW
	Bore hole size	More than 100mm				More than 150mm
	Material	Stainless steel				
	Net weight	14 kg	22 kg	35 kg	44 kg	61 kg
Accessories		Bed 1pc., Sluice valve 1pc., Check valve 1pc., Compound gauge 1pc.				
Weight and measurement		Weight : 390kg Measurement : 2.2m^3	Weight : 570kg Measurement : 3.2m^3	Weight : 750kg Measurement : 4.0m^3	Weight : 970kg Measurement : 4.8m^3	Weight : 1700kg Measurement: 7.4m^3

* The electrical characteristics are mean values based on measurements made at Standard Test Conditions which are : Irradiance of 100mW/cm^2, AM1.5 and cell temperature of 25°C

Table R.1 (2)

List of Candidate Area for Solar Pumping System

Case	Name of System	No. of families	Daily Water volume (m3/day)	Total Head (m)		Remark
1	Rutonde	620	93	120	40	
	Rusumo-1	1,217	197	210	20	
	Rusumo-2	1,382	229	330	**	
	Rusumo-3	1,120	182	230	23	
2	R-1	53	9	260	220	-40m O.K.
	R-2	26	5	230	180	-50m O.K.
	R-3	223	36	300	100	
	R-4	375	59	140	60	
	R-5	154	27	140	130	-10m O.K.
	R-6	251	40	230	80	
	R-7	348	54	230	65	
	R-8	325	50	230	70	
	R-9	306	49	190	70	
	R-10	178	27	310	130	
	R-11	151	23	270	150	
	R-12	134	22	230	152	
	R-13	112	21	330	155	
	R-14	251	40	350	80	
	R-15	421	67	280	55	
	R-16	191	32	280	120	
	R-17	301	51	210	67	
	R-18	344	56	150	64	
	R-19	281	46	230	75	
	R-20	462	72	350	52	
	R-21	199	31	190	115	
	R-22	115	20	120	160	O.K.
	R-23	1,185	189	320	23	
	R-24	144	23	350	150	
	R-25	122	21	340	155	
	R-26	1,422	220	350	**	
	R-27	274	44	350	76	

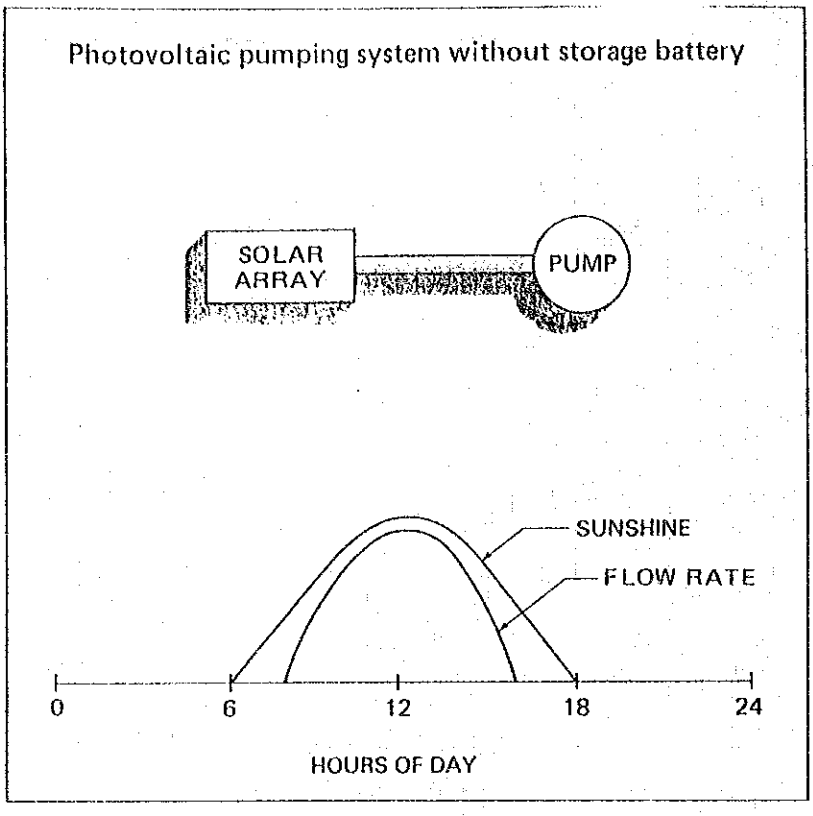
NO.	DESCRIPTION	UNIT	QUANTITY	Unit Rate Total (RWF)	Amount Total (RWF)	REMARKS
	Water Supply Facilities of System-4 (1)					Cost per head US$
1	R1	L.S.			40,650,100	1,323
2	R2	L.S.			40,264,600	1,368
3	R3	L.S.			67,421,480	310
4	R4	L.S.			50,350,160	175
5	R5	L.S.			47,476,340	403
6	R6	L.S.			79,496,660	413
7	R7	L.S.			75,665,180	343
8	R8	L.S.			66,718,520	267
9	R9	L.S.			95,358,300	407
10	R10	L.S.			49,779,400	366
11	R11	L.S.			48,229,900	418
12	R12	L.S.			41,513,600	404
13	R13	L.S.			112,291,360	1,305
14	R14	L.S.			67,009,260	348
15	R15	L.S.			66,945,880	207
16	R16	L.S.			58,286,140	397
17	R17	L.S.			52,572,540	228
18	R18	L.S.			58,458,220	222
19	R19	L.S.			63,715,340	296
20	R20	L.S.			87,132,617	267

