PROJECT TO PROVIDE PLANNING GUIDANCE

FOR

THE WATER SUPPLY PROJECT

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC

NON-REVENUE WATER REDUCTION PROJECT

IN THE VIENTINE CAPITAL

FINAL REPORT

MARCH 2021

MINISTRY OF HEALTH, LABOUR AND WELFARE

NIHON SUIDO CONSULTANTS CO., LTD.

PROJECT TO PROVIDE PLANNING GUIDANCE FOR THE WATER SUPPLY PROJECT

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SUMMARY

(1) Background

Japan has been an important partner in the development of the water sector in Laos. In recent years, JICA, in conjunction with the Department of Water Supply of the Ministry of Public Works and Transport (hereinafter referred to as “DWS/MPWT”) and the Department of Public Works and Transport of each province (hereinafter referred to as “DPWT”), has implemented technical cooperation projects to support the improvement of management and technical aspects of water supply operations. As such, in the five years from 2012 to 2017, JICA implemented the Project for Improvement of Management Capacity of Water Supply Sector (hereinafter referred to as “MaWaSU”). Now, the second phase of the MaWaSU Project (hereinafter referred to as “MaWaSU2”) is underway, starting in 2018 and lasting until 2023. In addition, a Japanese Loan Project for the expansion of the Chinaimo Water Treatment Plant is also underway.

Through the support provided through such projects, water supply operations of Vientiane’s water supply authority Nampapa Nakhonluang (hereinafter referred to as “NPNL”) has been able to expand along with population increases, and business management capacities have also been strengthened. Water supply operations in Vientiane are running relatively smoothly thanks in part to these improvements.

However, several issues related to management still exist:

- Increasing NRW rates and number of leakage repairs
- Worsening financial conditions

Financial conditions have been worsening recently and raising water tariffs has been considered. During the tariff revision in 2014, a five-year, 3%~4% per year tariff increase schedule was agreed upon. This would have brought tariffs to necessary levels by 2018. However, in 2017, the Prime Minister’s Office intervened to postpone the tariff increases. NPNL was advised that, before raising tariffs, operational efficiencies should be improved, including better control of non-revenue water (hereinafter referred to as “NRW”). Therefore, to ensure continuation of the tariff revision schedule and financial strength, improvement of operational efficiency, especially the reduction of NRW, has become an important issue for NPNL.

Without the necessary operational improvements and tariff revisions, funds for operational investments would continue to be insufficient, and financial conditions of NPNL could continue to deteriorate. Thus, NRW reduction and operational improvements are important factors for the financial future of NPNL.

NPNL has been implementing NRW reduction activities, but have not been able to achieve the desired results.

(2) Condition of Water Supply Operations of the Target Area

1) Water Supply

Vientiane is the capital city of the Country of Laos, with a population of approximately 830,000 (2019). NPNL is responsible for water supply to the entire area. Basic information related to NPNL operations are shown in Table-1.

In recent years, unit supply cost has exceeded unit supply revenue and has become a major issue for financial operations.

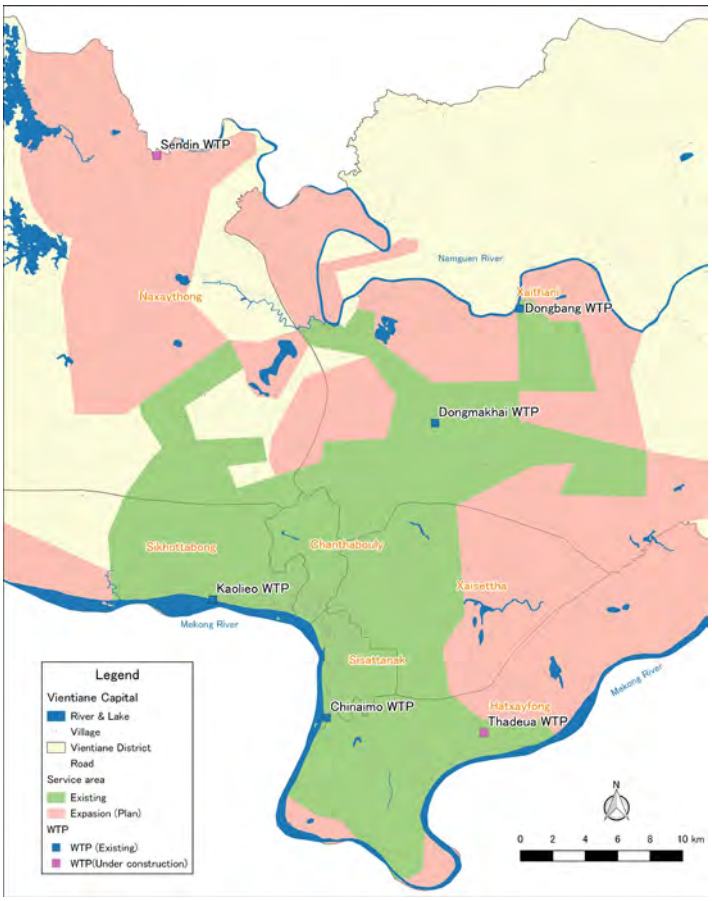
Table-1 Basic Data of NPNL (2019)

Item	Unit	Count
(1) General Data		
Population	ppl	835,410
Water supply area population	ppl	714,325
Water supply population	Ppl	648,618
Water supply penetration (total)	%	77.6
Water supply penetration (supply area)	%	90.8
Production volume	m^3/year	96,056,716
Billed volume	m^3/year	67,096,100
Non-revenue water	%	30
New connections	per year	11,158
Total connections	Connections	142,704
(2) Water Supply Facilities		
Water sources	Mekong River, Nam Ngum River	
Existing water treatment plants	No.	11
Existing elevated tanks, distribution reservoirs	No.	10
Total length of distribution mains	km	3,184
New distribution mains	km/year	77.2
(3) Unit cost		
Supply unit cost	JPY/m^3	29.7 (2,493 kip/m^3)
Billed unit cost	JPY/m^3	27.1 (2,281 kip/m^3)

Source: NPNL Annual Report 2019

2) Water Supply Facilities

Locations of water treatment plants (hereinafter referred to as "WTPs") are shown in Figure-1.



Source: JICA (2017) The Data Collection Survey on Water Supply Sector in Lao People's Democratic Republic

Figure-1 Locations of Major Water Treatment Plants of Vientiane Province

Table-2: Major Water Treatment Plants of Vientiane Province (2019)

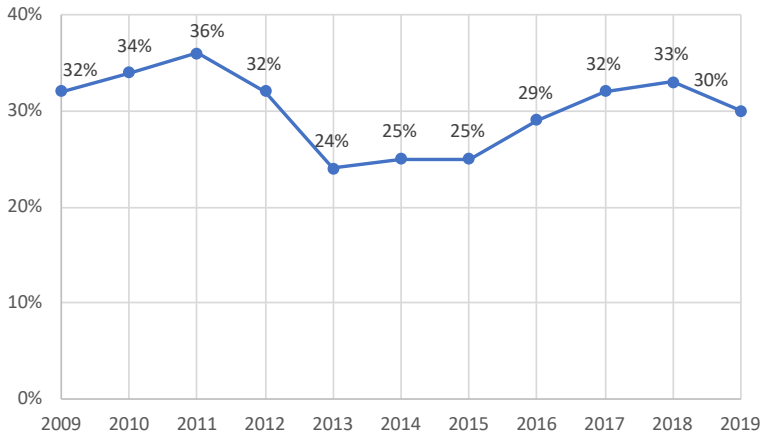
Name of WTP	Water source	Design Capacity (m^3/day)	Intake Volume (m^3/day)	Production Volume (m^3/day)	Treatment Loss (%)	Source of funds, etc.
Chinaimo	Mekong River	80,000	90,062	80,628	10.5	ADB, Japan Currently adding 40,000m^3/day of new capacity (Japanese Loan Aid)
Kaolieo	Mekong River	60,000	62,359	60,771	2.5	Japan
Dongmakhai 1	Nam Ngum River	20,000	21,438	20,453	4.6	Self-financed
Dongmakhai 2	Nam Ngum River	100,000	84,942	77,039	9.3	Chinese Export/Import Bank
Dongbang	Nam Ngum River	20,000	6,083	5,476	10.0	SPC (Vietnam Public Enterprise + NPNL)
Sendin	Nam Ngum River	24,000	N/A	N/A	N/A	Private Operator
Tha Deua	Mekong River	20,000	N/A	N/A	N/A	Private Operator
Total	-	324,000	258,801	244,367	5.6	

Source: NPNL Annual Report 2019

3) Non-revenue Water and Water Leakage

The NRW rate of NPNL operations was 36% in 2011. NRW fell to 25% in 2015, and rose to 33% in 2018. It has fallen again slightly in 2019, but is still high, at 30% (refer to Figure-2). In 2016, an additional 100,000 m^3/day of capacity was added to the Dongmakhai WTP, which increased water pressure in the water supply

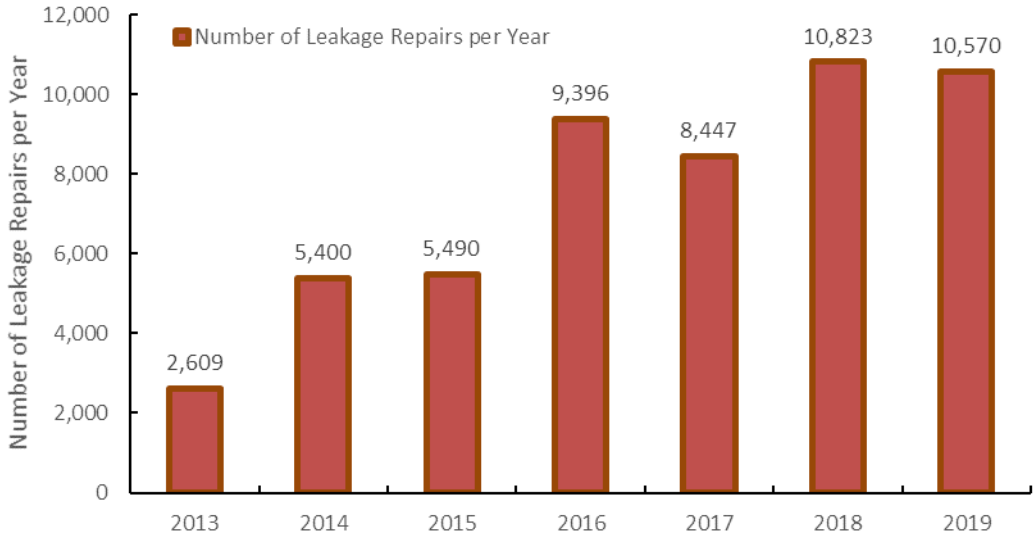
system. This pressure increase is thought to be one factor in the observed NRW increase after 2015. In addition, operation and maintenance (hereinafter referred to as “O&M”) of the piping network is becoming increasingly complex and difficult as the network is expanded.



Source: NPNL Annual Report 2019

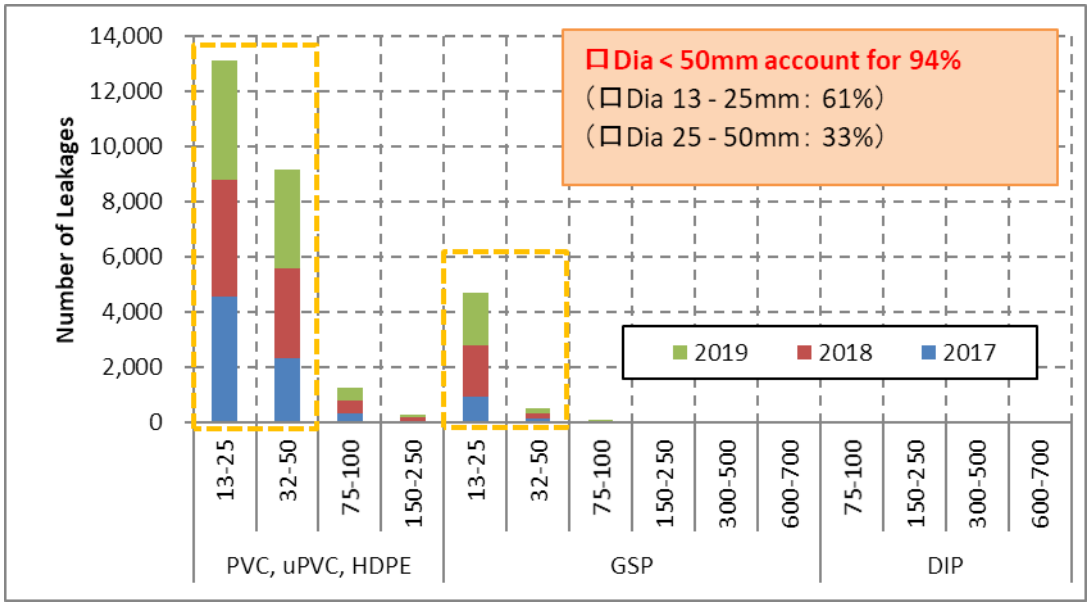
Figure-2 Record of NRW rates in Vientiane Province

As shown in Figure-3, 2,600 leakages were repaired in 2013. The last five to six years have seen a dramatic increase in this number, with 10,000 repairs being performed in 2019. Leakage repairs by pipe material is shown in Figure-4. It can be seen that over 90% of repairs are performed on pipes of diameter 50 mm or less. Repairs for pipes of diameter 13~25 mm is especially high, accounting for 60% of all repairs. This suggests leakages often occur in supply connections and other small diameter pipe works.



Source: NPNL Annual Report 2019

Figure-3 Number of Leakage Repairs



Source: NPNL Annual Report 2019

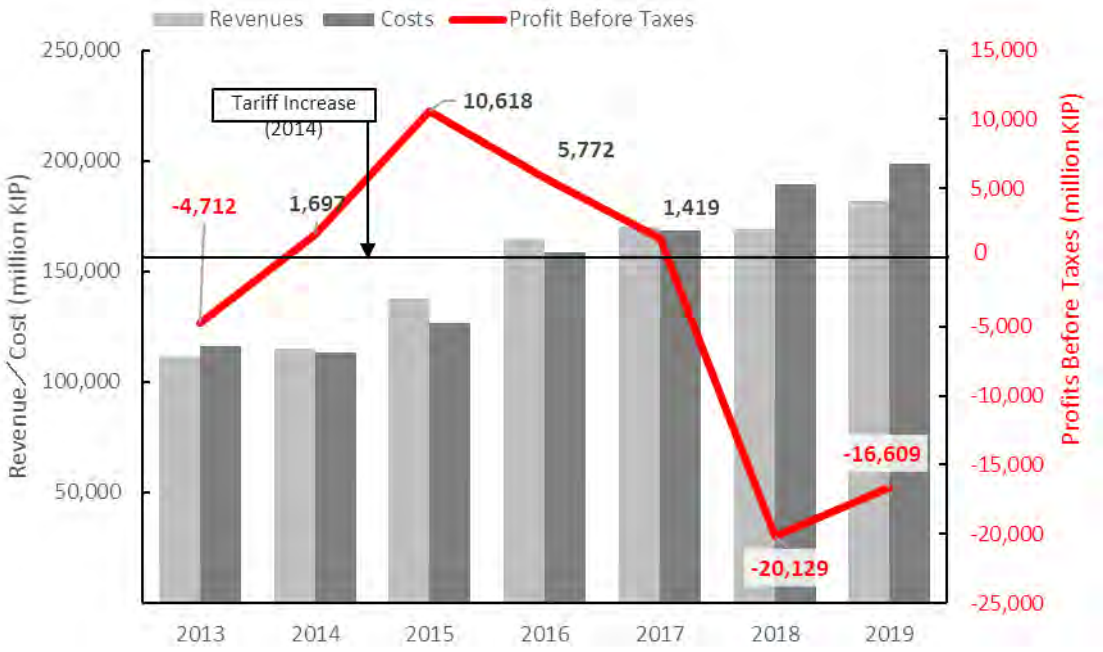
Figure-4 Leakage Repairs by Pipe Material and Size

Issues related to NRW in the target area are summarized as follows:

- NRW rate is high, at 30~35%
- 10,000 leakage repairs are being performed annually in recent years
- Small diameter pipes of (50 mm or less) account for 94% of leakage repairs

4) Financial Conditions

Figure-5 shows the financial situation of NPNL. Finances were in the red until 80% tariff increase was imposed in 2013, resulting in increased revenues and net positive income. However, after reaching a peak in 2015, net income has fallen for three straight years. The deficit in 2018 was 240 million JPY, and that in 2019 was 200 million JPY. These deficits were caused by rapid growth of expenses that outpaced the growth of revenues.



Note: 16,609 million KIP = 1.98 billion JPY (84.02 KIP/JPY, 2020/6/23 exchange rate)
Source: NPNL Annual Report 2019

Figure-5 NPNL Record of Revenues and Profits Before Taxes

The large deficits are thought to be caused by the following:

- Reliance on the private sector at relatively high costs to fill gaps caused by delays in public infrastructure development
- Delay in tariff adjustments

While population and water demand brought about by robust economic development continue to rise, WTPs are forced into overloaded operation to meet demand. Existing facilities need to be expanded, and new facilities need to be constructed. Under such circumstances, NLNP had no choice but to use private funds to enter into BOT contracts with three WTPs (Tha Deua WTP, Dongbang WTP, Sendin WTP) for bulk water supply to meet demand. Initial unit price of water is set at 21 JPY/m^3. After three years, unit price will gradually increase and will reach 55 JPY/m^3 in approximately 20 years. There is concern that NPNL financial conditions will continue to worsen as bulk water prices rise. In addition, water procured at this high price will be supplied through the NPNL pipe network, which currently has high leakage rates. However, it is difficult to secure the large funds needed for large-scale pipeline renewal works, resulting in a vicious financial cycle.

Another reason for the deficit is the delay in tariff increase. During the tariff revision of 2014, it was agreed to raise tariffs by 3%~4% annually over 5 years from 2014 to 2018. However, the Prime Minister's Office intervened in 2017 to stop the tariff increases. The Prime Minister's Office advised NPNL to improve operational efficiency and reduce NRW before increasing tariffs on consumers. Therefore, to ensure continuation of tariff revision and financial strength, improvement of operational efficiency, especially the reduction of NRW, has become an important issue for NPNL.

Without the necessary operational improvements and tariff revisions, funds for operational investments would continue to be insufficient, and financial conditions of NPNL could get much worse. NRW reduction and operation improvement are important factors for the financial future of NPNL.

(3) Issues

1) National Level

Major issues identified in the water supply sector at the national level are as follows:

- Finances required for operation cannot be secured
- Even if master plans (hereinafter referred to as "M/P") are prepared, funds necessary for implementation cannot be secured
- Because funds cannot be secured, improvements to facilities to meet growing demand cannot be self-funded. Utilities must rely on private water suppliers. But their unit prices are high, and have a large negative impact on finances
- NRW is high in some cities

2) Target Area

Solutions proposed for issues in the water supply operations in the target area are shown in Table-3.

Table 3 The Relationship Between Local Issues and the Proposed Project

Issues	Relationship to the Proposed Project
Procurement of funds	Implementation of the project is expected to reduce NRW, thus improving overall operation of the organization. This does not solve the root cause of the inability to procure funds, but improvement of operational indicators is expected to improve the ability to procure funds in the future. The MaWaSU2 project includes activities to create frameworks for procurement of funds in the water supply sector.
Increasing NRW, large number of leakages	Implementation of the proposed project is expected to improve the situation.
Development of water supply facilities is lagging behind increases in water demand	Reducing leakages will make more of the produced water available for consumption, and can be an alternative to construction or expansion of WTPs.
Maintenance of water supply facilities by high-cost private enterprises	Reducing leakages can be an alternative to construction of new WTPs, reducing dependence on high-cost private enterprises to maintain water supply facilities.
Delay of scheduled tariff increases	Although tariff increases are necessary, improvement of operational efficiency, including NRW reduction, is first required. Implementation of the proposed project is expected to reduce NRW, fulfilling the requirement for approval of tariff increases.

Source: Survey Team

(4) Outline of the Plan

The outline of the project plan is shown in Table-4

Table-4 Outline of the Project

Item	Contents
Objective	Reduction of NRW volume and NRW rate (NRW rate 30% → 20% ~ 25%)
Outline	Use JICA Grant with O&M Scheme to implement a performance-based contract to reduce NRW
Implementation Structure	Executing Agency: DWS Implementing Agency: DPWT, NPNL
Project Implementation Period	5 years
Main Activities	− Initial measurement of NRW − Establishment of DMAs, night-time minimum flow measurements − Leakage survey, repair, water pressure survey, water meter survey, pipe renewal, supply line replacement, installation of pressure reducing valves − Measurement of NRW after implementation of above-mentioned activities − Training of NPNL staff

Source: Survey Team

The Japanese Grant with O&M Scheme includes an ODA component and an O&M component. The ODA component will be implemented as a Japanese Grant Aid Project and the O&M component will be financed by the recipient country.

Generally speaking, construction and renewal of facilities related to NRW reduction will be financed though the ODA grant support, while surveys, analyses, and planning will fall under the O&M scope (refer to Table-5).

Table-5 Anticipated Contents of the Project

Component	**Main Activity**	**Comments**
ODA	Initial NRW measurement	All of the reimbursement portion is expected to be paid by the ODA budget. Placing an upper limit on the budget is expected to incentivize selection of locations with highest impact.
	DMA creation	
	Meter renewal	
	Pipeline renewal	
	Supply line renewal	
	Pressure reducing valve installation	
	Leakage repair	
	NPNL staff training	
O&M	Night-time minimum flow measurement	Payments will be made according to the amount of NRW reduction. Selection of locations with high impacts are important in ODA projects. It is expected that surveys will be selected for effectiveness and efficiency.
	Leakage survey	
	Water pressure survey	
	Water meter survey, household survey	
	NRW measurement after implementation of activities.	

Source: Survey Team

Estimated project costs for each case and calculation results of the benefits for the Lao side are shown in Table-6. The study areas used for the evaluation of each case is based on the zones shown in Figure-6.

Table-6: Outline Cost and Benefits (by Case) (Draft)

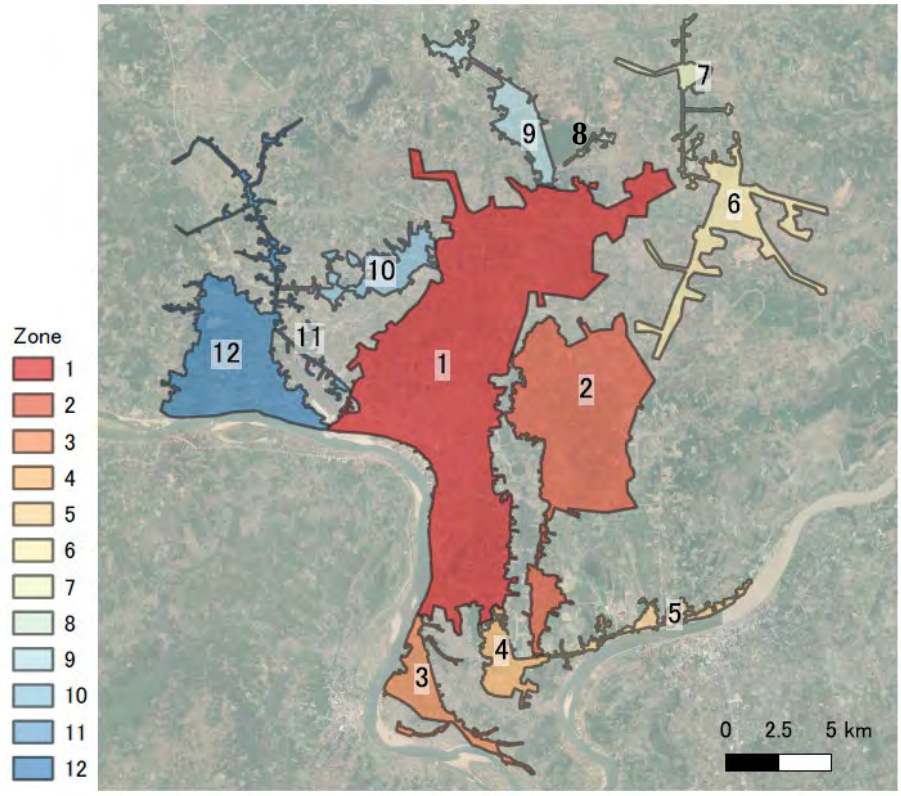
Million USD

Category		Item	Case					
			1	2	3	4	5	6
Target area			All Zones		Zones 1,5,8,11,12		Zones 5,8,11,12	
NRW reduction volume（m3/日）			26,317	13,158	19,980	9,990	4,632	2,317
Project Cost	Laos portion	O&M cost	4.7	2.4	3.6	1.8	0.8	0.4
	ODA Grant portion	Construction	11.1	5.5	8.4	4.2	2.0	1.0
		Construction supervision※	2.4	2.4	2.4	2.4	2.4	2.4
		Subtotal	13.5	7.9	10.8	6.6	4.4	3.4
	Total		18.2	10.3	14.4	8.4	5.2	3.8
Benefit	Laos side		11.7	5.5	8.6	4.1	1.8	0.9
			249%	231%	240%	228%	233%	230%
Selection			○					

※ Tendering support and construction supervision

Source: Survey Team

From the calculation results, considering project cots, benefitted area, NRW reduction volume, and other factors, Case -1 seems to be the most desirable for project implementation.



Source: GIS data from NPNL

Figure-6 Evaluated Zones

(5) Conclusions

The public water utility responsible for water supply operations in Vientiane, NPNL, needs to improve business operation efficiency but is unable to raise water tariffs. The high rate of NRW has made these issues even more pressing. Factors such as difficulty for NPNL to procure funds, lack of human resources, and lack of NRW reduction capabilities are some factors hindering NRW reduction in Vientiane.

At the same time, water supply development is positioned as a high priority field for Japanese ODA activities in Laos. It is also mentioned to develop cooperation and promote investment in Japanese private companies (including small to medium sized companies) in development assistance programs.

As described above, Vientiane has issues related to NRW, and has difficulty resolving these issues due limitations in securing funds, human resources, and NRW reduction capabilities. On the other hand, Japanese ODA policies prioritize water supply development and promote private sector investments in the field. In this way, needs of the Lao side and Japanese ODA policy objectives are highly aligned in the proposed project.

The implementation of the proposed project will utilize Japanese Grant Aid, human resources, and technical capabilities of private companies to address root issues related to NRW in Vientiane, and are expected to bring about effective results.

BASIC INDICATORS

Table-1 Basic Statistics of Laos

Item	Indicator (2020)	Indicator (2000)
Population	7,010,000 ppl	5,279,000 ppl
GNP per capita	2,654 USD (2019, Ministry of Planning and Investment)	290 USD
Economic Growth Rate	5.5% 2019, (Calculated based on data from Ministry of Planning and Investment)	5.7%
Foreign Debt	12,000 million USD	2,499 million USD
DAC Category	Least developed country	Least developed country
World Bank Category	iii/lower middle-income country	N/A

Source: Ministry of Foreign Affairs Databook, JETRO homepage (Summary of Laos, Basic statistics)

Table 2 Major Indicators of the Millennium Development Goals

Millennium Development Goals Indicator	Latest Data	Previous Data	SDG Goal
Goal 1 (Indicator 1.1): Proportion of people living on less than 1.25 USD a day	30.3% (2012)	55.7% (1992)	0.0% (2030)
Goal 2 (Indicator 2.1): Proportion of children, both boys and girls, that complete a full course if primary education	97.3% (2013)	64.9% (1990)	100.0% (2030)
Goal 3 (Indicator 3.1): Ratio of girls to boys in primary, secondary and tertiary education	0.95 ppl (2013)	0.79 ppl (1990)	Eliminate all disparities in education (2030)
Goal 4 (Indicator 4.1): Under-five mortality rate (number per 1,000 people)	71.4 ppl (2013)	162.0 ppl (1990)	12 ppl (2030)
Goal 5 (Indicator 5.1): Maternal mortality ratio (number per 100,000 births)	220 ppl (2013)	1,100 ppl (1990)	70 ppl (2030)
Goal 6 (Indicator 6.1): HIV prevalence among population aged 15-24 years (number of infections per 100 people)	0.01% (2013)	-	End of infections (2030)
Goal 7 (Indicator 7.8): Proportion of population with sustainable access to an improved water source, urban and rural	75.7% (2015)	39.7% (1994)	100.0% (2030)

Source: Ministry of Foreign Affairs Databook 2016, Sustainable Development GOALS, United Nations in Lao PDR

Table-3 Major Indicators of the Sustainable Development Goals

Goal 6: Ensure availability and sustainable management of water and sanitation for all.			
	Total	**Urban**	**Ural**
6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all			
6.1.1 Proportion of population using safely managed drinking water services	95% (2000) 94% (2015)	99% (2000) 98% (2015)	91% (2000) 89% (2015)
6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations			
6.2.1 Proportion of population using (a) safely managed sanitation services and (b) a hand-washing facility with soap and water	80% (2000) 96% (2015)	91% (2000) 96% (2015)	71% (2000) 95% (2015)

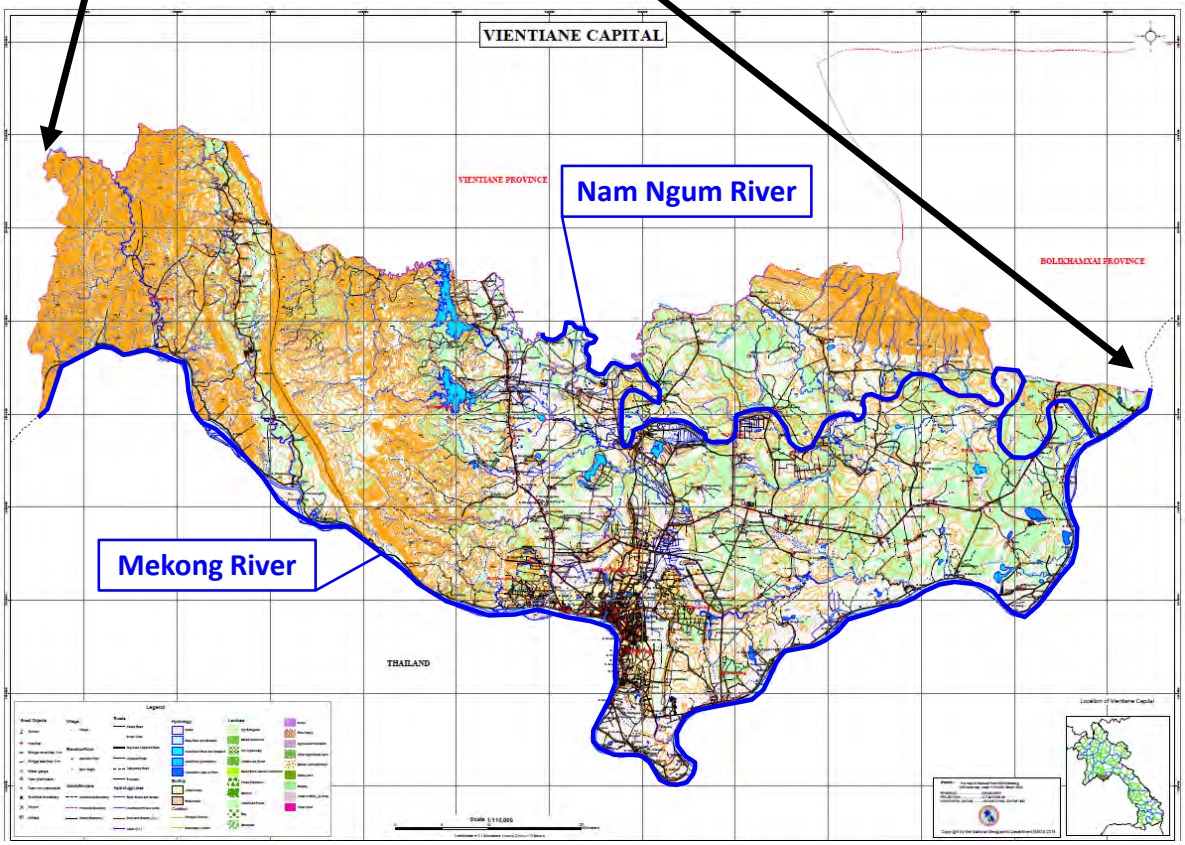
Source: Progress on Drinking Water, Sanitation and Hygiene 2017

