MINISTRY OF HEALTH, LABOR AND WELFARE

PROJECT TO PROVIDE PLANNING GUIDANCE FOR THE WATER SUPPLY PROJECT (PHASE-1)

PROJECT FOR IMPROVEMENT OF WATER SUPPLY SYSTEM IN MURANG'A, THE REPUBLIC OF KENYA

FINAL REPORT

JANUARY 2024

NJS CO., LTD.

PROJECT TO PROVIDE PLANNING GUIDANCE FOR
THE WATER SUPPLY PROJECT (PHASE 1)

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EXECUTIVE SUMMARY

BASIC INDICATORS

LOCATION MAP

PHOTOS

ABBREVIATIONS

Contents

List of Appendices

List of Figures and Tables

EXECUTIVE SUMMARY

1. Background of the Project

The Republic of Kenya (hereinafter referred to as “Kenya”) is located just below the equator in East Africa, sharing borders with Ethiopia to the north, South Sudan to the northwest, Uganda and Lake Victoria to the west, Tanzania to the south, and Somalia to the east. Keyna faces the Indian Ocean to the southeast. With a population of approximately 54 million people (World Bank, 2022), the country has a land area of about 580,000 km^2 (about 1.5 times that of Japan). Roughly 80% of the land consists of arid and semi-arid regions. The capital city, Nairobi, is renowned as one of the leading global cities in Africa, hosting the headquarters of numerous international organizations and representative offices for Africa.

The water supply sector is faced with increasing demand for water, driven by growing populations and economic and social development. Particularly in urban areas, the expansion of water supply services has not kept pace with the growing water demand, and as a result, the water supply rate remained low at 60% in the 2020/21 fiscal year. To address this water supply shortage, the Kenyan government has set goals linked to Goal 6 of the Sustainable Development Goals (SDGs) in its "National Development Plan (Kenya Vision 2030)". The goals include "universal access to safe water and adequate sanitation for all by 2030”, and “reduction of the NRW rate from 45% (in the 2020/21 fiscal year) to 25%”.

The project focuses on Murang’a City and its surrounding areas. Murang’a City is the central city in Murang'a County, one of the five counties in the former Central Province of Kenya. Murang'a County is located approximately 100 km northeast of Nairobi, bordering Nyeri, Kiambu, Nyandarua, Kirinyaga, Embu, and Machakos counties. The water supply operations in Murang’a City and its environs are currently managed by the Murang'a Water and Sanitation Company (MUWASCO). However, the business environment has undergone significant changes in recent years, and there is a growing demand for adapting to the current and future increases in water needs. The main factors driving the increase in water demand are as follows:

1) The Central City of Murang'a County
   Murang’a City is where major administrative institutions are concentrated. With the recent expansion of the Murang'a University, there has been an increase in the number of accommodation facilities, which has led to a rapid increase in the demand for infrastructure, including water supply.
2) Suburbanization of Nairobi
   Its proximity to Nairobi and the improvement of the Kenol-Makutano-Marua Highway that crosses the county have made commuting to Nairobi more convenient, resulting in population growth as a commuter town. Rapid urbanization in Nairobi has led to housing supply challenges in many areas, including shortages of residential land and escalating construction material costs. As a result, there is a trend, particularly among young families, to relocate to the outskirts.
3) Rural to Urban Migration
   The population is growing faster than the average growth rate within the county due to migration from rural areas to urban centers. Consequently, existing facilities are strained, resulting in instances like

water supply restrictions in areas previously receiving 24-hour water supply. These areas include the center of Murang'a City, Kiharu, Kabuta, and parts of Gaturi. This trend is anticipated to worsen over the next few years as Kenya approaches the goal of "universal safe water supply" outlined in the Kenya Vision 2030. The 2019 census projected that urban populations, constituting 31.2% of Kenya's total, would increase to 66% by 2050.

4) Expansion of the Water Supply Area

The Murang'a County government has announced new urban boundaries that will increase the area of Murang'a City from 145 km^2 to 330 km^2, and are expected to be implemented in the coming years. The newly added areas include regions with a water supply rate of less than 50%, indicating potential water demand. MUWASCO plans to expand the water supply areas alongside the city boundary expansion. Initiatives have already begun to extend some distribution networks, with plans to cover the entire 330 km^2 area with a comprehensive pipeline network within the next decade.

Due to the reasons mentioned above, MUWASCO's existing facilities do not possess sufficient capacity to meet the rapidly increasing water demand in recent years.

Based on the above background, this project involves conducting a survey in Murang'a City and its surrounding areas. The focus of the survey is to assess the current status of water supply facilities and the necessity for the development of water supply facilities. The survey team also provided a guidance on the planning of the "The Project for Improvement of Water Supply System in Murang'a".

2. Current Situation of Water Supply in the Project Area

Water supply in Murang'a City and its surrounding areas has been managed by MUWASCO since its establishment in 2006. Table S-1 presents the key performance indicators for MUWASCO's water supply from 2018 to 2022. The current total area of MUWASCO's water supply area is approximately 145 km^2, serving a population of about 78,000 with a water supply coverage rate of 97%. According to information obtained through interviews with MUWASCO, the estimated water demand in the current water supply area is 15,000 m^3/day, while the actual supply volume remains at a maximum of 10,000 m^3/day. Despite this, the actual hour of supply is reported to be 22-24 hours. The non-revenue water (NRW) rate stands at 24% as of 2022, which compares favorably to the national average of 44% in Kenya.

MUWASCO has maintained a positive business performance over the recent five fiscal years (2018-2022), operating with a surplus. The business income has been sufficient to cover expenses such as sales costs and depreciation. However, the surplus funds are deemed insufficient, and undertaking large-scale facility development projects with self-funding is not feasible.

Table S-1 Key Performance Indicators for MUWASCO's Water Supply (FY 2018–2022)

Indicators	Unit	2018	2019	2020	2021	2022
Total population in service area	Person	87,023	89,252	78,787	79,209	80,168
Total population served	Person	78,365	81,629	73,247	75,209	77,856
Total water produced*	1,000 m^3/year	2,420	2,423	2,450	2,757*	3,039*
Domestic + kiosk billed volume	1,000 m^3/year	1,074	1,033	1,165	1,313	1,254
Total billed volume	1,000 m^3/year	1,798	1,813	1,845	2,068	2,310
Production per capita	L/capita/day	85	81	92	99	107
Consumption per capita	L/capita/day	38	35	44	47	44
Total number of staff	Person	94	121	121	120	124
DWQ	%	93	93	93	93	100
Non-revenue water (NRW)	%	26	25	25	25	24
Water coverage	%	90	91	93	95	97
Hours of supply	Hour/day	24	24	22	22	23
Staff productivity (no. of staff / 1,000 connections)	Person/1,000 connections	5	7	6	6	5
Revenue collection efficiency	%	100	92	91	95	92
O&M cost coverage	%	121	110	123	104	107

*The total water produced in 2021 and 2022 was inaccurately stated, so the figures were back-calculated from the NRW rate (%).

Source: WASREB Impact Report 11～15

Currently, MUWASCO supplies water to the region shown in **Figure S-1** from two water treatment plants (WTPs), Kiawambeu WTP and Kayahwe WTP, located on the outskirts of Murang'a. The topography is characterized by higher elevation on the west side and lower elevation on the east side, and the water supply system operates by gravity flow from the water source to distribution.

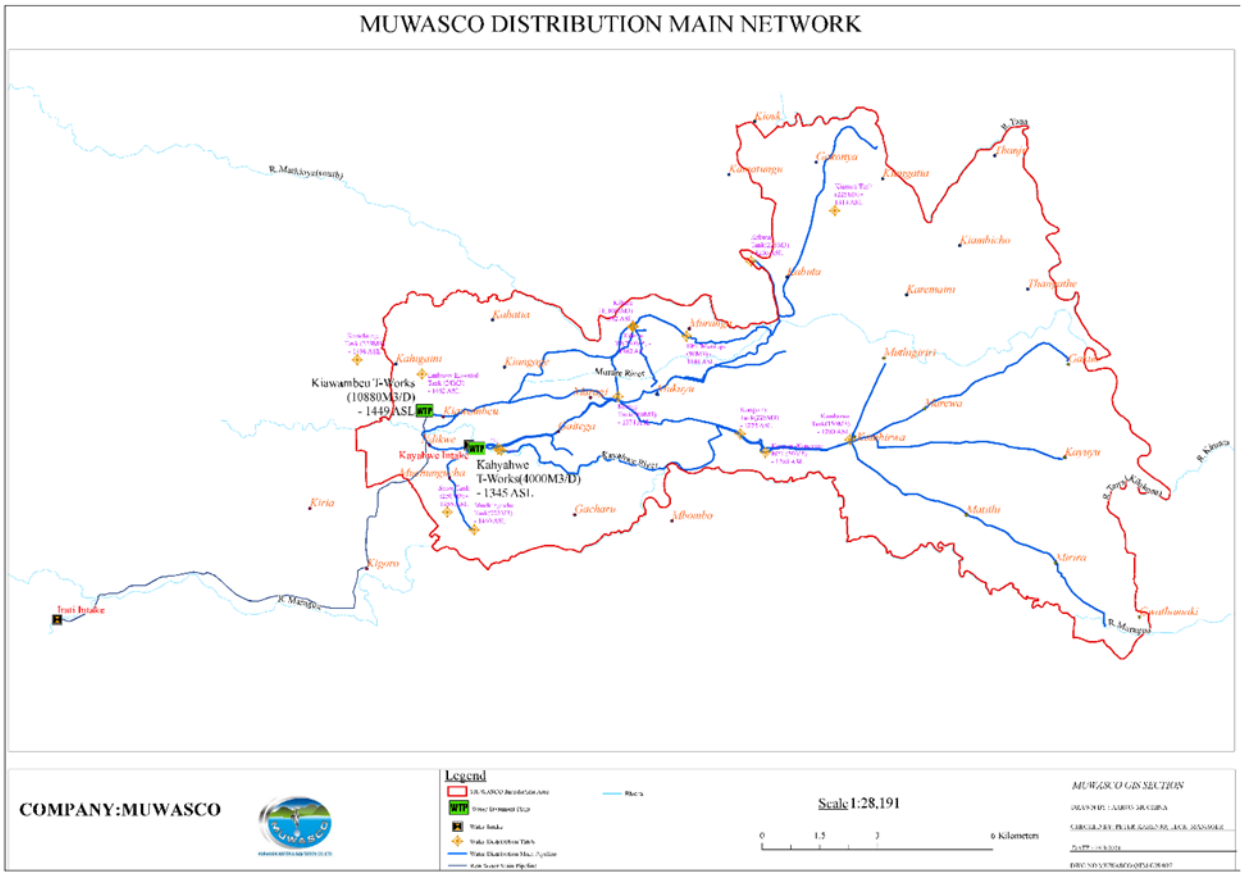


Figure S-1 Map of MUWASCO's Water Supply Area and Location of Water Facilities

Source: MUWASCO

The Kiawambeu WTP, MUWASCO's main treatment facility, was constructed in 2014 with financial assistance from the African Development Bank. It has a treatment capacity of 15,000 m^3/day and uses coagulation, sedimentation, and rapid filtration processes. Raw water is extracted from Irati River by intake weir and conveyed to the WTP. After the treatment process, the treated water is distributed and stored in the Kiharu Reservoir (1,350 m^3) and the Maragi Reservoir (500 m^3), from where it is distributed by gravity flow. The Kayahwe WTP, built in the 1970s, has a treatment capacity of 4,000 m^3/day and utilizes coagulation, sedimentation, and rapid filtration processes. It extracts water from the Kayahwe River, with intake weir located 135 m from the WTP. Following treatment, the treated water is distributed by gravity flow to southeastern areas such as Kambirwa and Mirira.

Table S-2 shows the relationship between the treatment capacity, accounting for water treatment losses, and the actual production volume for these WTPs. The total capacity of these two WTPs is 18,000 m^3/day, with 14,200 m^3/day for the Kiawambeu WTP and 3,800 m^3/day for the Kayahwe WTP. However, the actual production volume remains at 10,000 m^3/day (8,000 m^3/day from the Kiawambeu WTP and 2,000 m^3/day from the Kayahwe WTP), indicating that only around half of the facility capacity is being utilized.

Table S-2 MUWASCO's Water Treatment Plants

WTP Name	Water Source	Const. year	Capacity (*)	Water Production	Status
Kiawambeu WTP	Irati River	2014	14,200 m^3/day	8,000 m^3/day	In operation
Kayahwe WTP	Kayahwe River	1970s	3,800 m^3/day	2,000 m^3/day	In operation
Kiharu WTP	Mathioya River	1950s	750 m^3/day	-	Not in Operation

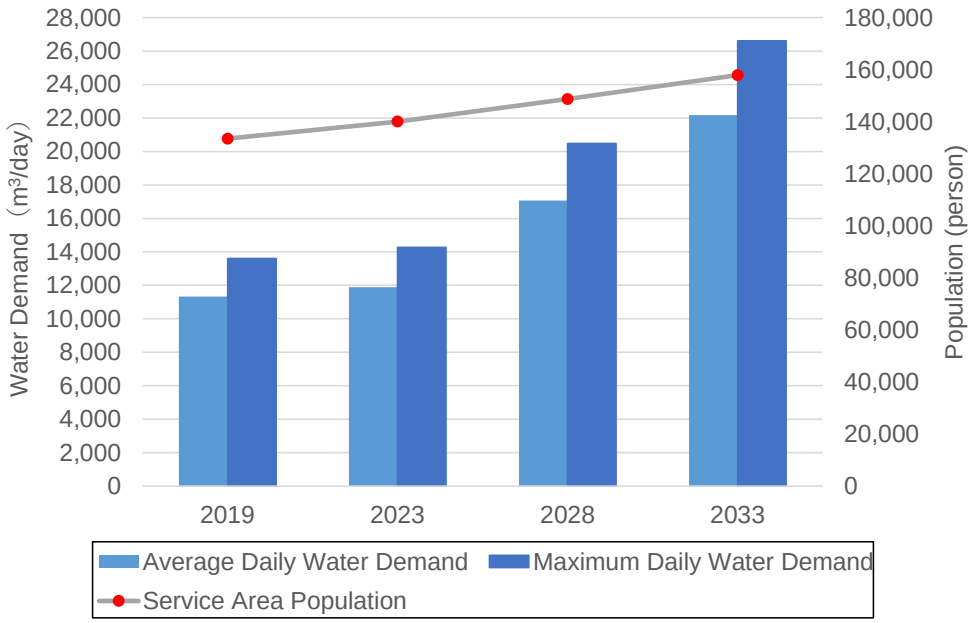
※ The treatment capacity was calculated as the maximum daily distribution capacity, accounting for water treatment losses (approximately 5%).

Kiawambeu WTP: Treatment capacity of 15,000 m^3/day × (1 - 5%) ≒ 14,200 m^3/day

Kayahwe WTP: Treatment capacity of 4,000 m^3/day × (1 - 5%) ≒ 3,800 m^3/day

Source: Based on information provided by MUWASCO and field survey results

As mentioned above, the external environment surrounding MUWASCO's water supply business has undergone significant changes in recent years. Faced with a continuously growing water demand, there is an urgent need to enhance the water supply capacity. The future water demand in Murang'a City and its surrounding areas is shown in **Figure S-2**. Based on the estimated results, the water demand by the year 2033 is projected to be an average of 22,200 m^3/day and a maximum of 26,600 m^3/day. Without capacity enhancement through facility development, in addition to the full operation of the existing WTPs, it will be impossible to meet the water demand at these levels.



※ The above case pertains to the future scenario in the event of expanding the water supply area.

Figure S-2 The Future Water Demand in Murang'a City and its Surrounding Areas

Source: Survey team

3. Current Water Supply Issues

(1) National Level

The main issues facing the water supply sector in Kenya are shown in below.

a) Insufficient budget for development of water supply project;
Water supply utilities alone cannot implement water supply projects for water facility development, and they often rely on financial assistance from county governments and international donors.

b) Unable to maintain financial independence;
The high non-revenue water rates and low tariff collection rates have led to a deteriorating financial situation, making it difficult to maintain a financial independence.

c) Water supply does not meet the demand;
The rapid urbanization in recent years has led to significant population growth, along with a corresponding increase in water demand, and the water supply is not keeping pace.

d) Insufficient data and information management regarding water quality and asset management;
The Ministry of Water, Sanitation, and Irrigation has identified the following issues:
- Insufficient water quality data for planning and decision-making.
- Lack of continuity in water quality surveys.
- Inadequate documentation of available information.

e) Inadequate technical expertise compared to the target level of operation and maintenance (O&M);
A high level of technical expertise is required in maintenance, addressing issues such as high NRW rates, database creation for water quantity and quality data, and data analysis and management using computers.

(2) Project Area

The relationship between the issues in the water supply in Murang'a City and its surrounding areas and the proposed project is shown in **Table S-3**.

Table S-3 Relationship between Issues (at Project Level) and the Proposed Project

Issue	Project
Low operation rate of existing WTPs	The following implementations aim to increase raw water inflow to the WTPs and improve the operation rate of the existing WTPs. ・Improvement of intake facilities ・Construction of additional raw water transmission pipelines
Insufficient water supply capacity for potential water demand	By improving the operation rate of the existing WTPs, enhancing the WTP's capacity, and expanding the distribution system, the water supply capacity will be strengthened.
Lack of budget for facility development	Through the proposed project, implementing facility development with Japan's Grant Aid will significantly improve revenue, eventually enabling future facility development through self-funding.
Sustainable use of drinking water sources	Implementing water supply facility development, considering adjustments between beneficiaries and sustainable use of drinking water sources.
Inadequate O&M management	Providing technical support for facility O&M, water quantity and quality management through soft components, aiming to enhance the O&M capacity of the water supply facilities.

Source: Survey Team

4. Outline of the Project

(1) Goal of the Project

This project aims to enhance the water supply system of MUWASCO, which serves Murang'a City and its surrounding areas in Kenya, to meet the continuously increasing water demand in the region. It contributes to the stable supply of safe and reliable water to the residents. **Table S-4** provides the basic conditions for planning the project.

Table S-4 Basic Conditions for Project Planning

Target Year	2033
Planned served population	158,000
Daily maximum water distribution amount	23,000 m^3/day

Source: Survey Team

(2) Outline of the Project

This project has the primary objective of increasing water production by improving the operation rate and enhancing the treatment capacity of the Kiawambeu WTP. In order to achieve this goal, the project plans to increase water intake from the Irati River (increasing the raw water inflow to the plant) and to strengthen the distribution capacity to handle the increased water volume. In addition, the project includes the installation of a micro-hydropower generator to reduce O&M costs. It also plans to provide the necessary equipment for O&M, along with soft components for the O&M of water supply facilities, water quantity and quality management.

The outline of the project is presented in **Table S-5**, the overall improvement plan of water supply system is depicted in **Figure S-3**, and the schematic diagram of system flow after improvement is shown in **Figure S-4**.

Table S-5 The Outline of the Project

Category	Project plan
Construction Works	Improvement of intake facilities: Q = 10,500 m^3/day
	Construction of raw water pipeline: L=15 km, φ500mm, HDPE
	Expansion of water treatment plant: Q = 5,000 m^3/day
	Installation of micro-hydropower generation system: 1 set, 30 kW
	Construction of transmission pipeline: L=5.5 km, φ250mm, HDPE
	Expansion of distribution reservoirs: 2 reservoirs (1,000m^3, 2,000m^3)
	Installation of electromagnetic flow meters: 4 locations (2 in raw water pipelines, 2 in transmission pipelines)
Equipment procurement	Water quality testing equipment: 1 set
Soft components	Training on O&M of water supply facilities
	Training on water quantity and quality management

Source: Survey Team

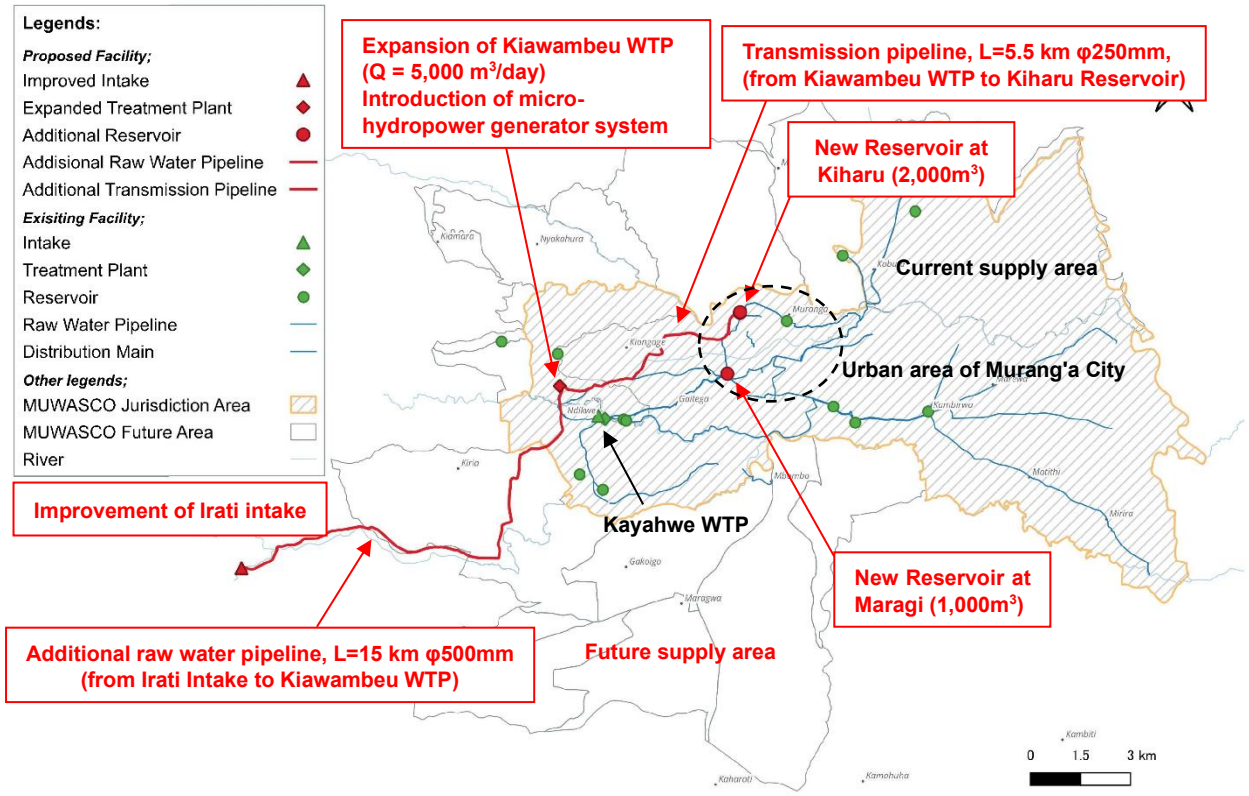


Figure S-3 Overall Improvement Plan for Water Supply System

Source: Survey Team

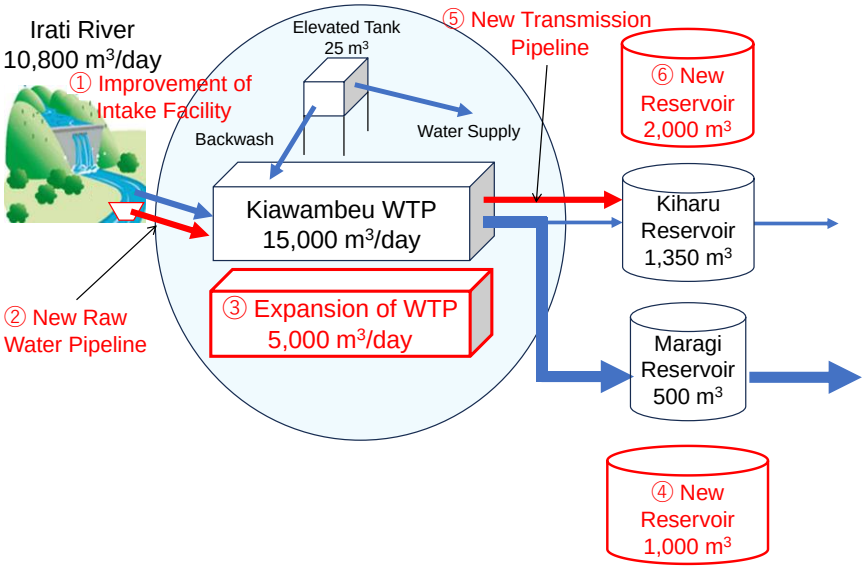


Figure S-4 Schematic Diagram of the Water Supply System Flow after Improvement (Red Text: Planned Components in the Project)

Source: Survey team

5. Conclusion

Murang'a City, where MUWASCO is responsible for water supply, serves as the administrative center of Murang'a County. The area has undergone significant changes, including the expansion of Murang'a University, suburbanization of Nairobi, rural to urban migration, and the expansion of the water supply area due to changes in the boundaries of Murang'a City and the area has a high potential for future water demand. On the other hand, MUWASCO's existing water supply facilities face various challenges, with low operational rates and insufficient facility capacity to meet future water demand. In certain areas of Murang'a City, there have been instances that water supply restrictions in areas previously receiving 24-hour water supply.

Considering the current status of water supply in the target area, the urgency of improving water supply facilities, and our country's aid policy towards Kenya, the project aims to provide a stable and reliable supply of safe water to meet the future water needs of Murang'a City and its surrounding areas by improving the operation rate of the existing WTPs, increasing water production through facility expansion, and strengthening the water supply function by improving the distribution system. This, in turn, is expected to contribute to the improvement of the residents' living environment and fostering regional economic development. In addition, the introduction of micro-hydropower generation system aims to utilize renewable energy, covering a significant portion of the power consumption in the water treatment plant. This plan is expected to serve as a high-quality infrastructure development exemplar contributing to climate change mitigation by reducing greenhouse gas emissions. Therefore, considering these aspects, this project is deemed highly significant as it contributes to addressing issues in target area and promoting climate change mitigation efforts simultaneously.

BASIC INDICATORS

Table-1 Key Economic Indicators in the Republic of Kenya

Year	2020	1990
Population	5.377 million	2.340 million
GNI per Capita	US$ 1,760	US$ 380
Economic Growth Rate	-0.30%	4.20%
External Debt Balance	US$ 38.194 billion	US$ 7.055 billion
DAC Category	Lower Middle-Income Countries	Lower Income Countries
World Bank Category	ii/Lower Middle-Income Countries/HIPC	Lower Income Countries/HIPC

Source: Ministry of Foreign Affairs Country Data Book 2021, 2005

Table-2 Millennium Development Indicators in Kenya

Millennium Development Indicators	Latest	Past
Goal 1: Proportion of population below $1.25 (PPP) per day	46.8% (2011)	38.4% (1992)
Goal 2: Net enrolment ratio in primary education	79.7% (2015)	62.9% (1990)
Goal 3: Ratios of girls to boys in primary, secondary and tertiary education (Boy: 1.0)	0.93 (2015)	0.97 (1990)
Goal 4: Under-five mortality rate (per 1000 live births)	92.0 (2013)	98.7 (1990)
Goal 5: Maternal mortality rate (per 100 000 live births)	510 (2013)	490 (1990)
Goal 6: HIV prevalence among population aged 15-24 years	0.29% (2013)	0.70% (2001)
Goal 7: Proportion of population using an improved drinking water source (%)	63.2% (2015)	42.8% (1990)

Source: United Nations Statistics Division, MDGs Database

Table-3 Infant, Under-five, Maternal Mortality and Life Expectancy

Category	1990	2000	2010	2015
Infant mortality rate per 1,000 live births	65	-	-	32
Under-five mortality rate per 1,000 live births	101	99	-	43
Maternal mortality rate per 100,000 live births	-	-	-	342 (2017)
Life expectancy at birth (years)	-	51	-	67 (2020)

Source: The State of the World's Children, 2021, UNICEF

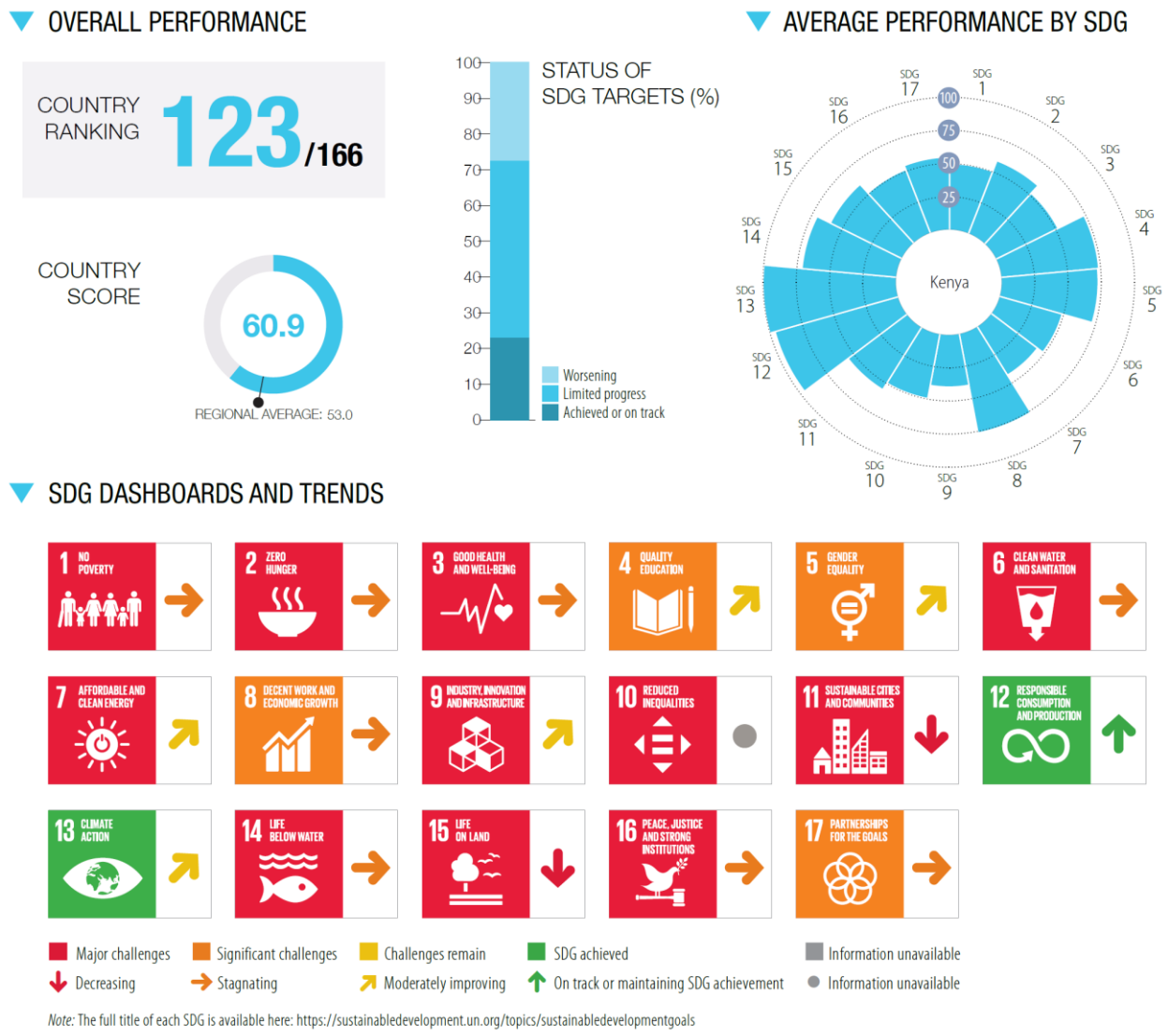
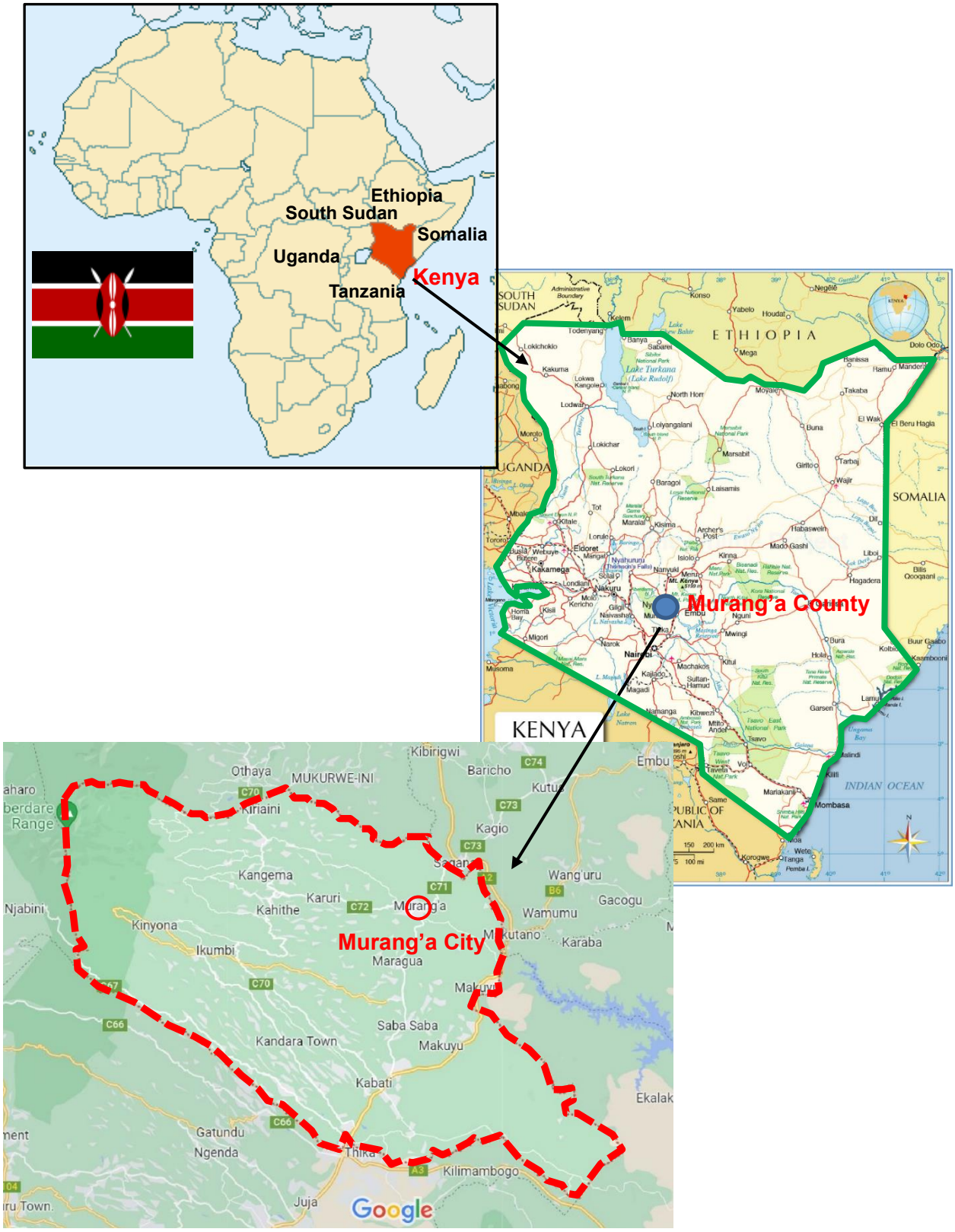


Figure-1 Progress on Sustainable Development Goals (SDGs) in Kenya

Source: Sustainable Development Report (https://dashboards.sdgindex.org/static/profiles/pdfs/SDR-2023-kenya.pdf)

LOCATION MAP



Source: Survey Team

PHOTOS

Photo 1: Murang'a Water and Sanitation Company (MUWASCO)
Since its establishment in 2006, MUWASCO has been responsible for the water supply services in Murang'a City and its surrounding areas.

