Kingdom of Cambodia

FY2016 Ex-Post Evaluation of Japanese Grant Aid Project

"The Project for Replacement and Expansion of Water Distribution Systems in Provincial Capitals"

External Evaluator: Satoshi Nagashima, INTEM Consulting, Inc.

0. Summary

This Project aims to improve the water supply service by implementing replacement and expansion of existing water distribution systems in the target provincial capitals (Pursat, Preah Sihanouk and Battambang), thereby improving the operation aspects of the water supply business in each province through improving the rate of non-revenue water.

Cambodia's policy to improve access to safe water in urban areas has not changed before and after implementation of the Project, and the Project is consistent with Cambodian development policy. In addition to this, the percentage of population served for water supply is lower than the national average in the three target provincial capitals of the Project and there is a continuous need to support the construction of urban water distribution systems in the three target provincial capitals. Furthermore, since the Project is consistent with Japan's aid policy, the relevance is high.

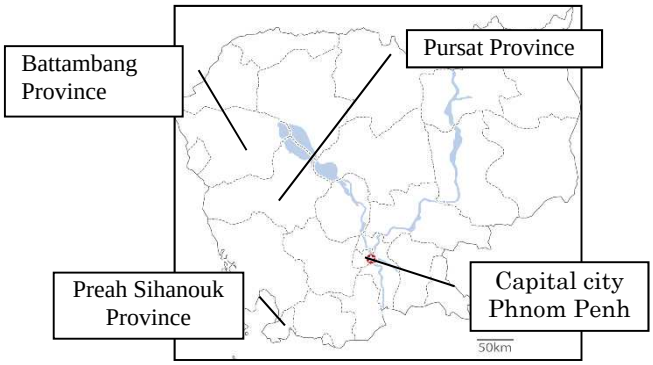
In the Project, the total expansion of the replacement of existing distribution pipes and of new water distribution pipes was slightly less than anticipated in the project plan. However, the cost of the Project was significantly lower than planned, while the duration of the Project was as planned. Therefore the efficiency is considered high.

Due to synergy with the Project, projects implemented by other donors and other projects undertaken by JICA, the operation and effect indicators for effectiveness such as increase of the maximum daily water supply, the population served by the water supply and decrease of water leakage rate. Furthermore, indicators for impact such as reduction of non-revenue water rate and the improvement of operational efficiency have mostly been achieved. Therefore, the effectiveness and impact of the Project are considered high.

The operation and maintenance institution, technique and finance necessary for maintaining the effectiveness of the Project have been secured for the water supply units in the three target provinces, and they are able to properly manage the water distribution network at the time of ex-post evaluation. Therefore, the sustainability is considered high.

In light of the above, this Project is evaluated to be highly satisfactory.

1. Project Description



Project Locations

Rusted water distribution pipe replaced in the Project and model of newly installed water distribution pipe (Preah Sihanouk)

1.1 Background

In Cambodia, assistance projects were carried out after the civil war for the construction of water supply systems and for the training of personnel for water supply operation and maintenance with the support of a range of donors including Japan, in order to improve the water supply capacity. In Phnom Penh especially, assistance to Phnom Penh Water Supply Authority (hereinafter referred to as “PPWSA”) has greatly succeeded in expanding the water supply area, decreasing the non-revenue water rate and increasing the number of water supply connections by utilizing various schemes including grant aid, technical cooperation, ODA loans by Japan. This has been referred to as the ‘miracle of Phnom Penh’ and its success is well regarded worldwide.

Meanwhile, the water supply capacity in local cities beyond Phnom Penh was still low and the supply of safe water to the public had not been sufficient prior to the implementation of the Project. According to the ex-ante evaluation, in the provincial capitals of Pursat, Preah Sihanouk and Battambang, the total population of those being served by the urban water supply services was only 80 thousand people, about 30% of the total population (269 thousand people), and the improvement of water supply services in local cities was a problem. Among the three target provincial capitals of Pursat, Preah Sihanouk and Battambang, installation of the water distribution network had not progressed sufficiently, and existing water supply capacities were not fully utilized although the water treatment plants had been expanded and improved through the support of donors such as the World Bank and the Asian Development Bank. In addition to this, leakage caused by aging of the water distribution pipes occurred frequently, and the loss due to non-revenue water was a major problem for the effective use of tap water and water supply operation management. Based on this background situation, the Cambodian Government requested a grant aid project to Japan for the expansion and replacement of the water

distribution network for the purpose of improving the water supply services in the three target provincial capitals above.

1.2 Project Outline

The objective of the Project is to improve the water supply service in the target provincial capitals, Pursat, Preah Sihanouk and Battambang by the replacement and expansion of existing water distribution system, thereby contributing to the improvement of the operational aspects of the water supply business in each province through improving the non-revenue water rate.

E/N Grant Limit or G/A Grant Amount / Actual Grant Amount	2,760 million yen / 1,645 million yen
Exchange of Notes Date (/Grant Agreement Date)	March 2011 / March 2011
Executing Agency	Ministry of Industry, Mines and Energy (currently Ministry of Industry and Handicrafts)
Project Completion	June 2013
Main Contractor	Kubota Construction Co., Ltd
Main Consultant	NJS Consultants Co., Ltd
Basic Design	July 2010 – March 2011
Related Projects	【Technical Cooperation】 The Project on Capacity Building for Urban Water Supply System in Cambodia Phase 1 (2003-2006), Phase 2 (2007-2012), Phase 3 (2012-ongoing) 【Grant Aid】 The Project for Expansion of Water Supply Systems in Kampong Cham and Battambang (2013) 【Other international organizations, aid organizations etc.】 Provincial Towns Improvement Project (Asia Development Bank, 2000-2006) Urban Water Supply Project (World Bank 1998-2004) Provincial and Peri-Urban Water and

	Sanitation Project (World Bank 2001-2005) Mekong Region Water and Sanitation Initiative (UN-HABITAT 2010-2015)

2. Outline of the Evaluation Study

2.1 External Evaluator

Satoshi Nagashima, INTEM Consulting, Inc.

2.2 Duration of Evaluation Study

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

Duration of the Study: July, 2016 – December, 2017

Duration of the Field Study: October 15, 2016 – November 1, 2016

January 15, 2017 – January 27, 2017

3. Results of the Evaluation (Overall Rating: A[1])

3.1 Relevance (Rating: ③[2])

3.1.1 Consistency with the Development Plan of Cambodia

At the time of the project planning, the Cambodian Government positioned "access to safe water" as one of the priority development goals for the *National Strategic Development Plan* (hereinafter referred to as "NSDP") (2006-2013) and it aimed to raise the rate of access to safe water[3] in urban areas to 80% by 2015.

