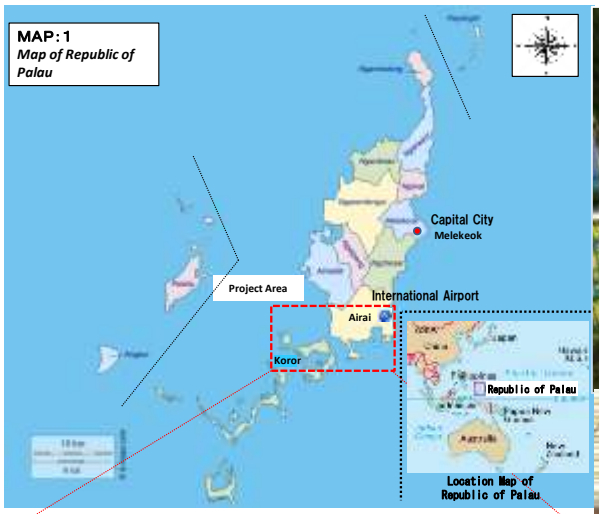
JICA PROJECT BRIEF NOTE

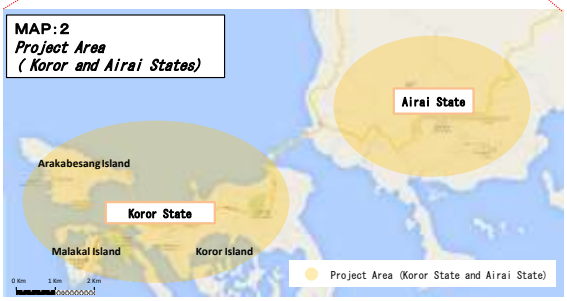
THE PROJECT FOR STRENGTHENING CAPACITY IN NON-REVENUE WATER REDUCTION IN PALAU

- CAPACITY DEVELOPMENT FOR ACTIVITIES AIMED AT SUSTAINABILITY AND WORK EFFICIENCY -

Japan International Cooperation Agency

Palau Public Utilities Corporation





1. Background of the Project and Issues

The Republic of Palau (hereinafter referred to as "Palau") is situated in the Micronesia region approximately 1,000 kilometers east of the Philippines. The estimated population of Palau is around 18,000 people. Approximately 81 % of the total population live in the old capital city of Koror which is an economic and industrial zone. In addition, the Airai State in the southern part of Babeldaob Island, where the capital Melekeok is situated, shares a border with Koror State. The Palau Republic Utilities Corporation (hereinafter referred to as "PPUC") is responsible for water supply services in these regions. The Basic information on water supply services in the PPUC's Koror-Airai water distribution system as of 2021 is as follows.

There are many and most likely deteriorated asbestos cement pipes (hereinafter referred to as "AC pipes") in Koror-Airai water distribution system that were laid over 40 years ago and have still been in use today. However, out of the AC pipelines of about 35 km, only around 13 km was rehabilitated in the past grant aid project. In addition, due to the absence of comprehensive detailed

Overview of Koror-Airai Water Distribution System
(As of 2021)

- Service Population: About 15,000 persons
- Daily Average Distributed Water : About 11,000 m^3/day
- Numbers of Connection: About 3,771
- Hours of Water Supply Service: 24 hours
- Monthly Water Tariff: USD 30 (In case of 31 m^3/household/month, which is average water consumption)
- Capacity of Water Treatment Plant: 15,140 m^3/day
- Transmission & Distribution Pipelines: About 58 km (23, 35 km respectively)
- Main Pipe Material: AC, PVC, Ductile Cast Iron
- Financial Recovery Ratio: Approximately 46%

records for all water distribution pipelines, PPUC had to use both new and old pipelines which made the situation more complex. Unfortunately, this has resulted in NRW ratio of approximately 50%[1].

Recently, Palau has been facing less-rainfall and drought due to the influence of El Nino, which is causing issues on the potential of water resource. In particular, Palau encountered serious drought in 2016 resulting in drying up water volume stored at dams, water rationing and water interruption. For these reasons, an effective use of water resource, NRW reduction, and water conservation through the improvement in residents' awareness is indispensable.

Against this backdrop, with the aim of enhancing the PPUC's capacity in NRW reduction operations and establishing a sustainable activity framework, the Palauan government requested the Japanese government for the technical cooperation "The Project for Strengthening Capacity in NRW Reduction in Palau" (hereinafter referred to as "the Project"). The Project focused on comprehensive capacity development related to NRW reduction, including the formulation of a basic pipeline renewal plan, leak detection, pipeline repair, and customer management.

2. Approach to Solution

2.1 Project Purpose and Outputs

The Project aims to enhance the implementation and the management capacity of PPUC to efficiently and systematically conduct NRW reduction operations in Koror State and Airai State. To achieve this purpose, three outputs were established immediately after the Project commenced (see Figure 1).

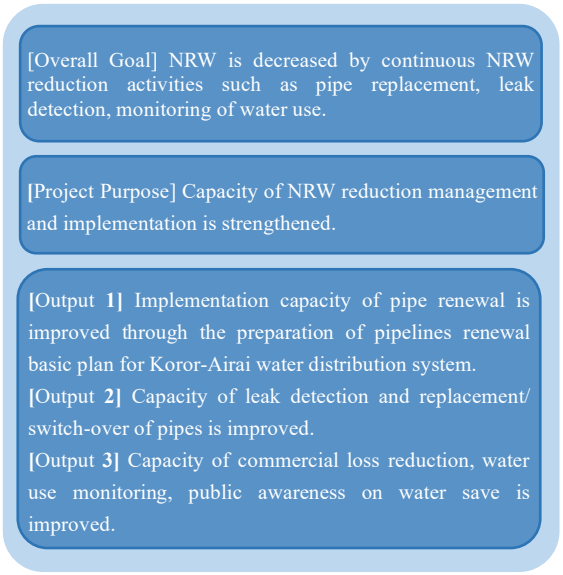


Figure 1 Project Purpose and Outputs

2.2 Activity Framework

To ensure effective and systematic implementation of the Project, the activity framework involves key roles: the CEO of PPUC serves as the Project Director, while the manager of the Project Planning and Implementation Department acts as the Project Manager. Additionally, the on-site staff from PPUC and the JICA Expert Team (hereinafter referred to as "JET") contribute to the Project (see Figure 2). Furthermore, the Joint Coordination Committee (hereinafter referred to as "JCC"), responsible for monitoring progress and evaluating the Project, comprises officials from the National

Figure 2 Framework of the Implementation

[1] NRW ratio data (June 2019 to June 2021)

Environmental Quality Protection Committee, Koror State, PPUC and JICA. Additionally, Asian Development Bank (ADB) and the Japanese Embassy participated in JCC as observers.

