No.

BASIC DESIGN STUDY REPORT

ON

THE PROJECT FOR RURAL WATER SUPPLY

IN

THE REPUBLIC OF RWANDA

JUNE 2006

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

G M
J R
06-107

PREFACE

In response to a request from the Government of the Republic of Rwanda, the Government of Japan decided to conduct a basic design study on Rural Water Supply and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Rwanda a study team from September 25 to November 7, 2005.

The team held discussions with the officials concerned of the Government of Rwanda, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Rwanda in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Rwanda for their close cooperation extended to the teams.

June, 2006

Masafumi Kuroki
Vice President
Japan International Cooperation Agency

June, 2006

Letter of Transmittal

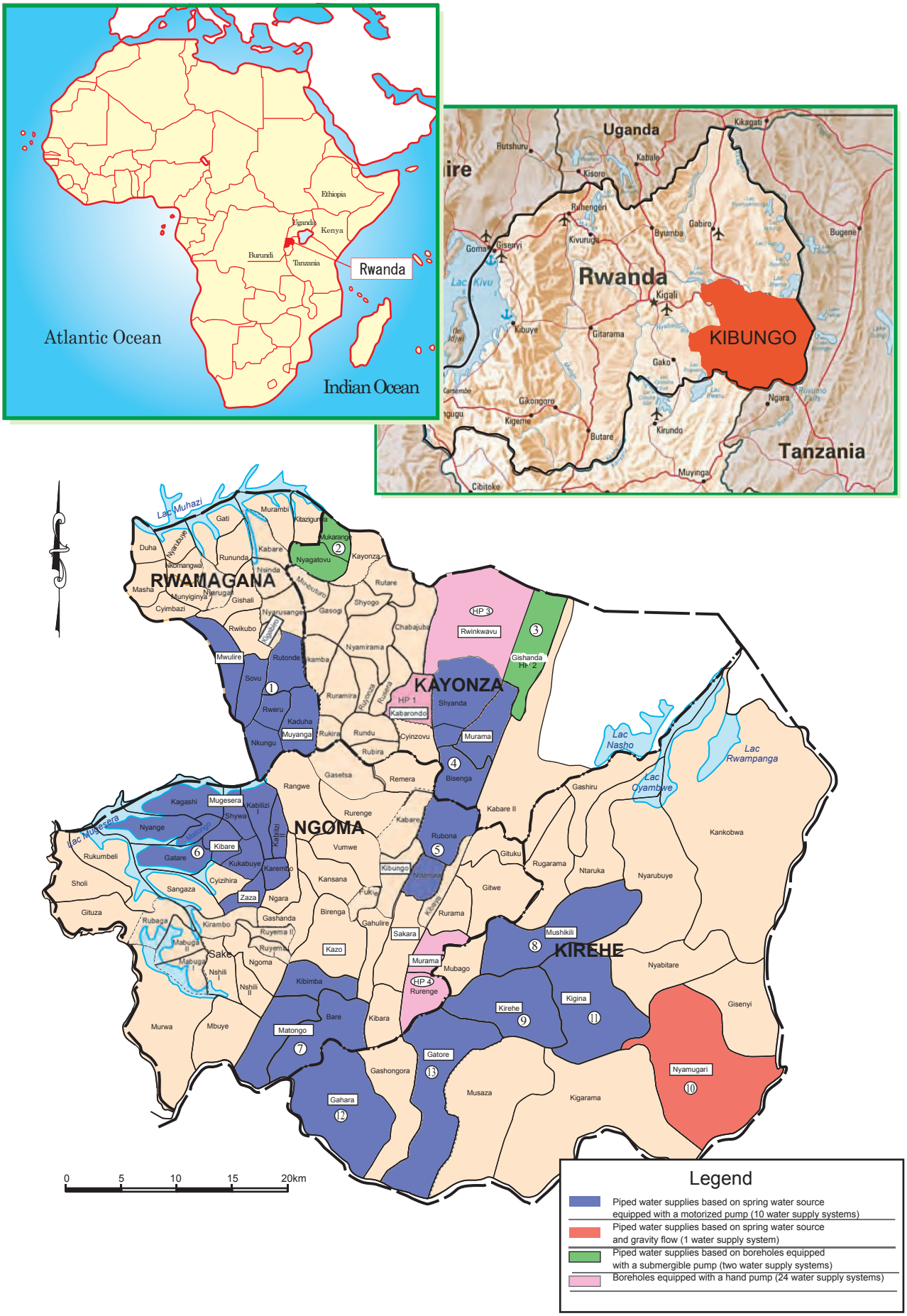
We are pleased to submit to you the basic design study report on Rural Water Supply in the Republic of Rwanda.

This study was conducted by Nippon Koei Co., Ltd., under a contract to JICA, during the period from September 25 to November 7, 2005. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Rwanda and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

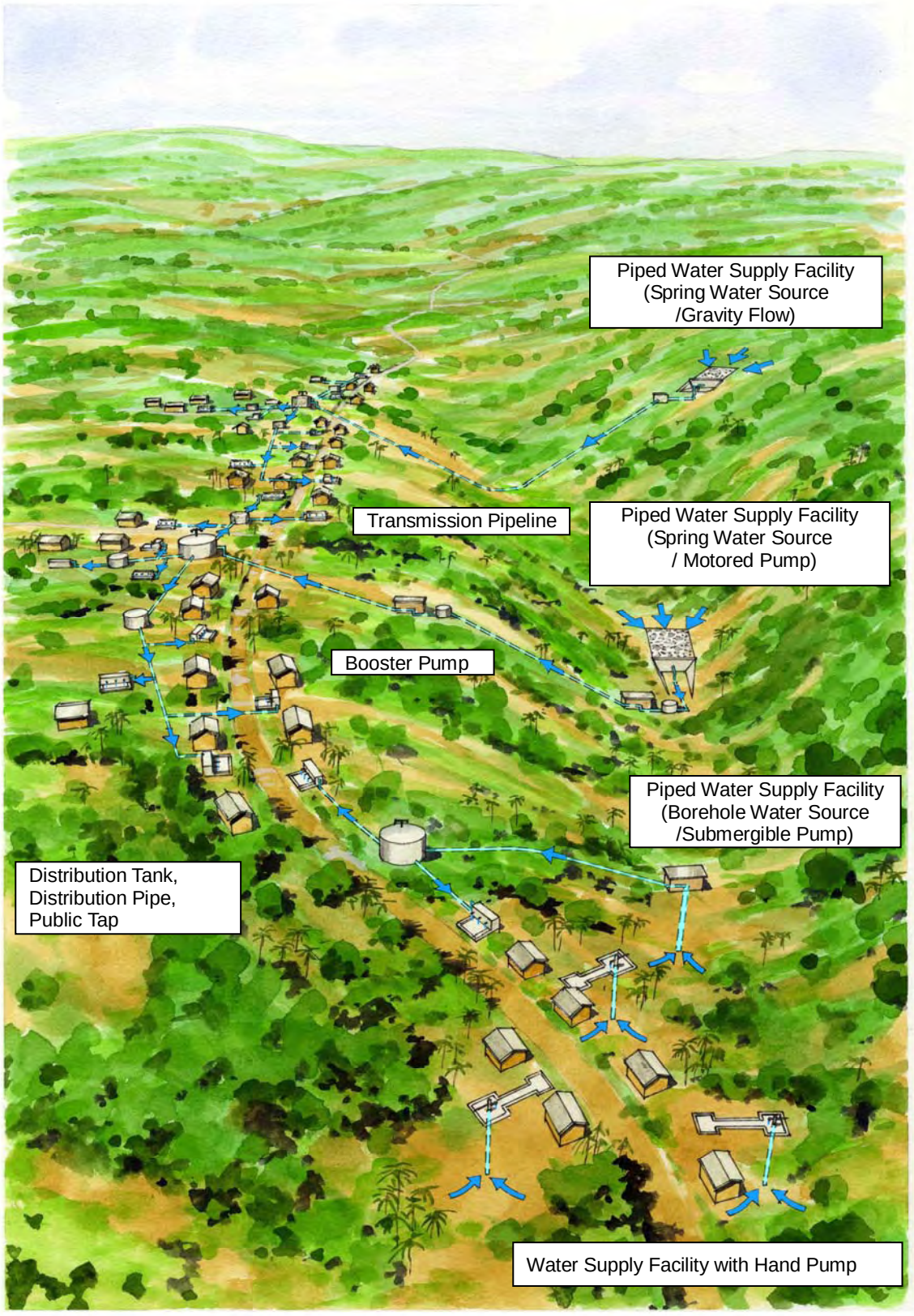
Very truly yours,

Shohei Yamamoto
Project Manager
Basic design study team on Rural Water Supply
Nippon Koei Co., Ltd.



REPUBLIC OF RWANDA
THE PROJECT FOR RURAL WATER SUPPLY

PROJECT LOCATION MAP



Perspective

ABBREVIATIONS

AfDB	African Development Bank
BADEA	Arab Bank for Economic Development in Africa
CDC	Community Development Committee
CDF	Common Development Fund
EC	Electric Conductivity
EU	European Union
FAFG	Fonds d'Assistance aux Rescapés du Génocide/Genoside Survivor Fund
Frw	Rwanda Franc
GDP	Gross Domestic Product
GNI	Gross National Income
GOJ	Government of Japan
GOR	Government of Rwanda
GPS	Global Positioning System
HIMS	Health Management Information System
IDA	International Development Association
IRC	International Red Cross
ISO	International Standard Organization
KIST	Kigali Institute of Science, Technology and Management
MDGs	Millennium Development Goals
MGEPROFE	Ministry of Gender and Woman Promotion
MINAFEET	Ministry of Foreign Affairs and Cooperation
MINAGRI	Ministry of Agriculture and Animal Resources
MINALOC	Ministry of local Government, Community Development and Social Affairs
MINECOFIN	Ministry of Finance and Economic Planning
MINEDUC	Ministry of Education, Science, Technology and Research
MINICOM	Ministry of Commerce, Industry, Investment Promotion, Tourism and Cooperative
MININFRA	Ministry of Infrastructure
MINISANTE	Ministry of Health
MINITERE	Ministry of Land, Environment, Forestry, Water and Mines
NEPAD	New Partnership for African Development
NIS	National Investment Strategy
NTU	Nephelometric Turbidity Unit
OJT	On-the-Job Training
NGO	Non-Governemental Organisation
PDC	Plan of Development Community
PDL-HIMO	Labor Intensive Local Development Plan

PRSP	Poverty Reduction Strategy Papers
uPVC	Unplasticized Polyvinyl Chloride
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
UNHCR	United Nations High Commissioner for Refugees
UTM	Universal Transverse Mercator Projection
TDS	Total Dissolved Solid
Vision 2020	National Development Plan
WHO	World Health Organization

UNIT

Extent

cm^2 = square-centimeters
m^2 = square-meters
Km^2 = square-kilometers
ha. = hectares

Length

mm = millimeters
cm = centimeters
m = meters
km = kilometers

Electricity

v = volt
kv = kilo volt
w = watt
Mw = mega-watt

Other Units

S = Siemens
(Unit for Electric Conductivity)
µ = micron
ppm = parts per million
ppb = parts per billion
C = degree Celsius
Mpa = mega-Pascal

Currency

¥ = Japanese Yen
US$ = United State Dollar
Frw = Rwandan Fran

Volume

cm^3 = cubic-centimeters
m^3 = cubic-meters
mL = milli-Liter
L = liter

Weight

N = newton
g = grams
kg = kilograms
ton = metric tonne

Time

sec = seconds
min. = minutes
hr. = hours

Exchange Rate : November 2005
1 US$ = 552.92Frw = ¥111.77

Summary

SUMMARY

The Republic of Rwanda is a landlocked country located in the central part of the African Continent; surrounded by the United Republic of Tanzania, Republic of Uganda, Democratic Republic of the Congo, and Republic of Burundi. The total area of the territory is 25,000 km^2. The topography of Rwanda is characterized by hills and large undulations. The average altitude is 1,600 m. There are two rainy seasons in Rwanda: one is from March to May, the other is from October to December. The precipitation of the eastern part of the country is about 700 mm and that of the western part is about 1,700 mm per year. The Southern part of the Eastern province, the former Kibungo province is the Target area of the Project and is located in the south-east part of the country. It has an area of 2,964 km^2 and yearly precipitation of 800 - 1,200 mm. Rwanda is in the tropics and the monthly average temperature varies by only about 20°C through the year. People living in rural areas are located along mountain ridges because of the national policy of living condition. The total population of Rwanda is 8.41 million and the GNI per capita is USD 220 (2004 data). Major industries are agriculture, service sector, and mining, which occupy 44%, 36% and 20% of GDP respectively. However, the national economic structure of Rwanda remains unstable since the income from coffee and tea, the main agricultural products of the country, are highly affected by international market prices. In the 1980's, the country implemented a structural reform for improvement of the national economy. However, the economic growth declined to become negative due to the civil war that broke out in 1990 and social and economic conditions suffered from the destructive damage caused by the 'Genocide' that took place in 1994. After the end of the civil war, Rwanda attained the same level of GDP as before the civil war in 1999, on the base of the stable recovery of agricultural production, as well as aid granted by donors. However, the standard of living of the population is still below the poverty line.

The Rwandan Government formulated the Vision 2020 in 2000 and the Poverty Reduction Strategy Paper (PRSP) in 2002 in order to improve the national economic situation. The Vision 2020 is the national development policy, which is the basis of the national development plan for poverty reduction and socio-economic development. It indicates the directions and indicators of national development; Rwanda aims to become a middle-income country. In the Vision 2020, the aim for the water supply sector is to achieve a water supply service ratio increase from 52% at this moment to 80% in 2010 and 100% in 2020 through increased water supply points, capacity building of water user associations, and sensitization for hygiene issue. The PRSP mentions that Rwanda shall tackle "poverty reduction" to attain national development, and has as a target to reduce

poverty by half by the year 2015 through decentralization, resettlement of residents, and reinforcement of the private sector. As for the water and sanitation sectors, the Rwandan Government emphasizes access to safe water for reduction of water drawing time for women, improvement of school enrollment rate for girls, and reduction of water-related disease numbers.

In the south-eastern part of Eastern province (the former Kibungo province), the development of water supply systems is behind other areas in Rwanda, with service coverage remaining at 31% in the whole province and 17% in the objective sectors. The inhabitants of the area where water supply service is not ready must rely on springs, lakes, and river water in valleys where there may be a difference in elevation between hilltop and valley of more than 100 m. People spend more than two hours to collect water every day. Moreover, it is reported that water-borne diseases are common because of coliform bacteria and total colonies in spring water.

Under these circumstances, the Government of Rwanda requested the Government of Japan to provide grant aid for implementing the Project for Rural Water Supply in Umutara in 2002 and also for the Project for Ground Water Development in Eastern and Central Regions in 2003. The Government of Japan therefore dispatched the mission for the Preliminary Study from June to July in 2004. Resulting from the Preliminary Study, it was identified that Japanese grant aid could be given for former Kibungo Province because the service level of water supply in former Kibungo Province was lower than in the other Provinces in Rwanda and no extensive aid from any other donor was available for the purpose of rural water supply in former Kibungo Province. The mission also confirmed that MINITERE, the implementing organization for the project identified, was requesting groundwater development for rural water supply by deep wells equipped with hand pumps. Meanwhile, it was found that the following issues should be further clarified before implementing the requested project under Japanese grant aid.

- The central government envisages the development of deep wells equipped with hand pumps but the relevant local governments wish to have piped water supplies to alleviate people's excessive daily workloads for fetching water.
- In Rwanda, rural people were living traditionally in the manner of widely scattered housing in rural areas. Meanwhile, the Government of Rwanda has been enhancing 'Imidugudu' to construct village-housed areas centralized along the road network with a view to effective land and infrastructure development. As a result, it is anticipated that the deep wells equipped with hand pumps would not be useful for rural people likely to move their houses under the policy of Imidugudu.

- The list of villages covered by the project for the development of deep wells equipped with hand pumps was presented to the Japanese mission by the Government of Rwanda. However, the list would not represent the actual situation for the villages subject to changes under the policy of Imidugudu.
- The Government of Rwanda is also implementing the policy of administrative decentralization. However, the administrative decentralization is still in progress and local governments have not been organized sufficiently to cope with the requirements for the policy of administrative decentralization.

To clarify the above-mentioned issues, it was recognized that the formation of the requested project should be improved together with a program approach organized with 'Grant Aid' and 'Technical Cooperation Projects'. The Government of Japan dispatched another mission for a Project Formation Study on Rural Development Programs in former Kibungo Province from April to May 2005. The mission concluded the need for the formation of programs as follows.

- The scope of the project was reorganized with the components including construction and rehabilitation/expansion of piped water supplies and deep wells with hand pumps.
- Rural Development Programs, organized with 'Grant Aid' and 'Technical Cooperation Projects', were formulated to incorporate the rural water supply project under the grant aid. Rural Development Programs are aimed at poverty reduction by giving comprehensive support to farm village development and living improvement through: 1) Improving access to safe water and a hygienic environment as a top priority for the objective areas, and 2) To alleviate people's excessive daily workload for fetching water, which is a factor that obstructs economic activities. Development accounting for the issues mentioned above will also contribute to "human security" in poor farm villages that have problems with the socially vulnerable peculiar to a post-conflict country, such as retired soldiers, returnees, handicapped people, women, and children.

On the basis of the above-mentioned process, the Rwandan Government made a request to the Japanese Government for "Grant Aid" consisting of construction of water supply facilities in 64 sites (26 sites of new/rehabilitation/expansion of piped water supply system and 38 sites of new/rehabilitation of deep wells equipped with hand pumps), procurement of operation and maintenance equipment, and improvement of capacity for operation and maintenance.

The Japanese Government decided to implement the basic design study corresponding to the request of the Rwandan Government. The Japan International Cooperation Agency,

JICA, implemented the site survey from September 27th to November 07th, 2005. Afterwards, they continued the basic design in Japan, and explained the draft final report from March 21st to 26th, 2006.

The water supply facilities were selected through two steps; 1) selection of water supply areas, and 2) study of water supply plan considering the request of the Rwandan Government. Screening was conducted in more detailed through field reconnaissance to confirm the actual conditions of all the sites.

- Local residents suffer from serious water supply problems.
- Village-housed residential area by Imidugudu is almost completed.
- There is no overlap with water supply plans of other donors.
- No financial resources are available from CDF or any other fund at present.
- Water supply service by private company is neither available nor scheduled.

Also, the following were the criteria for selection in the water supply plan:

- Water resource is stable and sustainable.
- Raw water quality meets water quality standards.
- The cost of operation and maintenance of the water supply facilities is reasonable.
- Effectiveness of water supply and sufficient service coverage is expected.

The water supply plan is formulated to follow the upper plan formulated by the Rwandan Government. The planning target year is 2010 and the unit water consumption is 20 L/p/day. Although the water quality of the water sources satisfies WHO chemical water quality standards, coliform bacteria and total colonies are detected from them. Therefore, chlorine disinfection equipment would be provided for the water supply facilities and then water quality will satisfy the WHO guidelines completely. It is considered that the reason for contamination of the groundwater is that bacteria contaminate the hand pump during maintenance. Therefore, chlorination will be introduced before installing hand pumps. Water supply facilities consisting of pipelines and boreholes equipped with hand pumps are adopted for the water supply plan taking into account topographic conditions, water source type, and the density of houses in the project area. Water supply facilities with pipeline are applied to the area:

- House areas exist on mountain ridges and the water sources located 100 m lower in elevation mean that hand pumps cannot release people from tough water drawing work;
- A large number of beneficiaries will be assumed by the project, and operation and maintenance will be realized by water tariff.
- Borehole equipped with hand pump is applied to the area:

- There are existing boreholes equipped with hand pump and groundwater development potential is expected to be sufficient from a hydro-geological view point.
- Local residents live in manner small villages near potential borehole locations.
- Water production by hand pump is able to attain an acceptable service coverage.
- Potential borehole locations are accessible by drilling machine.

Based on the survey results, 37 water supply facilities are planned, consisting of 24 boreholes equipped with hand pumps and 13 water supply facilities with pipelines. The plan has been discussed with the Rwandan Government and agreed mutually.

Proposed Water Supply Schemes under the Project

New District	Former District	New Sector (Previous Sector)	Water Source	No. of Water Users Association	No. of Deep Wells Equipped with Hand Pumps				No. of Piped Water Supplis					
					New	RH	No. of Water Sources	No. of Facilities	Deep Wells		Springs		No. of Water Sources	No. of Water Supplies
									New	RH/EX	New	RH/EX		
Rwamagana	Rwamagana	Mwulire (Mwulire), Munyaga (Kaduha, Rweru, Nkungu), Kigabiro (Sovu, Rutonde)	Rwakibogo	1							1		1	1
Kayonza	Muhazi	Mukarange (Mukarange, Nyagatovu)	Kazabazana	1						1			1	1
	Kabarondo	Kabarondo (Kabarondo)	Kabarondo	1	2	1	3	3						
	Cyarubare	Rwinkwavu (Gishanda)	Nyankora	1						1			1	1
	Cyarubare	Rwinkwavu (Rwinkwavu)	Gihinga	1	8	2	10	10						
	Cyarubare	Murama (Murama, Shyanda, Bisenga)	Gicaca Spring	1							1		1	1
Ngoma	Kibungo	Kigungo (Ndamira, Rubona)	Gasebaya/Nyakagezi	1							1		1	1
	Rukira	Murama (Murama・Rurenge)	Murama/Rurengeg	1	5	6	11	11						
	Mirenge	Karembo (Karambo), Zaza (Zaza, Kukabye), Kibare (Kibare, Gatare, Nyange), Mugesera (Kabilizi, Shywa, Kagashi)	Rwarutene	1								1	1	1
			Kabadeko								1		1	
	Kigarama	Mutendeli (Matongo, Bare), Kazo (Kibimba)	Kagoma	1								1	1	1
Kirehe	Rukira	Mushikiri (Mushikiri)	Nyakagongi	1							1		1	1
	Rusumo	Kirehe (Kirehe)	Gahama	1							1		1	1
			Muguruka									1	1	
	Rusumo	Nyamugari (Nyamugari)	Mayizi	1								1	1	1
			Cyanyizanyonza									1	1	
	Rusumo	Kigina (Kigina)	Kabingo	1							1		1	1
			Gasebura									1	1	
	Rusumo	Gahara (Gahara)	Gaharado	1							1		1	1
	Rusumo	Gatore (Gatore)	Rugina	1							1		1	1
Total				16	15	9	24	24	0	2	9	6	17	13

The following operation and maintenance equipment will be procured for smooth project implementation and sustainability..

