

5. Soft Component Plan

5.1 Background

The aim of the “Pursat Water Supply Expansion Project” is to establish a new water treatment plant with a capacity of 6,600 m³/day and install 89.8-km distribution pipeline in Pursat City, the capital of Pursat Province in the Kingdom of Cambodia.

Since the water supply system will be significantly improved by this project, Pursat Waterworks will need to raise the capacity of its organization to a sufficient level to properly manage, operate and maintain the new water supply facilities. Development of the organization requires the employment of new staff and the use of outside human resources, Pursat Waterworks should also focus on improving the capacity of both newly-employed staff, as well as existing staff who will train new staff in the future, as well as identify solutions for existing challenges.

5.1.1 Current situation

Pursat Waterworks operates an existing water treatment plant which has a capacity of 7,260 m³/day and was constructed with support from the Asian Development Bank (ADB). The facility is managed by a staff of 37, including the director general. The existing water treatment plant is operated 24 hours a day by staff in the production section in shifts, who perform relatively good operation and maintenance. However, shift hours are long for staff in the production section, which is an indication that additional staff may be needed.

Staff in the network section maintain the distribution facilities in the city in three teams: leakage surveys and repairs, network maintenance, and pipeline expansion and replacement. The network section also lacks the staff needed for these operations, and they sometimes bring in staff from other sections or use personnel from outside. Other sections, such as the business section, are also short on manpower. It is necessary for Pursat Waterworks to develop an organization that would be optimal for the expansion of facilities in this project.

5.1.2 Technological level

Pursat Waterworks is a provincial waterworks that is the target of a project on capacity building for urban water supply system in Cambodia (phase 2 and 3) by the Japan International Cooperation Agency (JICA). Technical transfer associated with the operation and maintenance of water treatment plants, water quality tests, and the operation and maintenance of distribution facilities were implemented for five years from 2007 to 2012, and technical transfer related to the improvement of management has been carried out from 2012. Today, the water supply meets national drinking water quality standards, except in cases where the turbidity of raw water rises rapidly due to sudden, heavy rain.

Operation and maintenance of the existing water treatment plant is performed periodically, and check sheets and Standard Operating Procedures (SOP) prepared in the capacity building project are utilized.

The skills for maintenance of distribution facilities transferred through the capacity building project, such as leakage surveys and creating construction records are adequately utilized. On the other hand, because there was not a distribution monitoring system during the project period, trainings related to the distribution monitoring were not performed in the project. Vital skills for the maintenance of distribution facilities, such as distribution flow monitoring, flow data analysis and countermeasures for reducing non-revenue water (NRW) based on flow analysis have not yet been established.

When service connections are installed, excavation is done by hand, materials are polyethylene that do not require special tools. Although the staff members in charge are familiar with the work process, efforts for improving quality of service connection installations are not carried out in particular. The construction supervision must be strengthened and implemented in order to prevent leakages from service connection installations which are expected to hereafter increase rapidly.

Overall, few technical staff members have completed higher education in engineering, and each staff member does not necessarily have a high level of expertise. Although existing water facilities can be operated, maintained and managed according to prescribed procedures, technical skills can be improved.

5.1.3 Challenges to be addressed

(1) Formulating and learning work procedures for new facilities

Initial operation instructions for the construction and procurement of new facilities mainly consist of instructions for the operation and maintenance of each facility in accordance with manuals, as well as control of the facilities under simple conditions. However, the operation and maintenance of the new facilities is not able to be performed only by the initial operation instructions.

Actual work procedures, such as water treatment in response to changes in raw water quality and water demand, practical maintenance without system shut-down, and the creation of records on operation and maintenance, must be formulated through repeated trial and error with sorting key points and risks obtained from trial operation and creating rules for safe and efficient operation after understanding the design concept and the manuals. In addition, OJT using actual facilities is indispensable for the staff members in charge to learn the procedures quickly. However, because they require the ability of logical thinking and water supply technique based on high expert knowledge and abundant experience, it is difficult for Pursat Waterworks to do this by itself at the current technical level.

(2) Distribution flow monitoring

Since water bill collection is almost 100% and water theft has been decreasing, it can be considered that leakage occupies most of NRW in Pursat. The cause of the leakage may be various causes, such as breakage of aged pipe, poor construction of service connection, and accident due to other construction. And the leakage has a property to recur over time after a repairing work.

In order to maintain relatively good current NRW rate (10.1%), but not a leakage survey that depends on intuition like the past, aggressive maintenance of distribution facilities, such as repair of invisible underground leakage and recurrent leakage is necessary.

Unlike water treatment facilities, most distribution facilities are located underground, which makes it impossible to perform visual maintenance and inspections.

Because leakage surveys and old pipe replacements at random in the distribution network which will be expanded in this project is inefficient, determination of priority area for the leakage surveys and old pipe replacements based on objective data is needed as efficient maintenance.

Distribution flow monitoring is a technique which monitors and records distribution flow rates and minimum night flows in each distribution zone, and it provides necessary information for grasping condition, detecting abnormalities and estimation of the cause of the abnormality of the distribution facilities by sorting and analyzing the obtained data. Although a distribution flow monitoring system will be installed in this project, the technique related to the distribution monitoring has not yet been established at Pursat Waterworks. It is necessary to be improved.

(3) Ensuring quality of service connection installations

The service connection installations are performed by one team of three staff of Pursat Waterworks. The staff members in charge are familiar with the work process, efforts for quality improvement are not carried out in particular.

Generally, since most leakages occur in service connections, improving the quality of service connection installations is important in terms of NRW reduction

The installation of service connections will increase rapidly through this project, it is expected that four teams of ten people will be necessary during the busiest period. Because the necessary additional staff will be supplied by use of outside human resources, in order to secure the quality of the service connections, review of work procedure and strengthening construction supervision system are necessary.

(4) Promotion of applications for service connections

The number of service connections is planned to increase from current 7,650 to 15,280 by the targeted year 2025 in this project. Although materials for new service connections will be provided for 257 poor families by the project, the installation cost should be borne by Pursat Waterworks. If the number of service connections fall short of the target, the revenue from water supply will stagnate and affect the management of the water supply business. Encouraging people to submit applications for service connections in the new water supply area is an important management issue.

Pursat Waterworks has an experience of the educational activity which aimed to obtain trust of customer and commune, reduce their dissatisfaction, enhance water saving awareness with

assistance from UN-HABITAT in 2015. In order to achieve the target number of the service connection, assistance for more efficient educational activity to encourage service connection application, such as preparation of materials and planning of activity is necessary.

(5) Improvement of production management

Although Pursat Waterworks needs to operate both new and old water treatment plants after the completion of the construction, they have no experience in managing plural water treatment plants. In the management of the two water treatment plants, advanced production managements, for example, utilization of water from the treatment plant where the treatment cost is smaller than the other by changing the division of distribution zones during a period when the daily water supply is small, and ensuring of inventory management of both water treatment plants are necessary.

Further, the existing water treatment plant has no sludge treatment process, however the new water treatment plant will include the process, formulation of a sludge treatment plan and procedures is necessary as well.

(6) Creation and revision of SOP

In order for the outcomes of this project to remain effective for a minimal period, procedures for operation and maintenance, principles for management of the new facilities, key points and precautions related to the operation must be simply compiled in SOP. It should also be referred at any time if necessary, for the staff. Followings are situations of existing SOP.

Necessary information for actual water quality tests, such as types, quantity and preparation method of reagents, operation and calibration of water quality test equipment are compiled in SOP in the capacity building project as mentioned above. However, they are formulated on the premise of use of the existing equipment. Because new water quality test equipment will be provided in this project, the contents of the SOP for all of water quality items must be confirmed and be modified as necessary.

Necessary information for the operation and maintenance of the existing facilities, such as basic knowledge, work procedures, safety points to note are compiled in SOP in each field, of water treatment, electric facility, mechanical facility and distribution facility in the capacity building project. However, the SOP are made for the purpose of using the existing facilities, it must be modified in accordance with the new facilities.

Because the SOP related to production management, such as management of both new and existing water treatment plants, inventory control, sludge treatment has not been created, it should be newly created.

However, it is difficult for Pursat Waterworks to do this by itself at the current technical level.

5.1.4 Necessity of the soft component

In order to start up this project smoothly and ensure that the outcomes of this project can be effective for a minimal period, the following requirements should be satisfied.

- (1) Development of key persons on site who understand the new facilities and can instruct other staff
- (2) Development of staff who have the minimum required knowledge and are able to operate and maintain the new facilities according to the instructions of the key persons
- (3) Improvement of the challenges stipulated in section 5.1.3

After construction has been completed on the new facilities through this project, Pursat Waterworks needs to operate the facilities immediately. However, it is difficult to confirm that Pursat Waterworks can satisfy the above requirements at its current technical level in such a short time, and support from highly skilled technical experts with considerable experience is essential. Therefore, the transfer of knowledge and technical skills for the operation and maintenance of water supply facility for Pursat Waterworks shall be implemented as a soft component of this project.

In addition, a new organization after the construction of the new facilities will add one new team with a deputy director as the leader, under the existing director of the production section, for the operation and maintenance of the new water treatment plant. The production section plans to increase total of 11 staff.

In the network section, it plans to increase four staff under an existing deputy director, for leakage survey, repairing and network management.

In the business section, it plans to increase five staff under an existing deputy director, for customer information management and meter reading. Administration and planning section also plan to increase one staff.

Figure 1-1 and Figure 1-2 shows current and future organization of Pursat Waterworks.

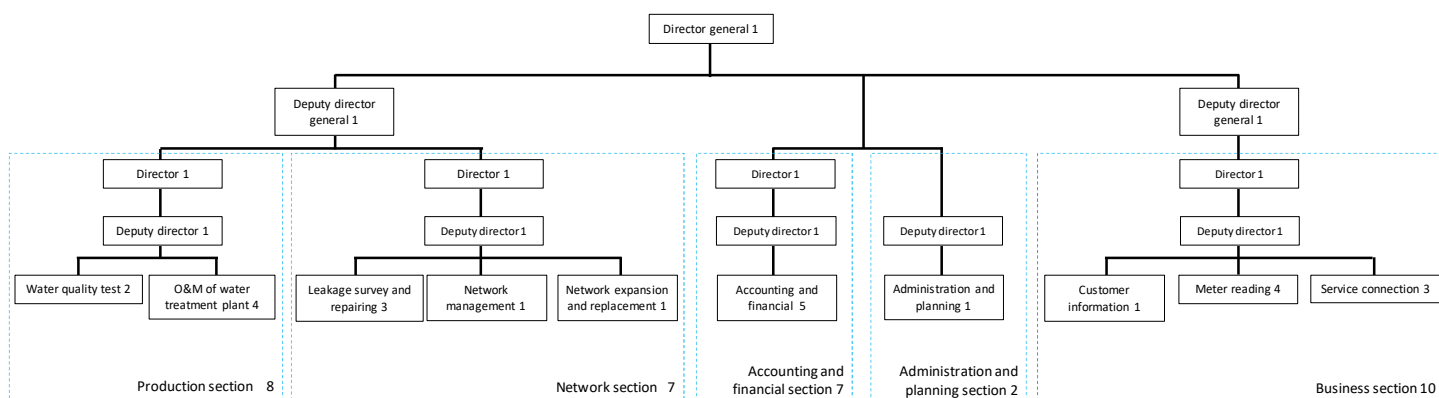


Figure 1-1 Current organization of Pursat Waterworks

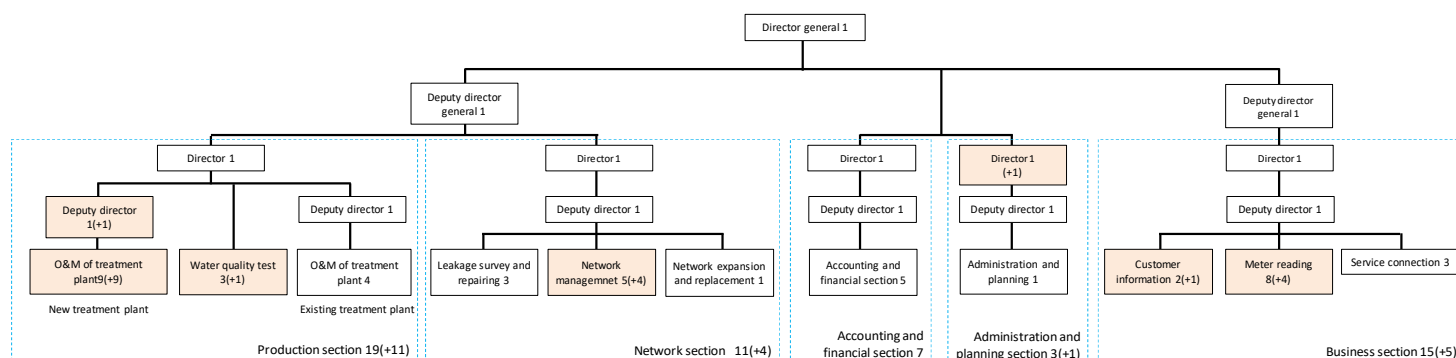


Figure 1-2 Future organization of Pursat Waterworks

5.2 Objective of the soft component

The target of this soft component is the proper operation and maintenance of the new facilities and a stable supply of water which meets water quality standards with the use of existing facilities by Pursat Waterworks.

5.3 Outcome of the soft component

Based on 1-3 Challenges to be addressed, the outcome of the soft component shall be set out as follows, and current situations are stated as well.

(1) Formulation and understanding of procedures for water quality tests using new equipment

Although water quality tests using existing test equipment can be performed relatively well, the procedures must be reviewed and modified as necessary in accordance with the new test equipment which will be provided in this project. It should be done in every water quality items with assistance from experts. In addition, in order to make new staff understand the procedures, and brush-up skill of existing staff, OJT by experts is necessary.

(2) Formulation and understanding of procedures for operation and maintenance of the new water treatment plant

Although operation and maintenance of the existing water treatment facilities can be performed relatively well, procedures for operation and maintenance of the new water treatment facilities must be newly formulated with assistance from experts. And in order to make both new and existing staff understand the procedures, OJT by experts is necessary.

(3) Improved capability in distribution monitoring

The existing distribution monitoring system has not been utilized efficiently, and the technique related to the distribution monitoring has not yet been established at Pursat Waterworks. Technical guidance for the distribution monitoring and analysis, formulation of operating procedures and OJT for the new distribution monitoring system are necessary.

(4) Strengthening construction supervision system for service connection installations

The quality of the service connection installations are responsibility of the staff at the site. However, efforts for quality assurance are not performed in particular.

To prevent leakage from service connections which are expected to be increased rapidly with implementation of this project, review of work procedure and strengthening construction supervision system for service connection installations with assistance from experts are necessary.

(5) Implementation of educational activities to promote applications for service connections

Although Pursat Waterworks has experience to carry out educational activities for residents with assistance from UN-Habitat, in order to achieve the target number of service connection in this project, assistance for preparation of more efficient materials and plan for educational activities is necessary.

(6) Improved capability of production management

Pursat Waterworks has no experience to manage plural water treatment plants, principles of efficient management of two water treatment plants must be studied, formulated and understood.

And the existing water treatment plant has no sludge treatment process, formulation of a sludge treatment plan and work procedure and OJT are necessary.

(7) Creation and revision of SOP

Although there are SOP which were formulated on the premise of use of the existing facilities and equipment, in order to make the staff understand the operation and maintenance of the new facilities and equipment, it is important that procedures, principles, key points and precautions are simply compiled in SOP. They should be referred at any time as necessary for the staff as well. Therefore, creation and revision of SOP are necessary.

5.4 Methods to confirm achievements

Achievements of the soft component will be confirmed as follows.

Table 4-1 Methods to confirm achievements of the soft component

Outcome	Achievement	Confirmation Method
(1) Formulation and understanding of procedures for water quality tests using new equipment	1. Water quality tests are performed appropriately 2. Required water quality items are tested at a defined frequency and the results are recorded	1. Check water quality records 2. Check existence of water quality records and frequency of implementation

Outcome	Achievement	Confirmation Method
(2) Formulation and understanding of procedures for operation and maintenance of the new water treatment plant	1. Operation of water treatment plant and management of water treatment process are performed appropriately 2. The turbidity of filtered water meets targeted value 5 NTU 3. The residual chlorine concentration of tap water meets the target value 0.1 mg/L 4. The maintenance of the facilities is performed appropriately according to a plan 5. Organization system for accidents and malfunctions is in place	1. Confirm actual work, and the operation records 2. Confirm the water quality records 3. Confirm the water quality records 4. Confirm actual work, maintenance plan and maintenance records 5. Confirm emergency contact system, defects in handling records
(3) Improved capability in distribution monitoring	1. Distribution flow monitoring is performed appropriately, and records are organized 2. Distribution flow analysis is performed 3. Grasp of condition of distribution facilities based on the distribution analysis is understood	1. Confirm the distribution flow monitoring records 2. Confirm the analysis records 3. Confirm by brief test
(4) Strengthening construction supervision system for service connection installations	1. Procedure for installation of service connection is reviewed and modified if necessary 2. Construction supervision system for service connection installation is studied and performed	1. Confirm SOP 2. Confirm the records of construction supervision
(5) Implementation of educational activities to promote applications for service connections	1. Materials related to public awareness are prepared 2. Activities for encouraging service connection application are performed	1. Confirm materials related to public awareness 2. Confirm actual activities and records
(6) Improved capability of production management	1. Efficient management of both new and existing water treatment plant is understood 2. Inventory management is performed appropriately 3. Sludge treatment is performed appropriately	1. Confirm by brief test 2. Confirm the inventory records 3. Confirm sludge treatment records and situations
(7) Creation and revision of SOP	1. SOP related to water quality test, operation and maintenance of water treatment facilities, distribution monitoring and installation of service connections are revised 2. SOP related to production	1. Confirm SOP 2. Confirm SOP

Outcome	Achievement	Confirmation Method
	management is created	

5.5 Activities (input plan)

5.5.1 Principle of the input

In this soft component, the first input will be carried out at a timing that overlaps with the test run (commissioning and initial operation instructions) during the construction and equipment procurement period to some extent, taking into consideration information sharing between the implementing resources and equipment suppliers. The first input will include training and reconfirmation of basic knowledge, OJT using the new facilities, and support for the revision and formulation of the SOP.

