

Republic of the Union of Myanmar

FY2019 Ex-Post Evaluation of Japanese Grant Aid Project

“The Project for Urgent Improvement of Water Supply System for Yangon City”

External Evaluator: Tomoko Tamura, Kaihatsu Management Consulting, Inc.

0. Summary

This project supported the improvement of water supply services in Yangon City by upgrading facilities that needed urgent rehabilitation.

From the time of project planning to the ex-post evaluation, improvement of water supply and sanitary conditions was a priority issue for the country, and there was a high need for improvement of water supply services in Yangon City. It has been recognized that the project was consistent with the development policy and needs of the country and also consistent with Japan's ODA policy of providing support to improve the lives of the citizens of Myanmar. Consequently, the relevance of the project is considered to be high. All planned facility construction was conducted, and the project cost did not exceed the budget. Since the project period was longer than expected, the efficiency of the project is considered to be fair. There were three components in the project. In the first component, (a) “Renewal of the Transmission and Distribution Pumps and Construction of a Pump House at the Nyaunghnapin First Phase Water Treatment Plant”, the defective pumps that were not properly functioning were replaced. At the time of the ex-post evaluation, the renewed pumps were almost fully operational, with an average daily operating time of 22.9 hours. In the second component, (b) “Renewal of the Distribution Main Pipeline at the Kaba Aye Pagoda Road¹”, the aging distribution main pipeline was renewed. Since the completion of the project, traffic has not been interrupted due to the pipeline bursting or for its repair, and the expected outcome was achieved. In the third component, (c) “Renewal of the Distribution Network in the Pilot Area in Yankin Township”, the aging distribution network was updated in the area. This solved the problem of frequent water leakage and reduced the rate of water leakage to 8% or less as planned. Improvement in the water supply service, including increased hours of water supply, resolution of the problem of water cuts, increased water pressure and quantity, improvement of the living environment, including reduction in the cost of electricity and working hours of the water pumps, and an improvement in hygienic behavior, were realized. Therefore, effectiveness and impact of the project are high. No major problem has been observed in the policy system, the structure, technical/financial aspects or in the current status concerning the operation and maintenance of facilities developed in the project. Further, some malfunctioning parts and attached facilities are expected to be repaired or improved. It is observed that sustainability of the project effects is high.

Considering these observations mentioned above, the project is evaluated to be highly satisfactory.

¹ This distribution main pipeline was described as "Distribution pipeline to Mayangon Township" in the preparatory survey report of the project. However, it is described as "Distribution Main at the Kaba Aye Pagoda Road" in this report according to the location of the pipeline.

1. Project Description



Project Location



Transmission and distribution pump at the Nyaunghnapin First Phase Water Treatment Plant



Water pressure and quantity were improved at this primary school in Yankin Township

1.1 Background

The water supply system of Yangon City served approximately 42% of the population of 5.1 million at the time of project planning in 2013. Water demand in the city had risen sharply with population growth, and the importance of the water supply service was increasing. However, the infrastructure of the water supply service had not been improved or expanded in a timely manner, because public investment in infrastructure and international support had been restricted, and there were limited choices of equipment suppliers for updating the facility due to the long-term economic sanctions imposed under the military administration. As a result, problems had arisen, such as water cuts, low water pressure, limited hours of supply and water leakage, because the facilities were aging or out of order.

The Ministry of Economy, Trade and Industry of Japan conducted the “Study on the Improvement of Water Supply and Waste Water Treatment in Yangon, the Republic of the Union of Myanmar” in 2011 in order to study interventions for such problems. The study identified five water facilities that needed urgent renewal, including the renewal of water transmission and distribution pumps at Nyaunghnapin Water Treatment Plant and the renewal of aging pipes in Yankin Township. Following the result of the study, Government of Myanmar requested cooperation for the urgent development of water supply facilities. This project was implemented in response to this request.

1.2 Project Outline

The objective of the project is to improve water supply services of Yangon City corresponding to the increasing demand for water by rehabilitating the facilities in need of urgent improvement, thereby contributing to an improved living environment for the local community.

Grant Limit Actual Grant Amount	1,900 million yen/1,851 million yen
Exchange of Notes Date /Grant Agreement Date	May 2013/ September 2013
Executing Agency	Water Resource & Water Supply Authority, Yangon City Development Committee (YCDC). The Authority was called “Engineering Department (Water & Sanitation)” at the time of project implementation
Project Completion	May 2016
Target Area	Yangon city
Main Contractors	Torishima Pump Mfg. Co., Ltd. and TODA Corporation
Main Consultant	TEC International Co., Ltd.
Preparatory Survey	February 2013-September 2013
Related Projects	<ul style="list-style-type: none"> • Study on the Improvement of Water Supply and Waste Water Treatment in Yangon City, the Republic of the Union of Myanmar (2011), Ministry of Economy, Trade and Industry • Preparation Survey on the Project for the Improvement of Water Supply, Sewerage and Drainage System in Yangon City in the Republic of the Union of Myanmar (2012-2014) • The Project for Improvement of Water Supply Management of YCDC (From 2015 onwards) • Dispatch of JICA experts <ul style="list-style-type: none"> – Advisor on Water Supply Management in Yangon City (April 2012-April 2015) – Advisor on Water Supply and Sanitation Improvement in Yangon City (August 2015-August 2017) – Advisor on Water Supply and Water Supply Administration in Yangon City (December 2018-December 2020) • Greater Yangon Water Supply Improvement Project (Phase I) (From 2014 onwards) • Greater Yangon Water Supply Improvement Project (Phase II Stage 1) (From 2017 onwards)

2. Outline of the Evaluation Study

2.1 External Evaluator

Tomoko Tamura, Kaihatsu Management Consulting, Inc.

2.2 Duration of Evaluation Study

This ex-post evaluation study was conducted with the following schedule.

Duration of the Study: July 2019-June 2020

Duration of the Field Study: September 15-29, 2019 and December 1-4, 2019

3. Results of the Evaluation (Overall Rating: A²)

3.1 Relevance (Rating: ③³)

3.1.1 Consistency with the Development Plan of Myanmar

National Sustainable Development Strategy (2009) and *Sustainable Development Plan (2018-2030)* are the development plans of Myanmar at the time of planning this project and at the time of the ex-post evaluation, respectively. Improving water supply and sanitation environment is an important goal in both development plans. At the time of planning, the water supply plan of Yangon City was the *The Study on Improvement of Water Supply System in Yangon City in the Union of Myanmar*, the development study conducted by JICA in 2002. At the time of the ex-post evaluation, the master plan proposed by JICA in the *Preparation Survey on the Project for the Improvement of Water Supply, Sewerage and Drainage System in Yangon City in the Republic of the Union of Myanmar* had been adopted as their water supply plan. This project is consistent with both master plans.

