

Kingdom of Cambodia

FY2018 Ex-Post Evaluation of Japanese Grant Aid Project

"The Project for Flood Protection and Drainage Improvement in the Phnom Penh Capital City (Phase III)"

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## **0. Summary**

This project constructed new drainage pipes, repaired a sediment chamber, procured drainage system maintenance equipment, and provided technical assistance for the purpose of strengthening the maintenance system for drainage pipes, in order to improve drainage functions of rainfall and reduce inundation damage in the southeastern part of the Phnom Penh Capital City,<sup>1</sup> which is the capital of Cambodia. In the Phnom Penh Capital City, which is required to work on drainage improvement in line with the expansion of not only the central urban area but also the surrounding emerging areas, the development of drainage facilities for this project to improve drainage functions and reduce inundation damage is consistent with Cambodia's development policy, development needs and Japan's assistance policy, and thus its relevance is high. In terms of project implementation, the project cost was within the plan and the project period was as planned, so its efficiency is high. Regarding the project effects, the quantitative effects achieved the target indicators for both maximum inundation depth and maximum inundation duration. Qualitative effects were confirmed by interviews with surrounding residents, workers and hospital staff who answered that the project contributed to the improvement of the drainage function of rainfall and the reduction of inundation damage. Therefore, it can be judged that the effects of this project have been achieved. With regard to the impacts, this project has improved drainage function and reduced backflow of sewage, and it is believed by interviews with nearby residents, workers and hospital staff that this project contributes to the improvement of hygiene. In addition, it is considered that this project also contributes to the alleviation of congestion caused by inundation, considering that the traffic congestion duration at the time of inundation would have become further prolonged along with the increase in absolute traffic volume if this project had not been implemented. As a result, the project achieved its planned effects and its effectiveness and impacts are high. No major negative impacts on the natural environment have been reported, and no resettlement has occurred. The high water jet machine procured in this project are also regularly used for environmental cleaning activities on roads and parks inside and outside the project area,

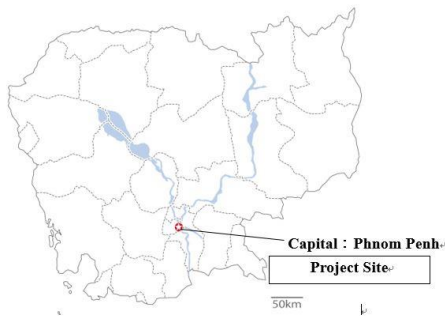
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<sup>1</sup> At the time of the contract of this project, since it was "Municipality of Phnom Penh," Phnom Penh "Shi" in Japanese was used as the name of Phnom Penh in the project title and contract documents. However, after the start of the survey, the Cambodian decree changed the notation of Phnom Penh in English to "Phnom Penh Capital City," and it is normal to use Phnom Penh "To" in Japanese. Based on the above history, in principal it is called Phnom Penh "Shi" in Japanese when showing the project title of this project, and Phnom Penh "To" is used in the contents of this report.

contributing to the beautification of the Phnom Penh Capital City. As for operation and maintenance, there are no problems with institutional/organizational and technical aspects, but there are problems with financial aspect and maintenance situation. Therefore, sustainability of the effects realized by this project is fair.

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

## 1. Project Description



Project Location Map



High Water Jet Machine

### 1.1. Background

In the Phnom Penh Capital City, the capital of Cambodia, inundation damage caused by torrential rain was frequent every year during the rainy season due to its topographical features, and urban areas had been protected from flood disasters, by the levee embankment in the city in case of floods (outside water) caused by rivers, as well as by drainage facilities (drainage pipes, pumps) in the case of rain (inland water) that has fallen into urban areas.<sup>2</sup> However, these flood prevention and drainage facilities in the city were significantly deteriorated due to the large number of facilities developed from the French colonial period to the 1960s, and did not function enough due to the devastating effects of the civil war in the 70s and 80s.<sup>3</sup> Furthermore, combined with the increase in runoff rainfall along with the progress of urbanization, inundation occurred in various places in the city even with about 20 mm daily rainfall that occurred about 20 times in the rainy season, and the inundation damage that the inundation depth reached approximately 20cm (the sidewalk, the knee level of a person) occurred approximately 10 times a year.<sup>4</sup> Flood damage and drainage problems caused serious problems for citizens' lives, such as economic damage caused by underfloor and inundation of houses, inundation of fresh market, traffic blocking, etc., and sanitation damage such as generation of offensive odor due to

<sup>2</sup> Information from the materials provided by JICA.

<sup>3</sup> Ibid.

<sup>4</sup> Ibid.

backflow of sewage, as well as caused traffic congestion, and thus the rapid improvement of drainage facilities was urgent and essential.<sup>5</sup> In order to implement comprehensive urban drainage and flood countermeasures against such flood risks, based on the "Study on Drainage Improvement and Flood Control in the Municipality of Phnom Penh" implemented by JICA in 1999, a *Master Plan* for urban drainage and flood countermeasures was formulated.<sup>6</sup> According to the *Master Plan*, "The Project for Flood Protection and Drainage Improvement in the Municipality of Phnom Penh (Phase I)" and "The Project for Flood Protection and Drainage Improvement in the Municipality of Phnom Penh (Phase II)" were implemented with grant aid, and this project is in Phase III. This project aims to improve drainage function of rainfall and reduce inundation damage in the project area by developing drainage facilities in the southeastern part of the city (Trabek Basin).

## 1.2 Project Outline

In the southeastern part (Trabek Basin) of the Phnom Penh Capital City of Cambodia, by constructing new drainage pipes, reconstructing a sediment chamber (storage tank), procuring drainage system maintenance equipment (sludge sucker, high water jet machine), and providing technical assistance aimed at strengthening the maintenance system of drainage pipes, this project aims to improve drainage function of rainfall and reduce inundation damage in the area, thereby contributing to alleviating traffic congestion and improving hygiene conditions in the target area.

Grant Limit/Actual Grant Amount	3,700 million yen/2,389 million yen
Exchange of Notes Date/Grant Agreement Date	March 2011/March 2011
Executing Agency	Department of Public Works and Transport (DPWT)
Project Completion	October 2015
Target Area	Phnom Penh Capital City, Trabek Basin
Main Contractors	Sumitomo Mitsui Construction Co., Ltd.
Main Consultants	JV of CTI Engineering International Co.,Ltd. and Nippon Koei Co.,Ltd.
Preparatory Survey	January 2010 - March, 2011
Related Projects	[Grand Aid] The Project for Flood Protection and Drainage

<sup>5</sup> Ibid.

<sup>6</sup> Ibid.

	<p>Improvement in the Municipality of Phnom Penh (Exchange of Notes Date: August 2002)</p> <p>The Project for Flood Protection and Drainage Improvement in the Municipality of Phnom Penh (Phase II)</p> <p>(Exchange of Notes Date: June 2007)</p> <p>[Technical Assistance]</p> <p>Project for Capacity Building of the Operation and Maintenance of Sewerage and Drainage System in Phnom Penh Capital City (2017-2020)</p>
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## 2. Outline of the Evaluation Study

### 2.1 External Evaluator

Masumi Shimamura/Ryoko Taguchi, Mitsubishi UFJ Research and Consulting Co., Ltd.