The second input shall be carried out several months after the start of actual operation. Operation records will be reviewed, support will be provided to identify problems and potential countermeasures, and assistance will be offered for a review of the SOP.

Expected schedule of input is shown in **Figure 5-1**.

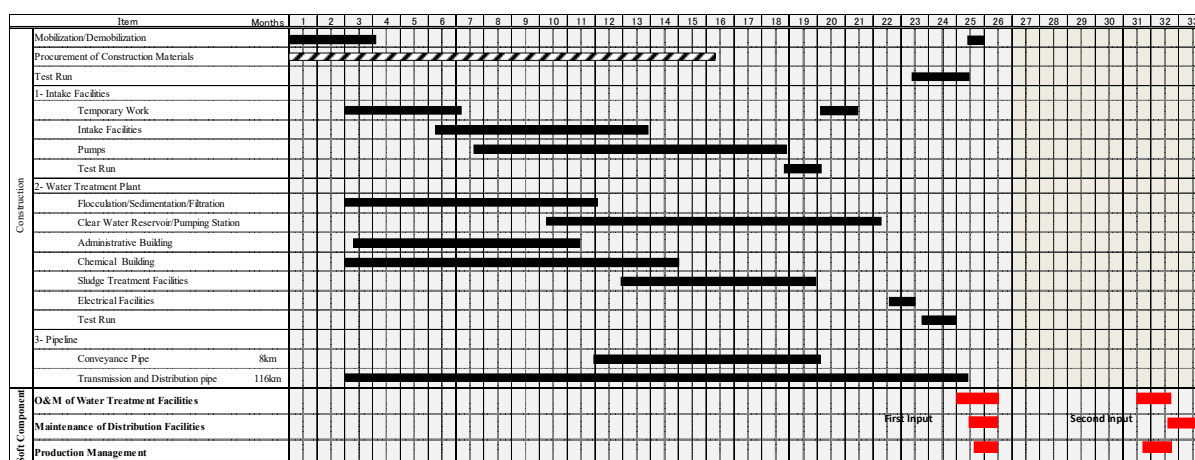


Figure 5-1 Schedule of input

5.5.2 Input plan

Main activities which require the ability of logical thinking and water supply techniquebased on high expert knowledge and abundant experience, such as formulation of procedures for the operation and maintenance of the new facilities, OJT, and assistance for revision and creation of SOP shall be implemented by Japanese experts as direct support, and partly special technology transfer can be made only by local engineer shall be implemented by utilizing the human resources trained through the capacity building project.

The human resources involved shall include Japanese experts, local engineers, local staff. Their roles are generally outlined below.

(1) Japanese expert

Summary of each training course, analysis of work content and work volume necessary for the management of the new facilities, training course management, formulation of procedures for operation and maintenance, OJT, assistance for revision and creation of SOP, preparation of training materials, evaluation of achievements

(2) Local engineer

Training based on experience in Cambodia, training with practical work such as valve operation, preparation of training materials in Khmer

(3) Local staff

Preparation of materials, preparation of training materials in Khmer, coordination with counterparts, interpreter for Japanese expert, document translation

It is planned that Japanese experts from water supply utilities are input into this soft component. Generally, in Japanese water supply utilities, mechanical and electrical engineers are deployed to operation and maintenance of water treatment facilities, and civil engineers are deployed to operation and maintenance of distribution facilities.

Therefore, assistance related to the formulation of procedures for operation and maintenance, OJT, and creation and revision of SOP shall be divided into two fields of water treatment facilities including the water quality test and distribution facilities mainly consisting of the distribution monitoring. And the mechanical and electrical engineers will be input into the field of the water treatment, and the civil engineers are input into the field of the distribution respectively.

The assistance for the production management shall be carried out separately from them.

Table 5-1 Activities of the Soft Component (Input Plan)

Field	Outcome	Activity	Trainee	Input
Operation and maintenance of water treatment facilities	(1) Formulation and understanding of procedures for water quality tests using new equipment	1. Review of water quality test procedures 2. OJT of water quality test - Water quality test - Analysis and records	19 people Production section	Japanese Expert - 1 person×2.63M/M First Input - Water quality test training - Water treatment plant operation training - Maintenance training - SOP revision guidance
	(2) Formulation and understanding of procedures for operation and maintenance of the new water treatment plant	1. Formulation of procedures for operation and maintenance 2. OJT of operation and maintenance - Water treatment - Operation records - Chemical injection - Back washing of filtration basin - Operation of pump		Second Input - Review - Follow up training - SOP revision guidance

Field	Outcome	Activity	Trainee	Input
		<ul style="list-style-type: none"> - Maintenance - Handling of facilities - Accident and malfunction handling 		Local Engineer - 1 person×0.20M/M
	(7) Creation and revision of SOP	1. Assistance for revision of SOP <ul style="list-style-type: none"> - Water quality test - Operation and maintenance of water treatment facilities 		Local Staff - 1 person×2.60M/M
Maintenance of distribution facilities	(3) Improved capability in distribution monitoring	1. Formulation of procedure for distribution monitoring 2. OJT of distribution monitoring <ul style="list-style-type: none"> - Distribution flow monitoring - Minimum night flow - Operation of monitoring system - Distribution flow analysis - Maintenance of distribution facilities 	11 people Network section	Japanese Expert - 1 person×1.94MM First Input <ul style="list-style-type: none"> - Distribution flow monitoring training - Service connection installation training
	(4) Improved supervision system of installation of service connections	1. Review of procedure for installation of service connections 2. Study of construction supervision system <ul style="list-style-type: none"> - Installation of service connection - Supervision of construction 	5 people Business section	- SOP revision guidance Second Input <ul style="list-style-type: none"> - Review - Follow up training - SOP revision guidance
	(7) Creation and revision of SOP	1. Assistance for revision of SOP <ul style="list-style-type: none"> - Distribution monitoring - Installation of service connections 	11 people Network section 5 people Business section	Local Engineer - 1 person×0.20M/M Local Staff - 1 person×1.90M/M
Production management	(5) Improved capability of production management	1. Formulation of efficient management of the existing and new water treatment plants 2. Formulation of sludge treatment plan 3. OJT of production management <ul style="list-style-type: none"> - Consumption unit - Water supply revenue and cost - Management of water treatment plant - Inventory control - Sludge treatment - Utilization of SOP 	8 people Director general Deputy director general Director of each section 19 people from the production section for the sludge treatment	Japanese Expert - 1 person×1.80MM First Input <ul style="list-style-type: none"> - Facilities management training - Service connection application promotion training - SOP preparation guidance Second Input <ul style="list-style-type: none"> - Review - Follow up training - SOP revision guidance
	(6) Implementation of educational activities to promote applications for service connections	1. Assistance for preparing public awareness materials 2. Assistance for implementation of educational activities		Local Staff - 1 person×1.76M/M

Field	Outcome	Activity	Trainee	Input
	(7) Creation and revision of SOP	1. Assistance for creation of SOP - Management of water treatment plant - Sludge treatment		

5.6 Identification of implementation resources

(1) Japanese expert

Experts from Japanese water utilities who have detailed knowledge on the water supply business and operation and maintenance of water supply facilities shall be assigned in each area of the operation and maintenance of water treatment facilities, maintenance of distribution facilities and production management respectively.

(2) Local engineer

Phnom Penh Water Supply Authority (PPWSA) has extensive experience in the operation and maintenance of water treatment facilities in Cambodia. From the perspective of distribution facilities, PPWSA has implemented countermeasures for reducing NRW by using a flow monitoring system in addition to direct water supply by means of pump and has been dispatching staff to other cities in many projects. In addition, other provincial waterworks also has been dispatching staff to other cities as well, even in this soft component, PPWSA and other provincial waterworks staff shall be utilized as local engineers.

Further, related to the promotion of service connection applications, local resources which have experience of educational activities shall be utilized if there is available resource in other cities.

5.7 Implementation schedule

Figure 7-1 shows the draft schedule of the soft component.

Item	22	23	24	25	26	27	28	29	30	31	32	33	People/Month	
													Cambodia	Japan
Operation and maintenance of water treatment facilities														
Japanese Expert				<div></div>	1.43MM				1.20MM	<div></div>			2.63	0.00
Local Engineer				<div></div>	0.20MM								0.20	0.00
Local Staff			<div></div>	1.50MM					1.10MM	<div></div>			2.60	0.00
Maintenance of distribution facilities														
Japanese Expert				<div></div>	0.97MM				0.97MM	<div></div>			1.94	0.00
Local Engineer				<div></div>	0.20MM								0.20	0.00
Local Staff				<div></div>	1.03MM				0.87MM	<div></div>			1.90	0.00
Production Management														
Japanese Expert				<div></div>	0.87MM				0.93MM	<div></div>			1.80	0.00
Local Engineer													0.00	0.00
Local Staff				<div></div>	0.93MM				0.83MM	<div></div>			1.76	0.00
Report													<div></div> Progress Report	<div></div> Final Report

Figure 7-1 Draft implementation schedule of the soft component

5.8 Deliverables of the soft component

The deliverables of the soft component are shown in **Table 8-1**.

Table 8-1 Deliverables of the soft component

Period of Submission	Products
The end of first input (Month of 26)	Progress report on the soft component Materials for trainings (implemented) Materials on other activities
The end of second input (Month of 33)	Final report on the soft component Materials for the trainings SOP for each area Format of various records Achievement / Evaluation (Monitoring sheet)

The report on the soft component shall be prepared in accordance with "Soft Component Guidelines (Third Edition)" (October 2010).

The deliverables shall be organized to be useful for comprehensive management of the facilities from the intake to the service connection in accordance with the spirit of "Guideline for Formulation of Water Safety Plan (Ministry of Health, Labour and Welfare)" (May 2008).

5.9 Cost estimates for the soft component

The following estimates have been provided for below as the approximate cost of the soft component: 2.63M/M for the expert on the operation and maintenance of the water treatment facility, 1.94M/M for the expert on distribution facility maintenance, 1.80M/M for the expert on production management, 0.40M/M for two local engineers, and 6.26 M/M for three local staff. The approximate costs for the soft component are shown in **Table 9-1**.

Table 9-1 Cost estimates for the soft Component

Costs	JPY (*1,000yen)	Local Currency		USD		JPY Total (*1,000yen)
		USD	JPY (*1,000yen)	USD	JPY (*1,000yen)	
Labor costs	4,829	0	0	0	0	4,829
Direct costs	4,326	16,579	1,857	0	0	6,184
Indirect costs	8,015	0	0	0	0	8,015
Total	17,170	16,579	1,857	0	0	19,027

5.10 Responsibilities of the implementing agency in the recipient country

This soft component provides the necessary technical guidance to Pursat Waterworks for the proper management of the new facilities. The Cambodian side should secure the personnel necessary for actual operation and the proper deployment of staff. Staff increase plan expected to be necessary is shown in **Table 10-1**.

Particularly, staff setup in the production section, network section, and business section, which are targeted sections for OJT in the soft component, must be completed before the implementation of the soft component, including new staff training by the waterworks.

In case there are difficulties in arranging staff and for this to be completed in time, the soft component for existing staff who will be involved in the operation and maintenance of the new facilities shall be implemented. Existing staff shall carry out training when new staff are deployed.

Table 10-1 Staff increase plan

	2017	2018	2019	2020	2021	2022	2023	2024	2025
Water production section	8	8	8	11	14	19	19	19	19
Network section	7	7	7	7	8	11	11	11	11
Business section	10	11	11	11	11	12	13	14	15
Accounting and financial section	7	6	6	7	7	7	7	7	7
Administration and planning section	2	3	3	3	3	3	3	3	3
Director general and deputy director	3	3	3	3	3	3	3	3	3
Total	37	38	38	42	46	55	56	57	58

It is assumed that the commissioning of the construction work will be completed in May 2022.

5.11 Collaboration with the capacity building project

SOP related to water quality control, water treatment, electrical facilities, mechanical facilities, and distribution facilities have been prepared through the capacity building project, which has been implemented since 2007, and are being utilized at Pursat Waterworks. In this soft component, existing SOP shall be revised in accordance with the new facilities. The most suitable human resources shall be selected out of the people trained in the capacity building project and utilized as local engineers.

In addition, assistance for provincial water suppliers is planned in a new technical cooperation project with the department of water supply in the MIH which is planned to be started from 2018. In implementing this soft component, it shall be taken care so that the activities of both sides do not overlap by sharing this soft component plan.

6. Relevant Data (List of Collected Data)

No.	Name	Figure	Original / Coopy	Issuing Institution	Year of Issue
		Book • Video Map • Photo, etc			
1	National Institute of Statistics 1998	Hard Copy	Copy	MOP	1999
2	National Institute of Statistics 2008	Hard Copy	Copy	MOP	2009
3	National Institute of Statistics 2013	Hard Copy	Copy	MOP	2014
4	Pursat Population (village)	Excel	Copy	Pursat WWs	2006-2015
5	PROVINCIAL TOWNS IMPROVEMENT PROJECT, PART B CONTRACT NO. ICB/PTIP/AB/002 FOR CONSTRUCTION OF WATER SUPPLY SYSTEMS IN BATTAMBANG, PURSAT, KOMPONG CHAM, KOMPONG THOM, KAMPOT AND SVAY RIENG AS-BUILT DRAWING FOR PURSAT	Hard Copy	Copy	MIH	2007
6	Pursat WWs Materials of increasing capacity of purification	Hard Copy	Copy	Pursat WWs	2015
7	Pursat WWs Water supply records	エクセル	Copy	Pursat WWs	2013-2017
8	Pursat WWs Water Quality records	エクセル	Copy	Pursat WWs	2013-2017
9	Budged for water service installation	Hard Copy	Copy	Pursat WWs	2016
10	Typical road occupation condition	Hard Copy	Copy	Pursat DPWT	Unknown
11	Standard of road structure and pavement structure	Hard Copy	Copy	Pursat DPWT	Unknown
12	Existing distribution pipe network drawings	Hard Copy	Copy	Pursat WWs	Unknown
13	Measurement data of water pressure	Hard Copy	Copy	Pursat WWs	2016
14	Pump operation manual	Hard Copy	Copy	Pursat WWs	2016
15	Pursat WWs Organization Chart, Duty assignment	Hard Copy	Copy	Pursat WWs	2016
16	Reports of works	Hard Copy	Copy	Pursat WWs	2016
17	Pursat WWs Asset data	Excel	Copy	Pursat WWs	2013-2017
18	Pursat WWs balance sheet	Excel	Copy	Pursat WWs	2013-2017
19	Sub Decree-MoE-07-on Biodiversity Conservation Corridor of Natural Protected Area	Hard Copy	Copy	MOE	2017
20	Water Resources Management Sector Development Program ADB Loan 2673- CAM and TA7610-CAM CAMBODIAN RESOURCES PROFILE	Hard Copy	Copy	ADB	2014

No.	Name	Figure	Original / Coopy	Issuing Institution	Year of Issue
		Book • Video Map • Photo, etc			
21	TA6456-REG: Preparing The Greater Mekong Subregion Flood and Drought Risk Management and Mitigation Project, Irrigation Engineer report	Hard Copy	Copy	ADB	2012
22	Rain fall Records	Hard Copy	Copy	MOWRAM	1996-2015
23	Water level data at Existing Intake Station	Hard Copy	Copy	MOWRAM	1995-2016
24	Labor Law	Word	Copy	MLVC	1997

Annex 7.1

Technical Notes

1. Technical Notes

1-1 The first Technical Note

The first Technical Note is attached as follows.

TECHNICAL NOTES
ON
PREPARATORY SURVEY ON THE PROJECT
FOR EXPANSION OF WATER SUPPLY SYSTEM
IN PURSAT AND SVAY RIENG
IN THE KINGDOM OF CAMBODIA

Japan International Cooperation Agency (hereinafter referred to as "JICA") has dispatched the first batch of the Preparatory Survey Team (hereinafter referred to as "the Team") headed by Mr. SAWARA, senior advisor for urban water supply, JICA to the Kingdom of Cambodia from 22 May 2017 for the purpose of preparing the Outline Design on the Project for Expansion of Water Supply System in Pursat and Svay Rieng in the Kingdom of Cambodia (hereinafter referred to as "the Project").