Table-4 Infant Mortality, Maternal Mortality, Under-5 Mortality, Average Life Expectancy at Birth

Item	1990	2000	2008	2018
Infant mortality (per 1000 births)	47	38	22 (2009)	23
Under five mortality (per 1000 births)	153	107	61	47
Maternal mortality (per 100,000 births)	-	650	410	-
Life expectancy at birth	54	59	65	68

LOCATION MAP

THE VIENTINE CAPITAL, THE LAO PEOPLE'S DEMOCRATIC REPUBLIC



PHOTOS

Zoom Meeting (Laos side, 9/2020)

Zoom Meeting
(screen capture of Laos side from Japanese side, 9/2020)

Zoom Meeting (Laos side, 12/14/2020)

Zoom Meeting (Laos side, 2/18/2021)

Zoom Meeting (Laos side, 2/18/2021)

Zoom Meeting (Laos side, 2/25/2021)

 Water Leakage (Photo: NPNL)	 Water Leakage (Photo: NPNL)	 Water Leakage (Photo: NPNL)
 Water Leakage (Photo: NPNL)	 Water Leakage (Photo: NPNL)	 Water Leakage (Photo: NPNL)

ABBREVIATIONS

ADB	Asian Development Bank
AFD	French Development Agency
BOT	Built Operate Transfer
DAC	Development Assistance Committee
DIP	Ductile Iron Pipe
DMA	District Metered area
DPWT	Department of Public Works and Transport
DPWT/VTE	Department of Public Works and Transport in Vientiane Capital
DWS/MPWT	Department of Water Supply in Ministry of Public Works and Transport
E/N	Exchange of Notes
EPC	Engineering, Procurement, Construction
ERC	Enterprise Registration Certificate
FS	Feasibility Study
G/A	Grant Agreement
GDP	Gross Domestic Product
GFCP	Grass Fiber Coated Pipe
GIS	Geographic Information System
GNI	Gross National Income
GRET	Groupe de Recherches et d'Echanges Technologiques
GRP	Glass Fiber Reinforced Pipe
GSP	Galvanized Steel Pipe
HDPE	High Density Polyethylene Pipe
IWA	International Water Association
JETRO	Japan Export Trade Promotion Agency
JICA	Japan International Cooperation Agency
JMP	Joint Monitoring Program
LDC	Least Developed Country
M/P	Master Plan
MDGs	Millennium Development Goals
MOF	Ministry of Finance
MPI	Ministry of Planning and Investment
MPWT	Ministry of Public Works and Transport
MaWaSU2	The Project for Improvement of Management Capacity of Water Supply Sector
NORAD	Norwegian Agency for Development Cooperation
NPNL	Nampapa Nakhonluang
NRW	Non-revenue Water
NSEDP	National Socio-Economic Development Plan

NTU	Nephelometric Turbidity Unit
O&M	Operation and Maintenance
ODA	Official Development Assistance
PB	Polybutylene
PBC	Performance-Based Contract
PPF	Project Preparation Facility
PPP	Public Private Partnership
PVC	Polyvinyl Chloride
SDGs	Sustainable Development Goals
SP	Steel Pipe
SPC	Special Purpose Company
WHO	World Health Organization
WSRC	Water Supply Regulatory Committee
WaSRO	Water Supply Regulatory Office
uPVC	Un-plasticized Polyvinyl Chloride

Chapter 1 Introduction

1.1 Objectives

1.1.1 Background

Goal 6.1 of the Sustainable Development Goals (hereinafter referred to as “SDGs”) adopted by the United Nations General Assembly in September 2015 states that all people shall have access to safe and available drinking water by 2030. There is still much progress to be made as, according to the World Health Organization Joint Monitoring Program (hereinafter referred to as “WHO/JMP”), only 71% of the world’s population have access to safe and managed water supply and 785 million people lack access to even the most basic water supply services, as of 2017.

On the other hand, Japan’s modern water supply, which spread rapidly nationwide after 1952, has practically achieved “public water supply for all,” with a penetration rate of approximately 98%. During its rapid growth, the sector experienced and resolved many issues related to rapid economic development and population growth such as water quality deterioration, water shortages, and high non-revenue water (hereinafter referred to as “NRW”) rates. Many developing countries around the world are facing similar issues and have high expectations for resolving these issues through Japanese support. Under such circumstances, it can be said that Japan has a duty as a member of the international community to utilize its high technological capabilities and extensive knowledge to support water supply sectors around the world and to promote the overseas expansion of Japanese companies and water supply operations.

In principle, Japanese ODA projects are request based, and require official application from the recipient country. However, many projects in the water supply sector in developing countries are immature in content at the time of application. This is thought to hinder the formation of robust projects. As such, support for project formulation by providing advice and guidance utilizing the experience of Japanese water supply operators in the project formulation stage is needed to create quality projects of high maturity.

1.1.2 Purpose

The objective of this survey is to provide advice and guidance that lead to the creation of plans to solve problems in water supply (with public-private cooperation) based on the experience and knowledge held by Japanese water supply companies and operators regarding facility maintenance, operations, maintenance, etc. In addition, through detailed examination of problem solving and project formulation methods with water supply managers and staff in developing countries, the project aims utilize Japanese knowledge and experiences to improve the capacity of the central and local governments in formulating water supply projects.

1.2 Schedule and Method

The schedule of this survey is shown in Table 1.2.1. Contents of the survey are shown in Table 1.2.2. Reporting schedule is shown in Table 1.2.1. Remote meetings already held are summarized in Table 1.2.3.

Table 1.2.1 Survey Schedule

Item	2020					2021		
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Work in Japan (1/2)								
Remote meetings		△			△		△ △ △	
Submit draft report				△				
Site survey	This was not implemented because the survey team could not travel to Laos							
Work in Japan (2/2)								
Submit report								△

Table 1.2.2 Contents of the Survey

Item	Timing	Contents
Work in Japan (1/2)	End of August until end of November	Review of existing reports and materials Review of laws and regulations Implementation of initial hearings Drafting of report
Remote meetings※ (Remote online meetings were used due to travel restrictions)	Mid-September until end of February (Careful consideration of travel restrictions)	Discussions with relevant agencies Guidance of local team Verification of validity of assistance request
Work in Japan (2/2)	Mid-February to end of February	Project implementation plan

※On-site surveys were not possible due to travel restrictions and remote meetings were used

Table 1.2.3 Conditions of the Remote Meetings

Date/time[1)]	Agency		Contents
	Lao Side	Japan Side	
September 10th, 2020 10:30~12:00	NPNL	Nihon Suido Consultants	・ Explanation of the aim of the project ・ Summary explanation of Japanese Grant with O&M Scheme
December 14th, 2020 10:30~14:00	NPNL	Nihon Suido Consultants Japan Research Institute, ltd. MaWaSU2	・ Explanation of analysis of GIS data ・ Introduction of NRW reductions projects implemented with performance-based contracts ・ Proposal of Japanese Grant with O&M project utilizing PBC ・ Legal issues, etc.
February 11th, 2021 10:00~12:00	NPNL	Nihon Suido Consultants Japan Research Institute, ltd	Same as above
February 18th, 2021 10:30~12:30	DWS/MPWT DPWT/VTE NPNL	Nihon Suido Consultants Japan Research Institute, ltd.	Same as above
February 25th, 2021 10:30~12:30	DWS/MPWT DPWT/VTE NPNL	Ministry of Health, Labor, and Welfare City of Saitama Nihon Suido Consultants Japan Research Institute, ltd.	・ Explanation of background of the survey ・ Proposal of Japanese Grant with O&M project utilizing PBC ・ Ask to write assistance request

1) Time Zone: Japan Standard time

1.3 Survey Team

Members of the Survey Team are listed in Table 1.3.1.

Table 1.3.1 Survey Team Members

Name	Position	Organization
Ryuichi MORISHITA	Project Planning	Ministry of Health, Labor, and Welfare Minister's Secretariat, International Affairs Division
Shinichi WATANABE	Project Planning	Ministry of Health, Labor, and Welfare Minister's Secretariat, International Affairs Division
Toru AOKI	Chief consultant/ NRW reduction plan	Nihon Suido Consultants Co., Ltd
Koichi MATSUBARA	Deputy chief consultant/ NRW	Nihon Suido Consultants Co., Ltd
Takehiko OGA	Transmission/ Distribution pipelines	Nihon Suido Consultants Co., Ltd
Kosei NISHIDA	Service connection/ Procurement	Nihon Suido Consultants Co., Ltd
Noriaki SAKUTA	Project scheme/ Legal system	Japan Research Institute. Ltd
Toshimitsu TAKAHASHI	Operation of water supply	City of Saitama Waterworks Bureau

1.4 Survey Area

The target area of the survey shown in Figure 1.4.1.

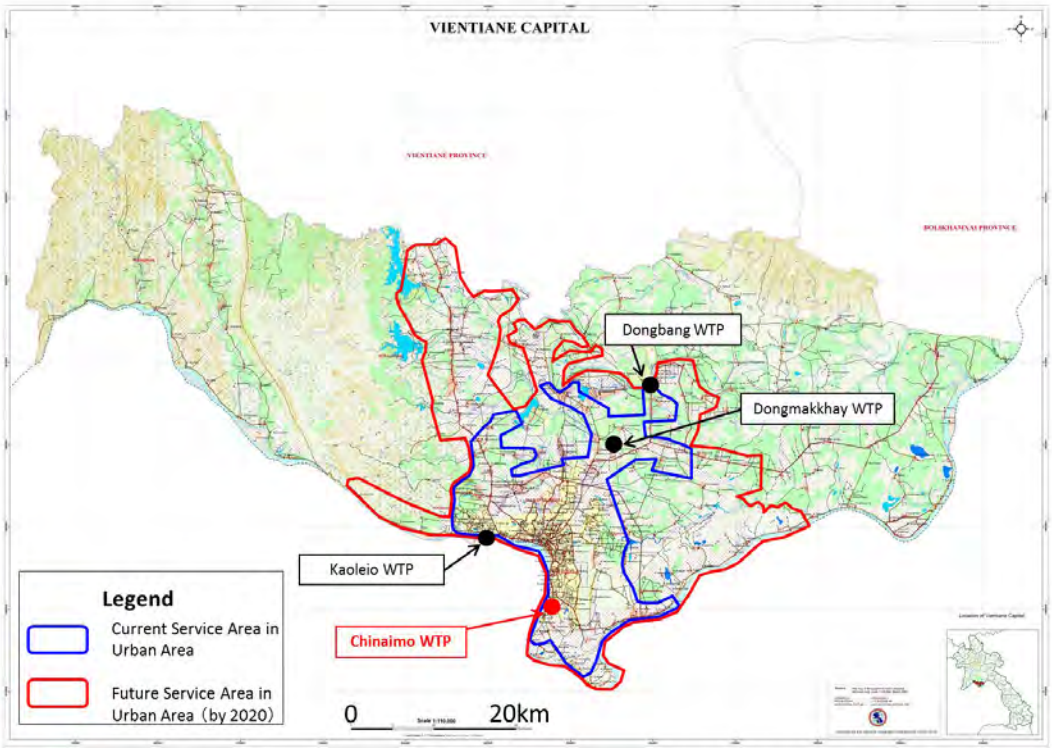


Figure 1.4.1 Location Map of the Survey Area

Vientiane, the capital city of the Lao People's Democratic Republic (hereinafter referred to as "Laos"), was the target area of this survey. Laos is the only landlocked country among the Association of Southeast Asian Nations (hereinafter referred to as "ASEAN"). It shares borders with China to the north, Vietnam to the east, Myanmar and Thailand to the west, and Cambodia to the south. 70% of the land area is mountains or highlands. The Mekong River flows through the country from north to south. The land area is 236,800 km^2, which is similar to the land area of Honshu, Japan.

The city of Vientiane is located on the left bank of the Mekong river, in an alluvial plain that stretches east to west. The city covers 3,920 km^2. The elevation of the eastern and urban area is 160 ~ 180 m while the elevation of the western area is 180 ~ 650 m.

Chapter 2 Understanding the Current Conditions of the Survey Area

2.1 Current Situation and Issues Related to Water Supply Operations in Laos

2.1.1 Current Status of the Water Supply Sector (National Level)

(1) Water Supply Penetration

The water supply penetration rate is 92% in urban areas and 73% in rural areas, as of 2015, showing a wide discrepancy in water supply penetration rates.

Goal 6 of the Sustainable Development Goals (hereinafter referred to as "SDGs") lists eight targets (6.1 ~ 6.b) and 11 performance indicators (6.11 ~ 6.b.1). Major indicators applicable to Laos and current achievement levels of each are summarized in Table 2.1.1.

Table 2.1.1 Lao Initiative for SDGs (Level of Achievement)

Item	Total	Urban	Rural
6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all			
6.1.1 Proportion of population using safely managed drinking water services	95% (2000) 94% (2015)	99% (2000) 98% (2015)	91% (2000) 89% (2015)
6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations			
6.2.1 Proportion of population using (a) safely managed sanitation services and (b) a hand-washing facility with soap and water	80% (2000) 96% (2015)	91% (2000) 96% (2015)	71% (2000) 95% (2015)

Source: WHO, UNICEF (2017) Progress on Drinking Water, Sanitation and Hygiene

Details regarding SDG goal 6.1.1 "Proportion of population using safely managed drinking water services" are described below.

As a part of the initiative to adopt SDG goals in Laos, the "8th Five-Year National Socio-Economic Development Plan (2016-2020)" is currently underway. The plan indicates that 90% of the population shall have access to safe water by 2020. In addition, Prime Minister's Decree 37 in 1999 and the 2016 Water Supply Development Plan aim to supply 80% of the urban population with safe and reliable 24-hour water service by 2020.

(2) Water Supply System (Conditions in Urban and Rural Areas)

Local government of Laos is divided into 17 provinces and the capital of Vientiane. Provinces are further divided into districts, which are further divided into villages. Nampapa, the Water Supply State Enterprise (WSSE), manages water supply operations in each province and provides piped water supply services to densely populated areas throughout the country. But there are many areas without widespread water supply. In some areas, private small-scale water supply enterprises are being developed. Of the 144 districts nationally, 48 districts (about 30% of the total) have no Namapapa facilities. In such areas, simple, small-scale (few ~ 10 households) water supply schemes (hereinafter referred to as "Nam Saat") are implemented under the jurisdiction of the Ministry of Health (hereinafter referred to as "MoH") on a village-by-village basis. For example:

1) Providing spring water by gravity flow to a village

2) Well pump water supply
3) Shallow well (approximately 10 m deep)
4) Spring water
5) Supporting development of water supply facilities such as rainwater storage

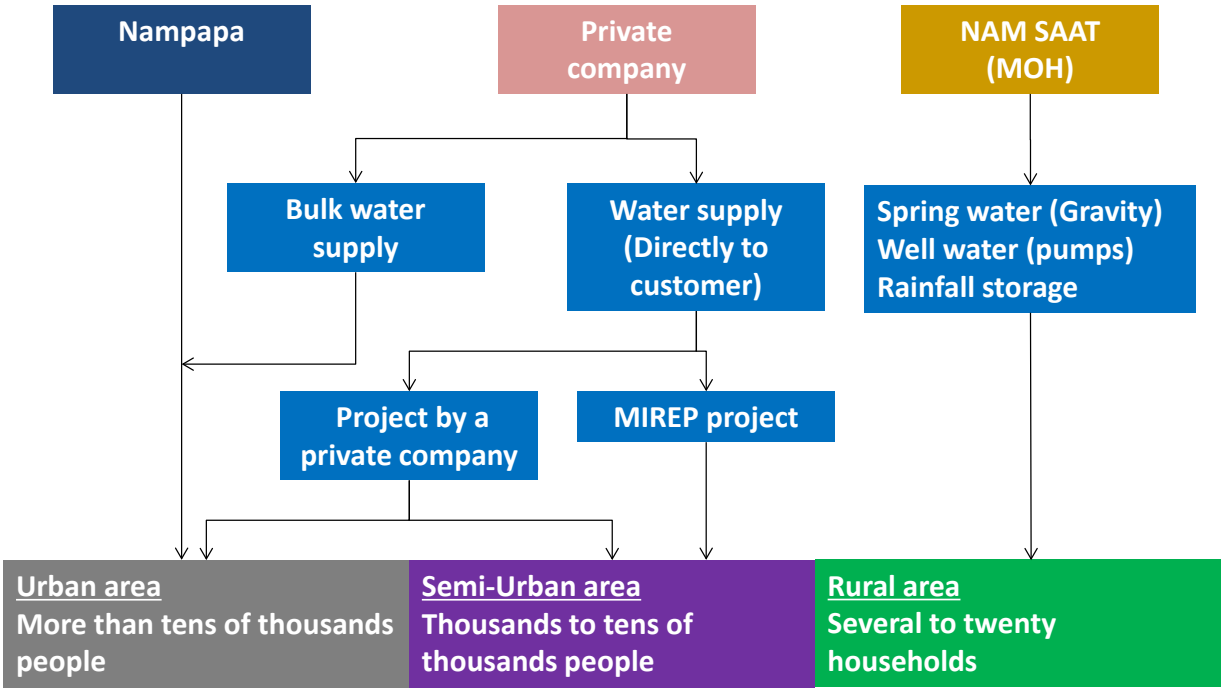
Often times, construction is done by the residents with funds from MoH. Local residents' committees carry on operation and maintenance after construction.

As shown in Table 2.1.2, water in densely populated urban areas is supplied by Nampapa, and Nam Saat supplies water in sparsely populated rural areas. The Nampapa system is under the jurisdiction of the Department of Water Supply (hereinafter referred to as "DWS") within the Ministry of Public Works and Transport (hereinafter referred to as "MPWT"), and the Nam Saat system is managed by MoH (refer to Table 2.1.2).

Table 2.1.2 Water Supply in Urban and Rural Areas

Supply System	Outline
Nampapa	Urban water supply systems operated by water supply authority under the jurisdiction of DWS/MPWT
Nam Saat	Rural water supply systems under the jurisdiction of the National Clean Water Center within the Hygiene and Health Promotion Department of the Ministry of Health

Although it is difficult to define and make clear distinctions between what is urban and rural, if settlements in Laos are categorized as urban, semi-urban, and rural, then the relation of each to the main water supply providers would be as represented in Figure 2.1.1. There are two types of private water supply; 1) bulk supply to public water utilities, and 2) direct supply to residents. In the case of direct supply to residents, the scale is small, in the range of a few thousand to a few ten-thousand people.



Source: JICA (2017) The Data Collection Survey on Water Supply Sector in Lao People's Democratic Republic

Figure 2.1.1 Conceptual Diagram of Urban and Rural Water Service Providers

2.1.2 Issues Related to Water Supply (National Level)

Category and items of problems related to water supply operations in Laos are summarized in Table 2.1.3.

Table 2.1.3 Issues in Water Supply Operations of Laos

Category	Item	Scale of Issue			Details
		S	M	L	
Regulations/ structural	a) Priority of water supply operations has not been made clear	○			Systems and regulations have been established
	b) Imitative and will to resolve the issue does not exist	○			Will to change is high in the field However, legal framework is not up to day and budgetary measures are necessary
	c) Organizational structure to prepare the necessary changes is not in place	○			The organization is a nationwide organization
	d) The number of experts is small comparted to the number of changes needed		○		Not enough water supply experts
	Due to privatization, the policy-making body and the implementation body have become separate entities		○		It has not been privatized. However, the policy-making body is located at the headquarters and is separated from the implementation body, which works at the local level
Planning/ Execution	e) High-level plants (master plans, etc.) have not been established		○		A future vision for water supply is being prepared with Japanese assistance. However, master plans have not been prepared, or if they are prepared, they are not implemented as planned
	f) There is no coordination between different donor countries/international organizations			○	Planned coordination has not been implemented
	g) Water supply facilities have not been balanced (size, technology)		○		The discrepancy between urban and rural facilities is large
	h) There is no balance with related sectors (water resources, wastewater, urban planning, etc.)	○			Since there are few issues regarding water resources, there is less pressure to develop wastewater facilities
Financial	i) Compared with the amount of development needed, funding is low			○	Procurement of funds is dependent on external donors
	j) Tariff collection system and policies are not in place		○		Tariff systems and collection systems are in place. However, tariff levels have been deliberately kept low
	k) Financial self-sufficiency		○		Due to low tariffs, finances are not self-sufficient
	l) Funds for repairs have not been secured		○		Repairs are being conducted, but the number of repairs is extremely high
	m) Funds for procuring chemicals have not been secured	○			Chemicals used in water treatment are adequately procured
Maintenance/ Management	n) Maintenance management standards are not in place	○			Manuals have been prepared through Japanese assistance
	o) Appropriate facility maintenance is not performed		○		This is being examined though Japanese technical cooperation projects. However, issues with pipelines remain.
	p) The number of experts is low compared to the amount of O&M work required		○		There are not enough experts/technicians for O&M of pipelines
Technical	q) Planning standards have not been established		○		Countermeasures are under progress though Japanese technical cooperation
	r) Applied technologies are not appropriate	○			Appropriate technologies are applied depending on the facility
	s) The technical levels of the technicians do not match the levels of the facilities		○		Technical capacities of technicians are under development through Japanese technical cooperation projects
	t) The technical levels of the technicians do not match the		○		Technical capacities of technicians are under development through Japanese technical cooperation

Category	Item	Scale of Issue			Details
		S	M	L	
	O&M requirements				projects
Others	u) Water deficiencies due to changes in precipitation		○		Many cities rely on the Mekong River for water supply. The low water levels during the dry season can cause issues
	v) Lack of equipment		○		The minimum equipment is there, but it is not enough
	w) Transfer of water supply operations to cities and operators	○			Water supply authorities are located around the country

Source: Survey Team

Much support has been provided to the water sector through Japanese assistance programs, and technical cooperation projects are being implemented to support issues related to water supply operations management. In such conditions, financing and creating master plans (hereinafter referred to as "M/P") are important issues.

(1) Issues related to Financing

When constructing new or improving existing water supply facilities in Laos, there are no domestic sources of low-interest funds. Only market interest rates of 8%~18% are available. Therefore, large scale facility development must rely on external donors. Even if support form external donors is obtained, from the start of the project to the completion of construction, including all of the necessary paperwork, can be a long-term process (for example, survey for Chinaimo Water Treatment Plant started in 2015 and completion of construction is scheduled for 2023). Even so, demand continues to raise due to increasing population spurred by continued economic growth, and existing water treatment plants (hereinafter referred to as "WTPs") are forced into overloaded operating conditions. Construction of new facilities and/or the expansion of existing ones is greatly needed. Under such circumstances, water supply utilities of major cities in Laos (Vientiane, Luang Prabang, Savannakhet, etc.) have had no choice but to rely on private funds to enter into BOT contracts with private water production enterprises for bulk water supply to meet demand. In such contracts, initial prices are low, but are scheduled to grow over time, growing to over twice the original price after 10 to 20 years. It has been pointed out that conditions will only make matters worse for water supply utilities in the future. In addition, the water procured at high cost is distributed through a leaky water supply network. But it is difficult to procure the funds necessary for proper repairs. The situation as a whole has created a vicious cycle of deteriorating infrastructure and rising costs.

(2) Issues related to Master Plan Formulation

M/Ps for water supply facilities have been established for major cities such as Vientiane and Luang Prabang. Although facilities that are necessary for meeting demand are planned in the M/Ps, actual construction of them have not been progressing as planned due to the lack of funds described above. If facilities are built at all, they are built on an ad hoc basis when private funds become available, and often conform to the scale of the funds, not the requirements outlined in the M/P. The purpose and utility of the M/P has been lost.

2.1.3 Issues Related to Sanitation and Waterborne Diseases (National Level)

Table 2.1.4 shows the number of cases of diarrhea caused by water in Laos. The number of cases per 100,000 is between 215 ~ 481, or about 0.2% ~ 0.5% of the population.

Table 2.1.4 Cases of Diarrhea by Region

Province code	Province name	2009		2010		2011		2012		2013	
		Cases	Incidence (Per 100 000 population)	Cases	Incidence (Per 100 000 population)	Cases	Incidence (Per 100 000 population)	Cases	Incidence (Per 100 000 population)	Cases	Incidence (Per 100 000 population)
1	Vientiane Capital	400	51	360	45	1444	174	3396	398	2242	255
2	Phongsaly	39	23	45	26	49	28	96	54	391	218
3	Luangnamtha	242	151	471	287	547	325	959	556	736	417
4	Oudomxay	484	166	781	261	1377	450	1091	348	743	231
5	Bokeo	331	206	983	596	1681	995	1189	686	1290	726
6	Luangprabang	418	98	597	138	752	172	1110	251	1293	288
7	Huaphanh	117	39	190	63	209	68	1028	331	1712	544
8	Xayabouly	251	70	212	58	271	73	156	41	148	39
9	Xiengkhuang	949	372	910	352	1642	626	2462	925	1824	676
10	Vientiane	1538	336	1947	416	2012	421	2214	454	1997	401
11	Bolikhamxay	1958	771	2059	787	2615	971	3539	1275	3958	1384
12	Khammuane	1067	289	530	141	2280	592	2960	752	3253	808
13	Savannakhet	2707	300	2556	278	4862	517	4746	494	4679	476
14	Saravan	905	253	1263	345	2031	541	2631	684	3174	806
15	Sekong	670	691	1120	1118	757	730	1328	1238	1877	1689
16	Champasack	896	136	1299	193	1179	172	1229	176	1502	211
17	Attapeau	211	169	999	777	814	616	985	724	1312	938
	Total	13 183	215	16 322	261	24 522	383	31 119	476	32 131	481

Source: International Journal of infectious Diseases 45(3), Trends of acute watery diarrhea in Lao People's Democratic Republic

2.1.4 Current Conditions of Water Supply Operations (Survey Area)

(1) Water Supply Operations

Vientiane is the capital city of the Country of Laos, with a population of approximately 830,000 (2019). The Nampapa Nakhonluang (hereinafter referred to as "NPNL") is responsible for water supply to the entire area. Basic information related to NPNL operations are shown in Table 2.1.5.

Table 2.1.5 NPNL Basic Information (2019)

Item	Unit	Count
(1) General Data		
Population	ppl	835,410
Water supply area population	ppl	714,325
Water supply population	Ppl	648,618
Water supply penetration (total)	%	77.6
Water supply penetration (supply area)	%	90.8
Production volume	m^3/year	96,056,716
Billed volume	m^3/year	67,096,100
Non-revenue water	%	30

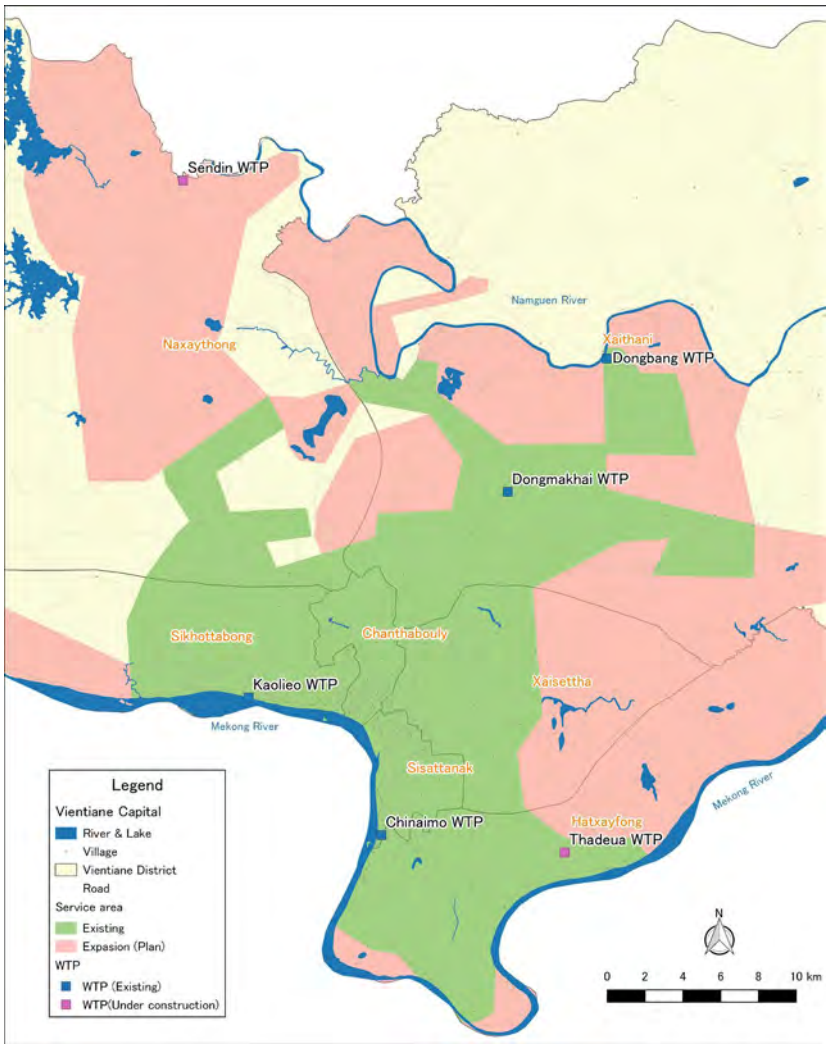
Item	Unit	Count
New connections	per year	11,158
Total connections	Connections	142,704
(2) Water Supply Facilities		
Water sources	Mekong River, Nam Ngum River	
Existing water treatment plants	No.	11
Existing elevated tanks, distribution reservoirs	No.	10
Total length of distribution mains	km	3,184
New distribution mains	km/year	77.2
(3) Unit cost		
Supply unit cost	JPY/m^3	29.7 (2,493 kip/m^3)
Billed unit cost	JPY/m^3	27.1 (2,281 kip/m^3)

Source: NPNL Annual Report 2019

(2) Water Supply Facilities

1) Water Treatment Facilities

Locations of water supply facilities are shown in Figure 2.1.2.



