No.

Ministry of Infrastructure
The Republic of Rwanda

IMPLEMENTATION REVIEW STUDY REPORT
ON
THE PROJECT FOR RURAL WATER SUPPLY
IN
THE REPUBLIC OF RWANDA

March 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

EARTH SYSTEM SCIENCE CO., LTD

JAPAN TECHNO CO., LTD

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PREFACE

Japan International Cooperation Agency (JICA) conducted the implementation review study on the Project for Rural Water Supply in the Republic of Rwanda.

JICA sent to Rwanda a survey team from 31 May to 22 August, 2009.

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 outline 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.

March 2010

Kikuo NAKAGAWA
Director General,
Global Environment Department
Japan International Cooperation Agency

March 2010

Letter of Transmittal

We are pleased to submit to you the implementation review study report on the Project for Rural Water Supply in the Republic of Rwanda.

This study was conducted by the Consortium of Earth System Science Co., Ltd. and Japan Techno Co., Ltd, under a contract to JICA, during the period from May 2009 to March 2010. In conducting the survey, we have examined the feasibility and rationale of the project with due consideration to the present situation of Rwanda and formulated the most appropriate outline 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,

Hiroyoshi YAMADA
Project Manager,
Implementation Review Study team on
the Project for Rural Water Supply in
the Republic of Rwanda
The consortium of
Earth System Science Co., Ltd. and
Japan Techno Co., Ltd.

SUMMARY

SUMMARY

1. General Description of Rwanda

The Republic of Rwanda is a landlocked country located in the central part of the African Continent, and is surrounded by the United Republic of Tanzania, Republic of Uganda, Democratic Republic of the Congo, and Republic of Burundi. The total area of the country is 26,338 km^2. The total population reaches 10 million (UNFPA, 2008). In the western part of Rwanda, Mt. Karisimbi (4,507m a.s.l.) is located on the border between Rwanda and Congo. A mountain range higher than 2,000m extends to the south from Mt. Karisimbi. The Central Plateau stretches on the east side of the range with an elevation of 1,500-2,000m a.s.l. and the Eastern Plateau with an elevation of 1,300-1,600m a.s.l., stretches along the east side of the Central Plateau. The mean annual precipitation in the western part is around 1,300mm. As we move towards the eastern part, the precipitation decreases, and it is around 1,000mm in Kibungo in the project area. There is a dry season from June to September, and October to May. Next year the rainy season will have peaks of precipitation in April and November. The country is located in the tropical zone with a high elevation, therefore the monthly mean temperature is around 20℃ through the year.

In Rwanda, GNI per capita is 296 US% (EIU, 2007), the economic growth rate is 6 % (EIU, 2007). The breakdown of GDP by industry is 36% for the primary industries, 16% for the secondary industries, 42% for the tertiary industries and others (NISR, 2008). The economy in Rwanda highly depends on agriculture in which 90% of total working population is engaged. The main products are coffee and tea. In order to become highly competitive in the international marketplace, Rwanda has introduced a policy to increase the quality of these products.

In 1980's, Rwanda accepted the structural adjustment programme for readjustment of economic conditions. However, the situation of the economy reached negative growth after the civil war, and suffered a devastating blow in 1994. In 1999, the GDP recovered to the same level of that before the civil war due to the steady recovery of the agriculture sector, assistance from donors and sound implementation of economic policy. In 2000, the Rwandan Government formulated VISION 2020, which is aimed at achievement of economic growth in 2020. In 2007, Economic Development and Poverty Reduction Strategy (EDPRS) 2008-2012 was formulated subsequent to PRSP. In accordance with those papers, the Rwandan Government has been implementing necessary actions for readjustment of economic conditions and poverty reduction.

2. Background of the Project

The topographic features of Rwanda are characterized by hilly terrain and most people have their dwellings on the top of hills under the policy of resettlement. Main water sources for the people in rural areas are springs, lakes and rivers, and water qualities of most of these sources do not meet drinking water standards. Those who live on the hilltops are forced to go up and down steep slopes to fetch water, and the time consumed for fetching water is regarded as one of the causes to obstruct the development of rural areas. In the policy paper, VISION 2020, it is stated that all of the population has access to safe water by 2020. In the Economic Development and Poverty Reduction Strategy (EDPRS) 2008-2012, it is stated that the rate of access to safe water is 64% in 2007 is to be increased to 86% by the year 2012.

In the target area of the south-eastern part of the Eastern province (former Kibungo province), the construction of water supply facilities are not well advanced compared to other areas and the coverage of water supply of the province remained at 31%.

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 the "Project for Groundwater Development in Eastern and Central Regions" in 2003. In 2005, JICA dispatched a mission for a "Project Formation Study on Rural Development Programs in the former Kibungo province" in order to improve the contents of this requested project. As a result of the study, JICA recognized the necessity of the construction of water supply facilities under Japan's Grant Aid schemes, as a component of the program formulated. In accordance with the program, JICA conducted the "Basic Design Study on the Project for Rural Water Supply" from 2005 to 2006, and designed to implement the project in 3 stages. In 2006, implementation of the 1st stage of the project was approved by the Cabinet, and completed in March 2008. However, the competitive tendering for the 2nd stage of the project was not executed due to declination of the company that had expressed interest. The Government of Japan analyzed the causes of the unsuccessful tendering, and finally concluded that the Implementation Review Study would conduct selecting schemes from the target sites of the 2nd stage and 3rd stage for designing the project to be implemented under Japan's Grant Aid scheme, considering the implementation period applied by the Government of Japan.

3. Result of the Study and Contents of the Project

3-1 Summary of the Result of the Implementation Review Study

Japan International Cooperation Agency (JICA) has dispatched the Implementation Review Study team (hereinafter referred to as "the team") to Rwanda for a Field survey from 31st May to 22nd August, 2009 and for the explanation of the draft outline design from 20th to 24th December, 2009.

The team has conducted the field survey of target 10 water supply schemes in total of 14 sectors in Kayonza, Ngoma and Kirehe districts. The basic policy of the study is to consider the background of the project that 5 schemes of the 2nd stage of the project are to be given higher priority, in case the implementation of each scheme is concluded as feasible. In addition, some of the 5 schemes of the 3rd stage of the project are to be selected with the consideration of the period of implementation set by the Government of Japan and the feasibility of each scheme.

As a result of the field survey and studies in Japan consisting of water source investigation, socioeconomic survey, formulation of water supply plan, formulation of implementation and procurement plan and cost estimation, it was concluded that the implementation of 5 schemes of the 2nd stage of the former project were feasible. With regard to the 5 schemes of the 3rd stage of the project, one scheme was excluded, since the target sector had a plan for further resettlement. Therefore, the remaining 4 schemes were prioritized in accordance with 7 criteria of ratio of cost /benefit, accessibility to water source, construction condition, operation and maintenance cost, scheme type, willingness to pay and rate of satisfaction on the current water supply conditions.

With regard to the existing borehole which needs to replace the hand pump, a pumping test and water quality analysis were conducted. As a result, it was confirmed that the yield of the borehole satisfied the criteria set in the Basic Design Study, and water quality satisfied the WHO drinking water standards.

As for the operation and maintenance system, it was observed that both Ngoma and Kirehe districts were still under consideration of a better way to introduce privatization, even though privatization of operation and maintenance has been promoted in Rwanda. This fact implies that both districts have not decided to not introduce privatization. In case the districts selected the operation and maintenance system by the Water Users Association (WUA), the required basic capacity of the organization in charge of O&M is similar. Under these circumstances, it was concluded that the support for the enhancement of capacity of the district to manage privatization, and enhancement of the capacity of the private organization/WUA through the district office should be addressed in the project

As a result of the study with consideration of the implementation period applied by the Government of Japan, the relevance of the implementation of 1) construction and rehabilitation of 5 schemes in 6 sectors

of the Kirehe district and 2 schemes in 5 sectors in the Ngoma district, 2) replacement of one hand pump, and 3) support of establishment of O&M system, are confirmed. Therefore, contents of the project were explained to the Rwandan side and discussed. Consequently, both sides have reached an agreement.

3-2 Summary of the Contents of the Project

(1) Construction and Rehabilitation of Water Supply Facility

The target year of the project is set as 2014. The water supply coverage in 11 sectors is designed to be improved from 41.6% in 2008 to 57.4% in 2014 with around 55 thousand beneficiaries. The unit water consumption is 20 litre/capita/day. The outline of the selected water supply schemes is shown in Table S-1.

Table S-1 List of the Selected Schemes

1) Construction of water supply facility		Construction/Rehabilitation of 7 water supply facilities in 11 sectors of 2 districts		2014 (Target Year of the Project)	
District	Scheme	Major Contents of Construction		Served Population*1	Coverage (%)*2
Kirehe	Mushikiri	New	Intake facility, Distribution tank, Transmission pipe 4.4km, Distribution pipe 15.6km, Public water stand	7,776	34.6
	Kirehe	Rehabilitation	Intake facility, Transmission pipe 3.0km, Distribution pipe 12.5km, Public water stand	3,772	28.8
	Nyamugali/ Mahama	Rehabilitation	Distribution tank, Transmission pipe 6.6km, Distribution pipe 1.7km, Public water stand	6,969	33.9
	Kigina	New	Intake facility, Distribution tank, Transmission pipe 1.5km,Distribution pipe 12.6km, Public water stand	6,998	41.8
	Gatore	New	Intake facility, Distribution tank, Transmission pipe 1.5km, Distribution pipe 8.3km, Public water stand Replacement of Hand Pump of existing well(1 no.)	4,665	44.9
Ngoma	Karembo/Zaza/Mugesera	Rehabilitation	Intake facility, Distribution tank, Transmission pipe 4.5km, Distribution pipe 24.8km, Public water stand	11,700	82.8
	Kazo,/Mutendeli	Rehabilitation	Intake facility, Distribution tank, Transmission pipe 1.8km, Distribution pipe 17.5km, Public water stand	13,219	93.5
2) Soft Component		Support in the establishment of institutional administration system of the cooperatives for operation and maintenance, and enhancement of the capacity of the districts to supervise the cooperatives			

Note) *1 : Number of beneficiaries of the project
*2 : Coverage calculated by sum of present served population and the number of beneficiaries of the project

Procurement of a simple water quality analysis kit for the Ngoma and Kirehe districts and maintenance tools for each scheme are included in the project.

(2) Soft Component

The soft component in the project are composed of enhancement of capacity of the district in managing privatization, and establishment of the institutional administration system of private organization or WUA for operation and maintenance through the support from the district office.

Activities and outputs of the soft component are as follows.

[Outputs]

1) Support and management system in the Ngoma and Kirehe district offices for private organization or WUA is strengthened.

2) Institutional administration system of private organization or WUA, which are established for operation and maintenance of the water supply system constructed in the project, is strengthened.

[Activities]

1) Support for preparation of draft of the contract document and selection of private organization, preparation of training manual and implementation of training, and supervision and monitoring of operation and maintenance, which are implemented by task force established in each district

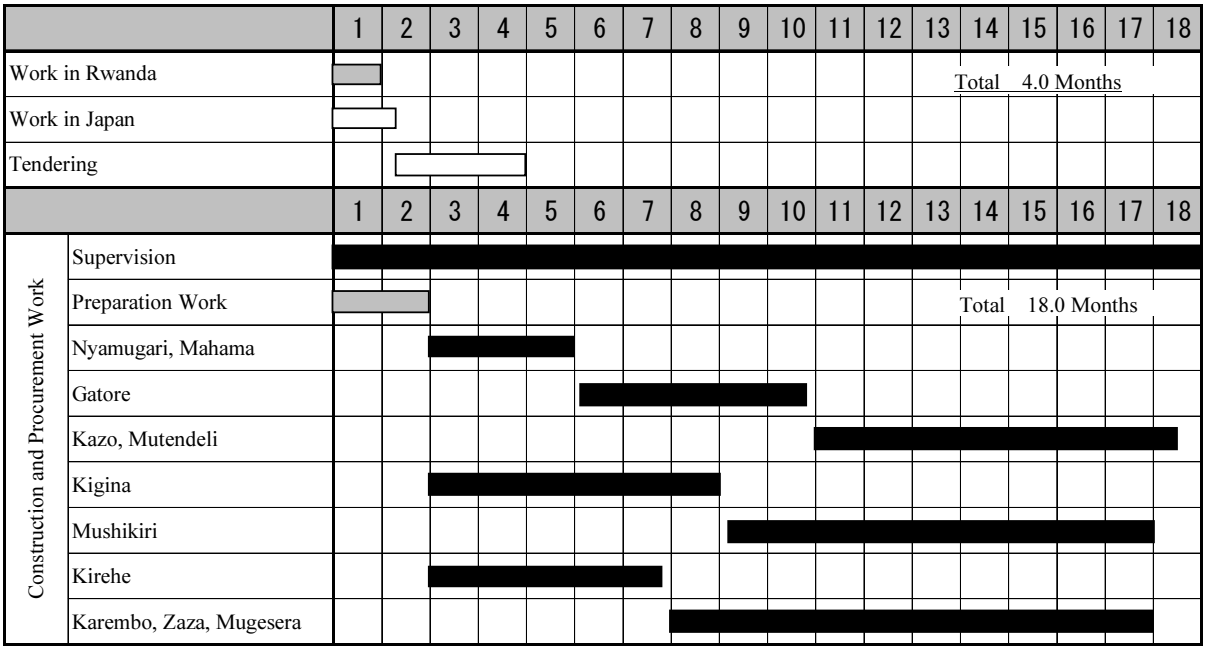
2) Implementation of training of private organization or WUA on operation and maintenance and follow up by the task force

4. Implementation Schedule and Initial Cost Estimation

4.1 Implementation Schedule

The project period of the Japanese side is scheduled to be completed within 22 months, consisting of 4 months for detailed design including tendering and 18 months for construction and rehabilitation of water supply facilities. The implementation schedule is shown in Table S-2.

Table S-2 Implementation Schedule



The soft component programme is scheduled to commence prior to construction of the water supply facility, and continue the activities in accordance with the progress of construction.

4.2 Initial Cost Estimation

In case the project is implemented, the project cost borne by the Rwandan side is estimated at approximately 23.2 million Rwf (approximately 40.3 thousand US$).