Since the JICA official members held discussions and conducted field surveys, Mr. KONNO, chief consultant of the Team has continued the survey. In course of field surveys and discussions on the technical aspects of the scope and basic information of the Project with the officials of the Royal Government of Cambodia (hereinafter referred to as "RGC"), both sides confirmed the items described in the Attached sheets of this note.

It is noted that the final scope of the Project, project implementation designs etc. will be decided after consultations with JICA in Japan.

Phnom Penh, 17 July 2017



Dr. Sreng Sokvung
Director
Department of Technical and Project Management
Ministry of Industry and Handicraft (MIH)



Mr. Hideki KONNO
Chief Consultant
Preparatory Survey Team
Japan International Cooperation Agency (JICA)

ATTACHMENT

1. Possible Water Sources and Intake Facilities**1) Possible Water Sources and Intake Site for Pursat City****Possible Surface Water Source for Pursat City**

The Team recommended that raw water from the Pursat River be drawn for supplying domestic water to the future expansion service areas and it was agreed by the Cambodian side. Details are as below:

- MIH sent a letter to MOWRAM on May 26, 2017 for requesting additional water abstraction of 14,500m³/day from the Pursat River, and is waiting for an answer from MOWRAM. MIH requested MOWRAM to respond to this letter by the end of July, 2017.
- The total raw water to be withdrawn from the Pursat River will be 7,200m³/day (for the existing system) + 14,500m³/day (for the future expansion) = 21,700m³/day(total) = 0.25m³/s.
- Abstraction of 0.25 m³/s will be possible because the minimum discharge from the Pursat River in 2015 when the most severe drought occurred in recent years is estimated approximately at 10 m³/s.

Intake Site along the Pursat River

Considering the conditions of stability of the river channel, movement of sand bars with bank erosion as well as problems of inflowing muddy sediment into the pump of the existing intake facility, as a result of comparing and examining seven water intake candidate sites (see **Annex-1**), the Team recommended withdrawing from the immediate upstream of Dhamnak Ampil Headwork (Site No.A) as the best option.

The recommended second option is intake from the immediate upstream of the existing intake point (Site No.00).

2) Possible Water Sources and Intake Site for Svay Rieng City**Possible Surface Water Source for Svay Rieng City**

Considering securing stable water resources and water quality, the Team recommended that raw water from the Vay Kor Lake be drawn for supplying domestic water to the future expansion service areas and it was agreed by the Cambodian side. Details are as below:

- In the same letter by MIH to MOWRAM dated May 26, 2017, MIH also requested water withdrawal of 12,100m³/day from the Vay Kor Lake, and is waiting for an answer from MOWRAM to be sent by the end of July, 2017.
- According to estimates of the Team, if the irrigation area around Vay Kor Lake is extended to 5,500 ha as planned in the future, the necessary irrigation water volume will increase to about 36 to 44 MCM. In this case, the amount of irrigation water exceeds 30 MCM, which is storage capacity of Vay Kor Lake estimated by the Team. Therefore, it is difficult to abstract tap water from Vay Kor Lake, unless the water supply is given priority over irrigation water consumption.

Intake Site in the Vay Kor Lake

The Team compared the candidate intake sites in the Vay Kor Lake (see **Annex-2**). As per the results, the most recommendable intake site is at the north side of the road dike of National Road No.1 (NR1)

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besides the existing bridge in the Vay Kor Lake (Site No.2). This is because, the water surface is near the road dike of NR1 and enough water depth during the dry season can be obtained under proper management of surface water resources of the Lake.

The both sides confirmed the other suitable sites for the second option is nothing as the results.

3) Problems of Scouring and Insufficient Flood Capacity at Vay Kor Dam

Vay Kor Dam is composed of slender reinforced concrete walls and supporting walls and concrete slab foundation and probably with concrete sheet piles under the concrete slabs.

There are the following risks attributing to instable dam body and insufficient dam structure, such as;

- scouring around the foundation
- deterioration of the reinforced concrete walls and supporting walls
- insufficient flood discharge.

The condition and problem of Vay Kor Dam is being studied by the Team through collecting information. In case the Dam collapses, it would be difficult to withdraw water from the intake site.

4) Potentiality of Groundwater Development in Svay Rieng City

Based on the hydrogeological survey results about Svay Rieng, the Team's explanation, which was also understood by the Cambodian side was as follows:

- There is a potentiality of groundwater development nearly equivalent to the present production wells. However, the detailed surveys are necessary in order to newly construct production wells because alluvium formation generally has considerable geological-facies change.
- Moreover, the Team are currently conducting groundwater quality survey, and has to evaluate the results.

2. Demand Projection

Cambodian Side confirmed the Team to conduct water demand projection by 2025, which is the target year of the National Strategic Development Plan 2014-2018 (NSDP) and 4 years after the expected completion of the Project. Water supply areas of Pursat and Svay Rieng in the target year are shown in Annex-3, respectively. 14 communes in 3 districts in Pursat and 12 communes in 3 districts in Svay Rieng shall be set as proposed water supply area.

The Team evaluated as below:

- Per Capita Consumption per day in the target year is set at 120L in Pursat and 125L in Svay Rieng based on the record from both waterworks during 2014 to 2016.
- Leakage ratio is estimated based on the non-revenue water ratio. Non-revenue water ratio is set at 12% in Pursat and 11% in Svay Rieng based on the record from both waterworks during 2014 to 2016.
- Day max. factor is set at 1.2 for both cities based on the record from both waterworks during 2014 to 2016.
- Existing water treatment plant capacity in the target year is set at 7,260m³/day in Pursat and 4,560m³/day in Svay Rieng. However, those capacities are to be confirmed by reviewing the scope of the ADB's Rehabilitation Project.

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- It is requested that we should consider economic growth and commercial consumption when we estimate water demand.

3. Site for New Water Treatment Plant (WTP)

Site for New Water Treatment Plant for Pursat City

To select the site of a new water treatment plant in Pursat, the Team made a preliminary evaluation for eleven candidate sites, proposed by the Cambodian Side (refer to **Figure A4-1**).

As a result of discussion among the MIH, Pursat provincial waterworks and the Team, three sites (No.04, 05 and 06) were selected as candidate locations.

The reason for selection of No.04, 05 and 06, is to be located at the middle points between the potential water source (Dhamnak Ampil Headwork) and the water supply area including future expansion supply area. In addition, these sites are more adequate locations than the others to distribute water to the supply area efficiently.

Site for New Water Treatment Plant for Svay Rieng City

To select the site for a new water treatment plant in Svay Rieng, the Team made a preliminary evaluation for three candidate sites, proposed by the Cambodian Side (refer to **Figure A4-2**).

As a result of discussion among the MIH, Svay Rieng provincial waterworks and the Team, one site (No.02) was selected as a candidate location for new water treatment plant.

The reason of selection for No.02 is that it is to be located at the point relatively close to the proposed intake location and the water supply area including future expansion supply area. In addition, this site is an adequate location to distribute water to the supply area efficiently.

4. Others

Next Actions

After returning to Japan, the Team finalizes each item on consultation with JICA, which is subject to change. The results will be explained to the Cambodian Side at the start of the second field survey.

Data Request

The Team would like the Cambodian Side to deal with the following items under request from the Team by the due date. The Team wishes to report the results as below:

Table 1. Items under request from the Team

No.	Items under request	Due date
1	Data and information on the ADB rehabilitation of the existing water treatment facilities and pipeline in Svay Rieng	July 31, 2017
2	Hydrological and Meteorological data from MOWRAM	July 31, 2017
3	Reply letter on Water Rights from MOWRAM	July 31, 2017
4	Data and information on the ADB rehabilitation of the existing water treatment facilities and pipeline in Pursat	July 31, 2017
5	Priorities at the village level to be added to new water supply areas in Svay Rieng, requested by Cambodian Side	July 31, 2017

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Annex-1 Comparison of Alternative Intake Sites along the Pursat River

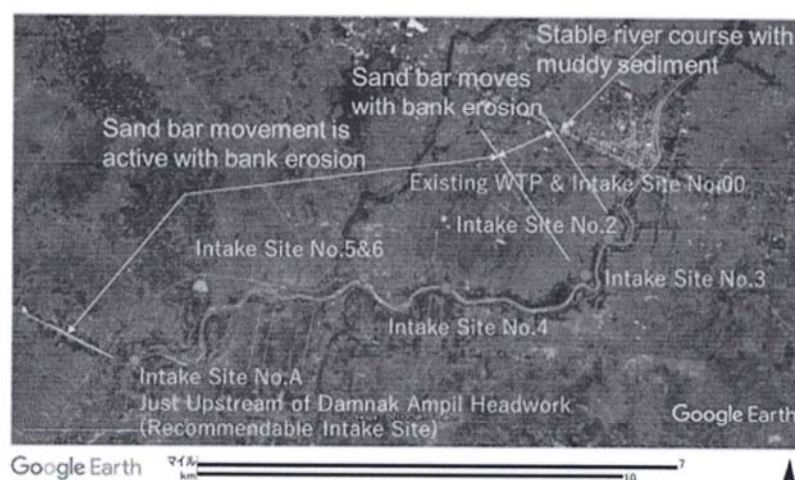


Figure A1-1 Candidate Intake Sites along the Pursat River

Table A1-1 Assessment of the Candidate Intake Sites for Domestic Water Supply along the Pursat River

Site No.	km from the existing intake	River Reach	Stability of River Course	Water Depth in Dry Season	Discharge in Dry Season	Sediment	Inundation during Flood	Site Suitability for Intake
No.00	20m upstream	Downstream	Stable	Enough near the left bank	Enough	Rather big muddy sediment in rainy season	About 1m inundation by 2006 Flood	Not so suitable
No.2	1.8km upstream near school	Downstream	Not so stable due to movement of sand bars	Shallow near the left bank	Enough	Rather big sediment with mud and sand	Not clear	Not suitable
No.3	3.0km upstream	Transition of mid-stream / downstream	Not so stable due to movement of sand bars and bank erosion	Shallow near the left bank	Enough	Rather big sediment with mud and sand	Not clear	Not suitable
No.4	6.2km upstream	Mid-stream	Not stable due to active movement of sand bars with bank erosion	Enough near the left bank	Enough	Big sandy sediment	Not clear	Not suitable
No.5 and No.6	8.1km upstream	Mid-stream	Not stable due to active movement of sand bars with bank erosion	Enough near the left bank	Enough	Big sandy sediment	Not clear	Not suitable
No. A	15.9km upstream at 15m U/S of Damnak Ampil Headwork	Mid-stream	Stable by Damnak Ampil HW's storage area	Enough near the left bank	Enough	Sandy sediment deposit in the storage area with some extent	0.3m over ground by 2006 Flood	Suitable & Recommendable

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Annex-2 Comparison of Alternative Intake Sites in the Vay Kor Lake

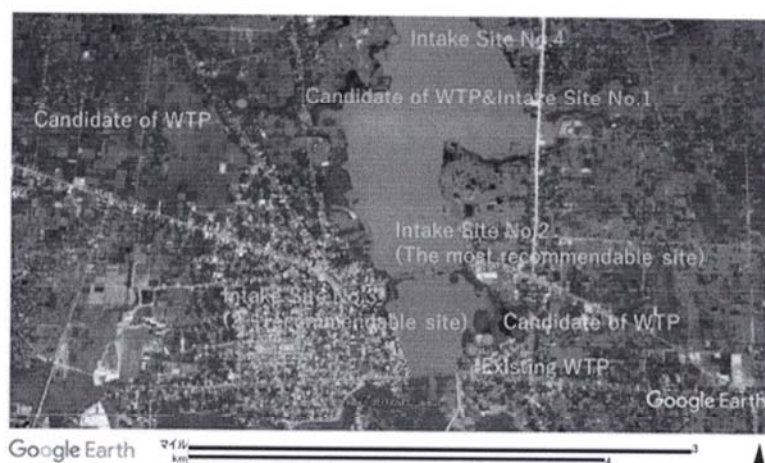


Figure A2-1 Candidate Intake Sites in the Vay Kor Lake

Table A2-1 Assessment of the Candidate Intake Sites for Domestic Water Supply in the Vay Kor Lake

Site No.	Km upstream from Vay Kor Dam	Water Surface from Bank in Dry Season	Water Depth	Inundation Floods	Environmental Protection Area	Site Suitability for Intake
No.1	About 2.6km at right bank	Long distance with about 300 to 400m from the bank	Shallow	Bank is almost equal to the max. WL of 2011 Flood	N/A	Not suitable
No.2	1.0km at right bank and upstream side beside the NR1 Bridge	Near within about 10 to 20m from the road dike of NR1	Enough	No inundation. Max. WL during 2011 Flood was about 0.5m below the shoulder of the road cum dike.	N/A	Suitable and the most recommendable site with facing bigger lake area in northern side.
No.3	760m at right bank along the road cum dike between Vay Kor Dam and NR1	Near within about 20 to 30m from the bank	Enough	No inundation. Max. WL during 2011 Flood was about 0.1 to 0.3m below the shoulder of the road cum dike.	Applicable	Not suitable
No.4	About 3.5km at right bank	Long distance with about 100m from the bank. Only small access road, which car cannot enter. No electricity line.	Shallow	Bank is almost equal to the max. WL of 2011 Flood	N/A	Not suitable

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Annex-3 Water Supply Area

Tentative distribution mains in the requested area by Cambodian Side are shown in Figure A3-1 and Figure A3-2. Both sides confirmed that based on the priority of pipe extension plan, required distribution pipelines will be further considered. The priority will be confirmed based on the population, existence of other measures to obtain the drinking water and poverty condition etc.

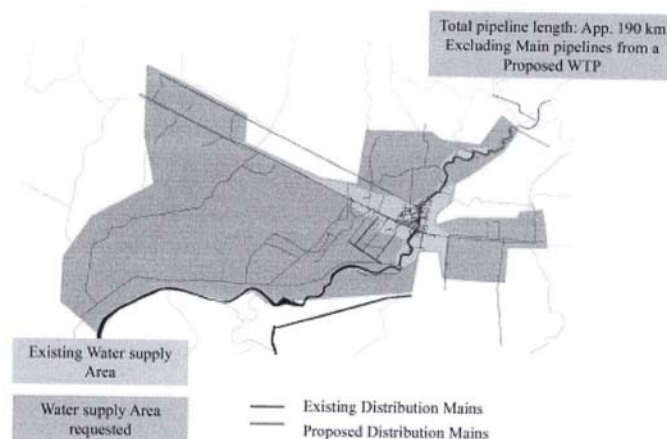


Figure A3-1 Distribution Mains in Pursat

Note) The length of the pipeline is tentative and will be further examined.

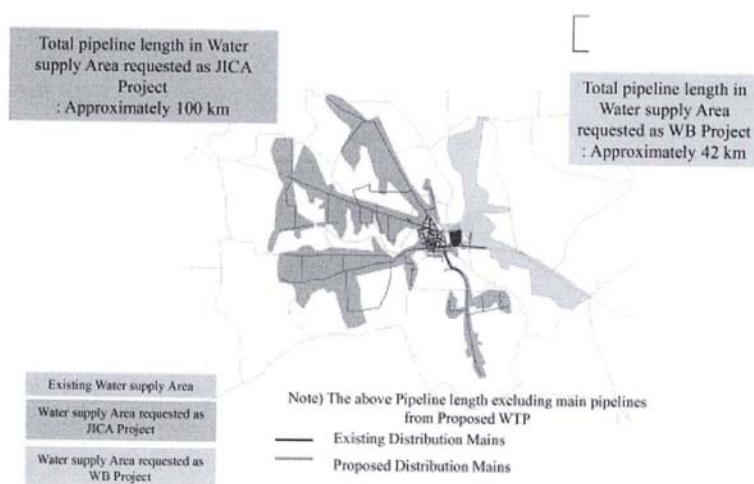


Figure A3-2 Distribution Mains in Svay Rieng

Note) The length of the pipeline is tentative and will be further examined.

Project support area will be determined with the further study on the basis of the priority plan prepared by the waterworks.

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Annex-4 Candidate Site for New WTP

Eleven candidate sites for new water treatment plant in Pursat were proposed by Cambodian Side as shown in Figure A4-1.

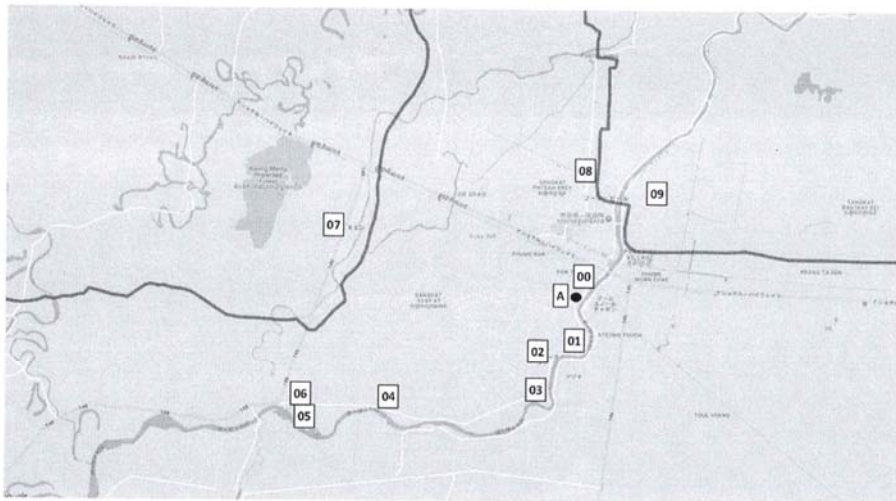


Figure A4-1 Candidate Site for New WTP in Pursat

Three candidate sites for a new water treatment plant in Svay Rieng were proposed by the Cambodian Side as shown in Figure A4-2.