2.3 Objectives of Activities by Issue

PPUC has encountered challenges, as shown in Figure 3. Specifically, the high NRW ratio in the PPUC's water supply service adversely affects the operation of water supply service. Additionally, Palau has faced with less- rainfall and drought in recent years. Addressing these issues involves the dual challenge of reducing NRW and ensuring water resource security. Figure 3 also illustrates that the objectives of each output's activities intersect with multiple issues, providing a clear view of their relationships.

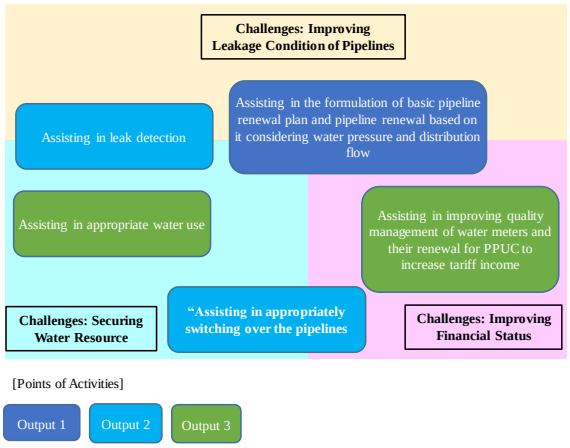


Figure 3 Objectives of Activities by Issue and Interrelation

Furthermore, in order to effectively tackle NRW reduction problems, the Project adopted not only a technical approach but also focused on capacity development for self-sustainability.

2.4 Activity by Output of the Project

The approach for activities related to the three outputs is illustrated separately.

2.4.1 Capacity Development for Pipeline Renewal, Planning, and Leak Detection through Pilot Activities (Output 1)

Through the pilot activities, the capabilities regarding NRW reduction were developed in areas such as pipeline renewal, formulation of the basic pipeline renewal plan, and leak detection, based on the sequence as shown in Figure 4. The Project Team carried out these pilot activities, following the sequence from "Activity Preparation" to "the Formulation of Basic Pipeline Renewal Plan".

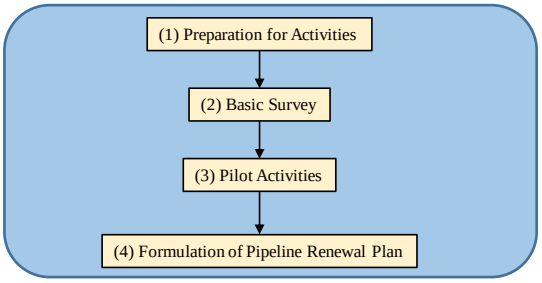


Figure 4 Flow of Capacity Development for Pipeline Renewal, Planning, and Leak Detection through Pilot Activities

(1) Activity Preparation

1) Establishment of the Team of Pipeline Renewal and Leak Detection

The Project Team formed a basic pipeline renewal plan team, responsible for the basic pipeline renewal plan, and a leak detection team, tasked with identifying and addressing leaks. Given the limited the PPUC staff, each team comprised two or three core members.

2) Informing PPUC staff about eliminating "Up-to-Individuals" regarding Data and Information

PPUC expressed the concerns about high NRW ratio, but did not learn concrete actions related to NRW information or mitigation measures. One contributing factor is that PPUC has managed information at an individual level. Consequently, access to information has remained restricted to a small number of staff, posing challenges in achieving a comprehensive solution for NRW reduction as shown in Figure 5.

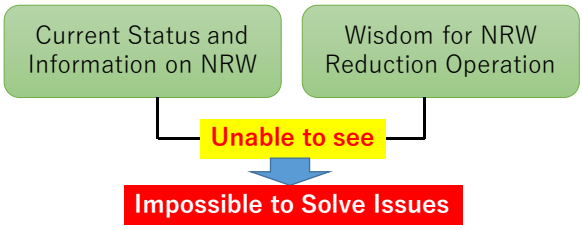


Figure 5 Problems to be occurred due to "Invisibility"

Visualizing data and information for the PPUC staff is crucial. However, it's essential to recognize that even if staff are encouraged to access it voluntarily, the sustainability remains uncertain without proper incentives and high motivation. Consequently, JET proposed the need to establish a system where data is consistently accessible to the PPUC staff. In essence, the concept is that visibility increases when information is presented. For instance, as shown in Figure 6, when staff can "see" the water supply operation status, they

can "identify" data changes and make informed "assessments" collaboratively.

By communicating (sharing) results with relevant stakeholders and taking action, concrete steps toward NRW reduction can be implemented. JET established the framework of the data sharing through discussions with the PPUC staff to develop this system.

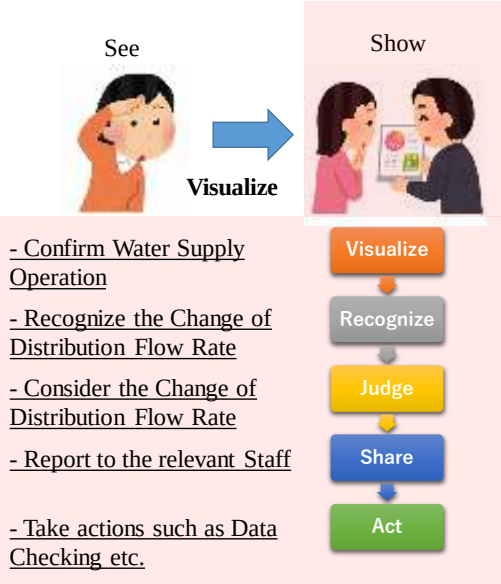


Figure 6 Visualizing Data

3) Developing Drawings

Traditionally, GIS data was centralized on the PPUC's servers, limiting access to specific staff. To address this, the Project Team enabled access to GIS data through the Google Earth App on the computers and smartphones as shown in Figure 7. Furthermore, the Project Team established a dedicated folder in the PPUC's Google Drive for storing drawings and GIS files.