Source: JICA (2017) The Data Collection Survey on Water Supply Sector in Lao People's Democratic Republic

Figure 2.1.2 Location Map of Major Water Supply Facilities of Vientiane

Table 2.1.6 Major Water Supply Facilities of Vientiane (2019)

Name of WTP	Source	Design Capacity (m^3/day)	Intake Volume (m^3/day)	Production Volume (m^3/day)	Treatment Loss (%)	Source of funds, etc.
Chinaimo	Mekong River	80,000	90,062	80,628	10.5	ADB, Japan Currently adding 40,000m^3/day of new capacity (Japanese Loan Aid)
Kaolieo	Mekong River	60,000	62,359	60,771	2.5	Japan
Dongmakhai 1	Nam Ngum River	20,000	21,438	20,453	4.6	Self-financed
Dongmakhai 2	Nam Ngum River	100,000	84,942	77,039	9.3	Chinese Export/Import Bank
Dongbang	Nam Ngum River	20,000	6,083	5,476	10.0	SPC (Vietnam Public Enterprise + NPNL)
Sendin	Nam Ngum River	24,000	N/A	N/A	N/A	Private Operator
Tha Deua	Mekong River	20,000	N/A	N/A	N/A	Private Operator
Total	-	324,000	258,801	244,367	5.6	

Source: NPNL Annual Report 2019

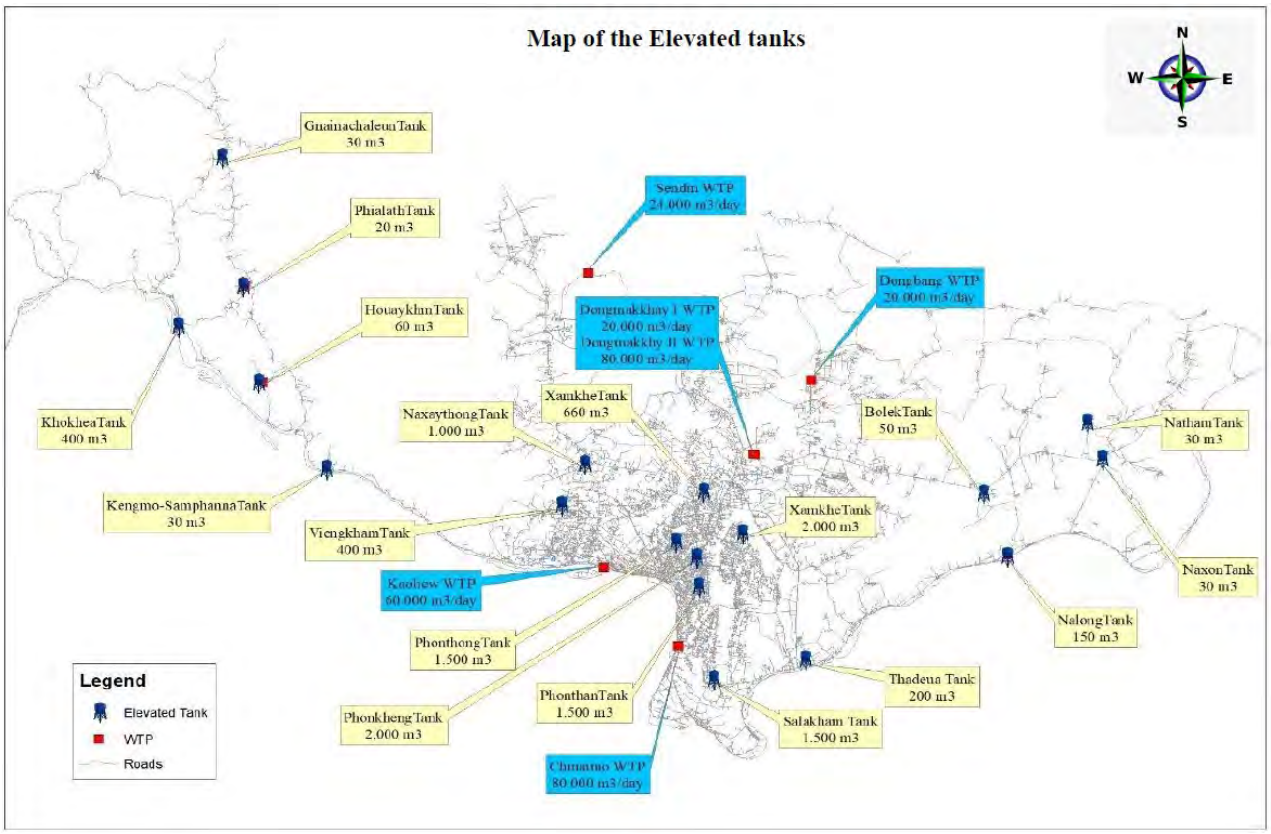
2) Water Transmission Facilities, Supply Facilities

Water reservoirs are listed in Table 2.1.7. Locations of the reservoirs are shown in Figure 2.1.3. Length of transmission mains is shown in Table 2.1.8.

Table 2.1.7 Distribution Reservoirs

Facility	Volume (m^3)	Year Construction	Funding Source
Phonkheng ET	2,000	1963	Japan
Phonetong ET	1,500	1983	Japan
Phonetanh ET	1,500	1983	Japan
Salakham ET	1,500	1993	Japan
Xamkhe ET	2,000	1994	ADB
Naxaythong ET	1,000	2004	France
Nonteng ET	1,000	2004	France
Champa vienkham ET	400	2008	France
Dongdok ET	660	-	France
Dongdok GT	1,000	-	France
Xok ET	2,000	Unknown	Unknown
Na Nga	1,000	2018	Norinco
Chaluenxay	1,000	2018	Norinco
Songkhuakangsen	1,500	2018	Norinco

ET: Elevated tank
GT: Ground tank
Norinco: Chinese private company



Source: NPNL Annual Report 2019

Figure 2.1.3 Location of Distribution Reservoirs

Table 2.1.8 Length of Transmission Mains

Diameter (mm)	Pipe material									Subtotal (m)
	DIP (m)	GSP (m)	HDPE (m)	PVC (m)	uPVC (m)	SP (m)	GFCP (m)	GRP (m)	PB (m)	
Ø300-1200	279,347	19	-	-	-	50,576	7,303	-	11,671	348,915
Ø75-280	152,167	10,599	344,232	317,801	920,110	1,135	-	-	-	1,746,045
Ø13-63	12	17,753	628,416	388,618	52,020	-	-	2,417	-	1,089,236
Total	431,526	28,371	972,648	706,419	972,130	51,711	7,303	2,417	11,671	3,184,196

Source: Table created by Survey Team based on data from NPNL Annual Report 2019

(3) Current Conditions of Water Supply Facility Operation

There are two WTPs in Vientiane operated under a public-private-partnership (hereinafter referred to as "PPP") scheme. Details of the two WTPs are shown in Table 2.1.9. The reason that WTPs are operated under PPP scheme, even though NPNL wishes to own and operate their own facilities in the future as has been done in the past, is summarized in the following points:

- Water demand has increased due to population growth, and construction and expansion of WTPs became necessary
- Financial conditions related to construction and expansion of water supply facilities are as follows:
  - If NPNL attempts to self-finance, the market interest rate (8% ~ 10% annually) applies and investment becomes impossible

- NPNL would like to continue using grants and loans of foreign donors as before, but time is required for application and other procedures, and the rapidly growing needs cannot be met on time
- NPNL must rely on private funds that can quickly start development of WTP facilities

Although privately funded projects can be started quickly, the major issue regarding the use of PPP mechanisms for water supply is the high unit cost. NPNL's unit billing price for water in 2018 was 2,200 kip/m^3. The purchase cost for PPP water is 2,200 kip/m^3. However, this is merely the initial cost and unit purchase costs are scheduled to increase year on year. Raising tariffs to match the rising PPP water cost is expected to be difficult. A situation where water is purchased at a greater cost than can be recovered by tariff revenues will result in the future. In addition, NRW, mostly caused by leakages, is high and some 30% of the procured water is lost, putting further strain on the financial health of the operations.

Continued use of PPP mechanism to meet growing demand is not a desirable strategy for NPNL.

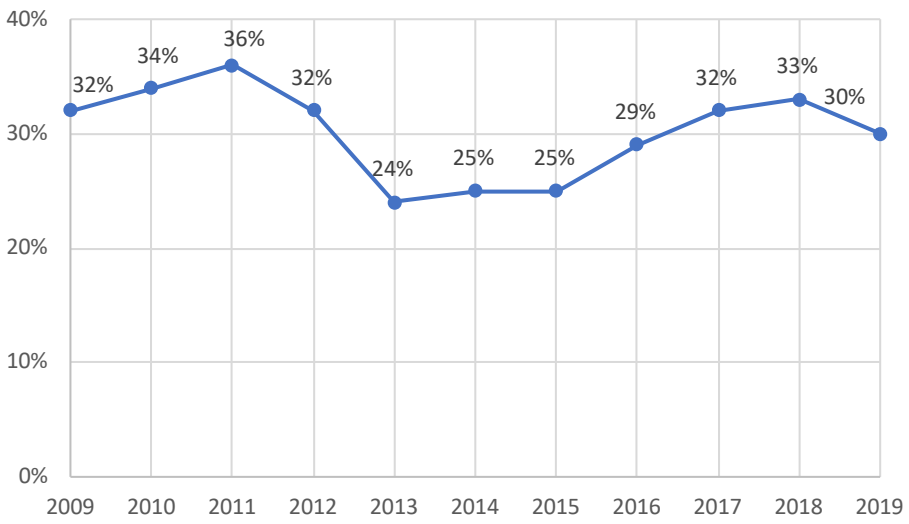
Table 2.1.9 Outline of PPP Water Treatment Plants in Vientiane

Item	Sendin WTP	Tha Deua WTP
Operator	Asia Investment Development & Construction Co., Ltd.	Vientiane Automation and Solution Engineering Co., Ltd.
Production capacity	24,000 m^3/day	20,000 m^3/day
Production capacity after expansion	48,000 m^3/day	40,000 m^3/day (by 2019)
Guaranteed purchase volume (m^3/day)	2018-2021: 15,000～18,000 2022-2027: 20,000 2028-2068: 40,000	No terms set
Purchase price (kip/m^3)	2018-2020: 1,850 2021-2023: 2,500 2024-2027: 3,000 2028-2032: 3,600 2033-2037: 4,300 2038-2042: 4,500 2043-2052: 5000 35-year average: 3920 2053-2068: Annual increase 4%	2016-2018: 1,750 2019-2021: 2,500 2022-2025: 3,000 2026-2030: 3,600 2031-2035: 4,300 2036-2050: 4,500 Average: 3,790
Operations	Water intake and treatment	Water intake, treatment, transmission mains
Cost (USD)	15,000,000	19,000,000
Construction period	18 months	24 months
Concessions term	50 years	35 years (extendable for 15 years)
Start of water supply	2018 scheduled completion	April 2017 scheduled completion
Contract type	BOT	BOT
Progress	January 2017 (Construction 38% complete)	April 2017

Source: JICA (2017) The Data Collection Survey on Water Supply Sector in Lao People's Democratic Republic

(4) Current Conditions of NRW and Water Leakage

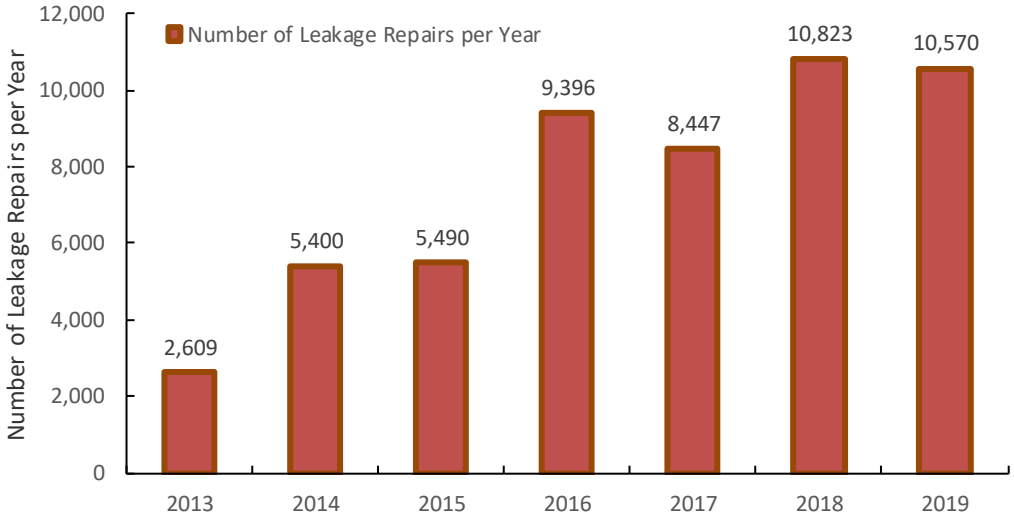
The NRW rate of NPNL operations was 36% in 2011. It fell to 25% in 2015, and rose to 33% in 2018. It has fallen again slightly in 2019, but is still high, at 30% (refer to Figure 2.1.4). In 2016, an additional 100,000 m^3/day of capacity was added to the Dongmakhai WTP, which improved water pressure in the water supply system. This pressure increase is thought to be one factor in the observed NRW increase after 2015. In addition, operation and maintenance (hereinafter referred to as "O&M") of the piping network is becoming increasingly complex and difficult as the network is expanded.



Source: NPNL Annual Report 2019

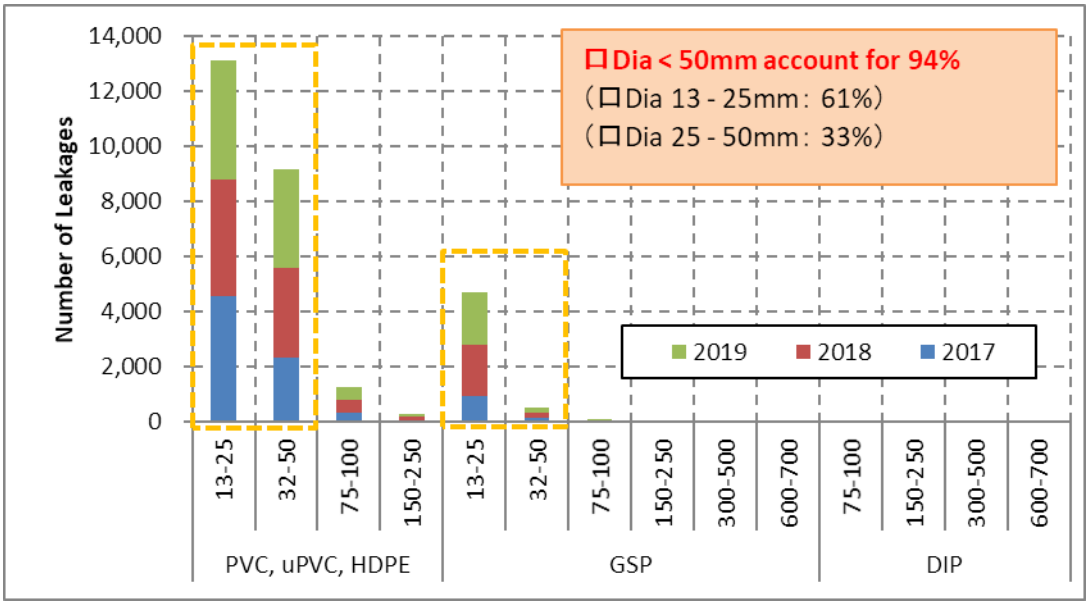
Figure 2.1.4 Record of NRW in Vientiane

As shown in Figure 2.1.5, 2,600 leakages were repaired in 2013. The last 5 to 6 years has seen a dramatic increase in this number, with 10,000 repairs being performed in 2019. Leakage repairs by pipe material is shown in Figure 2.1.6. It can be seen that over 90% of repairs were performed on pipes of diameter 50 mm or less. Repairs for pipes of diameter 13-25 mm were especially high, accounting for 60% of all repairs. This suggests leakages often occur in supply connections and other small diameter pipe works.



Source: NPNL Annual Report 2019

Figure 2.1.5 Number of Leakage Repairs

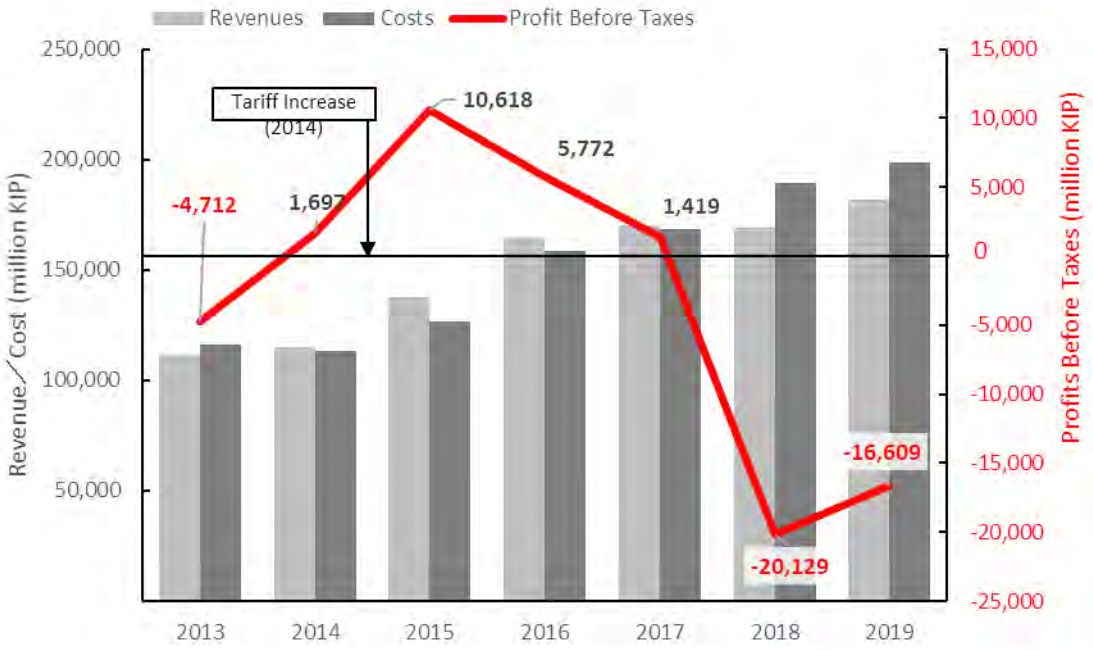


Source: NPNL Annual Report 2019

Figure 2.1.6 Leakage Repairs by Pipe Material and Size

(5) Financial Conditions

Figure 2.1.7shows the financial situation of NPNL. Finances were in the red until an 80% tariff increase was imposed in 2013, resulting in increased revenues and net positive income. However, after reaching a peak in 2015, net income fell for three straight years. The deficit in 2018 was 240 million JPY, and that in 2019 was 200 million JPY. These deficits were caused by rapid growth of expenses that outpaced the growth of revenues.



Note: 16,609 million KIP = 1.98 billion JPY (84.02 KIP/JPY, 2020/6/23 exchange rate)
Source: NPNL Annual Report 2019

Figure 2.1.7 Figure-5 NPNL Record of Revenues and Profits Before Taxes

The large deficits are thought to be caused by the following:

- Reliance on the private sector at relatively high costs in order to fill demand gaps caused by delays in public infrastructure development
- Delay in tariff adjustments

While population and water demand brought about by robust economic development continue to increase, WTPs are forced into overloaded operation. Existing facilities need to be expanded, and new facilities need to be constructed. Under such circumstances, NLNP had no choice but to use private funds to enter into BOT contracts with three WTPs (Tha Deua WTP, Dongbang WTP, Sendin WTP) for bulk water supply to meet demand. Initial unit price of water is set at 21 JPY/m^3. After three years, unit price will gradually increase and will reach 55 JPY/m^3 in approximately 20 years. There is concern that NPNL financial conditions will continue to worsen as bulk water prices rise. In addition, water procured at this high price will be supplied through the NPNL pipe network, which currently has high leakage rates. However, it is difficult to secure the large funds needed for large-scale pipeline renewal works, resulting in a vicious financial cycle.

Another reason for the deficit is the delay in tariff increases. During the tariff revision of 2014, it was agreed to raise tariffs by 3% ~ 4% annually over 5 years from 2014 to 2018. However, the Prime Minister's Office intervened in 2017 to stop the tariff increases. The Prime Minister's Office advised NPNL to improve operational efficiency and reduce NRW before increasing tariffs on consumers. Therefore, to ensure continuation of tariff revision and financial strength, improvement of operational efficiency, especially the reduction of NRW, has become an important issue for NPNL.

Without the necessary operational improvements and tariff revisions, funds for operational investments would be insufficient, and financial conditions of NPNL could get much worse. NRW reduction and operational improvement are important factors for the financial future of NPNL.

2.1.5 Issues Related to Drinking Water Supply (Target area)

In Vientiane, water quality testing laboratories are available at four WTPs (Kaoleio, Chinaimo, Dongmakhai, and Dongbang WTPs). Within these, the laboratory the Chinaimo WTP takes a leading role and is equipped with a spectrophotometer and an atomic absorption spectrophotometer (out of order).

Water quality test results from Kaoleio, Chinaimo, Dongmakhai, and Dongbang WTPs are shown in Table 2.1.10. The raw water turbidity of Chinaimo and Kaoleio WTPs, and that of Dongmakhai and Dongbang WTPs are quite different. The Mekong river is the raw water source of the former and turbidity can get as high as 4,000 NTU during the rainy season. The latter intake water from Nam Ngum River. The turbidity of Nam Ngum River is quite stable, reaching 200 NTU at the highest. Regardless of turbidity levels, treated water of all WTPs meet drinking water quality standards.

Table 2.1.10 Water Quality Analysis Items and Results of Raw and Treated Water at Major WTPs in Vientiane

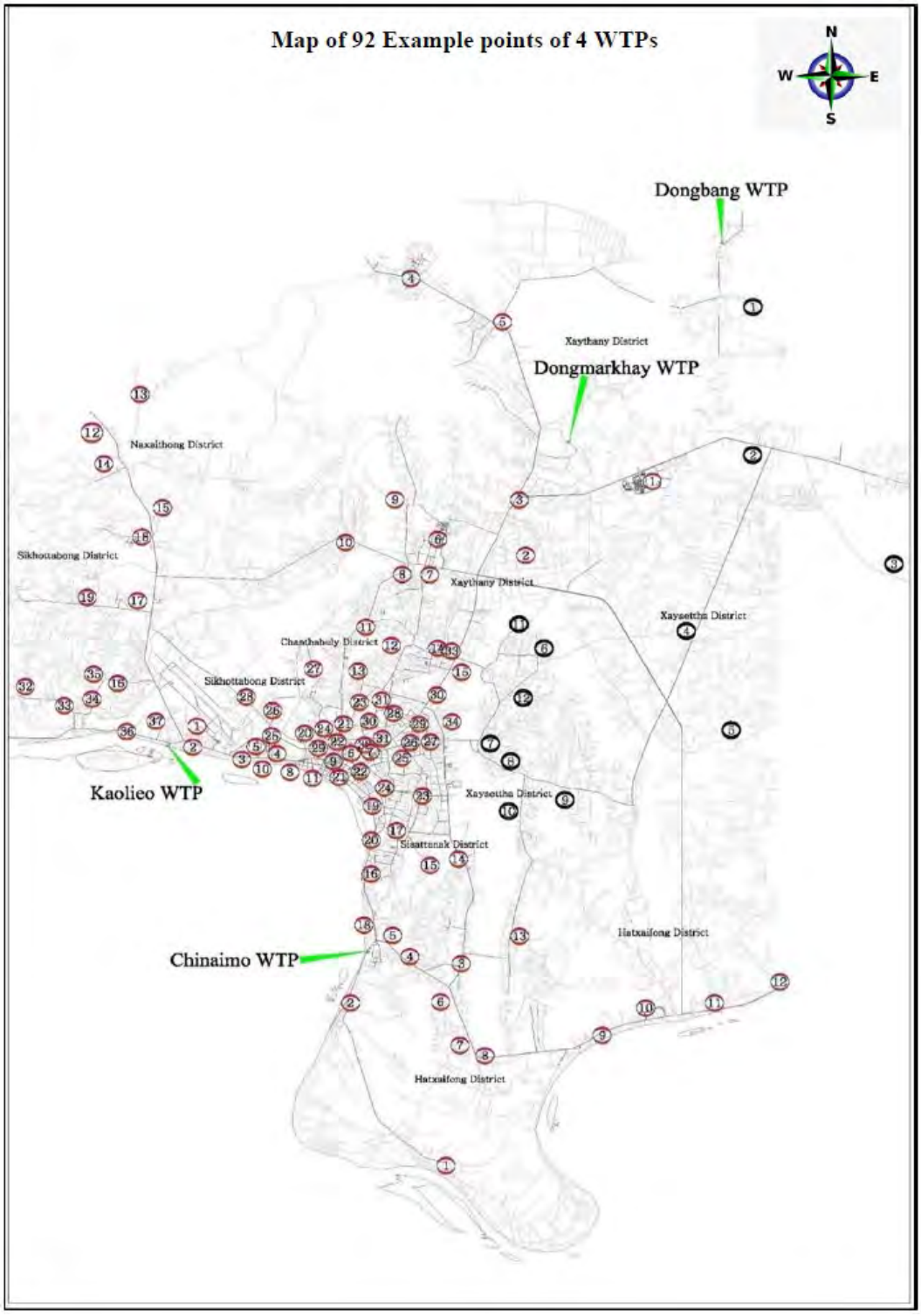
No.	Item	Unit	NPNL Standard	Chinaimo WTP		Kaoleio WTP		Dongmakhai WTP		
				Raw	Treated	Raw	Treated	Raw	Treated 1	Treated 2
1	Turbidity	NTU	<5	3.0	1.0	3.0	0.0	6.0	0	0
2	Color	CU	<5	4.0	1.0	2.0	1.0	10.0	1.0	1.0
3	Odor	-	Not offensive	Soil	Normal	Soil	Normal	Soil	Normal	Normal
4	Taste	-	Normal	-	Normal	-	Normal	-	-	-
5	pH (value)	-	6.5-8.5	8.5	8.1	8.3	8.1	7.9	7.8	7.9
6	M. Alkalinity ($CaCO_3$)	mg/l	-	108.0	96.0	112.0	102.0	72.0	74.0	64.0
7	Sulfate ion (SO_4^-)	mg/l	<250	<2	<2	<2	<2	2.4	<2	<2
8	Chloride ion	mg/l	<250	13.5	7.7	10.52	7.84	11.5	6.8	8.3
9	Fluoride ion (F^-)	mg/l	<1.0	1.44	0.06	1.74	0.08	1.34	0.06	N.D.<0.05
10	Total Hardness ($CaCO_3$)	mg/l	<300	96.0	84.0	94.3	86.5	69.0	62.0	64.0
11	E. Coli	MPN/100ml	0	5/5	0/5	5/5	0/5	4/5	0/5	0/5
12	$KMnO_4$ consumed	mg/l	-	14.7	6.9	18.4	6.61	16.9	5.8	6.3
13	Residue Chlorine (Cl_2)	mg/l	0.2-2.0	X	0.7	X	0.6	X	0.2	0.4
14	Iron (Fe)	mg/l	<0.3	0.63	N.D.<0.03	0.60	0.03	0.05	N.D.<0.03	N.D.<0.03
15	Manganese (Mn)	mg/l	<0.1	0.41	N.D.<0.01	0.22	0.04	0.24	N.D.<0.01	0.04
16	Aluminum (Al)	mg/l	<0.24	0.09	0.01	0.09	0.01	0.09	0.01	0.01
17	Cyanide ion (CN^-)	mg/l	<0.5	0.005	0.001	0.003	0.001	0.002	0.001	0.001
18	Total Dissolved Solids (TDS)	mg/l	-	168.0	171.0	165.0	171.0	98.0	99.5	97.2

N.D: Not Detected

Source: NPNL Annual Report (2019)

NPNL tests the standpipes shown in Figure 2.1.8 on a monthly basis for turbidity, color, pH, and residual chlorine.

According to results of 2019, turbidity was between 0 ~ 1.1 NTU, Color was less than 1, pH was between 6.5 ~ 8.1, and residual chloring was in the range of 0.1 ~ 0.65, and met all quality standards.



Source: NPNL Annual Report (2019)

Figure 2.1.8 Water Quality Testing Locations of Pipelines

As described above, treated and supplied water meet national drinking water quality standards and no major issues exist.

It is noted that bottled water is the main source of drinking water for most people. It is rare to drink water from the tap. If tap water is consumed, it is usually boiled before consumption.

2.1.6 Issues Related to Sanitation and Waterborne Diseases (Target area)

(1) Case Rate of Waterborne Diseases

As show in Table 2.1.4, the number of cases of diarrhea per 100,000 people was 45 ~ 389, or 0.05% ~ 0.4% of the population. This is slightly less than the national average of 0.2% ~ 0.5%.

2.1.7 Laws and Regulations Related to Water Supply Operations

The Prime Minister's Decree 37 and the Water Supply Law form the legal framework for water supply operations in Laos. They are discussed in detail below.

(1) Prime Minister's Decree 37

Prime Minister's Decree 37 is positioned as the overall governing policy related to water supply administration in Laos today. Mainly, the decree stipulates division of responsibilities of water supply operation among different ministries, establishes Water Supply Regulatory Committee, defines roles and responsibilities of water authorities, promotes community participation in water supply services, and supports human resources development. The decree established that the Department of Water Supply in the Ministry of Public Works and Transport (hereinafter referred to as "DWS/MPWT") will be responsible for water supply operations, and that water authorities of each province will manage water supply operations with independent budgets (the current government agency and executing agency for water supply operations will be further described in Section 2.3).

(2) Water Supply Law

The Water Supply Law came into effect in 2010 to regulate activities in the water supply and wastewater sectors. The law offers guidelines and supervision related to water resources and environmental protection, water supply infrastructure development and maintenance, operation of water supply, dispute resolution, and prohibitions for water supply operators.

In the following sections, overview of particular stipulations of the law that especially affect private water suppliers will be highlighted.

1) The Standing of Water Supply Operators (Water Service Providers and Authorized Water Supply Operators)

Under the Water Supply Law, a person or enterprise that holds a license for water supply operations or authorized water supply operators are considered water service providers. An authorized water supply operator is an entity that has a permit to construct water supply facilities and carry out water supply

operations according to concessions, having the rights summarized in Table 2.1.11 but also must meet the eligibility requirements listed in Table 2.1.12.

Table 2.1.11 Rights of Authorized Water Supply Operators

No,	Rights
1	Right to use land for construction of water supply facilities
2	Right to conduct water supply operations withing the terms of the concessions
3	Right to own water supply facilities constructed by the authorized water supply operator (during the concession period only)
4	Right to revenues coming from operations related to the concessions activities
5	Right to protection from damages caused by removal of facilities not related other construction projects to water supply
6	Right to accept and benefit from expert and technical advice related to water supply operations
7	Right to request extension of concession period
8	Right to transfer water supply operations in accordance with laws and regulations during the concession period

Source: Water Supply Law

Table 2.1.12 Requirements to Qualify as Authorized Water Supply Operator

No,	Qualification Requirement
1	Possess sufficient experience for the implementation of operations
2	Possess sufficient technical and financial capacity for the implementation of operations

Source: Water Supply Law

2) Investment and Participation in Water Supply Operations

Under the Water Supply Law, investments to water supply operations can be made in one of three ways:

1) Government investment
2) Joint investment by domestic and foreign private companies and governments
3) Investment by domestic and foreign private companies

In addition, any domestic or foreign individuals or groups that intend to establish a water enterprise must meet the five eligibility requirements set forth in Table 2.1.13 and obtain a water business license in accordance with the Law on Investment Promotion.