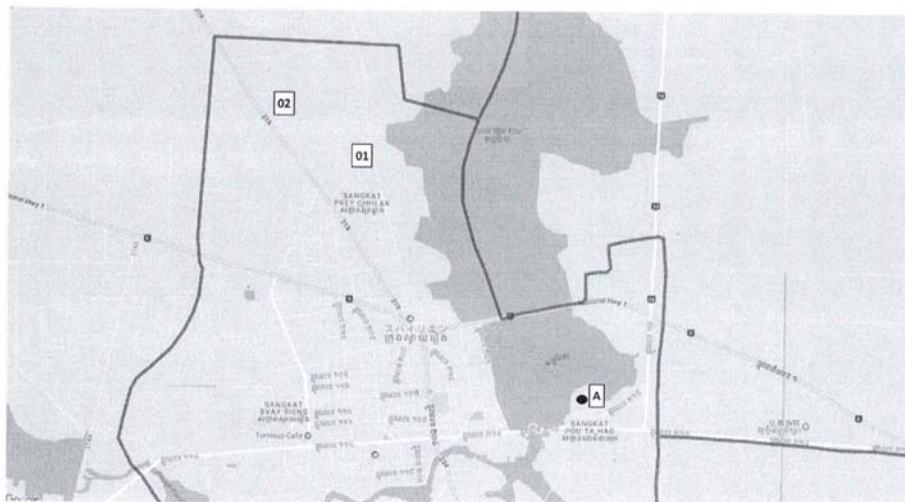


Figure A4-2 Candidate Site for New WTP in Svay Rieng

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1-2 The second Technical Note

The second Technical Note is attached as follows.

TECHNICAL NOTES
ON
THE PREPARATORY SURVEY ON THE PROJECT
FOR EXPANSION OF WATER SUPPLY SYSTEM
IN PURSAT AND SVAY RIENG
IN THE KINGDOM OF CAMBODIA

Based on the Minutes of Discussions (hereinafter referred to as "M/D") on the Preparatory Survey on the Project For Expansion of Water Supply System in Pursat and Svay Rieng in the Kingdom of Cambodia (hereinafter referred to as "the Project") signed on August 24th, 2017 between Japan International Cooperation Agency (hereinafter referred to as "JICA") and Ministry of Industry and Handicraft (hereinafter referred to as "MIH"), of the Government of Cambodia, the consultant members of the JICA Preparatory Survey Team (hereinafter referred to as "the Team") had a series of discussions and conducted field surveys from August 9th and will continue until September 4th, 2017.

As a result of the discussions and the surveys, both sides (MIH and the Team) confirmed the technical conditions described in the attached sheets of this note.

It should be noted that this technical note does not mean the commitment of the project scope, project implementation, design and method to be implemented. The final project scope, project implementation, designs, etc. will be decided by the Government of Japan.

Phnom Penh, September 1st, 2017



Dr. Sreng Sokvung
Director
Department of Technical and Project Management
Ministry of Industry and Handicraft (MIH)



Mr. Hideki KONNO
Chief Consultant
Preparatory Survey Team
Japan International Cooperation Agency (JICA)

ATTACHMENT

Both sides agreed upon and confirmed the following items.

Pursat**1. Location of Water Intake and Water Treatment Plant (WTP)**

The Team explained the comparison results of the new intake site alternatives in the Pursat River with combination of the new WTP candidate sites as shown in **Annex-1**.

Case 1: New Intake Facility at upstream of Dhamnak Ampil Headwork and the new WTP at Site No.5

- New intake site in the impounding area of Dhamnak Ampil Headwork at about 220m upstream from the Headwork.
- New WTP site at Site No.5
- Raw water transmission pipeline from the new intake site to the new WTP (L= about 8km)

Case 2: New Intake Facility at just upstream of the existing Intake Pumping Station and new WTP at Site No.2

- New intake site at about 50m upstream from the existing Intake Pumping Station.
- New WTP site at Site No.2
- Raw water transmission pipeline from the new intake site to the new WTP (L= about 1.5km)

Comparison was conducted by comprehensive way from the viewpoints of water sources, sediment problem to the intake facility, investment cost, operation and maintenance (O&M) including replacement of equipment, O&M cost, and social problems.

Case 1 has advantage in much higher stability of water source, less sediment problem, less investment cost and less social problems. Disadvantage is higher on O&M cost. There is less flooding problem around the new WTP site at Site No.5 (inundation depth of about 1m in 1996 and 2006 Floods).

Case 2 has rather stable water sources, but less stable than Case 1. Case 2 has more sediment problem, higher investment cost and less O&M cost. Case 2 has more social problems especially related to the access road to the new WTP. Furthermore, the new WTP site is located in the flood inundation area during 1996 Flood and 2006 Flood with inundation depth of about 2m.

- Based on the above comparison results, Japanese side (JICA and the Team) and Cambodian Side (MIH, Pursat District of Industry and Handicraft (DIH) and Pursat Waterworks) agreed to select the Case 1 on the Minutes of Discussion signed on August 24 in 2017.
- Furthermore, considering the problem of damage to the existing intake pump and the importance of sediment settling facility in the existing WTP, both sides agreed that coarse and fine sediment up to 0.08mm diameter is to be removed as much as possible just after taking water from the impounding area of Dhamnak Ampil Headwork before sending water from the Intake facility to the New WTP at

Site No.5 by using pump. For this purpose, sediment settling facility will be installed at the new intake site.

2. Intake Facilities

The Team explained alternative intake pumps such as vertical mixed flow pumps and horizontal end suction pumps. The Team also recommended that it is better to adopt horizontal end suction pump because of easier maintenance and less consumable parts than vertical mixed flow pump which is now using in the existing intake pump station. MIH agreed to the recommendation.

With reference to the method of abstracting water from Pursat River, the Team explained two alternative methods such as open channel type (see **Figure A2-1** in **Annex-2**) and horizontal suction pipe with strainer which is the same water intake method as the existing facility. MIH agreed to adopt the open channel type because it is easy to clean out the sediment in the intake passage. The outline specification for intake facility is shown in **Table A2-1** in **Annex-2**.

Sluice gates shall be installed at the intake mouth of channel for stoppage of flowing water. Grit chambers were recommended to be constructed in front of the pump suction pit to remove sand. To protect from erosion, appropriate bank protection shall be constructed at extend of 20m length to upstream and downstream.

3. Land for WTP

To select the site of a new WTP, the Team made a preliminary evaluation for eleven candidate sites, proposed by the Cambodian Side (MIH, Pursat DIH and Pursat Waterworks) (refer to **Figure A3-1** in **Annex-3**).

As a result of discussion among MIH, Pursat provincial waterworks and the Team, one site (Site No.5) was selected as candidate location (refer to **Figure A3-2** in **Annex-3**).

The reason of selection for Site No.5 is to be located at the middle points between the potential water source (Dhamnak Ampil Headwork) and the water supply area including future expansion supply area. In addition, this site is most adequate than the others to distribute water to the supply area efficiently.

And MIH, Pursat provincial waterworks and the Team discussed the layout and design condition of new WTP which needs further discussion for finalization. (refer to **Figure A3-3** and **Table A3-1** in **Annex-3**).

MIH requested to the Team more detail information about comparison of the alternative WTP layouts. The Team agreed to provide more detail information and continuous discussion with MIH.

4. Future Supply Area and Distribution System

The Team and MIH agreed on the future supply area shown in **Annex-4**. The number of related water supply areas are 13 communes in 3 Districts.

The area was comprehensively decided in terms of the piped water supply service ratios in the area, especially in the urban area, investment efficiency and sustainability of water supply operation, based on the results of the preliminary studies including case setting of the study area, estimation of increased population served and increased maximum daily supply in the area, preliminary design of whole water

supply facilities, cost estimation for initial construction, renewal, operation and maintenance, and cost-benefit analysis.

The Team explained the design policy (draft) as shown in **Annex-5** to Cambodian side (MIH, Pursat DIH and Pursat provincial waterworks) and Cambodian side agreed the design policy. The Team explained the alternative concept of the distribution system in Pursat as shown in **Table A6-1** in **Annex-6**.

- Alternative (A): Distribution pumps directly distribute water to the service area.
- Alternative (B): Distribution pumps directly distribute water to the service area and also send water to elevated tank to regulate the distribution flow or control water pressure in the service area.

MIH requested more detail information about merit and demerit of the above two alternatives. The Team agreed to provide more detail information and continuous discussion with MIH.

5. Demand Projection

MIH requested the Team to conduct water demand projection in 2025, which is the target year of the National Strategic Development Plan 2014-2018 (NSDP) and 4 years after the expected completion of the Project. MIH explained that the target service ratio shall be 90 % by piped water and remaining 10% will be covered by other measures. The Team explained that the design service ratio on this Project will be about 85% for urban area. The definition of urban area is based on the “Reclassification of Urban Areas in Cambodia, 2011 by National Institute of Statistics, Ministry of Planning”.

The Team explained other factors for the demand projection as below;

- Future population is based on the following information.
 - Results of 1998, 2008 and 2013 census.
 - Village level population data between 2006 to 2015 from Pursat provincial waterworks.
 - Village level population data from the study result of JICA technical assistance project “The Project on Capacity Building for Water Supply System Phase 3 in Cambodia”
- Water supply areas of Pursat in the target year are 13 communes in 3 districts shall be set as proposed water supply area.
 - Per Capita Consumption per day for domestic water in the target year is set as 100L based on the record from Pursat provincial waterworks during 2014 to 2016.
- Non-revenue water ratio is set to 15% based on the ministerial ordinance of the MIH. Leakage ratio is set to 11.3% which is 75% of non-revenue water ratio based on past experience of similar projects.
- Day max. factor is set as 1.2 for both cities based on the record from both waterworks during 2014 to 2016.
- Existing WTP capacity in the target year is set as 7,260m³/day.

The Team explained that based on the estimation, the capacity needed by the Project in 2025 is about 6,600m³/day for Pursat.

6. Social and Environmental Considerations

MIH agreed to play the main role of conducting Initial Environmental Impacts Assessment (IEIA) and Public Hearing. Both sides agreed that the IEIA report should be prepared by the firm which has the license of

Ministry of Environment. Both sides (MIH and the Team) confirmed that the resettlement would not occur in the project implementation and the land acquisition would be conducted in accordance with the JICA guidelines.

7. Land Acquisition by Cambodian Side

- Cambodian side (MIH, Pursat DIH and Pursat Waterworks) promises to acquire land for intake and WTP facilities by December 31, 2017.

8. Securing of Water Intake Permission

- MIH issued the letter to Ministry of Water Resources and Meteorology (MOWRAM) for water right for urban water supply in the beginning of June, 2017. The Team requested MIH to secure permission from MOWRAM for intake amount at the agreed location by September 15, 2017.

9. Confirmation of the Request

Cambodian side (MIH, Pursat DIH and Pursat Waterworks) requested the following items to be procured under this Project.

Item		Contents
Equipment	Water quality analyzer	Distillation apparatus, Micro scope, Reagents, Glassware, pH meter, Turbidity meter, UPS, Jar Tester, Residual Chlorine meter, Conductivity meter, Spectrophotometer, Refrigerator (for reagent)
	Maintenance tools of Electrical and Mechanical	Power tester, Vibration checker, Torque Wrench, Handy Flow Meter, Filtration Sand Tester
	Accounting system	SUMS System
	Distribution management tools	Pipe laying (socket fusion)

10. Schedule of the Project

The project schedule for expansion of water supply system in Pursat is as follows.

Item	2017												2018					
	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June				
Preparation in Japan	□																	
First Field Survey in Cambodia	■	■	■															
Work in Japan				□														
Second Field Survey in Cambodia				■														
Analysis in Japan					□	□	□	□	□	□	□	□	□	□				
Briefing Outline Design to Cambodian Side											■							
Submission of Preparatory Survey Report																	△	
Key Meetings with Cambodian Side	△	△		△							△							

11. Others

- Regarding operation and maintenance for new facilities, the Team recommended strengthening capacity for financial management such as utilization of SUMS system and recruitment of new staff and their training.
- MIH explained that they are on the process of preparing criteria, standards, and guidelines for water supply planning and design for more than 5,000 house connections.
- The Team explained major undertakings to be taken by the Recipient Government such as securing permission from related ministries for construction of facilities, connection of water supply pipe and meters, securing of access road for construction, drawing of electricity line, proper operation and maintenance of facilities and various tax exemption to purchase of the products and/or the services.
- As for the individual house connection for poor households, necessity of provision of the materials such as water meters, fittings and pipes in the Project will be examined in consideration of similar projects. MIH and the Team confirmed that MIH will bear the cost for installation works.
- MIH provides temporary yards and dump sites in Pursat for the Project. MIH acquired the candidate sites as shown in following table and figure as of August 2017. If these sites are not available for the Project in future, MIH shall prepare alternative sites which are same size.

Information of temporary yards and dump sites in Pursat (refer to **Annex-7**)

No	Purpose of use	Size	Area
①	Temporary Yard	100m x 200m	2.0ha
②	Temporary Yard	300m x 300m	9.0ha
③	Temporary Yard	100m x 15m	0.15ha
④	Dump Site	70m x 105m	0.74ha
⑤	Dump Site	55m x 210m	1.16ha

Svay Rieng

1. Possibility of Water Sources and Modification of the Preparatory Survey

The Team explained the following problems of Vay Kor Dam. By these problems, it is not possible to secure long-term safety of taking raw water from the Vay Kor Lake. Photos and sketch of Vay Kor Dam structure are shown in **Annex-8**.

a) Scouring around foundation

There is a possibility of causing damage to Vay Kor Dam or possibility of collapsing the Dam (even partially) due to recurrence of scouring at the foundation portion of the Dam. If the Dam is damaged, water in Vay Kor Dam will flow out, and the reservoir will be empty.

b) Deterioration of the reinforced concrete and supporting walls

There is a possibility of causing damage to the structure of Vay Kor Dam or possibility of partial collapsing of the Dam due to deterioration of the supporting walls and concrete walls of the Dam.

c) Insufficient stability of the dam structure

Vay Kor Dam cannot secure the stability against sliding and overturning with or without of riprap in the downstream side as counterweight. If the Dam is collapsed (even partially), water will flow out from the Lake.

d) Insufficient flood discharge.

Flood safety level of Vay Kor Dam is low with only 5 to 10-year return period of floods due to insufficient discharge capacity of the overflow portion of the Dam. Normally, the flood safety level of this kind of Dam (weir) should be more than 50-year return period of flood.

In addition, the discharge capacity of the Bridge at just downstream of Vay Kor Dam is also small.

There is a risk of overflowing over the Road Dike in the south end of the Lake during bigger floods such as flood of more than 20-year return period of floods. If this occurs, the Road Dike will collapse (even partially), and water in the reservoir will flow out and the reservoir will be empty.

Cambodian side (MIH, Svay Rieng DIH and Svay Rieng Waterworks) understood the above problems of Vay Kor Dam.

MIH and the Team also understood that it may be difficult or take long time to reconstruct Vay Kor Dam for ensuring the structural stability and securing enough safety against floods and scouring. Also, it may be difficult or take long time to improve the Road Dike for securing enough safety against floods.

Finally, Cambodian side expressed their expectation of continuing the Preparatory Survey by changing water source from surface water to groundwater.

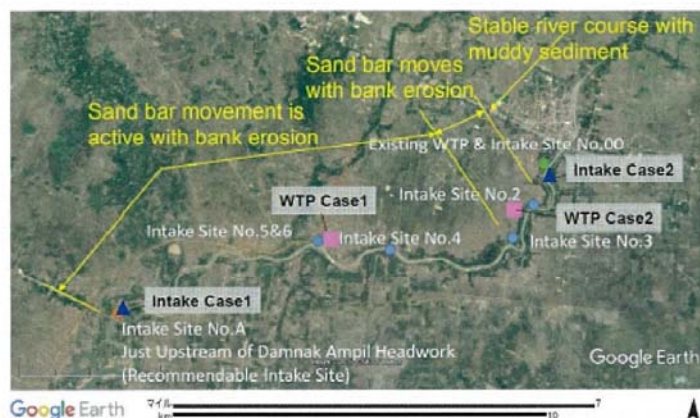
Considering the expectation, the Team will study necessary modification of the contents and schedule of the Survey for Svay Rieng, and will inform the results to Cambodian side. The Team also explained the necessity of additional surveys on groundwater source in Svay Rieng such as geophysical survey, test well drilling survey, pumping test survey and so on.