Photo 2: Meeting with MUWASCO
An exchange of opinions on the proposed project was conducted with MUWASCO's staff. The dedicated efforts of technical staff members were observed during the survey.

Photo 3: Meeting with Murang'a County Government
Accompanied by MUWASCO, the overview of the proposed project was explained, followed by an exchange of opinions.

Photo 4: Water Intake Weir (Irati River)
From the weir, 7,000 to 8,000 m^3/day of raw water is withdrawn and transmitted to MUWASCO's main WTP, Kiawambeu WTP.

Photo 5: Kiawambeu Water Treatment Plant (WTP)
MUWASCO's main WTP with coagulation, sedimentation, and rapid filtration. Its treatment capacity is 15,000 m^3/day. However, the current water production remains at a maximum of 8,000 m^3/day.

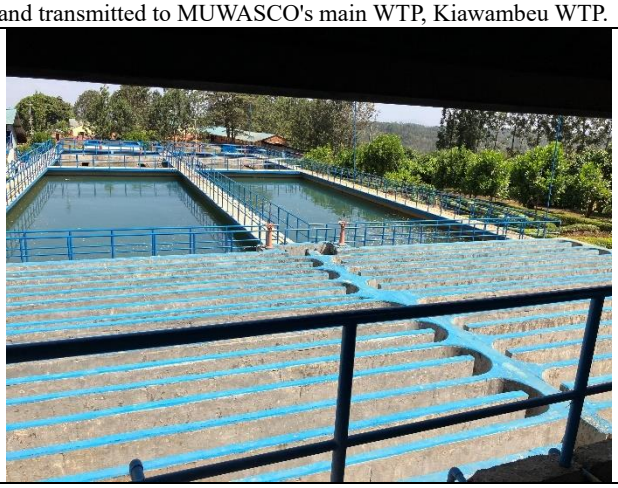


Photo 6: Flocculator and Clarifier (Kiawambeu WTP)
Rapid mixing is performed by gravity hydraulic jump, and then slow mixing is done in a horizontal flow flocculator with baffles. The clarifier adopts a horizontal flow chemical sedimentation basin.

Photo 7: Rapid Sand Filter (Kiawambeu WTP)
Backwashing of the rapid sand filter is performed with water from the elevated tank once a day. The backwash waste is discharged outside through sludge drying beds.

Photo 8: Clear Water Reservoir (Kiawambeu WTP)
The capacity is 2,000 m^3, and it operates as both a clear water reservoir and a distribution reservoir. It is the largest reservoir owned by MUWASCO for distribution purposes.

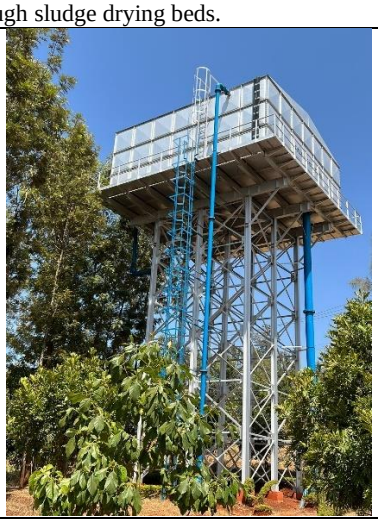


Photo 9: Elevated Water Tank (Kiawambeu WTP)
This elevated water tank, with a capacity of 250 m^3, is utilized not only for backwashing the rapid sand filter but also for distributing water to high-elevation areas.

Photo 10: Pump Room (Kiawambeu WTP)
Pump facilities for lifting treated water to the elevated water tank. The equipment was renewed in 2022.

Photo 11: Management Office and Laboratory
The WTP is operated and managed by two teams, each consisting of two people. Water quality is monitored by measuring turbidity, pH, and residual chlorine concentration taken every two hours.

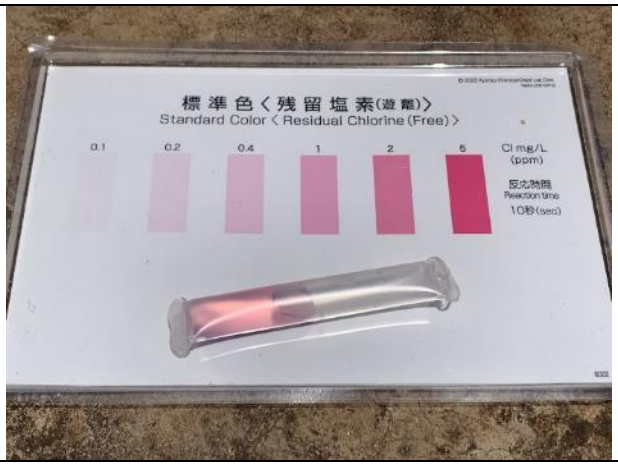


Photo 12: PACKTEST Results (Kiawambeu WTP)
The results of the PACKTEST conducted on the treated water taken from the clear water reservoir showed a residual chlorine level of approximately 0.4 mg/L, confirming that post-chlorination is being appropriately performed.

Photo 13: Intake Facility (Kayahwe River)
An intake of up to 5,000 m^3/day is transmitted from the Kayahwe River to the Kayahwe WTP. During the rainy season, the raw water becomes highly turbid, posing a challenge for the water treatment.

Photo 14: Kayahwe Water Treatment Plant (WTP)
Constructed in the 1970s, the Kayahwe WTP has a capacity of 4,000 m^3/day with coagulation-sedimentation and rapid filtration. The structures show no significant deterioration, and treatment is being appropriately carried out.

Photo 15: Maragi Reservoir
The Maragi Reservoir, with a capacity of 500m^3, receives treated water from the Kiawambeu WTP. While it is typically operated with a high-water level, there are days with significant water level fluctuations, leading to operations at low-water levels throughout the day. This situation indicates a shortage of reservoir capacity.

Photo 16: Kiharu Reservoir
The Kiharu Reservoir receives treated water from the Kiawambeu WTP. On the site, there are two distribution reservoirs with capacities of 1,100m^3 and 250m^3, respectively. The Kiharu WTP on the premises has not been in operation.

Photo 17: Kiharu WTP
The Kiharu WTP has not been operational following the commencement of the Kiawambeu WTP in 2014.

Photo 18: Bottled Water Manufacturing Company
MUWASCO is also engaged in the bottled water manufacturing business, contributing to the company's profits.

ABBREVIATIONS

AfCFTA	African Continental Free Trade Area
AfDB	African Development Bank
AWWDA	Athi Waterworks Development Agency
COVID-19	CoronaVirus Infectious Disease, emerged in 2019
EIA	Environmental Impact Assessment
EMCA	Environmental Management and Coordination Act
GDP	Gross Domestic Product
IMF	International Monetary Fund
IWRM	Integrated Water Resources Management
JICA	Japan International Cooperation Agency
KeRRA	Kenya Rural Roads Authority
KfW	Kreditanstalt für Wiederaufbau
KNHA	Kenya National Highways Authority
KPI	Key Performance Indicator
KURA	Kenya Urban Roads Authority
MD	Managing Director
MDGs	Millennium Development Goals
MoR&T	Ministry of Roads and Transport
MUSWASCO	Murang'a South Water and Sanitation Company
MUWASCO	Murang'a Water and Sanitation Company
MWS	Ministry of Water and Sanitation
MWSI	Ministry of Water, Sanitation and Irrigation
NEC	National Environmental Council
NEMA	National Environmental Management Authority
NEPAD	New Partnership for Africa's Development
NGO	Non-Government Organization
NRW	Non-Revenue Water
O&M	Operation and Maintenance
ODA	Official Development Assistance
SDGs	Sustainable Development Goals
SPA	Services Provision Agreement
TICAD	Tokyo International Conference on African Development
TWWDA	Tana Waterworks Development Agency
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
WASREB	Water Services Regulatory Board

WHO	World Health Organization
WRA	Water Resource Authority
WSB	Water Service Board
WSP	Water Service Providers
WSTF	Water Sector Trust Fund
WWDA	Water Works Development Agencies

Chapter 1

Introduction

Chapter 1 Introduction

1.1 Purpose of the Survey

1.1.1 Background

One of the Millennium Development Goals (MDGs) adopted in 2000 was to "reduce by half the proportion of people without access to safe drinking water compared to 1990 levels by 2015." This goal was achieved in 2010, and many people gained access to safe drinking water. However, access to safe drinking water and water supply services depends on the region, income level and other factors, and according to UNICEF, as of 2020, two (2) billion people worldwide do not have access to safe, controlled drinking water, among whom 490 million people (7% of the world's population) rely on untreated water from wells, lakes, rivers and irrigation canals that may be contaminated by external pollutants.

In contrast, Japan is working to achieve Goal 6 of the "Sustainable Development Goals (SDGs)", which were adopted in 2015: "By 2030, ensure access to and sustainable management of water and sanitation for all people." To achieve this goal, Japan has been continuously supporting developing countries by constructing water supply facilities through ODA-funded cooperation and dispatching water supply experts through technical cooperation projects, making use of the experience and knowledge gained through the successful expansion of water supply services in domestic projects.

Japan's water supply system has expanded rapidly throughout the country since 1952 and now has achieved the water supply coverage rate of 98.1% (Basic Statistics on Water Supply 2019, Ministry of Health, Labor and Welfare), and has formed a world-leading water supply system with low leakage rates and earthquake preparedness. In the process of its service expansion, Japan overcame many challenges such as the deterioration of water quality, lack of water sources and high non-revenue water rates (NRW) due to rapid economic and population growth, and contributed significantly to the reduction of waterborne diseases such as cholera and typhoid, and it is recognized that water supply is also important in the fight against infectious diseases. During the global outbreak of the coronavirus infection (COVID-19) since 2019, although washing hands with soap and clean water was recommended at the time of the pandemic as a general infection control measure based on the official announcement of WHO, it is estimated that approximately 30% or 2.3 billion people of the world's population were unable to perform basic hygiene behavior.

In addition, in recent years, the effects of climate change, such as the increase in average temperatures potentially caused by the global warming, rising sea water temperatures and levels, have led to more severe and frequent weather disasters such as heavy rainfall, floods and droughts, which have already brought an impact on water supply systems worldwide in terms of both water quantity and quality. As water supply systems are a basic core infrastructure and lifelines for human life, the disruption of water services due to the weather-related disasters will cause extensive damage to the lives of people and business activities in different regions / areas of the world. WHO, therefore, has called on countries to develop water security plans that take into account the effects of climate change and seek to build resilience to its impacts.

Global environmental problems are becoming increasing important to address on a global scale, and their

growing seriousness may also cause a major impact on waterworks which use water as a recyclable resource. For this reason, many countries, including Japan, have announced their aim to create 'carbon neutral' society that reduces GHGs (Greenhouse Gas) emission to zero by 2050, and the water supply sector is also required to take different measures for environmental conservation to build a low-carbon and recycling-oriented society.

In view of the need to support developing countries in achieving the SDGs and in overcoming climate change and infectious diseases, which most developing countries are facing, support for these countries is expected to come from the experience of Japan's water supply business and the utilization of Japanese technology. Under these circumstances, utilizing Japan's advanced technology and knowledge to support to the water supply sector in the above-mentioned countries is an important responsibility as a member of the international community, and also to encourage Japanese companies, local governments and other water utilities to expand their overseas business activities.

Japan's ODA is in principle implemented based on the requests from developing countries. However, most of the water supply project plans are immature in their content when the recipient countries requests assistance from the Japanese Government, which has become an obstacle to the formation of promising water supply projects. Therefore, surveys are needed to examine specific problem-solving measures in collaboration with water supply administrators and water utility staff in developing countries as a matter of practice to improve the capacity of central and local governments in these countries to prepare water supply project plans, formulate water supply policies and operate water supply services.

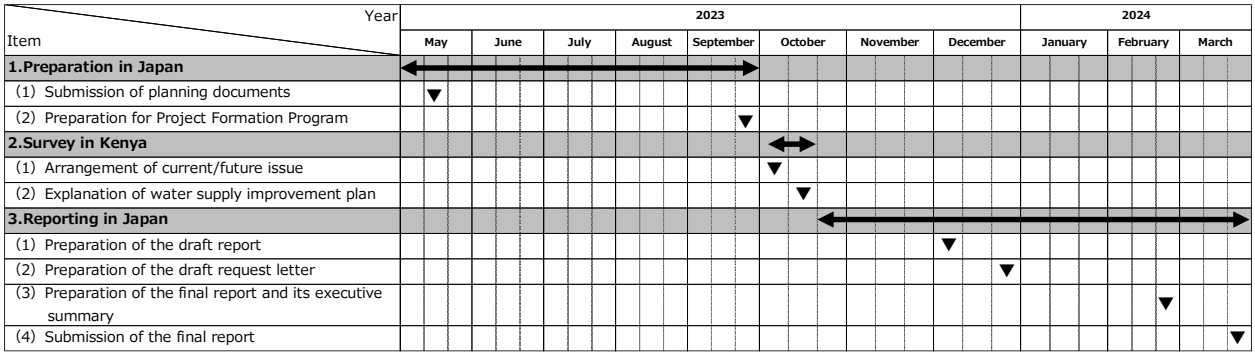
1.1.2 Purpose

The purpose of the survey is to provide advice and guidance that contributes to the preparation of plans for solving problems from a professional and technical perspective, based on the information on specific issues (facility development, operation and maintenance, human resources development, etc.) and potential needs in the water supply sector in developing countries that are independently identified by Japanese companies, local governments and other Japanese water supply utilities. The implementation of such advice and guidance under a public-private partnership will aim to improve the planning capacity of the recipient country and promote the formation of more promising and mature projects that can fully utilize Japan's knowledge and experience.

1.2 Schedule and Contents of the Survey

The schedule and contents of the survey are shown in Table 1-1 and Table 1-2, respectively. The duration of the work is approximately 11 months, and the deadlines for submitting reports are as indicated in Table 1-1.

Table 1-1 Survey Schedule



Source: Survey Team

Table 1-2 Contents of the Survey

Date / Month	Task	Contents
Mid-May, 2023	Preparation of Implementation Plan	• Purpose of the project • Basic policy of the project • Contents of the survey works • Work plan
June to September, 2023	Preparation of Implementation of Guidance on Water Supply Project Planning	• Collection and analysis of data and information • Preparation and submission of questionnaires • Review on the master plan • Organizing the current and future problems and issues • Preparation of the draft report • Schedule coordination with target organizations • Logistical coordination at the destination
Early to mid-October, 2023	Technical Guidance on the Water Supply Project	• Findings on the current situation • Organizing the current and future problems and issues • Collection and analysis of the relevant data on the current situation and future plans • Review and discussion of project contents • Technical guidance on preparation of draft application form for requesting the project
Late October to December, 2023	Preparation of Draft Report and Discussions	• Reconciliation of current and future problems and issues • Review of project contents • Preparation and discussion of draft report
Late January, 2024	Preparation of Draft Application Form and Discussions	• Guidance on drafting application form • Discussion on draft application form
Early to mid-February, 2024	Preparation of the report and its executive summary	(Implementation of post-guidance)
Early March, 2024	Submission of the final report	• Submission of the final report • Submission of the project performance report

Source: Survey Team

1.3 Survey Team

The survey team consists of the following members.

Table 1-3 Survey Team Members

Name	Job Title	Occupation
Dr. Moeko YOSHITOMI	Project Superintendent	Ministry of Health, Labor and Welfare
Mr. Kenta Hayashi	Chief Consultant / Water Supply Planning	NJS Co., Ltd.
Mr. Sanpei NAKANISHI	Water Source Planning	NJS Co., Ltd.
Mr. Akihisa ISHIDA	Pipeline Planning	NJS Co., Ltd.
Mr. Daisuke YASHIRO	Facility Planning	NJS Co., Ltd.
Mr. Tetsu TOYOTA	Facility Operation and Maintenance	Yokohama Water Co., Ltd.

Source: Survey Team

Chapter 2

Findings on the Current Situation of the Project

Chapter 2 Findings on the Current Situation of the Project

2.1 Outline of the Country and the Project Area

The country and the project target area are shown in Figure 2-1.

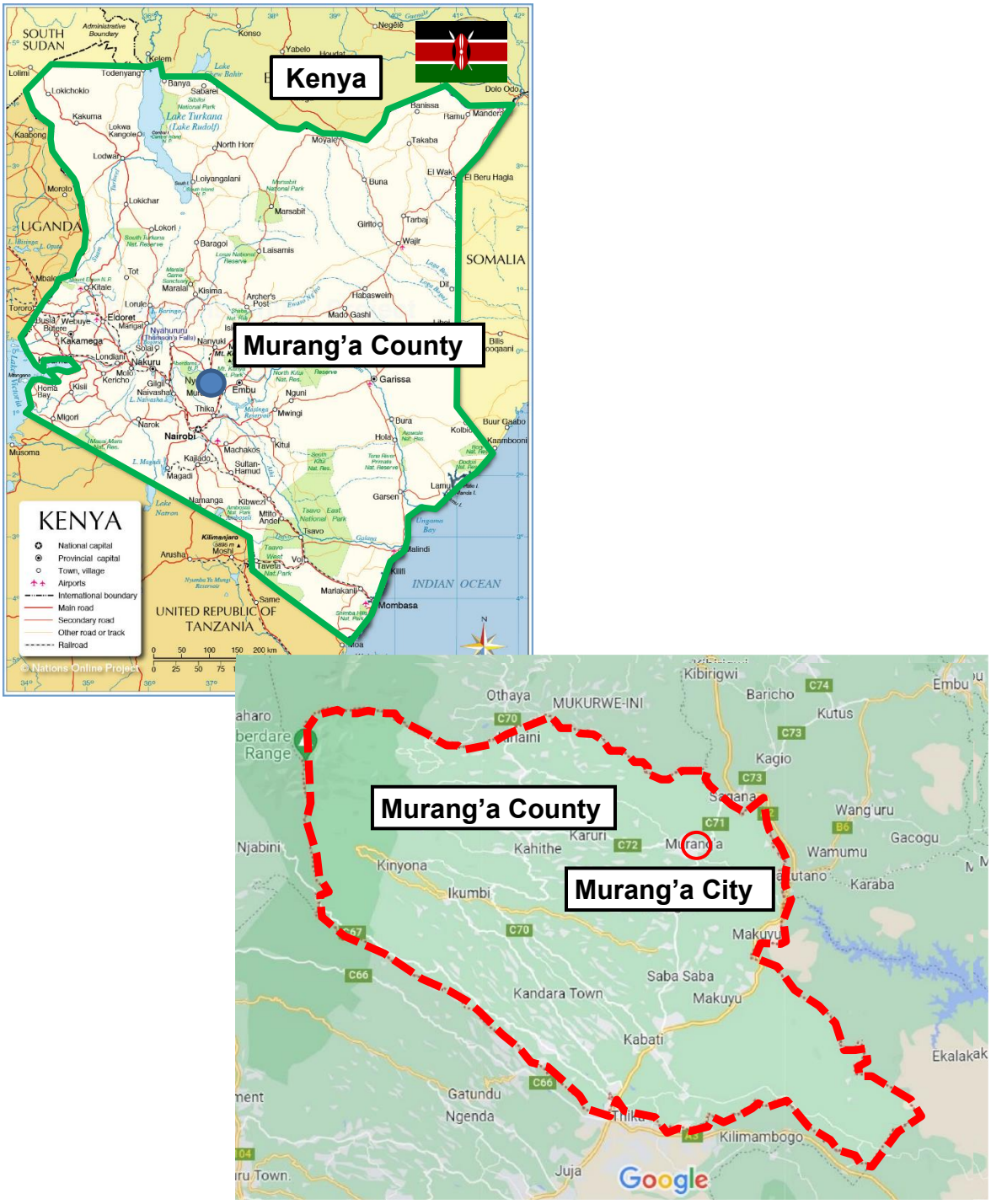


Figure 2-1 Location Map of the Country and the Project Area

Source: Survey Team

The Republic of Kenya is located just below the equator in East Africa, sharing borders with Ethiopia to the north, South Sudan to the northwest, Uganda and Lake Victoria to the west, Tanzania to the south, and Somalia to the east. Keyna faces the Indian Ocean to the southeast. With a population of approximately 54 million people (World Bank, 2022), the country has a land area of about 580,000 km^2 (about 1.5 times that of Japan). Roughly 80% of the country's land area is categorized as arid and semi-arid regions. The capital city, Nairobi, is renowned as one of the leading global cities in Africa, hosting the headquarters of numerous international organizations and representative offices for Africa.

The water supply sector is facing increasing demand for water due to population growth, economic and social development. Particularly in urban areas, the expansion of water supply services has not kept pace with the increasing water demand, and as a result, the water supply rate remained low at 60% in the 2020/21 fiscal year. To address this water supply shortage, the Kenyan government has set goals linked to Goal 6 of the Sustainable Development Goals (SDGs) in its "National Development Plan (Kenya Vision 2030)". The goals include "universal access to safe water and adequate sanitation for all by 2030", and "reduction of the NRW rate from 45% (in the 2020/21 fiscal year) to 25%".

The project focuses on Murang'a City and its surrounding areas. Murang'a City is the central city in Murang'a County, one of the five counties in the former Central Province of Kenya. Murang'a County is located approximately 100 km northeast of Nairobi, bordering Nyeri, Kiambu, Nyandarua, Kirinyaga, Embu, and Machakos counties. The water supply operations in Murang'a City and its environs are currently managed by the Murang'a Water and Sanitation Company (MUWASCO). However, the business environment has undergone significant changes in recent years, and there is a growing demand for adapting to the current and future increases in water needs. The main factors driving the increase in water demand are as follows:

1) The Central City of Murang'a County
   Murang'a City is where major administrative institutions are concentrated. With the recent expansion of the Murang'a University, there has been an increase in the number of accommodation facilities, which has led to a rapid increase in the demand for infrastructure, including water supply.
2) Suburbanization of Nairobi
   Its proximity to Nairobi and the improvement of the Kenol-Makutano-Marua Highway that crosses the county have made commuting to Nairobi more convenient, resulting in population growth as a commuter town. Rapid urbanization in Nairobi has led to housing supply challenges in many areas, including shortages of residential land and escalating construction material costs. As a result, there is a trend, particularly among young families, to relocate to the outskirts.
3) Rural to Urban Migration
   The population is growing faster than the average growth rate within the county due to migration from rural areas to urban centers. Consequently, the existing facilities are strained, resulting in instances like water supply restrictions in areas previously receiving 24-hour water supply. These areas include the center of Murang'a City, Kiharu, Kabuta, and parts of Gaturi. This trend is anticipated to worsen over the next few years as Kenya approaches the goal of "universal safe water supply" outlined in

Kenya Vision 2030. The 2019 census[1] projected that urban populations, constituting 31.2% of Kenya's total, would increase to 66% by 2050.

4) Expansion of the Water Supply Area

The Murang'a County government has announced new urban boundaries that will increase the area of Murang'a City from 145 km^2 to 330 km^2 and are expected to be implemented in the coming years. The newly added areas include regions with a water supply rate of less than 50%, indicating potential water demand. MUWASCO plans to expand the water supply areas alongside the city boundary expansion. Initiatives have already begun to extend some distribution networks, with plans to cover the entire 330 km^2 area with a comprehensive pipeline network within the next decade.

Due to the above-mentioned reasons, MUWASCO's existing facilities do not have sufficient capacity to meet the rapidly increasing water demand in recent years.

Based on the above background, this project involves conducting a survey in Murang'a City and its surrounding areas. The focus of the survey is to assess the current status of water supply facilities and the necessity for the development of water supply facilities. The survey team also provided a guidance on the planning of the "The Project for Improvement of Water Supply System in Murang'a".

2.2 Current Water Supply Situation and Issues in the Country

2.2.1 Current Situation in the Water Supply Sector (at National Level)

In urban areas of Kenya, the water supply coverage has shown improvement, reaching 57% in 2019, 60% in 2020, and 62% in 2021 (Impact Report No.14, 15, WASREB). However, despite this positive trend, the population growth, economic and social development have led to an increasing demand for water. As a result, the expansion of water services has not been in line with the growth in water demand. To address the shortage in water supply, the Kenyan government, within the Kenya Vision 2030 framework, has set goals linked to SDG Goal 6. These include ensuring "universal access to safe water and adequate sanitation for all by 2030" and reducing the NRW rate from 45% (in the 2020/21 fiscal year) to 25%. The status on achievement of the SDGs Goal 6 "Clean Water and Sanitation" in Kenya is summarized in Table 2-1.

Table 2-1 The Current Status of the SDGs (Goal 6) in Kenya

★Goal 6: By 2030, achieve universal and equitable access to safe and affordable drinking water for all★

SDG Global Targets	SDG Global Indicators	2000 (%)			2015 (%)		
		Nationwide	Urban	Rural	Nationwide	Urban	Rural
6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all	6.1.1 Proportion of population using safely managed drinking water services	—	—	—	—	—	—

[1] 2019 Kenya Population and Housing Census, Kenya National Bureau of Statistics

6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	6.2.1 Proportion of population using a) safely managed sanitation services and b) a hand-washing facility with soap and water	—	—	—	38	—	—
6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	6.3.1 Proportion of domestic and industrial wastewater flow safely treated	—	—	—	11	—	—
	6.3.2 Proportion of bodies of water with good ambient water quality		—	—	87*1	—	—
6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	6.4.1 Change in water use efficiency over time	—	—	—	15*1	—	—
	6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources	—	—	—	33*1	—	—
6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate	6.5.1 Degree of integrated water resources management implementation (0-100)	—	—	—	59*1	—	—
	6.5.2 Proportion of transboundary basin area with an operational arrangement for water cooperation	—	—	—	27*1	—	—
6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes"	6.6.1 Change in the extent of water-related ecosystems over time	—	—	—	23*2	—	—
6.a By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programs, including water harvesting, seawater intrusion, water efficiency, wastewater treatment, recycling and reuse technologies	6.a.1 Amount of water- and sanitation-related official development assistance disbursements	—	—	—	247 m$*2	—	—
6.b Support and strengthen the participation of local communities in improving water and sanitation management	6.b.1 Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management	—	—	—	—	—	—

*1: achieved as of 2020, *2: achieved as of 2021

Source: https://www.sdg6data.org/en/node/1, UN-Water SDG 6 Data Portal

2.2.2 Water Supply Issues (at National Level)

Table 2-2 summarizes water supply issues in Kenya.

Table 2-2 Water Supply Issues in Kenya

Category	Issue	Expected Magnitude of Issue Level			Rationale for Evaluation of Issue Level
		Small	Middle	Large	
Institutional / Organizational	The legal / institutional position of the water supply business is not clear.	○			National strategies for the water supply sector have been formulated through Kenya Vision 2030, the Water Act of 2016, and the National Water Services Strategy 2007 - 2015.
	There has been no confirmation of their policy of encouragement of self-effort.			○	With the decentralization of authority to counties, water supply utilities have come under the jurisdiction of counties as part of the new system. While there have been slight improvements in water supply coverage, water supply utilities have made efforts towards self-sustainability. However, water tariffs have not been raised to the level required for achieving financial independence. Additionally, high NRW rates and low tariff collection rates have contributed to a deterioration in the financial situation of water supply utilities.
	The organization has not been established to fulfill the legal / institutional requirements as a water supply service provider.		○		While the organizational structure is in place, the Water Act of 2016 does not explicitly specify the financial responsibilities of county governments towards water supply utilities. The response in cases where water supply utilities are unable to recover O&M costs from revenue collection is left to the discretion of the respective county governments. The National Water Quality Management Strategy, as outlined by the Ministry of Water, Sanitation and Irrigation (MWSI) has identified the following challenges: • Inadequate capacity among organizations mandated with preventing water pollution and complying with water quality standards. • Lack of incentives related to water quality pollution prevention and regulatory compliance. • Insufficient water quality data for planning and decision-making.
	Insufficient number of staff or human resources for the requirements of the water supply service operation.		○		The number of skilled technical staff is insufficient.
Planning / Coordination	An overarching plan such as a water supply master plan has not yet been formulated.		○		The National Development Plan (Kenya Vision 2030) sets the goal for the water and sanitation sector to ensure that universal access to safe water and adequate sanitation for all by 2030. However, since the enactment of the Water Act in 2002, there has been no separate top-level plan specifically formulated for the water supply sector, following the creation of the National Water Services Strategy 2007 - 2015.
	There has been no confirmation of coordination of donor or international institution support for water supply projects.		○		In the formulation of development plans, there is usually an avoidance of overlap between donors' implementation plans. However, the prioritization of the water supply sector can be influenced by each

					donor's national interests and priorities.
	Water supply service level balance (e.g., water supply volume, facility improvement progress) has not been achieved.		○		In the water supply sector, there are both urban water supply and rural water supply systems. While there is a certain level of planning in urban water supply, rural areas face challenges related to issues like water quantity and quality from the water sources. This has led to an imbalance in services between urban and rural areas.
	There is an imbalance in the planning or development of the water supply sector with other relevant sectors (e.g. water resources management, sewerage and urban planning).		○		Regarding water source planning and management, it is necessary to coordinate with the Water Resource Authority (WRA), which oversees water resources, and confirm the requirements for other water uses (such as irrigation and power generation) as well as river maintenance flow. This process helps establish the available water amount for water supply. Additionally, in recent years, rapid and unplanned urban development, including inappropriate land use (including slum areas), has caused changes in the retention capacity of watersheds and increased the frequency of floods. Therefore, considerations for these latest developments are essential in water supply infrastructure development.
Business Operations / Financial Management	Insufficient budget for development of water supply projects			○	In terms of funding for new water supply infrastructure projects, at the national level, MWSI has allocated 423 billion Ksh for water and sanitation infrastructure development in the 2022/23 fiscal year. However, water supply utilities alone cannot implement these projects, and they often rely on financial assistance from county governments and international donors.
	A water tariff system or policy has not been established.			○	The proposal, assessment, and approval of water tariffs for each water supply utility are under the authority of the Water Services Regulatory Board (WASREB). The framework and policies are in place for this process. However, in the actual operation of water supply business, high NRW rates and low tariff collection rates have negatively impacted their financial situation.
	The service provider cannot maintain the independent accounting system.			○	While there is some financial support from county governments for facility development, the high NRW rates and low tariff collection rates have led to a deteriorating financial situation. As a result, a sustainable independent accounting system is not being maintained.
Operation & Maintenance	A guideline or manual for maintaining the water supply facilities has not been developed.	○			WASREB establishes standards that serve as guidelines for water and sanitation services and enforces regulations.
	Data and information management, such as water quality and asset management, is not in place.			○	MWSI has identified the following challenges: • Insufficient water quality data for planning and decision-making. • Lack of continuity in water quality surveys. • Inadequate documentation of available information.
	Insufficient number of qualified maintenance personnel for the quantity or quality of maintenance work.		○		The number of qualified and experienced technical personnel is insufficient

Technical Aspects	Water source is vulnerable to the natural conditions (e.g. topography, geology, disaster, climate change)		○		80% of the country's land area is categorized as arid and semi-arid regions, and it cannot be said to be abundantly endowed with water resources. Moreover, the impacts of recent global warming suggest future temperature increases, which are expected to lead to increased precipitation and evaporation rates, resulting in increased uncertainty in the water source patterns of the watersheds.
	There is not enough water to distribute due to the deterioration of the water supply facilities			○	The existing water supply system is deteriorating, and adequate water supply services are not being provided.
	Water supply does not meet demand.			○	The rapid urbanization in recent years has led to significant population growth, along with a corresponding increase in water demand, and the water supply is not keeping pace.
	The disinfection facilities are not functioning, leading to hygiene issues in the water supply.	○			WASREB manages the water quality of water service providers, and the compliance rate for drinking water quality, including residual chlorine, was high at 95% for the 2021/22 performance, indicating a minimal presence of hygiene issues.
	The technology in use is not appropriate.			○	There are numerous technical improvements to be made, such as addressing the issue of high NRW rates, database creation for water quantity and quality data, and utilizing computers for data management.
	The technician level is inadequate compared to the maintenance level.			○	A high level of technical expertise is required in maintenance, addressing issues such as high NRW rates, database creation for water quantity and quality data, and data analysis and management using computers.

Source: Survey Team

2.2.3 Hygiene-related Issues and Waterborne Diseases (at National Level)

In Kenya, cholera outbreaks are reported every year, with significant outbreaks occurring every 5 to 7 years. These outbreaks have occurred in the region known as the Horn of Africa, under conditions such as drought, conflict, and political instability. Cholera outbreaks have occurred in areas with high population density, including the capital city of Nairobi, as well as in regions with two large refugee camps (Kakuma and Dadaab), where significant population movements are taking place within the country and neighboring countries.

Since early 2017, there has been a rapid increase in cholera cases in Kenya. The first cholera outbreak in the country in 2017 was reported in counties along the Tana River basin. This outbreak began in October 2016 and was brought under control by April 2017. The second cholera outbreak in 2017 began in Garissa County on April 2nd and later spread to nine other counties, including Nairobi County, Murang'a County, Mombasa County, Turkana County, Kericho County, Nakuru County, Kiambu County, and Narok County. Reports of the outbreak came from the general population as well, with cholera outbreaks occurring in two locations in Nairobi County, where 146 patients were treated in different hospitals. The main contributing factors to the current outbreak include mass gatherings (such as weddings or international conferences held

in hotels), limited access to safe water and proper sanitation, and high population density, which facilitates the spread and expansion of the disease, as well as significant population movements in neighboring countries.

2.2.4 Current Water Supply Situation (at Project Level)

(1) Current Water Supply Situation

MUWASCO has been responsible for water supply in Murang'a City and its surrounding areas since its establishment in 2006. The current jurisdictional area of MUWASCO in Murang'a County is shown in Figure 2-2. The company operated based on the Services Provision Agreement (SPA) entered into with Tana Waterworks Development Agency (TWWDA), which was the owner and licensee of the assets. However, ownership was later transferred to Athi Waterworks Development Agency (AWWDA), and since July 2023, it has been under the jurisdiction of the Murang'a County Government.