As mentioned above, the project had been consistent with the water supply development plan of the country from the time of planning to the time of ex-post evaluation.

3.1.2 Consistency with the Development Needs of Myanmar

At the time of planning, the need for improvement of the water supply facilities in Yangon City was high, because there were problems with water cuts, low water pressure, limited hours of water supply (average 16.5 hours per day), and water leakage (water leakage rate was 50% or more). Such a demand for facility development remains high even at the time of the ex-post evaluation. It is necessary to strengthen the capacity for water production, transmission and distribution and to draw up countermeasures for water leakage, in order to respond to the increasing water demand in the city.

In this project, the following three components which show the strong need and urgency for replacement and repair among the water supply facilities in the city were selected. These

² A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

³ ③: High, ②: Fair, ①: Low

components are almost independent of each other in the water supply system, and the main service areas of these facilities do not overlap.

- (a) Renewal of the Transmission and Distribution Pumps and Construction of a Pump House at the Nyaungnnapin First Phase Water Treatment Plant
- (b) Renewal of the Distribution Main Pipeline at the Kaba Aye Pagoda Road
- (c) Renewal of the Distribution Network in the Pilot Area in Yankin Township

(a) The transmission and distribution pumps at the Nyaungnnapin First Phase Water Treatment Plant provided 40% of the total water supply of the city, however, two of the four pumps were out of order and were suspended. The two pumps that were in operation also broke down frequently, because they had large cracks and water leakage, and because the water hammer prevention unit⁴ was defective. The pump house also had large cracks in the wall due to uneven settlement and was not suitable for use.

(b) The distribution main pipeline at the Kaba Aye Pagoda Road was an aging pipe that had been installed more than 60 years ago. The pipe had been laid at the shoulder of the road; however, due to frequent road expansion, the pipe was now located exactly under the road. This has caused frequent water leakages from the pipe due to the impact of the wheel load of vehicles. Interruption to water supply and traffic congestion due to the repairs were serious problems.

(c) The pilot area of Yankin Township had water leakages every day, caused by bursting of the aging distribution lines. In addition, the water supply pressure for each household was reduced, because water distribution lines were poorly organized as a result of continuous extension and connection of pipelines without an appropriate plan.

These facilities are essential for the water supply services in the city even at the time of the ex-post evaluation.

Therefore, the project is considered to be consistent with the development needs of the water supply sector of the country at the time of planning and ex-post evaluation.

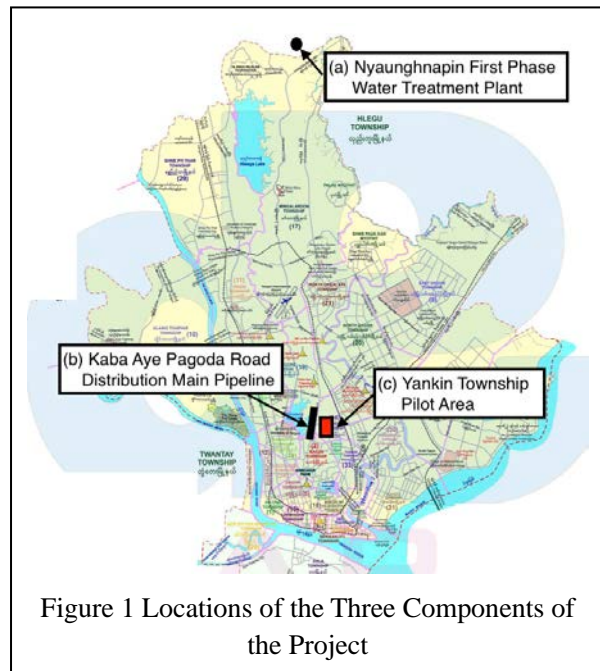


Figure 1 Locations of the Three Components of the Project

⁴ A unit to avoid risk of damages to the pump due to the backflow from the transmission line.

3.1.3 Consistency with Japan’s ODA Policy

This project was relevant to the specific measure of “development of health and medical services” and the “development of necessary infrastructure and systems for sustainable economic growth” that were formulated as a priority area of the ODA policy of Japan at the time of planning in order to improve the livelihood of the citizens of Myanmar, showing consistency with the policy.

As mentioned above, this project fits to Myanmar’s development plan and development needs as well as Japan’s ODA policy, and the relevance is high.

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

The main outputs of the components of the project were as follows:

- (a) Renewal of the Transmission and Distribution Pumps and Construction of a Pump House at the Nyaunghnapin First Phase Water Treatment Plant

In this component, four transmission and distribution pumps of the Nyaunghnapin First Phase Water Treatment Plant were renewed, and a pump house was constructed. The main outputs are shown in Table 1, which were in accordance with the plan.

Table 1 Actual Outputs of the Improvement of the Nyaunghnapin First Phase Water Treatment Plant

Construction of a Pump House	<ul style="list-style-type: none"> • Foundation work • Construction of a pump house (basement: reinforced concrete/ground floor: brick construction) • Facility construction (doors and windows, lighting, overhead traveling crane, floor drainage pump, etc.)
Facility related to Pumps and Motors	<ul style="list-style-type: none"> • Installation of four transmission and distribution pumps (2,850 m³/hour, pumping head 72 m, motor output 800 kw) • Installation of electrical control panels and wiring materials • Installation of pipes and valves attached to the pumps • Installation of water hammer prevention unit • Construction of an inlet pipe connected to the existing water treatment tank and an outlet pipe connected to the existing transmission line



Pump House (at the time of planning)



Pump House
(at the time of ex-post evaluation)



Transmission and Distribution Pump
(at the time of planning)



Transmission and Distribution Pump
(at the time of ex-post evaluation)

Note: The photos taken at the time of planning were reproduced from the preparatory survey report for this project, and the ones for the ex-post evaluation were taken by the external evaluator.

(b) Renewal of the Distribution Main Pipeline at Kaba Aye Pagoda Road

In this component, approximately 1.5 km of the distribution main pipeline along the Kaba Aye Pagoda Road was renewed. Table 2 shows the planned and actual outputs of the pipe laying. As a result of measurement at the time of detailed design, the pipeline extensions were reduced from the planned number⁵. Ancillary works, including construction of a water pipe bridge, installation of valves, connection to the seven existing lines, installation of four fire hydrants, and restoration work of the pavement, were also carried out.

