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

March 2025

Training on the leak detection by use of listening rods

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 Et hiopia, was estimated as 5.2 million in 2022. The city's population is growing at an annual rate of about 4.4%, and is expected to reach approximately 7.3 million by 2030. Water demand is also rapidly increasing in line with this population growth. Addis Ababa Water and Sewerage Authority (AAWSA), which is in charge of the City's water supply business, 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 balance. In addition, the NRW ratio remained high at around 40%, and effective countermeasures had 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. Regarding water tariffs, AAWSA has repeatedly explained to the City of Addis Ababa the necessity of raising prices. As a result, a decision has been made to gradually increase the current water tariff, which is approximately 6 to 85 JPY/m^3 (based on an increasing return system according to usage), to eventually reach about 30 to 240 JPY/m^3. After the tariff increase, the goal remains to reduce dependence on subsidies from the city and to improve the efficiency of water utility operations. /

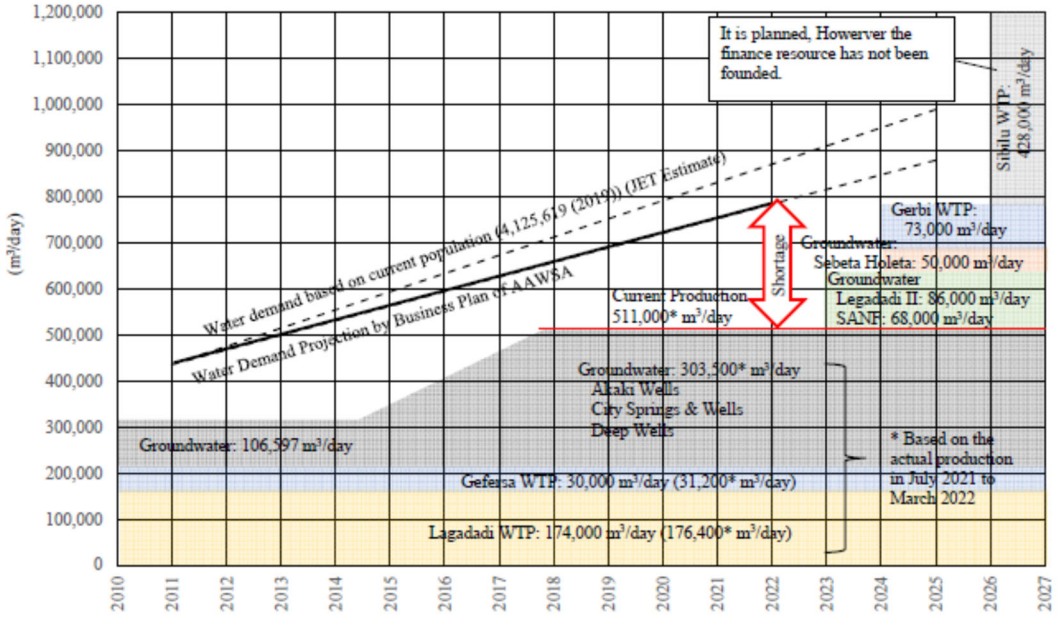


Figure 1 Discrepancy between water demand and water distribution facility capacity