### 2.2 Duration of Evaluation Study

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

Duration of the Study: August 2018-September 2019

Duration of the Field Study: December 2-21, 2018

## 3. Results of the Evaluation (Overall Rating: A<sup>7</sup>)

### 3.1 Relevance (Rating: ③<sup>8</sup>)

#### 3.1.1 Consistency with the Development Plan of Cambodia

At the time of planning, the Cambodian government regarded water resource management as one of the priority development goals in *the National Strategic Development Plan* (2006-2013), and "rehabilitation and reconstruction of drainage and irrigation systems" and "development and application of flood and drought control measures" were clearly stated in *the Plan*. In addition, *the City Development Strategy* of the Phnom Penh Capital City set the goals of "urban development considering reduction of inundation damage" and "improvement of sanitation and environmental condition."

At the time of the ex-post evaluation, the government identifies "flood measures and urban infrastructure development" in *the Rectangular Strategy Phase III* (2013-2018) and *the National Strategic Development Plan* (2014-2018) that embodies the *Strategy* as the most

<sup>7</sup> A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

<sup>8</sup> ③: High, ②: Fair, ①: Low

important development area. Also, in *the Rectangular Strategy Phase IV* (2019-2023), it has been shown that disaster prevention and mitigation should be strengthened by stating that it is important to "preserve environmental sustainability and preventative measures against climate change," and reduce flood risk and ensure long-term water safety. In addition, the flood and drainage development plan in the Phnom Penh Capital City has been affected by rapid urbanization and land use changes, and inundation damages in areas not covered by *the 1999 Master Plan* have become apparent. Thus, it is expected that in line with *the Sewerage and Drainage Master Plan* revised in the "Study on Drainage and Sewerage Improvement Project in Phnom Penh Metropolitan Area" (2014-2016), which is JICA's development plan research type technical assistance, development for drainage facilities in the suburbs and emerging development areas will be carried out with the target year at 2035.

From the above, the importance of this project is not only in line with the development policy at the time of the project planning of the Cambodian government, but also in line with the important policy of the Cambodian government at the time of the ex-post evaluation.

### 3.1.2 Consistency with the Development Needs of Cambodia

At the time of planning, the Phnom Penh Capital City experienced frequent inundation by heavy rain every year during the rainy season due to its topographical features, and the existing flood prevention and drainage facilities were significantly deteriorated and did not function well because of the effects of civil war degradation. Flood damage and drainage problems caused serious problems for citizens' lives, such as economic damage caused by underfloor and inundation of houses, flooding of fresh market, traffic blocking, etc., and hygiene damage such as generation of offensive odor due to backflow of sewage, as well as caused traffic congestion, and thus the rapid improvement of drainage facilities was urgent and essential.

At the time of the ex-post evaluation, as shown in Table 1, the total drainage pipe distance in the Phnom Penh Capital City has been growing upward.

Table 1 Drainage Pipe Distance in the Phnom Penh Capital City

	2013	2014	2015	2016	2017
Total Drainage Pipe Distance (m)	477,479	515,762	633,435	732,312	787,260
Newly Constructed Drainage Pipe Distance (m)	7,634	38,284	117,673	98,877	54,948

Source: Results from questionnaire survey to executing agency (DPWT)

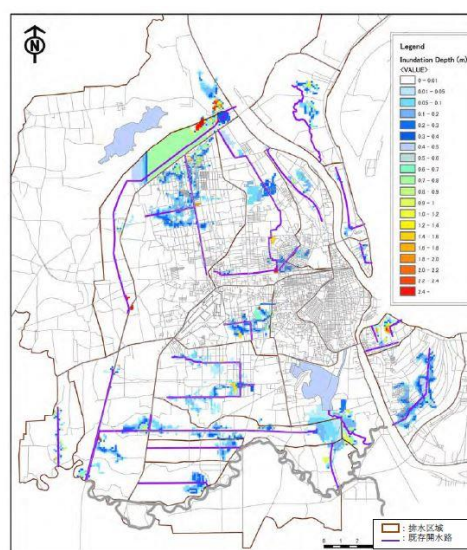
However, although the drainage plan in the central urban city (inside of the former inner ring wall<sup>9</sup>) has been developed in line with *the 1999 Master Plan* and the Japanese government has provided grant aids from Phases I to III, the project target areas do not cover the entire areas indicated by *the Master Plan* but they cover only the minimum major improvements urgently needed in the present situation. Therefore, significantly deteriorated drainage pipes still remain in the city, and mitigation of inundation damage in the city is still on the way. In addition, although urbanization has progressed significantly in the surrounding area of the central urban city (outside the former inner ring wall), drainage measures are not regarded as important, and sufficient drainage facilities may not be often developed, which has led to the problem of increasing inundation damage in recent years. In the city, it has been urgent to work on drainage improvement not only in the central urban city but also according to the expansion of new areas, and its development needs are higher than before.

From the above, this project is in line with the development needs of Cambodia at the time of planning and ex-post evaluation.

### 3.1.3 Consistency with Japan's ODA policy

At the time of project planning, the Japanese Government's *Country Assistance Plan for Cambodia* (2002) identified "realization of sustainable economic growth and stable society" as one of the priority issues, and stated the support for "social and economic infrastructure improvement as well as environmental improvement for economic promotion" as a specific assistance area. The plan mentioned that "because large-scale floods may occur in the Mekong River Basin, consideration should be given to infrastructure development that is resistant to disasters" and confirmed to promote the cooperation for flood prevention, and

Figure 1 Analysis Results of Inundation without Implementing the Drainage Improvement Measures Proposed in *the Revised Master Plan*



Source: Final Report of the Study on Drainage and Sewerage Improvement Project in Phnom Penh Metropolitan Area (December 2016)

<sup>9</sup> An embankment set up to surround a specific area to protect it from flooding.

thus this project is in line with the Japanese government's assistance policy.

From the above, this project has been 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 project constructed new drainage pipes, repaired a chamber (storage tank), procured drainage system maintenance equipment (sludge sucker, high water jet machine), and provided technical assistance as a capacity building program (soft component) for the purpose of strengthening the maintenance system for drainage pipes, in order to improve drainage functions of rainfall and reduce inundation damage in the project target area. Table 2 compares the planned and actual outputs of the main outputs.

Table 2 Comparison of Planned and Actual Outputs

Plan (2011)			Actual (2015)	
Project Items	Construction Area, Procured Equipment	Quantity	Quantity	
Drainage Improvement	(8 drainage districts) Drainage pipe laying	Ou Russei Area	3,926m	3,895m
		Boeng Reang Area	2,433m	2,428m
		Monireth Area	2,047m	2,045m
		Tuol Svay Prey Area	2,524m	2,499m
		Tuol Sleng Area	2,475m	1,978m
		Boeng Keng Kang Area	3,045m	3,040m
		Tuol Tumpung North Area	1,147m	1,161m
		Tuol Tumpung South Area	3,057m	3,086m
	Total Length of Drainage Pipes		20,654m	20,132m
Reconstruction of Sediment Chamber at R240	Sediment Chamber at R240	1	As planned	
Procurement of Drainage equipment for Drainage Pipes	High Water Jet Machine	2	4	
	Sludge Sucker	2	4	
Consulting Service/Capacity Building Program (Soft Component) Plan				
Project Items			Actual	
Detailed design			As planned	
Assistance in tendering			As planned	
Construction and procurement supervision			As planned	
Technical assistance to improve the operation and maintenance capacity of drainage facilities			As planned	

Source: Results from questionnaire survey to executing agency (DPWT)

In this project, changes in output occurred due to the shortening of the total length of

drainage pipes and the additional procurement of drainage system maintenance equipment. The results of interviews with the executing agency, Department of Public Works and Transport in the Phnom Penh Capital City (hereinafter referred to as "DPWT"), and the implementing consultant regarding these changes in output are as follows.

