FEASIBILITY STUDY REPORT:

BULK WATER PROJECT

Released in February 2022

Project code: WAUD 2022.01.01-Bulk Water

Location:

Tuol Prech and Mkak Communes, Angk Snuol District, Kandal Province;

Khsem Khsant Commune, Odongk District, Kampong Speur Province

Disclaimer

This feasibility study report is based on water engineering and investment appraisal perspectives to provide advice on the financial projection of the bulk water business and the size of the water infrastructure to supply clean water supply to the retailers in compliance with the technical requirement of the Ministry of Industry, Science, Technology, and Innovation.

Investors who are interested to bid for the competitive water permit to supply the bulk water shall conduct their own enquiries and interpret the information with their own verification.

The selected bidder, although receiving the permit from the MISTI, must work with the retailers to determine the terms and conditions of the commercial contract with the retailers. It is worth noting that the commercial contract template was already developed and attached to the bidding package.

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LIST OF ABBREVIATIONS

ALC	Applying for a license
CAPEX	Capital expenditure
LC	License
MISTI	Ministry of Industry, Science, Technology, and Innovation
MoP	Ministry of Planning
PIC	Pasteur Institute of Cambodia
PIP	Provincial Investment Plan for Piped Water Supply in Cambodia
PWSP	Piped Water Service Provider

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1. Introduction

1.1. Purpose

The feasibility study report was developed to serve two main purposes. Firstly, The Ministry of Industry, Science, Technology, and Innovation (MISTI) uses it as a part of the tendering package for a competitive permit to supply bulk water to Tuol Prech and Mkak Communes, Angk Snuol District, Kandal Province; and Khsem Khsant Commune, Odongk District, Kampong Speur Province. Secondly, the *Investing in Infrastructure (3i)* also uses this feasibility study report to determine the size of the investment grant it offers to the selected bidder (wholesaler).

1.2. Background

The MISTI understands the challenge of the clean water supply projects whose service areas are not located nearby the reliable water source such as big rivers and reservoirs. In such a situation, those projects must rely on the ponds which pose a question on the water sustainability due to climate change and the change in the landscape of the catchment area.

In collaboration with *Investing in Infrastructure (3i),* the MISTI has created a pilot project on the bulk water supply as the solution to the raw water source constraint. This project implementation will allow the MISTI to understand the key constraints and regulatory framework required support to successfully introduce this business model into the market.

Using the results from the Provincial Investment Plan for Piped Water Supply in Cambodia (PIP)[1], the feasibility study has identified locations that face the constraints on the raw water source and are potential for bulk water supply solution.

The study conducts a detailed feasibility study on three communes located in the North-West of Phnom Penh where there are two existing licensed Pipe Water Service Providers (PWSPs) relying on ponds to supply clean water and having expressed a strong interest in buying bulk water from a wholesaler.

1.3. Bulk Water Solution

The two PWSPs rely on ponds as the raw water source and face two main challenges. Firstly, it is the increasing demand for piped water. The connection grows over time in the existing villages where they already laid pipe. There are also new connections when they expand the pipe network to cover other villages under the service area. In addition, the urban development in the communes also increase the demand for piped water. There are many Boreys[2] and factories under the construction. Secondly, the existing water supply relying on the ponds are vulnerable to the decrease in the ability of the ponds to collect water over time. As

[1] PIP is the study of the investment viability in clean water supply in Cambodia. It was conducted by 3i in collaboration with the MISTI and fully funded by the Australian government.
[2] Boreys refer to the conglomerate of the residential buildings

the area get more and more developed, the pond catchment area keeps shrinking. The construction of residential and commercial buildings lead to the change in the topography of the landscape which disrupts the water flow channel. The solid and water waste disposal from the urbanization also poses a concern on the quality of rainwater collected. All of this reduces the ability of the ponds to collect the water from the rainfall and preserve the water for using in the production. To conclude, the two existing PWSPs face an issue on the raw water source which deter them from delivering the clean water supply to the households and businesses in their service area with reliability and sustainability.

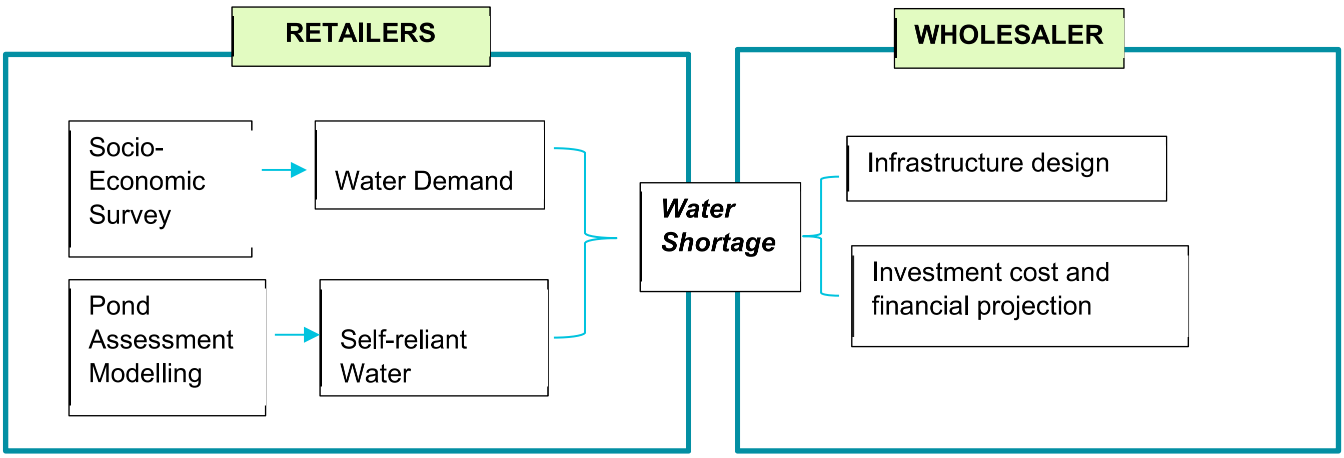
Bulk water was identified to be a potential solution. The wholesaler could extract water from a sustainable water source, treat the water, and deliver the clean water to the existing PWSPs. The PWSPs could still use the water from their ponds and buy the amount of the water shortage from the wholesaler to meet water demand of households and businesses.

1.4. Methodology, Limitation, and Assumptions

1.4.1. Methodology

This section describes the overview methodology. Firstly, the study conducts the socio-economic survey to estimate the consumption level of households and businesses in the service area of PWSPs. The study will estimate the water demand based on the survey results along with the assumptions on the connection speed with reference to the feasibility study guideline of the MISTI, the actual pipe coverage, and the investment plan of the PWSPs (interchangeably also called “Retailers” in this study). Secondly, the study assesses the existing ponds and their catchment areas of the PWSPs to estimate the ability that the ponds could collect water from the rainfalls and can be used for the water supply. This is the amount of the self-reliant water. Thirdly, the difference between the amount of the water demand and the self-reliant water (from the ponds) is the amount of the water shortage. The study assumes that the retailers will buy water from a wholesaler to fulfil the gap in the water shortage. Then, the study designs the water infrastructure and estimates the financial projection based on that. Figure 1 illustrates this.

Figure 1: Overview of Methodology



1.4.2. Limitation

The study faces a certain number of limitations. Firstly, the socio-economic study considers only the current number of households in the villages with and without pipes for the basis to forecast the population growth in the future. Thus, the inhabitants of Boreys are out of the scope of the study. Secondly, the socio-economic study considers only the current water demand of the existing businesses. There could be more businesses created or the current water demand of the existing ones increase in the future. All of this could result in the underestimation of the water demand. Thirdly, the pond assessment modelling considers the size of the current catchment areas which is vulnerable to be shrinking in the future. However, the decrease in the catchment area is not included in the study due to its uncertainty. This could result in the overestimation of the self-reliant water in the future. Fourthly, the study assumes that the retailers will buy the amount of water shortage from the wholesaler to fulfil the gap. However, the retailers could dig the pond the deeper and expand the pond larger though this solution is not efficient and not sustainable although the likelihood of this scenario is low considering the increase in land price in the service areas.

1.4.3. Assumptions

This feasibility study is based on the following assumptions:

1. For the investment projection, it is assumed all major investments are made in the first year.
2. There are assumptions about the household consumption, household water consumption growth rate, and population growth rate.

Table 1: Assumptions on consumption and the growth rate

Assumptions	**Unit**	**PWSP 1**	**PWSP 2**
Household consumption in the dry season	m^3/month	14	11
Household consumption in the wet season	m^3/month	10	6
Household consumption growth rate	%	0.5	1
Population growth rate	%	0.78	1.62

3. There is an assumption on the connection speed.

Table 2: Assumptions on connection speed

	2024	**2025**	**2026**	**2027**	**2028**
Connection speed	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
PWSP 1	80%	85%	90%	90%	90%
PWSP 2	60%	70%	75%	80%	85%

Percentage of existing connection as of 2021 is 62.8% for PWSP 1 and 30.3% for PWSP 2.

4. The infrastructure is designed with a safety factor of 10%. This is in line with the MISTI's recommendations.
5. For this design, it is assumed that a booster pump is more economical than a water tower.
6. System losses of clean water for retailers are expected to be 15% as per standard engineering practice in Cambodia which includes: 3% for raw water extraction, 2 % for production at the water station and another 10% from distribution.

7. System losses of clean water for wholesales are expected to be 10% which includes: 3% for raw water extraction, 2 % for production at the water station and another 5% from distribution.
8. PWSP 1 will buy the bulk water from the wholesaler to supply to users in Zone B of his service area. The detail information on the zone is found in section 3.1.
9. PWSP 2 will have access to another community pond, and the water available in the two community ponds are for the usage of PWSP 2 only.
10. The dry season lasts between November and April (6 months), while the wet season lasts between May and October (6 months).
11. The tariff of wholesaler is set at 1,500 KHR per m^3 to demonstrate the financial projection only. This shall not be interpreted as the encouragement for the bidding at the stated tariff.

1.5. Scope of bulk water infrastructure

To supply bulk water, the wholesaler needs the following facilities:

- Land size of 3,000 m^2 to build the water station
- A water treatment plant with a capacity of 150 m^3/h,
- A clean water storage tank with a capacity of 800 m^3,
- Three transmission pumps with a capacity of 15 kW each and an inverter to distribute the clean water from the water station to the retailers,
- Two raw water pumps with a capacity of 18.5 kW each to pump the raw water from the Tonle Sap river to the treatment plant,
- A raw water pipe and distribution pipe network for the service area with the total length of 23.8 km,
- Other investments: a pumping station, an office building, a warehouse, an electricity connection, a set of test kits, a motorbike, a computer, a printer and a telephone.

1.6. Structure of the report

The feasibility study report is structured as the following:

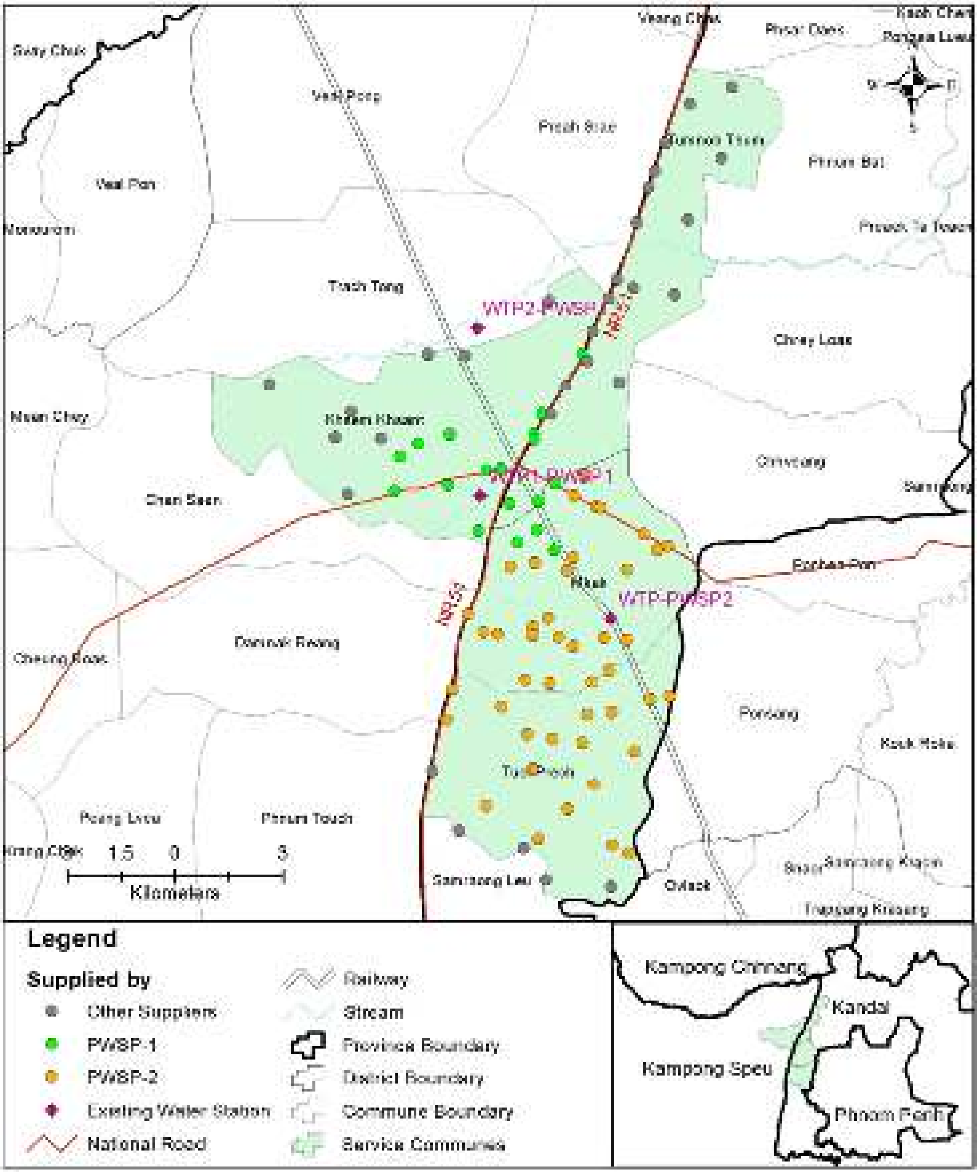
- **2. Retailers**: It explains about the profiles of the PWSPs, the demographics of the service area, the socioeconomic survey, the pond assessment, and estimation of water demand.
- **3.Technical Study**: It explains about the water source for the wholesaler and the water infrastructure calculation.
- **4.Financial Projection**: It explains the investment cost of the water infrastructure, the expenses, and the revenues of the bulk water project.
- **5.Outlook**: It explains the potential expansion of the bulk water.

