JICA PROJECT BRIEF NOTE

THE PROJECT FOR STRENGTHENING ADDIS ABABA WATER AND SEWERAGE AUTHORITY'S MANAGEMENT CAPACITY OF NON-REVENUE WATER REDUCTION IN FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

February 2023

Training on the Use of
Meter Instrument Error Test Equipment.

Location Map of AAWSA Addis Ababa City
Branch Offices (Current and New)

1. Project Background and Issues

1.1. Necessity of Non-Revenue Water Reduction in the Addis Ababa City

The population of Addis Ababa city, the capital of Ethiopia, was estimated as 5.2 million in 2022. The population in the capital city is growing at an annual rate of about 4.4%, and is expected to reach about 7.3 million by 2030. The water demand is also increasing rapidly in line with the population growth. Addis Ababa Water and Sewerage Authority (AAWSA), which is in charge of the City's water supply business, had formulated business plan in 2011. Under this plan, AAWSA set the planned water supply amount for the year 2020 at 763,000 m^3/day, and commenced development of new water resources and construction of a water treatment plant to meet the rapidly increasing water demand. The plan also aimed to reduce the non-revenue water (NRW) ratio of the entire city to 20% in order to maximize the use of existing water resources. However, while the water demand was estimated to be close to 900,000 m^3/day by 2022, due to exceeding projections population growth, large-scale water source development projects are still in the planning stage, and the water distribution capacity as of 2022 was approximately 511,000 m^3/day, which is not enough to meet the current tight supply-demand situation. In addition, the NRW ratio has remained high at approximately 40%, and effective countermeasures were not been implemented.

Under the Water Resources Management Policy, the top national policy in the Ethiopian water sector, the

principle is that water supply businesses should achieve full cost recovery through water tariffs. However, the current situation is that about 80% of capital expenditures are subsidized by the City of Addis Ababa. Although the current rate of water tariff collection is approximately 92%, water tariffs are kept at low levels, ranging from approximately 6 yen/m^3 to 85 yen/m^3 (increasing in accordance with the volume of water usage), and a water tariff increase is necessary to achieve full-cost recovery. However, the planned water tariff increase could not be realized due to the low level of service represented by intermittent water supply and low water pressure, and the water supply business management is dependent on the city's finances.

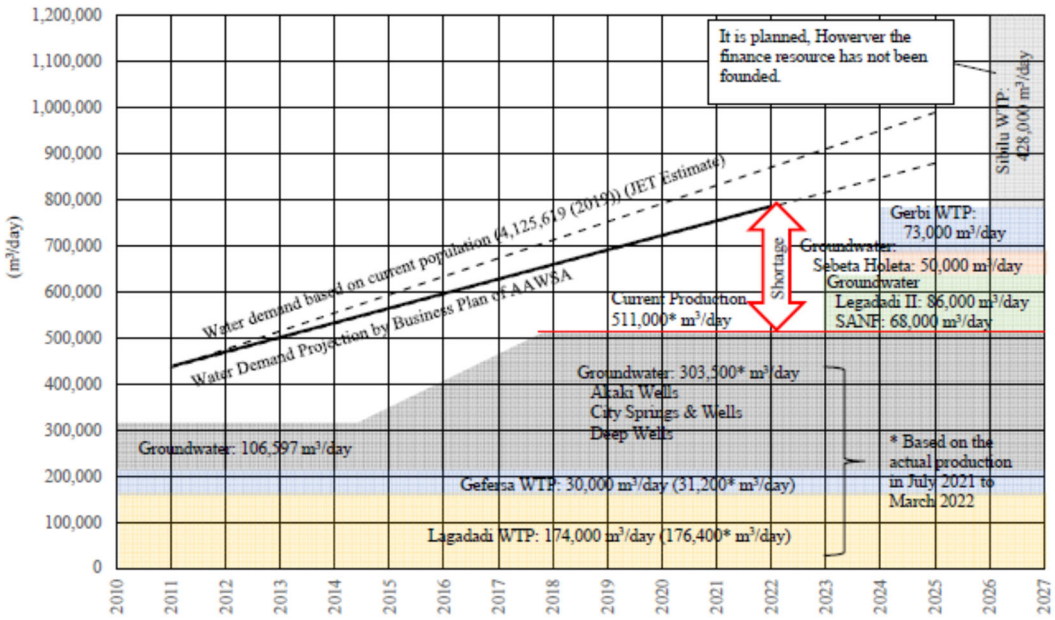

Figure 1 Discrepancy between water demand and water distribution facility capacity