With regard to the fact that the total length of drainage pipes was reduced from 20,654m at the time of planning to 20,132m, this change was because inundation damage on the R163 street in the Tuol Sleng drainage area was severe, so before the start of construction of this project, the Ministry of Interior in Cambodia laid its own drainage pipes with an inner diameter of 1,500mm. A drainage pipe with a larger diameter than the one planned to be used at the initial plan was adopted, and after installation, it was confirmed that the situation of inundation damage was improved to the same level as the target indicator of this project, so a design change was made to cancel the installation of drainage pipes in the street by this project. As a result of this change, the project cost was reduced by approximately 40 million yen, but there were no impacts on the project period. Some other changes in distance were due to the connection with existing pipes and fine adjustment of the installation position of the manholes. It is judged that the above change in output was appropriate because it did not significantly change from the original plan but was a change necessary to realize the drainage function at the time of planning.

Furthermore, using the remaining fund generated by competitive bidding and scope reduction, 2 sets of each drainage system maintenance equipment (sludge sucker, high water jet machine) were additionally procured at the request of the Phnom Penh Capital City. This change was made because the fact was found after implementing the capacity building program (soft component) that it took four to five years for the 2 sets of maintenance equipment initially planned to clean the 120km of important drainage line desirable to be cleaned every year, which might lead to deterioration of the flow capacity of the drainage pipes. In order to solve this issue and realize the planned drainage function, it was necessary to clean at least the important pipe lines in a two-year cycle. For that, based on the formula of "120km of important drainage line = 15km of yearly cleaning distance per 1 set x 2-year cycle x 4 sets" cleaning equipment was procured twice as much as planned. It is judged as appropriate because the above additional output was not a major change but for implementing smoother cleaning activities and thus improving drainage functions. There was no extension of the project period for the procurement of this equipment.

According to the executing agency and the implementing consultant, environmental monitoring, which was a responsibility of the Cambodian government, was conducted regularly by visual inspection. As for inundation damage monitoring, DPWT requested that Khan (district) in the project area conducts the monitoring. However, due to the lack of



budgetary measures and establishment of sustainable implementation system, there is an urgent need for improvement of institutional establishment because the submission and accumulation of inundation damage data to DPWT are not properly conducted.



Monument (near the Sediment Chamber at the South of the Royal Palace)



Sediment Chamber at the South of the Royal Palace (Clearly stated as "From the People of Japan")



Sludge Sucker



High Water Jet Machine

### 3.2.2 Project Inputs

#### 3.2.2.1 Project Cost

While the planned total project cost was 3,710 million yen, the actual total project cost was 2,390 million yen, which was within the plan (64% of the plan). Of which, the Cambodian government disbursed 1 million yen. The fact that the amount of Japanese contribution was significantly below the plan was due to the price competition of multiple bidders and the scope reduction.

#### 3.2.2.2 Project Period

The plan for the implementation period of this project when the grant agreement was concluded was 54 months from March 2011 (conclusion of grant agreement) to August 2015 (in-service start), but a correction was made at the stage of subsequent detailed

design, and the Cambodian government and the implementing consultant signed an agreement that the plan for the project period at the time of the conclusion of the contractor's contract was 56 months from March 2011 (conclusion of grant agreement) to October 2015 (in-service start). Based on this, when confirmed with the relevant departments of JICA, it is explained that in the case of this project, there was no obligation for the counterpart government and JICA to prepare an agreement document concerning the change of project period,<sup>10</sup> and the project period agreed at the time of the contractor's contract is more realistic than the project period at the time of the grant agreement. Therefore, the planned project period was judged to be 56 months from March 2011 to October 2015.

The actual project period was 56 months including additional equipment procurement that was not originally planned, and it was as planned (100% of the plan).

Table 3 summarizes the comparison between the planned and actual project period.

Table 3 Comparison of Planned and Actual Project Period

	Planned Period	Actual Period
Overall	March 2011–October 2015 (56 months)	March 2011–October 2015 (56 months)
Detailed Design and Tendering Support	March 2011–December 2011 (10 months)	March 2011–December 2011 (10 months)
Construction	January 2012– October 2015 (46 months)	January 2012– October 2015 (46 months)

Source: Information provided by JICA

Note 1) Definition of project completion is in-service start. The project period does not include the collateral period in the both planned and actual.

From the above, the project cost was within the plan, and the project period was as planned. Therefore, its efficiency is high.

### 3.3 Effectiveness and Impacts<sup>11</sup> (Rating: ③)

#### 3.3.1 Effectiveness

##### 3.3.1.1 Quantitative Effects

This project aimed at disaster mitigation of reducing inundation damage based on the assumption that some damage may occur, rather than aiming to prevent the damage.<sup>12</sup> At

<sup>10</sup> However, with regard to cabinet-decided projects in and after November 2015, the counterpart government is obliged to report the changes from the design to JICA.

<sup>11</sup> Sub-rating for Effectiveness is to be put with consideration of Impacts.

<sup>12</sup> Based on the interview with JICA Cambodia Office.

the time of planning, the maximum inundation depth and the longest inundation duration were set as the quantitative effects of this project. Table 4 summarizes the reference values, target values, and actual values from 2015 to 2018 for each indicator. As the project completion was in October 2015, the target year for comparison is 2018, three years after the completion.

Table 4 Quantitative Effects of this Project

Indicators	Baseline	Target	Actual			
	2010	2018 3 Years After Completi on	2015 Completi on Year	2016 1 Year After Completi on	2017 2 Years After Completi on	2018 3 Years After Completi on
<b>Largest Flood Depth (cm)</b>	100	20 or less	20 or less	20 or less	20 or less	20 or less
<b>Longest Inundation Duration (hrs)</b>	7	2 or less	2 or less	2 or less	2 or less	1 or less

Source: Information provided by JICA and results from questionnaire survey to DPWT and DSO

Note 1) Set based on 2-year probability scale rainfall. The 2-year probability scale rainfall is calculated as rainfall of 44.8 mm per hour and rainfall of 87.8 mm per day.<sup>13</sup>

Note 2) Each indicator was measured at 15 inundation damage survey fixed observation points.