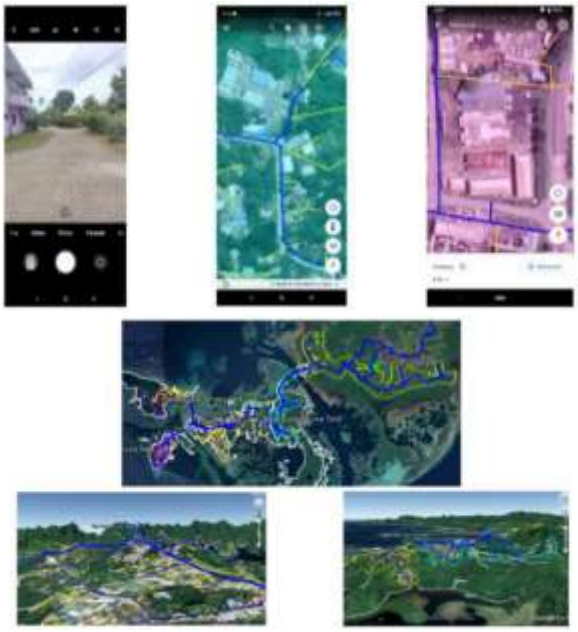


Figure 7 Display of GIS Data on Smartphone and PC

(2) Fundamental Survey

The fundamental survey plays a crucial role in implementing the basic pipeline renewal plan and pilot projects for the Koror-Airai water distribution area. The survey consists of the components shown in Figure 8.

- Learning Distribution Flow
- Learning Minimum Night Flow (hereinafter referred to as "MNF")
- Selecting Pilot Area

Figure 8 Components of Fundamental Survey

1) Learning Current Condition of Distribution Flow

The PPUC staff conduct twice-daily patrols of each reservoir, recording water levels and flow rates. However, they were merely inputting these readings into Excel, without effectively leveraging the data. Consequently, the Project Team developed a straightforward web system that monitors daily water distribution flow rates. This allows the PPUC's staff to view reservoir flow rates via the web using Google Looker Studio, a Business Intelligence (BI) tool. Now, the PPUC's staff can monitor and track flow rate trends through graphical representation (see Figure 9).

However, numerous errors occurred during flow rate readings, rendering them unanalyzable. To eliminate these errors, JET set upper and lower limits for each reservoir and structured the data to minimize reading errors. The results are shown in

Figure 10. Additionally, all the staff now have the ability to timely monitor the water distribution flow rate trend. Furthermore, NRW rate for the five water distribution areas has been graphed monthly by PPUC.

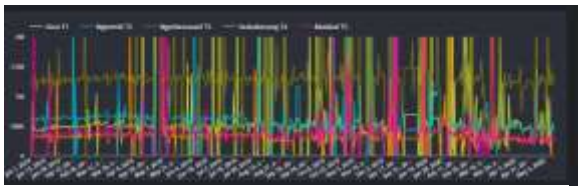


Figure 9 Flow Trend Graph based on Original Data

Figure 10 Flow Trend Graph with Upper and Lower Limits to eliminate Reading Errors

2) Learning Current Condition of Minimum Night Flow

To learn the ratio of MNF to the average daily water supply flow, the Project Team used mechanical flow meters to verify daily flow rate trends in each reservoir. Figure 11 presents the recorded water distribution flow rates across all water distribution areas. The "Minimum / Average" ratio exceeds 50% (as of April 2022) in all the water distribution areas. In contrast, Japan maintains a "minimum/average" ratio of 16%. This discrepancy suggests that in Palau, substantial water flow occurs from distribution reservoirs even during MNF. The likely cause is water leakage as long as there are no high-water-consuming customers during nighttime hours.

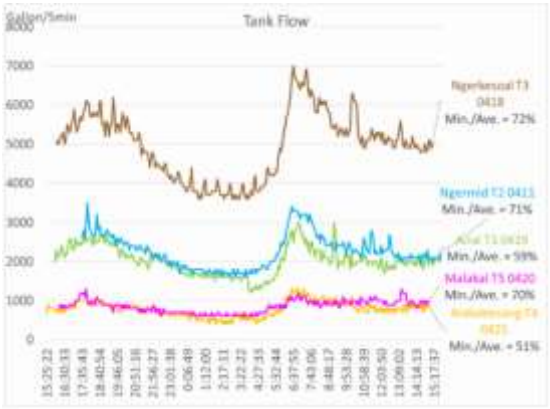


Figure 11 Rate of MNF to Water Distribution Flow

3) Selection of Pilot Area

Based on the information mentioned earlier and actual observations of water distribution flow rates and NRW obtained during the fundamental survey, the pilot area was selected from the five water distribution zones. The selection criteria included factors such as NRW ratio, distance of AP pipelines, and the frequency of pipe repair and leaks. To facilitate the pilot construction, the Project Team carefully considered aspects like minimal impact on economic and social activities and a few construction restrictions. Consequently, the pilot area was narrowed down to a specific location with an existing AC pipeline length of approximately 140 meters, targeting 24 households.

(3) Pilot Activities

In the pilot area for pipeline renewal, several key activities were composed of leak detection, water meter accuracy test, customer water usage surveys, and pipeline renewal work.

As part of the leak detection process, an acoustic survey was conducted on approximately 140 meters of water distribution pipelines and the service pipes of 23 households. Surprisingly, no pseudo-leak sounds were detected during this survey. Consequently, in terms of this specific survey, the number of water leaks served as the baseline was zero.