2. Retailers

2.1. Profiles and Demographics

In the bulk water project, there are two PWSPs[3] whose service areas are located next to each other in Khsem Khsant, Mkak, and Tuol Prech Communes. The area is about 36 km from Phnom Penh. One could reach there by traveling along NR 5 and turning west along NR 42. The communes border Preah Srae Commune in the North; Chrey Loas, Chhveang, Ponhea Pon, Ponsang Communes in the East; Samroang Leu Commune in the South; and Chan Saen and Damnak Reang Commune in the West. See Figure 2.

Figure 2: Map of the service areas of the retailers



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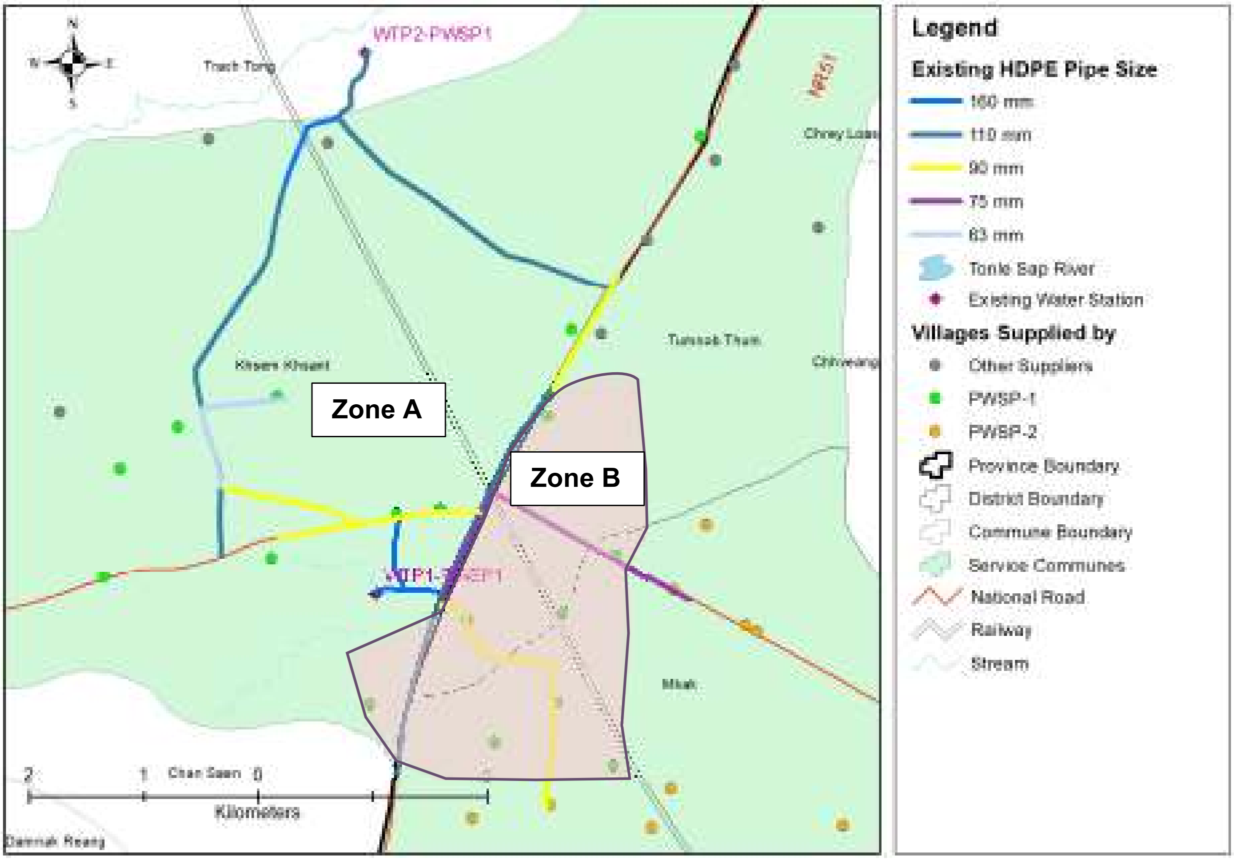
[3] The study does not disclose the personal information of the PWSPs.

2.1.1. PWSP 1

Figure 3 illustrates the service area, zoning, and existing infrastructure of PWSP 1. The retailer prefers to divide his service area into two zones, in which he uses his existing ponds to supply clean water into Zone A and the wholesaler directly supplies clean water into zone B in the form of selling bulk water supply to him. Detail information on the zoning is in section 3.1

Figure 3: Service area, zoning, and infrastructure of PWSP 1



Licensing information

PWSP 1 received the 20 years' permit from the MISTI in 2019 to provide clean water supply to 16 villages of Khsem Khsant Commune, Odongk District, Kampong Speur Province and Mkak Commune, Angk Snuol District, Kandal Province. In addition to his service area, he has the consent from the nearby PWSP to supply clean water to other 2 villages nearby. See Figure 3.

The permit sets the water tariff at 2,200 KHR per m^3 for the water consumption in the range between 0 and 3 m^3 per month and at 2,300 KHR per m^3 for the water consumption above or equal to 4 m^3 per month.

Demographics

There are 2,228 households or 10,344 people, 48.1% of whom are females. The number of existing connections is 1,400. See Table 3 for demographics data.

Table 3: Demographics of PWSP 1

Commune	N.	Village	household	population	Females	Zone[b]
Khsem Khsant	1	Bat Doeng	316	1,356	322	A
	2	Damnak Trach	134	563	304	A
	3	Kakab	146	755	451	A
	4	Sdok Lpov	163	734	396	A
	5	Ta Lak	204	904	451	B
	6	Trapeang Kansaeng	61	257	132	A
	7	Kandal	94	417	235	A
	8	Trapeang Krasang	100	471	249	A
	9	Trapeang Prei	107	518	275	A
	10	*Ta Ling*[a]	102	486	237	A
	11	*Baek Khlouk*[a]	78	374	174	A
Tumnob Thom	12	Srae Ta Meaeng	172	825	409	B
	13	Lvea	127	600	302	B
Mkak	14	Chongruk	69	301	163	B
	15	Ou	60	305	159	B
	16	Srae Kandaol	116	530	268	B
	17	Traeung	128	586	266	B
	18	Trapeang Snao	51	362	187	B
Total			**2,228**	**10,344**	**4,980**	

Source: data from the commune halls, 2021

Note: (a) PWSP 1 receives the consent from the nearby water operators to supply clean water to these two villages.

(b) PWSP 1 prefers to divide his service area into two zones. For zone B, he would buy the bulk water from a wholesaler to directly supply to users. Detail information on the zoning is in section 3.1.

Using the data on the population between 2015 and 2020, the study found that the annual population growth rate in the location is 0.78%.

Existing infrastructure

PWSP 1 has two water stations. Table 4 illustrates the existing major infrastructure in each of the water stations. Each water station has a treatment plant, storage tank, and a pond. For the existing pipe network coverage (data as of December 2021), the main pipe is 26 Km. Water station 1 is located in Trapeang Kansaeng Village, Khsem Khsant Commune; while water station 2 is located in Ra Village, Trach Tong Commune, Odongk District.

Table 4: Major water infrastructures at the water stations of PWSP 1

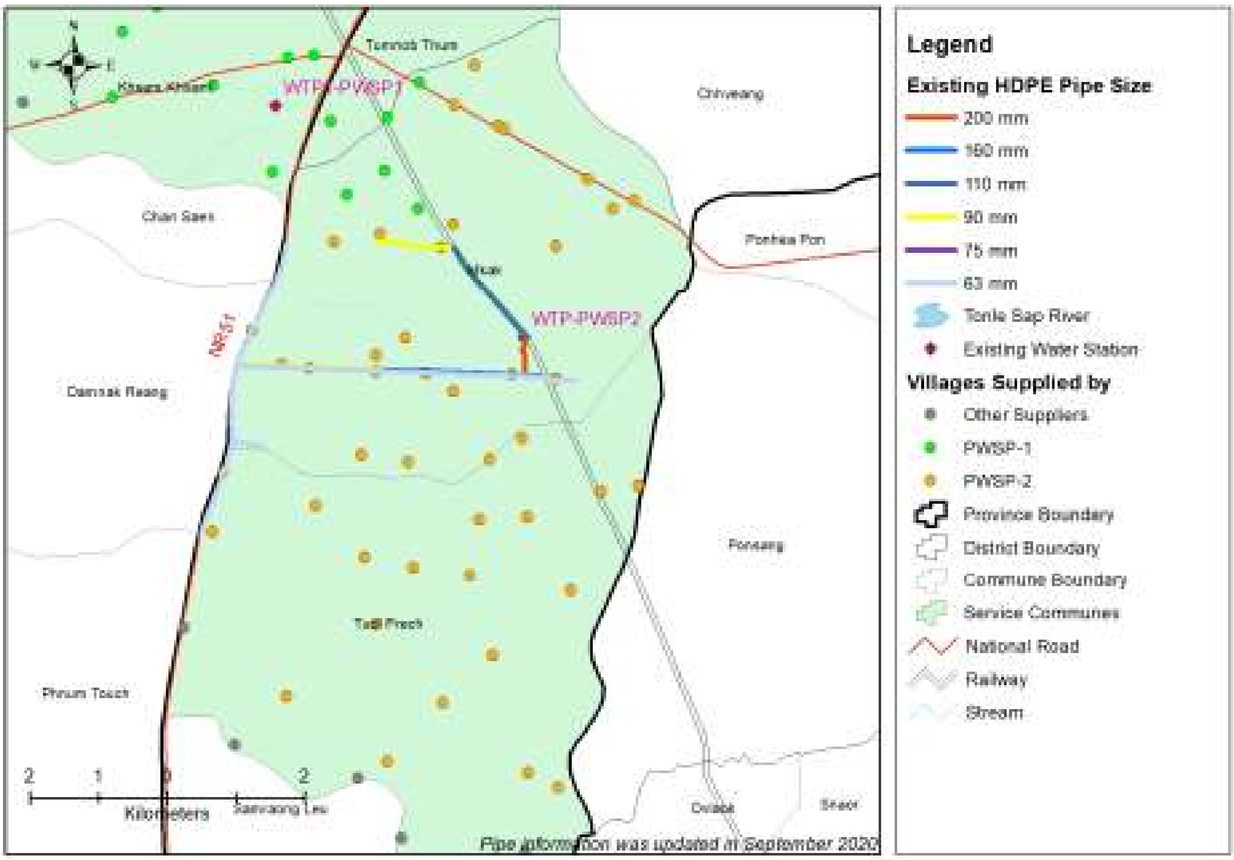
Water Infrastructure		Unit	Water station 1	Water station 2
Water Treatment plant		m^3/h	50	120
Water Storage tank		m^3	108	980
Main pipe		Km	26	
Pond	Pond surface area[(a)]	m^2	12,000	15,000
	Pond perimeter[(a)]	m	464	452
	Depth	m	15	5
	Pond volume	m^3	144,000	60,000
	Year of excavation		2012	2021

Note: (a) measured on Google Earth

2.1.2. PWSP 2

Figure 4 illustrates the service area and existing infrastructure of PWSP 2.

Figure 4: Service area and existing infrastructure of PWSP 2



Licensing information

PWSP 2 bought the 20 years' permit from the previous licensee in 2021. The Provincial Department of Industry, Science, and Technology (PDISTI) endorsed the purchase of service area of 20 villages under the existing license and endorsed the request to expand the service area to include additional 24 villages. At the time of writing, the formal request is being processed at the MISTI. The service area is located in Mkak and Tuol Prech Communes, Angk Snuol District, Kandal Province. This study assumes that MISTI will officially approve of the license purchase and request for service area expansion. See Figure 4.

The permit sets the water tariff at 1,800 KHR per m^3 for the water consumption in the range between 0 and 3 m^3 per month and at 2,100 KHR per m^3 for the water consumption above 4 m^3 per month.

Demographics

There are 4,154 households or 18,888 people, 52.3% of whom are females. The number of existing connections is 1,260. See Table 5 for demographics data.

Table 5: Demographics of PWSP 2

Commune	N	Village	household	population	Females	License
Mkak	1	Antong Kravien	116	474	256	LC
	2	Beng	116	530	278	
	3	Chamkar Chen	88	384	211	
	4	Chheu Buon	72	322	176	
	5	Chong Boeng	121	590	300	
	6	Lumhach	90	222	222	
	7	Trapeang Kak	135	603	319	
	8	Trapeang Tnaot	164	732	362	
Tuol Prech	9	Angk Srae Pou	126	521	274	
	10	Angk Ta Set	91	423	234	
	11	Boeng Khnar	29	144	79	
	12	Chambak Kaong	136	631	308	
	13	Chrak Krasang	65	294	164	
	14	Khnar	157	728	369	
	15	Koul	178	760	409	
	16	Meun Ream	37	170	94	
	17	Popel Rolum	33	167	80	
	18	Thmei	90	439	181	
	19	Tonloab	83	393	205	
	20	Tuol Khlong	82	383	212	
Mkak	21	Angkor Romeas	83	384	195	ALC
	22	Baset	182	711	370	
	23	Boeng Thnal	78	400	199	
	24	Chou Treach	67	327	148	
	25	Pongro	78	338	182	
	26	Pou Buon	92	387	197	
	27	Rumdeng	125	707	344	
	28	Sdok Veaeng	27	112	57	
	29	Trapeang Andaeng	111	526	262	
	30	Trapeang Krasang	120	516	288	
	31	Trapeang Reang	87	446	259	
	32	Trapeang Smach	90	415	173	
	33	Trapeang Tey	55	279	154	
	34	Trapeang Thnong-Mkak	95	488	265	
	35	Veaeng	141	623	315	
	36	Ta Prab	101	490	249	
Tuol Prech	37	Rumlech	140	627	322	
	38	Trapeang Kamphleanh	75	352	178	
	39	Prey Samraong	96	444	247	
	40	Prey Rumduol	40	168	84	
	41	Khlong	73	336	172	
	42	Tuol Serei	112	532	281	
	43	Srae Kach	36	180	97	
	44	Prey Totueng	41	190	98	
Total			**4,154**	**18,888**	**9,869**	

Source: data from the commune halls, 2021
Note: LC (License) refers to the villages that are under the existing license, while ALC (Applying for License) refers to the villages that PWSP 2 is requesting to the MISTI to expand the pipe network.