Procurement Items and Quantities

Items	Specifications	Numbers
1. Simple water quality test kit	Handy type	4
2. Stand-by pump	Submergible pump	2
3. Pipe repair tools	Tools to be necessary for daily machine and pipe maintenance work	13

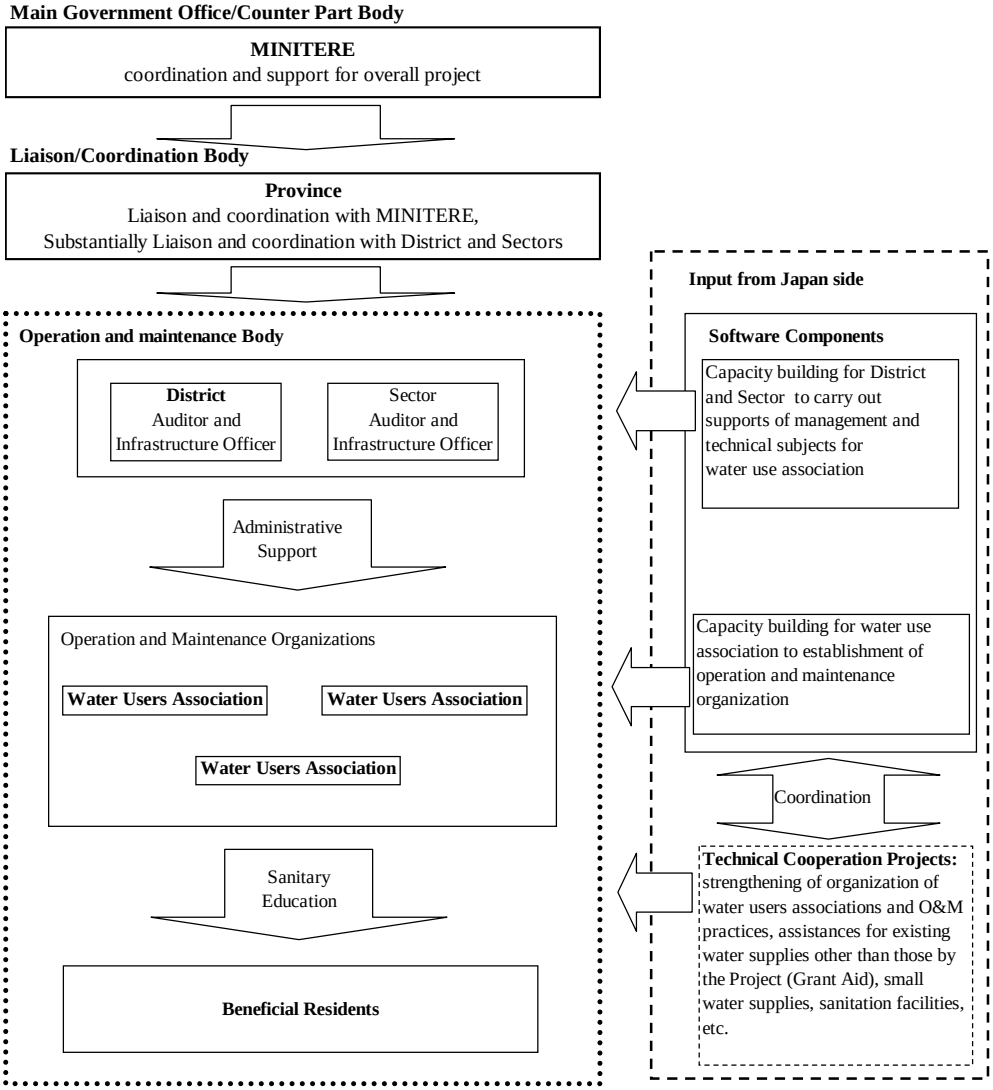
The software component plan will be implemented aiming to build the operation and maintenance system for the water supply facilities. It considers joint implementation of the software component and technical cooperation. The plan takes into account the local government's supporting capability, the management level of the existing water user association, and hygiene awareness of the local residents. It's aim is to develop the capacity to continue the minimum operation and maintenance works. On the other hand, technical

cooperation will improve the sustainable operation of the constructed water supply facilities under the grant-aid project. The project sites will serve as models for future projects so that water supply facilities will extend and progress throughout the whole country.

The following software component activities will be implemented by a local NGO with experience in similar projects:

1) Activities in which districts and sectors learn to support the management and engineering works of the water supply facilities
   Preparation of site work manuals, training materials, training, and follow-up works
2) Activities in which water user associations will be established or reorganized to operate the water supply facilities
   Preparation of selection criteria for the water user association committee/staff, and preparation of water user association regulations
3) Activities in which water user associations improve their operation and maintenance capabilities
   Preparation of operation and maintenance manual, training materials, training and follow-up works
4) Activities in which residents improve hygiene and enhance their life through water use
   Training in how to provide participatory hygiene education
5) Activities in which experts measure the project effect indicators
   Project effects monitoring by district and sector and follow-up works

The eastern province coordinates with the MINITERE and supports the districts and sectors. The districts and sectors improve their functions because staffs and many rights are transferred to them and they become the center of local administration. The water user association operates and maintains the facilities under the support of district and sector administrations.



Project Implementation and Operation and Maintenance System

The Project is divided into three (3) stages and total project period is 43 months, consisting of E/N signing, detailed design, tendering, contracting, construction, and software components. The approximate project cost is estimated at JPY 1,829 million. The Japanese side will contribute JPY 1,822 million and the Rwanda side owes JPY 7 million. The Rwanda side shall acquire the land for the facilities, construct the access road to the sites, provide lumber, level the land, install fences, and pay allowances to the water user association staff members and committees during the training period.

The Project effects are anticipated as follows:

The water supply service ratio of the project districts and sectors will increase to 64%, water supply and sanitation are improved, and basic infrastructures are constructed for regional revival and spontaneous development.

1) Direct effects

- Water served population will increase to approximately 160,000 persons in 2010.
- Water supply service ratio in the project area will increase from 17%, which is lower than whole Kibungo province 31% at this moment, to 64% in 2010.
- The districts and sectors will progress their management and technical capabilities to provide better support to the water user associations.
- Water user associations will be established or reorganized at each water supply facility and operation and maintenance capability will be improved.
- The water user association members will improve their awareness of hygiene and the relationship between health and safe water.

2) Indirect effects

- It is expected that hygiene conditions will be improved and water-borne diseases will be reduced to use safe and stable water.
- Women and children carry out water collection, it is quite a tough job because they carry water more than 100 m difference in elevation. They will be released from this heavy work load after the project. It is expected that women will enter into society and encounter work opportunities and children's study opportunities will increase.

The project has the objective of improving local residents' living environment through spring water and groundwater development. This contributes to the objectives of the Rwandan Government shown in the Vision 2020. Operation and maintenance system will be progressed by the software component and it will be further progressed by technical cooperation. The project is therefore highly appropriate.

The following points shall be considered for smooth and effective project implementation:

- The Rwanda side shall be required to select and employ the committee and staff of the water user association and establish or reorganize the association prior to construction of each water supply facility in order to conduct smooth and sustainable operation and maintenance
- The Rwanda side shall be required to acquire the land, construct the access road to the site prior to construction to construct the water supply facilities without delay.
- The Rwanda side shall be required to secure the budget of capacity building for water user association committee or staff and the counterpart and coordinator staff and their

budget.

- The districts and sectors shall surely provide instruction in use of the water quality test, facilities' repair, chlorine purchase, spare parts purchase, and fuel transportation.
- The Rwanda side shall establish cooperation system at districts and sectors level in order to perform effective joint operation of the software component and technical cooperation.

Basic Design Study Report
on
The Project for Rural Water Supply
in The Republic of Rwanda

Preface
Letter of Transmittal
Location Map/Perspective
Abbreviations
Summary

Table of Contents

List of Tables

List of Figures

Appendixes

Chapter 1
Background of the Project

CHAPTER 1
BACKGROUND OF THE PROJECT

In the south-eastern part of Eastern province (the former Kibungo province), the development of water supply systems is behind other areas in Rwanda, with service coverage remaining at 31% in the whole province and 17% in the objective sectors. The inhabitants of the area where water supply service is not ready must rely on springs, lakes, and river water in valleys where there may be a difference in elevation between hilltop and valley of more than 100 m. People spend more than two hours to collect water every day. Moreover, it is reported that water-borne diseases are common because of bacteria in spring water.

Under these circumstances, the Government of Rwanda requested the Government of Japan to provide grant aid for implementing the Project for Rural Water Supply in Umutara in 2002 and also for the Project for Ground Water Development in Eastern and Central Regions in 2003. The Government of Japan therefore dispatched the mission for the Preliminary Study from June to July in 2004.

Resulting from the Preliminary Study, it was identified that Japanese grant aid could be given for former Kibungo Province because the service level of water supply in former Kibungo Province was lower than in the other Provinces in Rwanda and no extensive aid from any other donor was available for the purpose of rural water supply in former Kibungo Province. The mission also confirmed that MINITERE, the implementing organization for the project identified, was requesting groundwater development for rural water supply by deep wells equipped with hand pumps. Meanwhile, it was found that the following issues should be further clarified before implementing the requested project under Japanese grant aid.

- The central government envisages the development of deep wells equipped with hand pumps but the relevant local governments wish to have piped water supplies to alleviate people's excessive daily workloads for fetching water.
- In Rwanda, rural people were living traditionally in the manner of widely scattered housing in rural areas. Meanwhile, the Government of Rwanda has been enhancing 'Imidugudu' to construct village-housed areas centralized along the road network with a view to effective land and infrastructure development. As a result, it is anticipated that the deep wells equipped with hand pumps would not be useful for rural people likely to move their houses under the policy of Imidugudu.

- The list of villages covered by the project for the development of deep wells equipped with hand pumps was presented to the Japanese mission by the Government of Rwanda. However, the list would not represent the actual situation for the villages subject to changes under the policy of Imidugudu.
- The Government of Rwanda is also implementing the policy of administrative decentralization. However, the administrative decentralization is still in progress and local governments have not been organized sufficiently to cope with the requirements for the policy of administrative decentralization.

To clarify the above-mentioned issues, it was recognized that the formation of the requested project should be improved together with a program approach organized with 'Grant Aid' and 'Technical Cooperation Projects'. The Government of Japan dispatched another mission for a Project Formation Study on Rural Development Programs in former Kibungo Province from April to May 2005. The mission concluded the need for the formation of programs as follows.

- The scope of the project was reorganized with the components including construction and rehabilitation/expansion of piped water supplies and deep wells with hand pumps.
- Rural Development Programs, organized with 'Grant Aid' and 'Technical Cooperation Projects', were formulated to incorporate the rural water supply project under the grant aid. Rural Development Programs are aimed at poverty reduction by giving comprehensive support to farm village development and living improvement through: 1) Improving access to safe water and a hygienic environment as a top priority for the objective areas, and 2) To alleviate people's excessive daily workload for fetching water, which is a factor that obstructs economic activities. Development accounting for the issues mentioned above will also contribute to "human security" in poor farm villages that have problems with the socially vulnerable peculiar to a post-conflict country, such as retired soldiers, returnees, handicapped people, women, and children.

On the basis of the above-mentioned process, the Rwandan Government made a request to the Japanese Government for "Grant Aid" consisting of construction of water supply facilities in 64 sites (26 sites of new/rehabilitation/expansion of piped water supply system and 38 sites of new/rehabilitation of deep wells equipped with hand pumps), procurement of operation and maintenance equipment, and improvement of capacity for operation and maintenance.

Chapter 2
Contents of the Project

CHAPTER 2
CONTENTS OF THE PROJECT

2.1 Basic Concept of the Project

In the result of enhanced Imidugudu, it became a general housing style for local residents to shape small villages along a ridge line in hilly terrain. They used to live in the manner of widely scattered housing in rural areas traditionally. The local residents take water traditionally from the spring, lake, and river close to their houses. After Imidugudu, it takes some hours for the local residents living on the ridge of the hill to go to fetch water at water source in the valley and transport water to their houses. Accordingly, piped water supply facilities based on spring, have been developed for the residential areas of Imidugudu in order to improve the access to water by securing water points at each village. These water supply facilities are mainly of gravity flow type, which is easy for operation and maintenance. However, most of suitable locations for the gravity flow type have already been developed up to date. On this account, it becomes necessary to develop the piped water supply facility, which consists of 1) intake facility in a valley (spring or borehole), 2) pumping up to hilly area by motored pump, and 3) piped water supply by gravity flow.

The former Kibungo Province as an objective area of the Project, Imidugudu has been completed approximately 90%. Development of piped water supply facility delays in comparison with other regions because locations suitable for the gravity flow type are not available much in the Province. Meantime the piped water supply facilities with motored pump type have also been developed. However, many of existing water supply facilities do not work properly. Major reasons are; 1) operation and maintenance capability is not efficient, 2) malfunction of the water supply facility due to inadequate design and construction, and 3) setting of water tariff is low level due to considering destitute people and vulnerable people such as widow, orphan, and handicapped and it is difficult to pay maintenance cost for motored pump facilities because of low tariff collection rate.

Although operation and maintenance for borehole equipped with hand pump is easy, these are not popular in Rwanda. The majority of village-housed residential areas are located in hilly terrain but possible locations for borehole equipped with hand pump is limited only in flat area the bottom of valley, where groundwater

development is expected but is generally distant from Imidugudu on the ridge of hill.

The eastern region including the former Kibungo Province has less spring water sources and yields in comparison with other regions in Rwanda. borehole equipped with hand pump was therefore constructed under the Japanese Grant in 1980's because the eastern region in Rwanda was identified as the potential region for developing groundwater. Thus, it is recognized that borehole equipped with hand pump is still regarded as effective for securing safe water in the villages located near the bottom of valley, where groundwater development is expected.

The Project aims at increasing served population in the Eastern Province (former Kibunbo Province) by development of the water supply facilities for achievement of the national target for water and sanitation development under Vision 2020 (2000~2020). The Project consists of 13 piped water supplies and 24 boreholes equipped with hand pump. The project contributes to the target of rural water supply to raise service coverage from current 17% to 64%. The Project envisages improving hygiene environment by supplying safe water, reducing the burden of women and children fetching water for promoting their labor productivity, and to upgrade living standard of the objective area.

The Project is one of the Rural Development Programs for the Eastern Province to be implemented under Technical Cooperation by Japan International Cooperation Agency (JICA).

The Rural Development Programs consist of two phases. Program-I aims at capacity building for the local governments in the field of water and sanitation, increment of access to water for local residents, and improvement of hygiene environment of the objective area in order to satisfy the basic human needs. Resulting from Program-I to create the opportunities for local residents to do productive activities, Program-II focuses on enhancement of rural economic activities and agricultural productivity increment to upgrade living standard of local residents.

Program-I will be implemented under Technical Cooperation coupled with Grant Aid as mentioned below:

Phase 1

Capacity building for the central and provincial government level in the rural water supply field (dispatching of an expert to MINITERE)

Phase 2

1) Project 1 (Technical Cooperation / Development Study)

Improvement of living conditions in the field of water and sanitation and capacity building for Districts and Sectors

- Improvement of water and sanitation environment to activate economic activities in rural area
- Construction of small scale water supply facilities using CDF and other funds
- Capacity building for water and sanitation projects' operation and maintenance matters for Districts and Sectors government by OJT
- Establishment of rural development base for Program-II

2) Project 2 (Grant Aid)

Construction of medium scale water supply facilities and extension and rehabilitation of the existing facilities

- Improvement of water access to the residents after implementation of the medium scaled water supply facilities and extension and rehabilitation of the existing facilities, which are not covered by CDF

The Project shall cover the development of rural water supply and procurement of equipment as shown in Table 2-1 and 2-2. In addition, 'Software Components' of the Project shall consist of training for water users associations and local governments to improve their operation and maintenance capability in order to ensure the sustainability of rural water supply. Under the captioned principles, the Project comprises construction and/or rehabilitation and procurement of the following facilities.

- piped water supplies based on spring water source equipped with a motorized pump (10 water supply systems)
- piped water supplies based on spring water source and gravity flow (1 water supply system)
- piped water supplies based on boreholes equipped with a submergible pump (2 water supply systems)
- boreholes equipped with a hand pump (24 water supply systems)
- procurement of equipment (water quality testing kits, standby pumps, maintenance tools for equipment and pipe works)

Table 2-1 Proposed Water Supply Schemes under the Project

New District	Former District	New Sector (Previous Sector)	Water Source	No. of Water Users Association	No. of Deep Wells Equipped with Hand Pumps				No. of Piped Water Supplis					
					New	RH	No. of Water Sources	No. of Facilities	Deep Wells		Springs		No. of Water Sources	No. of Water Supplies
									New	RH/EX	New	RH/EX		
Rwamagana	Rwamagana	Mwulire (Mwulire), Munyaga (Kaduha, Rweru, Nkungu), Kigabiro (Sovu, Rutonde)	Rwakibogo	1							1		1	1
Kayonza	Muhazi	Mukarange (Mukarange, Nyagatovu)	Kazabazana	1						1			1	1
	Kabarondo	Kabarondo (Kabarondo)	Kabarondo	1	2	1	3	3						
	Cyarubare	Rwinkwavu (Gishanda)	Nyankora	1						1			1	1
	Cyarubare	Rwinkwavu (Rwinkwavu)	Gihinga	1	8	2	10	10						
	Cyarubare	Murama (Murama, Shyanda, Bisenga)	Gicaca Spring	1							1		1	1
Ngoma	Kibungo	Kigungo (Ndamira, Rubona)	Gasebaya/Nyakagezi	1							1		1	1
	Rukira	Murama (Murama・Rurenge)	Murama/Rurengeg	1	5	6	11	11						
	Mirenge	Karembo (Karambo), Zaza (Zaza, Kukabye), Kibare (Kibare, Gatare, Nyange), Mugesera (Kabilizi, Shywa, Kagashi)	Rwarutene	1								1	1	1
			Kabadeko								1		1	
	Kigarama	Mutendeli (Matongo, Bare), Kazo (Kibimba)	Kagoma	1								1	1	1
Kirehe	Rukira	Mushikiri (Mushikiri)	Nyakagongi	1							1		1	1
	Rusumo	Kirehe (Kirehe)	Gahama	1							1		1	1
			Muguruka									1	1	
	Rusumo	Nyamugari (Nyamugari)	Mayizi	1								1	1	1
			Cyanyizanyonza									1	1	
	Rusumo	Kigina (Kigina)	Kabingo	1							1		1	1
			Gasebura									1	1	
	Rusumo	Gahara (Gahara)	Gaharado	1							1		1	1
	Rusumo	Gatore (Gatore)	Rugina	1							1		1	1
Total				16	15	9	24	24	0	2	9	6	17	13

Table 2-2 Proposed Procurement of Equipment under the Project

Equipment	Type	No.
1. Water Quality Testing Kit	• Handy Type	4 sets
2. Standby Pump	• Submersible Pump	2 sets
3. Maintenance Tools for Equipment and Pipe Work	• Pipe Wrench • Screw Cutting Tool • Tripod with Vice for Screw Cutting Tool • Spanner • Pipe Cutter • Saw for Cutting uPVC Pipe • Manual Punching Tool • Measure • Stepladder • Tester • Cramp Meter • Screw Driver	12 sets
	• Pipe Wrench • Screw Cutting Tool • Tripod with Vice for Screw Cutting Tool • Spanner • Pipe Cutter • Saw for Cutting uPVC Pipe • Manual Punching Tool • Measure • Stepladder • Screw Driver	1 set

A Project Design Matrix (PDM) is shown in Table 2-3.

Table 2-3 Project Design Matrix (PDM)

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal • Living environment of the residents in the rural areas covered by the Project is improved.	• Occurrence of water-borne diseases for residents • Time for water drawing	• Monitoring for the project after project implementation • Data from Ministry of Health • Official statistics	• No substantial change takes place on GOR in terms of the organization for operation and maintenance and basic policy for rural water supply.
Project Purpose • Potable water is made available for the residents in the rural areas covered by the Project.	• Quantity of water supply • Quality of water supply • Stability of water supply throughout a year • Others (to be decided within the Study)	• Monitoring for the project after project implementation • Annual report by water users association • Operation record of water supply facility • Financial and accounting record	• No substantial change takes place on the organization for operation and maintenance and responsibility of the authorities concerned.
Outputs • Water supplies are constructed in former Kibungo Province. • Operation and maintenance system is strengthened.	• Number of water source facilities • Extent of service areas • Financial indicators of water users association	• As-built drawings of water supply facilities • Annual report by water users association	• Impact on the sourced water due to abnormal weather
Activities **GOJ** Construction of facility • Piped water supplies and deep wells equipped with hand pumps Procurement of equipment • Operation and maintenance equipment Software Components **GOR** Construction of water supply facilities • Access road by local residents, tree cutting, and fencing at the project sites MINITERE, Province, Districts, and Sectors • Explanation to local residents regarding the project • Support for establishment of water users associations • Sanitary education for water users • Monitoring and support for implementing body of water supply • Tax exemption for procurement of operation and maintenance equipment	**Inputs** **GOJ** Human Resources (Construction supervision and Assistance for Software Components) • Japanese - Financial and management expert - Operation and maintenance expert • Local NGOs - Financial and management expert - Operation and maintenance expert - Sanitary education expert Construction of Facility • Construction of piped water supplies (new, rehabilitation and expansion) : 13 sites • Construction of deep wells equipped with hand pumps (new and rehabilitation) : 24 sites Equipment • Water quality testing kits: 4 sets • Standby submersible pumps: 2 sets • Maintenance tools for equipment and pipe work: 13 sets	**GOR** Human Resources (MINITERE, Province, Districts, and Sectors) • Counterparts - Project manager - Project coordinators (1 person per District) - Sector coordinators (2 persons per Sector) • 16 Water users associations Construction of Facility and Enlightenment Activity • Land acquisition • Fencing • Support for operation and maintenance • Establishment of water user's associations • Stores for operation and maintenance equipment to be procured • Provision of access roads Budgeting	• Water users associations established should remain sustainable. **Preconditions** • Local residents keep their participation in the water supply project. • Sustainable water sources are ensured.

2.2 Basic Design of the Requested Japanese Assistance

2.2.1 Design Policy

Water supply schemes to be provided under the Project are to be designed with an optimum type and scale for realizing safe and sustainable water supply in consideration of minimizing operation and maintenance cost.

(1) Principle for Basic Design

1-1) Selection of Service Facilities

The Government of Rwanda requested the Government of Japan to implement a grant aid project, which was originally composed of 64 schemes consisting of 1) construction and rehabilitation of 26 piped water supplies and 38 boreholes equipped with hand pumps, 2) procurement of operation and maintenance equipment for the water supply schemes, and 3) provision of enlightenment and technical assistance to water user associations who will be responsible for operation and maintenance of the water supply schemes within 10 Districts of the former Kibungo Province.

The Study was carried out to review the 64 schemes and to prepare the water supply plan as well as 4 additional handpumps and 10 springs and groundwater requested by the Government of Rwanda at the commencement of the Study involving construction and rehabilitation of boreholes equipped with hand pump (Rwinkwavu : 1, Kabarondo : 3) and possible construction and rehabilitation of piped water supply (Nkungu : 3, Kabadeko : 1, Rwanyakagezi : 1, Muguruka : 1, Cyanyizayonza : 1, Gasebura : 1, Gaharado : 1, Kitazigurwa : 1).

In the Study, the plan for the Project was formulated for piped water supplies and boreholes equipped with hand pump based on development of spring and groundwater. Service areas by the Project were screened in consideration of the following principles.

a) Initial Screening

In the early stage of the Study, 64 schemes were screened on the basis of the same criteria adopted by the Study for Rural Development Program for former Kibungo Province conducted by JICA from 6th April 2005 to 23rd May 2005. Screening was conducted in more detail through field reconnaissance to confirm the actual conditions of all the sites.

- Local residents suffer from serious water supply problems.
- Village-housed residential area by Imidugudu is almost completed.

- There is no overlap with water supply plans of other donors.
- No financial resources are available from CDF or any other fund at present.
- Water supply service by private company is neither available nor scheduled.

Other than the criteria above, access roads to construction sites (to be constructed by labor force of local residents to the maximum possible extent) and land to be secured for construction of water supplies should also be incorporated with the criteria. But these were not incorporated with the criteria as the criteria were already confirmed by Minutes of Meeting on Inception Report for the Study.