Furthermore, companies aiming to obtain concessions contracts for water services are required to submit the necessary applications to the Ministry of Planning and Investment (hereinafter referred to as “MPI”), also in accordance with the Law on Investment Promotion.

In general, concessions are valid for a maximum of 30 years, but can be extended for another 10 years with the agreement of the provincial governor.

Table 2.1.13 Requirement to Establish a Water Supply Operation

No,	Requirement
1	Possess experience related to implementation of operations and possess expertise
2	Possess, in numbers appropriate for the scale of operations, water analysts, electrical specialists, and operational management specialists, and accounting specialists
3	Possess sufficient materials, equipment, and funds to provide water supply services and construct basic water infrastructure
4	Possess water supply area that has been officially approved by Water Supply Agency
5	Possess water source approved by an agency responsible for water resources and the environment

Source: Water Supply Law

3) Water Tariffs

The Water Supply Law requires that water tariffs be aligned with the National Socioeconomic Plan (hereinafter referred to as “NSEDP”). As a result, The Department of Public Works and Transport (hereinafter referred to as “DPWT”) of the capital and each province cooperate with related agencies to implement technical surveys and research regarding water tariff revisions requested by water service providers. The results are required to be reported to MPWT.

In addition, the law requires that, water tariff revisions must pass through the parliament of the city or province, and be approved by the provincial governor, based on the request of DPWT.

4) Technical Agreement Regarding Construction of Water Supply Facilities

Technical agreements are required for the construction of water supply facilities, depending on the scale of the facility.

Specifically, DPWT approval is required for construction of facilities designed to serve 20,000 people or less. For facilities designed to serve over 20,000 people, MPWT approval becomes necessary.

2.1.8 Laws and Regulations Regarding PPP Infrastructure Projects

Various legal structures are being developed to promote PPP projects in the water supply sector in Laos. Some noteworthy legal structures are, the Prime Minister’s Decree on PPP (draft), Law on Investment Promotion, Public Procurement Law, Ministry of Finance Ordinance on Enforcement of the Public Procurement Law (hereinafter referred to as “Ministry of Finance Ordinance 0477”), the Enterprise Law, and the Land Law. Summaries of these laws are given in the following sections.

(1) Prime Minister’s Decree on PPP

The Prime Minister’s Decree on PPP was scheduled to be enforced starting in 2016. Hearing surveys in the field confirmed that the decree was promulgated and enforcement started in December 2020. Only the Lao Language version of the official text is currently available. An English language version is due to be published by MPI, but no specific date has been set.

With reference to the PPP Handbook (November 2015) which as prepared based on the draft of the 8th edition of 2015, the outline of the Prime Minister’s Decree on PPP is given in the following sections, keeping in mind that verification with the official English version of the decree at a late date will be necessary.

1) Operations and Operators Subject to the Prime Minister’s Decree on PPP

Infrastructure projects and related services included in the NSEDP are subject to the Decree. In addition, the Decree applies to all corporations established under Laotian laws, and all corporations established under foreign laws.

2) Project Formulation Procedure

Many current PPP projects in Laos were formed by unsolicited proposals that did not go through the

competitive public procurement process. The proposer was able to acquire operating rights through exclusive negotiations. The transparency of the contract awarding process is extremely low. In order to improve this situation, the Decree stipulates procedures for ensuring transparency in project formulation, as specified below.

First, as preparation for PPP project, Laos will establish a Project Preparation Facility (hereinafter referred to as “PPF”) to cover the costs required for advisory services such as project formulation, bidding, and financing. The PPF will be managed by the PPP Unit which is to be newly established within the MPI.

With the establishment of the above, the national government agency (ministry or equivalent) or local government agency responsible for preparing PPP contracts, bidding, implementation, and monitoring PPP projects which aims to develop a PPP project (hereinafter referred to as “the project owner”) will prepare the initial project proposal (with support from PPF if necessary), and get approval from the PPP Unit.

After receiving approval from the PPP Unit, the next step is implementation of a feasibility study (hereinafter referred to as “FS”) by the project owner (with support from PPF if necessary). At the same time, the project owner must report costs, payment schedule, government subsidies, government guarantees, and other obligations of the project owner or the national government expected during the PPP contract period to the MPI and Ministry of Finance (hereinafter referred to as “MoF”).

When the FS is complete, the project owner is required to report the contents of the FS to the PPP Unit. The PPP Unit will take the FS, along with the aforementioned MoI Report and MoF report, and write a recommendation letter. The FS and the recommendation letter will be submitted to the Investment Promotion Committee.

As the final stage of the procedure, the Investment Promotion Committee will review the PPP Unit’s FS and recommendation letter and give a decision whether to approve, delay (to collect and clarify additional information), or reject the proposal from the project owner. If the proposal is approved, bidding procedures will start. The Prime Minister’s Decree on PPP stipulates that the decision to delay any proposal cannot be made more than twice.

3) Procedure from Bidding to Selection of Priority Negotiator

Projects approved by the Investment Promotion Committee according to the project formulation procedure described in the above section are submitted for bidding. The procedure following the announcement of a bid is as follows:

First, the private company will create a proposal based on the tender documents and submit the proposal to the project owner. After receiving the proposal, the project owner will examine the proposal and select the priority negotiator. The project owner will then submit a PPP contract for signing to the PPP Unit. It will also submit payment schedules, guarantees and other obligations of the project owner and/or the Government of Laos to MPI and MoF.

Upon receiving the PPP contract for signing, the PPP Unit will create a letter of recommendation and submit it to the Investment Promotion Committee along with the PPP contract for signing. The Investment Promotion Committee will review the contract and the letter of recommendation and deliver a decision on

approval or denial. If the decision is to approve the project, the project owner will award the project to the priority negotiator and contract closing procedures will begin between the project owner and the priority negotiator. If the application is rejected by the Investment Promotion Committee, the procedure will be repeated.

There are exceptions to the bidding process. For example, if ODA funds are used in the project formulation, development, and implementation stages, the ODA agency may define the bidding procedures, provided that the Investment Promotion Committee approves, and they do not conflict with existing Lao national laws.

4) Regulations Related to Selection of the Operator

The operators are selected using international competitive bidding procedures. However, regulations include terms such that, if a company that is established and registered in Laos that has not received foreign investment (hereinafter referred to as “Lao domestic company”) can fulfill its PPP contract obligations at a level of quality equal to or better than foreign companies, it can receive marginal preferential rights (especially if the PPP contract uses Lao government funds). As such, preferential treatment of Lao domestic companies can be expected in the bidding process.

(2) Law on Investment Promotion

The Law on Investment Promotion was enacted in 2009, and amended in 2017. The below is a discussion of the amended law (New Law on Investment Promotion).

1) Forms of Investment and Businesses

The New Law on Investment Promotion defines five forms of investment:

1) Simple investment by domestic or foreign capital
2) Joint venture investment by domestic for foreign capital
3) Contract-based business alliance
4) Joint venture investment between state-owned and private companies
5) Joint venture investment by private companies

Two forms of enterprises are defined in the New Law on Investment Promotion; general businesses with investments in the general business sector (including those on the negative list), and concessions businesses which apply rights owned by the state and other rights for businesses and development. Businesses in 23 industries and seven sectors fall under concessions businesses as shown in Table 2.1.14, and are regulated by the Prime Minister’s Decree. Among these, water supply enterprises can fall under “intake, treated water production, and water supply” of the “PPP enterprises” or “various enterprises using state assets” categories.

In addition, the New Investment Promotion Law stipulates conditions for investors that can conduct concessions businesses. The conditions are, 1) being a registered corporation, 2) having sufficient experience and demonstrated performance in the sector, 3) having funds that have been approved and guaranteed by financial institutions in Laos and overseas, and 4) satisfying other conditions stipulated in relevant laws and regulations. Concessions are only granted to investors that meet all four of these requirements. The

maximum concession period is 50 years.

Table 2.1.14 Activities that Fall Under Concessions Businesses

No	Sector
1	**Agriculture/Forestry (4 categories)**
	Concession of government land for tree planing and fruit cultivation (excluding natural rubber)
	Land lease/concession of government land for shrubs, food, industrial crops, drugs, and other cultivation
	Land lease/concession of government land for animal husbandry
2	**Mines/Quarries (3 categories)**
	Mining and processing of minerals, research drilling for crude oil and natural gas
3	**Electrical Power (2 categories)**
	Specified electric power generation operations (hydroelectric, wind, solar, waste, etc.), power transmission, etc.
4	**PPP businesses (1 category)**
5	**Special Economic Zone Development (1 category)**
6	**Lease/concession of government land for businesses (5 categories)**
	Lease/concession of government land for infrastructure development, public works, construction of buildings, and services (for example: shopping centers, hotels, guesthouses, restaurants, parks, schools, hospitals, schools, markets, transportation hubs, etc.)
	National and local level development of natural, cultural, and historic tourism destinations
	Land lease/concession of government land for sports
7	**Various services using rights held by the government (7 categories)**
	Airport construction and ground services, water intake and treated water productions, water supply
	Transportation logistics, dry ports, etc.
	Wired and wireless communications, satellite communications, etc.

Source: Prime Minister's Decree No. 03/PM Decree on the Approval of the Negative List and Concessions Activities of Lao PDR (January 10th, 2019)

2) Procedures for Establishing a Local Office

Procedures outlined in the New Investment Promotion Law and the Enterprise Law apply to establishment of an enterprise in Laos. The jurisdiction when working to establish a company depends upon whether the enterprise activities fall under the negative list (details will be explained in section (4)), the form of the enterprise, and whether or not it is a concessions business. Business enterprises not included in the negative list fall under the jurisdiction of the Department of Enterprise Registration and Management of the Ministry of Industry and Commerce (hereinafter referred to as "MoIC") while business enterprises included in the negative list and concessions businesses are handled by the NPI One-Stop Service Office.

Specific procedures required to establish a company in Laos are shown in Table 2.1.15.

Table 2.1.15 Application Procedure of Establishing a Company

Step	Procedure
1	Trade name reservation procedure
2	Enterprise Registration Certificate (ERC) application, taxpayer number application
3	Business license application
4	Company seal application
5	Capital certificate issuance application

Source: Laos Investment Guidebook (JETRO March 2016)

3) Regulation of Foreign Capital

Stipulations regarding approval of businesses on the negative list and concessions business can be found in Article 3 of the Prime Minister's Decree. 44 industries in 14 different fields are listed on the negative list. Those intending to carryout activities listed in the negative list are required to pass a screening by the supervising ministry. If they pass the screening, a certificate of company registration is granted. Water supply enterprises are not included in the negative lists of the Prime Minister's Decree.

4) Regulation of Minimum Investments

For general businesses, no special provisions are provided in the New Investment Promotion Law, and the Enterprise Law and related regulations apply. In practice, MoIC recommends that investment capital of a least 1 billion KIP be maintained, even for businesses in fields where minimum capitals have not been set.[1]

For concessions businesses, the New Investment Promotion Law requires registered capital to be maintained at over 30% of the total capital. In addition, depending on the total investment, registered capital in the amount shown in Table 2.1.16 must be imported within 90 days of approval, and the remainder must be imported within 2 years.

Table 2.1.16 Percentage of Registered Capital to be Imported Within 90 Days of Investment Approval

Total investment amount	Percentage
Less than 10 million USD	3%
Greater than or equal to 10 million USD and less than 500 million USD	2%
Greater than or equal to 500 million USD and less than 1 billion USD	1.5%
Greater than or equal to 1 billion USD	1%

Source: New Investment Promotion Law

5) Incentives for Land-Use Rights

Two incentives are available for foreign investors participating in concessions projects.

The first is the right to transfer concessions rights to others. Foreign investors participating in concessions projects can transfer land use rights obtained as part of the contract to carry out the investment project to another party for the remaining period of the concessions contract, provided that more than 45% of the project has been completed according to approved plans, taxes and other obligations under the contract have been fulfilled, and the transfer has been approved by all other relevant authorities.

The second is the right to use government land outside of the concession area. Foreign investors participating in concessions projects can, with the agreement of provincial ministries, obtain rights to use government land other than those granted by the concession contract. Land use is limited to construction of offices and housing within the concession contract period.

(3) Laws Related to Public Procurement

The Public Procurement Law was promulgated in November 2017, and specific details regarding implementation were stipulated in MoF Decree 0477, issued by MoF in February 2019. MoF Decree 0477 defines the types of procurement (such as open bidding, designated competitive bidding, direct contract, and competitive bidding), bidding procedures, and contract procedures. The decree applies to all procurement carried out by government agencies such as central government ministries, local governments, state-owned enterprises, and enterprises funded by the government, unless there are security issues. According to hearings held during this survey, both the Public Procurement Law and MoF Decree 0477 apply to this project. Two items in the Public Procurement Law that require special attention are described.

The first is the preferential provisions for Lao domestic companies. While MoF Decree 0477 allows foreign companies to participate in public procurement bids if, during the proposal evaluation phase, the proposed

[1] JETRO Website (https: //www.jetro.go.jp/world/asia/la/invest_02.html) accessed February 22nd, 2020)

prices of domestic and foreign companies are within a certain range of each other, priority is given to the Lao domestic company.

The second is the exception to the application of provisions of the Public Procurement Act. As mentioned above, when security risks are not present, the Public Procurement Law stipulated in MOF Decree 0477 provides for procurement by government agencies such as central government ministries, local governments, state-owned enterprises, and enterprises funded by the government. However, as an exception, it is also stipulated that when the Lao government and a donor country agree, procurement provisions of the country providing aid to Laos will be applied.

(4) Enterprise Law

The Enterprise Law was established in Laos in 2014. The law mainly regulates business structures, management, operations, and dissolution of business enterprises, and is applied equally to domestic and foreign businesses. This section describes the types of companies that are licensed in Laos, and specific points to be noted in the Enterprise Law.

Under the Enterprise Law, the following three types of enterprises can be licensed to operation in Laos:

1) Limited liability companies
2) Public companies
3) Partnerships

Most foreign companies operate using the simplest of these forms; the limited liability company. Table 2.1.17shows salient details of the limited liability company under the Enterprise Law.

Table 2.1.17 Major Points Related to Limited Liability Companies

Item	Contents according to the Company Law
Company Number	Possible to established unique company number
Stockholders	One or more people
Limited Liability	Limited Liability. Liability of stockholders is limited to within the range of capital invested by the stockholder
Location	Must have address within Laos
Directors	One or more (no requirements for nationality or country of residence)

Source: Laos Investment Guidebook (JETRO March 2016)

One point that requires special consideration is the method of asset payment that is required. Under the Enterprise Law, after holding a meeting regarding the establishment of the company and before registering the company, 100% of the in-kind contribution and 70% of the cash contribution to the company must be paid. Once the payment is made, the Bank of the Lao PDR will issue a certificate of payment of assets. In practice however, corporate bank accounts in Laos cannot be opened until the registration of the company and tax registration are completed. Therefore, transfer of assets can only be completed after the company is established.

(5) Land Law

Laos has a Land Law. According to the Land Law, foreign and domestic individuals and groups cannot own

land in Laos. However, the law recognizes land use rights that include free possession of land, use of land, and transfer of rights. Foreign individuals and companies are not afforded permanent land use rights, and are limited to leasing or concessional use from the government of Laos, or Lao individuals (however, approval of congress is required to be granted leasing or concessionary rights for 10,000 hectares or more of land). Such land can also be used as collateral for financing or subleased.

In addition, the leasing period of land is defined in the Land Law as follows:

1) Leasing of state-owned land to a foreign company: Maximum 50 years, depending on the type, scale, and conditions of the foreign enterprise.
2) Leasing of privately-own land to a foreign company: Maximum 30 years.

In either case, the lease period can be extended with the required approval from the government.

(6) Issues and Considerations for Implementing the Project

Elements discussed in sections 2.1.7 and 2.1.8 that may become issues and/or require special attention for the implementation of the current project are outlined in Table 2.1.18.

Table 2.1.18 Issues and Points to Consider Regarding Implementation of this Project

No,	Item	Issue/Point to consider
1	Adjustment of water tariffs	Adjusting water tariffs of Vientiane requires decision by the governor after a resolution by the provincial council
2	The standing of the implementing body of this project according to the Water Supply Law	After confirming the standing of the project implementing body according to the Water Supply Law, it will be necessary to confirm in detail the scope of authority granted to the implementing body, and the procedures for obtaining necessary permits and licenses
3	Technical approval of scale of facilities to be constructed	Depending on the scale of construction, the approval of DPWT or MPWT is required
4	Restrictions on foreign capital	Whether this project is subject to foreign capital restrictions must be verified
5	Obtaining concession for water supply operation	Concession must be received to implement a water supply project that involves concessions. (However, it is necessary to confirm in detail the difference between concessions under the Water Supply Law and the Investment Promotion Law with relevant agencies.)
6	Obtaining approval for investment	After confirming whether this project is a general project or a concession project, it will be necessary to submit documents, undergo an examination by MPWT and Vientiane Province, and obtain an investment permit in accordance with established procedures.
7	Minimum capital regulations	If this project is a general project, it will be necessary to confirm whether it is a project for which minimum capital regulations have been set separately. In addition, in the case no capital regulations are set, it is still necessary to pay close attention to the condition of the minimum capital in implementing the project.
8	Agreement on tendering procedures	In order to make this a Japan-tied tender, it is necessary for Lao Side and the Japanese government to agree on the tendering procedures to be applied to this project. It is also necessary for the two countries to agree to whether or not to establish a review committee
9	Procedures for establishing a company (Method for paying investment capital)	Procedures paying the capital investment outlined in the Companies Act and those in actual practice differ, and should be noted
10	Obtaining land-use rights	When acquiring land-use rights by renting or leasing, it is necessary to confirm that the lessee holds land-use and land leasing rights
11	Parliamentary approval for large-scale land-use in concessions	Parliamentary approval is required to rent more than 10,000 ha of land or obtain concessions for such land

Source: Survey Team

2.1.9 Non-revenue Water (Target area)

As described in Section 2.1.4 Current Conditions of Water Supply Operations (Survey Area), the following issues related to NWR exist in the target area:

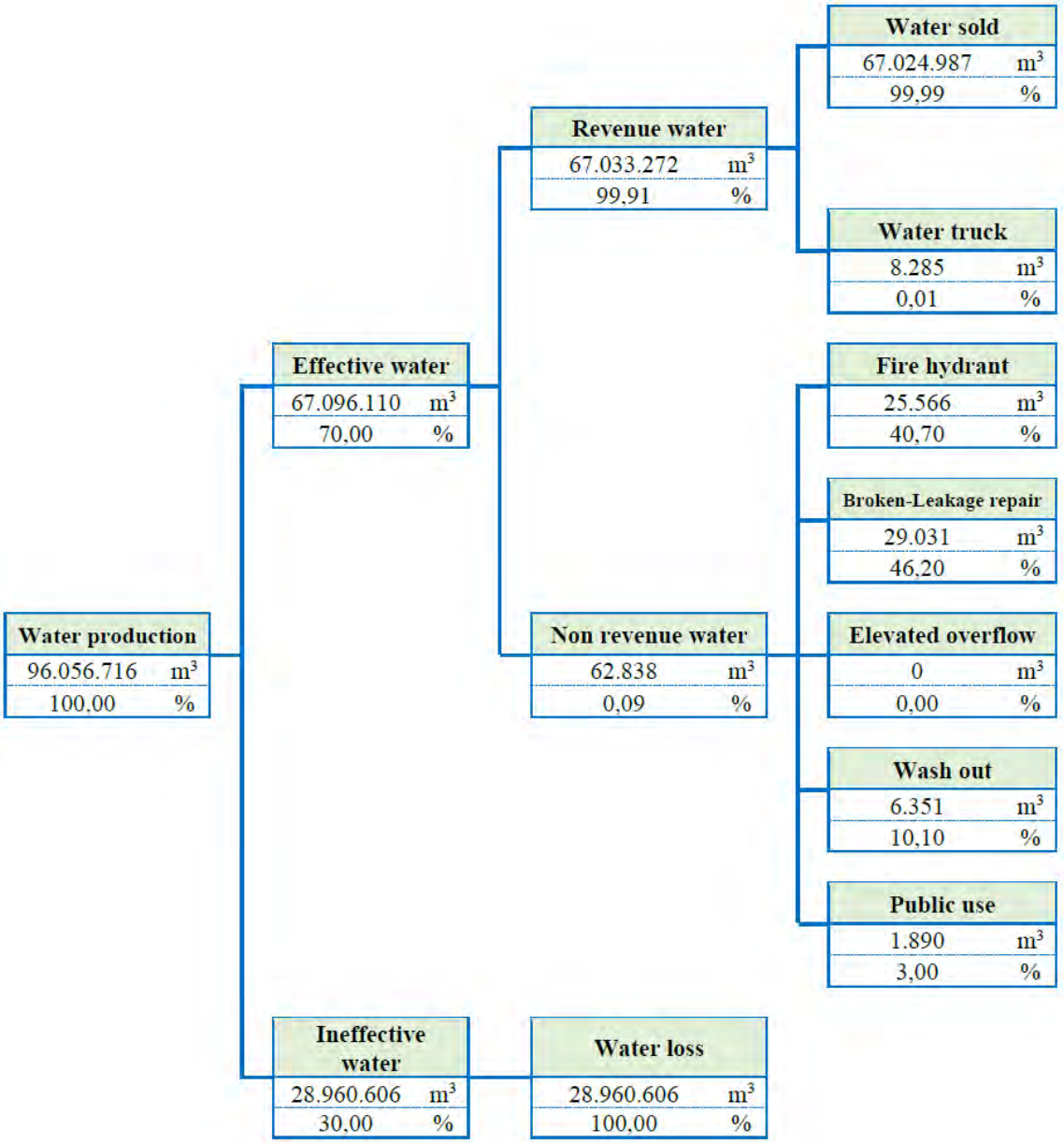
- NRW rate is high, at around 30% ~ 35%
- Approximately 10,000 leaks are repaired annually in recent years
- 94% of leak repairs are performed on pipes of diameter 50 mm or less

This section reviews the current NRW situation using data managed by NPNL and GIS data of water meters.

(1) Analysis of Water Distribution

Water distribution in 2019 was published in NPNL's 2019 Annual Report, shown in Source: NPNL Annual Report (2019)
Figure 2.1.9. Conclusions elucidated from the figure are as follows:

- 70% of the water volume is revenue water, 30% is non-revenue water
- Revenue water rate is 69.8% (67,033,272 m^3), the non-revenue water rate is 30.2% (62,838 + 28,960,606 m^3)
- Non-revenue water includes fire-fighting water, leakage repair water, drainage facility water, public water supply, physical losses. Of all non-revenue water, physical losses account for 99.8%.



Source: NPNL Annual Report (2019)

Figure 2.1.9 Analysis of Water Transmission

As seen above, 99.8% of NRW is attributed to physical losses. However, the following points should be noted regarding the analysis results:

- It is possible that any NRW that cannot be measured is categorized as physical losses
- In addition to water meter error, meter reading errors, and water meter failures, theft of water is considered to be a major contributor to NRW. However, this has not been studied in detail, and is not reflected in the above data. It is hoped that surveys of water meters and water theft will provide a more detailed breakdown of NRW
- World Bank reports indicate that in developing countries, physical losses (leakages) account for 60% and commercial losses (water meter issues) account for 40% of NRW (refer to Table 2.1.19). It is evident that commercial losses also account for a significant portion of NRW.

Table 2.1.19 Estimation of Global NRW Rates

Table 1: Estimates of Worldwide NRW Volumes

	ESTIMATES OF NRW								
				Ratio		Volume (billions of m^3/year)		
	Supplied population (millions, 2002)	System input l/capita/day	Level of NRW (% of system input)	Physical losses (%)	Commercial losses (%)	Physical losses	Commercial losses	Total NRW
Developed countries	744.8	300	15	80	20	9.8	2.4	12.2
Eurasia (CIS)	178.0	500	30	70	30	6.8	2.9	9.7
Developing countries	837.2[a]	250[b]	35	60	40	16.1	10.6	26.7
				TOTAL		32.7	15.9	48.6

Sources: WHO and authors' estimates.

l = liters; m^3 = cubic meters

a. Based on a total population having access to safe water supply of 1,902.7 million people, with 44 percent of these receiving water through individual household connections.

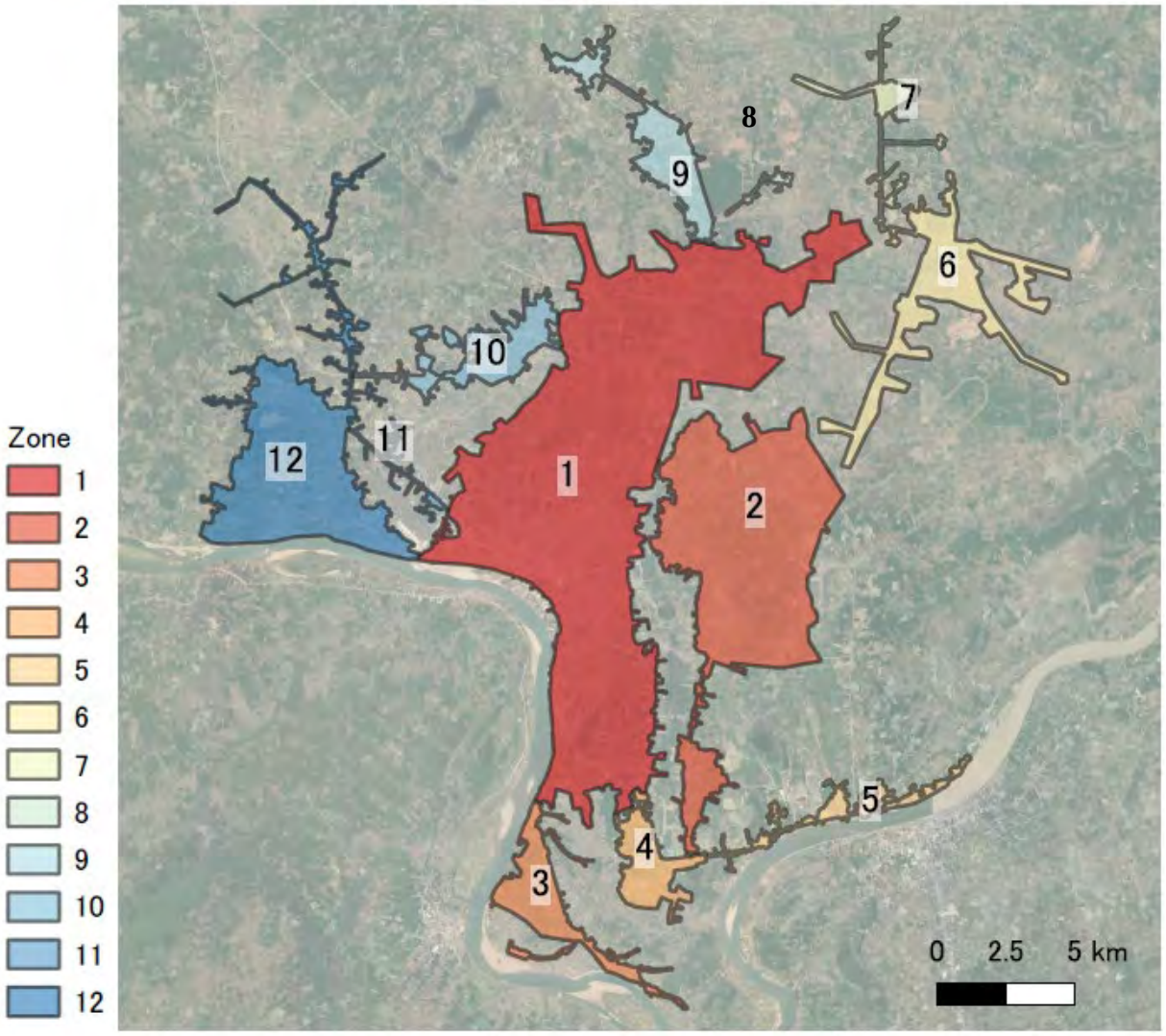
b. This figure reflects a wide discrepancy among developing countries, from 100 l/capita/day for some utilities in the poorest countries or those experiencing severe water shortages to more than 400 l/capita/day in many megacities of Latin America and East Asia. The figure used in this calculation is a conservative average.

Source: World Bank (2006) The Challenge of Reducing Non-revenue Water (NRW) in Developing Countries

(2) Distribution of Water Leakage

Leakage locations are managed in the GIS of NPNL. Leakage locations of the five years from 2015 ~ 2019 are shown in Figure 2.1.11. In order to determine which areas have high leakage rates, leakages per unit area is shown in Figure 2.1.12.

As shown in Figure 2.1.10, the target area was divided into 12 zones. When implementing NRW countermeasures, measurement of NRW before and after the project is necessary. In order to measure NRW rates, water into and out of a particular zone also needs to be measured. The 12 zones in the figure were established with the thought that meters required to measure flow into and out of each zone can be installed.