Using the data on the population between 2015 and 2020, the study found that the annual population growth rate in the location is 1.62%.

Existing infrastructure

PWSP 2 has only one water station. Table 6 illustrates the existing major infrastructure. There are a water treatment plant and a water storage tank. Currently, PWSP 2 has access to the community pond and has been extracting raw water from the pond. There is another community pond that PWSP 2 claims that he would be granted access if needed. For the conservative purpose, the study assumes that PWSP 2 has access to the two community ponds. For the existing pipe network coverage (data as of September 2020), PWSP 2 has laid pipes to cover all 20 villages under the service area and will continue to install pipes to remaining villages; the main pipe is 18 Km. The water station is located in Trapeang Tnaot Village, Mkak Commune.

Table 6: Major existing water infrastructures of PWSP 2

Water Infrastructure	Unit	Water station
Water Treatment plant	m^3/h	30
Water Storage tank	m^3	300
Main pipe	km	18

Table 7 illustrates the capacity of the two community ponds of PWSP 2. The volume of community pond 1 is 588,000 m^3 while that of community pond 2 is 648,000 m^3.

Table 7: Capacity of the two community ponds of PWSP 2

Description	unit	Community Pond 1	Community Pond 2
Pond surface area[(a)]	m^2	49,000	54,000
Pond perimeter[(a)]	m	933	999
Depth	m	15	15
Pond volume	m^3	588,000	648,000
Year of excavation		2019	2020

Note: (a) measured by Google Earth

2.2. Socio-Economic study

The socio-economic study covers the study on the households, businesses, and other users.

2.2.1. Household Socio-Economic study

2.2.1.1 Methodology

The study conducted the socio-economic survey to understand the water consumption level of the connected households, the perspectives of non-connected and non-covered households towards the alternative water sources, and the willingness to connect of the later. The survey was conducted in February 2021 using a structured questionnaire.

The sampling frame was developed as the following. First, the study classified villages into covered villages (there is pipe) and non-covered[4] villages (there is no pipe). Then, the study randomly selected villages from each category. For the covered villages, the study put a quota of 7 respondents for the connected households and of 5 respondents for the non-connected households. For the non-covered villages, the study put a quota of 5 respondents. See Table 8 for the sample size. During the field visit, the enumerators started from a household on his/her right to interview and moved to the next fifth house. If the latter did not meet the criteria on connection or non-connection, the nearby house could be included in the survey. The screening asked if the respondent must be a head or spouse of the head.

Table 8: Quota on sample size

Villages	Connection	Number of villages	Quota
Covered	Connected	6	42
Covered	Non-connected		30
Not covered	n/a	7	35
Total		13	107

2.2.1.2 Descriptive statistics

Upon the interview and data cleaning, the study has the sample of 100 respondents, half of which are in the service area in each of the PWSPs (See Table 9). 69% of respondents are females, while 65% are the heads of the households (See

Type	PWSP 1	PWSP 2	Total
Connect	28	21	49
Not Connect	14	12	26
Not Covered	5	20	25
Total	**47**	**53**	**100**

Figure 5).

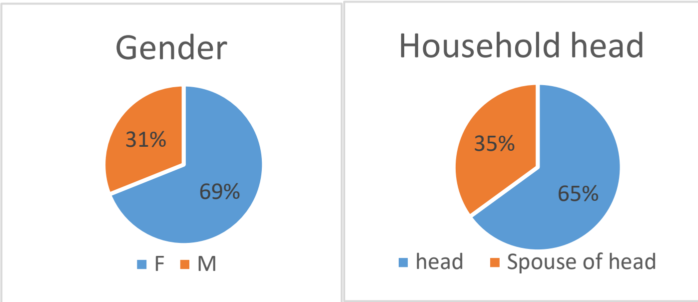
Table 9: The number of respondents

Type	PWSP 1	PWSP 2	Total
Connect	28	21	49

[4] At the time of conducting the socio-economic survey, PWSP 2 did not lay the pipe to all villages.

Not Connect	14	12	26
Not Covered	5	20	25
Total	**47**	**53**	**100**

Figure 5: Gender and household head of the respondents



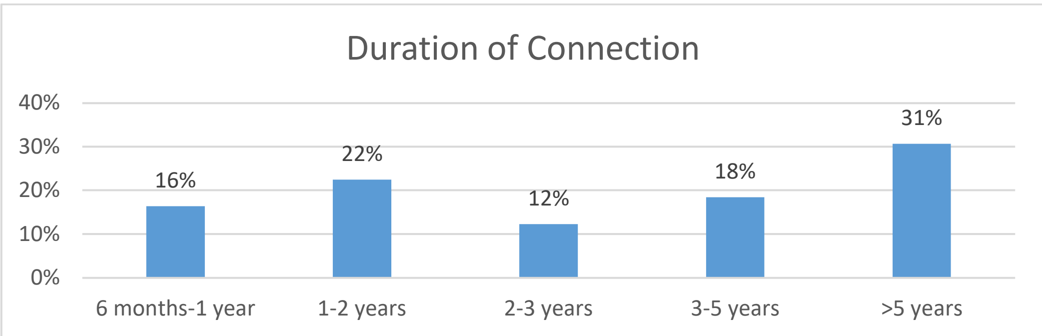
2.2.1.3 Connected households

This section reports the duration of the connection and the average monthly piped water consumption of households in the dry and wet seasons.

Duration of connection

Figure 6 illustrates the duration of the connection. 31% of the respondents have been connected for more than 5 years, while 16% have been done between 6 months and less than a year.

Figure 6: Duration of the connection

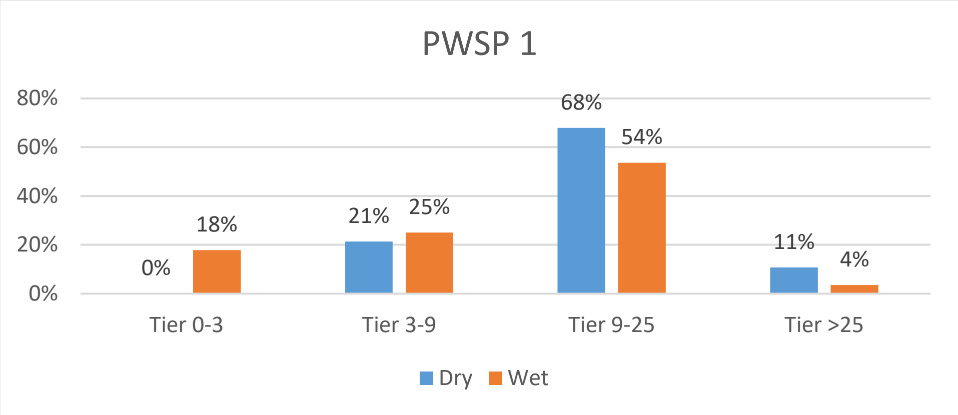


Average of monthly consumption

The survey asked how much a respondent spends on average on piped water per month in the dry and wet seasons. Then, average consumption per month was calculated by dividing the amount of spending by the effective tariff level. The study classified the amount of consumption into different consumption tiers to check if there are outliers.

Figure 7 illustrates the average monthly consumption of households on piped water in the dry and wet seasons in the service areas of the PWSP1.

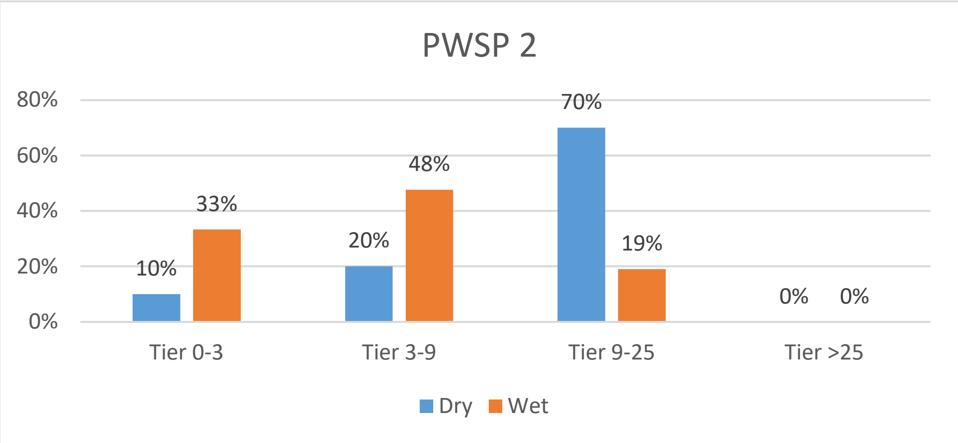
Figure 7: Average monthly consumption of respondents on piped water in the dry and wet seasons in PWSP 1



- Tier 0-3: None of respondent falls into this category in the dry season, while 18% consume less than 3 m^3 per month in the wet season.
- Tier 3-9: 21% of respondents consume piped water between 3 and 9 m^3 per month in the dry season and 25% of those do in the wet season.
- Tier 9-25: 68% of respondents consume piped water between 9 and 25 m^3 per month in the dry season and 54% of those do in the wet season.
- Tier >25: 11% of respondents consume piped water more than 25 m^3 per month in the dry season and 4% of those do in the wet season.

Figure 8 illustrates the average monthly consumption of households on piped water in the dry and wet seasons in the service areas of the PWSP2.

Figure 8: Average monthly consumption of respondents on piped water in the dry and wet seasons in PWSP 2



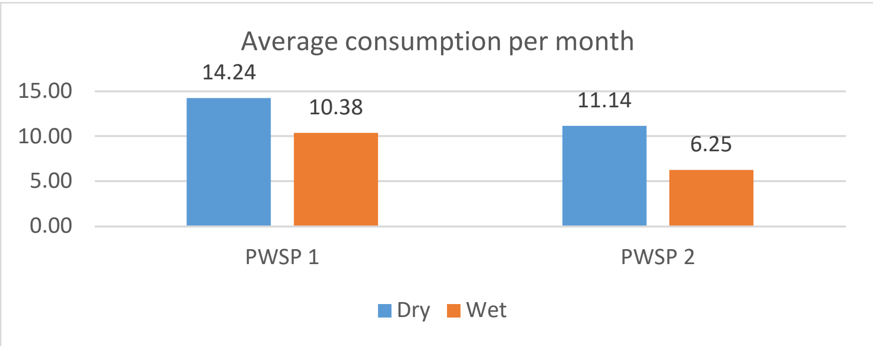
- Tier 0-3: 10% of respondents consume piped water between 0 and 3 m^3 per month in the dry season and 33% of those do in the wet season.
- Tier 3-9: 20% of respondents consume piped water between 3 and 9 m^3 per month in the dry season and 48% of those do in the wet season.

- Tier 9-25: 70% of respondents consume piped water between 9 and 25 m³ per month in the dry season and 19% of those do in the wet season.
- Tier >25: none of respondents consume piped water more than 25 m³ per month in the dry season and the wet season.

To estimate the average piped water consumption, the study decides to discard the consumption that is above 25 m³ per month. In the service area of PWSP 2, there is no respondent consuming more than 25 m³ per month. Although there is a small percentage of respondents consuming within this range in the service area of PWSP 1, the big consumers concentrate in the centre of the location. In other parts of the service area, the monthly consumption is not that high.

Figure 9 illustrates the average consumption per month in the PWSP 1 and PWSP 2. In the service area of PWSP 1, a respondent consumes on average 14.24 m³ per month in the dry season and 10.38 m³ per month in the wet season. In the service area of PWSP 2, a respondent consumes on average 11.14 m³ per month in the dry season and 6.25 m³ per month in the wet season.

Figure 9: Average consumption per month in the PWSP 1 and PWSP 2



For simplicity, the study assumes the following:

- In the service area of PWSP 1, a respondent consumes on average 14 m³ per month in the dry season and 10 m³ per month in the wet season; and
- In the service area of PWSP 2, a respondent consumes on average 11 m³ per month in the dry season and 6 m³ per month in the wet season.

The study also triangulated the results of the survey and the assumptions on the piped water consumption with the PWSPs. They confirmed the results were acceptable.