(Refer to Appendix-4 Minutes of Discussions)

b) Screening by Basic Study and Design

The schemes were further examined through the basic study and design against the following criteria.

- Water resource is stable and sustainable.
- Raw water quality meets water quality standards.
- The cost of operation and maintenance of the water supply facilities is reasonable.
- Effectiveness of water supply and sufficient service coverage is expected.

1-2) Selection Criteria for Spring Water Sources

a) Flow Rate

Spring, which secures sustainable and stable supply, is set as the target of this development. Basically more than 1.0L/sec. of spring amount are regarded as sustainable and stable water resource. In the case of less than 1.0L/sec. of spring amount, possible supply population will decrease and the effect of project may not be anticipated. However, the spring development will be considered if it can be implemented with the other spring developments in surrounding area.

b) Operation and Maintenance Cost

Based on the spring's flow rate, the difference in elevation from the spring to the water distribution reservoir, and the population to be served, the operation and maintenance cost for each water supply is estimated. When a water supply scheme's operation and maintenance cost is expected to be within the amount of revenue expected based on the willingness to pay by local residents, it could be selected and subject to development under the Project. The results of the Social Survey component of the Study showed that willingness to pay by local residents is Frw 10 per 20 L. Therefore, water supply schemes that require operation and

maintenance cost much exceeding Frw 11 per 20 L are excluded from the Project in principle.

c) Location of Spring Water Source for Development

In principle, springs to be developed will be located within the Sector to be served. It is also possible to introduce water from neighboring Sectors that have more than enough water sources for attaining 100% service coverage.

1-3) Selection Criteria for Groundwater Sources

a) Selection of Borehole Site

Based on the sites requested by the Government of Rwanda, groundwater sources were investigated to confirm the situations of village-housed areas and the surrounding hydro-geological conditions through field reconnaissance and electric sounding. Locations of borehole construction are selected in consideration of the results of the investigations.

b) Design of Borehole

Boreholes are designed in the light of the results of field reconnaissance and electric sounding. For additional locations of boreholes identified in the course of the Study, supplemental electric sounding will be conducted in the subsequent detail design stage.

c) Criteria for Successful Borehole

There are no specific criteria for identifying a successful well in Rwanda. Therefore, based on “Basic Design Guideline regarding Groundwater Development Project” (Japan International Cooperation System, 1996), Groundwater yield “more than 675 L/hr.“, and Static water level “within GL -40 m “ is set as the evaluation criteria.

d) Number of Boreholes

Based on the original plan and the requests from each district, number of boreholes will be basically designated with consideration of development possibility and beneficiary effect. In the planning process, a piped water supply based on a borehole equipped with a submergible pump was changed into boreholes equipped with hand pumps. For the target facility in this site (Ruincab sector, the number of boreholes is planned on the condition that the population served should be 337 persons per hand pump based on “Basic Design Guideline regarding Groundwater Development Project”.

1-4) Criteria for the Use of Existing Boreholes

a) Borehole for Hand Pump

When internal inspection of existing boreholes cannot be made due to existence of a suction pipe and hand pump cover remaining over the borehole, rehabilitation will be carried out in principle. For such a borehole, groundwater production capacity will be confirmed by air-lift test at the detail design stage. If, as a result of the air-lift test, the groundwater production capacity is found to be inadequate, the borehole will be excluded from the Project. Boreholes will be reconstructed if found to be blocked by stone and/or other materials thrown into the hole.

b) Borehole for Motored Pump

Rehabilitation of two existing piped water supplies based on boreholes was requested by the Government of Rwanda. Of the two boreholes, one was constructed in 1988 and the other in 1999. Nyankora borehole constructed in 1988 was found to be deteriorated by a pumping test conducted during the Study. Therefore, another borehole constructed near the existing borehole will be used for the purpose of the rehabilitation. Kazabazana borehole constructed in 1999 retains good function but its inner diameter of 100 mm is smaller than the outer diameter of a submergible pump required for the rehabilitation. A new borehole will be constructed accordingly for the purpose of the rehabilitation.

1-5) Evaluation of Water Quality

The standard of potable water quality in Rwanda follows WHO guidelines. In this Study, the spring and groundwater sources are evaluated in the light of WHO guidelines for health requirements. Furthermore, portable test in the field was carried out with pack test. Evaluation items of water quality includes iron, manganese, arsenic, fluoride, Ammonia, Nitrite, Nitrate, pH, electric conductivity, turbidity, E-coliform and Total-coliform.

1-6) Concept regarding the Selection of Borehole Equipped with Hand Pump and Piped Water Supply

a) Selection of Borehole Equipped with Hand Pump and Piped Water Supply

The objective sites are located in hilly undulating areas and the difference in elevation between hilltop and valley is more than 100 m. The majority of local residents live in village-housed areas established along ridges by Imidugudu. Meanwhile, some local residents live along the roads running through the valley.

Therefore, the water supply facility is selected according to the locations of water resource and service areas.

b) Borehole Equipped with Hand Pump

Borehole equipped with hand pump will be adopted for serving areas along the valley. When the following conditions are satisfied, boreholes equipped with hand pump are proposed in consideration of easy operation and maintenance even though a piped water supply was originally requested by the Government of Rwanda.

1) The area that there are existing boreholes equipped with hand pump and groundwater development potential is expected to be sufficient from a hydro-geological view point.
2) The area that Local residents live in manner small villages near potential borehole locations.
3) The area that Water production by hand pump is able to attain an acceptable service coverage.
4) The area that Potential borehole locations are accessible by drilling machine.

c) Piped Water Supply

Piped water supplies will be adopted to serve areas along ridges if:

- A borehole equipped with hand pump in the valley cannot provide enough reduction of water lift because the difference in elevation between the hilltop and valley is more than 100 m.
- Operation and maintenance of the water supply is expected to be sustainable on the basis of water tariff collection from a relatively large number of beneficiaries.

Rehabilitation and expansion of piped water supply requested by the Government of Rwanda will be incorporated into the Project because the rehabilitation and expansion are expected to attain early improvement in the service coverage.

1-7) Considerations for Service Area

a) Integration of Requested Piped Water Supplies

For the purpose of minimizing construction cost and operation and maintenance cost, some of the piped water supplies originally requested will be integrated. The integration will be planned under the following conditions.

- The water source for the piped water supply exceeds the amount required to

satisfy water demand within the corresponding service area.

- Another piped water supply is also planned in the neighboring service area expected to be served by the water source mentioned above.
- Integration of such piped water supplies as above is technically possible.

b) Water Source Insufficient for Demand within Corresponding Service Area

In case that a water source is not sufficient to satisfy water demand within the corresponding service area, water distribution will firstly be provided to villages located close to the water distribution reservoir and then be expanded to remaining villages as much as possible with due consideration of Cells prioritized by the District.

1-8) Selection of Motor Pump and Diesel generator

Motorized pumps and diesel generators will be selected in the following manner in consideration of effective performance and least cost for operation and maintenance.

- Specification of pump or diesel generator will be designated with consideration of easiness on procurement of spare parts and consumable.
- An optimum combination of pump and diesel generator with daily operation hours will be selected to minimize cost of power.
- A booster pump will be introduced when the cost of power becomes excessive due to a large pumping head required for water transmission by a single pump.

1-9) Rehabilitation and Expansion of Existing Piped Water Supply

The principal technical points for ensuring effective use of the existing water supplies, according to the observed technical problems of the existing water supplies are summarized in Table 2-4.

Table 2-4 Technical Points for Rehabilitation and Expansion of Existing Piped Water Supply

Facility	Technical Points
Spring Intakes	• Rehabilitated in principle but reconstructed in the case of serious deterioration.
Conveyance Pipelines	• Replaced totally because of serious deterioration as a whole.
Suction Pit for Pumps	• Rehabilitated in principle but reconstructed in the case of serious deterioration.
Pump Houses	• Rehabilitated.
Pumps and Diesel generators	• Pump, associated pipes, valves, and measuring instruments will be replaced due to conspicuous superannuation and difficulty of proper function.
Transmission Pipelines	• Replaced totally because of higher water pressure expected by replacement of pump.
Distribution Reservoirs	• Existing main structure of reservoir will be used with water proofing of the internal surfaces. • Internal steps will be provided for easier maintenance. • Cracked upper slabs will be repaired by injection mending and will be strengthened with supporting pillars. • Deteriorated connecting pipes and valves will be replaced. • Water meters will be installed on outlets for water distribution.
Distribution Pipelines	• Old distribution pipelines will be replaced in principle. • Pipe material with anti-corrosion properties to resist the weak acidity of raw water will be used. • Section valves will be installed at branches and at intervals at appropriate distances. • Expansion of the existing distribution network will be implemented to a limited extent.
Public Water Taps	• Reconstructed totally because of structural deterioration and breakdown of instruments such as valves and water meters.
House Connections	• Restored to original function in principle. • Water meters, valves, and chambers will be replaced along existing pipelines that are not subject to replacement under the Project. • Service valves, service pipes, water meters, valves, and chambers will be replaced along existing pipelines that are subject to replacement under the Project.

1-10) Introduction of Commercial Power Supply

At the beginning of the Study, introduction of commercial power supply was envisaged for 17 piped water supplies. However, a diesel generator will be adopted for all the piped water supplies (except boreholes equipped with hand pump and rehabilitation/expansion of existing piped water supply using commercial power supply) for the following reasons. Details are shown on the Appendix-5.1

- All the piped water supplies require the introduction of a long distance commercial power supply from existing middle voltage transmission line to

the pumped water intake. It is unrealistic to extend the middle voltage transmission because of the large construction cost to install the transmission or distribution line over such a long distance.

- Running cost of commercial power supplies accounts for 110% of that for diesel generator and there is not so different between commercial power and diesel power generation because of the electricity price of Frw 112/kwh raised on 1st of December 2005 from Frw 81.26/kwh.
- It is anticipated that a commercial power supply would be subject to frequent power interruption for up to 12 hours a day on average in a large part of the former Kibungo Province except in the vicinity of Rwamagana town. This would disrupt water supply.

(2) Natural Conditions

The construction area of planned spring intakes, pump houses, and transmission pipelines are located in a valley or on steep inclined plane in hilly area with undulation, hence it is need to construct access roads. The construction of access roads will be carried out by the recipient country as designated in the procedure of Japan's grant aid. Under the Project, it is envisaged that access roads will be constructed with manpower provided by local residents.

However, where construction of access road is not possible by local residents because of the need for excavation of boulder or rock, the roads will be constructed with suitable machinery as a part of the facility construction under the Project. Access road will be used for inspections after completion of the water supply facility.

(3) Socio-Economic Conditions (Considerations for Vulnerable People)

In general, 'Vulnerable People' means aged persons without family or relatives, widows, orphans, and handicapped persons. Such vulnerable residents live in places together with ordinary residents. According to interviews with Districts, it is recognized that the number of vulnerable people accounts for 10 to 25% of the total population. Indicators of regional economy show that average income per person remains below the poverty line of US$1/day. Moreover, there is a large gap takes between ordinary residents and vulnerable residents. Average income per person of ordinary residents is 2.8 times of that of vulnerable residents. Therefore, measures will be needed in the Project to take care of vulnerable people to ensure their access to clean water.

Resulting from discussions with the responsible officers and existing water user associations, conceivable measures for vulnerable residents are 1) to appoint water kiosk operators from the ranks of the vulnerable residents and 2) provide financial support to vulnerable residents to pay water tariff. Meanwhile, the water tariff will be fair for both ordinary residents and vulnerable residents in view of the followings.

- Complaints will be anticipated from ordinary residents if a lower water tariff is applied to vulnerable residents.
- Any authorization criteria of 'Vulnerable People' will be likely to create conflicts from the point of view of fairness.
- It will be hard to identify vulnerable residents at the time of water tariff collection.

(4) Circumstances of Construction

Since the genocide in 1994, Rwanda has experienced construction projects as economic and technical cooperation from countries in EU, China, etc. However, the number of engineers and other professionals with college level qualifications is inadequate in the construction field, and graduates generally have much less experience than those in neighboring countries. Therefore, leadership and management by Japanese engineers it is important issue to ensure good construction.

(5) Procurement of Operation and Maintenance Equipment

In the Project area, local Province, District and Sector administrations have been reorganized through implementation of a decentralization policy. In consideration of such a background, operation and maintenance equipment will be selected to cope with requirements from items and numbers appropriate for the local administrations concerned and organization structure for operation and maintenance of the Project.

(6) Capacity Building for Operation and Maintenance

Major problems for operation and maintenance of water supplies are as follows.

1) Technical support from District and Sectors do not function properly.
2) The organizations responsible do not have sufficient experience and know-how for well-organized operation and maintenance of water supplies.

3) Public awareness of the relationship between human health and clean water remains at a low level.
4) Local employment of capable personnel is difficult.

To cope with the problems above, countermeasures the Project will implement Software Components to establish sustainable operation and maintenance under the management of a water user association.

(7) Coordination between Grant Aid and Technical Cooperation Projects

The Project was planned though "Study regarding Project Formulation for Assistance of Formulation of Rural Development Program in Kibungo District".

This is identified as one of Rural Development Projects in East districts. The project is planned with technical assistance project which will be planned to be inputted.

Software Components will be Technical Cooperation Projects will aim at further improvement of sustainable operation and maintenance of the water supplies to be constructed under the Grant Aid. It is also envisaged that the Technical Cooperation will achieve combined effectiveness through Programs consisting of Grant Aid and Technical Cooperation Projects. Further popularization, development, and improvement of the water supplies to be constructed under the Grant Aid will be regarded as model cases for the purpose of the Programs.

2.2.2 Basic Plan

2.2.2.1 Selection of Water Supply Schemes for the Basic Design

Water supply schemes and corresponding service areas were selected as summarized in Table 2-5 below. Details are described in appendices as follows.

- Appendix-5.3 Summary of screening and selection of water supply schemes and corresponding service areas
- Appendix-5.4 Changes from the original request by the Government of Rwanda through evaluation on the basis of the results of field reconnaissance
- Appendix-5.5 Final results of screening and selection of water supply schemes and corresponding service areas on the basis of the basic study and design

Table 2-5 Summary of Screening and Selection of Water Supply Schemes

Former District	Kigungo		Rwamagana	Cyarubare		Kabarondo		Kigarama	Mirenge	Muhazi	Nyarubuye	Rukira		Rusumo
	Level 1	Level 2	Level 2	Level 1	Level 2	Level 1	Level 2	Level 2	Level 2	Level 2	Level 2	Level 1	Level 2	Level 2
No. of Scheme (as of the original request)	10	1	3	0	4	10	3	3	3	2	1	18	1	5
No. of Scheme (as of the request at the beginning of the Study)	▲10	1	0	10	0	▲6+3	4	0	0	0	0	▲7	1	1
No. of Scheme for Initiating Screening	0	2	3	10	4	7	7	3	3	2	1	11	2	6
Overlap with water supply plan by other donors	-	↓	↓	↓	↓	↓	▲1	▲1	↓	↓	↓	↓	↓	↓
Water supply service provided by private company	-	↓	↓	↓	↓	↓	↓	▲1	↓	▲1	↓	↓	↓	↓
Other financial resource available	-	↓	↓	↓	↓	↓	↓	↓	▲2	↓	↓	↓	↓	↓
Water resource not ensured	-	▲1	▲2	↓	↓	↓	▲3	↓	↓	↓	↓	↓	↓	↓
Water quality not acceptable	-	↓	↓	↓	↓	▲4	↓	↓	↓	↓	↓	↓	↓	↓
Wiilingness to pay not identified	-	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
O&M cost excessive	-	*▲1*	↓	↓	▲2	↓	↓	↓	↓	*▲1*	▲1	↓	↓	▲1
Service coverage not appropriate	-	↓	↓	↓	↓	↓	▲1	↓	↓	↓	*▲1*	↓	▲1	↓
No. Selected Schemes	0	1	1	10	2	3	2*	1	1	1	0	11	1	5

Note: Level 1 - Deep wells equipped with hand pump, Level 2 - Piped water supplies

Italic indicates duprication with another item

* To be merged with the piped water supply in Rwamagana

As seen in Table 2-5, 13 piped water supplies and 24 boreholes equipped with hand pump were eventually selected. In the process of the screening and selection, no water supply scheme failed the following qualifying criteria:

- Local residents suffer from a serious water supply problems.
- Village-housed residential area by Imidugudu is almost completed.
- Local residents indicate a willingness to participate in the operation and maintenance of the water supply and willingness to pay for water supply service.

In Rwinkwave Sector of Kayonza District, a piped water supply based on boreholes equipped with submergible pump was requested, but the conditions at this site match the criteria for boreholes equipped with hand pump. For this site, therefore, it was decided that deep wells equipped with hand pump are more suitable than a piped water supply.

2.2.2.2 Evaluation of Water Supply Sources

(1) Spring Water Potential and Water Quality

1-1) Spring Water Potential

The development potential of springs were considered on the grasp of the characteristics of river discharge within and near the target areas and the hydrologic systems of the target areas through meteorological and hydrological

analyses of the records measured at the Kibungo meteorological station and 5 hydrological stations within and adjacent to former Kibungo Province.

According to the characteristics of river discharge, the discharge amount from the catchment area of the river become minimum value between September to October in the end of rainy season. Term of on-site quantity survey is almost as same as of least discharge quantity from the river.

Thus, the spring discharge, measured at the end of the dry season and the beginning of the rainy season, reflects the lowest discharge of the annual runoff and indicate sustainable quantity for development through a year.

On the grounds that the spring water, of which quantity was measured for possible water resource, emerging from the existing protected spring facilities is supplemented, as intended in the field survey of the basic design, from the currently undeveloped spring facilities. However installation of collecting pipe and preparation of storage tank by this study can lead to increase intake efficiency. Thus an additional 10 % of the lowest discharges can be assured in the case of rehabilitation of the existing facilities and newly developed spring facilities, sustainable safe yields can be seen to be 1.1 times as large as the spring discharges measured in the field survey of the basic design study. A list of the spring development yields is shown in Appendix-5.6, and the condition of the catchment area is shown in Appendix-5.7 Discharge volumes shall be confirmed by the result of field survey during the detailed design study.

1-2) Water Quality from Springs

Based on the result of water quality survey, the water quality from the springs was suitable and there is no site due to unacceptable water quality. According to portable test by pack test, spring in the planned target area meets WHO guideline regarding chemical parameter but the E-coliform and total Coliform was detected. In addition, during distribution, the spring water may be polluted by E-coliform and total Coliform. Therefore, the Project will include equipping chlorination systems to maintain the WHO standard. The value of pH was found to be in the range of weak acid and some measure of anti-corrosion would be required for pipelines and reservoirs. The result of Water Quality Analysis is shown in Appendix-5.8.

Furthermore, at the stage of detail design, following items will be confirmed on institution of water quality analysis in Rwanda for the water quality of spring. The items of water quality include 1) pH, 2) TDS, 3) Turbidity, 4) Color, 5) Total

hardness, 6) Chloride, 7) Copper, 8) Iron, 9) Manganese, 10) Sodium, 11) Sulfric acid, 12)Zinc, 13) Temperature, 14)Arsenic, 15) Lead, 16) Fluoride, 17) Nitrate, 18) Hitrite, 19) E-Coliform.

(2) Groundwater Development Potential and Water Quality

2-1) Groundwater Development Potential

Hydro-geological investigation, including electrical soundings, pumping tests and chemical tests, was conducted after geological and geomorphological analyses of geological and topographic maps, in order to improve the precision of determination of the groundwater development potential in the target areas. According to the well inventory of "The Study on The Rural Water Supply Project in The Eastern Region (Phase III)" published in 1992, the safe yield was estimated at 38 m^3/day on average for the Kibungo Province and the aquifer thickness was 43.4 m. The results of the vertical electrical soundings and two-dimensional electrical sounding are shown in Appendix-5.9.

A pumping test was carried out to estimate the well performance and groundwater development potential at the existing well at Nyankora, Gishanza Sector, former Cyarubare District. As a result of the pumping test, deterioration of the well was confirmed. A well was constructed in the study at a well depth of 60 m and the static groundwater level was 19 m. The critical yield of the well was estimated at 2.5 L/sec.

Based on the above-mentioned study results, groundwater development potential in the target areas will be divided into four categories.

Table 2-6 Category of Groundwater Development Potential

Category	Description	Development Target
Good	Clearly identified aquifer without water quality problems	Yes
Fair	Identified aquifer without water quality problems	Yes
Poor	Possibly identified aquifer but including water quality problems	No
Very Poor	Not identified aquifer and including water quality problems	No

According to the results of identification and determination of the groundwater development potential for the target areas, the groundwater development potentials for each target area are categorized to be "Good" or "Fair" and the

groundwater for the target areas has enough potential to develop as shown in the following table.

Evaluation result of groundwater development potential is provided in Appendix-5.10.

Table 2-7 Groundwater Development Potential for the Target Areas

District	Sector (Former Name)	Cell (Former Name)	Sounding Survey Point	UTM-X	UTM-Y	Altitude (m)	GW Potential	Safe yield (L/sec.)
Rukira	Murama	Rukizi	N1	561813	9753909	1,365	Fair	0.67
	Rurenge	Ruzinga I	N2	561563	9752365	1,375	Fair	0.67
		Ruzinga II	N3	561006	9748776	1,346	Fair	0.67
	Murama	Nyagasozi	N4	562086	9755072	1,364	Fair	0.67
		Ntara	N5	561686	9752938	1,375	Fair	0.67
Kavarondo	Nkungu	Rushangara	N6	550349	9772647	1,336	Fair	0.67
		Mataba	N7	548548	9771789	1,333	Fair	0.67
	Kabarondo	Rugazi I	N8	564049	9778699	1,382	Fair	0.67
		Rugazi II	N9	563718	9777357	1,382	Fair	0.67
Cyarubare	Rwinkaby	Gihinga	N10	567302	9785990	1,331	Good	0.67
	Chabajwa	Chabajwa	N11	565089	9784181	1,366	Fair	0.67
	Gisyanda	Nyankora	Existing	574640	9786343	1,377	Good	2.00
Muhazi	Kitazigurwa	Gashuwa	N12	551598	9792583	1,435	Fair	0.67
	Mukarange	Kazabazana	Existing	557909	9788998	1,479	Good	3.33

2-2) Water Quality of Groundwater

The water quality from boreholes was tested and found to be acceptable in general, except for that of Nkung center in which salinity is detected, in the light of WHO guidelines for health requirements, except for bacteriological parameters. It is considered that the reason for contamination of the groundwater is that bacteria contaminate the handpump during maintenance. Therefore, chlorination will be introduced before installing handpumps. During the operation period, water quality tests will be conducted periodically in order to meet the WHO guideline demands.

For piped water facilities using groundwater, contamination might occur during the distribution of the water. Therefore, chlorination systems will be equipped to maintain WHO standards. The value of pH was found to be in the range of weak acid, the same as the spring water, and some measure of anti-corrosion would be required for pipelines and reservoirs.

The proposed handpump site in the Nkung sector is excluded from the target sites for the following reasons:

- The proposed handpump site is permanently using agricultural chemicals and chemical fertilizer, and a high level of ammonia nitrogen was found.
- As a result of the vertical electric survey, the groundwater was analyzed to be salty.
- During the field survey, it was identified that residents had abandoned the handpump facilities due to the salty water.