At the time of this ex-post evaluation, the NSDP (2014-2018) is still an important policy. In the plan, the goals of the urban water supply sector are listed to; 1) develop a legal framework for urban water supply, 2) promote decentralization and de-concentration[4] in urban water supply sector, 3) transfer full autonomy for service delivery to provincial waterworks, 4) increase sector financing through good partnership with other donors and encouraging investment from the private sector, 5) improve water source protection and enforcement of regulations, 6) rehabilitate water supply systems through funds from Cambodian Government and donors, 7) grasp difficulties related to income and expenditure of the water supply business, 8) improve human resources, and 9) improve sector performance (improve water quality, access

[1] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

[2] ③: High, ②: Fair, ①: Low

[3] The numerical value of the indicator includes supply of not only urban water service but also other water (mineral water etc.). Unit of water supply amount is 60 liters/person/day. According to the statistics (http://www.wssinfo.org/documents/?tx_displaycontroller[type]=count_files) provided by the joint monitoring program of WHO and UNICEF on water supply and sanitation, access rate to safe water is 100% in 2015, among which the water supply rate through the urban water supply is 75%.

[4] Decentralization is transferring the authority to the local cities, and de-concentration is to establish institutions in the local cities to implement services (as an independent organization, not a branch office of the central ministry).

to safe water) through utilization of PPWSA etc., and promoting access to safe water is still a priority goal. According to the indicators shown in the NSDP, it is stated that the rate of access to safe water in urban areas was already more than 85% as of 2013, and the goal of improving this in urban areas to 80% by 2015 had already been achieved.

As mentioned above, since there has been no change in the policy of providing safe water either before or after the Project, the consistency of the Project with policy is still high.

3.1.2 Consistency with the Development Needs of Cambodia

Prior to the Project, the water supply capacity of cities other than Phnom Penh was still low, and in the provincial capitals, especially in Pursat, Preah Sihanouk and Battambang, the urban water supply served was only 80 thousand in total (around 30%) of the population (269 thousand in total). In order to improve this situation, the Ministry of Industry, Mines and Energy (currently Ministry of Industry and Handicrafts) increased the number of the water treatment plants in the first half of the 2000s with the support of the World Bank (in Preah Sihanouk) and the Asian Development Bank (in Pursat and Battambang). However, the non-revenue water rate reached around 20 to 35% due to water leakage caused by severe aging of the water distribution pipe network. In addition to this, the total expansion of the water distribution pipe network was insufficient. Therefore, it was difficult to fully utilize the water supply capacity of the new water treatment plants to improve the water supply services.

At the time of the ex-post evaluation, the non-revenue water rate in the three target provincial capitals has been improved since assistance has continued to be offered by the Project and also the JICA technical cooperation project “The Project on Capacity Building for Urban Water Supply System in Cambodia (Phase 2 and Phase 3) (hereinafter referred to as “Technical Cooperation Phase 2” and “Technical Cooperation Phase 3”), and the water supply capacity of the water treatment plants can be utilized. Meanwhile, the water supply area of the three target provincial capitals of the Project has been expanded year by year, and the water supply rate of the urban water supply is still low as shown in the table below.

Table 1 Urban water supply rate in the targeted provincial capitals[5]

	2011	2012	2013	2014	2015
Pursat	54.8%	58.2%	56.2%	-	50.5%
Preah Sihanouk[6]	-	33.5%	38.3%	45.7%	53.0%
Battambang	27.1%	34.7%	34.9%	34.5%	37.7%

Source: Calculate based on the information provided by the water supply units in Pursat, Preah Sihanouk and Battambang

From the above, the urban water supply rate in the three target provinces in 2015 in the above table is less than water supply rate (75%) in urban areas nationwide based on the statistics provided by the joint monitoring program of WHO and UNICEF on water supply and sanitation, which suggests that the needs are high for continuing support to the urban water distribution systems in the three target provincial capitals.

3.1.3 Consistency with Japan's ODA Policy

During the planning period for the Project, improvement of the urban water supply system was taken up as one of the important subjects for the development of infrastructure for socioeconomic development in Japan's *Country Assistance Plan for Cambodia* (2002).
According to the above analysis, the water supply is recognized as one of the important subjects, and there is no difference between the Project and Japan's aid policy. Therefore, the consistency of the Project with Japan's ODA Policy is high.

As mentioned above, this Project is highly relevant to the country's development plan and development needs, as well as Japan's ODA policy. Therefore, its relevance is high.

3.2 Efficiency (Rating: ③)

3.2.1 Project Outputs

The difference between the plan and actual of Outputs of the Project is as follows.

[5] The water supply rate was calculated based on the population of urban areas and the number of water supply connections, obtained from each water supply unit. However, the data of urban population in 2014 that the water supply unit in Pursat acquired from the statistics bureau was exactly same as in 2013, and it was judged that consistency and reliability could not be secured sufficiently. Therefore, it was not possible to calculate the water supply rate of Pursat for 2014.

[6] As for Preah Sihanouk, data on total population of provincial capital was not available and only data on the number of households was available. Therefore, after the total population of the provincial capital was calculated by multiplying seven by the number of households, urban water supply rate was calculated by utilizing the population served.

Table 2 Difference between the plan and actual Outputs of the Project

		Plan	Actual
Facility construction	Replacement of existing water distribution pipe	Pursat 4.48km Preah Sihanouk 6.48km Battambang 20.81km Total 31.77km	Pursat 5.16km Preah Sihanouk 14.08km Battambang 26.48km Total 45.72km
	Expansion of new water distribution pipe	Pursat 9.37km Preah Sihanouk 30.93km Battambang 52.82km Total 93.12km	Pursat 9.44km Preah Sihanouk 22.45km Battambang 45.03km Total 76.92km
	Particular route	3 units	3 units
	Major accessory	3 units	3units
	Flow monitoring system	3 units	3 units
	Distribution flow control	1 unit	1 unit
Procurement of equipment	Materials for water pipe connection	Clamp saddle, HDPE, Valves, Fittings etc. for re-connection (replaced pipe) 4,400 sets Clamp saddle, water meters for new connection (expansion pipe) 2,400 sets Water meters for new connection (existing pipe) 700 sets	Clamp saddle, HDPE, Valves, Fittings etc. for re-connection (replaced pipe) 4,700 sets[7] Clamp saddle, water meters for new connection (expansion pipe) 2,400 set Water meters for new connection (existing pipe) 700 sets
	HDPE connector	SF connector 5 units Portable engine generator 5 units	SF connector 5 units Portable engine generator 5 units
Soft component	Technical guidance on service connection (clamp saddle/connection of pipe) and proper turn-over inspection (water pressure/water flow)		Technical guidance on connection of pipe
	Technical guidance on system operation and usage of integrated data (leakage reduction/facility design/action plan)		Technical guidance on flow monitoring system

Source: Materials provided by JICA

The total replacement of the existing water distribution pipes and expansion of the new water