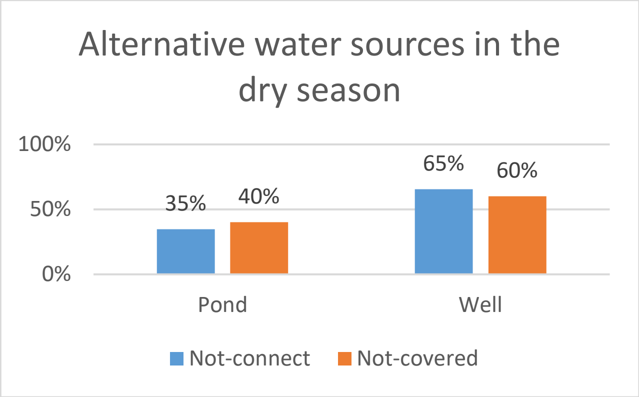
2.2.1.4 Non-connected and non-covered households

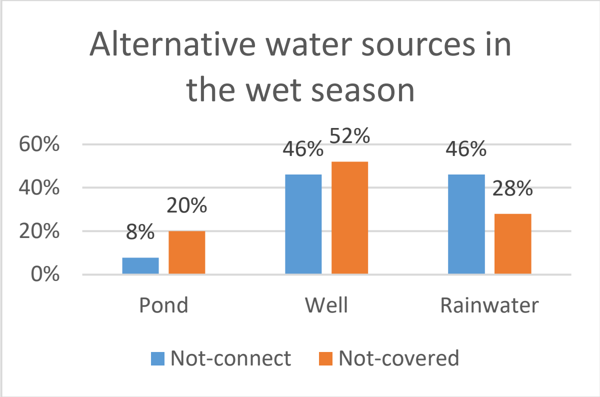
This section conducts the analysis on respondents that are non-connected and non-covered. Non-connected respondents refer to households who live in covered villages but are not connected to the piped water, while non-covered respondents refer to household in non-covered villages which piped water infrastructure is not yet available. It reports the perspectives of those respondents on the alternative water sources and their willingness to connect and pay for the monthly consumption fee.

Types of alternative water sources

Figure 10 illustrates the alternative water sources of respondents that are non-connected and non-covered. In the dry season, well is the most common alternative water source followed by pond. In the wet season, well is still the most common alternative water source yet followed by rainwater.

Figure 10: Alternative water sources in the PWSP 1 and PWSP 2





Satisfaction on alternative water sources

Table 10 illustrates the experiences of the respondents facing the problems when using the alternative water sources.

Table 10: Experiences of respondents facing problems of turbidity, smell, and shortage

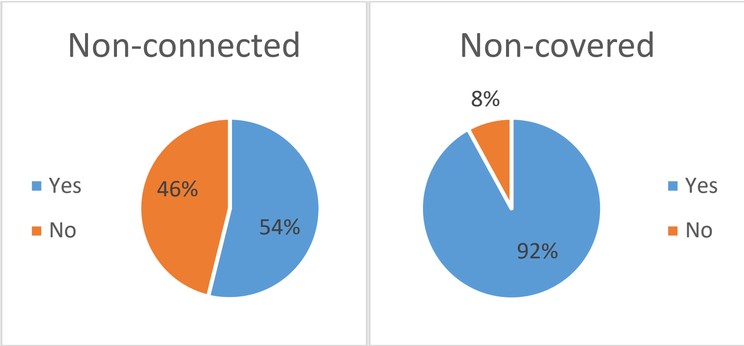
	Non-connected		Non-covered	
	Dry	Wet	Dry	Wet
Turbidity	15%	0%	32%	4%
Smell	4%	4%	16%	4%
Shortage	23%	19%	44%	16%

There are three important observations. Firstly, the issues tend to happen more frequent in the dry season in both non-connected and non-covered groups. Secondly, more respondents in the non-covered areas face issues more than those in the non-connected group. Thirdly, water shortage ranks the most common issue followed by the turbidity problem. Bad smell is the least of the problem.

Perspective on connection

Figure 11 illustrates the intention of respondents who want to connect. In the non-connected group, 54% reported that they would like to get connected. Although the connection is available in their service area, 46% reported that they did not want to get connected. In the non-covered group, 92% reported that they would like to get connected.

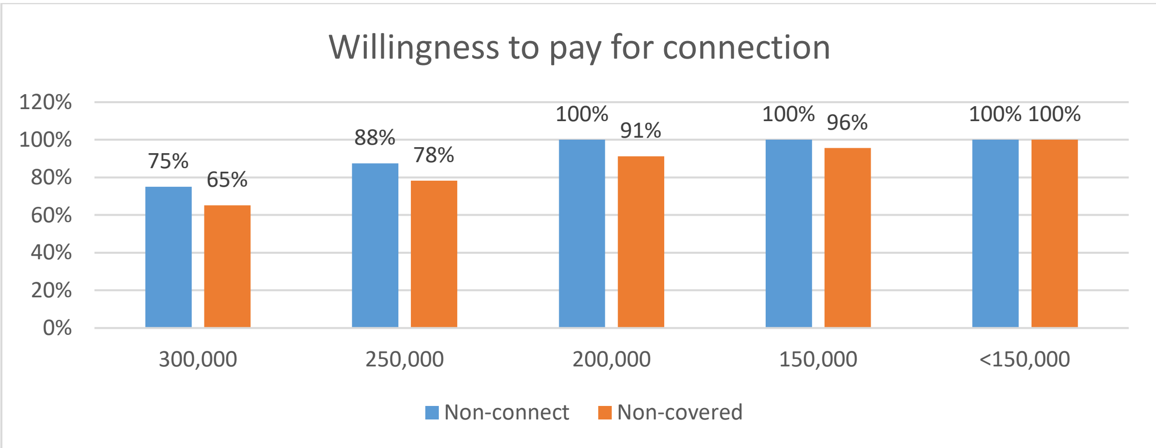
Figure 11: respondents' willingness to connect



Willingness to Pay for Connection Fee

For those who want to connect, the survey asked the question on how much they were willing to pay for the connection fee. The survey used the bid-down method. The survey started from 300,000 KHR and if the respondent said "Yes, I am willing to pay", the survey stopped there; however, if the respondent did not agree, the survey would ask the next price which was lower than the previous one. The repetition continued until the respondent confirmed to get connected.

Figure 12: willingness to pay for connection fee



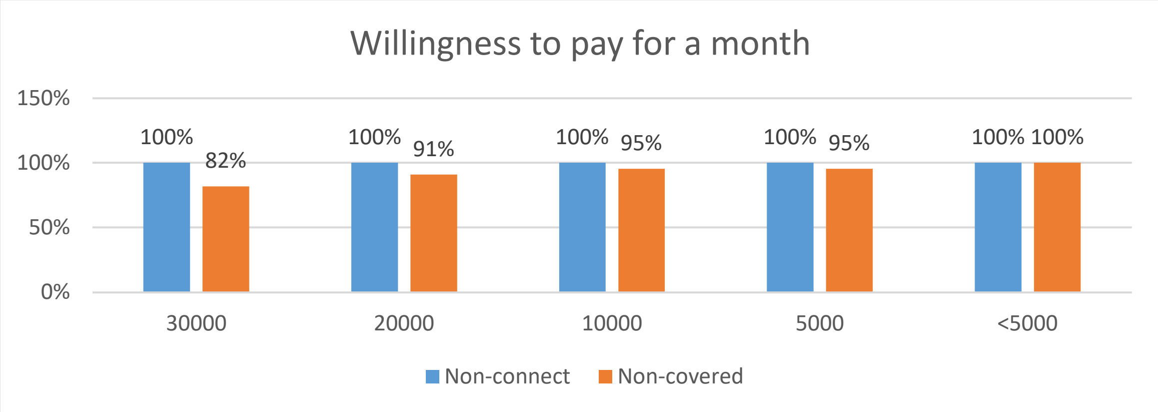
Starting from 300,000 KHR, 65% of respondents in the non-covered were willing to connect. As the connection fee decreases to the 200,000 KHR, 91% of respondents were willing to connect.

For the non-connected group, 75% of respondents were willing to connect if the connection fee is 300,000 KHR. However, if the fee drops to 200,000 KHR, 100% of the respondents were willing to connect.

Willingness to pay for monthly consumption fee

For those who want to connect, the survey asked the question on how much they were willing to pay for the monthly consumption fee. The survey used the bid-down method. The survey started from the fee of 30,000 KHR per month and if the respondent said "Yes, I am willing to pay", the survey stopped there; however, if the respondent did not agree, the survey would ask the next price which was lower than the previous one. The repetition continued until the respondent confirmed to get connected.

Figure 13: willingness to pay for monthly consumption fee



Starting from 30,000 KHR per month, 82% of respondents in the non-covered were willing to pay for the monthly consumption fee. As the fee decreases to the 200,000 KHR per month, 91% of respondents were willing to pay.

Starting from 30,000 KHR, 100% of respondents in the non-connected were willing to pay.

Synergy

Both non-connected and non-covered groups have access to alternative water sources mainly ponds, wells, and in the case of wet season rainwater. They face some challenges of turbidity and water shortage mainly in the dry season. Also, the non-covered group seems to face more challenge than the non-connected group. The study on willingness to connect and to pay for monthly consumption fee shows that both groups have high financial ability to connect and consume. It is also optimistic to predict those non-connected respondents would connect in the future, and they represent half of the total non-connection in the survey.

2.2.2. Water consumption of businesses

The study interviewed the PWSPs to understand the number of businesses located in the service area and their piped water consumption behaviour. In total there are 12 businesses that consume 8,475 m^3 per month. Those businesses include candy production factory, animal farms, fertilizer, market, banks, and concrete mixing factory. Table 11 illustrates this.

Table 11: List of businesses and their piped water consumption

PWSP	Type	Number	Monthly consumption/each (m^3/month)	Total consumption/ Month (m^3/month)
PWSP 1	Candy Production	1	800	800
	Animal farms	5	200	1,000
	fertilizer	1	1,800	1,800
	Tai Mengly Market	1	1,600	1,600
	Banks	3	25	75
PWSP 2	Concrete mixing	1	3,200	3,200
Total		**12**		**8,475**

2.2.3. Water consumption of Public Institutions

There are 11 public institutions in the service areas of the PWSPs. They include commune halls, police posts, health centres, a district hall, and a district police post. The monthly consumption per each public institution in Table 12 is based on the assumptions.

Table 12: List of businesses and their piped water consumption

Type	PWSP 1	PWSP 2	Total	Monthly consumption/each (m^3/month)
Commune hall	1	2	3	15
Police post	1	2	3	15
Health centre	1	2	3	25
District hall	1	0	1	50
District police post	1	0	1	15
Total			**11**	

2.3. Water demand study

It is understood that the tendering process conducted by the MISTI requires some time to process and select the winning bidder and the wholesaler also requires some time to construct the water infrastructure to supply clean water to the retailers. This whole process can approximately take up to 2 years. Hence, the feasibility study is based on the timeframe that year 1 starts from 2024.

2.3.1. Number of connections

There are three types of connections: households, businesses, and public institutions. The number of projected connections is based on current connection rate, the assumed connection speed and annual population growth rate in the service area of each PWSPs.

For the service area of PWSP 1, there are 2,228 households and 1,400 connections currently. The current connection rate is 62.8%. With the annual population growth rate of 0.78%, in year 5 of business operation the number of households will increase to 2,354 households and the number of household connection is 2,119. Combining with the number of businesses and public institutions, the total number of connections in year 5 is 2,135. Table 13 shows the number of connections from year 1 to year 5 of PWSP 1.

Table 13: Number of connections from year 1 to year 5 in PWSP 1

		2021	*2024*	*2025*	*2026*	*2027*	*2028*
Description	**Unit**		**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
PWSP 1							
household							
Number of people	people	10,344	10,588	10,671	10,754	10,838	10,923
Number of households	household	2,228	2,282	2,300	2,318	2,336	2,354
Connection rate	%	62.8%	80%	85%	90%	90%	90%
Number of household connection	connection	1,400	1,824	1,955	2,086	2,102	2,119

Business							
Number of businesses	business	11	11	11	11	11	11
Public institution							
Number of PI	PI	5	5	5	5	5	5
Total Connections		**1,416**	**1,840**	**1,971**	**2,102**	**2,118**	**2,135**

For the service area of PWSP 2, there are 4,154 households and 1,260 connections currently. The current connection rate is 30.3%. With the annual population growth rate of 1.62%, in year 5 of business operation the number of households will increase to 4,645 households and the number of household connection is 3,948. Combining with the number of businesses and public institutions, the total number of connections in year 5 is 3,955. Table 14 shows the number of connections from year 1 to year 5 of PWSP 2.

Table 14: Number of connections from year 1 to year 5 in PWSP 2

		2021	*2024*	*2025*	*2026*	*2027*	*2028*
Description	**Unit**		**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
PWSP 2							
household							
Number of people	people	18,888	19,821	20,142	20,468	20,800	21,137
Number of households	household	4,154	4,356	4,427	4,498	4,571	4,645
Number of connection rate	%	30.3%	60%	70%	75%	80%	85%
Number of household connection	connection	1,260	2,614	3,099	3,374	3,657	3,948
Business							
Number of businesses	business	1	1	1	1	1	1
Public institution							
Number of PI	PI	6	6	6	6	6	6
Total Connections		**1,267**	**2,621**	**3,106**	**3,381**	**3,664**	**3,955**

2.3.2. Water demand

Table 15 illustrates the amount of water demand and water supply of PWSP 1 by taking into consideration the annual consumption growth rate of 0.5% per year. The study assumes the consumption growth rate of 0.5% per year for PWSP1 because this operator has reached the connection rate of more than 60% and is reaching maturity for the consumption. The amount of water demand in year 1 is 331,356 m^3 and that in year 5 increases to 380,717 m^3.

Table 15: Water demand and water produced of PWSP 1

		2024	2025	2026	2027	2028
Description	**Unit**	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
PWSP 1						
Household						
Number of household connection	household	1,824	1,955	2,086	2,102	2,119
Consumption growth rate	% per year	0.50%	0.50%	0.50%	0.50%	0.50%

Monthly HH consumption (dry season)	m^3/month/hh	14.21	14.28	14.35	14.43	14.50
Monthly HH consumption (wet season)	m^3/month/hh	10.15	10.20	10.25	10.30	10.36
HH consumption per dry season	m^3/dry season	155,526	167,529	179,649	181,932	184,320
HH consumption per wet season	m^3/wet season	111,090	119,664	128,320	129,951	131,657
Business						
Biz Monthly consumption	m^3/month	5,275	5,275	5,275	5,275	5,275
Biz consumption per dry season	m^3/dry season	31,650	31,650	31,650	31,650	31,650
Biz consumption per wet season	m^3/wet season	31,650	31,650	31,650	31,650	31,650
Public Institution						
PI Monthly consumption	m^3/month	120	120	120	120	120
PI consumption per dry season	m^3/dry season	720	720	720	720	720
PI consumption per wet season	m^3/wet season	720	720	720	720	720
Total Water Demand						
Total water demand per dry season	m^3/dry season	187,896	199,899	212,019	214,302	216,690
Total water demand per wet season	m^3/wet season	143,460	152,034	160,690	162,321	164,027
Total water demand per year	**m^3/year**	**331,356**	**351,933**	**372,709**	**376,623**	**380,717**

Table 16 illustrates the amount of water demand and water supply of PWSP 2 by taking into consideration the annual consumption growth rate of 1% per year. The amount of water demand in year 1 is 314,427 m^3, and that in year 5 increases to 471,464 m^3.