⁵ At the time of project planning, the numbers of bypass pipelines of 300 mm and 200 mm were assumed by predicting the location of connections between the distribution main pipeline and the bypass pipelines, and the amount of water distribution. At the time of the measurement survey performed during the detailed survey, it was found that the number of locations of connections and amount of water distribution were fewer than assumed. As a result, the extensions of the bypass pipelines of 300 mm and 200 mm were reduced compared to the plan. Moreover, some locations to which 300 mm bypass pipelines were planned to be laid were found to be adequate for 200 mm, because the amount of water distribution at these locations was less than assumed. 200 mm pipes were laid for these locations, and this is another reason why the number of 300 mm bypass pipeline was reduced.

Table 2 Planned and Actual Outputs of the Renewal of the Distribution Main Pipeline at Kaba Aye Pagoda Road

Items	Diameter (mm) and material	Pipe laying extension (m)	
		Plan	Actual
Distribution main pipeline	1,000 ductile	1,700	1,567
Bypass pipelines	300 ductile	1,200	241
	200 ductile	1,400	1,173

Source: The planned figures refer to the preparatory survey report, while the actual figures are taken from the project completion report.

(c) Renewal of the Distribution Network in the Pilot Area in Yankin Township

Renewal of the distribution network, installation of control valves, air valves and water pipe bridges, setting up the valve chambers and a flow meter room, water supply connections and installation of individual water meters to the households in the target area were conducted in this component according to the plan. Around 500 households were planned to be included in the target area of this component. The project planned to establish a DMA (District Metered Area⁶) in the target area by making it hydrologically independent. However, the target area was expanded to include around 2,000 households. This was because the number of households which a DMA covers in the future was deemed to be around 2,000, and it was desirable to have a corresponding number of households in line with future prospect. The revised number of households in the target area was 1,945, which was almost four times that of the plan.

Table 3 shows the planned and actual outputs of the renewal of the distribution network. The pipe laying extension was increased due to the expansion of the target area as mentioned above.

Table 3 Planned and Actual Outputs of the Renewal of the Distribution Network in the Pilot Area in Yankin Township

Diameter (mm)	Material	Pipe laying extension (m)	
		Plan	Actual
400	Ductile	40	24
350	Ductile	620	1,674
200	Ductile	370	1,152
150	PVC	0	152
100	PVC	2,460	4,679
Total		3,490	7,681

Source: The planned figures refer to the preparatory survey report, while the actual figures are taken from the project completion report.

⁶ DMA is a small segment in a distribution network that is hydraulically independent. The purpose of DMA is to reduce non-revenue water by measuring the amount of all water entering and exiting the area with a flow meter and monitoring the amount of water used in the area.



Water supply line installed in a house in Yankin Township



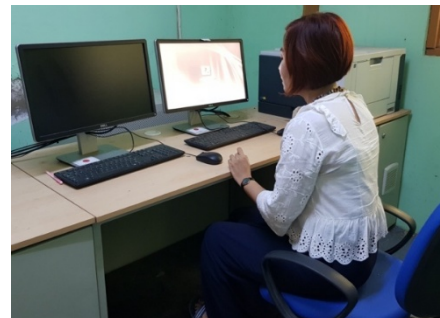
Individual water meters installed in Yankin Township

A set of transmission equipment for monitoring the DMA in the target area was installed in this component. This equipment includes a flow meter, flow indicator, water pressure indicator, chlorine indicator, equipment control unit and uninterruptible power supply unit, which were installed in Yankin Township, and a desktop computer, a printer, and a communication modem, which were installed in the monitoring room of Yegu pumping station. This equipment enabled Yegu pumping station to receive data on the flow rate, water pressure and chlorine content in the DMA in real time using internet communication. The purpose of installing this equipment was to estimate and calculate the non-revenue water (NRW) ratio⁷ by aggregating and analyzing the received data in a computer and comparing the data on the water distribution volume and the metered water volume.⁸

A capacity-building program aiming at providing technical guidance on data analysis and management of water distribution using this DMA monitoring system was also implemented as planned.



Data recording equipment for DMA monitoring system installed in Yankin Township



Monitoring equipment for the DMA monitoring system installed in Yegu pumping station

⁷ Non-revenue water is the water not counted for tariff collection due to leakages or theft from distribution pipes. Non-revenue water ratio is the ratio of non-revenue water out of the distributed water quantity.

⁸ The DMA monitoring system is useful for early detection of water leakage and theft, because it can monitor the change in volume of water distribution continuously. It is also useful to identify leakage points in the DMA by monitoring water distribution data while opening and closing valves in the DMA one by one late at night, when water usage volume is less.

As mentioned above, all planned facility developments were implemented. There was a change in the number in component (b); however, it was implemented in the consequences of actual measurement and confirming the necessity. The target area of component (c) was expanded to around four times.

As described above, the project produced more outputs than originally expected.

3.2.2 Project Inputs

3.2.2.1 Project Cost

The estimated project cost was 1,901 JPY million and the actual cost was 1,864 JPY million which came in under the budget (98%). The design and construction cost of the renewal of component (c) increased because the target area was expanded. The surplus amount generated as a result of efficient bidding for component (a) was allocated for the cost.

3.2.2.2 Project Period

In this project, construction work was implemented by dividing the three components into two contracts. The detailed design and bidding of component (a), which was more urgent, were conducted in advance so that the construction work would be completed early. Then, the detailed design, bidding and construction of components (b) and (c) followed. The project period was planned for 22 months and the actual period was 32 months; the actual period exceeded the plan (145%).⁹ The main reasons for delay in the project period were changes in the design due to the expansion of the target area of component (c), and a re-bidding becoming necessary for components (b) and (c) because the bidding price did not fall below the expected price due to depreciation of the Japanese yen at that time.

Although the project cost fell within the planned budget, the project period was extended. Therefore, efficiency of the project is fair.

3.3 Effectiveness and Impacts¹⁰ (Rating: ③)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

As described in the “Background of the Project,” the three components of the project were almost independent as water supply systems, and they were expected to create different effects. For that reason, in this ex-post evaluation, the status of achievement of the objectives expected for each component was individually verified, and these results were holistically taken into consideration to determine the effectiveness of the project.

⁹ The project period concerning both the planned and actual outputs started on the commencement date of the detailed design and completed on the completion date of the constructions of components (b) and (c).

¹⁰ Sub-rating for Effectiveness is to be implemented taking consideration of Impacts.

Table 4 shows the status of achievement for the indicators of the three components. The target of component (a) was mostly achieved, and the targets of components (b) and (c) were achieved. As will be described later, the effects of the project were confirmed from various information collected before and after the project in relation to these components. Thus, the effectiveness is high.