1.2. Project Framework and Implementation Structure

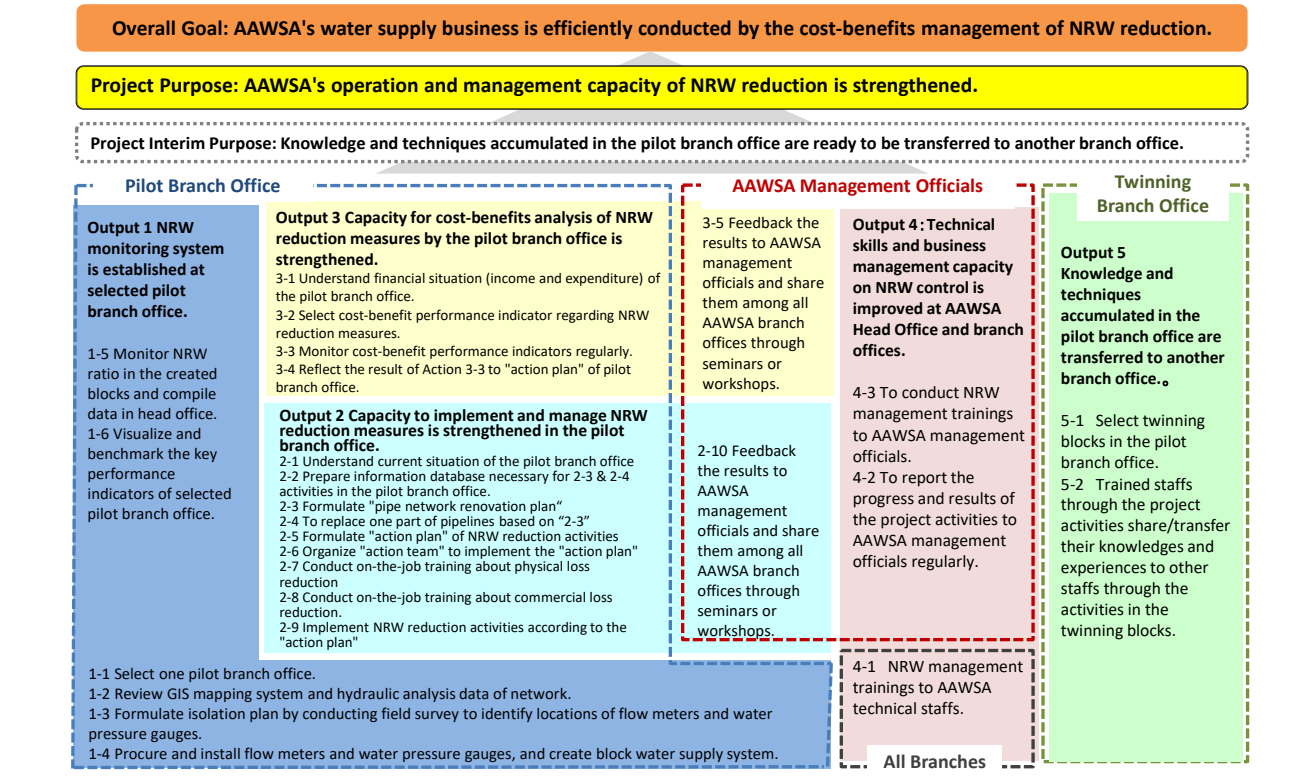


Figure 2 Project Goals and Activities

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" is under developing 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（approximately 600,000 connection） 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 March 2025.

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.

【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.

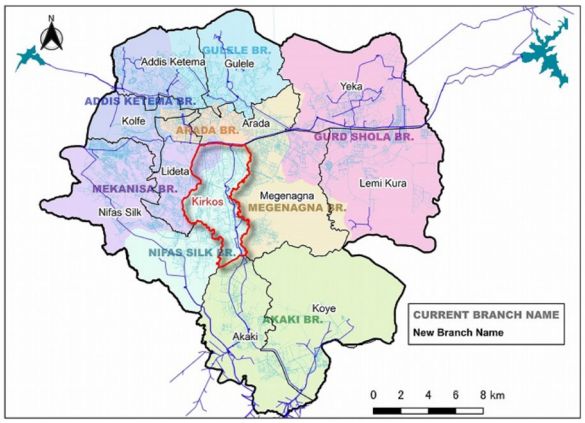


Figure 3 Results of pilot area selection

As shown in Table 1, the Kirkos area covers four current branches.

Table 1 Current branches in 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.