Table 16: Water demand and water produced of PWSP 2

		2024	2025	2026	2027	2028
Description	**Unit**	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
PWSP 2						
Household						
Number of household connection	household	2,614	3,099	3,374	3,657	3,948
Consumption growth rate	% per year	1%	1%	1%	1%	1%
Monthly HH consumption (dry season)	m^3/month/hh	11.33	11.45	11.56	11.68	11.79
Monthly HH consumption (wet season)	m^3/month/hh	6.18	6.24	6.31	6.37	6.43
HH consumption per dry season	m^3/dry season	177,752	212,839	234,043	256,211	279,364
HH consumption per wet season	m^3/wet season	96,955	116,094	127,660	139,751	152,380
Business						
Biz Monthly consumption	m^3/month	3,200	3,200	3,200	3,200	3,200
Biz consumption per dry season	m^3/dry season	19,200	19,200	19,200	19,200	19,200
Biz consumption per wet season	m^3/wet season	19,200	19,200	19,200	19,200	19,200
Public Institution						
PI Monthly consumption	m^3/month	110	110	110	110	110
PI consumption per dry season	m^3/dry season	660	660	660	660	660

PI consumption per wet season	m^3/wet season	660	660	660	660	660
Total Water Demand						
Total water demand per dry season	m^3/dry season	197,612	232,699	253,903	276,071	299,224
Total water demand per wet season	m^3/wet season	116,815	135,954	147,520	159,611	172,240
Total water demand per year	**m^3/year**	**314,427**	**368,653**	**401,423**	**435,682**	**471,464**

2.4. Pond capacity assessment

This section is to assess the water availability that the existing ponds could collect and supply raw water for each PWSP. In the wet season, the ponds collect water and at the same time PWSP also extracts raw water from the ponds to treat. In the dry season, the ponds do not collect any rainwater but only store remaining water collected after extraction in the wet season; nonetheless, the PWSP still extracts water in even a bigger amount to meet the water demand in the dry season.

2.4.1. Water availability estimation in the wet season

The capacity of the ponds to collect and store water in the wet season depends on three factors:

1. Collected rainwater: A pond collects rainwater. How much it can collect depends on several factors including (i) the annual rainfall in the location, (ii) the size of the catchment area that could collect the rainfall, (iii) the runoff coefficient of the soil, and (iv) the volume of the pond to store water.
2. Evaporation: The water in the pond will evaporate due to the sunlight and heat.
3. Seepage: There is water permeates from the pond into the soil or vice versa.

2.4.1.1 Collected rainwater

The runoff coefficient is assumed to be 0.05 based on the engineering standard given that the soil type in the catchment area is grass field. The volume of the ponds is also known. Thus, this section will explain about the catchment area and the annual rainfall.

Catchment area

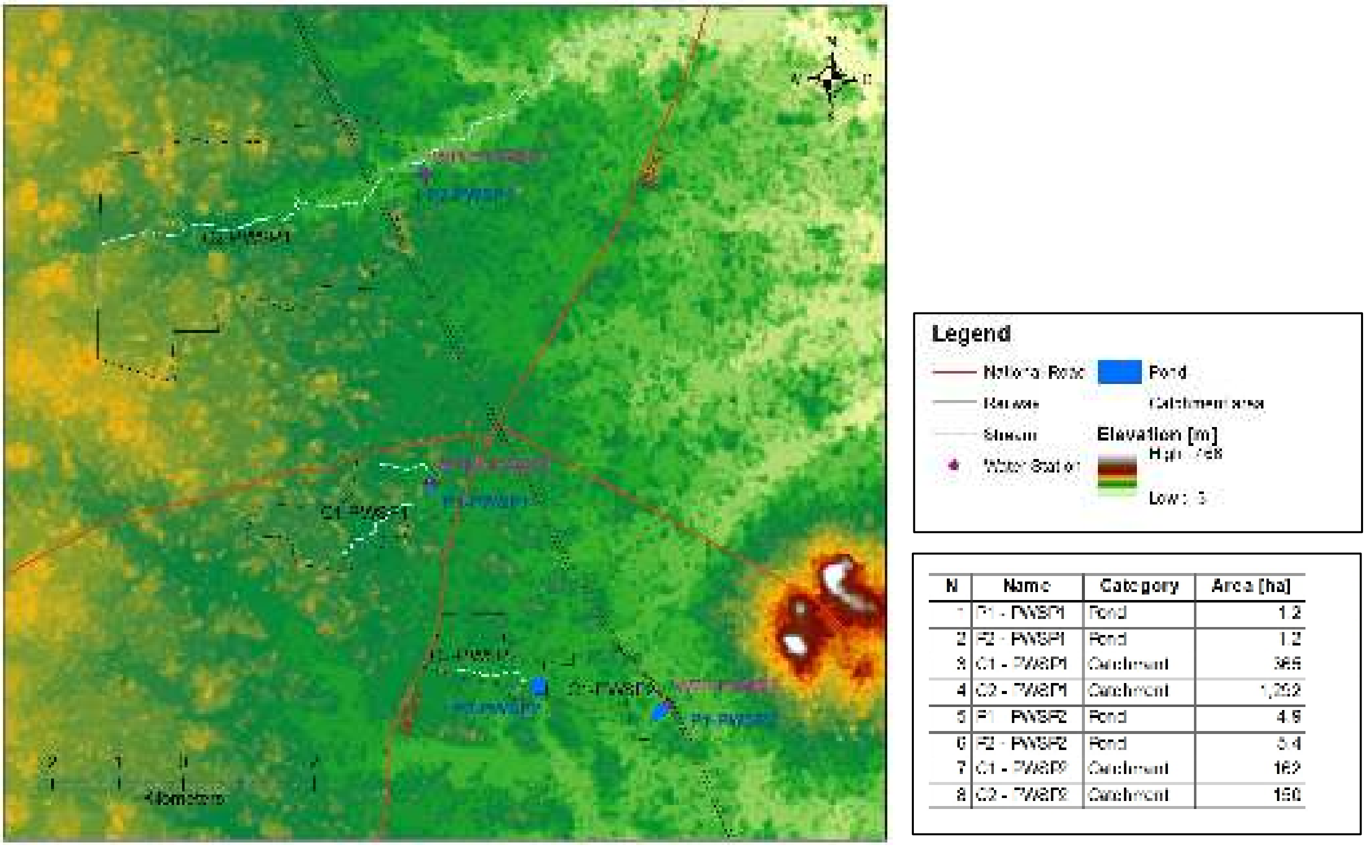
The catchment area was delineated by compiling the data from digital elevation model of SRTM with 30 meter resolution combining with satellite image of Google Earth. Figure 14 illustrates the location map of ponds and their relevant catchment area.

Table 17 illustrates the catchment area of each pond. The second pond of PWSP 1 has the biggest area of 1,292 ha while the second pond of PWSP 2 has the smallest area of 150 ha.

Table 17: Catchment area of each pond

Description	unit	PWSP-1		PWSP-2	
		Pond 1	Pond 2	Community Pond 1	Community Pond 2
Catchment area	ha	365	1,292	162	150

Figure 14: map of ponds and their relevant catchment area



Annual rainfall

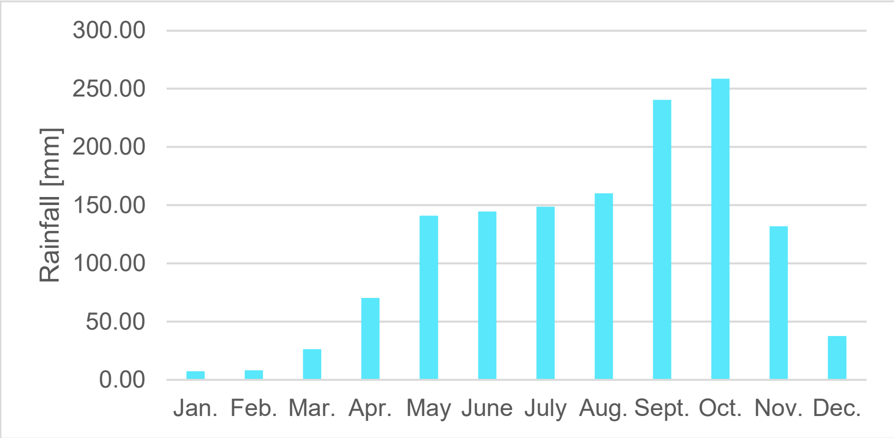
Cambodia locates in the humid climate affected by monsoon phenomena. Approximately 5–20% of the annual rainfall occurs during the pre-monsoon season, 50–78% during the summer monsoon season, and 12–36% during the post-monsoon season[5].

The nearest meteorological station to the pond location is the Pochentong station (Latitude:11°33N, Longitute:104°50E, Altitude 10m) located about 20 km in the south-west. This station recorded meteorological data including rainfall, temperature, humidity, solar radiation, wind speed, and evaporation.

Figure 15 illustrates the average monthly rainfall data. The maximum rainfall usually occurs in September or October, while the low rainfall usually occurs in the January and February. 80% of the rainfall concentrates in the wet season from May to October. The average annual rainfall between year 1901 and 2005 is 1,377 mm/year.

[5] Tsujimoto et al., 2018. Diurnal pattern of rainfall in Cambodia: its regional characteristics and local circulation. Progress in Earth and Planetary Science

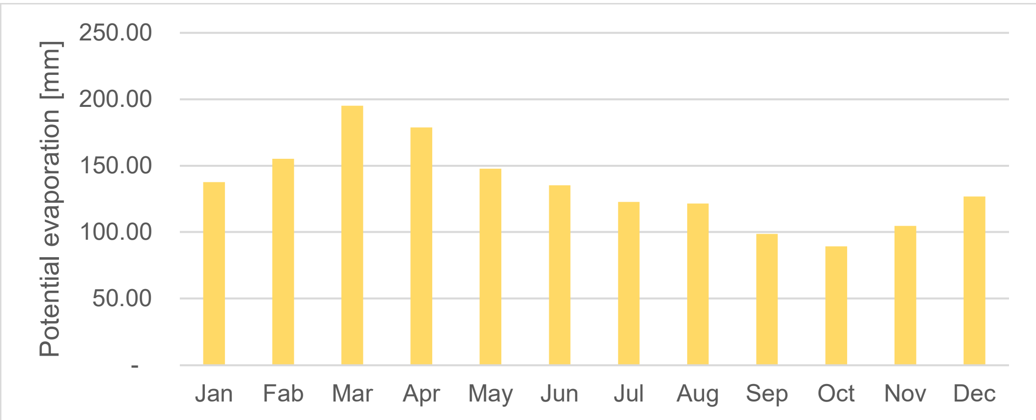
Figure 15: Average Monthly Rainfall 1901-2005



2.4.1.2 Evaporation

The Pochentong station provides the data on the evaporation between 1981 and 2005. Figure 16 illustrates the monthly potential evaporation. The highest evaporation rate occurs in March which is twice as high as the lowest rate in October. The average monthly potential evaporation in dry season (Nov-Apr) is 149.68 mm/month and in the wet season (May-Oct) is 119.18 mm/month. That is, the water in the pond evaporates by 149.68 mm per month in the dry season and by 119.18 mm per month in the wet season.

Figure 16 Average Monthly Potential Evaporation 1981-2005



2.4.1.3 Seepage

The seepage of water into and out of the pond depends on the water level in a pond and groundwater level. If the pond water level is above the groundwater level, the water leaks from the pond into the ground (losing pond). In contrast, if the pond water level is below the groundwater level, the water leaks into the pond (gaining pond).

To estimate the groundwater level, the study uses the Cambodian well map database[6]. Several wells were drilled at different places located near the ponds throughout the years which the static water levels were recorded. The data of May-June were considered as the minimum water level of dry season and the data of October-November were considered as the maximum water level of the wet season. The fluctuation of groundwater level varies between 1.5 meters (dry season) to 7.5 meters (wet season) below the ground.

To estimate the how much water leaks into or out of the pond, the study estimates the hydraulic conductivity using the ground water study of JICA report[7]. The pumping well N.322 is the nearest well to the pond areas. It is located about 15 km in the Southeast. The aquifer properties of this well are as the following:

- Transmissivity (T): 0.491 m^2/day (soil type is the silty sand.)
- Aquifer type: Quaternary sandstone
- Depth to aquifer: 14 m
- Thickness of the aquifer (b): 16 m

However, given that the soil type of the pond is silty clay, the transmissivity is revised to be 0.0491 m^2/day as per engineering practice. As a result, the calculation shows that the hydraulic conductivity is 0.003 m/day.

The study then estimates the seepage by multiplying the hydraulic conductivity, perimeter of the ponds, and different level between pond water level and groundwater level.

2.4.1.4 Water availability estimation in the wet season

Table 18 illustrates the water availability of each pond in wet seasons. For PWSP 1, the two ponds could supply water up to 204,000m^{3}000 m^3. For PWSP 2, the two ponds could supply water up to 252,517 m^3.

The detail of pond assessment is summarized in the following table:

Table 18: Water availability estimation of the ponds in the wet season

Description	unit	PWSP-1		PWSP-2	
		Pond 1	Pond 2	Pond 1	Pond 2
Catchment area	ha	365	1,292	162	150
Potential rainfall	mm	1,377	1,377	1,377	1,377
Runoff Coef.		0.05	0.05	0.05	0.05
Yearly refill capacity	m^3/year	267,000	909,164	175,636	173,915
Refill capacity in wet season	m^3/year	240,300	818,248	140,509	156,524
Groundwater seepage	m^3/year	3,460	874	6,957	7,450
Water loss due to evaporation in wet season	m^3	6,865	8,581	28,031	30,891
Water available in wet season	**m^3**	**144,000**	**60,000**	**119,435**	**133,082**

[6] https://cambodiawellmap.com/worldbank/maps
[7] JICA, 2002. Groundwater study in southern Cambodia.