As described above, for each indicator, actual values were obtained from DPWT indicating that the target values were achieved each year. According to interviews with the Drainage and Sewage Office (hereinafter referred to as "DSO") responsible for operation and maintenance work under DPWT, in particular, after the renovation of the Trabek pumping station, which is located in the south of the project area and functions as the final drainage point for rainwater, was completed at the beginning of 2018, the drainage capacity has been improved from 8m<sup>3</sup> per second to 23m<sup>3</sup> per second. However, although inundation damage monitoring has been carried out at the 15 inundation damage survey fixed observation points where a person in charge designated by Khan (district) which receives instructions from the DPWT measures inundation depth and inundation duration, a report to DPWT has been conducted orally and the data has not been properly recorded and stored. Although it is a problem that the records are not properly stored, DPWT receives reports on an oral basis, and the DSO chief who resides in the Phase III

<sup>13</sup> "Preparatory survey report on the project for flood protection and drainage improvement in the Phnom Penh Capital City (Phase III) in the Kingdom of Cambodia" (March 2011)  
[http://open\\_jicareport.jica.go.jp/617/617/617\\_109\\_12025086.html](http://open_jicareport.jica.go.jp/617/617/617_109_12025086.html) (Accessed on November 2, 2018)

target area conducts the inundation damage monitoring confirmed that the target values have met at the time of ex-post evaluation. From this, it is judged that the actual values obtained from the executing agency are credible as effective data for evaluation judgment.

Furthermore, as supportive evidence for the actual values obtained from the executing agency, a similar opinion<sup>14</sup> was obtained from the CTI Engineering International Co.,Ltd, an implementing consultant. In addition, according to the inundation damage survey<sup>15</sup> conducted in 2016 for 106 households in the Phase III target area, approximately 79% (84 out of 106 households) realized that the inundation depth decreased and the inundation duration shortened compared to before the project, and approximately 61% (65 out of 106 households) answered that the maximum inundation depth was 20cm or less, and approximately 76% (80 out of 106 households) answered that the maximum inundation duration was within 2 hours. In addition, from the interview results (described later) with the beneficiaries (residents, workers and hospital staff, total 20) which were carried out at the time of the ex-post evaluation, by developing the drainage facilities by this project, drainage function of rainfall has been improved and inundation damage has been reduced in the area, and thus 17 of 20 people answered that the maximum inundation depth is 20cm or less, and 16 of 20 people answered that the maximum inundation duration is within 2 hours at the time of ex-post evaluation.

From the above, each indicator obtained from DPWT and other data prove that the target values were achieved.

### 3.3.1.2 Qualitative Effects (Other Effects)

As a qualitative effect of this project, it was planned to realize the improvement of drainage function of rainfall and reduction of inundation damage.

According to the interviews with DPWT and DSO, the project constructed 1,023m of large drainage pipes with a diameter of 2m, which had never been installed before, especially in the project area where the inundation damage was severe, and also adopted the box culvert<sup>16</sup> to connect the existing drainage pipes with the newly installed drainage

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<sup>14</sup> Inundation damage monitoring is a responsibility of the Cambodian side, and after the project was completed, the implementing consultant has no obligation to measure the data of operation and effect indicators. Thus, based on the information obtained by the implementing consultant who voluntarily interviewed to DPWT staff and residents, it was answered that the target values of the operation and effect indicators have been achieved.

<sup>15</sup> It was conducted as a part of "Preparatory survey report on the project for flood protection and drainage improvement in Phnom Penh (phase IV) in the Kingdom of Cambodia" (January 2017) [http://libopac.jica.go.jp/images/report/12270807\\_01.pdf](http://libopac.jica.go.jp/images/report/12270807_01.pdf) (Accessed on February 15, 2019)

<sup>16</sup> It is a box-shaped structure buried in the ground and plays the role of a pipe for draining sewage and rainwater. In this project, new drainage pipes were buried in parallel with the existing drainage pipes, and both drainage pipes were joined by box culverts, so that rainwater is drained to both drainage pipes.

pipes in this project, which made it possible to drain by utilizing the existing drainage pipes. Thus, they explained that the drainage function of rainfall has been improved compared to before the project implementation. In addition, as for inundation damage reduction effect, according to DPWT and DSO, in Cambodia where rainwater and sewage are joined and drainage pipes also function as sewer pipes, the improvement of the drainage function of rainfall made it possible to mitigate backflow of sewage to the road, leading to reducing odor.

In addition, according to the interviews<sup>17</sup> with nearby residents, workers and hospital staff (beneficiaries of the project who live or work along the roads where the drainage pipes were installed or near the chamber) conducted at the time of the project site survey, 18 out of 20 people pointed out that this project has contributed to the improvement of drainage function of rainfall and the reduction of inundation damage in the project area. The respondents commented as follows.

- Restaurant owner: Before the project, rainfall infiltrated into the restaurant and the floor was flooded 10cm above, and when it was flooded, water would not be drained for 2 days, so the restaurant had to be closed all that time. After the implementation, a heavy rain fell in September 2017, but there was no damage on the floor and after a couple of hours we were able to resume business.
- Hospital director: There was an offensive odor while being flooded before the project implementation, but after the implementation, the backflow of the sewage has been suppressed, and the odor does not matter even after being soaked or dried.
- Slum resident: The inundation depth before the project was about 1m where water was rushing to the height of the bed at home, and furniture and luggage got wet. The inundation depth after the implementation is about 10 to 20cm, and there is no inundation on the floor.

Therefore, it is considered that this project contributes to the improvement of drainage function of rainfall and the reduction of inundation damage.

### 3.3.2 Impacts

#### 3.3.2.1 Intended Impacts

In this project, (1) improvement of hygiene and (2) mitigation of traffic congestion were expected as impacts. The status of these impacts is as follows.

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<sup>17</sup> The breakdown of the interview targets is 11 males (1 in 20s, 6 in 40s, 3 in 50s, 1 in 60s) and 9 females (1 in 30s, 4 in 40s, 1 in 50s, 1 in 60s, 1 in 70s, 1 in 80s), and a total of 20 people. Their occupations include village chiefs, elementary and junior high school teachers, restaurant owner, cosmetologist, street clothes seller, security guard, cake shop, household goods dealer, housewife, slum residence, etc.

(1) Improvement of hygiene

Table 5 shows the number of patients visiting the referral hospital<sup>18</sup> located in the Phase III target area after the occurrence of floods in the rainy season. Compared with before and after the project implementation, the number of patients complaining of skin disease, cold and diarrhea is decreasing and although there is a limit in showing a clear causality, it is considered that the improvement of drainage function by this project has contributed to the improvement of hygiene to some extent.

Table 5 Patient Data of the Referral Hospital Located within Phase III Target Area

	Before the Project Implementation (2010)	After the Project Implementation (2016)
Skin Disease	60~70 people	2 people
Cold	450 people	20 people
Diarrhea	40 people	0

Source: Data provided by DPWT

Note 1) All patients data were based on the number of patients who visited the Phsar Doem Thkav Health Center, which is located in the Tuol Tumpung North Drainage Area in Phase III, during 2-3 months after the occurrence of floods during the rainy season.

According to the interview survey with DPWT and DSO, by installing a wide-diameter drainage pipes while utilizing the existing drainage pipes at the same time by this project, they answered that drainage capacity has been improved, backflow of sewage has been suppressed, offensive odor has been reduced and sewage sludge lumps left on the road have been decreased. In addition to reducing backflow of sewage, it was also said that the drastic reduction of inundation duration seems to contribute to the reduction of number of people who complain of symptoms of dermatitis, cold, eye pain and diarrhea. Furthermore, it was believed that the reduction of inundation duration has helped to ease the traffic blocking and traffic congestion on detours caused by inundation, making it easier for patients and ambulances to access hospitals.

As a result of the interviews<sup>19</sup> with the nearby residents, workers and hospital staff conducted at the time of the project site survey, it was confirmed that 18 out of 20 people answered that this project has contributed to the improvement of hygiene. Respondents commented on the following health improvement effects.