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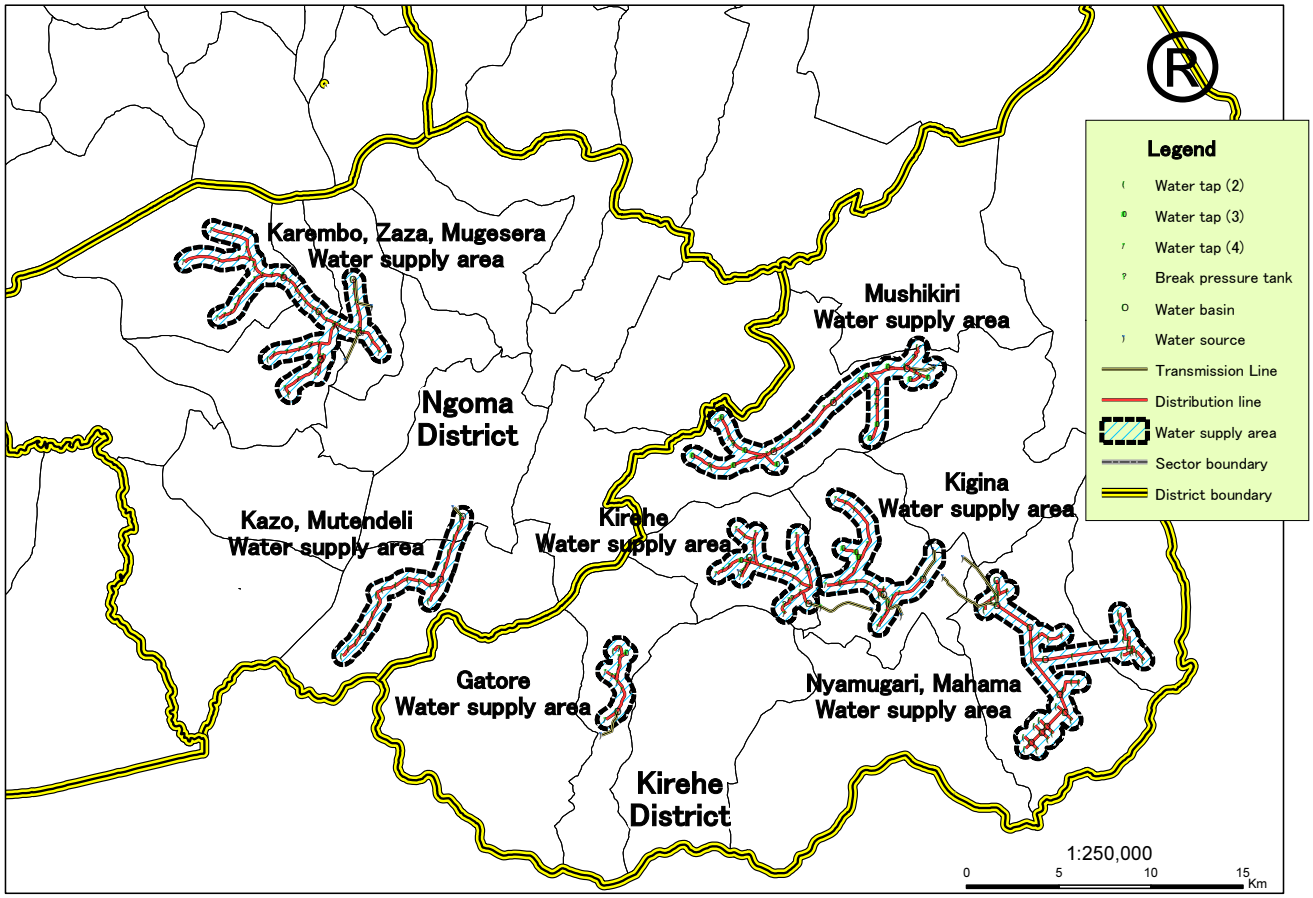
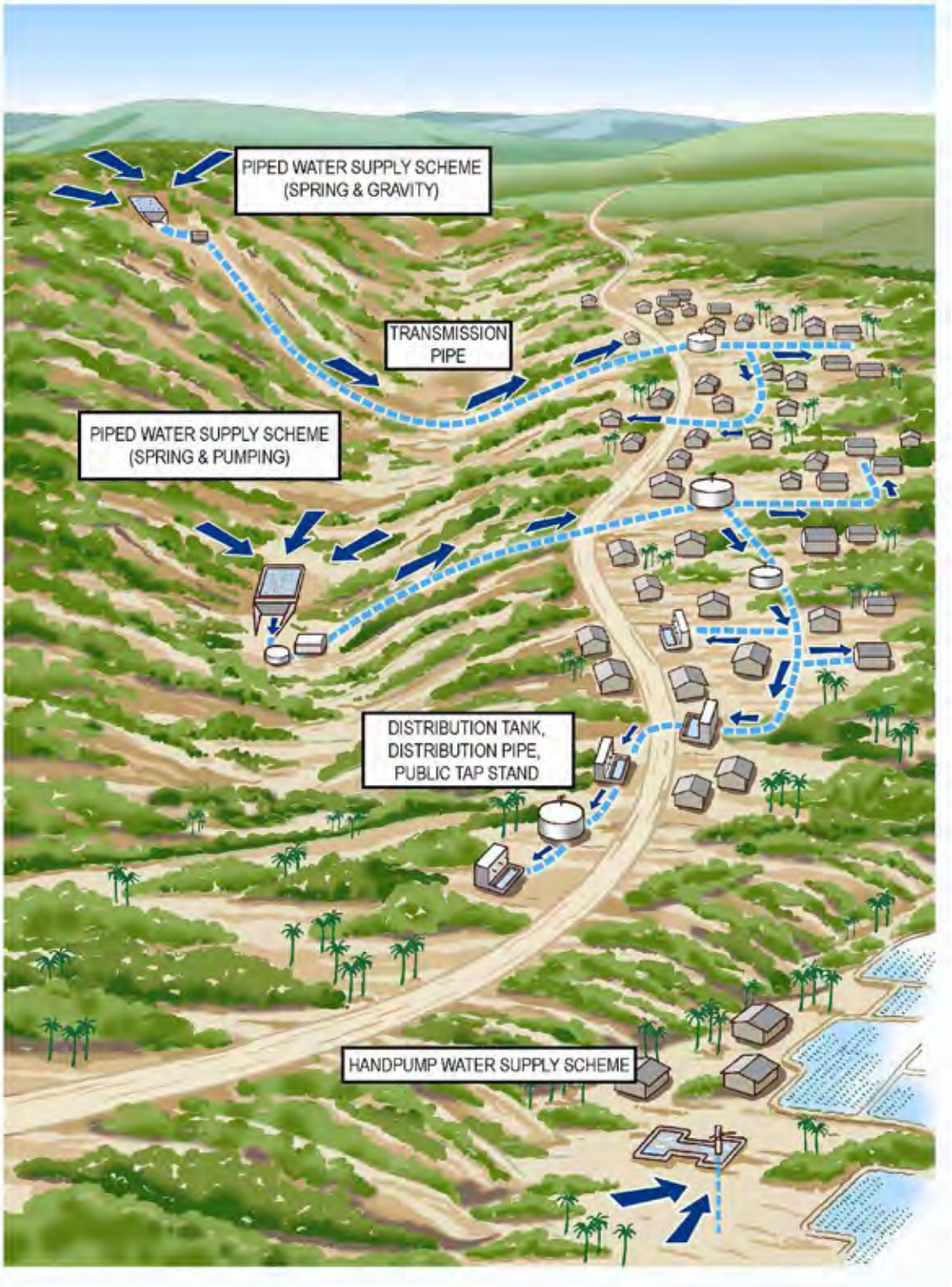


Location Map



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ABBREVIATIONS

AfDB	African Development Bank
BHN	Basic Human Needs
E/N	Exchange of Notes
EDPRS	Economic Development Poverty Reduction Strategy
EIA	Environmental Impact Assessment
EIU	Economist Intelligence Unit
EU	Europe Union
G/A	Grant Agreement
GDP	Gross Domestic Product
GNI	Gross National Income
IEE	Initial Environmental Examination
JICA	Japan International Cooperation Agency
m.a.s.l	meter above sea level
M/D	Minutes of Discussion
MDG	Millennium Development Goal
MINALOC	Ministry of Local Government, Good Governance, Community Development and Social Affairs
MININFRA	Ministry of Infrastructure
MINIRENA	Ministry of Natural Resources
Mpa	Mega Pascal
NGO	Non Governmental Organization
NISR	National Institute of Statistics of Rwanda
NPSH	Net Positive Suction Head
O&M	Operation and Maintenance
PDM	Project Design Matrix
pH	Potential of Hydrogen
PN	Nominal Pressure
PNEAR	National Programme of Rural Water Supply and Sanitation
PPP	Public Private Partnership
PRSP	Poverty Reduction Strategy Paper
RDB	Rwanda Development Board
REMA	Rwanda Environmental Management Authority
Rwf	Rwanda Franc
SPSS	Statistical Package for Social Science
TDS	Total Dissolved Solid
UNDP	United Nations Development Programme
UNFPA	United Nations Fund for Population Activities
UNICEF	United Nations International Children's Fund

uPVC	Unplasticized Polyvinyl Chloride
WFP	World Food Program
WHO	World Health Organization
WUA	Water Users Association

CHAPTER 1
BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

1-1 BACKGROUND OF THE PROJECT

The topographic features of Rwanda are characterized by hilly terrain and most of people have their dwellings on the top of hills in accordance with the policy of resettlement. The main water sources for the people in rural areas are springs, lakes and rivers, and water qualities of most of these sources do not meet drinking water standards. Those who live on hilltops are forced to go up and down the steep slopes to fetch water, and the time consumed for fetching water is regarded as one of the causes obstructing the development of rural areas. In the policy paper, VISION 2020 formulated in 2000, it is stated that all of population have access to safe water by 2020. In the Economic Development and Poverty Reduction Strategy (EDPRS) 2008-2012 formulated in 2007, it is stated that the rate of access to safe water is 64% in 2007, and is to be increased to 86% by the year 2012.

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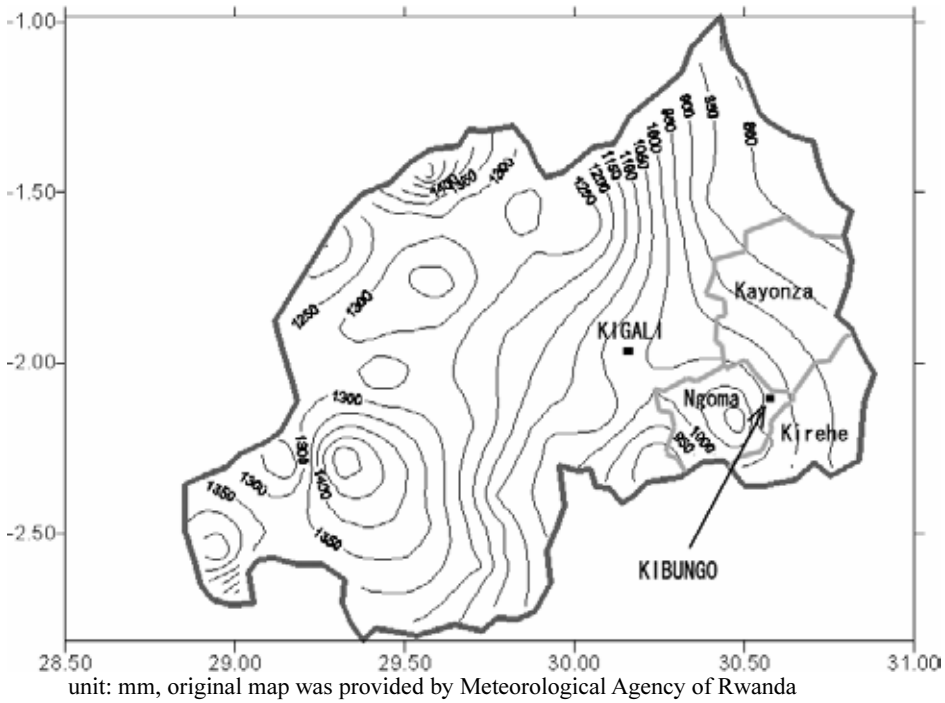
1-2 NATURAL CONDITIONS

1-2-1 METEOROLOGY AND HYDROLOGY

1-2-1-1 METEOROLOGY

The distribution of annual precipitation in Rwanda is shown in Figure 1-1. Mean annual precipitation in the target area is a little less than 1,000mm and it roughly decreases in the east. Figure 1-2 shows the monthly mean precipitation of Kibungo in the central area of the target area and Kigali, the capital of Rwanda. Annual precipitation in Kibungo and Kigali is 994 and 1,019mm, respectively. April and November are the peaks of the rainy season and the period of June to August forms a clear dry season.



unit: mm, original map was provided by Meteorological Agency of Rwanda

Figure 1-1 Distribution of Annual Precipitation

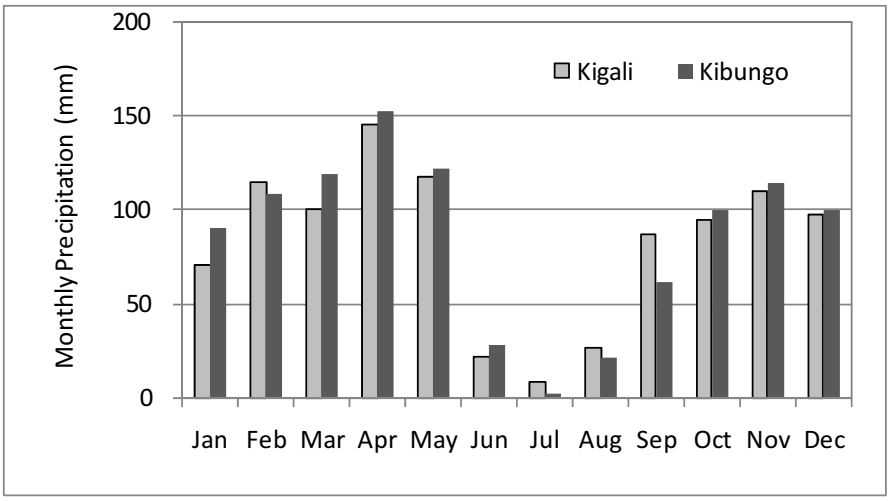


Figure 1-2 Monthly Mean Precipitation

Figure 1-3 shows monthly means of daily maximum, minimum and mean temperature and daily temperature range. The daily mean temperature shown in Figure 1-3 is the mean of maximum and minimum temperatures. Seasonal change of temperature is much less than its daily range, because solar radiation varies not much in a year at the latitude of 2°S. The monthly mean temperature varies only within 2℃. But the daily range of temperature varies greatly from 9 to 12℃ through a year with the biggest range in the dry season.

The monthly mean precipitation and potential evapotranspiration in Kibungo are shown in Figure 1-4. The potential evapotranspiration was calculated by the use of Thornthwaite's empirical formula. Annual potential evapotranspiration is 932mm and about 90% of annual precipitation in Kibungo.