[7] Among the materials for service connection, materials for reconnection have increased by 300 sets at the time of implementation compared with planning. According to the consultant who was in charge of the design, this was due to delayed confirmation of the number of newly connectable households by the Cambodian side, and it was found after the tender at the time of contract signing that there was a shortage in the estimated number of connections in the design stage. Therefore the quantity was increased without changing the contract amount due to negotiation at the time of contract.

distribution pipes in three target provincial capitals amounts to 45.72 km for the replacement of the existing water distribution pipes (143.9% of the plan) and 76.927 km for the expansion of the new distribution pipes (82.6% of the plan). Therefore, this is a 2.25 km decrease from the total expansion planned. This is due to the fact that 1) a part of the distribution pipes had been serviced in a hurry by the water supply units and 2) there was a change in the route of the water distribution pipes in each province from the viewpoint of the project efficiency as a result of a careful examination of each pipe. The reasons for the changes are appropriate. It was decided through formal procedures and it is reasonable.
According to interviews with the executing agencies, inputs by Ministry of Industry and Handicrafts and by three target provinces in Cambodia were conducted as planned.

3.2.2 Project Inputs

3.2.2.1 Project Cost

Regarding the project cost, it was estimated at 2,760 million yen at the time of the plan, but the actual result was 1,645 million yen (59.6% of the plan). The reason why the project cost fell below the planned amount was due to the fact that the contracted price at the time of the tender for the contractor was much lower than planned. In addition to this, although it was confirmed that all the items to be borne by the Cambodian side were carried out as planned, it was difficult to confirm the actual project cost.

3.2.2.2 Project Period

Regarding the Project period, the Project was supposed to be completed within 28 months. Compared with the plan, the actual project period was also 28 months (100% of the plan).

As for the Outputs of the Project, as a result of detailed design, the actual total expansion for the replacement of existing distribution pipes and the expansion of new distribution pipes was slightly less than anticipated in the plan. Regarding the inputs of the Project, the project cost fell within the planned amount since the tender amount for the contractor was significantly less than anticipated in the plan. Regarding the project period, it was as planned.

From the above, both the project cost and project period fell within the planned value. Therefore, efficiency of the Project is high.

3.3 Effectiveness[8] (Rating: ③)

3.3.1 Quantitative Effects (Operation and Effect Indicators)

The level of achievement of two indicators (daily maximum water supply, population served)

[8] Sub-rating for Effectiveness is to be put with consideration of Impact.

set for measuring the quantitative effects of the Project in the three target provincial capitals is as follows[9].

Table 3 Indicators of quantitative effects in three target provinces

		Baseline	Target	Actual				Percentage of actual achieved against the target
		2009	2016	2013	2014	2015	2016	
		Planned Year	3 Years After Completion	Completion Year	1 Year After Completion	2 Years After Completion	3 Years After Completion	
Pursat	Daily maximum water supply (m^3/day)	3,410	5,760	5,065	5,880	5,905	6,864	119%
	Population served (person)	Approx. 18,200	Approx. 31,500	29,773	32,549	35,879	36,310	115%
Preah Sihanouk	Daily maximum water supply (m^3/day)	6,200	12,210	6,775	9,278	12,130	13,743	113%
	Population served (person)	Approx. 23,000	Approx. 48,200	44,184	53,032	61,600	68,404	142%
Battam-bang	Daily maximum water supply (m^3/day)	9,220	11,520	10,868	11,598	15,009	16,242	141%
	Population served (person)	Approx. 42,900	Approx. 56,400	60,507	60,835	67,374	71,255	126%

Source: Documents provided by JICA, Water supply units in Pursat, Preah Sihanouk and Battambang

In the three target provinces, both of the set indicators (daily maximum water supply, population served) for the quantitative effects have been achieved. However, in addition to the contribution of the Project, this is a composite result by provision of materials for water supply connection for the poor by UN-HABITAT (1,310 households, connection to 6,550 people) (in Pursat), JICA technical cooperation and self-help effort of the water supply units in three target provinces.

[9] However, since the water supply areas of the three target provincial capitals of the Project are expanding year by year, the object of comparison differs between 2009 and 2016.

3.3.2 Qualitative Effects (Other Effects)

The level of achievement is as follows on the set of indicators for measuring qualitative effects of the Project in the three target provinces.

(1) Leakage rate is improved.

Statistical data on water leakage rate and non-revenue water rate are not individually measured in the three target provinces. According to the results of interviews obtained from the water supply units of each province, non-revenue water is mostly caused by leakage. Therefore, the data of the non-revenue water rate is used and analysed in this section.

Table 4 Change of non-revenue water rate in water supply units of three target provinces[10]

	2011	2012	2013 (Project completion year)	2014	2015	2016
Pursat	21%	21%	16%	14%	11%	10%
Preah Sihanouk	22%	16%	17%	20%	13%	16%
Battambang	21%	21%	20%	15%	11%	10%

Source: Water supply units in Pursat, Preah Sihanouk and Battambang

At the water supply unit in Pursat, the non-revenue water rate, which was 20.8% in 2011, has been improved to 10% in 2016 by replacing the old water distribution pipes for new ones in the Project, and the leakage has been improved. On the other hand, leakages have occurred frequently since there are some parts where old steel pipes have still been used and there is water leakage due to damage to water distribution pipes during road expansion works, and so on.

According to the interview survey at the water supply unit in Preah Sihanouk, the non-revenue water rate, which was 22.2% in 2011, is changing repeatedly. The reasons mentioned from the water supply unit in Preah Sihanouk were that since Preah Sihanouk has many uphill and downhill areas the water supply pressure naturally increases due to gravity, and it was difficult to manage the water supply pressure well. If the pressure inside the water pipes became high, there was a possibility that it might cause water leakage. This leakage from the joints of water distribution pipes frequently occurred in some sections after the completion of the Project (2013-2015)[11]. The other reason was that there was a lot of damage to the water distribution pipes due to road construction (2016).

According to the interview with the water supply unit in Battambang, the non-revenue water

[10] Regarding the data on non-revenue water, it was checked with the official information that was approved by the Ministry of Industry and Handicrafts, which was created under the support of the Technical Cooperation Phase 3 and confirmed that there was no problem on the data.

[11] However, this is not connected to the data change of non-revenue water rate. The reason is unknown.

rate was 21.3% in 2011, but it decreased to 10% in 2016. Water leakage from the old water distribution pipes is decreasing due to the replacement. However, just as in Pursat, water leakage is occurring frequently due to damage to the water pipe at the time of road extension works.

(2) Shortage of water volume and water pressure from the faucet has improved by maintaining an appropriate water supply pressure in the water distribution pipe

In the Project, planned water pressure (minimum dynamic water pressure, urban area network: equivalent to 150kPa, suburban single main line: equivalent to 100kPa, maximum dynamic water pressure: equivalent to 600kPa in whole distributed area) was set at the time of the project planning. The information obtained from each water supply unit was as follows on the minimum dynamic water pressure and maximum dynamic water pressure at suburban level of three target provincial capitals.