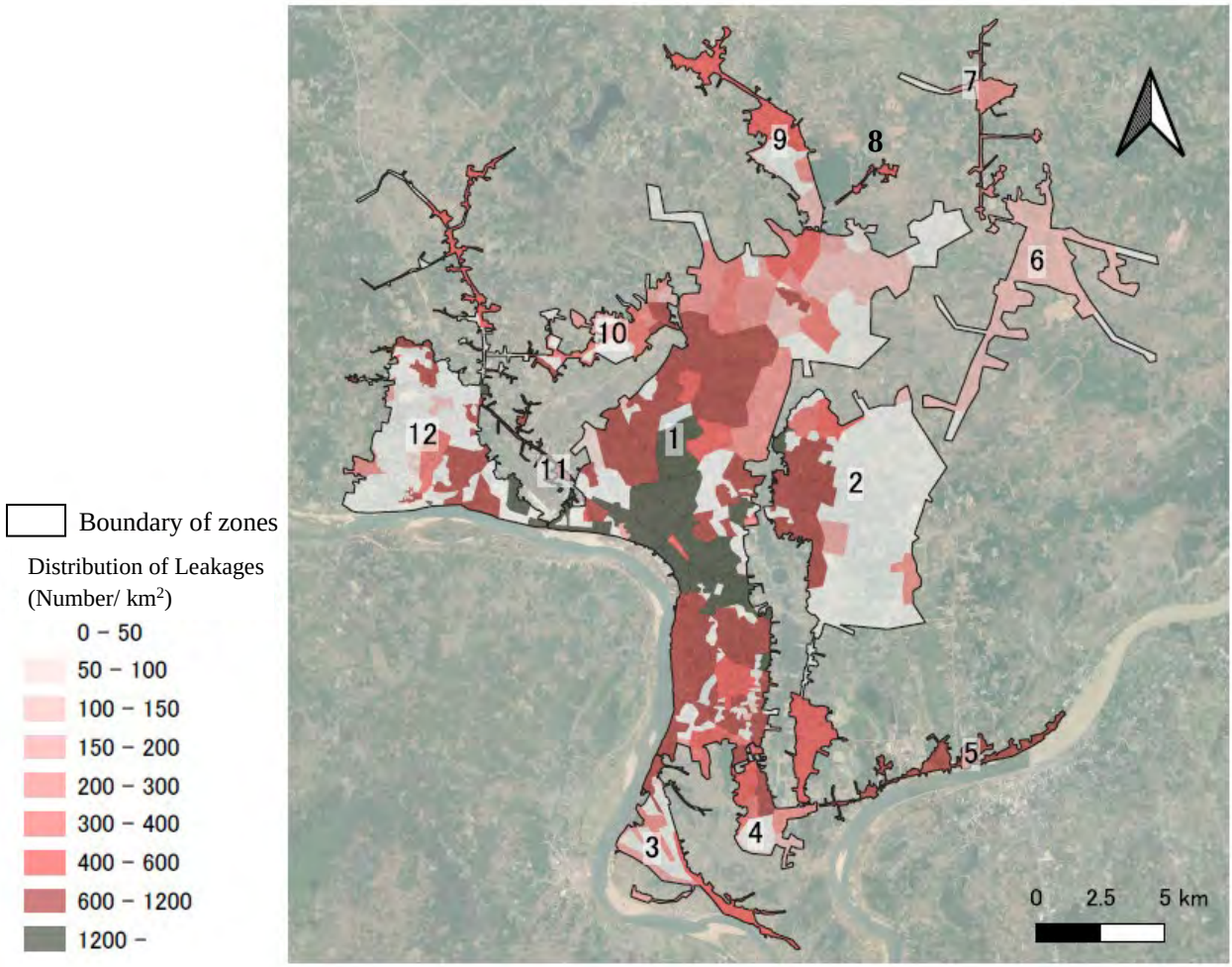


Source: NPNL GIS data

Figure 2.1.10 Evaluated Zones

Source: GIS data from NPNL

Figure 2.1.11 Locations of Leakages (2015 ~ 2019)



Source: GIS data from NPNL

Figure 2.1.12 Leakages per Unit Area

Table 2.1.20 Number of Leakages by Zone

Zone	Surface area（km²）	Number of leakages	Number of leakages/km²	Percentage of all leakages（%）	Number of leakages per 100 water meters
1	116.109	21,194	182	61.4	26.7
2	48.813	3,502	71	10.1	14.9
3	8.825	512	58	1.5	19.5
4	6.303	582	92	1.7	28.0
5	3.848	1,032	268	3.0	33.6
6	16.274	554	34	1.6	27.0
7	3.636	290	79	0.8	34.3
8	0.559	121	216	0.4	51.1
9	8.788	1,090	124	3.2	29.0
10	8.205	555	67	1.6	23.9
11	1.126	161	142	0.5	18.7
12	32.291	4,947	153	14.3	30.0
Total	254.777	34,540	-	100.0	-
Average	21.2	2,878	124	-	25.2

Source: Calculated based on GIS data of NPNL

- Zone 1 has the highest number of leaks, accounting for 61% of all leaks.
- Zone 5 has the highest density of leaks per unit area (number of leakages/km2). Zones 1, 8, 11, and

12 are also high, while Zones 3, 6, and 10 tend to have lower rates.

Table 2.1.21 Number of Leakages by Type of Pavement

Zone	Type of Pavement					Subtotal	Percentage
	Concrete	Asphalt	Unpaved	Sidewalk	Unknown		
1	2,028	13,816	470	4,694	186	21,194	61.1%
2	339	2,876	50	202	35	3,502	10.1%
3	20	440	8	42	2	512	1.5%
4	7	514	2	51	8	582	1.7%
5	32	813	16	167	4	1,032	3.0%
6	17	480	6	45	6	554	1.6%
7	2	198	8	77	5	290	0.8%
8	0	116	1	4	0	121	0.3%
9	76	871	20	113	10	1,090	3.1%
10	5	477	3	64	6	555	1.6%
11	3	108	5	45	0	161	0.5%
12	316	3,818	71	689	53	4,947	14.3%
N/A	11	111	3	17	3	145	0.4%
Subtotal	2,856	24,638	663	6,210	318	34,685	100.0%
Percentage	8.2%	71.0%	1.9%	17.9%	0.9%	100.0%	-

Source: Calculated based on GIS data of NPNL

- The types of pavement at leakage locations are asphalt (71%), sidewalk (17.9%), concrete (8.2%), and unpaved (1.9%).
- The above shows that the vast majority of leakage locations have some sort of pavement.

(3) Water Meters

Water meters managed in the GIS are shown in Table 2.1.22.

Table 2.1.22 Number of Water Meters (Those registered in the GIS)

Zone	Customer				Subtotal	Percentage %
	Domestic	Non-Domestic	Government	Unknown		
1	66,340	482	1,126	2,015	69,963	66.5
2	10,564			54	10,618	10.1
3	2,428			1	2,429	2.3
4	1,974	6	20	1	2,001	1.9
5	3,053	3	12	1	3,069	2.9
6	1,652	20	2	12	1,686	1.6
7	678	2		1	681	0.6
8	237			1	238	0.2
9	2,315	30	6	17	2,368	2.3
10	1,875	8	1	7	1,891	1.8
11	859			6	865	0.8
12	7,244			107	7,351	7.0
N/A	2,010		2	2	2,014	1.9
Subtotal	101,229	551	1,169	2,225	105,174	100
Percentage	96.2	0.5	1.1	2.1	100	-

Source: Calculated based on GIS data of NPNL

The total number of NPNL customers is 142,704, as of 2019 (refer to Table 2.1.5). Generally, most NPNL customers have water meters installed. The low number of water meters in the GIS database compared with the number of customers indicates that some water meters still have not been included in the GIS data. The

following were carried out in order to estimate the number of uncounted water meters in each zone:

- Areas that don't have water meter data, but have pipeline and leakage data were identified.
- The number of water meters in the above area was estimated by applying the meter density of similar areas nearby.
- Based on existing GIS data, the newly estimated water meters were allocated as follows: domestic water meters (98.3%), non-domestic water meters (0.5%), and government use water meters (1.1%).

Water meters estimated using the above procedure are shown in Table 2.1.23. Table 2.1.24 shows the total of GIS water meter data and estimated water meters.

Table 2.1.23 Estimated Number of Water Meters (Excluding water meters registered on the GIS)

Zone	Customer				Subtotal	Percentage
	Domestic	Non-Domestic	Government	Unknown		%
1	11,132	61	129	0	11,321	31.3
2	12,783	70	148	0	13,000	35.9
3	188	1	2	0	191	0.5
4	78	0	1	0	79	0.2
5	0	0	0	0	0	0.0
6	371	2	4	0	377	1.0
7	163	1	2	0	166	0.5
8	0	0	0	0	0	0.0
9	1,385	8	16	0	1,409	3.9
10	436	2	5	0	443	1.2
11	0	0	0	0	0	0.0
12	9,069	49	105	0	9,223	25.5
N/A	35,604	98	0	0	36,209	100.0
Subtotal	98.3	0.5	1.1	0.0	100.0	-
Percentage						

Source: Calculated based on GIS data of NPNL

Table 2.1.24 Total Number of Water Meters (Water meters registered on the GIS and estimated)

Zone	Customer			Subtotal	Percentage
	Domestic	Non-Domestic	Government		Domestic
1	77,472	543	1,255	79,269	57.8
2	23,347	70	148	23,564	17.2
3	2,616	1	2	2,619	1.9
4	2,052	6	21	2,079	1.5
5	3,053	3	12	3,068	2.2
6	2,023	22	6	2,051	1.5
7	841	3	2	846	0.6
8	237	0	0	237	0.2
9	3,700	38	22	3,760	2.7
10	2,311	10	6	2,327	1.7
11	859	0	0	859	0.6
12	16,313	49	105	16,467	12.0
N/A	134,823	745	1,578	137,146	100.0
Subtotal	98.3	0.5	1.2	100.0	-
Percentage					

Source: Calculated based on GIS data of NPNL

2.2 Related Plans

2.2.1 Outline of Development Plans

Table 2.2.1 outlines the recent history of national goals in the development of water services in Laos. Prime Minister's Decree of 1999 set out to achieve 80% water supply penetration in urban cities by 2020. In addition, the 8th Five-Year National Socio-Economic Development Plan (2016-2020) currently underway states that 90% of the population shall have access to "clean water" by 2020. The 9th plan is still in the draft stage, but the goal is network penetration of 95% by 2025.

The water supply penetration rates for urban areas shown in Table 2.2.1 refer to piped water distributed by public water supply authorities and private operators. Separate from urban water supply, the 8th Five-Year National Socio-Economic Development Plan most likely counts water provided by the Nam Saat System and bottled water as access to clean water. It is possible that the definition of water supply penetration is different for urban and rural areas.

Table 2.2.1 National Goals Related to Water Supply Penetration and Latest Developments

Name	Penetration Goal		Source		
	Urban	National	Title	Published	Publisher
Prime Ministers Decree No. 37	80% by 2020	-	Prime Ministerial Decision on Management and Development of Water Supply Sector	September 1999	Prime Minister's Office
The 7th Five-Year National Socio-Economic Development Plan (2011-2015)	75% by 2015	80% by 2015	The 7th Five-Year National Socio-Economic Development Plan (2011-2015)	November 2011	Ministry of Planning and Investment
Draft Water Supply and Sanitation Sector Vision 2030	80% by 2020 90% by 2030	-	Draft Water Supply and Sanitation Sector Vision 2030	February 2016	MPWT, Water Supply Director
Water Supply and Sanitation Sector Development	80% by 2020 85% by 2025 90% by 2030	-	Water Supply and Sanitation Sector Development	September 2016	MPWT, Water Supply Director
The 8th Five-Year National Socio-Economic Development Plan (2016-2020)	-	90% by 2020	The 8th Five-Year National Socio-Economic Development Plan (2016-2020)	June 2016	Ministry of Planning and Investment
The 9th Five-Year National Socio-Economic Development Plan (2021-2025) (Draft)	-	95% by 2025	The 9th Five-Year National Socio-Economic Development Plan (2021-2025) (Draft)	June 2020 (Draft)	Ministry of Planning and Investment

Source: JICA (2017) The Data Collection Survey on Water Supply Sector in Lao People's Democratic Republic に加筆

2.2.2 High-Level Plans and Related Plans Relevant to the Project

High-level plans and other plans that are relevant to the current project are the Water and Wastewater Sector Vision 2030 (draft), Water and Wastewater Sector Development Plan, and the 8th Five-Year National Socio-Economic Development Plan (2016-2020). They are summarized in Table 2.2.1. In the past, the Prime Minister's Decree indicated development objectives in the water supply. In recent years, the National Socio-Economic Plans have set national agendas.

2.2.3 Urgency and Priority of the Project in Laos

NRW rates are increasing in Vientiane, putting further pressure on financial conditions of water supply operations in the city. Operational indicators have deteriorated and operational deficits have appeared in recent years. Increasing tariffs has been discussed. However, the Prime Minister's Office believes operational efficiencies, including reduction of NRW, should be improved before relying on tariff increases, and tariff increases have been put on hold for the last few years. Therefore, reducing NRW and improving operational efficiency have become priority issues.

The current project is an extremely urgent and high priority initiative for NPNL and Laos for reducing NRW in Vientiane and improving operating efficiency.

2.2.4 Comparison of Multiple Candidate Projects

Comparison of possible candidate projects in the target area are shown in Table 2.2.2.

Table 2.2.2 Comparison of Candidate Projects

Candidate Project	Master Plan + NRW Reduction Project	Technical Cooperation Project for NRW Reduction	Japanese Grant with O&M for NRW Reduction
Outline	Include an NRW reduction project when formulating (updating) the M/P for water supply development in Vientiane	Implement a technical cooperation project for NRW reduction	Implement Japanese Grant with O&M project for NRW reduction
Objectives	Formulate an M/P that includes NRW reduction and plan for NRW reduction activities in the future. NRW will be reduced by implementing the M/P.	Increase technical capacity of NPNL staff to reduce NRW.	Utilize funds, technical expertise, and human resources of the private sector to reduce NRW.
Pros	It is possible to consider the current conditions and plan appropriate water supply facilities accordingly. Effective NRW reduction plans can be included in the M/P.	Technical capacity of NPNL staff will be increased.	By using funds, expertise, and human resources of the private sector, relatively fast results can be expected. In addition, by utilizing the Japanese Grant with O&M Scheme, grant aid can be used to finance a portion of the project.
Cons	Even if an M/P is formulated, it is possible that it will become a "pie in the sky" as has happened before. Compared to other methods, more time will be required to achieve NRW reduction.	If funds or human resources are lacking, progress will not be made.	-

Source: Survey Team

2.2.5 Other Related Sectors

There is no notable information regarding other sectors related to this project.

2.3 Responsible Agencies and Implementing Agencies

(1) Two Types of Water Supply Authorities and Supervising Ministries

Water supply operations in Laos are categorized into urban and rural water supply operations. Urban water supply refers to water supply services in the national and provincial capitals and other areas with high population density. Urban water supply delivers water by pipe to each household. Rural water supply refers

to water supply in areas that still do not have piped water supply, or is not yet widespread.

Urban and rural water supplies are managed by different supervising ministries. The supervising ministry of urban water supply is the DWS, under the MPWT. Rural water supply is managed by the National Clean Water Center of the Department of Health and Hygiene Promotion within MoH. The following section provides an overview of urban water supply operations and implementation structures.

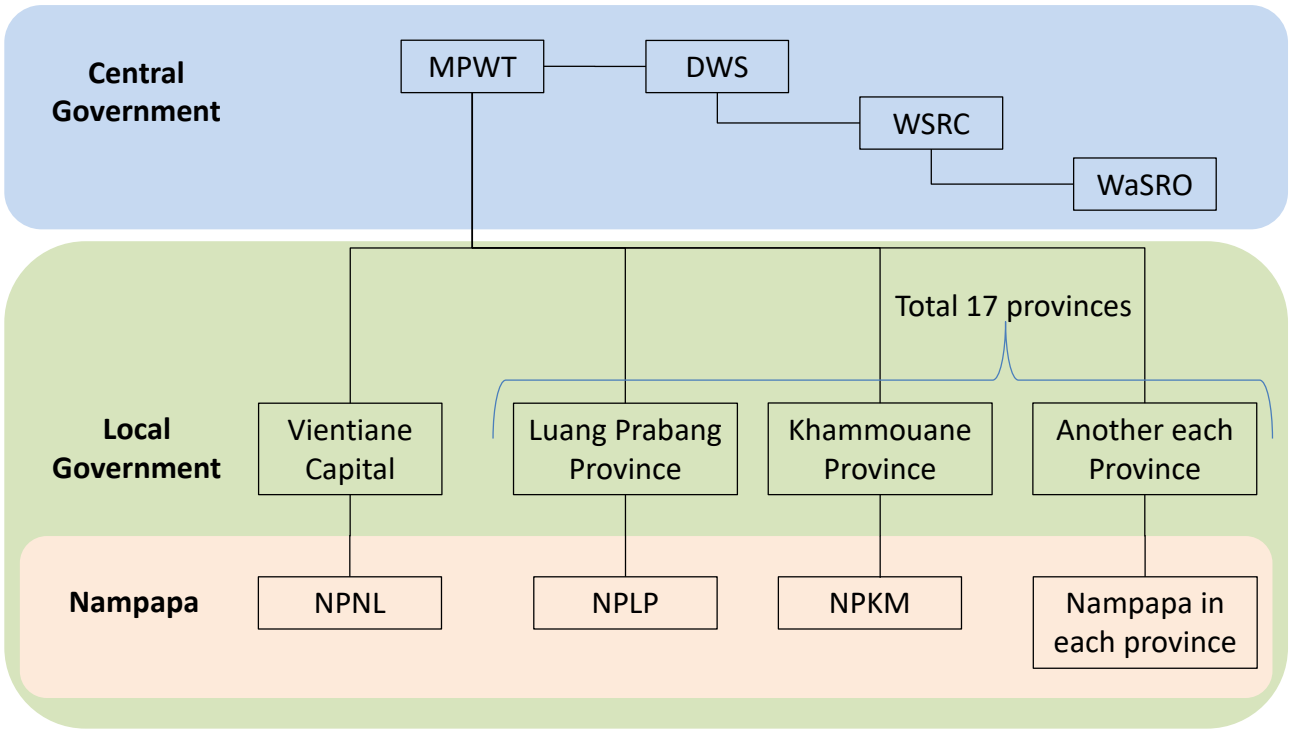
(2) Implementation Structure of Urban Water Supply Operations

The implementation structure of urban water supply operations is shown in Figure 2.3.1. Administration of water supply in Laos is divided into three levels: central government, local government, and Nampapa. Each level is discussed below.

MPWT occupies the top, central government level. It plays the leading role in determining policies, goals, and plans for water supply administration nationally. It holds the ultimate responsibility for water supply operations in Laos. The Water Supply Regulatory Committee (hereinafter referred to as “WSRC”) was established within DWT of MPWT. It is the regulatory supervisor of public and private water utilities. In addition, there is the Water Supply Regulatory Office (hereinafter referred to as “WaSRO”). It is the secretariat of WSRC and prepares draft regulations and guidelines, and evaluates water supply operators.

Cities and provinces are located in the second level. Here, each city or province determines their own policies, goals, and plans for water supply based on those designated by MPWT, and supervises water supply operations under their jurisdiction according to MPWT policies. They also supervise implementation of new water supply projects, if any exist. The capital and provinces each select outside directors to direct each water supply authority to maintain sound operations.

The water supply authority occupies the third level. Each authority formulates and implements water supply operations based on policies, guidelines, and plans put forth by MPWT and the capital or province.



Source: JICA (2017) The Data Collection Survey on Water Supply Sector in Lao People's Democratic Republic

Figure 2.3.1 Implementation Structure of Urban Water Supply Services

2.4 History of Japanese Assistance

2.4.1 History of Grand and Loan Aided Projects

History and scale of Japanese ODA projects is shown in Table 2.4.1.

Table 2.4.1 History of Japanese Aid in Laos

Fiscal year	Loan aid (Billion JPY)	Grant aid (Billion JPY)	Technical cooperation (Billion JPY)
FY 2013	150.62	62.11	30.55
FY 2014	-	35.44	29.76
FY 2015	102.71	44.85	35.14
FY 2016	-	33.10	28.23
FY 2017	-	50.21	22.54
Total※	484.36	1,579.94	753.42

※Includes FY 2012

Source: Ministry of Foreign Affairs of Japan (https: //www.mofa.go.jp/mofaj/gaiko/oda/files/000497951.pdf#page=32)

Major projects by Japanese cooperation in Japanese Loan and Grant projects are shown in Table 2.4.2.

Table 2.4.2 Major Projects by Japanese Assistance on Water Supply Sector (Loan and Grant)

Period	Name	Scheme	Summary of the project
2003/02 ～2004/02	**The Study on Vientiane Water Supply Development Project in Lao People's Democratic Republic**	M/P	**Project purpose**; M/P is prepared for the Vientiane water supply. The target year of the M/P is 2020 and the target year of facilitiy planning is 2015. Feasibility study for the priority project(s) is carried out based on the M/P. Futher, technical transfer to the counterpart personnel is also implemented in the course of the preparation of the study. **Outcome**; (a) To prepare a long term master plan for the Vientiane water supply. The target year of the master plan is 2020; target year of facility planning is 2015. (b) To conduct a feasibility study on priority project(s) identified in the master plan (c) To transfer technology to the counterpart personnel in the course of the study
2006/06 ～2009/03	**Vientiane Capital Water Supply Expansion Project**	Grant Aid	**Project summary** 1) Expansion of Kaolieo WTP: Expansion from 20,000 m3/day to 60,000 m3/day 2) Rehabilitation of Kaolieo WTP; Rehabilitation of existing WTP 20,000 m3/day 3) Improvement of Chinaimo WTP; Improvement of exsiting WTP 80,000 m3/day 4) Rehabilitation of existing Km6 pump station 5) Transmission pipeline; 720m and distribution pipeline; 8,615m 6) Consulting service(Detailed design, Tender assistance, Consutruction supervision, Sof component; ①O&M of WTP, ②Control of distribution water supply) **Granted Amount** 2.17 Billion JPY **Implementation schedule** Jun. 2006 to Mar. 2009
2013/06 ～2017/12	**Thakhek Water Supply Development Project**	Grant Aid	**Project summary** 1) Civil works and M&E works 【Fasility】Intake(16,500m3/day, intake pump 3 unit etc.,), Raw water transmission pipe (0.6 km), WTP (15,000m3/day, Rapid sand filtration, Treated water reservoir (1,500m3), Administration building (Total floor 784m2, etc.,), Transmission facility (Transmission pump 3 unit, Transmission pipe 10.8km), Distribution facilities (2 Elevated tanks (700m3、600m3), Distribution main pipe 39.7km (Japanese Grant), Distoribution main 10.0km (Lao responsible), Distribution pipelines 33.0km (Lao responsible) 【Equipment】Equipment for water quality analysis (pH, terbidity, Laboratory table etc.,), Car/Track (Lao responsible) 2) Consulting service **Total cost** Total cost 1.74 Billion JPY (Japanese side: 1.6 billion JPY, Lao side; 0.14 billion JPY) **Implementation schedule** Feb. 2013 to Dec. 2015 (total 35 months)
2013/02 ～2014/07	**Thakhek Water Supply Development Project**	Grant Aid	Detailed design works for the above project
2016/03 ～2021/04	**Vientiane Capital Water Supply Expansion Project**	Yen Loan	**Project summary** 1) Consutruction works; Expansion of Chinaimo WTP 2) M&E works and Procurement; Pumps for intake, transmission, and distribution, Monitoring system 3) Consulting service (Detailed design, Tender assistance, Construction supervision, Capacity building of O&M etc.,) **Total cost** 11.8 Billiong JPY (Yen Loan portion; 10.271 billion JPY) **Implementation schedule** Yen loan project: Feb. 2016 to Apr. 2022 (Total 75 months), The facilities are put into operation from Apr. 2021(original schedule)
2019/05 ～2022/08	**Project for the Expansion of Water Supply System in Luang Prabang City**	Grant Aid	**Project summary** 1) Transmission and distribution pipelines; 65 km (Expansion; 16km, Renewal of aged pipelines; 49km) 2) Namkhan WTP (Intake; Replacement of intake pump (13,200m3/day), WTP facility;フ Flocculation and sedimentation basin (6,000m3/day) and replacement of related facilities, Transmission facilities; Transmission pump (12,000m3/day), Wastewater treatment facility 3) Consulting service (Detailed design, Tender assistance, Construction supervision, Soft component) **Project cost** Total cost 2.059 billion JPY (Japanese side; 2.019 billion JPY, Lao side; 0.04 billion JPY) **Implementation schedule** May 2019 to June 2023 (Total 50 months), The facilities are put into operation from June 2022 (original schedule)

2.4.2 History of Technical Cooperation

Major projects by Japanese cooperation in technical cooperation projects are shown in Table 2.4.3.

Table 2.4.3 Major Projects by Japanese Assistance on Water Supply Sector (Technical Cooperation)

Period	Name	Scheme	Summary of the project
2012/08 ～2017/08	**The Capacity Development Project for Improvement of Management Ability of Water Supply Authorities**	Technical cooperation	**Overall Goal**: The system for sustainable and stable development of the water supply sector in Lao PDR is strengthened **Project Purpose**: The System of strengthening the capacity for management of the water supply state enterprises (WSSEs) with mid-term and long-term views is established in Lao PDR **Outputs**: Output1: Data necessary for long-term, mid-term and short-term corporate planning at each pilot WSSE is available on an ongoing basis Output2: The pilot WSSEs are managed based on long-term, mid-term, and short-term Corporate Plans (CPs) [1] through Plan-Do-Check-Action(PDCA) cycles Output3: Monitoring of the Corporate Plan, including Performance Indicators (PIs), is strengthened Output4: Technical guidelines on corporate planning is developed, utilizing the results of Output 1 to 3 Output5: A mechanism to disseminate techniques and knowledge relevant to the new technical guidelines to other WSSEs and private enterprises is developed, utilizing the results of Output 1 to 4 **Experts from Japanese side**：Saitama City, Saitama prefecture, Kawasaki City, Yokohama City
2018/05 ～2023/05	**The Project for Improvement of Management Capacity of Water Supply Sector (MaWaSU 2)**	Technical cooperation	**Overall Goal** ：The water supply sector management system and WSSE's capacity to achieve national goals is strengthened. **Project Purpose**: The foundation necessary for strengthening the water supply sector management system and WSSEs' capacity is formulated. **Outputs:** Output1: Transparency, accountability and governance (TAG) is enhanced in water supply sector institutions by improving administration of water supply service. Output2: Capacity of WSSEs for planning, implementation, monitoring and evaluation of water supply projects is enhanced. Output3: Technical standards necessary for water supply service are developed. Output4: Operational capacity necessary for the WSSEs to implement the water supply service is enhanced. **Experts from Japanese side**: Saitama City, Saitama prefecture, Kawasaki City, Yokohama City

Japan has consistently provided financial and technical assistance for facilities development and technical cooperation in the water supply sector. However, formation of projects in the water supply sector has slowed in recent years. Keeping in mind Japan's policy for assistance in Laos, and the opportunity to expand upon experiences gained and achievements reached so far, projects that integrate knowledge and experience of Japanese private and public sectors should be formulated to generate efficient and comprehensive cooperation projects.

2.4.3 Opinion of Lao Government and Agencies with Regard to the Project

(1) Opinion of Lao Government and Agencies with Regard to the Project

Japan has provided a substantial amount of assistance in the water supply sector to Laos, both regarding facilities development and technical cooperation. In particular, a strong and trusting relationship has been built between Laos and Japan among water supply officials in Vientiane, Luang Prabang, and Khammouane, which have had technical cooperation and grassroots technical cooperation projects in the past. From interview surveys conducted with DWS/MPWT, DPWT, and water authority personnel during the Project for

Improvement of Management Capacity of Water Supply Sector Phase 2 in 2017, many were thankful for the assistance projects so far and supported continued cooperation in the future.

(2) Opinion of Lao Government and Agencies with Regard to Future Cooperation Projects

NPNL has made substantial efforts to reduce NRW, but have not produced effective results. Therefore, they support implementation of an NRW reduction project.

2.5 History of Third Country/International Agency Assistance

2.5.1 History of Assistances and Types of Assistance Related to the Project

(1) Outline of Assistance and Types of Assistance Related to the Project

Cooperation from third countries and international agencies in Vientiane is outlined in Table 2.5.1.

Table 2.5.1 Assistance from Third Countries and Other Agencies (Water Supply Sector)

Donor	Details
ADB	Assistance is mainly focused on the following: ・ Development of water supply facilities in rural areas ・ Technical guidance for water authority staff and administrations Implemented the following in Vientiane: ・ Development of water supply facilities in Xanakham (2007 ~ 2010) ・ Development of water supply facilities in Keo-Oudom (2007 ~ 2010)
World Bank	Limited to small-scale water distribution pipes in rural areas
AFD	Implemented the following in Vientiane Water Supply Authority: ・ Formulation of Water Supply M/P 2014 ・ Renewal of transmission mains ・ Technical cooperation (accounting, budgetary planning, warehouse management, etc. Project was implemented by GRET)
NORAD	Implemented technical project for the 15 water supply authorities of Laos (including Vientiane Water Supply Authority) (~2017) ・ Introduction of software that combines accounting and billing systems, etc. Currently implementing the loan project below: ・ Water Supply and Sanitation Project (2013-2031) (Rural towns and select cities are targeted, and Vientiane is not included for implementation)
GRET	Currently implementing the following projects: ・ Promotion of PPP water supply projects in rural areas ・ Technical cooperation for accounting, budgetary planning, warehouse management in the Vientiane Water Supply Authority (Implemented due to request from AFD)
Export-Import Bank of China	Construction of Dongmakhai WTP in Vientiane (Scheduled completion: 2017) ・ Intake facility and transfer main (18.9 km) (Water source: Nam Ngum River) ・ Water treatment plant (100,000 m^3/day) ・ Transmission mains (19.5 km, diameter 500 ~ 1200 mm, ductile iron pipe)

Source: JICA (2017) The Data Collection Survey on Water Supply Sector in Lao People's Democratic Republic

As summarized in Table 2.5.1, most support was for rural villages, or technical cooperation for finance related work in water utilities. The French Development Agency's (hereinafter referred to as "AFD") project includes formulation of M/P and pipe renewal in Vientiane, which is the target area of the current project. Therefore, the contents of the AFD project are discussed in detail below.

(2) Pipeline Renewal Project in Vientiane Supported by AFD Assistance

1) Water Supply M/P Formulation

NPNL is currently creating a Water Supply M/P 2014 with AFD assistance. The objectives of the M/P are as follows:

- Create 10-year water supply plan
- Re-evaluate water supply of Vientiane
- Select a priority project and estimate asset costs
- Ensure consistency with urban development plans already approved for Vientiane
- Propose future water supply plan and development policy

The target year of the M/P is 2030. Population projection, and water demand forecast are shown in Table 2.5.2.

Table 2.5.2 Population, Water Demand Forecast, Water Demand Volume According to M/P 2014

	2010	2015	2020	2025	2030
Population in Vientiane Capital	813,679	943,840	1,094,169	1,268,442	1,470,472
Population in District Service Area	657,212	761,889	883,238	1,023,915	1,186,996
Population Served in Village Service Area	484,245	561,373	650,785	754,438	917,996
Per Capita Water Consumption (Domestic), Lpcd	208	220	218	218	217
Domestic Water Demand, m^3/day	100,803	123,722	141,731	164,174	199,273
Non Domestic Water Demand	22%	30%	35%	45%	50%
Non Domestic Water Demand, m^3/day	22,175	37,117	49,606	73,878	99,636
Total Water Demand, m^3/day	122,978	160,839	191,337	238,052	298,909
NRW Rate	36%	33%	25%	20%	20%
NRW, m^3/day	44,272	53,077	47,834	47,610	59,782
Water Demand with NRW, m^3/day	167,251	213,916	239,171	285,663	358,691
Peak Factor	1.15	1.15	1.15	1.15	1.15
Day Maximum Water Demand, m^3/day	192,338	246,004	275,047	328,512	412,494
Water Production (Development) Proposed, m^3/day	180,000	280,000	340,000	360,000	420,000

Source: Nam Papa Nakhone Luang Water Supply Assets Master Plan, Phase I & II- Final Report, September 2015

2) Pipe Renewal Project

As shown in Table 2.5.3, ADF provided co-financing with JICA for a project from 2006 ~ 2009. JICA financed the expansion of Kaoleio WTP and a part of water transmission mains while AFD financed other portions. Pipe renew was included in the scope of this co-financed project.