1.2. Project Framework and Implementation Structure

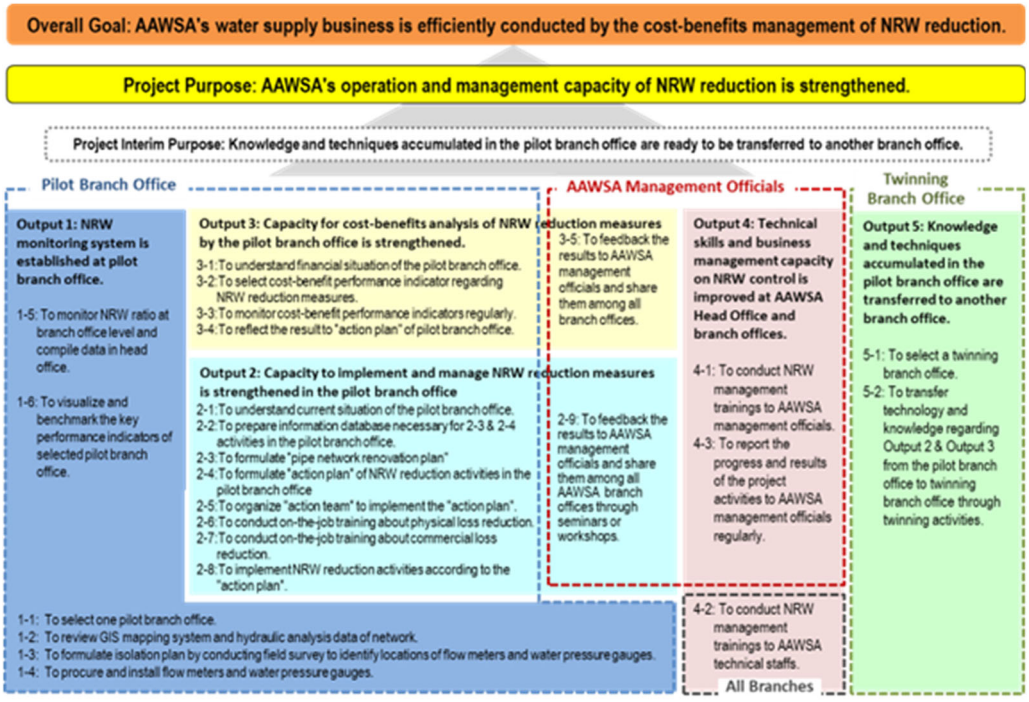

Figure 2 Project Goals and Activities

2. Approaches to Problem Resolution

The activities planned to solve the problem are shown below.

1 Systematic Implementation of NRW Reduction Activities Based on Cost-Benefits

In this project, priority countermeasure methods will be narrowed down based on cost-effectiveness, and an "Action Plan for Non-revenue Water Reduction" was formulated to organize what kind of NRW reduction measures should be implemented at the branch level, and NRW reduction measures will be implemented through on-the-job training in accordance with this plan.

2 NRW Ratio Monitoring at the Branch Office Level

The NRW reduction methods implemented by AAWSA to develop DMAs have not had an impactful effect on the entire AAWSA because of the limited scale of the measures.

Therefore, instead of developing DMAs for this project, a monitoring system for non-revenue water will be developed at the branch level, which is a larger unit.

3 Promotion of Drastic Leakage Reduction Measures and Formulation of Pipe Renovation Plans

In Addis Ababa City, galvanized steel (GS) pipes installed in the 1970s to 1990s are used as distribution pipes and service pipes, and leakage measures from aged GS pipes are one of the issues to be addressed.

A pipe renovation plan for the pilot branch office was formulated and pipe renovation by AAWSA will be promoted.

4 Visualization of the Effects of NRW Reduction Measures and Feedback to AAWSA Management

It is essential for AAWSA management to be actively involved in this project in order to address NRW reduction as a management issue for the entire organization. Active involvement of AAWSA management in this project will be encouraged by visualization and periodic feedback to AAWSA management on the cost-benefit of the NRW measures implemented by the pilot branch offices.

5 Output Spillovers and Project Period Segmentation

AAWSA expects the project to provide technical assistance to multiple pilot branches.

In order to encourage AAWSA to spread the project outputs to other branches in the future, the overall project period was divided into two periods (steps), with the first three years (Step 1) used for technology transfer to the pilot branches, and the remaining one year (Step 2) used for twinning activities by the pilot branches to spread the technology and know-how to other branches. In order to encourage active involvement of AAWSA management, an "interim project target" to be achieved in Step 1 will be set, and based on the achievement of this target, the project will be evaluated as to whether to proceed to Step 2 or to terminate the project in Step 1 only.

3. Results of Applying these Approaches

Based on the planned approach, the details of implementation are shown below. The following activities were carried out between August 2021 and February 2023.

3.1. Results of Activities for Output 1

(1) Selection of a pilot branch

As a result of the collection of data and discussions, the Kirkos area shown in Figure 3 was selected as the target area for the project activities.