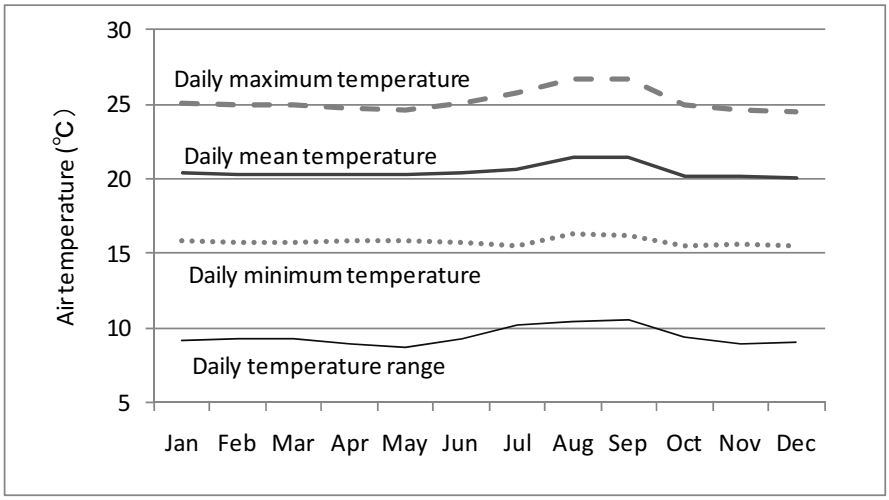


Figure 1-3 Monthly Mean Temperature of Kibungo

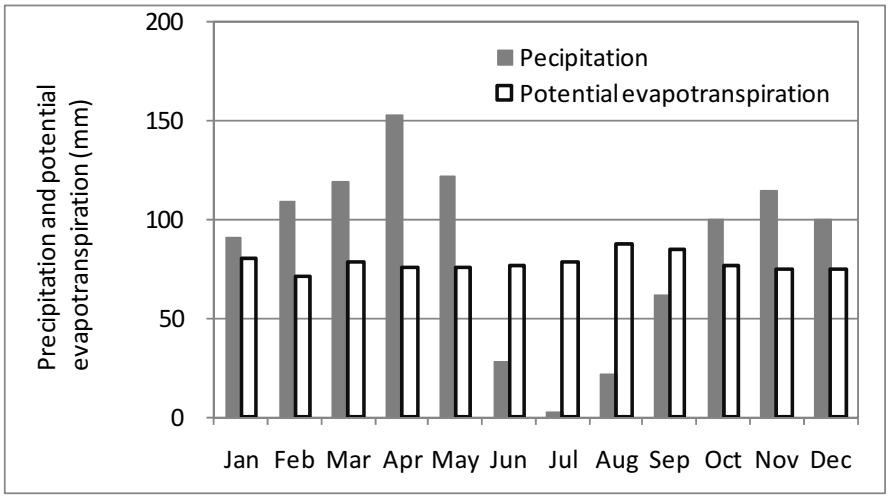


Figure 1-4 Monthly Mean Precipitation and Potential Evapotranspiration of Kibungo.

1-2-1-2 HYDROLOGICAL CHARACTERISTICS

All rivers in the target area belong to the Akagera river system. The Akagera River flows eastward along the southern boundary of the target area, then northwards along its eastern boundary. The precipitation received in the western side of the area flows into Lake Sake and Lake Mugesera, then flows in the Akagera River through swamps. Meanwhile the precipitation in the central and eastern part also flows into the Akagera River through small and medium-sized rivers and swamps. The precipitation on its northern edge flows northwards. The precipitation on the narrow area along the Akagera River flows directly into the Akagera River.

The water levels of rivers and lakes in the target area are shown in Figure 1-5. The locations and catchment areas are shown in Table 1-1. The changes of the water levels correspond well to the change of precipitation. The water level of the Cyunuzi River, small and medium-sized rivers, changes about one month after the change of precipitation. Meanwhile the highest levels in the lake or river with a large catchment area appear one month after in May and the lowest levels appear three months after in October.

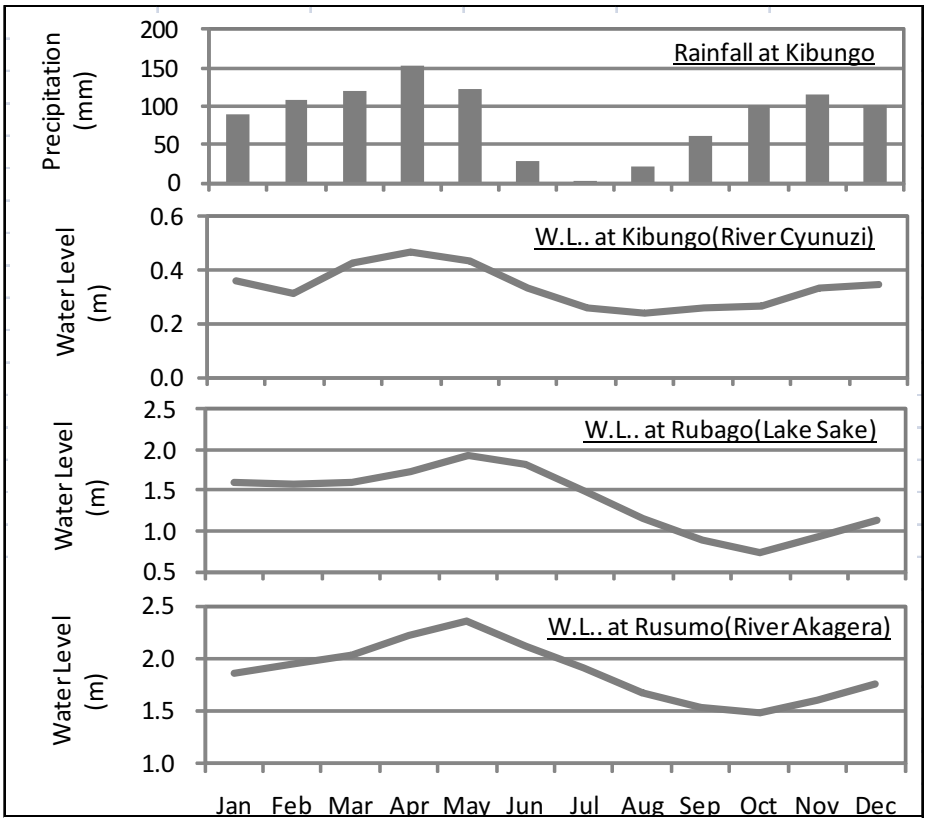


Figure 1-5 Relationship between Precipitation and Water Levels of River or Lake.

Table 1-1 Location of Water Level Gauging Stations and Catchment Area

River/Lake	Station	Latitude (South)	Longitude (East)	Elevation (m)	Water collection area (km^2)	Duration of data
River Cyunuzi	Kibungo	2°16.30′	30°33.32′	1335	298	Oct 1995 - Feb 2000
River Akagera	Rusumo	2°22.92′	30°46.82′	1325	30200	Jan 1956 - Jun 1996
Lake Sake	Rubago	2°14.83′	30°24.13′	1337	58	Apr 1995 - Dec 2000 Nov 2007 - Dec 2007

1-2-1-3 SPRINGS

All water sources to be used for piped water supply scheme in the project are springs[1]. In order to prepare a water supply plan reflecting the available quantity and acceptable quality of water, a water source investigation was conducted in the study. In the investigation, measurements of flow rate and water quality analysis of 26 selected springs were conducted. The flow rate measurement was periodically conducted from early June to the middle of August 2009, in order to understand the tendency of the fluctuation of water flow. With regard to water quality analysis, the samples were taken when the flow rate was measured, and analysis was conducted by the laboratory of the National University of Rwanda in Kigali and Butare.

As a result of measurements, it was concluded that 23 springs out of 26 were able to be sustainably utilized. The flow rates of 23 springs are shown in Table 1-2. With regard to water quality analysis, although Escherichia coli were detected in some springs, all springs satisfied the WHO drinking water standards in terms of chemical parameters.

[1] In the project, springs are designed to be used for 7 piped water supply schemes, and water source for one hand pump replacement site is groundwater.

Table 1-2 Flow Rate of Spring

District	Sector	Spring	Yield(L/sec)
Kirehe	Mushikili	Nyakagongi	0.9
		Nyagihanga	0.3
		Nkakwa-Upper	0.8
	Kirehe	Gahama	0.6
		Muguruka	1.1
	Nyamugari, Mahama	Mayizi	3.4
		Cyanyiranyonza	0.5
	Kigina	Gasebura-Upper	1.8
		Gasebura-Lower	0.3
	Gatore	Samuko-A	1.2
	Gahara	Gahararo Upper	1.0
		Gahararo Lower	1.8
Kayonza	Murama	Gicaca-A	1.8
		Gicaca-B	1.8
Ngoma	Kibungo	Nyakagezi	0.9
		Gasebaya	1.1
	Karembo, Zaza, Mugesera	Rwarutene	2.0
		Kabashuko	0.9
		Kabajara	1.0
		Gisuma	0.4
		Kabaromba	0.6
	Mutendeli, Kazo	Kagoma	1.2
		Musenyi	2.2

1-2-2 TOPOGRAPHY AND GEOLOGY

1-2-2-1 TOPOGRAPHY

The Republic of Rwanda is a landlocked country located in the central part of the African Continent, and is 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 26,338 km^2 in 1°3´ - 2°50´S and 28°51´ - 30°53´E.

Mt. Karisimbi (4,507m a.s.l.) is located on the border between Rwanda and Congo. A mountain range with an elevation of 2,000m and more extends to the south from Mt. Karisimbi. The Central Plateau stretches on the east side of the range with an elevation of 1,500-2,000m.a.s.l. and the Eastern Plateau with an elevation of 1,300-1,600m a.s.l., stretches along the east side of the Central Plateau.

The target area of the project is in the districts of Ngoma and Kirehe in the south side of the Eastern Plateau. Its topography is characterized by hills and large undulations encroached by the tributaries of the Akagera River.

1-2-2-2 GEOLOGY

Metamorphic rock and granite, which were formed in the Precambrian period, spread widely as basement rock in Rwanda. The granite is intrusive rock and the metamorphic rock mainly consists of schist metamorphosed by intrusion of granite. As the Great Lift Valley became active since the Cenozoic era, volcanic products covered the basement rock. Subsequently volcanic sediment was incised and then alluvial plains and swamps were formed in the mountain slopes and rivers with sediment moved from the upper streams.

Metamorphic rock is distributed in a striped pattern running from north to south, and many faults with the same direction exist because they are pressed into the direction of east and west.

Granite is distributed in the western part of the target area. Metamorphic rock of quartzite or schist and sedimentary rock of mudstone or sandstone are distributed in the central and eastern parts. Alluvia consisting of clay, sand or gravel are distributed along the Akagera River and around lakes.

1-2-3 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

The Initial Environment Examination (IEE) was conducted in the Basic Design Study of the project in accordance with the guideline prepared by JICA. As a result of IEE, the project was assessed as "Category C", and it was concluded that the Environmental Impact Assessment (EIA) for the project was not required.

When the Basic Design Study was conducted from 2005 to 2006, the legislation or regulation related to the environmental and social considerations was not yet enacted in Rwanda. In 2005, the Rwanda Environmental Management Authority (REMA) was established and the guideline of Environmental Impact Assessment was prepared in 2006. Therefore, the project designed in the Implementation Review Study was required to take necessary procedures stipulated in the guidelines. According to the guidelines, MININFRA, the responsible organization of the project, is required to submit the "Project Brief" to REMA for screening. The "Project Brief" is needed to describe the background and contents of the project, expected impact on environmental and social conditions, and mitigation measures to be taken. In case the project is categorized as one which may have critical impact, full EIA is required. If it does not have critical impact, a part of EIA procedure is required.

MININFRA has already submitted the "Project Brief" of the project to REMA in the middle of January 2010. As of early March 2010, the document is still under screening by REMA

CHAPTER 2
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2-1 BASIC CONCEPT OF THE PROJECT

(1) Overall Goal and Project Purpose

The Government of Rwanda has set the objective that all its population have access to safe water by 2020, in Vision 2020 formulated in 2000. The Policy states that in order to achieve the goals for water set out in Vision 2020, the country will have to increase the rate of potable water coverage by 2.5 percentage points annually. In 2007, the Economic Development and Poverty Reduction Strategy (EDPRS) 2008-2012 was formulated. The target in the water sector of EDPRS is to increase the rate of access to safe water from 64% to 86% during the implementation period of the EDPRS. With regard to rural water supply, the objective set in the EDPRS is to decrease the rate of number of the population who live more than 500m away from a safe water source from 36% to 15%.

In addition, the Government of Rwanda committed to the attainment of MDGs, and positioned the attainment of the objectives set in the EDPRS as an important factor for the achievement of the goal set in the MDGs related water sector, that is to reduce by half the proportion of people without sustainable access to safe drinking water.

In the project area, water supply coverage in the Ngoma and Kirehe districts in the Eastern Province are 73% and 25%, respectively. The coverage in the Kirehe district is the lowest rate among the 7 districts in the Eastern province. Therefore, further assistance to the Kirehe district is required to make progress towards the objectives set in the policy and strategy.

The overall goal of the project that was set considering the conditions of the project area is to improve the living conditions of households in the project area. The project purpose is to supply safe drinking water to the residents in the project area. In order to achieve the project purpose, 2 water supply systems in the Ngoma district and 5 water supply systems in the Kirehe district will be constructed and rehabilitated under the initiative of the Ministry of Infrastructure (hereafter referred to as MININFRA) as the responsible organization and the Eastern province, the Ngoma and Kirehe districts as the implementation organizations. It is expected that the served population will approximately be 150 thousand in the 11 target sectors with around 55 thousand beneficiaries of the project. Consequently water supply coverage will be increased to 57.4% in 2014 from 41.6% in 2008.

(2) Outline of the Project

The components of the requested project are: 1) Construction of 10 water supply systems comprising new construction at 6 sites and rehabilitation at 4 sites, 2) Replacement of a hand pump at 1 site, 3) Procurement of 2 simple water quality analysis kits and 4) Support for establishment of operation and maintenance system for water supply system (Soft component).

The basic policy of the Implementation Review Study on the Project for Rural Water Supply in the Republic of Rwanda (hereafter referred to as the study) is that 5 schemes of the 2nd stage of the project are to be given higher priority, in case the implementation of each scheme is concluded as feasible. In addition, some of the 5 schemes of the 3rd stage of the project are to be selected with consideration of the period of implementation of the project set by the Japanese Government and the feasibility of each scheme.

In order to optimize the contents of the project, a water source investigation, socioeconomic survey, formulation of water supply plan, formulation of implementation and procurement plan and cost estimation were conducted during the study. As a result, it was concluded that the implementation of 5 schemes of the 2nd stage of the project were feasible. With regard to the 5 schemes of the 3rd stage

of the project, one scheme was excluded, since the target sector had a plan of further resettlement, which is an indeterminate factor for implementing the project. Therefore, the remaining 4 schemes were prioritized from the viewpoint of the condition of construction on site and sustainability of operation and maintenance of the water supply facility. In addition, the implementation schedule of each scheme was carefully studied, in order to construct and rehabilitate as many water supply facilities as possible within 24 months after conclusion of the Exchange of Notes, which was originally scheduled by the Government of Japan. Consequently, construction and rehabilitation of 7 schemes were selected and scheduled to be implemented as listed in Table 2-1.