2-3) Success Rates of Boreholes

The success rates of boreholes have been estimated based on the existing database of boreholes and the number of unsuccessful boreholes in target sites confirmed by interview. The one re-drilling site at Kazabazana, in Mukarange Sector in former Muhazi District, is not considered successful rate because the same aquifer was confirmed. The water quality is not considered to be an element of the borehole success rate because there were no chemical problems with the health items in the target area. Calculated sheet is shown in Appendix-5.11

Table 2-8 Success Rates of Wells for the Target Districts

Yield	Success rates of wells (%)		
	Rukira	Kabarondo	Cyarubare
More than 675 L/hr.	72.7	83.3	83.3

2.2.2.3 Facility Plan for Water Supply Facilities with Spring Water Sources and Boreholes Equipped with Hand Pumps

(1) Planning Target Year

The planning target year of the project is 2010. The target for water supply system set by MINITERE is that a safe water service ratio of 66% will be achieved in 2010 and 80% in 2015.

(2) Unit Water Consumption

The unit water consumption is estimated at 20 L/p/day, which is proposed as the target in 2020 in the Vision2020.

(3) Planning Served Population and Water Supply Amount

The population forecast in the target area is based on the existing number of households and the population growth ratio. The population growth ratio in the planning is estimated at 2.9% /year, which is shown in “Vision 2020”.

Because the maximum water served population depends on the capacity of water resources, the served population is planned considering the water resource capacity of each district. The final decision on the planned served population in each district is based on a consideration of water source capacities, results of hydrologic calculation of the distribution system, project costs and affordability of maintenance cost, etc.

The served population of the project is 160,668. The served population covered by each supply facility is given in the Appendix-5.3. The planned water service amount is calculated based on the served population multiplied by the unit water consumption.

(4) Distance of Access to Hand Pump or Public Tap

Proposed water supply facility is to distribute water through water access points such as hand pumps or public taps. The maximum distance to a water access point is basically set at not more than 500 m in one way. However, in some scattered areas, the maximum distance of water access is set at 1 km in one way because of high maintenance costs. These are estimated based on the results of Imidugudu Survey and the population list in each Imidugudu and information of the water service area.

(5) Water Supply Facility Plan

5-1) Water Supply System Plan

a) Spring Water Source + Motored Pump + Piped Water Supply Facility

This type of system is adopted in areas where the Imidugudu is located on a ridge and a spring water source is available near the Imidugudu.

The water is taken from the spring water source and distributed to a distribution tank through a pumping facility and transmission main. Water in the distribution tank is sent to public taps by gravity flow. A booster pump is adopted if the water has to be pumped more than 200 m and the operation cost becomes lower than the system with no booster pump. The following tables and figures show the target area, the served population and conceptual diagrams of the various configurations.

Table 2-9 Target Site for Piped Water Supply Facility with Spring Water Source (Without Booster Pump)

District	Sector	Name of water source	New construction	Rehabilitation/ expansion	Total
Ngoma	Karenbo, zaza、kibare, musegera	Rwarutene	0	1	1
		Kabadeko	1	0	1
	Mutenderi, kazo	Kagoma	0	1	1
Kirehe	Mushikiri	Nyakagongi	1	0	1
	Kirehe	Gahama	1	0	1
		Muguruka	0	1	1
	Kigina	Kabingo i	1	0	1
		Gasebura	0	1	1
	Gatore	Rugina	1	0	1
Total			5	4	9

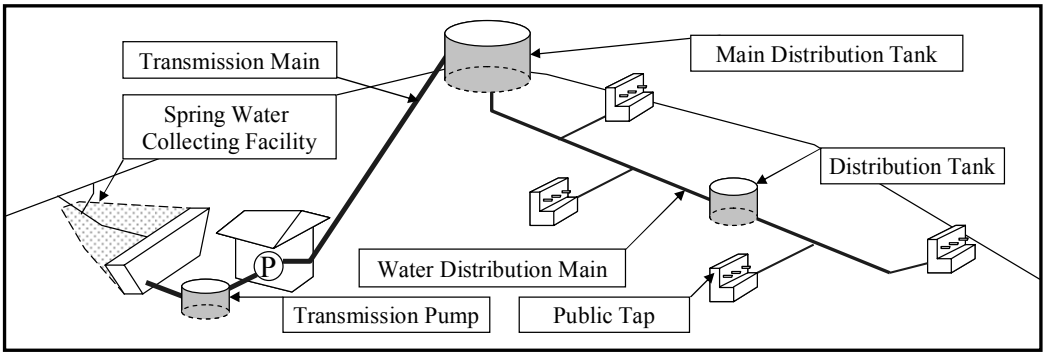


Figure 2-1 Concept Figure for Piped Water Supply Facility with Spring Water Source (Without Booster Pump)

Table 2-10 Target Site for Piped Water Supply Facility with Spring Water Source (With Booster Pump)

District	Sector	Name of water source	New construction	Rehabilitation/ expansion	Total
Rwamagana	Mwulire, kigabiro, muyanga	Rwakibogo	1	0	1
Kayonza	Murama	Cicaca	1	0	1
Ngoma	Kibungo	Gasebaya Nyakagezi	1	0	1
Kirehe	Gahara	Gaharado	1	0	1
Total			4	0	4

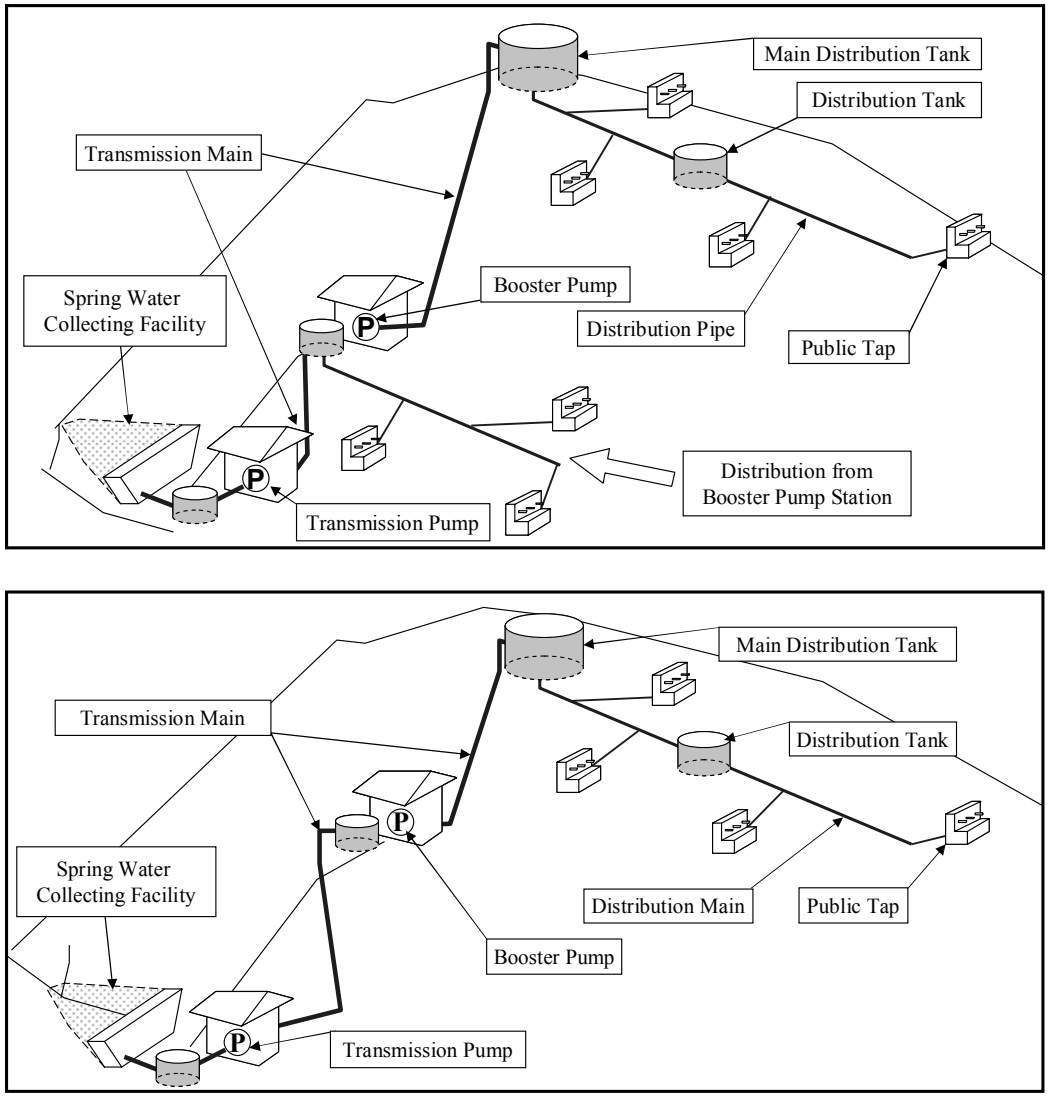


Figure 2-2 Concept Figure for Piped Water Supply Facility with Spring Water Source (With Booster Pump)

b) Spring Water Source + Piped Water Supply Facility

This system is adopted where a spring water source is located in a higher position than Imidugudu, and gravity water distribution is technically possible. Water is sent from a water source to a distribution tank by gravity, and water is then distributed from the distribution tank to water kiosks, also by gravity. The following table and figure show the target area, the service population and conceptual diagram.

Table 2-11 Target Area of Piped Water Supply Facility with Spring Water Source (Gravity Flow)

District	Sector	Name of water source	New construction	Rehabilitation/ expansion	Total
Kirehe	Nyamugari	Mayzi,	0	1	1
Kirehe	Nyamugari	Cyanyizayonza	0	1	1
Total			0	2	2

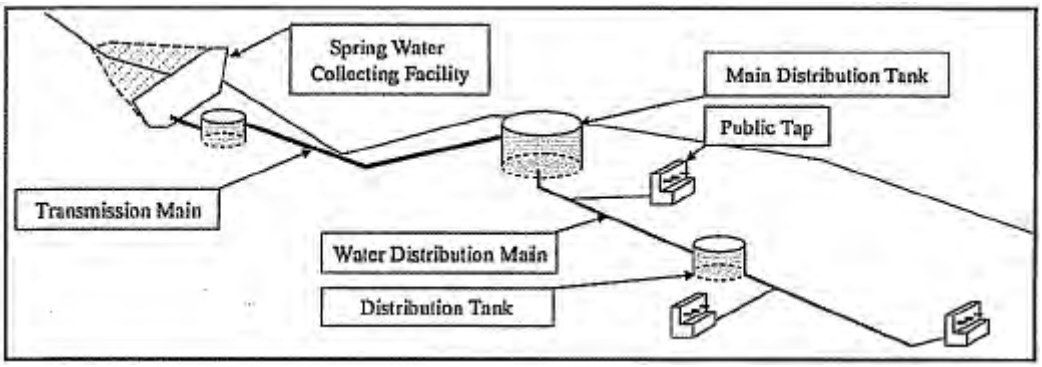


Figure 2-3 Concept Figure for Piped Water Supply Facility with Spring Water Source (Gravity Flow)

c) Borehole Water Source + Submergible Pump +Piped Water Supply Facility

This system is adopted where the Imidugudu is located on a ridge and a spring water source is not available near the Imidugudu. Water is taken from boreholes and sent to a distribution tank by a pump. Water in the distribution tank is sent to public taps by gravity flow. The following table and figure show the target area and a conceptual diagram.

Table 2-12 Target Area of Piped Water Supply Facility with Well and Pump

District	Sector	Water source	New construction	Rehabilitation/ expansion	Total
Kayonza	Mukarange	Kazabazana	0	1	1
	Kabare	Nyankora	0	1	1
Total			0	2	2

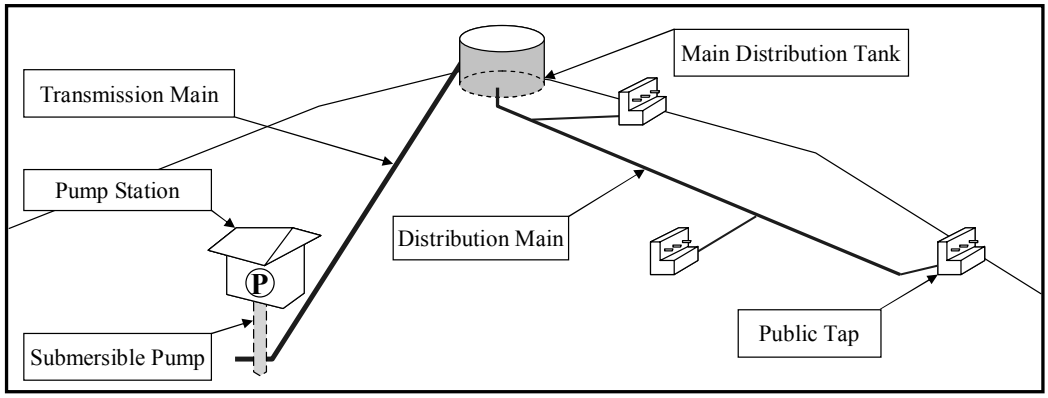


Figure 2-4 Concept Figure for Piped Water Supply Facility with Well Source

d) Borehole Equipped with Handpump

This type of system is adopted when there are scattered Imidugudu in lowland areas with sufficient groundwater source. In this case, the operation and maintenance cost is low because maintenance is easy and the power cost is almost zero. The following table and figure show the target area and conceptual diagram.

Table 2-13 Target Area of Water Supply Facility with Hand Pump

District	Sector	Name of water source	New construction	Rehabilitation/ expansion	Total
Kayonza	Rwinkwavu, kabare、kabarondo	Groundwater	10	3	13
Ngoma	Murama	Groundwater	5	6	11
Total			15	9	24

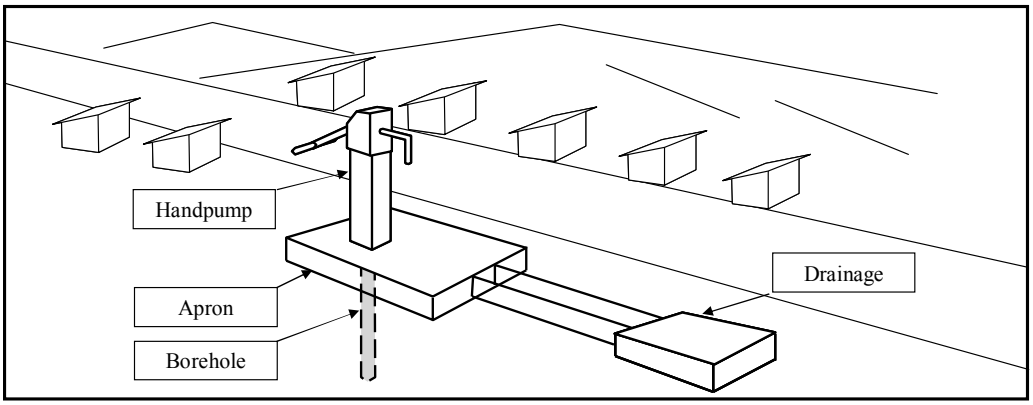


Figure 2-5 Concept Figure for Water Supply Facility with Hand Pump

5-2) Design Criteria and Outline of Piped Water Supply Facility

a) Design Condition of Piped Water Supply Facility

Design standards for water supply systems have not been established in Rwanda. The facility design is therefore carried out based on the design of the facilities in rural areas in Rwanda (Table 2-14).

Table 2-14 Design Condition

Items		Planning and design condition
Accounted water	Public tap	20 L/p/day
	Individual connection	20 L/p/day
Un-accounted for water		10% of accounted water
Water pressure in distribution pipe		5 m on a connection point of distribution pipe and public tap
Capacity of water storage tank with water transmission pump		24 hours storage capacity – pumped water amount in operation hours/day"
Capacity of water storage tank with booster pump		50% of capacity of water storage tank with water transmission pump that send water to the booster pump
Capacity of water storage tank with booster pump and distribution tank		50% of daily pumping capacity of booster pump + daily average of water distribution amount from the distribution tank
Capacity of distribution tank		An amount equal to planned daily average water supply
Service hours of public tap		Two (2) hours in morning and evening, respectively
Formula of hydrological calculation		Heazen – williams' equation
Coefficient of flow velocity in hydraulic calculation		C value: 110

b) Outline of Piped Water Supply Facility

i) Spring Water Collection Facility

Spring water collection facilities are to be installed by digging to a depth of 5 m around the spring water source. Downstream, a water intake wall will be installed by wet masonry. At the back of the water intake wall, perforated PVC pipe will be installed as spring water collection pipe. The PVC pipes will be back filled with a permeable filling material, such as cobble-stones and broken stones. In order to prevent the spring from contamination, the spring will be covered by a concrete structure. An inspection hole will be prepared in the structure because cleaning and replacement of the filling material will be required. It is proposed to install an overflow pipe to discharge excess water in the rainy season and dredging pipes to remove sediment. Detailed drawings of each spring source will be prepared based on the results of plane-table survey and hydro-geological survey to be carried out during further detailed design stage.

ii) Raw Water Main

Raw water main is the pipe from the spring collection facility to the storage tank for the transmission pump. It will be PVC pipe and basically installed underground. Connection pipe to the raw water main and the structure will be a lead plated steel pipe. Anti-corrosion measures are not considered because the length of the connection pipe is short and the pipe can be easily replaced. Detail drawings of raw water main will be based on the results of a route survey.

iii) Water Storage Tank with Water Transmission pump

In order to hold water from a spring water collection facility, a reinforced concrete tank will be constructed. Waterproofing will be carried out as the measure against corrosion.

iv) Pump Station and Diesel Generator Room

The pump stations and diesel generator rooms will be constructed of blocks. Because most of the rooms are located in lowland areas, a drainage system will be established to prevent water from affecting the equipment.

v) Pump and Diesel Generator

A vertical type multi-stage pump will be adopted for easy maintenance. To provide uninterrupted operation, a stand-by pump will be installed. A diesel engine is adopted as the power generator, and the designed power output from the diesel generator will target effective pump operation and reduced operating cost.

An air chamber and non-return valve will be installed to protect the pump from damage by water hammer.

vi) Pump Control Panel

The pump control panel will be a self-standing type or wall-mounted type depending on the pump capacity. A soft starter is adopted as the starting method in order to reduce the capacity of the diesel generator. In the case of a commercial power supply, a magnetic conductor will be adopted to control pump operation.

The pumps and diesel generators will basically be manually operated. The pump stop will be controlled automatically through a signal from a water storage tank with pump, a flow relay and a timer. If a commercial power supply is used, and the pump is located within 300 m of a distribution tank, the pump operation will be controlled automatically by a signal from a water level sensor located in the distribution tank.

vii) Transmission Main

The target area is generally steep mountain area. There is a 100-300 m difference between the Imidugudu where is a service area and spring water sources. The raw water in the area is slightly acidic. Polyethylene (PE) pipe is selected for the transmission main because the pipe will bear high pressure and resist the acidic raw water. From the view point of reducing pump operation cost, design flow velocity in the pipe is set at 0.5 m/sec. to reduce head loss. The diameter of the pipe is designed to keep about 0.5 m/sec. of water flow.

viii) Distribution Tanks

In order to realize a stable water supply, distribution tanks are to be constructed for the whole service area. The following points are to be considered in the site selection of distribution tanks

- A main distribution tank, which receives water directly from the transmission pump, will be located in a suitable position to supply water to the entire service area. The geographical condition will be considered to select a suitable location,
- If the Imidugudu, where service area, is located lower than the booster pump station, the booster pump station will also be constructed with a distribution tank,
- If a pressure reducing tank is required to be installed and the tank covers a service population of more than 1,000, the tank will be designed and used as a distribution tank also.

The capacity of the distribution tank will be large enough to hold the equivalent of 24 hours of water supply for the served population.

If there is no pressure reducing tank in the system, the main distribution tank will hold a 24-hour supply of water.

The maximum capacity of a distribution tank should be 100 m^3 from the view point of minimizing the difficulty of construction and maintenance works. If more than 100 m^3 capacity is required, two or more tanks will be constructed. The distribution tank will be constructed of reinforced concrete with waterproofing to increase water tightness.

A water level meter will be installed in the distribution tank in order to prevent water from overflowing. A water flow meter will be installed at the outlet point to record the amount of water supplied to the service area.

The detailed drawings of the distribution pipes will be prepared based on the results of a route survey.

ix) Chlorine Disinfection Facility

A chlorine disinfection facility will be installed in the main distribution tank. A gravity flow type is adopted for easy maintenance and because it can be procured in Rwanda.

x) Distribution Pipe

PVC pipe is selected for distribution pipe from distribution tank to public taps. Connection pipes to distribution tanks and pressure reducing tanks will be lead plated steel pipe for easy removal.

The pipe installation route will be placed a certain minimum distance from the shoulder of roads and a minimum earth covering for the pipe will be 600 mm. At road crossings, the pipe will be covered by concrete for strengthening and protection.

xi) Sluice Valve

Considering maintenance work of distribution pipes, sluice valves will be installed with 500 m interval along the distribution pipe route. At a pipe joint, a sluice valve will be installed on the downstream side.

In addition, sluice valves will be installed to divide the service area into several blocks to facilitate maintenance of the network.

xii) Air Valve

In the case of small scale water distribution networks, air valve is not necessarily installed because air can be removed through taps. In the project, basically air valves are not installed except for convex points on the pipeline route.

xiii) Wash-out Valve

A wash-out valve will be installed at the lowest point, the beginning and the ending of the pipe line, for the purpose of cleaning.

xiv) Break Pressure Tank (BPT)

In a water distribution network, hydrostatic pressure can often exceed 0.7 Mpa. In order to prevent pipe damage from such high pressure, pressure reducing tanks or pressure reducing valves are installed at points that have more than 70 m of water head. BPT is made of masonry.

xv) Public Water Tap

The public tab is to be made of concrete and will consist of a faucet, valve, water flow meter, apron and drainage ditch. The number of taps at a public tap will be decided based on the results of Imidugudu survey, social survey, living condition survey the villages around public taps. There are three types of public taps: 2-tap type, 3-tap type and 4-tap type. The criteria of the selection are as shown in Table 2-15.

Table 2-15 Type of Public Tap

Type	2-tap Type	3 -tap Type	4-tap Type
Water Supply Amount (L/sec.)	0.34	0.50	0.67
Servec Population (persons)	240	360	480

5-3) Planned drilling depths and required numbers of boreholes

The required total numbers of boreholes were estimated with consideration of the success rate of boreholes in the plan and shown in Table 2-16.

Table 2-16 Required Numbers of Boreholes for the Target Districts

Former District	Pump type	Drilling depths (m)	Ranges of drilling (m)	Planned numbers of boreholes	Success rate (%)	Total numbers of boreholes
Rukira	Hand pump	50	30～85	5	72.7	7
Kabarondo	Hand pump	50	40～70	2	83.3	3
Cyarubare	Hand pump	60	25～90	8	83.3	10
Muhazi	Motor pump	55	-	1	100.0	1

The drilling depths in the above table were estimated by the addition of 10 % to the initially planned drilling depths and by rounding-up to the next 5 m based on margins of error on the electrical sounding analyses.