2. Further Study for Expansion of Water Supply System in Svay Rieng

The following survey and study will be conducted in the next field survey after the revision of project contents and schedule for Svay Rieng.

- Confirmation of Land for New WTP.
- Future Supply Area and Distribution System
- Demand Projection
- Confirmation of the Request Items
- Securing of Permission from MOWRAM for Water Right

Annex-1 Intake and WTP Site in Pursat



	Case1 (Intake : Dhamnak Ampil, WTP : No.5)	Case2 (Intake : near the existing intake point, WTP : No.2)
Plan Drawing		
Outline of Intake Site and Facilities	<p>Site Condition</p> <ul style="list-style-type: none"> - WL Condition: LWL+16.300m, HWL+18.200m - Water Level Fluctuation: 1.9m - Land: 100mx100m (Intake and Yard for Construction) - 1.0m of inundation depth from the ground in 1996 and 2006 <p>Civil Work</p> <ul style="list-style-type: none"> - Conveyance Pipe: DIP350 x 8,000m - Pump Room and ancillary works : LxWxH=37.3mx8.4mx10.5m - Generator Room: LxWxH=6mx5mx4m - Land Creation: 0.5m up (EL18.070m→EL18.570m) <p>Temporary Work</p> <ul style="list-style-type: none"> - Cofferdam of River Side, Steel Sheet Pile SP-III - Excavation by Open Cut <p>Mechanical Works</p> <ul style="list-style-type: none"> - Pump Type: Horizontal End Suction Pump - Pump Head: 37m - Pump : 150mm/ 2duty +1 stand-by/ 30kW - Q=5.04m³/min 	<p>Site Condition</p> <ul style="list-style-type: none"> - WL Condition: LWL+11.635m, HWL+17.635m - Water Level Fluctuation: 6.0m - Land: 50mx50m, Residential houses are adjacent. (Intake and Yard for Construction) - Flood Prone Area, 2.0m of inundation depth from the ground in 1996 and 2006 <p>Civil Work</p> <ul style="list-style-type: none"> - Conveyance Pipe: DIP350 x 1,500m - Size of Pump Room and ancillary works : LxWxH=44.0mx8.1mx14.5m - Generator Room: LxWxH=6mx5mx4m - Land Creation: 2.0m up (EL16.135m→EL18.135m) <p>Temporary Work</p> <ul style="list-style-type: none"> - Cofferdam of River Side, Steel Sheet Pile SP-IV - Retaining Wall for Civil Work Construction SP-IV <p>Mechanical Works</p> <ul style="list-style-type: none"> - Pump Type: Horizontal End Suction Pump - Pump Head: 21m - Pump : 150mm/ 2duty +1 stand-by/ 15kW - Q=5.04m³/min
Outline of WTP Site and Facilities	<p>Site Condition</p> <ul style="list-style-type: none"> - Candidate Site No.5 - Area: 100mx100m - 1.0m of inundation depth from the ground in 1996 and 2006 - Distance from the River: Approx. 400m 	<p>Site Condition</p> <ul style="list-style-type: none"> - Candidate Site No.2 - Area: 100mx100m, Elementary school is adjacent. - Flood Prone Area, 2.0m of inundation depth from the ground in 1996 and 2006 - Distance from the River: Approx. 400m - 4 Residential Houses along Access Road

		Case1 (Intake : Dhamnak Ampil, WTP : No.5)	Case2 (Intake : near the existing intake point, WTP : No.2)
		Civil Work - Land Creation: 1.0m up (EL17.650m→EL18.650m) - Land Creation of Access Road: not Required (EL18.650m) Temporary Work - Access from the Main Road	Civil Work - Land Creation: 2.0m up (EL15.260m→EL17.260m) - Land Creation of Access Road: 1.0m (EL16.260m→EL17.260m) Temporary Work - Construction Road: L=500m, W=10m
Status of the water source	Stability of water intake	<input type="radio"/> Stable river channel <input type="radio"/> Proven track records of the water intake for the irrigation <input type="radio"/> Sufficient amount of water and water depth in the dry season	<input type="radio"/> Stable river channel <input type="radio"/> Located near the existing water intake facilities (upstream side) <input type="radio"/> Sufficient amount of water and water depth in the dry season
	Situation of sediment	<input type="radio"/> Coarse sand and a certain amount of floating sand accumulate in the flooded pond of the weir. <input type="radio"/> The flow is relatively slow because of the wide flooded pond, and the migration and floating of the silt part are less. <input type="radio"/> Sedimentation volume is less than Case2 and the damage to the intake pump will be less.	<input checked="" type="radio"/> Move of sandy soil (bedload, floating sand wash load) is relatively large. <input checked="" type="radio"/> The flow is relatively fast and the silt is easy to move and float. <input checked="" type="radio"/> Sedimentation volume is more than Case1 and the damage to the pump will be more.
Construction	Workability	<input type="radio"/> Large-scale temporary facilities are unnecessary because changes in the water level during the dry season and rainy season are small. <input type="radio"/> The traffic of heavy construction machinery is easy because of flat ground shape and the stability of heavy construction machinery can be secured. <input type="radio"/> Easy access from the main road. <input type="radio"/> Construction period for pump station is relatively short because the scale of the facilities (sedimentation basin and pumping station) are smaller than Case 2. <input checked="" type="radio"/> It takes time to install conveyance pipes because of long distance.	<input checked="" type="radio"/> Large-scale temporary earth retaining work is required, because changes in the water level during the dry season and rainy season are large and houses are adjacent to facilities. <input checked="" type="radio"/> The traffic of heavy construction machinery is difficult due to the narrow space of intake site and the stability of rough terrain crane with vibro hammer cannot be secured due to the unevenness of ground surface shape. <input checked="" type="radio"/> It is difficult to carry in/out construction vehicles, because the access road to the WTP is narrow and passes through a residential area. It is required the embankment and widening of the existing access road, or the provision of new construction road. <input checked="" type="radio"/> Construction period for pump station is relatively long because the scales of the facilities (pump station and ancillary works) are larger than Case 1. <input type="radio"/> The conveyance pipe is short, so the construction period is short.
	Impact on surrounding environment	<input type="radio"/> Neighboring construction is not required because there are few adjacent houses at the intake pump station and the WTP site. <input type="radio"/> There is no houses near the WTP site <input type="radio"/> There is no important facilities near WTP site.	<input checked="" type="radio"/> Neighboring construction is required because there are houses around the intake facility. <input checked="" type="radio"/> Impact on houses by widening the access road to the WTP site. <input checked="" type="radio"/> Using the school route of elementary school as the access road to the treatment plant is not preferred for safety reasons. It must be set such as the detour path or the temporary school road. In addition, there is the possibility that adverse effects on the school activities by noise and vibration during the construction will occur. Therefore, measures must be taken against them.

		Case1 (Intake : Dhamnak Ampil, WTP : No.5)	Case2 (Intake : near the existing intake point, WTP : No.2)
Facilities	Civil engineering facility	<ul style="list-style-type: none"> ○ Both pumping station and ancillary works of the water intake point are smaller than those of Case 2. ○ The risk of flooding is small, and the height of land forming is low. ▲ The water conveyance pipe extension is long (8.0 km). 	<ul style="list-style-type: none"> ▲ Both pumping station and ancillary works of the water intake point are larger than those of Case 1. ▲ Since WTP site is in flood prone, it is necessary to raise the ground (<u>about 2 m. in 1996 and 2006</u>). ○ The water conveyance pipe extension is relatively short (1.5 km).
	Electromechanical equipment	▲ Large motor output. Electricity cost is higher than Case2.	○ Small motor output. Electricity cost is lower than Case1.
Operation and Maintenance		<ul style="list-style-type: none"> ○ The cleaning and parts exchange frequency of the sand sedimentation is low. ▲ The distance is far between the WTP and the intake pump station. 	<ul style="list-style-type: none"> ▲ The cleaning and parts exchange frequency of the sedimentation basin is high. ○ Easy access between the WTP and the intake pump station
Cost	JPY	<ul style="list-style-type: none"> ○ Initial cost : 344,633 (thousand yen) : 36,531 (thousand yen/year) ▲ Running cost : 24,616 (thousand yen/year) 	<ul style="list-style-type: none"> ▲ Initial cost : 423,067 (thousand yen) : 44,845 (thousand yen/year) ○ Running cost : 22,054 (thousand yen/year)
	KHR	<ul style="list-style-type: none"> ○ Initial cost : 12,135 (million riel) : 1,286 (million riel/year) ▲ Running cost : 867 (million riel /year) 	<ul style="list-style-type: none"> ▲ Initial cost : 14,897 (million riel) : 1,579 (million riel/year) ○ Running cost : 777 (million riel/year)

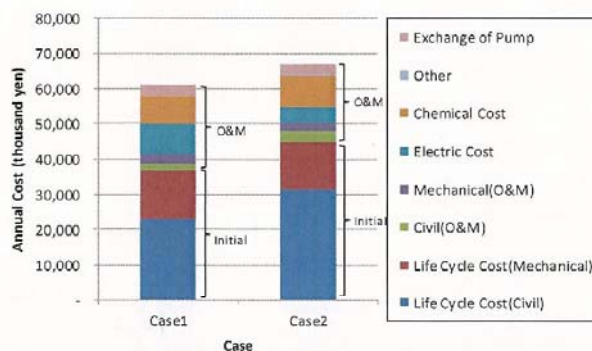
【JPY】

	Life Cycle Cost			O&M						Exchange of Pump	OM + Exchange of Pump	Total
	Civil	Mechanical	sub-total	Civil(O&M)	Mechanical (O&M)	Electric	Chemical	Other	sub-total			
Case1	22,928	13,603	36,531	2,163	2,567	8,801	7,759	75	21,365	3,251	24,616	61,147
Case2	31,660	13,185	44,845	2,987	2,488	4,401	8,819	208	18,902	3,151	22,054	66,899

【KHR】

	Life Cycle Cost			O&M						Exchange of Pump	Unit: Million Riel/Year	
	Civil	Mechanical	sub-total	Civil(O&M)	Mechanical (O&M)	Electric	Chemical	Other	sub-total		OM + Exchange of Pump	Total
Case1	807	479	1,286	76	90	310	273	3	752	114	867	2,153
Case2	1,115	464	1,579	105	88	155	311	7	666	114	777	2,356

Note: O&M cost of civil work is 1% of initial cost. The initial cost of civil work includes the cost of temporary work.



Note:

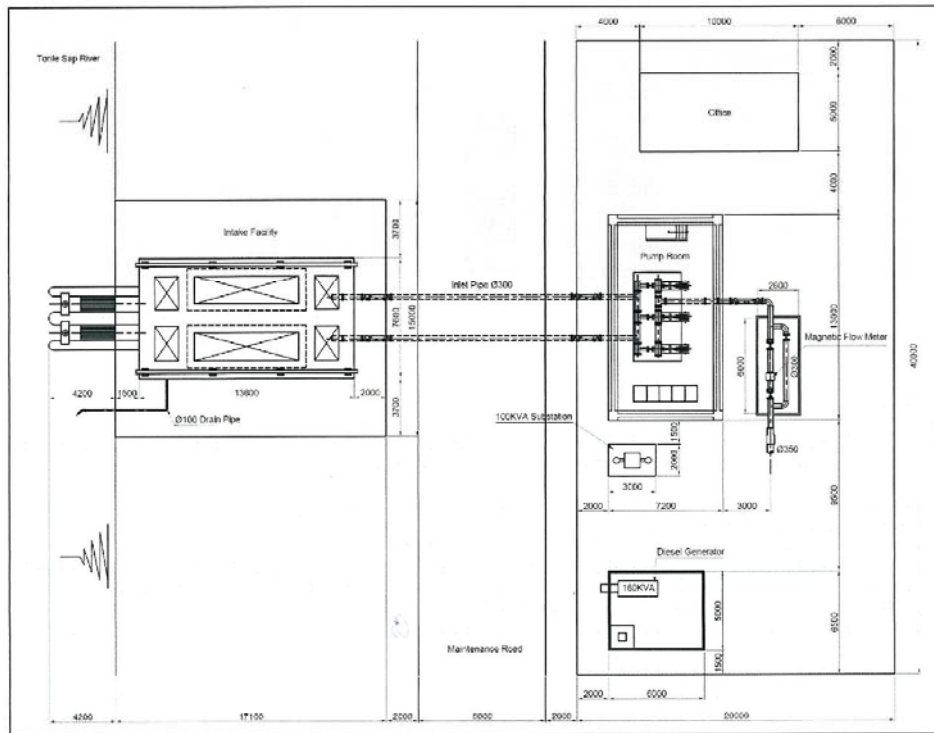
- 1 JPY=approx. . 37.4 riel(as of August 24, 2017)
2. The above comparison is based on the cost for yearly basis during lifecycle time.
3. The gap of electricity cost between Case 1 and Case 2 is approximately 4,400,000 yen/year (approx.164, 560,000 riel) . The gap of cost for 30 years is approximately 75,000,000 yen as the present value
4. Initial costs are calculated by annual expense ratio (cost ratio for 1 year) during the life cycle (30 years). The annual expense ratio is calculated by the following equation:

$$\text{Annual expense ratio} = r/(1-(1+r)^{-n})$$
 where, r: Interest Rate, n: Operation Years
5. Replacement Cost for vertical axis pump with inclined flow is estimated by pump life (15 years). The cost for replacement is the cost incurred by replacement taking the discount rate at the time of replacement into account to calculate the present value. The discount rate is calculated by the following formula:

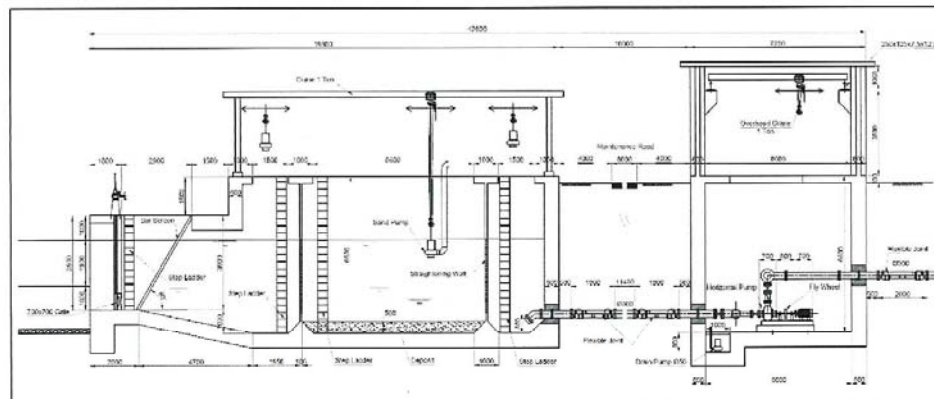
$$\text{Discount Rate} = 1/(1+r)^n$$
 where, r: Interest Rate, n: Operation Years

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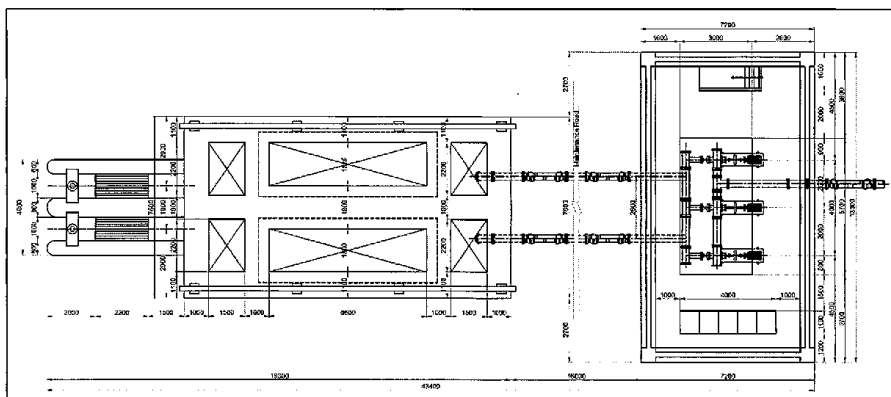
Annex-2 Intake Facility



Layout of Intake Facility



Section

**Plan****Figure A2-1 General Drawing of Intake Facility****Table A2-1 Outline Specification for Intake Facility**

No.	Item	Specification
Mechanical		
1	Standards	ISO, IEC, JIS, JEC
2	Pump type	Horizontal, end suction volute pump
3	Spare pump	1 set
4	Number of duty pump	2 set
5	Flow control system	Pump quantity control by manual
6	Intake type	Open channel type
7	Counter measure of water hammer	Flywheel type
8	Discharge method of sand	Sand submersible drainage pump
9	Crane type	Manual type, overhead crane
10	Intake screen	Steel bar screen
11	Sand discharge	Pursat river
12	Flange standard	ISO PN10
Electrical		
1	Standards	ISO, IEC, JIS, JEC
2	Monitoring items transmitted to WTP	<ul style="list-style-type: none"> - Flow rate - Integrate trouble - River side and pump pit water levels - Pump operation - Electric power source
3	Signal transmission method	Internet communication line
	Substation	22/0.4kV from EDC power line, received in pump station
4	Water flow meter	Magnetic type flow meter, installed in pit
5	Level meters	4-20mA signal, installed river and pump pit
6	Emergency diesel generator	100% capacity for all loads
7	Capacity of fuel tank	For 10hrs operation
8	Power factor at WH meter	0.95
9	Rated voltage of motors	380V/3-phase and 220V/single phase