(3) Formulation of hydraulic separation plan

In the distribution block plan for the Kirkos area, formulated in Phase 1, the plan was to divide the area into 11 blocks. However, it was found that some blocks could not be divided, and the plan was revised to divide the area into 10 blocks instead (see Figure 4). In the Process of creating distribution blocks, each block will be hydraulically isolated, and flow meters will be installed to measure the water supply to each block. This will allow the calculation of the non-revenue water (NRW) rate for each block and the identification of blocks with high NRW rates. Based on the NRW status, efficient NRW reduction activities, such as concentrating efforts in blocks with high NRW, can be implemented

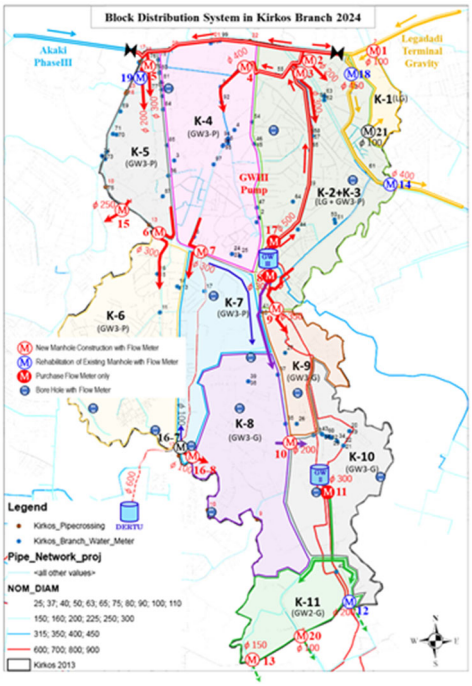


Figure 4 Proposed distribution block system plan

(4) Creation of Distribution Blocks

Based on the above distribution block system plan, construction for the creation of the distribution blocks is underway. Currently, only the K-1 block out of the 10 blocks has been completed, and the measurement of the non-revenue water (NRW) rate has begun. The measured NRW rates are presented in the results of Activity 3.

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

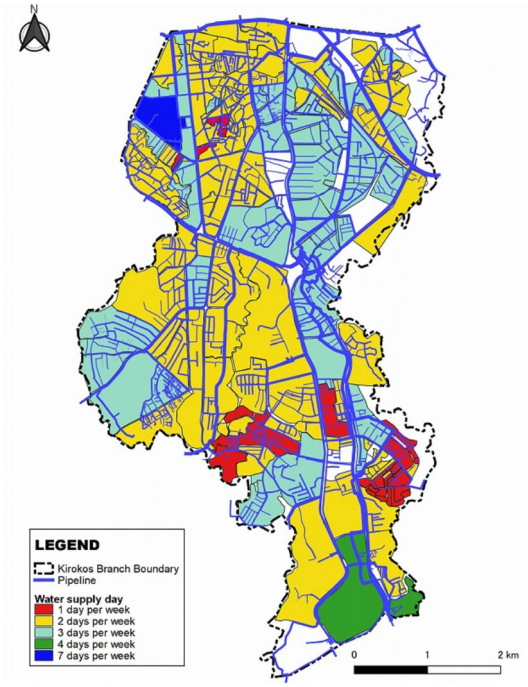


Figure 5 Water supply situation (Kirkos area)

Regarding the water distribution situation, the supply capacity is significantly insufficient to meet the demand. As shown in Figure 5, nearly half of the Kirkos area receives water for fewer than two days per week. Even on days when water is available, it is usually supplied for only a few hours rather than for the entire day.

(2) 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 with the C/P members related to the pipe renovation plan. In Addis Ababa, a large number of "spaghetti pipes" have been identified, as shown in Figure 6. This issue will also be addressed as part of this project.