Traditionally, PPUC conducted water meter accuracy test with incorrect assumptions, such as conducting tests within a certain flow rate range without adjusting that range. To address this, training was provided on appropriate accuracy test of water meters.

Figure 12 Pilot Construction (Pipe Renewal)

Customer water usage surveys indicated that all the households were keenly aware of water conservation and actively attempting to conserve water. However, water leakage within homes and or premises was confirmed in around 70% of

households.

In terms of construction, approximately 140 meters of AC pipelines were replaced, and 19 out of 24 water meters which did not meet accuracy standards, were also replaced (see Figure 12).

(4) The Formulation of the Basic Pipeline Renewal Plan

The Project Team formulated a basic pipeline renewal plan using data such as pipeline information, current water distribution flow, NRW ratio, actual water pressure, operating costs, water leakage records, unit costs from previous projects, and quantitative data and lessons learnt gained through pilot construction.

2.4.2 Capacity Development for Leak Detection, Pipe Repair, and Pipe Switching through Pilot Activities (Output 2)

By means of pilot activities, the capabilities of PPUC were developed in areas such as leak detection, pipe repair, and pipe switching, as shown in Figure 13. The Project Team took activities according to the sequence from "analyzing the current situation" to "reflecting on the basic pipeline renewal plan, the manuals, the lessons learned and the case studies".

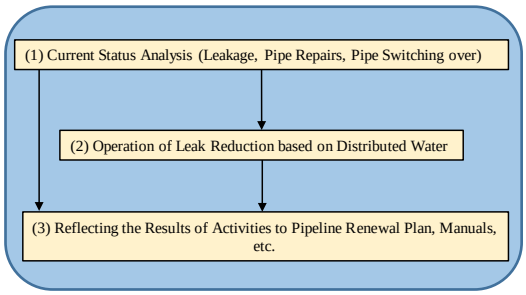


Figure 13 Capacity Development Flow for Leak Detection, Pipe Repair and Pipeline Switching over

(1) Analysis of the Current Situation (Leak Detection, Pipe Repairs and Pipeline switching over)

1) Current Status of Framework of Leak Detection and Pipe Repair

JET conducted a survey of the framework for leak detection and pipe repair. The findings revealed that PPUC had limited experience and insufficient staff in systematic water leak detection. Previously, they relied on reports from residents, identified leak points on-site, and carried out pipe repairs.

2) Implementation of Pipeline Switching over

A field survey was carried out to assess the progress of pipeline switching work. The findings revealed that one of the contributing factors to the persistent NRW in the Koror-Airai water distribution area is the occurrence of backflow. Despite pipeline renewal, there are specific locations where water flows from the new pipeline back into the old pipeline. This issue was identified during the survey (see Figure 14). Subsequently, the Project Team discussed to develop a systematic approach for preventing backflow.

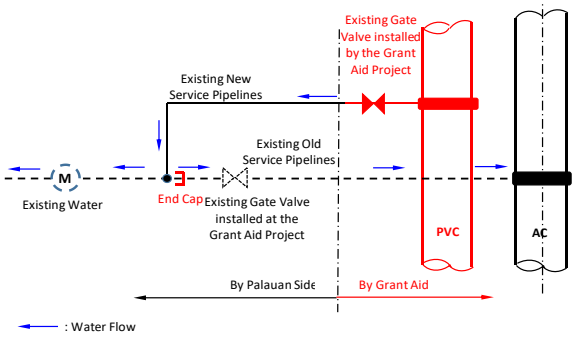


Figure 14 Back-flow

(2) Leak Response based on Distribution Flow Trend

Through the visualization of water distribution volume, the Project Team provided training on the correlation between water distribution flow patterns and water leaks, subsequently standardizing the response to water leaks. To identify the causes of the fluctuations of water distribution, PPUC measured the actual water consumption by customers and MNF, and detected water leaks.

(3) Reflection on the Basic Pipeline Renewal Plan, Manual and Lesson learnt & Case Studies

Drawing from the survey findings related to the leak detection and pipe repair framework, a manual for leak detection was developed in order for PPUC to conduct leak detection activities in a methodical manner. Furthermore, recognizing that insufficient pipeline switching directly contributes to the rise in NRW, the Project Team discussed mitigating measures that ought to be incorporated into the basic pipeline renewal plan and its accompanying manual.

2.4.3 Capacity Development for Measures to Commercial Loss [2] and the Improvement in Water Usage (Output 3)

[2] The term "commercial loss" refers to economic injury resulting from commercial water losses, including water losses due to errors in water meter readings and excess water that exceeds the predetermined rate in flat-rate

Through pilot activities, the Project Team developed PPUC's abilities in addressing commercial losses, improving in water usage, and managing public relations, as illustrated in Figure 15.

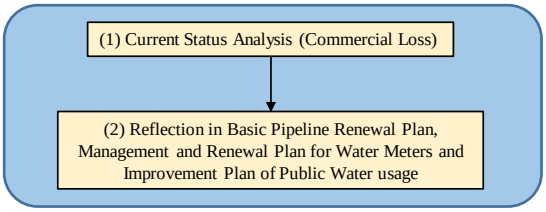


Figure 15 Flow of Capacity Development on Operation of Commercial Loss and Improvement in Water Use

(1) Analysis of the Current Situation on Commercial Loss

The Project Team conducted a survey on illegal connections, metering errors, and commercial losses resulting from the flat-rate tariff system in the Koror-Airai water distribution system. The findings are presented in Figures 16. Metering errors made up about 80% of total commercial loss.

Ratio of commercial loss to daily average water distribution flow was less than 10 %.

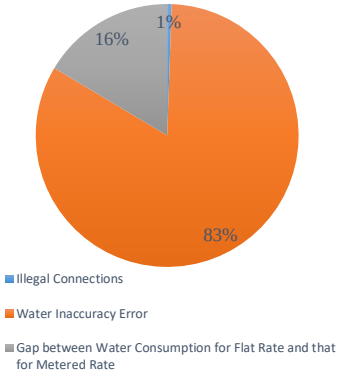


Figure 16 Breakdown of Commercial Loss

(2) Reflected in the Basic Pipeline Renewal Plan, the Improvement of the Management & Renewal Plan for Water Meters and the Improvement Plan of Public Water Usage

Drawing from the survey findings on commercial losses and customer water usage, the Project Team formulated the management and renewal plan for water meters to effectively upgrade and install water meters across the Koror-Airai water distribution system and the improvement plan of public water usage, aimed at fostering water conservation awareness among customers.