2.4.2. Water availability estimation in the dry season

The ponds do not collect any rainwater in the dry season, yet it stores water for raw water usage. The amount of water available in the dry season depends on three factors:

1. Remaining water after the wet season: After the raw water extraction in the wet season, the amount of remaining water in the ponds is the amount that the ponds store for extraction in the dry season.
2. Evaporation: The water in the pond will evaporate due to the sunlight and heat.
3. Seepage: There is water leakage from the pond into the soil or vice versa.

If the external factors do not change, the water availability of the ponds in the wet season does not change. However, the water availability in the dry season changes over time due to the internal factor of the water extraction in the wet season. The more PWSPs extract water in the wet season, the less available the water is in the dry season. The calculation based on evaporation and seepage still applies. The detail of the available water in the dry season of each pond is presented in section 3.

3. Bulk Water Purchase

This section explains about the amount of water shortage that the PWSP cannot fulfill due to the limited raw water from the ponds and thus require the purchase of the bulk water from the wholesaler.

3.1. PWSP 1

Through the consultation with PWSP 1, he prefers to divide his whole service area into two zones:

- Zone A is the part that he will provide water supply using his two ponds.
- Zone B is the part that the wholesaler will directly sell water to users through selling bulk water to PWSP 1.

It is worth noting PWSP 1 could not explicitly specify the villages for each zone. The study classifies the villages as per Table 3 in section 2.1.1 for the efficiency reason in the operation.

Table 19 illustrates the divisions of villages, households, businesses and public institutions into Zones A and B. In Zone A, there are 10 villages, 1301 households, 5 public institutions, and 7 businesses. In Zone B, there are 8 villages, 927 households, and 4 businesses.

Table 19: Division of users into zones of PWSP 1

	Zone A	**Zone B**
Number of villages	10	8
Number of Households	1,301	927
Number of people	5,931	4,413
Public institutions	5	0
Number of businesses	• 3 animal farms • The Tai Mengly market • 3 Banks	• 1 candy factory • 2 animal farms • 1 fertilizer handicraft

Table 20 illustrates the amount of water supply that PWSP 1 has to supply into Zone A and the amount of the water availability in the two ponds that PWSP 1 could extract in both dry and wet seasons. In the wet season, the required water produced in the first five years is between 45% and 52% of the water availability of the two ponds combined. In the dry season, the required water produced in the first five years is between 63% and 79%. Data in year 10 is provided for long term planning.

Table 20: Water supply in Zone A

		2024	2025	2026	2027	2028	2033
Description	Unit	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**	**Y10**
Water Produced							
Monthly water demand in wet season	m^3/month in wet season	13,013	13,831	14,657	14,811	14,977	15,804
Water demand. wet season	m^3/wet season	78,076	82,985	87,942	88,866	89,860	94,824
Water loss		15%	15%	15%	15%	15%	15%
Water produced. wet season	**m^3/wet season**	**91,854**	**97,629**	**103,461**	**104,548**	**105,718**	**111,558**
Monthly water demand in dry season	m^3/month in dry season	17,260	18,405	19,562	19,778	20,009	21,168
Water demand. dry season	m^3/dry season	103,559	110,431	117,371	118,665	120,056	127,006
Water loss		15%	15%	15%	15%	15%	15%
Water produced. dry season	**m^3/dry season**	**121,834**	**129,919**	**138,084**	**139,606**	**141,242**	**149,419**
Water Available in Pond							
Water Available. wet season	m^3/wet season	204,000	204,000	204,000	204,000	204,000	204,000
Water Available. dry season	m^3/dry season	192,147	186,371	180,540	179,452	178,283	172,443

Note: Water loss is assumed to be 15% since it is 5% for the water production system and the other 10% for the pipe distribution network.

Table 21 illustrates the amount of bulk water purchase that PWSP 1 buy from the wholesaler. The total amount of the bulk water purchase is 166,357 m^3 in year 1 and increases to 189,779 m^3 in year 5. Data in year 10 is provided for long term planning.

Table 21: Bulk water purchase in Zone B

		2024	2025	2026	2027	2028	2033
Description	Unit	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**	**Y10**
Monthly water demand in wet season	m^3/month in wet season	10,897	11,508	12,125	12,242	12,361	12,980
Water demand. wet season	m^3/wet season	65,384	69,048	72,748	73,455	74,167	77,879
Water loss		10%	10%	10%	10%	10%	10%
Bulk Water purchase. wet season	**m^3/wet season**	72,649	76,720	80,832	81,617	82,408	86,532
Monthly water demand in dry season	m^3/month in dry season	14,056	14,911	15,775	15,939	16,106	16,972
Water demand. dry season	m^3/dry season	84,337	89,468	94,648	95,637	96,634	101,830
Water loss		10%	10%	10%	10%	10%	10%
Bulk Water purchase. dry season	**m^3/dry season**	93,708	99,409	105,164	106,263	107,371	113,145
Total Water purchase	**m^3/year**	166,357	176,129	185,996	187,880	189,779	199,676

Note: Water loss is assumed to be only 10% for the pipe distribution network only.

There are two possible outcomes that could happen:

- Scenario 1: PWSP1, given that ponds 1 and 2 provide surplus raw water supply for Zone A, will take the surplus water from the ponds to supply to Zone B. This makes the amount of the bulk water purchase for Zone B from a wholesaler smaller than projected.

- Scenario 2: PWSP1 would cease the operation of water station 1 and pond 1 and thus the wholesaler could supply clean water to Zone B and some parts of Zone A given that pond 2 could provide only 60,000 m^3 during the wet season and could not supply to fulfil the demand in the wet season, not to mention the water demand in the dry season.

  Although PWSP 1 has two water stations with a pond each, there is a high possibility that he may cease the operation of the first water station for two reasons. Firstly, there has been an increasing difficulty on the water collection of the pond in that station due to the recent urbanization. The real estate developers have been filling land in the surrounding areas of the ponds which the water cannot flow into the pond, and PWSP 1 had to pump water from the rice fields into the pond last year. Given that the trend is still on going, there will be more and more difficulties from time to time. Secondly, as the areas get more and more urbanized and developed, the opportunity cost of the land usage for the water station and pond is increasing. Nevertheless, there is an uncertainty about the timing.

Given this uncertainty, this study assumes the wholesaler will supply clean water to Zone B and the PWSP1 will supply clean water to Zone A only.

The study also assesses the existing pipe network of PWSP 1 and finds that the existing pipe network could endure the pressure from the wholesaler and could deliver clean water to end users with enough pressure complying with the minimum technical requirement of the MISTI at the end of year 5 with very minimal modification. The modification is presented in section 4.3.2.

Table 22 illustrates the proposed delivery point that the wholesaler will provide the clean water supply to PWSP 1. To ensure that the users have enough water pressure and water quantity (by year 5), the flow rate is 35 m^3/h while the water pressure is at 20 m. The water pressure of 20 m is a result of required pressure of 15 m and the residual pressure of 5 m. See Figure 17 for the delivery point.

Table 22: Proposed delivery point of PWSP 1

Criteria	PWSP 1
Proposed Location of delivery point	11.685666, 104.701555
Flow rate (max. Year 5)	35.53 m^3/h
Water pressure (m)	20 m

3.2. PWSP 2

PWSP2 has access to a community pond and claims that he will have access to another community pond if needed. Taking this into account, the study estimates the amount that the two ponds could supply. The study also assumes that other users do not extract the water from the community pond. However, there are other users such as farmers who do dry season rice farming. Hence, the amount of water in the ponds available for PWSP2 to extract is less than projected. Nevertheless, for the conservative scenario analysis, the study assumes that the water availability is solely for PWSP 2 for both ponds.

Table 23 illustrates the amount of water that the PWSP 2 could extract from the ponds in the dry and wet seasons and also the amount of water that PWSP 2 will buy from the wholesaler to fulfil the water shortage. In the wet season, PWSP 2 is self-sufficient and does not have to buy the bulk water. However, in the dry season, PWSP 2 faces a significant amount of water shortage and has to buy the bulk water. The bulk water purchase is 123,605 m^3 in year 1 and will increase to 298,091 m^3 in year 5. Data in year 10 is provided for long term planning.

Table 23: Bulk water purchase for PWSP 2

		2024	*2025*	*2026*	*2027*	*2028*	*2033*
Description	Unit	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**	**Y10**
Water Produced							
-							
Monthly water demand in wet season	m^3/month in wet season	19,469	22,659	24,587	26,602	28,707	33,944
Water demand. wet season	m^3/wet season	116,815	135,954	147,520	159,611	172,240	203,663
Water loss		15%	15%	15%	15%	15%	15%
Water produced. wet season	**m^3/wet season**	**137,429**	**159,946**	**173,553**	**187,778**	**202,635**	**239,604**
Monthly water demand in dry season	m^3/month in dry season	32,935	38,783	42,317	46,012	49,871	59,472
Water demand. dry season	m^3/dry season	197,612	232,699	253,903	276,071	299,224	356,833
Water loss		15%	15%	15%	15%	15%	15%
Water produced. dry season	**m^3/dry season**	**232,485**	**273,764**	**298,709**	**324,789**	**352,028**	**419,804**
Water Available in Pond							
Water Available. wet season	m^3/wet season	252,517	252,517	252,517	252,517	252,517	252,517
Water Available. dry season	m^3/dry season	101,609	79,092	65,485	51,260	36,403	0
Water Demand to be supplied by ponds							
Water demand supplied by pond. wet season	m^3/wet season	214,640	214,640	214,640	214,640	214,640	214,640
Water demand supplied by pond. dry season	m^3/dry season	86,367	67,228	55,662	43,571	30,942	0
Water Demand to be supplied by wholesaler							
-							
Water demand supplied by wholesaler. wet season	m^3/wet season	0	0	0	0	0	0
Water demand supplied by wholesaler. dry season	m^3/dry season	111,245	165,471	198,241	232,500	268,282	356,833
Bulk water purchase							
-							
Water loss		10%	10%	10%	10%	10%	10%

Bulk water purchase. wet season	**m³/wet season**	**0**	**0**	**0**	**0**	**0**	**0**
Bulk water purchase. dry season	**m³/dry season**	**123,605**	**183,856**	**220,267**	**258,333**	**298,091**	**396,481**

Table 24 illustrates the proposed delivery point that the wholesaler will provide the clean water supply to PWSP 2. To ensure there is enough water quantity and water pressure get into the water storage of PWSP 1, the flow rate is 96 m^3/h while the water pressure is at 5 m. See Figure 17 for the delivery point.

Table 24: Proposed delivery point of PWSP 2

Criteria	PWSP 2
Location of delivery point	11.647013, 104.725500
Flow rate (max. year 5)	96 m^3/h
Water pressure	5 m

3.3. Bulk Water Purchase estimation

Table 25 shows that in year 5, the wholesaler expects to supply to meet the bulk water purchase of 405,462 m^3 in the dry season and 82,408 m^3 in the wet season. Given that there is an assumption of water loss at 10% due to the water production and distribution network, the amount of bulk water produced is 542,077 m^3 per year in year 5. Data in year 10 is provided for long term planning.

Table 25: Bulk water supply in the dry and wet seasons

		2024	*2025*	*2026*	*2027*	*2028*	*2033*
Description	Unit	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**	**Y10**
wet season. PWSP 1	m³/wet season	72,649	76,720	80,832	81,617	82,408	86,532
wet season. PWSP 2	m³/wet season	0	0	0	0	0	0
Wet season. Total	**m³/wet season**	**72,649**	**76,720**	**80,832**	**81,617**	**82,408**	**86,532**
dry season. PWSP1	m³/dry season	93,708	99,409	105,164	106,263	107,371	113,145
dry season. PWSP 2	m³/dry season	123,605	183,856	220,267	258,333	298,091	419,804
dry season. Total	**m³/dry season**	**217,313**	**283,265**	**325,432**	**364,596**	**405,462**	**532,948**
Grand Total	**m³/year**	**289,962**	**359,985**	**406,263**	**446,213**	**487,870**	**619,480**

4. Wholesaler: Technical Study

4.1. Water source

4.1.1. Water quantity

The wholesaler will extract water from The Tonle Sap River. Although located 16 km away the Tonle Sap River is the nearest reliable and sustainable water source for the bulk water supply. Connecting the Mekong River to the Tonle Sap Lake in Cambodia, the Tonle Sap River flows back and forth between the two main water sources in the dry and wet seasons. The historical data[8] shows that the maximum flow rate was in November 2018 at 6,512 m^3/s while the minimum flow rate was in June 2017 at 262 m^3/s.

4.1.2. Water quality

A water sample was taken on the 14th of June 2021 and brought to Pasteur Institute of Cambodia for testing on the next day. The test result, which is detailed in Table 26 below, shows that the water source is chemically clean. However, it has a high turbidity. Therefore, a conventional water treatment plant is needed for water treatment.

Table 26: Quality of water source

Parameters	Results	Permissible values[9]
Turbidity	37.00 NTU	<5
pH	6.95	6.5-8.5
Nitrite	0.36 mg/l	<3
Nitrate	0.45 mg/l	<50
Iron	0.00 mg/l	<0.3
Arsenic	0.00 mg/l	<0.05
Color	12.20 mg/l Pt	<5
Manganese	0.05 mg/l	<0.1
TDS (Total Dissolved Solid)	105.0 mg/l	<800

Source: Analysed by Pasteur Institute of Cambodia. Date the sample was analysed: 22 June 2021.

4.2. Clean water production system

4.2.1. Water treatment plant

The capacity of the water treatment plant is calculated based on the amount of water sold to each of the retailers including the water loss along transmission pipe and in the production system. Table 27 illustrates the calculation of the capacity of the water treatment plant.