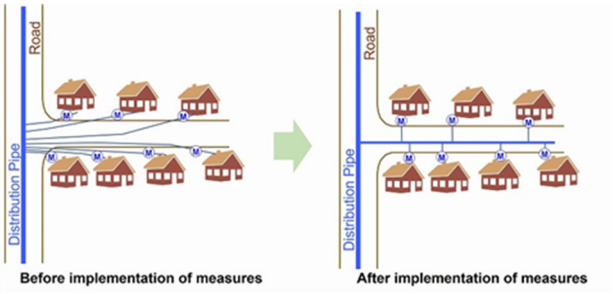


Figure 6 Improvement of spaghetti pipes

(3) Formulation of action plan

The main activities for reducing non-revenue water include pipeline renewal, leak detection and repair, customer surveys, water meter replacement, and measures against illegal connections etc., To implement these activities systematically with the relevant branches, an activity plan, as shown in Figure 7, has been developed and coordinated with AAWSA. This plan is regularly updated based on the progress of the activities.

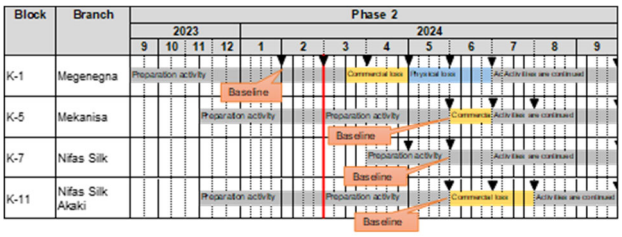


Figure 7 Example of Action Plan

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

1) Leak detection

One method to reduce the amount of NRW is leak repair. In the current situation, leak repair work is implemented immediately upon finding for aboveground leaks (visible leaks from the ground), but almost no measures were undertaken for underground leaks (invisible leaks from the ground).

In order to implement measures to prevent underground leakage, it is necessary to find the location of the underground leakage. For this reason,

after conducting training on leakage surveys, on-site leakage surveys were conducted. The surveys were conducted by listening for the sound of water leakage using a listening rod, which is the most basic method.

Leakage Survey Training

On-site Leakage Survey

Photo 2 Leakage Survey

(5) Pipe joint technology

If the quality of water pipe installation is poor, there is a risk of leaks occurring in the future. Since preventing leaks is of utmost importance, improving pipe connection techniques becomes one of the measures to reduce NRW.

To improve the technical skills in pipe connections, a three-day training program combining classroom instruction and hands-on practice was conducted under the leadership of Japanese experts. Additionally, to encourage autonomy within AAWSA, some AAWSA staff members were also appointed as instructors for the training.

1st Pipe Connection Technology Training (Led by Japanese Experts)

Training Period: Oct.31–Nov. 2, 2023 (3 days)
Participants: 24 individuals (from headquarters and branch offices)
Trainers: Japanese experts and AAWSA staff

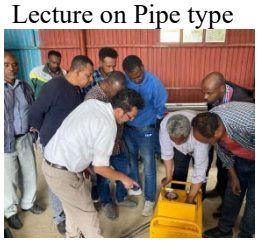
Based on the survey results and discussions following the training, it was evident that such training had not been previously conducted within AAWSA. With a satisfaction rate of over 90%, most participants expressed high satisfaction with the training. The AAWSA project manager, encouraged by the implementation status of the training and the positive attitude of the participating staff, organized the second pipe connection technology training. While the content of the second session was largely similar to the first, a different group of participants was involved, and the major difference was that it was led by AAWSA itself. This shift demonstrated AAWSA's growing autonomy in managing the project, which was a gratifying outcome for the Japanese experts involved.

2nd Pipe Connection Technology Training (Led by AAWSA)

Training Period: Dec.5–7, 2023 (3 days)
Participants: 24 individuals (from headquarters and branch offices)
Trainers: AAWSA staff and Japanese experts

Lecture on Pipe type

Pipe Cutting Training



Pipe Fusion Training

Group Photo after Trainin

Photo 3 Pipe Connection Training

1) Improvement of Pipe Repair Records and Strengthening of Repair Record Analysis Capabilities

While AAWSA records information when repairing pipes, the focus has primarily been on recording the working hours. As a result, technical details such as the repair location, specifics of the repairs, causes, leak volume, and materials used for the repairs are missing. Additionally, the current reliance on handwritten data makes it challenging to utilize this information effectively.