Table 5 Minimum and maximum dynamic water pressure at suburban areas of three target provincial capitals

		2011	2012	2013 (Project completion year)	2014	2015	2016
Pursat	Minimum dynamic water pressure	150 kPa	150 kPa	150 kPa	120 kPa	100 kPa	100 kPa
	Maximum dynamic water pressure	200 kPa	200 kPa	200 kPa	150 kPa	150 kPa	150 kPa
Preah Sihanouk	Minimum dynamic water pressure	200kPa	200kPa	200kPa	200kPa	200kPa	200kPa
	Maximum dynamic water pressure	700kPa	700kPa	700kPa	700kPa	700kPa	700kPa
Battambang	Minimum dynamic water pressure	-	-	-	-	-	80 kPa
	Maximum dynamic water pressure	75 kPa	70 kPa	65 kPa	60 kPa	50 kPa	220 kPa [12]

Source: Water supply units in Pursat, Preah Sihanouk and Battambang

From the above, it can be observed that the minimum dynamic water pressure is almost as planned in the suburbs of the three target provincial capitals. Although Battambang recorded 80

[12] Since the new water treatment plant which was constructed with Japan's grant aid in 2016 went into operation, the maximum dynamic water pressure has increased greatly.

kPa in 2016, which is lower than the planned water pressure value, the water supply service was sustained without service problems even at the lower pressure than 50 kPa until 2015.

The maximum dynamic water pressure is lower than planned in Pursat and Battambang, and the one in Battambang is lower than the planned value of the minimum dynamic water pressure. However, the maximum dynamic water pressure is set to prevent damage due to high pressure and increase in water leakage.

According to interviews conducted at the water supply units in Pursat and Battambang, it was confirmed that the Project reduced the leakage from water distribution pipes, and water services were provided without problems in these provincial capitals. The reason why the maximum dynamic water pressure was lower than planned is due to increased leakage from water distribution pipes damaged by road construction, and the policy of Cambodia to expand the service areas of urban water supply by which the population served has exceeded the assumptions of the Project.

On the contrary, in Preah Sihanouk, the tendency of maximum dynamic water pressure exceeds the planned value has not changed before and after the project implementation, and there was originally no rack of water volume and pressure. This is the effect of the uphill and downhill sloping of the terrain. However, it is not desirable to exceed the planned value, and it is one of the factors for leakage occurring at the joints of pipes. However, since the maximum dynamic water pressure is thus high only in part of the areas, there has not been a major impact on the overall water supply operation and water supply service is properly provided in Preah Sihanouk.

3.4 Impacts

3.4.1 Intended Impacts

(1) Quantitative Effects

Implementation of the Project was indirectly expected to reduce the non-revenue water rate and to improve the operation rate of the water treatment plants. In addition, improvements to the efficiency of the operation of the water supply units in three target provinces were expected through improvement of business income and expenditure. Higher achievement levels for the two indicators (non-revenue water rate and the operation rate of water treatment plants) and reference indicators (energy efficiency for the water supply and water cost recovery) for measuring the operational efficiency were considered as indicative of expected effects in the preparatory survey report to confirm the impact of the Project in the three target provincial capitals. With regard to the information on the operation rate for each water treatment plant, the accomplishment of the target on the operation rate is handled as analysis material for “the improvement of operational efficiency” according to the purpose of the Project, and is not directly used for the evaluation judgement.

1) Pursat

The baseline, target and actual values of the quantitative effect indicators of the impact in Pursat are as follows.

Table 6 Quantitative effect indicators of the impact in Pursat

	Baseline	Target	Actual			
	2009	2016	2013	2014	2015	2016
	Planned Year	3 Years After Completion	Completion Year	1 Year After Completion	2 Years After Completion	3 Years After Completion
Non-revenue water rate[13]	23%	19-14%	16%	14%	11%	10%
Operation rate of Pursat water treatment plant	59%	100%	88%	102%	103%	95%
Energy efficiency for water supply[14]	Consumption of diesel 0.222 L/m^3	Consumption of diesel 0.199 L/m^3	Consumption of diesel 0.145 L/m^3	Consumption of diesel 0.169 L/m^3 Consumption of electricity 0.407kwh/m^3	Consumption of diesel 0.159 L/m^3 Consumption of electricity 0.434kwh/m^3	Consumption of diesel 0.152 L/m^3 Consumption of electricity 0.429kwh/m^3
Water cost recovery[15]	114%	127%	127%	143%	173%	181%

Source: Water supply unit in Pursat

Regarding Pursat, the non-revenue water rate target has been achieved for the indicator. According to the water supply unit in Pursat, it was mentioned in the interview that leakage accounts for the majority of the non-revenue water rate. Therefore, it is likely that the effect of the Project and the support provided by other donors etc. is considerable.

The operation rate of the water treatment plant has almost reached the indicator target. Though it reached 103%[16] in 2015, it decreased slightly in 2016. The reason was that additional pumps for water intake and water distribution were installed in 2015 with the independent efforts of the water supply unit in Pursat and the water treatment capacity was improved in

[13] The rate at which the water supply fee which is not able to be collected although it was distributed from the water treatment plant due to water leakage or stolen water.

[14] Energy efficiency for water supply = Diesel amount (or consumption of electricity) used for water supply ÷ amount of water supply (m^3)

[15] Water cost recovery = income from water supply ÷ expenses for water supply. Concerning the items for calculation, it follows from the calculation method of the preparatory survey report for before and after comparison.

[16] Operation rate of the water treatment plant in Pursat in 2015 exceeds 100%. This is set with a margin so that the numerical value of the daily water supply capacity of the water treatment plant, which is the denominator at the time of calculation, can be supplied with the target water quality. It does not mean that the water treatment plant cannot produce more treated water. Therefore, as a result of water supply beyond the daily water supply capacity of the water treatment plant, it may exceed 100%.

2016[17].

In addition, since the water cost recovery has improved significantly, it can be judged that the operation is more efficient at the water supply unit in Pursat as below.

It was expected that water leakage would be reduced as a result of the project implementation and the efficiency of the management of the water treatment plant would be improved. For this reason, an indicator related to energy efficiency for water supply was set as a reference value. In the case of Pursat, the generator had been used at the time of the ex-ante evaluation. Following this, public electricity has been used except at the time of a power cut at the time of the ex-post evaluation. Since there was no prior data for comparing energy efficiency for water supply related to electricity, this indicator is not included in the evaluation judgment.

Regarding the water cost recovery, it is significantly higher than the targeted value. The two contributing factors appear to be 1) an increase of water supply revenue due to an increase of customers and a decrease in water leakage and 2) a decrease of fuel costs due to switching from generator to electric power as an energy source for the pump, and material expenses such as chemicals.