2.5 Capacity Assessment and Development

Organized to the capacity levels of the PPUC counterparts, the Project Team formulated an optimal training plan. PPUC has six teams responsible for tasks such as basic pipeline renewal plan, leak detection, public relations, water meter maintenance, billing, and customer management. This approach ensures sustainable and effective training. JET carried out a capacity assessment, leveraging the results from interviews and on-site verification of activity status. Subsequently, a team-level capacity development plan was devised, along with organized training to address the specific needs of each team. Figure 17 illustrates the progression of the leak detection team's equipment operation skills from the Project's inception to its completion. Following the capacity assessment, it was evident that the proficiency in identifying water leak locations was lacking. Consequently, on-the-job training (OJT) was conducted, with a specific focus on water leak detection plans and methods.

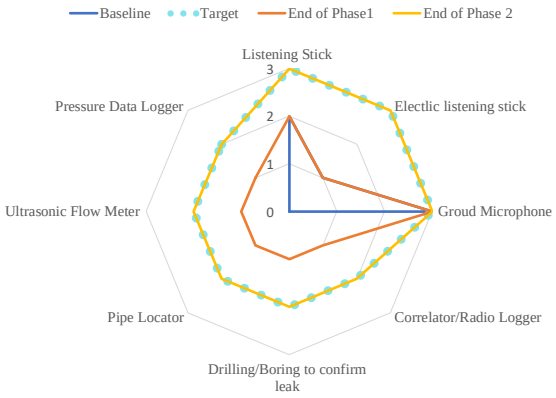


Figure 17 Progress in Capacity Improvement (e.g. Equipment Operation for Leak Detection Team)

2.6 Training in Japan

In addition to training focused on water leak detection, pipeline renewal, addressing commercial losses, and various construction experiences in Palau (see Figure 18), trainees also gained knowledge related to general NRW reduction measures and water supply service operations in Japan. A training session aimed at providing useful insights on future NRW reduction operation was conducted for the five PPUC staff from October

households.

17th to November 4th, 2022. The training locations primarily included Yokkaichi City, Ise City, Shima City, and Toba City in Mie Prefecture, which established a friendship alliance with Palau in July 1996.

Figure 18 Artificial Leak Occurrence by pressurized Water and Plumbing at Takano Water Treatment Plan, Mie Prefecture

3. Result of Approaches

The results of the Project evaluation were presented to the JCC in December 2023. The practical findings, as verified in the report, are outlined below.

3. 1 Capacity Development for Pipeline Renewal, Planning, and Leak Detection through Pilot Activities (Output 1)

3.1.1 Capacity Development for the elimination of Work Operation which is up to Individuals

Until now, the on-site staff at PPUC have been working without physical drawings. The Project generated digital data for drawings by utilizing the Google Earth app. As a result, the staff responsible for tasks such as water leak detection, repair, water distribution pipelines, service pipe plumbing, and meter reading now have the ability to access these drawings and GIS data on their smartphones, as shown in Figure 7. This has allowed everyone to visualize the pipe installations on-site, including details such as pipe diameter and material. This timely access not only enhances on-site work efficiency, but also provides PPUC management and board members with more frequent visibility. Furthermore, it is anticipated that this activity will promote awareness regarding NRW reduction.

3.1.2 Capacity Development for establishing framework to record water distribution flow accurately and recording it

Figure 9 reveals that, upon visualizing the daily flow rate from the reservoir, it became evident that reservoir flow meter readings contained errors, occurring approximately once every three days.

Following the introduction of Google Looker Studio, the PPUC staff gained the ability to swiftly identify fluctuations in water distribution flow rate. This allowed them to discern whether these fluctuations resulted from incorrect readings, water leaks, or sudden customer usage. As a result, accurate calculations for the distributed water volume can now be made by rectifying the readings. Additionally, in cases where water leaks are the cause, PPUC can promptly take action to address them.

3.1.3 Capacity Development for considering the relationship between MNF and Leak Occurrence

Figure 11 reveals that the Koror-Airai water distribution system exhibits high MNF. In light of this, the Project Team discussed the potential water leakage. To gain insights into the actual water usage, the Project Team specifically focused on nighttime consumption by large customers.

Figure 19 illustrates the water distribution flow in the Ngermid water distribution area, alongside the MNF for a major customer (Neco). Notably, the MNF associated with large customers is remarkably low, suggesting that their impact on the overall MNF is minimal. However, this also raises the possibility of water leakage. From this aspect, PPUC officials are committed to further survey, including assessing water use by other large customers and scrutinizing MNF within the water

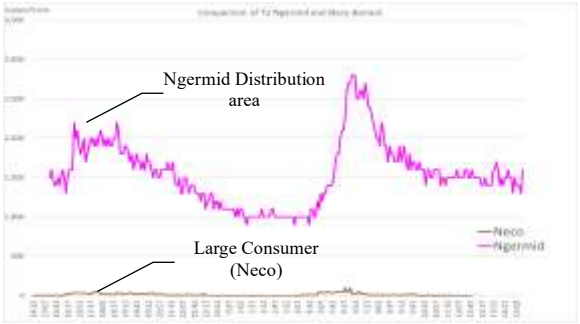


Figure 19 Daily Water Distribution Flow and Water Consumption of Large Consumer

distribution area and to pinpoint the root cause of the leak.

3.1.4 Effects by the Pilot Project

Through the pilot construction, PPUC acquired expertise in water meter accuracy test, meter installation, and pipe switching.

As of March 2022, NRW ratio in the pilot area stood at approximately 41.2%. Following the Project

Team's measurement of water distribution flow rate and water usage, the NRW ratio as of November 2023 declined to 31.1%. This 10.1 percentage point reduction was a direct outcome of the pilot project.