To address this issue, it was decided to utilize a smartphone application (free software) for managing pipe repair records in consultation with AAWSA. After a week of trial operation, a feedback meeting

was held with the technicians who input the data on-site and the engineers responsible for data management. The feedback was positive, leading to an expansion of the data collection activities. Since these pipe repair records will be useful when considering pipeline renewals and other related matters, it is expected that the activities will continue, and that data will be accumulated over time.

Introduction of Usage

Introduction of Usage

Discussion on record-keeping methods

Input screen

Photo 4　Pipe Repair Record Training

(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 (Including malfunction)

③ Errors caused by handling of meter reading data

④ Illegal connections

⑤ Errors in customer information

To address the above issues, a Customer Household Survey was conducted in the K-1 block to verify customer information and the actual conditions of the water meters.was conducted.

2) Customer Household Surveys

Outline of the customer household survey is shown in

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	・ 661 households (K-1 block)
Duration	・ October – December 2023(data collection) ・ January- March 2024 (data organization and analysis)
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
Surveyor	・ Megenagna：7 persons

Photo 5 Household survey

【Main Issues Identified from the Household Survey】

・Water meters are not operational (4 cases, 0.6%)
・Water meters are unreadable (38 cases, 5.7%)
・Water meters are slanted (265 cases, 40%)
・There is a risk of illegal connections
・Customer categories (residential, commercial, public taps) do not match the actual situation (this affects the billing amounts due to different pricing for each category)taff

Unreadable Meter

Slanted Meter

Branch before the meter

Tap before the meter

Photo 6　Example of a meter confirmed during the customer survey.

3) Accuracy test of Inclined Meter

As noted above, a customer household survey revealed that many water meters were not properly installed and were instead positioned at an angle. This led to discussions on whether these inclined meters should be reinstalled correctly or if they could remain as they were without issue. To verify this, an accuracy test of the inclined meters was conducted using a meter test bench.

Overview of Accuracy Test for Inclined Meters

- Meter Test Bench: A test was conducted by allowing a fixed volume of water to flow and comparing the actual flow rate with the volume measured by the meter.
- Test Conditions: The experiment was conducted at four different flow rates.
- Test 1: Conducted under standard conditions with 10 meters installed without tilt (see Photo 7).
- Test 2: Conducted with 10 meters installed at an inclined position (see Photo 8).

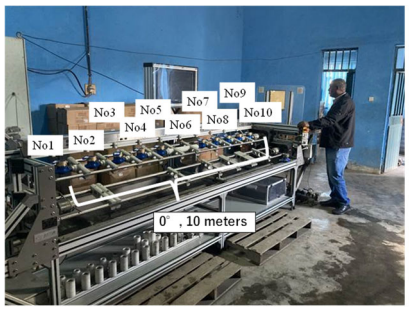


Photo 7 Test 1（Standard Condition）

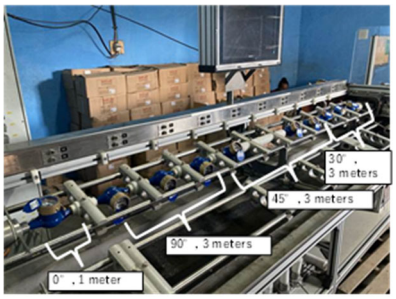


Photo 8 Test 2（Meter inclined）

Summary of the Test Results

- A greater inclined meter tended to result in larger measurement errors.
- Lower flow rates were associated with increased measurement errors.

Additionally, during the test, it was observed that under low-flow conditions, some inclined meters did not count water flow at all, meaning they failed to measure water consumption. This could contribute to increasing NRW.

Based on these findings, it was confirmed that improperly inclined water meters have the potential to cause NRW, indicating the necessity of reinstalling them correctly.