Table 2-1 Outline of the Selected Schemes

1) Construction of water supply facility		Construction/Rehabilitation of 7 water supply facilities in 11 sectors of 2 districts		2014 (Target Year of the Project)	
District	Scheme	Major Contents of Construction		Served Population*1	Coverage (%)*2
Kirehe	Mushikiri	New	Intake facility, Distribution tank, Transmission pipe 4.4km, Distribution pipe 15.6km, Public water stand	7,776	34.6
	Kirehe	Rehabilitation	Intake facility, Transmission pipe 3.0km, Distribution pipe 12.5km, Public water stand	3,772	28.8
	Nyamugali/ Mahama	Rehabilitation	Distribution tank, Transmission pipe 6.6km, Distribution pipe 1.7km, Public water stand	6,969	33.9
	Kigina	New	Intake facility, Distribution tank, Transmission pipe 1.5km,Distribution pipe 12.6km, Public water stand	6,998	41.8
	Gatore	New	Intake facility, Distribution tank, Transmission pipe 1.5km, Distribution pipe 8.3km, Public water stand Replacement of Hand Pump of existing well(1 no.)	4,665	44.9
Ngoma	Karembo/Zaza/Mugesera	Rehabilitation	Intake facility, Distribution tank, Transmission pipe 4.5km, Distribution pipe 24.8km, Public water stand	11,700	82.8
	Kazo,/Mutendeli	Rehabilitation	Intake facility, Distribution tank, Transmission pipe 1.8km, Distribution pipe 17.5km, Public water stand	13,219	93.5
2) Soft Component		Support in the establishment of institutional administration system of the cooperatives for operation and maintenance, and enhancement of the capacity of the districts to supervise the cooperatives			

Note） *1 : Number of beneficiaries of the project

*2 : Coverage calculated by sum of present served population and the number of beneficiaries of the project

The project design matrix (PDM) of the project is shown in Table 2-2.

Table 2-2 Project Design Matrix (PDM)

Title of the Project: Project for Rural Water Supply in the Republic of Rwanda Target Area : 7 Scheme in 11 Sectors of 2 Districts
Target Group : Residents in 11 Sectors of 2 Districts, Ngoma and Kirehe District Offices, Private Organization or WUA
Project Period : April 2010 – February 2012

Narrative Summary	Indicators	Means of Verification	Important Assumption
【Overall Goal】 Living condition of household in the project area is improved	1. Rate of water borne diseases is decreased in the project area 2. Operation and maintenance of water supply facility is being conducted	1. Document prepared by the responsible Ministry of health 2. Record of operation of facilities	
【Project Purpose】 Safe drinking water is supplied to the residents in the project area	1. Water supply coverage in the project area is increased from 41.6% in 2008 to 57.4% in 2014. 2. In 2014, all of water supply facilities constructed by the project are under the operation	1. Statistical data in each district 2. Inspection report of the completion of the construction	- Established system of operation and maintenance is sustained by districts and private organization or WUA - Available quantity of water is not reduced
【Output】 1. Water supply facilities are newly constructed and rehabilitated in the project area.	1. Construction of 3 water supply facilities and rehabilitation of 4 water supply facilities are completed within the contracted period.	1. Drawings of water supply facilities completed 2. Certificate of completion	- Private organization or WUA supported by the project continues operation and maintenance of water supply facility
2. Operation and maintenance system for the water supply facilities constructed and rehabilitated by the project is established	1. Task Force is established in each district 2. Cooperatives are selected for 7 schemes 3. Collection of water tariff is started	1. Contract document with cooperative 2. Record of water tariff collection	
【Activities】 1-1 Tendering is successfully executed 1-2 7 schemes in 11 sectors of 2 districts are constructed. 1-3 Construction of water supply facilities are properly supervised in accordance with the implementation schedule 2-1 Explanation of strategy of privatization of O&M system to the districts and sectors, and encouragement of establishment of Task Force 2-2 Establishment of Task Force and Follow Up 2-3 Setting the performance indicator for assessment of achievement of O&M to be conducted by the cooperative 2-4 Preparation of draft of Contract document on the O&M services rendered by the cooperative 2-5 Development of the training manual for enhancement of the capacity of private organization or WUA on O&M service 2-6 Explanation about introduction of privatization of O&M system and the indicators for evaluation of the cooperative to the target sectors 2-7 Selection of the cooperative 2-8 Providing training with private organization or WUA to enhance the capacity for O&M, and on-the-job training of Task Force 2-9 Follow up on the activities mentioned on item 2-8 above 2-10 Supervision and monitoring of the activities related to O&M of water supply system	**【Input】** *Japanese side* 【Construction of facility】 Construction of 7 schemes in 11 sectors of 2 districts Replacement of Hand Pump (1 no.) 【Procurement of Equipment】 Simple water quality analysis kit (2nos.) 【Human Resources】 Consultant, Technical Advisor 【Implementation Cost】 Construction cost for water supply facilities Cost for supervision Cost for soft component *Rwandan side* 【Human Resources】 Engineers, Technical workers 【Implementation Cost】 Cost of operation and maintenance of water supply facilities Cost for soft component		・Members of private organization or WUA are not changed. **【Preconditions】** 1. Contract is agreed between Rwandan Government and Japanese contractor 2. Privatization of operation and maintenance is being approached.

2-2 OUTLINE DESIGN OF THE JAPANESE ASSISTANCE

2-2-1 DESIGN POLICY

2-2-1-1 BASIC POLICY

(1) Selection of Schemes for the Japanese Assistance

1) Study Areas for the Implementation Review Study

The target schemes in the study are 5 schemes of the 2nd stage and 5 schemes of the 3rd stage of the project in the Kirehe, Kayonza and Ngoma districts as shown in Table 2-3. The basic policy of the study is that the 5 schemes of the 2nd stage of the project are to be given higher priority, in case the implementation of each scheme is concluded as feasible. In addition, some of the 5 schemes of the 3rd stage of the project are to be selected with the consideration of the period of implementation set by the Government of Japan and the feasibility of each scheme.

Table 2-3 Target Schemes for Implementation Review Study

District	Scheme	Served Population (BD&DD)	New Construction/ Rehabilitation	Means of Transmission of Water	No. of Water Source	Organization for O&M	Planned Stage in the Basic Design Study (2005)
Kirehe	Mushikiri	11,884	New	Pump up	2	New	2nd Stage
	Kirehe	12,000	Rehabilitation	Pump up	2	Existing	2nd Stage
	Nyamugali/ Mahama	16,776	Rehabilitation	Gravity	2	Existing	2nd Stage
	Kigina	10,082	New	Pump up	2	Existing	2nd Stage
	Gatore	4,948	New	Pump up	1	New	2nd Stage
	Gahara	13,244	New	Pump up	1	New	3rd Stage
Kayonza	Murama	9,132	New	Pump up	1	New	3rd Stage
Ngoma	Kibungo	8,536	New	Pump up	2	New	3rd Stage
	Karembo/Zaza/ Mugesera	22,421	Rehabilitation	Pump up	1	Existing	3rd Stage
	Kazo/Mutendeli	8,361	Rehabilitation	Pump up	1	Existing	3rd Stage

2) Selection of Schemes for the Japanese Assistance

Schemes for the Japanese assistance were selected in the following procedure.

a. Scheme(s) with the completed, on-going and planned water supply project(s) by the Government of Rwanda, other donors and NGOs, will be scrutinized. Based on the result of scrutinization, some of the scheme(s) will be excluded. In case the resettlement in the target area is still in progress, the water supply plan formulated in the projects will be carefully reviewed, in order to conclude if it to be excluded or not.

b. Concerning the 5 schemes of the 2nd stage of the project, feasibility of the implementation will be studied, based on the results of water source investigation, socioeconomic surveys, formulation of water supply plans, formulation of implementation and procurement plans and cost estimation.

c. Schemes of the 3rd stage of the project will be prioritized from the viewpoint of the condition of construction on site and sustainability of operation and maintenance of the water supply facility.

d. The implementation schedule of each scheme will be carefully studied in order to construct and rehabilitate as many water supply facilities as possible, since the project has to be completed within 24 months after conclusion of the Exchange of Notes. Based on the results, schemes for the requested Japanese assistance will be selected.

Consequently, the following 7 schemes including 5 schemes of 2nd stage of the project which were concluded as feasible have been selected.

- Kirehe district: Mushikiri, Kirehe, Nyamugari/Mahama, Kigina, Gotore schemes
- Ngoma district: Karembo/Zaza/Mugesera, Mutendeli/Kazo schemes

3) Criteria for the Prioritization for Schemes of 3rd Stage of the Project

Schemes of the 3rd stage of the project are prioritized by the criteria as described in Table 2-4. Contents of each criterion should be made more practicable compared with those agreed in the M/D, based on the results of the study.

Table 2-4 Criteria and Contents of Evaluation

Criteria		Contents of Evaluation
1	Cost/Benefit Ratio	Construction cost /Number of beneficiaries. Lower figure is given better evaluation
2	Accessibility to the source (in terms of cost of access road construction)	Condition of road construction is rated by the following 4 criteria. 1) Road will become available with the maintenance done by manpower (Ranking: High) 2) Road is needed to be widened by machinery (Ranking: upper middle) 3) Road is needed to be widened by machinery with risk caused by rocks (Ranking: lower middle) 4) Road to be constructed is situated in rocky area with high risk (Ranking: low)
3	Construction Condition	Condition of construction of facilities excluding road is rated by the following 4 criteria and summed up by the rated figure for rating each scheme. 1) Accessibility to the construction site 2) Condition of distribution of rocks at facility construction site 3) Condition of distribution of rocks along the distribution pipe laid site 4) Condition of distribution of rocks along the transmission pipe laid site
4	Operation and Maintenance Cost	Operation and maintenance cost to be borne per person (Lower figure is given higher evaluation)
5	Scheme Type(Gravity, Motorized by Generator, Booster pump)	Means of transmission of water from water source to main distribution tank of each scheme is rated by gravity, direct pump and pumped up with a booster pump. In case the transmission of water is required to use both pumps at collection tank and booster pumps at the relay point, the operation system becomes complicated. Therefore, a scheme without a booster pump is ranked higher. Gravity scheme is ranked as the highest, since pump operation is not required.
6	Willingness to Pay	Willingness to pay at each scheme obtained by the study was compared. No difference was identified among the 7 schemes
7	Rate of satisfaction on the current quantity of water supply	・ Comparison of the rate of satisfaction on the current quantity of water supply during the rainy season. It is anticipated that the water fee is not collected as often, and communities rarely participate in operation and maintenance as increased number of households continue to use rain water in the rainy season even though improved water supply facilities are constructed or rehabilitated. ・ Therefore, the scheme with a low rate of satisfaction is given higher evaluation.

(2) Available Quantity and Quality of Water Source

Water sources for all of water supply facilities to be constructed and rehabilitated by the project are springs. The yield of springs has been influenced by the variation of the volume of precipitation, though the yield depends on the condition of the recharge system and aquifer. Therefore, the minimum yield of the spring shall be applied to the calculation of the served population, in order to sustain a stable water supply to the communities.

In the study, a water source investigation of 14 springs was scheduled to be carried out, in order to secure the quantity and quality of water sources. It was observed that the yields of 9 springs were less than those measured in previous studies. Therefore, in order to secure the quantity of water to be supplied, 12 additional springs were selected from the viewpoint of expected available quantity of springs and cost performance for transmission of water. A total of 26 springs were investigated.

In order to verify the availability of the water source, a water quality analysis of springs was carried

out. Since the Rwandan Government has adopted the WHO standard for drinking water, this standard was applied to the study.

2-2-1-2 NATURAL ENVIRONMENTAL CONDITIONS

(1) Consideration of Rainy Season in Implementation Period

The mean annual precipitation in the target area is a little less than 1,000mm. April and November are the peaks of the rainy season and the period of June to August is categorized as the dry season. In the rainy season, traffic of vehicles can be difficult, because most roads are unpaved except for some national roads in the target area. Therefore the implementation schedule is to be carefully formulated taking into consideration of the influence of rainfall on the construction work.

(2) Consideration of Water Quality in Selecting Materials and Equipment

Water quality analysis of the spring water to be utilized as water sources shows that all spring water has weak acidity (pH 4.69 to 5.84). Materials with resistance to acid should be selected for pipes and other materials that contact the water.

(3) Consideration of Spring Water Yield in the Water Supply Plan

It was verified that the yield of spring water changed corresponding to the fluctuation of precipitation, based on the results of the investigation of the yields of springs during Basic Design, Detail Design and Implementation Review Study and the analysis of hydrological and meteorological data. The yield begins decreasing in June, the beginning of the dry season, and it reaches its minimum in October, the beginning of the rainy season, in the target area. Therefore the water supply plan should be designed based on the spring yield in October, the minimum in a year.

(4) Consideration of Working Methods in Bedrock Exposed Areas

The bedrock of granite or quartzite is widely exposed in the Kirehe district. It is assumed that the progress of works will be delayed compared to usual works. Therefore a breaker and/or large construction machinery are planned to lay piping or to maintain the road for services and maintenance of facilities smoothly. It is necessary to take into account the geology of the target sites when the construction machinery is supplied.

2-2-1-3 SOCIAL AND ECONOMIC CONDITIONS

(1) Social Conditions in the Target Area

In the Ngoma and Kirehe districts, agriculture is the main basic industry, and around 90% of residents are engaged in it. Staple crops are bananas, maize, beans, sorghum, cassavas, pineapple, coffee, potatoes and rice, which are able to be double-cropped in the target area. Land for cultivation is narrow, because the land is mainly located on the gentle slopes and the bottom of the valley. In addition, the irrigation system is not well developed. As a result, the productivity of agriculture is still low.

(2) Progress of Resettlement (Imidugugu)

In most of the target sectors, resettlement had been encouraged since 1997, and has already been completed in 2009. No change of number of villages (Imidugudu) has been observed in the recent 5 years. In the Gahara sector in Kirehe district, however, residences are still scattered. The sector office has planned another resettlement. In the plan, a quarter of the villages in the sector are planned to move to other villages which are located in the center of the sector with a relocation of residences.

Since these villages are a part of the target area of the project, a water supply plan is required to be carefully formulated.

(3) Vulnerable People

In the target districts, vulnerable people including victims of the incidents in 1994 have been recognized by the community and officially registered. The local government has established a system to support them, such as supply of housing materials, transportation to the medical center, payment of school expenses for children and so on. With regard to water supply, one or two jerry can (20 liters) per day is free of charge to them. The support for the vulnerable people is different in communities. In the project, therefore, the means of support for the vulnerable people will be discussed between an organization for O&M and communities in the presence of the officer in charge of water in the district.

(4) Gacaca (Trial related to the incident by the Community)

Gacaca, a trial for handling incidents in 1994, has been executed at each cell every week, under the participation of hundreds of residents in the community. In the target area, it is reported that Gacaca has already been completed in all sectors. Therefore, no influence of Gacaca is expected for the implementation of the project.

(5) Umuganda (Community Service)

Residents over 18 years old are engaged in community service every Saturday. Besides, the community service at sector/cell level is implemented once a week. Since all residents over 18 years old are required to participate in the community service in principle, the implementation plan and work schedule of the project shall be prepared after due consideration of the actual working days.

2-2-1-4 CONDITION OF CONSTRUCTION AND PROCUREMENT

It was observed that the quality of some materials available in Rwanda did not meet the required standards for the project, since the market condition was still under development. With regard to construction machinery, it was observed that the availability of machinery was limited for the implementation of the project, due to the rush for construction of hotels and office buildings in the capital city Kigali. Under these circumstances, in order to secure the implementation of the project, the necessary procedures for procurement and construction are carefully scheduled considering the following items:

1) In case the materials are acceptable in terms of quality and quantity, materials are procured from domestic suppliers.
2) In case the materials are available at agents, procurement from the agents is given priority.
3) In case the materials available in the neighbouring countries are acceptable in terms of quality and quantity, materials are procured from these third countries.
4) In case procurement of materials with acceptable quality and quantity from neither domestic suppliers nor third countries is available, procurement from Japan is acceptable.
5) In case the necessary materials are not available in the supply network inside and outside the country, procurement from the Republic of South Africa and European countries are possible candidates.