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<sup>18</sup> It is medical institution which performs the function of introducing and transporting patients to higher-order medical institutions when medical facilities such as local primary hospitals require more advanced medical practices that cannot be treated, or when patients with severe cases or non-specialties are suspected.

<sup>19</sup> The interviewees are the same 20 listed in footnote 17.

- Primary school principal: Before the project implementation, after it stopped raining and water was drained, there were students who got dirty powder of sewage left on the road into their eyes causing inflammation or caught a cold. However, after the project was implemented with the reduction of inundation damage, there is no dust left because backflow of sewage is suppressed, and the number of students who complain of these symptoms has decreased.
- Restaurant owner: It was flooded for 2 days before the project, and every time I walked in it, I felt itching on my feet, but now I feel itching less because the inundation duration has been shortened to about 30 minutes.
- Medical students: With the installation of drainage pipes, the roads above were paved with asphalt and became dust-free, and thus it became unnecessary to wear masks when riding a bike.

In addition, hospital staff also mentioned the effect of improving access to the medical services as follows.

- Hospital director: Before the project implementation, it used to be flooded for 3 days and during this time patients could not come to the hospital, but after the project implementation it has become easy for patients to come to the hospital because water is drained in 2 hours.
- Pharmacist: In the past, it was flooded for a full day and there were no customers coming in, but after the project was implemented it takes 1 hour to drain water, so customers can return faster, and medical services can be provided faster than before.

## (2) Mitigation of traffic congestion

From the interviews with DPWT and DSO, it was confirmed that the following effects for mitigating congestion and reducing traffic accidents during inundation were realized. By implementing this project, the inundation duration is shortened, which has led to reducing traffic interruption and congestion caused by inundation, and even after rainfall, it becomes possible to commute to work or school in a shorter time than before the project implementation. As a secondary effect, there were answers that the unevenness of the road on the pipes was paved with the drainage pipes installed, which has led to the reduction of accidents. As inundation depth is decreased, it was answered that the braking function of motorcycles and vehicles works normally even during inundation and the collision accident is decreased.

According to DPWT and DSO, it was pointed out that traffic congestion is intensifying as the number of vehicles and motorcycles has increased enormously compared to before,

along with the rise of population in the Phnom Penh Capital City. On the other hand, bearing in mind that if this project had not been implemented, the traffic congestion time during inundation would have been further prolonged in conjunction with the absolute increase in traffic volumes, it is considered that this project, which works for the reduction of inundation depth and shortening of inundation duration, contributes to the alleviation of congestion caused by inundation.

In addition, as a result of interviews<sup>20</sup> with nearby residents, workers and hospital staff conducted at the project site survey, it was confirmed that 17 out of 20 people answered that this project has contributed to the alleviation of traffic congestion during inundation. Specific answers are as follows. The effects of reducing traffic accidents and improving driving comfort for road users were also mentioned.

- Senior high school deputy principal: Before the project implementation, there were students who were late for school for 1 to 2 hours, and the school carried out shortened classes or replacement classes. But after the project implementation, the inundation duration is drastically shortened from 2-3 days to approximately 15 minutes, and thus students can come to school after being late for about 15 minutes.
- Medical students: Around the roundabout,<sup>21</sup> before the project implementation, water did not drain for 1 to 2 days when inundated, and vehicles and bikes run at a reduced speed, causing traffic congestion. But after the project implementation the inundation duration has become half a day, and thus once water is drained, the traffic congestion is resolved.
- Restaurant owner: The roads were uneven, and it was flooded for several days before the project implementation, so I often saw bikes that fell into pits and fell over, but as the road was paved flat by the project, I have not seen a fall accident.
- Village mayor Before the project implementation, the inundation depth was so high that it was flooded on the floor and inundated for 3 to 5 hours, so I saw that vehicles and motorcycles with engine stopped on the road were stuck. But after the project, engine trouble has become less because water is drained in 20 to 30 minutes.
- Slum resident: The project paved road with concrete and made it easier to drive on the roads.

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<sup>20</sup> The interviewees are the same 20 listed in footnote 17.

<sup>21</sup> A type of intersection where three or more roads are connected via a circular space.



### 3.3.2.2 Other Positive and Negative Impacts

#### (1) Impacts on Natural Environment

This project does not fall under easily-affecting sectors/characteristics and vulnerable areas listed in the "JICA Guidelines for Confirmation of Environmental and Social Considerations" (promulgated in April 2010). As it is judged that the undesirable effects on the environment are not serious, this project was classified as Category B

According to DPWT, the contractor constantly and visually carried out environmental monitoring (noise, vibration, dust, accidents, etc.) during the construction period, DPWT carried out regular monitoring once a month with the implementing consultant, contractor and client (the Phnom Penh Capital City), and during the construction, the mitigation measures described in the Initial Environmental Examination were properly implemented. In addition, when confirmed with DPWT, mitigation measures were taken such as thorough publicity of construction sections and detours as measures against traffic congestion. Some residents complained about dust/dirt and road blockade, but measures were taken to prevent dust/dirt by water spraying, accelerate the construction period, immediately pave the asphalt, and shorten the road blockade period. In addition, DPWT held briefing sessions on the project with surrounding residents and acted to seek an understanding of the construction, and no complaints have been confirmed since then. No particular negative environmental impacts have been reported at the time of ex-post evaluation. When interviewed with the local residents at the time of site inspection, it was confirmed that proper measures were taken against the negative impacts on the natural environment during and after construction. From the above, it is considered that there were no large negative impacts on the natural environment.

#### (2) Resettlement/Land Acquisition

Resettlement and land acquisition did not take place in the implementation of this project.

#### (3) Other impacts

According to interviews with DSO and the Kitakyushu City official (as described later, Kitakyushu City is currently implementing the JICA Partnership Program "Project for Capacity Building of the Operation and Maintenance of Sewerage and Drainage System in Phnom Penh Capital City" (2017-2020)), DSO regularly carries out environmental cleanup activities on roads and parks inside and outside the Phase III target area by using high water jet machines procured in this project. Therefore, it is considered that this project also contributes to the beautification of the Phnom Penh Capital City.

From the above, this project has largely achieved its planned objectives and thus its effectiveness and impacts are high.

### 3.4 Sustainability (Rating: ②)

#### 3.4.1 Institutional/Organizational Aspect of Operation and Maintenance

Operation and maintenance of the drainage pipes, chamber and cleaning equipment after the project completion are implemented by DSO under DPWT. Based on the maintenance plan, DSO carries out on-site work and constantly reports on the work progress to DPWT. In addition, Road and Bridge Division (hereinafter referred to as "RBD") is in charge of road repair including Phase III target area, and if necessary, reports the situation to the Governor of the Phnom Penh Capital City through DPWT, and the City consigns to a private company to repair it at the discretion of the governor. DSO and RBD are in constant communication with the overseeing DPWT, and a close collaboration has been established. With regard to securing the budget for operation and maintenance costs and hiring staff, an application has been submitted from DSO to DPWT, and after receiving approval from the Phnom Penh Capital City and related ministries, DPWT carries out budget allocation, personnel recruitment/placement. The decision-making process is clear and not a problem.