Although the Kirkos area is not the current branch boundary, this area was selected based on the following reasons.

- AAWSA is planning to restructure from the current 8 branches to 12 branches (timing undecided).
- In this project, flow meters will be installed so that pilot branch can measure the amount of NRW. By installing flow meters in line with future branch boundaries, it is expected that the flow meters installed will continue to be utilized and that the

project will be sustainable.

- As with the other areas, the Kirkos area is time-supplied, but has somewhat better water supply conditions than the other areas, making it easier to implement non-revenue water reduction activities.

【Kirkos Area Overview】

- The northern part of Kirkos area is located in the center of the city, while the southern part is a suburban area.
- Kirkos area covers an area of approx. 2,700 ha, with approx. 52,000 customers and approx. 300,000-400,000 residents.

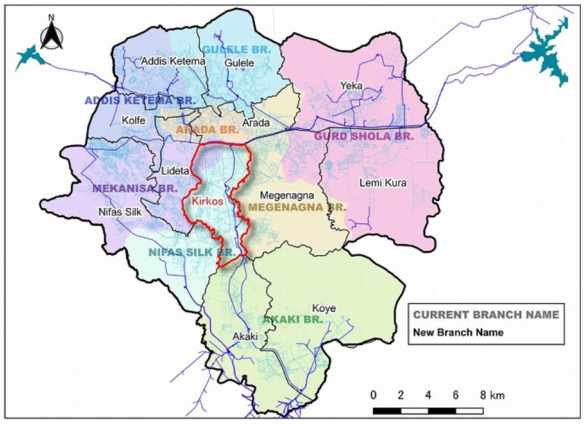

Figure 3 Results of pilot area selection

As shown in Table 1, the Kirkos area covers four current branches. Since the Nifas Silk and Mekanisa branches together account for approximately 96% of the total area, the project activities shall mainly target the staff of the Nifas Silk and Mekanisa branches.

Table 1 Current branches constituting the Kirkos area

Branch name	Area of occupation	Number of customers	
Nifas Silk	81.8%	41,525	80.6%
Mekanisa	14.0%	9,227	17.9%
Megenagna	2.4%	648	1.3%
Akaki	1.8%	97	0.2%
Total	100%	51,497	100%

(2) GIS and hydraulic analysis data review

GIS and hydraulic analysis data were collected for the Kirkos area to confirm the current situation of water pipeline installation, etc.

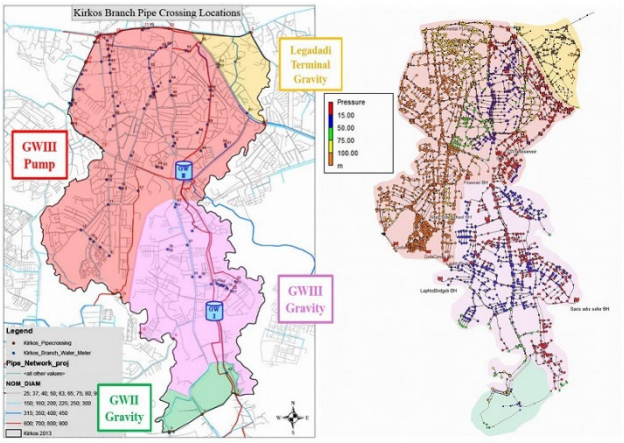

Figure 4 GIS and hydraulic analysis data

(3) Formulation of hydraulic separation plan

At the beginning of the project, the plan was to install flow meters at the boundaries of the pilot area to measure NRW. However, a distribution block system was decided to be applied to the Kirkos area due to the following reasons:

- The Kirkos area is large, approx. 2,700 ha in area.
- As a result of a detailed examination of the situation of pipe network installation in the Kirkos area, it was considered possible to divide the Kirkos area into several areas.
- Efficient NRW reduction activities can be implemented by prioritizing activities from areas with high NRW rates. In contrast, if blocks cannot be developed, it will be difficult to implement efficient NRW reduction activities. While planning the distribution block system, a hydraulic analysis was performed and a detailed study was conducted to create a distribution block system.

The results of the distribution block system formulation are shown in Figure 5.

As shown in Figure 5, the Kirkos area was planned to be divided into 11 blocks. While planning the distribution block system, the study took into consideration the boundaries of major roads, railroads, and rivers where few pipelines crossed.