Table 2.5.3 Scope and Budget Allocation of JICA and AFD Co-financed Project

Unit: million euro

Component 1	Scope	JICA	AfD	Lao	Total
1.1	Expansion of Kaoleio WTP	12.57		0.28	12.85
1.2	Transmission & Distribution Mains	3.46	4.00	0.58	8.04
1.3	Consultant Services	1.12	0.25	0.08	1.45
1.4	Contingency	2.23	0.25	0.28	2.76
Component 2					
2.1	Billing System Establishment	-	0.45	0.05	0.50
2.2	GIS Development	-	0.15	0.05	0.20
2.3	Water meters procurement	-	0.15	0.05	0.20
2.4	Initial Sewerage Study	-	0.15	-	0.15
2.5	Contingency	-	0.10	-	0.10
Total		19.38	5.50	1.37	26.25

Note: Component 2.4 Initial Sewerage Study was not implemented.

Source: JICA (2015) Preparatory Survey on Vientiane Capital Water Supply Expansion Project

Of the above project scope, actual construction cost of Component 1.2 was approximately 2.9 million EUR. The locations of transmission lines installed under this project (AEP-II Project) are shown in Figure 2.5.1.

The remainder of the budget for Component 1.2 and the Contingency budget were used to add the following to the scope of the project:

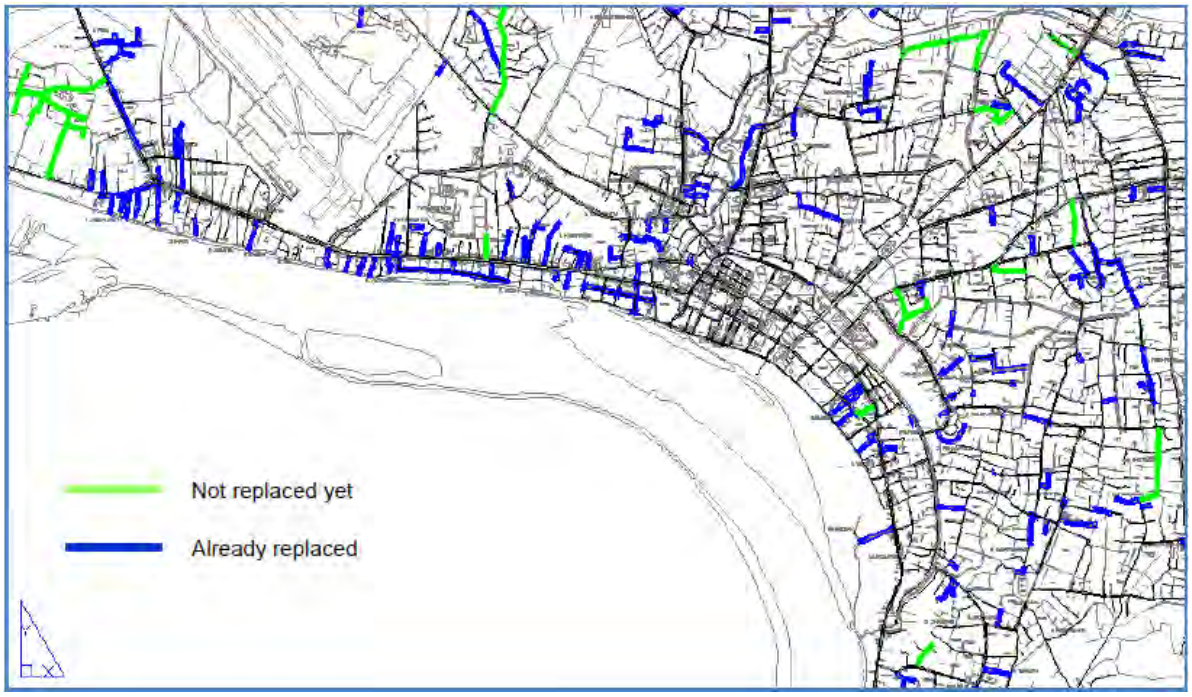
- Replacement of galvanized steel pipes of diameter 100 mm or less with high-precision HDPE or uPVC pipes (total installation length: 60 km)
- Creation of NPNL master plan and development of hydraulic model
- Financial audit for 2010 ~ 2012 by hiring financial management consultant
- Procurement of backhoe, vehicles, and computers

Sixty-two kilometers of pipes less than 100 mm diameter were actually replaced. Locations of replaced pipes are shown in Figure 2.5.2.

Sector A:	DIP, 5.9 km, dia. 300 mm	Sector D:	DIP, 1.1 km, dia. 250 mm
Sector B:	DIP, 3.9 km, dia. 250 mm	Sector E:	uPVC, 15.5 km, dia. 63 – 250 mm
	uPVC, 8.8 km, (Viengkhan Village: dia. 110 – 160 mm,	Sector F:	uPVC, 7.9 km, dia. 63 – 250 mm
	Chang Village: dia. 63 – 160 mm)	Sector G:	uPVC, 11 km, dia. 63 & 160 mm
Sector C:	DIP, 1.6 km, dia. 250 mm	Sector H:	uPVC, 18 km, dia. 63 – 200 mm
	uPVC, 9.8 km, dia. 63 – 250 mm		
	uPVC, 14.7 km, dia. 63 – 250 mm		

Source: NPNL

Figure 2.5.1 Location Map of Transmission Mains Installed in the AEP-II Project



Source: NPNL

Figure 2.5.2 Location Map of Galvanized Steel Pipes Installed in the AEP-II Project and NPNL Program

(3) Dongmakhai WTP

The Dongmakhai WTP as financed by the Export-Import Bank of China. It was completed and handed over in 2017. The construction was done through an EPC contract between MPWT and China Yunnan Construction Engineering Group Co., Ltd.

2.5.2 Request for the Project and Results

In this survey, the Japanese Grant with O&M Scheme was proposed to Laos for the reduction of NRW in Vientiane. NPNL has been making significant efforts to reduce NRW with little success, and the current survey was able to confirm their desire to implement the project.

2.5.3 Consistency with Japanese ODA policies (Aid Policy by Country, Water and Sanitation Broad partnership Initiative (WASABI), etc.)

The Country Aid Policy for Respective Countries for Laos formulated in April 2019 is outlined below.

[Country Assistance Policy for Laos (April 2019)]

1. Objective of development assistance in Laos
   - Working to develop out of the Least Developed Country (hereinafter referred to as "LDC") classification expected in 2024, improvements in the quality of growth, such as strengthening connectivity with neighboring countries and reducing regional disparities, are also needed
   - Assistance in Laos is also crucial to maintain Japanese presence in the Asia region as a whole
   - Since 1991, Japan has been building a strong bilateral relationship with Laos, as a top donor in supporting Laos according to DAC/OECD statistical standards, and has maintained cooperative relations in various international arenas, including the World Bank. In recent years especially, the relationship with Laos was upgraded to "strategic partnership" in 2015, and cooperation was further strengthened in 2016 through the "The Japan-Lao PDR Joint Development Cooperation Plan for the Sustainable Development of Lao PDR."

2. Basic assistance polity (top level goals): Strengthening of socio-economic foundations geared towards breaking out of LDC classification
   - The Lao government is working to break out of the LDC classification by achieving the three goals (economic, social, and environmental) defined in the 8th Five-Year National Social Economic Development Plan (2016-2020)
   - Japan will contribute steady implementation of the four priority areas (mid-level goals) listed below based on the "Japan-Lao PDR Joint Development Cooperation Plan for the Sustainable Development of Lao PDR" in order to contribute to the achievement of SDGs and reduction of disparities championed by ASEAN

3. Priority fields (mid-level goals)
   (1) Strengthen governance and cross-sectoral response, including financial stabilization
   (2) Strengthen relations with neighboring countries, including both hard and soft aspects
   (3) Diversification of industry, strengthening of competitiveness, and development of industrial human resources for that purpose
   (4) Reducing disparities through well-balanced urban and rural development activities that adequately take into account environmental and cultural preservation
      - In order to achieve social infrastructure and economic development in a well-balanced manner, assistance that contributes to the creation of a society that is in harmony with the local environment and

cultures will be prioritized and implemented (Tourism development, waste management, etc. that consider water supply, urban transport, cultural preservation, etc.)

4. Points to consider

(1) Promote investment by Japanese companies via development assistance founded on cooperation among private companies (including SMEs) local governments, and civil societies

As highlighted by the underlined sections above, from the perspective of improving water supply services and promoting investment in Japanese companies, the target project is consistent with Japan's assistance policy regarding Laos.

2.5.4 Necessity of Collaboration and Coordination with Other International Donors

According to interviews with the Lao side, all projects currently implemented by international organizations are JICA projects, as shown in Table 2.5.4. There are no confirmed plans after these projects, although expansion of Sendin WTP and Deua WTP will probably be necessary in the future.

Cooperative projects that have synergistic effects with JICA are hoped for.

Table 2.5.4 Related Projects Implemented by Third Countries or Other International Agencies in Vientiane

Category	Name	Period	Implementing Agency
In progress	The Project for Improvement of Management Capacity of Water Supply Sector (MaWaSU2)	2018～2023	JICA
	Grassroots project by Saitama City	2018～2021	JICA
	Vientiane Capital Water Supply Expansion Project	2016～2021 ※Initial schedule, extension is expected	JICA
Planned	PPP projects for expansion of Sendin WTP and Tha Deua WTP	Undecided	Private sector

Source: Survey Team

2.5.5 Reasons Other International Organizations are Not Interested in the Project

So far, Japan, France, and China have provided the majority of support for water supply projects in Vientiane. Most of the projects possible by international assistance have already been implemented, and PPP projects in water utility operation have been implemented in recent years. This could be a reason international assistance in the sector has decreased in recently. Due to travel restrictions caused by the COVID-19 pandemic, hearing surveys in the field have not yet been performed, but will need to be confirmed in the future.

Chapter 3 Outline of the Proposed Plans/Project

3.1 Approach to Remedy Problems

3.1.1 Issues in the Water Supply Sector and Relation to the Project (National Level)

Major issues identified in the water supply sector at the national level are as follows:

- Finances required for operation cannot be procured
- Even if master plans are created, necessary funds for implementation cannot be procured
- Because finances cannot be procured, improvements to facilities to meet growing demand cannot be self-funded. Utilities must rely on private water suppliers. But their unit prices are high, and have a large negative impact on finances
- NRW is high in some cities

The objective of the project is to reduce NRW rates. Reduced NRW is expected to improve operational conditions of water supply utilities and contribute to resolving issues prevalent in the sector.

3.1.2 Current Status of Water Supply Operations, Issues in Drinking Water Supply, and Their Relevance to the Project (Target area)

The relationship between water supply issues in the target area and the proposed project is shown in Table 3.1.1.

Table 3.1.1 The Relationship Between Local Issues and the Proposed Project

Issues	Relationship to the Proposed Project
Procurement of finances	Implementation of the project is expected to reduce NRW, thus improving overall operation of the organization. This does not solve the root cause of procurement finances, but improvement of operational indicators is expected to improve the ability to procure finances in the future. The MaWaSU2 project includes activities to create frameworks for procurement of finances in the water supply sector.
Increased NRW, large number of leakages	Implementation of the proposed project is expected to improve the situation.
Development of water supply facilities lagging behind increases in water demand	Reducing leakages will make more of the produced water available for consumption, and can be an alternative to construction or expansion of WTPs.
Maintenance of water supply facilities by high-cost private enterprises	Reducing leakages can be an alternative to construction of new WTPs, reducing dependence on high-cost private enterprises to maintain water supply facilities.
Delay of scheduled tariff increases	Although tariff increases are necessary, improvement of operational efficiency, including NRW reduction, is first required. Implementation of the proposed project is expected to reduce NRW, fulfilling the requirement for approval of tariff increases.

Source: Survey Team

Since the objective of the proposed project is to reduce NRW, issues, causes, and remedies for NRW are shown in Table 3.1.2.

Table 3.1.2 Issues Related to NRW, Causes and Countermeasures

Issues related to NRW		Possible causes	Countermeasures
Leakage	Pipes	The earthcover is shallow, causing active loads to heavily impact the pipes	・ Pipe renewal (ensure adequate depth) ・ Preparation of design/construction standards ・ Appropriate construction supervision
		Damage to pipes during road construction	・ Pipe renewal (ensure adequate depth)

Issues related to NRW		Possible causes	Countermeasures
			・ Preparation of design/construction standards ・ Appropriate construction supervision ・ Prepare and share accurate drawings
	Connection between distribution pipes and supply lines	Construction method and supervision method	・ Pipe renewal (ensure adequate depth) ・ Preparation of design/construction standards ・ Appropriate construction supervision ・ Selection of appropriate materials and equipment
	Connections in distribution pipes	Construction method and supervision method	・ Pipe renewal (ensure adequate depth) ・ Preparation of design/construction standards ・ Appropriate construction supervision ・ Selection of appropriate materials and equipment (pipes)
	Convergence of distribution mains	Not constructed strategically (especially small diameter pipes)	・ Pipe renewal (rearrangement of pipe network) ・ Use blocking ・ Strategic pipe network development
	Pipe materials	Materials used, material specifications	・ Confirmation and modification of pipe materials (as needed)
	Leakage repairs	Leakage repair techniques	・ Improvement of leakage repair techniques (as needed) ・ Review of leakage repair materials (as needed)
	Increased water pressure	Increases in water pressure due to construction of new water supply facilities	・ Identification of high-pressure areas ・ Use blocking ・ Installation of pressure reducing valves
	Leakage surveys	Strategic leakage surveys have not been implemented, lack of human resources	・ Implement strategic leakage surveys
Water meters	Water meter error	Insufficient survey of water meter breakdowns, etc.	・ Water meter survey
		Old meters have not been replaced	・ Meter replacement
	Water meter reading errors	Some meters are not read appropriately	・ Survey current condition of water meter readings ・ Improve water meter reading skills (as needed)
Theft	-	Theft of water	・ Survey together with water meter survey

Source: Survey Team

Current response level and responses planned in the proposed project are shown in Table 3.1.3.

Table 3.1.3 Countermeasures in the Proposed Project

Proposed countermeasure	Current status of countermeasure	Countermeasures in the proposed project	
Pipe renewal (ensure adequate earth cover)	No measures	○	Countermeasures possible for high priority pipes
Pipe renewal (rearrangement of pipe network)	No measures	△	Countermeasures possible in high priorities areas where rearrangements are expected to have high impact
Blocking	No measures	△	Same as above
Strategic development of distribution mains	No measures	×	Formulation of pipe renewal plan is required. Partial resolution with “pipe renewal” mentioned above is possible
Update and utilization of design/construction supervision manuals	Countermeasures being implemented by grassroots technical cooperation projects (development and utilization of local construction supervision manual)	-	Not needed (get feedback as needed)
Appropriate construction supervision	Countermeasures being implemented by grassroots technical cooperation projects	-	Not needed
Prepare and share accurate	No measures	-	The drawings are being improved by NPNL

Proposed countermeasure	Current status of countermeasure	Countermeasures in the proposed project	
drawings			
Selection of appropriate materials and equipment (pipes)	Countermeasures being implemented by grassroots technical cooperation projects	-	Not needed (get feedback as needed)
Selection of appropriate materials and equipment (pipes)	No measures	○	Counter measures possible (as needed)
Improvement of leakage repair techniques (as needed	No measures	○	Counter measures possible (as needed)
Review of leakage repair materials (as needed)	No measures	○	Counter measures possible (as needed)
Implement strategic leakage surveys	No measures	○	Counter measures possible
・ Identification of high-pressure areas	No measures	○	Counter measures possible
Installation of pressure reducing valves	No measures	○	Counter measures possible
Water meter replacement	No measures	○	Countermeasures possible for high priority pipes
・ Survey current condition of water meter readings	No measures	○	Counter measures possible
Improve water meter reading skills (as needed)	No measures	○	Counter measures possible

※1 ○: Countermeasures possible △: Partially able to implement solution, no countermeasures needed or as needed ×: Countermeasures not possible to implement
Source: Survey Team

3.1.3 Scope of Assistance

If the proposed project is implemented under the Japanese Grant with O&M scheme, the scope of cooperation from the Japanese side can be imagined as follows:

- Implementation of a preparatory survey for the project
- Tendering support
- Implementation of NRW reduction activities
- Construction supervision
- Soft components

3.1.4 Form of Assistance

The form of assistance will be Japanese Grant with O&M. Recipients can expect to benefit from the knowhow and manpower of the private sector to bring results quickly compared with conventional technical cooperation projects.

3.1.5 Implementation Schedule

Draft of the proposed schedule is shown in Table 3.1.4

Table 3.1.4 Project Implementation Schedule (Draft)

Item		Year 1												Year 2												Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12						
Detailed survey working towards E/N, G/A signing (JICA Preparatory Survey, etc.)		■	■	■	■	■	■	■	■	■	■	■	■																		
E/N、G/A signing																	■	■	■	■											
Project Impementation	Tendering procedure (selection of private operator)																				■	■	■	■							
	Project period																										■	■	■	■	■

Source: Survey Team

3.1.6 Others

(1) Evaluation of the Target area

The target area that is selected will affect the scale of the project. Items such as those listed in Table 3.1.5 should be considered when selecting the target area.

Table 3.1.6 shows the number of water meters and NRW rates in each zone. The distributed volume shown in the table is an assumed value calculated by dividing the total distribution volume by the number of customers. In addition, due to the lack of NRW data, NRW volumes are calculated assuming that the NRW rate is 30% in all zones.

Table 3.1.5 Items to Consider When Selecting Project Area

Item	Details
Number of customers (number of meters)	Needs to be considered due to its relevance to project scale
Distribution volume	Same as above
NRW rate	Although areas with the highest NRW rates should be selected, due to current lack of data on NRW rates by area, this item will not be considered.
History of leakage	Areas with high number of leakages should be selected
Water meters	Although areas with the highest rates of malfunctioning water meters should be selected, due to the current lack of water meter data by area, this item will not be considered.

Source: Survey Team

Table 3.1.6 Number of Water Meters and NRW by Zone

Zone No	Land area	No. of Customers (No. of meters)				Dist. Vol. (est.)	Condition (est.)	
	km2	GIS	Estimate	Total	Ratio	m3/day	NRW rate	NRW vol. m3/day
1	116.109	69,963	11,321	81,284	58.3%	153,488	30%	46,046
2	48.813	10,618	13,000	23,618	16.9%	44,598	30%	13,379
3	8.825	2,429	191	2,620	1.9%	4,947	30%	1,484
4	6.303	2,001	79	2,080	1.5%	3,928	30%	1,178
5	3.848	3,069	0	3,069	2.2%	5,795	30%	1,739
6	16.274	1,686	377	2,063	1.5%	3,896	30%	1,169
7	3.636	681	166	847	0.6%	1,599	30%	480
8	0.559	238	0	238	0.2%	449	30%	135
9	8.788	2,368	1,409	3,777	2.7%	7,132	30%	2,140
10	8.205	1,891	443	2,334	1.7%	4,407	30%	1,322
11	1.126	865	0	865	0.6%	1,633	30%	490
12	32.291	7,351	9,223	16,574	11.9%	31,297	30%	9,389
Total	254.777	103,160	36,209	139,369	100.0%	263,169	30%	78,951

Source: Survey Team

If the project is implemented as a performance-based contract (hereinafter referred to as “PBC”), payment to the contractor will depend on how much NRW is reduced. Therefore, revenue improvements that can be expected from the project need to be understood.

Results of simulations based on the conditions below are shown in Table 3.1.7.

[Simulation conditions]

Target area ※: ① All zones (1-12), ② Zones 1,5,8,9,11,12 ③ Zones 5,8,9,11,12

Target NRW rate: ① 25% ② 20%

※Zones with highest number of leakages per land area were selected

Table 3.1.7 Simulation Results of Each Zone at Different NRW Rate Reductions

Case	Zone	Volume (m^3/day)	NRW rate (%)[1]		NRW rate (%)[2]	NRW reduction volume (m^3/day)
		Current	Current	Target	After implementation	
1	All zones (1-12)	263,169	30	20	20	26,317
2			30	25	25	13,158
3	1,5,8,9,11,12	199,794	30	20	22.4	19,980
4			30	25	26.2	9,990
5	5,8,9,11,12	46,306	30	20	28.2	4,632
6			30	25	29.1	2,317

1) NRW rate of the target zone (by case)

2) Total NRW rate of Vientiane

Source: Survey Team

Based on the results shown in Table 3.1.7, it is possible to include the scale of the project when considering

the target area of the proposed project.

(2) Evaluation of the Project Framework

1) Case Study (NRW Reduction Project in Yangon)

Table 3.1.8 Outline of a Project that Used the Japanese Grant with O&M Scheme (Procurement Agent Type): Yangon NRW Reduction Project

Item	Details
Project name	Reduction of NRW in Mayangone Township in Yangon City
Aid amount	21.06 billion JPY
E/N execution day	March 19th, 2015
Project Scheme	Japanese Grant with O&M
Implementing agency	Yangon City Development Committee (YCDC)
Expected results	NRW rate: 66% (2011) → 30% (2022) NRW volume: 23,170m^3/day (2011 →1 0,539m^3/day
Project structure	ODA portion: Yangon City NRW Reduction Plan O&M portion: O&M project
Outline of project area	Yangon City, Ward 3 through Ward 10 of Mayangone area Area: 25.8 km^2 Population: 127,000 people (Total population of Yangon is 5.1 million) Number of households: 24,300 Number of supply connections: 9.212 (of which 8,416 are domestic connections) Supply volume: 19,700 m^3/day

Source: Survey Team

Table 3.1.9 Main Activities and Outline of the Contract

Contract	Objective	Activities	Main work	Comments
ODA portion (Grant Aid)	・NRW less than 30% in all DMAs ・When baseline NRW rate is greater than 60%, NRW rate is halved.	Various surveys Analysis Planning/design Preparation of drawings Construction plan, cost estimate	Site survey, documents collection, pipe survey, customer survey, leakage survey, measurement of supply volume Water network analysis, DMA proposal DMA establishment plan, meter replacement plan, leakage repair plan, pipe renewal plan	・Approx. 6 years ・Payment of 3% of construction costs on hold (97% will be paid, even for incomplete portions)
		Approval of plan		
		Establishment of DMAs	Installation (flow meters, valves), network development, etc.	
		Baseline NRW measurement	Measurement of NRW baseline	
		NRW reduction activities	Leakage survey, pipe repairs, pipe renewal, water meter replacement, meter reading, etc.	
		NRW measurement	Confirmation of results	
O&M portion	Maintain and improve the new NRW rates as much as possible	Implement after necessary meetings	Same as left	・Costs are borne by recipient ・More than 5 years

Source: Survey Team

2) Case Study (Performance-Based Contracts)

In performance-based contracts, the client and contractor discuss the contents of the contract and negotiate

key achievement objectives and related payment terms, and the final payment to the contractor is determined by the degree of achievement of the objectives. The International Water Association and the World Bank have taken on central roles in promoting this contracting approach and have made attempts to share their experiences and lessons learned.

In PBCs for NRW reduction, indicators for apparent water loss and physical water loss (number of domestic meters installed, rate of revenue increase, rate of collection of unpaid bills, number of leakage repairs, NRW rates, number of customers with 24-hour access to water, etc.) are set, along with payment terms according to the degree of achievement of each. Such terms are expected to act as incentive to the contractor to increase performance on agreed tasks. Water utilities also benefit by reduced amounts of NRW by optimal use of the expertise of the private sector.

[Main benefits of PBCs]

- Because payments are based on the final results, contractors are incentivized to achieve the maximum results with the highest efficiency
- Because payments are based on the final results, there is a level of fairness between the client and the contractor
- Because data such as conditions of facilities, operational data, NRW data, etc. need to be monitored to evaluate the achievement of indicators, such knowledge also accumulates within the client organization
- Because payments are based on the final results, it is possible to reduce financial risks of investment, such as the risk that funds invested for NRW reduction cannot be recouped by tariff increases

Source: JICA (2020) Project Research: Precautions for Determination/Formulation/Implementation of NRW Projects

In PBCs, careful consideration of performance indicators, payment methods, and degree of contractor freedom are particularly important.

Table 3.1.10 Important Factors in PBCs

Item	Points to consider
Establishing indicators	・ Indicators that provide effective incentives throughout the project period need to be established ・ Indicators need to be items that can be measured objectively
Payment methods	・ Referencing past examples, the lump sum method, management fee based on performance method, and reimbursement method exist as payment methods (refer to table 3.1.12). ・ These payment methods must be combined properly to provide the necessary incentives so that both the water authority and the private company can effectively implement the project
Freedom of the private company	・ Providing a certain degree of freedom to the private company will lead to implementation of efficient NRW reduction activities, as follows: ➢ Select and prioritize areas with highest cost-effectiveness ➢ Select meters to update based on age, type, manufacturer, size, and field survey results ・ In some projects, the private companies were allowed to select target areas, and which distribution mains to replace. How much to leave to the private company requires careful consideration. ・ Although a certain degree of freedom is required, how much freedom to give must be considered carefully. The effects of too much freedom must also be considered.

Source: Survey Team

Table 3.1.11 Comparison of Payment Methods

Item	Lump Sum	Management fee based on performance	Reimbursement
Summary	・ Payments are made based on achievement of preset objectives	・ Payments are made based on achievement of preset objectives	・ Payments are made based on completion of work
Example application items	・ NRW volume reduction ・ NRW rate reduction	・ NRW volume reduction ・ NRW rate reduction	・ Pipe renewal ・ Meter replacement ・ Leakage repair
Application examples	・ When NRW volume is reduced by a previously agreed amount, the contracted payment is made (terms such as partial payment if target is not reach can be added)	・ X USD for every m^3/day of NRW reduction ・ Y USD for every illegal connection discovered and resolved	・ X USD for very meter to pipe renewal (unit cost based on pipe diameter) ・ Y USD for every meter replaced ・ X USD for very leakage repaired ・ Y USD for very DMA established
Pros	・ Incentive to meet targets	・ Incentive to implement efficient activities to meet targets	・ By receiving partial reimbursement, the risk to the contractor is reduced, making it easier to participate, and improves the tendering process
Cons	・ If targets are met early, there is no incentive to continue to perform	・ Indicators and compensation must be optimal for incentives to be effective	・ If the reimbursement portion is too large, the incentive to efficiently reduce NRW gets weakened.
Points to consider	・ If targets are met early, there is no incentive to continue to perform. Therefore, setting appropriate targets is very important	・ Setting appropriate indicators and compensation is very important	・ Risk to the contractor and efficiency of NRW reduction must be considered in just the right amounts to set reimbursement amount that is not too large or too small

Source: Survey Team

3) Framework of the Proposed Project (Draft)

The framework of the proposed project (draft) is shown in Table 3.1.12.

Table 3.1.12 Framework of the Proposed Project (Draft)

Item	Details
Indicator	・ NRW reduction volume: compensation based on m^3/day of NRW reduced (management fee based on performance) must be established
Payment method	・ Combination of management fee based on performance and reimbursement
Target area	・ Select target area prior to start of project

Source: Survey Team

① Indicators

NRW is caused not only by leakages, but by water meter error and theft. Therefore, including all NRW sources in the PBC should be considered.

② Payment Method

For the reasons below, a combination of management fee based on performance and incurred cost reimbursement is proposed.

- Areas with high NRW have not been examined or estimated. High NRW areas will need to be

identified through leakage detection work and water meter surveys. By utilizing the management fee based on performance model, high NRW areas can we identified and lead to efficient reduction of NRW.

- Due to the reasons listed below, replacement of pipes of diameter less than 50 mm and water meters are considered necessary to reduce NRW. Currently, the actual length of such pipelines and number of such water meters is not known. Therefore, incurred cost reimbursement is considered appropriate. In addition, by setting an upper-limit to the reimbursement amount, the contractor will make efforts to narrow down and select areas that will have greatest impact on performance indicators per length of pipe or water meter replaced. Injection of Japanese Grant funds for the reimbursement portion of the project is being considered.
  - In old pipes, even if one leak is repaired, it is common for another leak to develop somewhere else. In such cases, replacement of the pipe is an effective solution. In Vientiane, the pipes are old and damaged, and there are many leaks. A significant portion of the leaks occur in pipes of diameter 50 mm or less. Replacement of these pipelines is considered an effective strategy for NRW reduction.
  - Survey of water meters has not been performed. It is thought that regular inspections have not been performed and considerable amount of NRW is caused by meter errors and failures. Replacement of water meters is considered an effective strategy for NRW reduction.

③ Target area

Working together with NPNL it is anticipated that, before the start of the proposed project, the target area will be selected from the 12 zones created in this survey.

3.2 Objective of the Proposal

3.2.1 Short-term Objectives

By implementing NRW reduction activities, this project aims to reduce commercial and physical losses and increase access to safe and stable water supply, increase operational efficiency, and improve financial conditions of operations.

3.2.2 Mid and Long-Term Objectives

Even after the completion of the project, the improved NRW conditions are expected to be maintained, or improved even further. This will lead to increased soundness of financial conditions of water supply operations and enable NPNL to deal with increased in population and water demand more effectively and foster improved living environments, tourism and industry.

3.3 Contents of the Proposed Project

3.3.1 Outline of the Plan

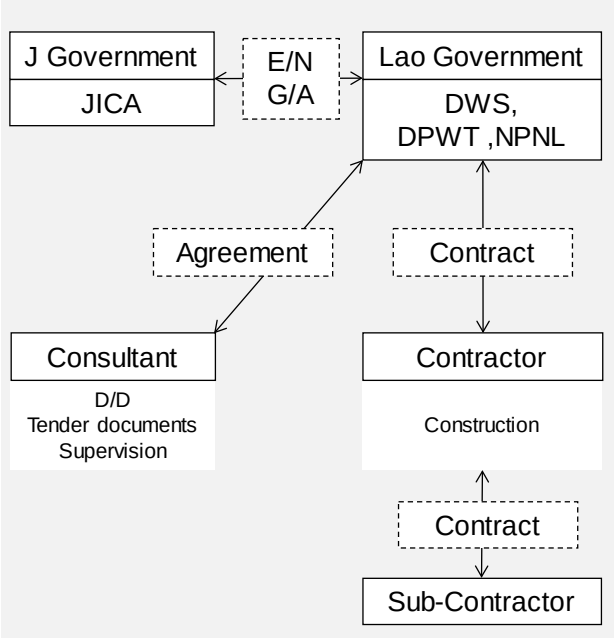
The outline of the proposed project is shown in Table 3.3.1.