At the time of the ex-post evaluation, DSO has 26 technical supervisory staff and 171 fixed-term staff (cleaners, drivers, etc.). Three cleaning groups (total of 30 people) are in charge of operation and maintenance of the drainage facilities and cleaning equipment in the Phase III target area. Each group is composed of 1 to 2 technical staff who supervise the work and 7 to 10 fixed-term employees who operate the cleaning equipment and conduct cleanup activities. DSO's technical staff formulates a maintenance plan under the supervision of DPWT and supervises fixed-term staff who carry out actual cleaning work according to the plan. DSO writes the work progress and reports to DPWT regularly, and there is a system that DPWT confirms whether there is no problem. Therefore, there is no problem in organizational aspect.

Depending on its technical expertise, DPWT implements public works by dividing into 15 departments such as DSO in charge of operation and maintenance of drainage facilities, RBD in charge of maintenance of roads and bridges, and parks administration department, vehicle registration department, etc. Although DSO and RBD are responsible for the maintenance of this project, their roles and work contents are different from the institutional and technical point of view and do not overlap. DPWT is responsible for the maintenance of this project.

From the above, no particular problems can be identified in the institutional/organizational aspects of operation and maintenance.

### 3.4.2 Technical Aspect of Operation and Maintenance

The DSO's technical staff who direct operation and maintenance of drainage facilities have engineering expertise, and there are many skilled workers among fixed-term employees who have several decades of work experience, and DSO has accumulated sufficient skills and experience for operation and



Veteran and Young DSO Staff

maintenance of drainage facilities. In addition, an environment has been developed where technical staff who have passed their retirement age can continue to work as fixed-term employees, and technique and know-how have been transferred from veteran staff to young staff. The technical level is considered to be sufficient for normal maintenance work.

In the capacity building program (soft component) of this project (technical assistance to improve the operation and maintenance capacity for drainage facilities), to the technical staff of DSO, the implementing consultant carried out the technology transfer regarding the formulation and implementation of the maintenance plan which incorporates the PDCA cycle,<sup>22</sup> and the manufacturer of the cleaning equipment transferred the technique concerning the maintenance method of the cleaning equipment. Even after the completion of technology transfer, the contents of training and guidance are shared and used within DSO, including newly hired employees and staff from other departments (such as staff in charge of operation and maintenance of pumping stations).

In addition, through the JICA Partnership Program "Project for Capacity Building of the Operation and Maintenance of Sewerage and Drainage System in Phnom Penh Capital City" (2017-2020) by the Kitakyushu City mentioned above, inspection of drainage pipes and cleaning instruction by using cleaning equipment are conducted to DSO staff, leading to the further establishment of operation and maintenance know-how.

The drainage facilities developed in this project have been operating without problems after the commencement of operation. Operation and maintenance, and periodic inspections are conducted according to the maintenance manual for cleaning equipment developed by the capacity building program (soft component) as well as the maintenance and inspection manual prepared by the implementing consultant. The manuals have been updated as necessary.

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<sup>22</sup> One of the methods for performing efficient work by repeating Plan(plan), Do (execution), Check (evaluation) and Action (improvement).

The implementation of the capacity building program (soft component) enabled to create a cleaning maintenance plan which covers the drainage facilities not only in the target area of Phase III but also in the target areas of Phase I and II, as well as the existing drainage pipes installed by the Phnom Penh Capital City inside and outside the target areas of Phase I to III. Basic skills to formulate a budget plan based on the cleaning and maintenance plan has been trained. In addition, the cleaning equipment (high water jet machine and sludge sucker) procured in this project are utilized for cleaning/maintenance for drainage facilities not only in Phase III but also Phase II, and existing drainage pipes inside and outside the target areas of Phase I to III, thereby contributing to the integrated drainage improvement in the Phnom Penh Capital City beyond the project area.

From the above, it is considered that there are no particular problems in the technical aspect, from the perspective of the DSO's organizational structure and the good operating condition of the drainage facilities at the time of ex-post evaluation.

#### 3.4.3 Financial Aspect of Operation and Maintenance

With regards to the operation and maintenance costs including the drainage facilities in Phase III, a budget proposal is submitted to DPWT based on the annual cleaning plan formulated by DSO, and DPWT submits it to the Governor of the Phnom Penh Capital City to be reviewed. The Phnom Penh Capital City allocates a portion of the amount equivalent to 10% of water bill to finance the maintenance of drainage facilities, and if additional expenditure is required for a special reason, the budget allocation is made from the Ministry of Economy and Finance (hereinafter referred to as "MEF") and the City allocates a separate budget. The City decides the budget allocation to DPWT among the financial resources, and the budget is allocated from DPWT to DSO. In addition, the budget from the Phnom Penh Capital City is also allocated to not only DSO which manages the drainage stations and main drainage pipes in the city, but also Khan (district) which manages small-scale drainage facilities as well as contractors who have contracts for electricity and cleaning and maintenance.

Table 6 below shows the recent budget application amount and actual expenditure amount (the actual expenditure amount and budget allocation amount are the same) related to the operation and maintenance of drainage facilities (including Phase III project) in the Phnom Penh Capital City covered by DSO. In any of the items, the actual expenditure amount (budget allocation amount) is significantly lower than the application amount, budget approval necessary for drainage pipe cleaning and repair work has not come from the Phnom Penh Capital City, and planned operation and maintenance cannot be implemented. Looking at the budget for drainage pipe cleaning costs, about 80% of the application amount was

allocated and executed in 2013, but less than 10% in 2014 and about 30% in 2015 and 2017. Furthermore, due to the lack of budget, DSO irregularly carries out symptomatic cleaning of drainage pipes as needed, such as by instructions from the Phnom Penh Capital City and requests from residents, and the expenses for these tasks are paid by the City each time. On the other hand, when confirmed to DSO, budget is applied for next fiscal year if the drainage facilities could not be cleaned due to lack of budget for this fiscal year. .

Table 6 Application and Actual Expenditure Amount for Operation and Maintenance of Drainage Facilities in Phnom Penh Capital City  
covered by DSO (including the Portion of this Project)

(Unit: Thousand riel)

Items	2013			2014			2015			2017		
	Application Amount (A)	Actual Expenditure Amount (B)	(B)/(A)	Application Amount (A)	Actual Expenditure Amount (B)	(B)/(A)	Application Amount (A)	Actual Expenditure Amount (B)	(B)/(A)	Application Amount (A)	Actual Expenditure Amount (B)	(B)/(A)
Cleaning drainage pipe and manhole	600,250	496,170	0.83	6,935,750	390,090	0.06	471,000	152,000	0.32	651,137	220,000	0.34
Repairing drainage pipe and manhole, cover	5,740,000	248,100	0.04	1,340,000	222,500	0.17	0	237,000	0	1,400,000	110,000	0.08
Maintenance and repairing on pumping station	10,975,000	262,000	0.02	8,800,000	255,946	0.03	14,275,800	230,000	0.02	13,935,000	70,000	0.01
Cleaning Main Channel	5,640,000	170,000	0.03	5,640,000	882,000	0.16	16,200,000	247,000	0.02	16,395,000	257,590	0.02
Installation of new drainage pipe, manhole, cover	3,825,000	2,525,979	0.66	3,541,711	2,959,377	0.84	46,708,568	3,622,780	0.08	71,846,044	24,000	0.00
Total	26,780,250	3,702,249	0.14	26,257,461	4,709,913	0.18	77,655,368	4,488,780	0.06	104,227,181	681,590	0.01

Source: Results from questionnaire survey to DPWT and DSO, and documents provided by DSO

Note 1) Actual expenditure and budget allocation are the same.