5-4) Design of Boreholes

a) Standard Design of Boreholes

As mentioned above, the geology throughout the study area can be considered as similar. Therefore, a standard borehole structural design has been prepared and is attached to this report.

b) Diameter of Boreholes

Casings with a diameter of 100 mm for hand pumps and 150 mm for submergible pumps have been adopted as the base of the boreholes in order to ensure their long-term stability. Since this diameter is generally used in Rwanda, no engineering problems should arise.

c) Drilling Diameter

A drilling diameter with sufficient clearance for casing work has been designed, assuming the above casing diameters. The adopted material for casing screen pipe is PVC. This has been used previously in Rwanda and its long-term stability has been proven in the existing boreholes. The screen is designed to be a slot-type, common in Rwanda.

d) Electrical Logging

The design allows for electrical logging to be undertaken after drilling the boreholes in order to identify the aquifer depth for provision of screen pipe at appropriate locations. This is expected to increase the success rate of the boreholes.

e) Gravel Packing, Slime Packing and Cementing

Gravel packing is to be provided for gaps between the casing/screen pipe and the inside of the drilled hole from the bottom to 10 m above static water level. The section to within 10 m of the ground surface will be packed with slime produced by the drilling, and the upper part to the ground surface will be filled with cement mortar. This cementing is designed to prevent intrusion of rainwater and wastewater from near the borehole. A bottom plug and temporary top cover will be provided.

f) Pumping Tests

A series of pumping tests will be undertaken after completion of borehole construction in order to identify the water yield:

- Trial test: by identification of clean water, maximum 8 hours
- Step test: 2 steps, 2 hours for each step (For handpump borehole)
  : 4 steps, 2 hours for each step (For submersible pump borehole)
- Continuous test : 20 hours for a handpump
  : 48 hours for a submersible pump

-Recovery test : 8 hours.

g) Water Quality Analysis

Water sampling will be done during the pumping test and water quality analysis undertaken by public laboratories in Rwanda. Parameters to be defined include: 1) pH, 2) TDS, 3) turbidity, 4) color, 5) total hardness, 6) chloride, 7) copper, 8) iron, 9) manganese, 10) sodium, 11) sulfate, 12) zinc, 13) water temperature for quality target, and 14) arsenic, 15) lead, 16) fluoride, 17) nitrate and 18) nitrite for health 19) E-coliform.

5-5) Design Condition and Specification of Hand Pump

a) Groundwater Yield and Pump Head of Hand Pump

In planning hand pump installation, it is necessary to consider pump head (groundwater depth) and possible amount of pumping water.

The water intake amount per stroke of a hand pump is a certain amount and is independent of the pump head. If the pump head becomes longer, the work load per stroke becomes bigger. In other words, the possible pumping water amount depends on the pump head (the groundwater depth) by using the same work load.

As the required condition to adopt a hand pump, the minimum groundwater yield should be 675 L/hr. per hand pump or more. For AFRIDEV type hand pumps, it is estimated that women and children are incapable of extracting groundwater than if pump head (groundwater depth) exceeds 45 m. In the project area, it is estimated that groundwater fluctuation is not so large, and the impact of hand pump operation is not expected. Considering a 10% allowance for draw down of the water level, it is judged that the AFRIDEV type hand pump is applicable in the area as ground water depth is 40 m or less. The following specification of the hand pump is applied for the project.

Table 2-17 Groundwater Yield and Pump Head of Hand Pump

	Specification
Minimum Groundwater Yield	675 L/hr.
Maximum Pump Head	40 m

b) Design Condition of Hand Pump

The following conditions are applied for the basic design of hand pumps.

- Groundwater Yield : 675 L/hr.
- Daily Water Consumption per capita : 20 L/capita/day
- Operation time : 10 hr./day maximum

c) Number of Hand Pump Required

Based on the above conditions, the maximum served population is estimated at 337 persons per one hand pump. The following table shows the served population per unit water supply facility and the number of water supply facilities in each sector. Served population per a hand pump for each sector is less than 337 peoples.

Table 2-18 Number of Public Tap in each District

District	Sector	Served Population	Number of Borehole Water Supply Facility with Hand Pump (nos.)	Served Population per borehole
Kayonza	Kabarondo	922	3	307
	Rwinkwavu	3,313	10	331
Ngoma	Murama	2,717	11	247

Table 2-19 Summary of Planned Facilities

Type	Water Supply Area /Served Population in 2010		Facilities	
	District Name	Sector Name / Served Population		
Piped Water Supply Facilities				
	1. Rwamagana	Mwuilre Kigabiro Muyanga Served Population : 20,060	Spring Water/Transmission by Pump up Booster Pumping Station Suction Pit for Pumps (100m^3) Transmission Pipe (PE Pipe, 110~200mm) Transmission Pipe (uPVC, 110~200mm) Reservoir (25~80m^3) Distribution Pipe (uPVC, 63~140mm) Public Water Stand	New, 1 no. New, 2 no. New, 2 no. New, 7.1 km New, 8.0 km New, 11 no. New, 53.8 km New, 57 locations
	2. Kayonza	Mukarange Served Population : 9,639	Deep well/Transmission by Pump up Booster Pumping Station Transmission Pipe (PE, 110mm) Reservoir (30~150m^3) Distribution Pipe (uPVC, 63~140mm) Public Water Stand	Rehabilitation, 1 no. Rehabilitation, 1no. New,1.9 km New, 1, Rehabilitation, 2 New, 3.2 km New, 6 location
	3. Kayonza	Rwinkwave Served Population : 6,632	Deep well/Transmission by Pump up Transmission Pipe (PE, 110mm) Reservoir (20m^3) Distribution Pipe (uPVC, 63~125mm) Public Water Stand	Rehabilitation, 1 no. New, 0.2 km Rehabilitation, 1no. New, 13.0 km New, 5 locations
	8. Kirehe	Mushikiri Served Population : 11,884	Spring Water/Transmission by Pump up Suction Pit for Pumps (80m^3) Transmission Pipe (PE, 200mm) Reservoir (40~100m^3) Distribution Pipe (uPVC, 63~160mm) Public Water Stand	New, 1 no. New, 2 no. New, 1.3 km New, 4 no. New, 28.0 km New, 31 locations
	9. Kirehe	Kirehe Served Population : 12,000	Spring Water/Transmission by Pump up Suction Pit for Pumps (60~80m^3) Transmission Pipe (PE, 160~200mm) Reservoir (40~80m^3) Distribution Pipe (uPVC, 63~140mm) Public Water Stand	New, 1, Rehabilitation, 1 New, 3 no. New, 2.3 km New, 4no. New, 16.5 km New, 26 locations
	10. Kirehe	Nyamugari Served Population : 16,776	Spring Water/Transmission by Gravity Flow Transmission Pipe (uPVC, 90~200mm) Reservoir (7.0m^3) Distribution Pipe (uPVC, 63mm) Public Water Stand	Rehabilitation, 2 no. New, 3.8 km New, 1 no. New, 4.2 km New, 36 location
	11. Kirehe	Kigina Served Population : 10,082	Spring Water/Transmission by Pump up Suction Pit for Pumps (60~80m^3) Transmission Pipe (PE, 160~200mm) Reservoir (60~80m^3) Distribution Pipe (uPVC, 63~200mm) Public Water Stand	New, 2 no. New, 3 no. New, 5.4 km New, 4 no. New, 16.7km New, 28 location

Type	Water Supply Area /Served Population in 2010		Facilities	
	District Name	Sector Name / Served Population		
Piped Water Supply Facilities				
	13. Kirehe	Gatore Served Population：4,948	Spring Water/Transmission by Pump up Suction Pit for Pumps（80m^3） Transmission Pipe (PE, 160mm) Reservoir（100m^3） Distribution Pipe (uPVC, 63~125mm) Public Water Stand	New, 1 no. New, 1 no. New, 0.7 km New, 1 no. New, 7.3 km New, 15 locations
	4. Kayonza	Murama Served Population：9,132	Spring Water/Transmission by Pump up Booster Pumping Station Suction Pit for Pumps（80m^3） Transmission Pipe (PE, 110~160mm) Reservoir（40~100m^3） Distribution Pipe (uPVC, 63~140mm) Public Water Stand	New, 1 no. New, 1 no. New, 2no. New, 3.0 km New, 3 no. New, 23.5 km New, 24 locations
	5. Ngoma	Kibungo Served Population：8,536	Spring Water/Transmission by Pump up Booster Pumping Station Suction Pit for Pumps（100m^3） Transmission Pipe (PE, 160mm) Reservoir（80m^3） Distribution Pipe (uPVC, 63~140mm) Public Water Stand	New, 1 no. New, 1 no. New, 2 no. New, 3.5 km New, 4 no. New, 15.2km New, 18 locations
	6. Ngoma	Karembo Zaza Kibare Mugesera Served Population：22,421	Spring Water/Transmission by Pump up Suction Pit for Pumps（60~100m^3） Transmission Pipe (PE, 160~200mm) Reservoir（20~100m^3） Distribution Pipe (uPVC, 125~160mm) Public Water Stand	New, 1 , Rehabilitation, 1 New, 4 no. New, 4.3 km Rehabilitation, 4 no. New, 8.4 km New, 52 locations
	7. Ngoma	Kazo Mutenderi Served Population：8,361	Spring Water/Transmission by Pump up Suction Pit for Pumps（100m^3） Transmission Pipe (PE, 200mm) Reservoir（20~100m^3） Public Water Stand	Rehabilitation, 1 no. New, 2 no. New, 0.7 km Rehabilitation, 4 no. New, 21 locations
	12. Kirehe	Gahara Served Population：13,244	Spring Water/Transmission by Pump up Booster Pumping Station Suction Pit for Pumps（80m^3） Transmission Pipe (PE, 160~200mm) Reservoir（60~100m^3） Distribution Pipe（uPVC, 63~125mm) Public Water Stand	New, 1 no. New, 1 no. New, 2 no. New, 2.5 km New, 5 no. New, 19.8 km New, 28 locations
Hand Pump Facilities				
	14. Kayonza	Kabarondo Served Population：922	Borehole equipped with Handpump Replacement of Handpump	New, 2 no. Rehabilitation, 1 no.
	15. Kayonza	Rwinkwavu Served Population：3,313	Borehole equipped with Handpump Replacement of Handpump	New,8 location Rehabilitation, 2 no.
	16. Ngoma	Murama Served Population：2,718	Borehole equipped with Handpump Replacement of Handpump	New, 5 locations Rehabilitation, 6 no.

(6) Procurement Plan for O&M Equipments

The following shows the results of the study on the operation and maintenance of equipment that was requested by Rwanda.

6-1) Mobile Water Flow Meter (10 units)

In both cases of new and existing water supply facilities, it is preferable to install water meters on the transmission main, distribution pipes and water taps from the view point of suitable maintenance of the facility.

A mobile water flow meter is also required for the survey of future water resource development at the district level. This type of survey is out of the scope of the project. The procurement of mobile water flow meters is not included in the procurement plan.

6-2) Handy Type Water Quality Analysis Equipment (10 sets)

Each district should have one set of Water Quality Analysis Equipment because maintenance of water resources including water quality testing is the duty of the districts.

The original request only included equipment for groundwater evaluation, so included only equipment for four water quality parameters: pH, electrical conductivity, iron and manganese. However, many spring water sources are also targeted. The requested equipment is insufficient to evaluate spring water quality for drinking water supply. It is therefore proposed to procure portable water quality analysis equipment to evaluate both groundwater and spring water.

6-3) Stand-by Booster Pumps (5 units)

The number of transmission pumps and booster pumps to be constructed and repaired in the project is 18 in total. The specifications of each pump depend on the pump capacity and pump head. It is planned to install one stand-by pump to each pump facility, instead of procurement of stand-by pumps.

As for the submergible pumps in boreholes, stand-by pumps can not be installed in deep wells. It is planned to procure one stand-by pump for each borehole water supply facility.

6-4) Spare Parts for Hand Pumps (L. S.)

There are 24 sites of the water supply facilities to be equipped with hand pumps, including both new construction and rehabilitation works. Because the parts of

hand pumps last only half a year, it is proposed to procure enough spare parts for at least the maintenance period of the project.

Spare parts will be procured for each hand pump site. Therefore, 24 sets of spare parts are required. The cost of the spare parts is included in the construction cost because the spare parts are usually provided with the hand pumps themselves.

6-5) Tools for Hand Pump Repair (3 sets)

There are four water user associations to manage and maintain water supply facilities with hand pumps. One set of tools for Hand Pump Repair is to be procured to each water commune. A total of four sets of tools is therefore required

The cost of the tools is included in the construction cost because the tools are usually procured with the hand pumps themselves.

6-6) General Mechanical Maintenance Tools and Plumbing Tools (10 sets)

General mechanical maintenance tools include inspection and repair tools for mechanical and electrical equipment of the pump facilities. Plumbing tools include inspection and repair tools for water distribution pipes, water taps, and valves. One set of general mechanical maintenance tools and one set of plumbing tools are planned to be procured for water user associations because both sets of tools are important for the maintenance works. However, districts that have no pump facility need only plumbing tools.

Considering the above situation, the procurement plan is proposed as below.

Table 2-20 Proposed Maintenance Equipment

Original Request	Contents of Procurement	Units	Remarks
Mobile Water Quality Analysis Equipment (10 sets)	Portable Water Quality Analysis Equipment Kit	4 units	1 unit/district
Stand-by Booster Pumps (5 units)	Stand-by of submergible pump	2 units	Applied to piped water scheme with borehole pump
Tools for general Mechanical Maintenance and Plumbing (10 sets)	• Pipe Wrench • Screw Cutting Tool • Tripod with Vice for Screw Cutting Tool • Spanner • Pipe Cutter • Saw for Cutting uPVC Pipe • Manual Punching Tool • Measure • Stepladder • Tester • Cramp Meter • Screw Driver	12 sets	Adopting for piped water scheme equipped with electric pump
	• Pipe Wrench • Screw Cutting Tool • Tripod with Vice for Screw Cutting Tool • Spanner • Pipe Cutter • Saw for Cutting uPVC Pipe • Manual Punching Tool • Measure • Stepladder • Screw Driver	1 set	Adopting for piped water scheme with gravity system

2.2.3 Basic Design Drawings

The following drawings were prepared by the Study and are attached to this report.

Table 2-21 List of Drawings

Drawing No.	Title
GENERAL DRAWING	
GE-001	LOCATION MAP OF THE PROJECT FOR RURAL WATER SUPPLY
PIPED WATER SUPPLY SCHEME	
PW-001	WATER SUPPLY SYSTEM (1)
PW-002	WATER SUPPLY SYSTEM (2)
PW-003	WATER SUPPLY SYSTEM (3)
PW-004	WATER SUPPLY SYSTEM (4)
PW-005	WATER SUPPLY SYSTEM (5)
PW-006	WATER SUPPLY SYSTEM (6)
PW-007	WATER SUPPLY SYSTEM (7)
PW-008	WATER SUPPLY SYSTEM (8)
PW-009	WATER SUPPLY SYSTEM (9)
PW-010	WATER SUPPLY SYSTEM (10)
PW-011	WATER SUPPLY SYSTEM (11)
PW-012	WATER SUPPLY SYSTEM (12)
PW-013	WATER SUPPLY SYSTEM (13)
PW-014	COLLECTING WEIR AND COLLECTION PIPE (1)
PW-015	COLLECTING WEIR AND COLLECTION PIPE (2)
PW-016	COLLECTING WEIR AND COLLECTION PIPE (3)
PW-017	RECEIVING TANK (SINGLE)
PW-018	RECEIVING TANK (TWIN)
PW-019	MAIN DISTRIBUTION TANK (SINGLE)
PW-020	MAIN DISTRIBUTION TANK (TWIN)
PW-021	DISTRIBUTION TANK (SINGLE)
PW-022	DISTRIBUTION TANK (TWIN)
PW-023	PUMPING STATION DETAIL (1)
PW-024	PUMPING STATION DETAIL (2)
PW-025	PUMPING STATION DETAILFOR NYANKORA SITE
PW-026	PUMPING STATION DETAIL FOR KAZABAZANA SITE (1)
PW-027	PUMPING STATION DITAIL FOR KAZABAZANA SITE (2)
PW-028	PUMPING STATION DITAIL FOR KAGOMA SITE
PW-029	CONTROL DIAGRAM OF PUMPING WORKS
TYPICAL DRAWINGS	
TD-001	MAINTENANCE OFFICE
TD-002	PUBLIC STAND FOR TWO TAPS
TD-003	PUBLIC STAND FOR THREE TAPS
TD-004	PUBLIC STAND FOR FOUR TAPS
TD-005	VALVE CHAMBER
TD-006	AIR VALVE, SLUICE VALVE, FLOW METER AND STRAINER CHAMBERS
TD-007	BREAK PRESSURE TANK
TD-008	PIPE INSTALLATION, LINE MARKER, AND THRUST BLOCK
TD-009	RIVER AND ROAD CROSSING OF PIPE
TD-010	CONSUMER CONNECTION
CONSTRUCTION OF BOREHOLE WATER SUPPLY SCHEME	
BW-001	BOREHOLE STRUCTURE
BW-002	STRUCTURE OF HAND PUMP FACILITY

2.2.4 Implementation and Procurement Plan

2.2.4.1 Principles for Implementation Plan

(1) Principles

Assuming that the Project is implemented under the Japanese Grant Aid Scheme, the following principles should be applied for implementation:

1) The executing agency of the Rwandan Government is MINITERE.
2) At the signing of the Exchange of Notes between the Japanese and Rwandan Governments, MINITERE should commence the preparation works in the Department of Water Development and four target districts and proceed with the necessary actions for implementation of the Project.
3) After the signing of the Exchange of Notes for the implementation of the Project between the Japanese and Rwandan Governments, a Japanese consulting firm will sign a contract with MINITERE, and the consultant will prepare detailed design and tender documents, and then commence the tendering procedure.
4) The Japanese contractor will sign a contract with MINITERE and execute construction works under supervision of the consultant.
5) The Japanese contractor will establish a site management office for construction works.
6) The Project should be implemented for former Kibungo province, comprising construction of spring sourced piped water scheme with motored pump (10 schemes), spring sourced piped water scheme with gravity system (1 scheme), groundwater sourced piped water schemes (2 locations) and borehole equipped with hand pump scheme (24 locations)
7) At the completion of construction works, responsibility for the constructed facilities is to be handed over to water users associations.
8) The construction material for the Project should be procured in Rwanda. This includes hand pumps, galvanized steel pipes, PVC pipes, steel plates, structural steel, reinforcing, cement, timber, fuel, oils, painting materials, and so on. The construction equipment for polyethylene pipe and its fittings, diesel generator and pump control panel will be procured from Japan or a third country.
9) The contract for construction and procurement is a lump sum contract.
10) Considering the size of the project, the Project is divided into three phases.

(2) Principles for Procurement of Operation and Maintenance Equipment

Operation and maintenance equipment such as portable water analysis equipment, submersible pumps, and operation and maintenance tools, which are available in the market in Rwanda, should be procured in Rwanda taking into account procurement of spare parts. These should be procured by the contractor.

2.2.4.2 Implementation Conditions

(1) Tax Exemption

Necessary procedures for tax exemptions involve many organizations including MINITERE. Therefore, it is assumed that these will take a significant period of time because of the complicated application and approval system.

Responsibility for the tax exemption procedure is taken by MINITERE, although the consultant and contractor should understand the laws and regulations, prepare required documents, and apply and process them.

(2) Environmental Protection

Environmental impact due to construction work relates to: 1) noise, 2), dust, 3) vibration from heavy construction equipment, and 4) traffic accidents in general. Since schools and health centers are located within the target area, the impact due to noise and vibration will be considered. Avoidance of traffic accidents could be achieved by strict management of traffic rules and driving speed, application of a registration system of drivers, restriction of private vehicle use, education of drivers, creation of awareness by periodic meetings, control of traffic, and so on.

2.2.4.3 Scope of Works

(1) Scope of Works to be Executed by Japanese Side

1) Execution of detailed design
2) Preparation of tender documents, evaluation and support for tendering process on behalf of MINITERE
3) Undertaking construction of boreholes and water supply facilities based on the terms of reference stipulated in the Basic Design Study Report.

(2) Undertaking by Government of Rwanda

1) Provision and arrangement of land necessary for implementation of the Project (borehole sites, storage tanks, public taps, distribution and transmission pipes

and so on.）

2）Cutting of bushes along pipeline route and within private land

3) Construction of access roads and fencing for water sources, pumping stations and storage tanks

4) Budget arrangements and payment of import tax, internal tax, and other levies

5) Arrangement of construction permission and payment of the expenses

6) Arrangement of necessary counterpart personnel.

2.2.4.4 Consultant Supervision

(1) Detailed Design and Tendering

1-1) Detailed Design

Based on the results of the basic design study, detailed design and tender documents will be prepared for:

- Plan survey at water source areas
- Plan and profiling surveys for raw water mains and distribution lines
- Vertical electrical sounding
- Air lifting tests for existing boreholes
- Detailed design for water supply facilities
- Preparation of design reports and drawings
- Quantity calculations and cost estimates
- Preparation of construction plans and tender documents.

1-2) Tender Assistance

Prior to the tender, a pre-qualification of applicants will be carried out. This announcement will appear in the name of MINITERE in major Japanese construction-related newspapers. The pre-qualification documents will be prepared and distributed by the consultant. Tender documents will then be distributed to the qualified contractors. The proposals of the tenderers will be received by the consultant and opened by the consultant in the presence of the staff of MINITERE. The proposals will be evaluated by the consultant and the staff of MINITERE immediately after opening them. The contract documents will be drafted and finalized by negotiation with the selected tenderer. The consultant will assist MINITERE with the following work:

- Tender announcement
- Preparation, distribution, and evaluation of pre-qualification documents

- Distribution and evaluation of tender documents and contract negotiation.

(2) Construction Supervision

After certification of the contract by the Japanese Government, the consultant will publish notification of the commencement of the work. After this commencement, a resident engineer will reside at the site. The resident engineer will supervise construction work and report work progress to the Embassy of Japan in Rwanda the JICA Rwandan office, and MINITERE. The resident engineer will take a role in facilitating communication among the concerned agencies including the contractor.