2) Preah Sihanouk

The baseline, target and actual value of the quantitative effect indicators of the impact in Preah Sihanouk are as follows.

[17] The operation rate of the water treatment plant is calculated by the daily maximum water supply ÷ the daily water supply capacity of the water treatment plant. Therefore, the operation rate may decrease when the daily water supply capacity of the water treatment plant improves beyond the rate of increase of the daily maximum water supply.

Table 7: Quantitative effect indicators of the impact in Preah Sihanouk

	Baseline	Target	Actual			
	2009	2016	2013	2014	2015	2016
	Planned Year	3 Years After Completion	Completion Year	1 Year After Completion	2 Years After Completion	3 Year After Completion
Non-revenue water rate	19%	14-10%	17%	20%	13%	16%
Operation rate of Wat Loeu water treatment plant[18]	81% (ANCO: 0%)	100% (ANCO: 45%)	44% (ANCO: 34%)	38% (ANCO: 64%)	51% (ANCO: 41%)	20% (ANCO: 61%)
Energy efficiency for water supply	Consumption of electricity 0.704 kWh/m^3	Consumption of electricity 0.634 kWh/m^3	Consumption of electricity 1.100kWh/m^3	Consumption of electricity 0.815 kWh/m^3	Consumption of electricity 0.762 kWh/m^3	Consumption of electricity 1.008 kWh/m^3
Water cost recovery	153%	161%	131%	130%	141%	-

Source: Water supply unit in Preah Sihanouk

At the water supply unit in Preah Sihanouk, the indicator of the non-revenue water rate has not been achieved. According to the interview survey at the water supply unit, the reason is that water leakage has not decreased.

As for the operation rate of Wat Loeu water treatment plant in Preah Sihanouk, indicators have not been achieved. The water supply unit in Preah Sihanouk originally had bought a part of the water to be distributed from ANCO, which was a private company, and the purchased water was supposed to be around 45% of the maximum daily supply amount of 10,000 m^3/day which had been agreed in the memorandum of buying water with ANCO at the time of the ex-ante evaluation. However, at the time of the ex-post evaluation, 90% and above of the water supplied by the water supply unit in Preah Sihanouk is covered by the water that ANCO is treating and selling[19]. Water treated at the water treatment plant maintained by the water supply unit in Preah Sihanouk is used only in emergency where ANCO cannot supply water, and the operation rate of the water treatment plant is low.

In addition to this, as described below, the improvement in operational efficiency was limited in Preah Sihanouk.

As for the energy efficiency for the water supply in Preah Sihanouk, the target values of the

[18] (ANCO:%) is a percentage of purchased water from ANCO, against the maximum daily water supply amount for the province according to the Memorandum of Understanding. Maximum daily water supply from ANCO is calculated at 10,000 m^3/day until 2014, and at 20,000 m^3/day from 2015 when the water supply unit in Preah Sihanouk started purchase of treated water from ANCO year-round.

[19] As a factor to rely on purchasing the water from ANCO, the water in Prektob Lake which the water supply unit in Preah Sihanouk had used as a water source dried up during the drought in 2013, and ANCO increased the supply of treated water. In return, the water supply unit agreed to buy the water year-round.

indicator have not been achieved. The cause is considered that the volume of the treated water is small despite consuming the electric power necessary for operation since the facilities of the water treatment plant are continuously used.

As for the water cost recovery, the target values of the indicator have been almost achieved. In Preah Sihanouk, the reason for this is considered that the cost was expensive due to operating the water treatment plant despite purchasing most of the supplied water from outside.

3) Battambang

The baseline, target and actual values of the quantitative effect indicators of the impact in Battambang are as follows.

Table 8: Quantitative effect indicators of the impact in Battambang

	Baseline	Target	Actual			
	2009	2016	2013	2014	2015	2016
	Planned Year	3 Years After Completion	Completion Year	1 Year After Completion	2 Years After Completion	3 Year After Completion
Non-revenue water rate	36%	20-13%	20%	15%	11%	10%
Operation rate of water treatment plant	80%	100%	94%	100%	130%	88%
			Water treatment plant which is newly constructed with Japan's grant aid[20]			40%
Energy efficiency for water supply	Consumption of electricity 0.609 kWh/m^3	Consumption of electricity 0.453 kWh/m^3	Consumption of electricity 0.42 kWh/m^3	Consumption of electricity 0.43 kWh/m^3	Consumption of electricity 0.40 kWh/m^3	Consumption of electricity 0.41 kWh/m^3
Water cost recovery	149%	200%	130%	159%	178%	180%

Source: Water supply unit in Battambang

Regarding Battambang, the indicator of the non-revenue water rate has been achieved the target values. The large reduction in water leakage has contributed to a decrease in the non-revenue water rate.

The operation rate of the water treatment plant at the water supply unit in 2016 has not achieved its target value. However, this is because the water supply area is expanding in the provincial capitals (this is beyond the assumption at the planning stage), and the operation rate of existing facilities has been too high (the operation rate of the water treatment plant in 2015 was 130%). To solve this, Wat Loeb water treatment plant was constructed and new investments was carried out for a new water distribution pipe network by Japan's grant aid in 2016, 'the Project for Expansion of Water Supply System in Kampong Cham and Battambang' in

[20] New water treatment plant started to be used in 2016. However, at the time of the ex-post evaluation, the old water treatment plant was still partially used. As the water supply area is expected to expand in the future, it is expected that the operation rate of the new water treatment plant will also be increased gradually.

accordance with an increase in new connections, and currently, two water treatment plants are being operated simultaneously.

In addition to this, the energy efficiency for the water supply has reached the target indicator, and the water cost recovery target values have been mostly achieved (90%) and improvement of the operational efficiency at the water supply unit in Battambang is confirmed.

(2) Qualitative effects

1) Changes to life by supplying safe water to the poor[21]

In the Project, the necessary materials for new connections and reconnections to the water service were provided in order to provide a safe water supply to the poor, aiming to promote connection to water service for the poor by the water supply units in each province after the project completion.

At the water supply unit in Pursat, a new connection for 400 households and 700 reconnections has already been implemented using the provided materials.

The water supply unit in Preah Sihanouk conducted a new water supply connection to 600 households in 2014 and utilized all the materials provided.

At the water supply unit in Battambang, new connections to the water supply were established for 1,124 households by January 2017 by using the materials provided by the Project. With regard to Battambang, they have not used all the materials since they are strictly identifying the poor. By the end of 2017, additional new connections are anticipated to be established to 376 households by utilizing the remaining materials[22].