Table 4 Status of Achievement of the Indicators of each Component

Indicators	Baseline	Target	Actual	
	2012	2018 (3 years after project completion)	2019	
			Value	Level of Achievement
(a) Transmission time at Nyaunghnapin First Phase Water Treatment Plant (pump operation hours/day/unit)	16.7	24.0	22.9	95%
(b) Number of bursts of the distribution main pipeline	17 times/2 years	0/year	0/year	100%
(c) Water leakage rate at the target area in Yankin Township	Over 50%	10%	8% or less	Achieved

Source: The baseline and target figures refer to the preparatory survey report, and the actual figures are based on the responses to the questionnaire of the ex-post evaluation.

(a) Renewal of the Transmission and Distribution Pumps and Construction of a Pump House at the Nyaunghnapin First Phase Water Treatment Plant

With this component, pumps that were not operating sufficiently due to aging and malfunction were replaced. At the time of planning, it was expected that the new pumps would be functioning 24 hours a day. At the time of the ex-post evaluation, these pumps were almost fully running, and the average daily operating hours in 2019 was 22.9 hours (95% target achievement) as shown in Figure 2. The average daily operating hours was less than 24 hours because sometimes one of the three pumps were stopped and only two operated when water demand decreased during nighttime, and because sometimes the pumps were stopped due to power cuts. The pump operation has never stopped due to a failure of the pumps. The amount of water transmitted by the pumps increased significantly after completion of the project (Figure 3). Pump outages (a day when the pump is shut down for 24 hours) and water hammer accident have never occurred, although they occurred frequently at the time of planning.

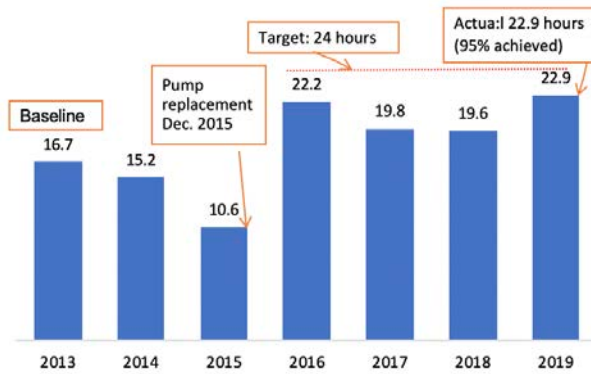


Figure 2 Average Operating Hours of Pumps per Day
(Unit: hour/day/unit)

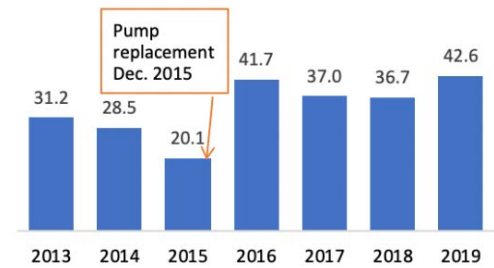


Figure 3 Average Water Transmission Volume of Pumps per Day
(Unit: Million Gallons/day)

Source: Prepared by the evaluator based on the responses to the questionnaire of the ex-post evaluation.

The number of water supply connections¹¹ using the water transmitted and distributed by the above-mentioned facility increased from 35,900 at the time of planning to 43,340 at the time of the ex-post evaluation. This was realized as a result of the distribution network in the distribution area of the water treatment plant being expanded and connected to new consumers, not only because of the increase in transmission hours and volume resulting from the development of facilities by the project, but also because the Water Resources and Water Supply Agency of YCDC replaced a part (19 km) of the transmission line of Nyaunghnapin First Phase Water Treatment Plant from 36-inch concrete pipe to 48-inch cast iron pipe after the completion of the project, reinforcing the transmission capacity.

(b) Renewal of the Distribution Main Pipeline at Kaba Aye Pagoda Road

At the time of planning, the distribution main pipeline frequent burst – as frequently as 17 times in around 2 years, from June 2010 to August 2012. Interruptions to traffic flow due to repairing pipe bursts were also a problem. It was expected that the project would solve such problem of interruptions to traffic flow. Accordingly, the effectiveness of this component was evaluated using the occurrence of interruptions to traffic flow due to repair of bursts to the distribution main pipeline as an effect indicator. After completion of the project, no traffic interruption due to pipeline bursts had occurred, and therefore the objective of this component was achieved.

The number of connections through the distribution main pipeline increased from 2,583 at the time of planning to 3,621 at the time of the ex-post evaluation. At the time of planning, the pipeline was used for gravity transmission by natural flow. However, the Water Resources and Water Supply Authority connected the pipeline to the Yegu pumping station so that water could reach farther by pumping transmission, because the pipeline became strong enough to withstand pumping transmission due to the renewal conducted by the project. In order to make effective use

¹¹ The number of connections is the number of locations that distribution pipes are connected to water supply pipes.

of the pumping transmission, the Authority renewed the distribution pipeline leading to Kamayut Township which was branched from the main pipeline, the distribution network, and pressure pumps of the Township, extending connections to new consumers. An increase in the number of connections has been realized as a result of these efforts.

(c) Renewal of the Distribution Network in the Pilot Area in Yankin Township

There were frequent water leakages in Yankin Township Pilot Area due to the old and improperly arranged distribution pipelines at the time of project planning. It was expected that this project would solve this problem. The effectiveness of this component was planned to be evaluated based on the leakage rate in the target area. Before the project implementation this was 50% or more, and the target was 10% or less. According to data provided by the Water Resources and Water Supply Authority of YCDC, the non-revenue water rate in the target area after project completion was 8% in July 2017, and thereby the water leakage rate is estimated to be 8% or less.¹² Thus, this component has also achieved the targets set at the time of planning.

As shown in Table 5, the number of water leakage incidents has been significantly reduced, water supply pressure has been significantly improved, and revenue from water bills has increased in this area.

Table 5 Status of Water Distribution and Supply in Yankin Township Pilot Area

Indicators	Status of water distribution and supply before and after the project
Leakage incident	Renewal of the distribution network significantly reduced the frequency of water leakages. Water leakages frequently occurred in the distribution network, and repair work was carried out every day before the project implementation. After project implementation water leakage rarely happened, and repair work was performed only twice in four years. These repairs were needed because a vehicle collided into the hydrant, and not because of a defect in the distribution network.
Water supply pressure	Water pressure was drastically improved because effective water volume was increased. This was attributed to the fact that the pipeline network was designed to distribute water effectively and that water leakages were not observed. Before project implementation water supply pressure was low, and households on the second floor or higher of apartment complexes had to pump water to their rooms using water pumps directly connected to the supply pipeline. These pumps sometimes drew surface water and underground wastewater when there were water leakages (source: Preparatory survey report of the project). After the project implementation, water is supplied to the 4th floor of apartment complexes without using such a pump, and no household was using the pump at the time of the ex-post evaluation.