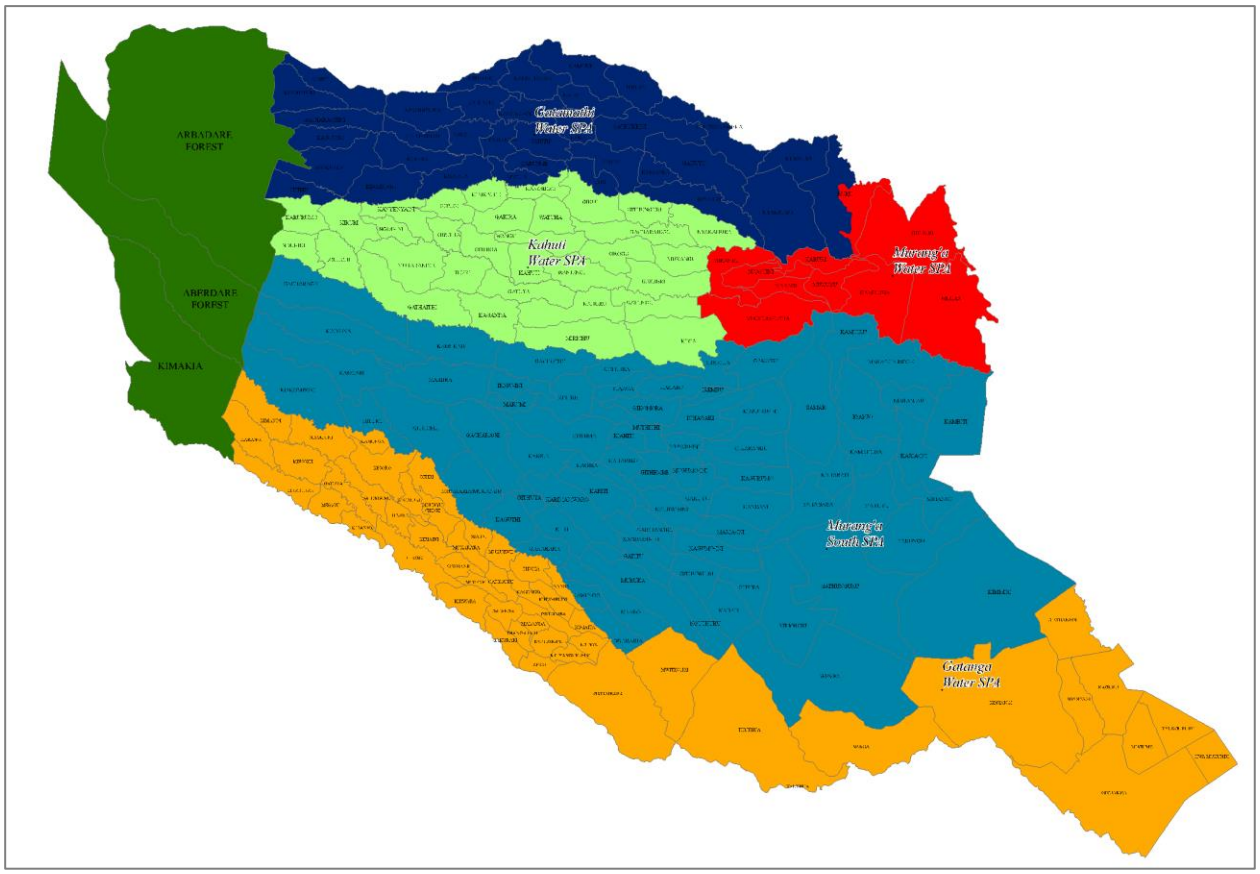


Figure 2-2 The Jurisdictional Area of MUWASCO in Murang'a County (highlighted with Red)

Source: MUWASCO

Based on the WASREB Impact Report, Table 2-3 presents the key performance indicators for MUWASCO's water supply from 2019 to 2022. MUWASCO's current water supply area covers approximately 145 km^2, serving a population of around 78,000, with a water supply coverage rate of 97%. The number of water

connections varies in different data sources, but according to MUWASCO's data as of July 2023[2], there are a total of 16,919 connections, broken down as follows: 15,978 domestic connections (94.4%), 738 commercial connections (4.4%), 195 public connections (1.2%), and 9 kiosk connections.

According to information obtained through interviews with MUWASCO, the estimated water demand in the current water supply area is 15,000 m^3/day, while the actual supply volume remains at a maximum of 10,000 m^3/day. Regarding this point, as discussed in 2.2.5(2) below, it is possible that MUWASCO's estimated water demand may be overstated, and the current water supply volume can adequately meet a significant portion of the actual water demand. In fact, water supply hours were reported to be 22-24 hours, as shown in Table 2-3. There are some areas with limited coverage and impoverished communities, and instances like water supply restrictions in areas previously receiving 24-hour water supply. These areas include the center of Murang'a City, Kiharu, Kabuta, and parts of Gaturi. The NRW rate stands at 24% as of 2022, which compares favorably to the national average of 44% in Kenya. MUWASCO has set a target to reduce the NRW rate to 15% by 2025 in its medium-term management plan "Strategic Plan 2020-2025[3]". However, the NRW rate remained at 23% as of September 2023, and the possibility of achieving this target is low.

Table 2-3 Key Performance Indicators for MUWASCO's Water Supply (FY 2018–2022)

Indicators	Unit	2018	2019	2020	2021	2022
Total population in service area	Person	87,023	89,252	78,787	79,209	80,168
Total population served	Person	78,365	81,629	73,247	75,209	77,856
Total water produced*	1,000 m^3/year	2,420	2,423	2,450	2,757*	3,039*
Domestic + kiosk billed volume	1,000 m^3/year	1,074	1,033	1,165	1,313	1,254
Total billed volume	1,000 m^3/year	1,798	1,813	1,845	2,068	2,310
Production per capita	L/capita/day	85	81	92	99	107
Consumption per capita	L/capita/day	38	35	44	47	44
Total number of staff	Person	94	121	121	120	124
DWQ	%	93	93	93	93	100
Non-revenue water (NRW)	%	26	25	25	25	24
Water coverage	%	90	91	93	95	97
Hours of supply	Hour/day	24	24	22	22	23
Staff productivity (no. of staff / 1,000 connections)	Person/1,000 connections	5	7	6	6	5
Revenue collection efficiency	%	100	92	91	95	92
O&M cost coverage	%	121	110	123	104	107

*The total water produced in 2021 and 2022 was inaccurately stated. Therefore, the figures were back-calculated from the NRW rate (%).

Source: WASREB Impact Report 11～15

[2] Quarterly reports (May - July 2023), Athi Water Works Development Agency
[3] Strategic Plan 2020-2025, MUWASCO

The profit and loss statement for MUWASCO for the past five years (FY 2018-2022) is presented in Table 2-4. The company has consistently recorded a profit during past five years, with business income covering expenses such as cost of sales and depreciation. The highest profit was achieved in the last year, 2022, with a figure of 37 million Kshs. According to an interview with MUWASCO, no taxes are levied on the income, as all profits are used to invest in the development of the facilities.

Table 2-4 MUWASCO's Income and Expenditure on Operations (FY 2018-2022)

Unit: Kshs

Item	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022
Total Income	**207,085,206**	**202,144,367**	**213,696,666**	**258,246,769**	**311,562,878**
Revenue Grants	14,526,490	12,675,878	12,236,565	39,570,807	45,036,274
Billings	188,634,886	182,692,262	195,691,168	213,571,944	261,745,623
Total Expenditures	**191,345,636**	**185,774,102**	**196,672,978**	**235,420,437**	**274,395,264**
Cost of Sales	121,370,175	123,051,423	126,918,947	157,711,755	179,646,336
General and Administrative Expenses	37,379,317	39,253,251	48,531,190	52,431,554	68,055,762
Depreciation and Amortization	23,999,721	22,216,611	20,488,074	23,023,785	26,682,263
Surplus from Operating Activities	**15,739,570**	**16,370,265**	**17,023,688**	**22,826,332**	**37,167,614**
Tax	0	0	0	0	0
Total Surplus	**15,739,570**	**16,370,265**	**17,023,688**	**22,826,332**	**37,167,614**

※1 Ksh = 0.917 JPY, January 2024

Source: MUWASCO's Audit Report for 5 five years

(2) Outline of Existing Water Supply Facilities

Currently, MUWASCO supplies water to the areas shown in Figure 2-3 from two WTPs, Kiawambeu WTP, Kayahwe WTP, and a deep well located in Kiangage. The details of MUWASCO's water supply facilities are described below.

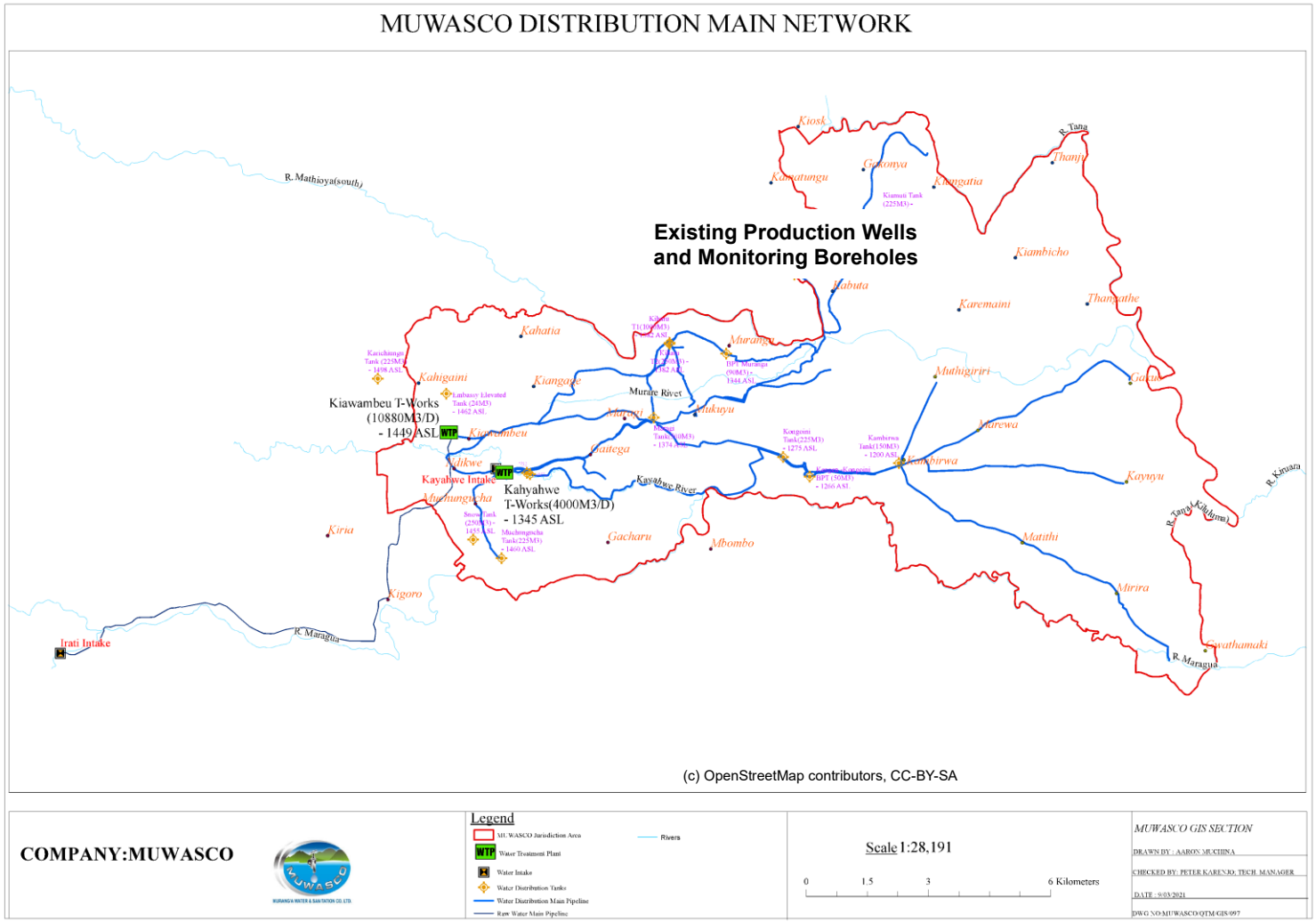


Figure 2-3 Location Map of MUWASCO's Water Supply Area and Water Supply Facilities

Source: MUWASCO

1) Water Supply Sources

a) Surface water

The Irati River, the water source for the Kiawambeu WTP, the Kayahwe River, the water source for the Kayahwe WTP, and the Mathioya River, the water source for the Kiharu WTP, are all tributaries of the Tana River. MUWASCO's water supply relies almost entirely on the Tana River Basin. The Tana River, the longest river entirely within Kenya, spans approximately 1,000 km, originating from Mount Kenya and receiving contributions from all rivers flowing from the Kenyan and Aberdare mountains. The basin covers an area of 126,026 km^2, representing about 21.9% of the country's land area and serving as the water source for approximately 50% of the country's total population. The basin extends from an elevation of 5,199 m at the summit of Mount Kenya to areas below 50 m in elevation along the Indian Ocean coast, categorized into the upstream region with an elevation of over 1,000 m, the midstream region with elevations between 1,000 and 300 m, and the downstream region with elevations below 300 m. The targeted area belongs to the upstream region, covering a basin area of 12,500 km^2[4], with rivers flowing southeastward (refer to Figure 2-4 and Figure 2-5). Among the three rivers serving as water sources for MUWASCO, the Kayahwe River Basin is the smallest, while the Mathioya River Basin is the largest, with the Mathioya River having the highest river flow among them.

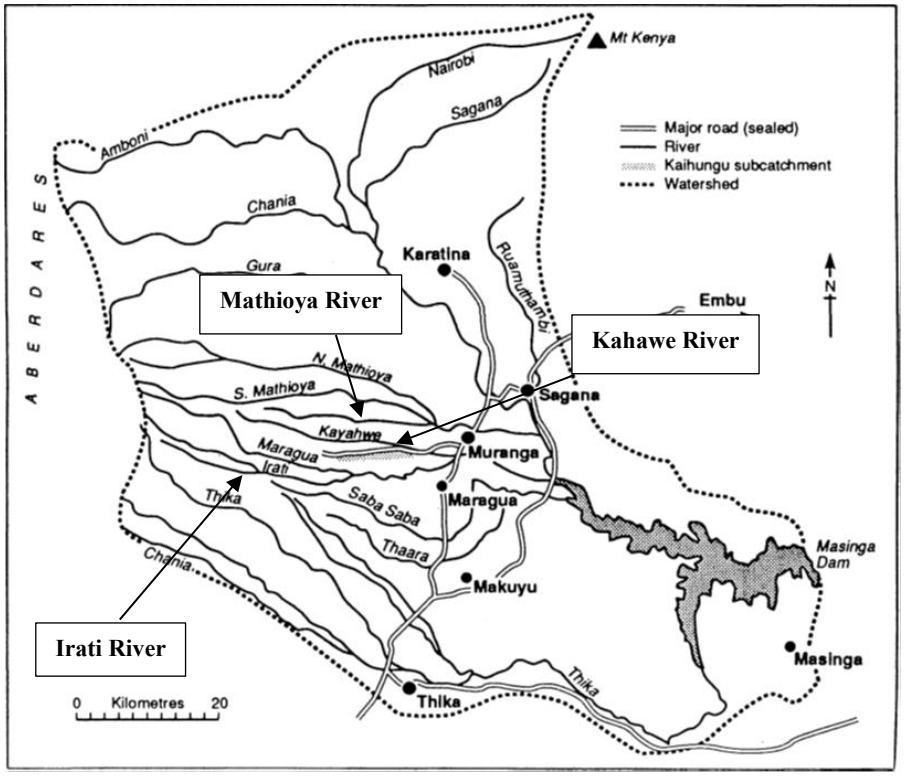


Figure 2-4 Location Map of River Basin for MUWASCO's Water Supply Sources

Source: Multi-scale estimates of erosion and sediment yields in the Upper Tana basin, Kenya, Tony Brown, 1996

[4] Assessment of the Influence of Rainfall and River Discharge on Sediment Yield in the Upper Tana Catchment in Kenya, Njogu and Kitheka, 2017

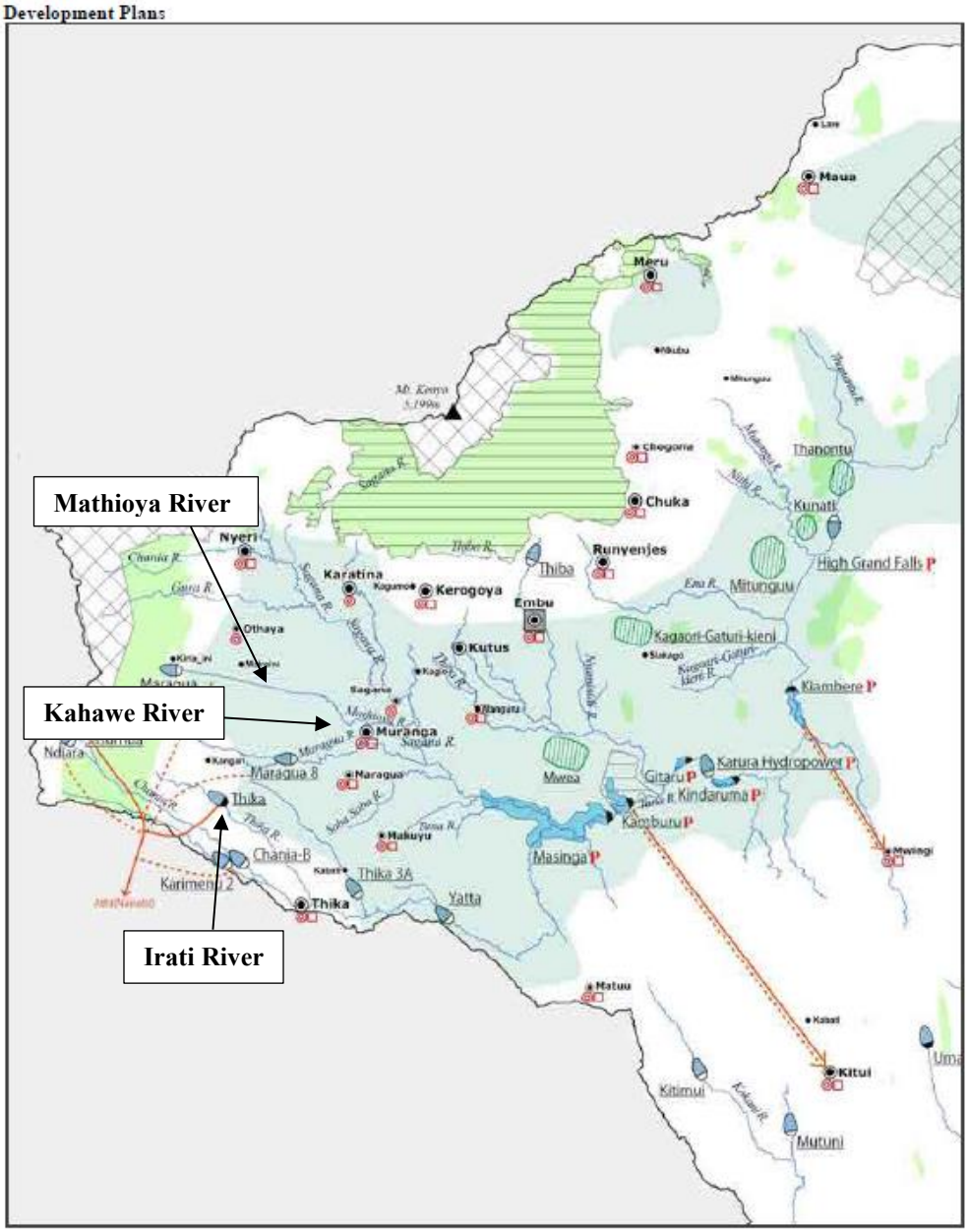


Figure 2-5 Upper Catchment Basin of the Tana River

Source: Report of the Technical Committee on Northern Collector Tunnel Project, 2015, Murang'a County Government

b) Groundwater

The main aquifer of the project site is formed in the upper layer of old geological formations located between pyroclastic flows, weathered and fragmented lava and basalt layers, and at the contact zone between basaltic pyroclastic flows and amphibolite basement rock that has undergone fracturing. These surface layers of basaltic fractured zones are the most significant aquifer in the target area. The average groundwater level in the project area is approximately 102 m below the ground surface, and the groundwater levels in the existing wells are as follows.

- Main Aquifer Thickness: 50～100 m

- Unconfined Groundwater Level: 15～25m
- Lifting Capacity: 2～50 m^3/hr
- Water Quality: Freshwater, pH: neutral, often silica components (ionic) detected

The target area is characterized by a confined aquifer, and groundwater flow has been observed in the north and northwest directions of Murang'a City, receiving recharge from horizontal directions.

According to the "National Water Master Plan 2030," formulated in 2013 with support from JICA, the estimated water resource availability in the Tana River Basin as of 2010 were 5,858 million m^3/year for surface water and 675 million m^3/year for groundwater. As of 2030, it is projected that surface water will increase to 7,261 million m^3/year due to the impacts of climate change, while groundwater is estimated to remain nearly unchanged at 567 million m^3/year.

Table 2-5 Annual Available Water Resources (Tana River Basin)

(Unit: MCM/year)

Year	Surface Water	Groundwater	Total
2010	5,858	675	6,533
2030	7,261	567	7,828
Ratio of 2030 to 2010	124%	84%	120%

Source: National Water Master Plan 2030

Although the present water demands in 2010 are estimated to be 14% (891 million m^3/year) of the available water resources, the water demands for 2030 are expected to sharply increase to about 105% (8,241 million m^3/year) against the available water resources in 2030 indicating severe water stress. However, the primary factor driving increased water demand is irrigation water. It has surged from approximately 696 million m^3/year in 2010 to around 7,770 million m^3/year by 2030, an increase of nearly elevenfold. Therefore, the master plan recommends the necessity to restrain the scale of irrigation development as outlined in Kenya Vision 2030.

2) Water Intake and Raw Water Transmission Facilities

The existing intake facilities of MUWASCO is shown in Table 2-6.

Table 2-6 Water Intake Facilities Owned by MUWASCO

Water Source	Facilities Details	Const. Year	Capacity	Condition
Irati River	Weir: 16m x 2m x 3m、RC	2013	26,000 m^3/day	Good
Kayahwe River	Weir: 16m x 2m x 3m、RC	1970s	5,000 m^3/day	Fair
Mathioya River	Pump（disposal）	1950s	1,500 m^3/day	Bad
Kiangage production well	Deep Well	2020	120 m^3/day	Good

Source: Based on the Detailed Planning Survey Completion Report of "Project for Strengthening Capacity of Water Service Providers on Formulating Bankable Project Plans, JICA, December 2022, the survey team made additional information after confirming with MUWASCO.

a) Irati River

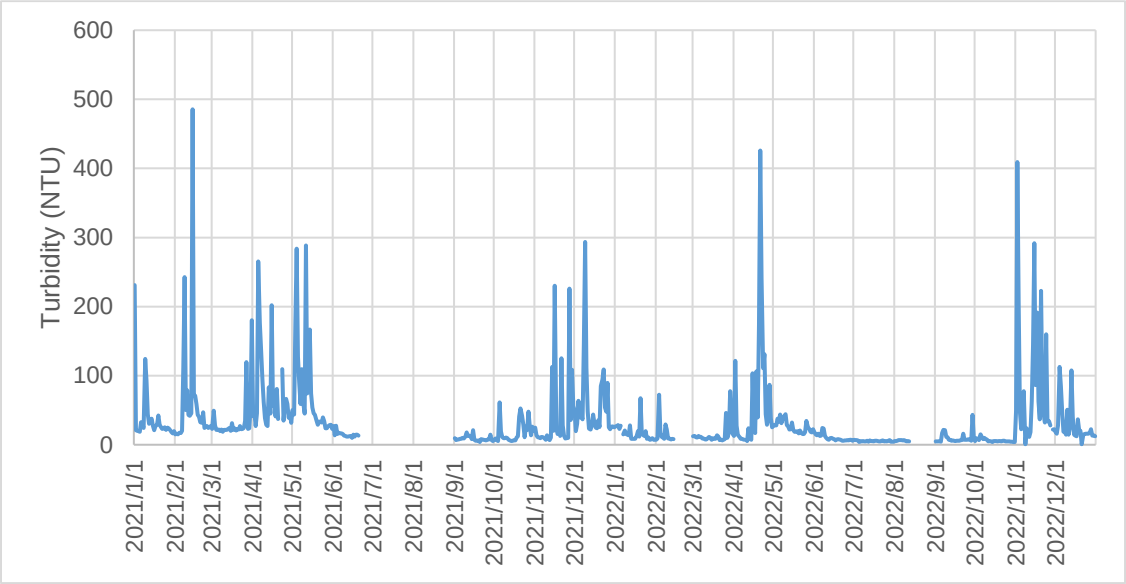
The water source for the Kiawambeu WTP, MUWASCO's primary WTP, had its intake weir and raw water pipeline constructed in 2013 to coincide with the construction of the WTP. The intake weir is located approximately 15 km upstream of the WTP on the Irati River and sends raw water to the WTP by gravity flow. The allowable water intake is 26,000 m^3/day, taking into account the future water demand for both Murang'a City and its surrounding areas, as well as Maragua City currently under the jurisdiction of Murang'a South Water and Sanitation Company (MUSWASCO). Additionally, a separate intake weir for irrigation use (refer to Photo 2-1) is constructed just downstream from the intake weir of MUWASCO, resulting in three water rights holders extracting water from nearby locations. The raw water pipeline to the Kiawambeu WTP is a steel pipe, with a diameter of 350 mm and a length of approximately 15 km. It is designed to send a maximum of 10,880 m^3/day of raw water by gravity flow[5], but the actual flow remains between 7,500 to 8,500 m^3/day. On the other hand, the raw water pipeline of MUSWASCO is also a steel pipe, with a diameter of 250 mm. According to MUWASCO, the intake volume for MUSWASCO is approximately 2,000 m^3/day. Therefore, the operational situation indicates a relatively comfortable margin in terms of the allowable water intake.

Photo 2-1 Irati Intake Weir

Photo 2-2 Intake Weir for Irrigation

Figure 2-6 shows the trend of raw water turbidity measured at the Kiawambeu WTP from January 2021 to December 2022, and Table 2-7 presents the period averages, maximum, and minimum values. The average raw water turbidity for the period is 30 NTU, with averages of 18 NTU during the dry season (January – February, June – October), 47 NTU during the rainy season (March-May), and 52 NTU during the short rainy season (November – December). The highest turbidity during the period is 485 NTU, and the minimum turbidity is 8 NTU. While the dry season experiences low turbidity, the rainy season sees occasional occurrences of turbidity exceeding 100 NTU. Despite this, the water quality treated at the Kiawambeu WTP generally meets the drinking water quality standards of Kenya, even during periods of high turbidity, indicating no issues with the treated water quality.

[5] Design Report Part 2 – Detailed Design, Detailed Design and Supervision for Murang'a North and Murang'a South Bulk Water Supply Project, Tana Water Services Board (2010)



※No data for 21 June – 31 August 2021.

Figure 2-6 Trends in Raw Water Turbidity of the Irati River (Jan 2021 – Dec 2022)

Source: Survey team based on information from MUWASCO

Table 2-7 Summary of Raw Water Turbidity of the Irati River

Item	Turbidity (NTU)	Period
Maximum Turbidity	485	
High turbidity (equivalent to 5% of total annual days)	120	
Average turbidity	30	
Average turbidity in dry season	18	Jan, Feb, Jun～Oct
Average turbidity in rainy season	47	Mar～May
Average turbidity in short rainy season	52	Nov, Dec
Minimum Turbidity	5	

Source: Survey team based on MUWASCO's information

b) Kayahwe River

The Kayahwe River is the water source for the Kayahwe WTP and water is drawn from the intake weir located 135 m away from the WTP. After that, raw water is sent through a steel pipe with a diameter of 300 mm by gravity flow. During the rainy season, the raw water experiences high turbidity, posing a significant challenge to the water treatment. In addition, water levels drop during the dry season, with the lowest recorded level in the past 10 years being 1 cm. Under these conditions, it is a challenge to

Photo 2-3 Kayahwe Intake Weir

anticipate additional water intake beyond current intake levels.

c) Mathioya River

Mathioya River is the water source for the Kiharu WTP which has not been operational since 2014 following the commissioning of the Kiawambeu WTP.

d) Kiangage Production Well

A production well was developed in Kiangage in 2020, and it has a low yield with a daily production capacity of 120 m^3. While a significant portion of MUWASCO's water supply area is connected to the distribution network from the Kiawambeu WTP, the western area at a higher elevation lacks a reliable water source. Currently, water supply to this region is provided through the well.

3) Treatment Facilities

The overview of MUWASCO's existing WTPs is presented in Table 2-8. The Kiawambeu WTP sources raw water from the Irati River, the Kayahwe WTP from the Kayahwe River, and the Kiharu WTP from the Mathioya River. The Kiharu WTP ceased its operation in 2014 following the commissioning of the Kiawambeu WTP. Currently, the total capacity of the two operational WTPs is 18,000 m^3/day.

Table 2-8 MUWASCO's WTPs

WTP Name	Water Source	Const. Year	Treatment Capacity	Daily Production	Conditions
Kiawambeu WTP	Irati River	2014	14,200 m^3/day	8,000 m^3/day	Operational
Kayahwe WTP	Kayahwe River	1970s	3,800 m^3/day	2,000 m^3/day	Operational
Kiharu WTP	Mathioya River	1950s	750 m^3/day	-	Non-operational

※ The treatment capacity is defined as the maximum daily distribution capacity, accounting for water treatment losses (estimated at approximately 5%).

Kiawambeu WTP: 15,000 m^3/day × (1 – 5%) ≒ 14,200 m^3/day

Kayahwe WTP: 4,000 m^3/day × (1 - 5%) ≒ 3,800 m^3/day

Source: Survey team based on information from MUWASCO

a) Kiawambeu WTP

The Kiawambeu WWTP is MUWASCO's main WWTP, constructed in 2014 with a loan from the African Development Bank (AfDB), using the coagulation-sedimentation + rapid sand filtration methods. The current water treatment process flow for the Kiawambeu WTP is shown in Figure 2-7, and photographs of each facility are provided in Photo 2-4 to Photo 2-13.

The well water receives an injection of aluminum sulfate from the adjacent chemical dissolution tank, and the specifications allow for the addition of caustic soda and pre-chlorine (lime powder) as needed. Subsequently, flocculation is induced through gravity-based rapid stirring using a cascade mixer and slow

mixing in a horizontal-flow flocculator. After flocculation, sedimentation is carried out in a lateral-flow sedimentation tank, followed by filtration through rapid filtration. Post-chlorination is then introduced, and the treated water is stored in a clear water reservoir (2,000 m^3). Subsequently, the water is gravity-fed to the Kiharu Reservoir (1,100 m^3 and 250 m^3) and the Maragi Reservoir (500 m^3). From there, water is distributed. Some of the treated water is pumped up to elevated tanks on-site and used for the once-daily backwash of the rapid filtration tank. Additionally, direct distribution to high-altitude areas is performed from the elevated tanks. The wastewater and sludge treatment facility consists entirely of sun-drying beds. Both settling sludge from the sedimentation tank and wash water from the filtration tank are discharged outside after passing through sun-drying beds.

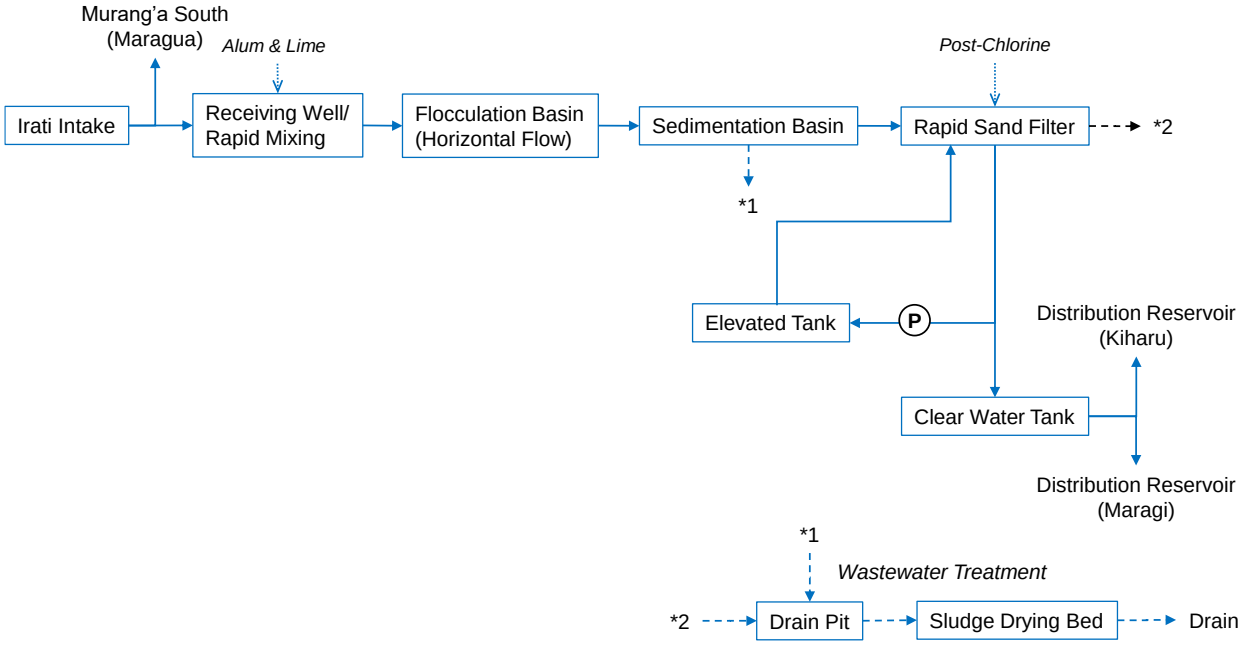


Figure 2-7 Water Treatment Process Flow of Kiawambeu WTP

Source: Survey team

Photo 2-4 Kiawambeu WTP

Photo 2-5 Receiving Well and Rapid Mixing

by Hydraulic Jump

Photo 2-6 Flocculator and Sedimentation Basin

Photo 2-7 Horizontal-Flow Flocculator with Baffled Walls (Inlet Part)

Photo 2-8 Horizontal-Flow Sedimentation Basin (Outlet Trough)

Photo 2-9 Rapid Sand Filter (Inlet Part)

Photo 2-10 Clear Water Reservoir (2,000m^3)

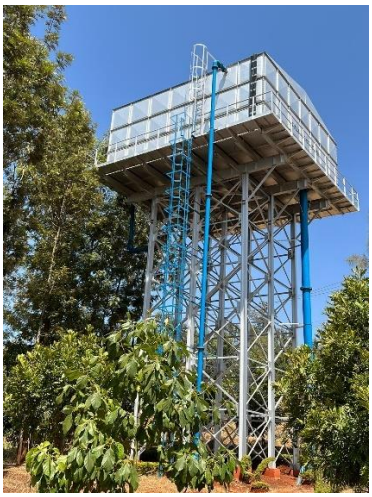


Photo 2-11 Elevated Tank (250m^3)

Photo 2-12 Sludge Drying Beds

Photo 2-13 Management Office and Laboratory

In terms of the water treatment capacity of the Kiawambeu WTP, the detailed design by the Kenyan consulting firm was set at 10,361 m^3/day[5]. However, MUWASCO recognizes the actual water treatment capacity to be 15,000 m^3/day (including water treatment losses). In contrast, the ongoing "Project for Strengthening Capacity of Water Service Providers on Formulating Bankable Project Plans" (hereinafter referred to as the "Technical Cooperation Project") conducted by JICA has concluded the following perspectives through capacity assessment.

- At full facility operation, the WTP can treat 15,000 m^3/day of raw water at maximum. However, if one sedimentation basin or one filter stops its operation, the operation of WTP does not meet the Kenya's design criteria.
- At the intake of 15,000 m^3/day, there is insufficient freeboard from the water surface to the top of the receiving well.

On the other hand, the survey team conducted a capacity verification using the actual facilities during the on-site survey. An overview of the capacity verification is as follows.

Verification method:

1) By installing a stop log and stopping one series, it was confirmed that even at the current water volume (7,500 to 8,500 m^3/day), there is double the water treatment capacity (15,000 m^3/day or more) when operating with one series. The operating time was set to 3 hours.
2) Measure the instantaneous inflow rate during single-series operation using a portable ultrasonic flowmeter.
3) As an impact on water quality, measure turbidity at three points: inflow raw water, treated water after sedimentation, and filtered water.