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

Based on the on-the-job training (OJT) conducted for both physical and commercial loss countermeasures, the following NRW reduction measures were implemented in K-1 Block, where block construction had already been completed:

- Leak detection and repair
- Replacement of customer meters, including the correction of inclined meters
- Countermeasures against illegal connections

These activities were carried out from April to June 2024. The trend of NRW rates during the period is presented later (see Figure 8).


Photo 9　Example of leakage found through leak detection survey.


Before replacement　　After replacement

Photo 10　Example of water meter replacement status.


Before Measures（Branch exist upstream of the meter）　　After Measures（Elimination of the branch）

Photo 11　Example of countermeasures against illegal connection

3.3. Cost-Benefit Analysis (Output 3)

(1) NRW Monitoring Results (K-1 Block)

In K-1 Block, the calculation of NRW rate has benn implemented, and measurements have been conducted since November 2023 (see Figure 8).

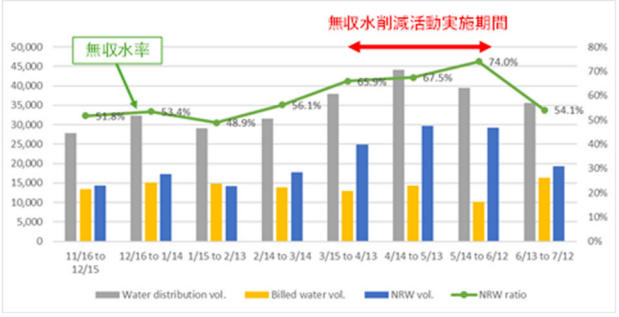


Figure 8 NRW ratio (K-1 Block)

As shown in **Figure 8**, the NRW ratio increased during the period when NRW reduction activities were implemented. Although a reduction in the NRW rate was anticipated, the ratio actually increased. In the target area, water is normally supplied about three days a week. However, to conduct leak detection surveys, the water supply schedule was specially adjusted to increase the number of supply days. As a result, more water flowed into the K-1 Block than usual, which likely led to an increase NRW.

NRW rate monitoring will continue to ensure that NRW reduction activities are effectively contributing to a decrease in the NRW ratio.

3.4. Management Capacity Building (Output 4)

(1) Implementation of training in Japan

To strengthen the implementation and management capabilities of NRW rmeasures, training programs were conducted in Japan according to the schedule shown in Table 3. This training was carried out with the cooperation of the Kitakyushu City Water and Sewerage Bureau.

Table 3 Overview of Training in Japan

Session	Period	Participants
1st	Sep-Oct 2023 (2 weeks)	8 technical staff
2nd	Aug 2024 (2 weeks)	6 management staff
3rd	Sep-Oct 2024 (2 weeks)	8 technical staff


Opening Ceremony　　Lecture Session


Leak Detection Training　　Leak Repair Training

Photo 12 Training in Japan

The AAWSA staff who participated in the training engaged actively with the instructors, asking insightful questions and acquiring a deeper understanding of NRW mitigation strategies. Concurrently, their commitment to addressing NRW was strengthened, and upon returning to Addis Ababa, they became more proactively involved in the project activities, resulting in a revitalization of the initiative. Moreover, the AAWSA management team expressed a keen interest in the differences between water utility operations in Addis Ababa and Japan, particularly the delegation of various functions to external contractors in Japan. They conveyed a strong intent to pursue similar approaches upon their return. Given that AAWSA currently handles a significant portion of operations internally, they are eager to establish an environment that facilitates outsourcing, thereby advancing more efficient water utility management practices.