Table 3.3.1 Outline of the Project

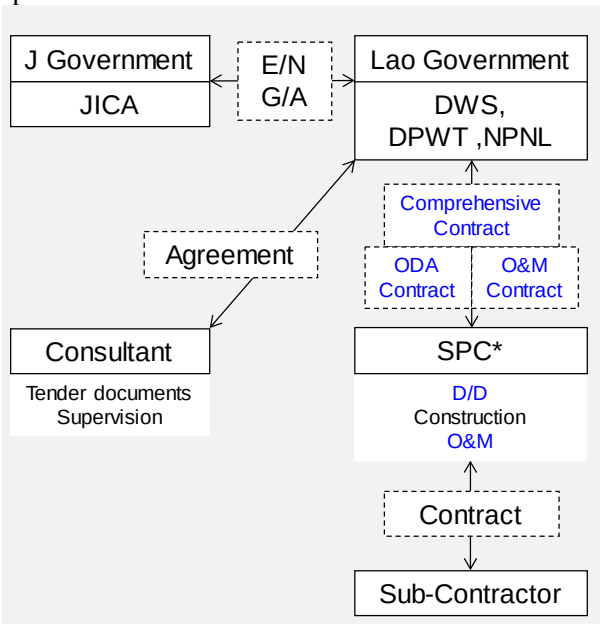
Item	Contents
Objective	Reduction of NRW volume and NRW rate (NRW rate 30% → 20% ~ 25%)
Outline	Use JICA Grant with O&M project to enter into a performance-based contract to reduce NRW.
Implementation Structure	Executing Agency: DWS Implementing Agency: DPWT、NPNL
Project Implementation Period	5 years
Main Activities	− Initial measurement of NRW − Establishment of DMAs, Night-time minimum flow measurements − Leakage survey, repair, water pressure survey, water meter survey, pipe replacement, supply line replacement, installation of pressure reducing valves − Measurement of NRW after implementation of above-mentioned activities − Training of NPNL staff

Source: Survey Team

Conventional Grant Aid Project



Japanese Grant with O&M



SPC: Special Purpose Company (Major equity holder: Japanese Entity)

Figure 3.3.1 Project Implementation Structure

3.3.2 Contents, Scale, and Quantities of the Project

The Japanese Grant with O&M Scheme includes an ODA component and an O&M component. The ODA component will be implemented as a Japanese Grant Aid Project and the O&M component will be financed by the recipient country.

Generally speaking, construction and renewal of facilities related to NRW reduction will be financed though the ODA grant support, while surveys, analyses, and planning will fall under the O&M scope (refer to Table 3.3.2).

Table 3.3.2 Anticipated Contents of the Project

Component	Main Activity	Comments
ODA	Initial NRW measurement	All of the reimbursement amount is expected to be paid by the ODA budget. Placing an upper limit on the budget is expected to incentivize selection of locations with highest impact.
	DMA creation	
	Meter renewal	
	Pipeline renewal	
	Supply line renewal	
	Pressure reducing valve installation	
	Leakage repair	
	NPNL staff training	
O&M	Night-time minimum flow measurement	Payments will be made according to the amount of NRW reduction. Selection of locations with high impacts are important in ODA projects. It is expected that surveys will be selected for effectiveness and efficiency.
	Leakage survey	
	Water pressure survey	
	Water meter survey, household survey	
	NRW measurement after implementation of activities.	

Source: Survey Team

Table 3.3.3 shows the scale of the project depending on the case.

Table 3.3.3 Project Scale by Case

Case	Zone	Volume (m^3/day)	NRW rate (%)[1)]		NRW rate (%)[2)]	NRW reduction volume (m^3/day)
		Current	Current	Target	After implementation	
1	All zones (1-12)	263,169	30	20	20	26,317
2			30	25	25	13,158
3	1,5,8,9,11,12	199,794	30	20	22.4	19,980
4			30	25	26.2	9,990
5	5,8,9,11,12	46,306	30	20	28.2	4,632
6			30	25	29.1	2,317

Source: Survey Team

3.3.3 Dispatch of Experts, and Contents, Scale and Quantities of Equipment to be Provided

NRW reduction activities under the Japanese Grant with O&M Scheme are implemented by private companies through special purpose companies (hereinafter referred to as “SPCs”). Therefore, no experts or equipment will be provided.

3.3.4 Estimated Project Cost

Project cost is estimated with reference to other PBC Projects that have been implemented.

(1) Outline of Similar Projects

Table 3.3.4 outlines other PBC projects that are similar to the proposed project.

Table 3.3.4 Summary of Other PBC Projects

Location	Kuala Lumpur	Bangkok (Nonthabri)	Bangkok (Sukhumvit)	Bangkok (Phasichareon)	Dublin	Ho Chi Minh
Period	9 years starting 2000	4 years starting 2000	4 years starting 2000	4 years starting 2000	2 years	2009～2014
Scale	NRW rate: 40%	Supply connections: 99,131 NRW rate: 42%	Supply connections: 238,591 NRW rate: 42%	Supply connections: 142,470 NRW rate: 42%	Supply volume: 440,000m^3/day Leakage rate: 40%	Supply volume: 1,000,000m^3/day NRW: >40%
Project Contents	DMAs established: 222 Leakage repairs: 11,000 (75% were at supply connections) Leakage survey Pressure reducing valve Meter replacement: 119,000	DMAs established: 86 Pipe renewal: 130 km (5.2% of 2,500km) Leakage repairs: 71,307 Leakage survey: 15,158km	DMAs established: 76 Pipe renewal: 156 km (4% of 3,900km) Leakage repairs: 31,182 Leakage survey: 8,933km	DMAs established: 73 Pipe renewal: 265 km (18%: of 1,472km) Leakage repairs: 51,905 Leakage survey: 21,649km	DMAs established: 500 Pipe renewal: 20 km Leakage repairs: 15,000 Leakage survey Pressure reducing valve Training	DMAs established: 119 Leakage repairs: 15,000 Leakage survey Pressure management Search and resolution of illegal connections Connection of new customers
Targets	NRW reduction volume (m^3/day): 198,9000 m^3/day	NRW reduction volume (m^3/day): No target	NRW reduction volume (m^3/day): No target	NRW reduction volume (m^3/day): No target	Leakage volume: 175,000→87,000 m^3/day	NRW reduction volume (m^3/day): at least 38,000 m^3/day
Results	4 years from project completion NRW reduction volume: 117,000 m^3/day Reduction of commercial loss: 50,000 m^3/day	＜Before project＞ NRW: 146,205 m^3/day NRW: 1,475 L/conn/day ＜After project＞ NRW: 106,300 m^3/day NRW: 1,072 L/conn/day NRW reduction volume: 39,905 m^3/day	＜Before project＞ NRW: 130,750 m^3/day NRW: 548 L/conn./day ＜After project＞ NRW: 97,353 m^3/day NRW: 408 L/conn./day NRW reduction volume: 33,397 m^3/day	＜Before project＞ NRW: 156,218 m^3/day NRW: 1,096 L/conn./day ＜After project＞ NRW: 64,313 m^3/day NRW: 451 L/conn./day NRW reduction volume: 91,905 m^3/day	＜Before project＞ Leakage volume: 175,000 m^3/day ＜After project＞ Leakage volume: 125,000 m^3/day Leakage volume reduction: 50,000 m^3/day	NRW reduction volume: 122,000 m^3/day
Unit cost of reduction	528 USD/m^3	408 USD/m^3	518 USD/m^3	246 USD/m^3	720 USD/m^3	125 USD/m^3
Contract, price setting, etc.	Single contract: 105 million USD Target NRW reduction must be maintained during contract period	Contract price: 16.3 million USD 1) Dependent on NRW reduction portion 2) Fixed portion (staff) 3) Reimbursement portion The reimbursement portion was large.	Contract price: 17.3 million USD 1) Dependent on NRW reduction portion 2) Fixed portion (staff) 3) Reimbursement portion The reimbursement portion was large.	Contract price: 22.6 million USD 1) Dependent on NRW reduction portion 2) Fixed portion (staff) 3) Reimbursement portion The reimbursement portion was large.	Paid amount: 36 million USD a) 15 million USD was competitive bidding portion* b) 21 million USD was reimbursement portion *If targets are not met, 2% of a) is not paid	Contract price: 15 million USD 70% or more is PBC 30% or less is reimbursements Payment for NRW reduction: 75 USD/m^3 Payment for illegal connections: 38 USD each Penalties: if NRW targets are not met, 50 USD/m^3/day

Source: The Challenge of Reducing Non-revenue Water (NRW) in Developing Countries, How the Private Sector Can Help: A Look at Performance-Based Service Contracting (World Bank, 2006)

The cost of reducing NRW by1 m^3/day is reported by the World Bank as shown in Table 3.3.5. It shows that reducing NRW by 1 m^3/day requires 215 USD ~ 750 USD. The reason cost is high in Dublin is the high human resources costs in Ireland. In developing countries in southeast Asia, 215 ~ 507 USD is needed to reduce NRW by 1 m^3/day.

Current water tariff is 2,300 kip/m^3 (0.247 USD/m^3). By referencing Figure 3.3.2, the payback period is 3 ~ 23 years. This payback period includes all project costs. If a portion of the cost is covered by the Japanese Grant, payback period is expected to be shorter.

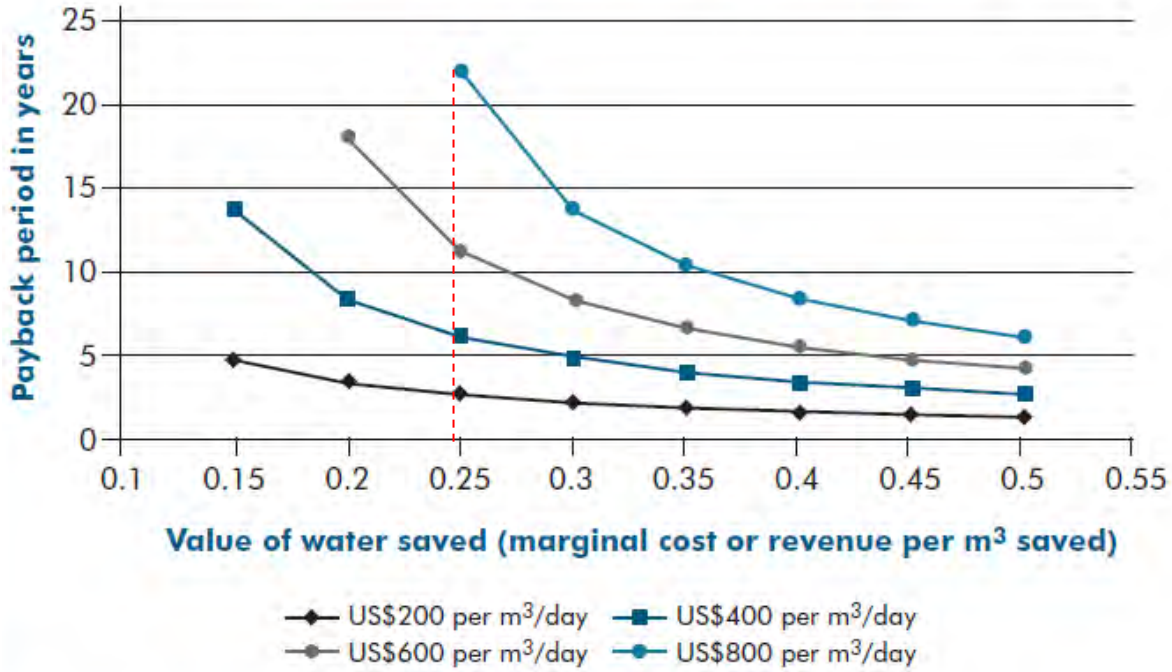
Table 3.3.5 Unit Cost of NRW Reduction (NRW Reduction Cost, USD/m^3/day)

Table 4: Unit Cost per Cubic Meter per Day NRW Reduction

Cost of NRW Reduction (in US$/m³/day)		
Bangkok	**Selangor**	**Dublin**
Contract 1 $400	Phase 1 $215	$750
Contract 2 $507	Phase 2 $500	
Contract 3 $240		

Source: Authors.
m³ = cubic meters

Source: The Challenge of Reducing Non-revenue Water (NRW) in Developing Countries, How the Private Sector Can Help: A Look at Performance-Based Service Contracting (World Bank, 2006)



Source: The Challenge of Reducing Non-revenue Water (NRW) in Developing Countries, How the Private Sector Can Help: A Look at Performance-Based Service Contracting (World Bank, 2006)

Figure 3.3.2 Estimated Payback Periods of PBC NRW Reduction Projects

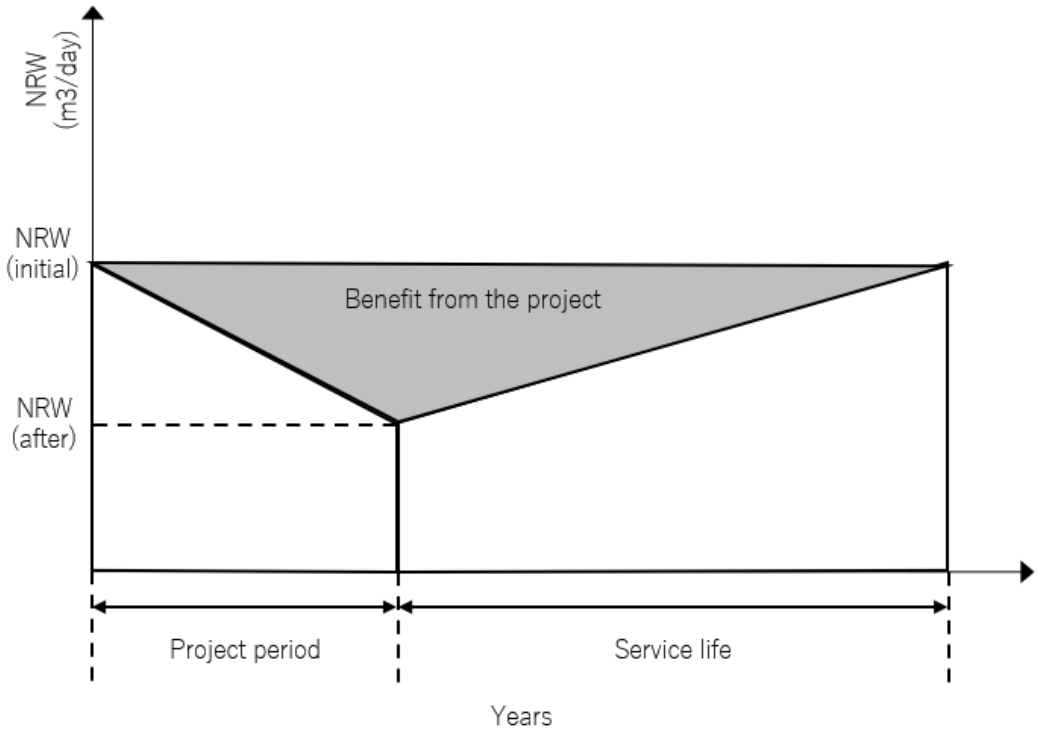
(2) Cost Estimate Conditions

Table 3.3.5 shows the conditions used for cost estimation. Profits gained by NPNL from the implementation of this project will be used to pay the SPC for their services. Therefore, project benefits for the NPNL are also included in the calculation, and shown in the table.

Table 3.3.6 Conditions for Project Cost Estimation and Benefit Calculations

Item	Conditions
Cases considered	The six cases considered in Table 3.3.7
NRW unit reduction cost	600 USD/m^3/day In the example shown in Table 3.3.5, NRW rate is high at 40%. The NRW rate of Vientiane is 30%. Reducing NRW from 30% is expected to be more difficult than reducing it from 40%. Therefore, the unit reduction cost was set to 20% greater than the historic unit costs of 215 ~ 507 USD/m^3/day.
Proportion of grant aid	70% of NRW reduction cost (Assuming 70% of total construction costs will be reimbursement, and 30% will be PBC)
NRW reduction volume	NRW reduction is set as follows. Budget allocations are set as below, and NRW reduction will be the same as the budget allocation: - Water meters (replacement) : 20% - Supply lines (replacement) : 50% - Distribution mains (renewal) : 20% - Leakage repairs: 10%
Service life	Service life of the following for items are set as follows: - Water meters (replacement) : 7 years - Supply lines (replacement) : 10 years - Distribution mains (renewal) : 20 years - Leakage repairs : 5 years
Increased billed water volume	It is assumed that water saved by NRW reduction will be sold to customers. The NRW reduced is expected to be as shown in Figure 3.3.3, and this is the benefit of the project.
Discount rate	4%
Exchange rate	1 USD = 103.51 JPY

Source: Survey Team



Source: Survey Team

Figure 3.3.3 Estimating the Benefits of NRW Reduction

(3) Cost Estimation Results

Results of cost and profit calculations are shown in Table 3.3.7, and broken down in Table 3.3.8.

Table 3.3.7 Project Cost Estimation and Benefits (By Case) (Draft)

Million USD

Category		Item	Case					
			1	2	3	4	5	6
Target area			All Zones		Zones 1,5,8,11,12		Zones 5,8,11,12	
NRW reduction volume（m3/日）			26,317	13,158	19,980	9,990	4,632	2,317
Project Cost	Laos portion	O&M cost	4.7	2.4	3.6	1.8	0.8	0.4
	ODA Grant portion	Construction	11.1	5.5	8.4	4.2	2.0	1.0
		Construction supervision※	2.4	2.4	2.4	2.4	2.4	2.4
		Subtotal	13.5	7.9	10.8	6.6	4.4	3.4
	Total		18.2	10.3	14.4	8.4	5.2	3.8
Benefit	Laos side		11.7	5.5	8.6	4.1	1.8	0.9
			249%	231%	240%	228%	233%	230%
Selection			○					

※ Tendering support and construction supervision

Source: Survey Team

Considering project costs, target area, NRW reduction volume, and other factors, Case 1 was found to be the most desirable for implementation for the following reasons:

- If target areas are narrowed down as in Cases 3 through 6, it becomes necessary to divide and isolate each area and accurately measure water inputs into each
- If all areas are included, calculation of project benefits becomes simplified and objective. NRW can be calculated by comparing the volume of water delivered from the WTPs with the amount accounted for in water bills
- Implementation of the project in all zone brings estimated costs to 1.4 billion JPY, which is still within the range acceptable for Japanese Grant Aid projects
- Costs for some components of the project will not decrease even if the scale of the project is reduced. Therefore, increasing the scale of the project to optimize efficiencies of scale is thought to be a better strategy for increasing investment efficiency

Table 3.3.8 Breakdown of Project Costs and Benefits

Case				1	2	3	4	5	6
1. Target area		-	-	All Zones		Zones 1,5,8,11,12		Zones 5,8,11,12	
2 Project period		-	years	5	5	5	5	5	5
3. NRW rate (initial)		-	%	30	30	30	30	30	30
4. NRW rate (after)		-	%	20	25	20	25	20	25
5. NRW volume reduced		-	m3/day	26,317	13,158	19,980	9,990	4,632	2,317
6. Unit reduction cost	1. Total	-	USD/m3/day	600	600	600	600	600	600
	2. NPNL portion		USD/m3/day	179	182	180	180	173	173
7. Construction cost	1. Total	-	million USD	15.8	7.9	12.0	6.0	2.8	1.4
	2. Grant portion %		%	70	70	70	70	70	70
	3. Grant portion		million USD	11.1	5.5	8.4	4.2	2.0	1.0
	4. NPNL portion		million USD	4.7	2.4	3.6	1.8	0.8	0.4
8. Water supply unit cost		-	USD/m3/day	0.247	0.247	0.247	0.247	0.247	0.247
9. Service life	Water meter	-	years	7					
	Supply line	-	years	10					
	Distribution main	-	years	20					
	Leakage repair	-	years	5					
10. Proportion of budget	Water meter (replace)	-	%	20					
	Supply line (replace)	-	%	50					
	Distribution main (replace)	-	%	20					
	Leakage repair	-	%	10					
11. Total cost	Water meter (replace)	「7.1.」×「10」	USD	3.16	1.58	2.40	1.20	0.56	0.28
	Supply line (replace)		USD	7.90	3.95	6.00	3.00	1.40	0.70
	Distribution main (replace)		USD	3.16	1.58	2.40	1.20	0.56	0.28
	Leakage repair		USD	1.58	0.79	1.20	0.60	0.28	0.14
	subtotal		USD	15.8	7.9	12.0	6.0	2.8	1.4
12. NPNL portion	Water meter (replace)	「7.4.」×「10」	USD	0.94	0.48	0.72	0.36	0.16	0.08
	Supply line (replace)		USD	2.35	1.20	1.80	0.90	0.40	0.20
	Distribution main (replace)		USD	0.94	0.48	0.72	0.36	0.16	0.08
	Leakage repair		USD	0.47	0.24	0.36	0.18	0.08	0.04
	subtotal		USD	4.7	2.4	3.6	1.8	0.8	0.4
13. NRW reduction vol.	Water meter (replace)	「5」×「10」	m3/day	5,263	2,632	3,996	1,998	926	463
	Supply line (replace)		m3/day	13,159	6,579	9,990	4,995	2,316	1,159
	Distribution main (replace)		m3/day	5,263	2,632	3,996	1,998	926	463
	Leakage repair		m3/day	2,632	1,316	1,998	999	463	232
	subtotal		m3/day	26,317	13,159	19,980	9,990	4,631	2,317
14. Increase in billed water	Water meter (replace)	「13」×（「2」+「9」）÷2×（1-「4」）×365	m3	9,220,776	4,323,060	7,000,992	3,281,715	1,622,352	760,478
	Supply line (replace)		m3	28,818,210	13,507,509	21,878,100	10,255,359	5,072,040	2,379,572
	Distribution main (replace)		m3	19,209,950	9,006,375	14,585,400	6,836,906	3,379,900	1,584,328
	Leakage repair		m3	3,842,720	1,801,275	2,917,080	1,367,381	675,980	317,550
	subtotal		m3	61,091,656	28,638,219	46,381,572	21,741,361	10,750,272	5,041,928
15. Total benefit	Water meter (replace)	「8」×「14」	million USD	1.87	0.9	1.39	0.66	0.29	0.16
	Supply line (replace)		million USD	5.65	2.68	4.19	1.99	0.91	0.43
	Distribution main (replace)		million USD	3.38	1.58	2.48	1.18	0.53	0.27
	Leakage repair		million USD	0.79	0.38	0.59	0.28	0.13	0.06
	subtotal		million USD	11.68	5.52	8.63	4.13	1.85	0.93
16. Total benefit	Water meter (replace)	「14」÷「11」	%	59%	57%	58%	55%	52%	57%
	Supply line (replace)		%	72%	68%	70%	66%	65%	61%
	Distribution main (replace)		%	107%	100%	103%	98%	95%	96%
	Leakage repair		%	50%	48%	49%	47%	46%	43%
	subtotal		%	74%	70%	72%	69%	66%	66%
17. NPNL benefit	Water meter (replace)	「8」×「14」	million USD	1.87	0.9	1.39	0.66	0.29	0.16
	Supply line (replace)		million USD	5.65	2.68	4.19	1.99	0.91	0.43
	Distribution main (replace)		million USD	3.38	1.58	2.48	1.18	0.53	0.27
	Leakage repair		million USD	0.79	0.38	0.59	0.28	0.13	0.06
	subtotal		million USD	11.68	5.52	8.63	4.13	1.85	0.93
18. NPNL benefit	Water meter (replace)	「17」÷「12」	%	199%	188%	193%	183%	181%	200%
	Supply line (replace)		%	240%	223%	233%	221%	228%	215%
	Distribution main (replace)		%	360%	329%	344%	328%	331%	338%
	Leakage repair		%	168%	158%	164%	156%	163%	150%
	subtotal		%	249%	230%	240%	229%	231%	233%

Source: Survey Team

3.3.5 Other Items

No specific other times.

3.4 Site Conditions

3.4.1 Location (Land Acquisition, Land Use, Facilities That Could Contribute to Pollution, etc.)

(1) Target area

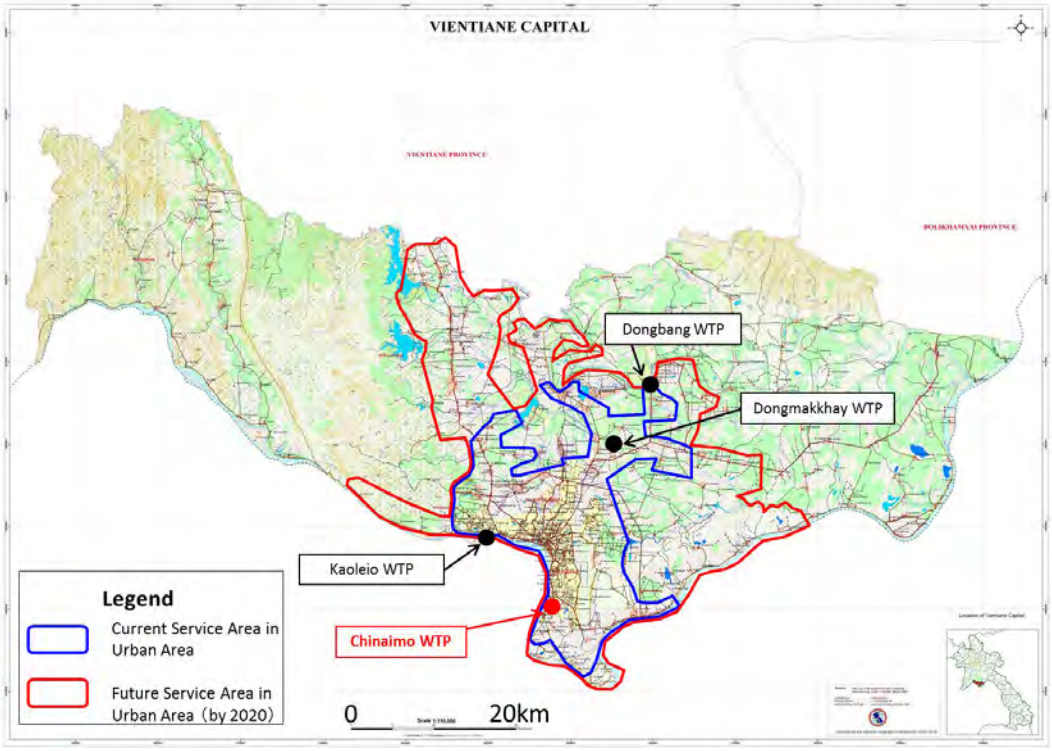


Figure 3.4.1 Map of Target Area

(2) Land Acquisition

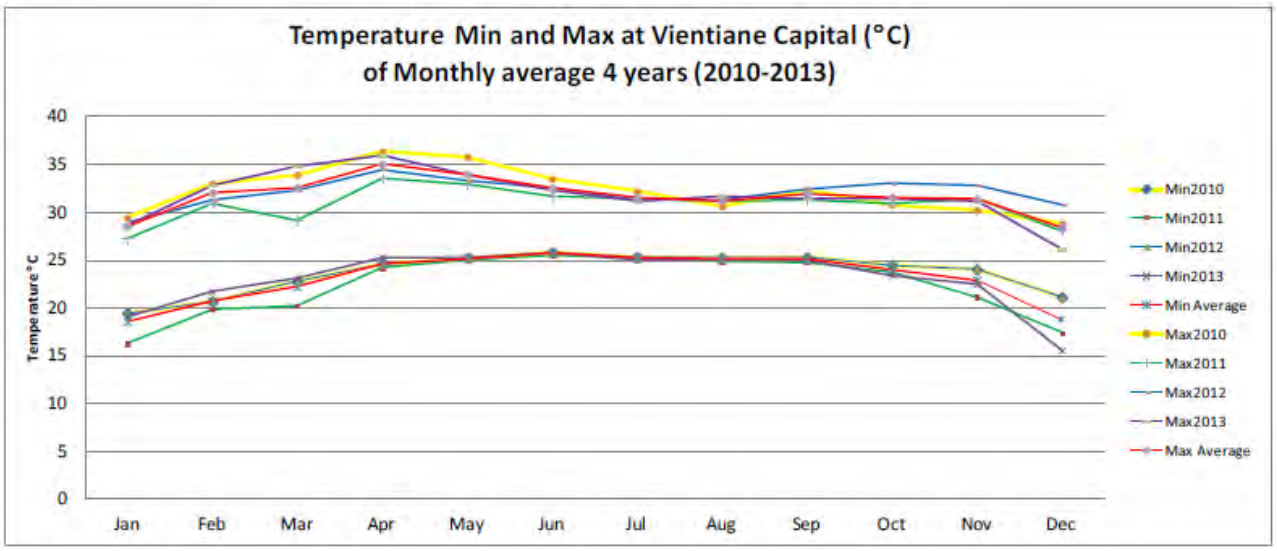
Land for storage for equipment used in NRW reduction activities is needed.

3.4.2 Natural Conditions (Precipitation, Surface Water, Groundwater, and Other Water Resources)

(1) Temperature and Precipitation

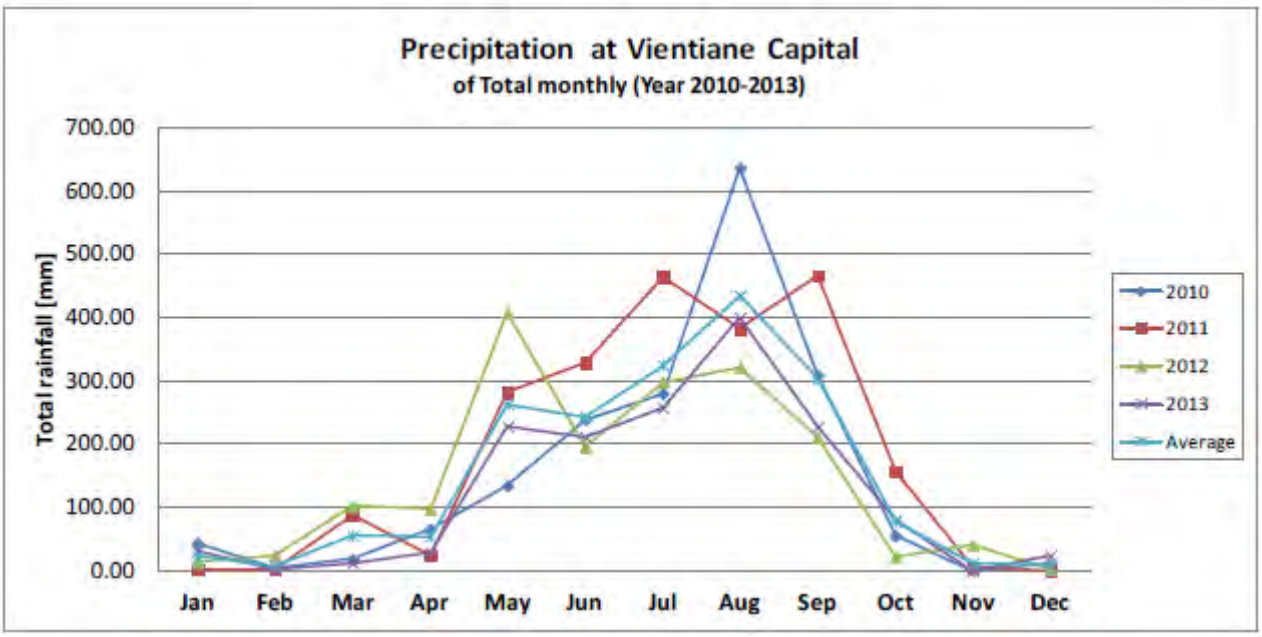
The climate in Vientiane is classified as tropical monsoon climate common in southeast Asian countries, with a rainy season and dry season. Most precipitation falls between May and September, and the dry season extends from November to April of each year. Almost 90% of the yearly rainfall occurs in the rainy season.

The average temperature in December is 18 degrees Celsius. Hottest temperatures are experienced in April, with highs reaching 35 degrees Celsius.



Source: Meteorology and Hydrology Department, Ministry of Natural Resources and Environment

Figure 3.4.2 Temperatures in Vientiane



Source: Meteorology and Hydrology Department, Ministry of Natural Resources and Environment

Figure 3.4.3 Precipitation in Vientiane

3.4.3 Access

Wattay International Airport is located within Vientiane, about 20 minutes by car to the city center. Access is good.