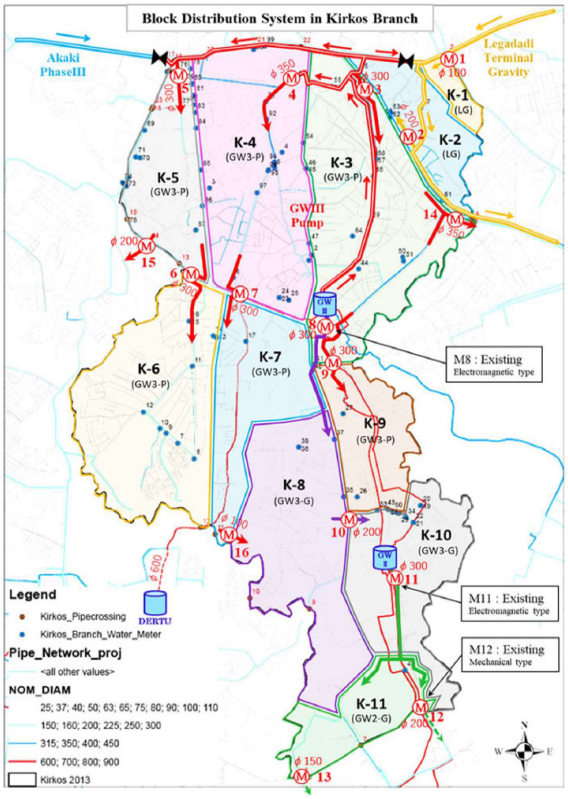

Figure 5 Proposed distribution block system plan

3.2. Results of Activities for Output 2

(1) Survey of current situation of pilot branch office

The survey was conducted in the Kirkos area by collecting data and conducting interviews and field surveys at the Nifas Silk and Mekanisa branches.

As shown in Photo 1, exposed and sbageti pipes were found, and the situation was identified to have many issues.

Photo 1 Situation of exposed piping and spaghetti pipes

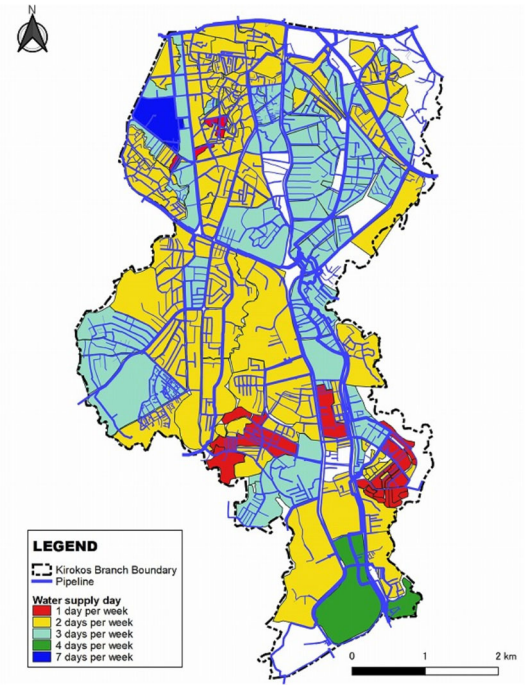

Figure 6 Water supply situation (Kirkos area)

As shown in Figure 6, about half of the Kirkos area receives water for less than two days a week, due to a significant shortage of water distribution capacity relative to water demand. In general, water is supplied for a few hours on the days when it is available and not for the entire day.

(2) Collection and organization of information on service and distribution pipes of pilot branch office

Figure 7 and Figure 8 show the figure/table that organizes the service and distribution pipe information.

【Classification by Diameter】

【Classification by Installation Year】

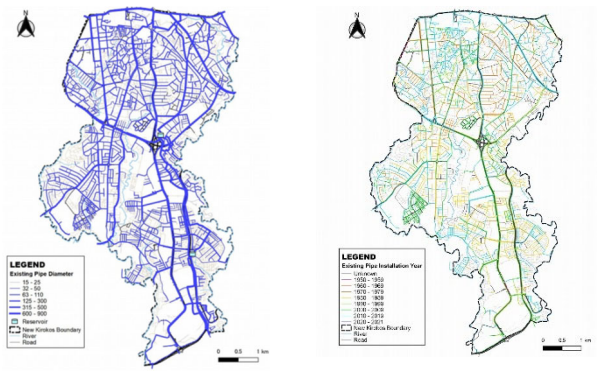

Figure 7 Results of information organized for distribution pipes (Kirkos area)

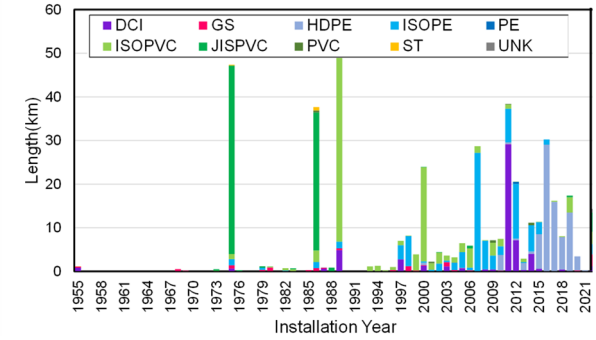

Figure 8 Length of pipeline by installation year and pipe Material (Kirkos area)

- Although the length of GS pipes installed is small in the data, it is considered that many GS pipes are actually installed, because the data for pipelines of 40 mm or less are not managed in the pipeline drawing.
- While it is easy to understand objectively from the collected data that GS pipes have many leaks, there are no such information management, and this is an issue to be addressed in the future.