The following are the major items of the supervision work:

1)	Approval of construction drawings	:	Evaluation and approval of construction and shop drawings, permission for construction work, material, specification of equipment and machinery, and so on
2)	Supervision of construction work	:	Instructions for the construction schedule, overseeing progress of work, shop inspection for materials, and other required work
3)	Inspection for completion	:	Inspection of as-built drawing and construction quality
4)	Approval for payment	:	Issuance of certificate for payment and completion of works
5)	Inspection at the end of defect liability period	:	Inspection of constructed facilities

2.2.4.5 Quality Control Plan

The quality control plan for the Project applies to borehole work, concrete work, piping work and manufacturing of equipment such as pipes, hand pumps, and so on. The quality control items are given as follows:

Table 2-22 Quality Control Plan

Quality Control Item	Content	Method
1. Borehole work	Material Inspection Electrical logging Pumping test	By inspection Borehole log Pumping test record
2. Concrete work	Slump test Compression test	Each 10 m^3 Each 10 m^3（7 day and 28 day strength）
3. Piping work	Hydraulic pressure tests	1.5 times normal pressure
4. Equipment	Shop inspection	Inspection sheets
5. Water Quality	Water quality test	Sampling and analysis of outlet water of water treatment facility and well water based on WHO guideline

2.2.4.6 Procurement Plan

(1) Material and Equipment, Local Contractor and Machinery

1-1) Materials and Equipment

a) General

Major materials and equipment for the Project, such as hand pump, submergible pump, transmission and distribution pipe, and others such as steel sheet, section steel, reinforcement bar, fuel, oil, and, paint, are not produced in Rwanda but can be procured through domestic agents. Meanwhile, cement and timber are available domestically. Polyethylene pipe, diesel generators, and control panels for pumps need to be procured from other countries.

b) Hand Pump

The AFRIDEV type hand pump, which is expected to be used in this project, is commonly used in neighboring African countries. Local agents handling hand pumps have initiated businesses in Rwanda recently and, therefore, spare parts for the hand pump can be procured easily within Rwanda. Accordingly, the hand pump will be regarded as a product manufactured in another country but procured within Rwanda.

c) Submergible Pump

An ordinary type of submergible pump will be used for piped water supply based on deep well. Such submergible pumps made in Europe can be procured from local agents and are used for existing water supply facilities in Rwanda. These will be accepted smoothly in view of operation and maintenance. In addition, spare parts essential for operation and maintenance can be procured from local

agents. Accordingly, the submergible pumps will be regarded as a product manufactured in another country but procured within Rwanda.

d) Vertical Multistage Pump

Vertical Multistage Pump will be used for water transmission from spring intakes to water distribution reservoirs. Booster pumps will be introduced when a large pumping head is required for water transmission. It is observed that existing motor pumps for water transmission are not maintained properly on the whole. The major reason for improper maintenance is attributed to careless handling and/or repair by unskilled workers. For the Project, the vertical multistage pumps that require careful handling with sufficiently specialized technique will be introduced to avoid careless handling. Such motor pumps are already introduced for some existing water supplies in Rwanda and are imported by local agents and, therefore, will be regarded as manufactured in another country but procured within Rwanda.

e) Diesel Generator

Electricity for pump equipment will be supplied by diesel generator to be installed together with the pump equipment, except for existing pump equipment powered by a commercial electricity supply. Diesel generators able to save fuel consumption will be selected for minimizing operation and maintenance cost. Only a limited variety of diesel generators are available at local agents. It is therefore hard to arrange the optimum combination of pump and diesel generator in the case of local procurement. For example, small capacity pumps may be coupled with an unnecessarily large capacity generator due to the limited choices possible in Rwanda. For the purpose of saving operation and maintenance costs, an optimum sized diesel generators for each pump will be selected from a wide variety of the products available in Japan.

f) Transmission and Distribution Pipe

Only PVC straight pipes are produced in Rwanda and are widely used for water supplies. Domestic factories manufacturing PVC straight pipes are not authorized by ISO. Meanwhile, the domestic PVC straight pipes are generally manufactured with to ISO specifications and are widely used for water supplies in Rwanda. Accordingly, it is possible for the Project to use the domestic PVC straight pipes. Galvanized iron pipes and PVC special fittings will be regarded as manufactured in another country but procured within Rwanda. Polyethylene pipes need to be procured from the other countries.

g) Water Meter, Bulk Flow Meter, and Valves

Water meters, bulk flow meters, and valves are imported from Europe and will be regarded as manufactured in another country but procured at local agents or in need of being direct procurement from Japan or other countries.

h) Steel Sheet and Section Steel

Steel sheet and section steel will be procured from South Africa or the Middle East countries through local agents in Rwanda.

i) Reinforcement Bar and Form

Reinforcement bars are imported from neighboring countries and can be procured through local agents in Rwanda. Domestic products are available for the formwork to be used for the Project. The cutting of wood is strictly controlled in view of environmental conservation in Rwanda, but there is no constraint to procure the forms for construction work.

j) Concrete Block and Red Brick

Domestic concrete blocks for building and walls are available. Red brick will not be used for the Project because the production of red brick is prohibited in Rwanda to avoid environmental degradation.

k) Sand and Aggregate

Sand underlying pipelines can be procured from quarries in the vicinity of the construction site. Better quality sand for mortar production can also be procured from borrow areas located in the same region. Fine aggregate, coarse aggregate, and crushed stones can be exploited within Rwanda.

l) Cement

Cement can be procured within Rwanda.

m) Fuel

Fuels can be purchased from the fuel stations of international petroleum companies with business operations in Rwanda. It should be noted that the fuel stations located to the east of Kibungo town do not deal with light oil. It should also be noted that the fuel stations in Kibungo town suffers from out-of-service due to the frequent power failures. In the case of the power failure, it is necessary to go to the fuel stations in Kayonza or Rwamagana towns located under better power supply conditions.

n) Fittings for Building Work

Fittings for building work such as windows and doors used in administration building can be purchased in Kigali.

o) Paint

Paints imported mainly from South Africa are available in Kigali.

p) Coating Material for Water Proofing

Coating materials for water proofing are not available in Rwanda and will be procured from Japan because good quality coating will be required for anti-corrosion of pipeline against the weakly acidic raw water.

Procurement of materials and equipment for the Project is summarized in Table 2-23.

Table 2-23 Procurement of Materials and Equipment for the Project

Material and Equipment	Rwanda	Japan	Other Countries	Remarks
Hand Pump			○	Imported product available in local agent
Submergible Pump			○	Imported product available in local agent
Motor Pump			○	Imported product available in local agent
Diesel Generator		○		Procurement in Japan
PVC Pipe and GI Pipe	○		○	Imported product available in local agent
Polyethylene Pipe			○	Procurement in other countries
Water Meter, Bulk Flow Meter, and Valve	○	○	○	Local or imported product depending on different specifications
Steel Sheet and Section Steel			○	Imported product available in local agent
Reinforcement Bar and Form			○	Imported product available in local agent
Concrete Block and Red Brick	○			Local product available
Sand and Aggregate	○			Local product available
Cement	○			Local product available
Fuel			○	Imported product available in local agent
Fitting for Building Work	○			Local product available
Paint			○	Imported product available in local agent
Coating Material for Water Proofing		○		Procurement in Japan

1-2) Local Contractor and Machinery

a) Local Contractor

In Rwanda, local firms are registered by type of business or industry but are not classified within the field of construction. There are some construction firms with experience in water supply. There is only one firm specialized in deep well drilling and this firm has experience in drilling some 100 deep wells per year.

b) Machinery

The drilling firm has drilling rigs and associated machinery. General construction machinery, on-site manufacturing equipment, and other associated equipment will be procured by possible lease contract within Rwanda. Equipment for connecting

polyethylene pipes will be procured from a foreign manufacturer dealing with polyethylene pipe.

2.2.4.7 Technical Assistance Plan

The purpose of technical assistance to be carried out by the Project is to enhance the ability of control, operation and maintenance for water supply facilities. The contents are as follows;

- On-the-job training for initial control and operation carried out by the Contractor
- Software Component Plan to be carried out by the Consultant (see next section)

It is difficult for water users association to hire good and skilled technical staffs to train above things. Therefore, the Contractor will train technical staffs who are employed in the Government and have good knowledge.

It is possible for them to participate in construction from beginning through on-the-job training, and the following results are expected;

- They will share the entire of water supply facility and make a plan for general maintenance through the construction of water supply facilities
- They will grasp the characteristics of water supply facilities, such as pipe connecting, inspection of machines and so on.

It is expected that the initial control and operation are smoothly trained to them and synergy effect will be appeared with the training for software component plan.

2.2.4.8 Software Component Plan

(1) Background

The Government of Rwanda is implementing the decentralization of local administrations to transfer the authorities from Province to District and from District to Sector. As a result of the decentralization in January 2006, it is expected that technical staff will be assigned to Sectors for strengthening of local level administrations. However, the number of staff to be assigned to Sectors and their capability are not distinguished clearly at this moment.

Through the Basic Design Study in Rwanda, it is recognized that many existing water user associations do not have sufficient capability in management, technical skills, operation and maintenance, and awareness of sanitation even they have a responsibility for it. It can be seen that many existing water supply facilities are found in lessening function or breakdown condition after several years of

completion because of incapable function of the facility and insufficient operation and maintenance with less technical skill. Moreover, it is occurring of water-borne diseases due to it is unfamiliar of personal hygiene for safe water among the rural residents. An improvement of enlightenment of personal hygiene is important.

The typical problem for rural water supply at the planned objective sites, particularly about Level 2 facilities, where pumping up more than 100m from spring source by transmission pipe is to master appropriate operation by water user associations. To manage, operate, and maintain of the rural water supply facility, particularly about Level 2 facilities, is required high standard of management (organization and financial affairs, etc.) and technical (operation and maintenance, etc.) respectively. However, under the condition of the rural area as shortage of manpower, training of water use association is essential feature to establishment of the operation and maintenance structure in a District, Sector or water management association.

To improve the condition mentioned above, it is essential to implementation of operation and maintenance by own ability under a support of local government such as a District or a Sector. Additionally, on establishment of utilization of water facilities, enlightenment of personal hygiene with taking a vulnerable people into account are also necessary for water use association to keep their sustainability of operation and maintenance.

The water supply facilities to be constructed under the Project (Grant Aid) belong to 16 water use association (3 associations of Level 1 and 13 associations of Level 2 facility) of 22 Sectors in four Districts. It is required to resolve problems mentioned above by the objective Districts, Sectors, and water use association for autonomous management, techniques, and operation and maintenance of the water supplies.

In addition, new water user associations to be organized by local residents under the Project will not have such capability and awareness at establishment.

(2) Objectives

Software Components under the Project envisage attaining the basis of sustainable management, technique, and operation and maintenance for water supply by newly established water user associations or those reorganized through corresponding training as well as sustainable administrative supporting system by District or Sector.

(3) Expected Achievements

Issues and expected achievements by Software Components will be the followings.

Table 2-24 Issues and Expected Achievements by Software Components

Issues	Expected achievements
1. Supporting system for existing water user associations by district or sector is not established.	District or sector will be trained to acquire administrative capability for supporting water user associations.
2. Water user associations need to be established for new water supplies. existing water user associations do not function appropriately.	Water user associations will be established or reorganized.
3. Local communities do not have experience and know-how to organize management, technique, and operation and maintenance for water supply. existing water user associations do not have sufficient capability.	Water user associations will improve their capability to organize management, technique, and operation and maintenance for water supply.
4. Awareness of relationship between human health and safety of potable water is not commonly recognized.	Committee members of water user associations will improve their awareness of sanitation relating to water supply.

The plan for Software Components aims at coping with the issues above to establish a basis for sustainable management, techniques, and operation and maintenance for water supply

(4) Evaluation of Achievements

Achievements by Software Components will be evaluated in the following manner.

4-1) Capacity building of District or Sector to support water user association regarding management and technique

Workshops and on-the-job training for responsible officers of District or Sector will be carried out for capacity building in management and technical supports to prepare a follow-up action plan. Districts or Sectors will monitor the performance of water user associations according to the follow-up action plan. At establishment of a water user association, support and monitoring by District or Sector will be provided as on-the-job training assisted by the Consultant to be appointed for implementing Software Components. Districts will conduct transportation of fuel bi-weekly and water quality testing monthly on request by the water user association. These will also be subject to monitoring.

4-2) Establishment and reorganization of Water User Association

District or Sector will establish or reorganize water user associations with assistance by the Consultant. For organizing water user association, District or Sector will to establish conditions for appointment of the committee members and conditions for employment of staff and will make employment examinations. These practices will be monitored and evaluated to ensure proper performance.

4-3) Capacity building of water user association to organize management, technique, and operation and maintenance for water supply

Water user associations need to acquire basic capability for 1) management of organization, 2) financial matters such as establishment of a water tariff, collection of water tariff, preparation of financial plan, accounting, and control of working funds, 3) technical and operation and maintenance subjects such as reduction of non-revenue water, operation of water supply facility, maintenance and repair, haw to deal with troubles, 4) monitoring subjects. The practices by water user association will be monitored and evaluated to ensure the progress of the capacity building in the light of an action plan including the followings.

a) Human resource development for technical staff

In addition to the activities covered by the scope of the software components, the technical staff of each water user association will be dispatched to local firms involved with the construction works of the Project to receive on-the-job training.

b) Human resource development for committee member and accountant

It is a fact that the committee members to be appointed such as chairman, vice chairman, secretary, and sanitation officer, and accountant to be employed, do not have experiences or sufficient capability to organize operation and maintenance for water supply. Therefore, they will be trained to acquire the capability for management, technique, and operation and maintenance for water supply by themselves.

c) Human resources development for water kiosk operator

Water kiosk operators will be trained by the water user association itself assisted by the Consultant. The conduct of the training will be monitored and evaluated to ensure its progress and achievements with written reports regarding 1) water tariff collection, 2) water meter reading, 3) number of water users, 4) quantity of water sold (number of jerry-cans), and 5) cleaning of water kiosk and surroundings.

4-4) Water user association committee members to improve awareness of sanitation

The Software Components will provide training for the sanitation officers of water user associations to undertake awareness-raising activities on sanitation relating to water use and to encourage changes to local practices for better sanitary conditions. The training will be conducted mainly by local NGOs. In the training, Participatory Health and Sanitation Transformation (PHAST) commonly used in African countries will be introduced to enhance the understandings of water-born disease related to local resident's sanitary customs and practices as well as the need for improvement of sanitary conditions together with the effective use of safe water.

In the sanitary education of the Software Components coordinated with Technical Cooperation Projects, the trained sanitation officers of water user associations will be Community Resource Persons (CORPs) who provide services in areas of water supply under the Project. The practices by CORPs will be monitored and evaluated to ensure adequate progress and achievements. CORPs will be women.

Achievements regarding the following matters will be confirmed for comparison of the results of the social survey before implementation of the Project with the monitoring/evaluation results after completion of Technical Cooperation Projects.

- Understanding of water-born disease relating to local resident's sanitary customs and practices
- Infection rate of prevailing disease and water-born disease
- Change in sanitation practices (ex. washing hands)
- Change in fetching and safekeeping of water
- Level of satisfaction with water quantity and quality

(5) Inputs for Software Components

Inputs for Software Components are planned on the basis of the following considerations.

5-1) Coordination with Technical Cooperation Projects

Software Components will provide assistance for creating the ability for autonomous management, techniques, and operation and maintenance of the water supplies to be constructed under the Project (Grant Aid). Technical Cooperation Projects will aim at further improvement for sustainable operation and maintenance of the water supplies to be constructed under Grant Aid. Table 2-25

shows the contents of Software Components under Grant Aid and Technical Cooperation Project to be coordinated with each other.

5-2) Considerations for District or Sector

Under the process of decentralization, it is reported that an envisaged follow-up system was not successful in terms of sustainability in a previous UNICEF project due to the administrative reform of District and reassignement of officers who were trained under the project. As the reassignement of officers in District or Sector may take place during implementation of the Project, the organization for operation and maintenance will not be established on a District or Sector basis.

Table 2-25 Software Components and Technical Cooperation Projects

	Software Components (Grant Aid)	Technical Cooperation Projects
Basic Concept	The basis of management, technique, and operation and maintenance for each water user association will be established to initiate operation of water supplies constructed under the Project (Grant Aid) smoothly Formation of model schemes Establishment of the basic conditions for management, techniques, and operation and maintenance	Based on the achievements of the Software Components, the following subjects will be further worked out. 1) Establishment of sustainable supports firmly for water user association by local administration 2) Further applications and developments of operation and maintenance practices for water supply 3) Applications of the practices to small scale project by CDF 4) Capacity development of other relevant organizations and/or officers 5) Sanitary education for regional level Further strengthening of water user association To ensure the achievements of Software Components through monitoring and follow-up Applications of the practices by Software Components to other options (ex. other rehabilitations, small water supplies, and sanitation facilities)
Operation and Maintenance System	Organization system for operation and maintenance is planned within the Basic Design Study and will be established through the practices by Software Components. (All of 4 Districts within the former Kibungo Province will be covered but Sectors will not be covered entirely.)	Organization system will be further developed in the light of the achievements of Software Components in order to strengthen water user association and establish firmly the follow-up system.
Preparation of Manuals	For the water supplies to be constructed under the Project (Grant Aid), operation and maintenance manual for water user association and field manual for supports by local administration will be prepared.	Through consultations with the Government of Rwanda and other donors, the manuals prepared by Software Components will be further developed for spreading the practices over the remaining Sectors and communities. Knowledge and lessons in the process of the development of the manuals will be fed back to the Project (Grant Aid). The manuals will be applied to other subjects out of the Project (Grant Aid)
Training Materials	For the water supplies to be constructed under the Project (Grant Aid), training materials for water user association will be prepared.	Through consultations with the Government of Rwanda and other donors, the training materials prepared by Software Components will be further developed for spreading the practices over the remaining Sectors and communities. Knowledge and lessons in the process of the development of the training materials will be fed back to the Project (Grant Aid). The training materials will be applied to other subjects out of the Project (Grant Aid)

	Software Components (Grant Aid)	Technical Cooperation Projects
Training	For the water supplies to be constructed under the Project (Grant Aid), training for administrative support and water user association will be prepared.	Experiences, achievements, and lessons in Software Component will be fed back to the Project (Grant Aid) and training system by administrations or other organizations will be established. The training will be applied to other subjects out of the Project (Grant Aid)
Monitoring and Follow-up	Monitoring and follow-up systems will be established for the water supplies to be constructed under the Project (Grant Aid)	Lessons from monitoring of operation and maintenance for the water supplies constructed under the Project (Grant Aid) will be fed back to the manuals, training materials, and trainings. Follow-up will be conducted for the water supplies constructed under the Project (Grant Aid) in view of sustainability and further development of operation and maintenance. Knowledge resulting from the follow-up will be recorded.
Sanitary Education	Sanitary education will be conducted for the responsible officers of water user association. An action plan will be prepared for sanitary education from the responsible officers of water user association to local residents.	Supports for the officers of water user association to popularize the sanitary education for local residents. It is expected that sustainability of the water supplies will be further improved with local resident's understandings and awareness for the need of safe water and sanitary improvement.

5-3) Considerations for Establishment of Water User's Association

a) Employment of Technical Staff

In the Project, the majority of the piped water supplies require electricity supply from diesel generator. Therefore, expenditure of water user associations on fuel will account for more than 50% of the total income from water tariff collection. Due to such a financial burden on the water user associations, it is difficult to employ appropriate persons. Additionally, technicians sufficiently skilled are scarce in the former Kibungo Province. Accordingly, technical staff having an acceptable ability will be employed through interview and examination and they will be up-skilled by training.

b) Employment of Committee Member and Accountant

Committee members of existing water user associations are selected by vote at the community level or regional level, but some water user associations do not have suitable committee members. In the Project, selection criteria for committee members will be prepared and presented to local residents or their representatives to nominate candidates. Among the candidates, the committee members will finally be selected through consultation with each District or Sector. Accountants having an acceptable ability will be employed through interview and examination.

c) Employment of Water Kiosk Operator

For ensuring vulnerable residents can use the water supply, some vulnerable residents involved with water user associations will be employed as water kiosk operators. Among vulnerable residents, widows or handicapped persons who can read and write water will be appointed as kiosk operators.

5-4) Inputs

Based on the considerations discussed above, the inputs for Software Components are planned as follows:

a) Capacity building of District or Sector to support water user association regarding management and technique

- Exchange of opinions with officers concerned within each District or Sector involved, for establishment of water user associations and field visits
- Preparation of field manuals (English and French)
  - i) Manual for Hand Pump
  - ii) Manual for Piped Water Supply Facility with Groundwater
  - iii) Manual for Piped Water Supply Facility with Spring
- Preparation of training materials (English and French)
- Preparation of training programs
- Preparation of follow-up action plan
- Training for capacity building regarding management and technique
- Follow-up of administrative supports
- Preparation of check-list for monitoring and follow-up of practices by water user association

b) Establishment and reorganization of water user association

- Establishment of selection criteria of committee members and staff of water user associations
- Preparation of draft articles of water user associations

c) Capacity building of water user associations to organize management, technique, and operation and maintenance for water supply

- Preparation of operation and maintenance manuals for water supply (English, French and Local Language)
  - i) Manual for piped water supply with water transmission by gravity
  - ii) Manual for piped water supply with water transmission by pump

iii) Manual for piped water supply with water transmission by pump (booster pump required)
iv) Manual for piped water supply with water transmission by pump (booster pump required and used for a part of water distribution as well)
v) Manual for piped water supply with water transmission by pump from deep well
vi) Manual for deep well equipped with hand pump

- Preparation of training programs
- Preparation of training materials for water user associations
- Training for operation and maintenance
- Up-dating of operation and maintenance manual
- Monitoring and follow-up of water user associations

d) Water user association committee members to improve their awareness of the need for sanitation

- Training of Community Resource Persons (CORPs) who will be women appointed as staff of water user associations
- Training of Participatory Health and Sanitation Transformation (PHAST)
- Practices by CORPs for sanitary education in the communities involved with the water supplies under the Project (to be conducted under Technical Cooperation Projects)

e) Evaluation of Achievements by the Project

- Monitoring and follow-up by District or Sector

For the inputs above, Table 2-26,27,28 and 29 shows the details of practices, purposes, targeted persons, methods, work periods, human resources required, and deliverables. The practices of Software Components are demarcated into the responsibilities of the Japanese and Rwandan sides, respectively. Achievements of the Software Components are envisaged on the condition that the responsible organizations of the Rwandan side should undertake their practices voluntarily.