Verification results:

- On the day of verification, there was a water leakage incident in the raw water pipeline, and the measured result of the inflow rate during single-series operation was slightly lower than usual, approximately 280 m^3/h (equivalent to 6,720 m^3/day). Therefore, it was assumed that with two series, the treated volume is equivalent to 13,440 m^3/day.
- During treatment, there was a secure margin of 40 cm or more from the water surface to the top of the receiving well, and there was no significant rise in the water level observed.
- The turbidity levels were 9.6 NTU for inflow raw water, 2.3 NTU for treated water after sedimentation, and 1.4 NTU for filtered water, resulting in meeting the water quality standards of

Kenya. There was no observed impact on the treated water turbidity due to the increase in water volume.

Considerations:

- In this verification, the inflow volume did not reach 15,000 m^3/day. However, it is believed that even with an increase in water volume of up to 15,000 m^3/day, there would be no overflow from the receiving well.
- As the verification was conducted during the dry season when the raw water turbidity is low, no impact on the treated water quality was observed. However, during the preparatory survey, it is essential to verify the treated water quality during periods of high turbidity, especially in the heavy rainfall season. In particular, the short retention time in the flocculator raises concerns about the quality of flocculation and its impact on the frequency of filter backwashing.

The installation status of the stop-log at the inlet of the flocculator

The water level at the receiving well during the capacity verification

In consideration of the above, the current treatment capacity of the Kiawambeu WTP in this project is regarded as 14,200 m^3/day (15,000 m^3/day minus water treatment losses). On the other hand, the actual distribution amount remains at 7,000 to 8,000 m^3/day, utilizing only about 50-57% of the treatment capacity. Additionally, as mentioned earlier, the available water intake from the Irati River is 26,000 m^3/day, which can accommodate the enhancement of the WTP by constructing additional raw water pipeline. Furthermore, the land for future expansion has been secured within the WTP.

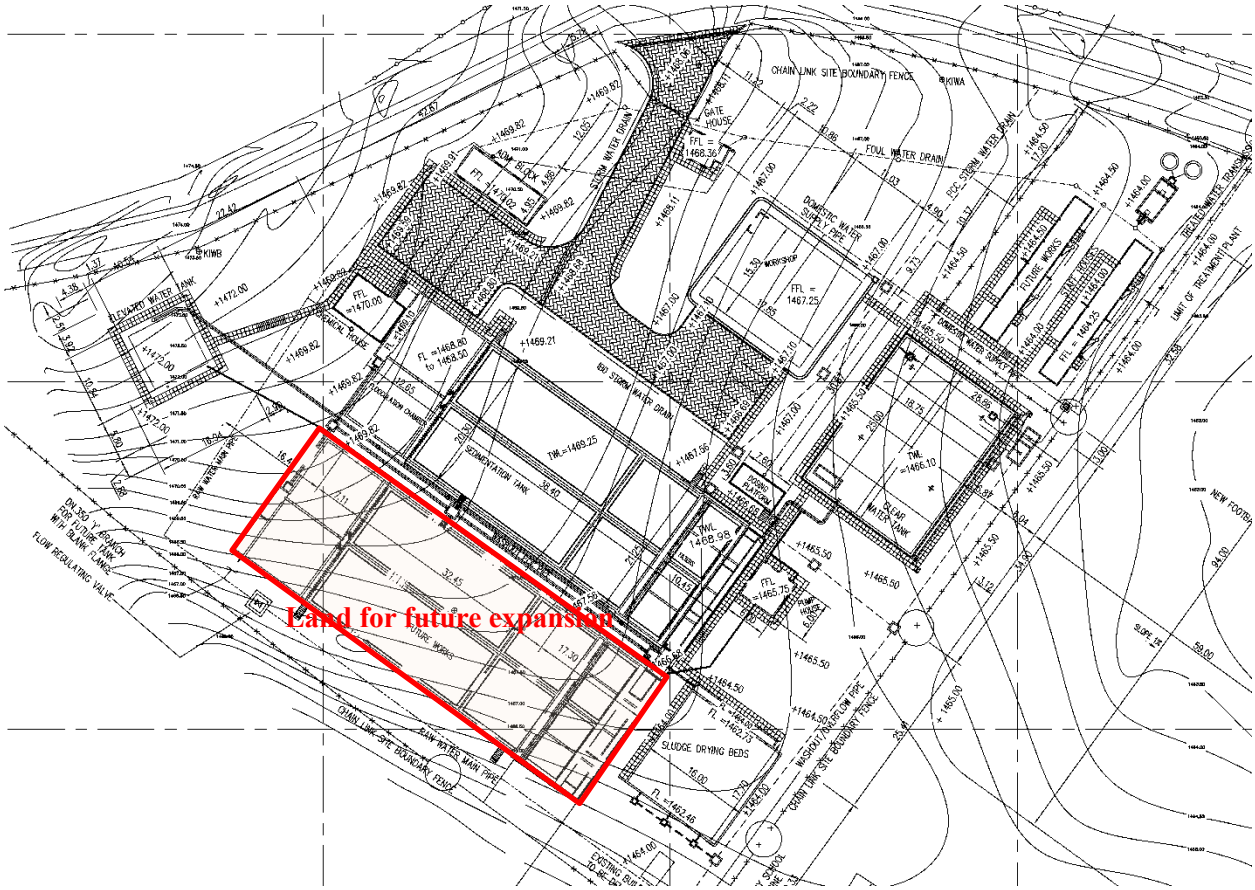


Figure 2-8 Kiawambeu WTP Plan Drawing and the Future Expansion Area

b) Kayahwe WTP

The Kayahwe WTP was constructed in the 1970s with a capacity of 4,000 m^3/day (including water treatment losses), using the coagulation-sedimentation + rapid sand filtration methods. Photos of each facility are provided in Photo 2-14 to Photo 2-21. Raw water is sent by gravity flow from the intake weir of the Kayahwe River, located 135 m away from the WTP. The basic treatment process is similar to the Kiawambeu WTP, but the slow mixing is mechanical mixing by multiple flash mixers. In the past, treated water stored in the clear water reservoir (370 m^3) was pumped to the Maragi Reservoir (500 m^3) for distribution. However, after the commission of the Kiawambeu WTP, pump operation was discontinued for cost reduction, and currently, it only handles distribution for the southeastern areas such as Kambirwa and Mirira in the southern part of the county, where water can be sent by gravity flow. Therefore, the current distribution volume remains around only 2,000 m^3/day.

Regarding water quality, while annual trend data for raw water turbidity at the Kayahwe WTP is not available, it experiences high turbidity during the rainy season. Under the current treatment method, there are cases where it cannot fully meet the Kenyan drinking water quality standards. In such instances, the WTP circulates treated water and repeats coagulation-sedimentation treatment to control the water quality.

Photo 2-14 Receiving Well and Rapid Mixing by Hydraulic Jump

Photo 2-15 Mechanical Slow Mixing

Photo 2-16 Horizontal-flow Sedimentation Basin

Photo 2-17 Horizontal-flow Sedimentation Basin (Outlet Part)

Photo 2-18 Rapid Sand Filter (Inlet Part)

Photo 2-19 Rapid Sand Filter

Photo 2-20 Backwash Tank (50 m^3)

Photo 2-21 Clear Water Reservoir (370 m^3)

c) Kiharu WTP

The Kiharu WTP was constructed in the early 1950s to supply water to the headquarters of the former Fort Hall district under the British colonial rule. It used water from the Mathioya hydroelectric dam. Located at an altitude of approximately 1,380m, this WTP was designed to supply around 750m^3/day of water to Murang'a city and its surroundings. However, it was decommissioned in 2014 with the commencement of the Kiawambeu WTP.

Photo 2-22 Kiharu WTP (Horizontal-flow Sedimentation Basin)

Photo 2-23 Kiharu WTP (Rapid Sand Filter)

4) Transmission Pipeline

MUWASCO's water transmission pipelines are presented in In addition, a water transmission pipe was installed from the elevated tank at the Kiawambeu WTP site to the Muchungucha Reservoir (225 m^3). From the Kayahwe WTP, water is conveyed by gravity flow to the southeastern low-lying areas, and water supply pipes have been laid to reservoirs such as the Kambirwa Reservoir (150 m^3).

Table 2-9. While most of the pipelines have been in use for around 20 years since their construction, significant aging or deterioration has not been observed, and leakage is at a minimal level, around a few percent. From the Kiawambeu WTP, a steel pipe DN400 mm (approximately 2.4 km) branches off at the

exit of the clear water reservoir and is laid over approximately 2.9 km to the Maragi Reservoir (500 m^3) as a steel pipe DN250 mm. Similarly, steel pipe DN200 mm extends over about 4.6 km to the Kiharu Reservoir (1100 m^3 and 250 m^3). In addition, a water transmission pipe was installed from the elevated tank at the Kiawambeu WTP site to the Muchungucha Reservoir (225 m^3). From the Kayahwe WTP, water is conveyed by gravity flow to the southeastern low-lying areas, and water supply pipes have been laid to reservoirs such as the Kambirwa Reservoir (150 m^3).

Table 2-9 MUWASCO's Water Transmission Pipelines

Pipe Material	Nominal Diameter (mm)	Length	Construction Year	Condition
Steel pipe	400	2.4 km	2014	Good
uPVC	300	12 km	2016	Good
HDPE	280	9 km	2020	Good
Steel pipe	250	7 km	2014	Good
Steel pipe	200	5 km	2014	Good

Source: Survey team based on MUWASCO

5) Distribution Facility

a) Distribution Reservoir

As shown in Table 2-10, MUWASCO has a total of 17 reservoirs with the exception of one reservoir that is currently inactive. It is important to note that this table includes the clear water reservoirs at the WTP. The primary reservoirs are the Kiharu Reservoir (1,100 m^3 and 250 m^3) and the Maragi Reservoir (500 m^3), which receive water from the Kiawambeu WTP. The other reservoirs are generally of smaller capacity, ranging from 200 to 250 m^3, and most of them are constructed using stone masonry. Additionally, the Kiharu Reservoir is located on the same site as the now decommissioned Kiharu WTP.

The total capacity of operational reservoirs is 6,169 m^3, which is equivalent to approximately 8.2 hours of the total capacity of the two currently operating WTPs (18,000 m^3/day). According to the Kenya's water design criteria, the storage time of reservoirs should ensure 12 hours of the planned maximum daily water supply. Currently, it falls below that standard, with a shortage of 2,831 m^3 in reservoir capacity.

Table 2-10 MUWASCO's Distribution Reservoirs

Area	Structure	Const. year	Capacity (m^3)	Elevation (m)	Status
Kiawambeu	RC	2014	2,000	1,449	In use
Kiawambeu	Elevated steel construction	2014	250	1,449	In use
Maragi	Maisonry structure	N/A	500	1,374	In use
Kiharu	Maisonry structure	N/A	1,100	1,382	In use
Kiharu	Maisonry structure	N/A	250	1,382	In use
Murang'a Town	Maisonry structure	N/A	90	1,344	Not in use

Area	Structure	Const. year	Capacity (m^3)	Elevation (m)	Status
Kabuta	Maisonry structure	N/A	225	1,260	In use
Muchungucha	Maisonry structure	N/A	225	1,460	In use
Karichiungu	Maisonry structure	2020	225	1,498	In use
Snow	Maisonry structure	2021	250	1,455	In use
Embassy	Elevated steel construction	N/A	24	1,462	In use
Kiamuti	Maisonry structure	2021	225	1,313	In use
Kayahwe	Maisonry structure	N/A	370	1,345	In use
Kayahwe	Maisonry structure	2016	50	1,345	In use
Kayahwe	Maisonry structure	2016	50	1,345	In use
Kengen	Maisonry structure	2016	50	1,266	In use
Kambirwa	Maisonry structure	2016	150	1,200	In use
Kongoini	Maisonry structure	N/A	225	1,275	In use
Total	**18**		**6,169**		

Source: Survey team based on MUWASCO

Photo 2-24 Maragi Reservoir (500 m^3)

Photo 2-25 Kiharu Reservoir (1,100 m^3)

Photo 2-26 Kiharu Reservoir (250 m^3)

b) Distribution pipelines

Table 2-11 shows the list of MUWASCO's distribution pipelines. The existing distribution pipes range from

DN15 mm to 150 mm, with a total length of approximately 1,200 km. Various pipe materials are used, including uPVC pipes, HDPE pipes, and precast concrete pipes (PPR pipes). Currently, MUWASCO does not adequately manage information such as the construction year of the pipes. Achieving the goal of a 15% NRW rate, as outlined in the Strategic Plan 2020-2025, is a challenge, and there is a need to establish an asset management system.

Table 2-11 MUWASCO's Distribution Pipelines

Pipe Material	Nominal Diameter (mm)	Length	Construction year	Condition
uPVC	150	54.5 km	N/A	Good
HDPE/uPVC	110	12.4 km		Good
uPVC/HDPE	75	23.7 km		Good
uPVC/HDPE/PPR	50	164.7 km		Good
uPVC/HDPE/PPR	40	192.2 km		Good
uPVC/HDPE/PPR	25	201.3 km		Good
uPVC/HDPE/PPR	20	332.4 km		Good
uPVC/HDPE/PPR	15	228 km		Good

Source: Survey team based on MUWASCO

2.2.5 Water Supply Issues (at Project Level)

(1) Low Performance of the Existing Water Treatment Plants

As mentioned in 2.2.4(2), the existing treatment capacities of the WTP are 14,200 m^3/day for the Kiawambeu WTP and 3,800 m^3/day for the Kayahwe WTP, totaling 18,000 m^3/day. However, the actual maximum water production remains at 10,000 m^3/day, with 8,000 m^3/day from Kiawambeu and 2,000 m^3/day from Kayahwe, utilizing only about half of the treatment capacity. Regarding this situation, the following points have been clarified so far.

Kiawambeu WTP

The reason for the underutilization of capacity is insufficient inflow to the WTP. The fundamental causes include a) the capacity of raw water pipeline is too small at 10,800 m^3/day compared to the water treatment capacity, and b) a reduction in sectional area of raw water pipeline due to sediment accumulation inside the pipe. In response to this, the ongoing JICA technical cooperation project proposes that MUWASCO should implement the following projects through borrowing money from city banks.

a) Physical separation of the raw water pipeline from Irati Intake to Malagua City, which is under MUSWASCO jurisdiction
b) Installation of valve chambers for washout valves and air release valves to the raw water pipeline (42 locations) and replacement of deteriorated valves (92 locations)
c) Leakage repair work at the Irati Intake
d) Installation of flow meters (at two locations, intake weir, and WTP)
e) Procurement of an ultrasonic flow meter

By implementing this project, the cause of b) is expected to be resolved, and the inflow volume is anticipated to recover to around 10,000 m^3/day. However, even in that case, there will still be a shortfall of approximately 5,000 m^3/day of raw water compared to the water treatment capacity (15,000 m^3/day), and the gap may not be completely filled.

Kayahwe WTP

At the time of construction, it was in full operation. However, with the commissioning of the Kiawambeu WTP in 2014, pumping to the Maragi reservoir was discontinued. Currently, water is only distributed to areas where gravity flow is possible. As a result, the production capacity remains at 2,000 m^3/day against a facility capacity of 3,800 m^3/day. In the future, as MUWASCO plans to expand water supply to the lower southern region, it is expected that the operation rate of the Kayahwe WTP will inevitably improve.

(2) Insufficient water supply capacity to meet potential water demand

1) Changes in the Environment Surrounding MUWASCO's Water Supply

In recent years, there have been significant changes in the situation in and around Murang'a City, and there is a strong societal demand to adapt MUWASCO's water supply operations accordingly. Specifically, there is a pressing need to enhance water supply capacity in response to the continuously increasing water demand driven by major factors mentioned above in Section 2.1.

2) Calculation of water demand

The calculated results for the a) current water demand in the existing water supply area and b) future water demand in the expanded water supply area are presented below. The calculation conditions were set in consultation with MUWASCO as follows.

【Conditions for calculation】

(i) The planning year was set as 2033, which is 10 years ahead of the current year, 2023.

(ii) The current water supply area covers 144 km^2 and 13 sub-locations, while the expanded water supply area is assumed to cover 330 km^2 and 29 sub-locations based on discussions with MUWASCO.

(iii) Future population growth is estimated using a population growth rate of 1.21% per year, which is applied from the "Third County Integrated Development Plan (2023-2027)[6]" population forecast for Murang'a East.

(iv) A 100% water supply coverage rate is assumed for the planning year.

(v) The water consumption per capita for domestic use was determined through discussions between MUWASCO and referencing past water supply records and the Kenya Water Service Practice Manual[7]. The units were set for urban areas (Mukuyu, Township, Njoguini, three Sub-Locations) and rural areas, as outlined in the table below.

Classification	2023 (Current)	2033 (Future)
Urban areas	75 L/person/day	150 L/person/day
Rural areas	40 L/person/day	60 L/person/day

[6] Third County Integrated Development Plan (2023-2027), Murang'a County
[7] Practice Manual for Water Supply Services in Kenya, Ministry of Water and Irrigation (Oct. 2005)

(vi) Non-domestic water use (commercial, industrial, etc.) is assumed to account for 20% of the total water demand based on the MUWASCO's record.

(vii) The current NRW rate is assumed to be 24%, based on WASREB Impact Report 15, and the target value in the Strategic Plan 2020-2025[3] is to reduce it to 15% in 2025. However, as a more realistic target, it is assumed in this calculation that the NRW rate would be reduced gradually up to 20% by 2033.

(viii) The planning loading factor is set at 83.3% (1.20 = "Maximum Production Capacity" / "Average Production Capacity"), referring to the "Population Size and Loading Factor" from the Design Criteria for Water Supply Facilities 2012 by the Japan Water Works Association[8].

a) Current Water Demand in the Existing Water Supply Area

The calculated results of water demand in the existing water supply area are shown in Figure 2-9. According to the 2019 census, the population in MUWASCO's water supply area is approximately 75,000 people, and assuming a continued population growth rate of 1.21% per year, it is projected to increase to about 85,000 people by 2033, with an additional 10,000 people. The water demand is expected to increase from the daily average supply of 7,600 m^3/day and a maximum daily supply of 9,200 m^3/day in 2023 to a daily average supply of 15,300 m^3/day and a maximum daily supply of 18,400 m^3/day by 2033.

In this case, the current combined maximum production of the two WTPs is 10,000 m^3/day, which is sufficient to meet the water demand as of 2023 and supports the 22-24 hour water supply reported in the WASREB Impact Report. However, to cover the increasing water demand over the next 10 years, it is essential to operate the existing facilities at the full capacity of 18,000 m^3/day (Kiawambeu WTP at 14,200 m^3/day + Kayahwe WTP at 3,800 m^3/day).

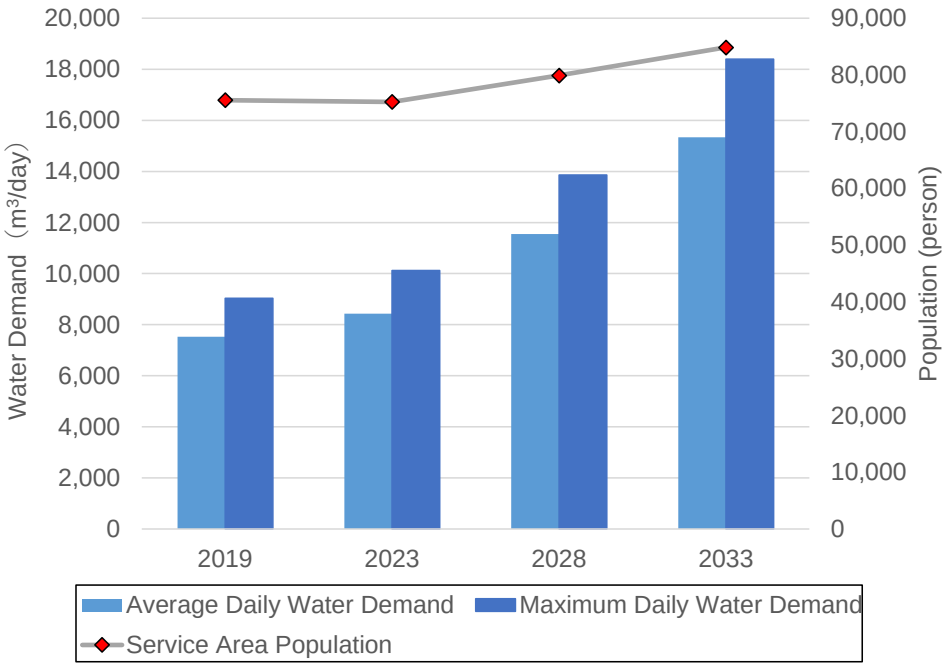


Figure 2-9 Calculation Results of the Water Demand in the Existing Supply Area

Source: Survey team

[8] The Design Criteria for Water Supply Facilities 2012, Japan Water Works Association

b) Water Demand for the Expanded Water Supply Area

The calculated water demand for the expanded water supply area is shown in Figure 2-11. According to the 2019 census, the population in the expanded water supply area is approximately 133,000 people. Assuming a continued population growth rate of 1.21% per year, it is projected to increase to about 158,000 people by 2033, with an additional 25,000 people. The water demand is expected to increase from the daily average supply of 11,900 m^3/day and a maximum daily supply of 14,300 m^3/day in 2023 to a daily average supply of 22,200 m^3/day and a maximum daily supply of 26,600 m^3/day by 2033.

In this case, even if the existing WTPs could operate at full capacity of 18,000 m^3/day, there would still be a shortfall of 4,200 m^3/day for the daily average water supply and 6,600 m^3/day for the maximum daily water supply by 2033.

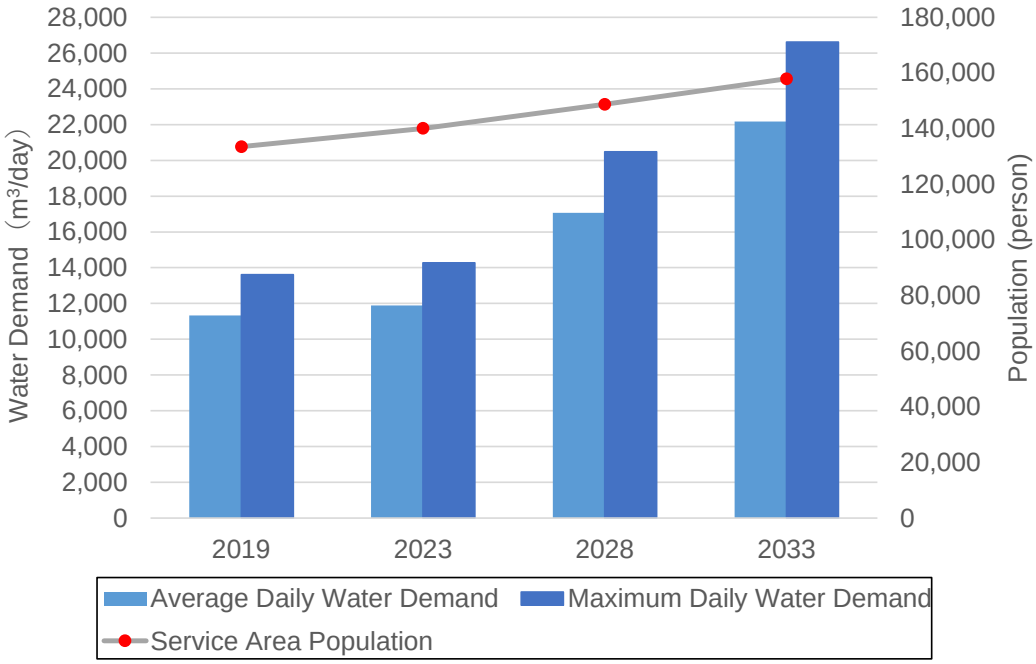


Figure 2-10 Calculation Results of Water Demand for the Expanded Water Supply Area

Source: Survey team

3) Conclusion

From the above, it can be concluded that for the existing water supply area, improving the facilities and operating the two existing WTPs at full capacity can cover the majority of future water demand. On the other hand, to meet the water demand in the expanded water supply area, it is necessary not only to operate the existing WTPs at full capacity but also to enhance capacity by developing new water supply and treatment facilities.

(3) Insufficient Budget for New Facility Development

As mentioned in section 2.2.4(1), MUWASCO's financial performance over the recent five years (2018-2022) has remained in the black. However, the annual profit figures have ranged from 17 million Kshs to 37 million Kshs, which is considered insufficient in terms of profitability.

The cash flow (CF) for the most recent five years is presented in Table 2-12. The financial trends over the past five years have been consistent, with positive CF from operating activities, negative CF from investing activities, and positive CF from financing activities. Overall CF has remained positive for the last three years. Notably, the CF from investing activities for the last two years have been significant due to the inclusion of expenses related to pipeline improvements and water meter installations, totaling approximately 30-40 million Kshs. From the above, although MUWASCO is systematically advancing network improvements using funds generated from its operational activities, there is limited surplus funding available. As a result, it is not feasible for MUWASCO to undertake large-scale facility improvement projects solely with its own funds.

Table 2-12 MUWASCO's Cash Flow (Fiscal Years 2018-2022)

Unit: Kshs

Item	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022
I. CF from operating activities	**18,661,413**	**10,429,915**	**12,978,819**	**43,038,699**	**28,677,583**
Surplus generated from operating activities	15,739,570	16,370,265	17,023,688	22,826,332	37,167,614
Adjustment for: Non-cash items	11,893,666	13,334,719	13,809,093	15,103,731	18,660,038
Changes in working capital	-8,971,823	-19,276,069	-17,853,962	5,108,636	-27,150,069
II. CF from investing activities	**-56,723,477**	**-14,988,062**	**-12,348,268**	**-59,303,115**	**-57,898,260**
Purchase of P.P.E and Intangible assets	-56,723,477	-14,988,062	-12,511,042	-59,303,115	-57,898,260
Disposal of motor vehicles			162,774		
III. CF from financing activities	**36,318,035**	**2,865,833**	**0**	**24,402,147**	**29,289,579**
Deferred income	36,318,035	2,865,833		24,402,147	29,289,579
IV. Net Decrease/increase in cash & cash equivalents	**-1,744,029**	**-1,692,314**	**630,551**	**8,137,731**	**68,902**
V. Cash and Cash equivalent at start of year	**4,164,464**	**2,420,433**	**728,117**	**1,358,670**	**9,496,401**
VI. Cash and Cash equivalents at end of year	**2,420,435**	**728,119**	**1,358,668**	**9,496,401**	**9,565,303**

※1 Ksh = 0.917 JPY, January 2024

Source: Survey team based on MUWASCO's past 5 years of Audit Reports

(4) Water Source Related-Issues

1) Overview of water source

In Kenya, deforestation has become a factor contributing to the degradation of water resource functions, such as reduced water retention. This has led to phenomena such as decreased river flow and increased frequency of floods. Kenya ranks fifth in Africa as a country that has lost over 90% of its traditional forests through deforestation. Changes in land use, including residential areas, cultivation, and development projects in forest conservation areas, result in the loss of over 5,000 hectares of forest annually. Additionally, recent warming trends have led to the shrinkage of glaciers on Mount Kenya. In some regions, the disappearance of glaciers has transformed rivers that once flowed throughout the year into seasonal

watercourses, exacerbating conflicts over water resources.

In addition to the above, in the Tana River basin, there is an increasing demand for irrigation water necessary for crop production in the sloping areas extending from Mount Kenya. This demand is affecting downstream water users, and there is competition among various water uses such as power generation, industrial water supply, tourism, and livestock rearing. In the case of Irati River, a primary water source for MUWASCO, there are three water rights holders—MUWASCO, MUSWASCO, and irrigation water users—drawing water from adjacent locations near existing abstraction facilities. The available water volume for abstraction from the Irati River is 26,000 m3/day, which is currently managed with a margin of safety. However, considering the low water levels during dry seasons, a detailed assessment of the potential for additional water abstraction is necessary at the stage of the preparatory survey.

2) Priority of water use

According to the Water Act of 2002, the priority of water use in river basins is as follows: River maintenance flow is the first priority, followed by existing water uses (domestic, irrigation, power generation, etc.) based on water rights allocation. The priority for new water development is lower than these existing uses.

Table 2-13 Prioritization of Water Allocation according to the Kenyan Water Act

Priority	Water Use
1	Reserve consisting of ecological and basic human needs
2	Existing water uses for domestic, industrial, irrigation and hydropower, and existing inter-basin transfer water (International obligation to allocate water is not considered, because there are no international commitments so far.)
3	New domestic and industrial water uses
4	New livestock, wildlife and inland fishery water uses
5	New irrigation water use
6	New hydropower generation use

Source: National Water Master Plan 2030

3) Issues Related to Water Source

Considering the impact of external factors such as climate change and deforestation on reduced river water flows, as well as the influence of other water users on water use, MUWASCO's challenge is to develop and secure sustainable water sources while ensuring the necessary river maintenance flows.

(5) Issues Related to Facility Operation and Maintenance

1) Water Quantity Management

At the Kiawambeu WTP, operational management is conducted by two teams, each consisting of two individuals. In terms of water quantity management, there is a balance between water demand and the amount of treated water available. Alternatively, there might not be enough treated water to meet the demand (resulting in an emptying of treated water reservoirs). Therefore, there is currently less necessity to control the amount of treated water at the WTPs. However, the implementation of the proposed projects

described in Chapter 3 will result in an increased amount of treated water. Therefore, conducting water demand forecasts and managing the treated water amount based on these results will become a future challenge.

2) Water Quality Management

Water quality management at the WTP involves measuring turbidity, pH, and residual chlorine concentration every two hours. Turbidity and pH are measured in raw water, treated water after sedimentation, and filtered water, while residual chlorine concentration is measured in treated water after sedimentation for pre-chlorination and filtered water for post-chlorination. Additionally, an external contractor conducts monthly measurements of the coliform group. Therefore, it can be said that the minimum water quality tests are being carried out. However, in the future, it is desirable to conduct measurements of inorganic substances, organic substances, and pesticides as specified in the Kenyan drinking water quality standards. In addition, although the jar tester is maintained, it is not used regularly. While there is a facility for injecting soda to supplement alkalinity during the rainy season, alkalinity is not measured, indicating that coagulant injection management based on water quality changes is not adequately implemented. Additionally, the fixed turbidity meter is malfunctioning, and a portable turbidity meter is used regularly. However, during periods of high turbidity, the measurement exceeds the measurable range, preventing accurate measurements.

3) Cleaning of Clear Water and Distribution Reservoirs

At the Kiawambeu WTP, the clear water reservoir is a single-tank structure, making it impossible to clean the tank while it is in operation. Similarly, other distribution reservoirs have the same structure, posing a challenge for regular cleaning. If regular cleaning of the distribution reservoirs cannot be performed, there is a risk of sediment flowing out, leading to the occurrence of turbid water at the water taps.

2.2.6 Hygiene-related Issues and Waterborne Diseases (Target Area)

(1) Occurrence of Waterborne Diseases

In the targeted area, there have been no reported cases of waterborne diseases in the last five years. The majority of residents use sanitation facilities such as septic tanks and simple pit latrines, and the connection rate to the sewer system is low, standing at 30%.

(2) Drinking Water Quality Standards

Kenya's drinking water quality standards are established by WASREB based on the Water Act 2002, and they monitor compliance with these standards for WSP's water supply operations. Additionally, discharge standards for wastewater from facilities such as WTPs are outlined in "The Environmental Management and Coordination (Water Quality) Regulations, 2006," and compliance with these standards is also required. MUWASCO's compliance with drinking water quality standards was 100% in the 2022 fiscal year, indicating that there are currently no issues in this regard. On the other hand, the WTPs may lack adequate wastewater treatment facilities, and there is a high likelihood that the discharge standards for wastewater may not be met.

2.2.7 Others

(1) Climate Changes

Kenya, characterized by approximately 80% of its land being arid or semi-arid, is considered a region with low resilience to climate change. The impacts of climate change on citizens' lives and the environment are increasing each year, with occurrences such as droughts, unpredictable and irregular rainfall, floods, and global warming becoming more frequent. These phenomena pose serious challenges to water security, food security, and economic growth. Particularly since 2020, the country has faced the worst drought in the last 40 years, leading to record levels of food shortages in affected areas. The agricultural sector, which constitutes about 33% of the Gross Domestic Product (GDP), is also at risk. It is predicted that by 2050, temperatures could rise by up to 2.5°C, and the frequency of extreme weather events such as floods and droughts is expected to further increase. In arid and semi-arid regions, droughts and floods have intensified, and coastal areas are experiencing sea-level rise and saltwater intrusion. Additionally, from 2010 to 2020, lakes like Lake Victoria and Lake Turkana have significantly expanded, causing flooding in the lakeside regions. These climate change challenges particularly impact vulnerable communities, women, youth, etc., affecting their daily lives, making tasks like water fetching more time-consuming and risky, and adversely impacting productive economic activities. Furthermore, global warming has led to the shrinkage of glaciers on Mount Kenya, and in some regions, rivers that used to flow year-round due to glacier disappearance are now seasonal, escalating conflicts over water resources.

The targeted area of Murang'a City and its surrounding areas are situated in the upper area of the Tana River Basin. In comparison to the midstream semi-arid area and the downstream arid area where floods are frequent during the rainy season, this area has a lower flood risk. Moreover, regarding drought, as mentioned in Section 2.2.4(2) 1), the anticipated increase in surface water across the entire Tana River Basin suggests minimal impact. The effects are considered to be more influenced by the increased water demand rather than the climate change factors affecting river flow.

2.3 Relevant Plans

2.3.1 Outline of the National Development Plan

The Kenyan government has formulated the "Kenya Vision 2030" as its national development plan from 2008 to 2030. This plan, inspired by the vision strategies of emerging Asian countries, represents the Kenyan government's long-term development strategy, completed in June 2008. Its goal is to transform Kenya into "a newly industrializing, globally competitive, and prosperous upper middle-income country with a high quality of life for all citizens by 2030". The Vision 2030 plan is structured around three pillars: economic, social, and political. Under the "social" pillar, the plan aims to ensure that all citizens have access to improved water and sanitation facilities in a clean and safe environment by 2030.

To concretize the above development plan and work towards achieving "Kenya Vision 2030", Kenya has established initiatives related to the Sustainable Development Goals (SDGs). Specifically, in 2017, Kenya developed the "Implementation of the Agenda 2030 for Sustainable Development in Kenya" in 2017 and formulated the "Roadmap to Sustainable Development Goals (SDGs) Kenya's Transition Strategy" in 2019.

These initiatives include the setting of Key Performance Indicators (KPIs) for short-term, medium-term, and long-term goals, aiming to promote comprehensive and sustainable development.

2.3.2 Upper-Level Plans and Relevant Plans for the Project

1) National Development Plan (Kenya Vision 2030)

Regarding the water and sanitation sector, the goal is for all citizens to have access to safe water and adequate sanitation facilities by 2030. In response to this goal, the urban water coverage improved from 48% in 2010 to 62% in 2021. However, the NRW rate remains above 40% and the Kenyan government has consistently viewed this as a significant challenge.

To address this issue, the Ministry of Water, Sanitation, and Irrigation (MWSI), responsible for water supply infrastructure in the country, has established NRW units within the Ministry and worked to encourage water service providers (WSPs) responsible for water supply projects across different regions to reduce NRW.

MWSI has developed a Strategic Plan 2018 – 2022 for the Water and Sanitation sector in alignment with the Medium Term Plan III (2018 – 2022). This plan sets an interim target to be achieved by 2022, aiming for 80% of the total population to have access to safe water. To reach this goal, the plan outlines an increase in the percentage of people with access to safe water, targeting an increase from 70.3% in urban areas in 2018 to 83% by 2022, and an increase from 55.9% in rural areas in 2018 to 78%.