(3) Formulation of pipe renovation plan

Based on the current situation, identification of issues, and consideration of priorities for renovation, a pipe renovation plan for the Kirkos area was formulated in cooperation with the C/P members related to the pipe renovation plan.

Photo 2 Discussions of the formulation of a pipe renovation plan

(4) Formulation of action plan

Action plans were developed for each of the following group units as a plan to implement activities for reducing NRW

- Distribution block system
- Pipe renovation plan
- Leak detection
- Pipe jointing technology
- Tariff collection/commercial losses
- Business management (study of cost-benefit)

Each group discussed the activities and finally created an action plan in the following format.

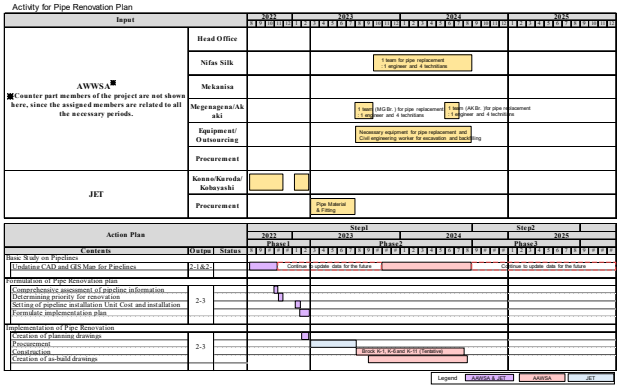

Figure 9 Action Plan (example of a pipe renovation plan)

(5) Implementation of on-the-job training on physical loss reduction

1) Leak detection

Leak repair is known as one of the methods to reduce the amount of NRW. In the current situation, leak repair work is implemented for aboveground leaks (visible leaks from the ground), but few measures were undertaken for underground leaks (invisible leaks from the ground).

Efficient NRW reduction measures can be achieved by focusing on aboveground leakage control measures while aboveground leakage is still occurring, and then shifting the focus to underground leakage control measures when aboveground leakage is decreasing.

To achieve this, leak detection technology is transferred to AAWSA staff.

At first, implementation of normal operations were confirmed in order to check the technical skills of the onsite staff.

Photo 3 Confirmation of Correlative Leak Detector Handling Status

Addis Ababa is supplied water on a hourly basis.

In order to detect leakage using a leak detector, it can only be detected during water supply hours, since leaks are looked for based on the sound of water leaking. On the other hand, during water supply hours, most customers try to store as much water as possible in their house hold tanks, so they open all water taps to receive water. Under this situation, it is difficult to distinguish the sound of water flow and the sound of leaks. In addition, it is difficult to find a leak within the limited water supply time, and even more difficult to detect a leak due to the sound of the water flow.

As a countermeasure, the application of an air leak detection method using air is being planned (see Figure 10).

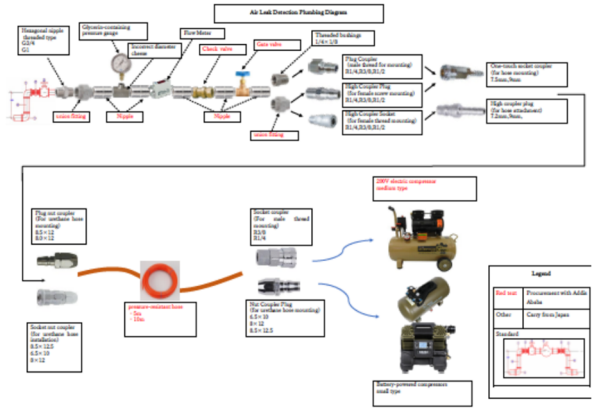

Figure 10 Air injection equipment system diagram

The air leak detection method does not identify the location of leaks, but is a method of narrowing down the location of leaks by looking for sections having leaks even under conditions where there is no water supply. It is expected to narrow down the sections with leaks more efficiently than conducting leak detection surveys on all pipelines. The current situation is that the necessary equipment for this survey is being procured, and it will be conducted as soon as the equipment is available.

2) Pipe joint technology

Regarding pipeline installation and repair, current technical skills are confirmed through on-site work situation assessment, and also capacity assessment of the parties involved were conducted by interviewing them (see Figure 11).