Annex-3 Location and Layout of New WTP in Pursat

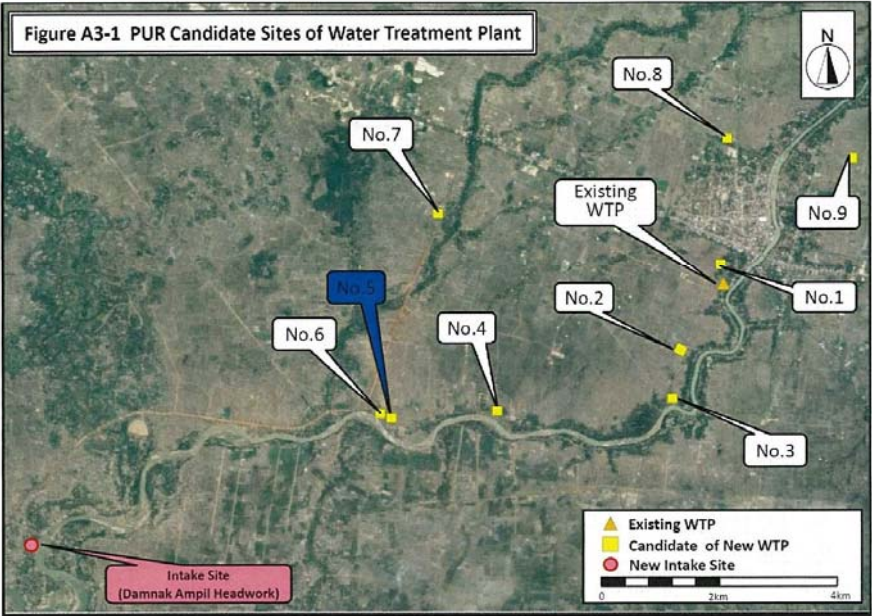


Figure A3-1 Candidate Site of New WTP

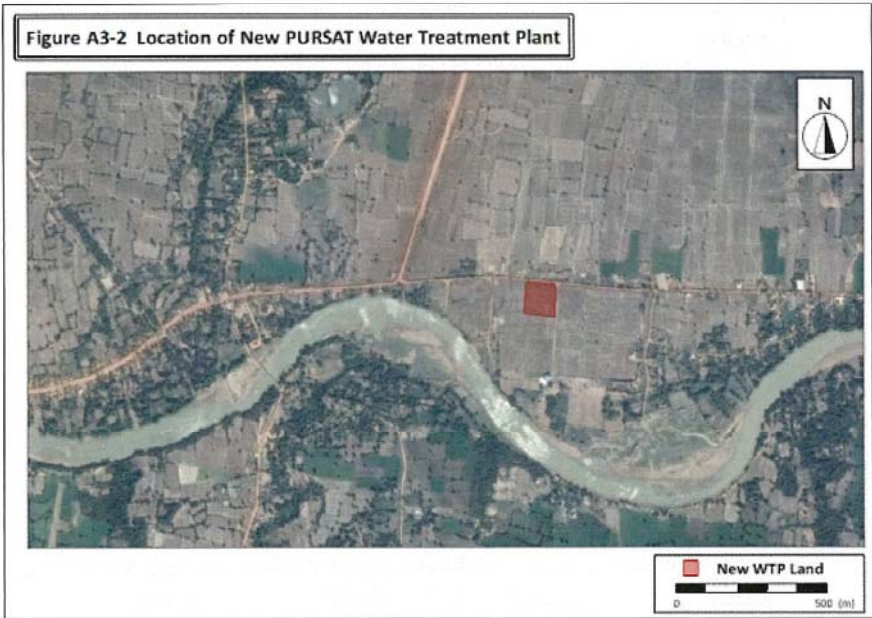


Figure A3-2 Location of New WTP

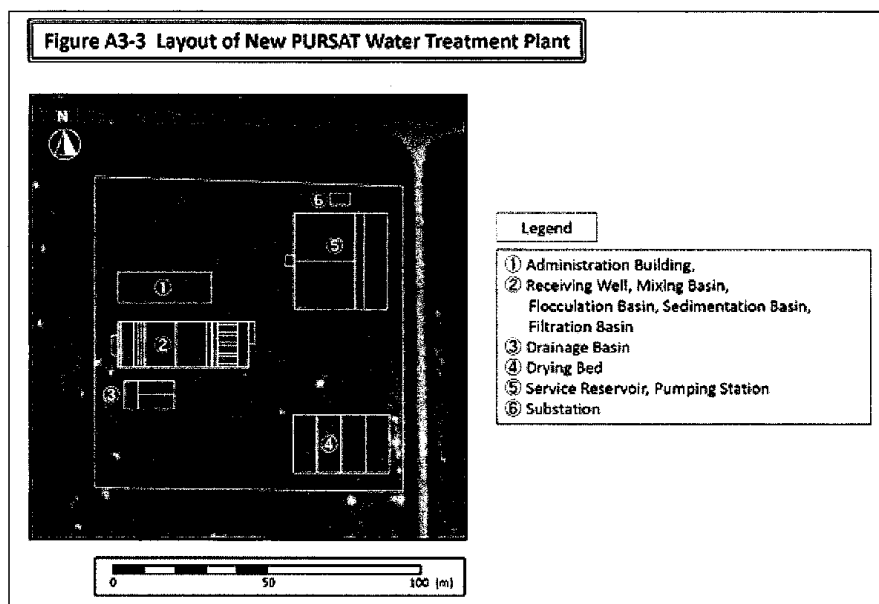


Figure A3-3 Layout of New WTP (one of the alternative layouts) 8

Table A3-1 Design Condition of New WTP

Name of Equipment & Facilities, etc.	Design criteria applied to the project			Reference		
				Japanese Design Criteria	Example of similar projects in Cambodia	Request
Civil Architectural Mechanical Electrical Raw Water	Selection of water treatment methods and water treatment facilities	Selection of water treatment methods	Pursat River	Well, River, Lake, Pond >Disinfection only >Slow sand filtration method >Rapid sand filtration method >Membrane filtration method >Advanced treatment method >Other treatment method	River	River
				Rapid sand filtration method	Rapid sand filtration method	
	Wastewater treatment	Sludge treatment type (Sludge of Sedimentation Basin) Wastewater treatment type (backwashing water of filter)	Drying bed>>To carry out the dried sludge cake and dispose of it. Returning from the wastewater basin to the receiving well. The one basin has two divisions with a perforated baffle. More than 1.5min (Target value: about 3min)	>Drying bed >Machine dehydrator >Dehydrating thermal dry	Drying bed >>To carry out the dried sludge cake and its dispose. Returning from the wastewater basin to the receiving well. The one basin has two divisions with a perforated baffle. Retention time about 3min	
				Two divisions. Drainage facilities and overflow facilities More than 1.5min		
	Receiving well	Structure and volume		>Aluminum sulfate >Polyaluminum chloride >Ferric chloride >Polysilicic iron >Lime >Sodium carbonate >Sodium hydrate >Methods to give mechanical energy from outside >Methods to utilize the energy of water flow	Aluminum sulfate Lime	PAC (Polyaluminum chloride) Lime
Feeding facility of coagulants	Coagulants	Coagulant type	PAC (polyaluminum chloride)			
	Acid and alkali agents		Lime			
Mixing basin	Structure and type		Methods to utilize the energy of water flow itself (Weir type)		Methods to utilize the energy of water flow itself (Weir type)	

Name of Equipment & Facilities, etc.	Design criteria applied to the project			Reference		
				Japanese Design Criteria	Example of similar projects in Cambodia	Request
Flocculation basins				itself(Weir type, partial flume type, water jump type)		
	Retention time		> 1-5 min (Target value : about 1.5 min)	1 - 5 min	1-2min	
	Structure and type		Methods to utilize the energy of water flow itself		Methods to utilize the energy of water flow itself	
	The number of basins		2 basins		2-4 basins	
	Shape		Roundabout flow type	>Mechanical stirring method > Roundabout flow type > Horizontal zigzag flow type	Roundabout flow type	
Chemical sedimentation basin	Retention time		Retention time 20 - 40min	20 - 40 min	Retention time 26.4 - 60.9 min (Dry season)	
	Composition and structure		Intermediate takeout type sedimentation basin	>Horizontal flow type sedimentation basins >Sloping-plate (tube) type sedimentation basin (Horizontal flow) >Sloping-plate (tube) type sedimentation basin (Upward flow) >Suspended solid contact clarifier	Intermediate takeout type sedimentation basin	
		Number of basins	2 basins	Over two basins principally.	2-4 basins	
		Effective depth	3 - 4m	3 - 4m	3.5-4.12m	
	Horizontal flow sedimentation basin	Overflow rate	Standard range 15 - 30mm/min (Target value : about 20mm/min)	>Single-floored type: Standard range 15 - 30mm/min >Multi-story type: Standard range 15 - 25mm/min	Surface Load: Q/A=19-20.0mm/min	
	Desludging facilities		Desludging valves (Cleaning the inside of sedimentation basin every two month)	Apply a proper method. Close at power outage.	Desludging valves (Cleaning the inside of sedimentation basin every	

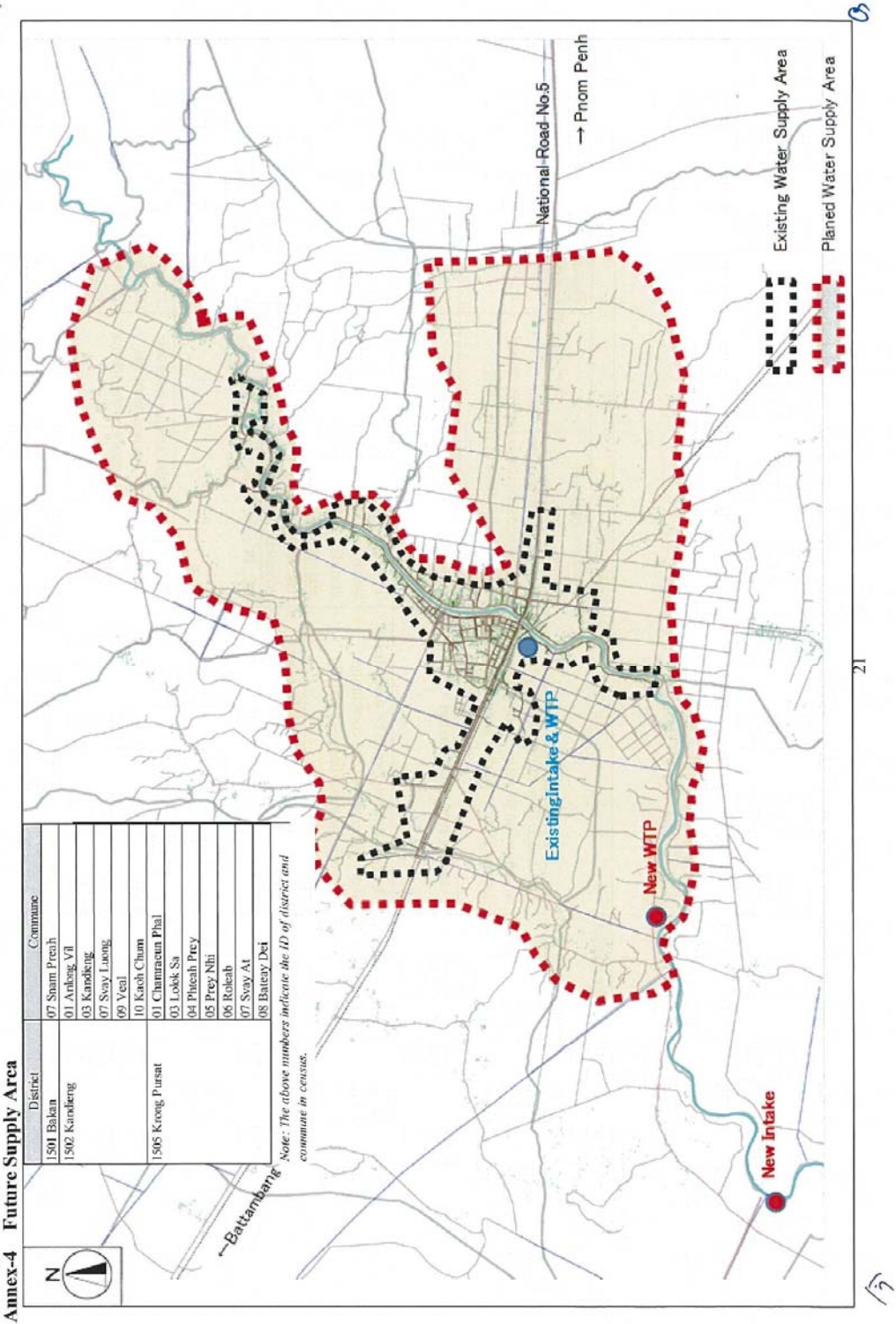
Name of Equipment & Facilities, etc.	Design criteria applied to the project			Reference		
				Japanese Design Criteria	Example of similar projects in Cambodia	Request
					two month)	
Rapid sand filters	Structure and type		Gravity type	Gravity filtration (Standard)	Gravity type	
	Filter bed area, number of filter units and shape	Filter units	4 basins	Over two basins	6 basins	
		Standby filter units	Nothing	One basin per ten basins	Nothing	
		Filter bed area	Less than 150m ² per one basin	The filter bed area per filter shall be less than 150 m ² .	17.5m ² (From the drawings)	
	Filtration rate controller	Shape	Rectangle	Rectangle	Rectangle	
			Downstream flow control method	A device to control the flow of filtration shall be installed.	Downstream flow control method	
	Filtration rate		120 - 150m/d (Target Value: About 120m/d)	120 - 150m/d	120m/d(about.)	
	Filter sand and its depth	Effective diameter	Effective diameter 1.0mm	0.45 - 0.75 mm (for surface washing)		For Backwash + Air wash
		Uniformity coefficient	Uniformity coefficient less than 1.7	Don't describe for Airwash Less than 1.7		
		Depth of sand	Depth of sand 100cm	60 - 70cm	Depth of sand: 100cm	For Backwash + Air wash
Disinfection facilities	Underdrain system		Porous plate type Only nozzle block type	>(Perforated) block type >Strainer(nozzle) type >Perforated pipe type >Porous plate type	Porous plate type block type	
	Type of washing		Backwash + Air wash	>Backwash+Surface wash >Backwash + Air wash	Backwash + Air wash	
	Types of chlorine agents, dosage and points of dosage	Type of chlorine agents	Powder (Calcium hypochlorite)	>Sodium hypochlorite >Liquid Chlorine >Calcium hypochlorite	Liquid Chlorine	Powder (Calcium hypochlorite)
		Points of dosage	Mixing basin Outlet of sand filter	>Receiving well >Chlorine mixing chamber >The entrance to the clear	Mixing basin Outlet of sand filter	

Name of Equipment & Facilities, etc.	Design criteria applied to the project			Reference		
				Japanese Design Criteria	Example of similar projects in Cambodia	Request
				water		
Drainage basin	Number of basins Water Depth	2 basins 2 - 4m		More than two basins 2 - 4m	2 basins Internal dimensions of one basin	
Drying bed	Number of beds Water Depth	4 beds More than 1m		More than two beds More than 1m	4beds	
Administration Building		3 floors >Administration office, Laboratory, Control room, Meeting room, Chemical feeding room (PAC, Lime, Powder Chlorine), Storage space of pipe material			3 floors >Administration office, Laboratory, Generator, Control room, Meeting room, Chemical feeding room (PAC, Lime)	Pursat WW's request to prepare the storage space of pipe material.
Chemical building		Not construct (The space include Administration Building)			Container room, Chlorinator room, Neutralization room	Chlorine agents : Powder chlorine (Not chlorine gas)
Pump Station		Pumps, Panels, Generator,			Pumps, Panels,	Pursat WW's requires the generator to be changed to be installed elsewhere. The Team propose it to be installed Pump Station.
Electrical Standard		ISO, IEC, JIS, JEC, JEM			ISO, IEC, JIS, JEC, JEM	
Substation		22/0.4kV from EDC power line, received in WTP		Depend on EDC (Electricity of Cambodia)	22/0.4kV from EDC power line, received in WTP	
Emergency diesel generator		100% capacity for all loads			100% capacity for all loads	
Load Power Factor		More Than 95%			More Than 95%	EDC requirement
Motor Rated Voltage		380V			380V	
Motor for Distribution Pump		Variable Speed Motor			Variable Speed Motor	
Method of Speed control		Discharge Pressure control			Discharge Pressure control	
Filter Control		Automatic Control			Automatic Control	
Monitoring Panel of		Self- Standing Graphic Panel			Self- Standing Graphic	

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Name of Equipment & Facilities, etc.	Design criteria applied to the project			Reference		
				Japanese Design Criteria	Example of similar projects in Cambodia	Request
WTP					Panel	
Monitoring system			Flow rate & Pump operation status		Flow rate & Pump operation status	



Annex-5 Draft Facility Planning and Design Policy for Water Supply Facilities (Raw Water Transmission and Distribution System)