[8] Fujii et al., 2019. Flow Observation of the Tonie ap River by ADCP and Cause of Decrease in Observation Accuracy
[9] Based on MISTI's standard

Table 27: The calculation of the size of the treatment plant

Key Calculation	Key Assumptions	Calculation	Output
Total number of retailors			2 retailers
Bulk water sold to PWSP 1	Average monthly water sold in dry season is proportional water sold in dry season divided by 6	= 107,371 / 6	17,895 m^3/month
Bulk water sold to PWSP 2	Average monthly water sold in dry season is proportional water sold in dry season divided by 6	= 298,091 / 6	49,682 m^3/month
Bulk water sold to both retailers per month		= 17,895 + 49,682	67,577 m^3/month
Amount of treated water produced per month	7% of treated water produced is lost (2% at water station and 5% along transmission pipe).	= 67,577/ (1-7%)	72,663 m^3/month
Daily water produced	One month is 30 days. The peak coefficient is 1.1.	= 1.1*72,663/30	2,664 m^3/day
Calculated treatment plant capacity	The operational time is 20 hours per day.	= 2,664/20	133 m^3/h
Proposed capacity of the treatment plant			150 m^3/h

For design simplicity, the capacity of the treatment plant is rounded up to 150 m^3/hour.

4.2.2. Clean water storage tank

The capacity of the clean water storage tank is designed to store the clean water which can be supplied to the consumers when there is a need for higher water demand during the day or when there is a short period of maintenance on the production facilities. The engineering practice suggests building a storage tank with the storage capacity equivalent to 30% of the amount of the water produced per day. Table 28 illustrates the calculation.

The clean water storage tank will be built under or nearby the treatment plant. The clean water from the treatment plant flows into the storage tank by gravity.

Table 28: The calculation of the size of the water storage tank

Key Calculation	Key Assumptions	Calculation	Output

Daily water to be produced	As per Table 27		2,664 m³/day
Calculated storage tank capacity	30% of amount of water produced per day	= 30% * 2,664	799 m³
Proposed capacity of the storage tank			800 m³

For design simplicity, the capacity of the storage tank is rounded up to 800 m³

4.3. Distribution pipe network

4.3.1. Topographical condition

The proposed water station of the wholesaler is located in Prey Phchek Village, Chhveang Commune, Ponhea Leu District, Kandal Province. The proposed location for the water station of the wholesaler is the optimum location for the infrastructure design from the investment and operation perspective.

According to the topography data from the Google Earth, this location is at the altitude of 15 m above the sea level, while the raw water intake point at the Tonle Sap River is at the altitude of 3 m. The delivery point of PWSP 1 is at 26 m, while that of PWSP 2 is at 23 m.

4.3.2. Distribution pipe network design

The Hazen-Williams formula is used to determine the pipe sizes and the correspondent friction losses for the distribution networks. The design of the distribution network is based on the following drivers and criteria listed in Table 29:

Table 29: Key design criteria used to compute the complete sizes of main pipes

Key Calculation Driver	Design Criteria
Design period	According to MISTI's guidelines, the design period for the main pipe network is set at 35 years.
The hourly peak demand coefficient	It is estimated to be based on engineering practices.
Water loss in the network	The water loss of the new system is estimated to be 5 % of the estimated consumption based on engineering practice.
Water velocity	The water velocity in the pipes ranges from 0.3 to 1.5 m/s to prevent particles clogging in the pipe and sedimentation build up.
Total pressure loss in year 35	The total pressure loss ranges from 7 to 9 bars
Total pressure loss in year 10	The total pressure loss ranges from 2 to 3.5 bars
Minimum residual pressure	It is designed to be 0.5 bar based on engineering judgements
The roughness of the pipe coefficient	140

Initially the pipe size is calculated using the below pipe diameter equation. Once the diameter of a section is found, the Hazen-Williams formula is used to verify the associated friction loss to ensure the safety of the pipe such that the friction loss of the main pipe ranges between 1 to 10 m per kilometre. If the friction loss is outside this range, the pipe size is adjusted to a size that can dictate a friction loss that would be in the safety range. Iteration is needed. The pipe diameter equation is as follow:

$$D = \sqrt{\frac{4Q}{3600\pi v}} \times 1000$$

Where: D = Inner pipe diameter, mm

Q = Flowrate, m³/h

The total friction losses are calculated by the formula of Hazen-Williams which stipulates that:

$$H_f = \frac{1.21 \times 10^{10} \times L \times \left(\frac{q}{C}\right)^{1.852}}{D^{4.87}}$$

Where: L = Distance between section 1 and section 2, m
D = Inner pipe diameter, mm
q = Flow rate, m³/h
c = Roughness coefficient

Since the raw water pipe is connected from the source water to the treatment plant and the treatment plant is designed for 5 years, the raw water pipe is also designed for 5 years. Using the equation stipulated above, the raw pipe size is calculated to be **315 mm** with a distance of 8,871 m from the water source to the production system. Table 30 illustrates the calculation of the raw water pipe size.

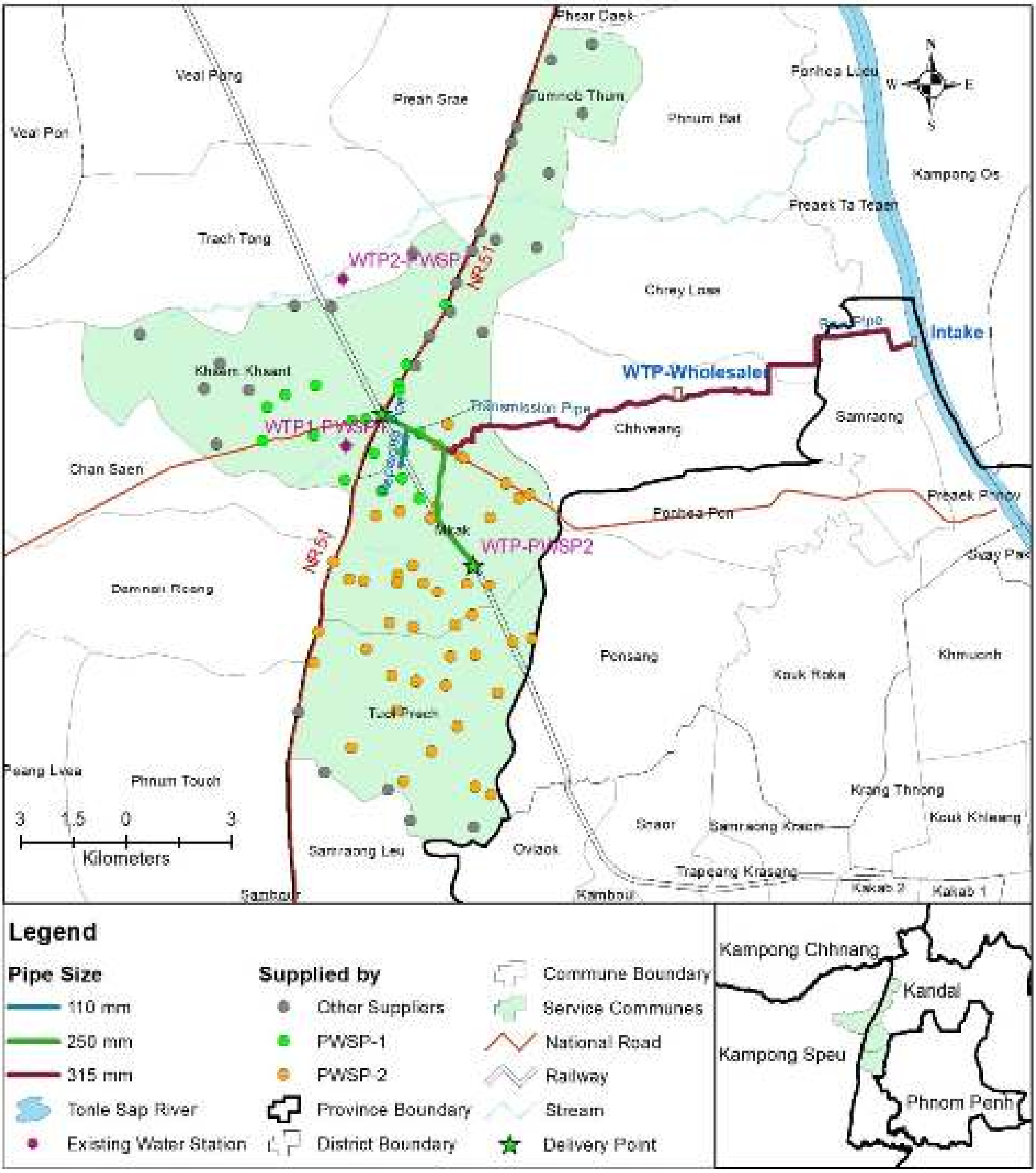
Table 30: Calculation of raw water pipe size and its corresponding friction loss

1. Calculate raw water pipe diameter, mm			
Flow rate	Velocity	Calculated pipe diameter	Actual pipe diameter
137.66 m³/h	1.2 m/s	$\sqrt{\frac{4 \times 137.66}{\pi \times 1.2 \times 3600}} \times 1000 = 221\ mm$	315 mm (for market availability and to ensure design safety). Inside diameter is 285 mm.
2. Calculate its corresponding fiction loss, m			
Flow rate	Length	Calculated friction loss	Judgment
137.66 m³/h	8,871 m	$\frac{1.21 \times 10^{10} \times 8{,}871 \times \left(\frac{137.66 \times 1000}{140 \times 3600}\right)^{1.852}}{285^{4.87}} = 10.76\ m$	Checked and acceptable as 10.76 m is in the safety range.

High Density Polyethylene (HDPE) is selected as pipe material because it lasts longer than Polyvinyl Chloride (PVC). It is easy to install and maintain and it is less vulnerable to damage and corrosion. The designed pipe network is shown in Figure 17.

The length of the distribution pipe network for the whole service area is estimated to be 23,793 m. After calculation and modelling, pipe diameters range from 110 mm to 315 mm. Figure 17 illustrates the distribution network and the network map can be found in the.

Figure 17 Map of pipe network for wholesaler



The details of pipe length are shown in Table 31.

Table 31: Length of pipe network

Pipe Type	110 mm	250 mm	315 mm	Sub-total
Raw pipe	-	-	8,871	8,871
Transmission pipe	-	-	8,045	8,045
	1,144[a]	1,985	-	3,129
	-	3,748	-	3,748
Total	1,144	5,733	16,916	**23,793**

Note: (a) The pipe length required for improving the pressure residual along the existing pipe network of PWSP 1

All pipe sections in the whole network are modelled to calculate the total friction losses. The pipeline that has the highest total head loss is used to determine the pipe size and pump selection. The above-stipulated Hazen-Williams formula shows the highest friction losses as follows:

- Year 5: 9.38 m (PWSP 1) and 15.67 m (PWSP 2)
- Year 10: 14.11 m (PWSP 1) and 25.14 m (PWSP 2)

4.4. Pump system and electricity consumption

In this bulk water supply system, two types of pumps are required:

- Raw water pumps: used for pumping raw water from the source water to the treatment plant.
- Transmission pump: used to deliver clean water from the water station of the wholesaler to the delivery points of the retailers.

The powers of pumps is computed with the below equation:

$$PP = \frac{\rho \times g \times Q \times H}{\eta \times 1000}$$

where:

PP Pump power, kW
ρ Water density, kg/m^3
g Gravitational force, m/s^2
Q Designed flow, m^3/s
H Total head, m
η Total efficiency[10], %

To estimate the capacity of the pumps, the following data are needed:

- Pump designed flow
- Total pump dynamic head
- Total pump efficiency

[10] For this study, the pump efficiency is assumed to be 65% as it is the average available pumps supplied in Cambodia.

4.4.1. Raw water pump

The raw water pump is designed to meet the water demand in year 5 and to be able to pump raw water from the water source to the top level of the treatment plant. Two raw water pumps are required. One is used in the operation while another one is used as a backup.

The designed flow rate of the raw water pump is 137.66 m^3/hour.

The raw water pump head is the addition of the raw pipe friction loss (10.76 m), minor loss (10%), elevation head (12 m), and the height of the treatment plant (4 m).

Raw pump head = 10.76 + 1.076 + 12 + 4 = 27.84 m

Using the equation stipulated above, the capacity of the raw water pump is

Table 32 Calculation of the capacity of a raw pump

Water density	Gravity force	Total head	Designed flow rate	Efficiency
1,000 kg/m^3	9.81 m/s^2	27.84 m	137.66 m^3/h	65%
$PP = \frac{1000 \times 9.81 \times 137.66 \times 27.84}{0.65 \times 36000 \times 100} = 16.06\ kW$				

The next size available in the market is **18.5 kW**

4.4.2. Transmission pump

In this project, the transmission pumps will be used, and the pumps are designed to meet water demand during peak hours at year 5. The water station shall use 3 transmission pumps while two are for operation and the other one is used as a backup.

The required total pump head is determined by addition all the friction loss (9.38 m), minor loss (10%), elevation head (11 m), the required pressure at delivery point (15 m)[11], and the residual pressure (5 m). The calculation of the total pressure head for the transmission pump is shown below:

Total pump head = 9.38 + 0.938 + 11 + 15 + 5= 41.3 m

Therefore, a total pump head of 41.3 meters is required at a volume of 61.25 m^3/hour. Using the equation stipulated above, the capacity of the raw water pump is

$$PP = \frac{1000 \times 9.81 \times 61.25 \times 41.3}{0.65 \times 36000 \times 100} = 11.29\ kW$$

The next size available in the market is **15 kW**. Hence, 2 clear pumps with the power of 15 kW each are required for the entire system, and an inverter is also needed to save electricity cost.

The summary of pump characteristics is found in Table 33.

[11] It is the highest required pressure at the delivery point at PWSP 1 to ensure that the end users have enough residual pressure.