2) Big Four Agenda 2018/2019

The Big Four Agenda is an economic blueprint developed by the Kenyan government to promote economic development and provide solutions to various socio-economic challenges faced by Kenyan citizens. This agenda is aligned with "Kenya Vision 2030" and has been mainstreamed in the Medium Term Plan III 2018 – 2022.

The Big Four Agenda outlines four key pillars of focus for the period from 2018 to 2022, which include strengthening of manufacturing, food security and nutrition, universal healthcare coverage, and affordable housing supply. Among these, "affordable housing supply" aims to provide clean water and continuous electricity supply, as well as the development of suitable, standardized, and spaced housing.

In this agenda, there is a focus on ensuring access to safe water for low-income groups and arid areas, with the goal of improving the access rate by 2022.

3) The Third Medium Term Plan (MTP III 2018 – 2022) and the Strategic Plan for the Water and Sanitation Sector (Strategic Plan 2018 – 2022)

The Kenyan government formulated MTP III to achieve the goals outlined in "Kenya Vision 2030". In the water supply sector, the aim of MTP III, aligned with the Big 4 Agendas and the Sustainable Development Goals (SDGs), is to achieve the water and sanitation-related objectives. To this end, they established a five-year strategic plan called "Strategic Plan 2018 – 2022" in December 2018.

4) National Water Resources Management Strategy (NWRMS) 2007 – 2009

In conjunction with the formulation of Kenya Vision 2030, the water supply sector has developed a National Water Resources Management Strategy with the fundamental objectives of eradicating poverty through the provision of water for drinking water production, ensuring equitable access to water resources, and promoting sustainable and efficient water utilization.

5) National Water Services Strategy 2007 – 2015

Since the enactment of the Water Act in 2002, a national water service strategy for the water supply sector has been developed. As part of this strategy, the goal was to reduce the average NRW rate from 60% to 30% by 2015 by addressing both commercial and physical NRW losses. Specifically, in urban water supply services, the strategy aimed to install meters for all customers to prevent water wastage and ensure accurate billing of water charges.

6) National Water Quality Management Strategy 2012 – 2016

The Ministry of Water and Sanitation (MWS), which preceded MWSI (Ministry of Water, Sanitation, and Irrigation), developed the National Water Quality Management Strategy 2012 – 2016 based on insights gained from the implementation of the National Water Resources Management Strategy.

Table 2-14 Development Plans in Kenya

Year of Formulation	Development Plans
2006	National Water Resources Management Strategy 2007 – 2009
2006	National Water Services Strategy 2007 – 2015
2008	Kenya Vision 2030 (National Development Plan)
2011	National Water Quality Management Strategy 2012-2016
2017	Big Four Agenda 2018/2019
2022	Medium Term Plan IIII 2023 – 2027: MTP IIII, Strategic Plan 2023 – 2027

Source: Survey team

2.3.3 Urgency and Priority of the Project

(1) Urgency of the Project

The target area, Murang'a City, serves as the central hub of Murang'a County with a concentration of key administrative institutions. With the recent expansion of the Murang'a University, there has been an increase in demand not only for housing, but also for water supply infrastructure. Additionally, its proximity to Nairobi and the improvement of the Kenol-Makutano-Marua highway, which traverses Murang'a County, have enhanced transportation convenience, making commuting between Murang'a City and Nairobi more accessible. As a result, the population of Murang'a City has been on the rise, surpassing the average population growth rate in Murang'a County. This population increase has imposed strain on existing water

supply infrastructure, leading to water supply restrictions even in areas that previously receiving 24-hour water supply.

Against this backdrop, the Kiawambeu WTP, the primary WTP in Murang'a City, is facing a situation where it cannot secure sufficient water intake to meet its water treatment capacity of 15,000 m^3/day. The plant is currently operating below its designed treatment capacity. Furthermore, the Murang'a County Government has announced plans to expand the current area of Murang'a City from 145 km^2 to 330 km^2. This expansion underscores the urgent need to increase water production capacity and expand the water distribution network to accommodate the growing water demand.

On the other hand, MUWASCO, the water service provider under consideration in the project, has recently operated with a surplus in its water supply operations. It is able to cover operating expenses and depreciation costs. However, securing funds for new facility development without subsidies from the Kenyan government or financial assistance from donor agencies is challenging. Additionally, it is difficult to allocate sufficient funds for the necessary maintenance costs to sustain the functionality of the existing facilities.

In order to sustain such operations, including grant aid projects from the Japanese government, they are urgently seeking support from donors.

(2) Priority of the Project

The COVID-19 pandemic, which has spread worldwide since the end of 2019, has further emphasized the importance of SDGs Goal 6, which aims to "ensure availability and sustainable management of water and sanitation for all." It has highlighted the need for additional measures to accelerate progress towards achieving this goal.

In other words, SDG Target 6.1 aims to achieve "universal and equitable access to safe and affordable drinking water." However, in the context of the COVID-19 pandemic, effective measures to prevent the spread of the virus, such as handwashing with soap, have become crucial. Since the outbreak of the COVID-19 pandemic, **ensuring access to hygienic water for handwashing, in addition to providing clean drinking water, has become a significant challenge**.

Therefore, to use water, which has been treated as a precious resource for drinking, to effectively remove invisible viruses, **it is necessary to have easier access to safe and clean water, along with an adequate supply of water. Additionally, the provision of sanitation facilities and the promotion of hygiene education, especially handwashing, become crucial**.

Our country, based on the long-term development strategy called "Kenya Vision 2030" set by the Kenyan government, has committed to providing focused support in five key areas: 1) economic infrastructure development, 2) agricultural development, 3) environmental conservation, 4) human resource development, and 5) healthcare.

In particular, in the field of 3) environmental conservation, we have pledged support in response to the

growing challenges of climate change. This includes assistance in **water supply and water resource management**, support for forest conservation and disaster mitigation, as well as efforts to enhance environmental management capacity to address the deteriorating urban environment due to the increasing urban population.

These basic policies of Japan's ODA align with the key sectors of Kenya's National Infrastructure Plan. Supporting these various sectors through assistance is believed to play a significant role in promoting stable development in both political and economic aspects.

Since the outbreak of the COVID-19, it is anticipated that Japan's support for water supply projects has shifted towards not just promoting water supply initiatives but also adopting a multi-dimensional approach that includes "water supply and sanitation" as well as "education and awareness campaigns."

According to the new Kenyan Constitution enacted in 2010, all Kenyan citizens have the right to access water, and access to safe water is considered a fundamental human right. Ensuring the stable supply of safe water is believed to contribute to addressing public health and healthcare challenges.

Given our track record of providing high-quality support to Kenya, the implementation of the project in Murang'a County can serve as an important precedent for Japan's multi-sector support in advancing water supply projects.

In Murang'a City, the rapid urbanization and the subsequent increase in urban population have led to a growing demand for access to water supply and sanitation services in urban areas, resulting in water stress. Therefore, this project not only compiles a water supply facility development plan to alleviate water scarcity in Murang'a City and its surrounding areas but also formulates a next-generation water supply facility development plan that utilizes renewable energy sources to reduce greenhouse gas emissions.

The implementation of the project will not only address the challenges of enhancing urban water supply services but also support the proper management of the natural environment, which forms the foundation for sustainable economic development. Additionally, it will contribute to promoting resilience against recent climate change impacts. Therefore, the project is considered to have a high priority.

2.3.4 Comparison of Possible Projects

There are no other possible projects.

2.3.5 Information of Relevant Sectors

There is no information of relevant sectors.

2.4 Responsible Authorities and Implementing Agencies

The organizational structure of Kenya's water sector includes MWSI, which oversees national-level policy making, budget allocation, monitoring, and coordination, and the Water Works Development Agencies

(WWDAs) under the Ministry, which are responsible for developing water facilities in eight regions across the country. The actual water services are operated by Water Service Providers (WSPs) based on service contracts entered into with WWDAs.

The implementing agency for this project, Murang'a WSP (equivalent to MUWASCO), was established in 2006, with Tana Water Services Board (WSB) serving as the asset holder and authorizer. Subsequently, organizational restructuring occurred under the SPA contract, and the current structure was established in 2016. In 2023, the Murang'a County Government acquired it, making it a subsidiary under the county government. The roles and responsibilities of the key agencies in the water sector are outlined in the table below.

Table 2-15 Roles of Key Organizations in the Water Sector

Agency	Name	Role
Implementing Agency	MUWASCO: Mulanga Water Supply Company	✧ Provide efficient and cost-effective water and sanitation services to all residents within the jurisdiction
Responsible Authority (at national level)	MWSI: Ministry of Water, Sanitation, and Irrigation	✧ Policy formulation related to the water sector. ✧ Supervision, guidance, and budget allocation for the water sector, etc.
Responsible Agency (at regional level)	WWDA: Water Supply Development Agency	✧ Contracting with WSPs for the efficient and cost-effective provision of water services ✧ Development and maintenance of water supply and sanitation facilities ✧ Technical support and capacity development for state governments and WSPs, etc.
Responsible Agency (at local level)	WSPs: Water service supplier	✧ Provision of water and sanitation services in designated areas using facilities developed by state governments and WWDA, etc.

Source: Survey Team

2.4.1 Relevant Government Agencies

(1) MWSI: Ministry of Water, Sanitation and Irrigation

MWSI is a ministry established by Executive Order No. 6 of August 22, 2019, as a result of the merger of the State Department of Irrigation and the Ministry of Water and Sanitation (MWS). Its primary role is to formulate policy in the areas of water supply, sanitation, and irrigation.

Specifically, it is responsible for formulating policies, drafting legislation, implementing legislation, monitoring policy implementation, and planning and allocating budgets in the areas of water resources management, water supply and sanitation services, wastewater treatment, water quality pollution management, irrigation, and related matters.

The Ministry comprises three main divisions: the Directorate of Water and Sanitation, responsible for technical functions related to water supply, sanitation, and water resources; the Directorate of Irrigation,

responsible for technical functions related to irrigation water management, drainage, and harvesting; and the Administrative Services, which oversees personnel, finance, accounting, procurement, administration, legal affairs, ICT, and supports the technical departments.

(2) WASREB: Water Services Regulatory Board

WASREB was established as the national regulatory agency for water and sanitation services in Kenya, in accordance with the Water Act 2002. As per Section 70(1) of the Water Act 2016, WASREB's role is to protect the interests and rights of water consumers while also ensuring the interests of other stakeholders. Therefore, WASREB sets standards and guidelines for water and sanitation services and enforces regulations.

According to Section 72 of the Water Act 2016, WASREB's main powers and functions are as follows:

- Determine and prescribe national standards for the provision of water services and asset development for water services providers.
- Evaluate and recommend water and sewerage tariffs to the county water services providers and approve the imposition of such tariffs in line with consumer protection standards.
- Set license conditions and accredit water services providers.
- Monitor and regulate licensees and enforce license conditions.
- Develop a model memorandum and articles of association to be used by all water companies applying to be licensed by the regulatory board to operate as water services providers.
- Monitor compliance with standards including the design, construction, operation and maintenance of facilities for the provision of water services by the water works development bodies and the water services providers.
- Advise the Cabinet Secretary on the nature, extent and conditions of financial support to be accorded to water services providers for providing water services.
- Maintain a national database and information system on water services, etc.

(3) WRA: Water Resources Authority

The Water Resources Authority (WRA) was established under Section 11 of the Water Act 2016. It is vested with powers delegated by the national government and is responsible for regulatory oversight related to the management and utilization of water resources nationwide. This includes water allocation, source protection, water quality management, pollution prevention, and other regulatory aspects concerning water resources.

Under Section 12 and Section 13 of the Water Act 2016, the main powers and functions of the WRA are defined as follows:

- Formulate standards, procedures and regulations aimed at ensuring proper management and use of water resources
- Enforce Regulations formulated by WRA so as to ensure compliance through inspection, monitoring

and enforcement

- Receive water permit applications for water abstraction, water use and recharge and determine, issue, vary water permits; and enforce the conditions of those permits
- Regulate Water use allocation
- Collect water permit fees and water use charges
- Provide information and advice the Cabinet Secretary for formulation of policy on National Water Resource Management, water storage and flood control strategies
- Manage the National Monitoring and Information System, etc.

(4) WWDA: Water Works Development Agency

The WWDA was established as a state corporation under the jurisdiction of the MWSI, inheriting its role from the predecessor WSB. This transition occurred in accordance with the provisions of Article 65 of the Water Act of 2016. The transfer of responsibilities from the existing eight WSBs to their respective WWDA entities was officially published in the government gazette on April 26, 2019.

The WWDA is responsible for operating and maintaining water supply facilities, including both national and cross-county water supply infrastructure. It manages the operation and maintenance of facilities during the period before the transfer of water and sanitation services functions to the WSP. In addition, the WWDA provides technical support and capacity building to counties and WSPs and offers technical assistance to the Ministry's activities.

It is noted that the WWDA overseeing MUWASCO, the water utility involved in this project, is the Athi Water Works Development Agency (AWWDA).

(5) WSP: Water Service Provider

In accordance with the Water Act of 2016, Water Service Providers (WSPs) are established or owned by county governments and are certified by WASREB as Public Limited Liability Companies to provide water and sanitation services. WSPs obtain operational licenses from WASREB and operate under its regulations to deliver water and sanitation services. The Water Act of 2016 outlines two main responsibilities for WSPs.

- Provision of water services within the area specified in the license
- Development of county assets for water service provision

In this way, the functions of the WSP include the development of county water and sanitation facilities. Furthermore, the same law stipulates that a public WSP can own public water and sanitation assets of the county or the country (Section 83), that the WSP must provide efficient and economical water and sanitation services (Section 91), and that funds collected by the WSP for water and sanitation services must be used in full for the cost of service provision and facility development (Section 131).

In practice, the WSP is responsible for providing water services, particularly in urban areas where commercial service provision is viable. Additionally, it also handles sewerage services, sanitation facility development, and sludge extraction services, among other responsibilities.

(6) WSTF: Water Sector Trust Fund

According to the Water Act 2016 (Section 113), the Water Services Trust Fund (WSTF) was established as a state corporation under the Ministry of Water, Sanitation, and Irrigation (MWSI). Its primary objective is to provide financial support for the development and management of water and sanitation services in underserved areas. To achieve this, WSTF offers counties both funds from the Equalization Fund and grants, whether conditional or unconditional. The Equalization Fund is created by reserving 0.5% of the central government's total annual revenue. This fund is utilized by the central government to provide essential services such as water, roads, and healthcare in marginalized regions. However, WSTF has not received funding from this source. The grants provided by WSTF cover the following areas:

- Community level initiatives for the sustainable management of water resources
- Development of water services in rural areas considered not to be commercially viable for provision of water services by licensees
- Development of water services in the under-served poor urban areas
- Research activities in the area of water resource management and water services, sewerage and sanitation

2.4.2 Organization of the Implementing Agency

Figure 2-11 shows the organizational chart of MUWASCO. MUWASCO is divided into eight main departments: Finance/Account, Commercial, Technical Service, Monitoring & Evaluation, Procurement, Human Resource & Administration, Internal Audit, and Corporate. As of July 2023, MUWASCO has a total of 126 staff members, consisting of 120 permanent employees and 6 temporary employees. [2]

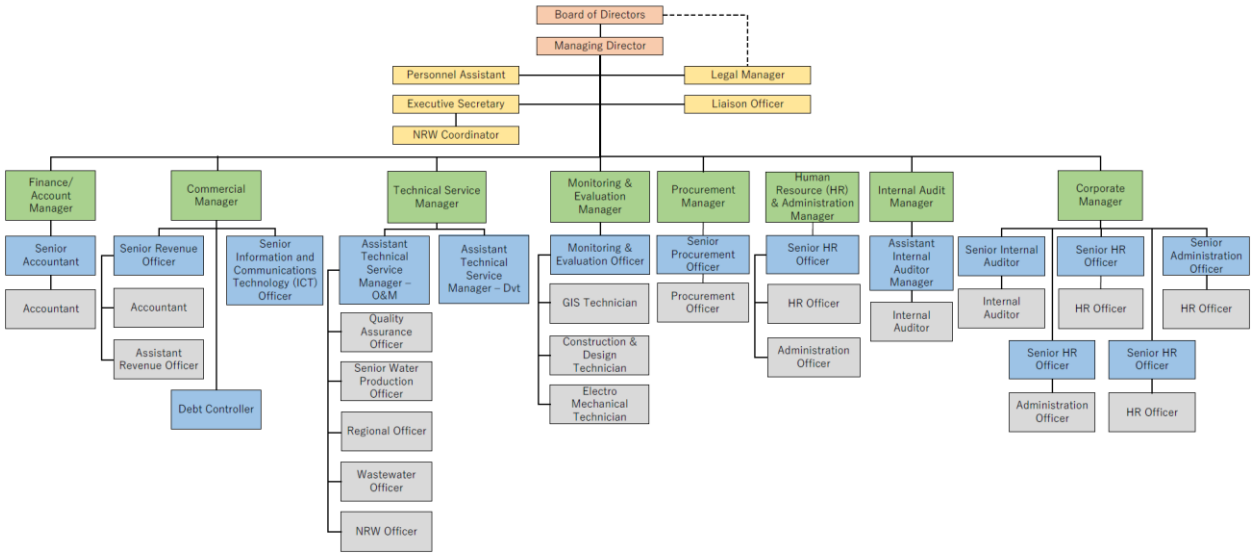


Figure 2-11 Organizational Chart of MUWASCO

Source: Survey team based on MUWASCO

2.4.3 Functions of the Implementing Agency

MUWASCO was established in 2006 with the aim of providing water and sanitation services to Murang'a and its surrounding areas. Currently, it operates its water business under the following Vision and Mission:

Vision To become a world-class water and sanitation service provider that exceeds customers' expectations now and in the future. Mission To provide quality water and sanitation services in a reliable, efficient and sustainable manner

Source: MUWASCO HP

In the Strategic Plan 2020－2025, MUWASCO has identified the following four core functions:

a. To source, treat and manage all the town's water supply & sewerage
b. Supplying good quality water in sufficient quantities to meet various needs while ensuring, safe disposal of waste water and environmental protection
c. Bill and collect water and sewerage revenue
d. Allocation of water in a sustainable, rational and economic way

2.5 Japan's Assistance to Kenya

2.5.1 History of Japan's Assistance

Shown in Table **2-16** is the historical ODA provided by Japan to Kenya (in terms of monetary amounts).

Table 2-16 Performance of Japan's ODA to Kenya

(Unit: 100 Million Yen)

Fiscal Year	Loan Aid	Grant Aid	Technical Cooperation
2016	－	18.95	44.07
2017	225.43	37.29	32.93
2018	－	9.72	36.90
2019	848.90	65.69	46.18
2020	80.00	26.70	21.40
2021		3.79	50.71
Total	4,910.09	1,415.79	1,410.30

Source: Ministry of Foreign Affairs Government Development Assistance (ODA) Country Data Compilation 2022

Assistance to the water supply sector in Kenya has been provided since about 1977 through development surveys, concessional funding cooperation, and non-concessional funding cooperation, as well as the dispatch of experts. In recent years, there has been a proactive emphasis not only on hardware aspects but also on software aspects, including projects and technical cooperation projects that focus on promoting the sustainable operation of water utilities, such as the dispatch of experts for pilot water supply projects.

Table 2-17 List of the Technical Cooperation Projects and Loan Projects (Water Sector)

Year	Name/Other	Summary
【Dispatch of Experts】		
To 1990s	Water supply experts: 11 Water resources development expert: 1	
Since 1990s	Water supply experts: 4 Water resources development experts: 7 Water supply business management experts: 2	
【Development Survey】		
1981	Mombasa District Water Supply Improvement Project	F/S for water demand and supply improvement in the Mombasa City, local 6 small towns and villages, and rural areas up to the year 2000
1988－1990	Marewa Dam Construction Project	F/S for dam construction in the Marewa River Basin to ensure and enhance water supply to the three cities of Nakuru, Kirgil, and Naivasha in the eastern rift valley province
1995－1997	Meru County Water Supply Project	Development of basic and priority plans for water resources development to improve water supply conditions in Meru City and its surrounding areas
1995－1997	Kisumu City Water and Sanitation Infrastructure Development Project	Development of basic plans and F/S for the expansion of Kisumu City's WTP, sewage treatment plant, intake facility, and water distribution facilities
1995－1998	Aftercare Study of the National Water Master Plan	Water resources development project performance assessment
2000s	Local Urban Water Supply Operation Improvement Plan Survey	Overseas development survey
2010－2014	Non-Revenue Water Management Project	Establishment of a nationwide system for monitoring, implementation, and promotion of NRW reduction measures, as well as support for enhancing NRW reduction capabilities
2010－2012	National Water Master Plan 2030 Development Project	Development of a master plan taking into consideration changes in the framework of water resource management, socioeconomic development, and anticipated impacts of future climate changes
【Loan Aid】		
1986－1994	Greater Nakuru Water Supply Project	This project aimed to provide water to the eastern region of Greater Nakuru, with the establishment of a water supply facility with a capacity of 17,000m^3 per day. Additionally, it included the restoration of wastewater treatment facilities

Year	Name/Other	Summary
		and the construction of rainwater retention ponds to preserve the water quality of Lake Nakuru. The project was supported by a concessional loan agreement of 5.017 billion yen.
1988－1994	Nairobi Water Supply Project	In Nairobi City, a new water supply facility was constructed using a fresh water source, increasing the water supply capacity from 194,000 m^3/day to 455,000 m^3/day. The project encompassed dam construction, water supply facilities, drainage facilities, and wastewater treatment plants, and it was carried out through coordinated financing involving the World Bank, the African Development Bank, and the European Investment Bank. The project was supported by a concessional loan agreement of 5.342 billion yen.
【Technical Cooperation】		
2016－2022	Project strengthening capacity in Non-Revenue water reduction	Urban water utility companies were strengthening Non-Revenue Water (NRW) reduction activities through the NRW Reduction Support Mechanism.
2022	Project for Strengthening Capacity of Water Service Providers on Formulating Bankable Project Plans	The objective of this project was to enhance the capacity of pilot water utility companies to develop bankable business plans and improve their capacity to implement such plans. This includes the development of bankable business planning guidelines for water utility companies across Kenya by WASREB. In addition, the project provided support in formulating an action plan to promote financing by the Ministry of Water, Sanitation, and Irrigation to encourage blended finance or commercial lending, capital market financing to water utility companies. The overall aim was to facilitate financing for water utility companies through blended finance or commercial lending, capital market financing, thereby contributing to the improvement of water supply services to residents by water utility companies across Kenya.

Table 2-18　List of Grant Aid Projects (Water Sector)

Year	Name	Project Cost (Mil. Yen)	Summary
1977	Itinga District Water Supply	400	Construction of a water supply facility in the Itanga District.

Year	Name	Project Cost (Mil. Yen)	Summary
	Project		
1981	Groundwater Development Project	1,200	Development and implementation of a groundwater development plan in the specified area.
1982	Itinga District Water Supply Extension	40	Construction of a water supply facility in the Itanga District.
1988	Groundwater Development Project	1,200	Development and implementation of a groundwater development plan in the designated area.
1988	Tabeta-Lumi District Water Supply Project	990	Development and implementation of a water supply plan in the Tabeta-Lumi District.
1999－2000	Laikipia County and Others Groundwater Development Project (Phase 1, Phase 2)	1,030	Construction of 57 wells in Laikipia County (19 locations), Samburu County (16 locations), and elsewhere, along with the implementation of technical guidance and community awareness activities for 90 water user groups.
2001－2003	Meru City Water Supply Project (Phase 1, Phase 2)	1,370	The project aimed to increase the water supply population from 14,000 to 51,000 people in Meru City by renovating and partially expanding the existing water supply facilities, procuring maintenance equipment, and improving water supply operations. In addition, it seeks to reduce NRW rates to below 30%, providing a hygienic and stable urban water supply.
2004－2007	Rural Water Supply Project (Phase 1, Phase 2)	810	The drilling of 53 wells (24 hand pumps, 24 submersible pumps, and 5 windmill pumps) in four counties (Machakos, Kitui, Mwingi, and Makueni), along with the procurement of associated equipment, and the carrying out of the necessary soft components for the management and guidance of the water supply facilities.
2006－2008	Rural Water Supply Project	530	Construction of 53 hand pump water supply facilities, 62 submersible motor pump and public tap water supply facilities, and one spring-based water supply facility in the counties of Kitui, Mwingi, Machakos, and Makueni in Eastern Province.
2007－2010	Project for Augumentation of Water Supply System in Kapsabet Town	2,046	The project includes rehabilitating the existing intake weir, constructing a new WTP, building a new distribution reservoir, laying supply, transmission, and distribution pipelines (approximately 400 households), procuring equipment, and implementing the necessary soft components for water supply facility management guidance in Kapsabet City.
2009－2011	Programme for Community-based Flood	480	Creation of hazard maps, disaster preparedness training, flood awareness education for elementary school students, construction

Year	Name	Project Cost (Mil. Yen)	Summary
	Disaster Management to Adapt to Climate Change in the Nyando River Basin		of evacuation centers, and establishment of evacuation routes in 24 communities within the Nyando River Basin.
2010－2013	Project for Improvement of Water Supply System in Embu and Surrounding Area	2,560	The establishment of new intake weirs, conduits, WTPs, and distribution networks for water supply in Embu City and the surrounding areas in Central Province, along with equipment procurement and the implementation of the necessary soft components to initiate water supply facility management.
2011	Second Phase of Rural Water Supply Project	609	To support the construction of over 50 water supply facilities in the Machakos and Makueni regions, including strengthening the operation and maintenance of the water supply facilities.
2012－2015	Project for Rural Water Supply in Baringo District	1,173	To construct 90 borehole water supply facilities, provide related equipment, and conduct awareness activities on maintenance and management.
2012－2015	Project for Augumentation of Water Supply System in Narok Town	1,410	To undertake the expansion and renovation of the WTP, lay various pipelines, provide related equipment, and offer technical guidance on maintenance and enhancing the capacity of water supply operations.

2.5.2 Opinions by Recipient Country / Agency on Cooperation by Japan

During the survey, a meeting was held with Eng. SAO Alima, the Water Secretary, and Eng. Patricia N. Kiarie, Deputy Director of Operation and Coordination, at MWSI. Both expressed gratitude for the strong relationship with JICA and acknowledged the past cooperation from the Japanese government in Kenya's water sector. They also expressed anticipation for further development in the collaborative relationship in the future.

2.6 Assistance by Third Party's Countries / International Donors

2.6.1 History of Assistance Related to the Project

Currently, the Kiawambeu WTP, which is the main water treatment facility owned by MUWASCO, was constructed in 2014 with a loan from AfDB. According to information obtained through hearings with MUWASCO, the repayment obligation for the loan was assumed by TWWDA, the supervisory authority for MUWASCO at that time, and MUWASCO, on its own, is not responsible for repaying the loan.

2.6.2 Existence of Request to the Project by International Donors

Kenya was excluded from the list of countries eligible for Japan's grant aid in the past, but due to the recent deterioration of its financial situation, it has regained eligibility for grant aid. However, the challenging

financial environment makes it difficult to implement grant aid projects. Additionally, if a large-scale project is to be implemented with loans, MUWASCO lacks sufficient repayment capacity for both the principal and interest. Against this backdrop, MUWASCO has not made any requests for support from third countries or international organizations for the proposed project.

On the other hand, "Improvement of Kiawambeu WTP's Operation Rate" is a crucial challenge for MUWASCO. Therefore, the component related to "Construction of Intake Facilities and Conveyance Pipes" within the proposed project has been explored for feasibility using various funding schemes.

In November 2022, MUWASCO applied for Aid On Delivery (AOD), but the application was not accepted. AOD is a form of blended finance that combines loans from commercial banks with grants from donors. In this case, the German Reconstruction Credit Institute (KfW) subsidizes 50% of the loan amount through a grant, contingent on the achievement of key performance indicators (KPIs) in WSP's water supply operations, facilitated through WSTF.

Subsequently, as part of the ongoing JICA technical cooperation project, the feasibility of implementing the project with a 100% loan from commercial banks has been evaluated. However, due to the unavailability of financial feasibility, significant scope changes have been necessitated. In light of these results, the current proposal under the JICA Technical Cooperation Project proposes to implement the existing water transmission pipeline rehabilitation project through a 100% loan from commercial banks to MUWASCO (refer to 2.2.5(1)). While this is not directly related to the proposed project, there is a need to establish linkages based on progress.

Chapter 3

Outline of the Project

Chapter 3 Outline of the Project

3.1 Approach to Solve Issues

3.1.1 Water Supply Issues (at National Level)

The main issues facing the water supply sector in Kenya are shown in below.

a) Insufficient budget for development of water supply project;
Water supply utilities alone cannot implement water supply projects for water facility development, and they often rely on financial assistance from county governments and international donors.

b) Unable to maintain financial independence;
The high non-revenue water rates and low tariff collection rates have led to a deteriorating financial situation, making it difficult to maintain a financial independence.

c) Water supply does not meet the demand;
The rapid urbanization in recent years has led to significant population growth, along with a corresponding increase in water demand, and the water supply is not keeping pace.

d) Insufficient data and information management regarding water quality and asset management;
The Ministry of Water, Sanitation, and Irrigation has identified the following issues:
- Insufficient water quality data for planning and decision-making.
- Lack of continuity in water quality surveys.
- Inadequate documentation of available information.

e) Inadequate technical expertise compared to the target level of operation and maintenance (O&M);
A high level of technical expertise is required in maintenance, addressing issues such as high NRW rates, database creation for water quantity and quality data, and data analysis and management using computers.

3.1.2 Relation with Water Supply Issues (at Project Level)

The relationship between the issues in the water supply in Murang'a City and its surrounding areas (mentioned in Sections 2.2.4 and 2.2.5) and the proposed project is shown in Table 3-1.

Table 3-1 Relation between Issues (at Project Level) and the Proposed Project

Issue	Project
Low operation rate of existing WTPs	The following implementations aim to increase the inflow of raw water to the WTPs and improve the operation rate of existing WTPs. ・Improvement of intake facilities ・Construction of additional raw water transmission pipeline
Insufficient water supply capacity for potential water demand	By improving the operation rate of the existing WTPs, enhancing the WTP's capacity, and expanding the distribution system, the water supply capacity will be strengthened.
Lack of budget for facility development	Through the proposed project, implementing facility development with Japan's Grant Aid will significantly improve revenue, eventually enabling future facility development through self-funding.
Sustainable use of drinking water	Implementing water supply facility development, considering

Issue	Project
sources	adjustments between beneficiaries and sustainable use of drinking water sources.
Inadequate O&M management	Providing technical support for facility O&M, water quantity and quality management through soft components, aiming to enhance the O&M capacity of the water supply facilities.

Source: Survey Team

3.1.3 Scope of the Project

The scope of the project is 1) the improvement of water supply system utilizing Japanese technology toward stable, safe and reliable water supply; and 2) the soft component through technical guidance for the training of knowhow on effective and efficient operation and management of the facilities and equipment.

3.1.4 Forms of Cooperation

The project utilizes a Japan's ODA scheme of Grant Aid Project including a Soft Component. This is a type of ODA Grants in which the government of the partner country enters into contracts with consultants or contractors to construct facilities or to procure equipment and materials.

3.1.5 Project Implementation Schedule

The implementation schedule of the project is shown in Table 3-2.

Table 3-2 Implementation Schedule of the Proposed Project (Tentative)

Milestone for Implementation	Year of Implementation
Submission of application form from the Republic of Kenya	2024
Evaluation of the request by the GOJ (Government of Japan)	2024 to 2025
Preparatory survey (Basic design)	2025 to 2026
Detailed design	2027
Implementation (Construction, procurement, soft component)	2028 to 2029

Source: Survey Team

3.2 Objective of the Project

3.2.1 Short-term Objective

The short-term objective of the project is to satisfy the water demand of Murang'a City and its surrounding areas, improve the living environment of the residents and contribute to the development of the local economy. To achieve this objective, the project will increase water production by improving the operation rate and enhancing the treatment capacity of the existing WTPs, and enhance the water supply function by improving the transmission and distribution systems.

3.2.2 Medium- and Long-term Objective

The medium to long-term objective is for MUWASCO to strengthen its financial foundation through the project and make it possible to cover a significant portion of the investment required for the expansion and maintenance of facilities by self-funding, and to make MUWASCO a model case for other water utilities in Kenya by achieving financial independence and sustainability in its water supply operations.

3.3 Outline of the Project

3.3.1 Outline of the Project

(1) Goal of the Project

This project aims to enhance the water supply system of MUWASCO, which serves Murang'a City and its surrounding areas in Kenya, to meet the continuously increasing water demand in the region. It contributes to the stable supply of safe and reliable water to the residents. Table 3-3 shows the basic conditions for planning the project.

Table 3-3 Basic Conditions for Project Planning

Target Year	2033
Planned served population	158,000
Daily maximum water distribution amount	23,000 m^3/day

Source: Survey Team

(2) Outline of the Project

The outline of the project is presented in Table 3-4. The primary objective of this project is to improve the operation rate of the Kiawambeu WTP and enhance its water treatment capacity to meet the growing water demand in the Murang'a City. To achieve this objective, the plan includes increasing the water intake amount from the Irati River (increasing raw water flow to the WTP) and strengthening the distribution capacity to handle the increased water volume. Specifically, the plan includes improvement of the intake facilities and installation of an additional raw water pipeline, expansion of the Kiawambeu WTP to boost production, construction of transmission and distribution facilities, installation of a micro-hydropower generator, and procurement of the necessary equipment for facility O&M. In addition, the plan includes technical guidance related to facility O&M and water quantity and quality management as soft components.