Consequently, the amount of billed water increased by 19%, leading to an annual cost reduction of USD567 for PPUC.

3.1.5 Capacity Development for the formulation of the Basic Pipeline Renewal Plan

Drawing from data on existing pipelines and insights gained during the pilot activities, the Project Team formulated the basic pipeline renewal plan for renewing the remaining AC pipes within the Koror-Airai water distribution system. JET conducted training sessions, emphasizing the following key points:

- Setting Priorities:
  - Consider pipeline status, water pressure, water distribution flow, and water leaks.
- Cost Estimation:
  - Accurately assess the financial implications of the renewal plan.
- Effects Calculation:
  - Evaluate the impact resulting from the implementation of the basic pipeline renewal plan

3. 2 Capacity Development for Leak Detection, Pipe Repair, and Pipe Switching through Pilot Activities (Output 2)

3.2.1 Capacity Development for Pipeline Switching over

To prevent backflow from the new pipe to the old pipe, which could contribute to an increase in NRW, PPUC has undergone training on reliable pipe switching techniques, as illustrated in Figure 20. By understanding the precise locations where valves should be opened and closed on the water supply pipes, PPUC was able to verify and take necessary action along routes where pipelines have been updated. It is anticipated that performing reliable switching over will steadily highlight the effects of renewing water distribution pipelines.

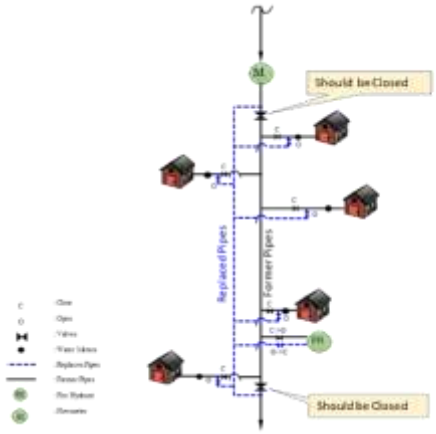


Figure 20 Operation of Switching over from Old to New Pipes

3.2.2 Capacity Development for Leak Detection and Pipe Repair based on Water Distribution Flow Trend

Figure 21 illustrates fluctuations in the water distribution flow from the service reservoir situated in the southwest of Koror State. Notably, a sudden surge occurred, with the water distribution flow reaching twice the usual level. The PPUC staff, recognizing the anomaly, promptly mobilized to the site and detected a water leak.

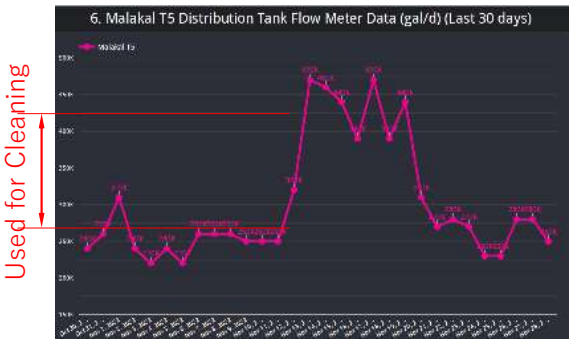


Figure 21 Sharp Increase in Water Usage of the Large Consumer (Change of Water Usage for a month)

Further the survey revealed that the increase in water distribution flow was attributed to a specific large customer utilizing water for their own facilities cleaning over three days. This customer lacked a water meter installation and operated under a flat-rate system. Consequently, PPUC swiftly installed water meters and transitioned to a metered system, effectively reducing NRW. Monitoring water distribution in this manner also led to an upswing in billed water volume.

In addition, Figure 22 illustrates fluctuations in the water distribution flow from the service reservoir situated in the northwest of Koror State.

Notably, a sudden surge occurred, with the water distribution flow rate reaching approximately 1.4 times the usual level within a month as highlighted in yellow line in Figure 22.

Subsequently, PPUC conducted a MNF survey, revealing an increase in the MNF compared to previous MNF measurements and identified the leak location through leak detection and promptly repaired it. These proactive measures significantly contributed to the reduction of NRW.

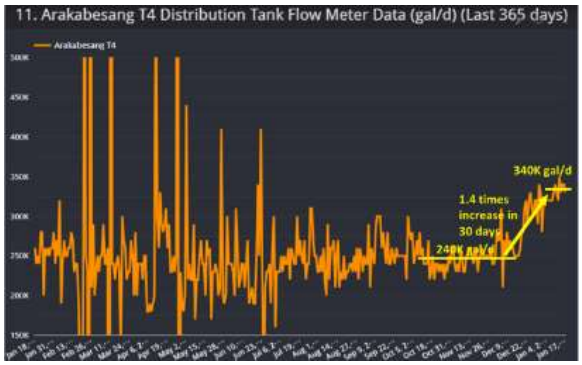


Figure 22 Annual Distributed Water at Arakabesang Service Tank

3.2.3 Sustainable Capacity Development for the Basic Pipeline Renewal Plan and Leak Detection

Drawing from data on existing pipelines and insights gained during the pilot activities, the Project Team formulated the basic pipeline renewal plan manual and the leak detection manual. These resources empowered PPUC to directly manage basic pipeline renewal plan and conduct leak detection.

As a specific example, in certain water distribution areas, water leaks remained undetected until the Project's commencement. However, during the Project period, PPUC effectively utilized the manuals and other tools to identify leak points. Consequently, PPUC could promptly identify and address water leak reduction. This proactive approach is estimated to reduce operating costs by USD120,000 annually (see Figure 23).

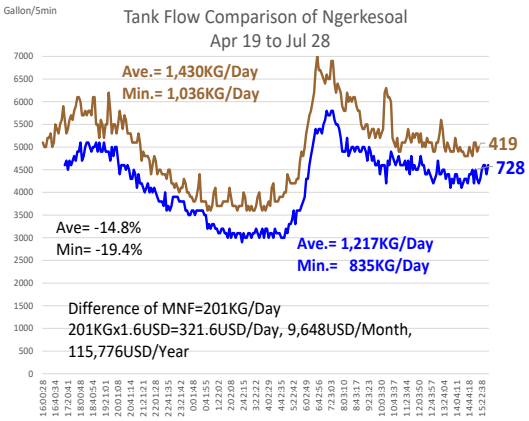


Figure 23 Effect of Leak Reduction

Furthermore, to ensure the efficiency and sustainability of water leak detection activities, the water leak detection manual mandates the use of Google AppSheet for developing a database of water leak records. This step further strengthened the water leak detection capabilities (see Figure 24).