Table 33: Summary of pump characteristics

Description	Transmission pumps	Raw pumps
Number of pumps	Two pumps in operation + one backup	One pump in operation + one backup
Flow rate	61.25 m^3/h	137.66 m^3/h
Total pump head	41.3 m	27.84 m
Pump efficiency	65 %	65 %
Pump power	15 kW	18.5 kW
Inverter	No	No
Control panel	Yes	Yes
Pump accessories	Wiring cable, pressure gauge, fitting, supports, and pumps base plate	

4.4.3. Electricity consumption

Electricity cost is one of the crucial costs that affect the cash flow of the business. For simplicity, the electricity cost is estimated per cubic meter of water.

The electricity consumption of a raw water pump is simply the multiplication of pump power and pumping duration. The electricity consumption of a raw water pump is estimated at 321 kWh/day. The transmission pump is designed to run 20 hours per day, and thus the electricity consumption of transmission pump is estimated at 452 kWh/day.

The electricity consumption per m^3 of water is the ratio of total power consumption (of raw water pumps and transmission pumps) and water produced per day. The electricity consumption is estimated to be **0.294 kWh/m^3**. A detailed calculation can be found in Table 34:

Table 34: Electricity consumption calculation

Pump type	Pump power (kW)	Total power used per day (kWh/day)
Raw water pump	16.06	16.06 x 20 = 321.28 kWh/day
Transmission pumps (Two)	11.29	11.29 x 2 x 20 = 451.79 kWh/day
Water produced per day by raw pump (m^3)		2,664 m^3/day
Water produced per day by transmission pump (m^3)		2,608 m^3/day
Power consumption per m^3	$= \frac{321.28\ kWh/day}{2{,}664\ m^3/day} + \frac{451.79\ kWh/day}{2{,}608\ m^3/day} = 0.294\ kWh/m^3$	

5. Wholesaler: Financial Projection

5.1. Investment cost

Table 35 lists total investment costs required for the wholesaler to invest. It is estimated to be 1,133,960 USD.

Table 35: Investment cost

N.	Items	Description	Cost (USD)
1	Pumping/Floating Station	1 unit	4,000
2	Water Treatment Plant	150 m^3/h	120,000
3	Water Storage Tank	800 m^3	80,000
4	Electricity Connection	100 A at WTP and 200 A at intake	7,875
5	Raw Water Pumps	18.5 kW; 2 units	19,142
6	Transmission Pumps	15 kW; 3 units	12,817
7	Office building	1 unit	4,000
8	Warehouse	1 unit	4,000
9	HDPE Pipe 110 mm	1,144 m	6,921
10	HDPE Pipe 250 mm	5,733 m	156,282
11	HDPE Pipe 315 mm	16,916 m	716,223
12	Test Kits	1 unit	700
13	Motorbike	1 unit	1,000
14	Computer	1 unit	500
15	Printer	1 unit	350
16	Phone	1 unit	150
Total			**1,133,960**

Note: The investment cost projected does not include the cost of land for water station.

5.2. Financial Projection

This section explains the financial projection of the water business over 5 years based on the following key drivers:

Table 36: Key drivers of the financial projection

Key drivers	Description	Reference
Number of staff	5 staffs	Assumption
General manager	1 @ 800 USD/month	Assumption
Pipe network staffs	2 @ 300 USD/month	Assumption
Production staffs	2 @ 300 USD/month	Assumption
Electricity Consumption	0.294 kWh/m^3	Technical calculation
Price of electricity	730 KHR/kWh	Commune office
Chemicals	0.02412 USD/m^3	Engineer's common practice

Inflation rate	3%	Institute of statistics of Cambodia
Maintenance	1% of Plant, Property, and Equipment	Assumption
Communication	100 USD/month	Assumption
Supplies	100 USD/month	Assumption

5.2.1. Expenses

5.2.1.1 Direct cost

The direct cost of the wholesaler includes the electricity cost, chemicals cost, and the maintenance cost. Table 37 illustrates this. The direct cost in year 1 is projected to be 36,397 USD and in year 5 is projected to increase to be 55,141 USD.

Table 37: Direct cost of the wholesaler

		2024	*2025*	*2026*	*2027*	*2028*
Description	**Unit**	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
Total water produced per year	m3/year	322,180	399,984	451,404	495,792	542,077
Energy cost						
Electricity price	KHR/kwh	730	730	730	730	730
Electricity price	USD/kwh	0.1825	0.1825	0.1825	0.1825	0.1825
Electricity consumption	kWh/m3	0.294	0.294	0.294	0.294	0.294
Electricity expense	USD/year	17,287	21,461	24,220	26,602	29,085
Chemical cost						
Inflation	%	3%	3%	3%	3%	3%
Chemical cost	USD/m3	0.02412	0.02484	0.02558	0.02635	0.02714
Chemical expense	USD/year	7,771	9,937	11,551	13,067	14,716
Maintenance & Repair						
Maintenance cost rate	%	1%	1%	1%	1%	1%
Maintenance cost	USD/year	11,340	11,340	11,340	11,340	11,340
Total Direct Cost	**USD/year**	36,397	42,738	47,111	51,009	55,141

5.2.1.2 Overhead cost

The overhead cost of the wholesaler includes the staff salaries, communication cost, and cost of supplies. Table 38 illustrates this. The direct cost in year 1 is projected to be 26,400 USD and in year 5 is projected to increase to be 29,412 USD.

Table 38: Overhead cost of the wholesaler

		2024	*2025*	*2026*	*2027*	*2028*
Description	Unit	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
Salaries						
Wage indexation	%	3%	3%	3%	3%	3%
Salaries	USD/year	24,000	24,720	25,462	26,225	27,012
Communication						
Communication	USD/month	100	100	100	100	100
Communication	USD/year	1200	1200	1200	1200	1200
Supplies						
Supplies	USD/month	100	100	100	100	100
Supplies	USD/year	1200	1200	1200	1200	1200
Total overhead cost	**USD/year**	**26,400**	**27,120**	**27,862**	**28,625**	**29,412**

5.2.1.3 Depreciation cost

Table 39 illustrates the depreciation cost of the investment with respect to the depreciation rates of each asset. It is constant over the period of 5 years at 31,287 USD a year.

Table 39: Depreciation cost

N.	Items	Cost (USD)	Depreciation rate	Depreciation cost
1	Pumping/Floating Station	4,000	2.00%	80
2	Water Treatment Plant	120,000	2.00%	2,400
3	Water Storage Tank	80,000	2.00%	1,600
4	Electricity Connection	7,875	0.00%	n.a
5	Raw Water Pumps	19,142	5.00%	957
6	Booster Pumps	12,817	5.00%	641
7	Office building	4,000	2.00%	80
8	Warehouse	4,000	2.00%	80
9	HDPE Pipe 110 mm	6,921	2.85%	197
10	HDPE Pipe 250 mm	156,282	2.85%	4,454
11	HDPE Pipe 315 mm	716,223	2.85%	20,412
13	Test Kits	700	14.28%	100
14	Motorbike	1,000	14.28%	143
15	Computer	500	14.28%	71
16	Printer	350	14.28%	50
17	Phone	150	14.28%	21
Total				**31,287**

5.2.1.4 Other expenses

Table 40 illustrates the profit tax of the wholesaler. The profit tax in year 1 is projected to be 2,930 USD and in year 5 is projected to increase to be 13,422 USD.

Table 40: Profit tax

		2024	*2025*	*2026*	*2027*	*2028*
Description	Unit	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
EBITDA[(a)]	USD/year	45,939	65,137	77,377	87,696	98,398
Depreciation cost	USD/year	(31,287)	(31,287)	(31,287)	(31,287)	(31,287)
Earning after Interest and depreciation	USD/year	14,651	33,850	46,089	56,408	67,111
Profit Tax rate	%	20%	20%	20%	20%	20%
Profit Tax	**USD/year**	**2,930**	**6,770**	**9,218**	**11,282**	**13,422**

(a): Note that the figure assumes that the tariff is 1,500 KHR per m^3 for demonstration purpose only.

5.2.2. Revenues

The revenue of the wholesaler includes the sale of bulk water to retailers. Table 41 illustrates this. The table assumes that the water tariff that wholesaler charges from retailers is 1,500 KHR per m^3. This assumption is for demonstration only. Hence, the sale revenue in year 1 is 108,736 USD and in year 5 is projected to increase to 182,951 USD.

Table 41: Sale revenue of the wholesaler

		2024	*2025*	*2026*	*2027*	*2028*
Description	Unit	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
Water sale to retailers	m^3/year	289,962	359,985	406,263	446,213	487,870
Wholesaler Tariff	KHR/m^3	1,500	1,500	1,500	1,500	1,500
Wholesaler Tariff	USD/m^3	0.375	0.375	0.375	0.375	0.375
Revenue from water sold	**USD/year**	**108,736**	**134,994**	**152,349**	**167,330**	**182,951**

6. Outlook

According to the results from the PIP study, the bulk water system along the national road 51 shall include more piped water systems of other existing piped water operators. They all currently depend on ponds and groundwater which face the constraint of the reliability and sustainability of the water source.

Figure 18 illustrates the locations of other potential retailers which include other 6 systems covering 12 communes in Odongk and Samraong Tong Districts. Table 42 illustrates the demographics of those other 6 systems. There are additional 17,314 households. Moreover, it is the fast-growing area next to Phnom Penh which could potentially attract more manufacturing factories and Boreys. All of this shall make the catchment area keep shrinking while the water demand keeps increasing. As a result, bulk water supply is the potential solution in the short coming future. For efficiency reason, the initial technical study suggests that the wholesaler have another water station in the North-west to take raw water from Kraing Ponley reservoir and synergize with the first water station that take raw water from the Tonle Sap River.

Figure 18: Map of potential service area for the bulk water supply

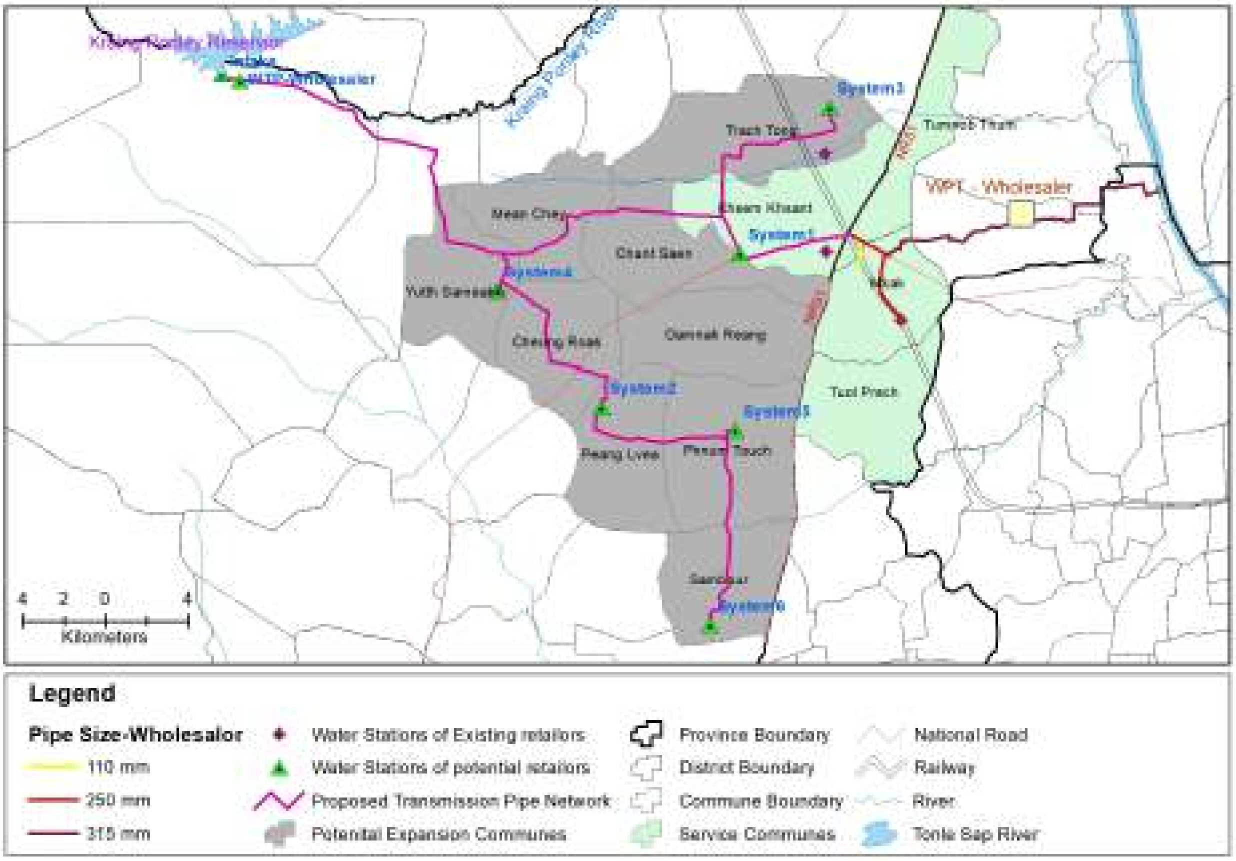


Table 42: The demographics of other potential retailers

System	District	Communes	Number of HH
1	Odongk	Chan Saen, Damnak Reang, Khsem Khsant, Trach Tong	4,700
2	Odongk	Cheung Roas, Krang Chek, and Peang Lvea	3,752
3	Odongk	Khsem Khsant and Trach Tong	964
4	Odongk	Mean Chey and Yutth Sameakki	3,006
5	Odongk	Phnum Touch	2,472
6	Samraong Tong	Sambour and Trapeang Kong	2,420
Total			**17,314**

Although there is a potential larger scale of the bulk water supply in this area, this feasibility study focuses only on the two PWSPs to proceed for the purposes of learning to formulate supporting policy development and coordination faciliatation among retailers. This pilot project is perhaps the first business model in the sector in Cambodia involving a private company as the wholesaler and other private companies as the retailers. The successful implementation of the pilot project shall build lessons and experiences for the MISTI and the confidence of the private sector to scale up the bulk water supply to include more potential retailers as per finding from the PIP study. Shall the bulk water supply increase the scale as stated above, the bulk water purchase could easily increase by at least 3 times.