According to the beneficiary survey[23], respondents described the changes to living conditions when the poor were starting to use the new water service this way; “I can use the water when I want (there is no need to go to get the water at the well which is heavy work, I can use the water even at night with peace of mind and I can use the water without worrying when the water

[21] The World Bank defines the international poverty line as income of US$ 1.9 per a day. However, the project did not decide the definition of the poor. For this reason, there were differences in definitions, such as those who have the poor certificate at the water supply unit in Battambang, and those who are apparently considered to be poor such as widows and old people at the water supply unit in Pursat.

[22] Regarding new/reconnection materials for each province, there is no complete information on the connection record of the water supply units in three target provinces, and there is also no information how many materials were provided to each province. Therefore, the numbers in this section are not perfectly consistent with the number of materials provided.

[23] Surveyors were employed and a beneficiary survey was conducted. It was a questionnaire survey targeting clients who were at home at three or four villages or communes recommended by each water supply unit for the survey area (Pursat (Chamkar Check village, Sthany village, Porktakouy village, Chlong Kat village), Preah Sihanouk (Kompenh village, Metaphep commune, Tomnuk Rlork town) and Battamban (Dam Spei village, Chamkarsamrong village, Wat Leap village, Wat Romdul village) (70 households with valid responses (210 households in three provinces), and male-female ratio of the respondents was 39% of male and 61% of female, the age composition was 11% of 30 years old or less, 17.6% of 31 to 40 years old, 26.2% of 41 to 50 years old, 25% of 51 to 60 years old, and 20% of 61 years old or over.

sellers will come). This was the highest answer as 141 people out of 174 people (about 81%) from new customers answered so in the questionnaire survey. In addition, while there were some opinions that the quality of water from the sources such as well water and water sellers is bad (water colour and smell are bad), 120 respondents out of 174 (about 69%) stated that “water provided by the water supply unit is clean and safe and I can use it with confidence”. Regarding the economic aspect that expenditure was reduced due to reasonably available water, there were a few answers such as 46 respondents out of 174 (about 26%). The cause was that the main sources of obtaining water before the water supply connection was the well (33%) and rainwater (4%) in the dry season, and the well (24%) and the rainwater (34%) in the rainy season, and the proportion of free water was high. However, while the selling price of the water seller is two dollars (about 8,050 Riel)/m^3, the water fee of the water supply units in three target provincial capitals was 1,500 to 1,600 Riel/m^3. Therefore, it is considered that there was a positive economic impact for households who had previously purchased water from the water seller.

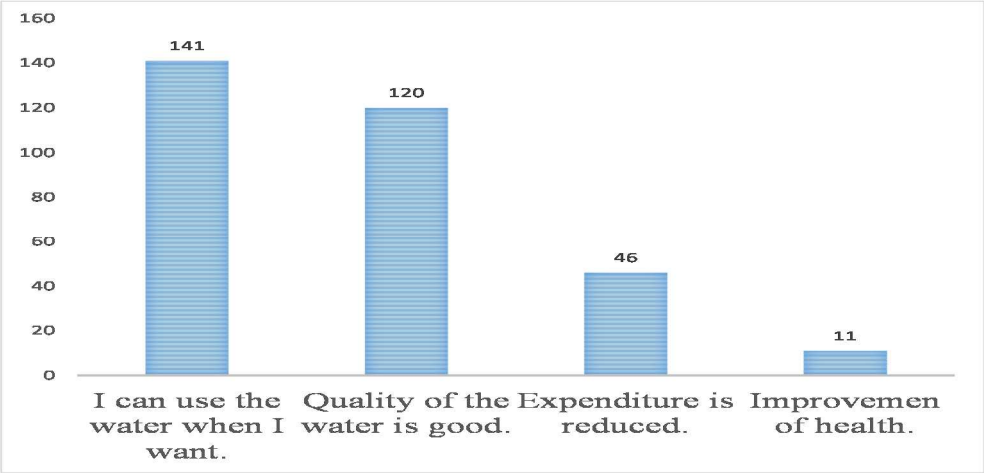


Figure 1 (Positive) impact after starting to use water service

Source: Beneficiary survey

3.4.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment, Land Acquisition and Resettlement

In the preparatory survey for the Project, it was assumed that the project would replace existing water distribution pipes and expand their reach, and that the Project would generally be affected only on these sites during construction work, and so the Environmental Impact Assessment Report Submission was not required. According to interviews with the executing agencies of the three target provinces, there was neither impact on the natural environment, nor land acquisition and resettlement during implementation of the Project.

(2) Synergistic effects through collaboration with other donors and other Projects by JICA

In the Project, synergistic effects with projects of other donors were expected. As stated in the effectiveness section above, materials were supplied for water supply connection to the poor by UN-HABITAT in Pursat. Although there was no direct linkage with this Project, synergistic effects were seen on the increase in population served by the water supply.

In addition, expansion of the capacities of water treatment plants were carried out in Battambang and Pursat by ADB in 2006 and in Preah Sihanouk by the World Bank in 2004. However, due to the aging of the water distribution pipes, the operation rate of these water treatment plants had been lowered. Therefore, the Project was planned. At the time of the ex-post evaluation survey, it was confirmed whether the operation rate of these water treatment plants had increased and whether there were synergistic effects with ADB or the World Bank projects. As a result, in Pursat and Battambang, since the water distribution pipes were replaced by the Project, it became possible to make use of the capacity of the water treatment plants, which were constructed but could not be fully utilized previously, to improve the operation rate of the water treatment plants, to increase population served by the water supply, and to obtain synergistic effects for spreading water supply services.

Unit: %

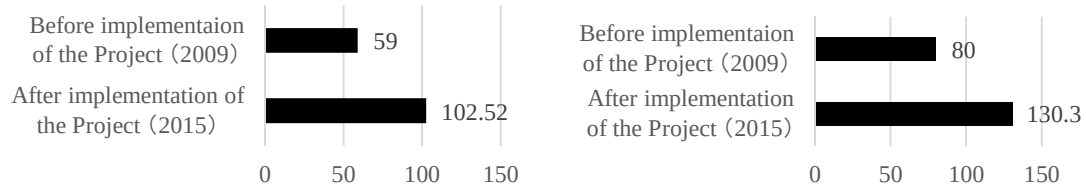


Figure 2 Change in the operation rate of water treatment plants before and after implementation of the Project in Pursat (Left) and Battambang (Right)[24]

Source: Water supply units in Pursat and Battambang

【Column】 Contribution of JICA technical cooperation projects

The target provincial capitals of the Project were included in the eight target provincial capitals of the Technical Cooperation Phase 2 (2007 - 2012). In the Technical Cooperation Phase 2, techniques were transferred for water quality testing, water treatment, electric facilities, machinery facilities and water distribution systems to the water supply units in each province to aim to improve the operation and maintenance aspects of the water treatment plants. In addition, Technical Cooperation Phase 3 was subsequently implemented after that to transfer techniques relating to the preparation of financial statements and business plan creation to aim

[24] In this figure, the data of 2015 was used as posterior data. The reason is that the water supply unit in Pursat has strengthened the capacities of the facilities since 2016, and a new water treatment plant has been constructed in the water supply unit in Battambang with Japan's grant aid in 2016. Therefore, the conditions of comparison may change if the data of 2016 is used.

to improve business operation aspects. In addition to the replacement and expansion of the water supply pipes by the Project, the techniques were transferred relating to the operation and maintenance of the water treatment plants by Technical Cooperation Phase 2, and the leakage rate was greatly reduced through implementation of the two projects compared to before the Project. Further, immediately after that, by supporting the growth of management capacities within Technical Cooperation Phase 3, a significant improvement in the operational management aspects was confirmed and the income and expenditure of all the water supply units targeted in the Project were found to be in the black. Therefore, since JICA implemented a series of technical cooperation projects which aimed to improve technologies related to the operation and maintenance of water treatment plants and management in parallel, with grant aid which aimed to replace and expand the water distribution pipe network in three target provincial capitals simultaneously, it led to the project generating higher effects.