- Design Policy on Raw Water Transmission And Distribution System
The selection of suitable routes of laying of transmission mains and distribution mains, the durability, prevention of water pollution in the transmission mains, the ease of maintenance, economic benefits, energy efficiency

■ Design Criteria

Facilities	Design criteria applied to the project			Reference	Example of similar projects in Cambodia
				Japanese guideline	
Raw water transmission	Design flow of raw water transmission		The design flow of raw water transmission facilities shall be based on the design flow of raw water intake.	The design flow of raw water transmission facilities shall be based on the design flow of raw water intake.	
	Type of raw water transmission		Pumping type, pipe conduit	Pumping type, pipe conduit	
	Raw water transmission mains	Pipe diameter	The pipe diameter shall be determined in consideration of the correlation between the pipe diameter and the annual cost.	The pipe diameter shall be determined in consideration of the correlation between the pipe diameter and the annual cost.	
		Flow velocity	The flow velocity shall be the most economic velocity	The flow velocity shall be the most economic velocity	
Service reservoir	Structure and type		RC	RC, PC, SS, SUS	Pursat: RC, Rectangle Kampong Cham: RC, Rectangle Battambang: RC, Rectangle Kampot: RC, Rectangle
	Capacity		The capacity of the service reservoir shall be 8 hours equivalent of the maximum daily supply of the service area. The firefighting water to be added to the above capacity (if necessary)	The capacity of the service reservoir shall be 12 hours equivalent of the maximum daily supply of the service area. The firefighting water to be added to the above capacity.	Pursat: 7.8 hours Kampong Cham: 5.2 hours Battambang: 6.5 hours Kampot: 3.5 hours
	Water depth	water depth	3~6m	3~6m	Pursat: 5.5m Kampong Cham: 3.8m

Facilities	Design criteria applied to the project			Reference Japanese guideline	Example of similar projects in Cambodia
Distribution mains	Distribution pump		Based on pipe network analysis H-W equation C=110	Based on pipe network analysis H-W equation C=110	Battambang: 4.3m Kampong Cham: RC, Rectangle Battambang: RC, Rectangle Kampot: RC, Rectangle
	Design distribution flow		The design maximum hourly distribution flow in the service area The ratio (K) of the design maximum hourly distribution flow to the average hourly flow shall be determined with reference to the experiences or the condition in the region with similar characteristics. K=1.5	The design maximum hourly distribution flow in the service area The ratio (K) of the design maximum hourly distribution flow to the average hourly flows shall be determined with reference to the experiences or the condition in the region with similar characteristics. K=1.5-2.0	
	Water pressure	The minimum dynamic water pressure	More than 50- 100 kPa (0.05 0.10 MPa)	More than 100-150 kPa (0.10-0.15 Mpa)	
		The maximum static water pressure	Less than 740 kPa (0.74 MPa)	Less than 740 kPa (0.74 MPa)	
	Pipe diameter		Based on pipe network analysis H-W equation C=110	Based on pipe network analysis H-W equation C=110	

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Annex-6 Draft Distribution System and Alignment of Pipelines

Table A6-1 Comparison of conceptual design for Distribution System

	Alternative (A)	Alternative (B)
Description	<ul style="list-style-type: none"> Distribution pumps in new WTP directly distribute water to the service area. The existing distribution pumps in the existing WTP directly distribute water to the modified service area having water demand amount corresponding to the capacity of those pumps /WTP. 	<ul style="list-style-type: none"> Distribution pumps in new WTP directly distribute water to the service area and also send water to elevated tank to regulate the distribution flow or control water pressure in the service area. The existing distribution pumps in the existing WTP directly distribute water to the modified service area having water demand amount corresponding to the capacity of those pumps /WTP.
Schematic illustration		
The ease of operation and maintenance	<ul style="list-style-type: none"> Easy compared to B 	<ul style="list-style-type: none"> A service reservoir is separately provided in the new WTP, and the distribution pressure is regulated by means of controlling pumps or inlet valves in relation to the water depth in the elevated reservoir. A little difficult compared to A.
Construction cost	<ul style="list-style-type: none"> Slightly cheaper compared to B Construction cost includes a service reservoir, distribution pumps, and distribution mains. 	<ul style="list-style-type: none"> More expensive compared to B Construction cost includes a service reservoir, distribution pumps distribution mains and an elevated tank.

	Alternative (A)	Alternative (B)
Energy efficiency	Total head of distribution pumps are comparable and B, energy saving can be expected by the inverter installation. Equivalent to Alternative B	Total head of distribution pumps are comparable and A, energy saving can be expected by the inverter installation Equivalent to Alternative A
	Recommendable	

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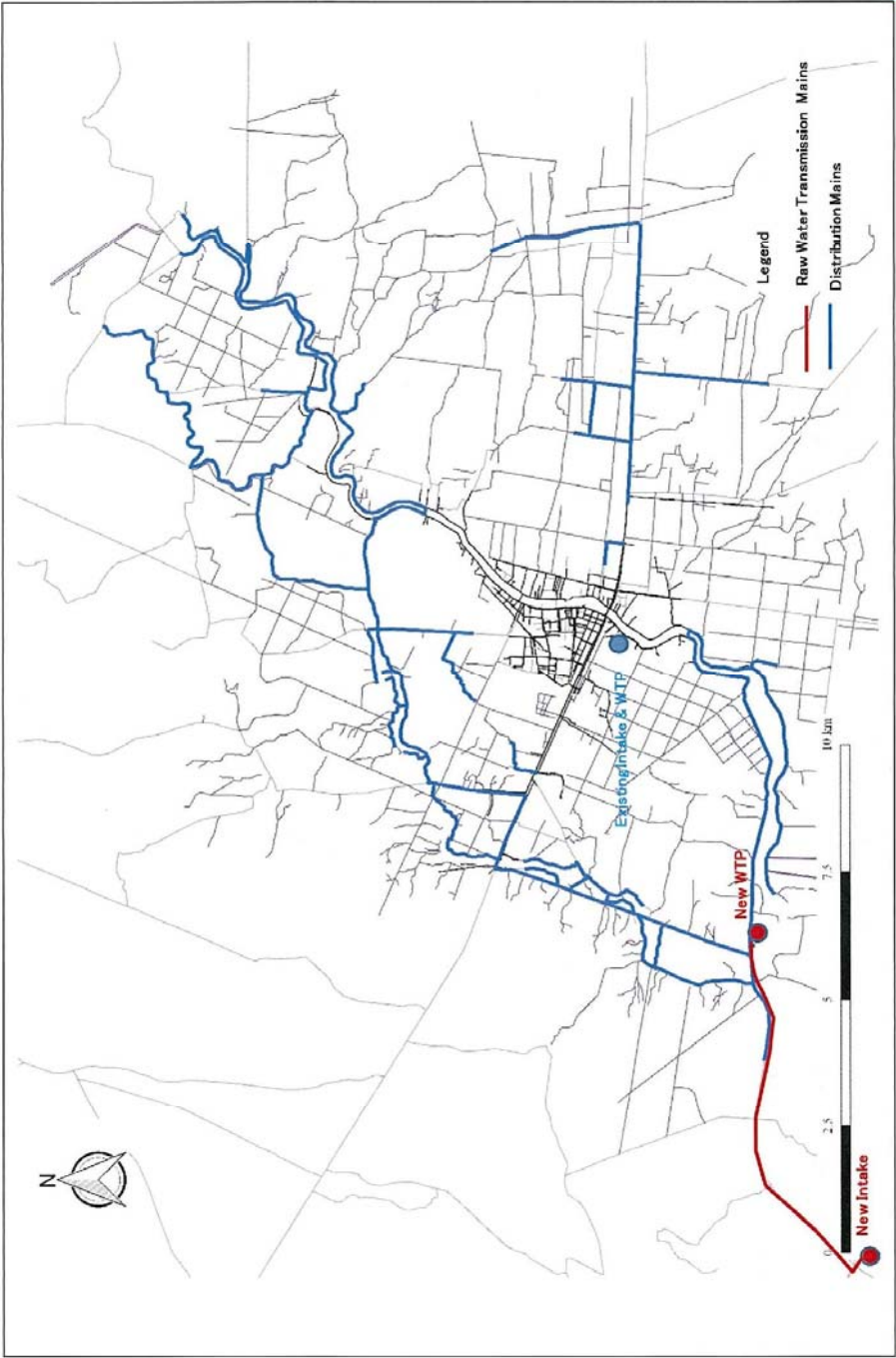


Figure A6-1 Alignment of Pipeline

Annex-7 Location of Temporary Yards and Dump Sites in Pursat

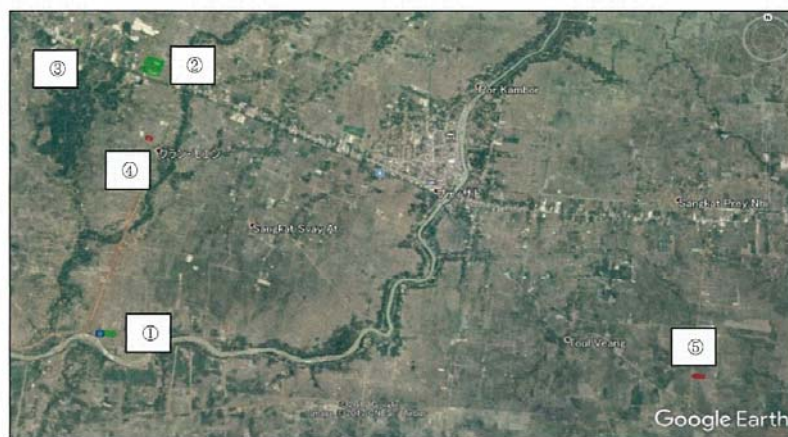


Figure A7-1 Site Location of Temporary Yards and Dump Sites in Pursat

Annex-8 Photos and sketch of Vay Kor Dam Structure



Figure A8-1 Vay Kor Dam During Placing Cobles (Left) and After Placing Cobles (Right) against Scouring in the Downstream Side of the Dam

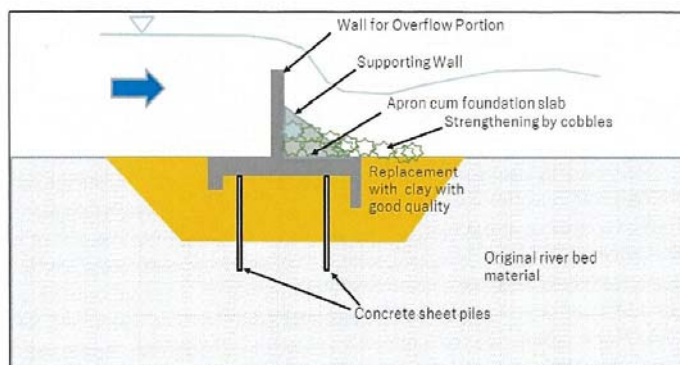


Figure A8-2 Sketch of the Structure of Vay Kor Dam (based on the Information from DOWRAM Svay Rieng Province)

1-3 The first Technical Note for Design Change

The first Technical Note for design change is attached as follows.

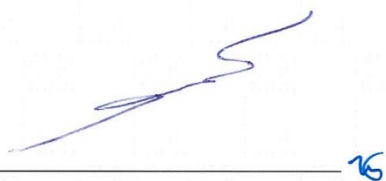
TECHNICAL NOTES
ON
THE PREPARATORY SURVEY ON THE PROJECT
FOR EXPANSION OF WATER SUPPLY SYSTEM
IN PURSAT AND SVAY RIENG
IN THE KINGDOM OF CAMBODIA

Based on the Minutes of Discussions (hereinafter referred to as "M/D") on the Preparatory Survey on the Project For Expansion of Water Supply System in Pursat and Svay Rieng in the Kingdom of Cambodia (hereinafter referred to as "the Project") signed on August 24th, 2017 ,and Second Preparatory Survey for the Project signed on February 14th, 2019 between Japan International Cooperation Agency (hereinafter referred to as "JICA") and Ministry of Industry and Handicraft (hereinafter referred to as "MIH"), of the Government of Cambodia, the consultant members of the JICA Preparatory Survey Team (hereinafter referred to as "the Team") had a series of discussions and conducted field surveys from March 17th and will continue until April 12th, 2019.

As a result of the discussions and the surveys, both sides (MIH and the Team) confirmed the technical conditions described in the attached sheets of this note.

It should be noted that this technical note does not mean the commitment of the project scope, project implementation, design and method to be implemented. The final project scope, project implementation, designs, etc. will be decided by the Government of Japan.

Phnom Penh, April 10th, 2019



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ATTACHMENT

Both sides agreed upon and confirmed the following items.

1. Intake Facilities

The Team explained alternative intake facilities such as rail type and pontoon type intake facilities shown in Table 1.

Table 1 Comparison of Intake Facilities

Items	Case1 Rail Type Intake Facility	Case2 Pontoon Type Intake Facility
Photo		
Summary	<ul style="list-style-type: none"> - The intake pump unit (house) moves upward and downward following seasonal water level fluctuation of the river. The pump house will be pulled up by electrical winch. - Dry pumps are applied. 	<ul style="list-style-type: none"> - The intake pump unit (house) moves upward and downward following seasonal water level fluctuation of the river. - The electricity for pump house movement following the water level fluctuation is not required. - Submersible pumps are applied.
Characteristic	<ul style="list-style-type: none"> - It takes electric cost for pump house movement in response to the river water level. - Frequent pipe remove and reconnection will be required. - Frequent cleaning along the rail against deposited mud and accumulated waste materials. 	<ul style="list-style-type: none"> - The electric cost can be reduced. - It is no need to remove and reconnection of pipe materials frequently. - The truss unit and pipes are connected by flexible joint materials in order to follow the water level fluctuation.
Applicability		○

The Team explained that it is better to adopt pontoon type intake facility because of easier maintenance and less electric cost than rail type intake facility. MIH agreed to adopt pontoon type intake facility whose drawing and specification shown in **Figure A1-1** and **Table A1-1**. The maintenance items for pontoon type intake facility are (1) cleaning of flown litter, branches and leaves etc. around the pontoon, (2) periodical painting for rust prevention and (3) maintenance of the parts of intake pump such as impeller, shaft and bearing etc.

With reference to the method of settling the sedimentation at the intake site, the Team explained to provide sand basin (elevated type) instead of ground type sand basin on the original design. The MIH and Team agreed to adopt sand basin (elevated type) at the land side of intake facility site instead of ground type sand basin considering the cost estimation result and affordability of budget to provide the sand basin (elevated type) shown in sample **Figure A1-2**.

Cambodian side requested to have remote control system in new treatment plant, not only monitoring system for intake facility operation.

2. Design Coverage Area and Distribution System

The Team and MIH agreed to modify design coverage area and distribution system according to minutes of discussion (MD) on February 14th, 2019. The Team collected latest population data for administrative area and coverage area, and the Team also investigated current distribution system status to examine the proper water distribution system such as the range of coverage area and distributed metered area (DMA). The collected data for confirmation of distribution system status is such as distribution trend data, distribution pressure on 13 locations, residual chlorine data and pump operation sheet. The target survey areas are 13 communes in 3 districts. As a result, some villages in northern area of coverage area on original design are excluded from proposed coverage area based on the following reasons.

- The population in the existing coverage area is on the increasing trend.
- The daily maximum water supply amount based on the current distribution pump operation record exceeds 7,260m³/day of the existing water treatment plant capacity. There are some data that the water supply amount sometimes reaches to 8,000 m³/day.
- The water pressure monitoring result on 24 hours shows high water consumption in the existing coverage area especially around of Pursat Market.

Based on the above reasons, the Team proposed the following design policy for confirmation of design coverage area and distribution system;

- Some villages in northern area of coverage area on original design are excluded from proposed coverage area and some distribution pipes from coverage area on original design are removed.
- The existing coverage area shall be divided and classified into separate DMAs. The scale of DMA including existing water treatment plant shall be set in accordance with the capacity of existing water treatment plant. The other new DMA will enhance the distribution capacity of the existing coverage area by combining the part of the existing coverage area and new coverage area as the new DMA.
- Based on the above, revised figure of DMA is shown as “ALT_2” in **Figure 1**.

Based on the above design policy, the Team will conduct the project cost estimation and evaluate the proper level of pipe length reduction.