¹² Non-revenue water includes water for which tariffs were not collected due to water theft or because a meter was not installed, in addition to the water that leaked from distribution pipelines. Therefore, the water leakage rate is lower than the non-revenue water rate.

Indicators	Status of water distribution and supply before and after the project			
Income from water supply	The project installed water meters on 1,945 households in the target area as explained in “3.2.1 Outputs.” As a result, the average monthly tariff revenue per connection has significantly increased when compared to the amounts before and after the project (see the table below). During this period the water tariff has not been revised. ¹³			
	Year and Month	January 2016	June 2016	July 2019
	Items	Before construction	Just after construction	At the ex-post evaluation
	Monthly income from water supply (Kyat)	2,784,600	3,229,080	5,815,466
	Number of water supply connections	1,547 ¹⁴	1,570	1,746
	Average monthly income from water supply per connection (Kyat/month/ connection)	1,800	2,057	3,331
Source: Responses to the ex-post evaluation questionnaire				

3.3.1.2 Qualitative Effects (Other Effects)

A qualitative survey was conducted for consumers in the water supply and distribution areas of each component.¹⁵ It was conducted to understand examples for improvements in water supply services in the beneficiary areas of the project. As a result, it was found that improvement of water supply services, including extension of hours of water supply, elimination of interruption of water supply, and increased water pressure and volume, were realized in the beneficiary areas of the project.

For example, the pressure and volume of water supply using the Kaba Aye Pagoda Road distribution main pipeline which was renewed by the project was increased after project completion, making it possible to distribute water to areas where water had not been supplied for the past 20 years. (See the column below).

¹³ The latest tariff revision was conducted in April 2012. It is 88 kyat/m³ for households installed with meters and the basic charge is 100 kyats. The fixed charge for households without meters is 1,800-3,000 kyats (as of November 2019).

¹⁴ The reason why the number of water meters installed (1,945 households) is larger than the number of water supply connections (1,547 locations) is that the distribution line is connected to a building at a single point, but water meters are sometimes installed at each shop or other units in the building.

¹⁵ Four group discussions were held. The total number of participants was 33 (21 males and 12 females). In addition, visits were paid to four households, and two primary schools, and one township hospital.

【Resumption of water supply in an area where water had not been supplied for the past 20 years】

Water supply services had stopped for about 20 years because water supply facilities were old and had deteriorated in the residential area near Inya Lake Road in Kamayut Township. The residents had been demanding a resumption of water supply services because the quantity and quality of the groundwater in the area was poor. The distribution main pipeline at the Kaba



Aye Pagoda Road, which had frequent leakages, was renewed by the project, and became able to withstand pressure distribution. The Water Resources and Water Supply Authority improved the distribution pipes leading from the distribution main pipeline to the township and the distribution network within the township and restarted the water supply service in the area after completion of this project. The result of interview with a resident in the area is described below.

Interview with a household (family of four)

We used well water before, but because the smell is like iron and the color is yellow, we were worried about using it for domestic water. Clothes turned yellow when we used well water for washing. We applied for a connection when we came to know that the water supply facilities had been renewed, and the service resumed. We are very satisfied with the service as the quality of the piped water is good and it can be used for cooking with peace of mind.

3.3.2 Impacts

3.3.2.1 Intended Impacts

It was expected at the time of planning that improvement of water supply services by the project would contribute to improving the living environment of the local community. As a result of the qualitative survey described above, it was found that the project contributed to an improvement in the living environment of the local community as follows (see also the column below).

- With the elimination of water cuts and increased hours of water supply, we can now use water immediately when we want to use it at home, such as for washing clothes and taking a shower. Even in primary schools, the water needed for washing hands and cleaning toilets is always available. This has made life easier and improved hygienic behavior.
- Electricity costs and working time have been reduced because there is no need to use a pump to pump well water or lift tap water to the upper floors of the apartment complex.
- In the past, water was supplied only once every few days and only late at night. When water came on in the middle of the night, we stored it in a tank as much as possible. After the project was implemented, water is also supplied during the daytime, so there is no need to secure water at midnight. We can sleep at night without any worries.

- Well water made our laundry yellow and could not be used for cooking because the quality was poor. After the project, high quality tap water became available for washing and cooking at ease.

There was no example found in health improvement. This is probably because the relationship between improvement of water supply services and health improvement is weak. At present, the pipe water has impurities, although the Water Resources and Water Supply Authority of YCDC is working on improving the quality of water. Because of this situation, every household purchase drinking water.

【Improvement of water supply service through the project contributes to improvement of living environment for the local community】

Interview with a household living on the second floor of an apartment complex in Yankin Township

We were using a pump to lift water to the room in the past, because water pressure was low. However, we couldn't pump water to the room during frequent power outages, which was very inconvenient. There were power outages at least one hour and up to 6 hours a day. This sometimes happened every day during the dry season. Water is supplied to the room without the use of a pump after the facility was renewed, making our lives much easier. We no longer have to pay electricity bills for pumping. Water is supplied regardless of the power outages, and we are satisfied with the water supply service in terms of its quality and quantity.



Interview with the director of the Mingaladon Township Hospital (25 beds)

We pumped up large quantities of well water for usage at the hospital until three years ago because piped water was scarcely supplied. We had to stop the pump motor when it got hot and start it when it cooled down, for a total of around 5 hours every day. The amount and pressure of the piped water supply improved after the improvement of the facility, and water became available 24 hours a day except when it is interrupted due to a power outage. There is no need to pump well water, saving on the electricity bill and reducing the workload.



3.3.2.2 Other Positive and Negative Impacts

According to the consultant in charge of this project, the project planned to use low-noise excavators and generators during construction and stop dump truck engines during loading of earth and sand, giving consideration to the surrounding residents. This has been done on the Kaba

Aye Pagoda Road, the target area of component (b), main road connecting Yangon City and Yangon Airport. The jacking method¹⁶ introduced for the first time in the country was effective in alleviating traffic congestion when the distribution main pipeline was laid under the road. Construction works for the component (a) were executed within the water treatment plant, and environmental impact was not anticipated. As expected, no issues have been occurred. Based on the monitoring plan, monitoring of noise and vibration was conducted monthly for components (b) and (c), which were conducted in the city. World Bank standards were used as reference values since Myanmar does not have environmental standards. The measurement value did not exceed the reference value to a great extent and overall values did not appear to be problematic. There was no complaint or claim from residents about the construction in all components.