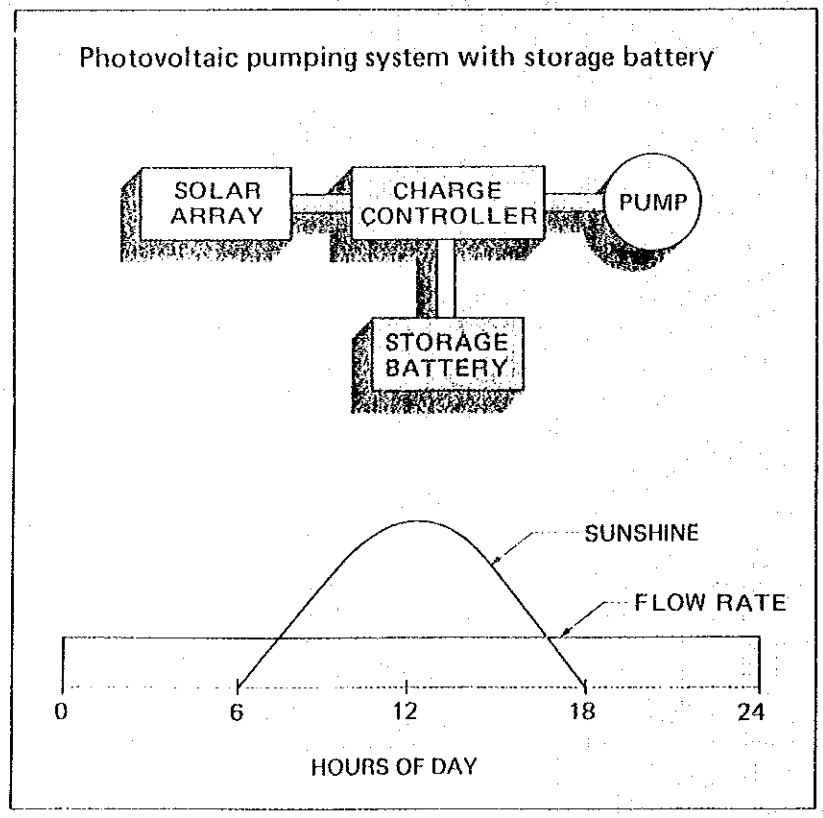
NO.	DESCRIPTION	UNIT	QUANTITY	Unit Rate Total (RWF)	Amount Total (RWF)	REMARKS
	Water Supply Facilities of System-4 (1)					Cost per head US$
21	R21	L.S.			54,571,500	302
22	R22	L.S.			40,897,780	463
23	R23	L.S.			129,039,860	180
24	R24	L.S.			78,553,760	260
25	R25	L.S.			91,446,500	320
26	R26	L.S.			181,413,940	202
27	R27	L.S.			61,206,240	291
	Total				1,906,467,177	

(continue)

Proposed Water Supply Facilities of System-4

Service Block Name	Intake Facilities					T.M.	Reservoir						Distribution Facilities									
	No. of Well	Pump Facility Φ40 (unit)				DCIP (m)	Tank (unit)						PVC Pipe (m)					Stand Pipe (unit)	T.M. Line (m)	Generater (unit)			
		3.7KW	5.5KW	7.5kw	11kw	Φ75mm	10m3	20m3	30m3	40m3	80m3	120	Φ30mm	Φ50mm	Φ75mm	Φ100mm	Φ150mm			3.7kw	5.5kw	7.5kw	11kw
R1	1				1	1,100	1						2,500					3					1
R2	1			1		1,500	1						2,600					3				1	
R3	1				1	2,200		1					3,260	4,340				5					1
R4	1		1			2,100			1				1,620	980	900			3			1		
R5	1		1			2,200		1					1,280	920				2			1		
R6	1			1		2,200		1					1,570	2,530				4	2,500				
R7	1			1		3,300			1				3,220	2,600	1,480			5				1	
R8	1			1		2,200			1				640	460	200			2	2,000				
R9	1			1		2,200			1				4,290	2,490	920			6	3,000				
R10	1				1	1,800		1					850	650				2	700				
R11	1				1	2,200		1										1					1
R12	1			1		2,200		1										1	200				
R13	1				1	2,900		1					10,720	4,080				9	2,000				
R14	1				1	2,900		1					2,470	1,530				3					1
R15	1				1	1,900				1			3,300	1,830	2,870			5					1
R16	1				1	1,800		1					3,080	2,820				5					1
R17	1			1		2,000			1				2,590	1,430	680			3					1
R18	1		1			2,000			1				3,410	1,880	1,710			5			1		
R19	1			1		2,000			1				5,490	3,030	580			6				1	
R20	1				1	3,300				1			3,460	1,910	3,730			6					1
R21	1			1		2,200		1					2,400	2,300				4				1	
R22	1	1				1,900	1						1,210	290				2		1			
R23	2				2	4,100					1			1,080	590	2,090	3,640	5					2
R24	1				1	3,000		1					5,420	2,580				5					1
R25	1				1	4,500		1					4,350	1,450				4					1
R26	2				2	5,400						1	2,580	1,430	3,190	6,010	4,290	10					2
R27	1				1	2,000			1				3,730	2,070	200			4					1
TOTAL	29	1	3	4	15	67,100	3	12	8	2	1	1	76,040	44,680	17,050	8,100	7,930	113	10,400	1	3	4	15


Photovoltaic pumping system without storage battery
SOLAR ARRAY
PUMP
SUNSHINE
FLOW RATE
0
6
12
18
24
HOURS OF DAY


Photovoltaic pumping system with storage battery
SOLAR ARRAY
CHARGE CONTROLLER
PUMP
STORAGE BATTERY
SUNSHINE
FLOW RATE
0
6
12
18
24
HOURS OF DAY