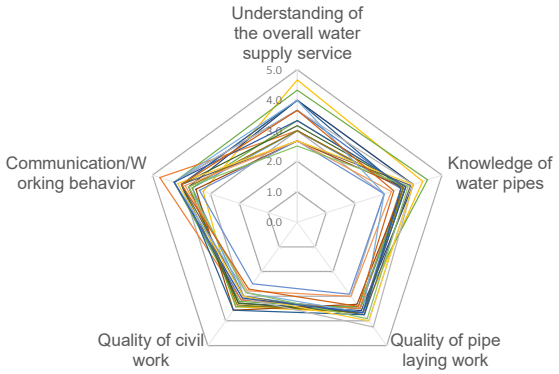

Figure 11 Capacity assessment results (related to pipe joint)

Photo 4 Pipe repair work

The following issues regarding pipe jointing technology were identified from the capacity assessment and current situation confirmation.

- Basic knowledge and techniques need to be improved for general pipeline works such as pipe installation, pipe repair, and service pipe installation.
- There are no manuals that indicate work procedures for pipeline construction, and techniques are shared only through on-site communication among staff members, which may

result in inappropriate information being shared.

- When repairing leakage, there are no appropriate records of leakage, so it is difficult to analyze which pipe materials, conditions, etc. are most likely to cause leakage.
- In some cases, the quality of the pipe materials procured are of inferior standard.

To address the above issues, the following activities are scheduled to be implemented to improve pipe jointing techniques and reduce NRW.

【Issues (Pipe Joining Technology)】

- Conduct desktop training on pipe installation, pipe repair, and service pipe installation, as well as on-the-job training.
- A construction manual will be developed to share appropriate techniques.
- Ensure to implement data management to keep appropriate data on the pipe work performed to repair leaks.
- The system shall be established to confirm that the procured pipe materials are arrived with appropriate specifications. Also, appropriate material management shall be ensured for the procured materials and equipment.

(6) Implementation of on-the-job training on commercial loss reduction

1) Collection of information on commercial losses and tariff collection

Gathering of information and interviews regarding commercial losses and tariff collection were conducted, and the following main issues were identified.

① Errors in water meter reading
② Errors in water meter devices themselves
③ Errors caused by handling of meter reading data
④ Illegal connections
⑤ Errors in customer information

Due to several errors in customer information described in ⑤ above, there is a possibility that meter readings are not billed to the corresponding customer, but to another customer, etc. To confirm the actual situation, a household survey of each customer was conducted.

2) Customer Household Surveys

Outline of the customer household survey is shown in Table 2.

Table 2 Outline of Customer Household Surveys

Item	Descriptions
Objectives	・To identify the priority intervention areas and action points for reduction of commercial losses ・To identify the potential risks for illegal connection ・To identify the gaps of the customer data between the system and the real ground for increasing the data accuracy
Target	・500 sample households ・in K-2 and K-5 of New Kirkos area
Duration	・October – December 2022(including planning stage)
Method of data collection	・Visit each customer to survey and collect data based on the questionnaire (an application called epicollect5 was used to share the data immediately). ・Confirm each customer's information from the customer information file of each customer managed by the branch office ・Water billing system information ・Confirm consistency of data from ① to ③ above
Survey team	・Nifas Silk branch（K-2） : 3 persons ・Mekanisa branch（K-5） : 3 persons
Others	・2 vehicles required

Photo 5 Situation of household survey

Although the survey is still under progress, following are the main issues identified from the household survey:

- There are cases where there are records on the water billing system, but no water meter is installed on site or the contract was terminated several years ago on the customer file.
- Many water meters are not installed according to installation standards.
- There were cases where customers may have modified the pipelines around the water meters.
- There were several water meters facing risk for illegal connection (see Photo 6).

Photo 6 Example of a branch installed upstream of a water meter

3) Water meter error survey

Basically, water meters are installed for the customers managed by AAWSA. Although water meters were installed, about 1/4 of the total installed water meters are more than 20 years old. In Japan, the law (Measurement Law) requires that water meters must be replaced every eight years. As water meters get older, the rate of measurement/ metering error increases.

The survey was conducted to check the errors of existing water meters. The survey method adopted was to use a bucket, based on the availability of the necessary equipment for the survey and the simplicity of the method.

A certain amount of water, such as 20 L, was filled into the bucket, and the number of L measured by the water meter was checked (see Figure 12).

Figure 12 Water meter survey method using a bucket

The first goal is to collect the survey results of 100 samples, and this survey will be conducted in the field in the future to analyze the error status of water meters from the collected data.

(7) Implementation of NRW reduction countermeasures based on the action plan

The flow meter installation is behind the original schedule, and it is anticipated that it will take more time before the NRW baseline in the Kirkos area can be measured. If the activities are implemented before the NRW baseline is measured, the NRW reduction effects of the activities will not be understood; therefore, the NRW reduction activities will be implemented according to the policy described below.