Table 2-26 Plan of Software Components - Preparatory Stage (1/4)

Practice	Purpose	Targeted persons	Method	Work period	Inputs	Deliverable
1. planning stage						
1.1 Exchange of opinions with officers concerned within each district or sector involved, for establishment of water user associations and field visits	Common understandings for software components within all the persons concerned. Explanation of the facilities. Consultations with different sectors to be relevant to one service area.	Responsible organization of the project, and auditors and infrastructure officers of 4 districts or 36 sectors involved	Orientations with workshop style Detail explanation of the facilities	1 day /district	Japanese consultant (organization and management) Local expert (organization and management)	Minutes of meeting
	For project staff members to gain an understanding of the water supply areas. Consultations with existing water user associations		Field visits. It is necessary to visit all sites because workers in the districts and sectors were moved after decentralization. Consultation meetings with existing water use association	2 days /district Visit 2 fields in 1 day		
1.2 Selection criteria for committee members and staff of each water user association, recruiting, and preparation of draft articles for each water user association • Establishment of selection criteria for committee members • Establishment of employment criteria for staff • Establishment of criteria for employment of staff • Draft articles of water user association	Selection of suitable committee members and employment of acceptably capable staff	Auditors and infrastructure officers of 4 districts or 36 sectors involved	Documentation with phast method by district and sectors	4 days/subject	Japanese consultants (organization and management / operation and maintenance) Local expert (organization and management) Local expert (operation and maintenance)	Announcement papers for recruiting Documents for evaluation of selection criteria for committee members Documents for evaluation of employment criteria for staff Draft articles of water user association
			Consultations with the districts or sectors involved Documentation	4 days/subject (1 day for each district due to different facility types)		
			Collecting existing articles, reviewing and documentation	2 days/subject (1day for collection, 1 day for documentation)		

(to be continued)

Practice	Purpose	Targeted persons	Method	Work period	Inputs	Deliverable
1.3 Operation and maintenance manuals • draft corporate plan of water user association • Management for organization of water user association • Development of skills for accounting of water user association • Operation and maintenance • Survey of water leakage • Sanitary education for water user association • Training materials	Practices for proper operation and maintenance by water user association	Water supplies to be constructed under the project, classified into 6 types	Consultations with the responsible organization of the project, districts or sectors involved Documentation and submitting	30 days/subject	Japanese consultants (organization and management / operation and maintenance) Local expert (organization and management) Local expert (operation and maintenance)	Operation and maintenance manuals for water supplies of 6 different types in english, french, and local language Training program
1.4 Field manuals and training programs	Preparation of field manuals for water supplies grouped into 6 different types to conduct administrative supports (management and technique) for water user associations.	Auditors and infrastructure officers of each district or sector involved	Consultations with the responsible organization of the project, districts or sectors involved Documentation and submitting	15 days/subject	Japanese consultants (organization and management / operation and maintenance) Local expert (organization and management) Local expert (operation and maintenance) Local expert (social development)	Field manuals for water supplies of 3 different types in english and french Training program
1.5 Training materials for administrative supports	Preparation of training materials for administrative supports (management and technique)	Trainees	Power point	3 days/subject	Local expert (organization and management) Local expert (operation and maintenance) Local expert (social development)	Training materials for field manuals for water supplies of 6 different types
1.6 Training materials for water user associations	Preparation of training materials for water user association	Water supplies to be constructed under the project	Power point	3 days/subject	Local expert (organization and management) Local expert (operation and maintenance) Local expert (social development)	Training materials for operation and manuals for water supplies of 6 different types

Table 2-27 Plan of Software Components - Construction Stage (2/4)

Practice	Purpose	Targeted person	Method	Work period	Inputs	Deliverable
2. construction stage						
2.1 Trainings for administrative supports	Capacity building of administrative supports by using training materials (practice 1.5 above)	Auditors and infrastructure officers of each district or sector involved	Field visits to existing water supplies Workshops	4 days /training	Local expert (organization and management) Local expert (operation and maintenance) Local expert (social development)	Reports on training and workshop
2.1 Trainings for operation and maintenance	Capacity building of operation and maintenance and sanitary education (phast) by using training materials (practice 1.6 above)	Committee members and staffs of each water user association involved	Field visits to existing water supplies Workshops	4 days /training (piped water supply) 3 days /training (deep well with hand pump)	Local expert (organization and management) Local expert (operation and maintenance) Local expert (social development)	Reports on training and workshop Management plan for trainings

Table 2-28 Plan of Software Components – Operation and Maintenance Stage (3/4)

Practice	Purpose	Targeted person	Method	Work period	Inputs	Deliverable
3. O&M stage						
3.1 Follow-up for administrative supports by each district or sector	Monitoring and evaluation to confirm the practices being done according to field manuals	Auditors and infrastructure officers of each district or sector involved	On-the-job trainings Review meetings	5 days /follow-up	Japanese consultants (organization and management / operation and maintenance) Local expert (organization and management) Local expert (operation and maintenance)	Results of water quality test Confirmation of fuel transportation Minutes of review meeting
3.2 Initial follow-up for operation and maintenance by each water user association	Monitoring and evaluation to confirm the practices being done according to operation and maintenance manuals	Each water user association	Field inspections Review meetings	3 days /association (piped water supply) 2 days /association (deep well with hand pump)	Japanese consultants (organization and management / operation and maintenance) Local expert (organization and management) Local expert (operation and maintenance)	Minutes of review meeting
3.3 Update of operation and maintenance manuals	Update of operation and maintenance manuals on the basis of practice 3.2	Each water user association		5 days /update	Local expert (organization and management) Local expert (operation and maintenance)	Updated operation and maintenance manuals

Table 2-29 Plan of Software Components - Monitoring and Follow-up Stage (4/4)

Practice	Purpose	Targeted person	Method	Work period	Inputs	Deliverable
4. Monitoring • follow-up stage						
4.1 Follow-up action plan and check-list	Preparation of check-list for evaluating performance of water user association Establishment of periodical monitoring system	Auditors and infrastructure officers of each district or sector involved	Workshops	3 days /follow-up	Local expert (organization and management) Local expert (operation and maintenance)	Follow-up action plan Check-list
4.2 Follow-up for monitoring by each district or sector	Advice for proper monitoring practices according to check-list	Auditors and infrastructure officers of each district or sector involved	On-site advisories	5 days /district	Local expert (organization and management) Local expert (operation and maintenance)	Reports on monitoring

(6) Experts for Software Components

Scope of work of the Japanese consultants is 1) launch of software component, 2) establishment of water use association, 3) documentation of operation and maintenance manual, 4) follow up of Districts, Sectors, and water use association, and 5) evaluation and consultation for status of operation and maintenance at the end of the project. The local expert will carry out following works under direction of Japanese consultants; 1) assistance for documentation of operation and maintenance manual and field manual, 2) implementation of trainings, and 3) follow up Districts, Sectors, and water use association.

Software Components will require the following experts.

6-1) Japanese Consultant

Table 2-30 Tasks of Experts for Software Components

Person in charge	Organization and management	Operation and maintenance
Tasks	• Supervision of management issues of water user association as well as overall progress of Software Components • Preparation of establishment of water user association • Documentation of operation and management manual for water user association • Preparation of training program for committee members for capacity building for operation and management • Follow up Districts, Sectors, and water user association for operation and management issues • Coordination with Technical Cooperation Projects • Contacts and reports to Japanese authorities concerned • Coordination with construction schedule	• Assistance with establishment of each water user association on operation and maintenance structure • Preparation of operation and maintenance manuals • Preparation of a training program for technical staff of water user association for operation and maintenance of intake, conduction pipe, transmission pipe, chlorination, and distribution • Preparation of training programs for reduction of non-revenue water • Contacts and reports regarding operation and maintenance to Client and Japanese authorities concerned • Evaluation of water quality test and status of operation and maintenance and necessary recommendation

6-2) Rwandan Counterpart: the responsible organization

One staff of MINITERE as a counterpart will participate in the Software Components to supervise the practices in collaboration with the Japanese experts. For smooth implementation of Software Components, the counterpart will also take charge of consultations with the other organizations concerned.

6-3) Local NGOs

In Rwanda, local NGOs having know-how and experience in the water and sanitation sector will be employed for establishment of operation and maintenance

systems of the water user associations. In consideration of this background, local NGOs having sufficient capability and experiences will be employed as local experts to conduct a series of the Software Components. Technical guidance and skill development for local experts who will carry out the training will be carried out at the initial stage to ensure that the training is carried out effectively.

The local experts will carry out practices such as assistance of preparation of manuals, training for each District or Sector, establishment of each water user associations, and capacity building for operation and maintenance to be undertaken by the Japanese side under the supervision of the Japanese experts.

The following local experts will be employed in consideration of the extent of the targeted water supply service areas and implementation period of the Project. The local consultants to be employed will have sufficient communication capability in Kinia-Rwanda, English, and French.

a) Local experts: in charge of organization and management

The expert will take initiative for the practices of the Software Components in terms of schedule management as well as introduction, methodology, and deliverables of the different practices and will make reports to the Japanese experts. The expert will be qualified with experiences in similar practices as a leader and/or experienced in workshops as a facilitator.

b) Local experts: in charge of operation and maintenance

The expert will assist the Japanese experts and local expert in charge of organization and management under their supervision. The expert will be qualified and have experience in f similar practices for water supply such as establishment, monitoring, evaluation, and capacity building of an operation and maintenance system, in particular, technical capability for engineering details for water supply in operation and maintenance stage.

c) Local experts: in charge of social development

The expert will assist the Japanese experts and local experts in charge of organization and management under their supervision. The expert will be qualified with experience in similar practices for water supply such as establishment, monitoring, evaluation, and capacity building for operation and maintenance system, in particular, planning of sanitary education.

(7) Schedule

The schedule of Software Components is shown in Table 2-31.

(8) Deliverables

The deliverables of the Software Components are shown in Table 2-26, 27, 28 and 29. A completion report of the Software Components will be submitted to both the Japanese and Rwandan sides. Other principal deliverables will consist of field manuals for Districts or Sectors, follow-up action plans for each District or Sector, reports on training activities and workshops, minutes of meetings, check-lists and reports on monitoring and follow-up, and reports on post-baseline survey. Progress and achievements will be monitored and evaluated with these deliverables.

(9) Undertakings by the Responsible Organization on the Rwandan Side

The following aspects of the Software Components will be undertaken by the responsible organization on the Rwandan side.

1) Assigning the responsible officers of each District or Sector (auditor and infrastructure officer) before commencement of the Software Components
2) Selection and employment of committee members and staff of each water user association with assistance of the Software Components before commencement of construction work under the Project
3) Establishment of water user associations before commencement of construction work under the Project
4) Guidance for each water user association and community to construct the access road before construction
5) Capacity building of operation and maintenance and sanitation awareness at the field level during construction work under the Project
6) Guidance for each water user association and community to construct fences around the constructed water supply facilities before operation is commenced
7) Provision of follow-up training for each water user association after commencement of water supply
8) Monitoring of each water user association constantly after commencement of water supply

Table 2-31 Implementation Program of Software Component

Practices			Required Days	No. of Practices				Total Days				Month
				Unit	Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3		
1	Preparatory Stage											
1.1	Exchange of opinions with officers concerned within each District or Sector involved, for establishment of water user's associations and field visits		3 days	District	3	1	1	9	3	3		
1.2	Selection criteria for committee members and staff of each water user's association, recruiting, and preparation of draft articles for each water user's association											
	a	Establishment of selection criteria for committee members and employment criteria for staff	4 days		1	0	0	4	0	0		
	b	Establishment of criteria for employment of staff	4 days		1	0	0	4	0	0		
	c	Draft articles of water user association	2 days		1	0	0	2	0	0		
1.3	Operation and maintenance manuals		30 days		1	0	0	30	0	0		
	a	Draft corporate plan of water user's association										
	b	Management for organization of water user's association										
	c	Development of skills for accounting of water user's association										
	d	Basic information for operation and maintenance by water user's association										
	e	Survey of water leakage										
	f	Sanitary education for water user's association										
	g	Training materials										
1.4	Field manuals and Training materials		15 days		1	0	0	15	0	0		
1.5	Training materials for administrative supports		3 days		1	0	0	3	0	0		
1.6	Training materials for water user's associations		3 days		1	0	0	3	0	0		
2	Construction Stage											
2.1	Trainings for administrative supports		4 days	Training	1	1	1	4	4	4		
2.2	Trainings for operation and maintenance											
	a	Committee Members, Accountant (piped water supply)	4 days	Training	5	5	5	20	20	20		
	b	Committee Members, Accountant (hand pump)	3 days	Training	2	0	0	6	0	0		
3	Operation and Maintenance Stage											
3.1	Follow-up for administrative supports by each District or Sector		5 days	District	0	3	2	0	15	10		
3.2	Initial follow-up for operation and maintenance by each water user's association											
	a	Water user's association (piped water supply)	3 days	sociation	0	3	10	0	9	30		
	b	Water user's association (hand pump)	2 days	sociation	0	3	0	0	6	0		
3.3	Update of operation and maintenance manuals		5 days	Training	0	1	2	0	5	10		
4	Monitoring and Follow-up Stage											
4.1	Follow-up action plan and check-list		3 days	Training	0	1	2	0	3	6		
4.2	Follow-up for monitoring by each District or Sector		5 days	District	0	3	2	0	15	10		
Experts												
	Japanese Expert											
	A .	Organization and Management										
	B.	Operation and Maintenance										
	Local Expert											
	A .	Organization and Management 1										
		Organization and Management 2										
	B.	Operation and Maintenance 1										
		Operation and Maintenance 2										
	C.	Social Development										

2.2.4.9 Implementation Schedule

After completion of the Basic Design Study, implementation includes detailed design, tendering and letting the contract, construction of water supply facilities and procurement of equipment. Considering the work volume, it is judged that the project schedule will need to be divided into three phases as shown in Table 2-32. The implementation schedule is shown in Table 2-33. Further, the soft component scheme will be executed during the implementation period.

Table 2-32 Implementation Phases and Periods

(Unit : Month)

Item	Phase-1	Phase-2	Phase-3
Detailed Design & Tendering	6.5	6.0	6.0
Construction and Inspection	14.0	12.0	12.5
Soft Component	13.0	10.5	13.5

This three phase implementation schedule is summarized below:

Table 2-33 Implementation Schedule

Phase		Works	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
First Phase	Detailed Design	Field survey															
		Preparation of Tender Documents															
		Approval of Tender Documents															
		Tendering to Contract Award															
	Construction	Preparatory works															
		Borehole with handpump construction															
		Piped water scheme construction															
		On-the-job training in the construction work															
		Initial operation guidance															
		Hand over															
	Procurement	Approval															
		procurement															
		Inspection, handover															
	Soft Component																

Phase		Works	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Second Phase	Detail Design	Field survey															
		Preparation of Tender Documents															
		Approval of Tender Documents															
		Tendering to Contract Award															
	Construction	Preparatory works															
		Piped water scheme construction															
		On-the-job training in the construction work															
		Initial operation guidance															
		Hand over															
	Procurement	Approval															
		procurement															
		Inspection, handover															
	Soft Component																

Phase		Works	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Third Phase	Detail Design	Field survey															
		Preparation of Tender Documents															
		Approval of Tender Documents															
		Tendering to Contract Award															
	Construction	Preparatory works															
		Piped water scheme construction															
		On-the-job training in the construction work															
		Initial operation guidance															
		Hand over															
	Procurement	Approval															
		procurement															
		Inspection, handover															
	Soft Component																

2.3 Obligations of the Recipient Country

Undertakings of the Government of Rwanda follow:

(1) To secure the sites for proposed water supply facilities.

(2) To clear, level and reclaim the sites prior to commencement of construction.

(3) To provide data and information necessary for the Project.

(4) To provide the land for access roads, a temporary site office, warehouse and stock yard during implementation of the Project.

(5) To provide warehouses for storing spare parts and other equipment procured by the Project.

(6) To undertake associated outdoor work such as security of the sites, fencing and gates at and surrounding the borehole sites if necessary.

(7) To construct access roads to the sites prior to commencement of construction if necessary.

(8) To bear the commission charges of the bank in Japan providing banking services based upon the Banking Arrangements.

(9) To take necessary measures for customs clearance of materials and equipment procured by the Project at the port of disembarkation. If tax exemption is not applicable, such tax expenses shall be borne by the relevant organizations in Rwanda.

(10) To exempt taxes and to ensure the prompt unloading and customs clearance at the port of disembarkation in Rwanda and facilitate internal transportation therein of the products purchased under the Grant.

(11) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies that may be imposed in Rwanda with respect to the supply of the products and services under the verified contracts.

(12) To accord Japanese nationals, whose services may be required in connection with supply of the products and services under the verified contracts, such facilities as may be necessary for their entry into Rwanda and stay therein for the performance of their work.

(13) To assign the necessary staff and secure the necessary budget for operation and maintenance of the equipment purchased under the Grant Aid.

(14) To maintain, and use properly and effectively, the equipment procured under the Grant Aid.

(15) To bear all the expenses, other than those to be borne by the Grant Aid, necessary for construction of the facilities.

(16) To maintain control of tools and spare parts purchased under the Grant Aid.

(17) To support the establishment of water management committees for the target communities.

(18) To establish and manage the project implementation organization and coordination with related government agencies.

(19) To bear all the expenses and staff costs for on the job training.

Therefore, it is expected that MINITERE is again able to conduct the above-mentioned tasks.

2.4 Organization for Operation and Maintenance

2.4.1 Basic Framework

The operation and maintenance plan for the Project is planned with the basic framework composed of 1) Promotion of self-dependent operation and maintenance by water users associations, and 2) Establishment of an organization structure composed of the involved administrative authorities to sponsor support services for operation and maintenance. The present process of decentralization to Districts and Sectors has been taken into consideration in planning the support services from the administrative authorities concerned.

A concept of the organization for operation and maintenance for the Project is illustrated in Figure 2-6.

(1) Basic Principles for the Operation and Maintenance Plan at Administrative Authority Level

The administration staff of Districts and Sectors shall be responsible for the support of ordinary operation and maintenance of water supplies. MINITERE shall organize overall coordination for the Province and support repairs needing more advanced techniques. The Province shall provide substantial coordination and support to Districts and Sectors. In the process of the decentralization, previous District authorities are to be transferred to Sectors. However, the Study does not present clear demarcation of responsibilities between District and Sector because each Sector's administrative organization and capability after the decentralization has not been defined for the time being and in some cases a water

users association will have a water supply scheme crossing over different Sectors. Each Sector's administrative organization and capability shall be confirmed in the implementation stage of Software Components. Responsibilities between District and Sector shall be demarcated afterwards, as required for administrative support to water users associations.

Each District and Sector shall monitor water users associations for which it has responsibility, for the purpose of sustainable promotion of operation and maintenance, and shall provide the necessary technical support to the members of those water users associations when the associations do not manage the operation and maintenance themselves. Training for Auditors and Infrastructure Officers, who shall be responsible for such roles within each District and Sector, shall be provided in the Software Components of the Project. These officers shall carry out the financial and technical support respectively for sustainable operation and maintenance by each water users association.

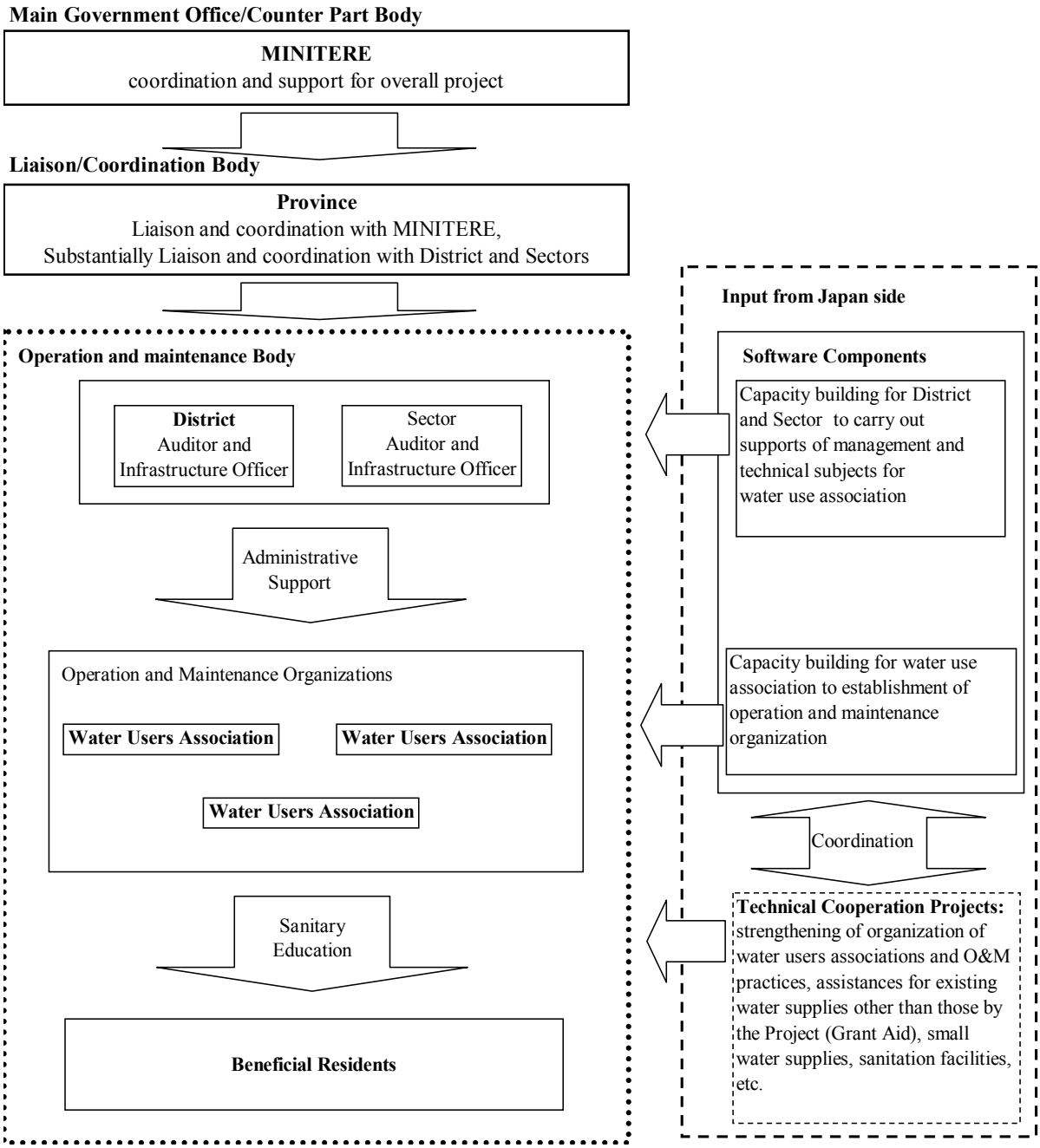


Figure 2-6 Concept of Organization for Operation and Maintenance

(2) Basic Principles for Operation and Maintenance Plans in Water Users Associations

At present, the existing organizations of water users associations are classified into 1) water users associations by water supply and 2) water users associations by District. The roles of water users associations consist of operation of water supply

facilities, ordinary maintenance, water tariff collection and accounting, and operation and maintenance in terms of minor repair.

Water users associations by District are generally organized with three or four layers such as District, Sector, Sell, and water kiosk levels but some of these do not function effectively due to insufficient coordination between the different levels.

The Project envisages establishing 'sustainable operation and maintenance organizations', 'implementation of effective training', and 'water users associations rationally organized', and for these purposes the water users associations shall be reorganized individually by water supply in consideration of the scale of the water supply and social characteristics. In principle, a water users association shall not cross over different Districts after the administrative decentralization in the light of the roles of auditor and infrastructure manager appointed by each District.

The water users associations shall be organized in the manner described hereafter in order to accomplish self-sustained management based on water tariff.

2.4.2 Operation and Maintenance Plan

(1) Roles of Each Organization Level

The roles of each organization level are presented in Table 2-34

Table 2-34 Organization for Operation and Maintenance Stage

Level	Organization		Responsibility	Remarks
Central Government	MINIETERE, Province Water and Sanitation Unit		• Overall coordination • Support for repair using more advanced techniques	
District and Sector	Local administrations to be supported by Software Components by the Project			
	Auditor		• Preparation of operation and maintenance plans by water users associations • Monitoring financial indicators of water users associations • Guidance and support of management by water users associations	
	Infrastructure Officer		• Guidance for repair of facilities • Water quality tests • Storage of water quality testing kits • Purchasing spare parts • Transport of fuel for diesel generators • Purchasing chorine	• Monitoring operation and maintenance of water supply facilities • Leading repairs and checks of water supply facilities as requested by water users associations
Water users association	Committee Members	Chairman	• Management of water users association and liaison • Preparation of operation and maintenance plan • Monitoring operation and maintenance for water supply facilities • Preparation of accounting reports for District and/or Sector level • Requests for budgeting and purchasing chorine • Researching the need for sanitary education	• Volunteer
		Vice Chairman	• Deputy for chairman	• Volunteer
		Secretary	• Managing general affairs and minutes of meetings	• Volunteer
		Sanitation Officer	• Researching people's need for water supply and sanitation • Conducting sanitary education for residents benefiting from the Project	• Volunteer (with Technical Cooperation Projects)
	Staff	Accountant	• Preparation of financial statements • Collecting water tariffs from water kiosk operator. • Recording revenue and expenditure • Management of bank account • Payment of salaries	• Employment with salary
		Pipe work technician	• Maintenance of transmission and distribution mains • Repairs of leakage • Chlorinating • Storing and keeping spare parts, instruments, stationery, etc.	• Employment with salary • (Not applicable for hand pump installations)
		Water source and pump equipment technician	• Maintenance of water sources and pump equipment • Periodical maintenance of pumps, equipment and generators • Meter reading for water transmission	• Employment with salary • (Maintenance only for hand pump installations)
		Water kiosk operator	• Accounting for water tariff collected • Cleaning water kiosk and/or hand pumps • Meter reading	• Employment with salary • (Meter reading not applicable for hand pump installations)

1-1) MINITERE and Province

When the decentralization has been accomplished, the roles of MINITERE and Province, after construction of the proposed water supplies under the Project, shall be limited to monitoring the activities of Districts and Sectors. Meanwhile, support by MINITERE for operation and maintenance shall be required when repairs needing more advanced techniques take place, e.g. overhaul of a diesel generator or electric pump.