Table 3-4 Outline of the Project

Category	Project plan
Construction Works	Improvement of intake facilities: Q = 10,500 m^3/day
	Construction of raw water pipeline: L=15 km, φ500mm, HDPE
	Expansion of water treatment plant: Q = 5,000 m^3/day
	Installation of micro-hydropower generation system: 1 set, 30 kW
	Construction of transmission pipeline: L=5.5 km, φ250mm, HDPE
	Expansion of distribution reservoirs: 2 reservoirs (1,000m^3, 2,000m^3)

Category	Project plan
	Installation of electromagnetic flow meters: 4 locations (2 in raw water pipelines, 2 in transmission pipelines)
Equipment procurement	Water quality testing equipment: 1 set
Soft components	Technical guidance on O&M of water supply facilities
	Technical guidance on water quantity and quality management

Source: Survey Team

The overall improvement plan of water supply system is shown in

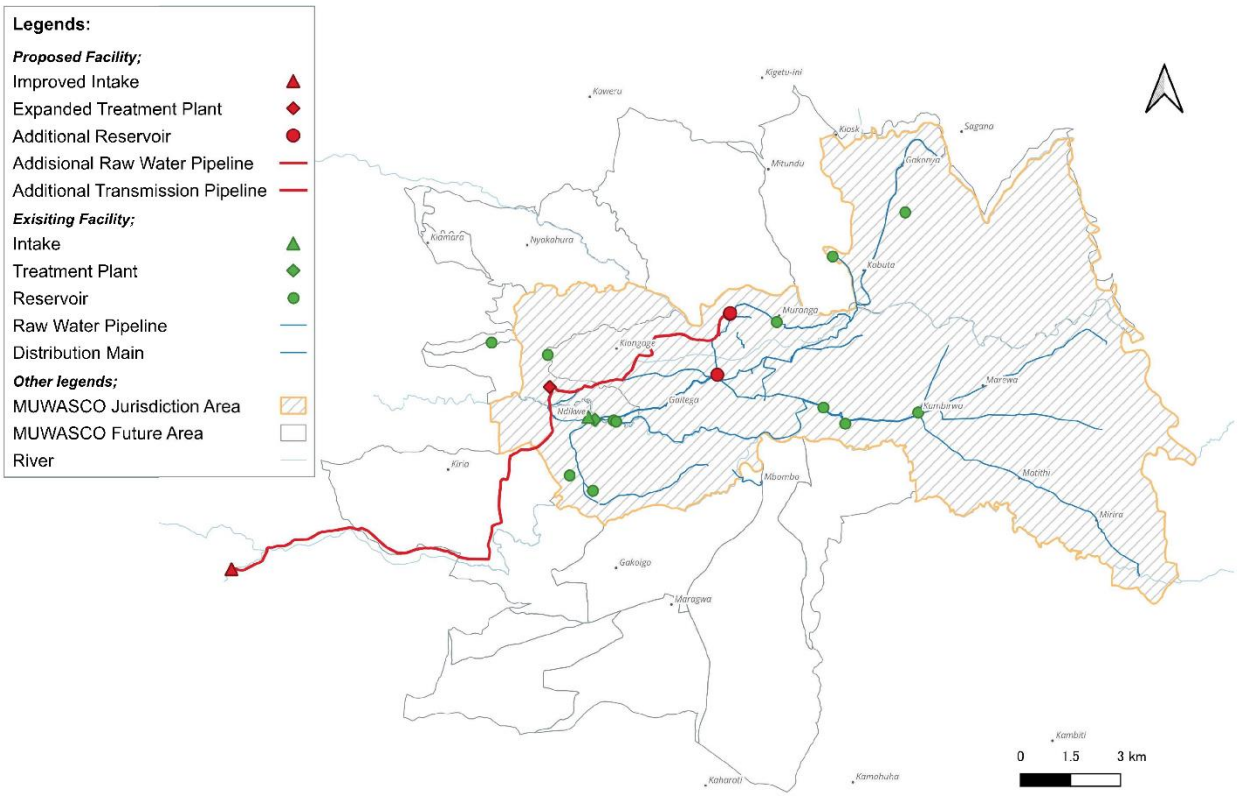


Figure 3-1, the schematic diagram of the water supply system flow and the hydraulic profile after facility improvement is shown in Figure 3-2 and in Figure 3-3, respectively.

The existing Irati Intake will be improved to install an additional raw water pipeline and raw water will be sent by gravity flow to the Kiawambeu WTP. This will increase the inflow of raw water to the Kiawambeu WTP by 10,500 m^3/day, resulting in improving its operation rate. In addition, the expansion of the Kiawambeu WTP will enable an additional 5,000 m^3/day of water treatment. The treated water stored in the clear water reservoir is sent by gravity flow to the Maragi and Kiharu Reservoirs and then distributed by gravity from both reservoirs. In this regard, the plan intends to enhance the existing distribution system through the expansion of both reservoirs and the addition of a transmission pipeline to the Kiharu Reservoir. It should be noted that MUWASCO has been already implementing network expansion by using its annual budget and has plans to expand its water supply area from the current 145 km^2 to 330 km^2 by the year 2033. Therefore, the expansion of distribution network is not considered in the project components.

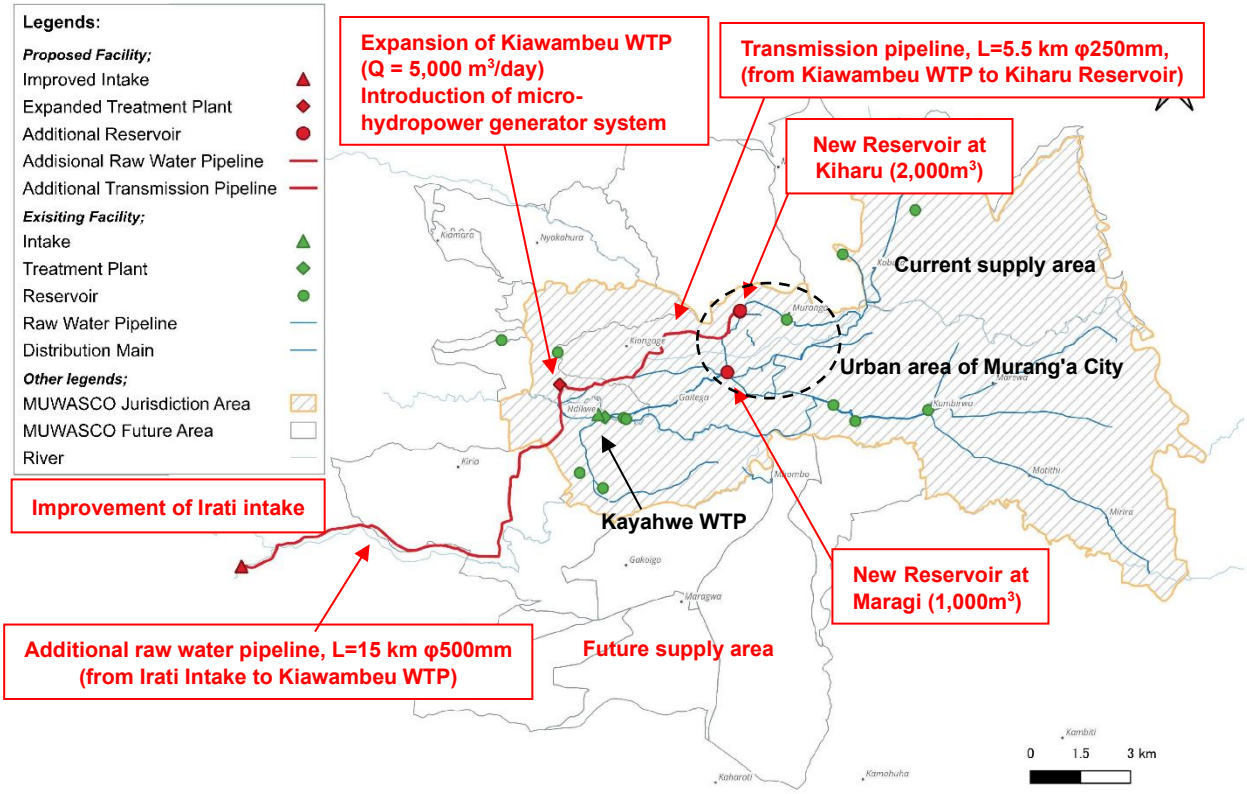


Figure 3-1 Overall Improvement Plan for Water Supply System

Source: Survey Team

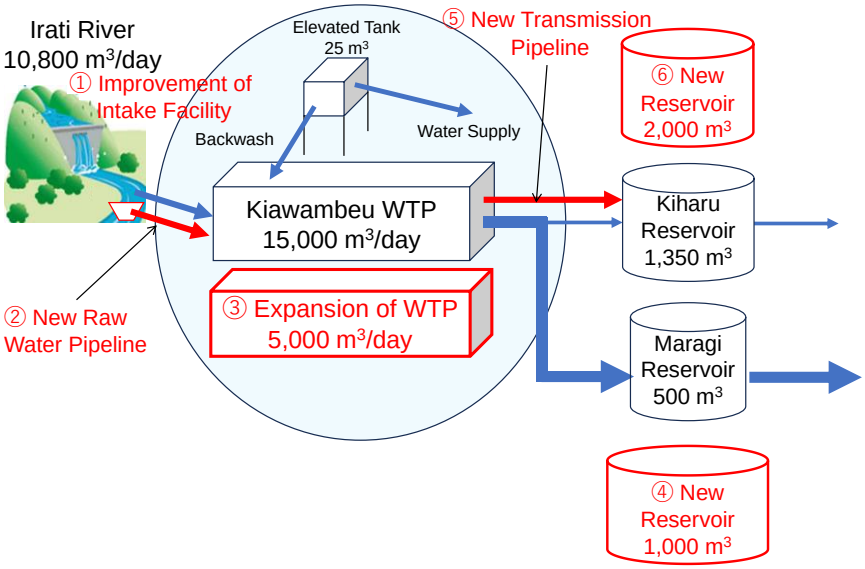


Figure 3-2 Schematic Diagram of the Water Supply System Flow after Improvement (Red Text: Planned Components in the Project)

Source: Survey Team

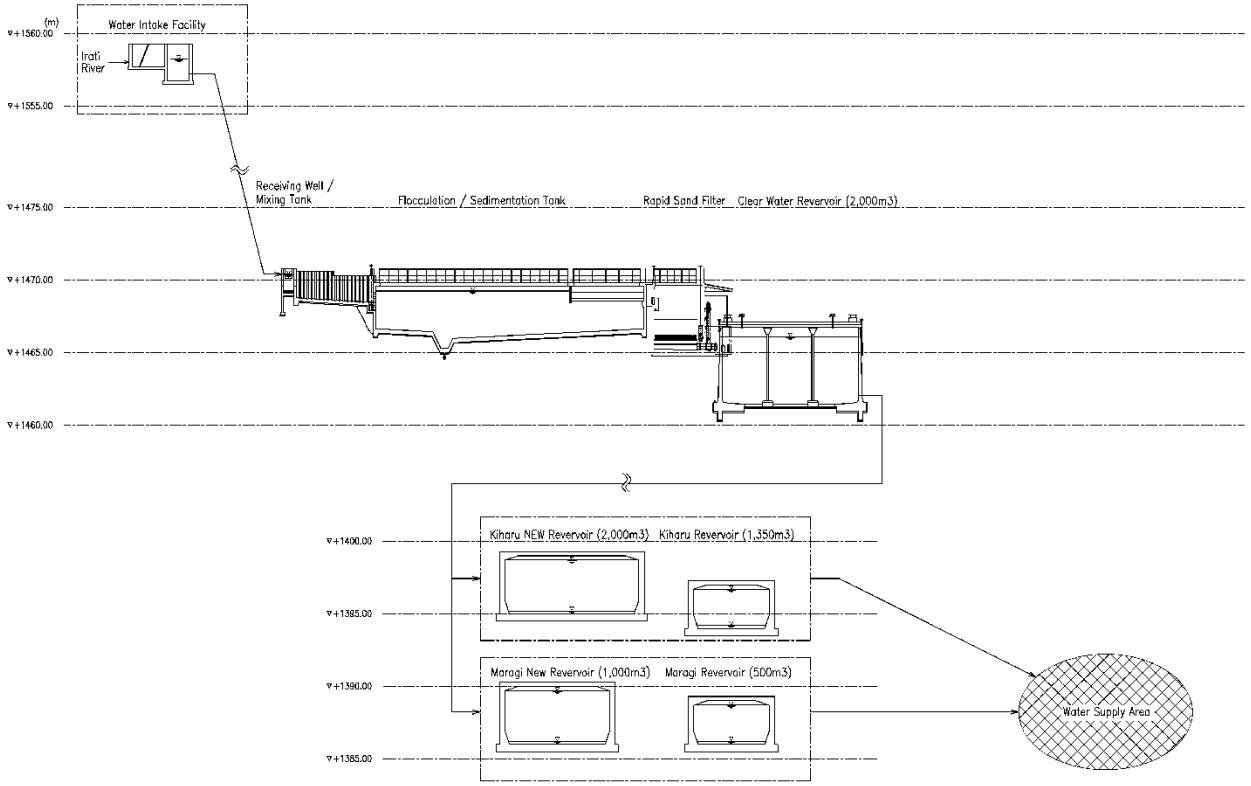


Figure 3-3 Hydraulic Profile after Improvement

Source: Survey Team

3.3.2 Contents, Scale and Quantity of the Project

The contents of the project are described as follows.

(1) Construction Works

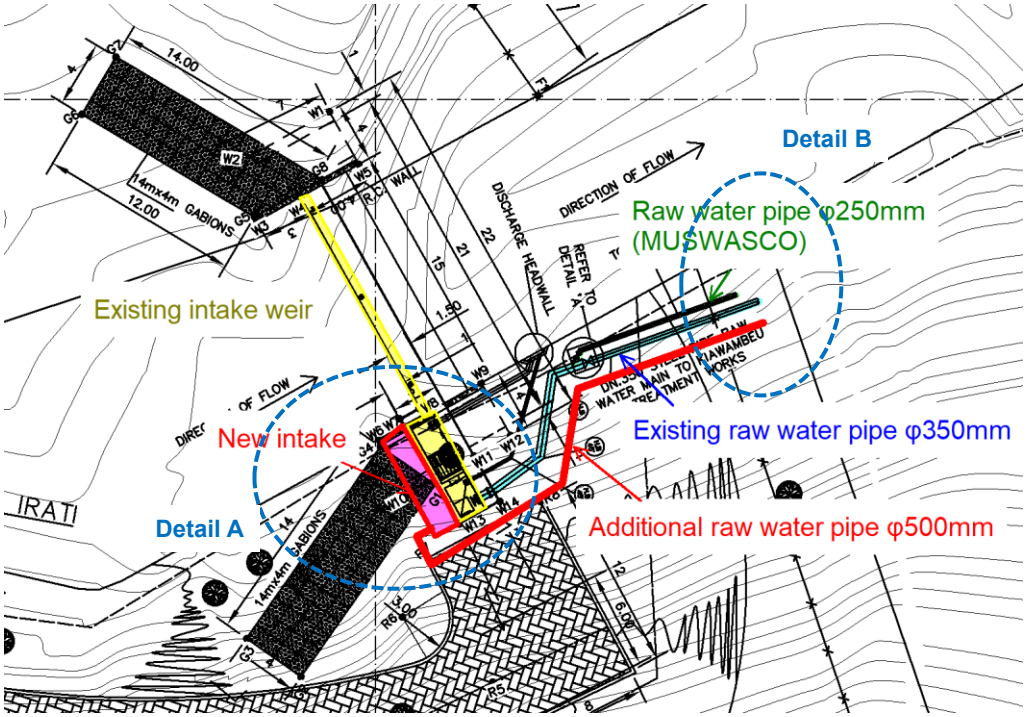
1) Improvement of Intake Facility and Construction of Additional Raw Pipeline

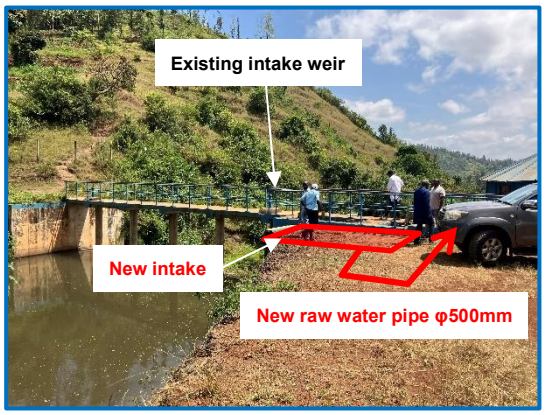
To construct an additional raw water pipeline at the Irati Intake, improvement works as shown in Figure 3-4 are planned. The raw water pipeline will be laid over approximately 15 km from the intake site to the Kiawambeu WTP. HDPE pipes with a nominal diameter of 500 mm are applied and laid parallelly along the existing raw water pipeline. This will enable an additional intake of 10,500 m^3/day.

As mentioned in 2.2.4(2) 1), the allowable water intake amount from the existing Irati Intake Weir is 26,000 m^3/day. This figure takes into account the future water demand for both Murang'a City and its surrounding areas, as well as Maragua City currently under the jurisdiction of MUSWASCO (approximately 2,000 m^3/day). Additionally, a separate intake weir for irrigation use (refer to Photo 2 2) is constructed just downstream from the intake weir of MUWASCO, which results in three water rights holders extracting water from nearby locations.

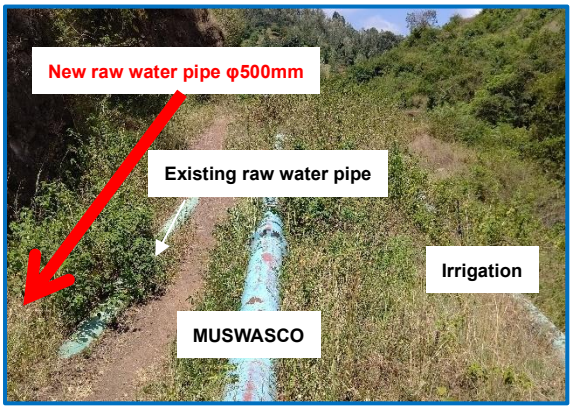
The project plans to take in a total of 10,500 m^3/day of additional water: 4,200 m^3/day for the capacity shortfall of the existing raw water pipeline and 5,300 m^3/day for the WTP expansion through the project.

Even in that case, raw water intake amount is expected to remain within the range of 26,000 m^3/day. Therefore, in principle, any change procedure of the water right on the authorized intake amount may not be necessary. However, it is required to confirm the necessity of any water right amendment procedures during the preparatory survey. Additionally, in the cooperative preparatory study, the impact of the additional water withdrawal on downstream water rights holders should also be investigated.





Detail A



Detail B

Figure 3-4 Image of Intake Weir Improvement and Additional Raw Water Pipeline

Source: Survey Team

2) Expansion of the Kiawambeu Water Treatment Plant

To accommodate future water demand following the expansion of the water supply area, enhancement of the water treatment capacity through the expansion of the Kiawambeu WTP. An image illustrating the planned expansion of the WTP is shown in Figure 3-5, and the treatment flow after the expansion is presented in Figure 3-6.

Taking into account water treatment losses, the capacity for the expanded portion is set at 5,000 m^3/day, combined with the existing capacity of 14,200 m^3/day, resulting in a total production capacity of 19,200 m^3/day. The treatment process will follow the existing facility, using coagulation sedimentation followed by rapid sand filtration.

Figure 3-5 Image of the Expansion of the Kiawambeu WTP

Source: Survey Team

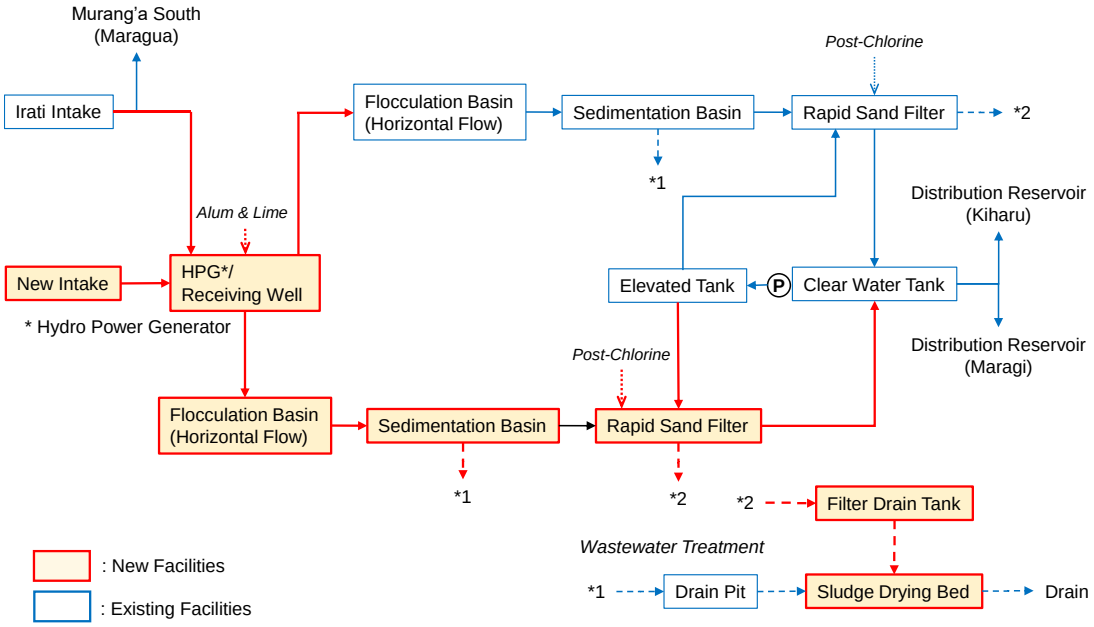


Figure 3-6 Treatment Flow After the Expansion of the Kiawambeu WTP

Source: Survey Team

3) Installation of micro-hydropower generation system

A micro-hydropower generation system will be installed on the newly constructed inlet pipe at the Kiawambeu WTP. With a drop of approximately 90 meters between the Irati Intake and the Kiawambeu WTP, the installation of the micro-hydropower generator within the WTP aims to generate energy and reduce the costs of electricity associated with the operation of the plant. Figure 3-7 provides an example of the introduction of a micro-hydropower generator system at another WTP in Kenya through Japanese Grant Aid Project. In this WTP, almost 100% of the electricity needed for operation is covered by hydropower, contributing to a reduction in operating costs.

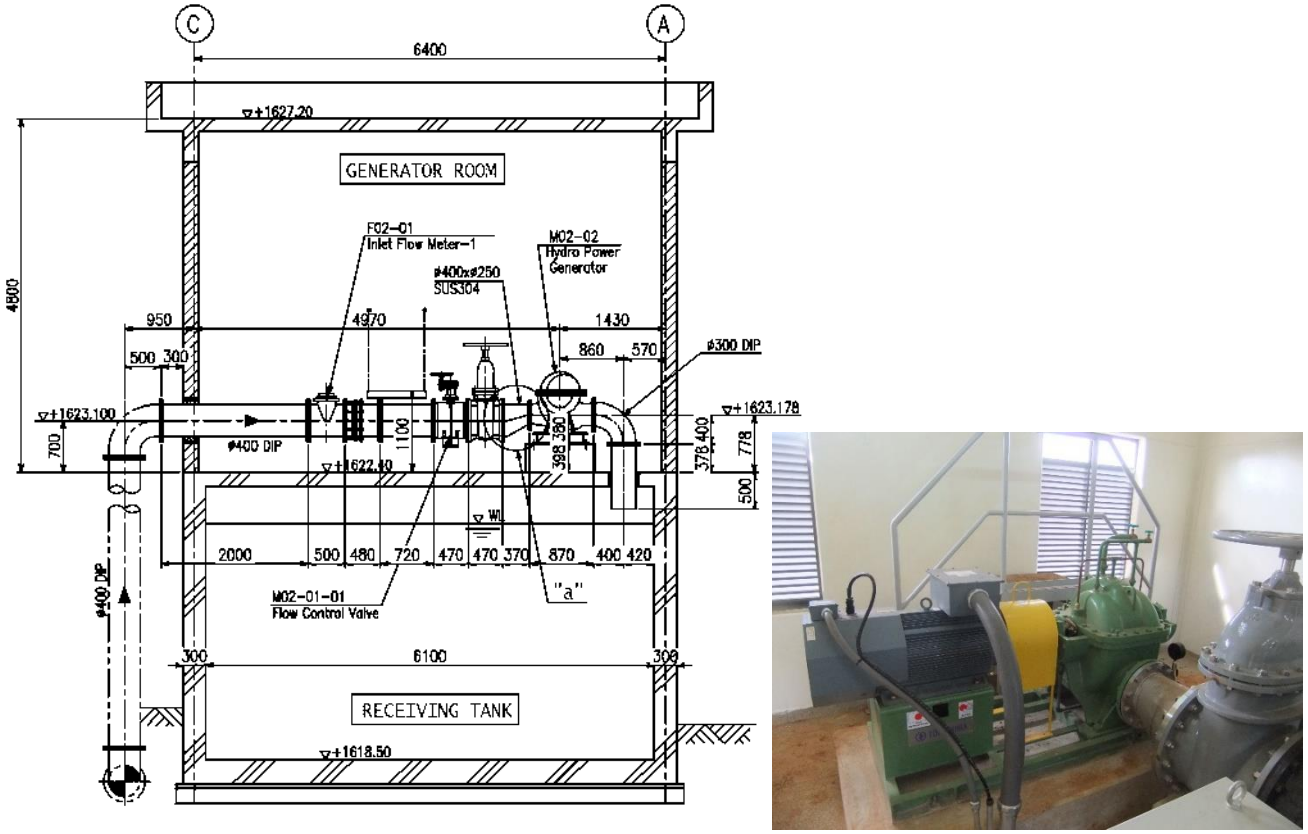


Figure 3-7 Micro-hydropower Generation System Developed through Japanese Grant Aid Projects at another WTP in Kenya

4) Construction of Transmission Pipeline

The transmission pipeline from the Kiawambeu WTP to the Maragi Reservoir (500 m^3) has a diameter of φ250mm, while the pipeline to the Kiharu Reservoir (1,350 m^3) has a diameter of φ200mm. It shows a mismatch between reservoir capacities and pipe diameters. In addition to solving this problem, an additional transmission pipeline will be installed from the Kiawambeu WTP to the Kiharu Reservoir to ensure efficient water distribution in the future water supply. The pipeline will be made of HDPE with a nominal diameter of 250mm.

5) Expansion of Distribution Reservoir

Expansion of the Maragi Reservoir to 1,000 m^3 and the Kiharu Reservoir to 2,000 m^3 will be implemented through the project. Sufficient land is available for construction within the existing sites of both reservoirs (see Figure 3-8 and Figure 3-9). This expansion will increase the capacity of the Maragi Reservoir from 500 m^3 to 1,500 m^3 and the Kiharu Reservoir from 1,350 m^3 to 3,350 m^3. The total capacity of the existing reservoirs, as mentioned in Table 2-10, is 6,169 m^3, and with the new addition of 3,000 m^3, the post-expansion total capacity will be 9,169 m^3. This will secure approximately 8.2 hours of the 2033 maximum daily water supply of 26,600 m^3/day for the expanded water supply area. While the "Practice Manual for Water Supply Services in Kenya" recommends a capacity of 50% (12 hours) of the maximum daily water

supply, considering the current situation of Murang'a City, the reservoir with a capacity of 8 to 10 hours, which described in the former Japanese Design Criteria, could satisfy the local needs.

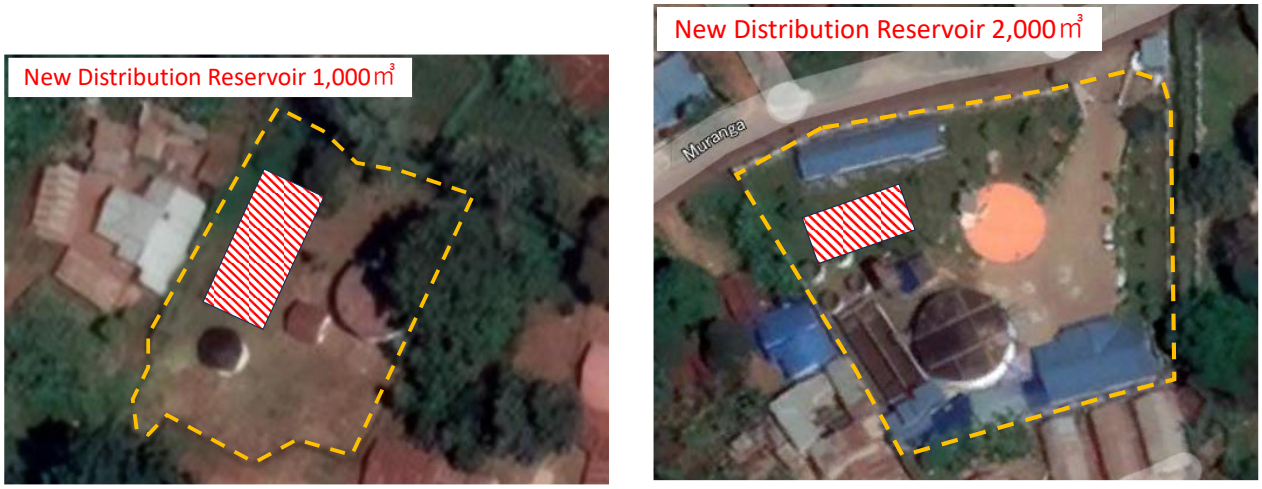


Figure 3-8 Image of Distribution Reservoir Expansion
(Left: Maragi Reservoir, Right: Kiharu Reservoir)

Source: Survey Team

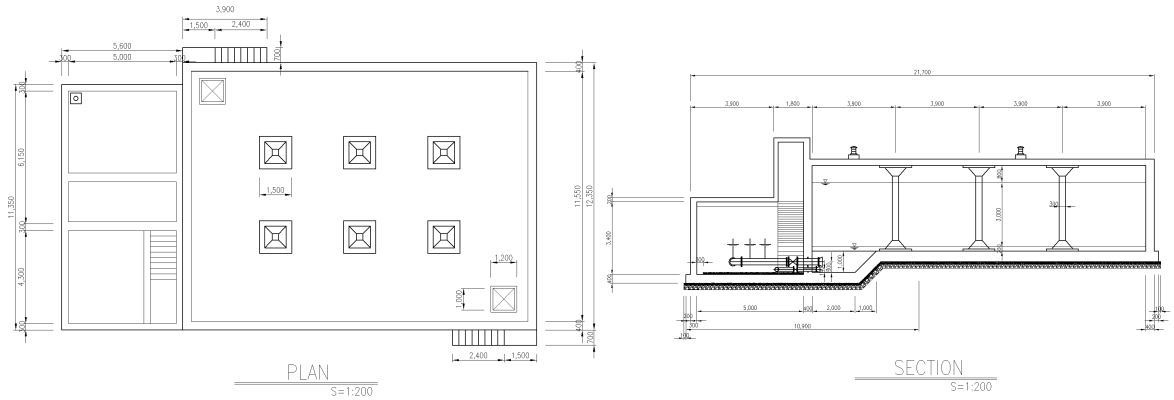


Figure 3-9 Plan and Section of Distribution Reservoir (1,000 m^3)

Source: Survey Team

6) Installation of Electromagnetic Flowmeters

Electromagnetic flowmeters will be installed at two locations each for the inlet pipes (raw water pipelines) and outlet pipes (transmission pipelines) of the WTP. This aims to establish a foundation for flow management in daily operations and utilize data effectively.

(2) Provision of Equipment for Operation and Maintenance

1) Water Quality Testing Equipment

Currently, water quality at the WTP is recorded for turbidity, pH, and residual chlorine concentration every two hours. However, due to manual recording, data analysis is not performed effectively. Additionally, parameters such as alkalinity, electrical conductivity, and color are not measured. Therefore, water quality

testing equipment needed for daily water quality management and PC for data analysis will be procured through the project. The aim is to provide a foundation for daily water quality management by enabling the digitization and analysis of water quality test results.

(3) Implementation of Soft Components

1) Background of Proposal for Soft Components

The project implementation will increase the scale of MUWASCO's water supply, requiring more efficient and reliable facility O&M. In particular, there is a strong need to strengthen daily water quantity control based on water quantity analysis and daily water quality management by ensuring water quality testing. Therefore, the implementation of soft components is essential to support MUWASCO's smooth start of the project and to ensure the sustainability of the project outcomes. Two items as the subject of soft components are indicated in Table 3-5.

Table 3-5 Subjects of Soft Components (Draft)

Subject	Objective
Technical guidance on O&M of water supply facilities	Improve the ability to efficiently operate the entire water supply system from intake facilities to service connections.
Technical guidance on water quantity and quality management	Improve capacity for water quantity management based on water quantity analysis and water quality management based on water quality test results

Source: Survey Team

2) Goal of Soft Components

The goal of the soft component is to contribute "to realize stable, safe and reliable water supply to consumers by proper O&M of water supply facilities based on a sound business foundation" after a certain period from the completion of the project.

3) Outcomes of Soft Components

The expected outcomes of the implementation of soft components are summarized below.

a) O&M of Water Supply Facilities

MUWASCO's staff will comprehend the composition / purposes of the entire water supply system which includes the facilities constructed by the project and acquire the proper O&M skills of the system.

b) Water Quantity and Quality Management

MUWASCO's staff will acquire the ability to appropriately record and manage water quantity data and perform water quantity management based on the distribution water amount analysis. In addition, they will gain the ability to effectively conduct water quality testing using the water quality testing equipment and use the data obtained for daily water quality management purposes.

3.3.3 Dispatch of Experts, Contents, Scale and Quantity of Materials and Equipment

(1) Dispatch Schedule of Experts

The dispatch schedule of experts is shown in Table 3-6.

Table 3-6 Dispatch Schedule of Experts

Works \ Year	1st Year												2nd Year												3rd Year												4th Year						Required M/M
	Basic Design												Detailed Design												Construction Supervision												Coonstruction Supervision & Soft Componenet						
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	
【Basic Design】																																										
Study on basic conditions (Planned Served Population)																																										2
Study on water source																																										3
Study on water supply system																																										3
Study on intake and raw water transmission facilities																																										6
Study on treatment facilities																																										5
Study on transmission and distribution facilities																																										5
Study on cost estimate, procurement and construction supervision																																										3
Study on environmental & social consideration																																										2
【Detailed Design / Construction Supervision】																																										
Intake Facility																																										4
Treatment Facility																																										18
Reservoir																																										12
Pipelines (Raw Water and Transmission)																																										20
Cost Esitmate / Bidding																																										5
【Soft Component】																																										
Training on O & M of water supply facility																																										2
Training on water quantity and quality management																																										2
【Dispatch of Experts】																																										
1 Project leader / Water supply planning																																										19
2.Water source planning																																										5
3. Facility planning and design																																										18
4.Pipe planning and design																																										18
5.Mechanical equipment /Climate change																																										8
6.Electrical equipment																																										8
7.Construction & procurement planning / Cost estimate																																										8
8.Environmental & social consideration																																										2
9. Financial and Business management																																										2
10.Facility O&M																																										2
11.Water quality management expert																																										2

Source: Survey Team

(2) Required Experts

Expert	Task
a) Team Leader / Water Supply Planning	1. Project management 2. Planning for facility development 3. Explanation and consultation with relevant agencies 4. Planning of soft components
b) Water Source Planning	1. Evaluation of existing water sources (existing water volume, available water volume, water quality, etc.)

Expert	Task
	2. Confirmation and support for changes in existing water rights 3. Survey of water rights situation related to water sources
c) Facility Planning and Design	1. Planning for facility development 2. Planning and design of new intake facilities 3. Planning and design of new water treatment facilities 4. Planning and design of new distribution reservoirs 5. Planning and design of effective utilization of existing facilities 6. Technical guidance on facility O&M 7. Technical guidance on the concept of asset management 8. Technical guidance on facility planning procedures
d) Pipeline Planning and Design	1. Planning for facility development 2. Planning and design of pipelines (raw water and transmission pipelines, and yard pipes in WTP) 3. Technical guidance on the O&M for pipelines 4. Guidance on safety measures
e) Mechanical Equipment / Climate Change	1. Planning for facility development 2. Examination of mechanical equipment for new intake facilities 3. Examination of mechanical equipment for new water treatment facilities 4. Examination of mechanical equipment for new distribution facilities 5. Examination of countermeasures against climate change (possibility of introducing micro-hydropower generation system, etc.)
f) Electrical Equipment	1. Planning for facility development 2. Examination of electrical equipment for new intake facilities 3. Examination of electrical equipment for new water treatment facilities 4. Examination of electrical equipment for new distribution facilities 5. Examination of electromagnetic flow meters
g) Construction and Procurement Planning / Cost Estimation	1. Planning for facility development 2. Cost estimation in the basic design and detailed design stages 3. Construction and procurement planning 4. Preparation of bid documents
h) Environmental and Social Considerations	1. Planning for facility development 2. Land acquisition surveys for proposed sites 3. Survey of water rights status for water sources 4. Support for Environmental Impact Assessment (EIA) for implementation of the water supply project 5. Support for stakeholder consultations on the water supply project
i) Financial and Business Management	1. Survey of water supply business operation status 2. Examination of financial feasibility for implementation of the water supply project
j) Operation and Maintenance	1. Technical guidance on facility O&M (soft component) 2. Technical instruction on the use of procured equipment 3. Technical guidance on daily data utilization
k) Water Quality Management	1. Technical guidance on water quantity and quality management (soft component) 2. Technical instruction on the use of procured equipment 3. Technical guidance on daily data utilization

Source: Survey Team

(3) Procurement of Equipment

- Provision of water quality testing equipment

3.3.4 Rough Estimate of the Project Cost

The estimated project cost including basic survey, facility construction, soft component and design / supervision is about 3.2 billion yen. The breakdown of the cost is shown in Table 3-7.