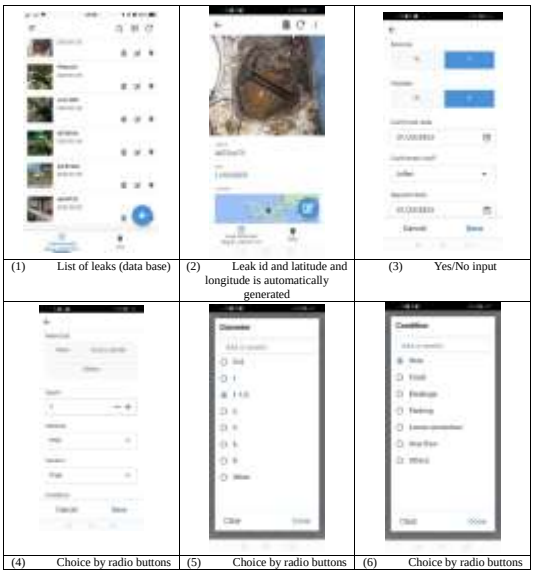


Figure 24 Input Display of Google Appsheet

3. 3 Capacity Development for Measures to Commercial Loss[3] and the Improvement in Water Usage (Output 3)

3.3.1 Capacity Development for Water Meter Accuracy Test

PPUC recognized that instrument errors vary based on the flow rate range both high and low of water

[3] The term "commercial loss" refers to economic injury resulting from commercial water losses, including water losses due to errors in water meter readings and excess water that exceeds the predetermined rate in flat-rate households.

meters. This realization led to the understanding that the accuracy test method employed so far was inaccurate. Moving forward, timely replacements can be carried out through precise accuracy test of water meters. As a result, an anticipated boost in water tariff income is expected due to the improved meter reading accuracy, significantly impacting water supply service operations.

For reference, in the Pilot area, 19 out of 24 water meters fell outside the acceptable accuracy range. After updating the water meters, the revenue water volume increased by approximately 19% compared to the pre-update State.

3.3.2 Capacity Development for Water Meter Quality Management, Renewal Activities and Activities of Water Use Improvement

(1) Quality Management and Renewal of Water Meters

PPUC now has the capability to independently conduct accuracy tests on water meters, including verifying their precision within specific flow rate ranges. This development is expected to enhance customer trust and to increase billing revenue.

In the improvement plan of management and renewal for water meters, PPUC calculated that 1,979 water meters would require replacement in the future, with an estimated cost of approximately USD420,000. Based on the results of accuracy tests during pilot activities, it is estimated that the revenue to be increased would amount to USD460,000 per year, allowing for cost recovery within a single year through water tariff income.

(2) Activities of the Improvement in Water Usage

In the pilot area, residents demonstrated a high level of awareness regarding water conservation. However, given that securing water resources remains a critical challenge for Palau, it is crucial to sustain this awareness among customers themselves. One effective approach is to reduce billing charges, reinforcing the importance of water-saving practices. From this perspective, PPUC has not only formulated the improvement plan of pubic water usage to encourage responsible water use but has also developed public relations materials emphasizing water conservation awareness and internal leak prevention, as shown in Figure 25.

Figure 25 Brochure for Water Conservation and the Awareness to prevent Internal Leaks

3.4 Achievement of Project Purpose Indicators and Future Prospects

3.4.1 Achievement of Project Purpose Indicators

There are three outputs in the Project. Figure 26 shows summarized outputs.

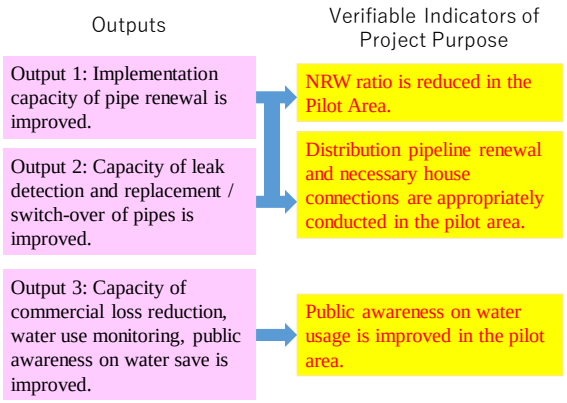


Figure 26 Outputs and verifiable Indicators

As one of results for Output 1, the basic pipeline renewal plan consisting of fundamental policies, the basic pipeline renewal priorities, cost estimation, and implementation schedules was formulated based on network analysis, lessons learned from the pilot project. In the case of Output 2, the practical manuals for leak detection and basic pipeline renewal plan were developed to guide the PPUC's staff in planning pipeline renewal and detecting water leaks. Additionally, Output 3 involved the development of the improvement plan of management and renewal for water meters as a strategic response to commercial challenges and the improvement plan of public water usage aimed at safeguarding water resources.

As a consequence of these concerted efforts, the performance indicators centered on the pilot project were successfully achieved. Furthermore, it was achieved that the PPUC's "Capacity of NRW

reduction management and implementation is strengthened" has been significantly achieved.

3.4.2 Future Prospects and Expectations

After acquiring skills for NRW reduction activities through the Project, PPUC has been consistently implementing NRW reduction and water flow monitoring. Simultaneously, PPUC is planning NRW reduction initiatives, including pipeline renewal based on the basic pipeline renewal manual, water leak detection using the leak detection manual, and the management and renewal plan for water meters. Considering that PPUC diligently conducts daily flow rate observations and efficient leak detection activities informed by data, while leveraging the basic pipeline renewal plan, the management and renewal plan for water meters, and various manuals, it is highly probable that the NRW rate in the Koror Airai water distribution system can be significantly reduced.