Note 2) Data in 2016 is omitted from the table because the application amount is unknown.

Note 3) Personnel expenses of DSO staff are covered by the budget of Ministry of Public Works and Transport (MPWT), not by the Phnom Penh Capital City and are not included in the table.

Note 4) Installation of new drainage pipe and manhole is a new investment budget so it cannot be strictly identified as an operation and maintenance cost. But by making a new investment in drainage pipes, the drainage capacity from the existing pipes to the pumping stations is enhanced, and it contributes to the good operation of the entire drainage facilities, and thus it is left in the table.

Note 5) (B)/(A) shows the ratio of the actual expenditure to the application amount.

Regarding the reason why there is no allocation from the Phnom Penh Capital City as requested by DSO based on the annual cleaning plan, when confirmed to DSO, there is an answer that it seems not possible to approve all the application amount due to the limited budget of the City. In fact, table 7 shows the supporting data for the reason. According to this, the amount of drainage related expenditure in the Phnom Penh Capital City has been significantly higher than the amount equivalent to 10% of water bill which is the main financial source since 2015, and the excess is considered to be covered by additional budget allocation from MEF.<sup>23</sup> Since 2015, expenditures especially for drainage pipe repair/new construction and maintenance expenses for pumping station building have increased while expenditure for drainage pipe cleaning has decreased. Thus, it is assumed that the City gives priority to drainage pipe repair/new construction and pumping station maintenance over cleaning drainage pipes, receives additional budget allocation from MEF and allocates budget to DSO, Khan (district) and contractors. In addition, drainage related budgets in the Phnom Penh Capital City are allocated to others than DSO according to their priorities (especially in the case of constructing new drainage pipes, budget allocation is often made to private contractors rather than DSO).

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<sup>23</sup> There is a statement in "Preparatory survey report on the project for flood protection and drainage improvement in Phnom Penh (phase IV) in the Kingdom of Cambodia" (January 2017) that a budget that exceeds a portion of the 10% equivalent of water revenue from the Phnom Penh Water Supply Authority (hereinafter referred to as "PPWSA") is considered to be allocated by the MEF (p2-4).



Table 7 Drainage related Expenditure in Phnom Penh Capital City and  
10% Worth of Water Bill

(Unit: million riel)

Item	2013	2014	2015	2016	2017
Pumping station electricity bill	5,264.00	4,447.00	3,850.83	5,967.30	6,062.10
Pumping station fuel cost	619.00	419.00	304.80	304.80	160.00
Drainage pipe cleaning	3,866.00	4,272.00	176.70	667.90	477.59
Drainage pipe repair, new installment	2,774.00	3,181.00	94,943.22	91,161.99	42,825.43
Pumping station building maintenance cost	362.00	256.00	15,362.00	51,162.58	7,143.59
Pumping facility maintenance cost	450.00	456.00	230.00	160.00	70.00
<b>Total (A)</b>	<b>13,335.00</b>	<b>13,031.00</b>	<b>114,867.55</b>	<b>149,424.57</b>	<b>56,738.71</b>
<b>10% worth of water supply income (B)</b>	<b>12,745.00</b>	<b>13,702.00</b>	<b>15,151.00</b>	<b>16,676.00</b>	<b>18,061.00</b>
<b>(B)/(A)</b>	<b>95.6</b>	<b>105.1</b>	<b>13.2</b>	<b>11.2</b>	<b>31.8</b>

Source: Questionnaire responses to DPWT, and PPWSA official website

Note 1) These expenses include the expenditure of DSO.

Note 2) No data are available on the budget allocation from the Ministry of Economy and Finance (MEF).

Note 3) (B)/(A) shows the ratio of 10% worth of water bill to drainage related expenditure in %.

Note 4) The electricity cost is the cost required to operate the supervisory monitoring equipment and crane equipment installed in the pumping station, and the fuel cost is required to operate the drainage pump when it rains.

As mentioned above, the operation and maintenance costs of DSO based on the annual cleaning plan have not been budgeted properly from the Phnom Penh Capital City, and since the planned cleaning activities have not been implemented, there is a possibility that the operation and maintenance of the drainage facilities by this project may be negatively affected. As mentioned above (effectiveness), the effects of this project are manifested at the

time of ex-post evaluation, but if sediment sludge is left due to budget shortage, there is a risk that the water flow capacity in the pipes may be gradually impaired. Therefore, the finance of operation and maintenance has a problem at the time of ex-post evaluation.

#### 3.4.4 Status of Operation and Maintenance

As a result of the project site survey at the time of the ex-post evaluation, it was confirmed that the drainage facilities developed by this project have no major problems or failures after the project completion in October 2015 and have been operating without problems.

DSO properly carries out regular inspections (once a month for drainage pipes and chamber, and every time after using cleaning equipment) in accordance with the maintenance manual for cleaning equipment developed by the capacity building program (soft component) as well as the maintenance and inspection manual prepared by the implementing consultant. On the other hand, cleaning activities have not been implemented according to the annual cleaning plan because budget allocation has not been made according to the application amount from the Phnom Penh Capital City. After the start of operation in 2015, the chamber was cleaned using cleaning equipment in 2016 and 2017, and the maintenance of cleaning equipment was performed in 2017, but cleaning of the drainage pipes laid in Phase III has not been conducted after the operation, and sediment of about 10 cm was confirmed at the regular inspection. Regarding the current drainage function, as described above (effectiveness), the initial target has been achieved, but if cleaning is not carried out as planned and sediment sludge is left in the future, there is a risk that the water flow capacity in the pipes may be gradually impaired. At the time of the ex-post evaluation, no concrete prospects for sediment sludge measures have been confirmed.

As the Phnom Penh Capital City has started thickening construction of road coatings, the manhole iron lids installed in this project became in a sunken state relative to the surroundings, and thus some areas that are dangerous for the passage of vehicles and motorcycles (pointed out at the time of the defect inspection) were also found at the time of the ex-post evaluation.

When confirmed to DPWT, it was answered that DPWT will request through the Phnom Penh Capital City in 2019 to raise the manhole iron lids as high as the road surface to the contractor in charge of



Tuol Svay Prey Area Drainage Area  
(Manhole sunken by about 5 cm)

thickening construction.

Necessary spare parts are properly managed by DSO. In particular, the hoses used for cleaning equipment are consumables, Japanese spare parts have already been used up, and Thai hoses are obtained and used in Cambodia, but the functions of the cleaning equipment are maintained without any problems. Spare parts such as hoses that can be domestically procured can be obtained in about two weeks after ordering and have been procured in a timely manner, so there are no problems.

Therefore, the status of operation and maintenance has some problems at the time of ex-post evaluation.

From the above, the operation and maintenance of the project has no problems with the institutional/organizational and technical aspects, but there are problems with the financial aspect. Thus its sustainability of the project effects is fair.