A worker died at the construction site for the pumping house one month after commencement of construction. This was qualified as an accidental death by an electric shock due to negligence of safety measures. It might have been prevented if sufficient safety measures had been taken from commencement of the construction. The construction was resumed after the contractor paid compensation to the family of the worker and implemented proper safety measures, including enhancement of the construction management system, update of construction plan, specific designation of safety officers and creation of safety procedure manual, and improvement of temporary electrical equipment and work environment. There was no objection or action against the project by the local community because necessary measures and compensation payment were made promptly. No accident was caused after that. The scope of the negative impact created by the accident was minimized by appropriate measures taken after the accident, and it is considered that the impact of the accident on the overall impact of the project is limited.

There was no resettlement or land acquisition by this project.

From the above, the project effects are present just as planned and its effectiveness and impacts are recognized as high.

3.4 Sustainability (Rating: ③)

3.4.1 Institutional/Organizational Aspect of Operation and Maintenance

In 2018, the Department of Water Supply and Sanitation was reorganized in accordance with the revision of the YCDC Law and separated into the Water Resources and Water Supply Authority, which is responsible for water supply services, and Wastewater and Sewage Management Authority, which is responsible for sewage services. Figure 4 shows the organization chart of the Water Resources and Water Supply Authority.

¹⁶ The pipe jacking is a technique for installing water pipes to underground. Water pipes are installed underground pit excavated by a drilling machine and are moved forward by a jacking machine one by one. This method requires less excavation of ground surface compared to the conventional excavation method, and it enables reduce vibration and noise caused by excavation and traffic congestion due to road blocking.

Despite the organizational reorganization and name change, there was no change in the composition and responsibilities of the sections within the Authority concerning water supply, and these changes had no effect on the operation and maintenance of this project. The Authority has a total of 2,852 staff members allocated.

The pump house of the Nyaunghnapin First Phase Water Treatment Plant is under the purview of Ngamoyeik Water Treatment Plant. The water treatment plant has a total of 116 staff members, and the responsibilities and roles of each department are clear. Necessary personnel were assigned at the water treatment plant and the pump house developed in the project for operation and maintenance.

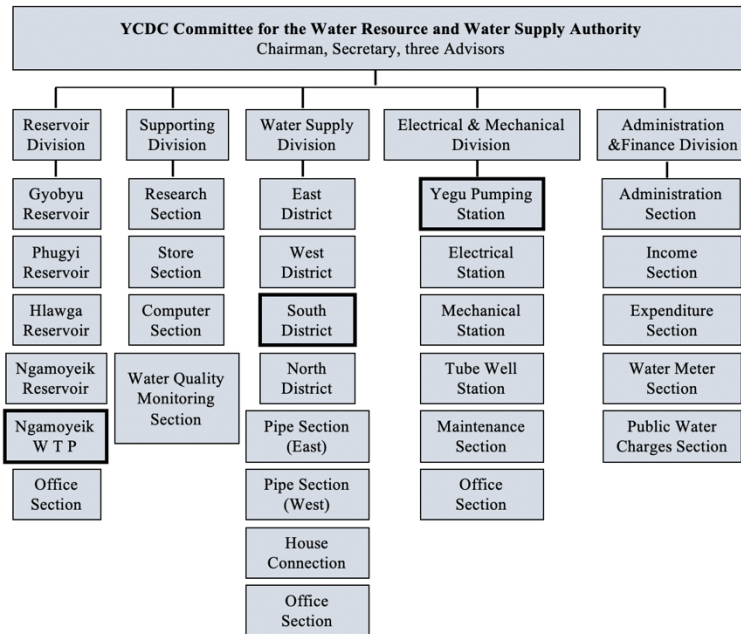


Figure 4 Organizational Chart of the Water Resource and Water Supply Authority of YCDC (as of December 2019)

The Pipe Section of the Yegu Pumping Station is in charge of maintenance of the Kaba Aye Pagoda Road distribution main pipeline. The Yankin Township Office is under the purview of the South District Office. The office has a total of 29 staff members, and their roles and responsibilities have not changed since the time of planning. The staff required for the operation and maintenance of the water distribution facilities developed in the project, meter readings, and fee collection are secured.

As mentioned above, there is no systematic or institutional issue that could hinder the sustainability of the project.

3.4.2 Technical Aspect of Operation and Maintenance

There is no facility and equipment in the project that is either not used or extremely inactive due to technical problems.

No technical problems have occurred with the data collection and analysis in the DMA monitoring system. Staff members record and analyze daily and monthly data and produce reports. NRW Management Section has learned how to calculate non-revenue water ratios. Staff of the Yankin Township office are recording leakages and estimating the amount of leakage with the support of a JICA long-term expert and from the technical cooperation project “The Project for

Improvement of Water Supply Management of YCDC” (hereinafter the “Technical Cooperation Project”). The Authority has purchased flow meters and leak detectors and plans to implement countermeasures for leakages by using these devices. The Water Resources and Water Supply Authority has been providing training for managers, new employees, pump operators and others to build their capacity, with support from the above-mentioned technical cooperation project.

As described above, there are no problems relating to the technical aspects of operation and maintenance of facilities developed in the project.

3.4.3 Financial Aspect of Operation and Maintenance

The Water Resources and Water Supply Authority is not an independent entity but remains to operate the water supply service since the planning of the project with a budget allocation as a department within the YCDC. After completion of the project, the Authority took advantage of annual budget to develop facilities that would expand revenue and to make good use of facilities improved in the project. The column 【Resumption of water supply in the area where water has not been supplied for the past 20 years】 on page 15 is one example. Each township office of the Authority plans to extend the distribution network and number of connections in the target area of the project in future with their budget. Further, it is expected to make effective use of the facilities developed in the project.

According to the breakdown of income and expenditure, tariffs account for 91% of income (Figure 5), and the main item of capital expenditure is water distribution projects (Figure 6). The main items of operational expenditure are electricity bills, purchasing of goods and labor costs (Figure 7).