2-2-1-5 CONDITION OF LOCAL CONTRACTORS

It was observed that the capacity of local contractors was satisfactory for the minimum requirement for construction. However, quality control and security management have not been satisfactorily addressed by them. This observation implies that it is difficult for the local contractor to secure the quality control required in the project, unless they are subcontracted by the Japanese contractor. In this context, subcontracting work shall be limited to the work that the local contractors are able to

appropriately manage by themselves such as road pavement work. Consequently, most of the construction work is planned to be undertaken by labour directly employed by the Japanese contractor.

2-2-1-6 OPERATION AND MAINTENANCE

In Rwanda, the operation and maintenance of water supply facilities has been the responsibility of the water users association since 1994. In 2004, the operation and maintenance system was assessed by the Rwandan Government and was concluded to be not properly managed due to inappropriate management and technique which were caused by several reasons, namely; 1) less ownership of users of water supply facilities, 2) members of the water users association are volunteers, 3) less participation of users in operation and maintenance, 4) less capacity of water users association to address technical issues and financial aspects.

In order to overcome these challenges, the Rwandan Government has decided to make use of private sectors in line with the policy of Public Private Partnership as a part of the sector strategy for 2004 to 2007, based on the results of discussion about operation and maintenance systems. In order to be in conformity with the policy, the water and sanitation policy is now under revision, and collaboration with private sector will be a part of the policy so as to secure sustainability of funding.

The Kayonza district, which is one of the target districts for the study, has already introduced privatization of the operation and maintenance system. The Ngoma and Kirehe districts have scheduled introducing privatization by the end of 2010. As of December 2009, both districts were still under the consideration of the better way to introduce privatization, and expressed their opinion that privatization after achievement of enhancement of capacity of WUA is the one of the processes.

In privatization, it is important to establish an operation and maintenance system in a private organization under supervision of the district office. Even though WUA conducts operation and maintenance, the support system of WUA is necessary to be established in the district office. Under these circumstances, the operation and maintenance plan is made focusing on the enhancement of capacity of district office on management of private organization/WUA.

2-2-1-7 CONSTRUCTION WORKS AND PROCUREMENT

A plan of construction works and procurement will be formulated in accordance with the following means taking into consideration the results of the field study.

1) For smooth implementation of the project, construction works at different schemes will be executed simultaneously, without duplication of peak of similar type of work in different schemes. A management system for the simultaneous work will be established.
2) In order to minimize the influence on the implementation schedule, construction will be executed by utilizing appropriate machines for the local standards. In case it is expected to create a risk on utilizing construction machinery at location of water intake facilities and other areas, construction works using manpower will be applied,
3) Construction work with manpower will be applied as much as possible, in case the influence on other works is expected to be relatively low.
4) Machinery to be used for construction will be procured inside the country and neighboring countries as much as possible, from the viewpoint of accessibility to the site and operating conditions.

2-2-2 BASIC PLAN

2-2-2-1 TARGET SCHEMES FOR THE JAPANESE ASSISTANCE

The 10 target schemes of the study were analysed and prioritized in accordance with the procedures and

criteria as described in section 2-2-1-1, Basic Policy. Based on the results of analysis and prioritization, the schemes to be implemented for the Japanese assistance were selected with the consideration of that the project has to be completed within 24 months after the conclusion of the Exchange of Notes. The results of the procedures taken are described below.

(1) Progress of the Resettlement (Imidugudu)

The resettlement of most of the target sectors, which had been encouraged in 1997, has already been completed in the year 2009. No change of number of villages (Imidugudu) has been observed in the recent 5 years. At present, the Ministry of Local Government, Good Governance, Community Development and Social Affairs (MINALOC) has been encouraging the local government authorities (Sectors) to expand the existing villages or establish new villages, in order to cope with increased population in the villages. Even in the target sectors, expansion of villages or establishment of new villages are scheduled to take place from late 2009 to early 2010. The establishment of new villages are planned in 8 sectors out of 14 target sectors. Though new villages are planned to be established near the target villages in 4 sectors, number of household to be moved are only 2 to 4 households per village. The expansion of villages are planned to be in 5 sectors out of the target 14 sectors. A total of 7 target villages in 2 sectors are planned to be expanded. However it has been concluded that the plan of expansion or establishment of villages does not influence the water supply plan of the project, since the plan of the sector is small scale and causes only slight movement of the people inside the village.

The Gahara sector, one of the target sectors in the study has planned to move a quarter of its villages with relocation of residents to other villages located in the center of the sector. In Gahara sector, 4 cells of Nyakagegi, Rubimba, Nyagaseni and Murehe are included in the target area and it was reported that the Rubimba cell is the one of the cells that was planned to move to other villages with relocation of residents.

Under these circumstances, even though the water supply facility is constructed in accordance with the plan formulated based on the current conditions, there is a possibility not to use a part of the facility. In addition, since the Rubimba cell is located in the center of the planned water supply area in the project, water is supplied to other 3 cells through the Rubimba cell. These conditions are indeterminate factors in the project implementation.

Therefore, it is concluded that the Gahara scheme is premature to implement the project and it was excluded from the project

(2) Feasibility of Implementation of 5 Schemes of 2nd Stage of the Project

Based on the result of the Basic Design Study conducted in the year 2005, the implementation of 5 schemes of the 2nd stage of the project have already been approved by the Government of Japan followed by the conclusion of the Exchange of Notes. The Rwandan Government strongly requests to implement the projects as soon as possible. In this context, the implementation of the 5 schemes of the 2nd stage of the project was given higher priority and agreed by both the Rwandan and Japanese sides. It is described in the M/D signed in the study.

Therefore, in case the feasibility of the implementation of each of the 5 schemes is confirmed, schemes of the 2nd stage of the project are given higher priority, as it is described in section 2-2-1-1, Basic Policy.

Though the water supply area and served population are required to be reduced comparing the plans prepared in the Basic Design and Detailed Design Studies due to a decrease of the available quantities of water sources, the relevancy of the implementation of each scheme of the 2nd stage of the project was confirmed in terms of the following points. Consequently, 5 schemes were selected as the schemes to be implemented under the Japanese assistance.

1) The water supply coverage of Mushikiri sector in the year 2008 was only 5%, while Gatore sector, which has the highest coverage among the 5 schemes, is still 31%. The coverage of the 5 schemes is lower than the average of the Eastern province which is 53%. It is, therefore clear that the immediate approach to construction and rehabilitation of the water supply facilities in those 5 schemes is indispensable, in order to contribute toward achievement of the objective set in Vision 2020, which is that all the population has access to safe water by 2020. In addition, the coverage of each of the 5 schemes is less than half of the coverage of schemes in the Ngoma district of the 3rd stage of the project. Considering these circumstances, the 5 schemes of the 2nd stage of the project should be given priority.

2) As a result of redesigning the water supply facilities of the 5 schemes of the 2nd stage of the project, it was concluded that the operation and maintenance of these schemes was not complicated. Because the transmission of water from water source to the main distribution reservoir of Nyamugari/Mahama scheme is done by gravity. With regard to the other 4 schemes, a booster pump to relay the water from the source is not required, though the transmission of water should be pumped up. Consequently, the feasibility of the implementation of the 5 schemes is confirmed in terms of sustainability of operation and maintenance.

3) The ratio of the cost of operation and maintenance to be borne per capita to the income per capita was estimated between 0.7 and 4.3%. For the project of JICA, a ratio lower than 5%, which is recommended by the World Bank, is adopted for the evaluation of affordability to pay for the beneficiaries against the amount to be borne by the beneficiaries to sustain the operation and maintenance of the water supply facility. Since the ratio estimated in the study are lower than 5%, the feasibility of the implementation of the 5 schemes is confirmed from the viewpoint of affordability to pay.

(3) Prioritization of 4 Schemes of the 3rd Stage of the Project

A total of 4 schemes of the 3rd stage of the project except the Gahara scheme were prioritized by applying the criteria described in Table 2-4, and the result is shown in Table 2-5. As a result, the Karembo/Zaza/Mugesera scheme and Mutendeli/Kazo scheme are ranked first followed by Murama scheme as the third and Kibungo scheme as fourth. The result of prioritization reflects the differences of the cost/benefit ratio, the cost of operation and maintenance per capita and conditions of operation and maintenance by scheme type.

Table 2-5 Result of Prioritization of 4 Schemes

Criteria for Evaluation / Scheme	1 Cost/Benefit Ratio (cost of construction/no. of beneficiaries)	2 Accessibility to the Source (in terms of cost of access rod construction)	3 Construction Condition	4 Operation and Maintenance Cost per Capita	5 Scheme Type	6 Willingness to Pay	7 Rate of Satisfaction on the Current Quantity of Water Supply in Rainy Season	Total	Rank
Murama	1	4	4	1	1	3	3	17	**3**
Kibungo	1	4	4	2	1	3	1	16	**4**
Karembo/Zaza/Mugesera	1	3	2	4	3	3	4	20	**1**
Kazo/Mutendeli	4	1	1	4	4	3	3	20	**1**

(4) Selected Schemes for the Japanese Assistance

As a result, a total of 7 schemes in 11 sectors, that is, the Mushikiri scheme, Kirehe scheme, Nyamugari/Mahama scheme, Kigina Scheme and Gatore scheme in the Kirehe district of 2nd stage of the project and Karembo/Zaza/Mugesera scheme and Kazo/Mutendeli scheme in the Ngoma district of 3rd stage of the project were selected. Table 2-6 shows the selected 7 schemes.

Table 2-6 Selected 7 Schemes for the Japanese Assistance

District	Scheme	New Construction/ Rehabilitation	Means of Transmission of Water	No. of Water Source
Kirehe	Mushikiri	New Construction	Pump up	3
	Kirehe	Rehabilitation	Pump up	2
	Nyamugari/Mahama	Rehabilitation	Gravity	2
	Kigina	New Construction	Pump up	1
	Gatore	New Construction	Pump up	1
Ngoma	Karembo/Zaza/Mugesera	Rehabilitation	Pump up	5
	Kazo/Mutendeli	Rehabilitation	Pump up	2

(5) Development Potential of Water Sources

As mentioned in section 2-2-1-1 Basic Policy, it was confirmed that the yields of 9 springs decreased among 14 springs which were planned to be used as water sources in the Basic Design and Detail Design Studies. Therefore 12 additional springs were selected and yields and the water quality of total 26 springs were investigated in the study. The measured yield data including the data measured in the investigation of the Basic Design study (in October 2005) and the Detail Design study (in June 2006) were quantitatively analyzed and usable springs as water sources were selected.

The yields of springs change corresponding to the fluctuation of precipitation as the water levels of lakes and rivers change. It was verified that the yields of the springs achieved their minima in October as a result of the analysis on the amplitude and the delay of phase of the fluctuations of the precipitation and the water levels of lakes and rivers in the targeted area.

The yields were continuously measured in the 3 months from June to October 2009. The yields as of October 2009 were estimated based on the result of the continuous measurement. The development potential yields were selected as the lower yield between the measurements in the Basic Design Study (in October 2005) and the estimated yield as of October 2009. Table 2-7 shows the development potential yields of the schemes which were selected for the project.

Table 2-7 Water Development Potential

District	Scheme	Spring	Yield (L/sec)	Water development potential in each scheme (L/sec)
Kirehe	Mushikiri	Nyakagongi	0.9	2.0
		Nyagihanga	0.3	
		Nkakwa-Upper	0.8	
	Kirehe	Gahama	0.6	1.7
		Muguruka	1.1	
	Nyamugari/Mahama	Mayizi	3.4	3.9
		Cyanyiranyonza	0.5	
	Kigina	Gasebura-Upper	1.8	1.8
	Gatore	Samuko-A	1.2	1.2

District	Scheme	Spring	Yield (L/sec)	Water development potential in each scheme (L/sec)
Ngoma	Karembo/ Zaza/ Mugesera	Rwartene	2.0	4.9
		Kabashuko	0.9	
		Kabajara	1.0	
		Gisuma	0.4	
		Kabaromba	0.6	
	Kazo/Mutendeli	Kagoma	1.2	3.4
		Musenyi	2.2	

The water quality of springs was analysed at the laboratory of National University of Rwanda. The result of analysis is shown in Table 2-8. Escherichia coli was detected in more than half of the springs. Therefore, water of these springs is required to be chlorinated.

Table 2-8 Result of Water Quality Analysis

District	Scheme	Parameters	Water Temp.	pH	EC	Turbidity	Total Dissolved Solids	Alkalinity as CaCO3	Total Hardness as CaCO3	Calcium Hardness as CaCO3	Calcium as Ca2+	Magnesium as Mg2+	Hydrogen carbonate as HCO3-	Ammonium nitrogen as NH3-N	Nitrite Nitrogen as NO2-N	Nitrate as NO3-N	Fluoride as F-	Chloride as Cl-	Sulfate as SO42-	Iron as Fe	Manganese as Mn	Zinc as Zn	Salinity	Sodium as Na	Potassium as K	Lead as Pb	Feacal Coliforms	E. Coliforms
		Unit	deg C		mS/m		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	‰	mg/L	mg/L	mg/L	Cfu /100ml	Cfu /100ml
		WHO Standard				5	1000							1.50	0.200	50.0	1.5	250.0	250.0		0.100	3.00		200.0		0.010	0	0
Kirehe	Mushikiri	Nyakagongi	23.0	5.62	7.89	6	38	25.6	28	20	8	1.9	25.6	0.00	0.002	1.2	0.2	0.0	3.0	0.17	0.000	0.09	0.0	11.2	47.5	0.000	**80**	< 1
		Nyagihanga	22.9	5.80	28.50	2	20	89.1	135	90	36	10.9	89.1	0.00	0.002	1.1	0.1	1.3	16.0	0.01	0.000	0.01	0.2	25.8	57.0	0.000	**> 100**	**> 100**
		Nkakwa-Upper	22.9	5.11	3.87	3	16	19.5	10	9	4	0.2	19.5	0.00	0.002	1.0	0.0	0.0	0.0	0.02	0.005	0.25	0.0	8.9	18.6	0.000	**2**	< 1
	Kirehe	Gahama	22.0	5.55	23.60	4	113	26.8	44	28	11	3.9	26.8	0.00	0.000	0.7	0.0	9.9	0.0	0.08	0.009	0.21	0.1	31.5	23.1	0.001	**20**	< 1
		Muguruka	22.2	5.84	18.42	3	89	42.7	68	50	20	4.3	42.7	0.03	0.001	1.4	0.1	2.3	4.0	0.01	0.000	0.08	0.1	11.2	13.7	0.000	< 1	< 1
	Nyamugari / Mahama	Mayizi	23.8	5.55	10.71	65	27	30.5	17	15	6	0.5	30.5	0.19	0.003	0.3	0.0	2.0	1.0	0.21	0.026	0.10	0.0	10.3	13.8	0.000	**10**	< 1
		Cyanyiranyonza	24.0	4.97	2.45	6	10	13.4	7	5	2	0.5	13.4	0.03	0.001	1.4	0.1	2.3	4.0	0.01	0.000	0.08	0.1	3.5	14.4	0.000	**30**	< 1
	Kigina	Gasebura-Upper	24.8	5.56	5.46	9	26	20.7	21	12	5	2.2	20.7	0.00	0.001	1.0	0.0	2.0	1.0	0.05	0.000	0.10	0.0	8.4	13.0	0.000	< 1	< 1
	Gatore	Samuko-A	23.9	5.61	3.87	2	18	28.1	37	16	6	2.5	28.1	0.00	0.015	0.3	0.2	0.6	0.0	0.01	0.032	0.38	0.0	12.1	12.7	0.000	**> 100**	< 1
Ngoma	Karembo/ Zaza/ Mugesera	Rwarutene	23.1	4.69	10.99	6	47	13.4	25	16	6	2.2	13.4	0.00	0.001	1.9	0.0	0.7	1.0	0.02	0.024	0.09	0.0	13.1	13.8	0.000	**9**	< 1
		Kabashyuko	22.9	5.41	9.66	8	43	17.1	36	29	12	1.6	17.1	0.01	0.002	1.4	0.0	1.6	2.0	0.07	0.014	0.41	0.0	5.7	14.6	0.008	**6**	< 1
		Kabajara	22.7	5.58	8.08	17	36	18.3	18	12	5	1.4	18.3	0.06	0.009	0.8	0.0	1.8	2.0	0.16	0.013	0.06	0.0	4.8	12.3	0.000	**> 100**	**> 100**
		Gisuma	24.1	5.00	7.32	2	33	25.6	29	25	10	0.9	25.6	0.03	0.000	1.6	0.1	1.8	2.0	0.07	0.002	0.05	0.0	4.9	16.4	0.000	< 1	< 1
		Kabaromba	23.1	5.36	17.25	5	82	22.0	39	24	10	3.6	22.0	0.01	0.002	1.1	0.1	3.3	3.0	0.07	0.020	0.45	0.0	14.8	17.5	0.000	< 1	< 1
	Kazo/ Mutendeli	Kagoma	22.9	4.93	12.65	0	52	14.6	27	18	7	2.3	14.6	0.01	0.001	2.2	0.0	0.3	2.0	0.03	0.000	0.74	0.0	48.7	82.5	0.000	< 1	< 1
		Musenyi	22.0	5.58	13.29	6	69	20.7	41	23	9	4.4	20.7	0.00	0.001	1.9	0.1	1.2	3.0	0.07	0.006	0.12	0.1	24.3	19.9	0.003	< 1	< 1