In the Project, all indicators for the quantitative effects assumed and most indicators for the qualitative effects at the time of planning achieved the target values and the effectiveness is rated high. In addition, in regards to impact, indicators concerning the non-revenue water rate and operational efficiency were generally achieved except for Preah Sihanouk. Moreover, there are no other negative impacts caused by the Project. Therefore, the impact of the Project is considered high. However, these are largely due to synergistic effects with UN-HABITAT and the technical cooperation projects implemented by JICA.

Based on the above, this Project has almost achieved its objectives. Therefore, effectiveness and impact of the Project are high.

3.5 Sustainability (Rating: ③)

3.5.1 Institutional Aspects of Operation and Maintenance

At the time of the ex-post evaluation, the water supply administration in Cambodia is under the jurisdiction of the General Department of Water, the Ministry of Industry and Handicrafts. Concerning the provincial administration, it is supervised by the Department of Industry and Handicrafts, and each of the water supply units in provinces operates and maintains it under the subordinate level. The structure of the water supply unit in each province, which implements operation and management of the Project is shown below.

1) Assignment of staff at the water supply units in each province

The water supply unit in Pursat is operated by total of 37 staff (head of unit, deputy heads of unit, 15 technical staff and 19 administrative staff) in five sections, under the supervision of the head of unit, two deputy heads of unit for production/distribution network and business sections.

The water supply unit in Preah Sihanouk is operated by total of 69 staff (head of unit, deputy heads of unit, 36 technical staff, 28 administrative staff, head of Bureau of Industry and Handicrafts and a technical assistant) in five sections, under the supervision of the head of unit, two deputy heads of unit for production/distribution/administration and planning/finance/business section.

The water supply unit in Battambang, it is operated by total of 71 staff (head of unit, deputy heads of unit, 33 technical staff and 35 administrative staff) in five sections, under the supervision of the head of unit, two deputy heads of unit for finance/business and technical section.

2) Organization of the water supply units in the target provinces

The main duties at the water supply units in the three target provinces are a) operation of the water treatment plant, b) repair and expansion of the water distribution network, c) collection of water fee and related administrative works, and there has been no change in this attributed to the Project.

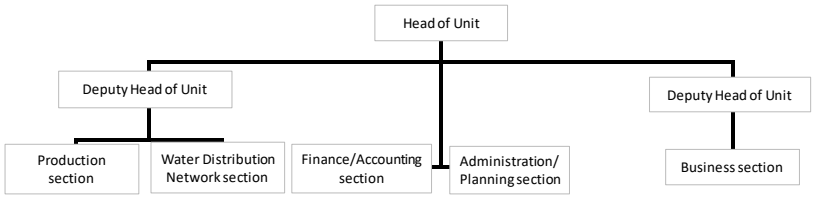


Figure 3 Organization chart of the water supply unit in Pursat
Source: Water supply unit in Pursat

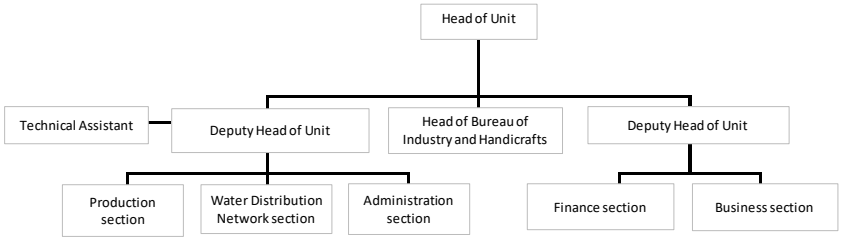


Figure 4 Organization chart of the water supply unit in Preah Sihanouk
Source: Water supply unit in Preah Sihanouk

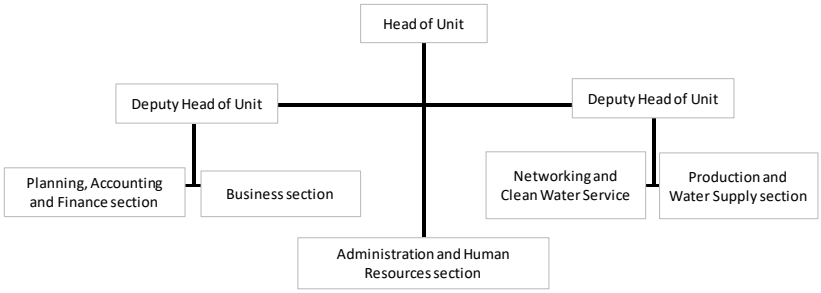


Figure 5 Organization chart of the water supply unit in Battambang
Source: Water supply unit in Battambang

As mentioned above, with regard to the organizational structure of the operation, maintenance and management of the water supply units in the three target provinces, the main functions such as the operation duties have not changed before and after the Project. Regarding the number of personnel, the number of staff in the water supply units, which could not be satisfied in all the provinces so far, has been increased by improving the financial situation, and the system is being strengthened. For example, it is possible to increase the number of staff if necessary in the future. In addition, the number of personnel at each water supply unit in the three target provinces is properly assigned exceeding the number of personnel required for operation and maintenance (37 persons in Pursat, 45 persons in Preah Sihanouk and 45 persons in Battambang) described in the preparatory survey report of the Project and these are appropriately assigned within a sufficient organizational structure.

3.5.2 Technical Aspects of Operation and Maintenance

In the water supply units at three target provinces covered by the Project, the water distribution network supported by the Project has been properly operated and maintained. In addition, each water supply unit in three target provinces has been a target organization for Technical Cooperation Phase 2 and Phase 3, and it is confirmed by the JICA experts in an interview survey that the techniques for the operation and maintenance are steadily improving through the technical transfer process. Therefore, there is sufficient technical capability for operation and maintenance of the water distribution pipe network in the future.