## **4. Conclusion, Lessons Learned and Recommendations**

### **4.1 Conclusion**

This project constructed new drainage pipes, repaired a sediment chamber, procured drainage system maintenance equipment, and provided technical assistance for the purpose of strengthening the maintenance system for drainage pipes, in order to improve drainage functions of rainfall and reduce inundation damage in the southeastern part of the Phnom Penh Capital City, which is the capital of Cambodia. In the Phnom Penh Capital City, which is required to work on drainage improvement in line with the expansion of not only the central urban area but also the surrounding emerging areas, the development of drainage facilities for this project to improve drainage functions and reduce inundation damage is consistent with Cambodia's development policy, development needs and Japan's assistance policy, and thus its relevance is high. In terms of project implementation, the project cost was within the plan and the project period was as planned, so its efficiency is high. Regarding the project effects, the quantitative effects achieved the target indicators for both maximum inundation depth and maximum inundation duration. Qualitative effects were confirmed by interviews with surrounding residents, workers and hospital staff who answered that the project contributed to the improvement of the drainage function of rainfall and the reduction of inundation damage. Therefore, it can be judged that the effects of this project have been achieved. With regard to the impacts, this project has improved drainage function and reduced backflow of sewage, and it is believed by interviews with nearby residents, workers and hospital staff that this project contributes to the improvement of hygiene. In addition, it is considered that this project also contributes to the alleviation of congestion caused by inundation, considering that the traffic

congestion duration at the time of inundation would have become further prolonged along with the increase in absolute traffic volume if this project was not implemented. As a result, the project achieved its planned effects and its effectiveness and impacts are high. No major negative impacts on the natural environment have been reported, and no resettlement has occurred. The high water jet machine procured in this project are also regularly used for environmental cleaning activities on roads and parks inside and outside the project area, contributing to the beautification of the Phnom Penh Capital City. As for operation and maintenance, there are no problems with institutional/organizational and technical aspects, but there are problems with financial aspect and maintenance situation. Therefore, sustainability of the effects realized by this project is fair.

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

## 4.2 Recommendations

### 4.2.1 Recommendations to the Executing Agency

#### Thorough Implementation of Inundation Damage Monitoring

Inundation damage monitoring, which is a responsibility of the Cambodian side under this project, has been implemented in a way that DPWT requests Khan (district) in the project target areas to conduct the monitoring. However, due to the lack of budgetary measures and the inability to establish a sustainable monitoring system, submission, management/accumulation of inundation damage data to DPWT have not been properly conducted. If inundation damage data are not collected properly, it is difficult to quantitatively verify the effects of the project. Until now, inundation damage monitoring has not been properly carried out, up to Phase III project. In the "Project for Flood Protection and Drainage Improvement in Phnom Penh Capital City (Phase IV)" currently underway, drainage facilities are planned to be constructed, the same operation and effect indicators are set as this project, and thus there is a risk that phase IV will face similar problems. Therefore, it is required for DPWT to quickly construct a more viable monitoring system (for example, a person in charge of monitoring takes pictures at the time of inundation and submits them using social media etc., and the submitted photo data is stored and accumulated in the DPWT database, etc.).

#### Necessity of Appropriate Budget Allocation According to the O&M Plan Formulated by DSO

DSO's recent actual expenditures (budget allocations) are significantly lower than the application amount, approval of the budget necessary for drainage pipe cleaning and repair work has not come from the Phnom Penh Capital City, and the operation and maintenance based on the annual cleaning plan cannot be implemented. If sediment sludge is left in the

future, there is a risk that the water flow capacity in the pipes may be gradually impaired. In the exchange of note and grant agreement concluded under this project, the Cambodian government agreed "to ensure that the facilities constructed and rehabilitated under the Grant and the equipment be maintained and used properly and effectively, and to bear all the expenses, other than those covered by the Grant, necessary for the implementation of the project." It is important for DPWT, the executing agency, to pay close attention to securing the Phnom Penh Capital City's budget so that budget allocation based on the maintenance plan formulated by DSO will be implemented properly and promptly.

#### 4.2.2 Recommendations to JICA

None.

#### 4.3 Lessons Learned

##### Implementation of Capacity Building Program (Soft Component) can be used to Maintain Major Facilities beyond the Project Area (Good Practice)

In the capacity building program (soft component) of this project, technology transfer was carried out for DSO staff in charge of operation and maintenance regarding the formulation and implementation of an operation and maintenance plan that incorporates the PDCA cycle. As a result, a cleaning plan for drainage facilities not only in the target area of Phase III, but also in the target areas in Phases I and II, as well as the existing drainage pipes installed by the Phnom Penh Capital City inside and outside the target areas in Phases I to III was created, and a maintenance plan for the main drainage facilities in the city was established. In case of this project, since the budget allocation from the Phnom Penh Capital City has been limited, the planned clean-up activities have not been carried out, but the basic skills to formulate the budget proposal based on the plan was trained through the implementation of the capacity building program (soft component). From this, by providing technical assistance for formulation and implementation of the maintenance plan that incorporates the PDCA cycle to the executing agency in charge of maintenance, the skills can be used for maintaining not only facilities and equipment to be constructed and procured in the target project, but also major facilities and equipment that the executing agency has overseeing maintenance beyond the project target area, and thus it can contribute to the realization of integrated project effects beyond the target area.

##### Importance of Implementing Inland Water Drainage Plan for Urbanization of Urban Areas, especially Surrounding Areas of the Central Urban Areas (Outside of the Ring Breakwater) (Problem)

In the Phnom Penh Capital City, along with rapid population growth and urban development,

lakes, ponds, wetlands etc. that used to function as buffers against inundation were buried, and temporary storage function of rainwater were lost, and especially in the surrounding area of the central city (outside the former inner ring wall), urbanization is being promoted without sufficient drainage facilities being developed, which has led to the increase in inland water damage. From this, especially in urban development outside the ring breakwater, it is important for responsible government agencies to consider the land use regulation based on the risk analysis of inland water floods and fully consider inland water drainage measures in designing the plan, and for implementing consultants to identify target support areas which need drainage improvement and set numerical target plans for drainage facilities to be newly constructed, in consideration of the possibility that urbanization is being promoted without importance being given to inland water drainage measures, in formulating drainage master plan.

A Written Agreement between Counterpart Government and JICA when there is a Change in the Agreement such as Project Period (Improvement Proposal)

In this project, the project period plan was revised in the detailed design after the grant agreement was concluded, and a contractor contract was agreed with an additional two months to the original project period plan when the grant agreement was signed. As a matter of fact, a planned completion date when a grant agreement is concluded, which is set based on a preliminary survey, may be changed after conducting a detailed design like this project. In this project, it was not mandatory to exchange an agreement document between the counterpart government and JICA regarding the addition of two months to the project period, but based on the fact that the project period of additional two months was agreed between the recipient government and the implementing consultant, the relevant department of JICA is confirmed that the project period agreed at the time of the contractor contract was more realistic than the project period agreed in the grant agreement. For this reason, based on the explanation, analysis and judgment of efficiency were conducted by regarding the project period at the time of the contractor contract as a plan. However, in the ex-post evaluation, according to JICA's external ex-post evaluation reference, how to count project period is, in principle, based on the number of months specified in the ex-ante evaluation set based on the preliminary survey, and thus at the process of evaluation and analysis, there was a misunderstanding between the parties regarding the concept of the project period. From this, if changes occur in the agreement such as the project period as a result of detailed design and bid preparation, it was desirable to leave the contents of the change in the agreement document such as minutes between the recipient government and JICA in order to keep track of the changes easily even in the future.

End