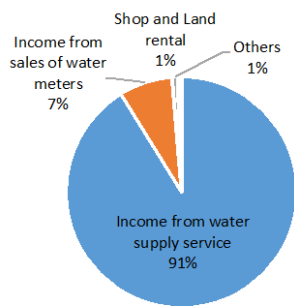


Figure 5

Income FY 2017

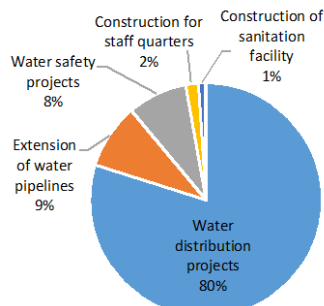


Figure 6

Capital Expenditure FY 2017

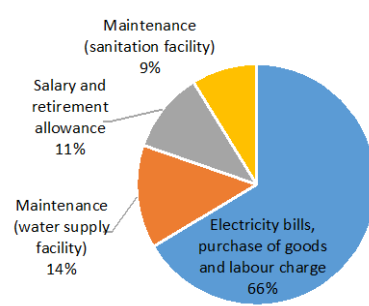


Figure 7

Operational Expenditure FY 2017

Note: All figures are actual numbers in FY 2017 (from April 2017 to March 2018)

Source: Responses to the ex-post evaluation questionnaire

Table 6 shows the income and expenditure of the Authority for the last three years.¹⁷ Revenue is delivered to the national treasury through YCDC. The expenditure is covered by the budget distribution from YCDC.

Table 6 Income and Expenditure of the Water Resource and Water Supply Authority

(Unit : million Kyats)

Items	FY 2016	FY 2017	FY 2018 1 st half
Income in total	12,104.343	13,772.791	5,989.607
Capital expenditure	14,919.868	40,246.935	33,021.079
Operational expenditure	18,153.377	18,150.290	10,772.863
Expenditure in total	33,073.245	58,397.225	43,793.942

Source: Responses to the ex-post evaluation questionnaire

As Table 6 shows, the expenditure of the Authority has exceeded its revenue, and it does not have financial independence. From the viewpoint of sustainability of the water supply service, it is desirable to have financial independence as an institution for water supply and improve the financial situation by increasing tariffs. Although the Authority is aware of the importance of these factors, the tariffs for water supply of the city have not been increased since April 2012 for political reasons. The Authority has not taken any specific measures for financial independence, although it is a future goal.

However, the budget necessary for operation and maintenance of the facilities developed in the project has been secured under the current financial system, and there are no financial problems that would hinder the sustainability of the effects of the project.

3.4.4 Status of Operation and Maintenance

(a) Pump Station of the Nyaunhnapin First Phase Water Treatment Plant

The pumps in the water treatment plant are operating smoothly, and maintenance work, including operation, lubrication and inspection, is carried out properly by maintenance staff of the water treatment plant management office. There are no defects in the components of the pump house. Daily inspection of moderate leakage from the pump shaft seals during operation, monthly checks of water level and drainage of air valves, monitoring of water meter values of the transmission pipeline, and periodic cleaning of the flow meter, which were suggested in the defect inspection, are also implemented.

The figures had not been displayed on the monitoring panels of the pumps since mid-2018. The staff checks the flow meter and measuring instrument of the pump's operation panels and

¹⁷ Myanmar's fiscal year was from April to the end of March of the following year. However, the fiscal year has changed from October to September of the following year from mid-2018. Therefore, the financial period for 2018 is the first six months from March to September.

records the measured value every hour for important monitoring items during operation such as pump flow rate, motor voltage and current. The problem of the display has not hindered the operation of the pumps. The temperature of pumps and motor bearings is checked by hand. However, a monitoring panel is required to check the water transmission pressure, the differential pressure of air valves, and the opening ratio of transmission valves. The head of the water treatment plant is aware of this situation and has already purchased a PLC (programmable equipment control device), which is a necessary part for repair of the panels. At the time of the ex-post evaluation, the head of the water treatment plant had referred to a specialist who could install the necessary programs for the installation of the PLC. He stated that they would like to install the parts as soon as possible and resume using the monitoring panels.

(b) Kaba Aye Pagoda Road Distribution Main Pipeline

The renewed distribution main pipeline had no defect or leakage, and the valves and hydrants are in good condition without any problems. The air valves with replaced parts at the time of the defect inspection, are functioning without problems.

(c) Distribution Network at the Pilot Area in the Yankin Township

The renewed distribution network is in good condition with no leak or defect. The water meters installed in each household are functioning without any problems. The staff scraped off and cleaned soil accumulates in the water meter box, if any, at the time of meter reading. It was pointed out that the filter in the meter had to be cleaned at the time of the defect inspection. This is to prevent the filter from being clogged by impurities in the water and causing measurement failure. The Yankin Township Office only carries out this cleaning when there is a complaint from a consumer and does not conduct the proposed annual cleaning.

The data recording unit of the DMA monitoring system is functioning normally, and data is recorded daily and monthly. Staff in the monitoring room of the system received and analyzed the data and produced reports. A software defect was found in the system in late 2017. Although the warranty period had expired, the supplier of the system dispatched a technician from India, taking into account the importance of the problem. He inspected and repaired the defect free of charge. Thereafter, the environment of the internet service which is needed for receiving the data, was changed, and the Authority changed the internet service provider. As a result, the system was functioning without problems in December 2018.

However, the speed of the internet became extremely slow; it has become impossible to receive the data for flow rate continuously, and it is taking a long time to boot the system after a power failure since January 2019. The data received is recorded daily and monthly, and reports are being prepared and submitted. However, the NRW ratio cannot be calculated because there is missing data. With regard to this issue, the Water Resources and Water Supply Authority mentioned that

they would like to find measures to integrate and operate the DMA monitoring system introduced in the project with the transmission monitoring system introduced in the above-mentioned technical cooperation project, as well as with the DMA monitoring systems to be introduced in several townships in the city by the two ODA loan projects which are being implemented at the time of ex-post evaluation.¹⁸

The external evaluator found that the flow rate was about three times higher than the consumption volume when she examined the monitoring results for December 2018, for the month almost all data was available. She informed the Water Resources and Water Supply Authority that the distribution network may have extended outside the DMA, and if there was an extension it would be necessary to install a flow meter at the extension point to keep the DMA measurable. The Agency responded that they would check for any extension and take necessary measures.

As described above, the operation and maintenance status of the facilities constructed under the project is generally favorable, and some defective parts and attached facilities are expected to be repaired or improved.

No major problems have been observed in the system, the structure, technical/financial aspects, or in the current status concerning the operation and maintenance in the project. Therefore, sustainability of the project effects is high.

【Timely and multi-dimensional assistance for improving water supply services in Yangon City】

This project developed the facilities identified most urgent and important in the “Study on the Improvement of Water Supply and Waste Water Treatment in Yangon, the Republic of the Union of Myanmar,” which was conducted by the Ministry of Economy, Trade and Industry of Japan just after the country had shifted to civilian rule in 2011, as described in the “Background” of this report. The water transmission and distribution pumps at the Nyaunghnapin First Phase Water Treatment Plant were renewed in the project after confirming its urgency in the study. Afterwards, the pumps had been submerged and became inoperable. An emergency situation would have occurred in which 40% of the total water supply of the city would have stopped if the pumps had not been renewed in this project. This indicates that the study conducted in 2011 was very timely. A grant agreement was signed for the project shortly after the study, and the component of the water treatment plant was completed in 2015. This was a speedy response to the urgency.