2-2-2-2 BASIC DESIGN

(1) Target Year of the Project and Served Population

1) Target Year of the Project

The target year of the Project is set as 2014 which is 5 years after the commencement of the study, in accordance with the target year set in the Basic Design Study in the year 2005.

2) Population Growth Rate and Population in the Target Area

In the development study for the formulation of the master plan of the water supply in the Eastern province which is being conducted by JICA, the population growth rate of every 5 years estimated by the National Institution of Statistics of Rwanda (NISR) is officially adopted. In order to be consistent with the development study, the population growth rate set by NISR is adopted to a projection of future population in the study as shown in Table 2-9.

Table 2-9 Population Growth Rate

Period	2007 - 2012	2013 - 2017
Annual Growth Rate in %	2.40	2.12

With regard to the present population in the target area, the population data in the year 2008 of each village provided by the districts is adopted in the study.

(2) Served Population and Supply Area

1) Unit Water Consumption

The unit water consumption set by the MININFRA, which is 20 litre/capita/day for the rural water supply, is adapted in the study.

2) Available Quantity of Water Source and Possible Served Population

In the water source investigation of 26 springs, no change of total quantity of water was observed in the 2 schemes of Gatore and Nyamugari/Mahama, compared with the quantity measured in the Basic Design or the Detailed Design Studies as shown in the column of quantity of water in Table 2-10, while the decrease of quantity of water was observed in the 5 schemes of Mushikiri, Kirehe, Kigina, Karembo/Zaza/Mugesera and Kazo/Mutendeli.

The possible served population which is calculated applying the estimated percentage of leakage and available quantity of water source is shown in the column of the possible served population in Table 2-10. In the table, the possible served population in Kazo/Mutendeli scheme will be increased compared to the served population in the Basic Design Study. However the possible served population of the 6 schemes result in a decrease. It is assumed that the difference of the served population is due to the change of the number of population and the consideration of leakage of water.

3) Served Population

The served population in each scheme constructed in the project was calculated based on the result of study concerning the difference of elevation in the served area, the water supply conditions of existing facilities and the exclusion of the area which was covered by other water supply projects. The served population in the project is shown in the column of served population in 2014 in Table 2-11. Each of the served population of Kirehe scheme, Nyamugari/Mahama scheme, Karembo/Zaza/Mugesera scheme is calculated by subtracting the present served population of existing facilities from the served population of newly constructed facilities.

4) Water Supply Area

The water supply area designed in the Basic Design and Detailed Design Studies were reviewed, in order to be consistent with the reduced quantity of water source and estimated served population with considerations of 1) the lowest administrative unit, cell, is the base, 2) the cells of the new construction scheme are covered as much as possible, considering topographic conditions, 3) In case available existing pipelines are laid in cells, the area laid the existing pipelines will be used as much as possible according to the available quantity of water source. If water volume exceeds the demand, the water supply area will be expanded.

Table 2-10 Available Quantity of Water Source and Possible Served Population

District	Scheme (Sector)		Basic Design and Detailed Design Studies			Implementation Review Study			
			Quantity of Water		Served Population	Quantity of Water		Possible Served Population calculated applying estimated ratio of leakage[*1] and quantity of water	Works
			liter/sec	m^3/day		liter/sec	m^3/day		
Kirehe	1	Mushikiri	3.3	285	11,884	2.0	173	7,776	New Construction
	2	Kirehe	2.0	173	8,640	1.7	147	5,140	Rehabilitation
	3	Nyamugari/ Mahama	3.9	337	16,776	3.9	337	11,793	Rehabilitation
	4	Kigina	3.1	268	10,082	1.8	155	6,998	New Construction
	5	Gatore	1.2	104	4,948	1.2	104	4,665	New Construction
Ngoma	6	Karembo Zaza/ Mugesera	5.3	458	22,421	4.9	423	14,817	Rehabilitation
	7	Kazo/ Mutendeli	3.8	328	8,361	3.4	294	13,219	Rehabilitation[*2]

Notes) *1: Estimated ratios of leakage on new construction and rehabilitation are 10% and 30%, respectively. In rehabilitation of existing facilities, only the part with leakage clearly detected will be repaired, and not all the pipeline are replaced in this project. Therefore, it is assumed that the late of leakage will decrease to 30 %.

*2: Pipes of the existing network have been replaced in 2008 in Kazo/Mutendeli; therefore the ratio of leakage is estimated at 10%.

Table 2-11 Served Population and Supply Coverage

Scheme			Year 2008*1			Implementation Review Study	Year 2014		
District	Sector	Cell	Present Served Population	Population of Sector	Coverage (%)	Served Population*2 in 2014 by the Project	Present Served Population plus Served Population by the Project	Population of Sector	Coverage (%)
Kirehe	Mushikiri	Rwayikona, Bisagara	1,122	22,436	5	7,776	8,898	25,724	34.6
	Kirehe	Gahama, Kirehe, Nyabikokora	2,444	18,802	13	*3 3,772	6,216	21,557	28.8
	Nyamugari/ Mahama	Kazizi, Nyamugari, Kagasa, Umunini	11,808	48,298	24	*3 6,969	18,777	55,383	33.9
	Kigina	Rwanteru, Ruhanga, Rugarama	3,193	21,285	15	6,998	10,191	24,406	41.8
	Gatore	Cyurazo, Rwabutazi	7,046	22,729	31	4,665	11,711	26,063	44.9
Ngoma	Karembo/Zaza/ Mugesera	Akaziba, Karaba, Ruhembe, Nyagatugunda, Nyamugari, Akabungo, Mugatare, Ntaga, Nyange	40,299	54,735	74	*3 11,700	51,999	62,763	82.8
	Kazo/Mutenderi	Karwema, Kibare, Mutendeli, Kinyonzo	28,794	39,192	74	13,219	42,013	44,937	93.5
			94,706	227,477	**41.6**	55,099	149,805	260,833	**57.4**

Notes) *1: JICA(2009), The Study on the Rural Water Supply Plan in the Republic of Rwanda, Interim Report
*2: Number of beneficiaries of the project
*3: For the rehabilitation schemes, "served population in 2014 by the project" is the figures deducted the served population of existing facilities.
Served population of rehabilitated facility is as follows. (1) Kirehe Scheme: 5,012, (2) Nyamugari/Mahama Scheme: 7,910, (3) Karmbo/Zaza/Mugesera Scheme: 13,420

(3) General Design

1) Concrete

(i) Water tank structure

- The standard design strength (compressive strength) is σck=24N/mm2.
- The cement strength is 42.5 N/mm2.

(ii) General structure

- The standard design strength (compressive strength) is σck=21N/mm2.

(iii) Plain concrete, Thrust block, Retaining wall, etc.

- The standard design strength (compressive strength) is σck=18N/mm2.

2) Pipe Line

(i) Depth of cover for pipes

Depth of cover for pipes is designed as follows;

- Under the national road : Min. 120cm
- Under the normal road : Min. 80cm
- Other conditions : Min. 60cm

Exposed pipeline was designed to be laid at the outcrop of hard rocks when it is clearly difficult to dig there.

(ii) Water pressure

i) Water Conveyance pipe, Distribution pipe and Transmission pipe (gravity)

Maximum hydrostatic pressure: Break pressure tanks and the pressure reducing valves will be installed appropriately in order to reduce the maximum hydrostatic pressure under 0.7Mpa if at all possible. However the condition of the land sometimes forces use of a high pressure type pipe.

Minimum dynamic water pressure: It is designed that the residual water pressure of the pipeline is over 0.1Mpa (Water head = 10m).

ii) Transmission pipe (pumping)

Designed pressure: The type of pipe in this project was determined appropriately after consideration of both the water hammer pressure and shutdown pressure which are 1.4 times the pipe. It is also designed that the residual water pressure of the pipeline is over 0.1Mpa (Water head = 10m).

3) Hydrologic Accounting

(i) Distribution pipe (Bore diameter: over 50mm)

- The Hazen-Williams formula was used for the calculation of the water flow volume.

(ii) Distribution pipe and Feed water pipe (Bore diameter: under 50mm)

- The Weston formula was used for the calculation of the water flow volume.
- Velocity coefficient 110 and bore diameter were used for the calculation of the water flow volume on hydrologic accounting.

(4) Type of Pipe

Appropriate pipes were designed under the situation that was assumed with the parameters of the service location, the working pressure, the bore diameter and the water quality.

1) Intake Pipe (inside an intake facility)

uPVC pipe manufactured with some holes or perforated pipe are used for the Intake pipe.

2) Water Conveyance Pipe（Intake facility to the receiving tank）

uPVC pipe (PN10) is adopted for the water conveyance pipe.

3) Pipe Around the Pumps

(i) Under the bore diameter, 65A

Polyethylene Lined Steel Pipe (PLSP) (the type of the pipe fitting: with a joint for corrosion prevention) is adopted.

(ii) Over the bore diameter, 80A

PLSP (the type of pipe fitting: the flanged connection and pipe manufactured in the factory) is adopted.

(iii) Adjustable pipe

SUS304TP (the type of pipe fitting: the flanged connection. This pipe is used for adjusting the gap between the pipes manufactured in the factory)

4) Transmission Pipe（Receiving tank to Distribution reservoir）

(i) Laid underground, under 0.7Mpa: uPVC (PN10)

(ii) Laid underground, from 0.7Mpa to 1.6MPa: uPVC (PN16)

(iii) Laid underground, 1.6Mpa to 2.0MPa: uPVC (Sch80)

(iv) Laid underground, over 2.0MPa: Polyethylene Lined Steel Pipe (30K)

(v) Exposed pipe: Aramid Convolved Polyethylene Pipe (flanged connection)

5) Distribution pipe

The type of pipe is the same as the transmission pipe.

(5) Water Quality Standards

In the project, the WHO standard for drinking water is applied, since this standards has been officially applied in Rwanda.

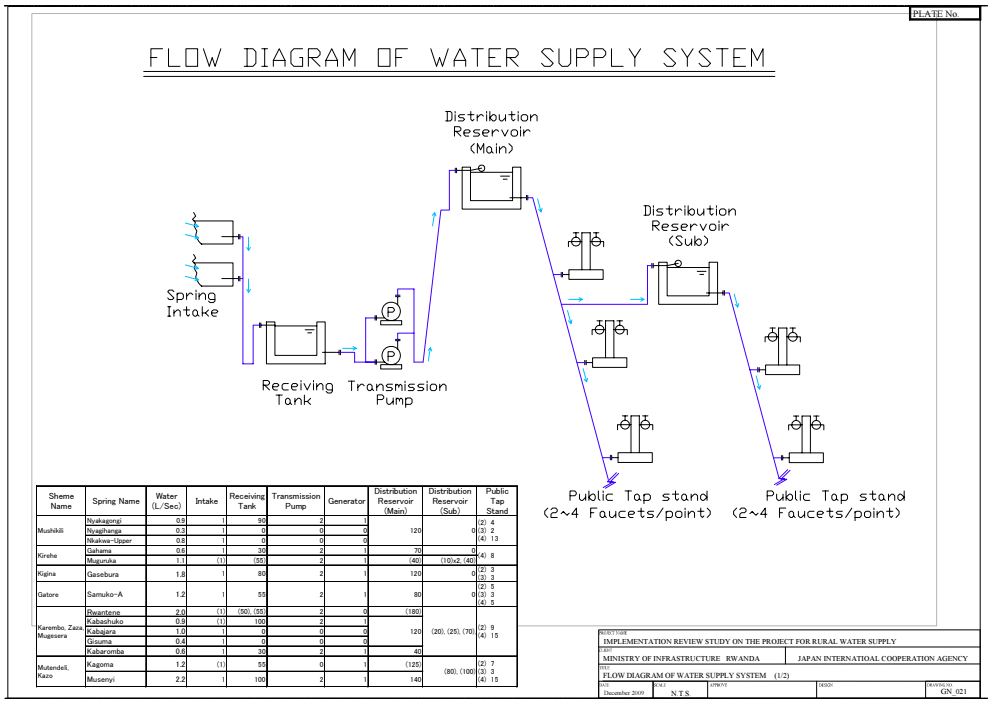
2-2-2-3 WATER SUPPLY FACILITY DESIGN

(1) Component of Water Supply System

The water supply system is designed taking into consideration: i) Springs around the water supply area are used as the water source, ii) Distribution reservoir is arranged at a place where water can be efficiently supplied to the water supply area, iii) Distribution pipeline is laid along a ridge in this area, and iv) Water is supplied from the public tap stands with some faucets according to the population served water.

A transmission pump is used for supplying the water from the water source to the distribution reservoir. In case the available water source is located higher than the selected location of the distribution reservoir, water is supplied to the reservoir from water source by gravity.