Table 3-7 Breakdown of the Estimated Project Cost

Unit: 1,000,000 JPY

Category	Item	Price
Construction Works (Direct construction cost)	Improvement of intake facilities: Q = 10,500 m^3/day Construction of raw water pipeline: L=15 km, φ500mm, HDPE Expansion of water treatment plant: Q = 5,000 m^3/day Installation of micro-hydropower generation system: 1 set, 30 kW Construction of transmission pipeline: L=5.5 km, φ250mm, HDPE Expansion of distribution reservoirs: 2 reservoirs (1,000m^3, 2,000m^3) Installation of electromagnetic flow meters: 4 locations (2 in raw water pipelines, 2 in transmission pipelines)	2,210
Overheads (30% of direct construction cost)		660
Equipment Procurement	Water quality testing equipment: 1 set	20
Total of construction cost		2,890
Soft Components	Training on O&M of water supply facilities Training on water quantity and quality management	30
Engineering fees	Detailed design / construction supervision	290
Grand Total		**3,210**

Source: Prepared by survey team

3.4 Conditions of the Project Site

3.4.1 Location (Land Acquisition, Land Use, Pollution Sources, etc.)

(1) Site for Intake Facility

The improvement of the existing intake facility owned by MUWASCO is planned. In principle, since there is plenty of land available, no new land acquisition is required unless the intake facility is relocated.

Ensuring the water quality of the water source is a fundamental requirement for water supply operation. Based on the survey results, as shown in Photo 3-2, activities such as laundry and agriculture are conducted upstream of the existing intake facility. However, these activities cannot become the major potential sources of pollution. On the other hand, the preliminary survey will require a detailed survey of the major potential sources further upstream from the existing intake facility.

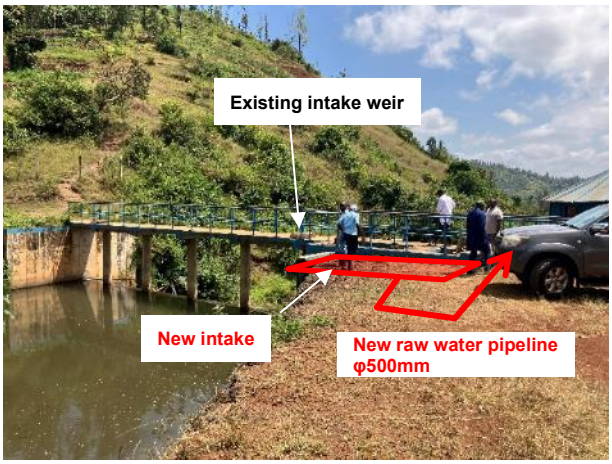


Photo 3-1 Site Situation for Intake Facility

Photo 3-2 Residents doing laundry near the existing intake facility

(2) Land for Pipelines (Raw Water Pipeline and Clear Water Transmission Pipeline)

The new raw water pipeline from Irati Intake to Kiawambeu WTP and the new transmission pipeline from Kiawambeu WTP to Kiharu Reservoir are both planned to be laid in parallel to the existing pipelines. Pipes are generally designed to be laid under the road, but if there is not enough space to lay them parallel to existing pipelines, alternative routes must be considered. As mentioned in 3.4.3(1), urban roads in the city are designed and constructed by the Kenya Urban Roads Authority (KURA), with the maintenance responsibility falling to the Murang'a Municipality. The major roads along the pipeline route include both asphalt-paved and unpaved roads. Even on paved roads, the asphalt thickness is thin, causing frequent pavement deterioration with noticeable potholes. Road maintenance conditions are poor, and there are ongoing asphalt repair works.

Photo 3-3 Road Condition for Pipeline Installation (Asphalt Paved)

Photo 3-4 Road Conditions for Pipeline Installation (Unpaved)

(3) Site for Expansion of Water Treatment Plant

There is a site secured for the facility expansion within the premise of the Kiawambeu WTP. Therefore, no new land acquisition is required. For details, refer to the aforementioned Figure 2-8 and Figure 3-5.

(4) Land for Distribution Reservoirs

The planned distribution reservoirs for the project are the Maragi Reservoir (1,000 m^3) and the Kiharu Reservoir (2,000 m^3). Both reservoirs can be developed within the premises of the existing reservoirs, as shown in Figure 3-8. Therefore, no new land acquisition is required. Regarding the Kiharu Reservoir, MUWASCO has mentioned that, if necessary, the removal of the currently decommissioned Kiharu WTP (with sedimentation and rapid sand filters) is also feasible.

3.4.2 Natural Conditions

(1) Topography and Geology

Murang'a County, the target area of the project, is situated between the eastern region with an altitude of 914 m and the western region with the altitude of 3,353 m, which features the slopes of the Aberdare Mountains. It slopes from the highland areas in the west towards the southeast, characterized by the outflow of numerous rivers. The Upper Tana can be divided in two main geological structures: in the west volcanic rocks of the Cenozoic are found and in the east the bedrock consists of metamorphic rocks of the Mozambique belt (Figure 3-10). Mount Kenya, an extinct volcano formed between 100-4000 million years ago, is located in the west of the catchment. The volcano erupted for the last time between 1.6 and 3.1 million years ago. Around the major lakes in the Upper Tana, patches of Precambrian intrusive rocks can be found.

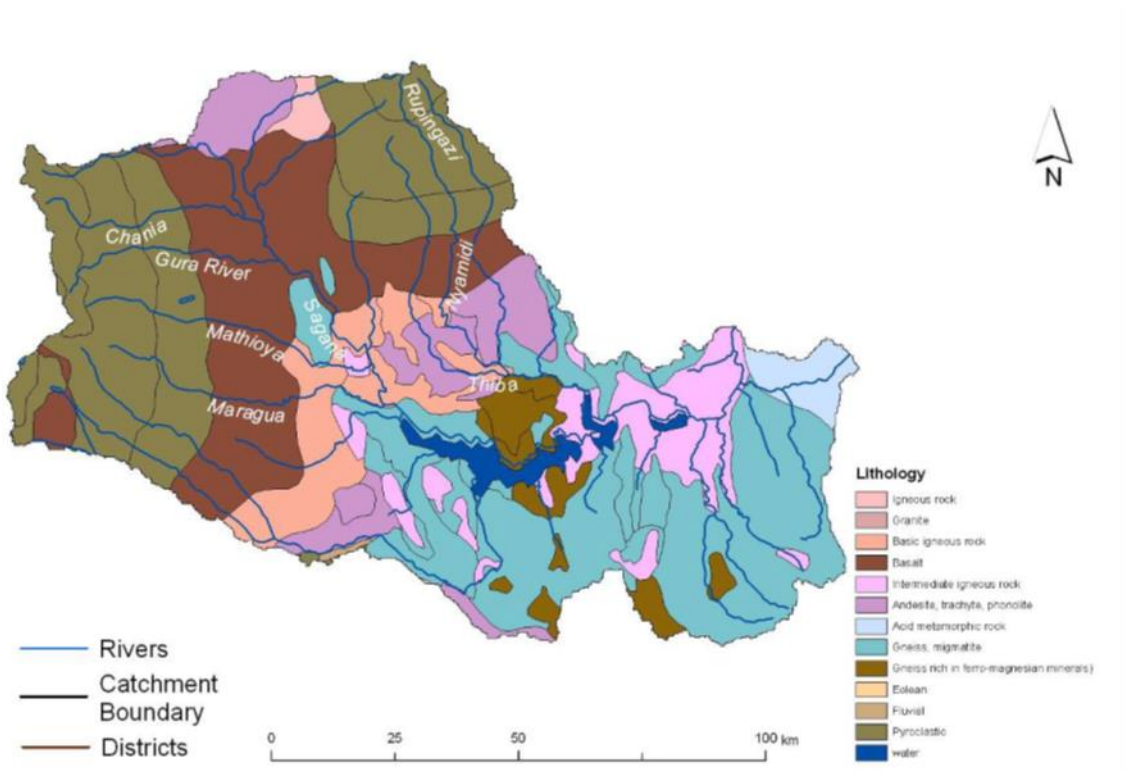


Figure 3-10 Lithology of the Upper Tana, Kenya

Source: Baseline Review of the Upper Tana, Kenya, Green Water Credit, 2011

The dominant soil type of the Upper Tana catchment is the Humic Nitisol, a Humic Nitisols in the Tana basin have formed on the volcanic deposits and thus are found within high altitude zones (Figure 3-11). Nitisols are fertile reddish-brown soils rich in nutrients, with high clay content and significant iron content, making them suitable for the cultivation of crops such as tea and coffee. In general, these soils are highly resistant to erosion. Other soil types in the Tana catchment include Vertisols, Cambisols, Ferralsols, Andosols and Leptisols.

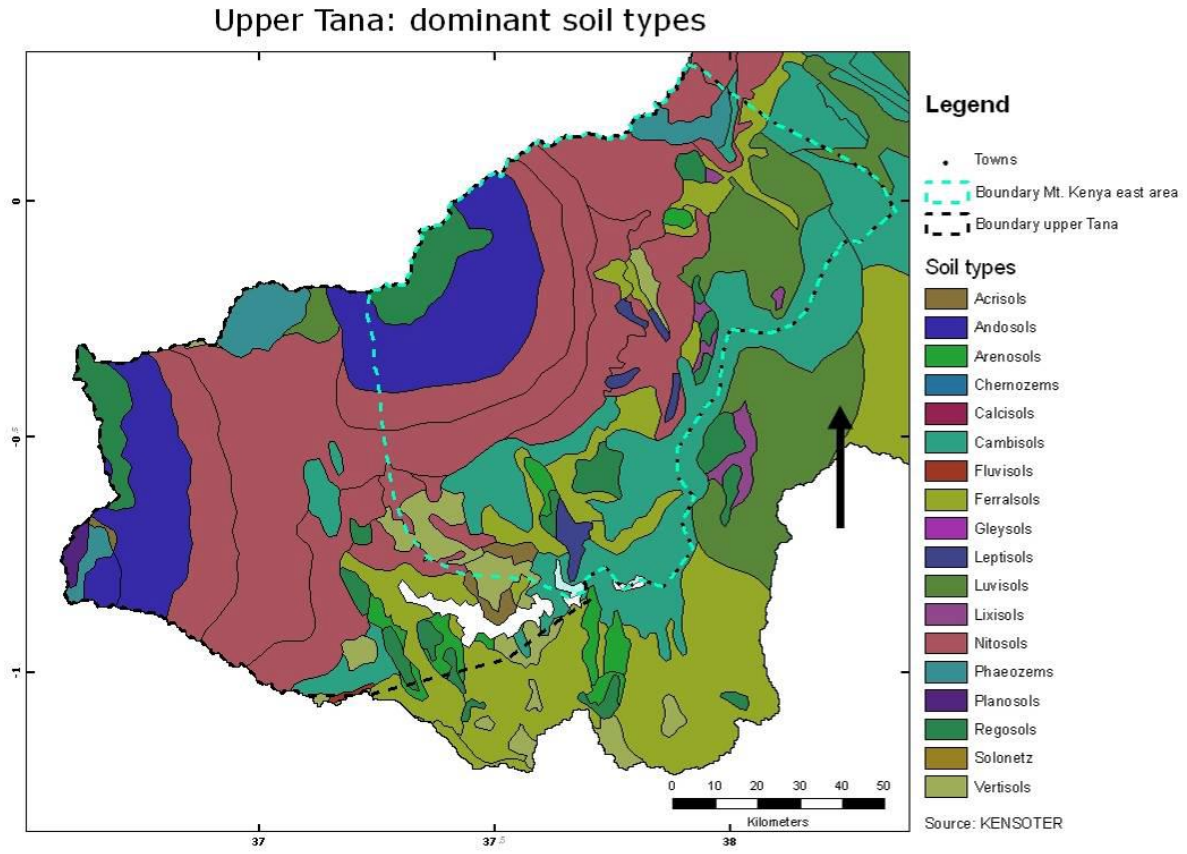


Figure 3-11 Soil Classifications in the Upper Tana River Basin

Source: Baseline Review of the Upper Tana, Kenya, Green Water Credit, 2011

(2) Meteorology

Murang'a County is classified as Aw (Tropical savanna climate) in the Köppen climate classification, with a significant reduction in rainfall during the winter compared to the summer season. The annual temperature, precipitation and number of rainy days are shown in Table 3-8. The annual average temperature is 19.7°C, with the highest temperature recorded in February at 27.9°C and the lowest in July at 13.4°C. The temperature difference throughout the year remains relatively small, around 20°C. There are two rainy seasons: from April to May and from October to December, with the total annual rainfall amounting to 996mm.

Table 3-8 Climate of Murang'a County

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average (°C)	20.1	21	21.2	20.2	19.5	18.7	18.1	18.5	20	20.3	19.2	19.4	19.7
Lowest (°C)	13.4	13.8	15.1	16.2	15.7	14.6	13.6	13.9	14.6	15.7	15.3	14.2	14.7
Highest (°C)	26.5	27.9	27.6	25.1	23.9	23	22.7	23.4	25.6	25.7	23.7	24.6	25.0
Precipitation (mm)	30	21	72	213	145	40	29	35	32	135	179	65	996
Humidity (%)	66	59	64	78	78	74	71	68	61	66	81	75	70.1
Rainfall (days)	5	4	10	19	16	8	7	8	8	14	18	11	128

※1991~2021

Source: https://en.climate-data.org/africa/kenya/murang-a/murang-a-57628/

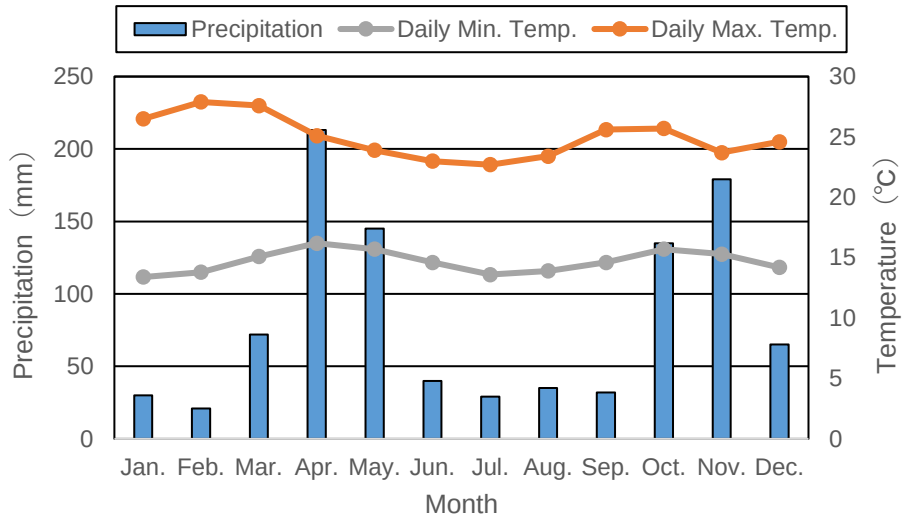


Figure 3-12 Temperature and Precipitation of Murang'a County

※1991～2021

Source: Survey team based on https://en.climate-data.org/africa/kenya/murang-a/murang-a-57628/

(3) River Water Sources

The Irati River, which serves as the water source of MUWASCO, is a tributary of the Maragua River in the upper Tana River Basin, as shown in Figure 3-13. The Irati River intake point, as depicted in Figure 3-13, is only about 100 meters upstream from the gauging station (4BE03). Therefore, the observed flow rates at the gauging station are considered usable for assessing the available intake volume in the proposed project.

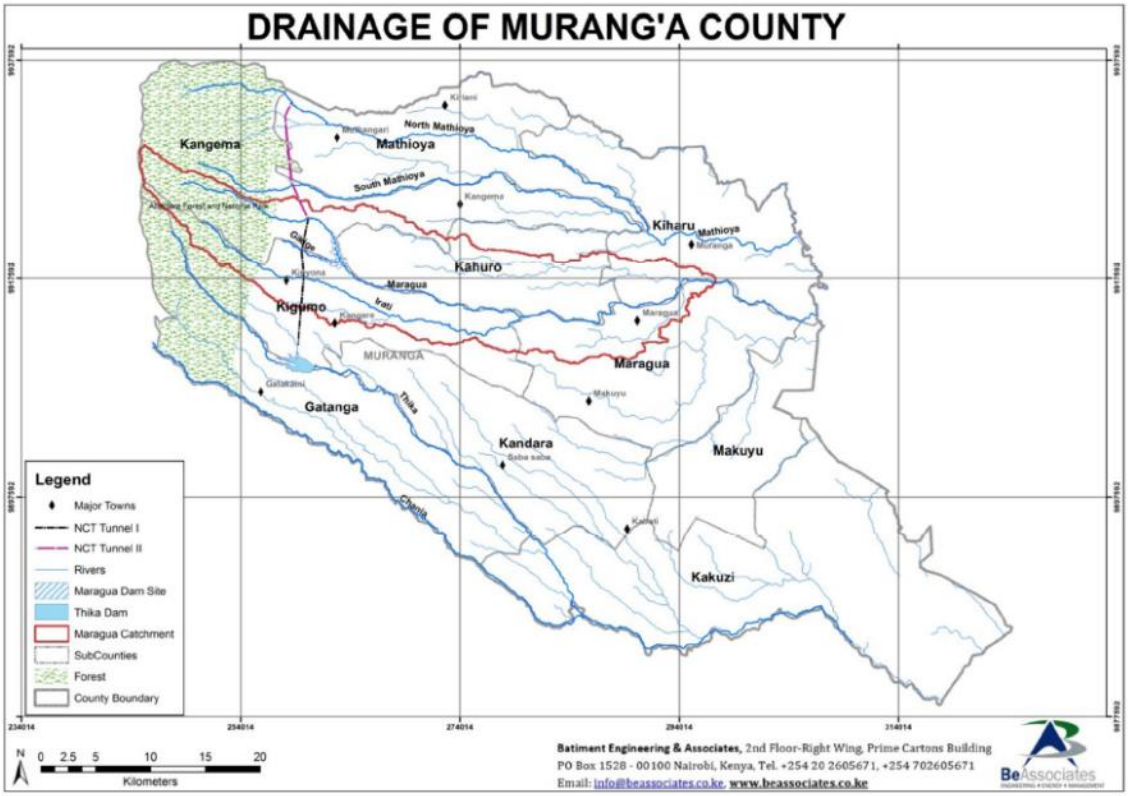


Figure 3-13 Irati River and Maragua River Basin

Source: Report of the Technical Committee on Northern Collector Tunnel Project, Murang'a County Government, 2015

It was able to obtain flow rate data from the gauging station (4BE03) for the years 1981 to 2023. However, data for the years 2001 to 2010 are missing, and only data from January to September is available for 2023. The minimum flow rate for each year was extracted for these excluded years and the Hazen method was used to obtain the 10-year probability low flow (0.337 m^3/sec = 29,092 m^3/day). The relationship between the 10-year probability low flow at the gauging station and the planned intake volume (existing intake: 10,800 m^3/day + new intake: 10,500 m^3/day = total 21,300 m^3/day) is as follows, suggesting that the planned intake volume is feasible.

The planned intake volume (21,300 m^3/day) ＜ the 10-year probability low flow (29,092 m^3/day).

However, there is a strong need for further study of water withdrawals during the preparatory survey, taking into account other water uses such as irrigation withdrawals.

Table 3-9 Annual Minimum Flow Rate at the Gauging Station (4BE03)

Year	Min. flow rate (m^3/sec)	Notes	Year	Min. flow rate (m^3/sec)	Notes
1981	0.733		2003	-	No data
1982	0.417		2004	-	No data
1983	0.499		2005	-	No data
1984	0.379		2006	-	No data
1985	0.417		2007	-	No data
1986	0.457		2008	-	No data

Year	Min. flow rate (m^3/sec)	Notes	Year	Min. flow rate (m^3/sec)	Notes
1987	0.499		2009	-	No data
1988	0.499		2010	-	No data
1989	0.840		2011	0.786	
1990	0.733		2012	0.634	
1991	0.587		2013	-	No data
1992	0.457		2014	1.335	
1993	0.308		2015	0.733	
1994	0.417		2016	0.683	
1995	0.683		2017	0.379	
1996	0.379		2018	0.542	
1997	0.587		2019	0.308	
1998	0.953		2020	1.201	
1999	0.634		2021	1.136	
2000	0.683		2022	3.712	
2001	-	No data	2023	0.036	
2002	-	No data			

3.4.3 Transportation

(1) Road

In Kenya, the Ministry of Roads and Transport (MoR&T) is the governing authority responsible for the country's road network. Under its umbrella, committees and local offices are established to oversee different classes of roads based on their traffic volume standards. For example, Class A, Class B, and Class C roads are managed by the Kenya National Highways Authority (KNHA) from planning to maintenance, while roads under Class D to Class E are maintained by the Kenya Rural Roads Authority (KeRRA). In addition, urban roads within cities are designed and constructed by the Kenya Urban Roads Authority (KURA), with the respective cities responsible for their maintenance.

(2) Harbor

Mombasa Port, the only international trade port in Kenya, is the largest port in the East African region. It serves as a crucial hub for imports and exports in Kenya and also plays a pivotal role in handling port functions for neighboring landlocked countries such as Uganda, Rwanda, South Sudan, and others. The volume of container cargo handled at Mombasa Port has seen a significant increase, and the demand is expected to continue growing in the future.

Mombasa Port is operated and managed by the Kenya Ports Authority.

(3) Railway

In June 2017, Kenya inaugurated the "Madaraka Express", a railway connecting the capital city Nairobi with the port city of Mombasa. This railway, considered the most extensive infrastructure development project since Kenya's independence in 1963, spans approximately 480 km between the two cities. There are

plans to extend the Madaraka Express further from Nairobi, with the eventual goal of connecting Kenya's western regions and potentially linking with six East African countries: Uganda, the Democratic Republic of the Congo, Rwanda, Burundi, South Sudan, and Ethiopia.

3.4.4 Power Supply and Telecommunication

(1) Power Supply

Kenya's national electrification rate is approximately 56%, falling below the global average of around 87%. Additionally, the electrification rates in urban and rural areas are 77.6% and 39.3%, respectively (both figures are from 2016, World Bank). These disparities in electrification between urban and rural areas contribute to economic inequalities between the two regions. The main reason for the low electrification in rural areas is the dispersed nature of small villages across the vast country, which results in high costs and time requirements for establishing a power transmission network. On the other hand, in urban areas, the situation becomes worsening as the increasing electricity demand due to economic development is outpacing supply.

The Kenyan government has positioned the power sector as one of the economic foundations in the national development plan “Kenya Vision 2030”. As a part of its top-priority initiatives to address the nation's most pressing issues, it is working on the “Last Mile Connectivity Project” with the aim of providing electricity to all households by 2020 and expanding the country's total electricity generation capacity to 17.5 million kW by 2030.

According to a report released by the Kenya National Bureau of Statistics in April 2022, 89.6% of Kenya's total electricity generation in 2021 was dependent on renewable energy sources. The composition consists of geothermal power at 40.6%, hydropower at 29.6%, and wind power at 16.0%, while non-renewable sources, such as thermal power, accounted for 10.2%. In contrast, Japan's proportion of renewable energy was 18.1% in 2021. Kenya is positioned as a leading country in renewable energy adoption with approximately 90% of its energy coming from renewable sources.

(2) Telecommunication

Based on "Kenya Vision 2030," which aims to elevate Kenya's GDP to the world average by 2030, the Ministry of Information, Communications, and the Digital Economy leads the digitization of government services and the promotion of the ICT industry. The e-government portal managed by the ministry offers online services such as obtaining various administrative information, checking the validity period of identification documents, and applying for tax refunds. Additionally, the Ministry is promoting the construction of the media park known as "Konza Techno City," with a focus on ICT-related developments, aiming to create 17,000 direct employment opportunities by 2018.

The percentage of smartphones to all mobile devices is accounted for 48% in 2020, and projected to reach 64% by 2025. Nigeria, South Africa, and Kenya are the three countries with the highest smartphone penetration rates. By 2025, it is anticipated that there will be 163 million smartphone lines in Nigeria, 89 million in South Africa, and 52 million in Kenya.

As of the end of June 2015, the number of mobile phone subscribers is approximately 36.1 million, with a penetration rate of about 84%. 97% of the subscribers use prepaid services. Safaricom, Airtel, and Telkom Kenya (branded as Orange) are major operators, and by 2013, the population coverage had reached nearly 100%.

In Kenya, the fixed broadband services are primarily provided by four major operators, namely Liquid Telecom, Access Kenya, Telkom Kenya, and the Indian-based Wananchi Group. These four operators hold over 80% of the market share, offering services such as ADSL, FTTx/LAN, and WiMAX. As of the end of March 2014, there were approximately 19.924 million internet service subscribers in Kenya, with 99% of them using mobile internet access.

3.4.5 Security

Kenya is a central hub for the East African regional economy and has experienced development. It attracts numerous tourists with its abundant tourism resources, including safaris and coastal areas. The target area of the project is near Nairobi County, where Kenya's capital is located. Except for the Eastleigh area and slum areas surrounding Nairobi city, the safety index for Nairobi County, including Nairobi city, is rated as "Level 1: Take adequate safety precautions" by the Ministry of Foreign Affairs in Japan.

On the other hand, due to the growing wealth disparity within the country, there has been an influx of people into urban slums, as well as conflicts over land and resources among different tribal groups. In addition, Kenya faces various challenges related to criminal activities and violence, attributed to factors such as the influx of refugees and the illegal flow of weapons and goods from neighboring unstable countries like Somalia.

In the past, Kenya witnessed several incidents, including the 1998 bombing of the U.S. Embassy in Nairobi, the 2013 terrorist attack at a shopping mall in Nairobi, and the 2019 terrorist attack at a complex in Nairobi, resulting in the deaths of numerous foreigners. Additionally, there have been incidents of violent crimes such as robbery and short-term kidnappings occurring in residential areas where many foreigners, including Japanese nationals, reside. In urban areas, there is a significant presence of unemployed individuals and street children, and robberies and violent crimes with firearms committed by them have victimized Japanese people regardless of the area or time of day.

Furthermore, as part of the countermeasures against the COVID-19 pandemic, when traveling locally, it is necessary to ensure social distancing by avoiding "3 Cs" (Closed spaces, Crowded places, and Close-contact settings), wear masks as appropriate, and prioritize regular handwashing with soap.

In addition, Kenya is known to have various infectious diseases such as malaria, dengue fever, cholera, rabies, yellow fever, and others. It is necessary to receive the required vaccinations for these diseases.

3.4.6 Others

(1) Population

In Kenya, national censuses have been conducted every ten years since 1969, with the most recent one

being in 2019. According to the 2019 national census, the population of Kenya was reported as 47,564,296 people, 12,143,913 households (Table 3-10). The population has consistently shown an upward trend since the beginning of these surveys, although the growth rate has been slowing, with the most recent survey indicating a 2.1% increase.

Table 3-10 Transition of the Population in Kenya

Census	1969	1979	1989	1999	2009	2019
Population	10,942,705	15,327,061	21,448,047	28,686,607	38,610,097	47,564,296
Population Density (No. per /km^2)	19	26	37	49	66	82
Growth Rate (%)		3.4	3.4	3.0	3.0	2.11

Source: Kenya Population and Housing Census 2009 and 2019, Kenya National Bureau of Statistics

In the 2019 national census, population projections were also made, and the results for Kenya as a whole and for Murang'a County are as follows.

Table 3-11 Population Projections for Kenya and Murang'a County

County	Items	2020	2021	2022	2023	2024	2025	2030	2035	2040	2045
Kenya	Population (thousand)	48,818	49,720	50,623	51,526	52,428	53,331	57,881	62,165	66,307	70,180
	Growth Rate (%)	2.64	1.85	1.82	1.78	1.75	1.72	1.65	1.44	1.30	1.14
Murang'a County	Population (thousand)	1,077	1,088	1,100	1,112	1,124	1,136	1,194	1,249	1,299	1,345
	Growth Rate (%)	1.93	1.02	1.10	1.09	1.08	1.07	1.00	0.90	0.79	0.70

Source: 2019 Kenya Population and Housing Census; Analytical Report on Population Projections Volume XVI

Chapter 4

Conclusion

Chapter 4 Conclusion

4.1 Special Notes

(1) Reason for Proposing as the Grant Aid Project

The project aims to a Japan's ODA scheme of Grant Aid Project including a Soft Component. The rationale behind this approach is twofold. Firstly, within the water sector, instances of Japanese companies venturing overseas through Public-Private Partnerships (PPPs) or other frameworks for utilizing private funds are limited. Moreover, the water supply business management situation of MUWASCO stands out as particularly outstanding among Kenya's national water utility companies. Hence, the necessity for utilizing private funds is relatively low. Secondly, considering the recent deterioration in Kenyan government debt situation, implementing large-scale water supply projects like the proposal through yen loans with interest payments seems unlikely due to insufficient prospects for repayment capacity.

(2) Ongoing JICA Project

MUWASCO is included in the ongoing JICA project, "Project for Strengthening Capacity of Water Service Providers on Formulating Bankable Project Plans", as one of the WSPs to be supported. As mentioned in Section 2.2.5(1), this technical cooperation project proposes the rehabilitation of the existing raw water pipeline from the Irati Intake to the Kiawambeu WTP using loans from city banks. This is expected to restore the performance of the existing raw water pipeline to approximately 10,000 m^3/day. On the other hand, the proposed project includes the construction of an additional new raw water pipeline. This aims to bridge the gap between the treatment capacity of the Kiawambeu WTP (15,000 m^3/day) and the capacity of the existing raw water pipeline (maximum 10,000 m^3/day), while also covering the capacity of the expansion portion of the Kiawambeu WTP in the project (5,300 m^3/day). This approach maximizes the synergies between the two projects.

4.2 Points of Concern

A comprehensive field survey of MUWASCO's water supply facilities from upstream to downstream of the water supply system was carried out during a short-term, and the project formulation was implemented based on the survey results. Therefore, in the preparatory survey, it is necessary to conduct a more detailed survey of the external environment related to the project implementation and to evaluate the feasibility of the project. In particular, the following items require detailed investigation: 1) Water source-related matters (such as available water intake volume, impact on other water users, water rights, etc.); 2) The treatment capacity of the Kiawambeu WTP during high turbidity periods (rainy season); 3) Pipeline routing; and 4) the necessary inputs by the Kenyan side and evaluation of financial feasibility (including the use of subsidy from the government). Among these, for water source issues, it is critical to verify that the planned water withdrawal for the proposed project is sustainable. This review will involve surveying upstream water users, assessing the impact of increased water abstraction on downstream water users, and assessing the impact of climate change on water source flows.

4.3 Conclusion

Murang'a City, where MUWASCO is responsible for water supply, serves as the administrative center of Murang'a County. The area has undergone significant changes, including the expansion of the Murang'a University, the suburbanization of Nairobi, rural to urban migration, and the expansion of the water supply area due to changes in the boundaries of Murang'a City, and the area has a high potential for future water demand. On the other hand, MUWASCO's existing water supply facilities face various challenges, with low operational rates and insufficient facility capacity to meet future water demand. In certain areas of Murang'a City, there have been instances that water supply restrictions in areas previously receiving 24-hour water supply.

Considering the current status of water supply in the target area, the urgency of improving water supply facilities, and our country's aid policy towards Kenya, the project aims to provide a stable and reliable supply of safe water to meet the future water needs of Murang'a City and its surrounding areas by improving the operation rate of the existing WTPs, increasing water production through facility expansion, and strengthening the water supply function by improving the distribution system. This, in turn, is expected to contribute to the improvement of the residents' living environment and fostering regional economic development. In addition, the introduction of micro-hydropower generation system aims to utilize renewable energy, covering a significant portion of the power consumption in the water treatment plant. This plan is expected to serve as a high-quality infrastructure development exemplar contributing to climate change mitigation by reducing greenhouse gas emissions. Therefore, considering these aspects, this project is deemed highly significant as it contributes to addressing issues in target area and promoting climate change mitigation efforts simultaneously.

4.4 Closing Remarks

During and after the field survey in Kenya conducted by our survey team in October 2023, the team perceived MUWASCO's strong expectations for the implementation of the proposed project and also received generous support by MUWASCO staff in providing necessary data and information for the project formulation. Furthermore, MUWASCO staff accompanied us for discussions with the Kenyan government, and even after returning, they proactively engaged in consultations with relevant authorities. These actions underscore the enthusiasm and eagerness for the realization of the proposed project.

The external environment surrounding MUWASCO's water supply operations, as reiterated multiple times in the main text, has undergone rapid changes in recent years. The project needs to be implemented immediately, taking the potential for economic development in Murang'a City into account. Addressing the challenges faced by MUWASCO through the implementation of this project is expected to have a significant economic impact on the Kenyan government beyond the direct benefits of improving the living environment and public health for local residents. It will contribute to further strengthening the relationship between our government and the Kenyan government.