JICA conducted the “Preparation Survey on the Project for the Improvement of Water Supply, Sewerage and Drainage System in Yangon City in the Republic of the Union of

¹⁸ “Greater Yangon Water Supply Improvement Project (Phase I)” and “Greater Yangon Water Supply Improvement Project (Phase II Stage 1).”

Myanmar” following the above study, since 2012. The study proposed future plans and targets for Yangon water supply in 2014. The study set the targets of water supply services and showed the path to achieve them at a time when a rapid increase in water demand of the city had started due to population growth and urbanization at the democratization advances in the country. It was an indispensable arrangement for implementation of the subsequent programs. At present, the YCDC has adopted the proposal from the study as a master plan for water supply in the city and has been working on improving water supply services by utilizing technical and financial assistance from JICA, including technical cooperation projects, ODA loan projects, dispatch of experts, and grant aid with a service concession arrangement project of the Ministry of Foreign Affairs of Japan.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project supported the improvement of water supply services in Yangon City by upgrading facilities that needed urgent rehabilitation.

From the time of project planning to the ex-post evaluation, improvement of water supply and sanitary conditions was a priority issue for the country, and there was a high need for improvement of water supply services in Yangon City. It has been recognized that the project was consistent with the development policy and needs of the country and also consistent with Japan's ODA policy of providing support to improve the lives of the citizens of Myanmar. Consequently, the relevance of the project is considered to be high. All planned facility construction was conducted, and the project cost did not exceed the budget. Since the project period was longer than expected, the efficiency of the project is considered to be fair. There were three components in the project. In the first component, (a) “Renewal of the Transmission and Distribution Pumps and Construction of a Pump House at the Nyaungnapin First Phase Water Treatment Plant”, the defective pumps that were not properly functioning were replaced. At the time of the ex-post evaluation, the renewed pumps were almost fully operational, with an average daily operating time of 22.9 hours. In the second component, (b) “Renewal of the Distribution Main Pipeline at the Kaba Aye Pagoda Road”, the aging distribution main pipeline was renewed. Since the completion of the project, traffic has not been interrupted due the pipeline bursting or for its repair, and the expected outcome was achieved. In the third component, (c) “Renewal of the Distribution Network in the Pilot Area in Yankin Township”, the aging distribution network was updated in the area. This solved the problem of frequent water leakage and reduced the rate of water leakage to 8% or less as planned. Improvement in the water supply service, including increased hours of water supply, resolution of the problem of water cuts, increased water pressure and quantity, improvement of the living environment, including reduction in the cost of electricity and working hours of the water pumps, and an improvement in hygienic behavior, were realized. Therefore, effectiveness and impact of

the project are high. No major problem has been observed in the policy system, the structure, technical/financial aspects or in the current status concerning the operation and maintenance of facilities developed in the project. Further, some malfunctioning parts and attached facilities are expected to be repaired or improved. It is observed that sustainability of the project effects is high.

Considering these observations mentioned above, the project is evaluated to be highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

- (1) Measures to resume function and utilize the DMA monitoring system at Yankin Township (Recommendation to the Water Resources and Water Supply Authority)

The DMA and DMA monitoring system introduced to Yankin Township in the project were expected to be a model for DMA formation and water distribution monitoring in the country in future. However, at the time of the ex-post evaluation, the equipment did not receive data continuously, and the measured flow rate was around three times more than the consumption volume; therefore, it was not utilized for water distribution monitoring. The Water Resources and Water Supply Authority would like to repair and operate the device by integrating it with the water transmission monitoring system introduced in the technical cooperation project, as well as with the DMA monitoring system to be introduced to multiple townships in two ODA loans. However, to realize this, time and cost for technology development, such as software integration, will be needed. Therefore, until this happens, the Authority is recommended to improve the communication environment of the location of the equipment by introducing fiber-optic network, investigate if there is any distribution out of the DMA, and if there is, install a flow meter to the relevant distribution branch point, in order to keep the DMA measurable, and to make the system functioning and utilize it for the distribution management.

- (2) Cleaning of filters in the consumer water meters once a year (Recommendation to the Yankin Township Office of the Water Resources and Water Supply Authority)

As pointed out in the defect inspection of the project, the Yankin Township Office is advised to clean the filters of the consumer water meters regularly approximately once a year, in order to prevent clogging of the water meter causing measurement errors.

4.2.2 Recommendations to JICA

- (1) Monitor status of usage of the DMA monitoring system introduced by the project, its issues, and utilization of lessons learned

It is planned to construct DMAs and install DMA monitoring systems in several townships in two ongoing Japanese ODA loan projects. JICA is recommended to continue monitoring the status

of usage of the DMA monitoring system introduced by the project and to utilize the issues and lessons derived from the monitoring in the ongoing ODA loan projects.

4.3 Lessons Learned

Continuous follow-up is required when newly introducing a system such as a DMA monitoring system, which use software and internet services

In this project, a DMA monitoring system was newly introduced, and training on the operation of the system was conducted in the capacity building program. However, a problem occurred in the software of the system about a year after its introduction, and staff were unable to analyze the data. Fortunately, given the importance of the problem, the supplier dispatched a technician from India for free inspection and they made repairs and inspection even though the warranty period had expired. However, the communication environment was changed one year later, and the staff were unable to receive the flow data. At the time of the ex-post evaluation, the system was not functioning properly and was not fully utilized.

A system, such as a DMA monitoring system which require software and internet service, can have problems that cannot be solved with the knowledge acquired through the initial technical training on operation. Software failure is an example of such problem. It also requires continuous update of communication services responding to the changes of communication environment at the installation site. Therefore, it is necessary to ensure in advance that the suppliers, the local agents of the system or the executing agency are able to assist when problems occur, so that the system is used effectively on an ongoing basis.

For example, it is necessary to confirm that the supplier, the local agency, or the executing agency is continuously capable of managing, fixing and updating the software installed in the system. Regarding Internet communication, it is important to notify the executing agency that they may need to change the service provider or subscribe new services if communication environment at the place the system is installed changes. Obtaining their advance commitment for these actions are also important.

If there is no prospect for the above-mentioned follow-up work or the cost burden for the purpose, it should be considered not to introduce the system or introduce a simple system that does not need such follow-up work.