1-2) Districts and Sectors

Districts and Sectors shall be responsible for the roles of 1) support for establishment of water users associations (e.g. appointment of committee members, recruiting staff, coordination of local residents involved, keeping fairness and transparency, and care for vulnerable residents, 2) management guidance for financial aspects, 3) technical guidance for maintenance of water supply facilities, 4) purchasing spare parts and carrying out water quality tests, and 5) continuous follow-up and monitoring.

Under implementation of the Software Components of the Project, a supporting system for follow-up of sustainable operation and maintenance by water users associations shall be organized through capacity building for Districts and Sectors. Software Components shall also support Technical Cooperation Projects for some subjects involved within the operation and maintenance plan. For the roles at District and Sector, the following training shall be implemented.

1) Capacity building to support establishment of water users associations
2) Capacity building to provide management guidance for financial aspects
3) Capacity building to provide technical guidance
4) Capacity building to carry out follow-up and monitoring

1-3) Water Users Associations

Water users associations shall be responsible for the operation and maintenance of water supply facilities. In principle, water users associations shall be newly established or reorganized individually for a particular water supply. When a water supply crosses over Sector boundaries, the committee members shall be appointed from each concerned Sector. The roles of water users associations shall cover all the subjects required for operation and maintenance of water supply facilities except water quality tests and purchasing spare parts. Supported by Technical Cooperation Projects scheduled later, water users associations shall also identify

residents' needs for water and sanitation and report the needs to District and Sector administrations to organize for the work to be implemented by the Community Development Fund (CDF).

The Auditor and Infrastructure Manager in each District and Sector, and the Chairman, Vice Chairman, Secretary, and Sanitation Officer, shall be volunteers in the same manner as the existing organizational system for rural water supply. Meanwhile, Accountants, Pipe Work Technicians, Water Source and Pump Technicians, and Water Kiosk Operators shall be employed with salaries to distinguish their different responsibilities. The concept of water users association by water supply scheme is shown in Figure 2-7.

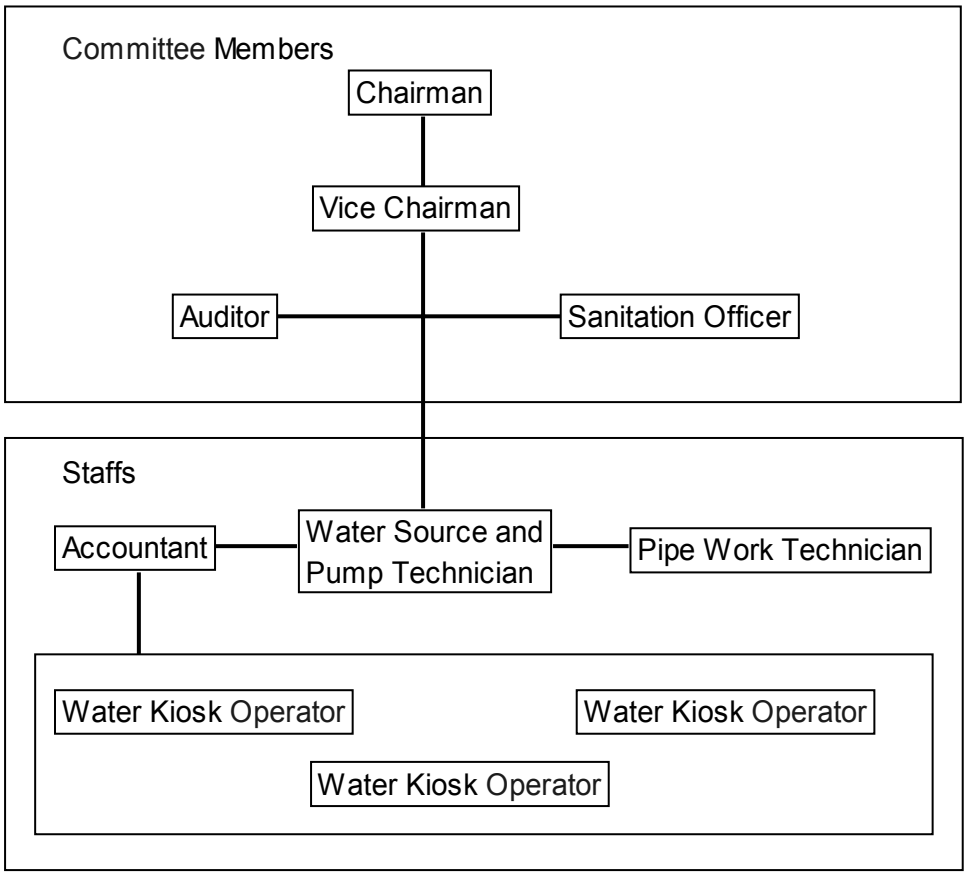


Figure 2-7 Concept of Water Users Association

For the water users associations, the following training shall be implemented.

1) Capacity building for management of water users associations
2) Finalization of corporate plans of water users associations
3) Establishment of water tariffs and collection systems
4) Preparation of budget documents, accounting system, and fund management

5) Operation, maintenance, repair, and trouble shooting for water supply facilities
6) Sanitary education for Sanitation Officers
7) Monitoring performance of operation and maintenance
8) Holding review meetings.

(2) Sanitary Education through Water Use

As a result of the social survey under the Study, it has been identified that local residents do not recognize the importance of the water quality of existing water sources being used for domestic purposes. In addition, many local residents advised that they will use rain water for domestic purposes in the rainy season, even after commencement of the water supplies to be constructed by the Project. Therefore, the local residents need to be enlightened to recognize the importance of water quality in order to achieve a successful outcome of the Project in terms of living environment and sanitary conditions. Otherwise, sustainability of the water supplies to be constructed by the Project would not be assured due to the shortage of income from water tariffs in line with the decrease of water users during the rainy season.

It is envisaged that the Software Components of the Project will enlighten the committee members of the water users associations regarding awareness of sanitation as a primary objective. Afterwards, these committee members shall be the main players to carry out sanitary education for local residents, with the support of Technical Cooperation Projects, which aims at enhancing awareness and action to improve sanitary conditions in the rural communities.

(3) Capacity Building for Technical Staff

For considering an effective capacity building for technical staff, on-the-job training to be applied. Employed staff who has basic capacity by Sector shall be transferred temporarily to the construction company of the Project.

2.4.3 Capacity Building for Operation and Maintenance and Organizational Strengthening

Based on the principles of the Japanese grant aid, the Government of Rwanda shall be primarily responsible for the development of operation and maintenance system as described before in this chapter. For realizing the sustainable water supply and ensuring the effects expected by implementation of the Project, the development of operation and maintenance system shall be enhanced by Software

Components as a part of the Project under the Japanese grant aid. In addition, enlightenment of sanitary awareness of local residents shall require changes in daily living practices of local residents through continuous supports for a long period. For this issue, Software Components shall be coordinated with Technical Cooperation Projects to envisage further enhancement of the sustainability of the Project.

2.5 Project Cost

2.5.1 Construction and Procurement Cost

The total project cost is estimated at 1,833 million yen. On the basis of the conditions described hereunder, 1,822 million yen of the project cost is to be born by the Government of Japan and 6.7 million yen by the Government of Rwanda. It should be noted that this cost estimate is provisional and will be further examined by the Government of Japan for the approval of a grant.

(1) Project Cost to be born by Japan

Table 2-35 Project Cost to be born by Japanese Side

	Item	Project Cost (Million Yen)	
	Boreholes equipped with a hand pump (24 water supply systems: 15 new and 9 rehabilitation)	55	1,520
	Piped water supplies based on boreholes equipped with a submergible pump (2 water supply systems' rehabilitation/expansion)	80	
	Piped water supplies based on spring water source equipped with a motorized pump (10 water supply systems: 6 new and 4 rehabilitation /expansion)	1,327	
	Piped water supplies based on spring water source and gravity flow (1 water supply system: rehabilitation)	58	
Equipment	• Potable Water Quality Testing Kit: 4 sets • Submergible Pump: 2 sets • Tools for Machinery and Pipe Work 13 sets	7	7
Engineering Services Detailed Design, Construction Supervision, and Software Components		295	295

(2) Project Cost to be born by Rwanda

Total cost: 33.07 million Frw (6.7 million Yen)

- Material for fences: 14.30 million Frw (2.9 million Yen)
- Per Diem of assigned engineer: 4.03 million Frw (0.8 million Yen)
- Fee of Banking Arrangement: 9.05 million Frw (1.8 million Yen)

- Per Diem for water users association: 5.70 million Frw (1.2 million Yen)

(3) Conditions of Cost Estimate

- Time of Estimation : November 2005
- Exchange Rate : 1 US$ ＝ JPY 111.77
  : 1 Frw ＝ JPY 0.202
- Procurement Period : As show in the implementation schedule
- Others : The project shall be implemented in accordance with the regulations and systems of Japan's Grant Aid Scheme.

2.5.2 Operation and Maintenance Cost

(1) Amount of Willingness to Pay

In the Social Survey component of the Study, 88% of interviewed local residents indicated their willingness to pay for the use of a water supply facility. Another question on willingness to use a water supply facility in consideration of payment was also directed to local residents to answer from the following selections.

1) To use water supply facility regardless of any water tariff
2) To use water supply facility with a low water tariff
3) Not to use water supply facility in the case of a high water tariff
4) Not to use water supply facility even in the case of a low water tariff
5) Satisfied with present water source

As a result, 19.5% of the local residents that had a willingness to pay answered they would use water supply facility regardless of the water tariff. Meanwhile, 78.2% answered they were willing to use a water supply facility if there was a low water tariff, and 2.0% answered they would not use a water supply facility in the case of a high water tariff.

For any kind of hand pump and public water tap facility, 17% of the local residents indicated a willingness to pay of Frw 5 per 20 L and 53% answered Frw 10 per 20 L. Only 7.3% were willing to pay Frw 20 per 20 L. The results of the Social Survey indicate that an acceptable water tariff would be around Frw 10 per 20 L, which corresponds with the results of a survey carried out in 2004 regarding the capability of local residents to pay a water tariff. This survey argued that Frw 20 per 20 L adopted by Electrogaz is too high for the local residents to pay and is likely to result in reduced use of the public water tap.

Willingness to pay for a jerry-can (20L) of water resulting from the Social Survey by District is summarized in Table 2-36.

Table 2-36 Willingness to Pay by Local Residents

Unit: Frw per 20 L

Former District (New District)	Ordinary Residents	Vulnerable people	Remarks
Kibungo (Kigungo)	9	8	
Rwamagana (Rwamagana)	9	9	
Kigarama (Kibungo, Rwamagana)	11	15	Less samples for vulnerable peoples
Kabarondo (Rwamagana)	12	9	
Cyarubare (Kayonza)	-	-	No applicable answer
Mirenge (Kibungo)	9	10	Less samples for vulnerable peoples
Rukira (Kibungo)	7	8	Less samples for vulnerable peoples
Rusumo (Kirehe)	11	10	
Nyarubuye (Kirehe)	11	10	
Muhazi (Rwamagana)	10	9	
Average	10	10	

As shown on the table above, it is adequate to deal an amount of willingness to pay as 10 Frw/20 L.

(2) Operation and Maintenance Cost for Hand Pump

Operation and maintenance cost for a hand pump broadly has three components, i.e. 1) daily operation cost, 2) maintenance cost for repair and spare parts, and 3) replacement cost for hand pump. Daily operation cost comprises the pump operator's salary, which is estimated at Frw 10,000/month. Annual maintenance cost is estimated on the condition that replacement needs to be made once in 2.5 years for consumable spare parts and once in 5 years for suction pipes. Replacement cost is also taken into account in the operation and maintenance cost in this Project because of the principle of payment by beneficiaries. In Rwanda, the life time of a hand pump should be 10 years with proper operation and maintenance. The annual replacement cost is therefore estimated on the condition that hand pumps will be replaced 10 years after installation. In addition to these costs, the operation and maintenance cost also covers miscellaneous expenses, mainly stationery and sundry supplies used by the water user's association.

Table 2-37 Annual Maintenance Cost for Hand Pump

Item	Condition	Annual O&M Cost (Frw/year)
Type of Pump	Hand Pump	Afridev
Pump Operator (salary)	Frw 10,000 /month x 12 months	120,000
Maintenance (spare parts)	Frw 505,000 /2.5 years	202,000
Replacement (with installation)	Frw 997,000 /10 years	99,700
Miscellaneous Expenses (stationeries, etc.)	Frw 1,000 /month x 12 months	12,000
Total		433,700

The minimum beneficiary population is estimated at 249 persons per hand pump. The operation and maintenance cost can be met from collected water tariffs when the water tariff of Frw 5 per jerry-can (20 L) prevailing for the use of hand pump at present is adopted.

(3) Operation and Maintenance Cost for Piped Water Supply

3-1) Motor Pump and Diesel Generator

In general, the depreciation period of a motor pump is 15 years and the standard operational life of a diesel generator is 10 years. Assuming that operation and maintenance by the water user's association is carried out properly, the cost is estimated to cover expenses for purchasing spare parts and the salary of an operator. Pump motors should be overhauled once in 2 years in the manner of minor and major maintenance. Therefore, periodical inspections of motor pumps shall be carried out once in 2 years by an engineer dispatched by the manufacturer. For diesel generators, overhaul should be made once in 5 years, and periodical inspections shall accordingly be conducted once in 5 years by an engineer dispatched by manufacturer.

3-2) Piped Water Supply

Operation and maintenance of piped water supplies shall be conducted by the water user's association formed by the beneficiaries. Operation and maintenance costs shall be met from funds collected as water tariff from the beneficiaries. The operation and maintenance cost broadly consists of 1) daily operation cost, 2) operation cost for machinery, 3) maintenance cost for repair and spare parts (water meters and water taps), 4) purchasing chlorine for disinfection. The daily

operation cost is comprised of salaries for an accountant, technical staff, and water kiosk operator. The salaries of the accountant and technical staff shall be Frw 30,000/month/person. In the light of actual results in Kibungo District, the water kiosk operator shall, in principle, receive 20% of the revenue from water sales at the water kiosk under his/her operation, but the actual amount to be paid to the water kiosk operator will be decided through agreement within the water user's association. The operation cost for machinery includes fuel for the diesel generator or commercial electricity to operate the motor pump. The maintenance cost is estimated to cover consumable spare parts for the motor pump and repairs to the pipeline in the light of the actual situation in Rwanda. Additional costs will include the cost of purchasing chlorine and miscellaneous expenses, mainly for stationery used by the water user's association.

Operation and maintenance cost per beneficiary for each piped water supply is estimated as shown in Table 2-38.

Table 2-38 Operation and Maintenance Cost per Beneficiary for Piped Water Supply

Sector to be Served	Water Source	O&M Cost per Beneficiary (Frw)
Mwulire, Munyaga, Kigabiro in Rwamagana District	Rwakibogo Spring	9.9
Mukarange in Kayonza District	Kazabazana Well	9.6
Rwinkwavu in Kayonza District	Nyankora Well	4.9
Murama in Kayonza District	Gicaca Spring	8.7
Kigungo in Kibungo District	Gasebaya/Nyakagazi Spring	9.7
Karembo, Zaza, Kibare, Mugesera in Kibungo Disrict	Rwarutene/Kabadeko Spring	7.2
Mutendeli, Kazo in Kibungo District	Kagoma Spring	9.3
Mushikiri in Kihere District	Nyakagongi Spring	7.6
Kihere in Kihere District	Gahama/Muguruka Spring	8.2
Nyamugari in Kihere District	Mayizi/Cyanyizanyoza Spring	3.4
Kigina in Kihere District	Kabingo/Gasebura Spring	9.6
Gahara in Kihere District	Gaharado Spring	9.8
Gatore in Kihere District	Rugina Spring	9.5

Note: O&M Cost per beneficiary shown in the above table are subject to change, depending on the service population, installed equipment (pumps, diesel generators), and fuel cost.

On the condition that each piped water supply serves an amount of water corresponding to 20 L/person/day, the operation and maintenance cost per beneficiary for a piped water supply scheme with motor pump varies from Frw 5 to Frw 10 within the piped water supplies under the Project. This variation in

operation and maintenance cost for piped water supplies results from differences in the total pumping head and number of beneficiaries.

2.5.3 Setting-up of Water Tariff

As described above, payment for the use of a piped water supply scheme with motor pump is estimated at around Frw 10. The results of the Social Survey also suggests that the local residents have a willingness to pay of Frw 10 per 20 L. From the viewpoint of capability to pay, average household income is low as given in Table 2-39 and there is a large gap in household income between ordinary residents and vulnerable peoples.

Table 2-39 Household Income and Expenditure

Income (Frw/month)			Expenditure (Frw/month)		
Ordinary Residents	Vulnerable peoples	Gap	Ordinary Residents	Vulnerable peoples	Gap
11,039	3,928	2.81	7,214	2,733	2.64

It is generally understood that payment for water accounts for 4% of household expenditure. Based on this percentage, the household capability to pay becomes Frw 15/day/household. Assuming that the average family size would be 5 persons/household, the average capability to pay would be Frw 3 per 20 L/day/person, which means many families could not cope with the expected water tariff of Frw 10 per 20 L. The majority of the local residents live by subsistence farming, so cash is therefore regarded as the secondary income of households. From this viewpoint, it is possible to establish a water tariff in the light of the willingness to pay of the local residents.

In the early stage of the Project operation, the water tariff needs to be set as low as possible so that local residents make high level of use of the water supply. The proposed water tariff is Frw 10 per 20 L for piped water supply by pumping and Frw 5 per 20 L for piped water supply by gravity and hand pump. In future, it is expected that the water tariff shall be around Frw 15~20 per 20 L after use of the water supply becomes firmly established. At this level the water user's association will be able to accumulate financial resources for future replacement of facilities and equipment.

The same water tariff shall be applied to both ordinary residents and vulnerable peoples, but financial support from the District to assist vulnerable peoples to pay the water tariff shall be considered because the capability of vulnerable people to pay is far less than that of ordinary residents. For vulnerable peoples to make strong use the water supply, other support shall also be considered to employ vulnerable people in positions such as water kiosk operator if they join the water user's association.

As a result of the study of the operation and maintenance cost and appropriate levels for water tariffs, it is clear that operation and maintenance cost of piped water supplies greatly exceeds Frw 11 per 20 L (or Frw 11/person/day) and are, therefore, not viable because of low sustainability. Such piped water supplies are therefore excluded from the Project.

Chapter 3
Project Evaluation and Recommendation

CHAPTER 3
PROJECT EVALUATION AND RECOMMENDATION

3.1 Project Effect

The water supply service ratio will increase from 17% to 64% in the four (4) districts in Eastern Province after the project implementation such that the living conditions in relation to water supply and sanitation improve. The Project will build the infrastructure for regional reconstruction and autonomous development.

The following table presents the project effects and the degree of improvement to be expected.

Table 3-1 Project Effects and the Degree of Improvement

Current status and problems	Countermeasures by the Project (Cooperation projects)	Project effects and the degree of improvement
Direct effects		
・ Water supply service ratio in the project area is 17%, which is less than the average of former Kibungo province, 31%.	・ Construction of water supply facilities in 13 places and construction of boreholes equipped with hand pump in 24 places	・ The served population increases to 160,000 in 2010. ・ ・ Water supply service ratio of the project areas increases to 64% in 2010.
・ Water user association has not been established. Existing water user association does not function well. ・ Local people do not have enough knowledge and experience in the organized operation, techniques, and maintenance of a water user association. The existing water user association is lacking in capacity.	・ Procurement of extra submersible pumps (2s) ・ Procurement of tools for operation and maintenance ・ Establishment of the operation and maintenance system using a local NGO ・ OJT training by the contractor, instruction in the initial operation method fro equipment and instruction in management methods	・ A water user association will be established or reorganized in each water supply facility and they will have improved operation and maintenance capacities after the project.
・ There is substantial technical support for the existing water user associations of the districts and sectors.	・ Procurement of simple water quality analysis kits ・ Implementation of software component relating to improvement of management capacity for the district and sector water user associations	・ District and sector water user associations will improve their management capacity.
・ Residents do not consider hygiene issues related to health and safe water.	・ Training for water user association's staff in charge of hygiene issues to improve their capacities	・ Water user association members will have improved hygiene consciousness concerning health and safe water.
Indirect effects		
・ Coliform bacteria and total colonies are detected at many springs.	・ Construction of the water supply facilities in 13 places and construction of boreholes equipped with hand pumps in 24 places. ・ Support for above software component plans	・ It is expected that the project will improve hygiene conditions and reduce water-borne diseases providing safe and stable water.
・ Housewives and children carry out water collection and transportation of water, which is very tough work because they carry the water over a more than 100 m elevation difference.		・ It is expected that the project will create opportunities for women to work and children can study because they will have a reduced work load.

3.2 Recommendations

The following issues shall be considered in order for the operation and maintenance of works to be conducted continuously and efficiently for the water supply facilities and the procured equipment provided by the Project, and to implement the water supply business in the four (4) districts in Eastern Province in Rwanda.

- Water quality monitoring conducted by the districts

Water quality of the spring waters satisfies WHO standards for chemical water quality; however, coliform and total colonies are detected in the water. Chlorine disinfection equipment will be provided to satisfy WHO water quality guidelines. Water quality will be analyzed by simple water quality analysis kits during the operation stage. It is important to monitor the water quality to determine whether it is suitable for domestic purposes. In addition, coliform and total colonies are detected from the existing boreholes equipped with hand pumps. It is supposed that water becomes contaminated during pump repair or replacement. Chlorination will be provided before hand pump installation as a countermeasure. Periodic water quality testing is necessary to secure the drinking water quality.

- Establishment of a supply system for spare parts and chlorine

The spare parts and chlorine are supplied to the water user associations to ensure sustainable operation and maintenance of the water supply facilities. There is no agent for the spare parts and chlorine in the project area and they must be purchased from the agent in Kigali city. It is inefficient for the water user associations to purchase them individually because it takes time to purchase them one by one and there is no transportation method from Kigali to the sites. It is efficient that the district purchases spare parts in one lot. Therefore, each district shall be required to establish a supply system for the spare parts and chlorine.

- Transportation of fuel for diesel engine generators

The cost of fuel for diesel engine generators will be met from the water tariff; however, there is no gasoline station in Kirehe district. It is essential to establish a continuous fuel transportation system using district vehicles.

- Establishment and reorganization of the water user associations

The water supply associations shall be required to select the water user association committee members, employ the association staff members, and

establish/reorganize the association prior to undertaking the construction works in order to guarantee smooth and sustainable operation and maintenance of the water supply facilities

- Acquisition of the project area and construction of the access road

The government of Rwanda shall be required to complete land acquisition and construct an access road prior to commencing construction at each site to implement the construction works immediately.

- Arrangement the project staffs and budget

The government of Rwanda shall be required to complete land acquisition and construct an access road prior to commencing construction at each site to implement the construction works immediately.

- Coordination with the technical cooperation

The aim of the software component plan is to build the operation and maintenance system for the water supply facilities. The aims of the technical cooperation are to enhance the sustainability of the water supply facilities constructed by the grant-aid project, to serve as a model case for future projects to extend the new system over the whole area, and to improve the entire system. The government of Rwanda is required to found the cooperation system for implementation of the software component and technical cooperation.

The following items shall be considered in order to cooperate with technical cooperation;

- Enhancement of organizational system in the water users associations, infiltration of monitoring and follow-up activity and promotion for improving water supply facilities and establishing sanitation facilities,
- Modification and dissemination of O/M and training manuals and establishment of training organizations,
- Support for hygiene education activity done by the water users association, and
- Reflection of knowledge taken to the grant-aid project from the technical cooperation activities