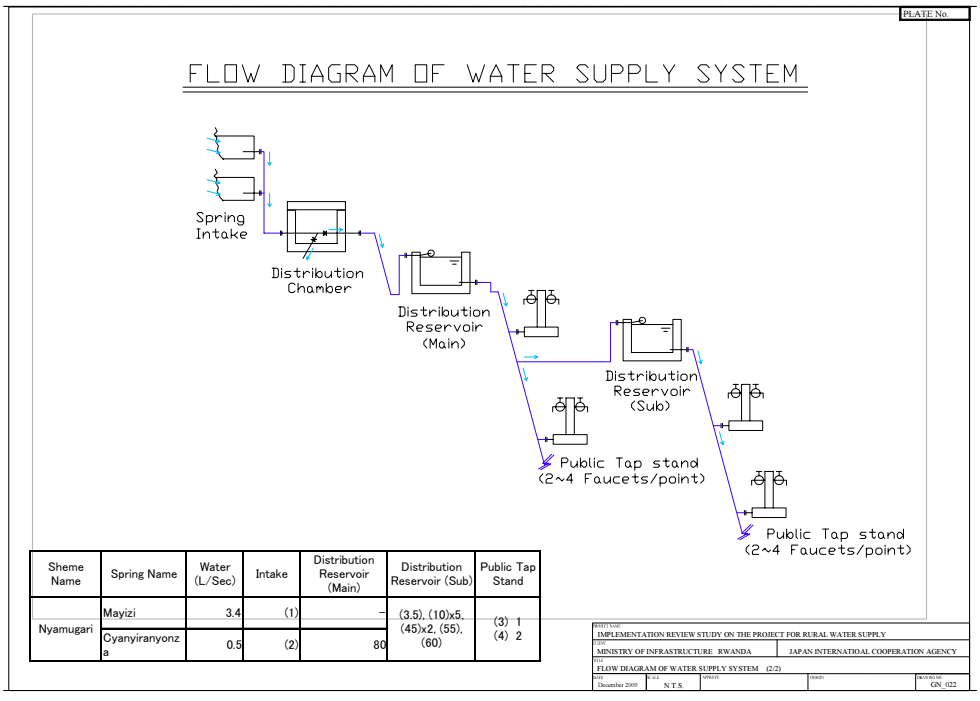
There are two types of water supply systems for the transmission of water, as shown in Figure 2-1 and 2-2.



Sheme Name	Spring Name	Water (L/Sec)	Intake	Receiving Tank	Transmission Pump	Generator	Distribution Reservoir (Main)	Distribution Reservoir (Sub)	Public Tap Stand
Mushikili	Nyakagongi	0.9	1	90	2	1	120	0	(2) 4 (3) 2 (4) 13
	Nyagharaga	0.3	1	0	0	0			
	Nkakwa-Upper	0.8	1	0	0	0			
Kirehe	Gahama	0.6	1	30	2	1	70	0	(4) 8
	Mugunuka	1.1	(1)	(55)	2	1	(40)	(10)x2, (40)	
Kigina	Gasebura	1.8	1	80	2	1	120	0	(2) 3 (3) 3
Gatore	Samuko-A	1.2	1	55	2	1	80	0	(2) 5 (3) 3 (4) 5
Karembo, Zaza, Mugesera	Rwantene	2.0	(1)	(50), (55)	2	0	(180)	(20), (25), (70)	(2) 9 (4) 15
	Kabashuko	0.9	(1)	100	2	1	120		
	Kabajara	1.2	1	0	0	0			
	Gisuma	0.4	1	0	0	0			
	Kabaromba	0.6	1	30	2	1	40		
Mutendeli, Kazo	Kagoma	1.2	(1)	55	0	1	(125)	(80), (100)	(2) 7 (3) 3 (4) 15
	Musenyi	2.2	1	100	2	1	140		

Flow of water (Intake - Collection tank - Transmission pump - Main distribution reservoir - Sub distribution reservoir - Public tap stand) at 6 schemes

Figure 2-1 Component of the Water Supply System (Type-1)



Sheme Name	Spring Name	Water (L/Sec)	Intake	Distribution Reservoir (Main)	Distribution Reservoir (Sub)	Public Tap Stand
Nyamugari	Mayizi	3.4	(1)	–	(3.5), (10)x5, (45)x2, (55), (60)	(3) 1 (4) 2
	Cyanyiranyonza	0.5	(2)	80		

Flow of Water (Intake - Distribution chamber - Main distribution reservoir - Sub distribution reservoir - Public tap stand) at 1 scheme

Figure 2-2 Component of Water Supply System (Type-2)

(2) Design Policy of each Facility

1) Intake Facility

An intake facility is designed taken into consideration the applying of a simple structure for construction on site like stone masonry, and the procurement of available materials on site

Faucets are designed to be installed near the intake facility, in order to supply water to the people who have used the water from the water source.

2) Receiving Tank

The receiving tank shall have enough volume to reserve the flow water from the intake during the non-operation period of a transmission pump. Two types of tanks are planned according to the land conditions, which are tanks both under ground and above ground.

3) Water Conveyance Pipe

An appropriate bore diameter of the pipe is selected.

4) Transmission Pump

A pump was selected to transport the water volume of the design daily supply during the pump working time that is twelve hours. In addition, attention is paid to the NPSH (Net Positive Suction Head) of the pump, and the method of installation of the pipes around the pump to avoid sticking when the pump starts to work, since the receiving tank is the under ground type in some sites.

The transmission pump is designed to be manually operated. The water level sensor is installed in the receiving tank to automatically inform the operator for the timely operation of the pump. Furthermore, in order to protect pump from the damage caused by operation of pump above water level, an automatic switch off system is applied.

5) Distribution Reservoir

(i) Volume of Reservoir（Actual Volume）

Considering the size of each water supply system, the volume of the reservoir was calculated in accordance with the “Explanation of the Standard for small water supply facility (re-published)”. This standard is applied in Japan and systematically summarizes the small water supply facility. The index, which is “Actual volume of the reservoir” in Table 2-12 below, was transformed from the designed population served to the maximum supply amount, because the unit water consumption is clearly different between Japan and Rwanda.

The index of the maximum supply amount is calculated by multiplying 200litre/day (unit water consumption in Japan) to the designed population served.

Table 2-12 Actual Volume of Reservoir

Designed Population Served (Standard in Japan)	Maximum Supply Amount（m^3/day）－Calculated Value	Actual Volume of the Reservoir
Over 5,000 people	Over 1,000m^3	12 hours-volume[1]
Over 3,000 people Less than 5,000 people	Over 600m^3 Less than 1,000m^3	13 hours-volume
Over 2,000 people Less than 3,000 people	Over 400m^3 Less than 600m^3	14 hours-volume

[1] The volume is the maximum supply amount

Designed Population Served (Standard in Japan)	Maximum Supply Amount（m^3/day） －Calculated Value	Actual Volume of the Reservoir
Over 1,000 people Less than 2,000 people	Over 200m^3 Less than 400m^3	16 hours-volume
Over 500 people Less than 1,000 people	Over 100m^3 Less than 200m^3	18 hours-volume
Over 300 people Less than 500 people	Over 60m^3 Less than 100m^3	20 hours-volume
Over 100 people Less than 300 people	Over 20m^3 Less than 60m^3	22 hours-volume*
Less than 100 people	Less than 20m^3	24 hours-volume*

(ii) Shape and Incidental Equipment

A square type of reinforced concrete tank was designed considering construction conditions. The strainer is designed to set up in the inlet pipe just near the tank, in order to prevent sands and other material entering the tank.

Furthermore a flow meter and a sluice valve are designed to be installed at the outlet side, in order to control the water flow and not waste the water when an accident occurs in the pipeline.

6) Chlorine Feeding Facility

According to the water quality analysis in the Basic Design, Detailed Design and the study, coliform bacillus was detected in some springs. Therefore, chlorination liquid is needed to be dosed into the water before distribution to sterilize the harmful bacteria and to preserve the water quality.

The chlorine feeding facility is set up by the main distribution reservoir to inject the chlorination liquid into the transmission pipe just before water enters the distribution reservoir.

7) Transmission Pipe and Distribution Pipe

(i) Transmission pipe

An appropriate bore diameter is selected to be able to supply the maximum supply amount during the pump operating time. Furthermore, the bore diameter which keeps water velocity around 0.5m^3/sec has been designed, in order to prevent occurrences of water hammer and surging.

The sluice valve, air valve and blow off valve were planned to be installed at a proper location in reference to Japanese facility standards. Furthermore, if the tees and/or elbows will be used, the thrust blocks are used for them under the standard design of water supply facilities. Anchor blocks will be utilized if the angle of land slope is over 15%.

(ii) Distribution pipe

The bore diameter of the distribution pipe is determined by the hydrologic accounting procedure as follows:

The Maximum hourly factor, which is described in the “Explanation of the Standards for small water supply facilities (re-published)”, is used for the hourly factor.

Table 2-13 Hourly Factor to be Adopted

Water Supply Population	120	180	240	360	480	600	1200	2400	3600
Hourly Factor	7	5.5	5	4	3.8	3.5	2.8	2.3	2.1

The method of laying distribution pipe is the same as the Transmission’s one.

8) Public Tap Stand

The locations of public tap stands were basically selected considering the distance between the public tap stand and the residence to be less than 500m set by the MININFRA, accessibility to the taps and available quantity of water. The number of faucets at one public tap stand is designed between 2 and 4 according to the water demand in the area. The water for the schools and dispensaries is designed to be supplied by the public tap stand which are installed near these facilities in the village since available quantity of water is limited.

9) Commercial Power Supply and Generator

The commercial power supply will is planned to be expanded for the eastern part of the target area in the future by the Rwandan Government. However it has not yet been supplied, except for a part of Karembo, Zaza and Mugesera sectors in Ngoma district.

Therefore, the generators are installed for operation of the pumps in the project except for the Rwartene water source of the Karembo/Zaza/Mugesera scheme.

With regard to the start system of pumps, economical design is needed to be applied. As a result of the study, the star-delta type of pump start was selected taking into consideration not only fuel cost but also the handling ease of the control panel according to generator size and pump start.

(3) Rehabilitation of the Existing Water Supply Facility

In the project, the existing water facilities in the 4 sites were confirmed in the 10 target sites. For the Kirehe scheme planned in the 2nd stage of the project the replacement of facilities and partial extension is designed as it was originally designed. With regard to the Karembo/Zaza/Mugesera scheme and Kazo/Mutendeli scheme, new constructions of water supply facilities were originally planned in the Basic Design Study. However it was confirmed that the existing facilities were still functioning and could be used. Therefore the existing facilities in those 2 schemes were planned to be rehabilitated and extended depending on the condition of facilities and water demand. The design policy for the existing water supply facility at each scheme is described below.

1) Kirehe Scheme

There is an existing water supply system including a pipeline from the Muguruka water source in Kirehe scheme. The transmission pump and transmission pipeline is designed to be replaced and a generator and control house are designed be installed at this site. The some existing receiving tanks and distribution reservoirs will be repaired, because some water leaks from the existing tanks were found during the field survey.

The water has been supplied to the Kirehe Hospital by the existing water supply system from the Muguruka water source. However enough water has not been supplied to the hospital up to now due to malfunction of the transmission facilities and the shortage of water has restricted the working of the hospital. Therefore, the water supply facility was designed to be able to supply enough water to meet water demand of the hospital.

2) Nyamugari/Mahama Scheme

Water leaks from the existing tanks were found in the field survey; therefore the tanks were planned to be suitably repaired. Since both transmission and distribution pipelines were laid in the 1960s, some part of pipeline has been replaced for the water leaks but overall replacement of the pipeline has not been conducted yet.

In the field survey, water leaks in the transmission pipeline were detected in the Kagasa area, therefore the replacement of the pipelines was planned. With regard to the distribution pipe line, it was impossible to detect the leakage since the water was not transmitted to the tanks. According to

the inhabitants, it was reported that water was supplied when water was transmitted to the tanks. Therefore, it was designed to utilize the existing distribution pipe line.

3) Karembo/Zaza/Mugesera Scheme

All existing pipelines in this scheme were planned to be replaced in the Basic Design. The existing pipeline was already replaced 10 years ago and the pipeline is not so old that it can't be used. Therefore it will not be replaced in this plan. However if it was found that the bore diameter was small for the proper diameter under hydrologic accounting, an additional pipeline will be laid or a new pipeline will be replaced in the needed area. Since the available water source in this area has enough quantity to supply to additional areas after repairing the existing system, new additional public tap stands and pipelines will be installed.

4) Kazo/Mutendeli Scheme

Almost all the existing pipeline was replaced by June 2009 from last year, therefore the replacement of the pipeline designed in the Basic Design Study will not be conducted. However in case the bore diameter was judged to be insufficient as a result of the hydrologic accounting, installation of new additional pipeline and/or or replacement of pipeline will be conducted. Besides, the additional installation of public tap stands and pipelines is planned, since the another available water source was identified in the study

(4) Installation of the Hand Pump in the Existing Deep Well

The target existing deep well in the project is located in the Gatore sector in the Kirehe district. It was confirmed that no hand pump was installed in this well and the well was left derelict.

The depth of the well was measured and a pumping test conducted to confirm the water supply ability by the hand pump. A water quality analysis was conducted to confirm possibility of use for drinking purpose.

As a result of the above investigation, it was confirmed that at least 15 litter/min. water can be pumped up, and the volume of water satisfied the 675 litter/min designed as the well standard in the Basic Design Study. The water quality was also confirmed to be satisfactory for the WHO standard which is used for the water national standard in Rwanda.

According to the investigation results, a hand pump will be procured and installed in this project. The design and specifications of the hand pump is the type of affridev hand pump which is generally used in Rwanda.

(5) Simple Water Quality Analysis Kit

It was confirmed that the duty of water quality control belonged to the district. However as they did not have water quality analysis equipment, it was found that they could not implement the work. Therefore it is concluded that the procurement of the water quality analysis equipment is indispensable to execute their responsibility, and relevant. Furthermore, in order to secure the sustainable water quality control by the district, the operation training of the procured equipment will be conducted. The enhancement of capacity of the person in charge of the water quality control will be also conducted by using the output in the training of the water quality management implemented in the currently on-going the technical cooperation project funded by JICA.