- Before the baseline measurement of NRW, the project will focus on preparatory studies and other activities to reduce NRW, such as leakage surveys, accuracy surveys of existing water meters, and other activities to reduce NRW.
- After the baseline measurement of NRW, activities to reduce NRW (repair of leaks, replacement of water meters, etc.) will be conducted mainly.

3.3. Cost-Benefit Analysis (Output 3)

(1) Assessing the financial situation of the pilot branch office

The target area is Kirkos area, but Kirkos branch does not exist yet as it is a branch planned to be established in future. Therefore, the financial situation of the Nifas Silk branch, which covers most of the area of Kirkos, was assessed.

Figure 13 shows the financial situation of the Nifas Silk branch office, which was confirmed based on collected information, interviews, and discussions with the C/P.

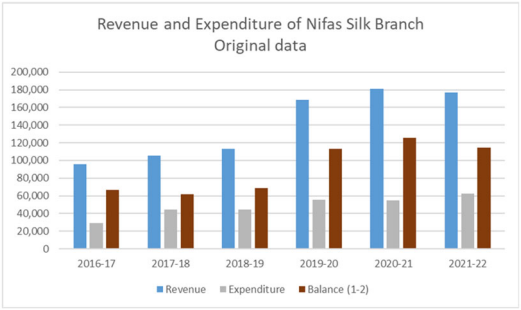

Figure 13 Revenue and Expenditure of the Nifas Silk Branch Office

The results in Figure 16 indicate that the Nifas Silk branch office operates with a healthy surplus. However, a detailed review of the revenue and expenditure situation reveals that the following expenditures are included in AAWSA's head office expenditures and are not borne by the branch office.

① Chemicals
② Electricity
③ Loan repayment expenditures
④ Other head office expenditures
⑤ Maintenance of mechanical and electrical equipment
⑥ Warehouse panel maintenance, etc.

The above items are expenditures that should normally be borne by the branch office, since these expenses are incurred to provide water service to customers within the branch office. Therefore, Figure 14 shows the revenue and expenditure for the above items as incurred by the Nifas Silk branch office.

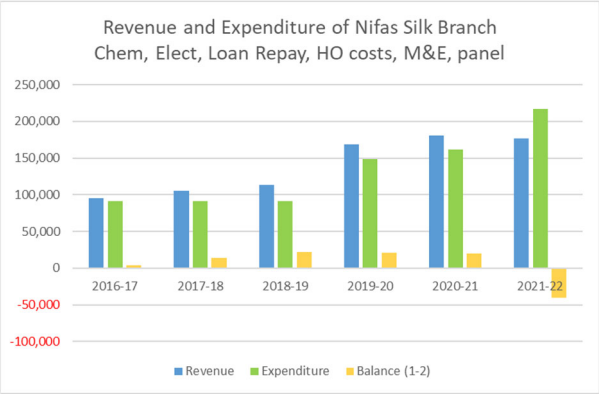

Figure 14 Revenue and expenditure of the Nifas Silk branch office (revised version)

After reviewing the revenues and expenditures of Nifas Silk branch office, it was inferred that the annual revenues and expenditures were in the red, as shown in Figure 14. It is important to properly understand the current situation in order to determine what expenses are wasteful and how to eliminate such waste.

(2) Selection of cost-benefit indicators related to NRW measures

The main indicators selected for monitoring at the time of implementation of NRW countermeasures are listed in Table 3.

Table 3 Main cost benefit indicators to be monitored

Indicator	Unit	Frequency of calculation
Distribution volume	m^3/ month	Once per month
Billing water volume	m^3/month	Once per month
NRW volume	m^3/ month	Once per month
NRW ratio	%	Once per month
NRW volume per connection	m^3/connection /year	Once per year
Water tariff bill amount	ETB/ month	Once per month
Annual total revenue	ETB	Once per year
Annual total cost	ETB	Once per year
Rate of total returns	%	Once per year
Operating ratio	%	Once per year
Unit cost of water	ETB/ m^3	Once per year
Unit price of water	ETB/ m^3	Once per year
Tariff recovery rate	%	Once per year
Collection efficiency	%	Once per year
Water supply revenue per staff	ETB/Staff	Once per year
NRW reduction measures cost	ETB	Once per month
Period of NRW reduction measures	Months	at any time
Cost-benefit ratio	%	Once per month

(3) To reflect the results of the above monitoring in the action plan

The periodic monitoring and analysis of evaluation indicators will reveal activities having high cost-benefit and, conversely, activities with low cost-benefit. Based on the results, the action plan will be reviewed, such as prioritizing the implementation of activities with high cost-benefit.