3.4.4 Electricity and Communications

(1) Electricity

Electrical Power in Vientiane is provided by Électricité du Laos, a state corporation of Laos. The power

situation is good, with no major power outages.

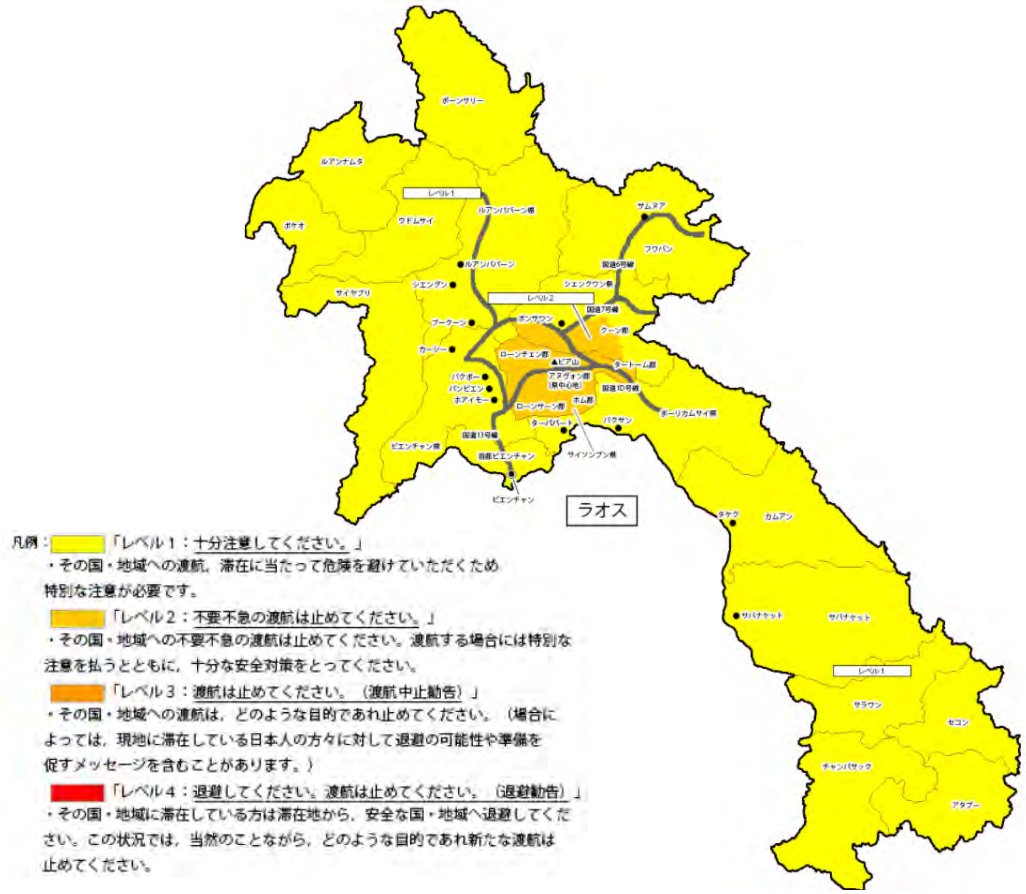
(2) Communications

This current survey relied on remote meetings, and no serious communications issues were experienced. Communications conditions are considered good.

3.4.5 Safety

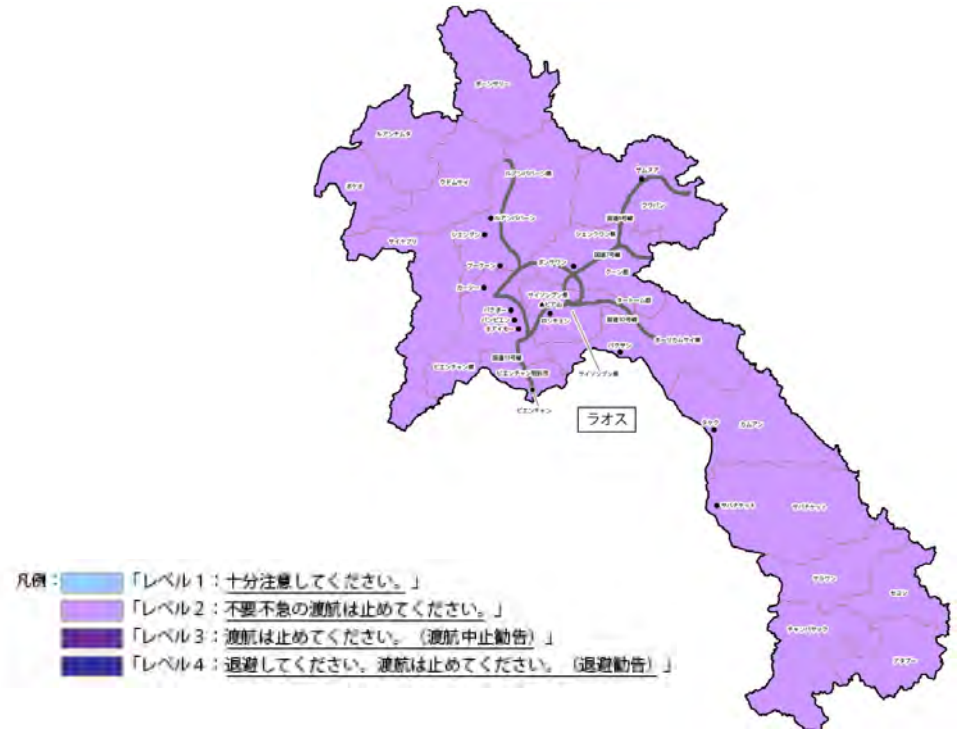
Ministry of Foreign Affairs of Japan's Advisory for Laos (prior to the COVID-19 restrictions) classified the advisory status of travel in Laos as "Level 1: Use sufficient caution," the lowest advisory category (refer to Figure 3.4.4, English not available). This means that travel to and within Laos can be conducted freely, provided that necessary precautions are taken. Safety is high compared to other developing countries.

On the other hand, advisories related to COVID-19 are categorized as "Level 2: Avoid unnecessary travel" (refer to Figure 3.4.5, English not available).



Source: Ministry of Foreign Affairs of Japan, Travel Advisory (December 24th, 2019) (Available in Japanese only)

Figure 3.4.4 Advisories Issued for Travel to and Within Laos



Source: Ministry of Foreign Affairs of Japan, COVID-19 Advisory (December 24th, 2019) (Available in Japanese only)

Figure 3.4.5 Advisories Issued for COVID-19 in Laos

3.4.6 Current Situation Related to COVID-19

Laos has been implementing lockdown measures and travel restrictions since April, 2020. As a result, infections are low, at 24 people (refer to Figure 3.4.6), and no deaths from COVID-19 have been confirmed in the country (as of November 2020).

Source: https: //www.worldometers.info/coronavirus/country/laos/

Figure 3.4.6 Total Number of People Infected with COVID-19 in Laos

Table 3.4.1 Summary of COVID-19 Countermeasures in Laos (2020)

Countermeasure/restriction	4/1～5/3	5/4～5/17	5/18～6/1	6/2～30	7/1～	12 月～
Going out (excluding for purchase of essential items)	×	○				
Travel within a Province	×	○				
Travel to other Provinces	×		○			
Commuting to office	×	○				
Training and meetings	×		○			
Operation of restaurants	×	○				
New Year's celebrations (April)	×	―				
Incoming foreign travelers	×			△[1)]		△[2)]

1) The procedures below are required for admission into the country:
   - Submit application for entry permit to the National Taskforce Committee for COVID-19 Prevention and Control (NTC)
   - NTC notifies the Ministry of Foreign Affairs Laos of the approval to entry
   - Submit certificate of PCR test results taken within 72 hours before departure
   - 14-day quarantine at a designated facility upon entry
2) Restrictions on entry of foreign nationals became strict and issuing of entry visas to those from countries with community acquired infections has been mostly stopped. Japan was designated as a country with community acquired infections.

Source: Information from Laos and Japanese Embassy homepage

Chapter 4 Recommended Project, and Effects and Impacts of the Project

4.1 Effects of Project Implementation

4.1.1 Degree of Resolution of Issues in the Water Supply Sector

Results of the project and impacts to the water supply sector following project completion are summarized in Table 4.1.1.

Table 4.1.1 Achievements and Impacts to the Water Supply Sector Following Successful Completion of the Project

Achievements		**After Completion**
Efficient NRW reduction	Areas with high NRW rates will be identified	Stabilization of water supply, increased efficiency of water supply operations, improvement of financial conditions will contribute to the safety of the water supply and fundamentally strengthen the operation.
	NRW will be reduced and water available to be supplied will increase from pipe renewals and water meter replacement	
	Optimal facilities management will be carried out due to the establishment of DMAs	
Increased capacities in NRW reduction and O&M	The capacity of NPNL staff to efficiently maintain and renew facilities will be strengthened	Even after the project is complete, facilities will be maintained and renewed strategically and sustainably, and NRW reduction will be implemented effectively
	Capacities related to leakage detection will be strengthened	
Application of water supply facility M/P	Ability to procure funds will be improved, and facility improvements according to the M/P will become possible	Mid- and long-term planning will be strengthened

Source: Survey Team

4.1.2 Degree of Resolution of Issues Related to Drinking Water Supply

Bottled water is the main source of drinking water in Laos and tap water is not directly consumed in most cases. Supply water quality meets all national standards and there are no issues with the quality of the treated

water. The implementation of the proposed project is expected to reduce NRW and make more water available for use, and contribute to a more plentiful and stable water supply.

4.1.3 Degree of Resolution of Issues Related to Hygiene and Waterborne Diseases

Waterborne diseases are not currently a major issue in the target area. Reduction of water leakages will help prevent infiltration of contaminated water into the water supply system, contributing to increased safety of supplied water and improve health of consumers.

4.2 Impacts of Project Implementation

4.2.1 Political Impacts

Laos has been experiencing continued economic growth, and population and industries have also been growing steadily. Despite growth in these areas, water supply facilities have not expanded and have been forced into overloaded operation conditions and have had difficulties meeting the growing water demand. For continued expansion of the capital city and to provide one on the most basic social needs, water supply facilities also need to be developed. The implementation of this project, which contributes to increased water supply and improvement of water supply operations, is expected to have meaningful political impacts.

4.2.2 Social Impacts

In Vientiane, water supply operations have maintained deficits since 2018. Although raising tariffs to meet budget shortfalls have been discussed, the Prime Minister’s Office’s opinion is that operational efficiencies should be increased, including reduction of NRW, before water tariffs are raised. Reduction of NRW is therefore a necessary and effective solution. Reduced NRW realized by implementation of this project along with tariff increases are expected to restore financially sound water supply operations.

In addition, although Vientiane is the beneficiary of the proposed project, the implementation of this project can be used as a model case to NRW reduction in other cities or even countries that are facing high NRW issues. In that case, the social impacts of this project will expand beyond Vientiane to other cities and countries.

4.2.3 Economic Impacts

Delay in water infrastructure development will have serious negative impacts on industrial growth and negatively impact the economy of Vientiane as a whole. In addition, by increasing the amount of available water, this project is expected to increase revenues from water tariffs. Furthermore, the project is expected to improve the NRW management capacity of staff, and improve operational efficiency of water supply operations overall.

By realigning costs and revenues of water supply, safe and stable water supply services can be provided without excessive dependence on private funds.

4.2.4 Technical Impacts

By having Japanese experts implement this project with cooperation of NPNL staff, high technical

capabilities that have helped maintain low NRW rates in Japan will be transferred to NPNL. NPNL will gain these skills and receive the corresponding benefits. Therefore, technical impacts are expected to be significant.

Japanese technical cooperation projects have been implemented consistently in Laos. The objective of the MaWaSU2 project currently underway is to strengthen water sector management systems and capabilities of water supply authorities in implementing water development projects. The project covers a wide range of fields to improve water supply operations and capacities, such as creation of technical standards. As such, reduction of NRW is not a major focus. However, NRW is a major issue faced by NPNL, so collaborative effects with MaWaSU2 and the proposed project are anticipated.

4.2.5 Diplomatic and Public Relations Impacts

NRW is a serious issue faced by many water authorities in Laos. And of all of the issues that need to be resolved, it is one of the most difficult. In such circumstances, if a Japanese company is able to show solid results and benefits by implementing an NRW reduction project, it will have noteworthy benefits for diplomatic and public relations with Laos.

Many water authorities in developing countries are experiencing issues related to NRW. If the project is able to demonstrate solutions to these issues, public relations benefits not only in Laos but in other developing countries can also be expected.

Chapter 5 Validity of the Recommended Project

5.1 Results of Comparative Analysis with Main Alternative Projects

There are no alternatives to this project.

5.2 Organizational Relevance and Sustainability of the Project

5.2.1 Organizational Management Capacity

Organizational capacity was evaluated in terms of operational management, construction, and O&M. The results are summarized in Table 5.2.1 to Table 5.2.3. The evaluation criteria are given as “High: 3, Medium: 2 and Low: 1”.

Table 5.2.1 Evaluation of Capacity (Organizational Management)

Issue	Criteria (High⇔Low)			Description
	3	2	1	
Organizational strength				
Dependence on higher level and superiors	○			Partly due to results of past Japanese Technical Cooperation projects, NPNL (working in the site) and MPWT/DWS (supervising ministries) have the same awareness and understanding of the issues related to water supply operations. Communications channels between the field and higher-level organizations have been established.
Demoralization	○			Although it is evident that this issue has been a long-term issue, the partner organization has a positive outlook for the new scheme
Attitude of top officials				
Accurate understanding of the issues	○			Issues such as aging facilities and lack of revenue, budget, human resources, technical capacity etc. are well understood, but have not been adequately dealt with due to insufficient time and funds
Visions for the future		○		Long-term plans have been prepared, but likelihood of implementation is not high
Willingness to undertake self-improvement measures		○		Water supply in the capital is aiming for financially self-sufficient operation and organizational structure for self-improvement are in place. However, tariffs are set at low levels and prospects for self-sufficiency are low
Authority to operate independently				
Authority to form an organization	○			The administration and human resources of NPNL are independent.
Authority to hire and appoint staff members	○			
Authority to enter into contracts		○		Contracts are made at the NPNL or MPWT levels. However, intervention from the central government cannot be ruled out.
Authority to decide income and expenditure through independent accounting		○		Although financially independent, approval of the central government is needed for grant aid
Establishment of an organization to manage water service users				
User information management	○			Database has been prepared
Billing and collection management	○			Billing and collection are good
Organization in place to manage accounting information and draw up the budget, accounts and long-term plan				
Budget, accounts and long-term plan			○	The national financial condition is heavily influenced by the treasury, and is poor overall
Materials management		○		
Assets (land, facilities and buildings)		○		
Organization in place to manage personnel		○		

Source: Survey Team

5.2.2 Organizational Construction Capacity

Table 5.2.2 Evaluation of Capacity (Construction)

Issue	Criteria (High⇔Low)			Description
	3	2	1	
A department in place to control construction work		○		Improvements are in progress through Japanese Technical Cooperation projects
Does the department have an influential voice and authority?		○		
Reliance on donor countries for construction wo		○		
A positive willingness to participate in planning, design and construction work		○		
Accumulation of experience in similar projects implemented so far		○		

Source: Survey Team

5.2.3 Organizational Operation and Maintenance Capacity

Table 5.2.3 Evaluation of Capacity (O&M)

Issue	Criteria (High⇔Low)			Description
	3	2	1	
A department in place to control maintenance management		○		
Does the department have an influential voice and authority?		○		
A center for the storage and supply of equipment and materials		○		
Equipment and materials stored and supplied coherently		○		There is room for improvement of storage. It takes time for supply of materials
A center for the control of repair works and repair shops			○	
Accumulation of experience in similar projects implemented so far		○		Experience has been accumulating through cooperation projects with Saitama City. However, as key persons leave, the knowledge and experiences get scattered

Source: Survey Team

5.2.4 Relevance to Residents

Water supply infrastructure is a basic lifeline service that is indispensable for local residents, whose interests and expectations in the topic are very high. Construction activities may affect traffic and create other inconveniences. It is important to gain the residents' understanding and cooperation for the project.

5.3 Financial Relevance and Sustainability in Project Implementation

5.3.1 Financial Sources of Costs to be Borne by Laos

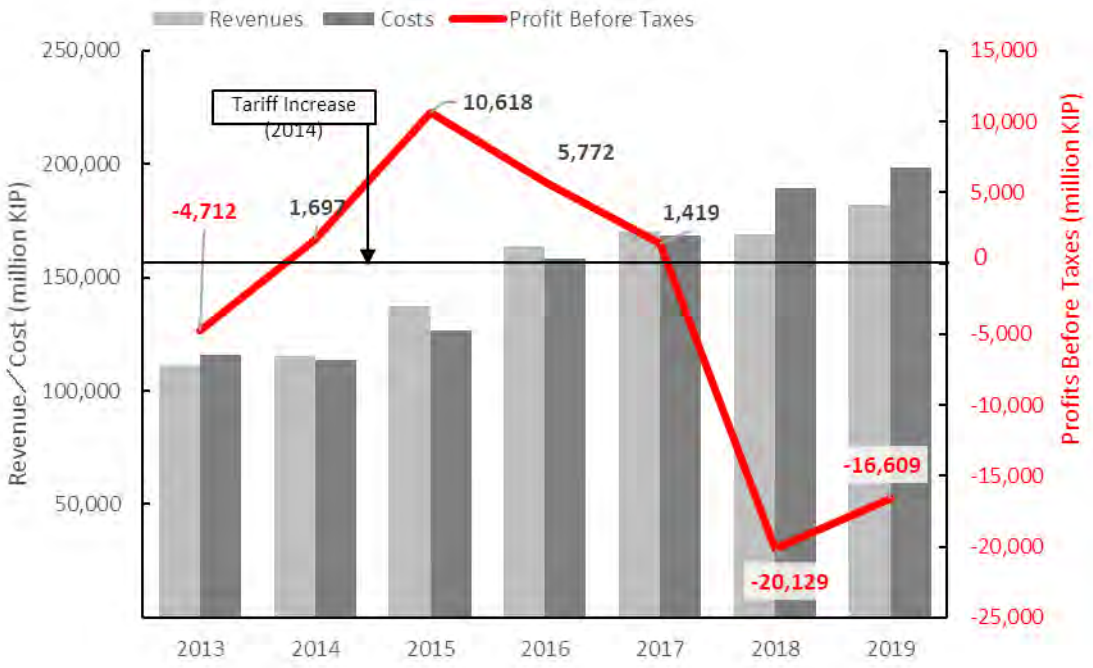
Increase in income due to reduced NRW and increased tariffs will be the sources of funds for costs borne by the Lao side.

5.3.2 Current Status of Water Supply Operational Indicators

NPNL has not established any project indicators. It is necessary to establish and collect them at the time of project implementation.

5.3.3 Changes in Financial Conditions

Figure 5.3.1 shows the financial situation of NPNL. Finances were in the red until 80% tariff increase was imposed in 2013, resulting in increased revenues and net positive income. However, after reaching a peak in 2015, net income has fallen for three straight years. The deficit in 2018 was 240 million JPY, and that in 2019 was 200 million JPY. These deficits were caused by rapid growth of expenses that outpaced the growth of revenues.



Note: 16,609 million KIP = 1.98 billion JPY (84.02 KIP/JPY, 2020/6/23 exchange rate)
Source: NPNL Annual Report 2019

Figure 5.3.1 NPNL Record of Revenues and Profits Before Taxes

5.3.4 Prospects for Future Financial Conditions

Although it is difficult to make long-term predictions about fiscal conditions of Vientiane, implementation of the project is expected to have a net positive impact. As mentioned, fiscal deficits at NPNL are caused by high cost of relying on the private sector to fill gaps in service and delay of tariff increases. Reducing NRW will decrease reliance on high-cost private sector water supply in the future. Billable water consumption will also increase. Both will lead to improved financial conditions. In addition, reducing the number of leakages that need to be repaired means workers dedicated to leakage repairs can be assigned to other tasks that will improve other aspects of water supply services. Through these physical and customer service improvements, customer satisfaction levels are expected to increase, and raising tariffs will become possible.

5.4 Technical Relevance and Sustainability of Project Implementation

5.4.1 Compatibility with the Technical Level of Laos

NPNL has been receiving technical cooperation from Japanese water utilities, such as Saitama City Waterworks Bureau, for over 25 years, chiefly through JICA technical cooperation schemes. NPNL top management also have deep understanding of NRW issues. In addition, many NPNL workers have

experience with JICA training programs in Japan and are familiar with Japanese technologies. So, it is expected that they will be able to adopt new Japanese technologies smoothly. Therefore, the technical levels of Laos with regards to the proposed project are considered good.

5.4.2 Recruitment and Assignment of Personnel

Regarding recruitment and retention of personnel, the top management of the organization has been established for a long time. The political situation has also been stable. Therefore, there have been no sudden, destructive personnel changes as have occurred in other countries. Technical knowledge and experience are passed along relatively effectively. However, there is always the possibility of staff who gained technical expertise through trainings implemented through this project leaving the organization. In the case of NPNL, employees leaving NPNL most often find work in contracting or consulting positions within the water sector. So, the knowledge is not completely lost and maintains relevance to the water supply sector.

5.4.3 Management of Facilities and Equipment

Operation and maintenance of facilities and equipment are not necessarily performed sufficiently. Technical cooperation will help improve management capacity and performance. In formulating the future plan, careful consideration should be given to feasibility such as introduction of appropriate and suitable technologies. As mentioned above, NPNL has a high level of understanding and interest in Japanese technologies and has active interactions with Japan. In addition, Laos is physically close to Thailand and Vietnam, where many Japanese companies are active and expanding. The probability that facilities and equipment that are introduced will be properly maintained is high.

5.5 Environmental Considerations

5.5.1 Expected Environmental Impacts

The main activity of the proposed project is the renewal of existing water supply infrastructure. Therefore, negative impacts to the environment and society will be limited.

5.5.2 Environmental Impact Assessment

Environmental impact assessment for the project will need to be carried out carefully according to Lao procedures. Such reports need to be carried out as part of ODA activities, or the Lao government needs to take budget measures and implement the assessment on its own.

Chapter 6 Conclusions

6.1 Special Notes

NPNL, the water supply authority in Vientiane, Laos, has been operating under financial deficits since 2018. Although tariff increases are required, the Prime Minister's office has suggested improvement of operational efficiency, including reduction of NRW, before increasing tariffs. Tariff increases are not possible currently. One measure that needs to be taken in this situation is the reduction of NRW. With the expectation that reducing NRW will improve financial performance of operations and make tariff increases possible, NPNL strongly desires to reduce NRW. However, due to budget and human resources constraints, and lack of NRW reduction knowhow, NPNL is overwhelmed with just fixing ground leaks. They are only able to respond to reported leakages, and have not been able to implement active prevention measures.

By implementing the proposed project, it will be possible to supply financing, human resources, and NRW reduction technical knowledge to NPNL for NRW reduction. With the successful completion of this project, NRW will be reduced, operational efficiency will be improved, and tariff increases will be possible. All of this together will contribute to more stable water supply operations.

Separately, Japanese projects to reduce NRW have been implemented mostly through technical cooperation projects. But as noted in "JICA (2020) Project Research: Precautions for Determination/Formulation/Implementation of NRW Projects", using technical cooperation schemes for NRW is not without its own issues. It is prudent for Japan to reconsider how assistance for NRW reduction in developing countries is provided. Therefore, consideration and implementation of new approached to NRW reduction projects is necessary, and implementation of the proposed project will be a significant step towards that goal.

6.2 Precautions When Implementing Cooperation Projects

The below are envisioned as payments to the private company in this project.

1) Reimbursement payment (replacement of water meters, renewal of pipelines, etc.)
2) Performance-based management fee (paid according to the extent of NRW reduction)

Of the above, 1) will be covered by Japanese grant funds while 2) will be borne by NPNL. An outline study conducted as part of this survey showed that the return for Laos will be approximately 300%. This should be an attractive figure for the Lao side. On the other hand, it is necessary to hold discussions with NPNL to consider whether NPNL will be able to make the required payments to the SPC if the SPC successfully reduces large amounts of NRW in the initial stages of the project. Detailed financial examination to assess whether NPNL can pay the management fees in addition to regular operating costs is needed. In addition, the legality of the payments themselves also need to be examined carefully.

In addition to the above, it is also necessary to confirm whether or not the Japanese company must establish a local office to carryout NRW reduction activities, and related legal matters. For this, the intentions of the Lao side and those of the Japanese companies will need to be confirmed.

There are two types of Japanese Grant with O&M; procurement agent type and JICA type. In the proposed

project, in order to fully utilize the knowhow of the private sector, the target area and zones will be based on surveys performed by the private company that maximize cost effectiveness. Therefore, JICA type implementation where target areas and facilities are selected and costs are estimated before the start of the project is considered unrealistic. The procurement agent type is suggested for the implementation of this project.

Based on findings from past projects, the following require careful consideration when attempting to implement procurement agent type Japanese Grant with O&M projects:

1) Keeping in mind that the recipient country will prepare the assistance request. Make certain that operational conditions and prerequisites are clearly defined and communicated to the recipient government (so that here is no room for reinterpretation of the terms)
2) When numerical figures that could affect operational profitability are presented to the recipient government, keep in mind that such figures might be quoted in assistance request forms and affect implementation of the project.

6.3 Conclusion

NPNL, the water supply authority in Vientiane, is facing issues such as inability to improve operational efficiencies or raise tariffs. High NRW rates have made these problems more obvious. Lack of funds, human resources, and technical capabilities are some reasons NRW rates remain high.

At the same time, water supply development is an area that is prioritized in Japanese ODA policy in Laos. Promotion of collaboration between private enterprise, local governments, and civil society, as well as promotion of investment by Japanese companies are also mentioned as important activities.

As mentioned above, high NRW rates are a problem in Vientiane, and lack of funds, human resources, and technical capabilities are some reasons NRW rates remain high. At the same time, Japanese ODA policy emphasizes water infrastructure development and desires to promote private investment in such fields. In this way, the issues faced by Laos and Japanese ODA policy are in very good alignment.

The proposed project hopes to solve the NRW issues in Vientiane by providing funds, human resources, and technical expertise through Japanese Grant with O&M assistance.

6.4 Closing Remarks

NRW is an issue in Vientiane. Lack of funds, human resources, and technical capabilities are some reasons NRW rates remain high. It is possible to resolved these issues though Japanese Grant with O&M assistance. In addition, Japanese ODA policy in Laos emphasizes water infrastructure development and promotion of private sector investments. As such, utilizing the expertise of the Japanese private sector through Japanese Grant with O&M project in order to reduce NRW in Vientiane fulfills the needs of both parties well, and leads to the conclusion that the implementation of the proposed project is valid.

Unfortunately, on-site field surveys could not be conducted for this survey due to the ongoing COVID-19 pandemic. Therefore, interviews and discussions held in online meetings were the main source of materials collected for this report. After explaining the purpose of the survey to NPNL in online meetings, scheduling

of online meetings and collection of relevant materials were also requested of them. The response was very positive. Their appreciation for Japanese support in the development of Lao water sector could have been one reason for their positive response. Furthermore, the fact that the project tackles NRW, an issue that is of high importance to NPNL, could also have led to their desire to bring project implementation to fruition.

By reducing NRW in Vientiane through the implementation of a Japanese Grant with O&M project, it is anticipated that NRW will be reduced, efficiencies within NPNL will be improved, and lead to more stable water supply operations. In addition, NRW is a serious concern for many water supply authorities in other developing nations. By successfully completing the proposed project, and implementing similar or even further improved projects in other locations, the project can be expanded to other water supply authorities that are facing NRW issues. The proposed project represents an important first step in resolving NRW issues using Japanese Grant with O&M scheme.

Appendices

Attachment-1 Survey Schedule

Date/time[1)]	Agency		Contents
	Lao Side	Japan Side	
September 10th, 2020 10:30~12:00	NPNL	Nihon Suido Consultants	・ Explanation of the aim of the project ・ Summary explanation of Japanese Grant with O&M Scheme
December 14th, 2020 10:30~14:00	NPNL	Nihon Suido Consultants Japan Research Institute, ltd. MaWaSU2	・ Explanation of analysis of GIS data ・ Introduction of NRW reductions projects implemented with performance-based contracts ・ Proposal of Japanese Grant with O&M project utilizing PBC ・ Legal issues, etc.
February 11th, 2021 10:00~12:00	NPNL	Nihon Suido Consultants Japan Research Institute, ltd	Same as above
February 18th, 2021 10:30~12:30	DWS/MPWT DPWT/VTE NPNL	Nihon Suido Consultants Japan Research Institute, ltd.	Same as above
February 25th, 2021 10:30~12:30	DWS/MPWT DPWT/VTE NPNL	Ministry of Health, Labor, and Welfare City of Saitama Nihon Suido Consultants Japan Research Institute, ltd.	・ Explanation of background of the survey ・ Proposal of Japanese Grant with O&M project utilizing PBC ・ Ask to write assistance request

1) Time zone: Japan Standard time

Attachment-2: List of Institutions Visited

Organization	Department	Name	Position
Ministry of Foreign Affairs	Country Assistance Planning Division I, International Cooperation Bureau	Mr. OISHI Kensuke	Senior Development Policy Planning Officer
	Country Assistance Planning Division I, International Cooperation Bureau	Mr. KAIYA Kazuki	Senior Development Policy Planning Officer
	Development Assistance Policy Coordination Division, International Cooperation Bureau	Mr. KAJIMOTO Masaru	Deputy Director
JICA	Water Resources Group, Global Environmental Department	Dr. MATSUMOTO Shigeyuki, Ph. D.	Deputy Director General and Group Director
	Water Resources Team1, Water Resources Group, Global Environmental Department	Mr. INOUE Yoichi	Director
	Water Resources Team1, Water Resources Group, Global Environmental Department	Mr. UJIKE Keisuke	
	Grant Aid project Management Division 3, Financial Cooperation Implementation Department	Mr. MASUDA Shinichi	Senior Director
	Grant Aid project Management Division 3, Financial Cooperation Implementation Department	Mr. INOUE Yuki	Deputy Director
DWS	Water Supply Division	Mr. Somchay INDAVONG	Technical Engineer
DPWT	-	Mr. Soulivanh PHOMMAHAXAY	Director
NPNL	-	Mr. Khampheuy VONGSAKHAMPHOUI	General Manager
	-	Mr. Viengthouay VANNARATH	Deputy General Manager
	-	Mr. Sisamone KONGMANY	International Cooperation Project Manager (PM) Vientiane Water supply Company (ODA -JICA)
	Mapping Unit	Mr. Souphet BOUPHAXAY	Chief of Mapping Unit
	-	Ms. Phutsadavong PHONEPHOMMAVONG	International Cooperation Technical Engineer
	-	Mr. Sonethong MAYJINGTENG	International Cooperation Technical Engineer

Attachment-3: List of Collected Data

No	Document name
1	Vientiane Capital Water Supply State Enterprise Annual Report 2019
2	GIS data of pipelines
3	Statistics of Leakage by Water Pipe Type
4	The 9th Five-year National Socio-Economic Development Plan (2021-2025) (Draft 2)