The item of water quality measured by the water quality analysis equipment will be the same as the tools procured in the 1st stage of the project. The tools for the measurement of the water quality item are described as follows:

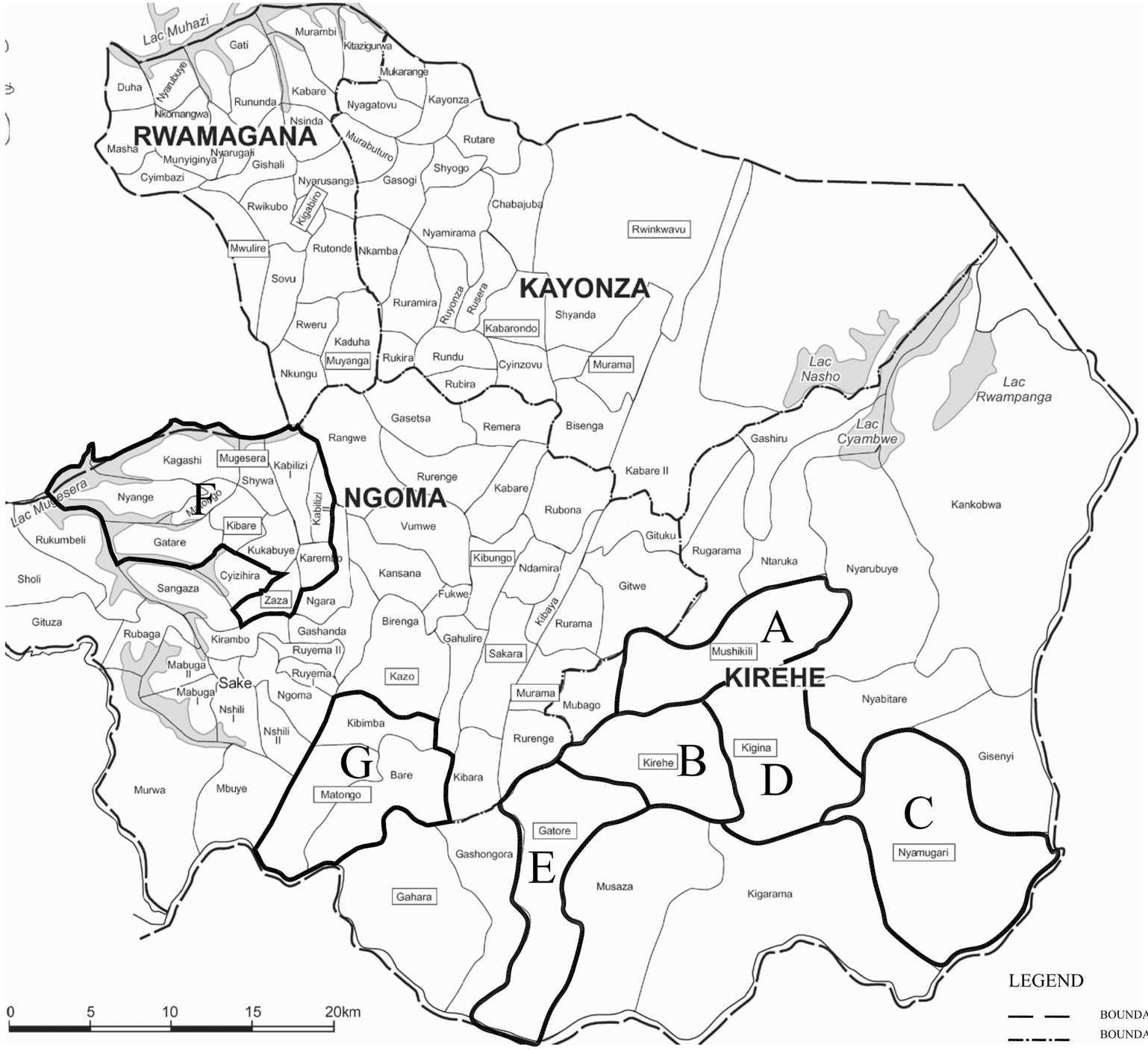
pH meter, Conductivity/TDS meter, Turbidity meter, Spectral photometer (Manganese, Iron, Nitrate, Nitrite, Fluoride, Ammonia, Sulphate, Potassium, Magnesium and Calcium), Chloride meter

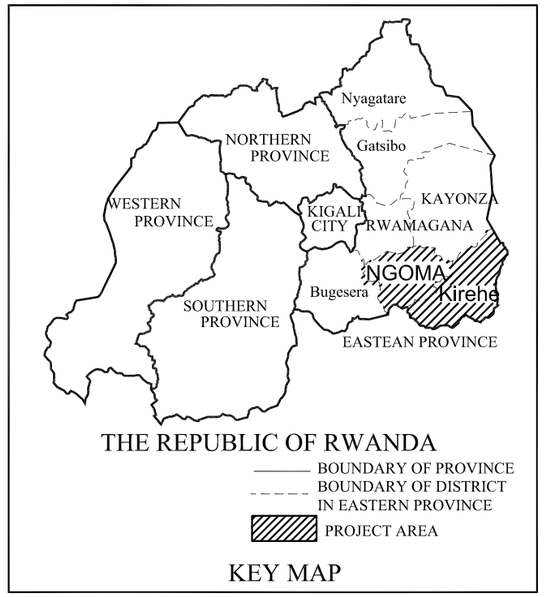
2-2-3 DESIGN DRAWINGS

Basic design drawings regarding the facilities planed to be constructed in this project are described as follows:

(1) General location map of sites（Figure 2-3）
(2) General layout map of each site（Figure 2-4 to Figure 2-10）
(3) Structure of Intake facility（Figure 2-11）
(4) Layout and cross section of Control house (Pump and Generator)（Figure 2-12）
(5) Layout and cross section of Distribution reservoir（Figure 2-13）
(6) Layout and cross section of Chlorination facility（Figure 2-14）
(7) Structure of Public tap stand（Figure 2-15）

PLATE No.





LOCATION OF PROJECT SITE		
SCHEME NAME	SECTOR	WATER SOURCE
PIPED WATER SUPPLY WITH MOTOR PUMP		
A. Mushikiri Scheme	Mushikiri	Nyakagongi
B. Kirehe Scheme	Kirehe	Muguruka , Gahama
D.Kigina Scheme	Kigina	Gasebura
E. Gatore Scheme	Gatore	Samuko-A
F.Karembo Zaza Mugesera Scheme	Karembo, Zaza, Mugesera	Rwartene , Kabashuko , Kabaromba
G.Kazo Mutendeli Scheme	Kazo, Mutendeli	Kogoma , Musenyi
PIPED WATER SUPPLY WITH GRAVITY FLOW		
C.Nyamugari Mahama Scheme	Nyamugari, Mahama	Mayizi , Cyanyiranyonza
HANDPUMP WATER SUPPLY SCHEME		
E. Gatore Scheme	Gatore	

LEGEND

BOUNDARY OF FORMER KIBUNGO PROVINCE

BOUNDARY OF DISTRICT

NAME OF SECTOR

DRAWING ISSUED FOR TENDER PURPOSES ONLY

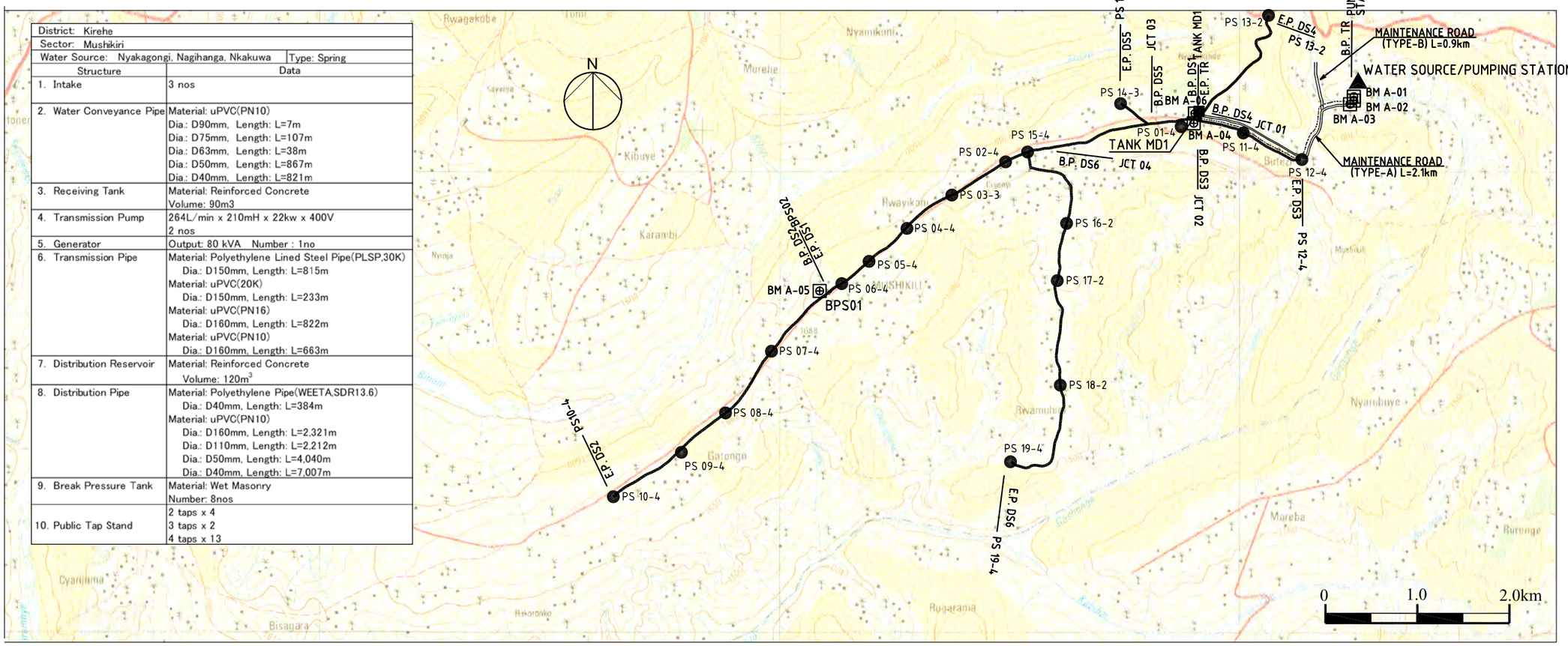
LOCATION MAP OF THE PROJECT

PROJECT NAME: IMPLEMENTATION REVIEW STUDY ON THE PROJECT FOR RURAL WATER SUPPLY				
CLIENT: MINISTRY OF INFRASTRUCTURE RWANDA		JAPAN INTERNATIOAL COOPERATION AGENCY		
TITLE: LOCATION MAP OF THE PROJECT				
DATE: March 2010	SCALE: N.T.S.	APPROVE	DESIGN	DRAWING NO.: GN_010

Figure 2-3 General Location Map of Sites

PLATE No.

District: Kirehe	
Sector: Mushikiri	
Water Source: Nyakagongi, Nagihanga, Nkakuwa	Type: Spring
Structure	Data
1. Intake	3 nos
2. Water Conveyance Pipe	Material: uPVC(PN10) Dia.: D90mm, Length: L=7m Dia.: D75mm, Length: L=107m Dia.: D63mm, Length: L=38m Dia.: D50mm, Length: L=867m Dia.: D40mm, Length: L=821m
3. Receiving Tank	Material: Reinforced Concrete Volume: 90m3
4. Transmission Pump	264L/min x 210mH x 22kw x 400V 2 nos
5. Generator	Output: 80 kVA Number : 1no
6. Transmission Pipe	Material: Polyethylene Lined Steel Pipe(PLSP,30K) Dia.: D150mm, Length: L=815m Material: uPVC(20K) Dia.: D150mm, Length: L=233m Material: uPVC(PN16) Dia.: D160mm, Length: L=822m Material: uPVC(PN10) Dia.: D160mm, Length: L=663m
7. Distribution Reservoir	Material: Reinforced Concrete Volume: 120m^3
8. Distribution Pipe	Material: Polyethylene Pipe(WEETA,SDR13.6) Dia.: D40mm, Length: L=384m Material: uPVC(PN10) Dia.: D160mm, Length: L=2,321m Dia.: D110mm, Length: L=2,212m Dia.: D50mm, Length: L=4,040m Dia.: D40mm, Length: L=7,007m
9. Break Pressure Tank	Material: Wet Masonry Number: 8nos
10. Public Tap Stand	2 taps x 4 3 taps x 2 4 taps x 13



LEGEND

- DISTRIBUTION PIPE
- TRANSMISSION PIPE
- WATER SOURCE/PUMP HOUSE
- PUBLIC STAND
- DISTRIBUTION TANK
- MAINTENANCE ROAD TO BE CONSTRUCTED BY THE CONTRACTOR
- BENCH MARK

DRAWING ISSUED FOR TENDER PURPOSES ONLY

Pipe Route; Mushikiri

PIPE LINE NAME	B.P.	E.P.	PIPE DIAMETER / LENGTH
WATER CONVEYANCE PIPE			
CO1	NYAGIHANGA W.S.	JCT02	DN40, L=821m
CO2	NYAKAGONGI W.S.	COLLECTION TANK	DN90, L=7m DN75, L=107m DN63, L=38m
CO3	NKAKUWA W.S.	JCT01	DN50, L=867m
TRANSMISSION PIPE			
TR	PUMPING STA.	TANK MD1	DN150-PLSP/30K, L=815m DN150-uPVC/20K, L=233m DN160-uPVC/PN16, L=822m DN160-uPVC/PN10, L=663m
DISTRIBUTION PIPE			
DS1	TANK MD1	BPT02	DN160 L=2,321m DN110 L=2,212m DN50 L=596m
DS2	BPT02	PS10-4	DN50 L=3,444m
DS3	JCT02	PS12-4	DN40 L=1,229m
DS4	JCT01	PS13-2	DN40 L=947m DN40-WEETA/SDR13.6, L=384m
DS5	JCT03	PS14-2	DN40 L=389m
DS6	JCT04	PS19-4	DN40 L=4,442m

(Pipe class is uPVC PN10 unless otherwise mentioned)

PUBLIC STAND

NO.	No.of TAPs	ZONE	EASTING (m)	NORTHING (m)	ELEVATION (mAMSL)
1	4	36M	245900	9760161	1772
2	4	36M	243849	9759697	1716
3	3	36M	243264	9759336	1715
4	4	36M	242799	9759012	1715
5	4	36M	242559	9758762	1725
6	4	36M	241995	9758334	1719
7	4	36M	241303	9757637	1674
8	4	36M	240930	9757077	1663
9	4	36M	240539	9756767	1660
10	4	36M	239583	9756054	1655
11	4	36M	246433	9760012	1735
12	4	36M	247070	9759720	1671
13	2	36M	246749	9761248	1692
14	3	36M	245099	9760330	1738
15	4	36M	244092	9759803	1715
16	2	36M	244512	9759028	1651
17	2	36M	244411	9758405	1607
18	2	36M	244442	9757286	1545
19	4	36M	243907	9756435	1521

Note: Coordinates are indicating the points of branch on main pipe.

BENCH MARK

NO.	ZONE	EASTING (m)	NORTHING (m)	ELEVATION (m Mushikiri)
BM A-01	36M	247635.70	9760405.98	1575.37
BM A-02	36M	247636.43	9760363.35	1576.20
BM A-03	36M	247594.56	9760323.16	1586.59
BM A-04	36M	245942.52	9760168.47	1775.47
BM A-05	36M	241919.70	9758292.10	1716.40
BM A-06	36M	246094.19	9760375.45	1780.37

Note: Ellipsoid: WGS1984

PROJECT NAME: IMPLEMENTATION REVIEW STUDY ON THE PROJECT FOR RURAL WATER SUPPLY				
CLIENT: MINISTRY OF INFRASTRUCTURE RWANDA		JAPAN INTERNATIOAL COOPERATION AGENCY		
TITLE: MUSHIKIRI WATER SUPPLY SCHEME GENERAL PLAN OF MUSHIKIRI SCHEME				
DATE: March 2010	SCALE: 1:50000	APPROVE	DESIGN	DRAWING NO.: MS_GN_010

Figure 2-4 General Layout Map of Mushikiri Site