4. Creative Solution and Lessons learned

4.1 Issues and Technical Creative Solution through the Project

(1) Promotion of Leak Detection through the Visualization of Water Flow

Conventionally, PPUC received reports from residents and dispatched two leak detection surveyors to various sites in order to identify water leaks. However, given the limited number of reports from residents, the frequency of water leaks observed to date suggests that there are numerous potential leak locations. The effort required for two individuals to discover such places would be substantial, and there would likely be cases where they would not succeed. To efficiently pinpoint areas where serious water leaks are likely to occur, the Project Team visualized daily fluctuations in water distribution flow. As a result, leak detection surveyors have currently been able to focus their efforts on areas exhibiting significant fluctuations.

(2) Enhancing the Efficiency of Water Leak Repair Operations

Initially, the PPUC's pipe repair team employed small concrete cutters and hammer drills to excavate through thick concrete pavement. However, this approach led to time-consuming excavation work. To enhance work efficiency, the Project Team procured a concrete cutter with a large blade diameter and a concrete breaker weighing over 20 kg specifically for this project.

(3) Enrichment of Leak Record

In the past, PPUC maintained basic records of water leak locations and the types of repaired pipes. However, these records were not structured as a database and could not be effectively utilized for future work. Consequently, the information from leak detection and pipe repair activities could not be harnessed to predict future water leaks. In the Project, Google AppSheet and Google Looker Studio were introduced to detailed record water leak locations, pipeline details, and repair types. By utlizing Google AppSheet, PPUC can now identify high-risk areas more efficiently. Additionally, Google Looker Studio provides a monitoring framework accessible to all PPUC employees, including the CEO. This framework enables any PPUC staff to offer advice to technical team such as leak detection team.

(4) Rapid Learning of the Possibility of Leak Occurrences

To evaluate the potential for water leakage, measuring the flow rate promptly using an ultrasonic flowmeter was crucial at the beginning of the Project to learn MNF. However, acquiring an ultrasonic flowmeter took time. Consequently, the Project Team installed a trail camera that captures images of the flow meter counter every five minutes. As a result, the Project Team gained early insights into the likelihood of water leakage based on MNF in the eastern part of Koror State.

4.2 Lesson Learnt

(1) Technical Aspect

1) Consideration regarding Switching of Service Pipelines due to Distribution Pipeline Renewal

During the replacement of water distribution pipelines as part of the grant aid project (completed in 2018), it was observed that, among approximately 300 water connections for which PPUC was responsible, there might have been instances of backflow from the new pipelines to the old water pipelines. This occurred because the transition between the new and old pipes was managed by opening and closing a gate valve. After switching the distribution pipeline, it is critical for the PPUC to ensure that the service pipeline is properly disconnected from the old distribution pipeline, using methods such as end caps.

2) Normalizing Water Meters

As part of the Project, it was verified that that Palau Community College (PCC) had multiple service connections lacking water meters. Actually, water meters should be installed at every connection, or all service pipelines within a single premise should be interconnected. This is because, of course, water flowing through service pipelines without meters is not billed by PPUC, which ultimately contributes

to NRW. Given that there may be other users than PCC, PPUC should thoroughly inspect service connections and water meters for institutional and commercial users as part of their NRW reduction activities.

3) Preventing Delays in Material Procurement

During the pilot project, the contractor ordered pipe fitting materials, but unfortunately, these materials were unavailable in stock at the supplier in Guam. As a result, the construction was delayed by three months. To prevent such delays caused by material procurement issues, PPUC should expand its distribution network and ensure sufficient inventory.

4) Consistent Data Collection, Management, Monitoring and Analysis

JET developed data monitoring system in the PPUC's Water Operation office and provided the PPUC staff with the training on the relationship between results of monitoring and following actions in terms of NRW reduction through a Workshop. In order for PPUC to maintain systematic work on data monitoring and following actions, it is desirable that a focal person as the Project Coordinator who encourages the concerned staff should be appointed in future.

5) Identification of Causes of High NRW even after Countermeasures

The Project Team noted high NRW ratio in the pilot area in Ngermid water distribution area at the final stage, even after pipeline renewal and the replacement of water meters. In the Project, significant points required for NRW reduction operation were shared with PPUC. The following are the quick check list. It is important for PPUC to take all the measures of operation in field.

- Setting-up pipe conditions (especially, high impact conditions: pipe material, pipe diameter, thickness, units, measurement interval) in an ultra-sonic flow meter;
- Checking valves on the old pipelines if they are closed;
- Checking gate valves on the service pipelines if they are closed;
- Checking if water at faucets in house and premises are closed;
- Checking the accuracy of water meters, though they are new ones, and
- Checking if there are unknown service pipelines in a certain service area.

(2) Ensuring Customers' Trust in PPUC

1) Well-mannered PR activities before and after the Replacement of Water Meters

After replacing water meters billed water increased in most cases. Some customers complained to PPUC and gave inquiries about the increase in amounts of bills. Therefore, PR activities that consist of the well-mannered explanation of the necessity of water meter replacement, the occurrence of increase or decrease in water consumption, etc. are important for PPUC to carry out prior to the replacement of water meters so that customers can understand the increase in billed water smoothly.

2) Careful Water Meter Reading after the Replacement of Water Meters

Water meter displays differ based on their type. Specifically, since the units such as liters, gallons, and the number of digits on the counter vary, it is crucial to carefully check them during readings. In the Project, it was uncovered that the scale and units of the newly replaced water meters differed from the old ones, leading to inaccurate readings by water meter readers. Such misreading can result in improper billing and erode customer trust in PPUC. Therefore, PPUC should provide training to water meter readers to ensure accurate readings for the new types of water meters.

[Project Period]

February 2022 – February 2024

[Source]

- The Project for Strengthening Capacity in Non-Revenue Water Reduction in Palau, Project Completion Report (February 2024 JICA)
- The Project for Strengthening Capacity in Non-Revenue Water Reduction in Palau, Project Design Matrix (PDM) (March 2021 JICA)
- The Preparatory Survey Report on the Project for Improvement of Water Supply System (April 2015 JICA)

End