(2) Implementation of Workshops and Seminars

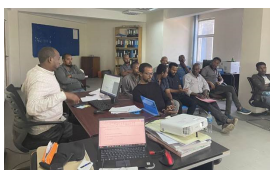
To address NRW, workshops on the following topics are conducted regularly on-site. The targets are AAWSA staffs involved in project activities:

- Distribution Block System
- Pipeline Renewal Plan
- Leak Detection
- Pipe Jointing Techniques
- Billing and Collection / Commercial Losses
- Management and Administration (including cost-effectiveness considerations)

Distribution Block System

Data Editing（Excel）

Management and Administration



Commercial Losses

Photo 13　Workshop

Photo 14　Seminar Photo

4. Creative Solutions and Lessons in Project Implementation

4.1. Proposal for Distribution Block System

At the start of the project, it was planned to hydraulically separate the Kirkos area as a single area. However, due to the large size of the Kirkos area, there was a challenge in determining where to initiate the NRW reduction activities. To address this, a proposal was made to divide the Kirkos area into 10-11 blocks through a distribution block system (**Figure 9**). The expected benefits of applying the distribution block system are as follows:

- By determining the NRW volume for each block, activities can focus on areas with higher NRW, enabling more efficient operations.
- Currently, because the water supply is intermittent, several valve operations are carried out daily to switch supply areas. With the completion of the block system, it may become possible to supply water on a block-by-block basis, reducing the manpower required for valve operations

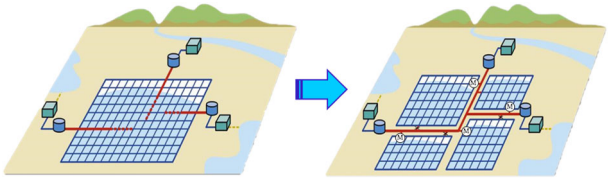


Figure 9 Image of distribution block system development

4.2. Securing a Budget for Project Activities of AAWSA

At the early stage of the project, arrangements were

made to initiate customer surveys as part of the on-site activities. However, a considerable amount of time was required before on-site activities could commence. The primary reason for this delay was the allowances for AAWSA personnel conducting the field surveys.

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.

Items No.1 to No.3 are commonly practiced in Japan; however, No.4 differs from the Japanese system. Notably, when personnel participate in donor-funded project activities, an additional allowance is granted based on their basic salary and rank.

In the context of this project, since JICA is recognized as a donor for AAWSA personnel, it was presumed that participation in JICA project activities would entitle them to additional allowances. However, as the project was unable to cover such allowances and AAWSA had not allocated a budget for them, the absence of payments led to diminished engagement in project activities, making it challenging to proceed with on-site operations.

To address this issue, discussions were held with AAWSA's management, and it was agreed that AAWSA would allocate the necessary budget to provide allowances to its personnel. This arrangement facilitated the continuation of project activities. However, due to issues related to internal communication within AAWSA, there were instances where allowances were not properly disbursed, causing disruptions to the activities. To mitigate such occurrences, prior coordination with the relevant branch office managers was implemented, allowing for a smoother execution of activities compared to previous arrangements.

4.3. Importance of C/P Ownership

In technical cooperation projects, the ownership of the implementing organization is a critical factor for success. While it is essential for AAWSA to take initiatives for project activities, it was difficult both for AAWSA and Japanese experts, since this project is the first technical cooperation project for AAWSA. A turning point in this situation was the training in Japan. In October 2023, the first group of eight trainees traveled to Japan, where they received training on NRW management. In addition to technical knowledge, many participants remarked that they gained valuable insights into aspects beyond technology, such as the Japanese approach to precise time management, humility, the spirit of knowledge-sharing, and a strong commitment.

Upon returning to Addis Ababa, the trainees became actively engaged in project activities, leading to notable progress in the previously stagnating initiatives. As part of the process, they reported their activities, findings, achievements, and lessons learned to AAWSA's management. These reports were presented directly by the AAWSA personnel who had carried out the activities, allowing the management staff to clearly observe their growth and capacity development. Initially, AAWSA's management prioritized immediate reductions in NRW over capacity building. However, through the above process, it was recognized that the objective of this project is to strengthen the capacity of AAWSA, and the current situation is that ownership of the project is being fostered.

The atmosphere is very good for the project, and we would like to take advantage of this situation to support the implementation of appropriate activities and promote the strengthening of AAWSA's non-revenue water management capacity.

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*