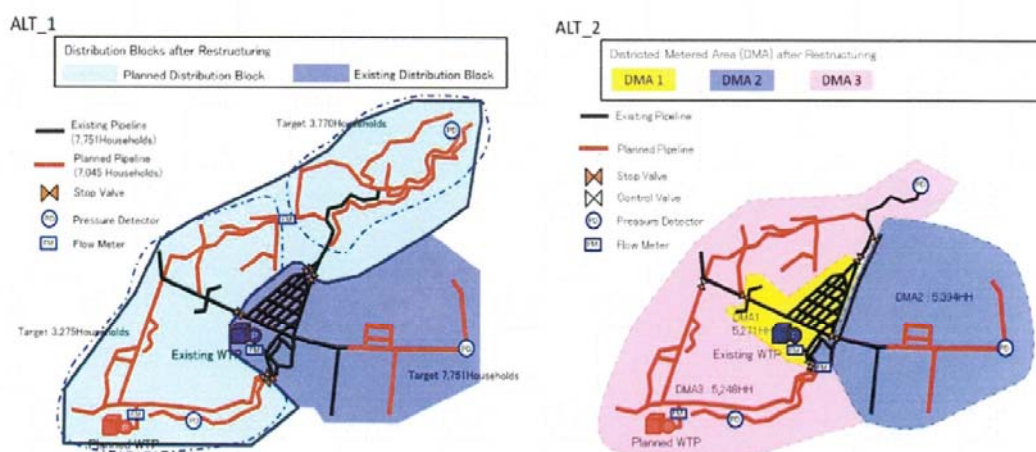


Figure 1 Illustration of DMA (Distributed Metered Area)

3. Demand Projection

MIH requested the Team to conduct water demand projection in 2025. By this year, the target water supply ratio of urban areas in provincial cities are disseminated in the MIH to be 100%. MIH explained that the target service ratio shall be 90 % by piped water and remaining 10% will be covered by other measures. The Team explained that the design water supply population will be 77,525 persons and the design service ratio on this Project will be about 88.6% for urban area (The service ratio for administrative area on this Project is 70.1%). The definition of urban area is based on the “Reclassification of Urban Areas in Cambodia, 2011 by National Institute of Statistics, Ministry of Planning”.

The Team explained other factors for the demand projection as below;

- Future population is based on the following information.
 - Results of 1998, 2008 and 2013 census.
 - Village level population data between 2006 to 2018 from Pursat provincial waterworks.
- 13 communes in 3 districts shall be set as proposed coverage area of Pursat in the target year
- Per Capita Consumption per day in the target year is set as 100L based on the record from Pursat provincial waterworks during 2014 to 2018. The consumption of industrial, public and commercial water supply amount is also estimated based on the trend of water supply amount during 2014 to 2018.
- Non-revenue water ratio is set to 15% based on the ministerial ordinance of the MIH. Leakage ratio is set to 11.3% which is 75% of non-revenue water ratio based on past experience of similar projects.
- Loading factor is set as 82.3% based on the record from waterworks during 2015 to 2018.
- Existing WTP capacity in the target year is set as 7,260m³/day.

The Team explained that based on the estimation, the capacity needed by the Project in 2025 is about 6,600m³/day for Pursat. Cambodian side agreed on it.

4. Social and Environmental Considerations

The Team explained the design change contents of intake facility such as pontoon type intake facility and sand basin (elevated type). The MIH confirmed to conduct the necessary procedures concerning the environmental assessment with assistance from the Team. The IEIA approval shall be received from the responsible authorities and submitted to JICA by the end of 2019.

5. Procurement of Equipment and Spare Parts

- As for the individual house connection for poor households, necessity of provision of the materials such as water meters, fittings and pipes in the Project will be examined in consideration of similar projects. Based on the information from Pursat WWs, 60 % of poor level 2 households can bear the pipe connection material cost by beneficiaries. The MIH and the Team agreed to reduce the procurement number of poor household's pipe connection materials covered by Japan side related to the part of poor level 2 households and the excluded northern part households from the coverage area.
- Cost reduction will be examined by following order as confirmed by minutes of discussion (MD) on February 14, 2019. On the other hand, with regard to the reduction of equipment shown in **Table-2**, since there are some items that cannot be procured in Cambodia such as laboratory equipment, Pursat

WWs requested to the Team not to reduce these items as much as possible. The Team explained that the reduction priority for equipment will be examined based on the result of project cost estimation after the completion of design change.

- 1) Change of procurement country of pipe and reduction of assessment rate, equipment and spare parts
- 2) Modification of coverage area
- 3) Change of intake facility
- 4) Change of pipe specification (pressure durability and flow coefficient)
- 5) Size reduction of sedimentation basin
- 6) Change of pipe specification (time coefficient)
- 7) Size reduction of clear water reservoir

Among the equipment items shown in **Table 2**, the Cambodian side agreed to reduce the items on shaded cells with priority in case that the project cost is not within the budget of the grant aid.

Table 2 Procurement of Equipment

Classification of Equipment to be Procured		Contents of Initial Request	Equipment to be Procure based on Field Survey Results
Procurement of Equipment	Sediment evacuation equipment for existing intake pit	-	One set of submersible sand pump, One set of power generator for driving submersible sand pump
	Equipment for Water quality management	Atomic absorption photometer, distillation equipment, microscope, reagents, glassware, turbidimeter, pH meter, UPS etc.	Jar tester, distilled water maker, pH meter, residual chlorine meter, conductance meter, water bath, microscope, continuous water quality analyzer for conductivity and residual chlorine, absorptiometer, UPS, microorganism analyzer, reagents, glassware, laboratory tables, etc.
	Equipment for electric machine	Power tester, detector, vibrometer, torque wrench, handy flowmeter, filter sand tester, insulation checker, etc.	Clamp power meter, vibration checker, mechanical torque wrench, portable ultrasonic flow meter and sieve shaker
	Equipment for management of distribution pipes	Leak detector, pipe detector, laying pipe equipment, pipe network information system etc.	Laying pipe equipment: Socket fusion
	Equipment and materials for house connection to poverty households	-	Water supply pipes, water meters and accessories
	Accounting system	-	SUMS System (PC and extra software license)

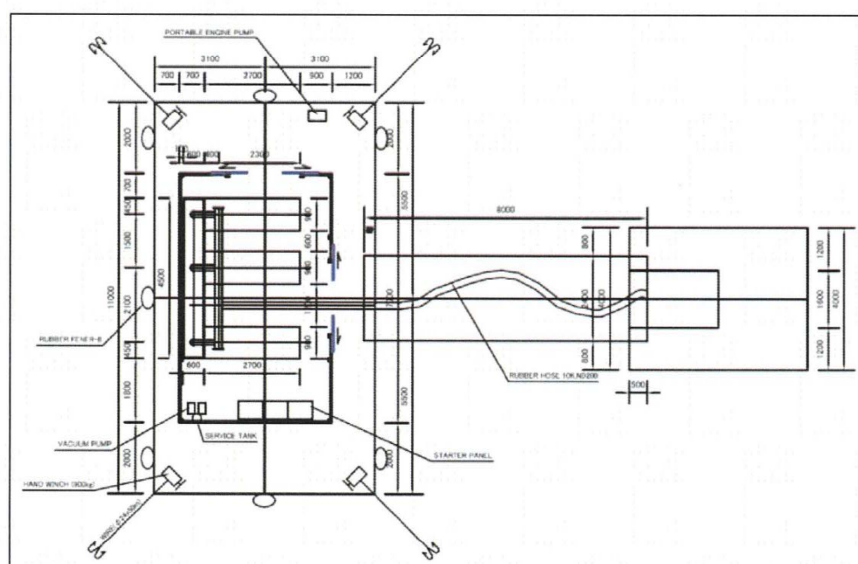
Source: JICA Survey Team

6. Schedule of the Project

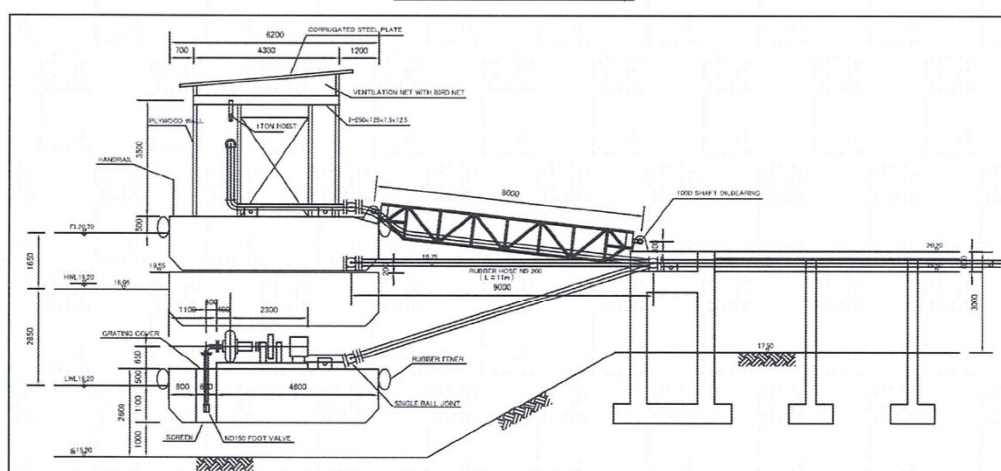
The project schedule for the time being for this project is as follows;

Items	2019											
	1	2	3	4	5	6	7	8	9	10	11	12
Preparation in Japan												
Field Survey in Cambodia												
Work in Japan												
Field Survey in Cambodia												
Analysis in Japan												
Briefing Outline Design to Cambodian Side												
Submission of Preparatory Survey Report												
Key Meeting with Cambodian Side												
Cabinet Meeting in Japan												

Annex-1 Intake Facility (draft)

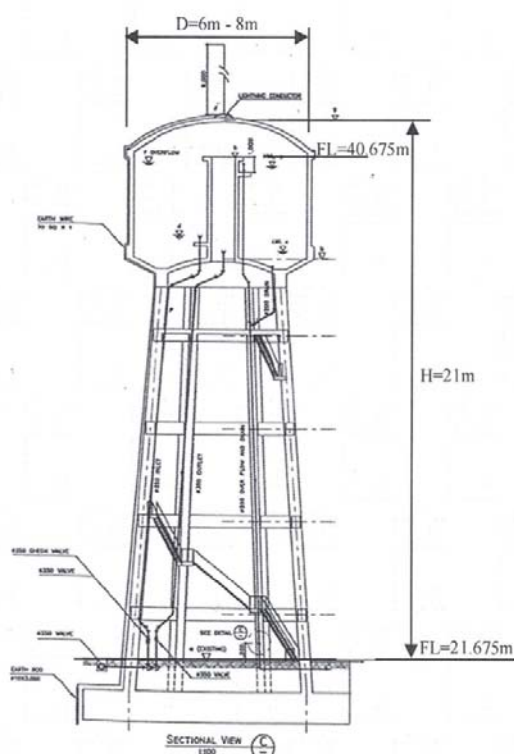


Plan of Intake Facility



Section

Figure A1-1 General Drawing of Intake Facility



Note: The dimensions are provisional values.

Figure A1-2 General Drawing (sample) of Sand Basin (elevated type)

Table A1-1 Outline Specification for Intake Facility

No.	Item	Detail	Specification (provisional value)
1	Intake Facility 7,260m ³ /day	Sand Basin (elevated type)	H=21m, D=6m-8m Inlet pipe ϕ 200(ϕ 100 x 3), Outlet pipe ϕ 350, Drain pipe ϕ 150 x 3, Overflow ϕ 200
2		Pontoon Facility	Floating barge L11.0m x W6.2 x H1.6m Equipped facility: incoming panel, control panels, intake pump (2.52m ³ /m x 3 sets), vacuumed pump 0.75kw, portable engine pump 4.7kw, suction hose ϕ 200, chain hoist 1t, hand winch
3		Generator House	Rectangular reinforced concrete structure Size: L9.0m x W7.5m x H3.5m (measuring under beam center of the walls) Equipped facility: generator, fuel tank, chain hoist 1t

Table-A2-1 Water Demand Projection

项 目		单位	式	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Population in Administrative Area	total	person	A	40,979	51,597	51,597	97,317	100,422	98,243	99,691	102,418	103,770	105,122	106,475	107,827	109,179	110,531
	urban	person		35,259	44,043	44,043	65,546	67,539	65,296	66,332	68,542	69,487	70,433	71,378	72,323	73,269	74,214
	rural	person		5,720	7,554	7,554	31,771	32,883	32,947	33,359	33,876	34,283	34,690	35,097	35,503	35,910	36,317
Population in Water Supply Area	total	person	B	40,979	51,597	51,597	56,330	57,994	57,546	57,288	59,279	60,007	60,736	61,465	62,194	62,923	63,652
	urban	person		35,259	44,043	44,043	46,851	48,137	47,566	47,118	49,086	49,694	50,301	50,908	51,515	52,122	52,729
	rural	person		5,720	7,554	7,554	9,479	9,857	9,977	10,170	10,192	10,314	10,435	10,557	10,678	10,800	10,921
Water Supply Population	total	person	C	24,652	29,773	32,549	33,772	35,682	36,885	37,661	39,921	40,719	41,533	42,377	43,257	44,169	45,081
	urban	person		22,011	26,584	29,063	29,976	31,843	32,912	33,658	35,677	36,391	37,119	37,972	38,861	39,789	40,729
	rural	person		2,641	3,189	3,486	3,796	3,839	3,973	4,003	4,243	4,328	4,415	4,406	4,496	4,589	4,681
Water Supply Ratio in Administrative Area	total	%	D = C/A x 100%	60.2	57.7	63.1	34.5	35.5	37.5	37.8	39.0	39.2	39.5	40.0	40.5	41.2	41.9
	urban	%		62.4	60.4	66.0	45.7	47.1	50.4	50.7	52.1	52.4	52.7	53.2	53.7	54.2	54.7
	rural	%		46.2	42.2	46.2	11.3	11.3	12.1	12.0	12.5	12.6	12.7	13.1	13.1	13.1	13.2
Water Supply Ratio in Water Supply Area	total	%	E = C/B x 100%	60.2	57.7	63.1	59.6	61.5	64.1	65.2	67.3	67.9	68.4	69.3	70.2	71.1	72.0
	urban	%		62.4	60.4	66.0	64.0	66.2	69.2	70.5	72.7	73.2	73.8	74.6	75.3	76.1	76.9
	rural	%		46.2	42.2	46.2	37.9	38.9	39.8	40.0	41.6	42.0	42.3	43.6	44.5	45.2	46.0
Water Supply Households	total	house	F	5,016	6,005	6,475	6,860	7,252	7,510	7,657	8,130	8,293	8,459	8,671	8,881	9,091	9,301
	urban	house		4,476	5,359	5,778	6,122	6,472	6,701	6,843	7,266	7,412	7,560	7,734	7,951	8,167	8,387
	rural	house		482	577	622	659	696	722	727	864	881	899	938	930	924	914
Water Supply Households (Poor Households)	total	house	G = F x poor household ratio	672	805	868	919	972	1,006	1,026	1,089	1,111	1,133	1,162	1,191	1,220	1,250
	urban	house		577	691	745	790	835	864	883	937	956	975	998	1,024	1,050	1,076
	rural	house		78	93	101	107	113	117	118	140	143	146	152	157	166	174
Average Water Consumption per Person per Day for Household	Average Water Consumption per Person	L/day/person	H	106.1	99.5	98.8	104.5	112.4	100.2	105.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Average Water Consumption per Day for Household	m ³ /day	I = H x C ÷ 1000	2,015	2,963	3,215	3,390	4,012	3,695	3,972	3,992	4,072	4,153	4,258	4,363	4,468	4,573
	Average Water Consumption per Day for Business and Institution	m ³ /day	J	390	454	538	829	1,037	1,228	1,259	1,459	1,607	1,755	1,903	2,051	2,199	2,347
Ineffective Water Amount	Effective Water Amount (total)	m ³ /day	K = I - J	3,005	3,417	3,753	4,338	5,049	4,923	5,231	5,451	5,679	5,908	6,161	6,414	6,667	6,920
	Ineffective Water Amount	m ³ /day	L = M - M x (R/100)	438	466	447	398	415	380	376	691	720	749	781	813	845	877
	Daily Average Water Supply Amount	m ³ /day	M = K ÷ R x 100	3,443	3,883	4,200	4,736	5,464	5,303	5,607	6,141	6,399	6,657	6,942	7,227	7,512	7,797
Average Water Consumption per Person per Day	Average Water Consumption per Person	L/day/person	N = M ÷ C x 1000	140	130	129	141	153	144	149	154	157	160	163	166	169	172
	Daily Maximum Water Supply Amount	m ³ /day	O = M ÷ T x 100	4,312	4,826	5,647	5,767	6,668	6,114	6,757	7,458	7,770	8,083	8,430	8,783	9,136	9,489
	Maximum Water Consumption per Person per Day	L/day/person	P = O ÷ C x 1000	175	162	173	172	187	166	179	187	191	195	198	201	204	207
Revenue Water Ratio	Revenue Water Ratio	%	Q	83.0	84.0	85.8	88.8	89.9	90.4	91.1	92.0	92.4	92.8	93.3	93.8	94.3	94.8
	Effective Water Ratio	%	R = 100% - S	87.3	88.0	89.4	91.6	92.4	92.8	93.3	94.0	94.4	94.8	95.3	95.8	96.3	96.8
	Leakage Water Ratio	%	S = (100% - Q) x 0.75	12.7	12.0	10.6	8.4	7.6	7.2	6.7	6.0	5.6	5.2	4.7	4.2	3.7	3.2
Loading Rate	Loading Rate	%	T = M ÷ O x 100%	79.8	80.5	74.4	82.1	81.9	86.7	83.0	82.3	82.3	82.3	82.3	82.3	82.3	82.3
	Construction Period																
	Existing Capacity	m ³ /day		5,760	5,760	7,260	7,260	7,260	7,260	7,260	7,260	7,260	7,260	7,260	7,260	7,260	7,260
Capacity required by this Project:		m ³ /day											823	1,170	3,289	4,890	6,559