Appendices

Appendix 1: Survey Schedule

Itinerary		Destination	Survey Contents
7th Oct	AM		
Saturday	PM	NRT (Narita 21:15) - ADD (Addis Ababa 06:35)	
8th Oct	AM	ADD (Addis Ababa 10:45) - NBO (Nairobi 12:55)	
Sunday	PM	Transfer to Murang'a Internal Meeting	
9th Oct	AM	Murang'a Water and Sanitation Company (MUWASCO)	・ Courtesy call, explanation of the project, exchange of the information ・ Confirmation of existing development plan, and current problems & issues on MUWASCO's water supply ・ Information & data collection
Monday	PM		・ Site survey of existing faiclities, construction sites and surrounding areas etc.
10th Oct	AM	Hotel work	・ Arrangement of problems & issues, and study on countermeasures of each field
Tuesday (National Holiday)	PM	Internal Meeting	・Sharing ideas and creating the draft development plan of water supply system in Murang'a
11th Oct	AM	MUWASCO Murang'a County Government	・ Re-confirmation of current problems & issues on MUWASCO's water supply ・ Discussion on the draft development plan of water supply system in Murang'a ・ Information & data collection ・ Courtesy call, explanation of the project, exchange of the information especially for development plan
Tuesday	PM	MUWASCO	・ Site survey for water source development
12th Oct	AM	(Group A) Ministry of Water, Sanitation and Irrigation (MoWSI) The National Treasury Water Resources Authority (WRA) HQ Japanese Embassy/JICA Kenya (Group B) MUWASCO WRA Branch Office	(Group A) ・ Transportation by car ・ Courtesy call, explanation of the project, exchange of the information (Group B) ・ Discussion on the draft development plan of water supply system in Murang'a ・ Information & data collection especially for water source development
Wednesday	PM		
13th Oct	AM	MUWASCO	・ Information & data collection ・ Wrap-up meeting, agreement on the requesting contents
Thursday	PM		
14th Oct	AM	Internal Meeting	
Saturday	PM	NBO (Nairobi 18:00) - ADD (Addis Ababa 20:00) ADD (Addis Ababa 22:35) -	
15th Oct	AM		
Sunday	PM	- NRT (Narita 20:05)	

Appendix 2: Visited Institutions

Institution	Name	Post
Embassy of Japan in Kenya	Yume Yorita	Second Secretary, UNEP Focal Point
Japan International Cooperation Agency (JICA) Kenya Office	Kenji Hayashi	Senior Representative
	Mizuki Kaneda	Representative
Murang'a Water and Sanitation Company (MUWASCO)	Eng. Daniel Ng'ang'a	Managing Director
	CPA. Joseph Maina	Commercial Manager
	Eng. Peter Karenje	Technical Manager
Ministry of Water, Sanitation and Irrigation (MWSI)	Eng. SAO Alima	Water Secretary
	Eng. Patricia N. Kiarie	Deputy Director Operation and Coordination
National Treasury and Economic Planning	Pennianah Mukami N.	Principal Economist
County Government of Murang'a	Dr. Irungu Kang'ata	Governor
Embassy of the Republic of Kenya in Japan	Tabu Irina	Ambassador Extraordinary and Plenipotentiary
	Nina Alai	First Counsellor

Appendix 3: List of References

No.	Name of Document
1	Strategic Plan 2020 – 2025, MUWASCO
2	Audit Report 2016/17 – 2021/22, MUWASCO
3	Complete set of drawing data (Murang'a Town Bulk Scheme)
4	WRMA Report（Complete set of target river data）
5	Murang'a County WS's Service Area（Jurisdictional map of each WSP）
6	MUWASCO Map（MUWASCO's map of water supply areas）
7	Design Report Part 2 – Detailed Design, Detailed Design and Supervision for Murang'a North and Murang'a South Bulk Water Supply Project, Tana Water Services Board (2010)（detailed design report for Kiawambeu WTP）
8	Quarterly reports (May – July 2023), Athi Water Works Development Agency
9	Pipeline GIS Data（Shape file etc.）
10	Water Delivery Volume Data（Excel file）
11	Reservoir Water Level Data（Excel file）
12	Material Unit Price Table Data（Excel file）

Appendix 4: Notification Letter on Dispatch of the Survey Team

Ministry of Health, Labour and Welfare
Japanese Government
1-2-2, Kasumigaseki,
Chiyoda-ku, Tokyo 100-8916
Tel ＋ 81-3-5253-1111

日本国厚生労働省
〒100-8916
東京都千代田区
霞が関１－２－２
電話 03-5253-1111

August 22nd, 2023

Dear Murang'a County Government,

I am writing to you to seek a possibility of your arrangements for the study in Murang'a.

The Ministry of Health, Labour and Welfare of Japan (MHLW) has a program called "the Water Supply Project Formation Program" to support the government which is in need of the technical guidance in the field of water supply. This program aims to transfer the technical expertise to the local water supply authority in the process of developing an official request for ODA technical cooperation.

This year the MHLW has been working together with the NJS Co., Ltd (NJS) toward the Project for Water Supply Improvement in Murang'a. We heard that the current water supply system had not filled the water demand for the supply due to the population growth and technical issues. Our team would like to assess the current picture and discuss what could be the best solution together with you.

It is sincerely appreciated if you could kindly accept our study team's assessment and meetings with the related institutions. We are also in need of some data for our prior study, whose list is attached to this letter.

Sincerely yours,

[redacted]

ITANI Tetsuya
Director, Office of Global Health Cooperation,
International Affairs Division, Minister's Secretariat,
Ministry of Health, Labour and Welfare,
Government of Japan

1

Ministry of Health, Labour and Welfare
Japanese Government
1-2-2, Kasumigaseki,
Chiyoda-ku, Tokyo 100-8916
Tel ＋ 81-3-5253-1111

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〒100-8916
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RESUME

1. SUMMARY OF THE PROGRAM

Japan's ODA is implemented by the Ministry of Foreign Affairs of Japan (MOFA) and Japan International Cooperation Agency (JICA). The Ministry of Health, Labour and Welfare of Japan (MHLW) is ordinary indirectly associated with ODA on water supply sector through consultation with MOFA and JICA as the ministry holding jurisdiction over the water supply in Japan. This program is provided by the MHLW to technically support the countries having a wide range of challenges in the water supply sector.

This year the MHLW has been working together with NJS Co., Ltd., proposing the Project for Water Supply Improvement in Murang'a.

2. PURPOSE OF THE STUDY

The study team conducts a fact-finding investigation from professional and technical points of view, aiming to improve the water supply systems in Murang'a, on October 8th to 14th, 2023.

3. STUDY ITEMS

Here are the major study items:

(1) To examine the current situations of water supply systems in Murang'a such as water resources, water supply facilities, operation and maintenance;
(2) To learn the future plans through communication with the government agencies with a/other donor/s;
(3) To technically discuss things with the local water authorities; and
(4) To confirm water improvement plan to propose to the Government of Japan.

4. EXPECTED INTERVIEWEE

(1) Eng. Daniel Ng'ang'a, Managing Director, Murang'a Water and Sanitation Co. Ltd;
(2) Eng. SAO Alima, Water Secretary, Ministry of Water, Sanitation and Irrigation;
(3) Murang'a County Government; and
(4) Water Resources Authority.

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Japanese Government
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Chiyoda-ku, Tokyo 100-8916
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5. MEMBERS OF OUR TEAM

Our team consists of the following members:

Name	Responsibility	Occupation
Mr. ITANI Tetsuya	Project Manager	Ministry of Health, Labour and Welfare of Japan (MHLW)
Dr. YOSHITOMI Moeko	Project Coordinator	Ministry of Health, Labour and Welfare of Japan (MHLW)
Mr. HAYASHI Kenta	Chief Consultant	NJS Co., Ltd.
Mr. NAKANISHI Sampei	Water Source Planning	NJS Co., Ltd.
Mr. ISHIDA Akihisa	Facility Planning (Pipeline)	NJS Co., Ltd.
Mr. YASHIRO Daisuke	Facility Planning (Overall)	NJS Co., Ltd.
Mr. TOYODA Toru	Facility Operation and Maintenance	Yokohama Water Co., Ltd.

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6. SURVEY AREAS

The survey area is the water supply areas of Murang'a.

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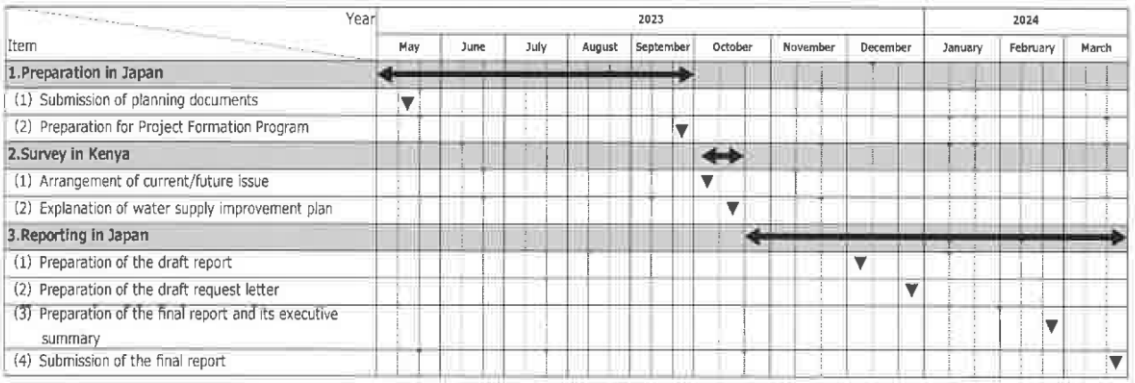
電話 03-5253-1111

7. STUDY SCHEDULE



Appendix 5: Minutes of Discussions

MINUTES OF DISCUSSIONS

ON

THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY SYSTEM

IN MURANG'A

Ministry of Health, Labour and Welfare, Government of Japan (hereinafter referred to as "MHLW") dispatched the Technical Survey Team (hereinafter referred to as "the Team") headed by Dr. Moeko YOSHITOMI, Project Superintendent, MHLW to the Republic of Kenya from October 7th to 15th, 2023.

The Team held a series of discussions with Murang'a Water and Sanitation Company Ltd (hereinafter referred to as "MUWASCO") and conducted a field survey.

In the course of the discussions and the field survey, two parties confirmed the main items as described in the Attachment. The Team will proceed to further works for the preparation of a request form to the Government of Japan for ODA (Official Development Assistance) project.

Murang'a, October 13th, 2023

[redacted]

Dr. Moeko YOSHITOMI
Project Superintendent
Technical Survey Team
Ministry of Health, Labour and Welfare,
Government of Japan

[redacted]

Eng. Daniel NG'ANG'A
Managing Director
Murang'a Water and Sanitation Co. Ltd
The Republic of Kenya

MURANG'A WATER & SANITATION
COMPANY LIMITED
P. O. Box 1050-10200
MURANG'A

ATTACHMENT

1. Objectives of the Survey

- Understanding problems and needs on water supply in Murang'a (water supply facilities, operation/ maintenance, financial and human resources etc.)
- Providing advice and guidance for water supply project planning to solve problems based on professional and technical points of view.
- Supporting preparation of a request form to the Government of Japan for ODA (Official Development Assistance) project.

2. Necessity of Project

I. Centre of Murang'a County

Murang'a is the centre of Murang'a County, where the main administrative offices are concentrated, and with the recent expansion of Murang'a university, has not only increased the demand for accommodation facilities but also on water and other support infrastructure. The mushrooming of hostel buildings around the town has raised the demand for water. This has led to a general increase in population of the general suburban area of Murang'a.

II. Commuter town

There has also been an influx of people attracted by its proximity to Nairobi and improved transport connectivity due to the dualling of Kenol – Makutano – Marua highway that traverses through the county. This has made it easier for people to commute daily for work to and from Nairobi.

III. General population growth

Being an urban area, the population of the town has been increasing at a higher rate the average growth in the county, generally due to migration of population from rural areas. This has put a strain on existing supply infrastructure resulting in water supply rationing in areas that were hitherto receiving adequate supply 24 hours a day. These areas include parts of Murang'a town CBD, Kiharu, Kabuta and Gaturi. The problem is projected to worsen over the coming years as the demand for water increases as we race towards universal water coverage by year 2030.

IV. Expansion of the water supply area

The county government has gazetted the new municipality boundaries that increased the current area of Murang'a Municipality from 145km^2 to 330 km^2. The additional areas record less than 50% water coverage and therefore puts pressure on MUWASCO to increase water production and supply network to meet the increased demand.

3. Measures proposed by the Team

The consultant, NJS Co. Ltd, had been conducted a field survey from 9th to 12th October 2023.

Based on the survey report, which the consultant has prepared as the result of the field survey, the Team explained the following provisional measures with the designs as shown in Annex. MUWASCO shall review the drawings and the estimated cost attached to the survey report and, if necessary, to give their comments by 31st October 2023.

Scope of Works

I. Construction Works

a) New Intake Facility	Q=10,500m^3/day
b) Raw Water Main Pipeline	L=15 km, HDPE OD 560mm
c) New Water Treatment Facilities	Q=5,000m^3/day
d) Hydro Power Generation System	1set 30kW
e) Transmission Pipeline to Kiharu	L=5.5 km, HDPE OD 280mm
f) New Water Reservoir (Maragi)	V=1,000m^3
g) New Water Reservoir (Kiharu)	V=2,000m^3
II. Supply of Equipment	Water quality testing equipment

4. Major Undertakings to be taken by MUWASCO

The Team and MUWASCO confirmed that, for the smooth implementation of the Project, MUWASCO should implement major undertakings described as follows.

1) Assignment of Counterpart
2) Allocation of the Budget and implementation of following construction works;
   a) Rehabilitation of the existing raw water main pipeline
   b) Removal of the existing facilities
   c) **Lobbying stakeholders toward expansion of water supply area**

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d) **Extension of water distribution networks**

e) Installation of water supply pipes and customer meters for new connections

f) Land acquisition for construction site

5. Mutual Understanding

- Scope of Works is subject to change due to discussions within the Government of Japan and is not finalized.
- The project cost is a rough estimate and is subject to change.

6. Tentative procedure

The various procedures to be followed after submission of a request form are as follows.

Step	Event	Action by
Application	Preparation & Submission of Application/Request Letter for Japan's Grant-aid Project by GOK	GOK
Study	JICA's Basic Design Study	JICA / Consultant
Appraisal & Approval	Appraisal by GOJ and Approval by Cabinet of GOJ	GOJ
Decision for Implementation	Exchange of Notes (E/N) between GOJ and GOK	GOJ & GOK
Implementation	JICA assists the recipient country in such matters as preparing tenders, contract documents and so on.	JICA / Consultant

Annex: Survey Report

Survey Report of The Project for Improvement of Water Supply System in Murang'a, the Republic of Kenya

13th of October 2023

Ministry of Health, Labour and Welfare

NJS Co., Ltd.

1

Contents of Presentation

1. Forecasting of Water Demand
2. Existing Water Flow
3. Future Plans
4. Estimated Cost

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2

1. Forecasting of Water Demand

1.1 Calculation Condition

■Target Year : 2033

■Daily Consumption (Urban Areas) :

150L/capita/day

■Daily Consumption (Rural Areas) :

60L/capita/day

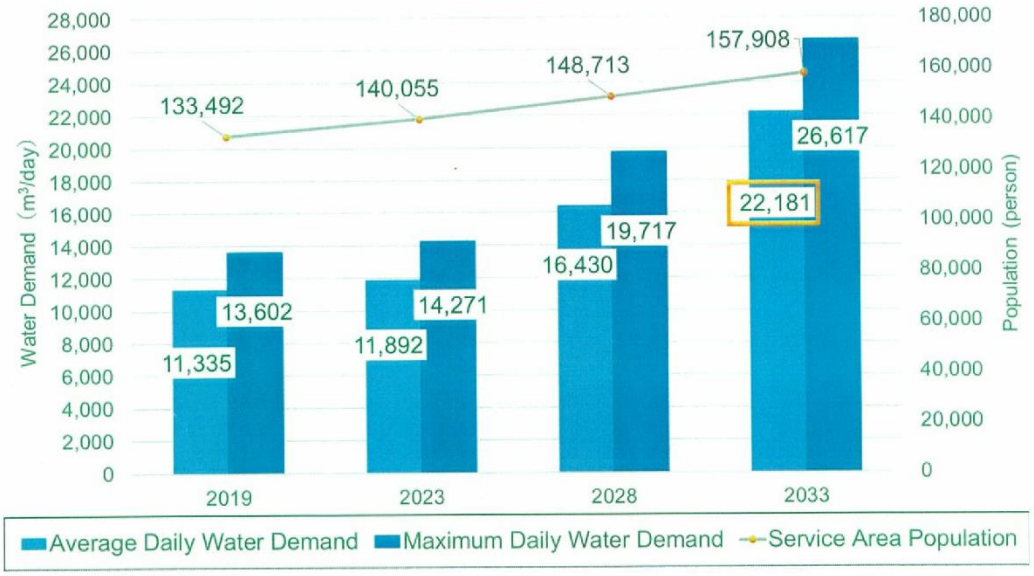
■NRW : 20%

■Peak Factor : 1.20

3

1. Forecasting of Water Demand

1.2 Future Water Demand



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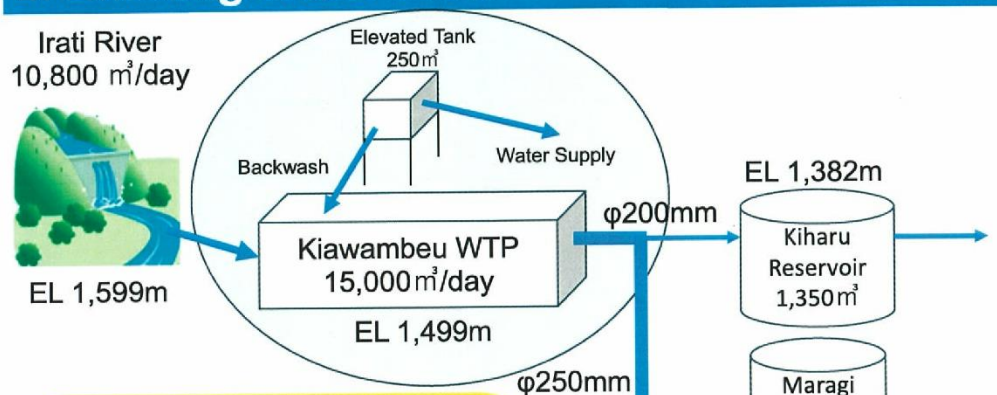
2. Existing Water Flow



① The elevation in **Maragi is 8m Lower** than Kiharu.

② The diameter for **Maragi is larger** than Kiharu.

Excessive amount of water is flowing into Maragi

Current Situation
- Irati Intake：
  7,500～8,500㎥/day
- Kiawambeu WTP：
  7,000～8,000㎥/day

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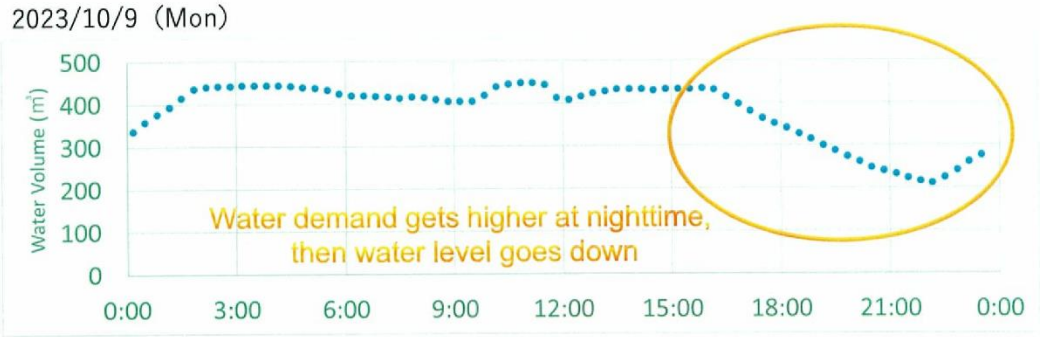
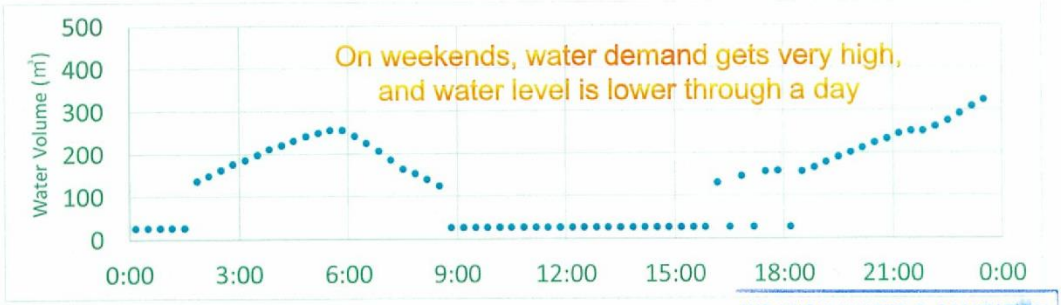
2. Existing Water Flow（Maragi Reservoir）

2023/10/9（Mon）



2023/10/7（Sat）



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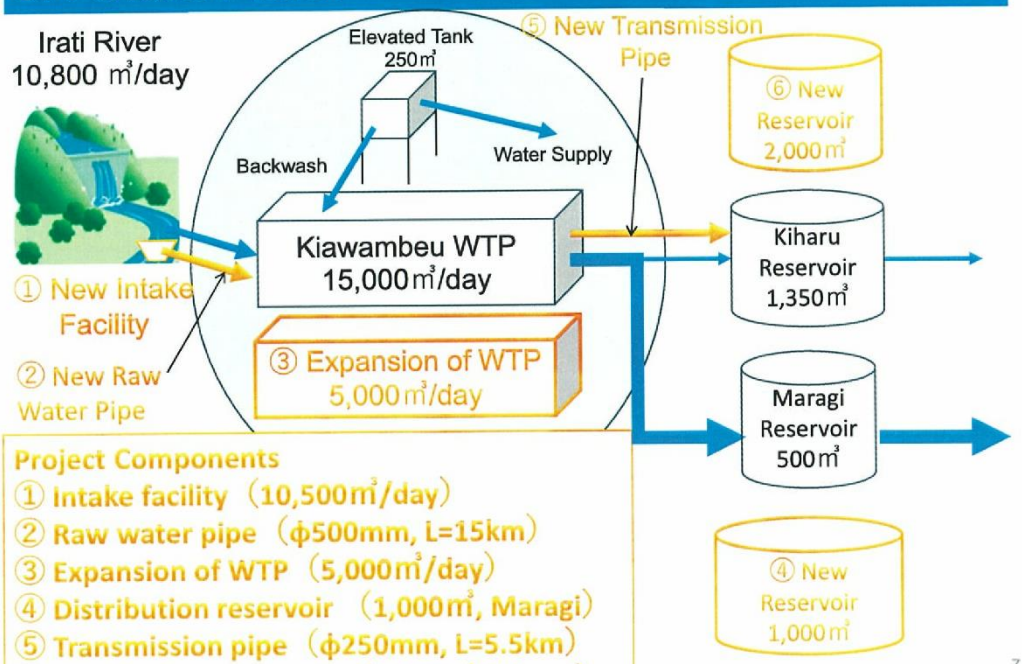
3. Future Plans



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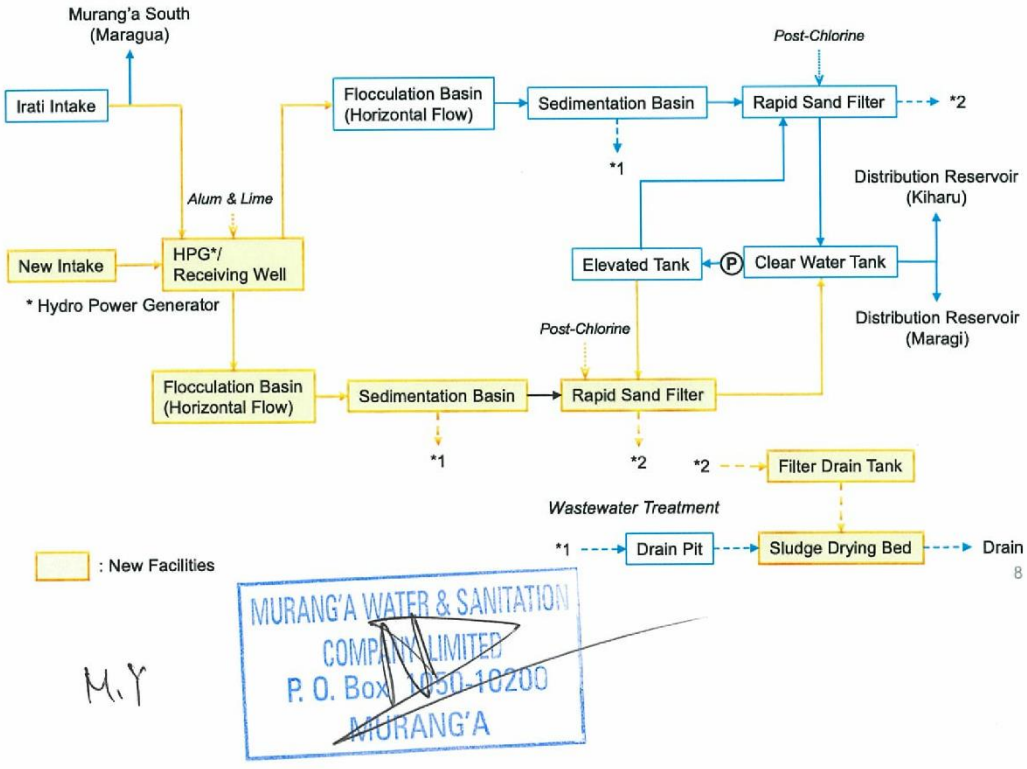
3. Future Plans

Kiawambeu WTP (Q=20,000m3/day) Future Process Flow



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MURANG'A

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3. Future Plans

① New Intake facility （10,500㎥/day）

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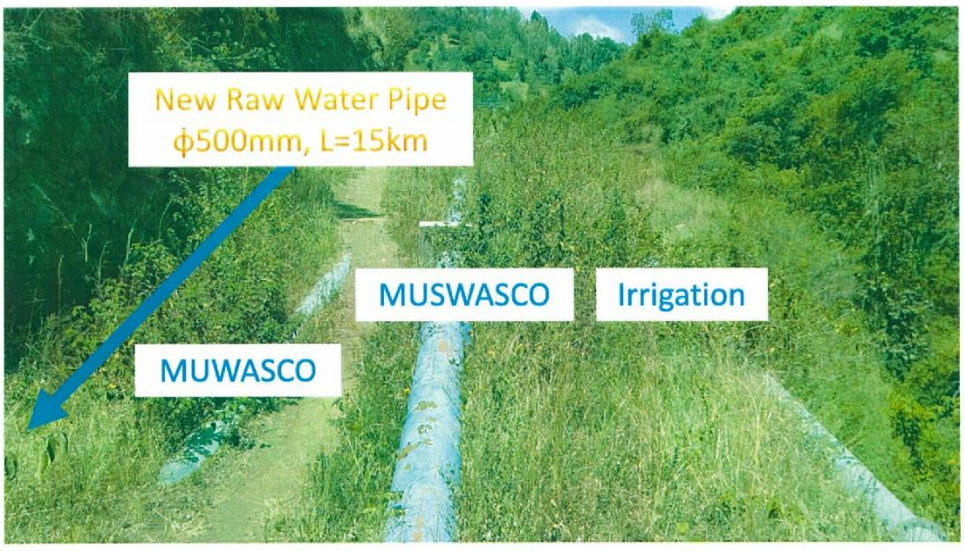
3. Future Plans

② Raw water pipe



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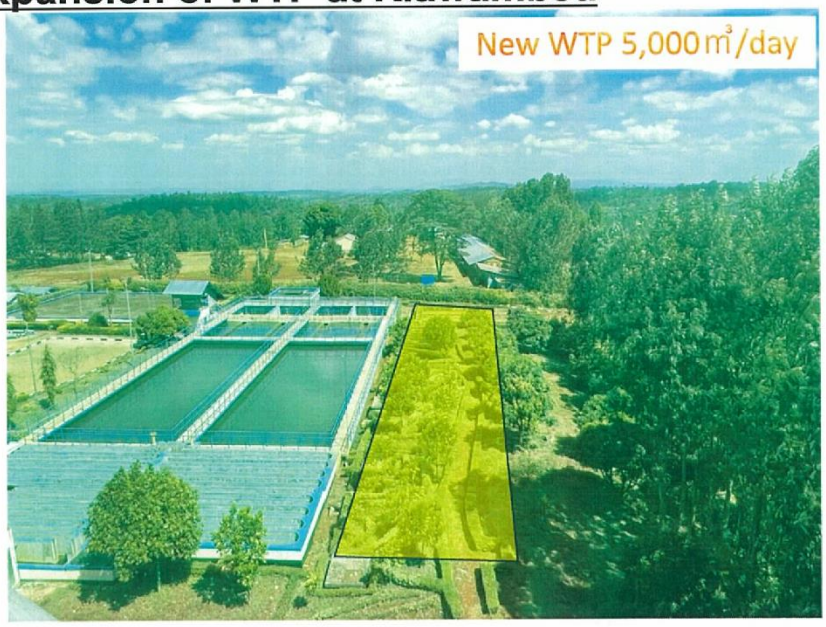
COMPANY LIMITED
P.O Box 1050-10200
MURANG'A

3. Future Plans

② Expansion of WTP at Kiawambeu



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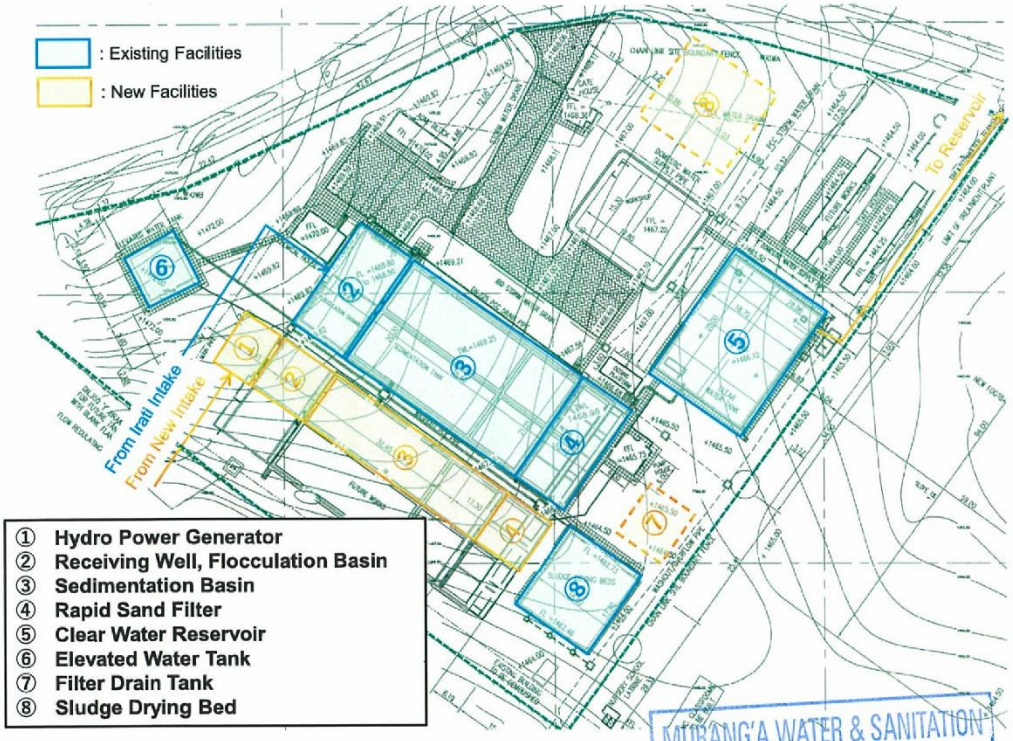
Rough Image of Capacity Enhancement of Kiawambeu WTP



① Hydro Power Generator
② Receiving Well, Flocculation Basin
③ Sedimentation Basin
④ Rapid Sand Filter
⑤ Clear Water Reservoir
⑥ Elevated Water Tank
⑦ Filter Drain Tank
⑧ Sludge Drying Bed

12

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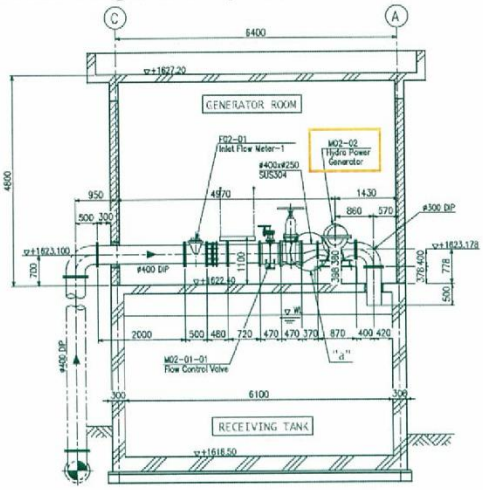
MURANG'A

3. Future Plans

Application of Small Hydropower Generator

- The elevation difference between NEW Intake and Kiawambeu WTP is approx. 90m, indicating in a large potential energy.
- By introducing small hydropower generator and utilizing the energy, electricity costs of WTP operation can be significantly reduced.

Hydro power generator installed at other WTP in Kenya



3. Future Plans

④ Distribution Reservoir （Maragi）

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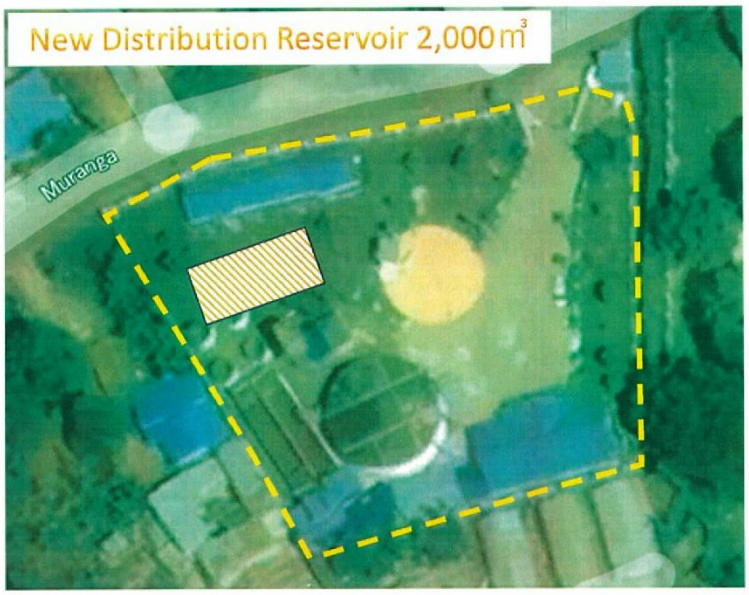
MURANG'A

3. Future Plans

⑥ Distribution Reservoir（Kiharu）



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4. Estimated Cost

		(Million JPY)
I. Total of Construction Cost		**3,440**
1. Construction Cost		3,420
1.1 Direct Construction Cost		2,630
a) New Intake Facility	Q=10,500m^3/day	150
b) Raw Water Main Pipeline	L=15 km, HDPE OD560mm	1000
c) Water Treatment Facilities	Q=5,000m^3/day	950
d) Hydro Power Generation System	1 set, 30kW	100
e) Transmission Pipeline	L=5.5 km, HDPE OD280mm	220
f) New Reservoir （Maragi）	V=1,000m^3	80
g) New Reservoir （Kiharu）	V=2,000m^3	130
1.2 Overheads (1.1x30%)		790
2. Supply of Equipment	Water quality testing equipment	20
II. Design & Supervision		**350**
III. Soft Component	Facility operation & maintenance, water quality/ quantity management	**30**
IV. Ground Total		**3,820**

As of Sept. 2023, 1 JPY = 0.99 Ksh

16

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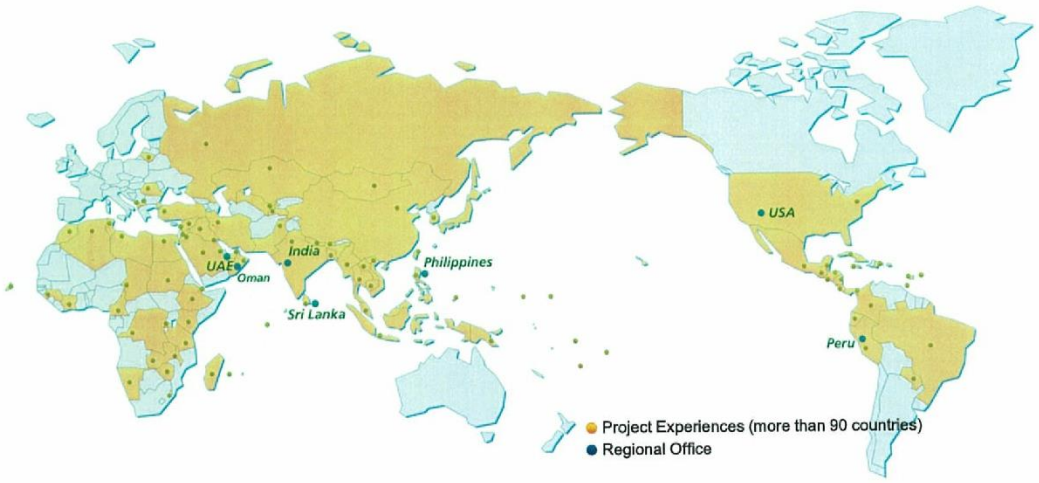

Thank you so much for your kind attention !

17

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