3.4. Management Capacity Building (Output 4)

(1) Implementation of training on NRW management for AAWSA technical staff

1) Workshop

The workshops are mainly related to the following topics. The target group is AAWSA staff involved in project activities.

- Distribution block system
- Pipe renovation plan
- Leak detection
- Pipe jointing technology
- Tariff collection/commercial losses
- Business management (consideration of cost benefit, etc.)

2) Seminar

In order to inform all AAWSA branches about the

Photo 7　Seminar Implementation

project activities, seminars were held to introduce the project and its activities.

4. Creative Solutions and Lessons in Project Implementation

4.1. Proposal for Distribution Block System

Since the current situation of the monitoring system for NRW has issues with the efficiency and accuracy of flow measurement, a more efficient and effective monitoring system for non-revenue water is desired in the Kirkos area, which is the pilot branch of the project. Therefore, it was the policy of this project to propose and implement the water distribution block system shown in Figure 15. The expected benefits of applying the distribution block system are listed below.

- Effective activities are possible by identifying the amount of NRW in each block so that activities to reduce NRW can be carried out from the area with the higher amount of NRW
- Currently, dozens of valves are opened and closed daily to switch water supply areas due to limited water supply hours. After the block system is completed, it will be possible to supply water in unit of blocks, thus reducing the manpower required to operate valves

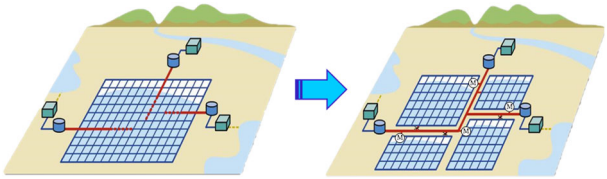

Figure 15 Image of distribution block system development

4.2. Securing a Budget for Project Activities of AAWSA

Although it was arranged to begin the customer survey as a field activity in November 2022, it took some time to start the field activities. The main reason it took so long to start the field survey was the allowances for the AAWSA staff who were to conduct the field survey.

Table 4 shows allowances other than base salary generally paid to AAWSA staff.

Table 4 Per diem, overtime, and other allowances*

No	Item	Payment standards	Remarks
1	per diem	Paid for travel outside of Addis Ababa City.	Meals, accommodation, etc.
2	Overtime allowance	Paid for work in excess of normal working time.	Overtime
3	Night shift and late-night allowance	Paid at a higher rate for overtime work out of normal working time.	Night work, etc.
4	Other allowances	Paid when performing work different from normal work. The amount is added in accordance with the base salary and job classification.	Project-related activities, work, etc.

*Details may differ due to hearing-based approach.

No. 1 through No. 3 are common in Japan, but No. 4 is different from those in Japan. The system is designed to provide additional allowances according to base salary and job class when performing work that differs from regular work, such as project activities, etc.

In the case of a technician performing field activities for customer surveys during project activities, as in this case, even during normal working hours, the technician is expected to be paid an additional allowance for working on the project as opposed to regular work, and without that allowance, the technician cannot carry out the activities.

Through the implementation of this customer survey, it was found that an allowance under No. 4 is needed to carry out the activities for the project. Therefore, it is necessary to have AAWSA prepare a budget for the project activities.

4.3. Importance of C/P Ownership

This project is the first Japan technical cooperation project for AAWSA; it is assumed that for AAWSA's previous projects with other donors, consultants have come in and taken the lead on the project.

In this project as well, in the early stages of the project, the JICA expert team often took the initiative in selecting pilot stations and examining flow meter installation locations, giving the impression that the Japanese side would do something for them. Therefore, from the initial phase of the project to the transition phase in which AAWSA took the initiative, the project proceeded with the mindset that the JICA expert team would do something for them. This was a point of regret.

From next phase, it is necessary to manage the project while considering the implementation of the project under the initiative of AAWSA.

When the project was introduced at a workshop for each branch office, the following comments were made by attendees when asked for feedback on this project.

- AAWSA itself does not have the capacity to implement, so AAWSA themselves need to improve their capacity through this project so that they can implement it themselves.

Although not all attendees may have had the above impressions, it is very important to raise awareness of the above issues. In order to change the mindset of more staff members, it is necessary to manage the project with a view of achievements related to NRW reduction, as it is considered important to show that with proper efforts, NRW can be reduced in this project.

Reference：

(1) *Federal Democratic Republic of Ethiopia, Planning and Development Commission, TEN YEARS DEVELOPMENT PLAN, A PATHWAY TO PROSPERITY 2021-2030*

(2) *AAWSA（2011）BUSINESS PLAN 2011-2020*

(3) *JICA (2020) The Study on detailed plan for Project for Strengthening Addis Ababa Water and Sewerage Authority's Management Capacity of Non-Revenue Water Reduction*