In addition, through a soft component and the technical cooperations mentioned above, all the water supply units in the three target provinces have acquired the techniques necessary for operation of a flow monitoring system which was installed at the water treatment plants by the Project.

3.5.3 Financial Aspects of Operation and Maintenance

The figures on income and expenditure for the past six years (five years for Preah Sihanouk)

obtained at the water supply units in the three target provinces are shown below.

Table 9 Financial balance of the water supply units in three target provinces

Unit: 1,000 Riel

		2011	2012	2013	2014	2015	2016[25]
Pursat	**Total income**	1,599,165	1,762,455	2,014,815	2,315,530	2,810,731	2,481,275
	Total expenditure	2,160,296	2,251,603	2,399,386	2,436,362	2,215,314	1,874,210
	Balance	-561,131	-489,148	-384,571	-120,832	595,417	607,065
Preah Sihanouk	**Total income**	4,119,574	4,869,233	5,106,951	7,002,431	9,313,869	-
	Total expenditure	4,262,176	5,006,152	4,886,424	6,277,435	7,807,019	-
	Balance	-142,602	-136,919	220,527	724,996	1,506,850	-
Battambang	**Total income**	3,900,834	4,018,751	4,249,205	4,989,858	6,078,446	5,646,202
	Total expenditure	4,642,158	4,448,204	4,484,717	4,566,733	4,972,066	4,798,438
	Balance	-741,324	-429,453	-235,512	423,125	1,106,380	847,764

Source: Water supply units in Pursat, Preah Sihanouk and Battamban

At the water supply units in three target provinces, the balance excluding depreciation expenses was surplus before the start of the Project. The income from water supply service has had tendency to increase after the Project due to increase in the population served by the water supply compared with 2012 at the water supply unit in Pursat. In addition to this, since the increase in expenditure has been suppressed after implementation of the Project, the balance including depreciation expenses has also achieved surplus from 2015.

At the water supply unit in Preah Sihanouk, the income from water supply services has increased due to an increase in the number of connections and an increase in the volume of water usage after the Project, the income from water supply in 2015 has almost doubled compared with 2012. From 2013, it has achieved surplus in the balance including depreciation expenses.

At the water supply unit in Battambang, the income from the water supply service has had tendency to increase subsequent to the project implementation due to an increase in the population served with the water supply compared with 2012. It has also achieved a surplus in the balance including depreciation expenses from 2014.

Thus, in the water supply units in three target provinces, a similar situation of a balance of income can continue if the distribution pipe network and the water treatment plants are operated

[25] For 2016, it is the data until September.

and maintained without any trouble in the future. Therefore, sustainability in terms of finance is high.

3.5.4 Current Status of Operation and Maintenance

The water distribution pipe network in the three target provinces supported by the Project was functioning without any problem at the time of ex-post evaluation. However, with regard to the water flow monitoring system[26], it has malfunctioned in Battambang and Preah Sihanouk. The cause of the failure has not been identified yet, and there is also no prospect of repairing it. However, since the water supply volume from the water treatment plants can be grasped also by the old system, and there is no immediate serious effect on the operation of the water supply units due to the failure of this system. Therefore, it is considered that the influence on the sustainability for entire operation and maintenance caused by the failures is relatively small.

Water flow monitoring system (Left) and the meters for measuring the volume of the supplied water (Right)

As mentioned above, no major problems have been observed in the institutional, technical, financial aspects and current status of the operation and maintenance system. Therefore, sustainability of the Project effects is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This Project aims to improve the water supply service by implementing replacement and expansion of existing water distribution systems in the target provincial capitals (Pursat, Preah Sihanouk and Battambang), thereby improving the operation aspects of the water supply business in each province through improving the rate of non-revenue water.

[26] The water flow monitoring system can grasp the situation of the water distribution pipe network by the meters which measure the water supply volume of several water distribution networks besides the water treatment plant since the information is collected from not only the water treatment plant but also from the water distribution pipe network. From now on, if the number of meters is increased, it becomes easier to identify the water leakage location from the difference in the water flow of each meter, and it is also possible to operate it more efficiently.

Cambodia’s policy to improve access to safe water in urban areas has not changed before and after implementation of the Project, and the Project is consistent with Cambodian development policy. In addition to this, the percentage of population served for water supply is lower than the national average in the three target provincial capitals of the Project and there is a continuous need to support the construction of urban water distribution systems in the three target provincial capitals. Furthermore, since the Project is consistent with Japan’s aid policy, the relevance is high.

In the Project, the total expansion of the replacement of existing distribution pipes and of new water distribution pipes was slightly less than anticipated in the project plan. However, the cost of the Project was significantly lower than planned, while the duration of the Project was as planned. Therefore the efficiency is considered high.

Due to synergy with the Project, projects implemented by other donors and other projects undertaken by JICA, the operation and effect indicators for effectiveness such as increase of the maximum daily water supply, the population served by the water supply and decrease of water leakage rate. Furthermore, indicators for impact such as reduction of non-revenue water rate and the improvement of operational efficiency have mostly been achieved. Therefore, the effectiveness and impact of the Project are considered high.

The operation and maintenance institution, technique and finance necessary for maintaining the effectiveness of the Project have been secured for the water supply units in the three target provinces, and they are able to properly manage the water distribution network at the time of ex-post evaluation. Therefore, the sustainability is considered high.

In light of the above, this Project is evaluated to be highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

1) Recovery of function of the water flow monitoring system

In the water supply units in Battambang and Preah Sihanouk, the procured water flow monitoring systems have failed and have not functioned. It would be very useful in the future to efficiently operate and manage the water supply business through utilization of this system, for grasping the volume of water supply in the target area and identifying the water leakage location easily by monitoring to the difference in the volume of the water supply. Therefore, it is recommended to recover its function as soon as possible in collaboration with the contractor.

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

(1) Importance of setting targets in implementation items by the counterpart country

In the Project, materials for household connection or reconnection to water distribution pipes were procured in order to steadily increase the number of water supply connections to poorer households. This was not planned to be implemented during the Project, but the water supply units of the three target provinces were responsible for the implementation of this goal after the completion of the Project. However, at the time of implementation, there was no definite advance agreement on the criteria for the accreditation of the poor household and the timing of completion of connection. As a result, the accreditation criteria of the poor are different in each province and the correspondence was mixed in each province at the time of the ex-post evaluation three years after the completion of the Project. While the water supply units in Pursat and Preah Sihanouk have used all the materials, the water supply unit in Battambang is strictly scrutinizing the accreditation process of the poor and has not used up the material yet. As a consequence, although it certainly has worked effectively as a measure to increase the number of households of the poor for water supply connection, the positioning of the procurement of this material became very ambiguous as an outcome of the Project. If the equipment is procured in the Project for activities to be carried out by an executing agency after the completion of the Project and if this will affect the Project effect such as in this case, the objectives such as the details and the period of implementation should be clarified for implementing these activities efficiently.